SOLAR ECLIPSE 1970 BULLETIN

F

(final bulletin)

PROGRAM FOR OBSERVATIONS OF THE TOTAL SOLAR ECLIPSE MARCH 7, 1970

NATIONAL SCIENCE FOUNDATION • WASHINGTON, D. C. 20550

CORONAL PHOTOGRAPH FROM THE 1970 ECLIPSE EXPEDITION OF HIGH ALTITUDE OBSERVATORY, NATIONAL CENTER FOR ATMOSPHERIC RESEARCH *

The solar corona observed about 30 seconds after second contact during the eclipse of 7 March 1970 at the "High Point" camp (16°20' North, $6^h\ 25.0^m$, altitude 8,800 feet) about 30 miles southwest of San Carlos Yautepec, Mexico. This photograph, made with a radially symmetric, neutral density filter in the focal plane to compensate for the steep decline of coronal radiance with increasing distance, allows structural features to be traced from the chromosphere out to 4.5 R_o on the original negative.

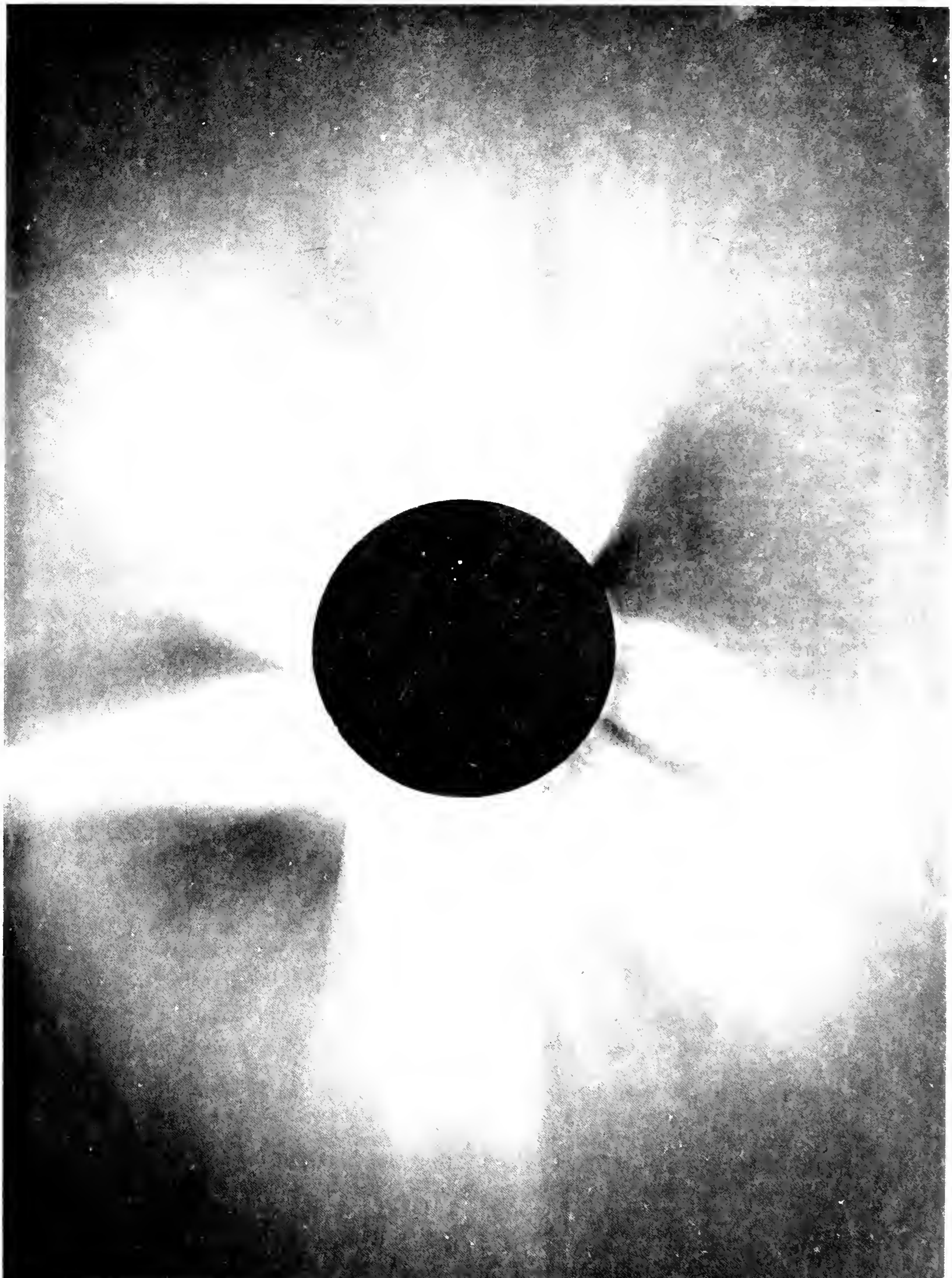
The photograph may be correctly oriented by noting that the long dimension of the frame is East–West (geocentric) and that the bright helmet streamer with a prominence at its base appears in the North–East (geocentric) and at a heliocentric position angle of about 50°. Other bright helmet streamers appear at the heliocentric positions 98°, 159°, 194° and 250°. The bright "horn" at 292° on the west limb appears, on the original negatives, to be due to the line–of–sight superposition of two fainter streamers. The corona at this time was unusual for the presence of streamers at high latitudes and the development of straight rays over the poles. The circumstances at the time of this eclipse were unusual for the rather dark sky. Long exposure photographs, made without the radially graded filter, show the lunar maria and suggest that the sky radiance did not exceed $3 \times 10^{-10}\ B_o$.

Technical data:

Objective aperture	– 11.1 cm
focal length	– 178 cm
focal ratio	– f/15
film	– Kodak Linagraph Shellburst (70 mm)
development	– D-76 (1:1) Nitrogen burst agitation 8^m at 70°F
filter	– Schott OG-3
effective wavelength	– 6400A
exposure	– 10 seconds
radial filter range	– 10^4 in transmission

Gordon Newkirk, Jr.
High Altitude Observatory
Boulder, Colorado 80302

* Sponsored by the
National Science Foundation



FOREWORD TO BULLETIN F

This issue of the SOLAR ECLIPSE 1970 BULLETIN completes the series of Bulletins which started on September 1, 1968 with Bulletin A. Unlike previous Bulletins which had a looseleaf format so that revised and additional pages could be inserted throughout the period of preparations for the eclipse, Bulletin F has been assembled in the form of a bound report. We believe that in this form it will have a more lasting value as a comprehensive reference manual of scientific activities related to the 1970 solar eclipse.

In order to keep the report to a reasonable size (and keeping in mind that the Bulletin is not a scientific treatise, but a vehicle for exchange of information among eclipse experimenters) we have regretfully edited some of the contributions to a smaller number of pages and illustrations. On the other hand, for the same reasons and to make the Bulletin a comprehensive record of scientific activities related to the 1970 eclipse, we have kept the Bulletin open to any professional or serious amateur groups. Therefore the quality of the contributions varies over a somewhat greater range than it would in a professional scientific journal. Nevertheless we are very much impressed by the performance and results of projects conducted during the 1970 eclipse. It is clear from the descriptions contained in Chapter 3 that major advances in the knowledge of solar-terrestrial relationships have been achieved and that the 1970 solar eclipse will be long remembered in terms of the interest which it attracted and its scientific productivity.

In addition to summarizing the 1970 solar eclipse program and in response to many inquiries, Bulletin F contains information on two related items:

1) The plans for a 1970 SOLAR ECLIPSE SYMPOSIUM are described in Chapter 7. It now appears probable that a symposium will be held in Seattle during the third week of June 1971.

2) A number of preliminary surveys of circumstances related to the 1972 and 1973 solar eclipses are provided in 4.8.

   In this connection has not yet been decided whether the U. S. National Science Foundation (NSF) will undertake national or international coordination of these two eclipses (particularly the 1973 eclipse) as it did for the 1970 solar eclipse program. An expression of your wishes would assist us in arriving at a decision.

It is with the greatest pleasure, as the series of SOLAR ECLIPSE 1970 BULLETINS terminates, that we make a number of long overdue acknowledgements:

We acknowledge with grateful thanks the splendid cooperation of the eclipse experimenters throughout the course of the program. It has made the task of coordinating this large undertaking much easier than it could have been; and in turn we hope that our coodination activities and the SOLAR ECLIPSE 1970 BULLETINS have been of benefit to you.

We also express our great appreciation for the encouragement and wholehearted support of the National Science Foundation, in particular Dr. E. P. Todd, Dr. T. O. Jones, Dr. A. P. Crary, Dr. F. D. White and the entire staff of the Atmospheric Sciences Section. Special thanks are due to my secretary, Mrs. Elizabeth Banks whose efficiency and devotion to the eclipse program, in addition to her many other duties, are responsible for the timely issuance of the SOLAR ECLIPSE 1970 BULLETINS.

We also thank Mr. Joseph Pope of ESSA for providing valuable full time assistance during the three weeks preceeding the eclipse, and to Mr. Allan Shapley of ESSA for arranging this assistance.

Finally, but certainly not least, we express our deep appreciation to the members of the various committees listed in Chapter 1, who provided very valuable liaison and advice throughout the course of the 1970 SOLAR ECLIPSE PROGRAM.

We offer our best wishes to all 1970 solar eclipse experimenters for a successful completion of the analysis projects now underway and we look forward to reading the results of these projects in the scientific literature.

August 7, 1970

Albert E. Belon
U. S. Coordinator for the
1970 Solar Eclipse

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DISTRIBUTION LIST

ACCARDO, Mr. Carl A.
Aerophysics Department
GCA Corporation
Bedford, Massachusetts 01731

ADAMSON, Dr. David
Mail Stop 160 T
Aerophysics Division
Langely Research Center
Hampton, Virginia 23365

AIKIN, Dr. Arthur
Code 615
Goddard Space Flight Center
Greenbelt, Maryland 20771

ALLDREDGE, Dr. Leroy R.
Secretary, IAGA
ESSA
Boulder, Colorado 80302

ALLIN, Mr. Roger
National Parks Service
Interior Building, Room 2216
19th and C Streets, N. W.
Washington, D.C. 20240

ANASTASSIADIS, Prof. Michael
Department of Physics
University of Athens
104 Solonos Street
Athens, Greece

ANDERHOLM, Dr. N. C.
Division 1224 - Box 5800
Sandia Laboratory
Albuquerque, New Mexico 87115

ANDERSON, Dr. Robert V.
Code 8320, Room 2B1
Naval Research Laboratory
Washington, D. C. 20390

ARENDT, Dr. P. R.
Division C
Institute for Exploratory Research
USAECOM
Ft. Monmouth, New Jersey 07703

ARGO, Dr. Harold V.
Los Alamos Scientific Laboratory
Post Office Box 1664
Los Alamos, New Mexico 87555

ARNQUIST, Dr. Warren N.
Douglas Aircraft Company
Advanced Research Laboratory
5251 Bolsa Avenue
Huntington Beach, California 92646

AARONS, DR. Jules
AFCRL (CRPA)
L. G. Hanscom Field
Bedford, Massachusets 01730

ATHAY, Dr. R. G.
High Altitude Observatory
Boulder, Colorado 80302

AVIGONNE Dr. F. T.
Department of Physics and Astronomy
University of South Carolina
Columbia, South Carolina 29208

BADER, Dr. Michel
Airborne Sciences Program
NASA - Ames Research Center
Moffett Field, California 94035

BADGLEY, F. I. (Prof.)
Department of Atmospheric Sciences
University of Washington
Seattle, Washington 98105

BAIN, Dr. W. C.
Radio & Space Research Station
Ditton Park, Slough,
Bucks., U. K.

BAKER, Dr. Doran J.
Electron-Dynamics Laboratories
Utah State University
Logan, Utah 84321

BAKER, Dr. Kay D.
Assistant Director
Upper Air Research Laboratory
University of Utah
Salt Lake City, Utah 84112

BAPPU, Dr. M. K. Vainu, Director
Kodaikanal Observatory
Kodaikanal - 3, India

BARNELL, Mr. Ronald
227 Mariaville Road
Schenectady, New York 12306

BARON, Dr. Murray
Radio Physics Laboratory
Stanford Research Institute
Menlo Park, California 94205

De La Barra, Dr. L.
A. Postal N° 41-541
Mexico 10, D. F.
Mexico

BARTELY, Mr. William
National Academy of Sciences
2100 Pennsylvania Avenue, N. W.
Washington, D.C. 20037

BECKERS, Dr. Jacques M.
High Altitude Observatory
Boulder, Colorado 80302

BELON, Albert E.
Geophysical Institute
University of Alaska
College, Alaska 99701

BELROSE, Dr. J. S.
Communications Research Centre
Department of Communications
P. O. Box 490
Terminal A
Ottawa 2, Canada

BENEDETTI, Dr. Edmund J.
Universidad Nacional del Nordeste
Corrientes, Argentina

BENNETT, Mr. Ernest
Bureau of Customs
Room 205
2100 K Street, N.W.
Washington, D. C. 20226

BERNING, Mr. Warren W.
Deputy Chief, Radiation Directorate
DASA (Defense Atomic Support Agency)
Washington, D. C. 20301

BERNSTEIN, Dr. W
TRW Systems R1/1070
One Space Park
Redondo Beach, California 90278

BIBL, Dr. Klaus
Ionospheric Physics Group
Lowell Technological Institute
Research Foundation, 450 Aiken St.
Lowell, Massachusetts 01854

BIERLY, Dr. Eugene
Program Director for Meteorology
National Science Foundation
1800 G Street, N. W.
Washington, D. C. 20550

BILLINGS, Dr. Donald E.
Department of Astro-Geophysics
University of Colorado
Boulder, Colorado 80304

BLACKADAR, Dr. Alfred K.
Head, Department of Meteorology
Pennsylvania State University
University Park, Pennsylvania 16802

BLAMONT, Prof. J. E.
Service d'Aeronomie
Observtoire de Meudon
Meudon (Seine-etOise), France

BLANK, Dr. Charles A.
Radiation Division - RAEL
Defense Atomic Support Agency
Washington, D. D. 20305

BLOCKS, Mr. Neil
4744 Carstem Lane
North Olmsted, Ohio 44070

BOQUIST, Dr. Wallace P.
Technology International Corp.
Wiggins Avenue
Bedford, Massachusetts 01730

BOWHILL, Dr. Sidney A.
Dept. of Electrical Engineering
University of Illinois
Ubana, Illinois 61801

BOYD, Prof. R. L. F.
Mullard Space Science Laboratory
University College
London, England

BRACE, Dr. L. H.
Code 621
NASA Goddard Space Flight Center
Greenbelt, Maryland 20771

BRANDT, Dr. John C.
Solar Physics Branch
NASA, Goddard Space Flight Center
Greenbelt, Maryland 20771

BRICE, Dr. Neil M.
Center for Radiophysics and Space Res.
Cornell University
Ithaca, New York 14850

BOMKE, Dr. Hans A.
Inst. for Exploratory Research
U. S. Army Electronics Command
Attn: AMSEL -XL-I
Fort Monmouth, New Jersey 07703

BROWNLEE, Dr. Robert R.
Los Alamos Scientific Laboratory
Post Office Box 1663
Los Alamos, New Mexico 87544

BRUECKNER, Dr. G. E.
Code 7140-B
U. S. Naval Research Laboratory
Washington, D. C. 20390

BULLOCK, Mr. Gilbert D.
NASA Goddard Space Flight Center
Greenbelt, Maryland 20771

BURGESS, Mr. Roger D.
Department of Physics
Ball State University
Muncie, Indiana 47306

BURNETT, Dr. Clyde R.
Dept. of Physics
Florida Atlantic University
Boca Raton, Florida 33432

Serials Section
Engrg. & Mathematical Sciences Libr.
University of California
405 Hilgard Avenue
Los Angeles, California 90024

CALLAHAN, Mr. Cornelius J.
Exec. Secy. ICAMR SAG
ESSA, Rm. 354, Page Building #1
2001 Wisconsin Avenue, N.W.
Washington, D. C. 20007

CAREY, Dr. Andrew
Tracking System Section
Mail Stop 490
NASA Langley Research Center

CARIGNAN, Dr. G. R.
Space Physics Research Laboratory
University of Michigan
Ann Arbor, Michigan 48105

CARLSON, Dr. Herbert
Arecibo Ionospheric Observatory
Post Office Box 995
Arecibo, Puerto Rico 00612

CAROVILLANO, Dr. Robert L.
Chairman
Department of Physics
Boston College
Chestnut Hill, Massachusetts 02167

CARPENTER, Dr. Donald L.
Radioscience Laboratory
Stanford University
Stanford, California 94305

CASTELLI, Mr. John P.
ARCRL (OAR)
L. G. Hanscom Field
Bedford, Massachusetts 01731

del CASTILLO, Luis G.
Torre de Ciencicias 3er Piso
Instituto de Geofisica
Cd. Universitaria D. F.
Mexico 20, D. F.

CHAMPION, Dr. K. S. W.
Code CRAB
ARCRL
L. G. Hanscom Field
Bedford, Massachusetts 01730

CHANG, Dr. Norman J. F.
Radio Physics Laboratory
Stanford Research Institute
Menlo Park, California 94025

CIMINO, Prof. M.
Osservatorio Astronomico
su Monte Mario
Via del Parco Mellini, 84
Roma, Italy

CLARK, Dr. Clayton
Engineering Experiment Station
Utah State University
Logan Utah 84321

CLARK, Dr. Kenneth C.
Program Director for Aeronomy
Atmospheric Sciences Section
National Science Foundation
Washington, D. C. 20550

CLARK, Dr. Ronald R.
Kingsbury Hall
University of New Hampshire
Durham, N. H. 03824

COOK, Dr. Richard K.
Geoacoustics Group, R45 x 7
ESSA
Rockville, Maryland 20852

COURTEN, Prof. Henry C.
Physics Department
Dowling College
Oakdale, New York 11769

COX, Dr. Arthur N.
Group Leader J-15
Los Alamos Scientific Laboratory
Los Alamos, New Mexico 87544

CRAINE, Prof. Lloyd B.
Electricl Sciences Section
College of Engineering
Washington, State University
Pullman, Washington 99163

CRAWFORD, Mr. James J.
Harvard College Observatory
Solar Satellite Project
767C Concard Avenue
Cambridge, Massachusetts 02138

CROOM, Dr. D. L.
Science Research Council
Radio and Space Research Station
Ditton Park, Slough
Bucks., England

CROSS, Mr. Douglas W.
746 Ecton Road
Akron, Ohio 44303

CULNAN, Mr. R. N.
Rx4
ESSA
Rockville, Maryland 20852

CUTOLO, Prof. Mario
Instituto Di Fisica E. Fisica Tecnica
Dell 'Universita
Napoli - Via Monteoliveto, 3
Italy

DANDEKAR, Dr. B. S.
AFCRL - Attn: CRAA/5478
L. G. Hanscom Field
Bedford, Massachusetts 01730

DAVIS, Dr. D. D.
Scientific Director
DOW Planetarium
1000 Quest Rue St. Jacques
Montreal, Canada

DAVIS, Dr. John R.
Code 5464
U. S. Naval Research Laboratory
Washington, D. C. 20390

DAVIS, Dr. M. J.
Radioscience Laboratory
Stanford University
Stanford, California 94305

General Electric Company
Post Office Box 2500
Daytona Beach, Florida 32015
Attn: Mr. Charles Day

de BIASE, Dr. Giuseppe A.
Osservatorio Astronomico Di Roma
Sede Di Monte Mario
Viale Del Parco Mellini, 84
00136 Roma, Italy

DECLERCQ, Mr. Wilfred F.
Scientific Attach
American Embassy
Belgrade, Yugoslavia

DEEHR, Dr. Charles
Geophysical Institute
University of Alaska
College, Alaska 99735

DEVINNEY, Dr. E. J., Jr.
Department of Astronomy
University of South Florida
Tampa, Florida 33620

DIX, Mr. William H.
Defense Communications Agency
Code 340
Washington, D.C. 20305

DOEKER, Mr. Robert B.
Chief, Space Disturbance
Forecast Services
ESSA, Research Laboratories
Boulder, Colorado 80302

DOHERTY, Dr. Robert H.
ITS
ESSA Research Laboratories
Boulder, Colorado 80302

DOLEZALEK, Mr. Hans
Office of Naval Research
Code 412 HD
Arlington, Virginia 2217

DOMINY, Mr. Jim
121 East Walnut Street
Cardington, Ohio 43315

DONAHUE, Dr. Thomas M.
Department of Physics
University of Pittsburgh
Pittsburgh, Pennsylvania 15213

DONALDSON, Dr. Robert
Lawrence Radiation Laboratory
P. O. Box 808
Livermore, California 94550

DONN, Dr. William L.
Lamont Geological Observatory
Columbia University
Palisades, New York

DOW, LCol. Raymond M.
OSD/ARPA/STOfc
Room 3-D-148
The Pentagon
Washington, D.C. 20301

DREYER, Maj. C. P. Jr.
USAF -- BROSE
Hdq. OAR
1400 Wilson Boulevard
Arlington, Virginia 2209

DRISKELL, LCol. Claude T., USAF
Chief, Aerospace Sciences Division
Headquarters 4th Weather Wing (MAC)
Ent Air Force Base, Colorado 80912

DUBIN, Dr. Maurice
Code SG
NASA Headquarters
Washington, D. C. 20546

DUNCOMBE, Dr. Raynor L.
Director, Nautical Almanac Office
U. S. Naval Observatory
Washington, D.C. 20390

DUNHAM, T. H.
Department of Astronomy and
Physical Science
Old Dominion University
Norfolk, Va. 23503

DUNKELMAN, Mr. Lawrence
Astronomy Systems Branch, Code 673
NASA - Goddard Space Flight Center
Greenbelt, Maryland 20771

DUNN, Mr. Jack A.
Curator
The Lafayette Natural History
Museum and Planetarium
Girard Park Drive at Auditorium Place
P. O. Box 108, USL
Lafayette, Louisiana 70501

DURBIN, Col Robert F. USAF
Chairman, ICAMR SAG
OJCS/SAES
Room 1B673, Pentagon
Washington, D. C. 20301

DYER, Dr. Edward R.
National Academy of Sciences
2100 Pennsylvania Avenue, N. W.
Room 420
Washington, D. C. 20037

EAKIN, Dr. David M.
c/o Professor Sumner P. Davis
Department of Physics
University of California
Berkeley, California 94720

EATON, Mr. Peter T.
Code SG
NASA Headquarters
Washington, D. C.

EDDY, Dr. Jack H.
W. A. Gayle Planetarium
1010 Forest Avenue
Montgomery, Alabama 36106

EGORAVA, Dr. N., Learned Secretary
Commission on Solar Research
The Astronomical Council
USSR Academy of Sciences
Vavilova 34
Moscow V-312, USSR

ELSASSER, Prof. Dr. H.
Landessternwarte Heidelberg
6900 Heidelberg 1
Germany

ENGELMANN, Mr. R. J.
U. S. Atomic Enery Commission
Division of Biology & Medicine
Washington, D. C. 20545

EVANS, Dr. Charles
Solar Division
Kitt Peak National Observatory
950 North Cherry Avenue
Tucson, Arizona 85717

EVANS, Dr. J. V.
Lincoln Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

EVANS, Dr. John W.
Director
Sacramento Peak Observatory
Sunspot, New Mexico 88349

EVERSON, Mr. Clarence E.
Hdq. 4th Weather Wing
Ent Air Force Base
Colorado Springs, Colorado 80912

EVIATAR, Dr. A.
Department of Environmental Sciences
Tel Aviv University
Rmat Aviv, Israel

EWING, Miss Ann
3138 Military Road, N. W.
Washington, D. C. 20015

FAIRE, Dr. Andrew C.
AFCRL (OAR)
L. G. Hanscom Field
Bedford, Massachusetts 01731

FASTIE, Mr. William G.
Department of Physics
Johns Hopkins University
Baltimore, Maryland 21218

FEDERER, Mr. Charles A. Jr.
Sky and Telescope
49 Bay State Road
Cambridge, Massachusetts 02138

FERRARO, Dr. A. J.
Department of Electrical Engineering
Pennsylvania State University
University Park, Pennsylvania 16802

FIROR, Dr. John
Director
NCAR
Boulder, Colorado 80302

FLEISCHER, Dr. Robert
Head, Astronomy Section
National Science Foundation
Washington, D. C. 20550

FLETCHER, Dr. Robert
Hdq., Air Weather Service
Scott Air Force Base
Belleville, Illinois 62226

FLOOD, Dr. Walter A.
328 Daniels Hall
Department of Electrical Engineering
North Carolina State University
Box 5275
Raleigh, North Carolina 27607

FONG, Mr. L. B.
NASA Headquarters
Code SRA

Run STOP #85

FRANCESCHINI, Dr. Guy A.
Department of Meteorology
Texas A & M University
College Station, Texas 77843

FRANGOS, Dr. Apsotolos Ch.
Program and Planning Co-ordinator
Scientific Group for Space Research
43 Ellanikou Str.
Athens, Greece

FRIEDMAN, Dr. Herbert
Code 7100
Naval Research Laboratory
Washington, D. C. 20390

FROST, Dr. A. D.
Director, Antenna Systems Laboratoty
Department of Electrical Engineering
University of New Hampshire
Durham, New Hampshire 03824

FUJITA, Dr. Tetsuya
Dept. of Geophysical Sciences
University of Chicago
Chicago, Ill.

GADSDEN, Dr. Michael
Aeronomy Laboratory
ESSA
Boulder, Colorado 80302

GAIZAUSKAS, Dr. V.
Astronomy Division
Dominion Observatory
Dept. of Energy, Mines & Resources
Ottawa, Ontario CANADA

GALL, Ruth
Instituto de Astronomia Instituto de Geofisica
Universidad Nacional de Mexico
Mexico 20, D. F., Mexico

GAMA, Prof. Lelio
Conselho Nacional De Pesquisas
Avenida Marechal Camara, 350
Rio de Janeiro - GB
Brazil

GARRIOTT, Dr. Owen K.
Code CB
NASA - Manned Spacecraft Center
Houston, Texas 77058

GARTON, Prof. W. R. S.
Physics Department
Imperial College
London, ENGLAND

GASSMAN, Dr. George
Air Force Cambridge Research Labs
L. G. Hanscom Field
Attn: CRPC
Bedford, Massachusetts 01731

GATTINGER, Dr. R.
Upper Atmosphere Research Section
Radio & Electrical Engineering Div.
National Research Council of Canada
Ottawa 7, Ontario, CANADA

GEISLER, Dr. J. E.
Division of Atmospheric Science
University of Miami
Coral Gables, Florida 33124

GELFREJH, Dr. G. B.
Main Astronomical Observatory
USSR Academy of Sciences
Pulkovo, USSR

GERA, Sr. Juan Carlos
Observatorio Astronomico de Montevideo
Montevideo, Uruguay

GERLACH, Dr. Alan M.
Deputy, Technical Plans & Operations
AFCRL - Attn: CRTP/4783
L. G. Hanscom Field
Bedford, Massachusetts 01730

GILLIS, Richard J.
Space Data Corporation
Eastern Operations Office
Post Office Box 460
McLean, Virginia 22101

GIESECKE, Ing. Alberto
Director Ejecutivo
Instituto Geofisico de Peru
Apartado 3747
Lima, Peru

GLASS, Dr. Neel
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87544

GNEVYSHEV, Dr. M. N.
Astronomical Observatory
Leningrad - M140, USSR

GODWIN, LCol. C. B.
ECAC - Bldg. 120
North Severn'
Annapolis, Maryland 21402

GOLDBERG, Dr. Allan
Director
Harvard College Observatory
Cambridge, Massachusetts 02138'

GOODY, Dr. Richard
Division of Engineering and
Applied Physics
Pierce Hall, 206-A
Harvard University
Cambridge, Massachusetts 02138

GORDON, Dr. William E.
Vice President and Dean
of Science and Engineering
Rice University
Houston, Texas 77001

GRANT, Prof. Lewis O.
Department of Atmospheric Sciences
Colorado State University
Fort Collins, Colorado 80521

GRAY, Robert S.
Building E-144
ESSA Ionosphere Station
Wallops Island, Virginia 23337

SOLAR ECLIPSE '70 ECLIPSE

GRASSINI, Mr. Athos D.
Associate Chief Cartographer
Cartographic Division
National Geographic Society
Washington, D. C. 20036

GUDOTTI, Mr. John
NASA- Goddard Space Flight Center
Code 724
Greenbelt, Maryland 20771

GWINN, Peter
Science Department
444 Madison Avenue
New York City, New York 10022

HAGEN, Dr. John P.
Department of Astronomy
Pennsylvania State University
University Park, Pennsylvania 16802

Hall Dr. Freeman F.
Douglas Aircraft Company
Advanced Research Lavoratory
5251 Bolsa Avenue
Huntington Beach, California 92647

HALL, Dr. J. E.
Radio and Space Research Station
Ditton Park
Slough, U. K.

HANSON, Dr. W. B.
Atmospheric Sciences
University of Texas at Dallas
Box 30365
Dallsa, Texas 75230

HANSEN, Dr. Richard T.
High Altitude Observatory
P. O. Box 727
Kamuela, Hawaii

HARBOUR, Prof. Richard D.
College of Engineering
Washington State University
Pullman, Washington, 99163

HARDY, Dr. Kenneth R.
AFCRL (OAR)
Weather Radar Field Station
Sudbury, Massachusetts 01776

HARO, Dr. Guillermo
Observatorio Astronomico Nacional
Apartado Postal 70-264
Cuidat Universitaria
Mexico 20, Mexico

HARVEY, Dr. Gale A.
Space Environment Branch
NASA Langley Research Center
Hampton, Virginia 23365

HARVEY, Dr. J. W.
Kitt Peak National Observatory
P. O. Box 4130
Tucson, Arizona 85171

HAUPT, Dr. Herman
University Observatory of Vienna
Vienna, Austria

HAUPT, Dr. R. F.
U. S. Naval Observatory
Washington, D. C. 20390

HAZEN, Mr. N. L.
Harvard College Observatory
Solar Satellite Project
767C Concord Avenue
Cambridge, Massachusetts 02138

HEATH, Dr. Donald F.
Code 622
Building 12, Room E30
Goddard Space Flight Center

HEINSHEIMER, Thomas F.
Centre National de la Recherche
Sci Service d'Aeronomie
91 Berrieres
Le Buission, France

HELMS, Dr. R. M.
Department of Physics
East Carolina University
Greenville, North Carolina 27834

HEMENWAY, Dr. Curtis L.
Dudley Observatory
140 S. Lake Avenue
Albany, New York, 12208

HENDERSON, Dr. Gordon
Department of Physics
Heriot-Watt University
Chambers Street
Edinburgh, 1, England

HENRY, Mr. R. N.
NASA Aerophysics Division
Langely Research Center
Hampton, Virginia 23365

HERSE, Mr. M.
Services d'Aeronomie du CNRS
Verrieres-Le Buission 91
FRANCE

HEYDEN, Rev. Francis
Georgetown College Ovservatory
Washington, D. C. 20007

HIDE, Dr. C. G.
South African Science Office
Chichester, House
278 High Holborn
London, WC1, England

HIDEBRAND, Mr. Verne E.
Naval Weapons Center
Coronal Laboratories
Code C6153
Corona, California 91720

HINES, Dr. C.O.
Department of Physics
University of Tprpmtp
Toronto, Canada

HINSCH, Dr. R. O. B.,
Sec. Ejecutivo
Consego National de Investigaciones
Cientificas y Techicas
Rivadavia 1917
Buenos Aires (R.25) R. Argentina

HIRSCHBERG, Dr. Joseph G.
Department of Physics
University of Miami
Coral Gables, Fla. 33124

HOFFMAN, Dr. A. A. J.
Computer Center
Texas Christian University
Fort Worth, Texas 76129

HOGG, Dr. D. C.
Bell Telephone Laboratories
Crawford Hill
Holmdel, New Jersey 07733

David Dunlap Observatory
University of Toronto
Richmond Hill, Ontario
CANADA
Attn: Professor H. S. Hogg

HOLCOMB, Mr. Robert
Science
1515 Massachusetts Avenue, N. W.
Washington, D. C. 20005

HOUGHTEN, Mr. Robert
Off. of Space Sciences & Applications
NASA Hq.
Washington, D. C. 20546

HOUTGAST, Dr. J.
Astronomical Observatory "Sonnenborgh"
Zonnenburg 2
Utrecht, The Netherlands

HORVATH, Dr. Jack J.
University of Michigan
2455 Hayward
Ann Arbor, Michigan 48105

HOWARD, Dr. Robert
Mt. Wilson Observatory
California Institute of Technology
Pasadena, California 91109

HUDSON, Dr. Frank P.
Radiation Phenomena Div. 5233
Sandia Corporation
Sania Base
Albuquerque, New Mexico 87115

HUDSON, Mr. Miller N., Jr.
Scientific Attache
U. S. Embassy
APO New York 09676

HULL, Dr. Anthony B.
Department of Astronomy
University of Pennsylvania
Philadelphia, Pa. 19104

HUMPHREYS, Dr. Curtis J.
Department of Physics
Purdue University
W. Lafayette, Indiana 47907

HUNTER, Dr. Raymond
Department of Physics
Valdosta State College
Valdosta, Georgia 31601

HUTERS, Mr. A. F.
Sandia Corporation
Division 7255
Post Office Box 5800
Albuquerque, New Mexico 87115

JAGODA, Mr. Barry
Associate Producer, Special Events
CBS News
524 West 57th Street
New York, New York 10019

JEFFERIES, Dr. John T.
Institute for Astronomy
University of Hawaii
2840 Koluwalu Street
Honolulu, Hawaii 96822

JENKINS, Dr. H. H.
Georgia Institute of Technology
Engineering Experiment Station
225 North Avenue, N. W.
Atlanta, Georgia 30332

JOHNSON, Dr. Charles Y.
Naval Research Laboratory
Aeronomy Section
Bldg. 42, Rm. 419
Washington, D. C. 20390

JOHNSON, Mr. David S.
Director
National Environmental Satellite Center
FOB 4
Washington, D. C. 20233

JOHNSON, Mr. Harvey K.
Chairman, Eclipse Committee
Detroit Astronomical Society, Inc.
25170 Strawberry Lane
Southfield, Michigan 48075

JONES, Dr. Shirley
Department of Astronomy
McCook 224
Trinity College
Hartfort, Connecticut 06106

JORDON, Dr. A. Raymond
Colorado School of Mines
Golden, Colorado 80401

KARPOVICH, Mr.
USAF/ETAC
Building 159
Navy Yard Annex
Washington, D. C. 20333

KASEMIR, Dr. H. W.
ESSA Research Laboratories
Boulder, Colorado 80302

KELAKOS, Mr. Michael G.
Scientific Attache
U. S. Embassy
Tel Aviv,Israel

KELLOGG, Dr. William
Laboratory of Atmospheric Sciences
NCAR
Boulder, Colorado 80302

KELLS, Mr. D. W.
E. M. I. Electronics Canada Ltd.
Post Office Bos 1005
Dartmouth, Nova Scotia
Canada

KERR, Mr. J. L.
Bureau of Reclamation
Code 211
Department of the Interior
Washington, D. C. MAIL STOP 43

KIM, Dr. J. S.
Atmospheric Sciences Dept.
State University of New York
1400 Washington Avenue
Albany, N. Y. 12203

KISSELL, Dr. Kenneth E.
ARL (ARP) Bldg. 57
Wright Patterson Air Force Base
Dayton, Ohio 45433

KITCHEN, Dr. W. L.
NASA Langley Research Center
Hampton, Virginia 23365

KLÜBER, Dr. H. Von
The Observatories
Madingley Road
Cambridge, England

KNAPP, Richard S.
Morehead Planetarium
University of North Carolina
Chapel Hill, North Carolina 27514

KNAPPENBERGER, Dr. Paul H.
DeKalb County Board of Education
Fernbank Science Center
156 Heaton Park Drive, N. E.
Atlanta, Georgia 30307

KOLB, Mr. Edward J.
Scientific Liaison
Naval Security Group Command
Washington, D. C. 20309

KOOMEN, Dr. M. J.
Code 71H1-K
Naval Research Laboratory
Washington, D. C. 20390

KOPP, Dr. R. A.
High Altitude Observatory
NCAR
Boulder, Colorado 89302

KORFF, Dr. Serge A.
Department of Physics
New York Umiversity
University Heights
New York, New York 10453

KOUTCHMY, Dr. Serge
Institut d' Astrophysique
98 bis Boulevard Arago
Paris 14, France

KOVAR, Dr. Natalie S.
Physics Department
University of Houston
Houston, Texas 77004

KOVAR, Dr. Robert P.
NASA - Code TG 4
Manned Spacecraft Center
Houston, Texas 77058

KRAUSE, LCol. Richard E. USAF
Commander
Latin American Office of Aerospace Res.
c/o U. S. Embassy - Rio de Janeiro
APO New York 09676

KRISTENSON, Dr. H.
Ole Romer Observatory
Aarhus C - Denmark

KUHN, Dr. Peter M.
Atmospheric Physics and Chemistry Lab.
ESSA
Boulder, Colorado 80302

Laboratory for Solar Physics
Code 680
Goddard Space Flight Center
Greenbelt, Maryland 20771

LAMBERT, Dr. Joseph
Director, Schellinger Laboratory
University of Texas at El Paso
El Paso, Texas 79999

LANZEROTTI, Dr. Louis J.
Bell Telephone Laboratories
Murray Hill, New Jersey 07974

LARMORE, Dr. Lewis
Douglas Aircraft Company
Advanced Research Laboratory
5251 Bolsa Avenue
Huntington Beach, California 92647

LATHAM, Dr. Donald
Institute of Atmospheric Science
University of Miami
Coral Gables, Florida 33124

LAWRENCE, Dr. James D.
GRIB - PMS
NASA Langley Research Center
Hampton, Virginia 23365

LEE, Dr. Robert B.
Mail stop 231
Langley Research Center
Hampton, Virginia 23365

LEONARD, Dr. Robert S.
Stanford Research Institute
Menlo Park, California 94025

LEVINE, Dr. Joel S.
Brooklyn College
The City University of New York
Brooklyn, New York 11210

LIBRARY OF CONGRESS
Science and Technology Division
Washington, D. C. 20540
Attn: Miss Jane Collins

LIEBENBERG, Mr. Donald H.
Los Alamos Scientific Laboratory
Post Office Box 1663
Los Alamos, New Mexico 87544

LIIMATAINEN, Dr. Robert C.
Scientific Attache
U. S. Embassy
Tehran, Iran

LINCOLN, Dr. J. Virginia
Director, WDC-A
Upper Atmospheric Geophysics
ESSA
Boulder, Colorado 80302

LINDQUIST, Dr. Rolf E.
Physics Department
The University of Alberquerque
St. Joseph Place, N. W.
Albuquerque, New Mexico 87120

LIPPINCOTT, Dr. Sarah
Sproul Observatory
Swarthmore College
Swarthmore, Pennsylvania 19081

LIVINGSTON, W.
Kitt Peak National Observatory
Solar Division
950 North Cherry Avenue
Tucson, Arizona 85717

LLOYD, Dr. J. W. F.
AFCRL - Attn: CRAA
L. G. Hanscom Field
Bedford, Massachusetts 01731

LOCKE, Dr. Hohn L.
Radio & Electrical Engrg. Div.
National Research Council
Ottawa, Ontario
CANADA

MAAG, Mr. Russell C.
Box 52 - Station "E"
St. Joseph, Missouri 64505

MacDOUGALL, Dr. J.
Department of Physics
University of the West Indies
Kingston 7, Jamaica

MACK, Dr. Robert J.
NASA Langley Research Center
Hampton, Va. 23365

MAHADEVAN, Dr. P.
Douglas Aircraft Company
Advanced Research Laboratory
5251 Bolsa Avenue
Huntington Beach, California 92646

MALVILLE, Dr. J. M.
High Altitude Observatory
National Center for Atmospheric Res.
Boulder, Colorado 80302

MAKITA, Dr. Mitsugu
Tokyo Astronomical Observatory
Mitaka
Tokyo, Japan

MARCUCCIO, Mrs. Phyllis
Naltional Science Teachers Association
1201 - 16th Street, N. W.
Washington, D. C. 20036

MARKHAM, Mr. T. P.
AFCRL - Attn: CROR
L. G. Hanscom Field
Bedford, Massachusetts 01731

MARKSON, Mr. Ralph
Atmospheric Sciences Department
State University of New York
1400 Washington Avenue
Albany, New York 12203

MATHER, Dr. Keith
Director, Geophysical Institute
University of Alaska
College, Alaska 99701

MATSUURA, Oscar Toshiake
Centro de Radioastronomia e Astrofisica
C. Postal 8792
Sao Paulo, SP, Brazil

MAYFIELD, Dr. Earle B.
Solar Physics Department
Aerospace Corporation
2400 El Segundo Boulevard

MAYNARD, Dr. Nelson
Code 645
NASA Goddard Space Flight Center
Greenbelt, Maryland 20771

McCAUGHEY, Mr. Louis
Chief, AeroSpace Relations Branch
Air Traffic Branch, ATT:30
800 Independence Avenue, S. W.
Washington, D. C. 20553

McCLELLAND
Scientific Attache
American Embassy
Stockholm, Sweden

McCOY, Dr. Donald R.
Heavy Military Electronics Dept.
General Electric Company
Syracuse, New York 13201

McDONALD, Dr. James E.
Institute of Atmospheric Physics
University of Arizona
Tucson, Arizona 85721

McDOUGAL, Mr. David S.
Mail Stop 231
NASA, Langley Research Center
Hampton, Station
Hampton, Virginia 23365

McELANEY, Dr. James H.
Department of Physics
Fairfield University
Fairfield, Connecticut 06430

McINTYRE, Mr. A.
AFCRL - Attn: CRTP
L. G. Hanscom Field
Bedford, Massachusetts 01730

McNAMARA, Dr. A. G.
Radio & Electrical Engr. Division
National Research Council
Ottawa, Ontario
CANADA

McPHERSON, Dr. D.A.
The Aerospace Sorporation
P. O. Box 95085
Los Angeles, California 90045

McQUEEN, Dr. R. M.
High Altitude Observatory
NCAR
Boulder, Colorado 80302

MEAD, Dr. James B.
Radar Division
U. S Naval Research Laboratory
Washington, D. C. 20390

MEDINA PERALTA, Ing. Manuel
Dept. of Geodesy
Instituto De Geofisica
Universidad Nacional de Mexico
Mexico 20, D. F. Mexico

MEDROW, Mr. Karl
Code 721
Goddard Space Flight Center
Beltsville, Maryland 20705

MEISEL, Dr. David D.
Department of Astronomy
Leander McCormick Observatory
University of Virginia-Box 3818
Charlottesville, Virginia 22903

MEJIA, Dr. Gaston R.
Director
Laboratorio de Fisica Cosmica
Universidad Mayor de San Andres
La Paz, Bolivia

MENCHER, Dr. Alan G.
Scientific Attache
American Embassy
London, England

MENDEZ, Manuel
Instituto de Astronomia
Universidad Nacional de Mexico
Mexico 20, D. F., Mexico

DE MENDONCA, Dr. Fernando
Comissao Nacional De
Atividades Espaciais
Sao Jose dos Campos
Sao Paulo, Brazil

MENZEL, Dr. Donald H.
Harvard College Observatory
60 Garden Street
Cambridge, Massachusetts 02138

MESTER, Mr. John C.
Ballistic Research Laboratories
Aberdeen Research & Development Center
Aberdeen Proving Ground, Md. 21005

MEYER, Dr. Rudolph
AEROSPACE Corporation
Plasma Research Laboratory
2400 El Segundo Boulevard
El Segundo, California 90245

MICHARD, Dr. R.
Head, Solar Departmen
Observatoire De Paris
Section D'Astrophysique
92 Meudon, FRANCE

MICKELSON, Dr. Michael E.
Department of Physics
Denison University
Granville, Ohio 43023

MILANO, Dr. Jose Carlos F., Rector
Universidade do Rio Grande do Sul
Avenida Joao Pessoa
Porto Alegre
Rio Grande do Sul, Brazil

MILLER, Dr. Glen H.
Div. 5414, Sandia Corp.
Sandia Base
Albuquerque, New Mexico 87115

MILLER, Mr. Jay
8924 Ridge Place
Bethesda, Maryland 20034

MILLINER, Mr. Cary F.
Building N159
NASA Wallops Station
Wallops, Island, Virginia 23337

MILLMAN, Dr. George H.
General Electric Company
Court Street Plant
Room 8, Building 9
Syracuse, New York 13201

MILLS, Mr. William H.
c/o American Embassy
Mexico City DF, Mexico

MINNIS, Dr. C. M.
Acting Secretary General
URSI, 7, Place Emile Danco
Bruxelles 18 - Belgique

MITRA, Dr. A. P.
Head, Radio Propagation Unit
National Physical Laboratory
New Delhi 12, India

MIYAMOTO, Prof. S.
Kwazan Observatory
University of Kyoto
Yamashina, Kyoto
Japan

MOGILEVSKY, Dr. E. I.
Solar Department
IZMIRAN
Moscow region, USSR

MOHLER, Dr. Orren C.
McMath-Hulbert Observatory
University of Michigan
Pontiac, Michigan 48055

MONTES, Dr. Herman A.
TELEDYNE ISOTOPES
Westwood, N. J. 07675

MOO, Mr. Charles
AVCO Corporation, Systems Div.
Industrial Park
Lowell, Massachusetts 01851

MOORE, Dr. A. G.
Hercules, Incorporated
Box 210
Cumberland, Maryland 21502

MOORE, James G.
Code CRUA
Air Force Cambridge Res. Labs.
L. G. Hanscom Field
Bedford, Massachusetts 01731

DE MORAES, Dr. Abrahao
Director
Instituto Astronomico e Geofisico
Universidad de Sao Paulo
Sao Paulo, Brazil

MOSINO, Ing. Pedro A.
Department of Meteorology
Instituto de Geofisica
Universidad Nacional de Mexico
Mexico 20, D. F., Mexico

MOURADIAN, Dr. Z.
Department "Physique du Soleil"
Observatoire de Paris - Meudon
92 - Meudon
FRANCE

MURPHY, Mr. J. D.
AFCRL - Attn: CRMP
L. G. Hanscom Field
Bedford, Massachusetts 01730

MYERS, Dr. Orlo E.
Department of Aerospace Engineering
University of Florida
Gainesville, Florida 32601

NARCISI, Dr. R. S.
AFCRL (OAR)
L. G. Hanscom Field
Bedford, Massachusetts 01731

NASON, Mr. Martin E.
ESSA - Office of Programs
Boulder, Colorado 80301

NATIONAL SCIENCE FOUNDATION
Library - Room 219
1800 G Street, N. W.
Washington, D. C. 20550

NELMS, Dr. G. L.
Communications Research Centre
Department of Communications
P. O. Box 490
Terminal A.
Ottawa 2, Canada

NELSON, Dr. David T.
Luther College
Decorah, Iowa 52101

NELSON, Mr. R. A.
Calagary Centennial Planetarium
Mewata Park, Calgary 2
Alberta, Canada

NICHOLIS, Prof. Ralph W.
Center for Research in
Experimental Space Science
York University
Toronto, Ontario, CANADA

NEUREITER, Dr. Norman P.
Scientific Attache
American Embassy
Warsaw, Poland

NEWKIRK, Dr. Gordon A., Director
High Altitude Observatory
Boulder, Colorado 80302

NOONKESTER, Mr. V. R.
U. S. Naval Electronics Laboratory Center
Code S2200
271 Catalina Boulevard
San Diego, California 92152

NORTHCOTT, Dr. Ruth J.
Department of Astronomy
University of Toronto
Toronto 5, Ontario, CANADA

NOU, Major Juri V.
Aerospace Environmental Consultant
Hq. AFSC (SCWV)
Andrews Air Force Base, Md. 20331

NOVIKOV, Dr. V. V.
Sternberg Astronomical Institute
University pr. 13 B-234
Moscow
USSR

NÜNEZ ARELLANO, Ing. Carlos
Direc. General de Telecom. S. C. T.
Torre de Telecom. 60 piso
Ave. Nino Perdido Esq. Cumbres de Acutzingo
Mexico 12, D. F. MEXICO

O'BRIEN, K. C.
3B-222
Bell Telephone Laboratories, Inc.
Whippany, N. J. 07981

OERTEL, Dr. Goetz K.
Solar Physics Program
NASA Headquarters
Washington, D. C. 20546
STOP 85

OETTINGER, Dr. Peter
Aerospace Corporation
Bldg. 120, Room 1205
Post Office Box 95085
Los Angeles, California 90045

OETZEL, Dr. George N.
Radio Physics Laboratory
Stanford Research Institute
Menlo Park, California 94025

OKON, Mr. Eugene
Bureau of Customs
Room 202-B
2100 K. Street, N. W.
Washington, D. C. 20226

OLESEN, Dr. J. K.
Ionosphere Laboratory
Technical University
2800 Lyngby
Denmark

OLSEN, K. H.
Los Alamos Scientific Lab.
P. O. Box 1663
Los Alamos, New Mexico 87544

OLSON, Dr. Donald E.
Department of Physics
University of Minnesota
Duluth, Minnesota 55812

O'NEILL, Capt. Thomas H. R. USN
Chief, Environmental Sciences Div.
Defense Research and Engineering
Washington, D. C. 20301

ORRALL, Prof. F. Q.
Institute for Astronomy
University of Hawaii
2840 Koluwalu Street
Honolulu, Hawaii 96822

OSTER, Dr. A.
ESLAB
Noordwitkerhout, Netherlands
Gravendamseweg 16 C

OUTCALT, Dr. S. I.
University of Virginia
Charolittesville, Virginia 22903

PARKINSON, Dr. W. H.
Harvard College Observatory
60 Garden Street
Cambridge, Massachusetts 02138

PASACHOFF, Dr. Jay M.
Harvard College Observatory
60 Garden Street
Cambridge, Massachusetts 02138

PATTERSON, Dr. Ronn
University of California Ext.
Berkeley, California 94720

PAUL, Dr. A. K.
ITS, Environmental Radio Physics
ESSA Research Laboratories
Boulder, Colorado 80302

PEPIN, Dr. Theodore J.
School of Physics and Astronomy
University of Minnesota
Minneapolis, Minnesota

PETERSON, Dr. Alan W.
Department of Physics & Astronomy
University of New Mexico
Albuquerque, New Mexico 87106

PIERCE, Dr. Keith
Associate Director, Solar Division
Kitt Peak National Observatory
950 North Cherry Avenue
Tucson, Arizona 85717

PIKE, Mr. Julian M.
Field Observatory Facility
NCAR - Facilities Laboratory
Boulder, Colorado 80302

PINTER, Dr. Stephen
Slovak Academy of Sciences
Geomagnetic Observatory
Hurbanovo
Czechoslovakia, Slovakia

PIRET, Dr. Edgar L.
Scientific Attache
American Embassy
APO New York 09777

PLOTKIN, Mr. Robert H.
7613 Riverdale Road
New Carrollton, Maryland 20789

POPE, Mr. Joseph H.
FOB 4, Room 2045
Suitland Federal Center
Suitland, Maryland 20023

POVEDA, Dr. Arcadis
Observatorio Astronomico Nacional
Universidad Nacional de Mexico
Mexico 20, D. F., Mexico

POWELL, Mr. Rex R.
Department of Zoology, LSB
University of California
Berkeley, California 94720

PERSKY, Mr. Raymond J.
Department 454 - Plant G
Goodyear Aerospace Corporation
Akron, Ohio 44315

QUANN, Dr. John
Code 565
Goddard Space Flight Center
Greenbelt, Maryland 20771

QUIROZ, Mr. Roderick S.
Upper Air Branch, Weather Bureau
Iverson Mall Office Building
Hillcrest Heights, Md. 20031

RAMBERG, Dr. Walter
Scientific Attache
American Embassy
APO New York 09794

RAMSAY, Capt. Alan C.
Solar Forecast Facility
Headquarter, 4th Weather Wing
Ent Air Force Base Colorado 80912

RAMSEY, Mr. Harry
Lockheed Solar Observatory
Lockheed California Co.
Plant 2, Bldg. 243
Burbank, California 91503

RANGASWAMY, Dr.
Code 551, Mission and Trajectory
Analysis Division
NASA - Goddard Space Flight Center
Greenbelt, Maryland 20771

RASMUSSEN, Dr. John E.
AFCRL (OAR)
L.G. Hanscom Field
Bedford, Massachusetts 01731

RAWER, Prof. K/
Arb. Gr. Physik Weltraumforschung
13 Kronen Street
78 Freiburg (F. R. Germany)

REBER, Dr. Grote
Radio Observatory
Post Office Box 293
Delaware, Ohio 43015

REED, Dr. Jack W.
Sandia Laboratories
Department 9150
Albuquerque, New Mexico 87115

REED, Major John W.
AFCRL (CROR)
L. G. Hanscom Field
Bedford, Massachusetts 01730

REED, Dr. Richard J.
Department of Atmospheric Sciences
University of Washington
Seattle, Washington 98105

REES, Dr. M. H.
Laboratory for Atmospheric
and Space Physics
University of Colorado
Boulder, Colorado 80302

REEVES, Dr. Edmond M.
Harvard College Observatory
60 Garden Street
Cambridge, Massachusetts 02138

RETTIE, Dr. R. S.
Chief, Space Res. Facilities Branch
National Research Council
Ottawa, Ontario
CANADA

RIGHINI, Dr. G.
Osservatorio Astrofisico di Arcetri
Via S. Leonardo 73
Firenze, Italy

RIGUTTI, Dr. Mario
Chairman, IAU-Working Group on
Solar Eclipses
Osservatorio Astronomico
Capodimonte P. G.
Via Moiariello, 16
80131 Napoli, Italy

ROBERTS, Mr. William T.
NASA, Marshall Space Flight Center
Aero-Astrodynamics Laboratory
Huntsville, Alabama 35812

ROBERTSON, Dr. M. M.
Org. 1122
Sandia Corporation
Albuquerque, New Mexico 87115

ROBINSON, Dr. Herman P.
Lawrence Radiation Laboratory
University of California
Berkeley, California 94720

Robinson, Mr. Leif
Sky and Telescope
49-50-51 Bay State Road
Cambridge, Massachusetts 02138

ROEDERER, Dr. Juan G.
Center for Study of Planetary
Radiation Environment
University of Denver
Denver, Colorado 80210

ROELOFS, T. H.
Dept. of Electrical Engineering
University of Hawaii
Honolulu, Hawaii 96822

De ROMANA, Fernando
Casilla 98
Arequipa, Peru

Da ROSA, Dr. Aldo V.
Radioscience Laboratory
Stanford University
Stanford, California 94305

ROTH, Mr. Herbert E.
c/o United Airlines
Flight Training Center
Stapelton International Airport
Denver, Colorado 80207

ROULEAU, Dr. John K.
International Scientific and
Technological Affairs, Rm. 7845
Department of State
Washington, D. C. 20520

ROUY, Dr. Auguste
Department of Chemistry
Rutgers University
40 Rector Street
Newark, New Jersey 07102

RYCROFT, Dr. Michael J.
Department of Physics
The University of Southampton
Southampton, SO9 5NH
England

SAFKO, Dr. John L.
Department of Physics and Astronomy
University of South Carolina
Columbia, South Carolina 29208

SAITO, Dr. Kuniji
Tokyo Astronomical Observatory
Mitaka, Tokyo
JAPAN

SALES, Dr. Gary S.
AFCRL (OAR)
L. G. Hanscom Field
Bedford, Massachusets 01731

SCHATTEN, Dr. Kenneth H.
Extraterrestrial Physics Branch
Code 692
NASA Goddard Space Flight Center
Greenbelt, Maryland 20771

SCHMIDT, Mr. Terry E.
President
TERSCH ENTERPRISES
Post Office Box 1059
Colorado Springs, Colorado 80901

SCHNEIDER, Dr. Otter
Observatorio Astronomico
Paseo del Bosque
La Plata, ARGENTINA

SCHRADER, Dr. D. H.
Electrical Engrg. Section
Washingto State University
Pullman, Washington 99163

SEARS, Dr. Robert
Department 52/14-202
Lockheed Palo Alto Res. Lab.
3251 Hanover Street
Palo Alto, California 94304

SELIGA, Dr. Thomas A.
Department of Electronic Engineering
Ohio State University
2015 Neil Avenue
Columbus, Ohio 43210

SEWELL, Dr. W. R.
Department of Geography
University of Victoria
Victoria, British Columbia
CANADA

SEYKORA, Dr. Edward J.
Department of Physics
East Carolina University
Greenville, North Carolina

SHAPIRO, Dr. L. Dennis
Director of Research
Aerospace Research, Inc.
130 Lincoln Street
Boston, Massachusetts 02135

SHAPLEY, Mr. Alan H.
ESSA-Research Laboratories
Office of Programs
Boulder, Colorado 80302

SHERMAN, Dr. Kenneth
U. S. Bureau of Commercial Fisheries
Biological Laboratory
W. Boothbay Harbor, Maine 04575

SHERRY, LCol. Don T.
SAES/OJCS
The Pentagon, Room 1B678
Washington, D. C. 20301

SIEVERS, Mr. J. R.
CSA
National Academy of Sciences - NRC
Washington, D. C. 20418

SIMON, Mr. Alyce R.
860 United Nations Plaza
Suite 30B
New York, New York 10017

SIMON, Dr. Michal
Department of Earth and
Space Sciences
State University of New York at
Stony Brook,
Long Island, New York 11790

SIMONPIETRI, Dr. Andre C.
U. S. Embassy
Buenos Aires, Argentina

SIMPSON, Dr. J. W.
Code C-03
Lockheed Electronics Co.
16811 E. Camino Real
Houston, Texas 77058

SINZI, Dr. A. M.
Chief, Astronomical Division
Hydrographic Department
Tsukiji - 5, Chuo-ku
Tokyo, Japan

SKRIVSETH, Mr. A. G.
Federal Communications Commissions
Office of Chief Engineer
Washington, D. C. 20554

SLAUGHTER, Dr. Charles
Solar Division
Kitt Peak National Observatory
950 North Cherry Avenue
Tucson, Arizona 85717

SLOAN, Dr. William
Dept. of Physics & Astronomy
Mount Union College
219 West State Street
Alliance, Ohio 44601

SMITH, Dr. Alex G.
Department of Physics and Astronomy
University of Florida
Gainesville, Florida 32601

SMITH, Mr. E. K.
R x 2
ESSA Research Laboratories
Boulder, Colorado 80302

SMITH, Dr. Leslie G.
GCA Technology Division
GCA Corporation
Bedford, Massachusetts 01730

SMITH, Dr. Sara F.
Lockheed Solar Observatory
Lockheed-California Company
Burbank, California 91503

SMITH, Mr. Sheldon
NASA - Ames Research Center
Moffett Field, California 94035

SMITH, Dr. Wendell S.
Aeronomy Branch
NASA, Goddard Space Flight Center
Greenbelt, Maryland 20771

SOWER, Mr. J. F.
SRDS, Federal Aviation Admin.
RD 215
Washington, D. C. STOP 34

SPEER, Dr. R. J.
Imperial College of
Science and Technology
Department of Physics
Prince Consort Road, London SW 7

SPENCER, Dr. N. W.
Code 620
NASA - Goddard Space Flight Center
Greenbelt, Maryland 20771

SQUIRE, Mr. Christopher A.
Science Reporting Officer
American Embassy
Moscow, Russia, USSR

STERN, Dr. David P.
Code 641
Goddard Space Flight Center
Greenbelt, Maryland 20771

STERNBERG, Dr. R.
Department of Physics,
University of Manchester
Manchester 13, Great Britain

STOCKHAUSEN, Mr. Ralph
Code 614 - Solar Physics Branch
Goddard Space Flight Center
Greenbelt, Maryland 20771

STREETER, Miss Jean R.
Geography Branch
Office of Naval Research
Washington, D. C. 20360

STROSCHEIN, Dr. Leander A.
U. S. Army Natick Laboratories
Natick, Massachusetts 01760

SUEMOTO, Dr. A.
Department of Astronomy
Faculty of Science, Univ. of Tokyo
Bunkyo-Ku, Tokyo
JAPAN

SULLIVAN, Mr. Walter
New York Times
229 West 33rd Street
New York, New York 10036

SUOMI, Professor Verner E.
Director, Space Science & Engrg. Ctr.
University of Wisconsin
Madison, Wisconsin 53706

SYKES, Dr. Robert B. Jr.
Director
Lake Ontario Environmental Laboratory
State University College
Oswego, New York 13126

TELEFORD, Dr. Larry
Microwave Physics Laboratory
ARCRL
L. G. Hanscom Field
Bedford, Massachusetts 01731

TESKE, Dr. Richard G.
Department of Astronomy
The University of Michigan
Ann Arbor, Michigan 48104

THIESSEN, Mr. Willard J.
Bristol Aerospace (1968) Limited
Post Office Box 874
Winnipeg, Manitoba, Canada

THOMAS, Mr. Robert, Jr.
Technical Publications
Volt Information Sciences, Inc.
5640 Fisher Lane
Rockville, Maryland 20852

THOMPSON, Dr. Warren E.
International Science Activities
National Science Foundation
Washington, D. C. 20550

THORNE, Dr. Rivhard M.
Department of Meteorology
University of California
Los Angeles, California 90024

TOMAN, Dr. Kurt
Ionospheric Physics Laboratory
AFCRL (CRPR)
L. G. Hanscom Field
Bedford, Massachusetts 01731

TOUSEY, Dr. Richard
Code 7140
Naval Research Laboratory
Washington, D. C. 20390

TRINKLIN, Mr. Frederick
Long Island Lutheran High School
131 Brookvolle Road
Glen Head, New York 11545

TVETEN, Dr. L. H.
Inst. for Telecommunication Sciences
ESSA Research Laboratories
Boulder, Colorado 80302

ULWICK, Dr. James C.
AFCRL (OAR)
L. G. Hanscom Field
Bedford, Massachusetts

VAIANA, Dr. Giuseppe
American Science and Engineering
11 Carlton Street
Cambridge, Massachusetts 02142

VAN de KAMP, Dr. Peter
Sproul Observatory
Swarthmore College
Swarthmore, Pennsylvania 19081

VANDE NOORD, Dr. E.
Ball Brothers Research Corp.
Boulder Industrial Park
Boulder, Colorado 80302

VARSAVSKY, Dr. Carlos M.
Director, Instituto Argentina
Radio Astronomy, Casilla de Correo 5
Villa Elisa
Buenos Aires, Argentina

VERBARA, Profesors Gladys
Universidad de la Republica
Facultad De Ingenieria Y Argrimensura
Montevideo, Uruguay

VESECKY, Dr. John F.
Center for Radar Astronomy
Stanford University
Stanford, California 94305

VIGNERON, Dr. Jacques
Groupe de Recherches Ionospherique
4 Avenue de Neptune
94, St. Maur des Fosses, France

VOILETTE, E. J.
ESSA Research Laboratories, I.T.S.
Boulder, Colorado 80302

WALDMEIER, Dr. Max, Director
Swiss Federal Observatory
Schmelzbergstrasse 25
8006 Zurich, Switzerland

WALKER, Dr. J. C. G.
Department of Geology
Yale University
New Haven, Connecticutt 06520

WALKER, Dr. Russell G.
AFCRL (OAR)
L. G. Hanscom Field
Bedford, Massachusetts 01731

WARD, Mr. Bobby J.
2729 Everett Avenue
Raleigh, North Carolina 27607

WATKINS, Mr. William H.
Chief Engineer
Federal Communications Commission
Room 714
Washington, D. C. 20554

WATSON, Mr. D. Keith
Assistant to the Director
High Altitude Observatory
Boulder, Colorado 80302

WAX, Dr. R. L.
Space Sciences Laboratory
TRW Systems
Redondo Beach, California

WEART, Dr. Spencer R.
Department of Astronomy
California Institute of Technology
Pasadena, California 91109

WEAVER, Miss Mary K.
Administrative Assistant
Astrophysics Research Corporation
Corona Division
P. O. Box 100
Norco, California 91760

WEICKMANN, Dr. H. K.
Atmosphere Physics & Chemistry Lab.
ESSA Research Laboratories
Boulder, Colorado 80302

WEBB, Dr. Willis L.
Atmospheric Sciences Office
U. S. Army Electronics Command
White Sands Missile Range, N. M. 88002

WEBBER, Dr. Robert T.
Scientific Attache
American Embassy
APO San Francisco 96503

WEIRAUCH, Dr. Robert F.
Department of Astronomy
Western Connecticut State College
181 White Street
Danbury, Connecticut 06810

WESTERVELT, Dr. Donald
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87544

WHEDON, Mrs. Frances L.
Office of Chief, Re. & Dev.
Department of the Army
Washington, D. C. 20310 (STOP103)

WIPPLE, Dr. Fred
Astrophysical Observatory
Smithsonian Institution C
Cambridge, Massachusetts 02138

WIEDER, Dr. Bernard
Ionospheric Telecommunication Lab
ESSA Research Laboratories
Boulder, Colorado 80301

WILKINS, Mr. Walter E.
President
Indiana Astronomical Society, Inc.
6124 Dewwy Avenue
Indianapolis, Indiana 46219

WILLIAMS, Dr. William W.
Scientific Attache
American Embassy
APO New York 09080

WILSON, Charles R. (Dr.)
Geophysical Institute,
University of Alaska
College, Alaska 99701

WILSON, Dr. R.
Astrophysics Research Unit
Culham Laboratory
Abingdon, Bershire, ENGLAND

WIRTANEN, Dr. Theodore
Terrestrial Sciences Laboratory
AFCRL (CRJA)
L. G. Hanscom Field
Bedford, Massachusetts 01730

WOLCOTT, John H.
Los Alamos Scientific Laboratory, J-16
P. O. Box 1663
Los Alamos, New Mexico 87544

WOODMAN, Dr. Ronald
Instituto Geofisco de Peru
Apartado 3747
Lima, Peru

WOODWARD, Dr. Ervin C.
Lawrence Radiation Laboratory
Post Office Box 808
Livermore, California 94550

WRIGHT, Dr. J. W.
ESSA Research Laboratories
Boulder, Colorado 80301

WUSSLER, Mr. Robert
Director, Special Events
CBS News
524 West 57th Street
New York, New York 10019

YEH, Dr. K. C.
Department of Electrical Engineering
University of Illinois
Urbana, Illinois 61803

YERKES, Mr. Peter
Time Yearbook
Time-Life Building
New York, N. Y.

ZHRINGER, Prof. J.
Max Planck Institut fur Kernphysik
Heidelberg, Germany

POINTS OF CONTACT FOR 1970 ECLIPSE ACTIVITIES
(for addresses see mailing list)

NATIONAL COORDINATORS:	United States	Albert E. Belon
	Mexico	Arcadio Poveda
	Canada	John L. Locke
REPRESENTATIVES OF SCIENTIFIC UNIONS:	IUCSTP	Edward R. Dyer
	IAGA	Leroy R. Alldredge
	IAU	Mario Rigutti
	URSI	C. M. Minnis
	Astronomical League	Russell C. Maag

AGENCY COORDINATORS:

NATIONAL AERONAUTICS & SPACE ADMIN (NASA)	G.K. Oertel & P.T. Eaton
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ENVIRONMENTAL SCIENCE SERVICES ADM (ESSA)	Martin E. Nason
LOS ALAMOS SCIENTIFIC LABORATORY (LASL)	Robert R. Brownlee
FEDERAL AVIATION ADMINISTRATION	William R. Andrews (Alternate: Edwin H. Price)
FEDERAL COMMUNICATIONS COMMISSION	William H. Watkins
DEPARTMENT OF THE INTERIOR (National Park Service)	Roger Allin

INTERNATIONAL ASTRONOMICAL UNION
Working Group on Solar Eclipses

Professor Mario Rigutti
Chairman, IAU-Working Group on
Solar Eclipses
Osservatorio Astronomico
Capodimonte P.G.
Via Moiariello, 16
80131 Napoli, Italy

Dr. R. G. Athay
High Altitude Observatory
Boulder, Colorado - USA

Professor M. Cimino
Osservatorio Astronomico
su Monte Mario
Via del Parco Mellini, 84
00100-Roma, Italy

Dr. R. L. Duncombe
Director
Nautical Almanac Office
Washington, D.C. 20390 - USA

Dr. G. B. Gelfrejh
Main Astronomical Observatory
USSR Academy of Sciences
Pulkovo, USSR

Dr. M. N. Gnevysev
Astronomical Observatory
Leningrad M-140, USSR

Dr. R. F. Haupt
U.S. Naval Observatory
Washington, D. C. 20390 - USA

Dr. G. Henderson
42, Horham Street
Glasgow S. 1, England

Dr. J. Houtgast
Astronomical Observatory
"Sonnenborgh"
Zonnenburg 2
Utrecht, Holland

Dr. J. T. Jefferies
Hawaii Institute of Geophysics
2525 Correa Road
University of Hawaii
Honolulu, Hawaii 96822 - USA

Dr. H. Von Klüber
The Observatories
Madingley Road
Cambridge, England

Dr. H. Kristenson
Ole Romer Observatory
Aarhus C, Denmark

Professor F. Q. Orrall
Hawaii Institute of Geophysics
2525 Correa Road
Honolulu, Hawaii 96822 - USA

Professor G. Righini
Osservatorio Astrofisico di Arcetri
Largo E. Fermi, 5
50125-Florence, Italy

Dr. Z. Suemoto
Tokyo Astronomical Observatory
Mitaka near Tokyo, Japan

Professor M. Waldmeier
Director
Swiss Federal Observatory
Schmelzbergstrasse 25, Switzerland

U. S. INTER-AGENCY COORDINATING PANEL FOR THE 1970 SOLAR ECLIPSE

NSF	- U.S. Coordinating Agency for 1970 Eclipse		
	Chairman	:	A. E. Belon
	International Affairs	:	W. Thompson
	Adviser	:	R. Fleischer
NASA	-		G. K. Oertel P. T. Eaton (Others as appropriate)
DOD	-		T. H. R. O'Neill W. W. Berning (Others as appropriate)
ESSA	-		Martin Nason
AEC (LASL)	-		R. R. Brownlee
NAS	- IUCSTP	:	E. R. Dyer
	CSTR & SSB	:	W. Bartley
STATE DEPT	-		J. K. Rouleau
FAA	-		L. McCaughey E. H. Price
FCC	-		W. H. Watkins
CUSTOMS	-		E. Bennett E. Okon
INTERIOR	-		Roger Allin

UNIVERSIDAD NACIONAL AUTONOMA DE MEXICO
OBSERVATORIO ASTRONOMICO NACIONAL

APARTADO POSTAL 70-264
CIUDAD UNIVERSITARIA
MEXICO 20, MEXICO

TELEFONOS: 48-37-12, 48-53-06, 48-65-00 EXT. 156

December 1o., 1969.

Dr. R. Belon
National Science Foundation
Washington, D.C. 20550
U.S.A.

Dear Dr. Belon,

We wish to inform you that the Mexican National Committee for the Solar Eclipse of March 7, 1970 has now been integrated. Representatives of the national institutions that will be active in this event form the committee and are listed below.

Arcadio Poveda, Coordinator	Director of the Astronomical Institute of the National University of Mexico
Víctor Bravo Ahuja	Governor of the State of Oaxaca
Carlos Elizondo	Secretary of the National Space Commission
Manuel Méndez	Astronomical Institute of the National University of Mexico
Ruth Gall	Institute of Geophysics of the National University of Mexico
José Manuel Alonso	National Polytechnical Institute
Manuel Maldonado-Koerdell	Panamerican Institute of Geography and History
Javier Lelo de Larrea	Department of Tourism
	Representative of the Ministry of Foreign Affairs

Please address all correspondence to the coordinator of the committee.

Sincerely yours,

A. P.

Dr. Arcadio Poveda

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CHAPTER 2 - CLASSIFICATION OF PROJECTS

In this chapter the projects which are presently planned have been classified according to discipline, projects' location, method of measurement, and agency. The list gives the page number where the description of a particular experiment and the principal investigater is found. It is hoped that such a classification will lead experimenters to contact and initiate coordination with other experimenters who have similar scientific or logistic interest.

Note: An expressed objective of projects preceded by a "G" was an attempt to detect gravity waves generated by the eclipse shadow.

2.1 - Disciplines:

The Sun - Optical Measurements

3.1-F-01.00	Houtgast
3.1-F-01.01	Makita
3.1-C-02.01	Devinney
3.1-E-02.02	Pierce
3.1-F-02.03	Evans
3.1-F-02.04	Livingston
3.1-E-02.05	Slaughter
3.1-F-03.00	Kopp
3.1-F-04.00	Newkirk
3.1-F-04.01	Malville
3.1-E-04.02	Beckers
3.1-F-04.03	Egorova
3.1-F-04.04	Novikov
3.1-F-04.06	Mack
3.1-F-04.07	Mogilevsky
3.1-F-05.01	Harvey
3.1-F-05.02	Arnquist
3.1-F-05.03	Larmore
3.1-F-05.04	Meisel
3.1-F-05.06	Kitchen
3.1-F-05.07	Sobolev
3.1-F-07.00	Sinzi
3.1-F-07.01	Safko
3.1-F-08.00	Kanno
3.1-F-09.00	Weart
3.1-E-10.02	Accardo
3.1-F-10.03	Vaiana
3.1-F-11.00	Goldberg
3.1-F-11.01	Brueckner
3.1-F-11.02	Koomen
3.1-F-11.03	Purcell
3.1-E-12.01	Cimino
3.1-E-14.00	Boquist
3.1-F-15.00	Saito
3.1-F-15.01	Billings
3.1-F-16.00	Michard
3.1-F-16.01	Koutchmy

The Sun - Optical Measurements (continued)

3.1-D-17.01	Hoffman
3.1-E-17.02	Keller
3.1-F-17.03	Engleman
3.1-E-17.04	Olsen
3.1-F-18.00	McQueen
3.1-F-19.00	Jefferies
3.1-F-19.01	Waldmeier
3.1-E-19.02	Sternberg
3.1-F-19.03	Henderson
3.1-F-19.04	Hirschberg
3.1-F-19.05	Eakin
3.1-F-20.00	Korff
3.1-F-21.00	Menzel
3.1-F-21.01	Menzel
3.1-E-21.02	Bappu
3.1-F-21.03	Lee
3.1-F-21.04	de Romana
3.1-F-21.05	Pepin
3.1-F-21.06	Safko
3.1-F-21.07	Smith
3.1-F-22.01	Righini
3.1-F-22.02	McDougal
3.1-F-22.03	Smith
3.1-F-22.04	Schatten
3.1-F-23.00	Teske
3.1-F-23.01	Safko
3.1-F-24.00	Reed
3.1-F-25.00	Stroscheim
3.1-F-27.01	Kovar
3.1-F-27.02	Kovar
3.1-F-27.03	Larmore
3.1-F-28.00	Maag
3.1-E-28.01	Johnson
3.1-E-28.02	Johnson
3.1-F-28.04	Schmidt
3.1-F-28.05	Roth
3.1-F-28.06	Wilkins
3.1-F-29.00	Helms

The Sun - Radio Measurements

3.1-E-28.01	Johnson
3.1-E-28.02	Johnson
3.2-F-01.00	Hagen
3.2-F-02.00	Wrixon
3.2-F-03.00	Aarons
3.2-F-04.00	Matsuura
3.2-F-05.00	Simon
3.2-F-07.00	O'Brien
3.2-E-08.00	Frost
3.2-F-09.00	Telford

The Interplanetary Medium

	3.1-F-05.03	Larmore
	3.1-F-11.01	Purcell
	3.1-F-23.01	Safko
	3.1-F-27.01	Kovar
	3.1-F-27.02	Kovar
	3.1-F-28.00	Maag
	3.1-E-28.01	Johnson
	3.1-E-28.02	Johnson
	3.1-F-28.04	Schmidt
	3.1-F-28.05	Roth
	3.3-F-01.01	Courten
	3.3-F-01.02	Lee
	3.3-F-04.00	Peterson
	3.3-F-04.01	Peterson
	3.3-F-05.00	Bernstein

The Upper Ionosphere

	3.3-F-05.00	Bernstein
G	3.4-E-01.00	Nelms
	3.4-F-02.01	Rycroft
	3.4-F-02.02	McPherson
	3.4-E-03.00	Aarons
	3.4-E-03.01	Millman
	3.4-F-03.02	Yeh
	3.4-F-03.03	Thorne
G	3.4-F-03.04	da Rosa
	3.4-F-03.05	Roelofs
	3.4-F-03.06	Mahadevan
G	3.4-F-03.07	McDougal
	3.4-D-05.00	Heath
	3.4-F-05.03	Wolcott
	3.4-F-05.04	Fastie
	3.4-F-06.00	Spencer
	3.4-F-07.00	Gray
G	3.4-F-07.01	Oetzel
G	3.4-F-07.02	Olesen
G	3.4-F-08.00	Tveten
G	3.4-F-08.01	Schrader
	3.4-F-08.02	Violette
G	3.4-F-08.03	Harbour
	3.4-F-08.04	Jenkins
G	3.4-F-08.05	Vesecky
	3.4-F-09.00	Evans
	3.4-E-09.01	Mead
	3.4-F-09.02	Carlson
G	3.4-F-09.03	Baron
	3.4-E-10.00	Bibl
	3.4-E-10.01	Bibl
G	3.4-F-10.02	Anastassiadis
	3.4-F-12.00	Toman
G	3.4-F-12.01	Montes

The Upper Ionosphere (continued)

G	3.4-F-12.02	Seliga
	3.4-E-13.00	Nunez
	3.4-F-14.00	Meisel
G	3.4-F-14.01	Sears
	3.4-F-15.00	Maynard
	3.5-F-03.00	Narcisi
	3.5-F-05.00	Davis
G	3.8-F-03.00	Wilson

The Lower Ionosphere

	3.1-F-24.00	Reed
	3.4-F-12.00	Toman
	3.5-F-01.00	Bowhill
	3.5-E-01.01	Smith
	3.5-F-02.00	McNamara
	3.5-F-02.02	Bain
	3.5-F-03.00	Narcisi
	3.5-F-05.00	Davis
	3.5-F-05.01	Cutolo
G	3.5-F-05.02	Clark
	3.5-E-08.00	Gassmann
	3.5-D-09.00	Sales
	3.5-F-11.00	Ferraro
	3.5-E-11.02	Gall
	3.5-E-12.00	Wieder
	3.5-F-13.00	Noonkester
	3.5-F-15.00	Doherty
	3.5-F-17.00	Gadsden
	3.5-F-17.01	Sides
	3.5-E-20.00	Weeks
	3.5-D-21.00	Lloyd
	3.5-F-21.01	Dandekar
	3.5-F-22.00	Horvath
	3.5-E-23.00	Faire
	3.5-E-24.00	Hilsenrath

Magnetic Variations

3.4-F-12.01	Montes
3.4-F-15.00	Maynard
3.6-F-01.00	Bomke
3.6-F-02.00	Del Castillo
3.6-F-03.00	Cotten
3.6-F-04.00	Lanzerotti
3.6-F-05.00	Safko

Meteorology

	3.1-F-05.06	Kitchen
	3.1-F-25.00	Stroschein
	3.1-F-27.02	Kovar
	3.1-F-27.03	Larmore
	3.1-E-28.01	Johnson
	3.1-E-28.02	Johnson
	3.4-F-05.04	Fastie
G	3.4-F-10.02	Anastassiadis
	3.4-F-12.01	Montes
	3.5-F-22.00	Horvath
	3.7-E-02.00	Williams
	3.7-F-03.01	Henry
	3.7-E-06.00	Kuhn
	3.7-F-09.00	Hall
	3.7-F-10.00	Hults
	3.7-F-10.01	Wirtanen
	3.7-F-10.02	Pate
	3.7-F-10.03	Quann
	3.7-F-10.04	Clark
	3.7-F-10.05	Seykora
	3.7-E-11.00	Mosino
	3.7 F-11.01	Outcalt
G	3.7-F-12.00	Badgley
G	3.7-F-12.01	Reed
G	3.7-F-12.02	Donn
G	3.7-F-12.03	Anderson
G	3.7-F-12.04	Latham
	See also projects 3.8-F-03.00 to 03.04	
	3.7-F-13.00	Markson
	3.7-F-13.01	Anderson
	3.7-F-14.00	Knappenberger
	3.7-F-15.00	Franceschini
	3.7-F-16.00	Lawrence
	3.7-F-17.00	Bullock

Biology

	3.7-F-14.00	Knappenberger
	3.7-F-15.00	Franceschini
	3.8-F-04.00	Sherman

Other

	3.1-F-07.00	Sinzi
	3.1-F-07.01	Safko
	3.4-F-05.04	Fastie
	3.8-F-01.00	Medina
	3.8-E-02.00	Mendez
G	3.8-F-03.00	Wilson
G	3.8-F-03.01	Craine

The Upper Ionosphere (continued)

G	3.4-F-12.02	Seliga
	3.4-E-13.00	Nunez
	3.4-F-14.00	Meisel
G	3.4-F-14.01	Sears
	3.4-F-15.00	Maynard
	3.5-F-03.00	Narcisi
	3.5-F-05.00	Davis
G	3.8-F-03.00	Wilson

The Lower Ionosphere

	3.1-F-24.00	Reed
	3.4-F-12.00	Toman
	3.5-F-01.00	Bowhill
	3.5-E-01.01	Smith
	3.5-F-02.00	McNamara
	3.5-F-02.02	Bain
	3.5-F-03.00	Narcisi
	3.5-F-05.00	Davis
	3.5-F-05.01	Cutolo
G	3.5-F-05.02	Clark
	3.5-E-08.00	Gassmann
	3.5-D-09.00	Sales
	3.5-F-11.00	Ferraro
	3.5-E-11.02	Gall
	3.5-E-12.00	Wieder
	3.5-F-13.00	Noonkester
	3.5-F-15.00	Doherty
	3.5-F-17.00	Gadsden
	3.5-F-17.01	Sides
	3.5-E-20.00	Weeks
	3.5-D-21.00	Lloyd
	3.5-F-21.01	Dandekar
	3.5-F-22.00	Horvath
	3.5-E-23.00	Faire
	3.5-E-24.00	Hilsenrath

Magnetic Variations

3.4-F-12.01	Montes
3.4-F-15.00	Maynard
3.6-F-01.00	Bomke
3.6-F-02.00	Del Castillo
3.6-F-03.00	Cotten
3.6-F-04.00	Lanzerotti
3.6-F-05.00	Safko

2.2 - Project Locations:

Mexico:

3.1-F-01.00	Houtgast
3.1-F-01.01	Makita
3.1-C-02.01	Devinney
3.1-E-02.02	Pierce
3.1-F-02.03	Evans
3.1-F-02.04	Livingston
3.1-E-02.05	Slaughter
3.1-F-03.00	Kopp
3.1-F-04.00	Newkirk
3.1-F-04.01	Malville
3.1-E-04.02	Beckers
3.1-F-04.03	Egorova
3.1-F-04.04	Novikov
3.1-F-04.07	Mogilevsky
3.1-F-05.02	Arnquist
3.1-F-05.03	Larmore
3.1-F-05.07	Sobolev
3.1-F-07.00	Sinzi
3.1-F-08.00	Kanno
3.1-F-09.00	Weart
3.1-E-12.01	Cimino
3.1-E-14.00	Boquist
3.1-F-15.00	Saito
3.1-F-16.00	Michard
3.1-F-16.01	Koutchmy
3.1-F-18.00	McQueen
3.1-F-19.00	Jefferies
3.1-F-19.01	Waldmeier
3.1-E-19.02	Sternberg
3.1-F-19.03	Henderson
3.1-F-19.04	Hirschberg
3.1-F-19.05	Eakin
3.1-F-20.00	Korff
3.1-F-21.00	Menzel
3.1-F-21.01	Menzel
3.1-E-21.02	Bappu
3.1-F-21.04	de Romana
3.1-F-21.05	Pepin
3.1-F-22.02	McDougal
3.1-F-27.01	Kovar
3.1-F-27.02	Kovar
3.1-F-27.03	Larmore
3.1-F-28.00	Maag
3.1-E-28.01	Johnson
3.1-F-28.04	Schmidt
3.1-F-28.05	Roth
3.2-F-01.00	Hagen
3.3-F-01.01	Courten
3.3-F-04.00	Peterson
3.3-F-04.01	Peterson
3.4-F-03.03	Thorne
3.4-F-03.06	Mahadevan
3.4-E-13.00	Nunez

Mexico: (continued)

3.5-E-11.02	Gall
3.5-F-17.00	Gadsden
3.6-F-02.00	Del Castillo
3.7-E-06.00	Kuhn
3.7-F-09.00	Hall
3.7-E-11.00	Mosino
3.8-F-01.00	Medina
3.8-E-02.00	Mendez

Florida:

3.1-F-22.01	Righini
3.1-F-28.00	Maag
3.1-E-28.02	Johnson
3.1-F-28.06	Wilkins
3.4-F-03.02	Yeh
3.5-F-05.01	Cutolo
3.5-F-13.00	Noonkester
3.5-D-14.00	Rasmussen
3.5-F-17.01	Sides
3.5-E-20.00	Weeks
3.5-E-23.00	Faire
3.6-F-01.00	Bomke
3.7-E-02.00	Williams
3.7-F-12.03	Anderson
3.7-F-12.04	Latham

Georgia:

3.1-F-28.00	Maag
3.4-F-08.04	Jenkins
3.7-F-14.00	Knappenberger

South Carolina:

3.1-F-07.01	Safko
3.1-F-21.06	Safko
3.1-F-23.01	Safko
3.6-F-05.00	Safko
3.8-F-05.00	Avignone

North Carolina:

3.1-F-20.00	Korff
3.1-F-21.07	Smith
3.1-F-28.00	Maag
3.1-F-29.00	Helms
3.4-F-03.04	da Rosa
3.5-E-12.00	Wieder
3.5-F-21.01	Dandekar
3.6-F-03.00	Cotten
3.7-F-10.00	Hults
3.7-F-10.05	Seykora

Virginia:

3.1-F-04.06	Mack
3.1-F-05.01	Harvey
3.1-F-05.04	Meisel
3.1-F-05.06	Kitchen
3.1-E-10.02	Accardo
3.1-F-11.00	Goldberg
3.1-F-11.01	Brueckner
3.1-F-15.01	Billings
3.1-F-21.03	Lee
3.1-F-22.03	Smith
3.1-F-23.00	Teske
3.1-F-28.00	Maag
3.2-F-05.00	Simon
3.2-F-07.00	O'Brien
3.3-F-01.02	Lee
3.3-F-05.00	Bernstein
3.4-F-03.02	Yeh
3.4-F-03.04	da Rosa
3.4-F-05.00	Heath
3.4-F-05.04	Fastie
3.4-F-06.00	Spencer
3.4-F-07.00	Gray
3.4-F-15.00	Maynard
3.5-F-01.00	Bowhill
3.5-E-01.01	Smith
3.5-F-03.00	Narcisi
3.5-E-08.00	Gassman
3.5-F-22.00	Horvath
3.5-E-24.00	Hilsenrath
3.7-F-03.01	Henry
3.7-F-11.01	Outcalt
3.7-F-10.02	Pate
3.7-F-10.03	Quann
3.7-F-10.04	Clark
3.7-F-13.00	Markson
3.7-F-16.00	Lawrence

Maryland:

3.4-E-09.01	Mead
3.4-F-03.04	da Rosa
3.7-F-13.01	Anderson

New Jersey:

3.2-F-02.00	Wrixon
3.4-F-12.01	Montes
3.6-F-04.00	Lanzerotti
3.8-F-03.02	Donn

New York:

3.4-E-03.01	Millman
3.4-F-12.01	Montes
3.7-F-12.02	Donn
3.8-F-03.02	Donn

Massachusetts:

3.1-E-14.00	Boquist
3.1-F-25.00	Stroschein
3.1-F-28.00	Maag
3.2-F-03.00	Aarons
3.2-F-04.00	Matsuura
3.2-E-08.00	Frost
3.2-F-09.00	Telford
3.4-E-03.00	Aarons
3.4-E-03.01	Millman
3.4-F-09.00	Evans
3.4-E-10.00	Bibl
3.4-E-10.01	Bibl
3.4-F-12.00	Toman
3.5-D-09.00	Sales
3.7-F-10.01	Wirtanen
3.7-F-12.02	Donn
3.8-F-03.04	Cook

Maine:

3.8-F-04.00	Sherman

Canada:

3.4-F-02.01	Rycroft
3.5-F-02.00	McNamara
3.5-F-02.02	Bain
3.8-F-03.00	Wilson

Other:

3.1-F-10.03	Vaiana
3.1-F-11.02	Koomen
3.1-F-11.03	Purcell
3.1-F-22.04	Schatten
3.2-F-05.00	Simon
3.2-E-08.00	Frost

Other: (continued)

3.4-F-02.01	Rycroft
3.4-F-02.02	McPherson
3.4-F-03.04	da Rosa
3.4-F-03.05	Roelofs
3.4-F-03.07	MacDougall
3.4-F-07.01	Oetzel
3.4-F-07.02	Olesen
3.4-F-08.00	Tveten
3.4-F-08.01	Schrader
3.4-F-08.02	Violette
3.4-F-08.03	Harbour
3.4-F-08.05	Vesecky
3.4-E-09.01	Mead
3.4-F-09.02	Carlson
3.4-F-09.03	Baron
3.4-F-10.02	Anatassiadis
3.4-F-12.01	Montes
3.4-F-12.02	Seliga
3.4-F-14.00	Meisel
3.4-F-14.01	Sears
3.5-F-05.00	Davis
3.5-F-05.02	Clark
3.5-F-11.00	Ferraro
3.5-F-13.00	Noonkester
3.5-F-15.00	Doherty
3.7-F-12.00	Badgley
3.7-F-12.01	Reed
3.7-F-15.00	Franceschini
3.8-F-03.00	Wilson
3.8-F-03.01	Craine
3.8-F-03.03	Jordan
3.8-F-03.04	Cook

Aircraft:

3.1-E-14.00	Boquist
3.1-D-17.01	Hoffman
3.1-E-17.02	Keller
3.1-F-17.03	Engleman
3.1-E-17.04	Olsen
3.1-F-24.00	Reed
3.4-F-05.03	Wolcott
3.7-F-13.00	Markson

Satellites:

3.4-E-01.00	Nelms
3.7-F-17.00	Bullock

See also section 4.7 of Bulletin E

Uncertain:

3.5-D-21.00	Lloyd

2.3 - Method:

Ground-based Optical

3.1-F-01.00	Houtgast
3.1-F-01.01	Makita
3.1-C-01.00	Devinney
3.1-E-02.02	Pierce
3.1-F-02.03	Evans
3.1-F-02.04	Livingston
3.1-E-02.05	Slaughter
3.1-F-03.00	Kopp
3.1-F-04.00	Newkirk
3.1-F-04.01	Malville
3.1-E-04.02	Beckers
3.1-F-04.03	Egorova
3.1-F-04.04	Novikov
3.1-F-04.06	Mack
3.1-F-04.07	Mogilevsky
3.1-F-05.01	Harvey
3.1-F-05.02	Arnquist
3.1-F-05.03	Larmore
3.1-F-05.04	Meisel
3.1-F-05.06	Kitchen
3.1-F-05.07	Sobolev
3.1-F-07.00	Sinzi
3.1-F-07.01	Safko
3.1-F-08.00	Kanno
3.1-F-09.00	Weart
3.1-E-12.01	Cimino
3.1-E-14.00	Boquist
3.1-F-15.00	Saito
3.1-F-15.01	Billings
3.1-F-16.00	Michard
3.1-F-16.01	Koutchmy
3.1-F-18.00	Mc Queen
3.1-F-19.00	Jefferies
3.1-F-19.00	Waldmeier
3.1-E-19.02	Sternberg
3.1-F-19.03	Henderson
3.1-F-19.04	Hirschberg
3.1-F-19.05	Eakin
3.1-F-20.00	Korff
3.1-F-21.00	Menzel
3.1-F-21.01	Menzel
3.1-F-21.02	Bappu
3.1-F-21.03	Lee
3.1-F-21.04	de Romana
3.1-F-21.05	Pepin
3.1-F-21.06	Safko
3.1-F-21.07	Smith
3.1-F-22.01	Righini
3.1-F-22.02	Mc Dougal
3.1-F-22.03	Smith
3.1-F-22.04	Schatten
3.1-F-23.00	Teske
3.1-F-23.01	Safko
3.1-F-25.00	Stroschein

Ground-based Optical (continued)

3.1-F-27.01	Kovar
3.1-F-27.02	Kovar
3.1-F-27.03	Larmore
3.1-F-28.00	Maag
3.1-E-28.01	Johnson
3.1-E-28.02	Johnson
3.1-F-28.04	Schmidt
3.1-F-28.05	Roth
3.1-F-28.06	Wilkins
3.3-F-01.01	Courten
3.3-F-01.02	Lee
3.3-F-04.00	Peterson
3.3-F-04.01	Peterson
3.4-F-05.04	Fastie
3.5-F-17.00	Gadsden
3.5-F-17.01	Sides
3.5-D-21.00	Lloyd
3.5-F-21.01	Dandekar
3.7-E-06.00	Kuhn
3.7-F-09.00	Hall
3.7-F-10.00	Hults
3.7-F-10.01	Wirtanen
3.7-F-10.02	Pate
3.7-F-10.03	Quann
3.7-F-10.04	Clark
3.7-F-16.00	Lawrence
3.8-F-01.00	Medina
3.8-E-02.00	Mendez

Ground-based Radio

3.1-E-28.02	Johnson
3.2-F-01.00	Hagen
3.2-F-02.00	Wrixon
3.2-F-03.00	Aarons
3.2-F-04.00	Matsuura
3.2-F-05.00	Simon
3.2-F-07.00	O'Brien
3.2-E-08.00	Frost
3.2-F-09.00	Telford
3.4-F-02.01	Rycroft
3.4-F-02.02	Mcpherson
3.4-E-03.00	Aarons
3.4-E-03.01	Millman
3.4-F-03.02	Yeh
3.4-F-03.03	Thorne
3.4-F-03.04	da Rosa
3.4-F-03.05	Roelofs
3.4-F-03.06	Mahadevan
3.4-F-03.07	MacDougall

Ground-based Radio (continued)

3.4-F-07.00	Gray
3.4-F-07.01	Oetzel
3.4-F-07.02	Olesen
3.4-F-08.00	Tveten
3.4-F-08.01	Schrader
3.4-F-08.02	Violette
3.4-F-08.03	Harbour
3.4-F-08.04	Jenkins
3.4-F-08.05	Vesecky
3.4-F-09.00	Evans
3.4-F-09.01	Mead
3.4-F-09.02	Carlson
3.4-F-09.03	Baron
3.4-E-10.00	Bibl
3.4-E-10.01	Bibl
3.4-F-10.02	Anastassiadis
3.4-F-12.00	Toman
3.4-F-12.01	Montes
3.4-F-12.02	Seliga
3.4-E-13.00	Nunez
3.4-F-14.00	Meisel
3.4-F-14.01	Sears
3.5-F-05.00	Davis
3.5-F-05.01	Cutolo
3.5-F-05.02	Clark
3.5-E-08.00	Gassmann
3.5-D-09.00	Sales
3.5-F-11.00	Ferraro
3.5-E-11.02	Gall
3.5-E-12.00	Wieder
3.5-F-13.00	Noonkester
3.5-F-15.00	Doherty
3.7-F-10.05	Seykora
3.8-F-03.00	Wilson

Ground-based Magnetics

3.1-F-23.01	Safko
3.4-F-12.01	Montes
3.6-F-01.00	Bomke
3.6-F-02.00	Del Castillo
3.6-F-03.00	Cotten
3.6-F-04.00	Lanzerotti
3.6-F-05.00	Safko

Ground-based Meteorology

3.1-E-28.01	Johnson
3.1-E-28.02	Johnson
3.4-F-10.02	Anastassiadis

Ground-based Meteorology (continued)

3.4-F-12.01	Montes
3.7-F-09.00	Hall
3.7-E-11.00	Mosino
3.7-F-11.01	Outcalt
3.7-F-12.00	Badgley
3.7-F-12.01	Reed
3.7-F-12.02	Donn
3.7-F-12.03	Anderson
3.7-F-12.04	Latham
3.7-F-13.00	Markson
3.7-F-13.01	Anderson
3.7-F-14.00	Knappenberger

Ships

3.7-F-15.00	Franceschini
3.8-F-04.00	Sherman

Aircraft

3.1-E-14.00	Boquist
3.1-D-17.01	Hoffman
3.1-E-17.02	Keller
3.1-F-17.03	Engleman
3.1-E-17.04	Olsen
3.1-F-24.00	Reed
3.4-F-05.03	Wolcott
3.7-F-13.00	Markson

Rockets

3.1-E-10.02	Accardo
3.1-F-10.03	Vaiana
3.1-F-11.00	Goldberg
3.1-F-11.01	Brueckner
3.1-F-11.02	Koomen
3.1-F-11.03	Purcell
3.3-F-05.00	Bernstein
3.4-D-05.00	Heath
3.4-F-06.00	Spencer
3.4-F-15.00	Maynard
3.5-F-01.00	Bowhill
3.5-E-01.01	Smith
3.5-F-02.00	Mcnamara
3.5-F-02.02	Bain
3.5-F-03.00	Narcisi
3.5-E-20.00	Weeks
3.5-F-22.00	Horvath
3.5-E-23.00	Faire
3.5-E-24.00	Hilsenrath
3.7-E-02.00	Williams
3.7-F-03.01	Henry

Satellites

3.4-E-01.00 Nelms
3.7-F-17.00 Bullock
See also section 4.7 of Bulletin E

Other

3.1-F-29.00	Helms
3.7-F-15.00	Franceschini
3.8-F-03.00	Wilson
3.8-F-03.01	Craine
3.8-F-03.02	Donn
3.8-F-03.03	Jordan
3.8-F-03.04	Cook
3.8-F-04.00	Sherman
3.8-F-05.00	Avignone

2.4 - Institutions:

UNITED STATES

Universities

3.1-C-02.01	Devinney
3.1-F-05.04	Meisel
3.1-F-07.01	Safko
3.1-F-09.00	Weart
3.1-F-11.00	Goldberg
3.1-F-15.01	Billings
3.1-F-19.00	Jefferies
3.1-F-19.04	Hirschberg
3.1-F-19.05	Eakin
3.1-F-20.00	Korff
3.1-F-21.00	Menzel
3.1-F-21.01	Menzel
3.1-F-21.05	Pepin
3.1-F-21.06	Safko
3.1-F-23.00	Teske
3.1-F-23.01	Safko
3.1-F-27.01	Kovar
3.1-F-29.00	Helms
3.2-F-01.00	Hagen
3.2-F-05.00	Simon
3.2-E-08.00	Frost
3.3-F-01.01	Courten
3.3-F-04.00	Peterson
3.3-F-04.01	Peterson
3.4-F-03.02	Yeh
3.4-F-03.03	Thorne
3.4-F-03.04	da Rosa
3.4-F-03.05	Roelofs
3.4-F-05.04	Fastie
3.4-F-06.00	Spencer
3.4-F-08.01	Schrader
3.4-F-08.03	Harbour
3.4-F-08.04	Jenkins
3.4-F-08.05	Vescky
3.4-F-09.00	Evans
3.4-F-12.02	Seliga
3.4-F-14.00	Meisel
3.5-F-01.00	Bowhill
3.5-F-05.02	Clark
3.5-F-11.00	Ferraro
3.5-F-17.01	Sides
3.5-F-22.00	Horvath
3.6-F-03.00	Cotten
3.6-F-05.00	Safko
3.7-F-10.00	Hults
3.7-F-10.04	Clark
3.7-F-10.05	Seykora

UNITED STATES (continued)

Universities

3.7-F-11.01	Outcalt
3.7-F-12.00	Badgley
3.7-F-12.02	Donn
3.7-F-12.03	Anderson
3.7-F-12.04	Latham
3.7-F-13.00	Markson
3.7-F-15.00	Franceschini
3.8-F-03.00	Wilson
3.8-F-03.01	Craine
3.8-F-03.02	Donn
3.8-F-03.03	Jordan
3.8-F-05.00	Avignone

National Centers

3.1-E-02.02	Pierce
3.1-F-02.03	Evans
3.1-F-02.04	Livingston
3.1-E-02.05	Slaughter
3.1-F-03.00	Kopp
3.1-F-04.00	Newkirk
3.1-F-04.01	Malville
3.1-E-04.02	Beckers
3.1-F-18.00	McQueen
3.4-F-09.02	Carlson

Industry

3.1-F-05.02	Arnquist
3.1-F-05.03	Larmore
3.1-E-10.02	Accardo
3.1-F-10.03	Vaiana
3.1-E-14.00	Boquist
3.1-F-21.07	Smith
3.1-F-27.03	Larmore
3.2-F-02.00	Wrixon
3.2-F-07.00	O'Brien
3.3-F-05.00	Bernstein
3.4-E-03.01	Millman
3.4-F-03.06	Mahadevan
3.4-F-12.01	Montes
3.4-F-14.01	Sears
3.5-E-01.01	Smith
3.6-F-04.00	Lanzerotti
3.7-F-09.00	Hall

National Aeronautics and Space Admin.

3.1-F-04.06	Mack
3.1-F-05.01	Harvey
3.1-F-05.06	Kitchen
3.1-F-21.03	Lee
3.1-F-22.02	McDougal
3.1-F-22.03	Smith
3.1-F-22.04	Schatten
3.1-F-27.02	Kovar
3.3-F-01.02	Lee
3.4-D-05.00	Heath
3.4-F-06.00	Spencer
3.4-F-15.00	Maynard
3.5-F-22.00	Horvath
3.5-E-24.00	Hilsenrath
3.7-F-03.01	Henry
3.7-F-10.02	Pate
3.7-F-10.03	Quann
3.7-F-16.00	Lawrence
3.7-F-17.00	Bullock

Environmental Science Services Admin.

3.4-F-07.00	Gray
3.4-F-08.00	Tveten
3.4-F-08.02	Violette
3.4-F-08.05	Lerfald
3.5-E-12.00	Wieder
3.5-F-15.00	Doherty
3.5-F-17.00	Gadsden
3.7-F-03.01	Henry
3.7-E-06.00	Kuhn
3.8-F-03.04	Cook

Atomic Energy Commission

3.1-D-17.01	Hoffman
3.1-E-17.02	Keller
3.1-F-17.03	Engleman
3.1-E-17.04	Olsen
3.4-F-05.03	Wolcott
3.7-F-12.01	Reed

Bureau of Commercial Fisheries

3.8-F-04.00	Sherman

Army

3.1-F-25.00	Stroschein
3.6-F-01.00	Bomke
3.7-E-02.00	Williams

Air Force

3.1-E-04.02	Beckers
3.1-F-22.01	Righini
3.1-F-24.00	Reed
3.2-F-03.00	Aarons
3.2-F-09.00	Telford
3.4-E-03.00	Aarons
3.4-E-10.00	Bibl
3.4-E-10.01	Bibl
3.4-F-12.00	Toman
3.5-F-03.00	Narcisi
3.5-E-08.00	Gassmann
3.5-D-09.00	Sales
3.5-E-20.00	Weeks
3.5-D-21.00	Lloyd
3.5-F-21.01	Dandekar
3.5-E-23.00	Faire
3.7-F-10.01	Wirtanen

Navy

3.1-D-05.00	Heath
3.1-F-11.01	Brueckner
3.1-F-11.02	Koomen
3.1-F-11.03	Purcell
3.4-E-09.01	Mead
3.5-F-05.00	Davis
3.5-F-13.00	Noonkester
3.7-F-13.01	Anderson

Amateurs

3.1-F-28.00	Maag
3.1-E-28.01	Johnson
3.1-E-28.02	Johnson
3.1-F-28.05	Roth
3.1-F-28.06	Wilkins

Other

3.1-F-21.00	Menzel
3.1-F-21.01	Menzel
3.1-F-21.07	Smith
3.1-F-28.04	Schmidt
3.4-F-02.02	McPherson
3.4-F-07.01	Oetzel
3.4-F-09.03	Baron
3.4-E-10.00	Bibl
3.4-E-10.01	Bibl
3.7-F-14.00	Knappenberger

National Geographic Society

3.1-F-21.00	Menzel
3.1-F-21.01	Menzel

AUSTRIA	3.1-F-21.05	Pepin
BRAZIL	3.2-F-04.00	Matsuura
CANADA	3.1-F-11.00	Goldberg
	3.4-E-01.00	Nelms
	3.4-F-02.01	Rycroft
	3.5-F-02.00	McNamara
DENMARK	3.4-F-07.02	Olesen
FRANCE	3.1-F-16.00	Michard
	3.1-F-16.01	Koutchmy
GREECE	3.4-F-10.02	Anastassiadis
INDIA	3.1-E-21.02	Bappu
ITALY	3.1-E-12.01	Cimino
	3.1-F-22.01	Righini
	3.5-F-05.01	Cutolo
JAMAICA	3.4-F-03.07	MacDougall
JAPAN	3.1-F-01.01	Makita
	3.1-F-07.00	Sinzi
	3.1-F-08.00	Kanno
	3.1-F-15.00	Saito
MEXICO	3.4-E-13.00	Nunez
	3.5-E-11.02	Gall
	3.6-F-02.00	Del Castillo
	3.7-E-11.00	Mosino
	3.8-F-01.00	Medina
	3.8-E-02.00	Mendez
NETHERLANDS	3.1-F-01.00	Houtgast
PERU	3.1-F-21.04	de Romana
SWITZERLAND	3.1-F-19.01	Waldmeier
UNITED KINGDOM	3.1-F-11.00	Goldberg
	3.1-E-19.02	Sternberg
	3.1-F-19.03	Henderson
	3.4-F-02.01	Rycroft
	3.5-F-02.02	Bain
USSR	3.1-F-04.03	Egorova
	3.1-F-04.04	Novikov
	3.1-F-04.07	Mogilevsky
	3.1-F-05.07	Sobolev

CHAPTER 3 - DESCRIPTION AND RESULTS OF PROJECTS

This chapter of Bulletin F contains descriptions of all the projects which were communicated to the U. S. Coordinator as of August 7, 1970, and summaries of preliminary results for most of these projects. The June 1970 of NATURE contains results from forty-one 1970 solar eclipse projects several of which are not included in Bulletin F because they were not communicated to the U. S. Coordinator. The reader is referred to this excellent issue of NATURE as well as to recent issues of SKY AND TELESCOPE and to the various scientific journals where 1970 eclipse-related articles will undoubtedly appear during the coming year.

The projects which were concerned with the detection of gravity waves generated by the eclipse shadow and which were described in a special section 3.9 in Bulletin E have been incorporated in the various disciplines of Chapter 3. However they are still identified by a "G" preceeding the project number in the classification of project (Chapter 2.1).

1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-01.00

Institution	:	Astronomical Observatory "Sonnenborgh", The State University of Utrecht, Zonnenburg 2, Utrecht, The Netherlands
Investigators	:	HOUTGAST, Dr. J.
Title	:	Variations in line profiles from the photosphere to chromosphere
Purpose	:	High-precision observations of line profiles and intensities in the transition region from the photosphere to the chromosphere and in the chromosphere as a function of height.
Description	:	A slit-spectrograph with a slit-jaw camera. Photographic observations around 4560 Å (linear dispersion: 1.7 mm/Å) and Photo-electric recording of the Mg I b line region (dispersion: 0.5 mm/Å) on magnetic tape. At the third contact the slit will be replaced by a slot.
Reference	:	Numerous publications by J. Houtgast (ex-chairman of the IAU Committee on Solar Eclipses) in Bull. Astr. Inst. Netherl. and other journals and many articles by O. Namba in Publ. A.S. Japan, Bull. Astr. Inst. Netherl. and other journals
Location	:	Miahuatlan, Oaxaca State, Mexico
Dates	:	From February 1 to March 11, 1970
Equipment	:	36 boxes and packages, about 2500 Kg. Transport by sea Entry: Veracruz
Special Site Requirements	:	An open area of at least 30 x 20 m^2. Local electric power: ~ 2 kWh. A possibility for a simple darkroom.
Number & Names of People	:	6 Persons: Dr. Jakob Houtgast, Dr. Osamu Namba, Mr. Robert J. Rutten, M.Sc., Mr. Mattheus W.M. de Graauw, B.Sc., Mr. Johannes W. van den Broek, and Mr. Heinz Jacob van Amerongen
Cooperating Groups	:	-----
Special comments and needs	:	Scientific time signal. Material (bricks or blocks, cement and sand) for pillars of total 3 m^3. Water supply.
Station Prob	:	1.0
Funds	:	The Netherlands Organization for the Advancement of Pure Research (Z.W.O)

SUMMARY OF PRELIMINARY RESULTS: In order to accomplish our purpose mentioned above we constructed a high-resolution spectrograph which is fed by a coelostat and an objective lens (D/F=25/343 cm). The spectrograph is of Littrow type and consists of reflecting slit, a collimating mirror (spherical, 25/336 cm), a Bausch & Lomb reflection grating (1200 groves/mm, ruled area 154 x 206 mm; used in the second order, blazed at 5000 A), an imaging mirror (spherical, 25/596 cm) and a flat for the photographic observations, and another imaging mirror (spherical, 16/180 cm) for the photoelectric ones.

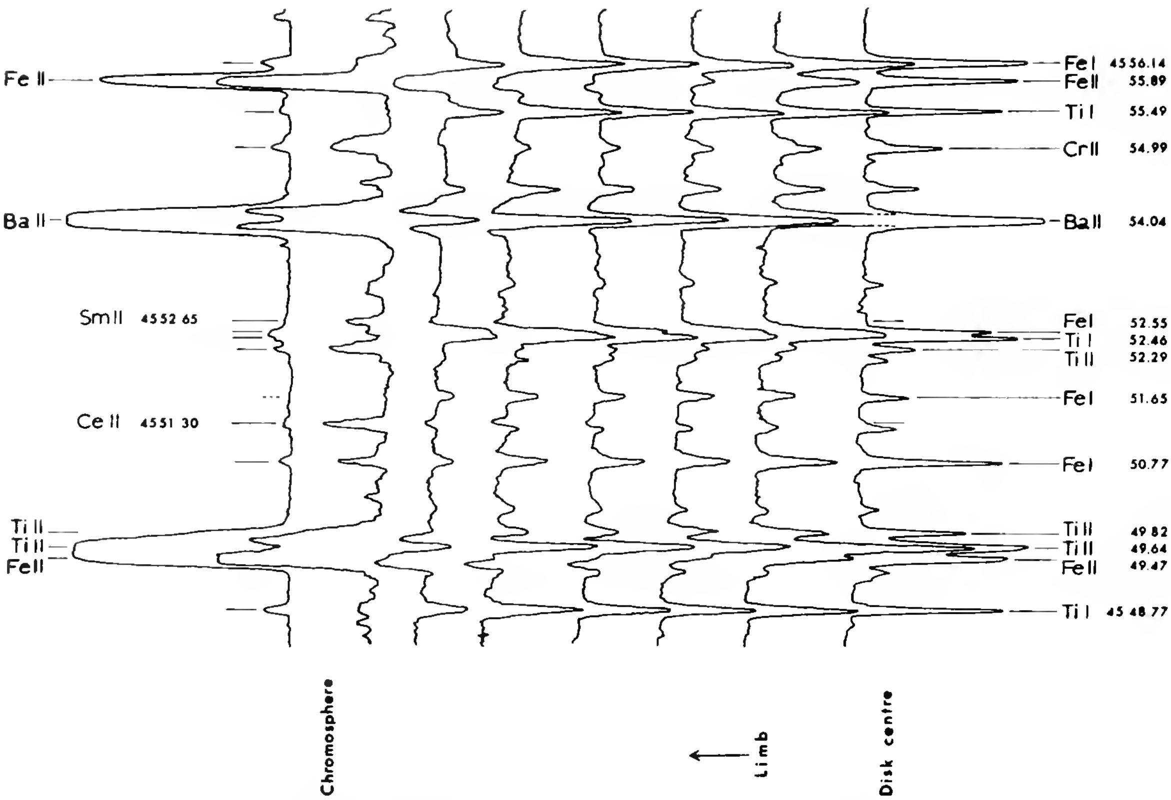
For the photographic observations a spectral region from 4545 to 4579 Å was chosen. Two cameras with an intensity ratio 90 % : 8 %, divided by a beam-splitter, worked simultaneously with 70 mm Kodak Tri-X film (ASA 400; 30m long). An electro-magnetic shutter, placed in front of the beam-splitter box, was commanded photoelectrically to obtain proper exposure times at the transition between the photosphere and chromosphere. The solar image and the entrance slit width are enlarged by a factor of 1.8. The linear dispersion is 1.7 mm/Å and the effective resolution is about 24 mÅ.

For the photoelectric observations a multiplex technique was applied (cf. Th. de Graauw, Applied Optics, in press). A spectral region of 25.5 Å, just covering the Mg I b triplet lines, was focused on a rotating hollow glass cylinder (12.25 mm long; 25 revolutions/sec) with an encoding mask around it. This mask consists of a matrix with 255 x 255 opaque and transparent elements. The coded spectrum, passed through the rotating cylinder, was directed by a small mirror, fixed in the inside of the cylinder at an angle of 45° to the rotation axis, to a beam-splitter. Two light beams thus divided were finally guided to two photomultipliers and the signals were recorded on a magnetic tape over three channels for each detector (dynamic range: 1000). Use was made of a seven-channel tape recorder. The spectroscopic resolution is 0.1 Å and the time resolution is 0.04 sec.

At the second contact a slit of 12 μm was used, slanting through the moon's limb near the contact point. Before the third contact the slit was replaced by a slot which included only the west limb. During the observations the position of the solar image relative to the slit or slot was filmed with a 35-mm cine camera. All the operational data were recorded on magnetic tapes together with the time signals.

We obtaineo some 50 good spectrograms from the eclipse . Before and after the eclipse we made many exposures for calibration, for measurements of possible polarization effect of the optics, and for the determination of the instrumental profile by the aid of a He-Ne laser and an I_2 tube.

At this moment we are at the very beginning stage of the reduction of our data obtained. Of some slit-spectrograms we made provisional microphotometric recording in transmission. The accompanying figure qualitatively shows very interesting variations in line profiles from different atoms and ions as one goes from the center of the solar disk to the chromosphere. For the reduction of the photoelectric records the influence of seeing and other irregularities upon the data is being investigated by means of computer simulation. We hope that our observations will yield accurate line profiles of the outer limb and the transition region to the chromosphere and beyond.



Variations in line profiles from the photosphere to chromosphere (scanning in transmission): a part of the spectra obtained by the Eclipse Expedition of the Netherlands on March 7, 1970 at Miahuatlan, Oaxaca, Mexico.

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-01.01

Institution	:	Tokyo Astonomical Observatory, University of Tokyo.
Investigator	:	MAKITA, Dr. Mitsugu
Title	:	Direct Photograph of the Chromosphere
Purpose	:	To investigate structures and physical conditions of the chromosphere.
Description	:	Direct images of the chromosphere were obtained with f=500cm horizontal camera before the corona was photographed. A region of the continuous emission was taken around λ6850, due to a combination of the red glass filter and the Kodak IV F emulsion.
Reference	:	None
Location	:	Puerto Escondido on the Pacific coast, Oaxaca, Mexico.
Dates	:	February 7 to March 10, 1970 staying at the observing site.
Equipment	:	Total weight 6 tons, numbering 80 boxes, shipment between Tokyo and Acapulco, truck between Acapulco and the site
Special Site Requirements	:	25 x 25 m horizontal flat area
Number and Names of People	:	4 persons: Dr.Kuniji Saito (leader), Dr. Mitsugu Makita, Shigeru Hata and Arata Tojo. (Dr. Saito will be leading the joint expidition from Japan)
Cooperating Groups	:	A joint expedition cooperated with Kwasan Observatory (3 persons) and Hydrographic Office of Japan (2 persons). See projects 3.1-D-07.00 and 3.1-D-08.00.
Special Comments and Needs	:	None
Station Prob	:	1.0
Funds	:	Govermmental

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.1-F-01.01

Combining a sharp cut red filter and the Kodak IV F film, the chromosphere was photographed at near λ 6850, where the line contribution was smaller than that of the continuous emission. The 35mm NIKON Motor Drive Camera covered a part of the 47 mm solar image at the focus of the 5m objective lens. The exposure times were 1/30, 1/8 and 1 seconds and about 80 frames were obtained after the second contact show the chromosphere structure, prominences and inner corona. Since the calibration is made successfully, it will be possible to investigate the physical conditions of the upper photosphere, chromosphere and lower corona.

The chromosphere photographed in the continuum emission around λ6850. The exposure started at 0.8 second after the second contact and continued 1 second.

1970 SOLAR ECLIPSE PROJECT NO. 3.1-C-02.01

Institution	:	University of South Florida, Tampa, Florida
Investigator	:	DEVINNEY, E. J.
Title	:	Chromospheric Studies of the March, 1970 Total Solar Eclipse
Purpose	:	Exp. I will make photoelectric measurements of the chromosphere and extreme limb with high spectral and time resolution. Exp. II will observe slitless spectra of the chromosphere from near UV to Hγ. Purpose is to shed light on physical conditions of the chromosphere.
Description	:	Exp. I utilizes 2-mirror coelostat fed plane grating spectrograph designed by J. E. Faller. Recording is photoelectric, analog outputs stored on magnetic tape. Exp. II uses Arriflex camera, transmission grating and UV achromat designed by W. Protheroe. Recording on E.G.&G. X-R film.
Reference	:	"Physics of the Solar Chromosphere." R. N. Thomas and R. G. Athay. Interscience Publication. "The Solar Spectrum." Edited by C. de Jager.
Location	:	Southeast of Oaxaca, Mexico.
Dates	:	February 1,- March 10, 1970
Equipment	:	4,000 lbs; 200 cu. ft.; $25,000; airshipped; via Mexico City
Special Site Requirements	:	Absolute guarantee of clear weather
Number and Names of People	:	3 - Devinney and two others
Cooperating Groups	:	None
Special Comments and Needs	:	None
Station Prob	:	1.0, if funded
Funds	:	NASA or FG

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE PROJECT NO. 3.1-E-02.02

Institution	:	Kitt Peak National Observatory, Solar Division
Investigators	:	PIERCE, A. K.; and KIRK, J.
Title	:	High Resolution Coronal Photograph-Limb Darkening
Purpose	:	To obtain a large scale photograph of the solar corona and measure the limb darkening at the extreme limb
Description	:	A 28-inch 2-element lens fed by a 36-inch coelostat will produce a 14 cm solar image. A broad pars filter will be used to isolate a 500 A continuum region at λ5000 A. Two exposures will be taken to photograph the inner and outer region. A light pick-off will interrupt some of the coelostat over-fill and will be fed to a photometer to measure the integrated limb darkening.
Reference	:	None
Location	:	Vicinity of Quiechapa, Oaxaca, Mexico
Dates	:	February 25 to March 7, 1970
Equipment	:	2500 lbs. value: $16,800
Special Site Requirements	:	None
Number and Names of People	:	A. K. Pierce and J. Kirk
Cooperating Groups	:	None
Special Comments and Needs	:	None
Station Prob	:	0.9
Funds	:	NSF

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-02.03

Institution	:	Kitt Peak National Observatory, Solar Division
Investigator	:	EVANS, Charles
Title	:	Coronal Photographs in the Light of Chromospheric Emission Lines
Purpose	:	To photograph the corona/chromosphere interface
Description	:	A multi-lens camera will be used with four interference filters to observe the inner corona in the light of chromospheric emission lines. The photographs will attempt to discover the detailed nature of the chromosphere-corona interface and the variation of spicule structure with height.
Reference	:	None
Location	:	Vicinity of Quiechapa, Oaxaca, Mexico
Dates	:	About February 25 to March 7, 1970
Equipment	:	300 lbs. value: $1,745
Special Site Requirements	:	None
Number and Names of People	:	Charles Evans
Cooperating Groups	:	None
Special Comments and Needs	:	None
Station Prob	:	0.9
Funds	:	NSF

SUMMARY OF PRELIMINARY RESULTS-PROJECT NO. 3.1-F-02.03:

The experiment was generally successful. The direct photographs of the Ka II H and K lines, though somewhat defocussed, produced iso-density tracings which indicate no essential differences in their morphologies.

The photographs in $H\alpha$ revealed no distinct features larger than 2.5 arc sec at a radial distance of 0.5 $R_{\odot}$ out to 3.0 $R_{\odot}$.

Finally, a set of observations centered on $\lambda 6707$ shows nothing out of the ordinary in the morphology of the electron corona near the limb.

Data reduction is essentially complete at this time.

1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-02.04

Institution	:	Kitt Peak National Observatory, Solar Division
Investigators	:	LIVINGSTON, W.; HARVEY, J.; and DOE, L.
Title	:	Coronal Velocity Field
Purpose	:	To determine the line-of-sight component of velocity in the emission line corona from the base of the corona to a height of about 1 solar radius.
Description	:	A relatively high-dispersion spectrograph is used to produce five nearly overlapping spectra of the λ5303 A line of Fe XIV from five entrance slits placed in different positions on the image of the corona. The amount of light is such that an image tube is required to produce a photographable spectrum. The Doppler shifts of the lines indicate the line-of-sight velocity components. It is expected that both the coronal rotation and the velocity of the solar wind will be measurable.
Reference	:	None
Location	:	San Carlos Yautepec, Oaxaca, Mexico
Dates	:	about February 25 to March 7, 1970
Equipment	:	1200 lbs. value: $20,327
Special Site Requirements	:	None
Number and Names of People	:	W. Livingston, J. Harvey, and L. Doe
Cooperating Groups	:	None
Special Comments and Needs	:	None
Station Prob	:	0.9
Funds	:	NSF

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.1-F-02.04

The experiment was performed as planned. Two spectra were obtained, one of the inner corona and a second, taken through a graded filter located at the focus of the telescope, which covers the range from the limb to somewhat more than 1 radius above the limb. Photographs of the instrument and one of the spectra appear in the May 1970 issue of Sky and Telescope, p. 281.

The wavelength of the coronal line has been measured with a Grant measuring engine by two independent observers on both spectra at approximately 100 locations in the corona. All results are in reasonable accord. The errors of measurement are strongly dependent on the brightness of the coronal line with respect to the background. The errors of our best measurements are roughly ± 0.1 km/sec. Although not a goal of our experiment, we find that the average wavelength of the green line is 5302.83 A.

On our spectra the coronal velocity field is composed of two components: rotation and random. Preliminary analysis indicates that the inner corona rotates much like a solid extension of the photosphere. Beyond a few tenths of a radius, the random component becomes relatively large. Its amplitude is as large as ± 3 km/sec measured with an effective spatial resolution of about 70,000 km. There is evidence of fine structure in the velocity field. In an effort to improve the spatial resolution of our measurements we plan to subject the spectra to digital analysis when digitization of our microphotometer is completed.

Further analysis will consist of detailed comparison of the velocity field with the projected 2-dimensional and reconstructed 3-dimensional structure of the corona.

1970 SOLAR ECLIPSE PROJECT NO. 3.1-E-02.05

Institution	:	Kitt Peak National Observatory, Solar Division
Investigators	:	SLAUGHTER, C.; and AIKENS, R.
Title	:	Coronal Emission Line Profiles
Purpose	:	An eight channel spectrophotometer will be used to measure the line profile and flux in six coronal iron emission lines.
Description	:	The corona above a 1.5 cm solar image will be projected onto a curved slit positioned at 1.2 $R_{\odot}$. Six conjugately curved slits positioned in the exit plane of a simple Czerny-Turner spectrograph will feed separate photo-cell amplifier systems. Digitizing logic and recording equipment operate in synchronization with grating oscillation to obtain spectrum scanning. Spectrograph resolution of 0.05 A will permit 0.1 A resolution photometry. 3 angstrom scans will be obtained with no on-line integration. All scans will be recorded on incremental magnetic tape for later combination. The measurements will permit derivation of a temperature and density assuming a structure to the corona. The structure assumed will be taken from polarization measurements to be made by Dr. Gordon Newkirk of HAO.
Reference	:	None
Location	:	Vicinity of Quiechapa, Oaxaca, Mexico
Dates	:	about February 25 to March 7, 1970
Equipment	:	600 lbs. value: $26,890
Special Site Requirements	:	None
Number and Names of People	:	2 - C. Slaughter and R. Aikens
Cooperating Groups	:	None
Special Comments ans Needs	:	None
Station Prob	:	0.9
Funds	:	NSF

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-03.00

Institution	:	High Altitude Observatory, National Center for Atmospheric Research, Boulder, Colorado 80302
Investigators	:	KOPP, R. A., and GOSLING, J. T.
Title	:	Iron Line Profiles
Purpose	:	To measure the radial temperature variation at selected position angles in the corona.
Description	:	Simultaneous measurements of the 5303 A and 6374 A profiles by means of a high dispersion echelle spectrograph and image tube.
Reference	:	
Location	:	Southeast of Oaxaca, Mexico near the villages of San Carlos and Quiechapa.
Dates	:	February 4 - March 10, 1970
Equipment	:	2000 lbs.; 100 cu ft.; $25,00; ship by air; entry at Tampico.
Special Site Requirements	:	None
Number and Names of People	:	4 - Roger Kopp, Jack Gosling, George Gooras, Bob Wendler.
Cooperating Groups	:	Field support by Field Observing Facility, NCAR (5 people - headed by Harry Vaughan)
Special Comments and Needs	:	None
Station Prob.	:	1.0
Funds	:	NCAR's prime NSF contract

SUMMARY OF PRELIMINARY RESULTS

Simultaneous radial-slit spectra of the red and green forbidden lines (6374 A, 5303 A) were recorded at four position angles - 30°, 57°, 72°, and 93°. Sky conditions during totality were judged excellent. Three exposures (1^s, 5^s, 25^s) were made at each position angle, the longest showing continuum emission of the K-corona out to the limit of observation, approximately 0.4 radii from the solar limb. Intensity standards and wavelength calibrations were also obtained.

The spectra are currently undergoing detailed photometric analysis to determine the height variation of half-width and relative intensity for each line. At this preliminary stage we note only that, at the position angles observed, the coronal red line exhibited substantially more spatial structure than did the green line. In particular, at position angle 30° (large streamer in northeast quadrant) little if any red-line emission was discernible, indicating a relatively high temperature in the central regions of this streamer.

1970 SOLAR ECLIPSE-PROJECT NO. 3.1-F-04.00

Institution	:	High Altitude Observatory, National Center for Atmospheric Research, Boulder, Colorado 80302.
Investigator	:	NEWKIRK, Gordon Jr.
Title	:	High Resolution Photography of the White Light Corona and Chromosphere
Purpose	:	To study the structural details of the white light corona and chromosphere.
Description	:	Photographic photometry of pictures taken with a wide angle camera.
Reference	:	
Location	:	Southeast of Oaxaca, Mexico near the villages of San Carlos and Quiechapa.
Dates	:	February 4 - March 10, 1970
Equipment	:	1000 lbs.; 50 cu. ft.; $20,000; ship by air; entry at Tampico.
Special Site Requirements	:	None
Number and Names of People	:	4 - Gordon Newkirk, Lee Lacey, John Preston, Keith Watson.
Cooperating Groups	:	Field support by Field Observing Facility, NCAR (5 people headed by Harry Vaughan)
Special Comments and Needs	:	None
Station Prob	:	1.0
Funds	:	NCAR's prime NSF contract

SUMMARY OF PRELIMINARY RESULTS

This experiment consisted of two instruments with identical mounts and identical optical systems. One instrument was used to obtain 16 photographs of the white light corona at a variety of polarization angles, also some with no polaroid, and a few through a radial-gradient filter. The other instrument was used to obtain a movie of the total phases of the eclipse at a rate of 6 frames per second in an attempt to observe high speed motions in the corona.

Because of the very fine observing conditions at the time of totality both instruments produced very good data. A lengthy analysis of the polarization photos is just beginning; the high speed movie has been carefully studied and no motions are evident in the corona.

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-04.01

Institution	:	High Altitude Observatory, National Center for Atmospheric Research, Boulder, Colorado 80302
Investigator	:	MALVILLE, J. M.
Title	:	Monochromatic Photographs of Prominences
Purposes	:	To study the thermal structure of a prominence
Description	:	Utilize a telescope and interference filters to make monochromatic photographs of a prominence in two wavelengths - 4686 A and 4861 A.
Reference	:	
Location	:	Southeast of Oaxaca, Mexico near the villages of Quiechapa and San Carlos.
Dates	:	February 28 - March 9, 1970
Equipment	:	600 lbs.; 25 cu. ft.; $15,000; ship by air; entry at Tampico.
Special Site Requirements	:	None
Number and Names of People	:	2 - Kim Malville, Gary Emerson.
Cooperating Groups	:	Field support by Field Observing Facility, NCAR (5 people - headed by Harry Vaughan)
Special Comments and Needs	:	None
Station Prob.	:	1.0
Funds	:	NCAR's prime NSF contract

SUMMARY OF PRELIMINARY RESULTS

Photographs of the entire limb were obtained as planned in the light of neutral hydrogen (4861 A) and ionized helium (4686 A) with a 6" coronagraph. Our He II photographs probably represent the first filtergrams of quiescent prominences taken in that faint emission line. Microphotometry of the plates is now in progress. We are measuring the line to continuum ratios in the prominences and are searching on our plates for any evidence of He II emission in the corona.

1970 SOLAR ECLIPSE PROJECT NO. 3.1-E-04.02

Institution : Sacramento Peak Observatory of the Air Force Cambridge Research Laboratories and the High Altitude Observatory of the National Center for Atmospheric Research

Investigators : BECKERS, Jacques M. and WAGNER, William J.

Title : Coronal and Prominence Line Polarization

Purpose : To measure the degree and direction of polarization of the emission lines of the corona and prominences.
As a minimal goal, information will be obtained which will add an additional constraint to the possible identifications of the forbidden coronal lines.
Further analysis should provide a determination of the configuration of the coronal magnetic fields and an estimate of the relative importance of collisional versus radiative excitation of each line. Such simultaneous observations of many lines can be expected to give insight into the line of sight distributions of coronal temperature, density and magnetic fields.

Description : The Dunn airborne eclipse spectrograph has been modified by the addition of a Savart plate and an achromatic quarter wave plate in front of the entrance slits. A polarizing beam-splitter is mounted behind the slit. The resulting 3300-9000 Angstrom spectra consist of double images in orthogonal polarizations. Alternating fringes parallel to the dispersion appear in each spectral line image for radiation polarized at the sun.
A temperature control system has been installed in the instrument for the present ground-based eclipse experiment.

References : Wagner, W. J. and House, L. L. 1968, Solar Physics, 5, 55.
Hyder, C. L. 1965, Ap. J., 141, 1382.

Location : At the High Altitude Observatory site southwest of Oaxaca, Mexico

Dates : February 5 - March 11, 1970

Equipment : Three crates totaling approximately 1300 pounds. Equipment will be shipped via ANG airplane with the other High Altitude Observatory experiments.

Special Site Requirements : Power and logistics are being provided by the Field Observing Facility of the National Center for Atmospheric Research

Number & Names of People : Two previously-mentioned investigators

Cooperating Groups : Field Observing Facility of the National Center for Atmospheric Research

Special Comments and Needs : None

Station Prob : 1.0

Funds : National Science Foundation. Travel expenses for Dr. Wagner will be provided by the Air Force.

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-04.03

Institution	:	Astronomical Council of the USSR Academy of Science, State Sternberg Astronomical Institute of Moscow University
Investigators	:	EGOROVA, N. B., and SHEGLOV, P. V.
Title	:	Photography of the Solar Corona with a Radial Compensating Filter
Purpose	:	To study the structure of the solar corona
Description	:	A double astrograph 90/1300 mm with a neutral radially symmetric compensating filter. Wavelength region 6300- 7000 Å. Compensating filter density range - 3.5 log units. Guiding telescope 80/1200 with an ocular micrometer. Equatorial mounting.
Reference	:	M. Laffineur, Comptes rendus de l'Acad. Sci., N 15 (1961), p. 2180
Location	:	Near Miahuatlan, Oaxaca, Mexico
Dates	:	February 16 - March 12, 1970
Equipment	:	Total weight 500 kg, 8 cases
Special site Requirements	:	None
Number & Names of People	:	Two: N. B. Egorova, P. V. Sheglov
Corperating Groups	:	None
Special Comments and Needs	:	None
Station Prob	:	1.0
Funds	:	Governmental

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.1-F-04.03

During totality four plates were obtained with 10, 30, 50, 30 sec exposures. The coronal structure is well seen from the limb up to about 5 solar radii on all plates. The plates are under measurements.

The figure shows the plate obtained with the exposure 50 sec.

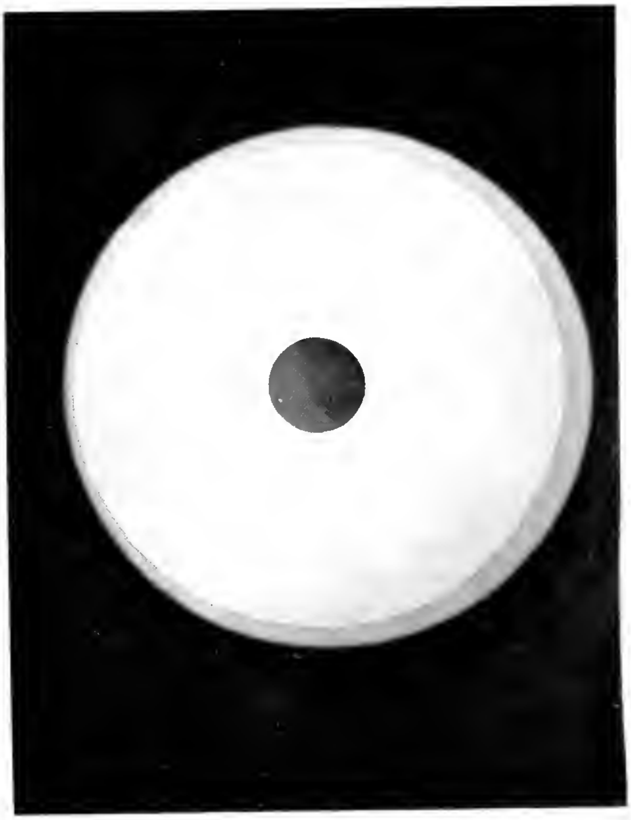


Fig. 1 - The solar corona with a radial comoensating filter. Exp. 50 sec.

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-04.04

Institution : State Sternberg Astronomical Institute of Moscow University

Investigators : LIPSKIY, Dr. Yu. N., and NOVIKOV, V. V.

Title : Photographs of the Sun's Corona in Polarized Light

Purpose : Studying of polarization of solar corona by photographic method is the traditional task. The final results in our task is research of distribution of extent of polarization in the inner and outer sun's corona.

Description : A trihedral prizm with polaroids glued on its side with orientation one reference to another by angle 120° was placed in front of the objective of airfotocamera. Such orientation of polaroids is the optimal one. It allowed to determine three Stokes's parameters: the full intensity in the integral light, degree orientation of polarization plane. Three images of the corona in polarized light are obtained by one camera in one film and practically in one of its part. It is very profitable for photometry.

Reference : The method was described in
И.С.Шкловский "Физика солнечной короны", р. 32-39, Москва,1962.

Location : Near Miahuatlan, Oaxaca, Mexico.

Dates : February 9 - March 15, 1970

Equipment : 1 cases, total weight 35 kg.

Special site Requirements : None

Number & Names of People : One: V. V. Novikov

Cooperating Groups : None

Special Comments and Needs : None

Station Prob : 1.0

Funds : Governmental

SUMMARY OF PRELIMINARY RESULTS:

No Report

1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-04.06

Institution : Langley Research Center

Investigator : MACK, Robert J.

Title : CORONAL PHOTOGRAPHS OF THE MARCH 7, 1970 ECLIPSE

Purpose : To photograph the inner and outer solar corona in white light

Description : A camera using a 24-inch focal length F/6 Aero Tessar lens system and 70 mm plus X roll film has been built for medium wide-field photography (5° x 8°). To reduce the fogging effect of scattered light, a #12 yellow filter has been added. Photographs will be taken during totality to record shape and extent of solar corona.

Reference : The Sun by G. Abetti

Location : Skywatcher's Observatory at Langley Air Force Base, Va.

Dates : March 6-7, 1970

Equipment : About 100 pounds including camera and mount setup on site

Special Site Requirements : 115 volt A.C. power outlet, photo-processing facilities

Number & names of People : Two, Robert J. Mack with Allan Vig to assist

Cooperating Groups : Langley Research Center

Station Prob : 1.0

Funds : Langley Research Center

SUMMARY OF PRELIMINARY RESULTS

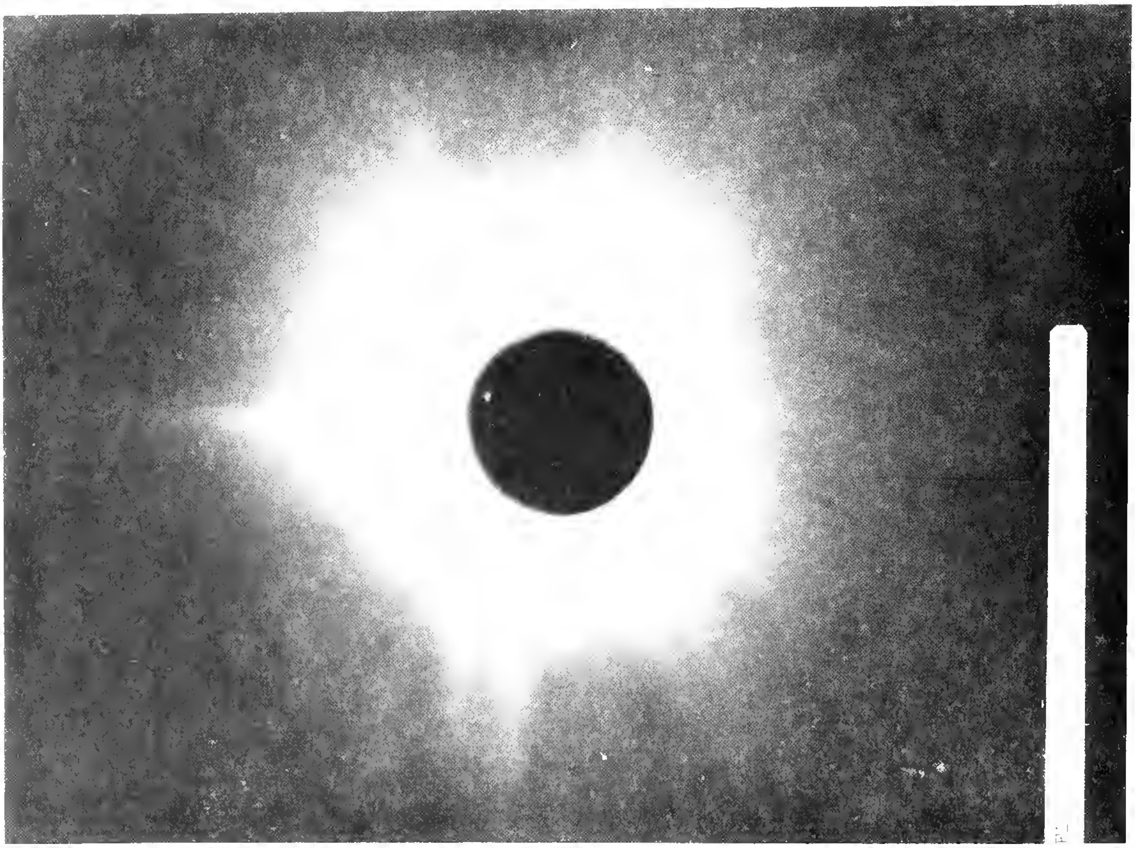
Apparatus

A camera employing a 4-inch (10cm) aperture, f/6 Aero-Tessar lens was used for coronal photography during totality. The 2.5-inch (6.35 cm) by 3.375-inch (8.5725 cm) image size gave a 5.96° by 8.04° field of view. A No. 12 yellow filter was mounted behing the lens to neutralize Rayleigh scattering and a Packard bulb-operated shutter was installed so that manually actuated exposures could be made. This method allowed simplicity of design and a wide range of exposure times at the cost of being able to accurately time the exposures. A motor-operated Varatron film pack holding 70-mm Plus-X film slid in and out of the adjustment rack to permit aiming and focusing on a ground-glass screen.

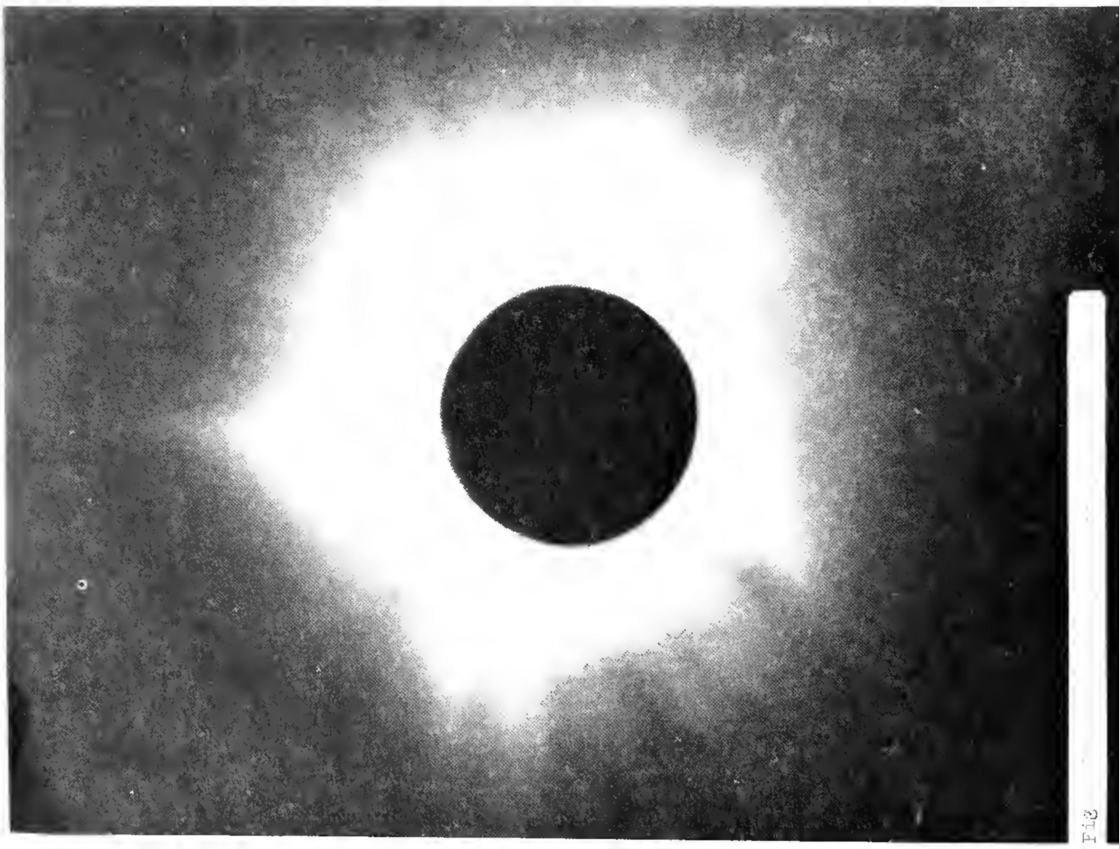
The camera was set on a platform and continuously moved until shortly before totality. It was then fixed, the film pack was inserted, and the negatives were exposed. Exposures were made at shutter speeds and focal ratios which varied from about 1/20 sec at f/11 to about 1 sec at f/6.

Results

Eighteen exposures were made during about 100 seconds of totality. From these, two were selected for enlarging and printing. Since the area close to the moon's disk was far more exposed than areas several diameters away, it was necessary to "dodge," i.e. selectively expose the print paper, in order to print as much detail as possible. At the suggestion of Leonard M. Weinstein (NASA Langley Research Center), a variable transmittance "dodge" was made of cardboard and a piece of 0.5 neutral density gelating filter, and used to print the enlargements shown in figures 1 and 2. In both pictures, celestial north is toward the upper edge. Figure 1 was made from a negative exposed at f/8 and about 1/10 sec while figure 2 is from a negative exposed at f/6 and about 1 sec. Both enlargements were made on polycontrast print paper using a No. 3-1/2 filter to bring out the low contrasts details in the negatives. The streamers which were the dominating feature of the March 7, 1970, eclipse are evident in both pictures.



F



Fig

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-04.07

Institution : Department of Solar Physics, Institute of Terrestrial Magnetism, Ionosphere and Radio-Wave Propagation, (IZMIRAN), Academy of Sciences, USSR

Investigator : MOGILEVSKY, Professor E. I.

Title : a) Investigations of Polarization of the coronal Emission Lines

b) Spectrophotometry of the Chromosphere and Corona.

Purpose : a) Investigation of polarization on a number of coronal emission lines with the optical transitions of the following types:

$^2P_{3/2} - {}^2P_{1/2}$ (Fe X, Ni XII, Ni XVI, Ca XIII)

$^2P_{1/2} - {}^2P_{3/2}$ (Fe XIV), $^3P_2 - {}^1D_2$ (Fe XIII, Ni XIII, Fe XI).

b) Investigation of the nature of calcium-emission in the chromosphere and corona (filtrograms in K-line Ca II)

Description : Horizontal telescope (coelostat with two mirrors, two secondary mirrors, three objectives) fed three instruments: two spectrographs and K-birefrigent filter. Additional observations of the coronal structure were obtained with the photographic cameras with the 0,5 and 1,5 m objectives.

References : (1) E. I. Mogilevsky, G. M. Nikolsky, K. I. Nikolskaja, Astr. J. (Rus.), 1960, 37, 236.

(2) E. I. Mogilevsky, Geomagn. and Aeronomy (Rus.), 1962, 2, 1041.

(3) G. M. Nikolsky, A. A. Sazanov, Astr. J. (Rus.), 1969 (in press)

(4) N. S. Shilova, Soln Dannye, 1969 (in press)

Location : Miahuatlan, Oaxaca, Mexico, L = 96° 35' φ = 16° 21', height above the sea level - 1800 m.

Dates : Expedition departure 9 February 1970, return 19 March 1970

Equipment : Organization and fulfillment of the IZMIRAN expedition and the transport of equipment was carried out by the General Expedition of the USSR Academy of Sciences.

Number and Names of People : Dr. B. A. Ioshpa, Dr. V. N. Obridko, Mr. V. G. Utrobin

Cooperating Groups :

Special Comments and Needs :

Station Prob : The planned program of investigations was performed

Funds :

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.1-F-04.07

The Scientific expedition of the Solar Physics Department of IZMIRAN (Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation of the USSR) was the part of the General Scientific Expedition of the USSR Academy of Sciences. The following observations were made by our expedition:

(A) Polarization in Emission Lines of the Solar Corona.

High degree of polarization both in green (Fe XIV 5303) and red (Fe X 6374) lines was obtaines during the solar eclipse of 30.IV.1957 /I/ . On the other hand, from the theory of resonance scattering, the polarization in the red coronal line should be equal to zero. But if the polarization does exist, it may be conditioned by direct electron fluxes. During the eclipse of 7th March c.y. polarization spectrograms of the corona were obtained with two spectrographs: the prism spectrograph with small dispersion, and diffraction spectrograph (echellette) with great dispersion ($\sim$6-10 Å/mm). At the prism spectrograph ISP-65 (Dr. Mogilevsky as the observer) the Wallastone prism was placed inside the collimator, a pair of spectrograms with ortogonal polarization was simultaneously obtained. Three pairs of such high-quality spectrograms were obtained. At the diffraction spectrograph STE-1 (Drs. B. A. Ioshpa and V. N. Obridko) two series of spectrograms (three spectrograms in each series for three positions of the polaroid) were obtained. The both spectrographs were fed by horizontal telescope. The spectral slit was tangentially oriented on the east limb at the point of the second contact. Examination of spectrograms showed the existence of 6-7 coronal lines. Most interesting of them is the Ni XII 4231 line, which has the same transition ($^2P_{3/2}$ - $^2P_{1/2}$) as Fe X red line.

(B) The Nature of Ca-II-Emission at Coronal Altitudes.

During a number of previous eclipses many authors revealed the resonance Ca-II line emission at high latitudes. During the observation of the eclipse in Mexico we made observations with the polarization-interference narrow-band filter (0,6 Å) in order to elucidate whether this phenomenon is explained by scattering of chromospheric emission, or perhaps, by radiation in weak prominences. Horizontal telescope with objective (F=165 cm, D = 1100mm) was used. Mr. V. G. Utrobin obtained nine filtrograms at different positons of the filter band ($\pm$ 0,6; 1,2 Å and in the band center). The K Ca II line emission is visible at east and west limbs (most bright in the band center) both in prominences and weak chromospheric jets.

(C) During three previous eclipses Dr. R. S. Steblova revealed considerable variations of the temperature and thickness of ozone layer. This effect of relatively fast changeability of the Earth's ozonosphere during the eclipse was again investigated at two geographical points: echellette spectrograph in Mexico (observer - Mr. Utrobin), and quartz spectrograph at Kuba Island (observer - Dr. Steblova). A large series of spectrograms were obtained during partial phases and on control days, by which one could find the needed ozonosphere effect.

1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-05.01

Institution : Space Environment Branch, NASA Langley Research Center

Investigator : HARVEY, Gale A.

Title : Flash Spectra of the Chromosphere

Purpose : To obtain a solar flash spectrum of 123Å/mm over a range of wavelengths from 3,100Å to 9,000Å in order to relate the flash spectrum near solar cycle maximum with previous flash spectra, and other observations of the 1970 eclipse.

Description : Two F/1.3-inch aperture Maksutov slitless spectrographs, an F/6 6-1/2 inch aperture Newtonian slitless spectrograph, an F/11 3-1/2 inch aperture Newtonian slitless spectrograph, and an F/3.5 1-inch aperture refractive slitless spectrograph were operated.

References : None

Location : NASA Langley Research Center, Hampton, Virginia, 23365

Date : March 2-9, 1970

Equipment : High-speed panchromatic emulsion (2485) will be used with one Maksutov spectrograph and high-speed IR emulsion with the other. Ektachrome film will be used with the F/3.5 spectrograph. An absolute spectral sensitometer will be used for calibration.

Special Site Requirements : A flat, stable area 15 ft x 15 ft to mount the spectrographs and electrical power (110 volts AC) to operate the necessary equipment.

Number and Names of People : Gale A. Harvey and Ian O. MacConochie (NASA Langley Research Center)
Roy Proctor (Smithsonian Astrophysical Observatory)

Cooperating Groups : Langley Skywatchers Astronomy Club provides the 6-1/2-inch Newtonian telescope.

Special Comments and Needs : No interference is expected from this equipment.

Station Prob : 1.0

Funds : NASA. The funds necessary to accomplish this experiment are available as well as the equipment and personnel.

SUMMARY OF PRELIMINARY RESULTS-PROJECT NO. 3.1-F-05.01:

Spectra were obtained on the F/3.5 1-inch spectrograph and the F/6 6-1/2-inch spectrograph. Three spectra from the F/3.5 spectrograph (twin-lens reflex camera and 300 ℓ/mm diffraction grating) were recorded on Ektachrome film and are judged to be of limited documentary utility. Six spectra were obtained on the 6-1/2-inch aperture telescope. The spectrograms cover approximately 600Å in spectral range and are centered at 4,000Å. The film is spectroscopic analysis No. 1 and a relative film calibration was obtained.

Spectrogram from 60-inch focal length 6-1/2-inch aperature Newtonian telescope with 400 ℓ/mm SiO_2 transmission diffraction grating and spectroscopic analysis No. 1 film. (Newtonian telescope provided by Langley Skywatchers Astronomy Club.)

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-05.02

Institution	:	Douglas Advanced Research Laboratories, Huntington Beach, California
Investigator	:	ARNQUIST, W. N.
Title	:	White Light Coronal and Chromospheric Observations and Atmospheric Radiance Measurements
Purpose	:	White light photographic polarization photometry to obtain the coronal polarization, and photoelectric photometry for the approach to totality and contact times.
Description	:	931A Photomultiplier and collecting telescope with long focal length camera and Polaroid filter mounted on polar axis mount; amplifier and chart recorder.
Reference	:	Proceedings, 1965 Solar Eclipse Symposium, Ames Research Center, Moffett Field, Calif., Dec. 16-17, 1965. 1966 Solar Eclipse Symposium, Sao Jose dos Campos, Brazil, Feb. 5-9, 1968 (Proceedings in press). Solar Physics 11, 82-91, 1970. ISA Trans. 5, 105-109, (1966).
Location	:	Near San Carlos Yautepec, 16°26'N. 96°00'W (from contact times), Oaxaca, Mexico
Dates	:	28 February - 8 March, 1970
Equipment	:	A Dodge van weighing about 2-1/2 tons gross carried the equipment to the site and served as the field laboratory. Mexicali was the port of entry.
Special site Requirements	:	Level working area with good visibility and sufficiently removed from roads to minimize dust interference.
Number & names of People	:	Sr. Sergio Camacho, University of Mexico and personnel of 3.1-D-05.03 and 3.7-D-09.00.
Cooperating Groups	:	Harvard College Observatory, Dr. D. H. Menzel; Senor F. de Romana, Arequipa, Peru
Special comments and needs	:	Good WWV reception
Station Prob	:	0.9
Funds	:	Company Independent R&D Program, about $20,000

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.1-F-05.02

White light photometric observations were made with two 931A photomultipliers, associated telescopes and calibrated filters on a motor driven equatorial mount. The two channels were the same except for the circular fields of view. In one case (1.4° in diameter) the integrated brightness from first to fourth contact was recorded. From the mid-point between the times of equal brightness immediately before and after the inner contacts, mid-totality was found at UT 11h 32m 0.1s. Although this time is rather sharply defined in this way, the times of the contacts involve more uncertainty because the very last approach is gradual. Preliminary results are 11h 30m 19s and 11h 33m 41s corresponding to a site location about 14 miles from the center line at coordinates 16°26'N. and 96°00'W. The field of view of the second channel was about 0.14° in diameter. This channel recorded the brightness of the solar center, the lunar center and the transition between the two. The observations during totality provide a measure of the atmospheric scattering at the time.

A 35 mm camera with a 400 mm f/4.5 achromat lens was mounted with the photomultiplier photometers and operated by hand. Plus X film was used and the development in Kodak D-76 was extended to reach density 5 (Kodak Tech Bits, No. 2, 1968). One set of one second explosures recorded the inner and middle corona and several 10 second exposures were made to reach farther out. The exposures were satisfactory and the necessary microdensitometry measurements will be attempted later.

1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-05.03

Institution : Douglas Advanced Research Laboratories

Investigators : LARMORE L., and VANDE NOORD, E. L.

Title : Observations of the Chromosphere and Corona in the Near Infrared.

Purpose : a) To record the infrared emission structure of the chromospheric flash spectrum during 3rd contact.

b) To obtain low resolution spectra of the infrared thermal emission from interplanetary dust.

Description : A Michelson interferometer, situated on a 4-axis scanning mount, will be used to investigate the spectral region between 1 and 3.5 microns. The foreoptics utilize a 15 cm (f/8) reflecting telescope; the field of view is 6 by 30 arc minutes. The analog signals are recorded on magnetic tape along with timing and auxilary information.

References : Peterson, A. W., Ap. J., 155, 1009, 1969.
McQueen, R. M. Ap. J., 154, 1059, 1968
Larmore, L. and Ireland, A., Proceedings of the NASA Eclipse Symposium, 1965

Location : Southeast of Oaxaca, Mexico, near the village of San Carlos Yautepec.

Dates : February 28 - March 9, 1970

Equipment : 600 lbs., 40 cu. ft., $20,000; transport by truck entering at Mexicali.

Number and Names of People : Larmore, Vande Noord, possibly 1 more
See also projects 3.1-D-05.02 and 3.7-D-09.00

Cooperating Groups : None

Special Comments and Needs : None

Station Prob : 1.0

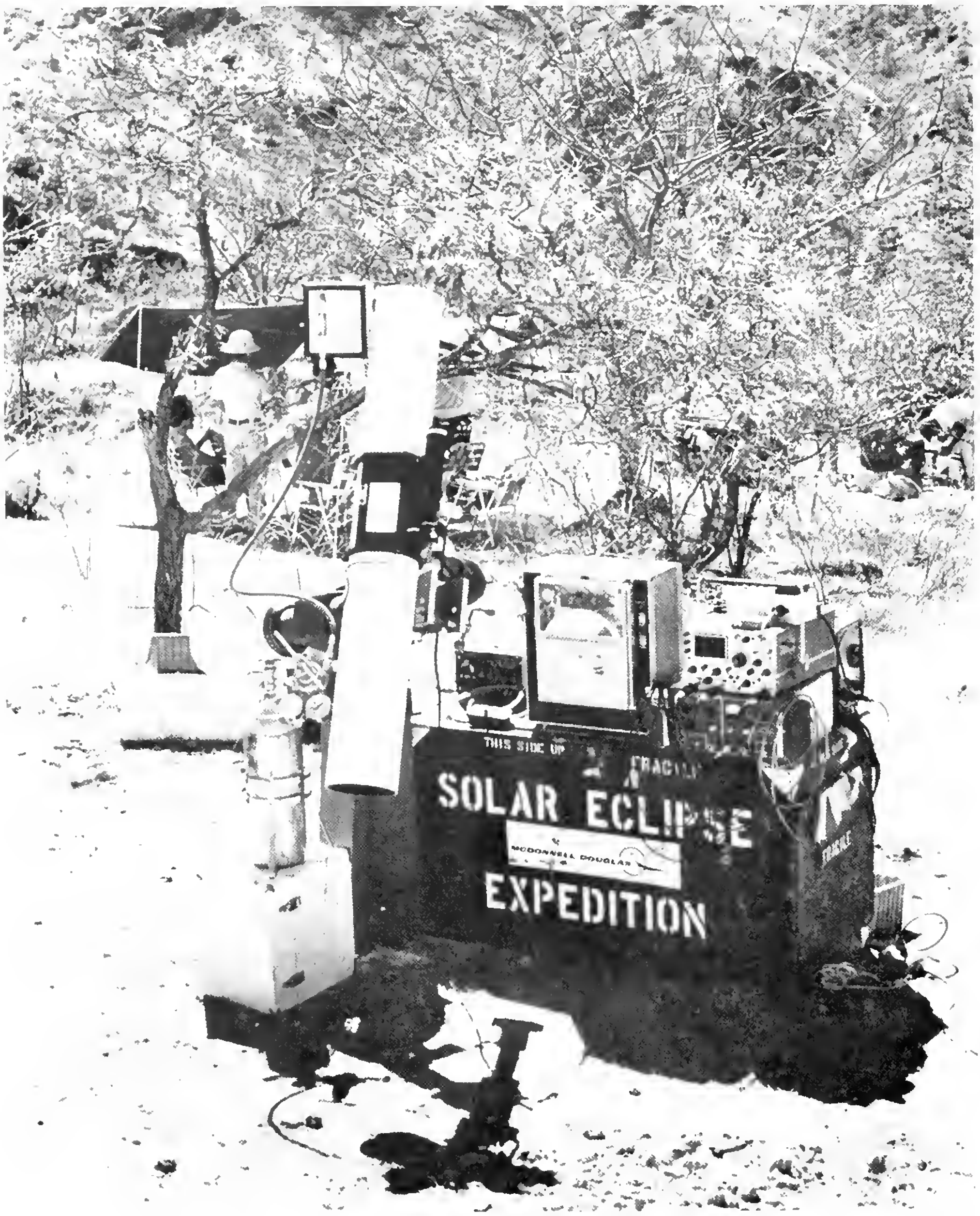
Funds : McDonnell Douglas Corporation

SUMMARY OF PRELIMINARY RESULTS

The two infrared experiments (chromospheric flash spectrum and dust thermal-emission corona) were performed essentially as planned. The equipment was located near the village of San Carlos Yautepec at an approximate altitude of 3000 feet. A photograph of the interferometer-spectrometer and associated electronics, as it was set up at the eclipse site, is shown in Figure 1.

Immediately after second contact, the field of view of the interferometer was scanned along the ecliptic plane from the center of the sun out to 5 $R_\odot$. During this scan, interferograms of the corona were continuously recorded on magnetic tape. The scan was stopped successively at 3.5 $R_\odot$ and 4.0 $R_\odot$ where several low spectral resolution ($\lambda/\Delta\lambda$ 35) interferograms of the thermal emission features located at these distances were recorded. At 5 $R_\odot$ the direction of the scan was reversed; when the limb of the sun was reached, scanning stopped and the field of view was rotated from the ecliptic plane to the point of third contact. During the last 30 seconds of totality, interferograms ($\lambda/\Delta\lambda$ 300) of the chromospheric flash spectrum were recorded. Following fourth contact, relative calibrations were obtained by viewing the solar disk through an aperture stop and neutral density filter.

The analog data tapes have been digitized and additional black body calibrations have been performed in the laboratory. The interferograms from the thermal emission zones are presently being combined in interpretive programs in order to improve the signal-noise ratio of the resulting spectra. Hopefully, these spectra will contain useful information on the temperature and chemical properties of interplanetary dust. The quality of the chromospheric data was impaired by a misalignment of the telescope foreoptics. Additional analysis is required before this problem can be resolved.



1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-05.04

Institution	:	Leander McCormick Observatory University of Virginia
Investigators	:	MEISEL, Dr. David D.
Title	:	Near Infra-red Flash Spectrum, Prominence, and Coronal Photography.
Purpose	:	Determine scientific uses of Kodak Type 8443 Infra-red film in solar eclipse photography.
Description	:	Calibrated, but unguided exposures with the 8443 emulsion will be taken from a ground station near the central eclipse line and compared with panchromatic photographs taken from the same site.
Reference	:	
Location	:	Backbay Wildlife Management Area, Backbay, Va.
Dates	:	March 07, 1970
Equipment	:	Objective Grating; 3½" Maksutov telescope; 35mm cameras with 20mm telephoto and other lenses.
Special site Requirements	:	None
Number and Names of People	:	D. Meisel plus eleven others.
Cooperating Groups	:	Mathematics and Science Center--Richmond, Va.; Virginia Dept. of Game and Fisheries; and NASA Langley Research Center.
Special comments and needs	:	Replaces previously proposed airborne experiment.
Station Prob	:	1.0
Funds	:	Internal and private.

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.1-F-05.04

During the March 07, 1970 total solar eclipse exposures on 35 mm Kodak Type 8443 film were obtained with a f3.5 200 mm telephoto lens. An orange filter (Nikon 056) with cutoff λ<5600Å was used. The emulsion was not cooled. A series of unguided exposures between 1/2 second and 1/250 second were made in perfect weather conditions at Back Bay, Virginia. On the same roll of film, a reflection gray-scale and standard color chart illuminated by diffuse sunlight at the appropriate zenith distance (with skylight excluded) at comparable light levels was exposed with the same lens, filter, lens openings and shutter speeds. Initial processing was done commercially by a custom laboratory with previous experience in handling this film. Final color balance was determined by comparing the sunlight illuminated transparencies of the test gray scale through different color-correction filters. It was not possible to find a filter combination for which the entire gray-scale could be balanced. In keeping with "standard" photographic practice, prints were made with filters which produced satisfactory middle-scale grays ($\simeq$ 18% reflectivity). However, because of the extreme contrast of the film and reciprocity failure of the uncooled emulsions (particularly the IR one) at exposures longer than 1/20 second, underexposed regions tend to be bluish, a phenomenon shown on coronal photographs with ordinary Ektachrome film. Transparencies of the outer corona balanced for the middle grays are quite spectacular with strong magenta in the inner corona caused by a combination of the characteristic oversensitivity of color films to bright line radiation (only FeX λ6374 and FeXI λ7892 since Fe XIV λ5303 is excluded by the filter) and reciprocity failure. These photographs differ from those taken with ordinary panchromatic, blue sensitive films in that scattered skylight and internal optical reflections are somewhat reduced and the delineation of the isodensity contours at two different levels in the corona is considerably accentuated.

Short exposures (1/60 second or less) balanced in a like manner are of greater scientific interest. The most interesting transparencies of the inner corona were taken just after second contact. While a black and white photograph taken at the same phase of the eclipse would show only the Bailey's beads phenomenon, use of the type 8443 film and an orange filter enables one to clearly differentiate between the brightest coronal condensations (pinkish) and prominences (orange or green) by simple visual inspection. Usually the oversensitivity of a color emulsion to line radiation is detrimental, but in this case the coronal radiation combination (continuum with λ6374 plus λ7892) affects the film quite differently from prominences which have predominantly $D_3$$\lambda$5876 plus H$\alpha$ λ6563 (green) or Hα λ6563 plus CaII λ8498, λ8542, and λ8662 (orange) and should provide a convenient non-spectroscopic method for investigating features in the corona-chromosphere interface at future eclipses.

After August 1, 1970, inquiries concerning the use of Type 8443 film for future solar eclipse work may be directed to the Investigator at the Department of Physics, State University College, Geneseo, New York 14454.

1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-05.06

Institution : NASA, Langley Research Center

Investigator : KITCHEN, W. L.

Title : Solar Eclipse Support from NASA Sandbridge, Va., site

Purpose : To photograph events of the solar eclipse (specifically the contact points), to photograph the flash spectrum, and to photograph the shadow bands occurring at 2nd and 3rd contacts.

Description : The Sandbridge site would be instrumented with 16-mm and 70-mm format cine cameras with range timing for events data, 70-mm cine spectrograph cameras with range timing for the flash spectrum data, and special white platform and cine camera for shadow band data.

Reference : Sky and Telescope Magazine, March 1967, March 1968, July 1969. Solar Eclipse Photography for the Amateur, Kodak brochure AM-10.

Location : Sandbridge, Virginia

Date : March 7, 1970

Equipment : Optical Instrumentation - 7 cameras; Electronic Instrumentation- 1 control van; Instrumentation Mount - 1 electronics.

Number and Names of People : W. L. Kitchen, S. Sokol, W. R. Young, C. L. Munday, S. J. Kubalak, C. W. Stump, and S. Press.

Funds : NASA/LRC

TABLE 1

OPTICAL INSTRUMENTATION AT SANDBRIDGE FOR MARCH 7 SOLAR ECLIPSE

CAMERA	LENS SYSTEM	FILM	EXPOSURE	FILTER	SCIENTIFIC OBJECTIVE
16-MM Milliken # 2	4 in. F16	TRI X	1/18	ND-5 ND-0	Sequence data versus time during partial phase Sequence data versus time during totality
16-MM Milliken # 4	6 in. F8	EKTA-CHROME	1/18	ND-5 ND-0	Sequence data versus time during partial phase Sequence data versus time during totality
Cine Spectro-graph # 3	12 in. F2.6 (210 L/MM)	PLUS X	1/120	ND-3	Flash spectrum versus time (10 frame/sec)
Cine Spectro-graph # 1	12 in. F2.6 (210 L/MM)	PLUS X	1/240	ND-1	Flash spectrum versus time (20 frame/sec)
Flight Research # 5	7.5 in. F4	PLUS X	1/54	ND-4 ND-0	Sequence versus time of Bailey's Beads Sequence versus time of corona
Flight Research # 6	7.5 in. F11	PLUS X	1/54	ND-4 ND-0	Sequence versus time of partial phase Sequence versus time of prominences
16-MM Cine # 7	2 in. F1.9	TRI X	1/64	ND-0	Shadow band data

SUMMARY OF PRELIMINARY RESULTS-PROJECT NO. 3.1-F-05.06

TABLE II.- Data results from Sandbridge of March 7 Solar Eclipse

CAMERA NO.	TIME FROM	TIME TO	DATA
16-MM # 2	12:40	13:30	10 sec. periods of partial phase at 5 min. intervals. 36-bit NASA time code.
	13:30	13:40	Continuous coverage of partial phase Bailey's Beads, 2nd contact, totality, diamond ring, and 3rd contact. Also 36-bit NASA time code.
	13:45	14:35	10 sec periods of partial phases at 5 min. intervals. 36-bit NASA time code.
16-MM # 4	12:40	13:30	10 sec. period of partial phases at 5 min. intervals. *See Note 1.
	13:30	13:40	Continuous coverage of partial phase, Bailey's Beads, totality, prominences, and diamond ring.
	13:45	14:35	10 sec. periods of partial phases at 5 min. intervals.
70-MM # 1	13:34:47.34	13:35:06.2	Good spectral data in 1st order spectrum. Zero order displays Bailey's Beads. NASA 36-bit time code.
	13:35:40.64	13:38:10	Good spectral data in 1st order spectrum. Zero order displays Bailey's Beads. NASA 36-bit time code.
70-MM # 3	13:34:49.4	13:34:52.4	Fair spectral data in 1st order. Zero order displays Bailey's Beads. NASA 36-bit time code.
70-MM # 3	13:37:42.2	13:38:25.8	Fair spectral data in 1st order. Zero order shows Bailey's Beads. NASA 36-bit time code.
70-MM # 5	-	-	Malfunctioned
70-MM # 6	∿13:34:30	∿13:34:51	95 frames of partial phase and Bailey's Beads. NASA 36-bit time code did not record.
	∿13:35:12	∿13:36:30	350 frames of totality showing prominences. NASA 36-bit time code did not record.
16-MM # 7	∿13:34:30	∿13:35:00	Shadow bands can be seen for a few seconds before 2nd contact. No timing was planned.

Note 1.- No timing was recorded because of low color film response to timing light. However, very close time correlation may be obtained between cameras # 4 and # 2.

Note 2.- For reference, predicted contact times were: 2nd 13:34:53 EST
3rd 13:37:47 EST

1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-05.07

Institution	:	The Main (Pulkovo) Astronomical Observatory of the USSR Academy of Sciences
Investigators	:	SOBOLEV, V.M., STRELETSKY, Y.S., VJALSHIN, G.F.
Title	:	Chromospheric Photographic Spectra of H, He, He^+
Purpose	:	Detailed investigations of the neutral and ionized helium lines and also the lines of hydrogen in the chromospheric spectrum by means of the high dispersion grating spectrograph. It permits to improve the model of the chromosphere.
Description	:	For obtaining the chromospheric spectra during the solar eclipse the high-dispersion grating spectrograph was designed and built. The grating (size- 150X140 mm^2) is ruled with 600 grooves per mm and operates in the fifth and the sixth orders. Two spectrum regions (λ3800-4000 A with the dispersion of 0.9 A/mm and 4600-4800 A with the dispersion of 1.6 A/mm) are photographed simultaneously. The solar image is projected by the parabolic mirror with the focal length of 2 m and the diameter of 20 cm.
References	:	Vjazanitsyn, V.P., Izvestija Pulkovo Observatory v.XIX, no. 149, 1952. Thomas, R.N. and Athay, R.G., Physics of the Solar Chromosphere, New York - London, Interscience, 1961.
Location	:	Equipment is mounted on the foundations; height - 1 meter over the ground; (site location presumably in Mexico)
Dates	:	No additional dates required.
Equipment	:	Bulk is 8 m , weight - 2000 kg, 12 packages. Transportation by ship and lorry.
Special Site Requirements	:	Power - 2 kv, delivery voltage - 220v with the frequency 50 Hz; Darkroom is required.
Number and Names of People	:	Sobolev, V.M., Streletsky, Y.S., Vjalshin, G.F.
Cooperating Groups	:	No necessity
Special Comments and Needs	:	No special requirements
Station Prob	:	0.9
Funds	:	Funds of the USSR Academy of Sciences.

SUMMARY OF PRELIMINARY RESULTS:

The high-dispersion grating spectrograph was designed and made for simultaneous registration of the HeI, HeII and HI chromospheric lines. The projecting system consists of a coelostat, an additional mirror, a main parabolic mirror (D = 200 mm, F = 2000 mm) and a diagonal mirror. The solar beam passes from the slit to the collimator mirror then it passes through the prism to the grating with ruled area of 150 x 140 mm^2. Having passed through the prism and being reflected from the plane mirror (size 280 x 160 mm), the light falls on the camera mirror (size 420 x 180 mm, F = 2000 mm) forming the image of two parts of the spectrum in the plate-holder intended for the plates with the size of 18 x 24 cm. For compensation of astigmatism and reducing the spherical aberration of the system of cylindrical lens is installed just after the slit and a spherical lens - before the photographic plate. The prism is intended for dividing the orders of the spectrum. The grating has 600 lines/mm. The operating orders of the spectrum are the 5th and the 6th ones. Two parts of the spectrum are photographed simultaneously: λ3800-4000 A with the dispersion of 0.9 A/mm and λ4600 - 4800 A with the dispersion of 1.6 A/mm.

The printing chronograph is used for registration of the exposure moments. Having been adjusted the spectrograph is turned in its supports so that the slit be perpendicular to the line of contacts, the position of which is to be calculated beforehand.

For determining the transparence of the atmosphere on the day of the eclipse, before the first contact, four photographs of the disc center were taken using the stepped light reducer. After the first contact the standardization and calibration of the disc center through the stepped light reducer were photographed. Then the slit was replaced by the rectangular diaphragm. The image of the sun being too small, the width of the chromospheric crescent arc in the slit plane is expected to be about 0.1mm for the st4ong lines and nearly half of it for the weak ones. Thus the photographs being taken without the slit of the line profiles and the chromospheric structure in different lines can be investigated simultaneously. The size of rectangular diaphragm was selected to let the whole chromospheric crescent arc passing through it.

Two seconds before the second contact the 1st photograph was taken (exposure time = 1/8 sec). Just after the second contact 7 photographs of the chromospheric spectra were obtained (exposure time = 1/4, 1, 2 and 4 sec.). In the 190th second of the total phase the first exposure commenced for taking the photographs of the third contact, however a Baily bead interrupted the duration of the total phase and it became impossible to take satisfactory photographs of the chromospheric spectrum about the third contact.

At the end of the partial phase the standardization and calibration were repeated. There were used the ORWO NP-22 photographical plates made in 1969.

At the Preliminary Analysis of the Chromospheric Spectrograms the Following Lines were found:

No	Wavelength in Å	Element
1.	3833.52	Fe
2.	3835.28	CN
3.	3835.39	H_9
4.	3839.28	Mg
5.	3856.80	Fe
6.	3860.28	Fe
7.	3878.50	Fe
8.	3886.08	Fe
9.	3888.40	He
10.	3888.74	H_8
11.	3895.32	Fe
12.	3899.32	Fe
13.	3900.17	Ti^+
14.	3913.01	Ti^+
15.	3919.78	Fe
16.	3922.50	Fe
17.	3927.86	Fe
18.	3929.86	Fe
19.	3933.35	Ca^+(K)
20.	3943.68	Al
21.	3950.13	Y+
22.	3957.00	Fe
23.	3958.14	Zr^+
24.	3961.56	Al
25.	3968.75	Ca^+(H)
26.	3970.44	H_ε
27.	3983.27	Y^+

The groups of spicules are clearly visible in the H and K Ca^+ chromospheric lines as well as in the H_ε, H_8 and H_9 It permits to compare the chromospheric lines in the spicules with those in the areas between the spicules.

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-07.00

Institution	:	Hydrographic Department, JAPAN
Investigator	:	SINZI, Dr. A. M.
Title	:	Determinations of the Contact Times by the Spectrophotometric Method and of the Geocentric Position of the Observing Site by Satellite Geodesy.
Purpose	:	Determination of the position of the sun to secure the accuracy of the ephemerides.
Description	:	Spectra of the sun are taken by a cinematograph near at the second and third contacts to obtain the exact contact times by flash spectra. The spectrograph consists of an equatorial telescope (56 mm in aperture and 930 mm in focal length) equipped with a direct vision 60° prism of SF2 optical glass on top of the tube and a 16-mm-movie camera with a timing system on the other end.
Reference	:	Kristenson, H. : Spectrophotometric determination of contact at the total eclipse of the sun, Stockholms Observatriums Annaler, Band 17, No. 1, 1951, etc.
Location	:	Puerto Escondido, Oaxaca, the Pacific coast of MEXICO.
Dates	:	February 7 to March 10, 1970.
Equipment	:	Bulk 9 cub. m, Weight 1.5 tons, No. of packages 36.
Special Site Requirements	:	None
Cooperating Groups	:	Tokyo Astronomical Observatory and Kwasan Observatory
Special Comments and Needs	:	Tolerance level of equipments is 20 dB.
Station Prob	:	1.0
Funds	:	Governmental

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.1-F-07.00

The intentions of the expedition were thoroughly attained except for satellite triangulation. The items of the observations carried out are: (1) Determination of contact times by the spectrophotometric method (2) Determination of the astronomical longitude and latitude, and elevation of the station (3) Meteorological observation. The following paragraphs give some descriptions on the observations.

I. Position of the station

The telescope was set up in the yard of the National Electric Plant. The astronomical position of the station was determined by equal altitude method and its elevation was derived from simple observations of tide in Puerto Escondido Bay. The preliminary results are:

longitude : 97° 04' 25" West,
latitude : 15° 51' 54" North,
elevation : 93 m.

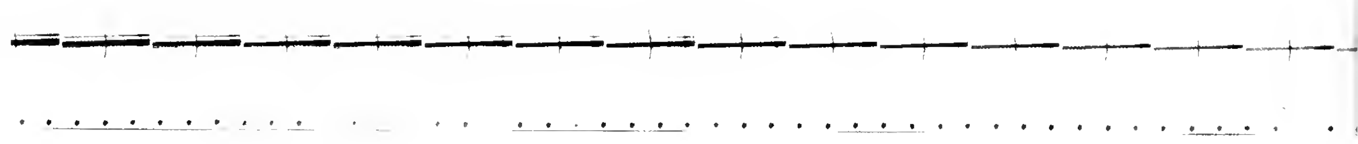
II. Observation of contact times

Some descriptions to be added to the preceding project are:

photographing interval		
2nd contact	:	from 25 seconds before to 20 seconds after
3rd contact	:	from 20 seconds before to 25 seconds after
exposure	:	16 exposures per second, which corresponds to 0.022 second of exposure time
film	:	Kodak 16 mm-cine negative, Plus-X (ASA 80)
time system	:	timing flashes of a neon lamp were regulated by a crystal clock which was compared with WWV 15 MHz signals

III. A glance at the photograph

The developed film shows good images of the flash spectra: the diameter of the sun is about 9 mm and the spectrum covers the range of 4600A to 5200A in wave length, the mean dispersion of which is 100A per mm. Though the film ran 45 seconds at the second and third contacts, respectively, the available parts for photometry are restricted only to those of 7 to 8 seconds at each phenomenon, which correspond to 30° of arc on the solar limb.



The figure is a reproduction of the photograph near at the second contact. The strongest line in the center is 4861A of hydrogen and the magnecium triplet appears on the end of the spectrum. A series of dots on the frame shows the 50 Hz signals from the crystal clock.

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-07.01

Institution	:	University of South Carolina
Investigators	:	SAFKO, John L.
Title	:	Melton Memorial Observatory 1970 Eclipse Expedition
Purpose	:	Measurement of Contact Times
Description	:	Our detectors consisted of a Weston copper oxide photo voltaic cell and an RCA 929 vacuum photodiode. The power for the photodiode was provided by a 140 V dry cell. Each were mounted at the end of hollow aluminum tubes of 3 3/8 inch inside diameter and three foot length. Thus each detector saw a section of the sky 5° in diameter. Each tube was attached to another optical experiment mounted on separate equatorial telescope drives. The signals from both detectors were fed into separate channels of a 6 channel Sanborn DC strip chart recorder (DC Amplifiers -- Sanborn 150-2900 z; Recorder ITTL D2262781G1) running at 1mm/sec. In additon to the internal time marker of the recorder, signals from WWV were fed into another channel; each 5 minute signal was marked by hand.
Location	:	Givhans Ferry State Park, South Carolina, USA
Date	:	March 5-7, 1970
Equipment	:	Weston copper oxide cell, RCA 929 photodiode, Sanborn DC Amplifiers 150-2900 z, Sanborn Recorder ITTL D2262781G1, equitorial telescope drives.
Number and Names of People	:	(3) Dr. Safko, Frank Maloney, Robert Owen
Funds	:	2/3 State of South Carolina, 1/3 NSF Grant GA-16771

SUMMARY OF PRELIMINARY RESULTS

A high haze and broken clouds were present over our observation site for most of the day of totality. Fourth Contact was completely obscured and first contact nearly so. Second and third contacts can be read to better than 1/10 second. The problem remains as to which second. Some of the static on WWV passed through our 1 kc output filter and there were small fluxuations in the driving speed of the recorder. Analysis to account for these difficulties is being performed.

1970 SOLAR ECLIPSE-PROJECT NO. 3.1-F-08.00

Institution : Kwasan Observatory, University of Kyoto, Kyoto, Japan

Investigator : KANNO, Mitsuo

Title : (1) Coronal Lines in the Chromosphere
(2) Spectra of the Coronal Formations
(3) Direct Photography of the Inner Corona

Purpose : The chromospheric slitless spectra will be photographed at the second and third contact. The observed wave-length ranges are 4100 ± 200A, 4600 to 6700A and 7892 ± 225A. The first range will be anlayzed to infer the conditions of the chromospheric active regions. The second and third are aimed specifically to verify that the interspicular medium of the chromosphere emits the coronal lines of FeXIV 5303 A, FeX 6374 A and FeXI 7892 A. During the totality, the slit spectra of the innermost corona will be photographed to analyze the physical conditions of the coronal formations. The white light photographs of the inner corona will be taken to investigate the structure of the coronal formations.

Description : A coelostat and an objective lens with a 30 cm effective aperture and 450 cm focal length produce a solar image of 4.2 cm diameter in the entering focal plane where a wide slot or a slit will be located for the flash spectra or the coronal spectra, respectively. The light through a collimating lens (ϕ=14 cm and f=70 cm) falls on a sgating of 600 grooves/mm which produces a spectrum from 3900 to 8100 A with an average plate dispersion of 20 A/mm. An aerial camera and two motor-driving 35 mm-cameras are placed behind an imaging lens (ϕ=14 cm and f=70 cm).

Another coelostat with a 20 cm effective aperture, an objective lens (ϕ=10 cm and f=500 cm), and a camera of the cabinet size will be used for the direct photography of the inner corona.

Reference : R. G. Athay and W. O. Roberts, Ap. J., 121, 231 (1955)
R. G. Athay and R. N. Thomas, Ap. J., 125, 788 (1957)
M. Kanno, Publ. A.S. Japan, 18, 103 (1966)
T. Tsubaki, Publ. A.S. Japan, 18, 1 (1966)

Location : Puerto Escondido (Pacific coast), Mexico

Dates : February 8 to March 10, 1970, staying at the observing site

Equipment : Total weight 13 measure tons, numbering 65 boxes. Shipment between Tokyo and Acapulco, and truck between Acapulco and the site.

Special Site Requirements : 20m by 20m horizontal flat area.
Electricity chargeable to the batteries.

Number and Names of People : 3 persons: Mitsuo Kanno, Tokio Tsubaki and Hiroki Kurokawa

Cooperating Groups : A joint expedition with Tokyo Astronomical Observatory and Hydrographic Office of Japan

Special Comments and Needs : -

Station Prob : 1.0

Funds : Governmental

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.1-F-08.00

The Japanese Expedition which included the Kwasan Observatory Party selected the observing site at the plant of CFE (Comision Federal de Electricidad) in Puerto Escondido, Oaxaca, Mexico, where it was 28 km from the central line of totality. The sky was perfectly clear before and after the eclipse.

The eclipse project of the Kwasan Observatory Party has been conducted according to the prearranged plan, except that another 20 cm coelostat system has not been used and the direct photographs of the inner corona have been taken by using the imaging system for spectrographic observations by means of a rotatable mirror which turns the solar image alternately toward the spectrograph and the corona camera.

Three cameras for the chromospheric slitless spectra were all operated by a single control system. Several exposures for the partial sun were made from 70 sec to 60 sec before second contact, and then the cameras ran from 20 sec before till 40 sec after second contact. The exposure time ranges 0.25 sec to 4 sec and the interval for film transport is less than 0.6 sec. During the midphase of totality direct photographs of the inner corona were taken in four exposure times of 1, 2, 5 and 10 sec. Subsequently the slit spectra of the coronal formations at the east limb were taken in two exposure times of 5 and 25 sec. Again the cameras were started at 40 sec prior to third contact and run in a reverse program to that of second contact.

The flash spectra between 4600 and 6700 A are of good quality and clearly display the coronal lines 5303 and 6374 A in addition to chromospheric lines and continuum. The flash spectra for 4100 ± 200 A show H_δ, CaII H and K lines of the chromosphere and prominences. Owing to an incomplete operation of the 35 mm-camera, the spectra of the infrared region were generally underexposed for the coronal line 7892 A.

The slit spectra of the corona at the east limb show the coronal lines 5303, 6374, 6701 and 5116 A as well as emission lines of prominences. The line 6374 A exhibits structural features of the coronal formations. The direct photographs of the inner corona cover about three solar radii in an appropriate exposure.

1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-09.00

Institution	:	California Institute of Technology, Astronomy Department
Investigators	:	WEART, Dr. Spencer R., ZIRIN, Dr. Harold
Title	:	Photoelectric Continuum Observations
Purpose	:	Obtain observations of solar continuum emission in four bands, using the eclipse to reduce scattered light and to improve height resolution. Analysis of the data could lead to a model of temperature, electron density, etc. for the region of transition from photosphere to corona. Band studies are 3538-3543, 4500-4520, 7000-7050, & 8670-8745 A.
Description	:	The apparatus uses multilayer interference filters, photomultipliers, and pulse-counting electronics.
Reference	:	Weart, Photoelectric Eclipse Observations of Continuum and Coronal Line Emissions at the Solar Limb, JILA Report No. 96, 1968
Location	:	Puerto Escondito, Mexico
Dates	:	February 15 - March 10, 1970
Equipment	:	3000 lbs.
Special Site Requirements	:	Near center line
Number and Names of People	:	M. Clark, J. Cowley, L. Cowley, S. Weart, H. Zirin
Cooperating Groups	:	None
Special Comments and Needs	:	Gyro-stabilized heliostat provided by NASA-Ames
Station Prob	:	1.0
Funds	:	NSF

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.1-F-09.00

The weather on our site was unusually clear, and the instrument functioned as planned. Our data are currently in the form of several million dots on 35 mm film, for we elected to record the data by high-speed photography of binary lights. We are presently converting these data to punched cards preparatory to computer processing.

A rough eyeball survey of the data indicates that they confirm the results of the 1966 eclipse reported in the reference, namely, a very rapid dropoff in surface brightness at second contact, abruptly terminating in a plateau of surface brightness. More detailed results cannot be expected until analysis of the data is completed.

California Institute of Technology eclipse spectrometer on site near Puerto Escondito, Mexico. The spectrograph is on the left. Other apparatus (telescope, coelostat, electronics) is under cover to protect it from solar heat.

1970 SOLAR ECLIPSE PROJECT NO. 3.1-E-10.02

Institution	:	GCA Technology Division
Investigators	:	ACCARDO, C. A.
Title	:	Measurement of Solar X-Rays
Purpose	:	Determine flux of x-rays at and near totality
Description	:	Flux of solar X-rays will be determined at several wavelength bands using Geiger counters carried on two Nike Apache rocket payloads.
References	:	L.G. Smith, C.A. Accardo, L.H. Weeks and P.J. McKennon, J. Atmo Terr Phys. 27, 803, 1965. H.V. Argo, et al., Solar Physics, 5, 551, 1968.
Location	:	Wallops Island, Virginia
Dates	:	7 March 1970
Equipment	:	
Special Site Requirements	:	
Number & Names of People	:	C. A. Accardo, with three supporting personnel
Cooperating Groups	:	G. W. Sharp, Lockheed Research Laboratory N. C. Maynard, NASA Goddard Space Flight Center
Special Comments and Needs	:	
Station Prob	:	1.0
Funds	:	NASA

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-10.03

Institution : Solar Physics Group, American Science and Engineering Cambridge, Massachusetts

Investigators : VAIANA, G. S.; VANSPEYBROECK, L. P.; KRIEGER, A. S.

Title : High Resolution X-ray Photographs of the Sun on March 7, 1970.

Purpose : To obtain high resolution photographs of the solar X-ray corona at the time of the solar eclipse of March 7, 1970. The rocket was launched from White Sands Missile Range while the moon was de-occultating the limb of the sun at the end of the partial eclipse.

1) De-occultation Experiment: A rapid sequence (approx. 1/2 arc-sec) of X-ray photographs taken as the solar occultations by the moon ends in order to improve the effective resolution in the lower corona by using the shadow of the moon.

2) High Resolution Photographs: A series of long exposure with various passband filters to observe the structure and the spectral content of the X-ray corona on the disk and the limb.

Description : The payload is flown with an Aerobee 150 rocket. The X-ray telescope is similar to the one flown by our group over the past several years and described in the references (1, 2, 3, 4), it consists essentially of a grazing incidence X-ray mirror, a camera in the focal plane, a sequence of filters transmitting specific broadbands in the 3 to 60 A wavelength region, a pointing control system and appropriate control electronics.

References : (1) Reidy, W.P.; Vaiana, G.; Zehnpfennig, T. and R. Giacconi: Astrophys. J. 151, 333 (1968). (2) Vaiana, G.; Reidy, W.; Zehnpfennig, T.; VanSpeybroeck, L. and R. Giacconi: Science, 161, 564 (1968). (3) Vaiana, G. and R. Giacconi: Plasma Instabilities in Astrophysics (edited by Wentzel and Tidman and published by Gordon and Breach, 1969), p. 91. (4) Giacconi, R.; Vaiana, G.; VanSpeybroeck, L. and T. Zehnpfennig: Space Science Rev., 9, 3 (1969).

Location : White Sands Missile Range

Dates : Planned Timing Schedule March 7, 1970, 18:53 UT

Equipment : Approximately 300 lbs. of payload and 800 lbs. supporting equipment.

Special Site Requirements : Standard Aerobee facilities at White Sands and open lines to solar observatories. We require the launch of the rocket within ten seconds of requested launch time.

Number and Names of People : G. Vaiana, L. VanSpeybroeck, A. Krieger, R. Haggerty, A. DeCaprio, H. Manko, J. Lupone plus supporting NASA personnel.

Special Comments and needs : See NASA Flight Plan

Funds : NASA Contract NASW-2027

SUMMARY OF PRELIMINARY RESULTS:

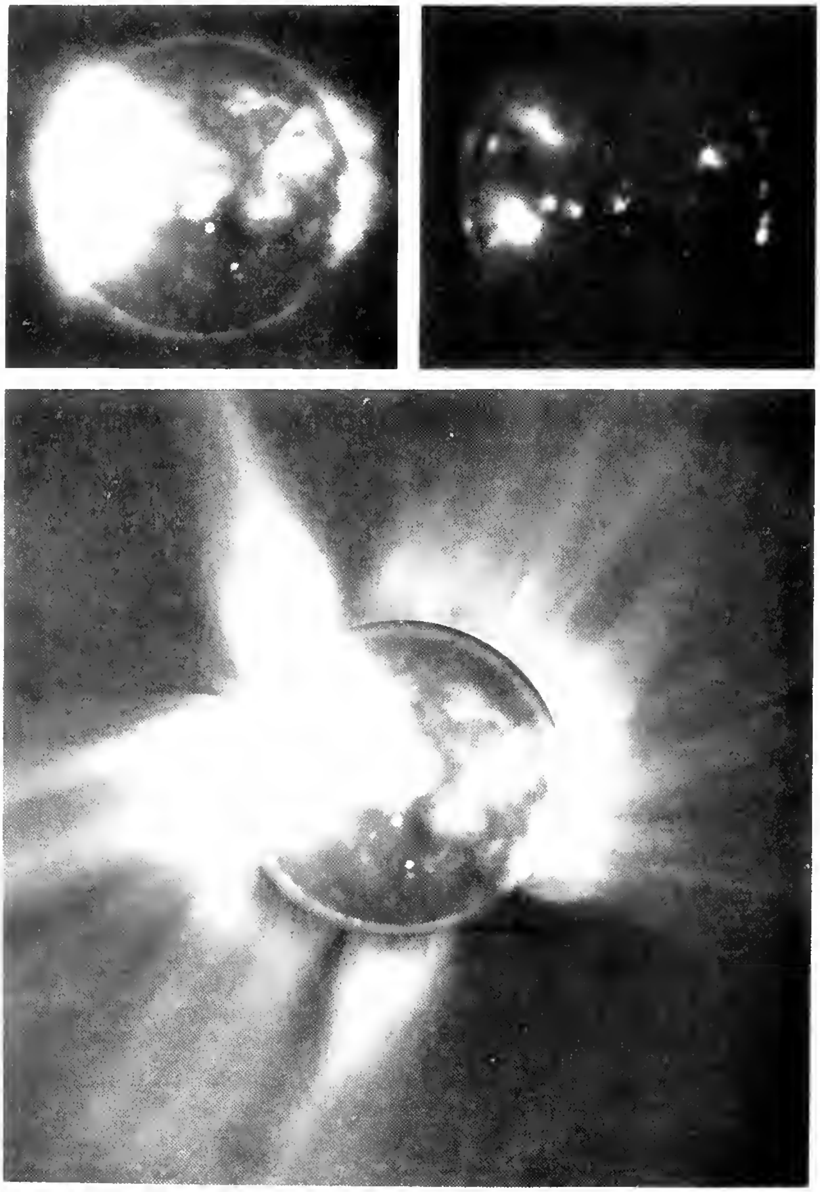
The experiment was very successful and the data was of excellent quality. The data consisted of a series of exposures with various passband filters and exposure times:

Exposure No.	Duration*	Passband**	Exposure No.	Duration	Passband**
1-62	1.5 sec	P	67	6 sec	T
63	49 sec	P	68	6 sec	M
64	29 sec	M	69	7 sec	B
65	27 sec	T	70	1 sec	white light
66	11 sec	P			

*The exposures were taken between 18:54:28 and 18:58:54 UT
**The filter materials (and nominal passbands) are as follows:
P = .85 micron Parylene N +2500 A Al. (3-30 A, 44-55 A);
M = 3.8 micron Mylar +3000 A Al. (3-15 A, 44-48 A);
T = 3.2 micron Teflon + 1.1 micron Parylene N +3000 A Al. (3-13 A, 19-24 A); B = 1.3 micron Be +1000 A Al. (3-15A).
The nominal passbands correspond to 5% or greater transmission.

Three years of minor but important improvements in the instrumentation have led to higher sensitivity for the longer wavelength X-rays which are produced primarily by the cooler coronal plasma. Therefore, faint structures in the corona outside of active regions are visible in these photographs which would have been unobservable in previous flights. These results clarify the association of the X-ray corona with chromospheric features, the white light corona, and magnetic fields. A paper on this subject is being published in Nature.

A quantitative analysis of the photographs is in progress and when completed will allow an evaluation of the spectral content and of the Ne^2h for each resolution element.



SOLAR PHYSICS GROUP
AMERICAN SCIENCE AND ENGINEERING
CAMBRIDGE, MASSACHUSETTS

Fig. 1 - The appearance of the corona in X-rays and white light on March 7, 1970:
(a) an X-ray exposure in the bands 3-30 A, 44-55 A;
(b) an exposure in the band 3-13 A, 19-24 A;
(c) a white light coronal photograph (courtesy of G. Newkirk) and a superposition of the X-ray exposure of Figure 1a.

1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-11.00

Institutions	:	Harvard College Observatory, Cambridge, Mass. (USA) Imperial College, Physics Department, (England) Center for Research in Experimental Space Sciences, York Univ. (Canada) Astrophysics Research Unit, Culham Laboratory (England)
Investigators	:	GOLDBERG, Prof. L.; GARTON, Prof. W. R. S.; NICHOLLS, Prof. R. W.; WILSON, Dr. R.
Title	:	Experiments for the Recording of the Solar Flash Spectrum 850A°-2150A° During the Solar Eclipse of March 7, 1970
Purpose	:	Because of specific observational difficulties the transitions photosphere/chromosphere and chromosphere/corona are known in crude detail only and mechanisms of energy transfer and heat balance in these regions (300 km) - 20,000 km above the limb) remain largely ill defined. The recovery of emission structure as a function of height in lines of both high and low opacity would allow positive inferences to be made on the solar atmospheric structure, provided (a) emissions were chosen covering a wide range of excitation temperature, and (b) the spatial resolution was comparable to the inferred scale heights. We propose to photograph time-resolved stigmatic flash spectra by means of rocket-borne spectrographs.
Description	:	Time-resolved and stigmatic flash spectra were taken during the eclipse with one Wadsworth spectrograph covering the range from 850A - 2150A. The spectrograph used no entrance slit and imaged the remaining crescent of the solar disk on the film with wavelength resolutions of 1 A. The solar images are 4.5 mm indiameter. The spectral dispersion is 16.6A/mm. The instrument was aligned to the solar limb and disposed so that the direction of dispersion is parallel to the line of centers. The camera cassette held 50 film strips sensitive to exposures alternating between 0.2 to 1 seconds.
Reference	:	Burton, Ridgeley and Wilson, 1967, Mon. Not. Roy. Astron. Soc., 135 207.; Detwiler, Garrett, Purcell and Tousey, 1961, Ann. d. Geophys. 17, 263.; Dupree, A., and Goldberg, L., 1967, Solar Physics, 1, 229.; Fowler Rense and Simmons, 1965, App. Opt., 4, 1596; Melus, Grosjean and Vanderbeen, 1966, Canon of Solar Eclipses, Pergammon Press.; Parkinson, W. H., and Reeves, E. M., Symposium on Calibration Methods in Ultraviolet and X-ray Regions of the Spectrum, 1968, May, Max-Planck Inst., Munich, Germany.
Location	:	Portable Aerobee launch tower at Wallops Island, Virginia
Dates	:	February 1, 1970 Final integrations and test at Wallops Aerobee launch site. March 7, 1970 - Launch at 18h36m15s UT
Equipment	:	Instrumented stabilized Aerobee 150 payload
Special Site Requirements	:	Radar plot to 0.1 km, 3 axes. The aircraft carrier USS Guam was the recovery vessel
Number and Names of People	:	Several from each of the four participating groups.
Cooperating Groups	:	NASA Sounding Rocket Branch
Funds	:	U. S. A. : NASA Contract Nsr-22-007-067 United Kingdom: Scientific Research Council Canada : National Research Council

The payload which was successfully launched with an aerobee 150 rocket completed its programmed pointing manoeuvers and at 18h39m32s UT entered the umbra at an apogee of 142km. A sequence of 50 spectra were recorded over a period of 180 seconds in the range 850A - 2150A. Throughout the data acquisition the maximum pointing excursions in pitch and yaw were $\pm$ 10 arc seconds with mean body rates of 5 arc seconds per second. For the several critical frames around second contact the body rates were less than 2 arc seconds per second with the result that the data taken then are limited only by optical aberrations and film grain. A preliminary flight reconstruction shows that the maxium apparent angular rate of the lunar limb at second contact is 0.36 arc seconds per second.

Second contact occurred close to the twentieth frame in the time sequence at which point the chromospberic flash spectrum is clearly resolved. The sequence then progresses steadily to a point close to equal mid-totality resulting in spectra entirely dominated by the corona. Several prominences and a plage region are clearly visible in Lyman α and their spectra are isolated and spatially resolved throughout the whole sequence. Figure 1 shows a part of the total wavelength range between 1100A and 1400A selected from two of the fifty frames. Exposure a) corresponds to a few seconds after second contact, while exposure b) was taken near mid-totality. In the Lyman α images one can observe structure and emission out to 1.3 solar radii which is well beyond the emission from the forbidden lines of Fe XII at 1242A and 1350A, also visible in figure 1. Preliminary estimates allow radiative recombination, electron excitation and dust scattering (F corona) to be discarded as possible mechanisms to explain the observed intensity of coronal Lyman α. Thompson scattering is also eliminated by noting the sharp edge of the lunar disk image, since this mechanism, if present would result in a Doppler broadening of approximately 30A half-width.

It is concluded that the observed intensity is due to resonance scattering of the intense eclipsed Lyman α radiation by residual neutral hydrogen atoms in the corona. Although the relative concentration of neutral hydrogen at a coronal temperature of 2×10^6 K is only about 10^{-7}, the high abundance of hydrogen and the high flux of the Lyman-line from lower levels is sufficient to produce the observed intensity within the errors of this early calculation. This "L α corona" therefore reflects the distribution of neutral hydrogen and has an intensity in the inner corona of the order of 10^{-3} of the low lying chromospheric Lyman α.

Further quantitative considerations of the eclipse data await further reduction. This is now underway by all participants. The eclipse films are being densitometered and the analysis assisted by computer methods.

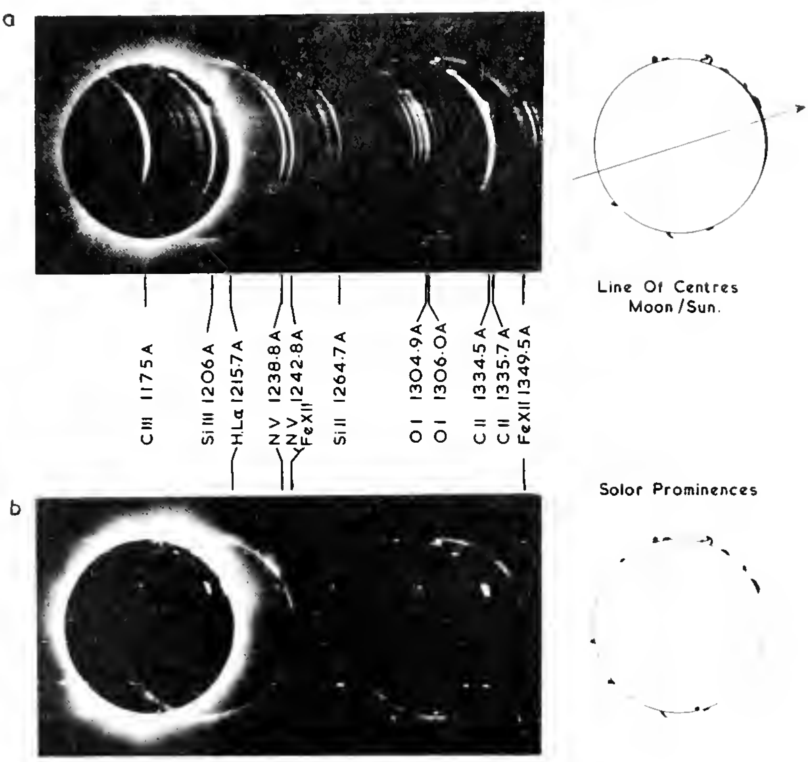


Fig. 1 - EUV SOLAR FLASH SPECTRA - 1970 SOLAR ECLIPSE
a) A few seconds after second contact - b) Near mid-totality

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-11.01

Institution : E. O. Hulburt Center for Space Research, Naval Research Laboratory

Investigators : BRUECKNER, Dr. G. E., BARTOE, Mr. J-D.F., NICOLAS, Mr. K. R., and TOUSEY, Dr. R.

Title : Charateristics of the Solar Atmosphere in the Ultraviolet

Purpose : The transition region between the photsphere and chromosphere can be studied most successfully by measuring the UV continuum between 1400-2000 Å. During the eclipse this can be done with the very high spatial resolution which is required.

The chromosphere and the transition region between chromosphere and corona can be investigated by measuring the intensities of a variety of emission lines which have different stages of ionization and therefore can be seen only in the UV region of the solar spectrum. All the existing spectra lack the necessary spatial resolution which can be obtained during the eclipse.

The inner corona's temperature, iron abundance, etc., can be studied only by measuring very high ionized lines (Fe IX-Fe XVI). During the eclipse the absence of stray light from the solar disk will make it possible to obtain much purer spectroheliograms of the corona.

Description: Five instruments will be flown on board an Aerobee-170 vehicle. All will be fine-pointed to the sun by means of a special eclipse pointing system, which has been developed by NRL.

Instr. #1 - Wadsworth spectroheliograph 150-437Å, 8.3Å mm^{-1}, resol. $\approx$ 2Å, flash spectrum and corona; photographic.

Instr. #2 - Wadsworth spectroheliograph 727-1060Å, 8.3Å mm^{-1}, resol. $\approx$ 2Å covering Lyman series and Lyman continuum, flash spectrum; photographic.

Instr. #3 - Modified Wadsworth spectroheliograph. Lyman-alpha only 1.2Å mm^{-1}, resol. $\approx$ 0.02Å flash spectrum Lyman-alpha profile; photographic.

Instr. #4 - Wadsworth spectroheliograph 1400-1965Å, 9.4Å mm^{-1}, resol. $\approx$ 0.2Å far limb spectra, flash spectrum; photographic.

Instr. #5 - Multichannel Wadsworth configuration scanning spectrometer. 1300-2000Å, resol. 1Å, one complete spectrum can be obtained in 0.5 sec.

Reference : R. Tousey, Ap. J. 149, 239 (1967).

Location : Aerobee-350 Tower at Wallops Island

Dates : Launch at $18^{h}38.1^{min}$ U.T. + 1 min ± 2 sec
- 4 min ∓ 2 sec

Equipment : Aerobee-170 Rocket; Aerojet ACS modified with eclipse crescent sensor and rate-integrating gyros.

Special Site Requirements : Rocket launch site from which the eclipse shadow could be reached.

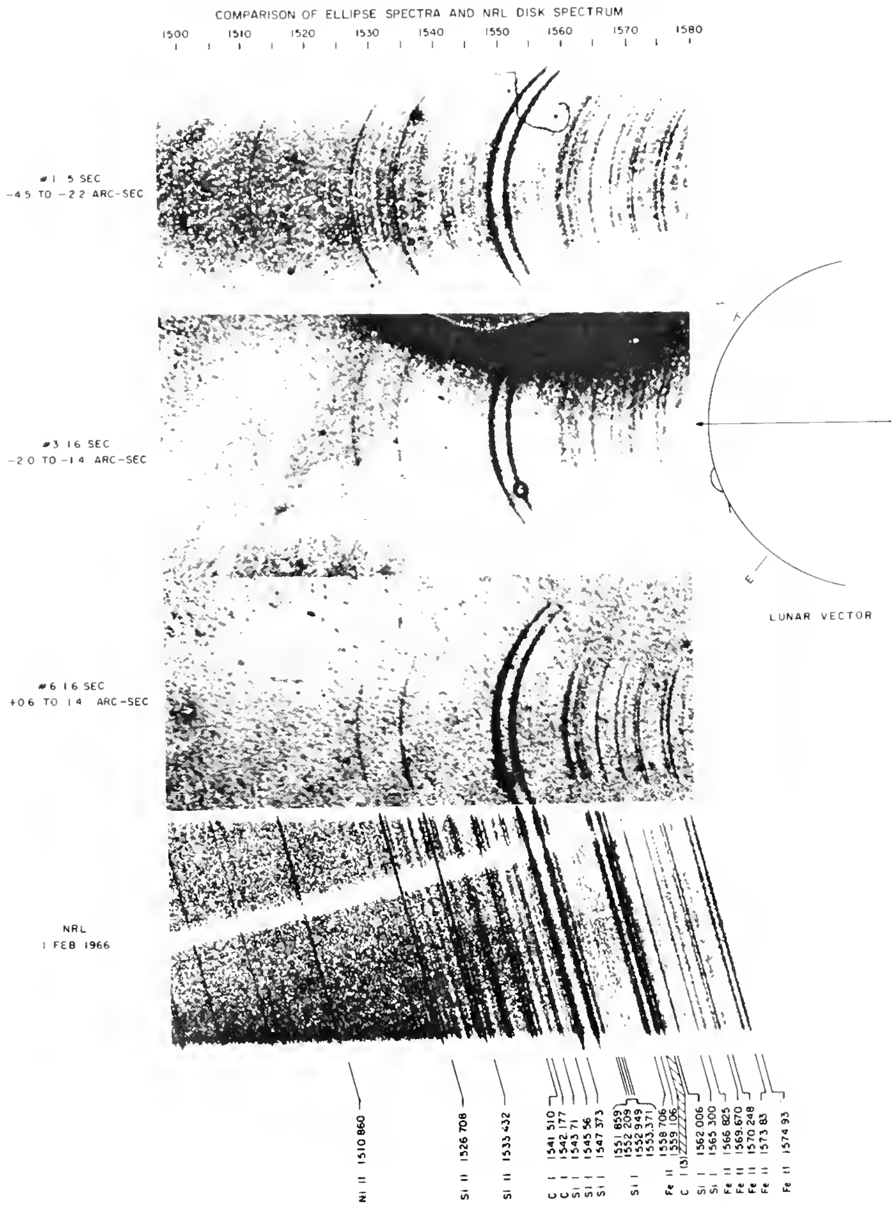
Cooperating Groups : NASA; GSFC, ARC, Wallops Station; Aerojet General Corp; Fairchild-Hiller Corp; Exotec Corp; US Navy Supervisor of Salvage.

Station Prob : 1.0

Funds : NASA (SG), NRL

SUMMARY OF PRELIMINARY RESULTS-PROJECT NO. 3.1-F-11.01:

The rocket launch, trajectory, pointing performance and operation of four of the five instruments were excellent. A malfunction of the instrumentation severance system prevented the parachute from opening. As a result the instrumentation section impacted the sea surface in free fall, imploded and sank in 1770 meters of salt water. It was recovered after 14 days with an unmanned submersible. The film in Experiments 1, 2, and 3 was ruined by electrolytic action. The film strips from Experiment 4 were saved from complete loss by a thin Teflon coating inside the camera. Although not of good photometric quality, the flash spectra show many emission lines from the solar temperature minimum well into the chromosphere, with excellent spectral resolution. Figure 1 is a short section of three exposures, made before and after second contact as indicated, and matched to the NRL stigmatic rocket spectrum of February 1, 1966 showing the spectrum across the disk and at the opposing limbs. A preliminary description has been published in NATURE 226, 1132 (1970).



1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-11.02

Institution : Space Science Division, Naval Research Laboratory

Investigators : KOOMEN, M. J.: PURCELL, J. D. and TOUSEY, Dr. R.

Title : Rocket Observations of the White-Light and Extreme Ultraviolet Corona

Purpose : (1) To photograph the white-light corona at elongations between 3 and 9 solar radii, where the corona and streamers in earth-based eclipse photographs usually fade into the background sky. (2) To photograph the solar disk and inner corona in the ultraviolet band 170-500 A. (3) To obtain photographic spectroheliograms of the disk and inner corona in the sun's emission wavelengths between 170 and 500 A.

The ultraviolet measurements (2) and (3) are aimed at identifying the mechanisms which produce the extreme ultraviolet corona.

Fly-along instruments include an ion chamber detector to measure the Lyman α (1216 A) solar flux, and a photoelectric detector to measure solar flux in the band 170-800 A.

Description : The following instruments are carried in a University of Colorado biaxial solar pointing control, mounted in an Aerobee-150 rocket: (1) White-light coronagraph--two small Lyot coronagraphs placed side by side. Solar occultation for each is by an external disk placed at the end of a 30" spar; (2) Extreme ultraviolet (XUV) heliograph--a 25 cm focal length, paraboloidal mirror which forms a direct solar image on Schumann-type film. An aluminum film filter restricts the pass band to 170-500 A. (3) XUV Spectroheliograph--a system similar to the heliograph but with a 50 cm focal length concave grating (3600 lines/mm) in place of paraboloidal mirror, to form a series of solar emission images in a slitless spectrum.

Reference : R. Tousey, G. D. Sandlin and M. J. Koomen, I.A.U. Symposium 35, Structure and Development of Solar Active Regions, 385-388, K. O. Kiepenheuer (Ed.) D. Feidel Publ. Co. Dordrecht, 1968.; J. D. Purcell, R. Tousey and M. J. Koomen, Space Research VIII, 450-457, North Holland Publ. Co., Amsterdam, 1968.

Location : Aerobee 350 launch tower, darkroom and lab. facilities of Naval Ordnance Missile Test Facility, White Sands Missile Range, New Mexico.

Dates : Launch Time 1930 UT., 7 March 1970

Equipment : 27 packages, 1000 lbs, 500 cu. ft., $100K; shipment by commercial van and air freight.

Special Site Requirements : Rocket range where recovery is possible.

Number and Names of People : NRL (6); M.J. Koomen, R.T. Seal, R. Chaimson, W. Funk, H. Heitman, B. Snider; U of Colo. (3); V. Stone, H. Haas, T. Haynes; GSFC (1); R. Demorest.

Cooperating Groups : Vehicle Services and Launch Operations; NASA Goddard Spaceflight Center and Naval Ordnance Missile Test Facility. Solar pointing control and Services, U. of Colorado

Funds : NASA (SG).

SUMMARY OF PRELIMINARY RESULTS: The white-light corona was successfully photographed from 3 to 9 $R_\odot$ at 1930 UT. A print is shown in Fig. 1. An eclipse photograph supplied by Dr. Gordon Newkirk Jr. of the High Altitude Observatory has been introduced to the proper scale into the center area occupied by the occulting disk of the rocket coronagraph. The dark crescent to the left of center is the edge of the moon which was at small elongation when the rocket photograph was taken. In the rocket photograph the individual coronal streamers appear as parallel or slightly diverging with no detectable curvature. Therefore the range beyond 3 solar radii is not greatly influenced by the complex magnetic fields near the limb. There is a dark sector in the southeast, perhaps produced by projection of several different streamers onto the plane of the sky, or possibly by some peculiarity in the large-scale magnetic field. The dark south-west sector shown in the eclipse photograph is not noticable in the rocket photograph.

All streamers appear to lose contrast and disappear into the general coronal background as they approach the edge of the field at 9 $R_\odot$. The prominent equatorial enhancement of the background corona seems real, with a neglegible contribution from stray light as evidenced by the blackness of the lunar silhouette which lies in the equatorial plane, and by the fact that the enhancement remained fixed in space during successive exposures while the coronagraph focal plane rotated 60° due to rocket precessional motion.

Fig. 2 shows successively longer exposures of the solar disk image obtained with the rocket XUV heliograph. Noticable features are the corona-like emission above the limb and a narrow limb-brightened ring around the entire disk. Much of the corona-like emission projected beyond the disk is produced by a mechanism different than that producing the white-light corona, but its outline is similar in shape to the inner white-light corona observed in short-exposure eclipse photographs. The outline of the XUV corona is somewhat more scalloped, with the dark notches seemingly located where there is limb activity in the form of Hα prominences.

The longer exposures of Fig. 2 show no XUV structures which correspond to white light streamers, but these may have been blurred by image rotation produced by rocket precession.

Several spectroheliograms of the disk and inner corona, in the emission wavelengths between 170 and 500 A, were recorded with a spatial resolution of one arc minute or better. Emissions in He II (304 A) and high stage ions of Ne, Mg and Fe are prominent.

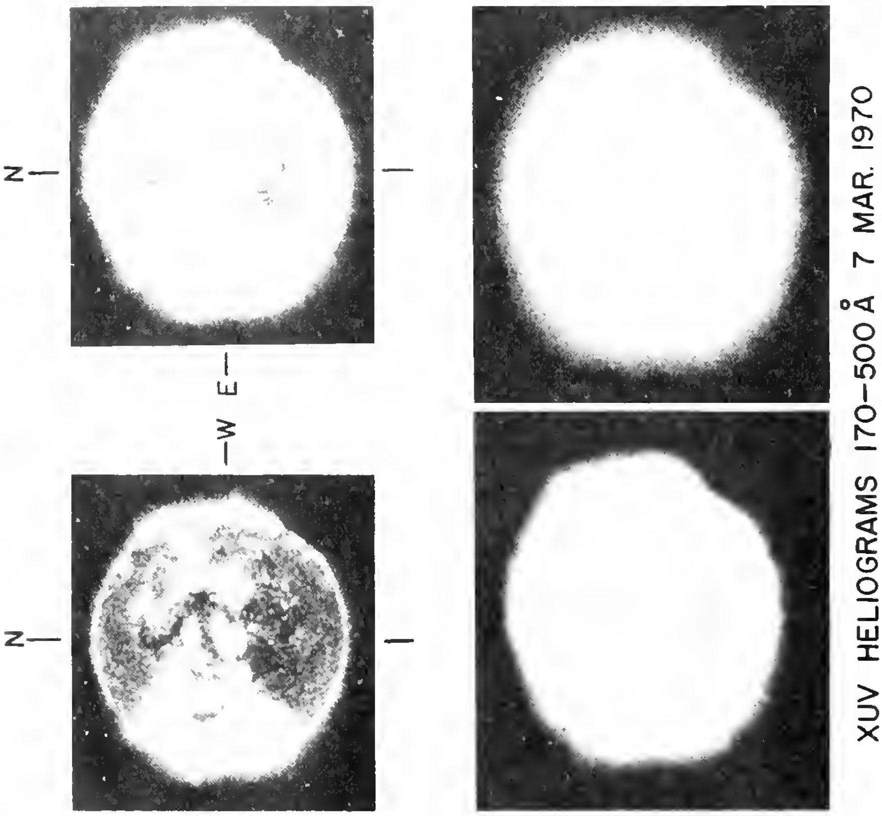


Fig. 2 - The solar disk photographed in the band 170 - 500 A with successively longer exposures to record corona; 7 March 1970, 1930 UT.

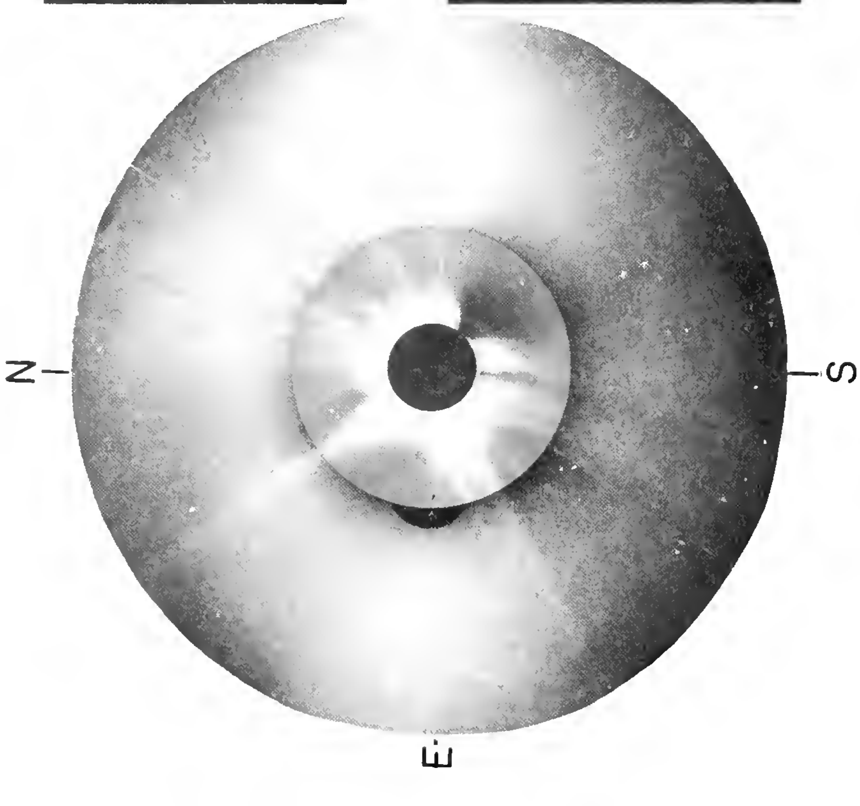


Fig. 1 - White-light corona from the solar limb to 9 radii on 7 March 1970. The corona beyond 3 $R_{\odot}$ was recorded with the NRL rocket coronagraph at 1930 UT. The center is a HAO eclipse photo taken at 1740 UT. In both the radial decrease in brightness has been compensated to give uniform exposure over the field.

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-11.03

Institution : Space Science Division, Naval Research Laboratory Washington, D.C.

Investigators : PURCELL, J. D., and TOUSEY, Dr. R.

Title : Extreme Ultraviolet Spectra of the Solar Corona and Chromosphere

Purpose : To obtain, on the 7 March eclipse day, ultraviolet spectrograms (1200-1800 Å) of discrete areas of the chromosphere and corona. The desired area is isolated by a slit 2 arc sec. wide and 60 arc sec. long, with the long dimension parallel to the solar limb. Spectrograms are obtained from locations (1) 30 arc sec. inside the limb in the photosphere, (2) 3 arc sec off the limb in the corona and (3) 8 arc sec. off the limb in the corona.

In addition, a small heliograph instrument is designed to photograph the solar disk and inner corona in the band 170-600 Å. Launch time is chosen to have the moon silhouetted against the XUV corona as an indicator of instrumental stray light.

The rocket flight is a systems test for a similar double-size instrument for the ATM instrument S082B to be flown in Skylab I.

Description : An Aerobee-150 rocket carries a spectrograph instrument which works as follows: A paraboloidal mirror forms a solar image on a 2 arc sec. by 60 arc sec. slit. Light passing through strikes a predispersing grating and aperture which selects the 1200-1800 Å band of the first order. This light passes on to the main grating which forms a second order spectrum onto a strip of Schumann-type film. Resolution is approximately 0.05 Å.

The XUV heliograph instrument consists of concave mirror which forms an image of solar disk and corona on Schumann-type film. The passband of the instrument is restricted to 170-600 Å by an aluminum film filter.

In flight, the experiment payload is separated from the rocket engine burnout and pointed at the sun with the NASA-Ames Solar Pointing Aerobee Control System (SPARCS). A program of appropriate pointing offsets is provided to direct the spectrograph slit to the spatial locations mentioned above.

Location : Aerobee-150 launch tower A, and NASA Vehicle Assembly Building, White Sands Missile Range, New Mexico.

Dates : Launch time 1900 UT, 7 March 1970.

Equipment : 1200 lb. 400 cu. ft. $350K

Special Site Requirements : Rocket range where payload recovery is possible, near eclipse path where $1/2^{\circ}$ lunar elongation is possible.

Number and Names of People : NRL (3) J. D. Purcell, M. E. VanHoosier, R. Mason
Marshall Space Flight Center (1) W. C. Keithly
Ball Bros. Res. Corp. (9) W. Frank, D. Bradshaw, J. Haynes, R. Gablehouse, D. Schneible, A. Befus, D. Armstrong, N. Gosset, G. Smith
Goddard Space Flight Center (2) H. Myerson, J. Connellee
NASA-Ames Res. Center (2) E. Gabris, H. Zimmer

Cooperating Groups : (1) Marshall Space Flight Center--management for "Skylab" project. (2) NASA Goddard Space Flight Center and Naval Ordnance Missle Test Facility--vehicle services and launch operations. (3) NASA-Ames Research Center--solar pointing control. (4) Ball Bros. Research Corp--spectrograph payload.

Special Comments and Needs : Data are on photographic film; payload recovery is required soon after launch. Launch time of 1900 UT required to give approximately $1/2^{\circ}$ center to center separation of the sun and moon.

Station Prob : 1.0

Funds : NASA-ATM (Skylab) Project.

SUMMARY OF PRELIMINARY RESULTS:

Flight and recovery were excellent, but no data were obtained because of the failure of the SPARCS to point the instruments at the sun.

1970 SOLAR ECLIPSE PROJECT NO. 3.1-E-12.01

Institution	:	Osservatorio Astronomico di Roma
Investigators	:	CIMINO Prof. Massimo; DE BIASE Dr. G. A.; CROCE Dr. V.
Title	:	High resolution photometric measurements of extreme so limb in different wavelengths.
Purpose	:	a) To continue photoelectric photometry of the extrem solar limb in different wave lengths, made in the occasion of 1966 (Greece and Brazil) and 1968 (Yurgamish, USSR) solar eclipses, in order to dete the temperature and other physical conditions (sou function, absorption, etc.) of the upper layers of photosphere and the low chromoshpere, by a photoel photometer with a high temporal resolution (down t of a second) in different wave-lengths contemporan b) To measure intensity and polarization of the inner corona by photographic methods, with a camera on e mounting (teleobjective lm. focal length, 12 cm. a
Description	:	-
References	:	-
Location	:	Oaxaca or Mihuatlan (Mexico).
Dates	:	In site February 15-20, 1970.
Equipment	:	About 1 ton equipment; two equatorial mountings with t cameras; electronic equipment; value $30,000.
Special Site Requirements	:	Electric power: 4 kw at 220 ± 20 volts.
Number & Names of People	:	Five persons: Professor M. Cimino; Dr. G. A. De Biase Dr. V. Croce + 2 technicians.
Cooperating Groups	:	-
Special Comments and Needs	:	-
Station Prob	:	0.95
Funds	:	Rome Astronomical Observatory and National Council of

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE PROJECT NO. 3.1-E-14.00

Institution	:	Technology International Corporation, Bedford, Mass. 01730
Investigators	:	BOQUIST, W.P. and DEUEL, R.W.
Title	:	Optical Measurements of Solar Ionization Sources and Corona
Purpose	:	A. To determine the characteristics and radiant power of the coronal source near and during totality in the visible and low infrared regions of the spectrum. B. To study the structure and polarization of the extreme outer corona in order to correlate with solar magnetic field. C. To study temporal changes in the coronal structure over an extended period of time with strategic positioning of site locations.
Description	:	Photographic and Spectrographic Instrumentation to be operated from one aircraft station and two ground stations.
References	:	Boquist, W.P., "Optical Measurements of Coronal Phenomena," (U), DASA Report No. 1976, October 1967.
Location	:	One aircraft station; two tentative ground stations as follows: A. AFCRL KC-135 Research Aircraft - Pacific Ocean B. Ground Station - Oaxaca, Mexico C - Ground Station - Nantucket, Mass.
Dates	:	On Stations: D-5 days to D+2 days (approximately)
Equipment	:	2 - 20" f/5.6 70mm Cameras 2484/IR Aero Color 2 - 36" f/8.0 70mm Cameras XR Mod/XR Color 1 - 12" f/5.6 35mm Camera PAX Film 1 - 2" f/0.7 Coronal Spectrograph I-F Plates
Special Site Requirements	:	None
Number & Names of People	:	2 scientific crew each station
Cooperating Groups	:	Scientific activities will be coordinated with overall objectives of rocket experimenters as well as with other aircraft programs.
Special Comments and Needs	:	None
Station Prob	:	90%
Funds	:	

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-15.00

Institution : Tokyo Astronomical Observatory, Tokyo University

Investigator : SAITO, Dr. Kuniji (leader)

Title : Polarization of the Corona

Purpose : (1) To investigate the 3D construction of the fine structures in the corona such as coronal streamers etc. by means of polarimetric method.
(2) To investigate the 11 year change in the brightness and total light of the corona.

Description : (1) Direct and polarized images of the white light corona are obtained as far as $5R_{\odot}$ with f=500 cm horizontal camera equipped with a radially graded neutral density filter as Dr. G. Newkirk, HAO, first employed and with the rotatable polarizing filter at the focus. Film size is 24 cm x 24 cm large.

(2) A pair of the quadruple-lens polarigraphs of f=228 cm and f=30 cm enables us to take four differently polarized images of the corona at one shot of exposure from $1R_{\odot}$ to $20R_{\odot}$

Reference : K. Saito-D. E. Billings, "Polarimetric observations of a coronal condensation", Ap. J., 140, No. 2, 760, 1964.

K. Saito-C. L. Hyder, "A concentric ellipse multiple arch system in the solar corona", Solar Physics, 5, 61, 1968.

Location : Puerto Escondido on the Pacific coast, Oaxaca, Mexico

Dates : February 7 to March 10, 1970 staying at the observing sit

Equipment : 27 m^3, 9 tons, 53 wooden boxes, 30,000 U. S. dollars equivalent. Shipment between Tokyo and Acapulco, and truck between Acapulco and the site.

Special Site Requirements : Electric power AC 125 V, 5 A. Photographic darkroom. 25m x 25m horizontal flat area.

Number and Names of People : Dr. Kuniji SAITO (leader), Dr. Mitsugu Makita, Mr. Shiger Hata, Mr. Arata Tojo, and Dr. Tadao Takenouchi from Tokyo Astron. Obs.

Cooperating Groups : A joint expedition cooperated with the Kwasan Observatory (3 persons) and the Hydrographic Office of Japan (2 persons).

Station Prob : 1.0

Funds : Governmental

SUMMARY OF PRELIMINARY RESULTS

(1) Horizontal camera

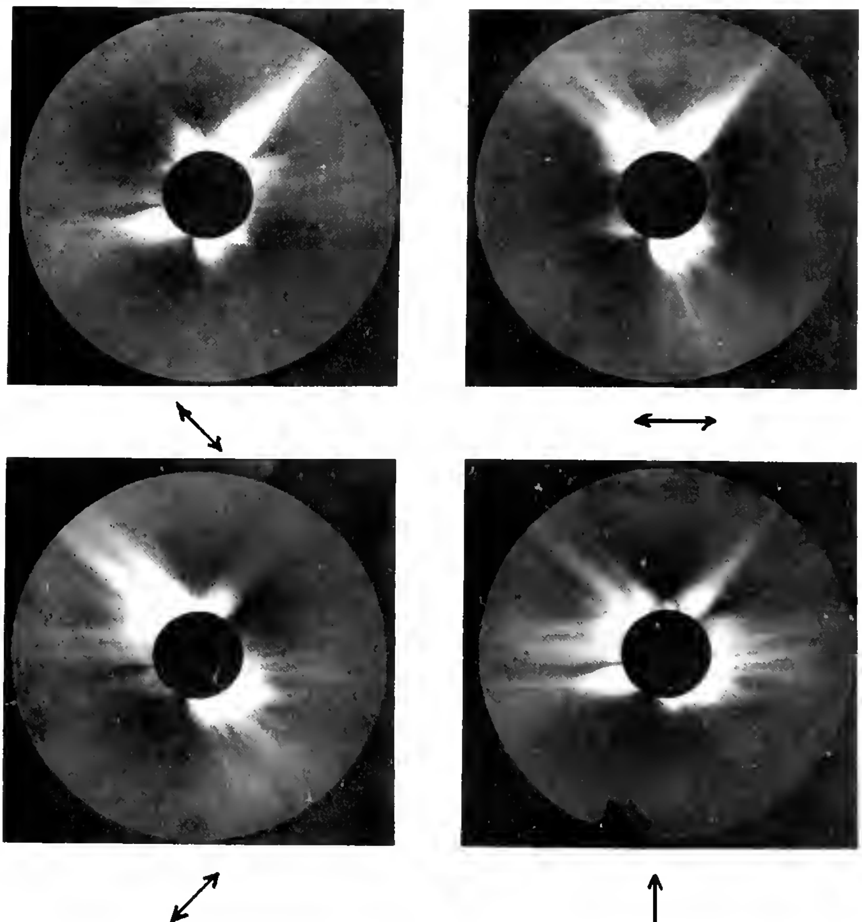
Three direct photographs of the white light corona were taken with exposur of 3 sec., 6 sec. and 10 sec. with a horizontal camera of f = 500 cm and F/32. radially graded neutral density filter similar to that first successfully used i Dr. G. Newkirk, HAO, was put at the focus of the camera. Photographs obtained reveal remarkable forms of the coronal streamers, helmet arches, rays as far as 5 solar radii. After exposures of the direct photographs, a rotatable polarizi filter was inserted in the light path just in front of the ND filter above ment After making each exposure of 18 seconds the polarizer was rotated every 45 deg so that four differently polarized images of the corona were obtained as given the attached quadruple photographs, which are reduced in size from photographs ally as large as 24 cm in diameter each.

It is expected that (1) analysis of the four pictures enables us to locate in space the structures in the corona such as the streamers, arches, etc. or to derive the 3D construction of them, (2) electron density distribution in the radial direction will be compared accurately between the general corona and the streamers, (3) geometric forms of the streamers, arches will be investigated in comparison with theory.

(2) Quadruple-lens polarigraphs

A pair of the quadruple-lens polarigraphs of f = 228 cm and f = 30 cm were used to take four differently polarized images of the corona with one shot of exposure. It is expected that the brightness values are obtained in a range from 1 to 20 solar radii. This work was first undertaken at the 1955 Ceylon eclipse. Then the 1958 South Pacific, 1962 New Guinea, 1963 Japan, 1965 Cook Islands, 1966 Peruvian and 1970 Mexican eclipses were observed with two exception of clouded-out ones.

The work is aimed at obtaining the brightness, flattening and polarization data of the white light corona during one 11-year period of the solar activity cycle by using one and the same cameras so as to be free from any systematic errors caused by the use of different instruments.



Four differently polarized photographs of the white-light corona taken with the f = 500 cm and F/32 horizontal camera equipped with a radially graded neutral density filter and a rotatable polarizing filter at the focus. Arrows indicate the orientation of the electric vectors of the polarizer at each exposure.

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-15.01

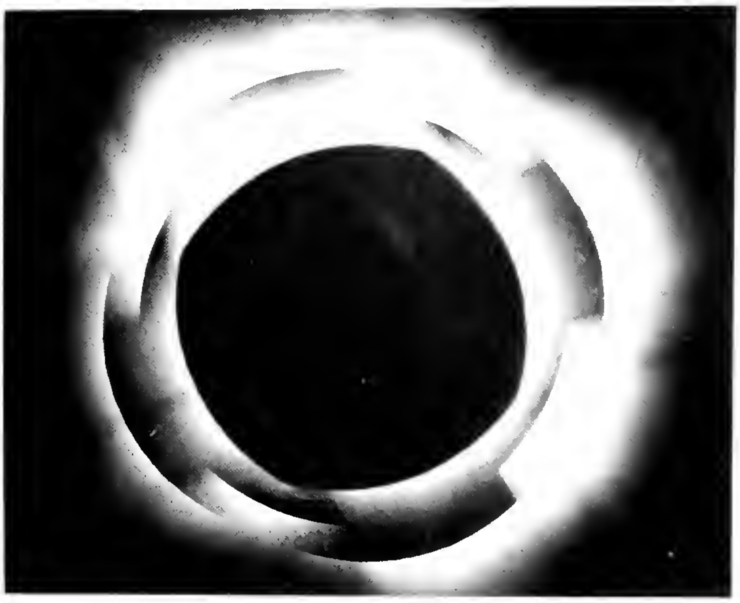
Institution	:	University of Colorado; NASA Langley Research Center
Investigators	:	BILLINGS, D. E., University of Colorado MORRELL, F. R., and SMITH, B. O., NASA Langley Research Center
Title	:	The Color of Polarized Components of the K-Corona
Purpose	:	To investigate the phenomenon of an expected difference between the color of tangentially and radially polarized radiation from the K-corona near the limb, and to use the phenomenon for determining the spatial location of coronal features.
Description	:	The procedure is to separate the two polarized components by Wollaston prisms placed near the image in a telescope, and to study the color of the two components by two-color photographic photometry
Reference	:	Billings, "A Guide to the Solar Corona," 1966, Academic Press, New York, pp. 151-152.
Location	:	Langley Research Center, Hampton, Virginia, using $9\frac{1}{2}$" cassegrain telescope on site.
Dates	:	January 15-29, 1970, February 26-March 9, 1970
Equipment	:	Telescope, permanently on site, plus an optical assembly for the Wollaston prisms manufactured by Crystal Optics. The prism assembly was mounted in a Bronica camera behind two Wratten filters, and the camera assembly attached to the telescope so that it could be rotated about the optic axis in 45° steps. Also a special calibrating device.
Special Site Requirements	:	None, other than already present
Number & Names of People	:	Donald E. Billings, F. R. Morrell, B. O. Smith
Cooperating Groups	:	Various shops and facilities at NASA Langley Research Center
Special Comments and Needs	:	None
Station Prob	:	0.9
Funds	:	NASA

SUMMARY OF PRELIMINARY RESULTS-PROJECT NO. 3.1-F-15.01:

We obtained eight 1/8 second exposure pictures of the corona with the camera on successive 45° positions, and three additional picture at 1/2 second exposure. Figure 1 shows one of the 1/8 second pictures. The four double images of the corona are through four Wollaston prisms which alternately throw the electric-vector-parallel-to-the-limb image out and in. The unsplit images are through fused images are through fused quartz pieces holding the Wollastons together.

Data were also obtained for three modes of calibration, one using scattered sunlight from a white reflectance plate, one using the uncovering sun and a diffusing plate, and one using a diffusing plate and a variable aperture.

Analysis of the calibrations is now almost finished, and analysis of the coronal photographs will begin shortly. We plan to make microphotometer tracings at each 1° position on the limb, for both polarized images, for all eleven photographs, eliminate the effect of overlapping images, find the ratio of the ratio of red to blue image intensity in the two polarized components, then determine from this ratio the distance of the coronal feature from the plane of the sky.



1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-16.00

Institution	:	Observatoire de Paris-Meudon Département, "Physique du Soleil et du Système Solaire"
Investigators	:	FORT, B.; MICHARD, R.; MOURADIAN, Z.
Title	:	Spectrophotometry of Chromosphere and Corona
Purposes	:	To measure intensities and profiles of chromospheric lines at the chromosphere-corona transition To measure intensities and polarization of forbidden coronal lines throughout the inner and outer corona
Description	:	a) The chromospheric spectrum 3600-8800 Å will be photographed with a slit spectrograph, fed with 40 cm telescope and coelostat. Average dispersion 2 Å/mm; solar image diameter: 10 cm. Height coverage: 1500-10,000 km; height resolution ≃ 1000 km (seeing permitting!) b) The intensities (and polarization) of 5303, 6374, 7892 Å coron lines will be measured up to 1.2 - 1.3 solar radii, in the whole corona with spatial resolution ≃ 6. Line separation is achieved with a Savart interferometer and interference filters, fed by a 25 cm telescope. c) The intensities and polarization of 5303, 10747, 10798 Å corona lines will be measured by monochromatic photographs obtained throug narrow bands interference filters, using Lallemand electron cameras of improved and ruggedized design. Detection of green line is expected up to 2 solar radii in a selected quadrant of the corona.
Reference	:	
Location	:	"El Gramal" near Nejapa at 126 km south of Oaxaca
Dates	:	February 10 to March 11, 1970
Equipment	:	6 tons
Special Site Requirements	:	Electric power of 220V and 11 A with 50 Hz, one darkroom and one dust free laboratory
Number and Names of People	:	Boche, Raymond — experiment b Chevillot, Mme. Annick — " c Dupin, Jean-Pierre — " c Felenbok, Paul — " c Fort, Bernard — " c Guerin, Jean — " c Michard, Raymond — " b Mouradian, Zadig — " a Picat, Jean-Pierre — " c Rousset, Gabriel — " c Simon, Guy — " a
Cooperating Groups	:	
Special Comments and Needs	:	
Station Prob	:	
Funds	:	Centre National de la Recherche Scientifique, Paris

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.1-F-16.00:

a) The chromospheric and coronal spectrum 3600-6600 A were photographed simultaneously at the second contact, with a slit spectrograph, fed with 40 cm telescope and coelostat. Average dispersion 2 A/mm; solar image diameter: 10 cm. Height coverage 1500-10.000 km. Unfortunately, because of poor seeing the spatial resolution was much worse than expected.

b) A new technic was used where line separation is achieved with a Savart interferometer and interference filters, fed by a 25 cm telescope. A technical accident impaired the measurement of the intensities of 5303 and 6374 A coronal lines. However some information might be extracted from the interferogrammes.

c) The project of the third experiment was to measure the intensities and polarization of 5303, 10747, 10798 A coronal lines. The monochromatic images are obtained through narrow bands interference filters, and photographed using Lallemand electron cameras of improved and ruggedized design. The use of cameras has met many difficulties, only the green line could be observed.

1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-16.01

Institution : Institut D'Astrophysique De Paris
Centre National De La Recherche Scientifique

Investigators : KOUTCHMY, Serg and LAFFINEUR, Marius

Title : Weighted Photometry and Polarimetry of the Solar Corona

Purpose : The purpose is to obtain calibrated photographs with high spatial resolution in order to study the fine structure of the K corona in a larger than 3^{o} field.

The connection of the K corona structures and their models with other manifestations of solar activity is possible only with good plates correctly exposed. For a very little object contrast, plates in both natural and polarized light are used with an exposure in the region where plates have a maximum resolution. We also tried to minimize the instrumental scattered light.

Available information are also sought for on physical processes in the K corona.

Description : A special 4x camera coronograph was used with the following characteri[stics]: F 1526 mm; D 100 mm;/5700 $\pm$ 200 A°. Every time one focuses, a neutral radial filter allows directly for the decrease of brightness during the whole exposure time. Kodak Plus X on Ektar 4'x5' films were chosen. A plate in natural light was obtained throu[gh] a rectangular window within the attenuator in order to get variations of the diffused light superimposing the earthshine.

For two cameras, polarizing filters were set near the focal plane. Filters were comp[osed] of the 12 sectors of a polaroid film held between two glass disks and epoxy resin. A motor set the disks in motion with a 360 rpm rotation speed as an average. Thus, we obtain, with calibration plates, E-radial and E-tangential polarized lights, natural light and other classical photographs of the corona and the sky.

References : LAFFINEUR, M. L'Astronomie, 337 (1969); KOUTCHMY, S. Astrophys. Lett., 3, 215 (1969); KOUTCHMY, S., LAFFINEUR, M. Nature, 226, 1441 (1970); KOUTCHMY, S. C.R.A.S. July (1970), to be published.

Location : The French camp (an expedition of observers led by Dr. Michard) settle down near the Pan American Highway, on the road between El Gramel and Nejapa. Coordinates were 16°40'N and $6^{h}23$, 2^{m}W, altitude 3300 ft.

Dates : February 15 - March 15, 1970

Equipment : 300 kg

Special Site Requirements : Power and darkroom

Cooperating Groups : Support functions were required from Meudon Obs. Dr. Michard's expedit[ion]

Funds : Centre National de la Recherche Scientifique; Bureau des Longitudes; Ministere des Affaires Etrangeres

SUMMARY OF PRELIMINARY RESULTS:

The three best pictures, with 20 and 60 sec exposure time, reveal interesting details [of] the K corona such as superposition in the line of sight of different streamers or the very high degree of the fine structure polarization. One plate in natural light (fig. 1) was obtained through a rectangular window in the attenuator. It seems that for practical purposes the centre of the moon was not too much affected and the photometry of the earthshine is obtained. A preliminary estimate of the brightness of the "coronal aureole" at $R/R_{\odot}=6$ is I, 5, $IO^{-9}.\bar{B}_{\odot}$ (with F corona).

The filament structure is evident and the dispertion of the intensities of the various streamers as well as their superposition shows that the plates register a large range of streamers situated in quite distinct plane. Dark filaments (fig. I) were observed and it seems impossible, a priori, to interpret these structures as "holes" in the cor[ona].

Both plates in polarized light show the well known E-tangential polarization of the co[rona] but with many more details than usual. Strong polarization rates are obtained for fin[e] structures, especially for discontinuities, but a puzzling E-radial polarized light is recorded for some features. (fig. 2).

A series of 30 plates with different exposure times and focusings are also obtained an[d] using for the drawing of isophotes and the study of the sky. Stars in the proximity o[f] the 7th magnitude are visible on same plates.

(See also: Nature, 226, p. 1141, June 20, 1970)

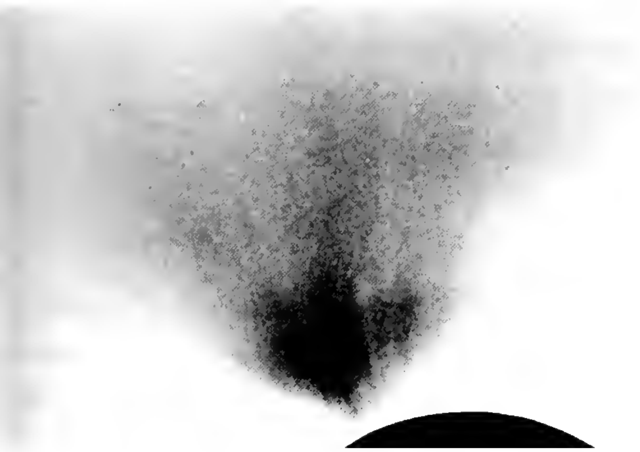


Fig. 1 - Enlargement showing two "dark filaments" in the S-W quadrant of the natural light plate.

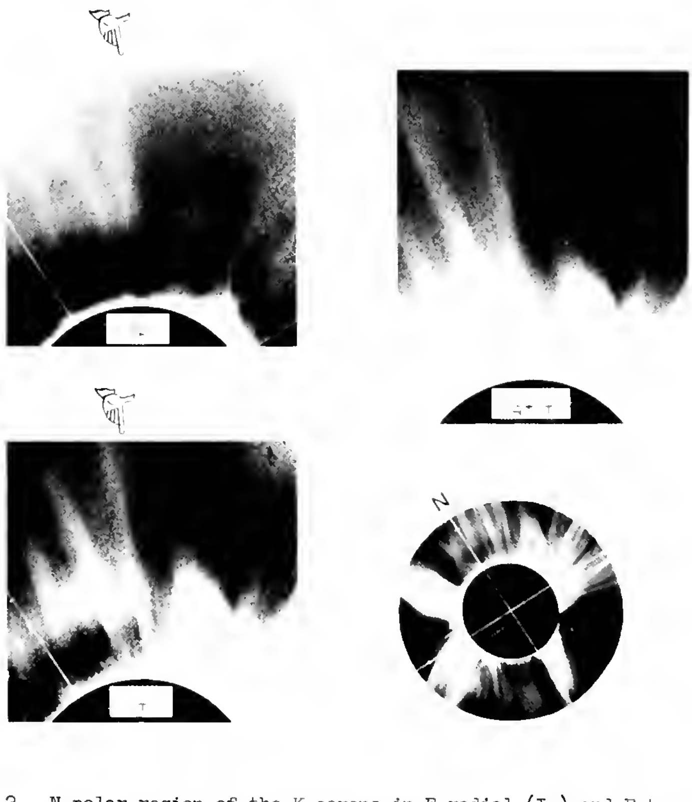


Fig. 2 - N-polar region of the K corona in E-radial (I_R) and E-tangential (I_T) polarized light and in natural light with highly contrasted prints, showing unexplained strong E-radial polarized stream. At the right bottom, the whole inner corona is in natural light.

1970 SOLAR ECLIPSE PROJECT NO. 3.1-D-17.01

Institution	:	Los Alamos Scientific Laboratory (University of California)
Investigators	:	HOFFMAN, Marvin M., LIEBENBERG, Donald H., LIEBER, Albert J.
Title	:	Solar Coronal Observations
Purpose	:	1) Observation of emission line shape as a function of distance above the photosphere. 2) Observation of emission line shape in the vicinity of prominences. 3) Observation of the degree & direction of emission line polarizatio
Description	:	The image of the solar corona during totality formed by the 80-inch telescope will be observed through narrow-band optical filters. Emission lines thus selected will be analyzed for polarization, and the line shape will be analyzed using a high resolution interferometer. Analyzed optical signal will be intensified and recorded photographically and/or electrically with a video camera and tape recorder.
Reference	:	None at present
Location	:	AEC aircraft
Dates	:	
Equipment	:	80-inch tracking telescope, narrow-band optical line filters, polarization analyzer plates, channel plate image intensifier tube, Fabry-Perot gas cell interferometer, high resolution image orthicon video camera, video recorder, photographic recorder
Special Site Requirements	:	None
Number and Names of People	:	4 or 5 on aircraft: D.H. Liebenberg (image selection); M.M. Hoffman (photography); A.J. Lieber (image intensifier and video camera); G. J. Yates (video recording); R. Partridge (tracking)
Cooperating Groups	:	Others on LASL aircraft
Special Comments and Needs	:	None
Station Prob	:	0.9
Funds	:	LASL

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION
(However, see: Nature, 226, p. 1140, June 20, 1970)

1970 SOLAR ECLIPSE PROJECT NO. 3.1-E-17.02

Institution : Los Alamos Scientific Laboratory (Univ. of California)

Investigators : KELLER, C. F.

Title : Photographic Measurements of Polarization in the Solar Corona from an Airborne Station

Purpose : To observe the amount of polarization in the solar corona as a function of distance from the limb to several solar radii (approximately 10).

To study the fine structure of this polarization as exhibited in coronal streamers.

To compare with similar observations made during the 1966 eclipse by R.R. Brownlee.

Description : An optical telescope (f/6, focal length = 610 mm) using 3 axis inertial stabilization will be used to photograph the corona from a NC-135 aircraft at an altitude near 40,000 ft. The corona will be recorded on 70 mm film (Kodak 2475). The field of view will extend 10 solar radii at the poles and 12 radii at the equator. Thus an attempt will be made to duplicate the work of R.R. Brownlee who photographed the corona to 10 radii in 1966. Photographs will be made in the frequency range 5500 < λ < 7000 A°. Plane polarizing filters will be used, positioned at 3 orientations 60° apart. Additional photographs employing a radial filter are planned.

References : Cox, A.N., Brownlee, R.R. et al, "Racing the Moon's Shadow", Sky and Telescope Feb., 1967, XXXIII.

Location : AEC aircraft, Pacific Ocean west of Mexico. Staged from Kelly AFB.

Dates : March 3--8.

Equipment : Telescope and mount, 100 lbs; Electronic Control packages, 75 lbs.

Special Site Requirements : None

Number & Names of People : C.F. Keller, L.L. Rice, B.G. Strait, O.G. Winslow

Cooperating Groups : Others on LASL aircraft; also B. Brixner, H. Mortenson of LASL

Special Comments and Needs : Extreme accuracy in tracking may be possible due to the center of gravity mount used. Tracking may be less than 5 arc seconds.

Station Prob : 1.0

Funds : LASL

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION
(However see: Nature, 226, p. 1140, June 20, 1970)

1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-17.03

Institution	:	Los Alamos Scientific Laboratory (University of California)
Investigators	:	ENGLEMAN, Rolf
Title	:	AIRBORNE PHOTOGRAPHIC OBSERVATIONS WITH A CORONAL EMISSION-LINE CAMERA.
Purpose	:	To photograph and map the solar corona through narrow-band interference filters at several emission-line wavelengths, giving spatial details of the émission of various elements in various stages of ionization.
Description	:	As many as 4 multiple photographs of the corona with different exposure times to be taken with camera described below.
Special Site Requirements	:	None
References	:	None
Number & Names of People	:	Three; D. Dybig, R. Engleman and R. E. Partridge.
Location	:	AEC NC-135 diagnostic aircraft (#369, LASL staffed). Off Pacific Coast of Mexico (based from San Antonio, Texas).
Dates	:	Approximately D-3 to D+1.
Equipment	:	The instrument will be used essentially as on the 1966 eclipse, but with better interference filters and possibly improved tracking equipment to compensate for irregularities in aircraft motion. The instrument has 9 parallel optical channels, each of 50 mm aperture, approximately f:6,8 of which feed directly to a photographic film, with the other channel diverted to the tracking sensors by a mirror. The entire camera is carried in gimbals, and is moved by hydraulic actuators controlled by the tracker, to neutralize the motion of the aircraft.
Cooperating Groups	:	Others on LASL aircraft, plus others as appropriate.
Special Comments and Needs	:	None
Station Prob	:	1.0
Funds	:	AEC

SUMMARY OF PRELIMINARY RESULTS PROJECT NO. 3.1-F-17.03

Four exposures were taken during the total eclipse using a nine-lens camera with the following filters:

Wavelength (Å)	Purpose
5277	White light background
5303	Fe XIV Emission
5303	Fe XIV Emission (with added polarizer)
5357	White light background
5694	Ca XV Emission
5890	Na I (D_2) Emission
6374	Fe X Emission
6426	White light background
7892	Fe XI Emission

All line filters had half-widths of about 3 Å and peak transmissions of about 30%.

One exposure was blurred by tracking problems but the other exposures, two of 27 seconds each and one of 104 seconds, are satisfactory for data reduction. No unusual features are observed on visual examination of the films which show the corona extending out to several solar radii. Detailed data reduction awaits the availability of a two-dimensional scanning microdensitometer.

(See also: Nature, 226, p. 1140, June 20, 1970)

1970 SOLAR ECLIPSE PROJECT NO. 3.1-E-17.04

Institution	:	Los Alamos Scientific Laboratory (Univ. of California)
Investigator	:	OLSEN, K. H., and ANDERSON, C. R.
Title	:	Measurement of the Coronal Spectrum from 1 - 5μ
Purpose	:	High resolution (1 cm^{-1}) determination of the coronal spectrum with some study of spatial and temporal changes during the eclipse.
Description	:	Analogue recording of interferogram for later A-D conversion and data reduction.
Reference	:	None
Location	:	AEC aircraft
Dates	:	
Equipment	:	Fourier transform Michelson interferometer with InSb detector.
Special Site Requirements	:	None
Number and Names of People	:	2-3 people - K. H. Olsen and C. R. Anderson
Cooperating Groups	:	Others on LASL aircraft
Special Comments and Needs	:	To be determined
Station Prob	:	0.9
Funds	:	LASL

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION
(However see: Nature 226, p. 1140, June 20, 1970)

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-18.00

Institution	:	High Altitude Observatory, National Center for Atmospheric Research, Boulder, Colorado 80302
Investigators	:	MacQUEEN, R. M., MANKIN, W. G., and LEE, R. H.
Title	:	Infrared F-Corona
Purpose	:	To determine the chemical composition of the F-Coronal material
Description	:	Two-channel radiometric observations of the coronal radiance in the intermediate infrared.
Reference	:	MacQueen, Ap. J., 154, Dec. 1968, p. 1059.
Location	:	Southeast of Oaxaca, Mexico near the villages of Quiechapa and San Carlos.
Dates	:	Frebruary 4 - March 10, 1970
Equipment	:	8000 lbs; 250 cu. ft.; $35,000; ship by air; entry at Tampico.
Special Site Requirements	:	Low water vapor - high altitude
Number and Names of People	:	5 - Robert MacQueen, William Mankin, Robert Lee, Richard Euchler and Gene Ellis
Cooperating Groups	:	Field support by Field Observing Facility, NCAR (5 people - headed by Harry Vaughan)
Special Comments and Needs	:	Liquid helium and liquid nitrogen will be required to cool a germanium bolometer detector.
Station Prob	:	1.0
Funds	:	NCAR's prime NSF contract

SUMMARY OF PRELIMINARY RESULTS

Observations of the F-corona were carried out in the intermediate (10 μ) infrared on eclipse day, under visually clear skies.

Radial scans at 2 speeds were obtained during the period of totality, with the system sensitivity limited by thermal fluctuations of the sky emission.

Interferometric spectra were recorded prior to and following totality. All data have been reduced to digital form for analysis and interpretation.

1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-19.00

Institution	:	Institute for Astronomy - University of Hawaii
Investigators	:	JEFFERIES, J. T., ORRALL, F. Q., and ZIRKER, J. B.
Title	:	Coronal Spectroscopy
Purpose	:	To obtain photographic spectra of the solar corona at several heights in the wavelength range 3000 - 7000 A. The objective is to secure needed data for determination of coronal abundances and the physical conditions in coronal condensations.
Description	:	The experiment will use an existing f/4.5 spectrograph to obtain several exposures of the corona during totality. The equipment is self contained and needs no power supply.
References	:	Proceedings of the 15th International Astrophysical Symposium, Liege 1968 (Papers by Jefferies and by Jefferies, Orral & Zirker).
Location	:	Nejapa, Mexico
Dates	:	February 26, 1970 - March 9, 1970
Equipment	:	About 1500 pounds in 5 crates, valued at $23,000. Entry by air at Mexico City.
Special site Requirements	:	None
Number & names of People	:	(4) John T. Jefferies, Frank Q. Orrall, J. B. Zirker (Univ. of Hawaii); A Minzoni (Univ. of Mexico).
Cooperating Groups	:	None
Special comments and Needs	:	None
Station Prob	:	1.0
Funds	:	NASA

SUMMARY OF PRELIMINARY RESULTS PROJECT NO. 3.1-F-19.00

As an important part of its program for the study of the physical structure and composition of the corona, the University of Hawaii has made spectroscopic observations at the total solar eclipse of 1965, 1966 and again in 1970. On each occasion, we were fortunate in obtaining good observations of the forbidden emission line spectrum of coronal condensations and enhancements.

For our experiment in March 7, 1970, we utilized the existing eclipse spectrograph that had already seen service in 1965 and 1966. The spectrograph had been modified to make it insensitive to temperature changes during the eclipse, and had been provided with a convenient means for focusing the spectrograph. Two films with different spectral sensitivity were spliced together for use during the eclipse - a blue sensitive 103AO and a panchromatic linograph shellburst.

Our observational program consisted of 13 exposures centered on totality - the longest exposure being 48 seconds. A number of interesting bright regions were recorded on the eclipse spectra which cover the interval 3000 Å to 7000 Å at a dispersion of 36 Å/mm in the first order (18 Å/mm in second order).

λ	Ion	λ	Ion
7059	FeXV	3801	CoXII
6702	NiXV	3643	NiXIII
6535	MnXIII	3601	NiXVI
6374	FeX	3454	- -
5536	ArX	3388	FeXIII
5303	FeXIV	3329	CaXII
5116	NiXIII	3171	CrXI ?
4566	CrIX	3124	- -
4232	NiXII	3074	- -
4086	CaXIII	3021	FeXII
3986	FeXI		

Both the spectrograph and telescope maintained excellent focus during the eclipse and the spectra were well exposed. The eclipse observations were preceded and followed by a series of calibration spectra which provide the photometric standards necessary to reduce the observations. This reduction is now underway and we plan to publish the coronal data later this year.

A number of bright prominences were also recorded on the spectrograms. These spectra will provide new material for the determination of the physical structure and composition of prominences.

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-19.01

Institution	: Swiss Federal Observatory, Zurich, Switzerland, Schmelzbergstrasse 25
Investigator	: WALDMEIER, Professor M.
Title	: a) Fine Structure of the Inner Corona. b) Structure and White Light Distribution of the Corona. c) 5303-Emission.
Purpose	: a) Photometric and polarimetric measurements will be used to derive the density distribution at large as well as in individual structures. b) The intensity variation of the line 5303 Å will be measured along 16 different radii. These observations together with the density determinations will provide the basic material to discriminate between line excitation by collisions and by radiation.
Description	: a) Horizontal camera of 800 cm focal length. b) Horizontal camera of 150 cm focal length. c) Altazimut camera of 120 cm focal length. d) One-prism spectrograph, rotatable along its axis, feeded by a coelostat and an object glass of 150 cm focal length.
References	: ZS. f. Astrophys. 67, 463 (1967); 69, 193 (1968).
Location	: Two groups: one near Miahuatlan, the other near Nejapa.
Dates	: February 12 - March 10, 1970.
Equipment	: 13 boxes, 1500 kg, $20,000.00; port of entry: Veracruz.
Special Site Requirements	: near Nejapa: flat ground, 20 x 20 mi; near Miahuatlan: 10 x 10 mi.
Number and Names of People	: 5, M.Waldmeier, leader Susi E. Weber, A. Zelenka, J. Durst, Fr. Aebersold.
Station Prob	: 1.0
Funds	: Swiss National Foundation for Scientific Research.

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.1-F-19.01

The Swiss Federal Observatory in Zurich owns a long tradition of solar eclipse observations. During the Saros cycle 1952-1970 the author has sent out and participated in 13 expeditions. Among them the Mexican Eclipse will range as one of the most successful ones. To minimize the risk of being clouded out the expedition, in which five members of the Zurich observatory participated, had been split up into two groups: One operating at Nejapa, the other at Miahuatlan. A variety of programs was carried out, all dealing with the solar corona: photometric, polarimetric and spectroscopic observations as well as studies of the structure of the corona. In addition to the scientific programs motion pictures of the eclipse and color pictures of the corona were obtained for educational purposes.

For more than thirty years the author observes the coronal emission lines without an eclipse at the Arosa observatory. The coronographic method is restricted to the relatively bright innermost corona. Even the brightest line, the green line at 5303 Å, can hardly be observed to distances larger than 6' from the sun's limb. The excitation of this line can be by photospheric radiation as well as electron collisions. To separate the contributions of these two mechanisms the line intensity has to be observed to much larger distances than can be reached with coronographs. To arrive at this goal a low dispersion spectrograph of high luminosity was used. The whole spectrograph could be rotated about the axis of its collimator. By this device the radial distribution of the instensity of the green line was measured at 16 different position angles and out to about one solar radius from the sun's limb. The spectrograph is especially built for the green line, but it gives the whole spectrum from 3900 to 6500 Å. Therefore the spectrograms can be used to study the behavior of lines other than the green one.

For the interpretation of the line intensities and their variations a thorough knowledge of the electron density is needed. This is achieved by a careful measurement of the distribution of the white light of the corona. For that purpose with two cameras of 120 cm and 150 cm focal distance pictures of the corona in white and green light were obtained, which are photometrically calibrated. The corona's white light is photospheric light scattered by free electrons. As this mechanism of light scattering is well understood, the photometric measurements can easily be transformed into electron densities.

The corona is not a homogenous atmosphere; it consists of a multitude of individual streamers. These streamers again are not homogeneous, but are built up of finer details as is seen on pictures of high resolution. Therefore large-scale pictures of the corona are needed to reveal its fine structure. For that purpose we put into operation a camera of 8 meters focal length. With such a camera one gets but the inner parts of the corona; it is just in the innermost region where the corona shows the finest and most fascinating structures, especially over centers of activity. These structures are formed by magnetic fields emanating from deeper layers into the corona. The study of these formations is by now the only way to get an insight into the shape of the magnetic fields in the immediate surroundings of the sun.

The theory of scattering predicts a strong polarization of the corona's white light. The degree of polarization depends considerably on the angle of scattering. A streamer whose axis is perpendicular to the line of sight shows a stronger polarization than one with a smaller inclination. From a picture of the corona nothing can be said about the location of the streamers in space. It is only by polarimetric measurements that the inclination of the streamers to the line of sight can be determined. Therefore an extensive program of polarimetric measurements was carried out, for which a camera of 120 cm focal length was used.

It is hoped that the concerted efforts of these different methods of approach will result in a realistic picture of the structure and the physical state of the corona.

1970 SOLAR ECLIPSE PROJECT NO. 3.1-E-19.02

Institution : University of Manchester, Manchester M13 9PL, England.

Investigators : JAMES, J.F.; STERNBERG, R.S.; and McNAUGHTON, L.

Title : a) Determination of the Line Profile of the 5303 Å Emission
b) Cine-spectrography of the Paschen discontinuity at 8200 Å

Purpose : a) Line profiles will provide a measure of the coronal temperature and of Doppler shifts at a number of points out to at least 1° from the solar limb.

b) To provide data for the analysis of chromospheric structure.

Description : a) 10" Newtonian telescope produces a primary image of the eclipsed sun and its corona. A photographic lens re-images this through an interference filter and a Fabry-Perot etalon. An auxilary system passes the green light of a Hg 198 lamp through the same optics, and the resulting system of fringes is recorded photographically. Expected spectral resolution is 0.1 Å.

: b) The flash spectrum is photographed at about 10 frames per second through a 1200 line per millimetre reflection grating that is blazed for 1 micron in the first order. The lens aperture is F1.9 and the film is Kodak high speed infra-red.

References :

Location : Pacific coast of Mexico, east of Puerto Escondido.

Dates : Arrive Mexico 8th February. On site by 20th February

Equipment : Approximately 1500 lbs packed in a Landrover vehicle imported from U.K.

Special Site Requirements : Water supply, food for purchase.

Number & Names of People : 3 - J. F. James, R. S. Sternberg, L. McNaughton.

Cooperating Groups : None

Special Comments and Needs : None

Station Prob : 0.9 Puerto Escondido; 0.1 Miahuatlan or Nejapa.

Funds : Royal Society

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-19.03

Institution : Heriot-Watt University, Edinburgh, Scotland, U.K.

Investigators : HENDERSON, Dr. G.; MARSHALL, Mr. P. M.; and LARSEN, Mr. A.

Title : Interferometry of E-corona at λ5303A and λ6374A.

Purpose : To derive line profiles of the Fe XIV anf Fe X emissions of λ5303A and λ6374A in selected regions of the corona.

Description : A coelostat and reflecting telescope will will feed a pair of Fabry-Perot Spectrometers which are scanned by the piezo-electric effect. Photomultipliers will be used as detectors.

Reference :

Location : Miahuatlan, Oaxaca, Mexico

Dates : February 7 - March 10, 1970

Equipment : Coelostat (12 inch) telescope, interferometers, electronics. Petrol generator

Special Site Requirements : Security arrangements.

Number and Names of People : 3, Dr. G. Henderson, Mr. P.M. Marshall, Mr. A. Larsen

Cooperating Groups : None

Special Comments and Needs : Road access to site for truck

Station Prob : ?

Funds : The Royal Society and the Science Research Council of U.K.

SUMMARY OF PRELIMINARY RESULTS:

The original intention was to measure line profiles of the green and red coronal lines in the North and South polar regions. At totality no measurable emission could be found in these regions and so a contingency plan was adopted whereby measurements were made in the equatorial region. Some 17 green line profiles and 4 red were obtained at a signal to raise ratio of about 3 to 1. The maximum radial distance achieved was about 0.3 radii from the limb. This was somewhat less than expected and we are currently engaged in checking the efficiency of the electronic detector and amplifier system.

Analysis should be completed by October 1970.

1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-19.04

Institution : University of Miami (Florida), Department of Physics

Investigators : HIRSCHBERG, Joseph G. and WOUTERS, Alain

Title : Fabry-Perot Studies of Solar Corona

Purpose : A study is planned of turbulence phenomena in the solar corona by measurement of emission line profiles during the total solar eclipse of March, 1970. The measurements by Fabry Perot interferometer of the line profiles, with emphasis on the spatial variation of the strongest coronal line (λ = 5,303; FeXIV) and the difference between the profile of this ion line and a calcium line (λ = 5694; Ca XV), should be a means of determining the temperature structure and the magnitude of the turbulent motions in the solar corona.

Description : A 10-inch apochromatic refractor with coelostat and Fabry-Perot will be used photographically; while a photoelectric freon-swept Fabry-Perot will be mounted on an equatorial mount.

References : Fabry-Perot Interferometer Measurements of Temperature and Optical Density of Barium Clouds, by J. G. Hirschberg and Alain Wouters, MIAPH-OP-68.10, University of Miami Optical Physics Laboratory (1968).

Spectroscopic Investigation of a Weakly Ionized Plasma in a Helium Hollow Cathode Discharge, by Joseph G. Hirschberg, Einer Hinnov and and Fritz W. Hofmann, Princeton University, MATT-236 (1963).

Location : A flat field near the center line in southern Mexico, near Nejapa del Madero.

Dates : Arrival at site, March 2, 1970. Departure March 8.

Equipment : About 100 cubic feet weighing about 1,500 pounds including scientific equipment, tents, power supplies, etc. About 20 packages. Valuation $60,000. To be shipped by Dodge Motor Van, also carrying personnel. Port of entry, Nueva Laredo.

Special Site Requirements : None

Number & Names of People : Joseph G. Hirschberg, Douglas Duke, Francis Cooke, Jr. Walter Fried, Marc Read, and Alain Wouters. (6)

Cooperating Groups : None

Special comments and needs : None

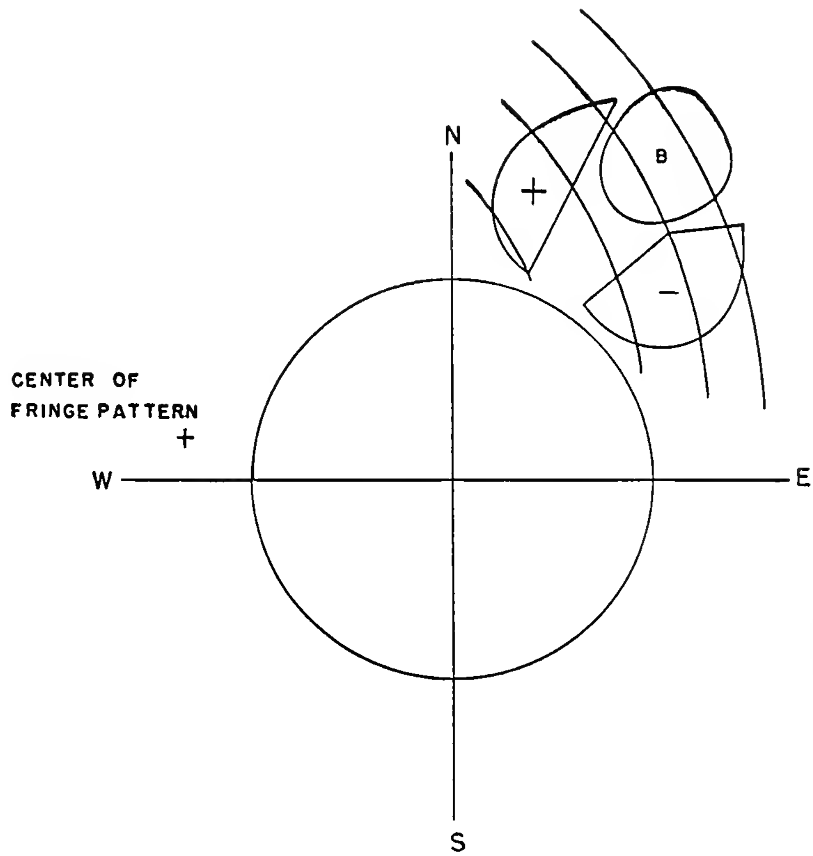
Station Prob : 1.00

Funds : National Science Foundation

MMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.1-F-19.04

e project was performed essentially as planned with the photographic Fabry-Perot ed at an effective aperture of f/7 and a total transmission factor of approximately 1. Test exposures taken with a thallium lamp (5350A) showed an effective finesse about 10; the separation of the plates was 0.48 mm. The exposures used, 5, 15, and records, did not show any trace of the calcium line (5964A; Ca XV) but provided otographs of fringes extending to a rather large distance from the sun with the green ronal line (5303A; Fe XIV).

eliminary photographic results indicate that the half intensity width of the green ronal line during this eclipse varied between 0.8 and 1.1A, that marked wavelength ifts were present, and that the intensity distribution was definitely unequal, with e brightest areas present in the southern hemisphere and in an active region which tended up to 1.8 solar radii toward the northeast. The above bright area corresponds a prominence, strong arches and fan rays, and is of particular interest because of e changes in width and wavelength shifts associated with it. These variations appear be restricted to definite localities corresponding to the arches in the white rona (Figure). As is shown, the results suggest a giant vortex system in the corona ntered about an active area on the surface. The central part of the vortex appears be about 50% hotter than the periphery.



Position of principal wavelength shifts and broadening of the 5303A line and position of the fringe pattern.
The region indicated by + has the line shifted toward longer wavelength and the region - the opposite; the region B corresponds to a decrease of intensity and a broadening of the line.

1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-19.05

Institutions	:	John Swett High School, Crockett, California and University of California, Berkeley, California
Investigator	:	EAKIN, Dr. David M.
Title	:	Search for Ca II and He I Emission in the Outer Corona
Purpose	:	To confirm observations of Ca II emission at 2 solar radii during the 1966 eclipse, and to search for suggested possible He I emission.
Description	:	Direct photography of the outer corona with long focal-length lenses. Interference filters are used to isolate the calcium lines (H and K) at 3968 and 3933 A, and the helium line at 5875 A.
Reference	:	J.G. Conway, W. F. Morris, and C. F. Andrews, Astrophys. J., 150, 299 (1967)
Location	:	near Nejapa, Mexico
Dates	:	March 6 and 7, 1970
Equipment	:	no large instruments
Special Site Requirements	:	small level areas
Number and Names of People	:	David Eakin, John Warnecke, Gary Cappelletti
Cooperating Groups	:	None
Special Comments and Needs	:	None
Station Prob	:	1.0
Funds	:	no funding, investigators pay all expenses personnally

SUMMARY OF PRELIMINARY RESULTS-PROJECT NO. 3.1-F-19.05:

At the 1966 solar eclipse in South America, an unusual strong emission of Ca II (H and K lines) was observed in the middle corona at one solar radius above the limb (Conway, Morris, and Andrews). We attempted to confirm this spectrographic observation with direct photographic evidence.

A graded series of exposures was taken during totality using a telescopic system of 400 mm effective focal length with a multilayer dielectric interference filter centered at 3965 A to pass the solar lines of ionized calcium at 3968 and 3933 A.

The developed films show flares and prominences well (see figures 1 and 2), and considerable coronal structure in calcium emission, steadily decreasing in intensity with increasing distance (as in Fig. 1 of the reference), but no reappearance at 2 solar radii was detectable by visual inspection of the films. Densitometer tracings of the films have not been made, but clearly there was no phenomenon of Ca II emission of the magnitude observed in 1966.

A second camera searched for helium emission at large distances, again using an interference filter to isolate the D_3 line at 5876 A. This search was prompted by studies of Gnevyshev and Gnevysheva at Pulkovo, USSR, in 1955. As with the calcium, the expected inner coronal structure was observed, but no unusual or intensive emission at greater distances (see figures 3 and 4).


Figures 1 and 2 (above): Exposures of 1/15 and 1 second respectively, taken in light of ionized calcium. The interference filter had a passband of 50 A centered on the H and K lines. Tri-X film developed in Microdol-X.


Figures 3 and 4 (above): Exposures taken in light of neutral helium. The interference filter had a passband of 50 A centered on 5876 A. Tri-X film developed in Microdol-X.

1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-20.00

Institution	:	New York University, University Heights, N.Y. 10453
Investigators	:	KORFF, Dr. S. A. and MENDELL, Dr. R. B.
Title	:	Study of motions in solar corona.
Purpose	:	To determine transport velocities of matter in the corona of the Sun. This problem bears upon the overall problem of the acceleration of charged particles in the sun. We expect that, in the corona there may be regions where charged particles may be accelerated by electromagnetic induction processes, and may reach high energies. Velocities of small agglomerations visible in the corona may enable such determination to be made and this in turn may help throw light on the problem of the acceleration of particles to high energies in solar flares.
Description	:	The experiment is to take high resolution photographs of the corona from several stations at various locations in the eclipse path, thus providing pictures of the corona at various different times. By looking for small irregularities which can be followed, it may be possible to find velocities of material in the corona.
Reference	:	
Location	:	Mexico and North Carolina
Equipment	:	Several high resolution cameras. We already have two.
Special Site Requirements	:	
Number and Names of People	:	Drs. S. A. Korff, R. B. Mendell and two graduate students. One per station. .
Cooperating Groups	:	
Special Comments and Needs	:	
Station Prob	:	
Funds	:	

SUMMARY OF PRELIMINARY RESULTS

1. We made photographs of the corona of the March 7, 1970 eclipse from Mexico and from North Carolina, with several cameras at each location. Among these were a QUESTAR at each place, using XR film.

2. There is almost exactly an hour's difference in the time between the two locations.

3. We have been studying the pictures. We are not yet certain whether we have any significant motions visible. We will report as soon as we are convinced we have or do not have anything.

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-21.00

Institution : Harvard College Observatory

Investigators : MENZEL, Donald H. and PASACHOFF, Jay M.

Title : Spectrographic and Photographic Coronal Studies

Purpose : To investigate the relative contributions of the F- and K- coronas, and other topics.

Description : 1) A coronal spectrograph has been constructed to study the spectral region from 3500 to 6000 A at a dispersion of 18.6 A/mm. The slit covered 10 solar diameters, and was placed along the solar equator in order to permit calibration of scattered light against the center of the moon. The spectrograph is from a new design by James G. Baker. The data should provide improved information on the separation of the F- and K-coronas and the contribution from light scattered in the earth's atmosphere and in the instruments, and on the agreement of the photospheric and coronal spectra in the region of the Ca II H and K lines.

2) The 5 cm f/18 telescope constructed for the 1968 eclipse was again employed, with an improved mounting and shutter, to photograph the white-light corona at different angles of linear polarization.

3) A series of lenses ranging up to 500 mm photographed the corona in white light. These films were calibrated, and can be reduced to give coronal intensities. Photographs were also obtained through a Questar.

References : Schatten, K. M., Menzel, D. H. and Pasachoff, J. M. 1969, paper presented at the 129th A.A.S. Meeting, Honolulu.
Menzel, D. H. and Pasachoff, J. M. 1968, Sky and Telescope 36, 380.
Menzel, D. H. and Pasachoff, J. M. 1968, P.A.S.P. 80, 458.

Location : Miahuatlan (Escuela Filarmonica Municipal)

Dates : February 7 - March 10, 1970

Equipment : 4,500 pounds in 19 crates. Air freight to Mexico, D. F. and then truck to site; return by road.

Number and Names of People : F. A. Budreski, A. S. Clarke, D. L. Fernald, J.R. Hamilton, L. A. Lief, M. Mattei, D. H. Menzel, F. K. Menzel, J. M. Pasachoff, J. A. Pitts, D. H. Read, F. de Romaña, W. W. Salisbury, and C. Sepulveda.

Cooperating Groups : 3.1-F-21.01, 3.1-F-21.04

Funds : Harvard College Observatory, Smithsonian Astrophysical Observatory, National Geographic Society, National Science Foundation, Air Force Cambridge Research Laboratories, and private funds.

SUMMARY OF PRELIMINARY RESULTS

We obtained a variety of data related to the separation of the K-corona from the F-corona and from light scattered in the earth's atmosphere or in the instruments. The exceptionally clear skies on the day of the eclipse reduced the scattered light in the atmosphere to far lower levels than are usually present at eclipses.

A series of exposures was made with the coronal spectrograph, and show, in chronological order, the photospheric spectrum for comparison, the flash spectrum at 2nd contact, the coronal spectrum, the flash spectrum at 3rd contact, and the photospheric spectrum again. Since our slit was placed across an equatorial diameter, we have coronal continuum on two limbs, although emission extends to only 1 solar radius. Since the radial slit is perpendicular to the chromosphere, the flash appears as a dispersed series of dots at the point where the slit crosses the chromosphere.

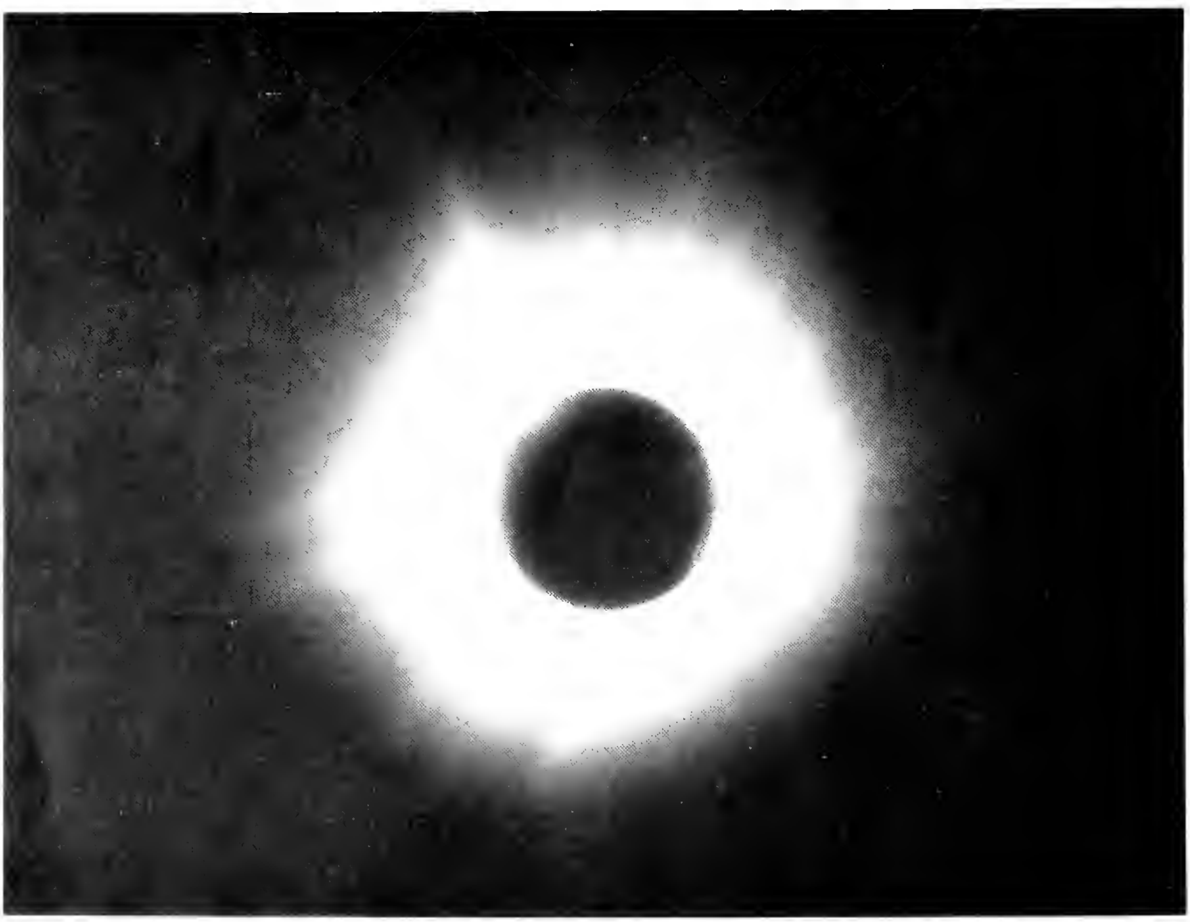
Two series, each of four exposures at position angles 0°, 45°, 90°, and 135°, were obtained with the 5 cm f/18 eclipse telescope, with the camera (shutter and film-holder) rotating behind a Polaroid filter. Reduction of this data will give the coronal polarization out to about 1 solar radius.

The coronagraphic-quality sky gave the white-light photography special significance. We suceeded in photographing the coronal streamers, from our ground site in Miahuatlan, to distances greater than 10 solar radii above the limb. We have series of photographs, with different lenses and exposures, showing all levels of the corona both inner and outer. A list of the apparatus follows, and a photograph taken through one of the 500-mm lenses appears.

Table. White-Light Photographic Equipment

lens	body	film	f/	comments
500-mm Nikon	Nikon	Kodachrome II	8	motor film drive prominences and corona
500-mm Nikon	Nikon	Kodachrome X	8	motor film drive, partial phases, prominences, and corona
300-mm Nikon	Nikon	Panatomic-X	4.5	tracking, 1, 5, 10, 60 sec exp.
200-mm Tamron	Minolta	Kodachrome X	3.5	corona
135-mm Nikon	Nikon	H. S. Ektachrome	2.8	corona and Venus
135-mm Tamron	Canon	Pantatomic-X	2.8	coronal streamers
80-mm Zeiss	Hasselbald	H. S. Ektachrome	2.8	corona and Venus
875-mm Questar				prominences and corona
150-mm Yvar	16 mm Bolex	Kodachrome II	4	time lapse; tracking
60-mm Ansco	S-8 mm Ansco	Anscochrome II	1.8	time lapse; tracking
114-mm Polaroid	Polaroid	Polacolor	8.8	developed during eclipse

References: joint articles by D. H. Menzel and J. M. Pasachoff
Nature, in press (June 1970)
National Geographic, in press (August 1970)
Applied Optics, submitted (December 1970)
Picture book, Harcourt, Brace & World, in preparation.



1970 SOLAR ECLIPSE.- PROJECT NO. 3.1-F-21.01

Institution	:	Harvard College Observatory and Smithsonian Astrophysical Observatory
Investigators	:	MENZEL, Donald H., SALISBURY, Winfield W., and FERNALD, Darrell L.
Title	:	Coronal Polarization Studies
Purpose	:	To measure the intensity, percentage and direction of polarization of each square arc minute of the corona.
Description	:	Four television cameras record the coronal intensity on videotape. Three of the cameras view through polarizing filters that rotate every 13 seconds, one in white light, one in the red, and one in the blue. The fourth camera simply records the white-light corona without any filters. The rotation indices of the polarizers are recorded on the audio channels of the videotape.
Location	:	Miahuatlan (Escuela Filarmonica Municipal)
Dates	:	February 7 - March 10, 1970
Equipment	:	About 1000 pounds in 6 crates, included in 3.1-F-21.00 total.
Number and Names of People	:	F. A. Budreski, A. S. Clarke, D. L. Fernald, J. R. Hamilton, L. A. Lief, M. Mattei, D. H. Menzel, F. K. Menzel, J. M. Pasachoff, J. A. Pitts, D. H. Read, F. de Romana, W. W. Salisbury, and C. Sepulveda.
Cooperating Groups	:	3.1-F-21.00, 3.1-F-21.04.
Funds	:	Harvard College Observatory, Smithsonian Astrophysical Observatory, National Geographic Society, National Science Foundation, Air Force Cambridge Research Laboratories, and private funds.

SUMMARY OF PRELIMINARY RESULTS

The four television cameras operated satisfactorily during the eclipse. The camera without a Polaroid filter videotaped not only the eclipse itself, but also time lapse of the partial phases. We now have data from this camera and from two of the cameras with rotating Polaroids. The data from the remaining camera was lost because of a malfunction resulting from damage sustained in shipping, but this is not serious because of the considerable redundancy in the experiment.

The amount of data on the videotapes is very large, and suitable data reduction programs are under investigation. The data are stored on the videotapes in analogue form, and digitization of the raster is straightforward. For a first look at the polarization, reduction will be carried out in parallel with the reduction of the photographic polarization data described in 3.1-F-21.00. This limitation to four position angles of the Polaroid will simplify this preliminary work.

A benefit of the videotape recording may be accurate timing of the eclipse. Radio time signals were recorded on the audio channel of the videotape from the camera with no Polaroid filter. Since a raster is completed in 1/30 sec., and since we may be able to fix the contact times to a fraction of a raster, accuracy should be excellent.

References: joint article by the Investigators Applied Optics, submitted (December 1970 issue)
Menzel, D. H. and Pasachoff, J. M., National Geographic, in press (August 1970)
Menzel, D. H., Applied Optics, submitted (December 1970)

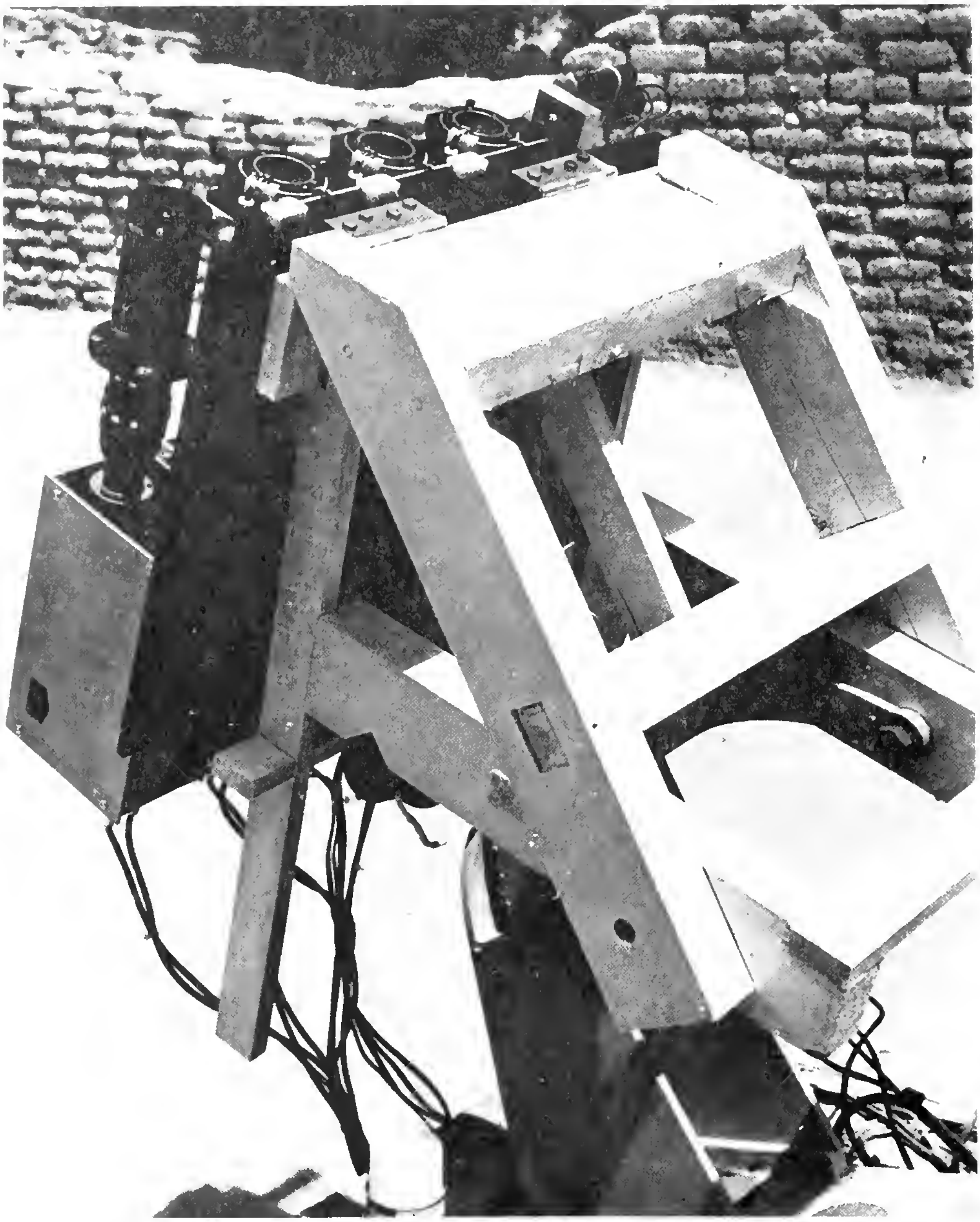


Figure: The four television cameras mounted on the polar axis at the site. The camera with no filter is leftmost. The shaft that turns the three Polaroid filters extends from a motor at the far side of the apparatus.

1970 SOLAR ECLIPSE PROJECT NO. 3.1-E-21.02

Institution : Kodaikanal Observatory, Kodaikanal, India

Investigators : BAPPU, M. K. V. and BHATTACHARYYA, J. C.

Title : 1) Coronal spectroscopy
2) Coronal photography

Purpose : 1) To obtain photographic spectra of the solar corona in the wavelength range 3300 - 8000A, for the study of physical conditions in the corona.

2) Direct photography of the corona with a pass band of about 500A in the green for the photometric study of coronal details.

Description : 1) A double spectrograph for coronal spectra at both East and West limbs.

2) A coelostat-telescope combination that yields a solar image 55mms in diameter is used.

References : None

Location : Near Miahuatlan, Oaxaca, Mexico

Dates : February 4 to March 9, 1970

Equipment : 3 boxes; 4000 kg: Transport by sea; Entry: Vera Cruz

Special Site Requirements : None

Number & Names of People : M.K.V. Bappu and J. C. Bhattacharyya

Cooperating Groups : None

Special Comments and Needs : None

Station Prob : 1.0

Funds : Government of India

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-21.03

Institution	:	Space Environment Branch, NASA Langley Research Center
Investigators	:	LEE, Robert B., III and LEVINE, Joel S.
Title	:	Coronal Polarization
Purpose	:	Photographically measure the intensity and polarization of the solar corona
Description	:	Polarization measurements of the inner and outer corona with four K-24 cameras equipped with rotating polarizers
References	:	Billings, D. E.,1966: A Guide to the Solar Corona. Academic Press
Location	:	NASA Langley Research Center, Hampton, Virginia 23365
Dates	:	March 4-8, 1970
Equipment	:	Four K-24 Aero-Ektar f/2.5 wide-angle cameras mounted on equatorial clockdrive
Special Site Requirements	:	None
Number & Names of People	:	Robert B. Lee, III and Joel S. Levine
Cooperating Groups	:	Space Environment Branch, NASA Langley Research Center (D. McDougal, 3.1-E-22.02)
Special Comments and Needs	:	None
Station Prob	:	1.0
Funds	:	NASA

SUMMARY OF PRELIMINARY RESULTS

The image of the corona, as well as the planets Mercury and Venus, recorded on the five second exposure negatives appear to be useful while the images recorded on the 1/75 second exposure negatives were distorted due to the vibrations of the cameras. On the five second exposures, the photographic densities of the coronal images have been measured from two to six solar radii. The determination of the absolute intensity of these photographic densities is pending the calibration and normalization of successive negatives using the absolute intensities, optical polarization properties, and recorded photographic densities of Mercury and Venus. Once the negatives have been calibrated, we will attempt to determine the intensity and polarization of the corona from two to six solar radii.

1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-21.04

Institution	:	Peruvian Expedition
Investigator	:	DE ROMAÑA, Fernando
Title	:	Coronal Polarization Photography
Purpose	:	To photograph the corona at different position angles of polarization on a large scale
Description	:	A 15.7 cm f/16 achromatic telescope photographed the corona through Polaroids on 4 x 5 Tri-x film
References	:	Arnquist, W. N., Menzel, D. H. and de Romaña, F. 1970, Solar Physics 11, 82.
Location	:	Miahuatlán
Dates	:	March 2 - 8, 1970
Equipment	:	Telescope, shipped from Peru
Number and Names of People	:	F. de Romaña, C. de Romaña, A. de Romaña, M. de Romaña, & A. de Romaña
Cooperating Groups	:	3.1-F-21.00, 3.1-F-21.01
Funds	:	Private

SUMMARY OF PRELIMINARY RESULTS:

The equipment functioned perfectly, and 14 photographs were obtained. The image scale is 1.2 centimeters per solar radius. 4"x5" Tri-X Pan Professional film packs were used, and developed at the site in Mexico.

Three series of four photographs each were taken through Polaroids. Each series includes position angles 0°, 45°, 90°, and 135°. The exposure times for each series were 1, 7, and 10 seconds, respectively. At the completion of this program, a 30 second exposure was taken without a Polaroid, and a 15 second exposure then terminated with the diamond ring at third contact. Laboratory step wedges were exposed for calibration.

Reduction of these data are being carried out in collaboration with 3.1-F-21.00.

A photograph of the apparatus, with Fernando de Romana on the left and Andrisito de Romana on the right, is shown below.

A print of the 30-second white light exposure is shown opposite.

Figure 1
Fernando de Romana and Andres de Pomana of Peru stand with their 15.7 cm f/16 telescope, used to photograph coronal polarization.

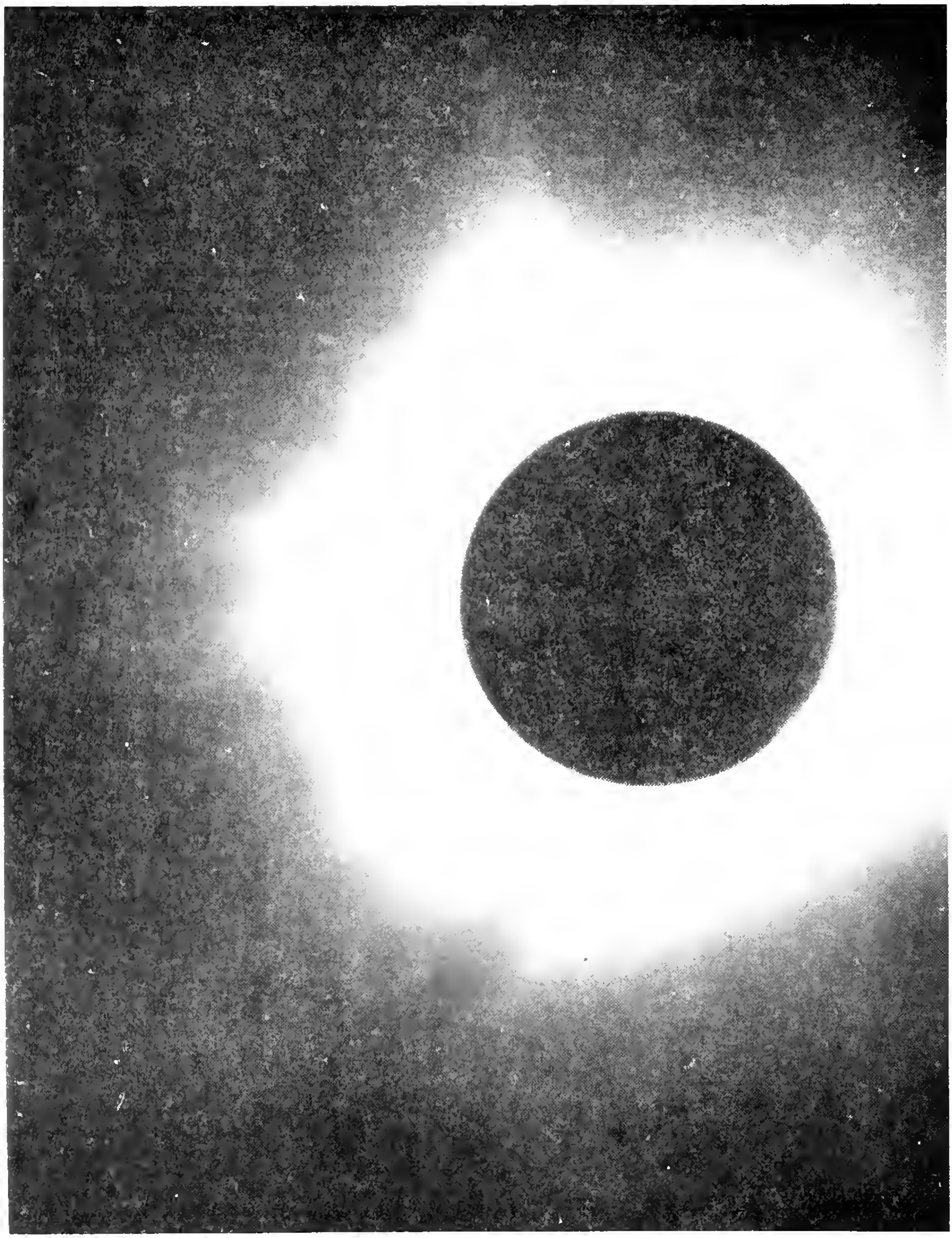


Figure 2

One of a series of photographs of the corona taken through Polaroids at four different angles by the Peruvian Expedition

Institution : 1) School of Physics and Astronomy, University of Minnesota
2) University Observatory of Vienna, Austria

Investigators : 1) PEPIN, Theodore J.
2) HAUPT, Herman; FIRNEIS, Maria; KLEMENT, Gerhard

Title : Brightness and Polarization of the Solar Corona

Description : See summary of results

Location : Santa Maria Tonameca (near Pochutla), Mexico.

Dates : March 1970

Funds : University of Minnesota participation supported by ONR

SUMMARY OF PRELIMINARY RESULTS

The equipment used was constructed at the University of Minnesota under the direction of Dr. E. P. Ney and has been used in three previous eclipses to measure the brightness and polarization of the corona. It consists of two one meter focal length telescopes which raster scan the corona measuring its brightness and polarization in the near infrared and visible regions of the spectrum. Two 19 cm focal length telecopes were also used to measure the brightness and polarization of the sky around the corona. With the data from these four telescopes, the absolute surface brightness, percent polarization and the direction of polarization as a function of position in the corona can be determined in each of the spectral regions.

Between second and third contact we were successful in making six raster scans in each spectral region. This data, after many hours of analysis, should provide a detailed knowledge of the polarization and brightness of the corona.

A fifth telescope consisting of a 65 cm focal length f-5 objective mounted in a baffled lens barrel imaged the corona onto a 35 mm movie camera. This camera, loaded with improved type Extended Range film (XR-film), was started some seconds before second contact and photographed the corona at 8 frames persecond during totality. The photographs and data accompanying this article are from just two of the 1600 odd frames of this movie.

XR-film is a three emulsion layer panchromatic film. Each of the emulsion layers has a different sensitivity and when the film is processed as color negative film the most sensitive layer appears as cyan, the intermediate sensitivity layer appears as magenta and the least sensitive layer appears as yellow. The sensitivities of these layers permit a brightness range of over a million to be recorded.

The camera and optical system used was such that the background sky and outer corona were properly exposed in the magenta layer while the limb of the sun just before second contact, was well exposed in the yellow emulsion layer. The exposure in the cyan layer is well suited for study of the inner corona.

Sensitometry wedges were placed on the ends of the film using the same exposure time used to take the coronal movies. These wedges allow one to determine the relative surface brightness of the corona by densitometering the negatives and comparing the measured densities with the densities of the sensitometry wedges for which the relative surface brightnesses are known. The three layers can be separated by densitometering the negative through colored filters. A blue filter is used to separate the yellow layer, a red filter is used for the cyan layer and a green filter enables one to study the magenta layer of the film.

The isodensity recordings accompanying this article were made with a Joyce-Loebl microdensitometer equipped with an Isodensity Recorder. This equipment enables a negative to be scanned and contours of constant density to be plotted automatically. Densitometry that would take months using more conventional techniques can be done with this instrument in an afternoon.

The isodensity recordings can be used to determine relative surface brightness in the corona since the edges of the isodensity contours are lines of constant brightness or isophotes. This can be accomplished by using the density vs log of the surface brightness or gamma curve relation for each of the emulsion layers, which was determined from the sensitometry wedges, along with a single plot of density as a function of position on a line across the image of the corona on the negative.

It is interesting to note that the plot of density as a function of position across the frame, made through a green filter of the magenta of the film, suggests that there are two components to the corona. One observes that the density decreases with almost constant steep slope from the solar limb until about two solar radii from the sun's center and then decreases less rapidly until the edge of the frame again with almost constant slope. The light producing the rapid fall off near the sun is interpreted by the author as being primarily due to light from the K-corona while the light producing the shallow gradient beyond 2 solar radii as due to the light of the F-corona. This is particularly evident since the gammacurve for the magenta layer is to first approximation linear in the range used for this exposure.

The K-corona is due to Thompson scattering of the solar light from electrons near the sun in the solar atmosphere whereas the F-corona is produced by the small angle scattering from the zodiacal dust particles between the sun and the earth.

The success of our expedition is in large part due to the help and cooperation of Mr. Edwin Rudisuhle of Mexico City who helped us with our planning and logistics and who accompanied us at the camp site. Special thanks should be extended to Mr. Carlos Hernandez and his helpers who transported the ton of equipment needed for the measurement over rough and dangerous roads without damage.

Editor's note: This summary has been condensed from: "Theodore J. Pepin, The March Eclipse from Santa Maria Touameca, Atmospheric Physics Report AP-33, University of Minnesota, May 1970."

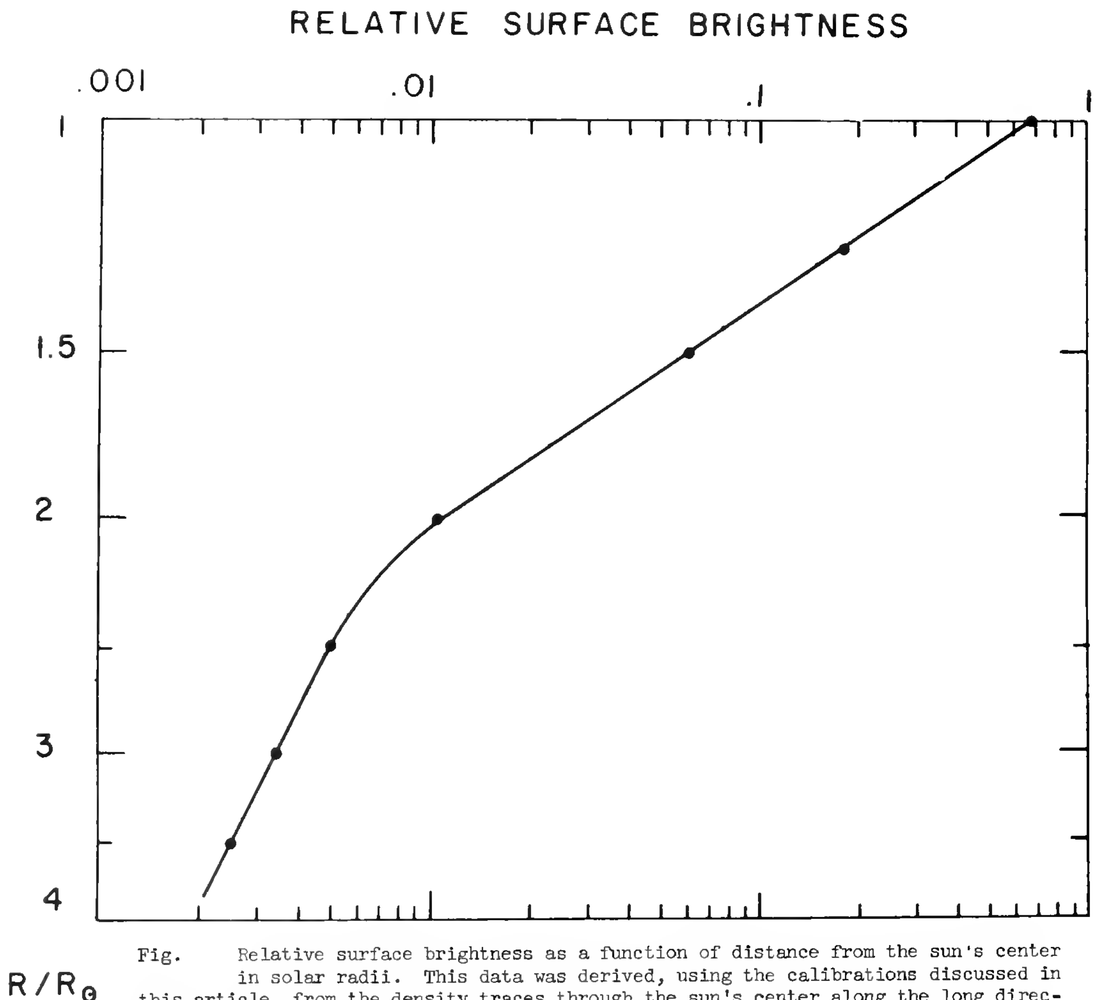


Fig. Relative surface brightness as a function of distance from the sun's center in solar radii. This data was derived, using the calibrations discussed in this article, from the density traces through the sun's center along the long direction of the frame. The righthand side was used which is observed to be brighter near the limb than the lefthand side. One observes a change of slope in this curve just beyond two solar radii from the sun's center which is interpreted by the author to show the separation of the K and F corona.

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-21.06

Institution : University of South Carolina

Investigators : SAFKO, John L.; CHILDERS, R.L.

Title : Melton Memorial Observatory 1970 Eclipse Expedition

Purpose : Measurement of Coronal Polarization at 2 $R_{\odot}$

Description : Equipment was designed to measure the radial and tangential components of light received from 2 $R_{\odot}$ and 10 $R_{\odot}$ from the sun for a 90° sector of the sky during totality. Our apparatus consisted of a 2 foot focal length aerial photography lens system operated at f/11. At the focal plane we placed a rotating disk having four holes spaced at 90° intervals. Two of the holes were at twice the solar image radius (0.21 inches) with a diameter of 0.021 inches (1/10 solar radius) and two at ten times the solar image radius with a diameter of 0.041 inches. Type HN polaroid material was placed over each hole with two holes covered in the radial mode and two in the tangential mode. This disk was rotated at a speed of 2 1/2 revolutions per minute.

Immediately behind the rotating disk we placed a solid disk with a quarter sector cut out. Thus only light from one hole at a time could pass on through further lenses to a 6292 photomultiplier. There further lenses formed an image of the objective on the photocathode. The output signal was fed to a channel of the strip chart recorder (see 23.01 A).

The data obtained should be the coronal brightness as a function of angle (time) for 1/4 of the surrounding circle. This information would be repeated for both radial and tangential polarizations at 2 and 10 solar radii. The signals at 2 $R_{\odot}$ should give us the polarization angle and hence the ratio of K to F coronas. The signals at 10 $R_{\odot}$ would give us background corrections only, not K-F ratios since we are beyond the 5 solar radii limit for neglecting the polarization of the F-corona. If the photomultiplier is calibrated we also obtain absolute measurements of the coronal and background light. At 2$R_{\odot}$ the ratio of K-F expected is nearly 1-1 (or a signal ratio of 3-1) and a factor of 10 larger than the ideal background sky light. Since previous data indicates the corona does not change structure during the extent of an eclipse, we hoped to repeat the experiment at least 4 times.

References : Bulletin of the South Carolina Academy of Science XXXII 1970 (Available 1971).

Location : Givhans Ferry State Park

Dates : March 5-7, 1970

Equipment : Photomultiplier polarimeter as in description, recorder and drive.

Number and Names of People : Dr. Safko and Childers, F. Maloney, R. Owen

Special Comments : Experiment not performed - bad weather conditions

Funds : 2/3 State South Carolina; 1/3 NSF Grant GA-16771

SUMMARY OF PRELIMINARY RESULTS

Experiment not performed due to poor weather conditions.

1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-21.07

Institution : Lockheed Observatory and Aerospace Corporation

Investigators : SMITH, S. F.; MARTIN, D. C.; and CHAPMAN, G.

Title : Coronal Photography

Purpose : (1) Photograph the green line corona (5303A) at four polarization positions 45° apart. (2) Record interesting aspects of entire eclipse throughout totality on infrared color film and professional color film. (3) Try experimental photography of coronal ray structure on high contrast, fine grain film using a 250A land pass filter centered at 6563A.

Description :

Focal length	Filters	Film
68 cm	none	Ektacolor
815 cm	5303A - 1A	103a - G
146 cm	6563A - 250A	SO - 375
40 cm	Wratten 12	IR Ektachrome

Location : Near Williamston, North Carolina

Dates : March 6 - 7, 1970

Equipment : (1) Close filtered (one Angstrom unit pass-band at 5303A) 24 inch focal length, f/12 plane polarizing telescope feeding Kodak 103AG film. Exposures were made at 5303A at four polarizing positions, sequentially 45° apart. A fifth (off band) exposure was made in the nearby continuum for comparison purposes. (2) A second system combined a four-inch Questar with a 250A passband filter centered at 6563A and formed its coronal image on SO-375 film. Graduated exposures provided high contrast photography tracing coronal structure near the solar limb outward. (3) The third instrument brought together a 680 mm F.L. solid catadioptric objective with an automatic film transport camera used to obtain a color film record of the whole eclipse. (4) The remaining camera fed by a 400 mm F.L. lens was used to record the solar corona on Kodak infrared film utilizing a minus blue filter.

Number and Names of People : 3, S. F. Smith, D. C. Martin, G. Chapman

Funds : Private and company

SUMMARY OF PRELIMINARY RESULTS:

Noteworthy features of our Lockheed-Aerospace eclipse expedition were the "twelfth hour" selection of an observing site through a highly mobile plan contingent upon the latest weather updating and the resultant photography of the coronal green line at 5303A. We also recorded the eclipse in color infrared, color white light, and broad band H-alpha photography.

Our mobile plan for site selection incorporated these elements: 1) Experiment instrumentation was kept highly portable and capable of being set up on almost any surface. 2) No specific location was preselected but the range of possible sites was made to include all those points lying along the path of totality between Tallahassee, Florida and Norfolk, Virginia. 3) Departur from Los Angeles International Airport was to be delayed to the latest possible hour (consistent with arriving at any point along the path of totality three hours before second contact) in order that we might avail ourselves of the latest, and therefore the most reliable east coast weather prognosis.

The plan's execution saw our expedition flying into Atlanta, Georgia some 32 hours before totality. Weather assessment there dictated flying to Norfolk where a final judgment was made to motor southwest into North Carolina in order to avoid possible coastal stratus clouds (which did not develop). Final site selection was made on the morning of the eclipse. Mr. Grimes, a farmer residing near Beargrass, kindly allowed us access to the northern edge of his field planted in rye. The "rye patch" was an ideal location because of its isolation and unobstructed southern view.

Although our trek admittedly had as its primary purpose the viewing of one of Nature's most spectacular phenomena, four coronal photographic experiments were pursued. The first of these was a coronal "green line" experiment conceived by H. E. Ramsey of Lockheed. It consisted of a close-filtered* (one Angstrom unit pass-band at 5303A) 24 inch focal length, F/12 plane polarizing telescope feeding Kodak 103 AG film. Exposures were made at 5303A at four polarizing positions, sequentially 45°apart. A fifth (off band) exposure, for comparison purposes, was made in the nearby blue side continuum by tilting the narrow band Fabry-Perot filter.

The "green line" photograph in Figure 1 is typical of the on-band pictures and results from a 10 second exposure. Visual comparison of the four 5303A polarigraphs show no important coronal intensity differences. Small effects, if any, await densiometric evaluation of the negatives.

*Filter on loan to LSO by Spectrolab of Textron primary value of the 5303A "green line" photographs is in the study of coronal rays, arches, other structural detail. We have found a very close correspondence in the general configu- on of the "green line" corona with the white light corona although our white light photo- ns do not show nearly as much structural detail. However, further comparisons of the "green " pictures with higher resolution white light photographs taken by Sheldon Smith of NASA Research Center show an even greater similarity in the form, and structure of the corona. tructures are visible in the "green line" that are not also visible in Smith's white light ographs showing more extensive detail. We feel certain of the reality of the structure 303A because an exposure of equivalent length was taken with the 5303A filter tuned approxi- ly 2 Angstroms into the blue wing of the line. This 10 second off-band exposure reveals a narrow, irregular band of corona around the limb with an absence of structural detail. wer, in the "on-band" 10 second "green line" exposures, structure can be seen out to a ance of 0.3 solar radii.

"green line" structure is sparse at the solar poles and predominant in the zone of active ons. A pronounced system of closed coronal arches is visible in the N.W. quadrant of Fig. 1 er right). These arches and other structure of a similar scale are rendered more visible e negative print in Fig. 2. This print was made by the superpositioning of positive and ive transparencies of the same original exposure thereby reducing the radial density ient. Then one transparency was rotated slightly relative to the other. The effect of rotation is to enhance the contrast of radial structure. We have found that other systems oops intermingled with the ray structure on the east and west limbs can be identified in original negatives through high contrast printing.

largest of the prominences visible during the eclipse is an extension of the large filament e N.E. quadrant of the solar disk seen in H-alpha light in Figure 3. The filament (or inence) is situated in the northern part of the active region zone and does not appear uniquely associated with any particular loop system in the inner corona. However, in the light photographs of Sheldon Smith, the outer corona reveals an extensive helmet and mer above this prominence as well as above the prominences on the S.W. and N.W. limb. e S.W. limb, the northern end of a loop prominence, as seen in H-alpha, appears to termi- in a very tiny active region. This region began developing on the solar disk on the ding day around 1700 U.T. During the eclipse a very small flare and corresponding small occurred in this active region from approximately 1733 to 1741 U.T. The active region just within the southern boundary of the active region zone. The "green line" corona the region is not intense even though the region is situated almost exactly on the limb. ently the "green line" exposure is so short that it reveals only the base of the helmet ture and streamers over this active zone. Above the small prominence on the N.W. limb, ver, concentric arches within the helmet can be seen in the "green line" photographs as as in Sheldon Smith's white light photographs.

er camera used aero infrared ectachrome to obtain pictures of the corona. Exposure times from 32 sec. down to 1/60 sec with a Wratten # 12 filter. Streamers can be seen out to ly 5 solar radii on the 4 sec exposure. In general, structures agree well with those seen e normal color film, but the radial density gradient on the infrared film seems to be what lower. The inner portions of the corona are over-exposed and appear white. The rly exposed regions, outside the white aureole, show a deepening blue with increasing radius.

light color photography of entire eclipse through totality was achieved on a third instru- utilizing a 680 mm F.L. solid catadioptic objective (loaned by Boller & Chivens) and a a with automatic film transporting mechanism (loaned by EPOI West). Among these photo- s are pictures of the diamond ring effect, Bailey's beads, prominences, and exposures ng the inner corona and outer corona to a distance of 2.3 radii.

contrast broad-band H-alpha picures were also taken for study of the details of the coronal structure. A graduated series of exposures were taken on a four inch Questar telescope with A passband filter centered at 6563A utilizing Kodak SO-375 film.

Fig. 1

Fig. 2

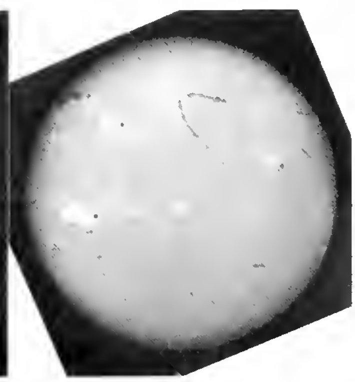


Fig. 3

1 - The green line corona - Note system of closed arches in N.W. quadrant
2 - The green line corona by superposition of neg. & pos. transparencies to enhance contrast
3 - The H_α solar disk during the eclipse (Lockheed Solar Observatory)

1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-22.01

Institutions : Osservatorio Astrofisico di Arcetri, 50125 Firenze, Italia
USAF Aerospace Research Labs, WPAFB, Ohio

Investigators : RIGHINI, Prof. G., KISSELL, K.E. (ARL), RIGHINI, A.

Title : Photometry of the K & F Corona in the Region of Hα.

Purpose : The corona was to be photographed through a special tunable Lyot filter (0.25 A passband) at three wavelengths, at the center of Hα, at a nearby wavelength in the continuum and on a selected nearby Fe line of intermediate strength. Exposures of different durations were to be made to record the inner corona and the outer oorona to a radius 0.5 R from the limb. Since the filter transmits a single plane of polarization, additional series of exposures were to be made with the filter rotated. It was planned to introduce a focalplane occulting disc to reduce the scattered-light for the outer corona exposures. The observations were proposed to be done from the Convair 990 aircraft to reduce the scattered light to a minimum. Cancellation of the aircraft forced an attempt on the ground in North Florida. Exposure was programmed for an automatic camera. The f/3.5 telescope, filter, camera, heliostat were already available with the telescope having been used in 1966 by a ground party at Bage (Brazil). It was planned to support the entire apparatus on a portable mount used by ARL for satellite studies. Photoelectric calibrations were to be effected on the ground and in dry runs for polarization and vignetting corrections. All optical systems were assembled at Arcetri. The mating of the optics, and observatory were effected by WPAFB. A tape recorder was to be used to establish exposure times and event times as well as oral comments.

References : Deutsch, A. J. & Righini, G. - Ap. J., 140, 313, 1964
Deutsch, A. J., Righini, G., & Steffey, P.C. - Airborne Spectroscopy of the May 30, 1965 Eclipse. Douglas Report DAC 59012, May 1966
Steffey, P. C., Righini, G., Gehriss, J. D., & Deutsch, A.J. - Airborne Coronal Spectroscopy at the Nov. 12, 1966 Solar Eclipse. Douglas Report, January 1969
Kissell, K. E. and Byard, P.L., 1965 Solar Eclipse Symposium Proceedings, p. 359
Whittaker, J. L., Burdin, C. & Clark, J. D. - Heliostatic Image Stabilization System. Douglas Report S, -48335, Feb. 1966
Kissell, K.E. and Byard, P. L. - "Coronal Continuum in the Near IR in the Eclipse of Nov 12, 1966" Presented at the AAS Spring Meeting, Honolulu, March 1969

Location : Perry, Florida, 1 March - 9 March 1970

Equipment : 8000 lbs., 15 cu. yds., $90,000 including the telescope, Zeiss filter, recording camera, photoelectric equipment, tape recorder and electronics, and portable observatory.

Special Site Rqquirements : Total 4000 watts, 230 V AC/60 cps.

Number & Names of People : 5 experimenters, including heliostat engineer, Captain Louis S. Macknik (ARL)

Cooperating Groups : None

Special Comments and Needs : Needed access to darkroom facilities for processing of test films refrigerator storage of data film, temporaty concrete pad to support trailer.

Station Prob : 1.0

Funds : In-House

SUMMARY OF PRELIMINARY RESULTS

Cloudy weather at the selected observation site prevented acquisi[tion] of data.

1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-22.02

Institution : Space Environment Branch, NASA Langley Research Center

Investigator : McDOUGAL, David S.

Title : Photoelectric Photometry of the Intensity and Polarization of the Solar Corona

Purpose : To determine photoelectrically the coronal intensity to a statistical accuracy of one percent. Simultaneous wideband multicolor measurements of the intensity and polarization of the coronal radiation will be made out to 5 $R_{\odot}$. For the first time, the determination of the fine structure of the coronal electron density and temperature will be made.

Description : NASA's Satellite Photometric Observatory (SPO) is a completely mobile and self-supporting facility. It consists of a 24-inch Cassagrainian telescope, a unique four-axis tracking mount, and a four-channel cryogenically cooled, phototube detection system for intensity and dual-beam polarization measurements. Spiral scans of gradually increasing radius from the lunar disk center out to 5 $R_{\odot}$ will be made of the orthogonal components of the coronal radiation. Measurements will be made simultaneously in the B and R bands of Johnson's and Morgan' UBVRI system.

References : Brandt, J. C.; Livingston, W. C.; and Trumbo, D. E.: Temperature of the Solar Corona From Intensity Gradients Measured During the May 30, 1965, Total Eclipse. PASP, 79, 140-151, 1967

Romick, D. C.; Emmons, R. H.; Preski, R. J.; and Kalasky, E. D.: The Modification and Use of a Ground-Based Photometer for Evaluation of Satellite Materials. NASA CR-66772, 1968

Location : Miahuatlan, Mexico

Dates : February 20 - March 10, 1970

Equipment : SPO is housed in a 16-ton, dual axle drive truck and valued at 200 K. Shipment via air/boat/road.

Special Site Requirements : Fairly flat and stable 32 ft x 25 ft area. 110 volts AC if possible, but not mandatory.

Number and Names of People : McDougal, D. S.; Brumfield, M. S.; and Keating, G. M.

Cooperating Groups : Goodyear Aerospace Corporation

Special Comments and Needs : No interference is expected from our equipment. Liquid nitrogen.

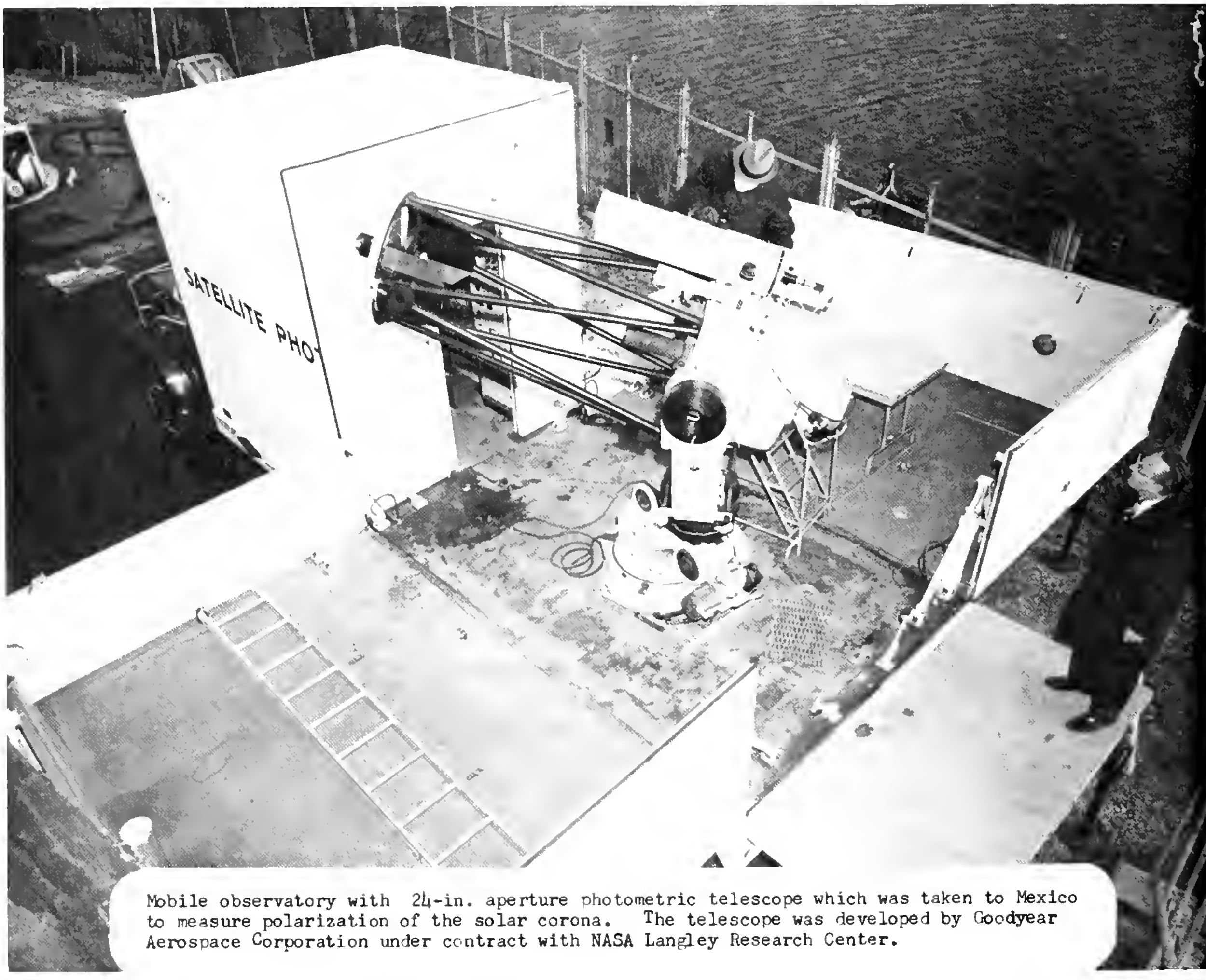
Station Prob : 1.0

Funds : NASA

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.1-F-22.02

The Langley Research Center mobile observatory was deployed at a site approximately 12 kilometers south of Miahuatlan, Mexico. A photograph of the observatory is attached. A 24-inch Cassegrainian telescope and a four-channel photoelectric photometer equipped with a Wollaston prism and a rotating half-wave plate were used to make simultaneous measurements of both orthogonal components of the polarization of the solar corona in the B and R bands of Johnson's and Morgan's UBVRI system. One and one-half spiral scans were performed beginning at the center of the lunar disk and moving with gradually increasing radius out to five solar radii. The results of these measurements should facilitate the construction of a model of electron density and temperature for the entire corona out to five solar radii.

The data have not been reduced as of this date. Only a quick-look investigation of the oscillograph traces and a preliminary playback of the magnetic tapes have been done. These preliminary examinations indicate that polarization levels were recorded on both records for at least part of the corona. A detailed reduction program is beginning now which will incorporate calibration and extinction coefficients into the results to obtain polarization values. After determining polarization values, profiles of polarization and intensity will be established, and from that a model of the temperature and electron distributions will be developed.



Mobile observatory with 24-in. aperture photometric telescope which was taken to Mexico to measure polarization of the solar corona. The telescope was developed by Goodyear Aerospace Corporation under contract with NASA Langley Research Center.

Institution : NASA Ames Research Center, Moffett Field, California

Investigators : SMITH, S. M. and WEINSTEIN, L. M.

Title : Photography of Coronal Structure

Purpose : To obtain photographs of about 20 arcsecond or better resolution of the low contrast, intermediate scale structure of the electron corona so that a quantitative evaluation of calculated and predicted[1] forms of coronal structure may be attempted.

Description : To reduce the extremely steep radial brightness gradient of the inner corona, a specially shaped rotating sector wedge occulter (or radial transmission filter)[2] will be mounted just before the prime focus of the existing 16-inch, F/5.6 Newtonial telescope of the Langley Skywatchers Astronomy Club. Photographic resolution should be limited by the coma of the primary parabola to about 10 arcseconds at 2 $R_{\odot}$. Ten to twenty exposures of varying durations, which will span a factor of 30 times in film exposure, will be made with a yellow gelatin filter on 70 mm Plus X Pan film.

Reference : 1. Schatten, K. H., Nature, 226, 251, Apr. 18, 1970. 2. Smith, S. M., Henderson, M. E., and Torrey, R. A.: NASA TN D-4012, June 1967.

Location : NASA-Langley Research Center

Dates : March 2-7, 1970

Equipment : 2 or 3 packages, less than 25 lbs.

Special Site Requirements : None

Number & Names of People : 3 persons: S.M. Smith, L.M. Weinstein, and M.E. Henderson

Cooperating Groups : NASA Langley Research Center; Langley Skywatchers Astronomy Club

Special Comments and Needs : None

Station Prob : 1.0

Funds : NASA Ames Research Center

SUMMARY OF PRELIMINARY RESULTS:

A. Photographic Data Acquired:

Fifteen photographs (including "diamond ring" effects at both contacts) were obtained with the radial transmission filter and other instrumentation as described in the Questionnaire. Fifteen arcsecond or better resolution of low contrast coronal structure was obtained. Three defects in the photographs are apparent in some reproductions. At the left (east) edge of the camera frame a diffuse image of the inner corona was created by reflection off the uncoated glass window supporting the secondary flat of the Newtonian telescope. Second, a faint dark circular band located 2.2 radii ($R_{\odot}$) from the center of the disc is due to a small nonuniformity in the radial transmission filter. Third, slightly irregular shutter motion created a series of faint, dark, linear bands across the shorter two exposures. Fortunately the location of these shutter bands changed with time, so they can be made to nearly cancel by superimposing exposures taken near the second and third contacts. The photograph shown below results from the superposition of positive copies of three separate negatives. The Fluor-O-Dodge contact printer was used to maintain latitude in two of the reproduction steps.

B. Observed Structures:

1. Numerous (4 or more), DARK, narrow (15-30 arcseconds wide), ray-like filaments with varying amounts of curvature were observed to extend as far as 2 $R_{\odot}$ above the limb. The width of these dark rays stays approximately constant. About 0.9 $R_{\odot}$ above the eastern equator, one of the dark rays is crossed by an equally narrow bright ray. However, the bright ray is not completely obscured by the dark ray.

2. Helmet streamers in the south and low arches with bright, linear rays in the north have replaced the usual poloidal plumes at the rotational poles.

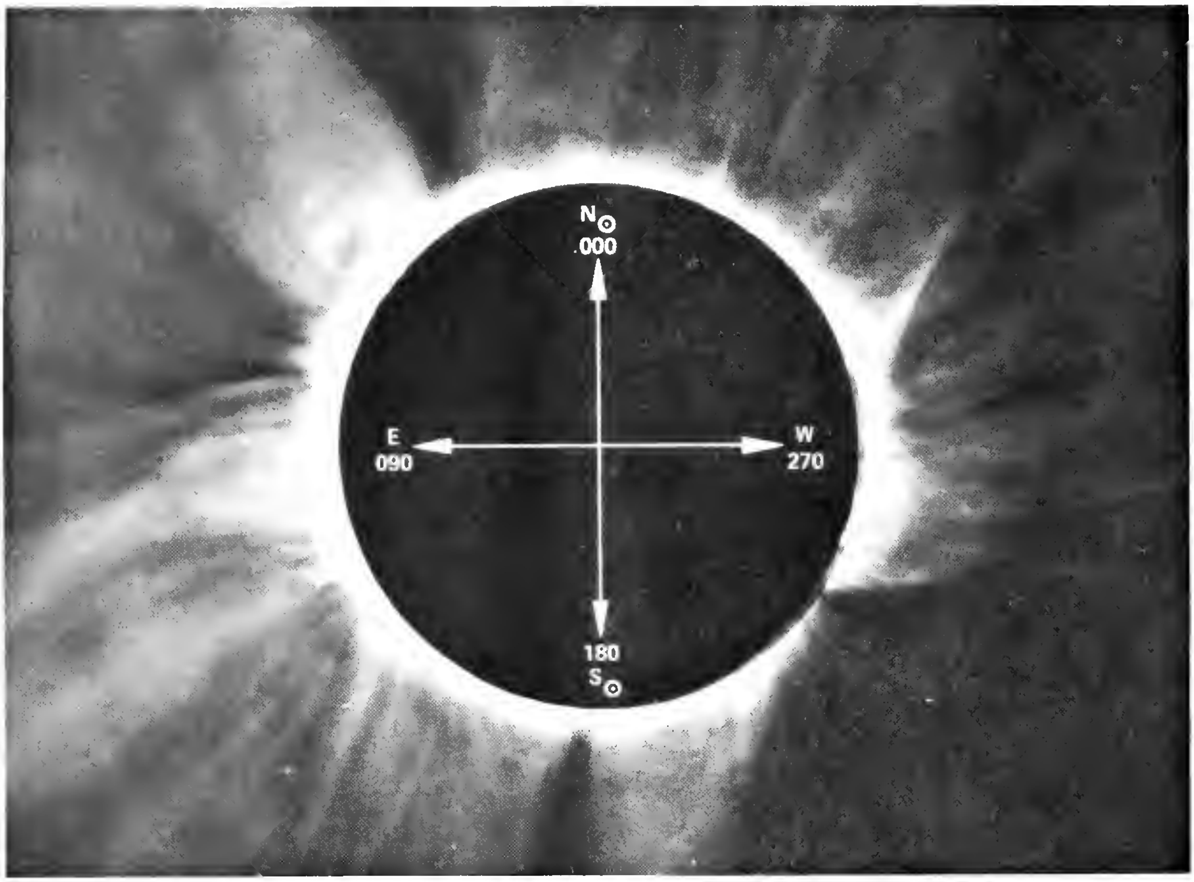
3. The height of most closed structures is very low and there is a predominance of open, linear, ray-like structure. This, and the preceeding observation, are characteristic of coronal structure near the maximum of the cycle of solar activity.

C. Analysis:

1. A preliminary quantitative comparison of the predicted with the observed structure has been completed and will appear in one of the June 1970 issues of Nature. The major points of agreement and disagreement are tabulated. A modification of the technique for calculating coronal magnetic fields above active regions is suggested. In summary, the predominantly open structure of the predicted corona agrees on a large scale basis with the maximum corona observed. The largest single structure apparent at this eclipse (the streamer in the north-east) was correctly forecast.

2. Qualitative comparison of the fine structure in the excellent "green line" photograph by Sara Smith of Lockheed's Rye Canyon Observatory with that in the white light photograph shows no significant difference on a size scale of 30 arcseconds. A densitometric comparison of the two photographs is contemplated.

A70-1610-5-5



THE INNER AND MID CORONA ON MARCH 7, 1970.
A superposition of three radial transmission filter photographs obtained between 1841 and 1843 U.T.

S. M. SMITH
NASA — AMES RESEARCH CENTER

L. M. WEINSTEIN
NASA — LANGLEY RESEARCH CENTER

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-22.04

Institution	:	Goddard Space Flight Center Greenbelt, Maryland 20771
Investigator	:	SCHATTEN, Kenneth S.
Title	:	March 7, 1970 Coronal Structure Prediction
Purpose	:	To predict the features of the corona as it would appear during the March 7th solar eclipse. This provides a test for magnetic models of the corona when utilized with a high quality eclipse photograph.
Description	:	Magnetograms and sunspot drawings from the Hale Observatory (Mount Wilson) prior to the solar eclipse were digitized to provide information about the photosphereic magnetic field. This information was then processed by a computer and magnetic fields thus predicted in the corona were displayed. The structures displayed were then traced into a composite picture of what might be seen at the March 7th solar eclipse.
Reference	:	Schatten, K. H., Nature, to be published (June, 1970) Schatten, K. H., Nature, 222, 652 (1969) Cowling, T. G., The Observatory, 973, 212 (1969).
Location	:	Pasadena, Calif. and Berkeley, Calif.
Dates	:	February 26, 1970 - March 3, 1970
Equipment	:	Use of the Mount Wilson Magnetograph and computer facilities.
Special Site Requirements	:	None
Number and Names of People	:	Kenneth H. Schatten
Cooperating Groups	:	Dr. Robert Howard Hale Observatories Dr. John Wilcox - Space Sciences Lab., U.C., Berkeley
Special Comments and Needs	:	None
Station Prob	:	
Funds	:	NASA and support form cooperating groups.

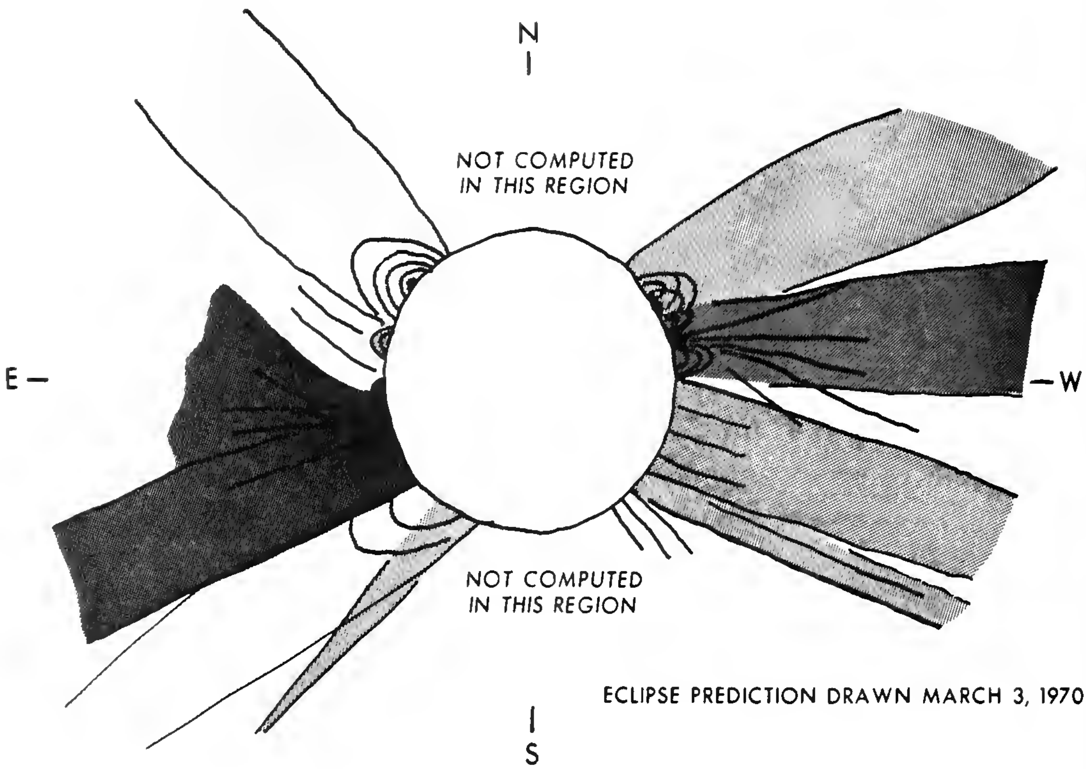
SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.1-F-22.04

A prediction was made on March 3 of the coronal structure of the March 7, 1970 eclipse of the sun. (see figure) A "sourse surface" at one solar radius above the photosphere rather than on at 0.6 solar radii as used in earlier work was employed, to try to allow for the more active sun.

Smith and Schatten (Nature; June, 1970) discuss a preliminary comparison of the prediction with a high quality photograph of the structure. A. table of detailed comparisons is given. Some of the major findings are the following:

The predominantly open structure of the predicted corona is in agreement on a large scale basis with the maximum type corona observed. The largest single structure apparent at the eclipse was correctly forecast. Detailed agreement of intermediate size features is best near older, more stable regions and is worst near coronal condensations.

It is further suggested that many field lines from active regions return to the sun via large loops in the ourter corona beyond 10 solar radii as suggested by outer Schatten (Solar Physics, 11, 236, 1970). This result is based upon the small number of field loops seen in the active corona along with the relatively constant interplanetary magnetic field observed throughout the solar cycle.



ECLIPSE PREDICTION DRAWN MARCH 3, 1970

1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-23.00

Institution : Department of Astronomy and The McMath-Hulbert Observatory
The University of Michigan
An Arbor, Michigan 48104

Investigators : TESKE, Dr. Richard G. and MOHLER, Dr. Orren C.

Titles : White-Light Photography of Corona

Purpose : 1) To obtain coronal photographs which show the K-coronal structure for comparisons with CaII K and Hα spectroheliograms. It is desired to deduce the association of coronal structures with chromospheric features.
2) To obtain data on distribution of electron density within solar corona at the time of the eclipse.
3) To train graduate and undergraduate students in the problems and techniques of observing the sun during eclipses.

Description : A portable coelostat (14" diam. mirror) will be used to feed a 25-foot focal length camera (10" diam. achromatic doublet lens). The camera will be aligned horizontally at the correct azimuth and will capture o n 8" x 10" plates coronal radiation between $400 \lesssim \lambda \lesssim 5500$Angstroms.

References : None

Location : Sandbridge site is desired, location on the asphalt parking lot.

Dates : Site occupancy by March 3. Vacate on March 8.

Equipment : Equipment will be brought in by truck or van from Ann Arbor. Anticipated number of pieces: 5 to 8. Total weight 500-800 lbs., with heaviest piece $\sim$200 lb. (about 1 cubic foot). Total volume knocked down will not exceed 20 cubic feet.

Special Site Requirements : 1) A clear area for coelostat. 2) A path for camera 30 feet x 10 feet running on azimuth of $\sim 83\overset{\circ}{.}5$ west from coelostat. 3) Electrical power: Standard 120 v. A.C., 60 Hz. Needed for powering coelostat (0.36 amp. motor). Adapter plugs for power receptacles. 4) Radio for WWV time signals. 5) Use of darkroom facilities (at Langley?).

Number & Names of People : Five: (Teske, Mrs. Anne Hutchinson, Mr. Tefvik Soyumer, Mr. John Iwanski, Mr. Clifford Bennett). Possibly O. C. Mohler

Cooperating Groups : None

Special Comments and Needs : None known. Special transportation from the road across sand to the site <u>may</u> be required.

Station Prob : 1.0 (100%).

Funds : NASA

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.1-F-23.00

Six excellent direct photographs of totality were taken on Eastman Kodak Tri-X orthochromatic sheet film. Four were taken at f/67 and two at f/30. Relative photometric calibrations were obtained as well. The various coronal exposures show detail at useful photographic densities from the lunar limb out to about one solar radius. The Sandbridge sky was cloudless and free of haze.

Purpose (3) was fulfilled. The same students who participated in the observations are participating in their reduction.

In the analyses of the data, purpose (1) has been completed. A report of the association of coronal and chromospheric features was published in the June 20 issue of NATURE.

At the time of writing (June 10) photometric analyses had not been begun. An attachment to the McMath-Hulbert Observatory's isophotometer has been designed that will permit reduction of the photographs and it is about half completed in the observatory's shop. It is intended to analyze at least one exposure to obtain electron density gradients in the corona for comparison with results from previous eclipses. This work will commence in early July and may be completed by the end of summer.

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-23.01

Institution	:	University of South Carolina
Investigators	:	SAFKO, J. L., EDGE, R. D., DARDEN, C. W., WOOD. R. E.
Title	:	Melton Memorial Observatory 1970 Eclipse Expedition
Purpose	:	Still and motion picture photographs, video taping, comet search.
Description	:	1) A fast f/2.5 camera with a field of 19 x 24° was constructed to search for comets within 10° of the sun and to obtain photos of the general star field. 2) Uncalibrated sill and motion picture photographs were taken at our site from an airplane, and from a site in North Carolina. 3) A 30 minute split screen video tape was made during the 2½ hours surrounding totality. The images were the sun, a clock, and the optical experimental area. Before totality the sun was viewed by the corona through #14 welders glass.
Location	:	Givhans Ferry State Park, an airplane over South Carolina, a site just into North Carolina.
Date	:	6-7 March 1970
Equipment	:	f/2.5 camera, several telescopes and 35 mm cameras
Number and Names of People	:	(38) Drs. Safko, Edge, Darden, Wood and Hill; J. Bernard, J. Parish, F. Maloney and approximately 30 students.
Cooperating Groups	:	1) Lower Richland High School Astronomy Club (J. Bernard and approximately 30 students) 2) Emory University (Dr. R. E. Wood and Mr. J. Parish) 3) Western Carolina University (Dr. C. R. Hill and 8 students) 4) University of South Carolina Television Center 5) South Carolina State Educational Television Center 6) Dr. H. Bebehogne, Royal Observatory of Belgium
Special Comments	:	Comet search and star field photographs were not performed since there was a high haze and clouds during totality.
Funds	:	2/3 State of South Carolina; 1/3 NSF Grant GA-16771.

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.1-F-23.01

Attached is a photograph of totality taken by Drs. R. D. Edge and C. W. Darden from an airplane over South Carolina.

Institution : AF Cambridge Research Labs., L. G. Hanscom Field Bedford, Mass.

Investigator : REED, Major John W., Project Officer

Title : Airborne Interferometric Measurements of Infrared Airglow and Solar Corona

Purpose : To determine the reaction rates and mechanisms responsible for airglow above 50 km altitude during the March 1970 solar eclipse. To observe the spectral nature of the solar corona in the 1 to 8 micron region.

Description : Utilize newly developed infrared instrumentation on-board KC-135 aircraft Sn53120. The aircraft will be flown at 12 km in the eclipse umbra and in the direction of umbra travel. This flight profile was selected to take advantage of reduced atmospheric absorption and scattering, and increased observation time. The measurement technique will be to observe airglow phenomena with a new Michelson interferometer system capable of continuous spectral intensity measurements throughout the 1 to 14 micron region with wavenumber resolution of 5 cm^{-1}. The presence of excited species will be determined by the techniques of Fourier Spectroscopy data reduction. Reaction rate information will be obtained by continuous observations of emissions before, during, and after the eclipse totality. These observations will contribute significantly to an understanding of the atmospheric role of such species as O, OH, O_3, H and and possibly HO_2, O_2^*, NO, NO_2 and NO^+. The primary instrument employed for these studies is designated Type III Interferometer, and features a unique, exterior to the aircraft, liquid nitrogen cooled chopper to eliminate the detrimental effects of aircraft window radiation.

Other photometric and radiometric infrared systems will be used to corroborate the Type III data. Two laser monitored interferometers will be used to observe the corona.

The geometric constraints imposed by existing instrumentation mounts and existing acquisition window configuration on the aircraft, combined with those set by the eclipse parameters, required observations near 14° N 98° W, southwest of Oaxaca, Mexico. Pretotality maneuvers were made 100 miles from the nearest coastal point to preclude any persistent contrails from drifting over ground-based observation sites.

References : Stair, A. T., Jr., Huppi, E. Ray, and Steed, Allan R. (1969) Infrared Emissions From the Atmosphere and Aurora, presented at the Spring 1969 Meeting of the Optical Society of America.

Stair, A. T., Jr., and Huppi, E. Ray (1969) Infrared Auroral and Airglow Measurements From 40,000 Feet Altitude, presented at the Air Force Science and Engineering Symposium.

Huppi, E. Ray, and Stair, A. T., Jr. (1969) Sunset-to-sunrise variations of the OH emission of the night sky, in Atmospheric Emissions, Billy M. McCormac and Anders Omholt, Eds., Van Nostrand Reinhold, pp. 471-475 (The published Proceedings of NATO Advanced Study Institute held at Agricultural College of Norway, As, Norway, 29 July to 9 August 1968).

Location : Base: Kelly AFB, Texas; aircraft in umbra over Pacific Ocean; refueling required at Acapulco Airport, Mexico.

Dates : Aircraft installation approximately February 1 through 19, 1970. Local airborne phase February 20 to 26, 1970. Deployed airborne phase - February 27 to March 11, 1970.

Special Site Requirements : Gaseous (3600 psi and liquie nitrogen available in staging area. Aircraft parking and ground support (ground power cart, air cart, aero stand, fork lift).

Number and Names of People : 13 experimenters, 6 aircrew, 3 observers.

Special Comments and Needs : Flight at altitude - 40,000 ft. is required; request block altitude clearance.

Funds : USAF

Airglow and solar coronal data were obtained during the 7 March 1970 eclipse by means of newly developed infrared instrumentation on-board KC 135 aircraft SN53120. The aircraft flew at 12.2 km in the eclipse umbra, in the direction of umbral travel. Thirteen scientific crew members operated ten data-acquisition systems.

Airglow phenomena were observed with the Type III interferometer system capable of continuous spectral intensity measurements from 3 to 14 μm with wavenumber resolution of 5 cm^{-1}

A visible-wavelength photometer and two near-infrared wavelength radiometer systems provided a time history to corroborate the Type III data. These systems viewed zenith sky emissions.

Direct measurements of solar emission from 1 to 7 μm provided infrared atmospheric transmission documentation both before and after eclipse totality. Observations of atmospheric background - from normal full solar illumination to totality-darkened sky conditions - as well a solar coronal emissions during totality, were documented. A trio of laser monitored interferometers were used for these observations.

Second contact was observed at 17:22:50 UT from a point approximately 10 naut. mi. south of the ground eclipse center line. During totality, sharp decreases in zenith signals to approximate nighttime levels were observed by the infrared radiometer systems; at the same time, the visible-wavelength photometer observed a characteristic decrease, then an increase approaching third contact. Spectral information of the sky emission was recorded from the Type III Interferometers. Observations of atmospheric transmission prior to and after totality were supplemented by direct observations of the solar corona, including coronal continuum in the region from 1.4 to 3.0 μm. Reduction and analysis of interferometer and radiometer histories, spectral signatures, low-light-level-low-dispersion spectrograph records, and all-sky and long-focal-length photographic documentation (with a variety of film emulsions) of the 5 min 28 sec of totality is proceeding.

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-25.00

Institution	:	U. S. Army Natick Laboratories
Investigators	:	STROSCHEIN, Leander A.; and DALRYMPLE, Paul C.
Title	:	Spectral Solar Measurements, Nantucket Island
Purpose	:	To measure both narrow and wide band spectral measurements of the solar intensity before, during and after a total solar eclipse. Ultraviolet through long wave radiation.
Description	:	New solar radiometers being manufactured give the scientist opportunity to measure the solar spectrum in wave bands which were never before possible. These instruments will be taken to Nantucket Island, away from the dust and pollution associated with metropolitan areas on the mainland, and measurements taken at the U. S. Weather Bureau site at the Nantucket Airport.
Reference	:	Various publications in radiation climatology from Barrows, Alaska, Plateau, Antarctica, and Sakae-rat, Thailand.
Location	:	Nantucket Airport, Nantucket Island
Dates	:	6 - 8 March 1970
Equipment	:	Military will transport equipment to ferry at Woods Hole; Ferry, Wood Hole to Nantucket Island; U. S. Weather Bureau vehicle from Nantucket to Airport
Special Site Requirements	:	None. (if unobstructed roof site available, will use, otherwise will set up in field adjacent to building with power.)
Number and Names of People	:	Not to exceed four. Stroschein and Dalrymple will be two of the four.
Cooperating Groups	:	Possible Eppley Laboratory, Newport, Rhode Island
Special Comments and Needs	:	None
Station Prob	:	0.8 (Only departure of scientists for new jobs would eliminate program).
Funds	:	$500 - Army will support

SUMMARY OF PRELIMINARY RESULTS

The project was performed with slight revisions from description above.

No report of results.

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-27.01

Institution : Physics Department, University of Houston

Investigator : KOVAR, Dr. Natalie S.

Title : Studies for the March 7, 1970 Eclipse

Purpose : Experiment A: 1) To determine the brightness and polarization of the ou corona-inner zodiacal light at selected elongations and wavelengths. 2) To measure th sky brightness and polarization prior to, during, and after the eclipse (with N. K. Shankar, LEC).

Experiment B: To search for comets near the sun (with G.P. Bonner, NASA-MSC).

Description : Experiment A:

A two (2) telescope system was employed to measure the intensity a polarization of the combined F and K coronae and the sky. The measurements were made a rotating filter-polaroid system at effective wavelengths of 4360Å, 5460A, 5890A and Filters, which were driven by a 30 rpm synchronous motor, had bandwidths ranging from . to 57Å and transmissions from 0.41 to 0.60. The rotating polaroid, mounted in front o the filter wheel, was continuously driven at 600 rpm. The sampling time per filter wa 15 seconds. Data was simultaneously recorded on a stripchart and on magnetic tape.
1) Observations were made at $3R_{\odot}$ and $13R_{\odot}$ in the eclipse plane. Sky observation were also made at the above mentioned wavelengths. The optical system had a 10 arc mi field of view, 12 cm objective and a focal ratio of f/16.6. Boresighted photographic techniques were used to determine pointing accuracy.
2) A photometric system was used to monitor the brightness and polarization of the This was a telecentric system with aperture 2.5 cm, focal ratio of f/9, and a 30° fi of view. Observations were begun at 9:00 a.m. C.S.T. at a position 90° north of the S and continued at 30 minute intervals until 11:00 a.m. C.S.T. Thereafter, the sky brigh and polarization was continuously monitored through totality. Measurements at one-hal hour intervals were continued after total eclipse until 2:00 p.m. C.S.T.

Experiment B:

A photographic search for comets was conducted employing a two (2) camera system. The first of these was a standard Hasselblad camera with an 80mm len operated at f/2.8 for wide field coverage (30° x 30°). The second was a seven-inch Questar and Hasselblad system for near solar coverage (1° x 1°). A total of 18 frames were obtained with both systems.

Reference : A: Kuiper, G.P., The Sun, Chapter 5, "The Chromosphere and the Corona"
B: Courten, H.C. and Ganberg, R.W., A. J., 72, 791, 1967.

Location : Near Miahuatlan, Oaxaca, Mex. Lat. 16°15'N, Long. 96°34'W, Alt. 2160 me

Dates : On site February 23, 1970 to March 9, 1970

Equipment : Included in the NASA-MSC package

Cooperating Group: Lockheed Electronics Co. (LEC) & NASA-Manned Spacecraft Ctr., Houston, T

Funds : NASA

SUMMARY OF PRELIMINARY RESULTS:

Experiment A:

1) Our experiment yielded measured polarizations at elongations of 1/2° and 3°. At 1/2° th range from a low of 17% for the Mercury e line (4360A) to 22% for the H-alpha filter. The o average at all four effective wavelengths was 20%. At 3° the polarization is about 2% for a wavelengths.

Figure 1 compares our results to previously published eclipse values. In this figure the crosses represent the measurements of Blackwell at the 1954 eclipse, the circles the measurements of Michard at the 1952 eclipse, the triangles the measurements of von Kluber at the 19 eclipse, the daggers the measurements of Saito at the 1962 eclipse and the stars are our mea ments. The line through our $13R_{\odot}$ point reflects our estimated positional error. At $3R_{\odot}$ w estimate our positional error to be essentially zero. As can be seen from this figure, our values are in good agreement with previously measured values.

Coronal surface brightnesses at 5460Å are 5×10^{-9} $B/B_{\odot}$ at $3R_{\odot}$ and 3×10^{-10} $B/B_{\odot}$ at $13R_{\odot}$. Evaluation of these quantities at the other effective wavelengths is currently under analysi

The brightnesses and polarizations given above are the result of the analysis of our strip chart recorder data. These will be superceded by the values obtained from the magnetic tape data.

se preliminary results were presented at the 132nd meeting of the American Astronomical ety at Boulder, Colorado in June 1970.

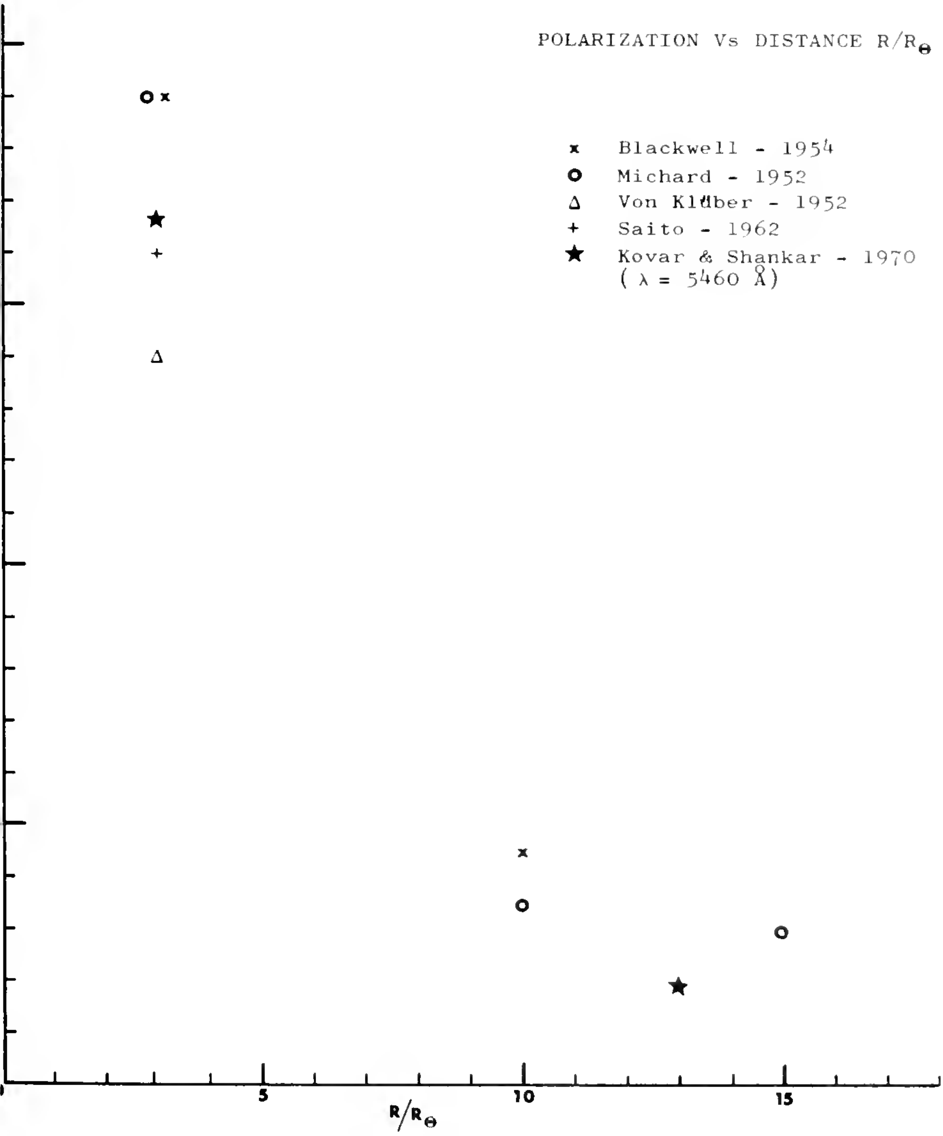
The measurements of intensity and polarization of the sky as obtained by the 30° field of telecentric system are in the process of reduction. Neither the strip chart data nor the etic tape data are, as yet, thoroughly analyzed. However, we believe that our analysis be completed shortly.

eriment B:

our comet search equipment a total of 18 frames of film were obtained. However, due to the pected brightness of the corona and the sky during totality, a number of the frames were rexposed to some degree.

ination of all the frames indicates that no bright comet was present. Four (4) of the best es have undergone examination for identification of star images and film defects. Stars to magnitude +3.5 have been identified, as well as the images of Venus and Mercury. No un-tified images with a brightness equivalent to +3.5 magnitude or greater have been found.

ly results of this experiment were presented at the June 1970 meeting of the American Astro-ical Society at Boulder, Colorado.



1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-27.02

Institution : NASA-Manned Spacecraft Center
Space Physics Division

Investigators : G. P. BONNER, K. D. CASHION, M. F. HEIDT, C. L. KOTILA R. P. KOVAR (Coordinator); NASA/MSC. J. H. REID and N.K. SHANKAR; LEC.

Title : Solar Eclipse Studies

Purpose : a) Separation of the F- and K-corona using a deep Fraunhofer line (R.P. Kovar). b) Coronal polarization (J.H. Reid and K. D. Cashion). c) Brightness and polarization of outer corona-inner zodiacal light and the sky (N.K. Shankar and N.S. Kovar, University of Houston). d) Comet search (G.P. Bonner and N. S. Kovar). e) Source and nature of the shadow bands (M.F. Heidt). f) Flash spectrum in the ultraviolet (C.L. Kotila).

Description : a) Photography of the corona through a 0.7Å filter centered at Hα using a telecentric optical system and high speed film. b1) Four camera system, 16.3 cm objectives operated at f/5.6, 4 polaroids at 45° intervals, used to determine the white light polarization of the corona. b2) An 11 cm, f/9 system, 4 polaroids at 45° intervals, to determine the polarization of the inner corona at 6560Å. c) and d) See report of University of Houston. e) A high speed motion picture camera and photometer system viewed a white surface to determine the intensity variation, spacing, size, and velocity of the shadow bands before and after totality. f) A Maurer Camera with a 2.1 cm lens operated at f/3.3 was used in conjunction with an objective grating having a reciprocal dispersion of 184Å/mm and a maximum response in the 2000-4000Å region to record the flash spectrum in the 3000-4000Å SPECTRAL REGION.

Reference : Kuiper, The Sun, Chapter 5, "The Chromosphere and the Corona."

Location : Near Miahuatlan, Oaxaca, Mexico. Latitude 16° 15' N, Longitude 96° 34' W. Altitude 2160 meters.

Dates : On site, February 23 to March 9, 1970

Equipment : 1 truck, 1 panel truck, 2 campers. Entered Mexico at Nuevo Laredo.

Number & names of People : B. R. Baker, G. P. Bonner, K. C. Cashion, M. F. Heidt, C. L. Kotila, R. P. Kovar, J. W. Shafer; NASA/MSC. T. Burk, F. Mayo, N. K. Shankar, C. J. Stanbrough, W. E. Trump; LEC.

Cooperating Groups : Lockheed Electronics Company (LEC), Houston, Texas and the University of Houston, Houston, Texas.

Funds : NASA

SUMMARY OF PROJECT RESULTS

a) Hα Telescope: Seven exposures were made during totality on Kodak 2485 speed film. An examination of the negatives after development indicated that no information could be obtained from this experiment due to a defect in the prefilter. The layers of the prefilter had become separated and inclined to the optical axis producing a series of overlapping images on the film. Thus, no significant data could be obtained from this experiment.

b1) Coronal Polarization: Four identical telescopes were used to photograph the corona through four polaroids. Three of the camers produced identical sequences of 44 exposures each, while one telescope produced only 33 exposures, for a total of 132 usable images. The corona was recorded out to about $5 R_{\odot}$, but due to the unexpected brightness of the corona, the inner portion was slightly overexposed. Figure 1 is an example of one set of images.

Due to the large number of frames, detailed photometry is being restricted to two sets of exposures at each of the four exposure times, for a total of 32 frames. To select these, all of the 132 frames have been processed in the Videometer. This instrument uses video techniques to produce approximate isophotes, which are then combined to form a composite isophote diagram. The composite isophote diagrams for the 132 frames are presently being constructed.

For the accurate photometry, microdensitometer traces will be made in a radial pattern at 10° intervals in order to determine the intensity of the corona as a function of radial distance, position angle, and polaroid. These values will be combined to determine total intensities, percentage and direction of polarization, and ultimately, electron densities.

b2) A telescope-polaroid system was used to determine the polarization of the inner corona ($R<2\ R_{\odot}$) at 6560Å. A total of 20 frames were obtained during totality.

At this time, the 12 frames taken with exposure times of 1/2, 1/10 and 1/25 seconds have been isodensitometered. These contours are presently being converted to intensity units on each of the tracings. These values will then be used to determine the percentage and direction of polarization of 10° intervals.

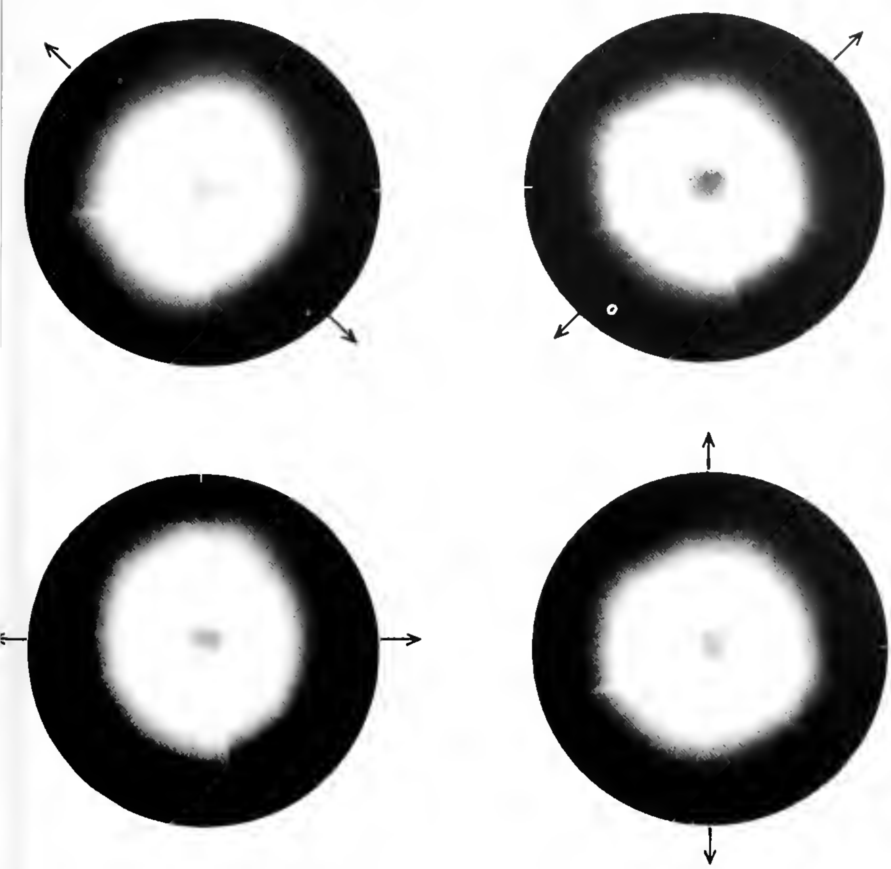
c) and d) See the University of Houston report.

d) Shadow Bands: The photographic and photelectric data is under analysis. One preliminary conclusion that can be drawn from the data is that the visual appearance of the shadow bands is much stronger than the actual intensity fluxuation. A few seconds after third contact, the intensity modulation depth is about 1%. About 30 seconds after third contact, this had decreased to 0.3%.

Some difficulty has been encountered in obtaining data from the photographs. Isodensitraces of successive frames show systematic changes from frame to frame; however, the effect is nearly lost in the film background noise. With photographic enhancement techniques, it will be possible to improve the quality of the images, and therefore obtain accurate values of the velocity and size of the shadowbands as a function of time.

From inspection of the data on hand, it appears that the shadow bands are caused by atmospheric turbulence at the tropopause level, in a fashion similar to stellar shadow bands and scintillation. The difference between these two phenomena being due to the nonadiabatic conditions in the umbra and the changing size of the light source (the Sun), during the eclipse.

e) Flash Spectrum: During the time period near second and third contact a total of 18 frames were taken. Of these, five are in the interval at which the flash spectrum appears. These frames are currently being examined with the microdensitometer.

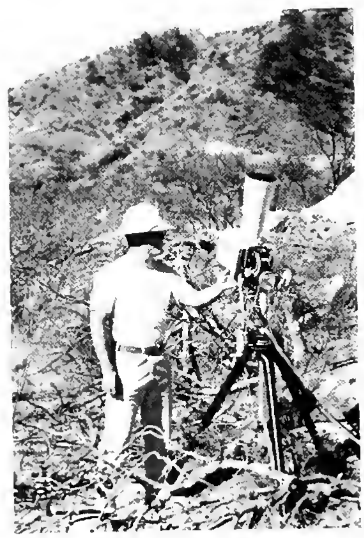


1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-27.03

Institution	:	Douglas Advanced Research Laboratories
Investigators	:	LARMORE, L.
Title	:	Photographic Sequence of the Eclipse and Movie Photography of the Shadow Bands
Purpose	:	Photograph the flash spectrum at beginning and end of the eclipse in color with intermediate stages Record shadow bands with high-contrast movie film
Location	:	Southeast of Oaxaca, Mexico
Equipment	:	Leica camera with 135 mm lens. Objective grating 2887 lines/inch Bolex movie camera
Funds	:	McDonnell Douglas Corporation

SUMMARY OF PRELIMINARY RESULTS:

Obtained 18 low resolution spectra of the eclipse. Color copies of seven of these photographs are enclosed. Obtained a few seconds of the shadow bands on high contrast movie film which show their appearance and nature successfully.



1970 SOLAR ECLIPSE PROJECT NO. 3.1-F-28.00

Institution : ASTRONOMICAL LEAGUE (National Federation of Amateur Astronomical Societies in U.S.A.).

Investigators : MAAG, Russell C.

Title : Chairman, Coordinating Committee

Purpose : 5 phase program of photography for coronal streamers and their motion, Comets Search by photography, Shadow Band photography, Bailey's Beads and Prominence photography. Coronal Streamer photography - prime purpose.

Description : Photographic observing stations using small telescopes (refractor and reflecting types) from 2.4 to 12.5 - inch equipped with cameras were stationed along the eclipse path from Mexico to Nantuckett Island, Massachusetts.

5 - inch f/5 Apogee refractor telescopes all diaphragmed to f/8 (to lessen lens field curvature) were equipped with 35 mm camera backs working at prime focus and loaded with Extended Range XR type film (ASA layers .004 to 400.0) were used at some 25 stations along the eclipse path to photograph coronal streamers.

Reference : Eclipse Bulletin #2, Astronomical League, distributed by Russel C. Maag, 1601 Blackwell Road, St. Joseph, Mo. 64505 Special Bulletin: Distributed by Paul Valleli, 4 Jerome, St. Boston, Mass., 02125, described use of XR film and the data for photographic sequence as well as calibration.

Location : In mexico our prime observing site was located at El Gamal, with the team headed by Glen Chambers 3023 Aloma, Wichita, Kansas. Paul Valleli address above headed our team at Nantuckett Island.

Dates : March 1, 1970 through March 8, 1970

Equipment : 5 - inch Apogee refractors, reflectors and reflectors from 2.4 inch to 16 inch aperture. Cameras were used with lens systems from 0.9 to 800 mm telephoto. Most telescopes were used with 35 mm camera backs at prime focus. Shadow Band screens, photometers, timing equipment and portable darkroom equipment.

Special site Requirements : 110 A.C. voltage lines, 60 cy.

Number & names of People : Estimated at all sites approximately 800 persons actually part of Astronomical League teams who were successful in photographic attempts.

Cooperating Groups : American Association of Varible Star Observers, Association of Lunar and Planetary Observers and Western Amateur Astronomers plus two Centres (Toronto and Montreal) of The Royal Astronomical Society of Canada.

Special comments and needs : Amateur "Ham" radio stations acted as special communications net between stations which proved fairly successful. Net "control" was maintained by Merlin "Bud" Checkett, WTPB, 6821 Woodhurst, Berkeley, Mo. 63121, who set up a control station on campus at Valdosta State College, Valdosts, Ga.

Station Prob : 1.0

Funds : Astronomical League, National Treasury, Nine Regional Treasuries, private funds

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.1-F-28.00

Following are examples of some of the photographic and visual observing reports from many which have been submitted.

Coronal Streamer Project - Paul Valleli, 4 Jerome St., Boston, Mass. 02125 in charge.

Positive transparencies have been made from all Extended Range XR film on #3404 Kodak film in green light. Measurements at 7X, using a protractor scale to estimate azimuths of 11 coronal features show all images to be very soft. No very significant changes in these features could be measured in a preliminary fashion between the exposures made in Mexico against the ones made on Nantuckett Island. Nearly all film images showed actual image motion due to vibrations of the mountings or the optical systems of the telescope-camera setups. No exposures were long enough to record prominences in the slow cyan layer of the XR film at ASA.004.

Further analysis of the film will be made using an isomicrodensitometer and several select frames will be sent to Dr. Gordon A. Newkirk, Jr., High Altitude Observatory, Boulder, Colorado, for further study.

Comet Photography - to date no observers have reported comet finds.

Shadow Band Observations - Several teams have sent detailed shadow band reports as given by the enclosed examples. Additional reports may be had for study or comparison by writing the undersigned.

Prominence and Bailey's Beads Photography - nearly all photographs submitted show both of these features. In addition several observers were successful in the photography of prominences showing some development by cinematographic technique using both black and white and color film.

Editor's Note

Mr. Maag also provided to the SOLAR ECLIPSE 1970 BULLETIN several excellent reports, photographs and illustrations by members of the Astronomical League:

- Dr. Raymond E. Hunter, Department of Physics and Astronomy, Valdosta State College, Valdosta, Ga. 31601 (Report on eclipse activities in Valdosta, Georgia for Solar Eclipse of March 1970)

- Mr. Ernest W. Pinu, 1356 Longfellow Way, San Jose, California 92129 (A comprehensive technical report "Total Solar Eclipse, 7 March 1970" published by the Dalmo Victor Company, Belmont, Californaia)

- Mr. Earl S. Brook, 506 Linden Avenue, York, Pa. 17404 (Detailed reports on the observations of shadow bands)

- Mr. George M. Hurley, Selbyville Central School, P.O. Box 232, Selbyville, Delaware 19975 (Detailed reports on the observations of shadow bands)

1970 SOLAR ECLIPSE PROJECT NO. 3.1-E-28.01

Institution	:	Detroit Astronomical Society
Investigators	:	JOHNSON, Harvey K. (Chairman), SAIGEON, Newell (Co-Chair)
Title	:	Comprehensive Comparative Measurements of Optical, Radio and Ground Level Phenomena
Purpose	:	To observe projects planned: (a) Temperature Measurement (b) Overhead Light Intensity (c) Humidity and Barometric Measurement (d) Shadow Bands (e) Inner Corona Photography (f) Outer Corona Photography (g) Flash Spectrum Photography (h) Comet Search Photography
Description	:	Instruments being prepared: (a) Thermistor rasistance Bridge Recorder (b) Photoelectric Cell Strip Recorder (c) Mercury and Aneroid Barometer, Sling Psychrometer (d) 5 Ft. Square Screen with 16 mm Motion Picture and 35 mm Still Cameras (e) Various Astro Cameras (f) Schmidt Camera (g) Cassegrain 6"-35 mm with transmission or reflection gratings (h) Wide Field Astro Camera, Black and White Film
References	:	Detroit Astronomical Society records of the previous expedition, Arequipa, Peru, November 12, 1966.
Location	:	Yautepec, Mexico
Dates	:	March 4 - 8, 1970
Equipment	:	Personal equipment to be transported by individual members of the expedition, Bulk, weight and number of packages undetermined.
Special Site Requirements	:	115V, 60cps, 1kw power.
Number & Names of People	:	Approximate total: 20
Cooperating Groups	:	Astronomical League
Special Comments and Needs	:	Local Cooperation
Station Prob	:	0.7
Funds	:	Detroit Astronomical Society - Some equipment Individual members will finance own participation.

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE PROJECT NO. 3.1-E-28.02

Institution	:	Detroit Astronomical Society, Detroit, Michigan
Investigator	:	JOHNSON, Harvey K., (Chairman); MARSHALL, C. D., (Co-Chairman)
Title	:	Comprehensive Comparative Measurements of Optical, Radio and Ground Level Phenomena
Purpose	:	To observe projects planned: (a) Temperature Measurement (b) Overhead Light Intensity (c) Humidity and Barometric Measurement (d) Radio Emission (e) Satellite Picture Receiver (f) Shadow Bands (g) Inner Corona Photography (h) Outer Corona Photography (i) Flash Spectrum Photography (j) Comet Search Photography
Description	:	Instruments being prepared: (a) Thermistor resistance Bridge Recorder (b) Photoelectric Cell Strip Recorder (c) Mercury and Aneroid Barometer, Sling Psychrometer (d) Portable Radio Telescope (e) NASA APT No. SP-5079 (f) 5 ft. Sq. Screen with 16mm Motion Picture and 35mm Still Camer (g) Various Astro Cameras (h) Schmidt Camera (i) Astro Cameras 35mm with Transmission or Reflection Gratings (j) Wide Field Astro Camera, Black and White
Reference	:	Detroit Astronomical Society records of the previous expedition, Arequipa, Peru, November 12, 1966
Location	:	Perry, Florida
Dates	:	March 4 - 8, 1970 (approximately)
Equipment	:	Personal equipment to be transported by individual members of the expedition. Bulk, weight and number of packages undetermined.
Special Site Requirements	:	115V, 60 cps, 1kw power, Dark Room
Number and Names of People	:	Approximate total: 20
Cooperating Groups	:	Astronomical League
Special Comments and Needs	:	Local Cooperation
Station Prob	:	0.7
Funds	:	Detroit Astronomical Society - some equipment. Individual members will finance own participation.

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-28.04

Institution	: Tiara Observatory, South Park, Colorado (Expedition "SoCo")
Investigators	: SCHMIDT, Terry E. (Director) and staff
Title	: Color Educational Slides for School Distribution
Purpose	: We wish to photograph all possible scientifically related events in color of a total solar eclipse to be used as visual aids in school classrooms and laboratory exercises. This is a continuing science-education project begun at the July 20, 1963 eclipse and conducted by a group designated as Expedition "SoCo" (solar color). The resultant color slides offer a unique historical record for the layman and scientist alike.
Description	: Color photography of the following events/features: (1) structure of the inner and outer corona, (2) prominences, (3) diamond ring, (4) Bailey's beads, (5) partial phases, (6) an eclipse series, (7) sky coloration during totality, (8) planets near the eclipsed sun, (9) flash spectrum at 2nd and 3rd contacts, (10) coronal spectrum, (11) all-sky camera totality views, (12) polarization of corona at four angles, (13) color filter photos inner and outer corona at 5301A^{o} and 6316A^{o}. (14) landscape coloration before and during totality, (15) corona outside of totality after 3rd contact, (16) the moon's shadow, (17) comet search
Reference	: None
Location	: In the town of Nejapa, Oaxaca, Mexico
Dates	: March 3rd thru March 7th
Equipment	: Weight - 500 lb. Valuation - $4,000. Method of shipment - trailer. Port of entry - Ciudad Juarez
Special Site Requirements	: 1/2 acre of flat land (we are self-contained for all other logistic requirements)
Names and Number of People	: Terry E. Schmidt; Eva B. Schmidt; Brian D. Warner; Bruce A. Warner; Maurice Wunderlich; Alice Wunderlich
Cooperating Groups	: NAA
Special Comments and Needs	: None
Station Prob	: 1.0
Funds	: Tersch Enterprises and private funds

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.1-F-28.04

General Comments: From our station at Nejapa, six members of our party operated eleven cameras during totality ranging in focal length from ½" to 62". During totality 129 exposures were obtained while 54 exposures were made outside of totality (all were color transparencies). Seeing conditions during totality were estimated to be better than 1 sec. of arc, and the transparency was very good. The sky was a very bright, pale blue during totality which was unexpected, and all exposure controls could be easily read without artifical illumination. The great intensity of the inner corona within 1/10 radii of the lunar limb almost hurt the eyes when viewed thru 7X50 binoculars. No diamond ring was viewed or recorded on film at second contact (unusual). At third contact, the diamond ring was formed by a single bead of light which grew in intensity without the addition of any other beads. A magnificent eclipse!

Specific Comments: Reduction of data is slow as usual. Regarding prominences, 17 were recorded at the east limb just after 2nd contact while only 5 were found at the west limb just prior to 3rd contact. One prominences may have gone unnoticed by most observers. It's approximate position is at 65° heliocentric position angle. It was a long, narrow jet-like structure with a bright knot at its base corresponding to no chromospheric limb feature and radial in nature. It was approximately 22,300 miles long with its base 33,400 miles above the photosphere.

Regarding interesting coronal features, a composite map is being compiled at the present time. Four looped structures with varying end points were found at the base of the helmet streamer at 50° heliocentric position angle. A large S-shaped dark gap was found at the base of the helmet streamer at 250° heliocentric position angle. 18 major rays or streamers were discovered extending outward from the lunar limb to one or more solar diameters. The sharpest and most well defined coronal feature was a long, narrow, non-radial ray apparently eminating from a base at 92° heliocentric position angle. The ray extended outward to 2 solar radii. Excellent seeing conditions permitted recording of this feature. Polarization photos were taken at four angles separated by 45° and revealed separation of the F and K coronas out to 2 radii. A broadband red light shot of the corona revealed the diffuse structure of the coronal streamers in the continuum near the 6374A° line while a broad-band green light shot near the 5303A° line revealed clear-cut structure and fine detail. Slides taken on Kodak Ektachrome Infrared Aero film with proper filtratior gave an infrared record of the corona only between 7000-9000A°. The cyan image of the corona in a 1 sec. exposure at f/11 recorded streamers out to 3 radii with good detail visible to within ½-radii (burn-area). This particular filter-film combination seem to act like a partial radial density gradient filter setup. This procedure deserves more testing.

Two stars were recorded during totality - Phi Aquarii, an M0-type star at magnitude 4.4; and 96 Aquarii (about a 6th magnitude star). Of course Venus and Mercury were very easy objects to photograph. No comets were discovered.

Excellent records of the flash spectrum at 2nd and 3rd contacts plus the coronal spectrum were secured. The intense green ring at 5303A° was recorded on both flash spectra revealing the brilliant nature of the inner corona at this eclipse during the relatively brief exposures. Detailed data reduction on the spectra will take some time.

Kodachrome-X film was mainly used for this eclipse and yielded excellent detail and tonal relief. Our staff would like to thank NSF for their fine pre-eclipse information which made all of our jobs much easier to live with!

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-28.05

Institution	: National Amateur Astronomers
Investigators	: ROTH, H. E., Eclipse Coordinator NYE, Derald
Title	: Eclipse Photograph Research
Purpose	: Inner Corona photography Photographic search for Sun grazing comets Time lapse photography of all contact, color. Time lapse photography of 2nd and 3rd contacts, B. & W. Inner motion photographic investigation
Description	: INSTRUMENTATION 8" F/4.5 reflector/Nikon F 5" F/5 refractor/Canon SLR 610 mm FL F/6 Aero Tessar 36" FL F/4.5 reflector 3" F/5 refractor 2 time lapse motion cameras
Reference	: NAA convention proceedings of 1959, 1964 and 1969
Location	: Near village of Nejapa de Madero, in the state of Oaxaca, Mexico. Long. 095^{o} 58.13' W. Lat 16^{o} 38.25' N. Elevation 2,250 feet.
Dates	: Camped on site March 3rd thru 8th, 1970
Equipment	: Bulk......................... 1.6m^3 Weight...................... 355kg Number of pkg's .... 12 Valuation.................... $10,040.00 Method of shipment........... Transported by truck Port of entry .... Ciudad Juarez
Special Site Requirements	: Generated our own power (total continuous output of 375 watt hours for equipment operation only). Imported our own fuel, tools, food, water, and living accommodations.
Number and Names of People	: Six persons in all. Chief investigators - Derald Nye and Herbert Roth.
Cooperating Groups	: Astronomical League, Denver Astronomical Society, and University of Denver.
Special Comments and Needs	: Successfully utilized 27.035 mc. and 27.065 mc for communications coordination.
Station Prob	: 1.0
Funds	: National Amateur Astronomers, and private funding.

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.1-F-28.05

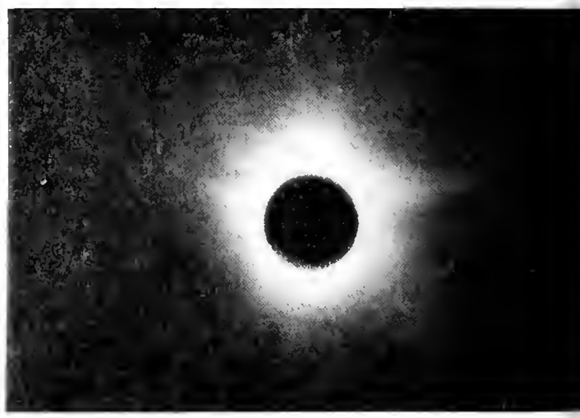
1. Using a modified off axis Carroll-Thomas mount as drive, we produced a series of pictures (such as the enclosed, 19.1 cm by 24.2 cm) with a 610 mm FL F/6 Aero Tessar lens. The enclosed picture was a 2 second exposure taken 180 seconds after 2nd contact. We used 4" X 5" Tri-X film with normal D-19 development.

2. Attached to the off axis Carroll-Thomas mount mentioned above with a 36" FL F/4.5, we used the XR (extended ranges triple layer emulsion film) in 35 mm cartridge to photograph the inner and outer corona. The film was developed by C-22 process (commercial development). The fast layer was extremely grainy and did not record streamers as well as the Tri-X film.

3. Also attached to the off axis Carroll-Thomas mount with a 3" F/5 refractor and using an 8 mm movie camera operating at 1 frame every 2 seconds, we took time lapse color photography from the beginning of 1st contact for a total time of 2 hours and 15 minutes. A 3" Questar filter was mounted on front of objective which was removed for the exposure of 104 frames during totality (3 minutes 28 seconds). Despite some problems from internal reflections within the camera we did secure some very good frames.

4. Using a stationary tripod for drift effect, and an 8 mm movie camera operating at 1 frame every 1 second, we took time lapse B. & W. photography beginning 45 minuted after 1st contact and until 15 minutes after 3rd contact. A #5 N.D. filter was used in front of the camera lens throughout the filming session with the exception of 208 frames during totality (3 minutes 28 seconds). While this method produced a smaller solar disk then our color time lapse photography, we experienced far less problems from reflectivity.

5. Using a stationary tripod with a 5" F/5 refractor of 635 mm FL we shot 21 pictures of 35 mm 1875 recording film, during the 3 minutes and 28 seconds of totality. A (wratten) red filter was inserted between the bellows connected canon SLR and the prime focus of the refractor. The film was exposed at 250th of a second. A print of this series is also enclosed taken at the beginning of the 3rd contact.



1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-28.06

Institution	:	Indiana Astronomical Society, Inc. Solar Eclipse Committee
Investigators	:	WILKINS, W. E. (leader); Society members
Title	:	Eclipse Observations by Photography in Florida
Purpose	:	Polarization photo of corona, Photo of inner corona and prominences, Series for position angle, Outer corona photo, Color motion picture, other photography by 35mm cameras.
Description	:	4" and 5" cameras (5 of them) have been built for use with 4 x 5 extended range film. 10 rolls of EGG extended range film have been distributed to members for use with 35mm cameras. General descriptive picture record of expedition will also be made. Special timing equipment has been completed.
Reference	:	None
Location	:	Either Jennings, Florida or Perry, Florida: exact location and altitude will be furnished
Dates	:	Begin March 5, and end March 7.
Equipment	:	Approximately 15 packages of observation equipment will weigh about 775 pounds. Personal camping equipment will also be part of the load. Value is $3500 for observation gear. Transportation by individuals in cars.
Special Site Requirements	:	110 volt 60 cycle current, about 5 watt peak. Misc. items needed can be secured locally.
Number and Names of People	:	20 members will accompany the group D. Bowsher, W. Boyce, L. Deming, C. Faulkner, C. Fishburn, K. Burroughs, B. Gaither, W. Gommel, W. Graney, W. Landborg, A. Mackintosh, A. Pittman, R. Rankin, R. Stewart, R. Waddington, W. Wilkins (List incomplete)
Cooperating Groups	:	Advice as to program and film for large cameras from Indiana University Astronomical Dept. We are members of A. L.
Special Comments and Needs	:	None known
Station Prob	:	1.0
Funds	:	Individual financing, except for small amounts for which I. A. S. treasury is responsible.

SUMMARY OF PRELIMINARY RESULTS

No data was obtained due to cloudy weather

1970 SOLAR ECLIPSE - PROJECT NO. 3.1-F-29.00

Institution	:	East Carolina University, Greenville, North Carolina
Investigator	:	HELMS, R. M.
Title	:	Solar Eclipse Conference for Instructors of College Astronomy
Purpose	:	To provide opportunity for instructors of college astronomy to experience a total solar eclipse in association with their peers thus gaining mutual reinforcement, and to attend lectures, by eminent astronomers, on variou aspects of eclipses and solar physics; to enhance the background of instructors of astronomy so as to pass thei increased understandings and enthusiasm to their students These instructors were to be not primarily astronomers.
Description	:	One hundred college instructios, who are not primarily astronomers, attended a two-day conference on eclipses and related solar physics. Seven eminent astronomers presented papers. Conferees were provided ground space and low wattage electric power for any needs that their hand-carried equipment required. A report-discussion session was held following the eclipse. First reports from Mexico and other eclipse areas were announced and local observations were compared and discussed.
Reference	:	None
Location	:	Physics and Biology buildings and grounds of East Carolina University, three miles east of the central line of totality.
Dates	:	Friday, March 6 and Saturday, March 7, the day of the eclipse.
Equipment	:	Each conferee provided his own hand-carried equipment. Included were Questars, Newtonian reflectors, small refractors, and cameras. Some conferees preferred unhampered observation and enjoyment of this spectacle of astronomy.
Special Site Requirements	:	A university setting, located very close to the center of totality with eclipse near middle of the day.
Number and Names of People	:	A hundred instructors of college astronomy
Cooperating Groups	:	None
Funds	:	National Science Foundation, $15,405 Facilities and incidentals provided by East Carolina University.

SUMMARY OF PRELIMINARY RESULTS

Ninety-six instructors of college astronomy, themselves not primarily astronomers, plus a number of guests attended the Conference. Conferees were from 35 states, eleven from Pennsylvania, seven from West Virginia, and four or more from seven other states. Peripheral institutions represented were at El Paso, Texas; Logan, Utah; and Grand Forks, North Dakota.

The conferees were mostly physicists, 69 of the 96; 17 were in physical science, and 7 in mathematics. Sixteen were ranked as instructors, 26 as assistant professors, 28 as associate professors, and 26 as professors. At least seven were department heads or deans. Some conferees were accompanied by spouses.

Due to the long distances to improtant airports, chartered bus service was provided for those who traveled by plane. Also chartered bus service was provides between motels and the Physics Building since there is no local bus service.

Four lecture sessions were held at which seven papers were presented by noted astronomers. Lecturers and their topics were: (1) Wasley S. Krogdahl, Professor of Astronomy, University of Kentucky: Introducing eclipses. (2) Dion Scott Birney, Professor of Astronomy at Wellesley College: Conditions for occurrence of eclipses. (3) Robert W. Hobbs, Solar Physics Section, Goddard Space Center: Radio Astronomy and eclipse phenomena. (4) Kenneth Schatten, Plasma Physics Section, Goddard Space Center: Solar Physics pertaining to eclipses. (5) Sara Lee Lippincott, Research Associate and Lecturer, Sproul Observatory: Observing solar eclipses. (6) Peter van de Kamp, Professor of Astronomy, Swarthmore College: Current problems in solar eclipses. (7) Roy Marshall: Dean of Directors of Planetariums: Summary and discussion of the eclipse (after the event).

Everything about the Conference was pointed to the eclipse which should start at 12:14 EST for Greenville. The rainy cloudy weather of Wednesday and Thursday cleared Friday during midday and fair weather continued through the eclipse on Saturday and until Sunday. The seeing conditions seemed nearly perfect, and so was the eclipse. The eclipse was a success, and so was the Conference. Before the eclipse, the sky was cloudless; by mid-eclipse there were a few wispy clouds which disappeared after the eclipse. Temperature dropped from 64°F to a low of 50° during totality. Shadow bands were very prominent both before and after totality. No one could escape seeing them against any kind of natural background. The direction of their motion was the same as that of the eclipse shadow both before and after totality. Probably this was because our observing point was so close to the middle of shadow path--within three miles, where the path was 87 miles wide. The separation of the shadow bands seemed somewhat less than a foot, and their speed seemed to be about 5 feet per second, which is quite slow compared to the speed of the eclipse shadow which was about 3,200 ft/sec.

Most observers considered that it was less dark than expected during totality. The planets Venus and Mercury were easily seen. Mars and Saturn, further to the east were not seen by many, if at all, and stars likewise were not noticed although first magnitude Deneb and Capella were suitably postioned. The corona was magnificent and much detail could be observed either by naked eye, or by binoculars. Drawings made of the corona were in good agreement with the prediction given by Dr. Schatten during his lecture on the previous day. Correlation of prediction and observation together with shadow bands were principle discussion topics in the session which followed the eclipse. The red flash and Bailey's Beads were not seen by many, but there was a brilliant "diamond ring." And then the eclipse was over. Two responses were universal: "What? Is it already over?" and followed by: "Ah! Wonderful! Now let's do it again!" Then many of those present began thinking in terms of the Candian eclipse of July 10, 1972.

The Conference was not planned to include serious research; there were, however, four such projects. That which received most attention was the shadow band study conducted by Dr. Malcolm Hults and party from Ball State University. This research involved five separate groups at different locations. Observing techniques included visual, photographic, and photo-electric. A second project involved the aforementioned correlation of observed corona structure and structure predicted on basis of studies of the current solar magnetic fields. A third project was one by a party from North Carolina State University headed by Dr. E. R. Manring and dealing with electron density profiles in the D region. The fourth project was one by Dr. Edward Seykora of East Carolina University in which attempt was made to identify shadow bands in the RF portion of the spectrum and which gave negative results.

The Conference was considered very successful by the host and sponsor, the Physics Staff of East Carolina University. The conferees concurred as evidenced by their verbal statements at the time and by unsolicited letters written by nearly half of their number. The hundred teachers of astronomy carried back to their classes photographs and slides taken during the Conference. They had increased their knowledge of one of the topics in astronomy. They had had two days of association with their peers. Most important, each conferee returned with new enthusiasm born or personal, satisfying experience.

1970 SOLAR ECLIPSE PROJECT NO. 3.2-F-01.00

Institution : Pennsylvania State University, Department of Astronomy

Investigators : HAGEN, John P; SWANSON, Paul; HAAS, Robert

Title : Millimeter Wave Radial Brightness Distribution

Purpose : The purpose of this experiment is to obtain an improved radial brightness distribution for the sun at two millimeter wavelengths. The principal investigator while at NRL performed a similar experiment at three earlier eclipses: Attu 1950, Khartoum 1952 and Oskarshamn Sweden 1954. The results at Sweden showed that 8mm there was sharp limb brightening coupled with a lesser brightening in the central region. This was interpreted in terms of a spicule type structure of the chromosphere. With improvements in techniques since that time new measurements at 8mm and 3mm should better define the radial brightness distribution and thereby arrive at a better understanding of the structure of the chromosphere at heights of a few thousand kilometers above the photosphere.

Description : Two radiometers on a solar tracking mount and operating at 8mm (ca 36 GHz) and 3mm (ca 90 GHz) would track the sun and measure the change in flux with time during the eclipse. Analysis of the eclipse curve will yield a radial brightness distribution function and will in addition reveal the location and intensity of sources of enhanced radiation.

References : Hagen, J.P., 1951. Ap.J.113:547.1954. J.Geophys.Res.59:158.1956. "Solar Eclipse and the Ionosphere." Ed.W. Beynon and G. Brown (London Pergamon Press), p.253.1957. "Radio Astronomy." Ed. H.C. van de Hulst (Cambridge: At the University Press). p.263. Haddock, 1954. J.Geophys.Res.59:174. Mayer, C.H., Sloanaker, R.M. and Hagen, J.P. 1957. "Radio Astronomy." Ed. H.C. van de Hulst. (Cambridge: At the University Press) P. 269. Coates, R.J., Gibson, J.E., and Hagen, J.P. 1958. Ap.J.128: 406.

Location : South of Miahuatlan, Mexico

Dates : Six week period. Four prior to eclipse for construction, set up, etc., and two after for further calibration and clean up.

Equipment : Approximately one van load weighting 6,000-8,000 lbs. The van will be used as a laboratory during site occupation.

Special Site Requirements : 115v, 60 cy., less than 10 kw.

Number & Names of People : Five, J.P. Hagan, P. Swanson, R. Haas, R. Vogt and F. Wefer

Cooperating Groups : ESSA (3.5-D-17.00)

Special Comments and Needs : Location should be at least one mile from traveled roads and not too near an industrial area, however, this is not too critical.

Station Prob : 1.0

Funds : NSF

SUMMARY OF PRELIMINARY RESULTS:

Conditions for observing the eclipse in Mexico were excellent. The equipment was located at an elevation of approximately 8,500 ft., relative humidity was typically 20-30%; and on eclipse day, the sky was completely clear. The only difficulty was an interfering signal from a communications channel used by the television broadcasting crew. The signal fell within the bandpass of the 8 mm intermediate frequency. The effect was to superimpose a burst or spike type signal on top of the solar signal at random times. It now appears that by discarding those parts of the trace where interference is observed the 8mm record can be saved and useful results obtained.

The original eclipse record is shown in figure 5, a photograph of the equipment in figure 1.

Reduction of the data is not complete at this writing. The original eclipse curve has been digitized for handling by a digital computer. Corrections for gain and ambient temperature have been made to the original data. The atmospheric attenuation and lunar temperature have been calculated but have not as yet been applied as corrections to the eclipse curve. The following table summarizes the various quantities used in the data reduction for March 7.

	3 mm	8 mm
Solar Antenna Temperature	1100K	425K
Lunar Antenna Temperature	22K	8.5K
Atmospheric Antenna Temperature	60K	30K
Atmospheric Attenuation	0.4db	0.1db

TABLE I.

The computer programs which will perform the deconvolution of the eclipse curve are partially written. The results of the computer analysis are being carefully compared with the analysis done by the Naval Research Laboratories in the 1950's.

There were several active regions on the sun on March 7. These somewhat confuse the analysis of the eclipse. On the other hand, the active regions themselves are worthy of study. Because of the high anuglar resolution obtained by the eclipse the angular dimensions of the active regions can be determined. Also the two frequencies of observation can give the millimeter wavelength spectral index of these active regions.

During the period of testing and calibration before the eclipse, two moderate sized solar flares were observed at 8mm.

Good data was obtained during the eclipse under favorable conditions. Some interference was caused by the live television broadcast.

1970 SOLAR ECLIPSE - PROJECT NO. 3.2-F-02.00

Institution	:	Bell Telephone Labs., Crawford Hill Laboratory, Holmdel, New Jersey
Investigator	:	WRIXON, G. T.
Title	:	Solar Eclipse Measurements at 16 and 30 GHz
Purpose	:	To Measure the Residual Flux at 16 and 30 GHz and thus obtain size of Radio Sun at these frequencies.
Description	:	An automatic sun tracker (4-foot aperture) whose antenna parameters have been measured is used to determine residual solar flux at 16 and 30 GHz. Receivers operating at these frequencies have been accurately calibrated for this purpose.
Reference	:	R. W. Wilson, Bell System Tech. J., May 1969.
Location	:	Crawford Hill, Holmdel, New Jersey
Dates	:	
Equipment	:	Equipment on site
Special Site Requirements	:	None
Number and Names of People	:	
Cooperating Groups	:	None
Special Comments and Needs	:	None
Station Prob	:	1.0
Funds	:	In-house

SUMMARY OF PRELIMINARY RESULTS

The data reduction is complete. Good weather conditions during the eclipse facilitated accurate measurements.

The fraction of total solar flux visible at the time of greatest eclipse was measured to be 5.6% at 30 and 6.53% at GHz. The eclipse curves obtained were consistent with a uniform limb brightness distribution at both frequencies. These results, together with the fact that at Crawford Hill the eclipse had a greatest magnitude of 0.964, indicate that at 30 and 16 GHz the diameter of the radio sun is, respectively, 2.1% and 3.1% greater than the solar optical diameter. Thus, radiation from outside the optical disc is 4.2% of total solar flux at 30 GHz and 6.2% at 16 GHz.

1970 SOLAR ECLIPSE PROJECT NO. 3.2-F-03.00

Institution : AF Cambridge Research Labs,. (CRPA) Hanscom Fld, Bedford, Mass.

Investigators : AARONS, Dr. Jules; STRAKA, Ronald M; CASTELLI, John P.

Title : Study of Solar Active Regions

Purpose : The concept of the solar program is to study solar active regions at eight discrete frequencies ranging between 245 and 35,000 MHz. Angular diameters, brightness temperature, electron temperature and electron density profiles of active regions will be obtained.

Description : Discrete frequency measurements through the microwave spectrum provide spectral data of active regions present on the sun eclipse day. Even to the present there is relatively little data available on the spectra of coronal condensations. To obtain a near complete spectral picture, measurements were made at 245, 606, 1415, 2695, 4995, 8800, 15,400 and 35,000 MHz.

References : "Observations at the Sagamore Hill Solar Radio Observatory", R. M. Straka and J. P. Castelli, Nature, Vol. 226, 20 Jun 70.

"AFCRL Radio Observations of May's Eclipse," J.P. Castelli and R. M. Straka, Sky and Telescope, Vol. 31, No. 3, 1966.

"Microwave Spectral Observations of the 20 May 1966 and 12 Nov. 1966 Solar Eclipses", R. M. Straka, Proceedings of Eclipse Symposium, Sao Jose dos Campos, Brazil, 1968.

"Microwave Spectral Observations of Coronal Condensations" R.M. Straka, Proceedings NATO Advanced Study Institute on Solar Eclipses and the Ionosphere, Athens Greece, '69.

"A Survey of Radio Observations of Solar Eclipses" J.P. Castelli and J. Aarons, in Solar System Radio Astronomy, ed. J. Aarons, Plenum Press, 1965.

Location : Observations were made at the Sagamore Hill Radio Observatory, Hamilton, Mass., where the eclipse was 96% total. The routine solar patrol equipment was used for the observations. Coordinates of the site are 42.632°N, 70.821°W.

Dates : N/A

Equipment : No transportation involved

Number & names of People : 10 - 15

Cooperating Groups : A three-man team from Mackenzie University, Sao Paulo, Brazil, used 7000 MHz equipment at the above site to do polarization studies. They were under the direction of Professor P. Kaufmann.

Special comments and needs : Steps were taken to inform all non-eclipse groups of the date and urge "radio quiet" from unnecessary radar exercises on that date. The same applied to routine testing activities.

Station Prob ; 1.0 Plans were followed.

Funds : No special fundings was required for the routine observations.

SUMMARY OF PRELIMINARY RESULTS

Magnetic tape playbacks of the recorded AFCRL radio eclipse data obtained on eight frequencies from 245 MHz to 35 GHz are shown in Figure 1. Scaled analog chart recorder values (dashed portions of eclipse curves) are used in the interval where a tape recorder malfunction occurred. Measurements were also made at 114 MHz but the existence of an intense noise storm during the eclipse limited the value of this data. Noise storm activity can also be seen on the 245 MHz curve in Figure 1.

A preliminary reduction of data was performed for the radio condensation region associated with McMath Plage # 10607, located near N6, W26. Results of this reduction are reported in the 20 June 1970 issue of Nature. The region, though having a peak flux of less than 12 x 10^{-22}W $m^{-2}Hz^{-1}$, displayed a peaking in its spectrum near 6 cm wavelength which is typical of that found for intense radio sources.

At maximum phase of the eclipse (m = 0.96 at Sagamore Hill), when only the residual flux is measured, the solar brightness temperature T_b had a spectral index γ of -1.5 ($T_b = af^{\gamma}$); as compared to the index γ of -1.9 for the 12 November 1966 eclipse. A flatter spectrum is generally found for periods of high solar activity.

Presently, the analysis is being extended to include the more intense radio sources which were associated with the complex regions, such as with McMath Plages #10617 and 10618, present on the sun during the eclipse. Sizes and heights of all radio regions will be calculated. The large range of wavelengths measured should allow good determinations of electron temperature and electron density profiles in the condensation regions to be obtained.

(See also: Nature. 226, p. 1149, June 20, 1970)

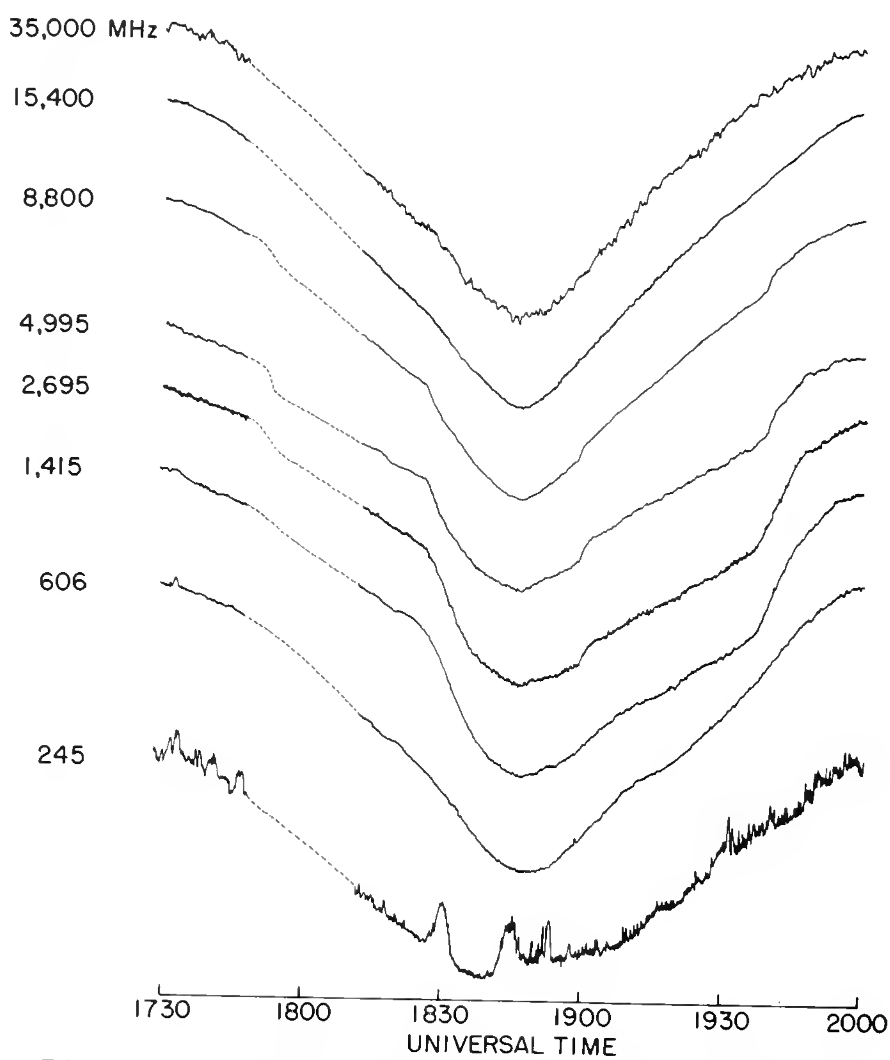


FIGURE 1 TRACING OF ACTUAL ECLIPSE CURVES MARCH 7, 1970 AT SAGAMORE HILL SHOWING COVERING AND UNCOVERING OF STRONG SOURCES OF THE SLOWLY VARYING COMPONENT OF RADIO EMISSION.

1970 SOLAR ECLIPSE PROJECT NO. 3.2-F-04.00

Institutions : Mackenzie University
Centro de Rádioastronomia e Astrofísica, São Paulo, SP, Brazil

Investigators : MATSUURA, Oscar Toshiaki, DOS SANTOS, Paulo Marques; SCALISE JR., Eugênio; and KAUFMANN, Pierre

Title : Flux and Circular Polarization Measurements at 7 GHz.

Purpose : 1. Brightness distribution over the solar disk at 7 GHz.

2. Location of the S-components and study of the morphology of them at several heights above the photosphere.

3. Location of circularly polarized sources and their analysis in connection with the spots of magnetic fields.

4. Study of the oppositely polarized emission from the solar hemispheres

5. Residual flux measurements.

First of all, the eclipses' observations with polarization measurements are too much rare. We are interested in the resolutive observations of S-components regarding to the enhancement's three-dimensional distribution, as well as to the circular polarization. The scope is a reliable model of the coronal condensations. It will be interesting to confirm some results obtained from recordings of 12 Nov. 1966 eclipse in Brasil (Bagé) in connection to the solar general magnetic field. The study of the morphology based on the simultaneous spectral data of enhanced zones will provide some conclusions about the assymetry or bending of the coronal streamers.

References : 1. "On the possible Emission of Microwave Polarized Radiation from the Solar Hemispheres" by Kaufmann, P., Matsuura, O.T. and dos Santos, P.M. Ap.J., 156,43, (1969).

2. "The cm-Wavelength Solar Corona" by Kaufmann, P. and Matsuura, O.T., Nature 219,92, (1968).

3. "A Partial Solar Eclipse Observed at 100 cm Wavelength on 12 Nov. 1966" by Kaufmann, P., Matsuura, O.T., dos Santos, P.M. and Monno, M., Planetary and Space Science, 16, 363 (1968).

4. "Experimental Resutls from Measurements Performed During the Nov. 1966 Total Solar Eclipse with a 4.28 cm Radio Polarimeter," by Kaufmann, P., Matsuura, O.T. and dos Santos, P.M., Icarus 7, 380 (1967).

5. "Some Characteristics of a S-Component Identified on Nov. 1966 Eclipse at 4.28 cm Wavelength" by Kaufmann, P., Solar Physics, 4, 58 (1968).

6. "Observation of the 7 March 1970, Solar Eclipse with a 7 GHz polarimeter" by Matsuura, O.T., Escalise, E., Jr., dos Santos P.M. and Kaufmann P., Nature (in press).

Dates : February-March 1970: installation of the antena, control data, eclipse measurements, control data, packing, return to Brasil

Equipment : 7 GHz (4.28 cm wavelength) radiometer, able to measure the total flux and the degree of the circular polarization. Minimum of the circular polarization percentage (at the total solar flux level): 0.03%. At lower levels of flux, this minimum improves. Antena: 1.5 paraboloid dish, HBW - 2^{o}. Equatorial mount motor driven tracking system. Receiver provided of Dicke modulator.

Special Site Requirements : Power comsumption: 1.5 kw. Peak: approximately 2.0 kw.
Voltage: 110v AC; Frequency: 60 Hz.

Number and Names of People : 3, Oscar Toshiaki Matsuura, Marcio Luiz Bezzi, and Paulo Mourilhe Silva.

Cooperating Groups : Supporting institutions: LAOAR, Rio de Janeiro, Brazil; U.S. Army, DROLA; Fundacão de Amparo ã Pesquisa do Estado de São Paulo (FAPESP) and Conselho Nacional de Pesquisas (CNPq), Rio.

Scientific Institutions: AFCRL, Bedford, Massachusetts and Observatōrio Nacional do Rio de Janeiro, Brasil.

Special Comments and Needs : No power failure. No explosion engines of planes or cars or transmitters near the site. Voltage stability 0.1%. Frequency stability for the tracking motor-frequency controlled. Protection against strong winds. Precises local geographical determination and an area of about 5m x 5m. Also a housing site for internal units of about 3m x 3m, down to 20m from the antenna. We never did experiments with snowing weather.

Funds : Transportation: LAOAR Office in Rio, Brasil and AFCRL, Mass. Per diem, packing personnel travels: FAPESP, CNPq and Observatōrio Nacional.

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.2-F-04.00

Little before the time of eclipse's maximum, at ~18 45 UT, only the solar northern hemisphere was let visible by the Moon, and the polarization degree was definitively left-handed (being less than 5% approximately). This result would favour partially the possible emission of polarized radio emission from the solar hemispheres (Ref. 1), but it cannot be taken as definitive since important coronal condensations were reported in the solar limb by optical observers, and their contributions, if any, could influence this polarization effect.

The derivative of the eclipsing curve, following well known methods but preliminarily taken only each 2 minutes of time, evidenced the presence of stronger active regions. At least two extended regions, one with intensity bigger than 10 flux units and another with intensity bigger than 40 f.u. can be identified in the record. Most of the active regions were not strongly polarized, excepting region no. 2 (probably associated with McMath plage 10618 in the solar eastern hemisphere), but presented a total contribution of 48 flux units. During the eclipsing period of this large active zone, a strong right-handed polarized smaller region was covered and computations showed that its degree of polarization was around 10% being the relative flux of this polarized component of the order of 30 f.u. It could be due to the preceeding part of a relatively complex sunspot group.

Burst activity at metric wavelengths was reported by AFCRL, Sagamore-Hill Radio Observatory at about 1830 UT, close to the eclipse's maximum. Apparently it did not appear at frequencies bigger than 606 MHz, being however possible that the S-component where such bursts originated, did not remain stable during the eclipse, explaining some of the assymetries in the eclipsing curve derivative.

The residual flux at eclipse's maximum was nearly 8% from the total solar flux, and nearly 13% from the quiet solar flux (deduced from the derivative curve and being corrected from the moon contribution), a figure bigger than that one obtained during the 1966 eclipse (Ref. 4), since, at the present occasion, part of the solar disk was still visible at eclipse's maximum.

The radiosphere diameter was not determined with great accuracy. Just before the first contact, the burst activity reported at 200 MHz, could have influenced in some extent the activity at 7 GHz. However from the more definite fourth contact, and eclipse curve derivative it is possible to expect the existence of detectable coronal emission at 7 GHz for heights lower than 1.2 solar radius.

The researches on this event are currently directed to the investigation of the residual behavior of the eclipsing curve, taking account of several frequencies, brightness distribution over the solar disk, and more detailed characteristics of active regions. Papers to be published in the future will account for the detailed results and discussions.

(See also: Nature, 226, p. 1153, June 20, 1970)

1970 SOLAR ECLIPSE PROJECT NO. 3.2-F-05.00

Institution : State University of New York at Stony Brook

Investigator : SIMON, M.

Title : Solar Brightness Distribution at CM and MM Wavelengths

Purpose : To determine the brightness temperature distribution near the solar limb at Wavelengths 2 cm and either 1 mm or 3 mm. Analysis of the data is expected to lead to a realistic model of the chromosphere.

Description : We plan to use the N.R.A.O. 140-ft. telescope at Green Bank at 2 cm and the N.R.A.O. 36-ft. telescope at Kitt Peak operating at 1 mm if possible (otherwise at 3 mm) to observe the lunar occultation of a quiet portion of the solar limb. The narrow beamwidth of these telescopes provides two important advantages: (1) a total eclipse is not required and (2) a portion of the solar limb undisturbed by active regions can be chosen for the observations (the optimal positions are at first and last contact).

Reference : Previous observations and application to the structure of the solar atmosphere are discussed in a paper by M. Simon and H. Zirin, Solar Physics, 1969, (in press)

Location : Green Bank, West Virginia and Kitt Peak, Arizona

Dates : three days on either side of the eclipse

Equipment : As above (already established)

Number & Names of People : 4 persons: M. Simon, H. Zirin and two others

Cooperating Groups : NRAO, KPNO - To provide as broad a wavelength coverage as possible, we shall have also a cooperative observing program with the radio astronomy groups at the Aerospace Corp. (3 mm), Univ. of Texas at Austin (2 mm), and Lincoln Labs. (135 cm).

Funds : National Science Foundation

SUMMARY OF PRELIMINARY RESULTS:

To obtain high resolution observations of the chromospheric brightness temperature distribution near the solar limb (and thus to infer the spatial and height distributions of electron density and temperature in the chromosphere) a cooperative observational effort was carried out among several observatories during the eclipses of Sept. 11, 1969 and March 7, 1970. The general technique of the observations was to position the axis of the main beam of the antenna on the first (and last) contact points on either the moon or sun during the occultation. In between the times of contact high resolution observations of active regions and filaments were obtained. Since the main beams of all the telescopes used were far smaller than the size of the sun, totality was not required for these observations. At the present writing our analysis of the data is still incomplete. To provide a convenient summary of our observations, and to facilitate cooperative analysis with other workers, we list below by wavelength of observation the data available at that particular wavelength and a description of the analysis that has been carried out. The observations marked * have been described more completely in a paper by Simon, Buhl, Cogdell, Shimabukuro and Zapata in the Nature eclipse issue.

March 7, 1970 eclipse

*3.3 mm Aerospace Corp. (Shimabukuro). High resolution scans obtained by tracking first and last contact points on moon as moon moved across disc. The regions covered by these scans were essentially quiet with the exception of an active region near last contact. Solar limb observations indicate an upper limit of 1% on the power that might be contained in an annular spike of limb brightening and $0.04R_\odot$ on its width. The scans of the undisturbed sun away from the limb revealed brightness temperature fluctuations over about 1/2 minute of arc, suggesting an origin in the chromospheric network.

3.5 mm -- NRAO/Kitt Peak (Simon). Same observational technique as above. These scans covered only quiet regions. Analysis of limb observations are consistent with the 3.3 mm upper limits on limb brightening. Two filaments were occulted and appeared as absorption features indicating that the mean temperature of the filament material is less than 6500°K. A detailed analysis of the plasma parameters for the filament derivable from these observations and those of 9/11/69 (see below) is in progress.

*1.35 cm -- Haystack - Lincoln Laboratories (Zapata). Same technique as above. Both active and quiet regions were observed. Only the quiet region data near and at the limb has been analyzed at this time and it shows a similar rough structure as observed at 3.3 and 3.5 mm. An enhancement of brightness temperature near the limb was observed which appears to be due to the superposition (due to foreshortening) of the brightness temperature enhancements observed away from the limb.

1.95 cm -- NRAO (Buhl). Observations of first and last contact, quiet and active regions, obtained by tracking the antenna on the appropriate solar region and having the moon occult it. Data analysis in progress at present.

Complete solar maps were obtained prior to or after the eclipse at 3.3 mm, 3.5 mm, and 1.95 cm.

September 11, 1969 eclipse

2.1 mm -- Univ. of Texas (Cogdell). Observations of first and last contact, obtained by tracking on solar limb. Data analysis in progress.

*3.3 mm -- Aerospace Corp. (Shimabukuro). Same technique as on 3/7/70. Analysis of limb observations complete and consistent with 3/7/70 results. Filament observed as an absorption feature.

*9.5 mm -- NRAO/Kitt Peak (Simon, Tlamicha and Zirin). Observations obtained at last contact by tracking on solar limb. Data analysis in progress.

*1.2 cm -- Hat Creek - U.C., Berkeley (El-Raey). Observations of first and last contact by tracking on solar limb. Analysis carried out by M. El-Raey revealed no significant limb brightening and a possible high coronal contribution to the solar emission.

*3 cm -- Owen Valley - C.I.T. (Moffet). Observations of first and last contact, and an active region, obtained by tracking on sun. Data analysis in progress.

Complete solar maps were obtained prior to or after the eclipse at 3.3 mm, 9.5 mm and 1.2 cm.

PRELIMINARY CONCLUSIONS

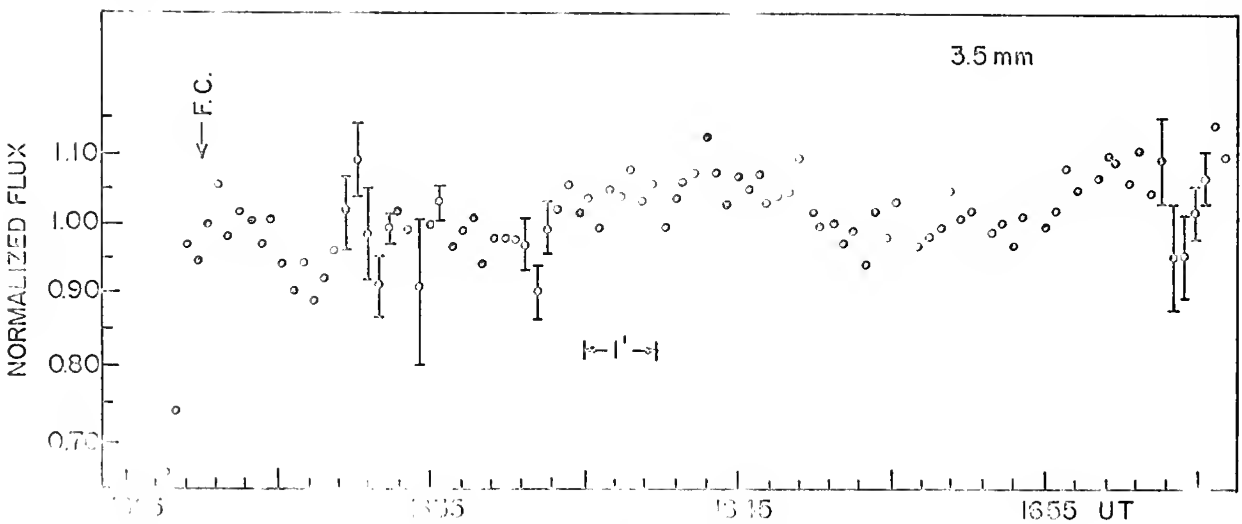
The following are the principal results of our cooperative observational program, based on data analyzed to date:

1) Upper limit of 1% on the power that might be contained in an annular spike of limb brightening, and $0.04R_{\odot}$ on its width, at 3 mm.

2) Resolution of brightness temperature fluctuations over about a 1/2 arc min suggesting an origin in the chromospheric network.

3) Resolution of filaments as absorption features at 3 mm, indicating that their mean brightness temperature is less than 6500°K.

Most of our preliminary results have been reported in the NATURE eclipse issue. Since the writing of that paper we have anlayzed our 3.5 mm NRAO/Kitt Peak data. I am enclosing a copy of the first contact data. The absorption features at 1638 and 1659 UT are filaments. All information prior to about 1634 UT is "new" in the sense that it took an eclipse observation to resolve it.



Normalized solar radio flux at 3.5 mm during the period of first contact of the March 7, 1970 solar eclipse

(See also: Nature, 226, p. 1154, June 20, 1970)

1970 SOLAR ECLIPSE PROJECT NO. 3.2-F-07.00

Institution	:	Bell Telephone Laboratories, Inc. Whippany, N. J. 07981
Investigators	:	O'BRIEN, K.C.; GRAEDEL, T.E.
Title	:	16 GHz Total Eclipse Observation
Purpose	:	Obtain solar radial brightness distribution at 16 Ghz using wide beam antenna.
Description	:	A portable 16 GHz solar telescope equipped with a four foot offset paraboloid antenna is used. Dual, prime-focus feeds allow atmospheric emission to be subtracted out.
References	:	John Castelli and Jules Aarons, in Solar System Radio Astronomy, ed. Jules Aarons, Plenum Press, 1965.
Location	:	Virginia Beach, Va.
Dates	:	February 16, to March 8, 1970
Equipment	:	Telescope trailer and tow vehicle. Valuation $200,000
Special Site Requirements	:	20 amp. 110V. A.C.
Number and Names of People	:	Kevin C. O'Brien, T. E. Graedel, G. J. Owens, Elliot R. Nagelberg, R. R. Redington, P. J. Puglis
Cooperating Groups	:	Crawford Hill Laboratory, Bell Telephone Laboratories, Holmdel, New Jersey.
Special Comments and Needs	:	None
Station Prob	:	0.8
Funds	:	Bell Telephone Laboratories, Inc.

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.2-F-07.00

This report contains preliminary results which are described in more detail in Nature, 20 June, 1970. Further data analysis is continuing, and the results will be published at some future time.

The transportable radio telescope, is mounted on a steel flatbed trailer which is raised on mechanical jacks when on site. After rough leveling with the jacks, an adjustment of a rotating table and tilt base allow the precision elevation over azimuth pedestal to move in right ascension and declination. The 40 in. aperture, offset paraboloid antenna has a measured 1.4° beam width at 16 GHz. First side lobe levels are more than 30 dB below main lobe gain. Two multimode feed horns are equally displaced in hour angle by one half the horn diameter about the prime focus of the antenna. One beam is directed at the sun; the other is -3.5° from the sun in right ascension. The receiver alternately samples the two signals at a 1 KHz rate by means of a switchable circulator. The result of this two-beam technique is the subtraction of the atmospheric emission background, leaving only the signal due to the sun as attenuated by the atmosphere.

The receiver is of usual superheterodyne design and employs a balanced schottky barrier diode mixer disigned by W. M. Sharpless. It has a 1200°K noise temperature and a 3dB bandwidth of 225 MHz (singleside band). The signal was synchronously detected during the eclipse using a 12 sec. time constant and recorded on strip chart recorders. Laboratory tests show that the output was linear within 2% over a -20dB range from the normal solar signal, with a signal resolution of approximately 1 part in 10^{4}. The observed fluctuations on the signal were due entirely to receiver gain variations, and were approximately proportional to the signal level. The signal to noise ratio was approximately 75.

Contact times were determined by the initial and final discontinuities in the time derivative of the signal strength. The first and fourth radio contact occurred approximately 90 $\pm$ 10 seconds before and after the respective optical contacts. This implies an average 16 GHz radio diameter for the sun of 1.038 + 0.002 times the optical diameter. The maximum of the radio eclipse occurred 18 ± 4 seconds (corrected for the system time constant) after the optical maximum, implying an asymmetry of the radio sun as a result of extended emission from regions on the NE limb. The larger values observed for the time derivative of the signal strength following the maximum radio eclipse as compared to pre-maximum values, along with the relatively early time of first radio contact, suggest that McMath Plage Region 10621, on the SW limb, was a small but bright source of emission at 16 GHz. The residual signal at maximum eclipse is $2.6 \pm 0.2\%$ of the uneclipsed solar value which implies a solar radio diameter of 1.039 times the optical diameter. Corrections for the lunar signal were made on the basis of measurements of the ratio of the solar to lunar signals on the days before and after the eclipse.

A detailed study of the data for the purpose of reconstructing the structural features of the radio disk has not yet been completed, but some preliminary results may be presented here. Upon occultation of the large sunspot group at S15E40 (McMath Plage Region 10618) a decrease in the magnitude of the slope was observed, indicating the presence of a cool region on the disk. The occultation of the sunspot at W38N07 (McMath Plage Region 10607) has also been seen on the 16 GHz data.

1970 SOLAR ECLIPSE PROJECT NO. 3.2-E-08.00

Institution: University of New Hampshire
Antenna Systems Laboratory

Investigators: FROST, A. D.; CLARK, R. R.; CATALA, P. J.

Title: Location of solar radio burst activity by occultation observations

Description: A radio interferometer of 200 wavelengths(137 MHz) baseline will be operated in the period before, during and after the eclipse. Since at this baseline the total sun radiation is resolved, only emission due to local radio burst activity, if present, will be detected. The termination of such signals when occulted by the moon will permit an exact location of the active region.

Reference: Eclipse Symposium, San Jose dos Campos, Brazil February 1968 Proceedings

Location: Durham, N. H. or Nantucket, Mass.

Dates: 5, 6, and 7 March 1970

No. of people: 3-5

Equipment: Radio receivers, antennas, recorders, truck

Cooperating: Nantucket site not located yet.

Power: 1 kw.

Special Needs: Clear area with low radio noise level. Preferably field or beach with no obstructions to west and clear for 600' to 800' cable run.

Status: 1.0 for Durham
0.3 for Nantucket

Funds: n/a for Durham 1.0
$500 for Nantucket 0.6

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE PROJECT NO. 3.2-F-09.00

Institution	:	Air Force Cambridge Research Laboratories Microwave Physics Laboratory
Investigators	:	TELFORD, Larry; FALCONE, Vincent
Title	:	Measurements at 35 GHz of the 7 March 1970 Eclipse
Purpose	:	The main objective is to observe the absence or presence of limb brightening, determine the radio diameter of the sun at 35 GHz, and attempt to establish the angular extent of three active centers on the sun as they are occulted by the leading and trailing edges of the moon.
Description	:	A 29 foot millimeter wave precision antenna (half power beam-width approximately 4 minutes of arc at 35 GHz) is pointed toward the limb of the moon exactly where it would first intersect the solar limb. In addition, as the moon occults the solar surface, the antenna is positioned so that its beam (truncated by the moon) will scan three active centers that have been located on the radio temperature map just prior to the eclipse. Precise knowledge of the moon's path across the sun is necessary. These data are being generated.
References	:	Coates, R. J., Gibson, J. E., and Hagen, J. P. (1958) Astrophys J. 128:406 Simon, M., and Zirin, H. (1969) Solar Physics 9:317
Location	:	The observation site is the permanent AFCRL Millimeter Observatory located on Prospect Hill in Waltham, Mass.
Dates	:	The site is in continuous use
Equipment	:	A precision 29 foot millimeter wave parabolic antenna on an az - el mount with computer controlled tracking. Various radiometers are used for recording solar temperatures on magnetic tape.
Special Site Requirements	:	None
Number & Names	:	3 - Larry E. Telford, Vincent J. Falcone, Karl N. Wolfsberg
Cooperating Groups	:	None
Special Comments	:	None
Station Prob.	:	1.0
Funds	:	U.S. Air Force

SUMMARY OF PRELIMINARY RESULTS:

No report

1970 SOLAR ECLIPSE PROJECT NO. 3.3-F-01.01

Institution	: Dowling College (formerly Adelphi - Suffolk)
Investigators	: COURTEN, H., in cooperation with B. DONN, Goddard Space Flt. Center
Title	: Eclipse Comet Search
Purpose	: Investigate possible occurrence of faint comets visible in proximity to the sun. This could furnish significant data on the frequency and general characteristics of comets too small to be normally observed at distances greater than about 0.5 A.U. from the sun.
Description	: This is a continuation of the GSFC eclispe comet search in Maine, 1963 and subsequent searches by Henry Courten of Grumman Aircraft Corporation and Adelphi University in Brazil, November, 1966 and Siberia, September, 1968. Photographic and photo-electric scanning methods will be employed to detect possible cometary images. Similar equipment at two stations would be desirable for definite confirmation of suspected comets.
Reference	: (1) Dossin, F., C. R. (Paris) 257, 2246, 1963 (2) Courten, H. C. and Genberg, R. W., Ast. J. 72, 791, 1967
Location	: Near Miahuatlan, Mexico
Dates	: Set up about one week prior to eclipse.
Equipment	: Photoelectric scanner, 2 MOTS-40 1000 mm Cameras 7 boxes, 170 cu. ft.; commercial air to Mexico City truck to site.
Special Site Requirements	: None
Number & Names of People	: H. Courten, D. Brown, - Dowling College; M. Miranian - U.S. Naval Observatory, D. Albert - Adelphi University
Cooperating Groups	: Astronomical League, GSFC, U.S. Naval Observatory, Grumman Astronomical Society
Special Comments and Needs	: K40 1200 mm camera at Elizabethtown, N.C-L. Cafiero & H. Dunaver, Grumman Astronomical Society
Station Prob	: 1.0
Funds	: NASA, NSF

SUMMARY OF PRELIMINARY RESULTS-PROJECT NO. 3.3-F-01.01:

The primary station of Project 3.3 - E - 01.01 was operated just a few km. southeast of Miahuatlan. Five good photographic plates (approx. 9 X 7 degrees) were obtained with stellar images at least as faint as +9V. Four complete scans were made with the narrow-band photometer. The latter instruments recorded good signals out to 20 $\odot$ radii. While possible cometary emissions were anticipated at $3883A^{o}$ and $5890\text{-}96A^{o}$ within 10 radii of the sun the instrument also recorded a significant amount of signal between 15 and 20 $\odot$ radii. These signals appear to originate from two "clusters" equidistant from the sun along the ecliptic.

Seven very fine photographic plates were obtained from the cooperating station in North Carolina.

The photographic plates from both stations have been scanned and all potential images marked for later correlation. The photometric data had been reduced to a suitable format for cross check with the photographic data.

Several more weeks will be required to complete the data analysis.

1970 SOLAR ECLIPSE - PROJECT NO. 3.3-F-01.02

Institution	:	Space Environment Branch, NASA Langley Research Center
Investigators	:	LEE, Robert B., III and LEVINE, Joel S.
Title	:	Comet Search
Purpose	:	A search for undetected comets in vicinity of the sun
Description	:	Photographic search during totality for undetected comets near the sun using K-24 cameras.
References	:	Courten, H. C. and Genberg, R. W., 1970: Astron. Jour., 72, 791 Courten, H. C. et. al., 1969: Bull. Amer. Astron. Soc. 1, 338
Location	:	NASA Langley Research Center, Hampton, Virginia 23365
Dates	:	March 4-8, 1970
Equipment	:	Three K-24 Aero-Ektar f/2.5 wide angle cameras mounted on equatorial clockdrive
Special Site Requirements	:	None
Number & Names of People	:	Robert B. Lee, III and Joel S. Levine
Cooperating Groups	:	Dowling College (H. Courten 3.3-E-01.01), Goddard Space Flight Center, NASA (B. Donn)
Special Comments and Needs	:	None
Station Prob	:	1.0
Funds	:	NASA

SUMMARY OF PRELIMINARY RESULTS

Inspection of the comet negatives was most disappointing. Although Venus was recorded, neither Mercury nor any other star-like or cometary images could be found on the five 20-second exposure negatives. On these plates the sky appeared very dark suggesting that they were overexposed. The sky during totality was much brighter than had been expected.

While the five 20-second exposures on the comet cameras did not record Mercury or any star-like or cometary images, the five second exposures through the polarizers with a transmission of 37 percent recorded Venus and Mercury. Closer examination of these negatives with strong magnifier over a bright light box revealed at least a half dozen extremely faint images on each negative. We are now in the process of trying to identify corresponding images on different negatives--thereby eliminating spurious images that may be due to water or chemical spots, dust, or scratches on the negative. We will then try to identify the remaining images with stars--with the hope of identifying the residuals as possible comets.

1970 SOLAR ECLIPSE PROJECT NO. 3.3-F-04.00

Institution	:	The University of New Mexico
Investigator	:	PETERSON, A.W.
Title	:	Infrared Scans of the Corona and Dust Emission Zones
Purpose	:	To obtain multi-wavelength infrared measurements of the interplanetary dust emission zones and of the outer coronal reddening.
Description	:	Two dual-channel infrared photometers carried on a four axis mounting will make three sweeps across the corona at three position angles. Data at eight wavelengths, between 0.8 and 5.3 microns, will be obtained for each sweep. The data will be analyzed to yield information on the physical and chemical properties on the interplanetary dust.
Reference	:	A. W. Peterson: Thermal Radiation from Interplanetary Dust, AP.J. 138, 1218 (1963); Experimental Detection of Thermal Radiation from Interplanetary Dust, AP.J. 148, L37 (1967); The Coronal Brightness of 2.23 Microns, AP.J. 155, 1009 (1969).
Location	:	Nejapa, Mexico
Dates	:	March 1 - 8, 1970
Equipment	:	900 lbs. Will drive a truck to site. Port of entry - Nuevo Laredo
Special site Requirements	:	Low humidity
Number & names of People	:	A. W. Peterson and two graduate students - Lois M. Kieffaber and David A. Linton
Cooperating Groups	:	None
Special Comments and Needs	:	None
Station prob	:	0.8
Funds	:	NSF and NASA equipment

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.3-F-04.0C

Two dual-channel infrared photometers made six scans across the coronal along radial trajectories aligned along a) the ecliptic, b) the celestial equator, and c) at 23.5° inclination to the celestial equator. One photometer contained a PIN photodiode and a CO_2-cooled PbS cell. the PIN detector provided data at wavelengths of 0.84 and 0.97μ, while the PbS cell operated at 1.57 and 2.23μ. The other photometer contained a PbS cell and an InSb cell, both cooled by cryostat generated liquid nitrogen. The PbS cell operated at 3.22 and 3.70μ, while the InSb cell operated at 4.13 and 4.70μ.

Apparently our 50 lb tank of CO_2 gas developed a leak during the trip. On eclipse day it produced only one 4-ounce cake of solid CO_2. Thus the chopper in the PbS-InSb photometer had to be operated at ambient temperatures, over 30°C, rather than being cooled to near dry ice temperatures.

In addition, the InSb cell failed to operated at eclipse time. Hence no data were obtained at wavelengths greater than 4μ while the 3μ data were recorded as negative-going signals due to the hot chopper. These signals are on the order of a few millivolt (mv) changes on a large constant signal of about 200 mv.

A new Ithaco phase-lock amplifier was used to process the 1.6 and 2.2μ signals . Calibrations in the lab yielded excellent results, but, at the eclipse site, when the preamplifier was operated from the main amplifier's power supply rather than batteries, the signals were noisy. The manufacturer has recently called attention to the fact that the remote preamplifier supply lines are not bypassed and when operated this way the preamplifier oscillates and degrades the system performance. Good data were produced by the PIN detector.

In an effort to combat the rather noisy signals at the eclipse site all data were recorded with large amounts of electrical damping. Thus, an undamping routine had to be developed to analyze the data. Our routine will easily retrive a square wave which has been damped down to an approximate sine wave of 1/3 square wave's original amplitude.

Processing the data is still in progress. The one notable result so far is that the $4R_{\odot}$ dust emission was detected at both 0.84 and 0.97μ. Comparing these values with the 2.2μ value obtained at the 1966 eclipse suggests that the dust vaporizing at $4R_{\odot}$ may be at a temperature of above $1500^{\circ}K$.

1970 SOLAR ECLIPSE - PROJECT NO. 3.3-F-04.01

Institution	:	The University of New Mexico
Investigator	:	PETERSON, A. W.
Title	:	Coronal Spectra
Purpose	:	To obtain low dispersion spectra of the outer corona
Description	:	Two spectrographs will record low dispersion spectra of the corona in the region of the dust emission zones. A search will be made for coronal emmission lines originating from interplanetary dust vapor resulting from the deposition and vaporization of dust in the outer corona.
Reference	:	A. W. Peterson: Thermal Radiation from Interplanetary Dust, AP. J. 138, 1218 (1963) and unpublished calculations.
Location	:	Nejapa, Mexico
Dates	:	March 1-8, 1970
Equipment	:	900 lbs. Will drive a truck to site. Port of entry- Nuevo Laredo
Special Site Requirements	:	None
Number and Names of People	:	A. W. Peterson and two graduate students Lois Kieffaber and David A. Linton
Cooperating Groups	:	None
Special Comments and Needs	:	None
Station Prob	:	0.99
Funds	:	NSF and NASA

SUMMARY OF PRELIMINARY RESULTS-PROJECT NO. 3.3-F-04.01

Two equatorially mounted spectrographs, operated by Lois M. Kieffaber, were to record the corona spectrum form 3000 to 7000 Å, and to $\pm 10\ R_{\odot}$ Elongation. Both cameras used E.K.C. type 098-02 high-speed red emulsion. From 4000 to 7000 Å a dispersion of 300 Å/mm was obtained with a transmission grating and an F-0.95 Canon camera lens. In the ultraviolet a quartz prism and a quartz-lithium fluoride achromat provided a dispersion of about 700 Å/mm. In the visible, exposures of 10 and 160 seconds were made, while in the ultraviolet, one exposure of 180 seconds was made.

Upon development, all plates, including those unexposed, were found to be fogged to a density of about 2.0. The source of fogging is unknown. Baking a sample plate at 35° C for one week produced little fog; hence, the high temperature at the eclipse site cannot be blames. Mr. Swann of Eastman Kodak Company suggests that the lucite structure built to transport the plates could outgas and chemically fog the plates. Finally, there could have been an accidental exposure of the plate supply at sometime during the trip. This seems unlikely, however, because of the uniformity of the fog on all plates.

In spite of the severe fog, contact prints on type III a J emulsion reveal the spectra in some detail. Eleven emission lines in the inner corona were recorded and identified. Three faint lines between 6850 and 7000Å remain unidentified.

Chemical reduction of the data plates will be performed eventually and possibly more lines will be found. However, it seems that faint lines in the $4R_{\odot}$ region could not be retrieved even if they were present.

During the long exposures on the spectrographs, Miss Kieffaber obtained a fine series of color photographs of the corona using a 35 mm camera and 400mm telephoto lens. At 1/500 second the inner corona and prominences are revealed on the high speed Ektachrome film. On the longest exposure of 1 second a streamer in the north east quadrant of the sun can be traced to beyond $12R_{\odot}$

Institution : Space Sciences Laboratory, TRW SYSTEMS GROUP
One Space Park, Redondo Beach, California 90278

Investigators : W. BERNSTEIN, R. L. WAX and G. T. INOUYE

Title : Energetic Hydrogen Atoms Associated with the Solar Wind

Purpose : Two indirect experimental measurements indicate the existence of energetic (1 kev) fluxes of hydrogen atoms associated with the solar wind. This flux arises from charge exchange of the solar wind with neutral atoms in the interplanetary medium and possibly, but very unlikely, as a result of direct emission of energetic neutrals by the sun itself. Typical theoretical estimates of the flux range from 10^{-2}-10^{-4} of the solar wind flux, although it has been suggested that this flux may increase greatly during periods of solar activity. These neutral atoms will not be deflected around the earth in the bow shock but will penetrate to altitudes as low as 600 Km without significant attenuation. This experiment is the first attempt at the direct measurement of this postulated neutral component of the solar wind.

Description : In this experiment, three energetic hydrogen atom detectors will be launched on a Javelin Rocket to an altitude of 800 Km; the rocket will be within the umbra for a period of ∼67 sec at apogee. They payload consists of two hydrogen energy spectrometers (0.6-3 kev), one energy independent total hydrogen detector, one sun sensor and an aspect magnetometer. The instrument apertures are arranged so that they will view the eclipsed sun for ∼10% of each spin cycle. Suitable measurements of the ambient energetic proton flux and instrument EUV sensitivity will also be performed.

References : Energetic H^{o} Flux: (1) Akasofu, S. I., Panetary Space Science, 12, 905 (1964). (2) Patterson, T. N. L., F. S. Johnson, and W. B. Hanson, Planetary Space Science, 14, 809 (1963). (3) Bame, S. J., A. J. Hundhausen, J. R. Asbridge, and I. B. Strong, Phys. Rev. 20, 393 (1968).
Instrumentation: (1) Bernstein, W., G. T. Inouye, N. L. Sanders, R. L. Wax, J. Geophys. Res., 74, 3601 (1969). (2) Wax, R. L. and W. Bernstein, Rev. Sci. Instr., 11, 1612 (1967).

Location : The rocket payload will be launched from Wallops Island, Va. The trajectory will provide apogee of approximately 800 Km in totality for 67 sec.

Dates : January 17 - February 15, 1970

Number and Names of People : 5 from TRW: W. Bernstein, R. L. Wax, W. Simpson, G. Inouye, A. Cole. NASA complement unknown

Funds : NASA

SUMMARY OF PRELIMINARY RESULTS:

Results : The Javelin rocket did not follow the calculated trajectory and thus, there were no measurements of the neutral hydrogen flux in the umbra. However, the observed fluxes of neutral hydrogen were astoundingly large, 10^{9} cm^{-2} sec^{-1} str^{-1}, and the solar ultraviolet was only a small background perturbation.

The payload consisted of two identical energy spectrometers very similar to instruments that have been flown into the aurora (Bernstein et al., 1969).[1] The neutral channels consisted of an electrostatic charged particle deflector system followed by a 2 $\mu gr/cm^2$ carbon stripping foil; ∼10% of the neutral beam is ionized in transit of the foil. The resulting protons were energy analyzed in a hemispherical electrostatic analyzer. Each neutral channel was paired with a background channel having the same charge deflector system and analyzer but without the carbon foil. This channel should have measured any sources of non-energetic neutral background.

We have concluded the reported neutral fluxes were not significantly contaminated by ultraviolet light, energetic electrons or protons, low energy ionospheric ions or electrons, or by vehicle generated electronic noise.

Figure 1 shows the differential flux of neutrals observed in each of the four energy channels during a portion of the flight. The energy spectrum was usually peaked at 1 kev and fell off rapidly at higher energies. The typical energy flux of 2.5 ergs cm^{-2} sec^{-1}. Simultaneous measurements of the proton flux on the same rocket show that the magnitude of the neutral flux had a much larger variation on a ten second time scale than protons of comparable energy. The proton fluxes were typically 10^{7} cm^{-2} sec^{-1} str^{-1}, with an energy spectrum which was flat below 1 kev and fell off more rapidly at higher energies than the neutral spectrum. The proton flux above 1 kev was consistent with the flux expected from the atmospheric stripping of the observed neutrals.

Both the neutral and proton fluxes showed strong anisotropy as the rocket scanned in azimuth. The region of the sky from which the enhanced fluxes came is shown in Figure 2. As can be seen, this region was definitely not centered on the sun. The degree of anisotropy defined as the ratio of count rate observed from the source to the count rate elsewhere varied from about 1 to 10. Detailed analysis of counts observed from the source direction has not yet been done.

1. Bernstein, W. G., T. Inouye, N. L. Sanders, and R. L. Wax, J. Geophys. Res., 74, 3601, 1969.

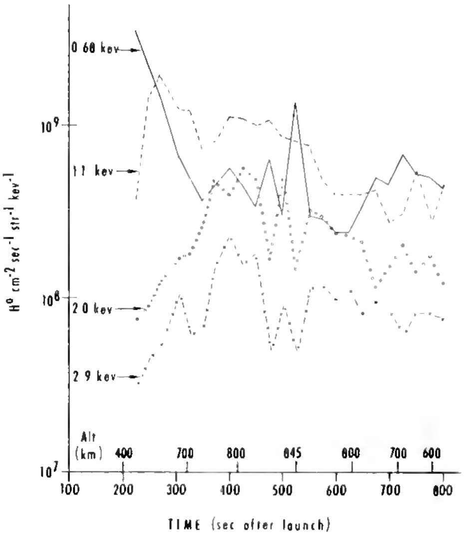


Figure 1. Observed differential flux of neutral hydrogen as a function of time and altitude.

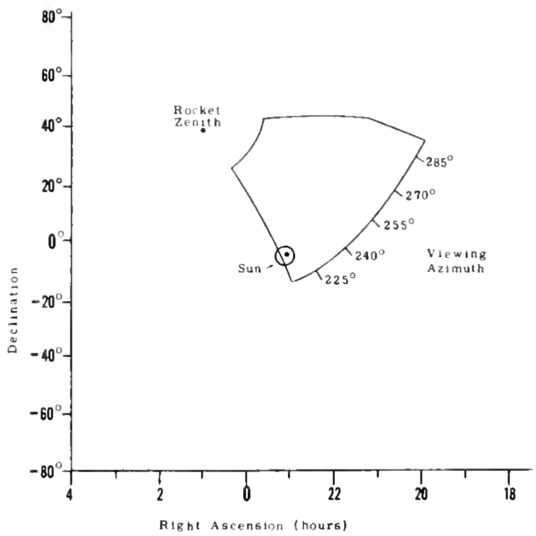


Figure 2. The region of enhanced neutral flux outlined on a sky map. The instruments were scanning in azimuth in clockwise direction on this map.

1970 SOLAR ECLIPSE PROJECT NO. 3.4-E-01.00

Institution : Department of Communications, Communications Research Centre, CANADA

Investigators : NELMS, Dr. G. L.

Title : Topside Sounding of the Ionosphere

Purpose : To determine the detailed distribution with height of electron number density in the topside ionosphere, as a function of latitude along a north-south line intersecting the path of the eclipse, before, during, and after the eclipse. From this information to determine recombination and relaxation times in the topside ionosphere.

Description : The alouette ISIS satellites are in high inclination orbits, so that the paths of the satellites are nearly north-south, and successive orbits are spaced by about 30^o longitude at the equator. The orbits are circular at 1000 kilometers for Alouette I, elliptical at 500 - 3000 for Alouette II, and at 570-3520 for ISIS-I.

These satellites are capable of taking topside ionograms at intervals of 20 to 30 seconds (150 to 200 kilometers along the orbit). In addition, the ISIS-I satellite will have on board a fixed frequency sounder from which conditions at the satellite can be measured with much finer resolution. From each of the ionograms the N(h) distribution of the topside ionosphere between the satellite and the peak of the F layer can be obtained. From the ionograms and the fixed frequency soundings a great deal of information also can be obtained about conditions in the plasma at the spacecraft.

There are rather severe limitations to satellite borne investigations of unique localized events. The satellite usually is not in the right place at the right time. For this eclipse, the Alouette II and ISIS-I satellites will be in the best position; they will cross the eclipse region 52 and 27 minutes after totality. Unfortunately the ISIS-I orbit crosses the eclipse path at the sunset line, so the effects of eclipse and of sunset will be mixed.

It is planned to sample the eclipse region during two or three days before and after the event, to obtain control information, and on the day of the eclipse to sample the region to the east (before) and to the west (after) the eclipse. During the eclipse a continuous run of records will be taken from the equator, through the eclipse region, and far to the north. From these records the height distribution of electrons, at 150 kilometer intervals along the orbit, through and to the north and south of the eclipse region will be calculated and compared with similar data from the control days.

Data will be collected from other experiments on the Alouette II and ISIS-I satellites; in particular, on ISIS-I, measurements will be made of the ion and electron temperature at the satellite, the spectrum of particle energy from a few eV to several keV, and above 8 keV, the background noise environment at the satellite, and the occurrence and strength of VLF signals in the frequency range of 500 Hz to 30 kHz. These data will be particularly valuable in establishing a complete and detailed picture of the ionosphere at the satellite across the eclipse region. It is expected that the ISIS experimenters will analyse their data individually, and also will support a cooperative exchange and joint analysis of the eclipse data from ISIS-I.

References : Warren, Can. J. Phys. 40, p. 1692 (1962). Nelms, Electron Density Profiles in Ionosphere and exosphere, p. 358, North Holland Pub.(1966). Nelms & Lockwood, Space Research VII, p. 604. King, Legg and Reed, J.A.T.P. 29, p. 1365 (1967).

Location : Alouette I (if operating), Alouette II, ISIS-I. (see pp. 4.7-E-05.00, 05.01, 05.02)

Equipment : Topside sounders, fixed frequency sounders.

Cooperating Groups : ISIS Working Groups; CRC and NRC (Canada); NASA (USA); RSRS (U.K.); ESSA/ERL (USA); U. of Texas at Dallas (USA); AFCRL (USA).

Station Prob : 0.9

Funds : Through continuing NASA and CRC programmes.

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE - PROJECT NO. 3.4-F-02.01

Institution : Department of Physics, The University, Southhampton, S09 5NH, England

Investigator : RYCROFT, Dr. Michael J.

Title : Whistler and other VLF observations.

Purpose : Very low frequency (VLF) observations, particularly of whistler are to be made at two pairs of closely conjugate stations. Information on magnetospheric electron density changes is to be sought.

Description : Stations at Hanover, New Hampshire, and Argentine Island (L~3) are operated as part of the Whistlers East network (Prof. M. G. Morgan). A Stati exists at Halley Bay (British Antarctic Survey, and Dr. K. Bullough, University c Sheffield); a conjugate station (L~4) is to be temporarily established near St. Newfoundland (University of Southampton, in conjunction with the National Researc Council of Canada).

Reference : J. O. Thomas and M. J. Rycroft, Plenum Press, to be published, 1970.

Location : St. Johns, Newfoundland

Dates : February 24 to March 10

Equipment : Portable, battery-operated, VLF receving equipment

Special Site Requirements : Minimal man-made interference.

Number and Names of People : Dr. M. J. Rycroft and Mr. C. D Reeve.

Cooperating Groups : Dr. R. S. Rettie and Mr. J. H. Craven, National Research Counc Ottawa, Canada.
Professor M. G. Morgan, Radiophysics Laboratory, Dartmouth, College, Hanover, New Hampshire, 03755, U. S.A.
Dr. K. Bullough, Department of Physics, The University, Sheffield, England.

Station Prob : 0.98

Funds : British Science Research Council.

SUMMARY OF PRELIMINARY RESULTS

The experiments were conducted as planned, except that:

i) no observations were made at Argentine Island,

ii) no whistlers were received in New Hampshire or New Foundland during the ec

Preliminary results have been discussed in a letter to Nature, 226, 1126-1 June 20, 1970. These show that during the eclipse period:

i) the predominant VLF signals present in Newfoundland were tweeks, atmospher propagating under a "night-time" ionosphere (fig. 1, paper chart recording),

ii) for two minute close to totality, a series of eighteen intense rising-freq (1.8 to 2.4 kHz) tones, risers, was observed (fig. 2, Sonagram of signal recorde on magnetic tape). These signals are presumed to be of magnetospheric origin, ar transmitted through the eclipsed ionosphere, rather than being absorbed by the normal daytime D-region.

iii) geomagnetic conditions were somewhat disturbed.

Figure 1

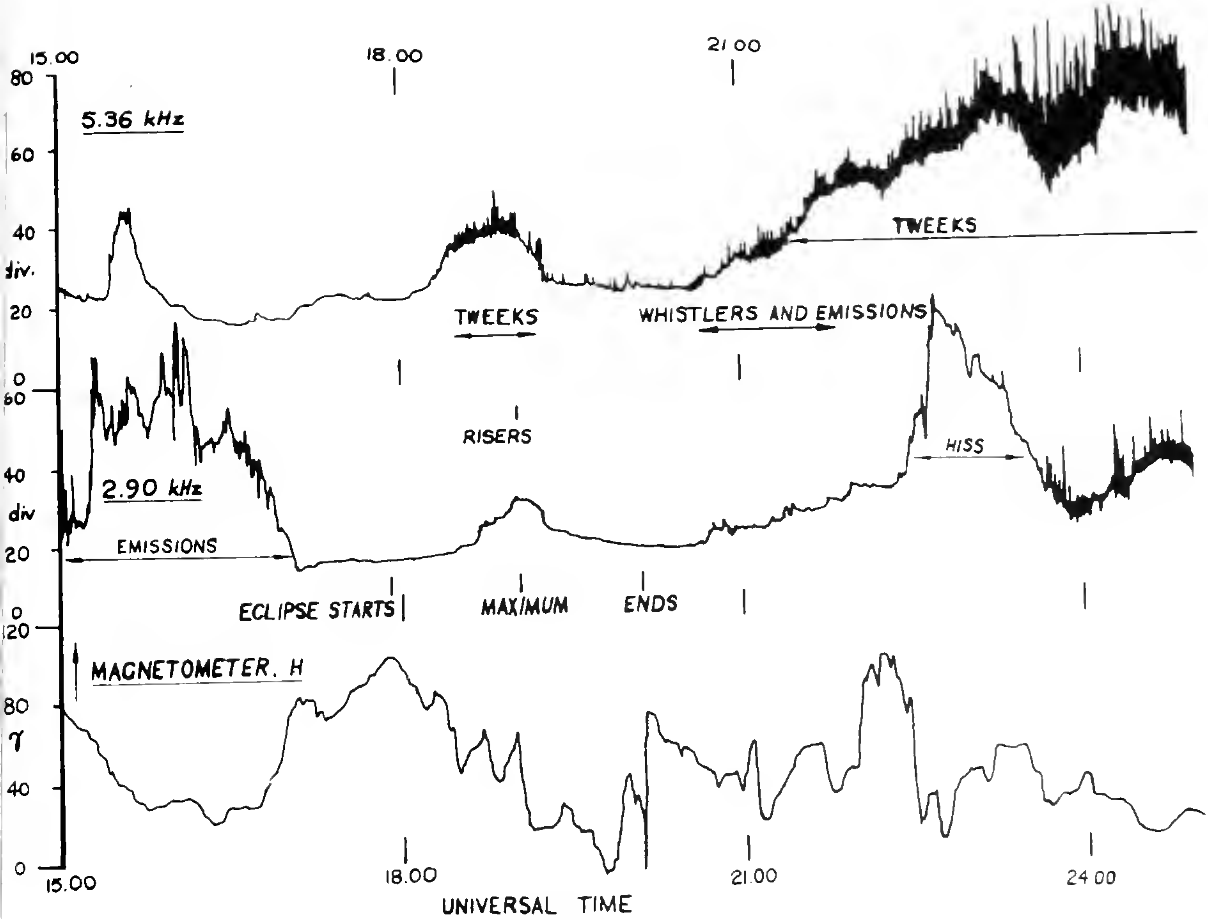
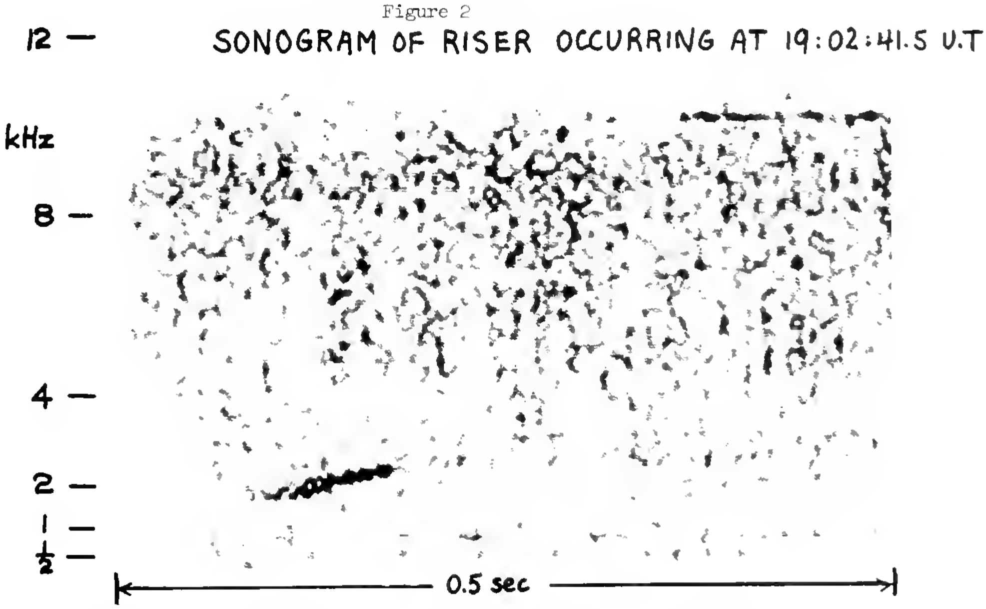


Figure 2



: 1 - Variations with time for the eclipse period of: upper trace) the intensity of the background
;nal at 5.36 kHz, showing the occurrence of tweeks during the eclipse and during the local night, each
rtical trace corresponding to a particularly strong atmospheric, middle trace) the intensity of the
kground signal at 2.90 kHz, showing the occurrence of chorus emissions before 17.00 UT, of risers be-
een 19.01.03 and 19.03.42 UT, and of hiss between 22.30 and 23.30 UT, and low trace) the north-south
rizontal component of the geomagnetic field, 1 - being 1 nanoTesla. All quantities increasing upwards.
re 2 - Spectrogram of VLF waveform at 19.02.41½ UT, showing a riser (2 kHz), atmospherics, and an
ega transmission.

1970 SOLAR ECLIPSE - PROJECT NO. 3.4-F-02.02

Institution	:	The Aerospace Corporation Post Office Box 95085 Los Angeles, California 90045
Investigators	:	MCPHERSON, D. A. KOONS, H. C.
Title	:	Total Electron Content of Geomagnetic Field Line (Measurement from Whistler Propagation Characteristics)
Purpose	:	The objective of the experiment is to determine the variation of total electron content of the geomagnetic field lines which intercept the northern hemisphere north of the path of eclipse. The dispersion of whistlers propagating from the southern to the northern hemisphere will be measured for this purpose. The dispersion of whistler mode waves in the magnetosphere is a function of the electron density along the magnetic field line.
Description	:	A receiver with bandwidth from 30 to 20,000 Hz was located north of the eclipse path in Forest Falls, California. The antenna was a three turn loop with major dimensions of approximately 40 feet. The output of the receivers was recorded on magnetic tape. For periods of an hour about the time of the eclipse, the total electron content of the field line may be less than for normal conditions. This will be determined from the dispersive character of the recorder whistlers.
Reference	:	1) Carpenter, D. L., and R. L. Smith, Whistler Measurements of Electron Density in the Magnetosphere, Rev. Geophys. 2, 415, 1964 2) Helliwell, R. A., Whistlers and Related Ionospheric Phenomena, Stanford University Press, Stanford, 1965. 3) Outsu, J. and A. Iwai, Some Correlations between Occurrence Rate and Dispersions of Whistlers at Lower Latitudes and Magnetic K Index, Proc. Res. Inst. Atmospheric, Nagoya University, 9, 19-24, 1962.
Location	:	Forest Falls, California
Dates	:	6 March 2200 PST- 12 March 1200 PST
Equipment	:	Tape recorder, antenna, VLF receiver, assorted test gear, all battery-operated and portable.
Special site Requirements	:	None
Number and Names of People	:	(2) Dr. D. A. McPherson Dr. H. C. Koons
Cooperating Groups	:	None
Special comments and needs	:	None
Station Prob.	:	1.0
Funds	:	Aerospace Corporation in-house funding.

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.4-F-02.02

The experiment was operated during the following time periods.

6 March 70	2200 - 2400 PST
7 " "	0000 - 2400 "
8 " "	0000 - 2400 "
9 " "	0000 - 1100 "
11 " "	1800 - 2400 "
12 " "	0000 - 1200 "

The data have not yet been analyzed.

<u>1970 SOLAR ECLIPSE PROJECT NO. 3.4-E-03.00</u>

Institution	:	AF Cambridge Research Labs., Hanscom Field, Bedford, Mass.
Investigator	:	AARONS, Dr. Jules
Title	:	Ionospheric Effects of the Solar Eclipses
Purpose	:	Using satellite beacons, observations would be made of changes in total electron content during an eclipse. Available equipment at present making measurements of the synchronous satellite, ATS-3 and the 1000 Km satellite, Explorer 22, would be used.
Description	:	Continuous measurements will be made of the polarization twist of VHF signals from ATS-3 by means of an electronic polarimeter. Calibrations of the data for absolute values of twist will be made by reference to BE-B passes.
Reference	:	Klobuchar, J.A., and H. E. Whitney, "Ionospheric Electron Content Measurements During a Solar Eclipse," <u>Journal of Geophysical Research</u>, Vol 70, No. 5, March 1, 1965.
Location	:	Sagamore Hill Radio Observatory, Hamilton, Massachusetts. No special sites required.
Dates	:	
Equipment	:	
Special Site Requirements	:	
Number and Names of People	:	
Cooperating Groups	:	
Special Comments and Needs	:	This measurement is part of a routine series of measurements currently being carried out by AFCRL at the Sagamore Hill Radio Observatory. No additional logistic support is required.
Station Prob	:	
Funds	:	

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE PROJECT NO. 3.4-E-03.01

Institution	:	General Electric Company
Investigators	:	MILLMAN, George H. and ANDERSON, Roy E.
Title	:	Ionospheric Phase Fluctuation Measurements
Purpose	:	To determine from satellite transmissions the total electron content and the phase perturbations imposed by the irregularities in the ionosphere.
Description	:	Transmissions emanating from the Transit satellites at the coherent frequencies, 150 and 400 MHz will be monitored.
References	:	Millman, G. H. and Anderson, R. E., "Ionospheric Phase Fluctuations of Satellite Transmissions," Journal of Geophysical Research, Vol. 73, pp. 4434-4438, July 1, 1968
Location	:	General Electric Radio - Optical Observatory, Schenectady, N.Y., Lat. 42.8°N, Long. 74.1°W.
Dates	:	Permanent installation at which routine measurements are conducted
Equipment	:	Equipment permanently installed. No additional equipment required
Special Site Requirements	:	None
Number & Names of People	:	General Electric personnel
Cooperating Groups	:	U.S. Navy - satellite orbital elements
Special Comments and Needs	:	None
Station Prob	:	0.9
Funds	:	General Electric Company

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE PROJECT NO. 3.4-F-03.02

Institution	:	Ionosphere Radio Laboratory, Department of Electrica Engineering, University of Illinois
Investigators	:	YEH, K.C., FLAHERTY, B. J.
Title	:	Measurement of Faraday Rotation of Radio Waves Transmitted from a Geostationary Satellite
Purpose	:	To measure and study the behavior of electron conter during the 1970 solar eclipse
Description	:	Electronics equipment will be set up at two locatio along the path of totality on the east coast of the U.S. Faraday rotation data of radio signals of the geostationary satellite ATS-III shall be recorded at these two stations for a period of two weeks. Da of this sort may help us understand some aspects of F2 region aeronomy.
References	:	J. A. Klobuchar and R. S. Allen (ed.) A. F. Cambrid Research Labs: Rept. AFCRL-64-962, 1964 Pound, et al., J. Geophys. Res.,71, 326-329, 1966 Howard, et al, J. Geophys. Res., 69, 540-544,1964
Location	:	Norfolk, Virginia and Turkey Pt., Flordia
Dates	:	March 1 - 14, 1970
Equipment	:	Radio equipment in approximately 10 boxes for each site. Will be shipped by car from Illinois.
Special Site Requirements	:	Low radio noise and interference
Number & Names of People	:	H. D. Webb, K. C. Yeh, B. J. Flaherty, Anthony Szelpal, Robert Clark, Maurice Youakim
Cooperating Groups	:	AFCRL
Special Comments and Needs	:	
Station Prob	:	0.99
Funds	:	AFCRL

UMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.4-F-03.02

easurements of Faraday rotation of a linearly polarized signal transmitted by the eostationary satellite ATS-III at 137 MHz were made at Norfolk, Virginia; Turkey oint, Florida and Urbana, Illinois. Excellent data have been obtained from all hree stations and the data processing is nearly complete. The effect of the solar clipse on all data is obvious. For example, first contact at Norfolk occurred at 206 EST. The electron content was observed to increase for approximately 40 inutes before it started to decrease. At the start of this decrease, the sun was pproximately 40% eclipsed. The minimum in content was fairly broad and was reached 9 minutes after totality. The content returned to its normal value about 43 minutes fter the fourth contact. The change in content from the first maximum to minimum as 22.5% and from the minimum to the second maximum was 19.5%. These percent hanges are in agreement with those measured in 1963, although the absolute values re quite different due to differences in solar activities.

reliminary results have been published in a paper, "Response of the F-region Ionoshere to a Solar Eclipse" by B. J. Flaherty, H. R. Cho and K. C. Yeh, Nature 226 o. 5251, 1121-1123, June 20, 1970.

(See also: Nature, 226, p. 1121, June 20, 1970)

1970 SOLAR ECLIPSE PROJECT NO. 3.4-F-03.03

Institution : University of California, Department of Meteorology

Investigators : THORNE, Richard M. and VENKATESWARAN, S. V.

Title : Ionospheric F-region Effects of the Total Solar Eclipse of March 7, 1970

Purpose : To measure the eclipse effect on the total electron content of the ionosphere. The experiment is intended to give information on the relative importance of electron production, loss and transport processes in the F-region at a low geomagnetic latitude. The measurements are heavily biased towards the F2 region and the topside ionosphere where field aligned transport is expected to be more important.

Description : Faraday rotation measurements were made on the 137 MHz transmissions from the geostationary satellites, ATS-1 and ATS-III, located respectively at 150°W and 85°W. To an observer on the ground, the signal emanating from each satellite is polarized elliptically with a known orientation. The Faraday rotation, incurred by the satellite signal during its passage through the ionosphere was measured using rotating Yagi polarimeters.

References : (1) Evans, J. V., (1965): An F Region Eclipse, J. Geophys. Res., 70, 131. (2) Howard, H. T., Lusignan, B.B., Yoh, P., and Eshelman, V.R. (1964): Radar Doppler and Faraday polarization measurements of the cislunar medium during the July 20, 1963 solar eclipse, J. Geophys. Res., 69, 540. (3) King, J.W., Legg, A.J., and Reed, K.C., (1967) Observations of the topside ionosphere during three solar eclipses, J. Atmosph. Terr. Phys., 29, 1365. (4) Klobuchar, J.A., and Whitney, H.E., (1965): Ionospheric electron content measurements during a solar eclipse, J. Geophys. Res., 70, 1254.

Location : Miahuatlan, Mexico (observation site shown in figure 1).

Dates : February 23 - March 10, 1970

Equipment : Two radio polarimeters; 2000 lbs; $20,000; air-fright and local automobile

Site Requirements: Freedom from VHF interference

Names of People : R. M. Thorne, P. Kuttner, B. Bienstock and F. D. Scruggs

Cooperating Group: Douglas Advanced Research Laboratories (Project 3.4-F-03.06)

Funds : UCLA Academic Senate and NSF

SUMMARY OF PRELIMINARY RESULTS:

The center of gravity of the ionospheric electron density distribution is known to be located at approximately 350 km. Our Faraday rotation technique is therefore primarily sensitive to the F region, and to the topside ionosohere which accounts for approximately 80% of the total content. Because of the long recombination times (~hours) at these altitudes, the observed eclipse effect are expected to be controlled by the process of plasma transport. The experiment described in this note was conducted with the main purpose of investigating such transport.

Figure 2 shows the effective total electron contents at the location B indicated in Fig. 1 both on the eclipse day and on the previous "control day". At both locations A and B it is found tha relative to the control day, the electron content starts to decrease after first contact. Also, a minimum in electron content is observed approximately at the time of maximum obscuration. At 102°W (Fig. 2) where the maximum obscuration was 86%, this reduction amounted to 2.3×10^{17} elec metre^2. Somewhat anomalously, the corresponding maximum reduction at 96°W, where the eclipse wa total, was 1.7×10^{17} electrons/metre^2. These values represent one quarter of the total number electrons in the ionosphere, and are significantly larger than the reductions measured by Evans and Klobuchar and Whitney.[4] These previous measurements were made at high geomagnetic latitude during a period of solar minimum in the month of July.

The observed rapid changes in electron content clearly demonstrates the importance of ionization transport in the topside ionosohere. As Evans[1] has previously noted, such transport is promoted by the rapid decrease of the temperature of electrons (and to a lesser extent of ions) in the to side ionosphere. The transport is essentially aligned with the geomagnetic field. The extent o electron reduction observed in Figure 2 will therefore depend upon the relative orientation of the geomagnetic field and the lines of sight to each satellite. This geometrical consideration can qualitatively explain the previously mentioned anomaly in the maximum electron reductions shown in Figure 2.

A detailed analysis of our observations is being undertaken utilizing ionosonde data from El Cerrillo near Mexico City. This should enable us to develop a model for transport of ionization in the topside ionosphere.

This work was supported by the National Science Foundation under grant number GA-20110. We than Dr. A. E. Belon for his help in coordinating our experiment, and Dr. Arcadio Poveda and the Mexican government for making our stay in Mexico enjoyable.

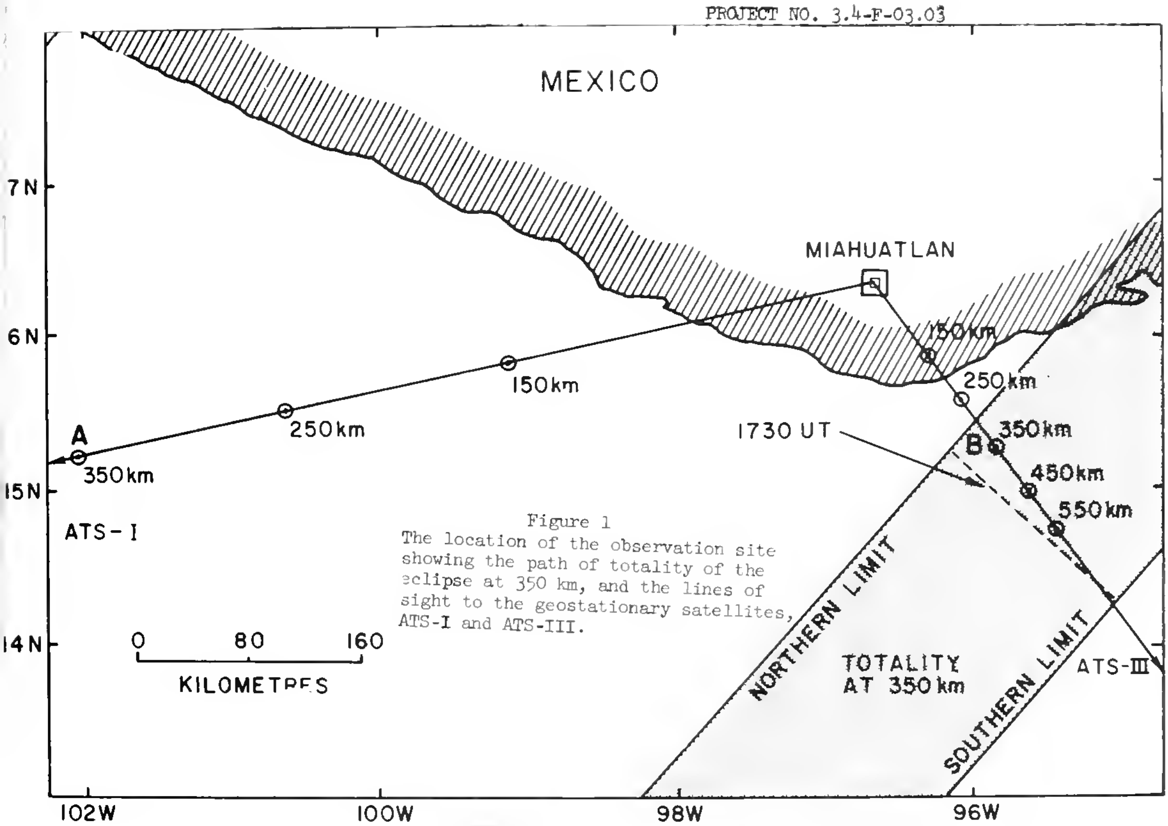


Figure 1
The location of the observation site showing the path of totality of the eclipse at 350 km, and the lines of sight to the geostationary satellites, ATS-I and ATS-III.

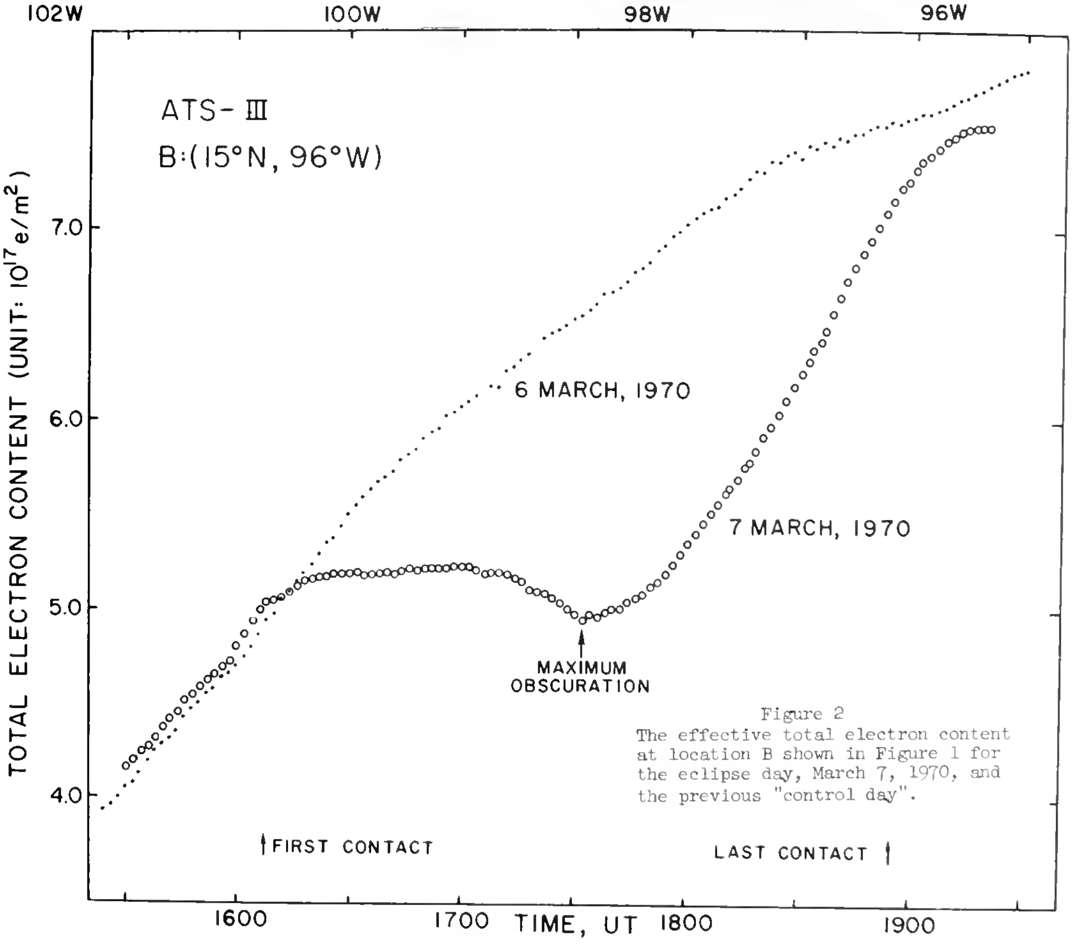


Figure 2
The effective total electron content at location B shown in Figure 1 for the eclipse day, March 7, 1970, and the previous "control day".

1970 SOLAR ECLIPSE - PROJECT NO. 3.4-F-03.04

Institution	:	Radioscience Laboratory, Stanford University
Investigators	:	da ROSA, A. V.; ALMEIDA, O. G.
Title	:	Measurement of Faraday Rotation Angle, Phase Path Difference and Amplitude of VHF/UHF Signals Transmitted from Geostationary Satellites (ATS-3; ATS-1)
Purpose	:	Measurement of columnar electron content during solar eclipse.
Description	:	Continuous measurements of the polarization angle and amplitude variations of VHF signal from ATS-3 and ATS-1 for a period of 2 weeks. The phase path difference between the VHF and UHF transmissions from ATS-3 will also be recorded during the same period.
Reference	:	Garriott, O. K., "The determination of ionospheric electron content and distribution from satellite observations," J. Geophys. Res., 65(4), 1139-1157, 1960. Almeida, O.G, O. K. Garriott and A. V. da Rosa, "Determination of the columnar electron content and the layer shape factor of the plasmasphere up to the plasmapause," Planet. Spa. Sci., 18, 159-170, 1970.
Location	:	Eastville, Va. - ATS-3 Greenbelt, Md. - ATS-3 Ft. Collins, Colo. - ATS-1 Stanford, Calif. - ATS-3 & ATS-4 Clark Lake, Calif. - ATS-1 Rosman, N. Carolina - ATS-3 Arecibo, P. Rico - ATS-3
Dates	:	February 22 to March 8
Equipment	:	Radio Equipment
Special site Requirements	:	Low radio noise and interference
Number & Names of People	:	One - S. C. Hall
Cooperating Groups	:	NASA - Goddard Space Flight Center

SUMMARY OF PRELIMINARY RESULTS:

Measurements of the Faraday rotation angle of the VHF transmission from the geostationary satellites ATS-I (150° W) and ATS-III (85° W) were carried out at several of our observatories in the United States. In addition, at Eastville, Virginia (37° 20' 50" N, 75° 54' 13" W) we measured amplitude of the signals and the changes in the differences of the VHF and UHF path length between ground and ATS-III.

Figure 1 shows the curve of the electron content versus time for Eastville on 7 April 1970. Corresponding curves obtained at Greenbelt, Maryland and Rosman, North Carolina exhibit a very similar behavior. All these sites observed a volume of the F-region in which the eclipse was above 95%. At Eastville the bulk of the ionosphere was totally eclipsed. In Figure 1 a pronounced bite-out is seen which, using the previous day as a control day, can be estimated as about 20 x 10^{16} electrons m^{-2}. The relative bite-out was $\approx$ 30%. A 35 minute delay was observed between the time of minimum electron content and the time of totality.

The bite-out in electron content at stations farther removed from the path of totality was surprisingly low as indicated in the table below:

	Eclipse Magnitude	Bite-Out (%)
Eastville, Va.	$\approx$100%	$\approx$33
Greenbelt, Md.	$\approx$ 95%	$\approx$25
Rosman, N. Carolina	$\approx$95%	$\approx$30
Fort Collins, Colorado	$\approx$45%	non-detectable
Clark Lake, California	$\approx$28%	non-detectable
Stanford, California	$\approx$26%	non-detectable

From the measurements made at Eastville, both the columnar electron content and its time derivative were calculated. The latter quantity is determined with very great accuracy from the phase path length experiment. Near the end of totality -- 18:36:30UT -- the ratio between the rate of change of the columnar content and the absolute value of columnar content reached its largest negative value of $(-1.16 \pm 0.05) \times 10^{-4}$ sec^{-1}.

Traveling ionospheric disturbances (TID) were observed following the eclipse at the four stations operated in the western United States (Stanford: ATS-I and ATS-III, Clark Lake, and Ft. Collins). These distrubances traveled from east-to-west and occurred near the time predicted for arrival of atmospheric gravity waves due to the eclipse /Chimonas and Hines, 1970/ . These TIDs were quite unusual since we have not previously observed disturbances traveling in such direction which retained their character over such large distances (>1000 km).

REFERENCES:

1. Almeida, O.G., O.K. Garriott and A. V. da Rosa, "Determination of the Columnar Electron Content and the Layer Shape Factor of the Plasmapbere Up To The Plasmapause," Planet Spa. Sci., 18, 159, 1970.

2. Chimonas, G., and C. O. Hines, J. Geophys Res., 75, 875 (1970).

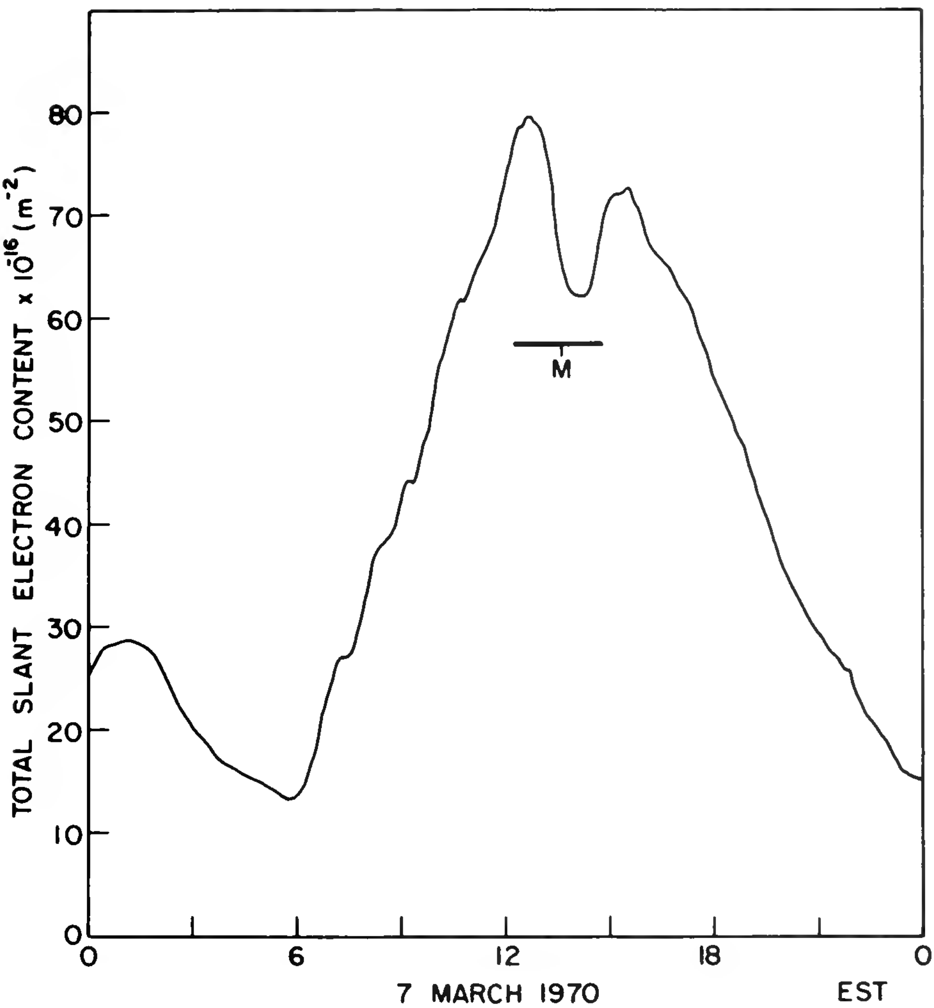


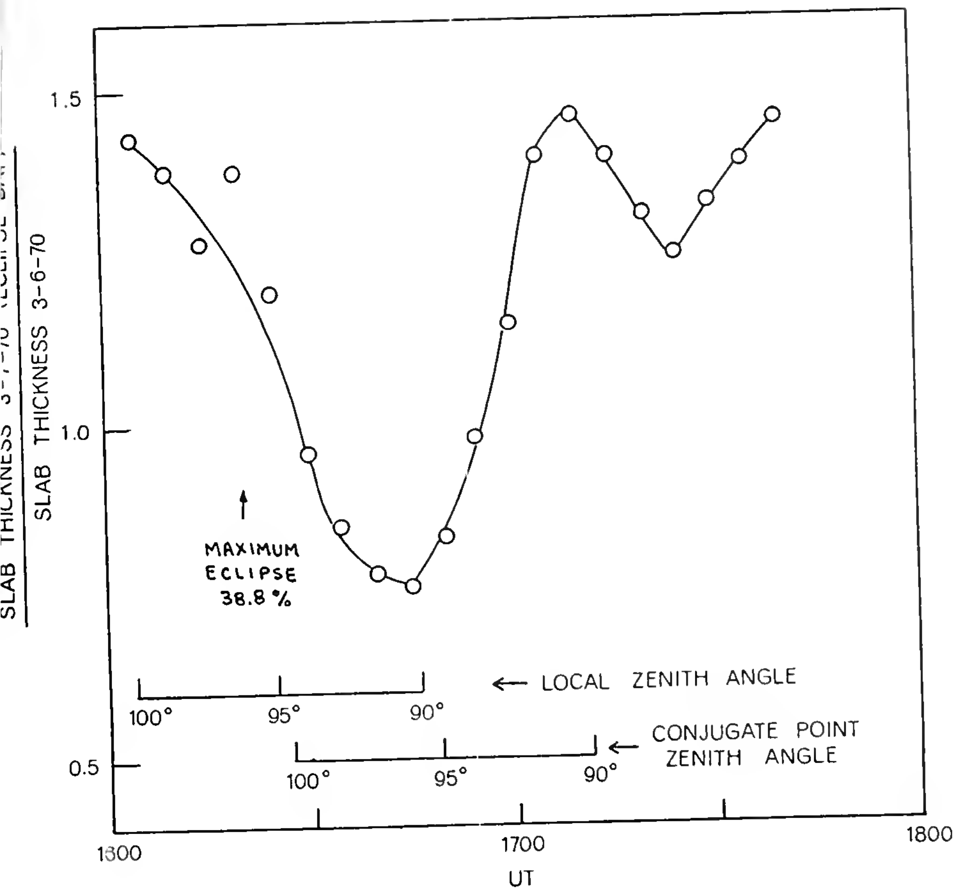
Figure 1 - Slant columnar electron content along the ATS-III to Eastville, Virginia path. The values of electron content were determined by the method of Almeida et al.[1]. The horizontal bar indicates the duration of the eclipse.

1970 SOLAR ECLIPSE PROJECT NO. 3.4-F-03.05

Institution	:	University of Hawaii Honolulu, Hawaii 96822 Department of Electrical Engineering
Investigators	:	ROELOFS, T. H.
Title	:	Ionospheric Heating by Conjugate Photoelectrons
Purpose	:	Presunrise ionospheric heating caused by magnetic conjugate-poi photoelectrons has been postulated by Hanson (1963) and observe by Carlson (1966). Predawn slab thickness increases of the ionosphere over Hawaii (Yuen & Roelofs 1967) are interpreted as further evidence of this effect. During the March 7 eclipse, Hawaii's ionosphere will experience a maximum eclipse near sunr while the conjugate point will not be eclipsed. From known sol obscuration and observed heating rate it should be possible to estimate the relative importance of local and conjugate heating
Description	:	Electron content data are obtained by measuring the polarizatio twist of the 137.5 Mhz telemetry signal from ATS-1. Values of peak electron density are obtained from ionograms recorded by th ESSA station on the island of Maui. Slab thickness, the ratio content to peak density, is a measure of layer temperature.
References	:	Carlson, H. C., "Ionospheric Heating by Magnetically Conjugate-Photoelectrons," J. Geophys. Res. 71. 195-199, 1966. Hanson, W. B., "Electron Temperatures in the Upper Atmosphere," Space Res. 3, 282-303, 1963. Yuen and Roelofs, "Seasonal Variations in Ionospheric Total Ele Content," J. Atmos. Terr. Phys., 29, 321-326, 1967.
Location	:	Honolulu, Hawaii ATS-1 satellite
Dates	:	Permanent recording site. Data routinely taken.
Equipment	:	-----
Special Site Requirements	:	None
Number & Names of People	:	-----
Cooperating Groups	:	-----
Special Comments and Needs	:	-----
Station Prob	:	1.0
Funds	:	National Science Foundation

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.4-F-03.05

During the eclipse of March 7, 1970, the ionosphere over Hawaii experienced a maximum obscuration of about 39% near sunrise. The conjugate point sunrise was normal. Rapid-run ionograms obtained from Maui were analyzed together with electron content data recorded at Honolulu to obtain slab thickness variations during the eclipse. Slab thickness variations were also obtained at corresponding times for days preceding and following the eclipse day. Slab thickness was depressed 40% during local eclipse and enhanced 35% during conjugate sunrise. Assuming that slab thickness is a good indicator of layer temperature, it appears that during sunrise, conjugate photoelectrons contribute about one-third of total heat input to the ionosphere at this latitude.



1970 SOLAR ECLIPSE - PROJECT NO. 3.4-F-03.06

Institution : Douglas Advanced Research Laboratories
Huntington Beach, California

Investigators : MAHADEVAN, P. and CARPENTER, H. C.

Title : Ionospheric Effects of a Total Eclipse of the Sun

Purpose : To study the ionospheric F-region effects of the total solar eclipse of March 7, 1970 by measuring the total columnar electron content of the ionosphere using the technique of Faraday rotation of VHF signals from geostationary satellites.

Description : This project was undertaken in collaboration with the Department of Meteorology, University of Calif., Los Angeles (project no. 3.4-F-03.03). It is expected that the experiment will enable us to assess the relative importance of electron production, loss and transport processes responsible for the observed F-region changes during the eclipse. A monitoring station, consisting of a rotating Yagi antenna and data acquisition and recording system was set up at El Cerrillo in Mexico. The 136 MHz signal from the geostationary satellite ATS III, transmitted through the ionosphere was received by the antenna and the angle of rotation of its plane of polarization was continuously recorded for a period beginning a few days before to a few days after the eclipse. Vertical soundings of the bottom side ionosphere were made by the Mexican ionosonde station at El Cerrillo during the same period. This latter data would enable us to isolate the effects on the top side ionosphere from the total. Data from these two independent stations is currently being processed.

SUMMARY OF PRELIMINARY RESULTS

See description

1970 SOLAR ECLIPSE-PROJECT NO. 3.4-F-03.07

Institution	:	Department of Physics, University of the West Indies Kingston 7, Jamaica
Investigator	:	MACDOUGALL, Dr. J.
Title	:	Detection of Ionospheric Gravity Waves
Purpose	:	Search the routinely acquired ionospheric data for the occurrence of gravity waves which may be generated by the solar eclipse.
Description	:	Two types of measurements will be made. 1) Measurement of changes in the phase path, group path and angle of arrival of radio waves at 6.2 MHz. 2) Measurement of total electron content from the Faraday rotation of geostationary satellite radio signals.
Location	:	Kingston, Jamaica (76° 45' W, 18° 00' N)
Dates	:	Continuously operating
Station Prob	:	1.0

SUMMARY OF PRELIMINARY RESULTS

Records of total electron content (Faraday rotation) on stationary satellite, group and phase height at 6.15 MHz (F-region) and angle of arrival (6.15 MHz, F-region) were obtained. Preliminary analysis only has been performed to see whether ionospheric waves were obviously present. T.E.C. (total electron content) did not show any very notable features. The T.E.C. was a bit low for the entire day. There was not any obvious feature which one could pick out as being unusual, or which would indicate an anomalous change in T.E.C. or a wave.

Group and phase height both showed very large changes centered on the time of maximum eclipse here. The change is most clear in phase height which began to rise rapidly at about 1655 UT, reached a peak equivalent to a height change of about 39.5 km around 1815 UT and returned smoothly to the normal level at around 1915 UT. This change was larger than was expected. There was no obvious ionospheric wave (which could be expected here, at about 1845 UT). A very weak "wave" passed over at about 2010 UT. (height changes only about 3 km) and we are planning further analysis of this and some ripples observed during the rising portion of the eclipse effect.

The angle of arrival data has not yet been analysed (we use it in conjunction with phase height to deduce movements of ionospheric waves)

After we have a chance to study this data further (are still getting out the regular daily variations) we shall be willing to exchange copies of the reduced data.

1970 SOLAR ECLIPSE PROJECT NO. 3.4-D-05.00

Institution : NASA/GSFC

Investigator : HEATH, D. F.

Title : Investigation of the Role of Resonance Scattering and Photoelectron Excitation in the Production of the Far Ultraviolet Dayglow

Purpose : To determine the relative importance of resonance scattering of sunlight and photoelectrons in the production of the far ultraviolet dayglow.

Description : A Nike-Tomahawk would be launched from Wallops Island during totality under the conditions that the atmosphere at apogee is illuminated whereas the region below 200 km would be in totality. With the use of forward and side looking photometers and spectrometers, one could measure the height profiles of H. Lyman a, OI., 304, 1356, and the N_2, Lyman Birge Hopfield system and the horizon effects. This information could enable one to assess the relative importance of resonance scattering and photoelectron excitation in the production of the far ultraviolet dayglow.

High resolution ground based observations could be made of N_2 + 3194 Å or OI, 5577 Å and 6300 Å for correlative purposes.

Reference :

Location : Wallops Island, Virginia

Dates : 7 March 1970

Equipment : Rocket borne ultraviolet photometers and spectrometers. Telemetry Frequency optional.

Special Site Requirements : Normal launch support.

Number & Names of People : 2 people.

Cooperating Groups : University of Michigan (pitot probes) - Horvath, Smith, Theon.
GSFC/Univ. of Mich./Yale (Thermosphere Probes) - Spencer, Brace, Walker and Carignan.
GSFC - Ozone rocket payload - Hilsenrath, Smith.

Special Comments and Needs : None

Station Prob : 1.0

Funds : NASA (SA)

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE - PROJECT NO. 3.4-F-05.03

Institution	:	Los Alamos Scientific Laboratory (University of California) Sandia Laboratories Albuquerque
Investigators	:	WOLCOTT, John H. (LASL) and ROBERTSON, M. M. (Sandia)
Title	:	Airglow During Eclipse
Purpose	:	To measure O I atomic and N_2 molecular spectral line intensities simultaneously with background intensities. This will be related to excitation mechanisms.
Description	:	A six barrel scanning photometer utilizing narrow band interference filters will be programmed to measure intensities arising from different points in the shadow and sky backgrounds.
Reference	:	J. G. Moore and C. R. N. Rao, Extrait des Annales de Geophysique, Tome 23-No..2, 197 (1967)
Location	:	AEC aircraft
Dates	:	Calibration flights: Dec. 22, '69; Jan. 23, '70; Feb. 23, '70; Mar. 4, '70.
Equipment	:	Will be carried on aircraft
Special Site Requirements	:	None
Number and Names of People	:	Principal Investigators
Cooperating Groups	:	Others on AEC aircraft
Special Comments and Needs	:	None
Station Prob	:	1.0
Funds	:	AEC

SUMMARY OF PRELIMINARY RESULTS

The experiment went very smoothly on eclipse day, and there is every indication that we have good data. The photometer was programmed to scan from directly up the shadow line to 90° with respect to the shadow line. Observed intensities were very close to predicted values.

Data reduction is currently awaiting geometric calculations of the percent solar illumination as a function of altitude, time, and scan angle. A first look at the data indicates that the solar corona was observed for many solar radii, and that enhanced airglow intensities were observed at angles further away from the sun line.

1970 SOLAR ECLIPSE PROJECT NO. 3.4-F-05.04

Institution	:	The Johns Hopkins University
Investigators	:	FASTIE, W. G. (Principal Investigator) HOLLIDAY, G. (Expedition Manager)
Title	:	1) Photometric and Spectroscopic Observations of Day Airglow 2) Photometric Studies of Shadow Bands 3) Photographic and Photometric Determination of Contact Times
Purpose	:	1) To measure OI emission (5577 Å and 6300 Å) and Rayleigh scattering from a vertical column as a function of shadow height 2) To determine the spatial and temporal behavior of the shadow bands at different wavelengths 3) To determine lunar ephemeris
Description	:	A one-meter Ebert spectrometer will monitor the dayglow emissions in the wavelength region 6290 Å to 7300 Å. A photometer, employing an interference filter peaked at 6303 Å, will attempt to measure the OI (^1D-^3P) line at 6300 Å while a half-meter Ebert spectrometer will scan the region from 5555 Å to 5595 Å to detect the OI (^1S-^1D) line at 5577 Å. Rayleigh scattering in the direction of the zenith will be observed with a 1^o FOV photometer in the wavelength range 6500 - 8000 Å. For observations of the shadow bands, photometers at 4852 Å and 6690 Å, with FOV of 6^o will look directly at the sun.
References	:	None
Location	:	Dam Neck Naval Training Center, Virginia Beach, Virginia [Exact coordinates to be supplied later.]
Dates	:	March 4-9, 1970
Equipment	:	Spectrometers, Photometers, and Recording equipment will be contained in one JHU/APL trailer
Special Site Requirements	:	None
Names of Participants	:	I. H. Schroader, G. G. Sivjee, P. Takacs, W. McKinney, P. Feldman, J. Barry, H. W. Moos, M. D. Chedester, plus 10 student assistants
Cooperating Groups	:	JHU Physics Department JHU Applied Physics Laboratory
Special Needs	:	None
Station Prob	:	1.0
Funds	:	NASA, U.S. Navy

SUMMARY OF PRELIMINARY RESULTS PROJECT NO. 3.4-F-05.04

During totality a few individual spectrometer scans showed atmoic oxygen emissions at 4477 Å superimposed on a background of scattered radiation. The intensities of these lines have been determined to be 1200 ± 300 rayleighs and 1700 ± 400 rayleighs, respectively.

Shadow bands were successfully recorded before and after totality for a period of about 1.5 minutes. Our station location directly on the eclipse center-line and perfect weather conditions contributed to ideal experimental conditions. The bands exhibited a structure not apparent to the eye: They have a very sharp leading edge and a long trailing edge, both before and after totality. Modulation of light intensity in the pattern is as great as 50%. No conclusions about fine structure detail (less than 1 cm) can be made, due to insufficient detector resolution. The bands appear to have the same structure at both wavelengths.

Eclipse occurred approximately 3 seconds early by photometric measurement of second and third contacts. Result subject to resurvey of site and check of ephemeris calculation.

1970 SOLAR ECLIPSE PROJECT NO. 3.4-F-06.00

Institution	:	NASA/GSFC/Univ. of Michigan/Yale
Investigators	:	SPENCER, N.W., BRACE, L.H., WALKER, J.C.G. and CARIGNAN, G.R.
Title	:	Investigation of Thermal Balance and Photochemistry of the E and F Regions
Purpose	:	To determine the ion production and loss rates and the electron cooling rates in the E and F region, and further to measure the dynamic response time of the ions and neutrals to the reduction in solar ultraviolet heating.
Description	:	An identical pair of rocket payloads would be launched; one at about 50% obscuration and the second near totality. By employing both upleg and downleg data, four profiles of ion, neutral and electron structure would be obtained at intervals along the obscuration curve. A time dependent solution of the particle and energy equations of the neutral and charged populations will be employed to attempt to fit the observations. From this, we would expect to vastly improve our understanding of the photochemistry and the dynamic processes induced by the known variation in solar input.
References	:	Spencer, N. W., L. H. Brace, D. R. Taeusch, G. R. Carignan, H. Niemann, "Electron and Molecular Nitrogen Temperature and Density in the Thermosphere." J. Geophys. Res., 70, 2665, 1965 Spencer, N. W., G. R. Carignan and D. R. Taeusch, "N_2 Temperature and Density Data for the 150 to 300 KM Region and Their Implications," Ann. Geophys., 22, 151-160, 1966. Spencer, N. W., G. R. Carignan and D. R. Taeusch, "Recent Measurements of the Lower Thermosphere Structure," AMS Meteorological Monographs, Vol. 9, No. 31, 201-207, 1968. Spencer, N. W., G. P. Newton, G. R. Carignan and D. R. Taeusch, "Thermospheric Temperature and Density Variations with Increasing Solar Activity," Space Research X, North-Holland Publishing Co., Amsterdan (1970).
Location	:	Wallops Island, Virginia
Dates	:	7 March 1970
Equipment	:	Thermosphere Probe Rocket Payloads (2) TM Frequencies Optional
Special Site Requirements	:	None
Number & Names of People	:	8 people
Cooperating Groups	:	GSFC/University of Michigan pitot-static rocket series - Horvath, Smith, Theon. GSFC - Ozone rocket series - Hilsenrath, Smith. GSFC - Airglow rocket - D. F. Heath
Special Comments and Needs	:	Timing of launches in eclipse is critical, both within this pair and among other launches by cooperating groups listed above.
Station Prob	:	1.0
Funds	:	Available, GSFC rocket program.

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.4-F-06.00

Two identical Thermosphere probe payloads were launched at Wallops Island into 40% and 80% obscuration during the 7 March, 1970 solar eclipse. Both payloads operated successfully and complete data recovery was achieved.

On each payload an omegatron mass spectrometer provided measurement of molecular nitrogen temperature and density, an ion spectrometer provided ion composition measurements, and a Langmuir probe provided electron temperature and density measurements. Current status is that the measured parameters versus altitude are in near final form with work to start shortly on the interpretation of the measurements in terms of atmospheric photochemistry and the dynamic processes induced by the known variation in the solar input.

1970 SOLAR ECLIPSE PROJECT NO. 3.4-F-07.00

Institution	:	ESSA Research Laboratories
Investigators	:	GRAY, R. S., WRIGHT, J. W., SHIMAZAKI, T.
Title	:	Ionospheric Dynamics by Radio Soundings
Purpose	:	To observe time-dependent variations of electron density and motions in the region 90 - 300 km on eclipse and control days. In subsequent analysis we shall attempt to interpret the measurements in terms of ionospheric responses to the variations of photoionization, temperature, dynamo current flow, and ionospheric convection caused by neutral motions.
Description	:	A J-5 ionosonde already established at Wallops Island will be operated on a suitable accelerated schedule, as follows: one ionogram each $5^m \pm 1$ day, one ionogram each minute ± 3 hours of totality; quarter-hour soundings $\pm$ 5 days or more. Subsequent analysis to N(h) profiles, and interpretation will be performed in Boulder.
Reference	:	Vertical Drift Velocities of the Ionospheric F-region During the Eclipse of 12 November 1966, by T. Shimazaki and A. R. Laird, Journal of Geomagnetism and Geoelectricity, Vol. 20, No. 4, pp. 323-335, 1968.
Location	:	Wallops Island, Virginia
Dates	:	March 1 - 15, 1970
Equipment	:	Standard ionosonde
Special Site Requirements	:	None beyond facilities now in place
Number and Names of People	:	R. S. Gray and C. Smith
Cooperating Groups	:	NASA Wallops Station
Special Comments and Needs	:	None except possible RF interference coordination
Station Prob	:	95%
Funds	:	$10,000

SUMMARY OF PRELIMINARY RESULTS:

Electron density profiles have been calculated for 0900 - 1715 EST (see Table 1), March 6 and 7, 1970 for vertical incidence ionograms taken at Wallops Island, Virginia (38°N, 75°W). Figure 1 (attached) is a sample graph showing electron density variation at fixed heights. Monthly median electron density profiles have also been calculated. No analysis of the data is planned at this time, but these data are available to all researchers through the World Data Center A, ESSA, Boulder, Colorado, for a nominal copying cost. The data reduction was sponsored by ESSA/NASA. Electron density profiles for other eclipses are also available for comparison:

Station	Geog. Coord.	Date
Aitutaki	19°S, 160°E	May, 1965
Rio Grande	32°S, 52°W	November, 1966.

Table 1

Time spacing of electron density tabulations

Date \ Interval	1 minute	5 minute	10-30 minute	hourly
March 6			1300-1500	0900-1300 1500-1715
March 7	1310-1420	1200-1310 1420-1500	1500-1600	0900-1200 1600-1715

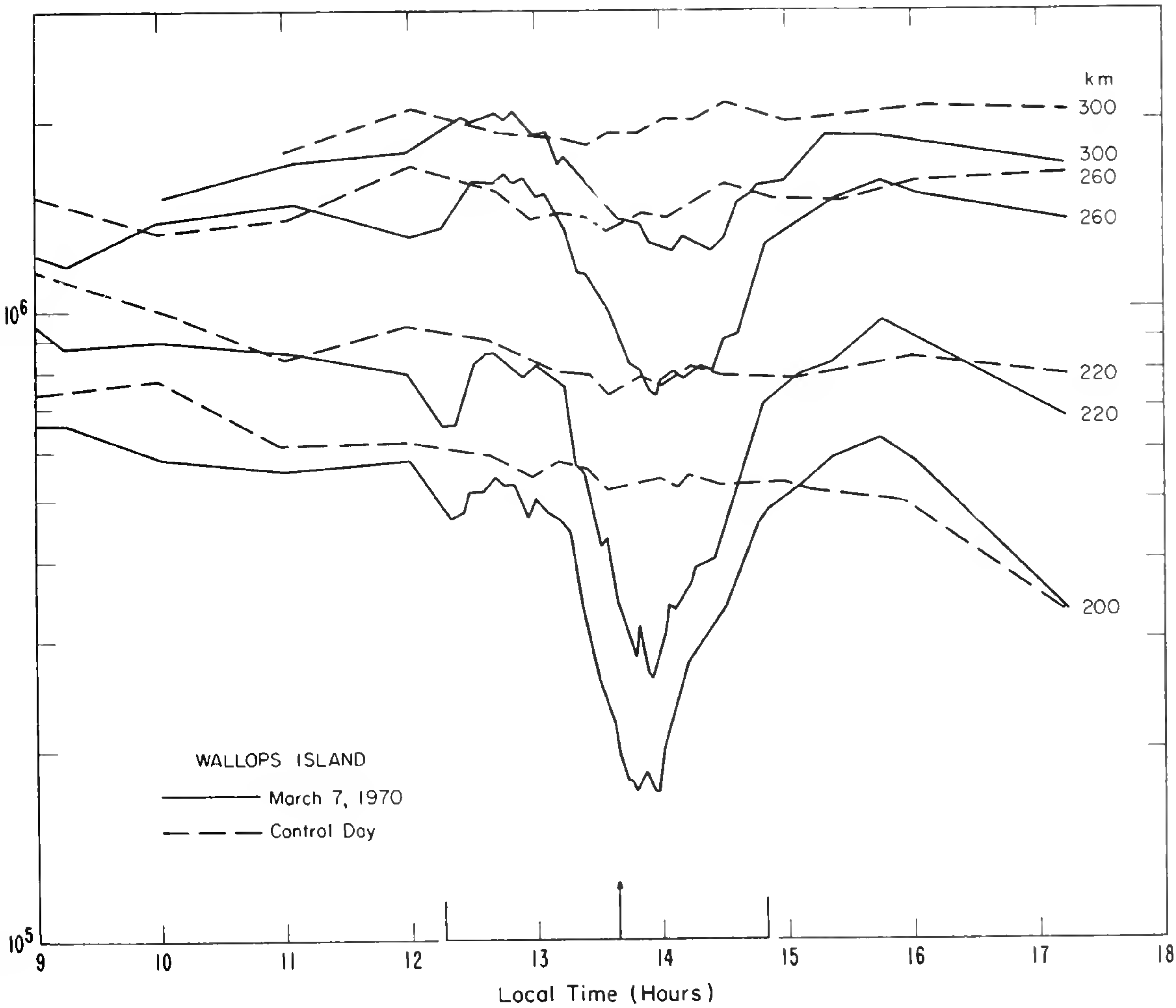


Figure 1. Electron density variation at fixed heights.

1970 SOLAR ECLIPSE PROJECT NO. 3.4-F-07.01

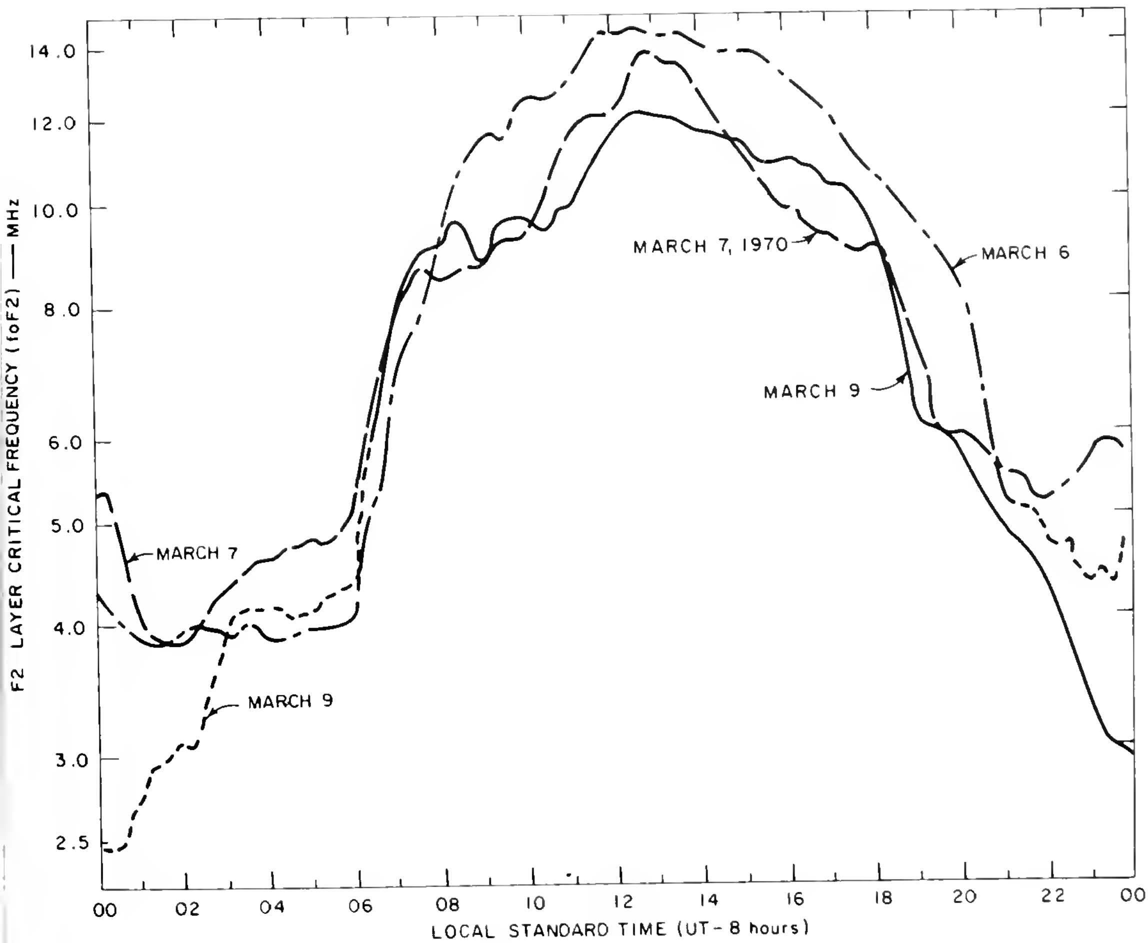
Institution	:	Stanford Research Institute, Radio Physics Laboratory Menlo Park, California 94025
Investigators	:	OETZEL, G. N. and CHANG, N. J. F.
Title	:	TID Investigation at Stanford, California During the 1970 Solar Eclipse
Purpose	:	To determine the effects of the eclipse on the ionosphere over the recording site
Description	:	Ionograms produced by a modified C-3 ionosonde at Stanford, California operating on a 5-minute program will be studied for the presence of traveling disturbances produced by the eclipse. In order to separate any unusual effects from the diurnal changes foF2 plots on the eclipse day will be compared with control days before and after the eclipse. The sequence of ionograms on the eclipse day will be examined for the presence of cusps near foF2 and/or the existence of satellite traces which move with time.
Reference	:	January 16, 1970 letter from Albert E. Belon, U.S. Coordinator for the 1970 Solar Eclipse
Location	:	Stanford, California
Dates	:	
Equipment	:	Modified C-3 Ionosonde
Special Site Requirements	:	None
Number and Names of People	:	None
Cooperating Groups	:	None
Special Comments and Needs	:	None
Station Prob	:	1.0
Funds	:	Normal data collection is supported by Stanford Research Institute. No funds are available for data analysis.

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.4-F-07.01

In response to G. Chimonas' and C. O. Hines' (J. Geophys. Res., 75, 875, 1970) suggestion that atmospheric gravity waves may be launched by the March 7, 1970 solar eclipse, the ionosonde at Stanford, California was operated on a 5-minute program from 1400-2400 UT on the eclipse day.

A plot of the F2 layer critical frequencies on March 7, 1970 is shown in Figure 1. For comparison F_oF2 plots for the day prior to and two days following the eclipse are shown. March 8, 1970 is not included due to the adverse ionospheric effects of a large magnetic storm that started at approximately 1419 UT.

Eclipse effects on the ionosphere at Stanford are not evident from the f_oF2 plots. In addition, a careful study was made of the ionograms for 7 March 1970. Particular attention was paid to the presence of cusps near the F-layer penetration frequency and/or to satellite traces that appear separated from the normal ionogram trace, and that move with time. None of these anomalies were found. Although time lapse movies of the 7 March ionograms may reveal motion attributable to the eclipse a visual inspection of the sequence of ionograms does not suggest any unusual changes with time. Thus if the 7 March 1970 solar eclipse had any effect on the ionosphere over Stanford, California it was too small to be readily detected by the ionosonde.



1970 SOLAR ECLIPSE PROJECT NO. 3.4-F-07.02

Institution	:	Ionosphere Laboratory, Meteorological Institute Technical University, 2800 Lyngby, Denmark
Investigator	:	OLESEN, J. K.
Title	:	Investigations of travelling ionosphere disturbances during the 1970 Solar Eclipse
Purpose	:	Detection of atmospheric gravity waves which may be generated by the solar eclipse resulting in travelling ionospheric disturbances.
Description	:	Three ionosondes routinely operated in Greenland will provide the data.
Location	:	Narssarssuaq at southern tip of Greenland geogr. 61.2°N, 45.4°W, geom. 71.2°, 36,7°
		Godhavn at mid Greenland west coast geogr. 69.3°N, 53.5°W, geom. 79.9°, 32.6°
		Thule at north western "corner" of Greenland geogr. 77.5°N, 69.2°W, geom. 89°, 358°
Dates	:	Continuously operated.

SUMMARY OF PRELIMINARY RESULTS

All equipment was operated as planned. Ionograms appear to be obsoured by heavy absorption produced by the concurrent solar disturbance. It is presently doubtful that the data will yield useful information on TID.

1970 SOLAR ECLIPSE PROJECT NO. 3.4-F-08.00

Institution	:	Institute for Telecommunications Sciences ESSA Research Laboratories Boulder, Colorado 80302
Investigators	:	TVETEN, L.H. and HUNSUCKER, R.D.
Title	:	High-frequency Backscatter investigation of the ionosphere during a solar eclipse.
Purpose	:	A narrow-beam HF radar which is scannable in elevation and azimuth operated form the ESSA Lab. field sites near Boulder, Colorado. The radar beam looked almost normal to the eclipse path. Simultaneous azimuth scan and elevation scan backscatter delay versus angle photographs were made at 15.7 MHz. Sweep frequency narrow beam backscatter records were made every 10 minutes and multiple range gate backscatter Doppler records were made once per minute.
Description	:	A narrow-beam HF radar which is scannable in elevation and azimuth operated from the ESSA Laboratory field sites near Boulder, Colorado. The radar beam looked almost normal to the eclipse path. Simultaneous azimuth scan and elevation scan backscatter delay versus angle photographs were made at 15.7 MHz. Sweep frequency narrow beam backscatter records were made every 10 minutes and multiple range gate backscatter Doppler records were made once per minute.
Reference	:	L.H. Tveten Ionospherically propagated sea scatter, Science, <u>157</u>, Sept. 15, 1967, 1302-1304. R. D. Hunsucker and L. H. Tveten, Large Travelling ionospheric disturbances observed at midlatitudes utilizing the high resolution hf backscatter technique, Jour. Atmos. Terr. Phys., <u>29</u> August 1967. Robert D. Hunsucker, Radio studies of the high latitude ionosphere during the solar eclipse of 20 July 1963, Radio Science, <u>69D</u>, February 1965, 267-272 Tveten, Lowell and Robert D. Hunsucker, Remote sensing of the terrestrial environment with an HF radio high-resolution azimuth and elevation scan system, Proc. IEEE, <u>57</u>, No. 4, Apr. 1969, 487-493.
Location	:	Boulder, Colorado
Dates	:	March 4-9, 1970
Equipment	:	Already installed at field sites.
Special Site Requirements	:	--
Number & names of People	:	L. H. Tveten. R. D. Hunsuker plus two or three other support personnel
Cooperating Groups	:	--
Special Comments and Needs	:	--
Station Prob	:	1.0
Funds	:	ESSA

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.4-F-08.00

Several types of high-frequency backscatter observations were made using the ITS-ESSA high resolution azimuth and elevation antenna arrays located near Boulder, Colorado and directed southeastward over the central United States.

Azimuth-elevation scan photographs* were made each minute at a frequency of about 15.7 MHz. Sweep frequency backscatter records were made over a frequency range of 6.7 MHz to 29 MHz once each 10 minutes during a 2 minute time slot. Multiple-range gate Doppler records were also made each minute at 1/2 msec backscatter delay intervals between 10 and 20.5 msec. These observations were made over a 9 hour period bracketing the eclipse and also for a similar time period on March 9.

The analysis of the data is still in quite a preliminary stage. However, all of the data taken showed the effects of the eclipse. The azimuth-elevation scan backscatter data showed large scale tilt effects. Sweep frequency backscatter showed greater skip distance changes with the longer ranges (reflection area closer to totality). Multiple range gate Doppler showed some effects whose interpretations are not entirely clear as yet.

*Tveten, Lowell and Robert D. Hunsucker, Remote sensing of the terrestrial environment with an HF radio high-resolution azimuth and elevation scan system, Proc. IEEE, 57, No. 4, Apr. 1969, 487-493.

1970 SOLAR ECLIPSE PROJECT NO. 3.4-F-08.01

Institution	:	Electrical Engineering Section, College of Engineering, Research Division, Washington State University.
Investigators	:	SCHRADER, D. H.
Title	:	Solar Eclipse TID Investigation.
Purpose	:	A Search for a TID generated by the solar eclipse of March 7, 1970. The F region will be scanned using a 3 Kw backscatter sounder operating at 30 MHz. These data will be processed using Valverde's method (Stanford University Radio Proposal Laboratory Science Rpt. AFCRC-TN-58-414, May 1, 1958). The E region will be scanned using a 3 receiver, phase path sounder operating at 2.155 MHz.
Description	:	-
References	:	B. P. Johnson adn D. H. Schrader "Traveling ionospheric disturbances during the IQSY", Washington State University CERD research rpt. 68/16-59 N. K. Shi and D. H. Schrader, "An attempt to detect traveling waves in the ionosphere with a phase path sounder", Washington State University CERD research rpt. 68/16-97.
Location	:	Pullman, Washington.
Dates	:	March 7, 1970.
Equipment	:	30 MHz backscatter sounder, 2.155 Mhz phase path sounder.
Station Prob	:	0.8
Funds	:	National Science Foundation - Washington State University.

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.4-F-08.04

The preliminary examination of data recorded on March 7, 1970 has produced no evidence of a traveling wave at Pullman triggered by the solar eclipse.

On the day in question we had a 30 MHz, pulsed backscatter radar operating and we received F-layer echoes throughout the day. Early in the morning there was an auroral type echo which was followed by a TID passing overhead about 1600 UT coming from the northeast. We speculate that this TID was associated with the aurora. Another TID was observed on this radar passing overhead at about 0100 UT March 8. This TID came from the north and traveled south.

The phase path sounder operating at 2.155 MHz was operative from 1430 UT to about 1900 am (UT) at which time equipment malfunction caused the records to be useless. From the time from 1730 to about 1830 there appears to be some type of oscillatory waveform in the phase vs time record. This occurred at a time which makes it unlikely to be associated with the solar eclipse because the propagation velocities required are too great. We feel that this might be associated with the aurorally produced TID and we are examining it more carefully. We have not yet completed this examination.

1970 SOLAR ECLIPSE PROJECT NO. 3.4-F-08.02

Institution	:	ESSA Research Laboratories, I.T.S.
Investigators	:	VIOLETTE, E. J., PAUL, Adolf K. and MCKINNIS, Dean
Title	:	HF Sounding with On-line Digital Computer.
Purpose	:	To detect and measure the characteristic of atmospheric gravity waves which might be generated by the March 7 Eclipse and propagated to the vicinity of Boulder, Colorado.
Description	:	The computer will be programmed to concentrate the observation on time-dependent variation of virtual heights, r.f. phase, and amplitude over the 100 to 300 km region during the period of 1600 to 2400 hrs. U.T. Identical measurements will be made over a four-day interval beginning two days before and continuing until the day after the eclipse. Considerable data processing will occur on-line before storing on magnetic tape to simplify the reduction and comparison of the four days of observation. The computer selection of frequencies will provide optimum coverage without generation of unnecessary data.
References	:	Letter of January 16, 1970 from Albert E. Belon, U.S. Coordinator for the 1970 Solar Eclipse.
Location	:	Erie Field Site, 20 miles East of Boulder, Colorado.
Dates	:	March 5 through 8, 1970.
Equipment	:	Dynasonde (Computer Controlled Digital Ionosonde).
Special Site Requirements	:	None
Number & Names of People	:	Three: E. J. Violette, A. K. Paul, D. McKinnis
Cooperating Groups	:	
Special Comments and Needs	:	None
Station Prob	:	95%
Funds	:	Funds for recording the data will be found within ESSA, but to date funding for the data reduction and publishing has not been located.

SUMMARY OF PRELIMINARY RESULTS:

The project was performed as planned in the above description. The only complication was the disturbed situation on 8 March which confuses the background data.

No preliminary results are yet available.

1970 SOLAR ECLIPSE PROJECT No. 3.4-F-08.03

Institution	:	Washington State University
Investigator	:	HARBOUR, Professor Richard D.
Title	:	Oblique Low Frequency Phase Path Measurements
Purpose	:	Attempt to detect passage of atmospheric gravity waves from solar eclipse by measuring the difference in frequency with time of a signal propagating from a standard frequency station and a local standard frequency source
Description	:	A propagating atmospheric gravity wave may cause a change in D region electron density that will affect the phase path of WWVB standard frequency signals. A number of stations on different azimuths may be able to record the perturbation in the normal difference in frequency drift pattern due to passage of a wave front and possibly be able to separate this signal from other changes caused by the eclipse. A sufficient number of stations would define the time of passage of the wave and allow velocities and directions to be established.
References	:	
Location	:	Pullman, Washington
Dates	:	24 hours each side of eclipse time
Equipment	:	Standard frequency source, WWV receiver and difference frequency recording equipment
Special Site Requirements	:	None
Number and Names of People	:	To be organized
Cooperating Groups	:	To be listed later
Special Comments and Needs	:	
Station Prob	:	.3
Funds	:	Volunteers — local organizations

SUMMARY OF PRELIMINARY RESULTS:

No report

1970 SOLAR ECLIPSE PROJECT NO. 3.4-F-08.04

Institution : Georgia Institute of Technology, Engineering Experiment Station Electronics Division, Communications Branch, Atlanta, Georgia

Investigator : JENKINS, H. H.

Title : HF Radiolocation and Propagation Experiments

Purpose : Radiolocation experiment objectives were to study eclipse effects on the direction-of-arrival of ionospherically propagated HF transmissions both longitudinal and transverse to the eclipse shadow track. Propagation experiment objectives were to (1) determine effects on the amplitude-time characteristics of test transmissions propagating parallel and perpendicular to the shadow track and (2) observe the overall effect on the upper (10-20 MHz) region by means of broadband spectral-analysis.

Description : Radiolocation experiments were performed using a 2-20 MHz short-baseline rotating interferometer. Direction-of-arrival data on transmissions from Mexico, Canada, Cuba, and the U. S. (WWV and VOA Greenville, N. C.) were obtained before, during, and after the eclipse interval. Bearing data were reduced to obtain mean and standard deviation parameters.

Propagation data were obtained by continuous amplitude-time recordings of the AGC output voltages of two R-390 receivers multicoupled to an 18-foot vertical monopole. Test transmissions originated from the U. S., Canada, Mexico, and Cuba.

Location : Radiolocation site near Tucker, Georgia, fourteen miles east of Georgia Tech campus. Propagation experiment site on Georgia Tech campus in Atlanta, Georgia.

Dates : Radiolocation data obtained on seven days between February 2 and March 7. Propagation data obtained on twenty-one days between January 31 and March 12 including March 7 eclipse interval.

Equipment : Radiolocation equipment was a six-foot baseline, vertical dipole, sum-and-difference, rotating interferometer with CRT read-out of bearing data. Propagation data were obtained by using two R-390 receivers multicoupled to a 18-foot vertical monopole. Spectral analysis was performed using a HP1415 storage display with an HP8554L RF section feed by a horizontal dipole.

Number and Names of People : Four (two at each site). H. H. Jenkins and R. W. Moss, plus two support technicians.

Funds : Internally supported Georgia Tech Electronics Division research project.

SUMMARY OF PRELIMINARY RESULTS:

Radiolocation Experiments

Test transmissions used were Radio Mexico (15.110 MHz), Radio Canada (15.320 MHz), Radio Havana (15.260 MHz), VOA Greenville, N. C. (15.225 MHz) and WWV (15 MHz). The above test transmissions afforded the best combination based on transmission consistency, diversity of paths relative to the shadow track, and operating frequencies relative to the calculated maximum MUF's as obtained from ESSA prediction data. The Mexican and Canadian transmissions provided propagation paths longitudinal to the shadow track; the WWV path was relatively remote from the shadow track; the shadow track passed directly across the VOA site.

Reference direction-of-arrival data were obtained on February 2, 11, 12, 20, 22 and March 1 between 1600 and 1900 hours U. T. Reference data were also taken on March 7 between 1600 and 1700 hours U. T. prior to the eclipse. Primary eclipse data were obtained between 1700 and 1900 hours U. T. on March 7.

Direction-of-arrival data were reduced to obtain mean error (referenced to the calculated great circle bearing), standard deviation, and absolute spread.

Comparison of primary data with reference data show that no significant deviations from normal occurred during the eclipse interval except for a slight lateral deviation on the Radio Mexico transmission. Overall, the March 7 eclipse interval direction-of-arrival data exhibited less dispersion than that noted during control intervals. Standard deviations of approximately $\pm$ 3° on control days decreased to about $\pm$ 2° during the eclipse interval. Mean bearing off-sets were typically equal to or less than $\pm$ 2°.

Propagation Experiments

Amplitude-time reference data recordings of the test transmissions were obtained on eighteen days prior to and three days after March 7. All recordings were made during the 1600-1900 hours U. T. interval on the control days. In general, 15 minutes of data were recorded on each transmission on each control day. On March 7 continuous recordings of Mexico and Havana were obtained from 1715-1830 hours U. T. Canada and WWV were monitored from 1830-1915 hours U. T. Broadband spectrum monitoring began on March 2 and ended on March 8. Photographs of the spectrum were made every 15 minutes during the 1630-2000 hours U. T. interval on March 2, 5, 6, 7, and 8.

Data were reduced to obtain mean signal strength and fade rates and depths.

In general, mean signal strengths were considerably enhanced during the eclipse period. The Mexican and Canadian transmissions (longitudinal paths) exhibited significantly large increases in signal levels on March 7, e.g., the Canadian signal level doubled and the Mexican level quadrupled.

Fade rates also changed decidedly when compared with reference data, and deviations tended to be time-collated with the eclipse track. The table below presents average fade rates in fades/second obtained on the control days and the fade rate range (minima and maxima) observed on March 7 during the specified time intervals.

Transmission	Average Fade Rate Control Days (Fades/sec)	Fade Rate Range - March 7 (Fades/sec)
MEXICO	0.06	0.15-0.78 (1730-1815 h)
HAVANA	0.07	0.01-0.44 (1730-1830 h)
CANADA	0.14	0.2800.94 (1835-1925 h)
WWV	0.08	0.14-0.37 (1845-1925 h)

Short periods (5-10 seconds) of very rapid fading (rates greater than 10 per second) were noted on each transmission. The higher fade rates corresponded quite closely with the shadow track. For example, for the Havana transmission the fade rate did not begin to increase until some ten minutes prior to the intersection of the eclipse path with the great circle bearing line. The maximum rate of 0.44 fades/sec for Havana occurred some seven minutes after the shadow track intersected the great circle bearing line. Similar time lags were noted on the other transmissions. Experiments repeated on March 8 during the same time intervals also disclosed higher than normal fade rates. The character of the relatively rapid fading observed on March 7 and 8 was consistently periodic and, in most cases, superimposed on a longer period fade, i.e., a double periodic fade was typical. The rapid fading significantly affected transmission quality by lowering intelligibility.

Fade depths did not significantly change during the eclipse interval.

Broadband (10-20 Mhz) spectral analysis disclosed that the entire upper HF spectrum was enhanced during the eclipse interval with levels typically showing 5-10 dB increases relative to levels obtained on control days.

1970 SOLAR ECLIPSE - PROJECT NO. 3.4-F-08.05

Institutions : Stanford Research Institute, Menlo Park, California

ESSA Research Laboratories, Boulder, Colorado

Investigators : VESECKY, John F. and KANELLAKOS, Demetri (SRI)

LERFALD, Gordon (ESSA)

Title : Ionospheric Responses During Eclipse Measured Using Two Radio Techniques.

Purpose : To observe the propagation of radio energy in the HF band over a 1500 km west-to-east path before, during and after the eclip[se] by use of two different techniques.

Description : Two techniques were used; one employed transmission of very sh[ort] pulses centered at a frequency of 18 MHz and the other transmission of a Cw signal which was linearly swept from 5 to 30 MHz at a 1 MHz/sec rate (CHIRP signal) The transmitters were located at Palo Atlo, California and the receiving equipment at Table Mountain field site about 10 miles north of Boulder, Colorado.

The CHIRP ionosonde data, recorded on magnetic tape, were played through a spectrum analyzer and oscilloscope display to obtain ionograms of more or less conventional appearance. These were recorded on 35 mm film and later on a 16 mm movie type camera. The latter film, when projected as a movie, showed evidence of interesting systematic changes in the ionogram traces with time. The 35 mm filmed ionograms were scaled in detail by use of an electromechanical scaler which recorded digital data on magnetic tape as each ionogram was traced by a manual pointer. These data were then processed and plotted using a CRT plotter on a large digital computer. One approach is to plot the signal delay vs. time at specific frequencies.

The 18 MHz short pulses were transmitted once per second for the first six secon[ds] of each minute. The IF (1 MHz bandpass) and FM detected receiver output corresponding to the received pulses were displayed on 100 and 500 μsec. oscilloscope traces and recorded photographically. Manual scalings of the photographs yield total pulse travel time, pulse length, etc.

Reference : Chimonas, G. and C. O. Hines, "Atmospheric Gravity Waves Induced by a Solar Eclipse", J. Geophys. Res., 75, 875 Feb. 1970.

Location : Palo Alto, California (transmitting site) and Boulder, Colorado (receiving site).

Dates : March 6-9, 1970

Equipment : Sweep frequency (CHIRP) oblique ionosonde (5-30 MHz), 18 MHz short pulse, high power transmitter, 18MHz radio receiver with IF and FM detected outputs.

Special Site Requirements : Receiving site required absence of substantial radio frequency interference.

Number and Names of People : ESSA Labs (3), Boulder, Colo.: E. Berger, R. Hines, G. M. Lerf[ald] SRI (3), Palo Alto, Calif.: D. J. Carrick, A. V. McKinley, J. F. Vesecky.

Cooperating Groups : Ionospheric Dynamics Group, Radioscience Lab., Stanford University, Stanford, Calif. 94305.

Special Comments and Needs : High power short pulse transmitter may course interference nea[r] transmitting site. (None was reported during the experiment.)

Station Prob : 0.8

Funds : Internal funding at both ESSA and SRI.

Figure 1 shows a composite of several plots of group delay vs. time plotted as described above, at 1 MHz intervals in frequency in the range 13 to 21 MHz. The group delay scales are arbitrarily shifted relative to one another along the vertical axis so as to avoid excessive overlapping. A number of quasiperiodic variations appear present. Lines sketched in to connect associated peaks indicate a tendency for the higher frequencies to have a leading phase compared to lower frequencies. No attempt at interpretation will be made at this time. Anyone wishing to make detailed comparisions with other data are invited to contact the experimenters for more extensive data.

The 18 MHz short pulse data are presently being scaled to obtain pulse arrival time and pulse length (as received) during the time period shown in Figure 1.

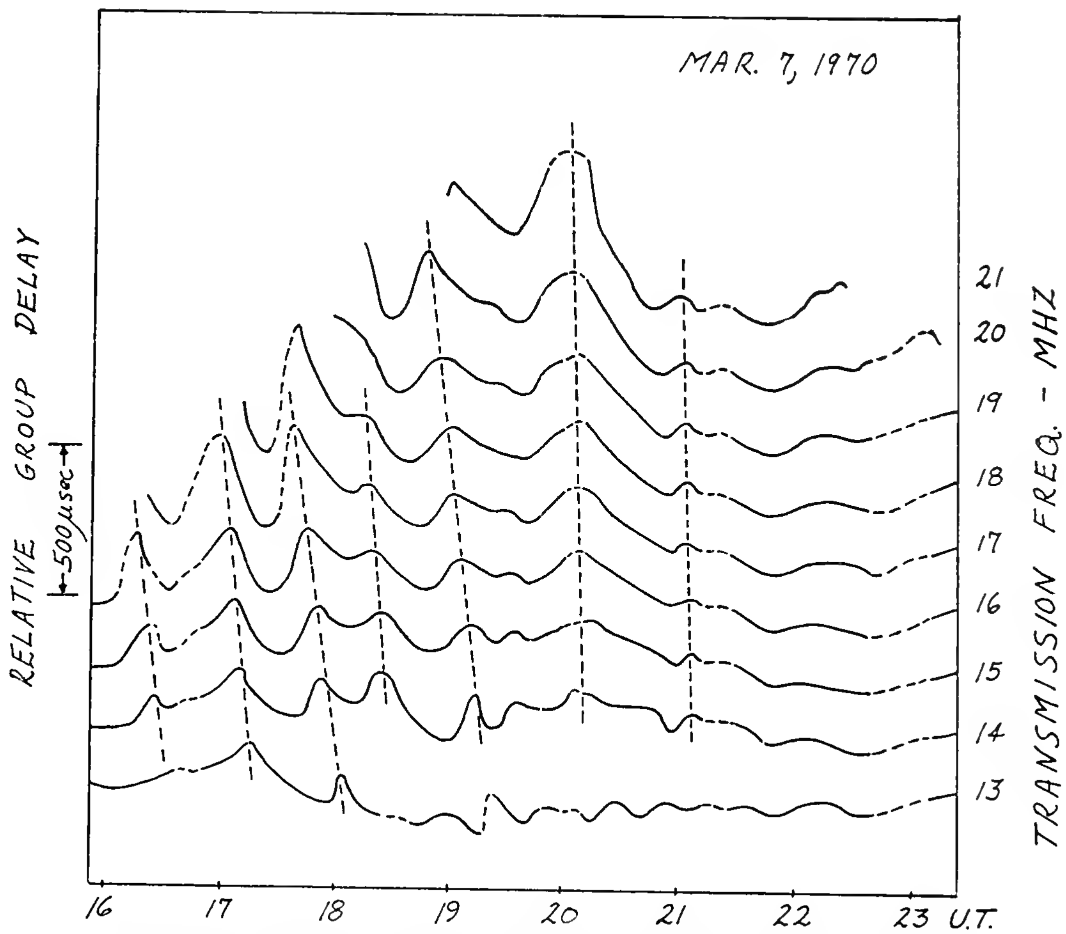


Fig. 1 Group time delay vs. time curves derived from oblique CHIRP ionosonde data at several transmissions frequencies. The path was from Palo Alto, California to Boulder, Colorado. Dotted lines indicate interpolations filling in gaps in the data. Traces have been shifted vertically to avoid overlap.

1970 SOLAR ECLIPSE PROJECT NO. 3.4-F-09.00

Institution	:	M.I.T. Lincoln Laboratory
Investigator	:	EVANS, J. V.
Title	:	Incoherent Scatter Radar Studies
Purpose	:	Examine the effects of the eclipse on the electron density, electron and ion temperature, ion composition and vertical drift in the height interval 120-500 km.
Description	:	Vertical soundings were made with the Millstone Hill incoherent scatter radar operated in four separate modes to cover the region 120-500 km. Two-pulse observations were made (i.e., the signal autocorrelation function was measured). The cycle time to complete the observations in all four modes and begin the next cycle was 20 mins. Data was collected on two control days prior to the eclipse with a 30 minute cycle time.
Reference	:	None.
Location	:	42.6°N 71.5°W.
Dates	:	March 5-7, 1970.
Equipment	:	Incoherent Scatter Sounder.
Special Site Requirements	:	None.
Number and Names of People	:	Evans, J. V., Reid, W. A. and others.
Cooperating Groups	:	None.
Special Comments and Needs	:	None.
Station Prob	:	100%
Funds	:	Yes please!

SUMMARY OF PRELIMINARY RESULTS :

Observations were made (see description).
No report of results.

1970 SOLAR ECLIPSE PROJECT NO. 3.4-F-09.01

Institution	:	U.S. Naval Research Laboratory, Radar Division
Investigators	:	MEAD, Dr. James B.; GOODMAN, Mr. John M.; WAGNER, Dr. Leonard S.; and NICHOLSON, Mr. Peter F.
Title	:	Incoherent Backscatter Experiment
Purpose	:	To measure F-region electron density profiles before, during, and after the eclipse. One of the following two experiments also will be carried out: measurement of plasma drift velocity along geomagnetic field lines or (b) measurement of electron and ion temperatures in the altitude range from 100 to 300 kilometers.
Description	:	The Randle Cliff Radar located at the NRL field station at Chesapeake Beach will be used to carry out Thomson scatter measurements. The 150-foot antenna at Sugar Grove, West Virginia will be employed as a possible bistatic station.
References	:	
Location	:	Chesapeake Beach, Maryland; Sugar Grove, West Virginia
Dates	:	March 7, 1970
Equipment	:	VHF radar 138.6 MHz 5 MW peak power operating into 150-foot diameter fully steerable paraboloid
Special Site Requirements	:	See under "Special Comments and Needs"
Number & Names of People	:	James B. Mead - NRL; Leonard S. Wagner - NRL; John M. Goodman - NRL; Peter F. Nicholson - NRL; Melvin Lehman - Chesapeake Bay Division
Cooperating Groups	:	
Special Comments and Needs	:	Freedom from radio frequency interference 138.6 MHz (bandwidths as high as 200 Kc are being considered). Previous operations have encountered severe RF interference from the following sources: (1) Security - police transmitter located at CBD (2) Military - communications near 138 MHz (3) Airline - communications
Station Prob	:	Clear air space near region of antenna beam pointing directions. Aircraft create coherent returns which will prevent useful data collection.
Funds	:	NRL

SUMMARY OF PRELIMINARY RESULTS:

Project was performed as planned.

No report of results.

1970 SOLAR ECLIPSE PROJECT NO. 3.4-F-09.02

Institution : Arecibo Observatory, Arecibo, Puerto Rico

Investigators : CARLSON, Herbert C.; HARPER, Robert; NELSON, Graham

Title : Thomson Scatter Observations of Ionospheric Eclipse Effects

Purpose : During a solar eclipse, ionospheric production and heat input are diminished; changes in electron density, electron and ion temperature, drif velocities, and possibly F_1 ionic composition (O^+ to "NO^+") and ν_{in} will be observed. A measure of change in neutral temperature, and density may be obtai The 5-20 eV energy segment of the photoelectron energy spectrum will be monitor for change. Effects of changes in production, redistribution, and possible rec bination will vary with altitude and attempts will be made to distinguish these Heat balance and photoelectron energy spectra changes will be compared with the Composition changes may aid reaction rate estimates.

Description : The installation at Arecibo will observe Thomson scatter at 43 with supplementary ionosonde (and hopefully ATS Faraday Rotation) measurements. 1000-foot spherical reflector will receive the ionospheric return from 2.5M wat pulses at nominal 6% duty cycle. The Thomson scatter ionic component will prov charged particle temperatures with nominal 6 and 40 Km - 15 minute - 5% resolut Thomson scatter plasma line return will give electron densities with nominal 3 5 minute - 2% resolution. Effort will concentrate on the 95 Km to 600 Km range

References : Gordon, W. E., Radar backscatter from the earth's ionosphere, IEEE Trans., Ap-12, 876-878, 1964.
Evans, J. V. and M. Loewenthal, Ionospheric backscatter observations, Planet. Space Sci., 12, 915-944, 1964.

Location : Arecibo Observatory: 66° 27^m W, 18.4° N geographic
29° N latitude geomagnetic (1.4 - 1.5 L Shell)

Dates : March 6, 7, 8, 1970 to include control periods (to range at le several hours before and after 18:30 U.T.)

Equipment : Standard equipment in location at the A.O.

Special Site Requirements : Standard equipment only

Number & Names of People : Member of ionosphere group and students: Herbert Carlson, Rob Harper, Graham Nelson, Thomas Trost, Leroy Cogger, Vincent Wic

Cooperating Groups : Cooperation expected with other groups gathering relevant data of other sites (e.g. other Thomson scatter installations in pa of eclipse, and other groups not yet contacted).

Station Prob : 0.9

Funds : A.R.P.A., NSF

SUMMARY OF PRELIMINARY RESULTS:

On March 7 during the eclipse, which reached a maximum of abou 30 per cent near 14:30 AST with a semiduration of about 80 minutes at Arecibo, data were taken alternating between two incoherent backscatter modes summarized in table 1. After 17:00 operation was continuous in Mode 1,(to optimize sensitivity to possible gravity waves effects). Data were gathered on March 6 and 8 as control days. Limited data were gathered before noon March 7 due to replacement of a $1\frac{1}{4}$M watt klystron. The March 8 data will be of limited control value due to the very high magnetic activity on this day. In addition to the incoherent backscatter data, some ionosonde data were also gathered on all three da

All Mode 1 data have been reduced, excepting extraction of $KT_{\parallel}$ from the plasma line intensities and T_e/T_i from the plasma line altitudes. The Mode 2 data and the ionosonde data have not yet been reduced.

o particularly dramatic or surprising changes of the measured raw parameters ere observed. As regards the heat balance, the ion temperature profile remained ssentially constant (within the 5% error bars) throughout the eclipse while F egion electron temperature was systematically $100^{o}K$ lower at mideclipse than at he onset or termination times. More significantly, the electron to ion energy ransfer rates deduced from the mid-eclipse data at 300km and 260 km (6800 and 300 eV cm^{-3} sec^{-1} respectively) were about 30 percent lower than near the onset nd termination times, indicating a decreased heat input to the bottomside F_2 egion electron well matched to the percentage of totality experienced. The opside plasma line intensities, which relate to the photoelectron flux in the -25 eV range, showed no significant change during the eclipse, and the heat conuction downward through the 550 km level throughout the eclipse was consistent ith $1.8 \pm 0.3 \times 10^{9}$ eV cm^{-2} sec^{-1}. The heat conduction downward through greater ltitudes observed appears to show a statistically significant dip at mideclipse, ut this could be explained simply by the increased topside electron density and onsequent electron to ion loss rate at this time.

n the photochemically dominated region the electron densities show a distinct ip at mideclipse in accord with recombination effects. The backscatter profile nd the ionosonde showed a distanct F_1 ledge for about 45 minutes centered on the clipse, contrary to the normal situation at this time when there is only the mere uggestion of an F_1 ledge. The Mode 2 data and ionosonde profiles are to be educed before the implications to ionospheric chemistry are examined in detail.

he topside electron densities show a distinct increase at mideclipse which a priority could be consistant with downward transport from well above 700 km followng a decreased topside electron temperature, or upward transport of the F egion of order 10 m/sec. Preliminary examination of the full F region profile avors the former explanation. It was suggested by Chimonas and Hines that tmospheric gravity waves might be generated by a solar eclipse. A 6 percent four standard deviation) wave with 15 minute period was observed between 175 km nd 225km and with onset about 17:30 AST. If one assumed the disturbance to riginate from the point of closest approach of totality, the velocity of proagation would be about 200 m/sec. The question of whether these waves are ssociated with the eclipse needs to be considered within the context of data rom other stations. For further detail see Nature, vol. 226, p. 1124, June 20, 970.

Table 1. Summary of the Arecibo Obervations

measured	Techniques PL	PP	AC	Altitude Resolution	Time Resolution	Uncertainty	Measured Range Top and Bottomside	
e	X			2-5 km	7 min	$\pm$ 2 km	3.5-8.5 MHz	
'n	X			~5 km	15 min	$\stackrel{+}{\sim}$30%	~5-25 eV	
e			X	40 km	7 min	6%	220-640 km	
.			X	40 km	7 min	6%	200-640 km	Mode
e		X	X	<45 km	7 min	~5%	200-640 km	1
							130-780 km	(PP)
/Ti	X	X	X	40 km	7 min	~5%	3.5-8.5 MHz	
e		X	X	9 km	12 min	~6%	100-500 km	
e		X	X	9 km	12 min	~6%	115-300 km	
.		X	X	9 km	12 min	~6%	115-300 km	Mode
)+		X	X	9 km	12 min	~10 km	145-235 km	2
l		X	X	9 km	12 min	~20 m s^{-1}	115-300 km	

: plasma line; PP: power profile; AC: autocorrelation function

(See also: Nature, 226, p. 1124, June 20, 1970)

1970 SOLAR ECLIPSE - PROJECT NO. 3.4-F-09.03

Institution	:	Stanford Research Institute
Investigators	:	BARON, M. and WATT, T. M.
Title	:	Incoherent Scatter Observations
Purpose	:	Measurement of electron density, electron and ion temperatures, as functions of altitude between approximately 200 and 600 km.
Description	:	The incoherent (or Thomson) scatter technique is employed using an L-band radar with an 88-ft antenna and 5 Mwatts peak power. Time resolution of measurements will be on the order of a few minutes. Altitude resolution will ba about 25 km for density measurements, 50 km for temperature measurements.
Location	:	Near Stanford, California 37° 24' N, 122° 11' W
Dates	:	March 6, 7, 8, 1970, 1300-2200 GMT
Station Prob	:	1.0
Funds	:	DASA

SUMMARY OF PRELIMINARY RESULTS:

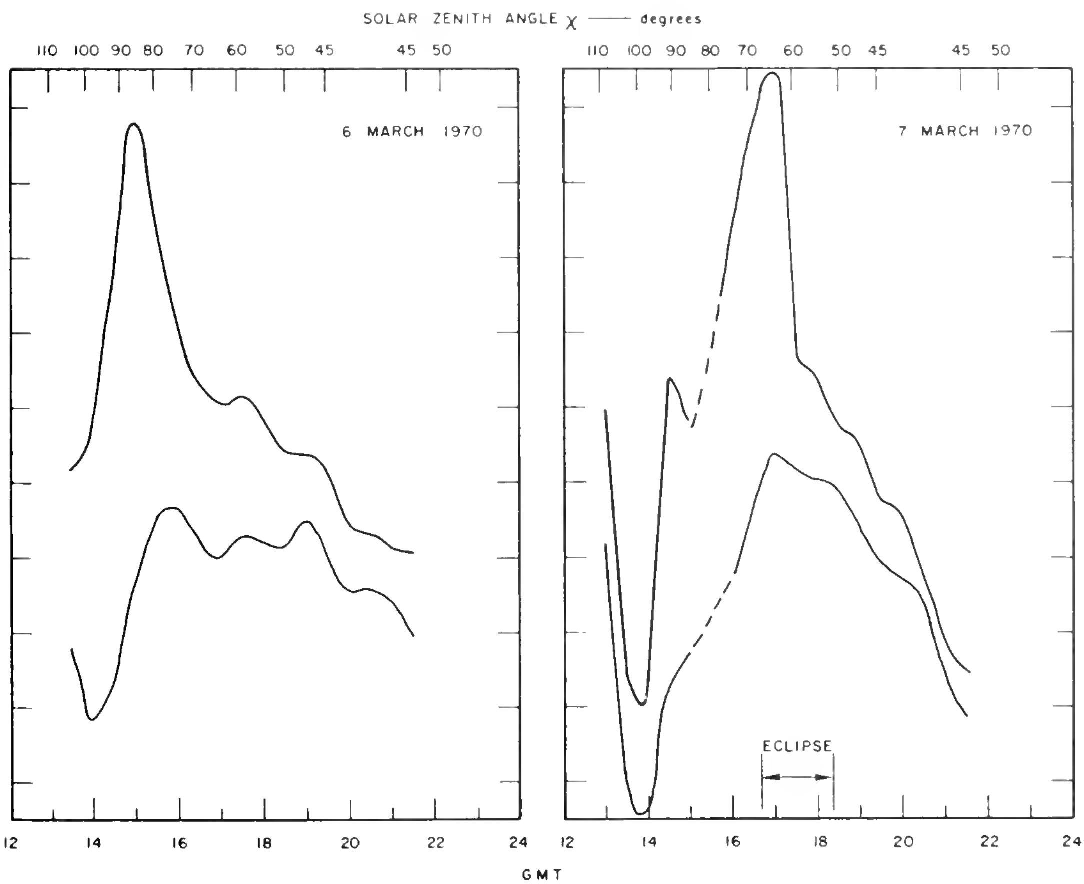
Measurements of electron density and electron and ion temperatures were made during the 7 March 1970 partial solar eclipse at Stanford, California. Vertical drift velocities and possible gravity wave effects were also considered. The technique used for these measurements was the incoherent-backscatter method. Electron-density profiles were obtained nominally between 200km and 600km altitude at 15-minute intervals for at least an hour preceding each eclipse and for several hours following the eclipse Profiles over the same altitude range with the same time resolutio were also taken on the day before each eclipse and on the day afte the eclipse for use as background control data. Electron and ion temperatures were deduced from the backscattered spectra for all three days at 50-km intervals. The main eclipse effects--namely, reduced electron densities and reduced electron temperatures--were evident at almost all altitudes above 200-km for two to three hours following the eclipse.

Eclipse effects have been reported before. The main effects of an eclipse are: (1) Electron densities tend to decrease at all altitudes or if the eclipse occurs during sunrise when electron density is normally increasing, the rate of increase is substantially slowed down during the period of the eclipse; (2) electron temperatures decrease during the period of the eclipse; (3) the height of the maximum of the electron density porfile decreases during the period of the eclipse; (4) recovery time of the ionosphere following an eclipse appears to be of the order of two to three hours. These effects were all observed as part of the eclip reported here.

Consideration has been given to the possibility of induced gravity waves for the 7 March eclipse using a technique developed earlier. Downward propagating wavelike structures in electron density profi were observed for both 6 March and 7 March 1970, suggesting the presence of gravity waves. However, in order to verify the prediction it would be necessary to show significantly more evidence for gravity waves on the day of the eclipse than on the control day and this was not observed. It would appear, then, either gravity are not more likely to appear as a result of a solar eclipse or that the particular eclipse of 7 March was not complete enough to produce the predicted effects.

An attempt was also made to determine whether or not variations in vertical drift velocity of the plasma could be attributed to the eclipse of 7 March 1970. It has been shown that in the upper F-region an upward drift of the plasma can be associated with sunrise. It has also been shown that a wide day-to-day variation exists in observed drift velocities. Figure 1 illustrates profiles of observed vertical drift velocity for periods of interest during 6 March and 7 March 1970.

There are two features of the velocity profiles on 7 March that are especially interesting. Firstly, it can be seen that the upward velocity present at all altitudes just prior to the beginning of the eclipse is generally increasing with time until just after obscuration begins, when a sudden decrease takes place. It appears from this that the ambient velocity profile has been affected by the eclipse-associated cooling of the ionosphere, resulting in a thermal contraction and a subsequent tendency toward diminishing the upward flow. The second interesting feature associated with the 7 March obervations is that, following the period of obscuration, upward velocities continue to decrease steadily until finally, by 2100 GMT, a net downward flux begins at all observed altitides more than two hours after the eclipse. This velocity trend is interesting because it differs from observed trends typically occuring at this time of day. This observed velocity trend may or may not be significant in terms of eclipse effects, since the entire period of observation was one of high geomagnetic activity.



1970 SOLAR ECLIPSE PROJECT NO. 3.4-E-10.00

Institution	:	AF Cambridge Research Labs., Ionospheric Physics Lab. and Lowell Technological Institute Research Foundation (participant)
Investigators	:	BIBL, K., & REINISCH, B.(Lowell Tech.), TOMAN, K & VIDEBERG, J (AFCRL
Title	:	Ionospheric Variations Study During Eclipse Using Digisonde
Purpose	:	To investigate dynamic variations and special phenomena produced by a solar eclipse in the D, E and F regions at the ionosphere. The variations include electron density profile and structure, as well as ionospheric motions and gradients. Special phenomena include appearance of new layers (eg. F 1-1/2, Es) and the relationship between E and F layer effects. The increased capability of the Digisonde will improve presentation of these events and provide a thorough study of the absorption profile by accurate height and amplitude measurements.
Description	:	The equipment will consist of a new digital (integrating) ionosonde (Digisonde 128) operating between 0.25 and 14 MHz with 20 KW peak power using a new 200' high rhombic antenna for vertical incidence measurements. This sounder will obtain amplitude, phase, and virtual height data as a function of frequency. Results will be coordinated with those from other experiments.
References	:	1. "Solar Eclipses of the Ionosphere" Beynon & Brown, Pergamon Press, 1956. 2. "Ionospheric Sporadic E", Smith & Matsushita, Pergamon (Macmillan Co.), 1962 3. "Proceedings of AFCRL Workshop on 29 July 1963 Eclipse" Klobuchar & Allen. AFCRL 64-962 (Dec. 64) 4. Bibl, K. et al, Airborne Measurements of the Ionosphere, Final Report LTIRF 272/IP, AFCRL 68-0106, Aug. 68.
Location	:	AFCRL Maynard Field Test Site (USA Natick Laboratories Annex) (42° 25' N, 71° 27' W) under construction NOTE: Backup site, Billerica, Mass. (42° 33'N, 71° 17'W)
Dates	:	20 Feb. thru 20 Mar. 70
Equipment	:	As described
Special Site Requirements	:	New site under construction including 200' high crossed vertical rhombics over ground screen
Number & Names of People	:	4 to 6: J. Videberg, B. Reinsch, K. Bibl, etc.
Cooperating Groups	:	a. Toman & Lorentzen (3.4-D-12.00) b. C-4 Ionosonde, Ray Cormier c. Fixed frequency ionospheric drift system
Special Comments and Needs	:	New site scheduled for completion 15 Feb. 70. Alternate site, Billerica, Mass. using smaller vertical rhombic
Station Prob	:	0.8
Funds	:	AFCRL

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE PROJECT NO. 3.4-E-10.00

Institution	:	Air Force Cambridge Research Laboratories, and Lowell Technological Institute Research Foundation
Investigators	:	BIBL, Klaus (LTIRF); and PFISTER, Wolfgang (AFCRL)
Title	:	Ionospheric Drift Investigation for Eclipse-Induced Motions and Waves.
Purpose	:	Fixed-frequency ionospheric drift system will be used for observing eclipse-associated large-scale motions and waves as well as changes in drift speed and direction. These changes will be correlated with Sporadic-E appearance.
Description	:	Pulse amplitude and phase of 2.85 MHz is being monitored on three spaced antennas. Complex correlation analysis is used for separation of effects caused by atmospheric waves and by motion of turbulent structures.
References	:	Bibl, K., Large-Scale Fluctuation of the Ionosphere, AFCRL-64-900. Pfister, W., Bibl, K., Pulse Soundings with Closely Spaced Receivers as a Tool for Measuring Atmospheric Motions and Fine Structure in the Ionosphere, AFCRL-68-0662.
Location	:	Billerica, Massachusetts (42° 33' N; 71° 17' W).
Dates	:	Permanent installation.
Equipment	:	a) Fixed-frequency ionospheric drift system; b) C-4 sweep frequency sounder (1.7 to 14 MHz Frequency range; 10 kW peak power; 1-minute sweep time)
Special Site Requirements	:	None.
Number & Names of People	:	None.
Cooperating Groups	:	Digital Ionosonde (K. Bibl, B. Reinisch, LTIRF; J. Videberg, K. Toman, AFCRL). C-4 Ionosonde (Ray Cormier).
Special Comments and Needs	:	Permission to sound at one-minute interval will be required.
Station Prob	:	Operating.
Funds	:	Air Force Cambridge Research Laboratories.

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE PROJECT NO. 3.4-F-10.02

Institution : Ionospheric Institute, University of Athens

Investigator : ANASTASSIADIS, Professor M.

Instrumentation : Scaramanga Ionosonder, continuous recording; 50 kw Peak
Kreta Island Ionosonder, normal ionogram every minute;
course of type 1 kw. Microbarograph, National Observatory
of Athens, sensitivity 0.01 mB

Stations : Scaramanga (Athens)
Hersonissos Kreta Island
Meteorological Institute, Athens
National Meteorological Service

SUMMARY OF PRELIMINARY RESULTS:

: Ionospheric and microbarometric observations were performed before, during and after the March 7, 1970 solar eclipse and uncommon phenomena at least in foF2 and hF (continuous recording) were observed:

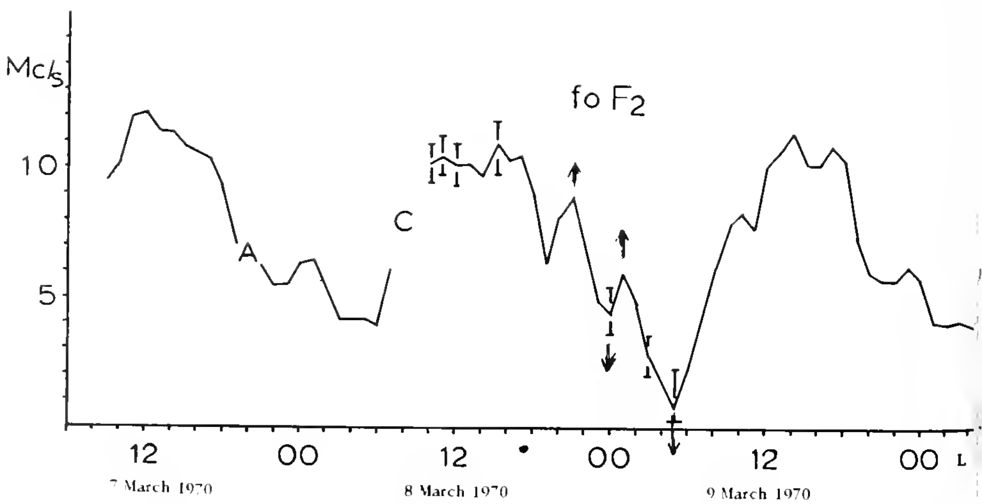
Increases in foF2 were observed at 19.00 and 23.00 UT on March 8
Decreases in foF2 were observed at 22.00 on March 8, and 03.00 on March 9, UT

These unusual increases and decreases were observable 24 to 34 hours after the eclipse time (18.40 on March 7, 1970). Examination of foF2 values and hF continuous recordings for previous solar eclipses in the North Hemisphere during the period 1960-70 did not show similarity with the above results in 1970.

The microbarograph of the Meteorological Institute of the National Observatory of Athens did not show any particular variation. The National Meteorological Service of Greece also, using Richard Baro Barograph report that a variation of 0.1 MBS of unusual regular form was recorded between 23.00 to 24.00 LT on March 8, 5 hours after the time of the eclipse. The NMS of Greece is not associating this variation with eclipse.

Examination of recordings of atmospheric electricity did not present any particular event.

Eclipse effect after several hours on foF2 is reported and discussed by Dr. Matsoukas of the University of Athens, in a paper presented in the Lagonissi Conference in May 1969 (Solar Eclipse and the Ionosphere-Plenum Press 1970, in press.)



1970 SOLAR ECLIPSE PROJECT NO. 3.4-F-12.00

Institution : Air Force Cambridge Research Labs., Ionospheric Physics Laboratory

Investigators : TOMAN, Dr. Kurt and LORENTZEN, A. H.

Title : Eclipse Experiment

Purpose : For an observer at a moderate geographic latitude, the sun is eclipsed daily by the earth. Totality lasts for the duration of a night. At astronomically predicted times the sun is also eclipsed by the moon and total obscuration of the ionizing solar radiation together with the local time of occurrence favorable for quasi-equilibrium conditions in the ionospheric regime near local noon make this rather unique astronomical event a focal point for short-term ionospheric radio experiments. The purpose of such experiments is the gathering of a wide variety of data derived from different observational techniques. Based on this data, ionospheric models are constructed and compared in time for their consistency with theories for the physics and chemistry, particularly of the lower ionosphere.

The eclipse effort proposed here is aimed to provide amplitude, frequency, and phase data for three radio frequency transmissions to be established in the predicted path of totality for the March 7, 1970 eclipse. This data will be compared and combined with other ground-based airborne and rocket data gathered before, during, and after this eclipse.

Description : An HF transmitting site and an HF receiving site will be selected so that the ionospheric mid-point between the two sites will be in the path of totality. Three frequencies to be used in the generation of the data, will be chosen to optimize the experimental results. The parameters, on each frequency, to be measured will consist of amplitude, phase and doppler information. This work will be done utilizing phase-stable transmitter and receivers.

References : (1) K. Toman, "Ionospheric Phase and Group-Path", J.A.T.P. 29, pp. 1019-1023 (1967). (2) K. Toman, "Frequency Variations of an Oblique 5 MHz Ionospheric Transmission", presented at AGARD-NATO Symposium, 9-12 Oct 1967: Ankara, Turkey. (To be published in the Proceedings). (3) K. Toman, A.H. Lorentzen, "Monitoring the Ionosphere by means of HF Frequency Measurements", presented at Fall URSI Mtg, Boston, Mass., 9-12 Sep 1968. (4) R.D.Sears, "Effects of the Nov.12, 1966 Solar Eclipse on High Freq. Phase Path & Amplitude Measurements." DASA Report SR66 (Feb 1968). (5) K.-H. Ohle, J. Taubenheim, "Effect of the Solar Eclipse of May 20, 1966, on the Ionospheric Absorption of Cosmic Noise on 25 MHz", J.A.T.P. 29, pp. 1663-1668 (1967).

Location : Nantucket and Chatham, Massachusetts

Dates : March 1, to March 15, 1970

Equipment : All equipment will be contained in two trailers

Site Requirements: The transmitting site will need sufficient area for the trailer and three antennas. The plot should be approximately 100 ft by 400 ft. The receiving site will need a plot of land 50 ft by 300 ft. The power requirement for the transmitting site is 20 kw single phase, 3 wire service. The power requirement for the receiving trailer is 7.5 kw single phase, 3 wire service.

Names of People : A.H. Lorentzen, R.E. Beauchesne, J. Corbett, R. Temple

Cooperating Group: Lowell Technological Institute Research Foundation; U.S. Coast Guard

Special Needs : Three frequency allocations for C.W. carriers in the 2 to 4 MHz band

Funds : AFCRL

SUMMARY OF PRELIMINARY RESULTS:

The transmitters were housed in a trailer which was located at Sankaty Head Coast Guard Station at Nantucket Island. The receiving trailer was located on the grounds of the Coast Guard Light House at Chatham, Mass., essentially due north of the transmitters. Fig. 1 illustrates the layout of the stations. The solid north-south line on the right represents the projection of the transmission path: the circle indicates the midpoint. To the right of the slant, solid line lies the region where totality could be observed at the earth's surface. The surface distance for the transmission was 43 km. The geographic coordinates of the midpoint were $69^{\circ}57\frac{1}{2}'$ W, $41^{\circ}28\frac{1}{2}'$N. For the midpoint the anticipated degree of obscuration was computed as a function of time for h=0, 50, 100, 200 and 300 km altitude. (Courtesy U.S. Naval Observatory, Nautical Almanac Office and AF Cambridge Research Labs., Data Analysis and Simulation Branch.) Accordingly, first contact was expected at 1731 U.T. at H=0, and at 1736 U.T. at h=300 km. Totality was to occur on the surface at about 1847 U.T. and last for 48 seconds. Maximum obscuration of 0.995 at h=50 km was expected a minute later. At h=300 km maximum obscuration of 0.98 was expected at 1852 U.T. Totality could not materialize in the ionosphere above 50 km. At the surface, fourth contact was predicted for 1958 U.T.; at h=300 km for 2003 U.T. Maximum obscuration was therefore delayed by one second for each kilometer of altitude.

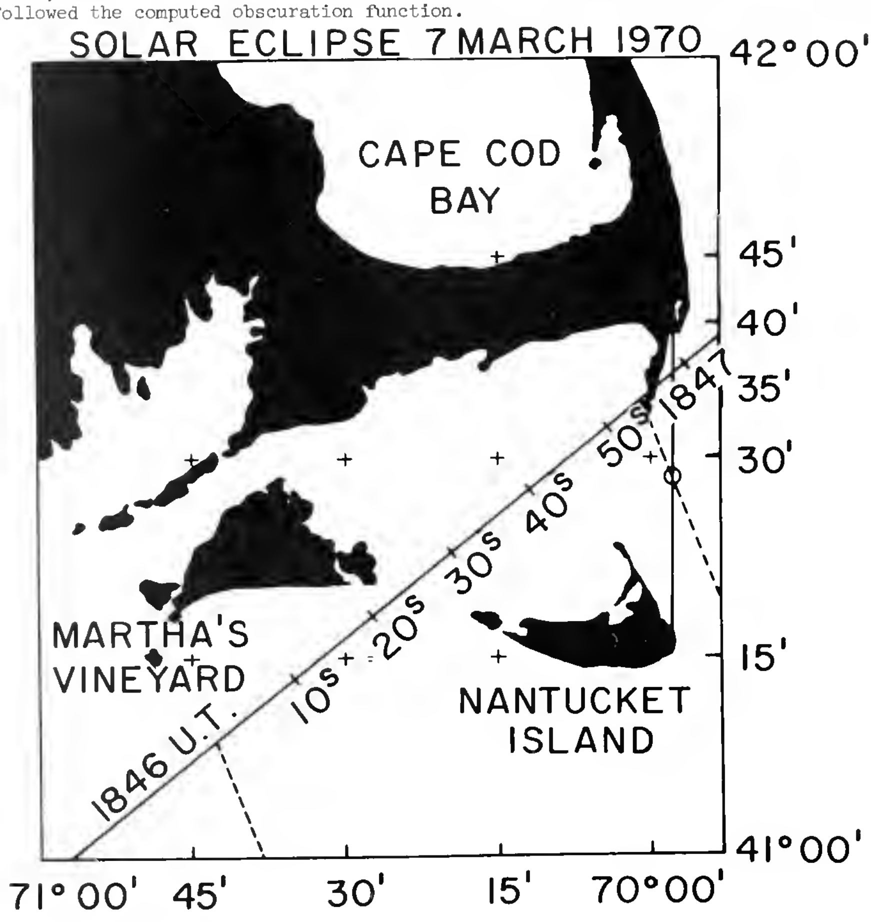
Licenses to operate on 2.232, 3.295, and 4.450 MHz were obtained. Successful transmissions were established on 3.295 and 4.450 MHz. For these frequencies, Doppler and amplitude measurements were made. Phase measurements were waived because of instrumental difficulties. Morever, the operational cycle of the air-conditioner in the transmitting trailer was identified as the cause of a cyclic modulation in the Doppler records. During its "on" period, the reference frequency of the 5 MHz standard was decreased by about 0.18 Hz. This cyclic modulation will complicate further data reduction and analysis. Presently, we are able to report the following preliminary results.

For the two operational transmissions, Doppler frequency variations were measured throughout the eclipse period. Noticeable changes in the Doppler frequency excursions became observable at about 50% obscuration. At 1855 U.T. the negative Doppler reversed to a positive Doppler. The total increase of phase path amounted to 100 km for both frequencies. This implies a phase height change of approximately 50 km. Associated with this height change was a maximum increase of signal amplitude by about 5 db for 4.450 MHz. By 2000 U.T. the phase path had decreased again by 80 km. The amplitude level of the 4.450 MHz signal revealed pronounced enhancements with recurrence periods between 6 and 12 minutes. Those enhancements were associated with rapid frequency changes suggesting the presence of curved reflection surfaces due to wavelike perturbations in the ionosphere. It is believed, however, that these observations do not necessarily suffice to propose a causal relationship of these periodicities with the eclipse event. It is more likely to conclude that the presence of ripples characterized the ionospheric structure over the Cape Cod area already before and certainly throughout the eclipse phase. The presence of these perturbations together with the previously mentioned instrumental pulsation effects will limit further data analysis.

The signal amplitude of the CHU 7.335 - transmission, originating in Ottawa, Canada, was continuously recorded 480 km away at AFCRL. The ionosphere above the midpoint at the southern tip of Lake Champlain experienced only partial obscuration. For maximum obscuration at about 1850 U.T. the average signal level had increased by 6 db. Subsequently, the signal level dropped by 16 db reaching a pronounced minimum at 1950 U.T. (1450 EST), which was followed by a 20-min. recovery. We believe that this temporary loss of signal one hour after maximum obscuration is related to ionization depletion in a sluggishly responding F region.

Atmospheric Pressure and Temperature were measured at Sankaty Head, Nantucket. The observed temperature variation clearly showed the eclipse phenomenon. In the shade the maximum temperature drop was 7° F. A thermometer exposed to sunlight recorded temperatures which were higher by 9°F and the maximum drop was 14° F. With a resolution of 0.1 millibar no pronounced pressure variations were noted that could be related to the eclipse phenomenon.

At Chatham, Mass., A Weston, Master II Lightmeter, facing south, was used to measure brightness. At first contact, the reading was 1000 candles/square foot. The general behavior of the brightness curve followed the computed obscuration function.



1970 SOLAR ECLIPSE PROJECT NO. 3.4-F-12.01

Institution : Teledyne Isotopes, Westwood, New Jersey

Investigators : MONTES, H.; and RAO, G.

Title : Propagation of Long Period Acoustic Gravity Waves

Purpose : (1) Study of electron density variations at F region levels as a function of eclipse obscuration using CW phase-path sounder records. (2) Investigation of eclipse effects on geomagnetic rapid variations and correlation with phase-path sounder records. (3) Investigations of eclipse generated acoustic and internal gravity waves using a long period (1 min $< T <$ 100 min) microbarograph array.

Description : Middle latitude observations above F2 peak during solar eclipses showed that the electron temperatures responded rapidly to the variations of the input heat flux due to solar photons (Evans, 1965). The rapid temperature (and scale height) decrease approaching eclipse totality causes the ionosphere to contract, and NmF2 to increase. Ionosonde observations during eclipse times indicated an increase followed by a decrease in the value of f_oF2 (Anastassiades and Moraitis, 1968). Topside ionosphere soundings taken during a previous eclipse have indicated a decrease in electron concentration by a factor of two. This reduction in electron concentration appeared to result from a bodily downward motion of the F2 layer. It appears from these investigations that below NmF2 there would be changes in reflection heights due to contraction of the F2 layer as well as changes in the electron concentrations. These changes produce a frequency shift on H.F. radio waves reflected from the ionosphere due to the variation of their phase-paths. It is proposed to use the phase-path doppler sounder array data to study the ΔF variations, in the F2 region below NmF2, as a function of eclipse observation.

Variations of electron density due to a solar eclipse would affect the electrical conductivity changing the distribution of electric fields in the lower ionosphere. These changes should be in turn induce variations in the electric currents flowing at these levels producing fluctuations in the geomagnetic field. If the amplitudes of these fluctuations are of the order of a few gammas they might be detected by ground-based magnetometers. It is proposed to investigate whether eclipse induced geomagnetic field fluctuations can be observed at ground level stations.

Hines and Chimonas (1970) have pointed out that solar eclipses may induce acoustic gravity waves in the earth's atmosphere. These waves could be observed as perturbations on microbarograms. It is intended to investigate the eclipse associated effects in the microbarograph records. However, it should be pointed out that the microbarograph array is located about 150 km from the totality path and therefore close to the source.

Reference : Long period sound waves in the thermosphere from Appolo launches. Tolstoy, I., H. Montes, G. Rao and E. Willis (communicated to J.G.R.). Fluctuation fields in the ionosphere between 130 and 250 km. I. Tolstoy and H. Montes (communicated to J.A.T.P.).

Location : Area of arrays extends over states of New York, New Jersey and eastern Penna.

Dates : A permanent installation in operation over the last six months.

Equipment : The instrumentation consists of superimposed arrays of microbarographs, magnetometers and CW phase-path sounders. The microbarograph array is composed of 10 elements with average separation of 60 km between them, and a total aperture of 250 km. The magnetometer array consists of three 3-component stations. The phase-path sounder array was composed of 3 stations operating at a single sounding frequency (4.8 MHz) and one station operating at two frequencies (4.8 and 6.0 MHz); the separation between reflection points was of the order of 60 km. The data from all three arrays is collected in digital form at a central station located in Westwood, N. J. The frequency response is 30 sec- 100 min. The sampling rate is 10 sec. Fig. 1 shows the geographic distribution of the stations.

Names of People : Teledyne Isotopes Geoacoustic Staff

Cooperating Group: Lamont Doherty Observatory, Palisades, New York - Dr. W. Donn

Funds : ARPA-AFOSR supports array operation & investigation of Long Period Acoustic-Gravity Waves. Research effort supported "in-house".

SUMMARY OF PRELIMINARY RESULTS:

The phase-path doppler sounder records, at all the stations of the doppler array, showed significant changes that could be attributed to the solar eclipse effect at F2 region levels. Typical doppler and magnetometer traces are shown in Figure 2. It can be seen in this figure that the doppler frequency decreased gradually starting at 1815Z reaching a minimum at 1843Z. The magnitude of this departure is about 1 Hz. Beginning at 1843Z the situation is changed and the frequency starts increasing until it reaches a maximum at around 1848Z. The frequency change from minimum to maximum amounts to 1.5 Hz. After 1848Z the doppler variation recovers slowly to its normal background level. In order to arrive at a quantitative interpretation, ionograms from nearby ionospheric stations will be used.

A preliminary examination of magnetometer records indicated that the magnetic field was slightly disturbed from March 6 at 2300Z to March 7 at 0400Z. During the time interval 0400Z to 1930Z the magnetic records are relatively quiet. At 1930Z some disturbances are seen in the records, developing a few hours later into a moderate to severe magnetic storm which continued through the next two days. The presence of these distrubances in the magnetometer records suggest that extreme caution must be used in the interpretation of the ionospheric data.

High frequency fluctuations with periods of the order of 0.5 to 2.0 minutes were recorded on all doppler traces from 2003Z to 2009Z. Magnetometer records showed at this time some micro-pulsation activity (Figure 2).

Further analyses of phase-path records, magnetograms and microbarograms are in progress.

References:

Anastassiades, M. and G. Moraitis, J. Atmosph. Terr. Phys., 30, 1471, 1968.
Evans, J. V., J. Geophys. Res. 70, 131, 1965
Hines, C. O. and G. Chimonas, J. Geophys. Res. 75, 875, 1970

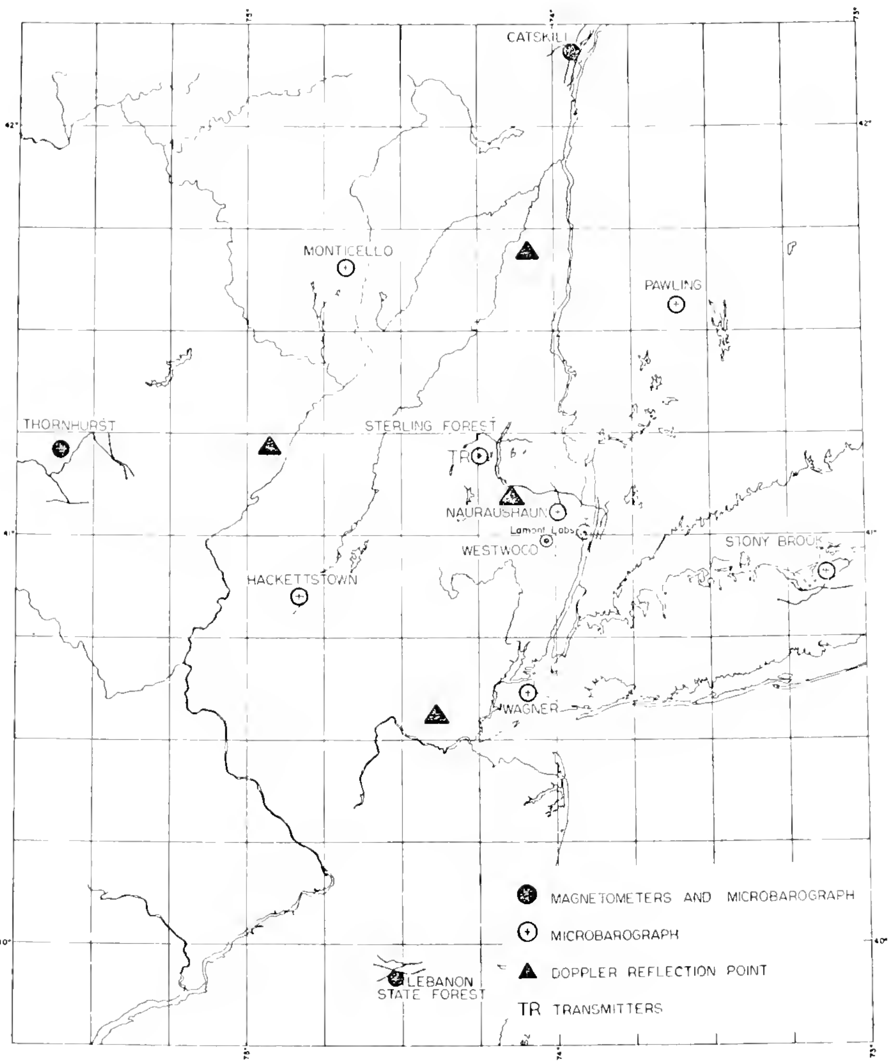


Figure 1 - Location of Stations

1970 SOLAR ECLIPSE - PROJECT NO. 3.4-F-12.02

Institution	:	The Ohio State University Department of Electrical Engineering
Investigator	:	SELIGA, Thomas A.
Title	:	Detection of Travelling Ionospheric Disturbances Resulting From The 1970 Solar Eclipse
Purpose	:	To detect and measure travelling ionospheric disturbances arising from the passage of the total solar eclipse of March 7, 1970 over the Eastern United States using phase and group height soundings at four discrete frequencies.
Description	:	Measurements of phase and group height variations were performed on March 6, 7, 8, 1970 at four discrete frequencies. The equipment used was a V-system sounder transmitting into a right-hand circularly polarized, wide-band, cronical spiral antenna and receiving with a similar left-hand circularly polarized antenna. Typical operating frequencies were approximately 3, 5, 8, & 9 MHz with data recorded from 0900 to 1900 local time.
Reference	:	Chimonas, G. and C. O. Hines, "Atmospheric Gravity Waves Induced by a Solar Eclipse," J. Geophys. Res., 75, p. 875. Dietrich, F. J. and R. K. Long (1969), "An Efficient Moderate-Size Vertical-Incidence Ionosonde Antenna for 2-20 MHz Polarization Studies," IEEE Trans. Ant. Prop., AP-17, #5, p 551-557.
Dates	:	March 6, 7, 8, 1970
Equipment	:	V-System, 4-Channel, Ionospheric Sounder
Special site Requirements	:	Not applicable
Number & Names of People	:	3
Cooperating Groups	:	Heath Air Force Station, Newark, Ohio (Monitoring VLF & LF Transmissions)
Special Comments and Needs	:	None
Station Prob	:	1.0
Funds	:	NSF, Ohio State University

SUMMARY OF PRELIMINARY RESULTS

The experiment was performed and data acquired as planned. We are at present developping electronic techniques to change the data that is stored on magnetic tapes into a format that is readily useable for computer analysis.

Sample by-hand sealing of portions of the direct read-out records obtained during the eclipse has not yet produced definitive results.

1970 SOLAR ECLIPSE PROJECT NO. 3.4 E-13.00

Institution	:	Dirección General de Telecommunicaciones, S.C.T.
Investigator	:	Ing. Carlos NÚÑEZ ARELLANO, Ing. Alfonso RAMOS, Dirección General de Telecomunicaciones.
Title	:	Vertical Soundings.
Purpose	:	
Description	:	Changes in the ionospheric structure during the eclipse using the C-4 Vertical Sounder; Readings will be taken at intervals of 2 minutes or less, if possible.
References	:	
Location	:	El Cerrillo, State of Mexico.
Dates	:	March 5 -8, 1970.
Equipment	:	
Special Site Requirements	:	
Number & Names of People	:	Ing. Alfonso Ramos Cancino and assistants.
Cooperating Groups	:	
Special Comments and Needs	:	
Station Prob	:	
Funds	:	Dirección General de Telecomunicaciones.

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE PROJECT NO. 3.4-F-14.00

Institution	:	Leander McCormick Observatory University of Virginia
Investigator	:	MEISEL, Dr. David D.
Title	:	1970 Eclipse Radio Reception Survey
Purpose	:	Correlation of qualitative as well as quantitative signal strength records of high-power commercial short wave radio transmissions over a variety of propagation paths in and out of the eclipse zone.
Description	:	Efforts of volunteer monitors in thirty different countries will be coordinated in a manner similar to previous eclipse radio reception surveys (see references).
References	:	Meisel, D. D. 1968, Solar Physics 5, 575 1969, Solar Physics 8, 477 1969, Solar Physics 9, 487 1970, Solar Physics 11, 338
Location	:	Numerous in Europe and Americas.
Dates	:	Feb. 14, 21, 28, 1970; March 4, 5, 6, 7, 1970.
Number and Names of People	:	Between 300 and 500 individuals expected.
Cooperating Groups	:	Austria Radio; Voice of America; Canadian Broadcasting Corporation--International Service; Radio Nederlands, Radio Finland, Radio Sweden, Radio Stations WINB, WWV, WWVH, CHU, WNYW, and numerous others.
Special comments and needs	:	
Station Prob.	:	Not known
Funds	:	Internal and private

SUMMARY OF PRELIMINARY RESULTS:

Data reduction was not complete by June 30, 1970. After August 1, 1970, inquiries may be directed to the investigator at at the Department of Physics, State University College, Geneseo, New York, 14454.

1970 SOLAR ECLIPSE PROJECT NO. 3.4-F-14.01

Institution	:	Lockheed Palo Alto Research Laboratory 3251 Hanover Street Palo Alto, California 94304
Investigators	:	SEARS, Robert D.
Title	:	Detection of Eclipse-Induced Ionospheric Doppler Dispersion
Purpose	:	In addition to the effects of changing ionization source function and plasma transport in the ionosphere, Chimonas and Hines (1970) have suggested that a total solar eclipse can create observable acoustic-gravity waves in the ionosphere. Such waves should produce identifiable Doppler frequency effects upon radio signals reflected from the disturbed ionosphere, if large enough.
Description	:	The Doppler dispersion and amplitudes of WWV transmissions on frequencies (5. 10 and 15 MHz) were monitored at Palo Alto. The propagation path was located almost parallel to the acoustic-gravitational wavefront predicted by Chimonas and Hines for this eclipse. At a distance of about 3500 km from the eclipse path of totality the apparatus can detect Doppler frequency dispersion as small as 0.01 Hz which means that vertical motions of the reflection level as small as about 0.1 m/sec can be detected at 15 MHz. Nominal daytime HF phase path changes induce as much as 100 times this value of Doppler dispersion, eg., up to 1 Hz or so.
Reference	:	R. D. Sears, "Low Latitude Ionospheric HF Doppler Dispersion Study," Radio Science, in publication. G. Chimonas and C. O. Hines, "Atmospheric Gravity Waves Induced by a Solar Eclipse," J. Geophys. Res. 75, 875 (1970).
Location	:	Lockheed Palo Alto Research Laboratory Palo Alto, California - receiver sity Ft. Collins, Colorado - transmitter site
Dates	:	1 March 1970 to 10 March 1970
Equipment	:	3 receivers for WWV Doppler frequency and amplitude measurements on 5, 10 and 15 MHz
Special site Requirements	:	None
Number & names of People	:	One observer at Lockheed Palo Alto Research Laboratory
Cooperating Groups	:	None
Special comments and needs	:	None
Station prob	:	100%
Funds	:	Lockheed Independent Research funds

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.4-F-14.01

Standard frequency HF transmissions on 5, 10, and 15 MHz from WWV, Ft. Collins, Colorado, were monitored with phase sensitive receivers at Palo Alto. The amplitudes and phases (relative to a local high precision frequency standard) of the three signals were recorded continuously from 1600 UT to 2100 UT on 7 March 1970, the period covering the total solar eclipse. Changes in apparent Doppler frequencies as small as 0.01 Hz could be detected. The goal of the experiment was to detect the passage of ionospheric acoustic-gravity waves which were predicted by Chimonas and Hines (1970). The propagation path, Ft. Collins to Palo Alto, was approximately parallel to the expected disturbance wavefront, at a distance of about 3500 km from its source along the path of totality. The eclipse day Doppler frequency dispersion data plotted at 10 minute intervals shows no disturbances present with magnitudes larger than the normal day-to-day variability, about 0.1 to 0.5 Hz. A number of brief, quasi-periodic small scale distrubances were observed but these had periods of 10's of seconds and durations of up to 4 minutes at the longest. The acoustic-gravitational waves predicted by Chimonas and Hines were expected to have periods of 15 to 150 minutes and to arrive in the western U. S. about 1900 UT or so. No large scale disturbances of this nature were observed on 10 or 15 MHz. The 5 MHz signal had only intermittent phase track data because of its low amplitude.

If waves were present in the ionosphere as predicted, the apparent failure to observe their Doppler dispersive effect could be explained by the small magnitude of the wave at the reflection height of the hf-signals. Detailed examination of both eclipse day and background day Doppler records and determination of the reflection heights from ionogram records will assist in clarifying these results.

1970 SOLAR ECLIPSE - PROJECT NO. 3.4-F-15.00

Institution	:	Magnetic and Electric Fields Branch Goddard Space Flight Center Greenbelt, Maryland
Investigator	:	MAYNARD, Nelson C.
Title	:	Ionospheric Electric Fields During Storm Eclipse
Purpose	:	To investigate the effects of the enhancement of electric fields in the E region of the ionosphere resulting from the decreased conductivity in the path of totality and the corresponding local interruption of the Sq current system.
Description	:	Measurements of the two components of the electric field in the spin plan were made using the technique of Aggson. The difference in floating potential between two long cylindrical antennas (each 20 feet) was monitored with a high input impedance differential voltmeter. This divided by the distance between the element mid-points is equal to the sum of the ambient electric field plus $\vec{V} \times \vec{B}$. One flight (14.457) was launched into totality and the other (14.456) was used as a control, being launched at the same time on March 6.
Reference	:	Aggson, T. L., Probe measurements of electric fields in space, Atmospheric Emissions ed. B. M. McCormac and A. Omholt, Van Norstrand Reinhold Co., New York, 1969.
Location	:	Wallops Island, Virginia
Dates	:	March 6 and 7, 1970
Equipment	:	(See description)
Special site Requirements	:	NASA Rocket Support
Number and Names of People	:	2 at Wallops
Cooperating Groups	:	GCA - Solar X-rays - Accardo (Project 3.1-F-10.02) Lockhead - Conjugate Photoelectrons - Sharp
Special needs and comments	:	
Station Prob	:	1.0
Funds	:	GSFC

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.4-F-15.00

Good D.C. electric field information was obtained from both rocket flights, although the data from flight 14.456 are limited due to vehicle overspin and the subsequent breaking of the antennas. Initial indications are of electric fields of a few millivolts/meter. $\vec{V} \times \vec{B}$ calculations are not yet complete, hence exact information is lacking. It is expected that the enhancement from the eclipse will be between 1.3 and 2.0. In addition, some ELF electric field effects which are now under study.

1970 SOLAR ECLIPSE PROJECT NO. 3.5-F-01.00

Institution	:	University of Illinois, Aeronomy Laboratory, Elect. Eng. Dept.
Investigators	:	BOWHILL, S. A., MECHTLY, E. A.
Title	:	Lower Ionosphere Rocket Measurements
Purpose	:	Determination of lower ionosphere species, their concentrations and their reaction rates.
Description	:	Measurements of electron concentrations, electron temperatures, and electron collision frequencies will be made by Nike Apaches 14.435, 14.436, 14.437, and 14.438. Each payload includes two radio propagation experiments, at 2225 and 3385 kHz.
References	:	Mechtly, E. A., K. Seino, and L. G. Smith. Lower ionosphere electron densities measured during the solar eclipse of 12 November 1966, Radio Sci. 4(4), 371-375 (1969).
Location	:	Wallops Island, Virginia
Dates	:	March 7, 1970
Equipment	:	All supporting equipment provided by NASA.
Number and Names of People	:	(6) S. A. Bowhill, E. A Mechtly, C. F. Sechrist, G. W. Henry, S. D. Bengston, N. D. Busboom, and T. W. Knecht
Cooperating Groups	:	GCA Corporation (L. G. Smith will fly dc probes and 44-60, 1216, and 2600 Å photometers on the Nike Apaches). AFCRL (R. S. Narcisi will fly two neg. ion, and a neutral mass spectrometer respectively on three Nike Iroquois rockets).
Special Comments and Needs:		Beacon tracking is required, radio interference at 2225 and 3385 must be excluded.
Station Prob	:	1.0
Funds	:	NASA

SUMMARY OF PRELIMINARY RESULTS

The seven rockets in the coordinated program of the University of Illinois, GCA Corporation, Air Force Cambridge Research Laboratories, and NASA were launched on 7 March 1970 at the times and under the eclipse conditions outlined in Table 1.

Good data were recorded from all four of the UI-GCA-NASA rockets. A quick-look analysis of the differential absorption data at 2225 kHz shows total differential absorptions up to 85 km of 28dB, 12 dB, 10 dB, and 5 dB, respectively, for full sun, 1.5% of full sun, beginning of totality, and 50 seconds after the beginning of totality.

Table 1.

Solar eclipse of 7 March 1970, launch and eclipse conditions of University of Illinois, GCA Corporation, and AFCRL Rockets.

Rocket	Launch Time h:m:s (GMT)	Ionosphere Point Az.	El.	Hor.Rng.	Alt.	Time at Ionosphere Point h:m:s (GMT)	Eclipse Condition at Rocket	Instrumentation
14.435	15:45:00	110°	70°	30 km	80 km	15:46:10	Full Sun before 1st Contact, X=58° AM	Radio, Probe, 44-60, 121c,2600
14.436	18:37:10	135°	64°	40 km	80 km	18:38:20	Three seconds after 2nd contact, X=47° PM	Radio, Prove, 44-60, 1216.
D2-4694	18:37:30	130°	78°	---	---	---		-ion Spectrometer.
14.437	18:38:00	135°	64°	40 km	80 km	18:39:10	Fifty seconds after 2nd contact, X=47° PM	Radio, Probe, 44-60 1216.
D2-4692	18:39:30	125°	78°	---	---	---		-ion Spectrometer.
14.438	18:40:40	135°	64°	40 km	80 km	18:41:50	After totality, X=48° PM (1.5% of solar disc)	Radio, Probe, 1216, 2600.
D2-4693	18:46:00	120°	78°	---	---	---	----	Neutral Spectrometer

Abbreviations

Radio = University of Illinois radio propagation experiments operating at two center frequencies, 2224750 ± 50 Hz, and 3385000 ± 50 Hz.

Probe = GCA Corporation Langmuir probe.

1460 = GCA Corporation X-ray experiment at 44-60 Å band.

1216 = GCA Corporation photometer at 1216 Å.

1600 = GCA Corporation photometer at 2600 Å.

(L. G. Smith)

All spectrometers by R. S. Narcisi and C. R. Philbrick of AFCRL.

1970 SOLAR ECLIPSE PROJECT NO. 3.5-D-01.01

Institution	:	GCA Technology Division
Investigator	:	SMITH, L. G.
Title	:	Lower Ionosphere Rocket Measurements
Purpose	:	Investigation of Ionization Equilibrium in the Lower Ionosphere
Description	:	Measurement of electron density, electron temperature, neutral species (O_2 and O_3) and solar UV and X-radiation by instrumented payloads on Nike Apache rockets.
References	:	L.G. Smith, et al., J. Atmos. Terr. Phys. 27, 803, 1965. L.G. Smith, et al., J. Atmos. Terr. Phys. 30, 1301, 1968. E.A. Mechtly, et al., Radio Sci. 4, 371, 1969.
Location	:	Wallops Island, Virginia
Date	:	March 7, 1970
Equipment	:	5 rocket flights (including one back-up).
Number and Names of People	:	L. G. Smith with four supporting personnel
Special Site Requirements	:	
Cooperating Groups	:	University of Illinois, Aeronomy Laboratory (3.5-D-01.00)
Special Comments and Needs	:	Telemetry frequencies to be different for each payload and not assigned to any other rocket flight
Station Prob	:	1.0
Funds	:	NASA

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE PROJECT NO. 3.5-F-02.00

Institutions : National Research Council of Canada
Department of Communications-Communications Research Centre
Radio and Space Research Station, Slough

Investigators : McNAMARA, Dr. A.G., Langmuir Probe Experiment
BELROSE, Dr. J.S., Radio Propagation Experiment
BODE, Mr. L.R., Radio Propagation Experiment (at launch site)
BAIN, Dr. W.C. & HALL, Dr. J.E., L-α and X-ray

Title : 1970 Eclipse Rocket Launchings in Nova Scotia

Purpose : These experiments are designed to measure simultaneously (1) the intensity of the ionizing radiation in the lower ionosphere by measuring the intensity of atmospheric absorption of solar X-radiation as well as Lyman-alpha radiation; (2) the ion density, the electron density and the electron temperature. The rockets will be launched at an azimuth perpendicular to the eclipse path ($146^\circ \pm 15^\circ$ azimuth) at an elevation angle of 85° from a temporary launch site near East Quoddy, Nova Scotia (44° N 54.4', 62° W 20.1'). Apogee will be centred on the mid-path of the eclipse track.

By performing these experiments at a time when the ionosphere is not eclipsed and at times when ionization changes associated with the eclipse are most rapid, it will be attempted:

1) to separate the role of Lyman-alpha and X-rays in D-region ionization.
2) to determine the effective attachment and recombination coefficients and to find evidence for their dependence on electron temperature.
3) to obtain a more detailed picture of the production and loss processes by measuring the abundance of positive ions as well as of electrons, and so indirectly infer the negative ion densities.

Description : The eclipse rocket experiment contains two complementary electron density measurements; a Langmuir probe experiment and a radio wave propagation experiment. In addition to the rocket-borne direct measurements, a ground-based pulse transmitter/receiver provides supporting data by the partial reflection technique.

Another experiment is carried on the eclipse rockets to measure the role of two important wavelength regions of solar radiation which produce ionization in the D-region. These radiations are the Lyman-α line at 1216 A wavelength, and the X-ray band from 1.5 to 8 A. The particular advantage of an eclipse for this measurement is that the parts of the sun from which these radiations emanate are eclipsed at different rates, and this makes it possible to separate the contributions of the two regions.

The Langmuir probe experiment on the rocket provides a direct measurement of the variations in electron and positive ion densities over the complete trajectory, to a height of approximately 150 km. The good frequency response of this instrument resolves fine structure to within a few meters. In the upper portion of the trajectory, the absolute values of electron density can be computed from the probe theory. In the lower D-region, the probe theory is complicated by collision-dominated processes in the plasma. However, accurate comparison of relative density profiles in this region can be made between the different flights. Moreover, the probe current profiles in the lower D-region will be 'calibrated' by the absolute density measurements made by the companion propagation experiment.

The rocket-borne propagation experiment provides the direct measurement of the differential amplitudes of the ordinary and extraordinary modes of propagation from a ground-based transmitter which radiates circularly polarized pulse pairs (50 μ-sec pulses at a rate of 10 pulse pairs per second). This experiment provides a measure of the electron density up to a height of about 80 km during the daytime (the upper height is that where the differential absorption amounts to about 20 db).

It is known from ground-based observations made during previous eclipses that the most rapid ionization changes occur at a time when more than 80 per cent of the sun is obscured, and that the maximum of the eclipse effect occurs 6 minutes after totality. The present rocket program is therefore intended to study the ionization changes which occur during the central portion of the eclipse period. Three rockets will be launched, at 6 minute intervals, during the period centred on totality. The first of the four rockets to be launched will be fired 6 minutes before first contact. The rocket experiments will be supported by ground-based observation of ionization changes by the method of partial reflection (Belrose and Burke, 1964, and Belrose, et al, 1967a, b) made at the eclipse site (Quoddy Inlet, N.S.) and in more detail at Ottawa employing elaborate high power, high antenna gain systems at two frequencies 2.66 and 6.275 MHz. (2.66 MHz only will be used at the launch site.) The ground-based experiments will (1) provide control data to establish that the eclipse day was normal, or otherwise; (2) establish the regular diurnal change so that it can be allowed for in establishing the change associated with the eclipse; and (3) measure ionization changes throughout the eclipse for comparison with the rocket data and for providing continuous data throughout the eclipse.

References : Belrose, J.S. and M.J. Burke, Study of the lower ionosphere using partial reflections, 1., Experimental technique and method of analysis, J. Geophys. Res., 69, 2799, 1964.

Belrose, J.S., I.A. Bourne and L.W. Hewitt, A critical review of the partial reflection experiment, and A preliminary investigation of diurnal and seasonal changes in electron distribution over Ottawa, Churchill and Resolute Bay in Proc. of Conf. on Ground-Based Radio Wave Propagation Studies of the Lower Ionosphere, pp. 125-151 and 167-188, Defence Research Board, 1967.

McNamara, A.G., Rocket Measurements of Auroral Plasma, Bulletin of the Radio and Electrical Engineering Division, National Research Council of Canada, Vol. 15, No. 2, April/June 1965.

Location : Near East Quoddy, Nova Scotia (44^{o} 54.4'N; 62^{o} 20.1'W.)

Dates : 22 February - 8 March, 1970

Equipment : Four Black Brant III rockets and payloads, four launchers, building for rocket preparation, and fire control, etc. Transmitting and receiving equipment, and antenna system comprising four half-wave dipole antennas arranged in the form of a square on 80 foot towers.

Special Site Requirements : A level flat piece of land free from trees, near or on the coast so that the rockets can be launched over sea.

Number and Names of People :

Cooperating Groups : The National Research Council, Radio and Electrical Engineering Division, and the Defence Research Telecommunications Establishment are cooperating in providing the experimental packages. The NRC Space Research Facilities Branch is providing the rockets (nose cones and motors), the launch and telemetry facilities, and is responsible for all aspects of the rocket launches.

Radio and Space Research Station, Slough, U.K.

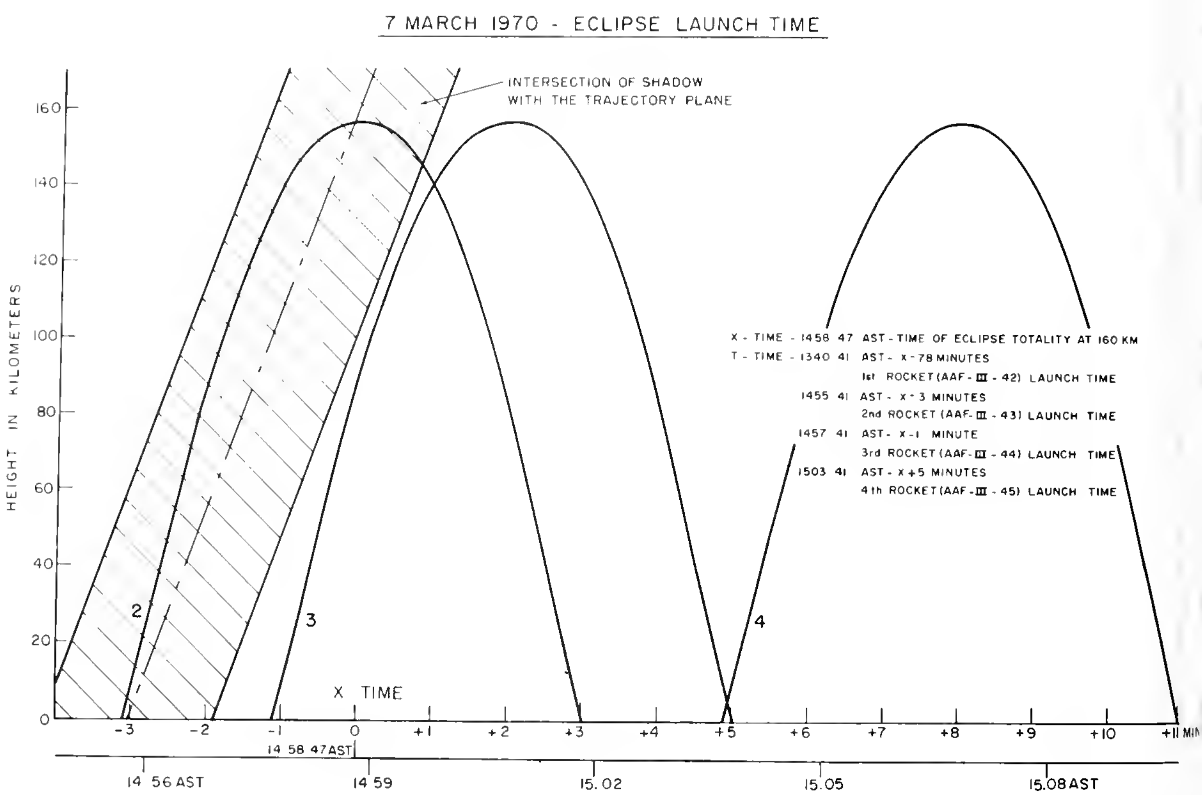
Special Comments and Needs :

Station Prob : 1.0

Funds :

The four rockets were launched exactly on the predetermined schedule as indicated in the Figure, and the rockets achieved very good performance, nearly equal to the predicted apogee. Three Langmuir probes for the direct measurement of charge densities were mounted on each rocket. A split nose cone shroud was released at an altitude of 57 km to expose the probes.

A total of twelve Langmuir probes were flown on the four rokets and all operated successfully with the exception of one probe on the first rocket, AAF-III-42. Preliminary analysis has shown that good charge density profiles were obtained on all flights, over the altitude range 57 km to 155 km. A pronounced E Region peak density was observed at an altitude of 110 km.



Summary of rocket launch times and a plot of the trajectories flown relative to the eclipse shadow.

1970 SOLAR ECLIPSE PROJECT NO. 3.5-F-02.02

Institution : Radio and Space Research Station, Ditton Park, Slough Bucks, U. K.

Investigators : BAIN, Dr. W. C. and HALL, Dr. J. E.

Titles : 1. Spectral Intensity and Atmospheric Absorption of 1.5-10 A Solar X-Radiation.

2. Intensity and Atmospheric Absorption of Lyman-alpha Radiation.

Purpose : To measure sources of ionization in the D-Region as functions of time and altitude, before and during the eclipse.

Description : 1. The X-ray spectrum is measured using a proportional photon counter, which produces charge pulses proportional to the energy of the photons absorbed. The charge pulses are sorted according to amplitude into seven channels where they are counted. In this way a seven point spectrum is found from 1.5-10 A.

2. Lyman-alpha intensity is measured using an ionization chamber with lithium fluoride window and a nitric oxide gas. The ions produced in the gas are attracted to a central electrode biased negatively with respect to the body of the chamber. A feedback amplifier is used to give a signal suitable for telemetry.

Location : Nova Scotia

Dates : 20 February to 15 March Approx.

Number and Names of People : 2 P. H. Dickinson, A. J. Hall

Cooperating Groups : This project has been incorporated in the Canadian rocket program. The combined purpose and logistics of the total program are described on pp. 3.5-E-02.00 and 02.01.

Funds : Science Research Council, U. K. (for expenses relating to our own experiments; other funds for the Canadian workers).

SUMMARY OF PRELIMINARY RESULTS

The intensity of solar radiation at H-Lyman-a 121.6 nm (1216Å) and in the part of the S-ray spectrum from 0.15 nm to 0.8 nm (1.5-8Å) was measured immediately before and during the eclipse by experiments carried on four rockets launched from Nova Scotia. The first rocket was launched immediately before first contact, the second at totality and the third and fourth 2 and 8 mins. after totality. The eclipse remained total throughout the first half of flight 2 because of the rocket motion.

Figure 1 shows the observed Lyman-a intensity as a function of rocket flight time. The curves have been normalized to full sun intensity. Before 80s and after 280s the intensity is reduced because of atmospheric absorption. (The rate of absorption can be used to calculate the density of oxygen in the earth's atmosphere.) While rocket 2 was in total shadow the intensity never rose above 0.2%. However, this is a significant level and means that some Lyman-a came from beyond the visible disc, possibly by resonant scattering from hydrogen in the sun's outer atmosphere. Although the intensity of Lyman-a increased as more of the sun became uncovered in flights 2, 3 and 4 it did not do so in proportion to the uneclipsed area. This is particularly true for flight 4 and is due to the unevenness of Lyman-a emission over the solar disc. Ten minutes after totality the Lyman-a intensity had recovered to 12% of the full sun value.

At times when, due to rocket spin, the sensors were facing away from the sun, the Lyman-a intensity did not fall to zero. Figure 2 shows the background intensities measured for eclipsed and uneclipsed sun. The three eclipse flights gave very similar background intensities although they cover the time from totality to plus 10 mins. The small background decrease of a factor of three contrasts sharply with the decrease from the sun of a factor of about a thousand. The maintenance of the background during the eclipse must have been due to scattering from distant parts of the earth's atmosphere still strongly illuminated by the sun.

The data from only one channel of the X-ray experiment, vis. that sensitive to radiation at 0.6 nm, is presented here since data reducation is incomplete. In figure 3, the photon count rate for each flight is normalized to that at the apogee of the flight and the Lyman-a intensity similarly treated is shown for comparison (broken curve). Parts of the flight severely affected by atmospheric absorption are shown dotted. It may be seen that the X-ray intensity did not behave in the same way as Lyman-a and is even less dependent on uncovered solar area. This is probably because of the small size of X-ray emission areas.

The data from these rockets will be used to calculate production of ionization in the D region of the ionosphere as well as to study the sizes and distribution of Lyman-a and X-ray sources on the sun.

(Further details of these experiments can be found in Nature 226, 1105 (1970).)

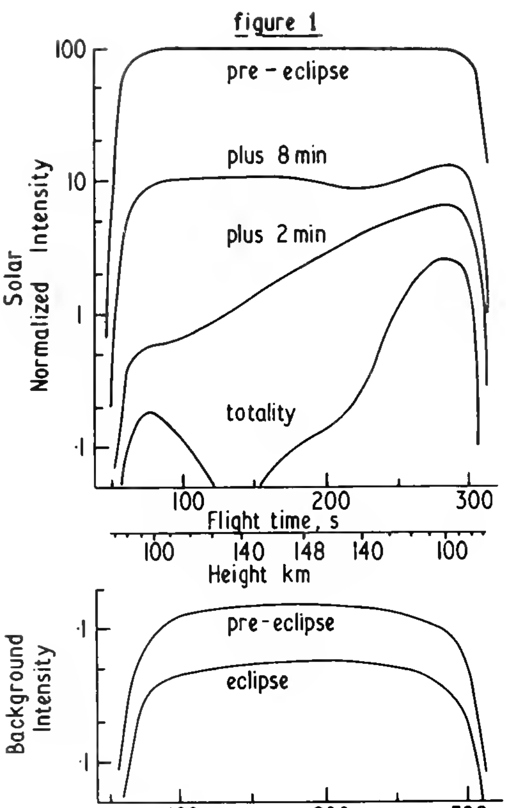


figure 2

Lyman-α Intensity

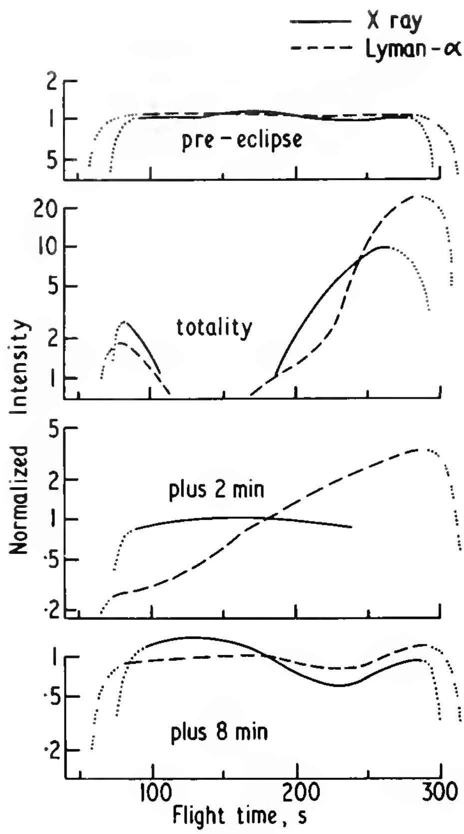


figure 3

Comparison of X ray and Lyman-α Intensity Variations

1970 SOLAR ECLIPSE PROJECT NO. 3.5-F-03.00

Institution : AF Cambridge Research Labs., Hanscom Field, Bedford, Mass.

Investigators : NARCISI, Dr. R. S., PHILBRICK, Dr. C.R. and ULWICK, J.C.

Title : Neutral and Charged Particle Composition Variations Between 60 and 140 km During Totality.

Purpose : The primary objective of these experiments is to determine the detailed physical-chemistry in the D and E regions. The experiments are designed to measure near totality the following parameters between 60 and 140 km: (1) the negative ion composition, (2) the major and minor neutral constituents, (3) the total electron density, (4) electron temperatures, and (5) the total positive ion density. These measurements coupled with other measurements such as those of the solar ionizing radiation will then be applied in a detailed, time-dependent reaction rates computer program. Of special interest will be a determination of the relative roles of electron attachment and recombination.

Description : Measurements will be performed using NIRO rockets with cryo-pumped quadrupole mass spectrometers and Langmuir probes. Two rockets carrying a negative ion mass spectrometer and a third rocket carrying a neutral mass spectrometer will be launched near totality. Cylindrical Langmuir probes will be included in the two ion composition payloads.

Reference : "Positive Ion Composition Measurements in the Lower Ionosphere During the 12 November 1966 Solar Eclipse," R.S. Narcisi, A. D. Bailey and L. Della Lucca, AFCRL-70-0209, Physical Sciences Research Papers, No. 416, April 1970.

Location : Wallops Island, Virginia

Dates : 16 February to 7 March 1970.

Equipment : Three NIRO rockets and three payloads (160-200 lbs.) each containing mass spectrometers, two with Langmuir probes and all containing gyros, FM/FM T.M., and S-band beacons. Approximately ten boxes weighing between 100 and 300 lbs. and typical size 3'X3'X3' containing launch control and support equipment and materials.

Special site Requirements : Three clear launch rails from T-6 hrs. to T-0 T.M. reception, and radar track, both from launch to splash will be supplied by NASA launch facilities. Ten 160 liter liquid N_2 dewars and sixteen 2000 psi dry N_2 cylinders are required.

Number & names of People : 17 people: Dr. R.S. Narcisi; Dr. C. R. Philbrick; Mr. J.C. Ulwick, Capt. D.M. Thomas; Mr. A.D. Bailey; Mr. R. A. Wlodyka; Miss Lois Della Lucca; Mr. G. Federico, plus 9 supporting personnel.

Cooperating Groups : This will be part of a joint AFCRL-DASA-NASA-University of Illinois effort. (See projects 3.5-D-01.00 and 01.01)

Station Prob : 1.0

Funds : AFCRL/OAR and DASA sponsored

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.5-F-03.00

The mass spectrometers were of the quadrupole type, internally evacuated by liquid-nitrogen cryosorption pumps. The negative-ion spectrometer, which has a sensitivity range from 1 to 100 ions/cc, was programmed to scan the mass range from 8 to 162 amu every 2 sec. The neutral mass spectrometer, which has a dynamic sensitivity range of from 10^7 to 10^{15} particles/cc, was programmed to scan the mass spectrum from 4 to 85 amu every 1.2 sec.

The Langmuir probes were stainless-steel rods having a total collection area of 21 cm^2 and a charged particle sensitivity of 10 to 10^5 particles/cc. The measurements were taken for every 5 sec, as follows. The rods were held at +3V for electron measurements, linearly swept from +3V to - 10V for electron temperature determinations, and held at - 10V for positive ion measurements.

The planned timing of the rocket launches was as follows. A negative ion payload would first be fired into totality, at 1837:30 UT. If this payload failed, the second negative ion payload would be launched at 1839:30 UT; if the first payload was successful, the second would be launched considerably after totality, at 2010 UT, by which time the ionosphere should have recovered to normal. The neutral mass spectrometer would be launched about 8 min after totality, at 1846 UT, at which time the minor neutral constituents should have undergone maximum change.

On the day of the eclipse, the first negative-ion payload was launched at 1837:30 UT. Because there were indications of marginal instrumentation performance, the second negative-ion payload was launched as a backup shortly after the first, at 1839:30 UT. The neutral mass spectrometer was launched as planned, at 1846 UT. All vehicle apogees were in the range 110 to 120 km.

The results from the first negative-ion payload were marginal. Negative-ion mass spectra were obtained but these were degraded because of an instrument malfunction that occurred approximately 58 sec into the flight. The Langmuir probe data, which were also questionable, showed reduced electron currents and no positive ion currents.

The second negative-ion payload was completely successful. Negative ion mass spectra were obtained between 70 and 115 km. The major negative ions measured were O^-, O_2^-, NO_2^-, and $NO_3^-(H_2O)_n$, with n = 0 to 5. The water cluster ions were seen to be restricted to below 90 km whereas the ions of lighter mass were predominant above 90 km. Good Langmuir probe data were obtained between 65 and 115 km on both ascent and descent.

The first successful measurements with a newly designed neutral mass spectrometer were obtained 8 min. after totality. Both the instrument and vehicle performed well. Mass spectra were obtained from 70 km to apogee at 120 km and on downleg to below 50 km. Measurements of the major neutral constituents and some of the minor neutral species in the mesosphere and lower themosphere were obtained.

The data are only in preliminary reduction stages. It is anticipated that in the future, it will be possible to assess the relative roles of electron attachment and recombination near totality.

1970 SOLAR ECLIPSE PROJECT NO. 3.5-F-05.00

Institution	:	U.S. Naval Research Laboratory
Investigator	:	DAVIS, John R. - Code 5464
Title	:	HF Radar Study of Ionospheric Layer Modulations
Purpose	:	To discern short-lived turbulences in ionospheric layer structure engendered by the sudden removal of a major inozation source.
Description	:	An HF Backscatter Radar will scan the eclipse path via earth backscatter. Coherent demodulation with a sophisticated spectrum analyzer will permit the doppler spectrum, and hence the internal motions, of the reflecting inospheric layer to be continuously measured. Group delay measurements will permit translatory motions of the layer to be determined.
Reference	:	No special references exist. General reference is: Beynon, W.J.G., and G.M. Brown (Ed.): Solar Eclipse and the Ionosphere, Pergamon Press, N.Y. 1956.
Location	:	NRL, Washington, D.C.
Date	:	--
Equipment	:	--
Special Site Requirements	:	--
Number & Names of People	:	J. R. Davis; D. R. Uffelman; E. L. Althouse; J. T. Ferrell; V. J. Gagner
Special Comments and Needs	:	Will utilize two 10 KHz (clear channel) communications channels in 10-20 MHz frequency band.
Station Prob	:	1.0
Funds	:	Internal

SUMMARY OF PRELIMINARY RESULTS PROJECT NO. 3.5-F-05.00

1. Earth backscatter radars were operated from the Naval Research Laboratory's Chesapeake Bay Division so as to provide transmission paths through the ionosphere as follows:

a. 13.580 MHz radiation directed at an azimuth of 055°, which afforded E- and F-layer illumination of the eclipse shadow region between about 1845 and 1905 GMT, and

b. 15.635 MHz radiation directed at an azimuth of 190°, which afforded illumination of the E- and F-layer eclipse shadow region between about 1810 and 1830 GMT.

Both radars were operated in a coherent-pulse-doppler format, and provided time-delay resolution of a few hundred microseconds. Doppler resolution of a few hundredths of Hertz was also achieved.

2. Principal results are as follows:

a. On the 13.580 MHz, northeasterly directed path, an F-layer distrubance began at about 1810 (all times GMT), and was characterized by gradual doppler diffusion and apparent modal separation. Of the five initially discrete spectral components, three disappeared completely by 1835 and the two others gradually diffused and shifted downward (indicating an effective rise in the reflecting layer) until about 1850. They then began to shift upward, passing through zero at about 1855, and remained positively doppler shifted until about 1925. The three components which had disappeared at 1835 returned at about 1920. Stabilization to pre-eclipse conditions occurred by about 1950.

b. On the 13.580 MHz, northeasterly directed path, E-layer propogation showed no specific eclipse-related signature. Conditions were slightly disturbed from the very beginning of observations at about 1800. A very pronounced cyclic disturbance, of about 1 minute period, caused four doppler-shift excursions of 2 Hz deviation above and below zero beginning at 2004. This large, initial impulse was followed during the next hour by several smaller ones.

c. On the 15.635 MHz, southerly directed path, the F-layer data have not been fully analyzed. Initial indications are that qualitatively similar behavior to that described in (a) above occurred, with about one-half hour earlier onset.

d. On the 15.635 MHz, southerly directed path, the E-layer data were somewhat similar to those described in (b) above. There was no apparent temporal displacement, however, and the initial cyclic disturbance at 2004 was much less pronounced than that which appeared in the 13 MHz data.

3. The nature of earth backscatter data of this sort does not permit meaningful conclusions to be drawn from them alone. Detailed inspection of the results can be carried out when other data are available for reference.

1970 SOLAR ECLIPSE PROJECT NO. 3.5-F-05.01

Institution : Physics Institute of the University of Camerino, Italy

Investigator : CUTOLO, Professor Mario

Title : Wave Selfmodulation in Lower E Region (Bailey's Layer)

Purpose : Measurements of the receiving percentage of modulation of a radiowave pulse modulated at different audio frequencies with a constant depth of modulation for the purpose of determining collision frequency profiles, absorption.

The experiment is important because the variation of the receiving percentages depends on the collision frequency. electron density, etc. This is a continuation of the experiment made in Italy during the 1961 total solar eclipse.

Description : Operation involves use of a pulse transmitter of 20 KW power in antenna. The carrier frequency varies from 1345 kc/s to 1349 kc/s i.e. only the frequencies under the gyrofrequency, therefore in the lower band of resonance frequencies. The method used is the new technique called "modulated pulse" for which each pulse is modulated at different audio frequencies with a constant depth of modulation. By this method is possible to separate the different echoes and so to study the overmodulation or the demodulation.

References : Sant Ram and P.K. Kaw, Can. J. Phys., 45, 399I (1967)

M. Cutolo, Scient. Final Report, Contract A. F. 61(514)-1299 Suppl. Agreem. No. 3, May 1961; Atti Soc. Astron. Italian October 1962: N.B.S. Technical Note No. 2II, 2,39 (1964)

Location : Old Town, Florida

Dates : 15 February to 19 March 1970

Equipment : All equipment will be contained in about 10 boxes, Wt: 1 long ton

Special Site Requirements : The transmitting site will need sufficient area for a folded dipole

Number and Names of People : 5; Prof. M. Cutolo, Dr. G. Agnelli, Dr. G. Gaffuri, Dr. F. Fabbri, Mr. M. Jannello and Mr. P. Di Maio

Cooperating Groups : Univ. of Florida (Dr. A. G. Smith and Dr. R. Flagg)
Astronomical Observatory of Rome,
Institute of Physics and Technical Physics (Archit.) Univ. Of Naples, C.S.R.

Special Comments and Needs : I frequency allocation for C.W. carrier in the U.H.F. band.
Low noise receiving site is desirable.

Funds : Universities of Camerino and Naples, Banco di Napoli, other sources

SUMMARY OF PRELIMINARY RESULTS:

During the total solar eclipse of 7 March 1970 we studied the behaviour of ionospheric wave selfmodulation (that is the variation of the percentage of modulation of a modulated radiowave passing through the ionosphere) to find out if the phenomenon depends on the collision frequency and electron density, as some new theories propose (1). The experiment was a continuation of that made in Italy during the 1961 total solar eclipse.

The operation involved a pulse transmitter and receiving equipment a few kilometers apart.

The method used is the new technique called "modulated pulse" for which each pulse is modulated at different audio frequencies with a constant depth of modulation (2). By this method it is possible to separate the echoes to eliminate interference due to the different ionospheric paths and so study the overmodulation or the demodulation that the echoes often have.

The pulse transmitter (peak power 11 kw, repetition frequency 30 c/sec, pulse length 500 - 2000 usec), formed by a quartzed pilot, a preamplifier, a modulator, a sinchronizer, a power amplifier, was located at Old Town (lat. 29°31'50" N, long.

83°01'55" W) in the field laboratory of the Radio Astronomy Observatory of the University of Florida. The receiving equipment formed by a quartzed receiver, other receivers, oscillographs, cameras and a phase variator to eliminate completely the ground wave, was placed in the Suwannee Gables Motel, at 8 km from the transmitter. The transmitting antenna was a folded dipole, located at about 20 m from the ground. The receiving system consisted of two loop antennas tuned on the emitted carrier frequencies, one for the minimum of the signal and the other for the maximum. In this way it was possible to eliminate the ground wave.

Our work program during the eclipse was to transmit the carrier frequency 1335 kc/sec, modulated at 480 c/sec, 60% for 30 seconds, one minute every 5 minutes, from 10^h30^m to 13^h10^m (local time) and from 13^h25^m to 14^h35^m. The same transmission was to be made continually from 13^h10^m to 13^h25^m, that is around the totality of 100 km from the ground.

Unfortunately we did not have any echoes during the passage of the moon from the first to second contact and from the third to fourth contact.

We used the 1335 kc/sec frequency because it is undisturbed by radio Broadcasting and is at a few percent far from the local gyrofrequency Ω_H (Ω_H= 1390 kc/sec at 90 km from the ground). After V.A. Bailey the band of resonance frequencies is large (about 400 kc/sec around the local gyrofrequency). Therefore 1335 kc/sec is in the resonance band.

The echoes began to be present only at $13^h24^m0^s$ and until $13^h33^m29^s$. They were always small, often very small and distorted, that is the envelope of the H.F. echoes was not always sinusoidal. The signals were irregularly undistorted and measurable only from $13^h25^m03^s$ to $13^h26^m19^s$. As the echoes began to appear on the screen of the oscillograph only at 13^h25^m and as the reflections of the signals took place between 85 km and 102 km from the ground (more often at 90 km in the Bailey's region), we were obliged to shorten the length of the pulses to about 600 usec and to increase the modulation frequency. Therefore our transmission was the following: carrier frequency 1335 kc/sec, repetition frequency of the pulses 30 c/sec, pulse length 597 usec, modulation frequency 1680 kc/sec, average percentages of modulation 23,0% from 13^h25^m to $13^h25^m20^s$ and 21,8% from $13^h26^m7^s$ to $12^h26^m19^s$.

During the eclipse the reception of ground and sky waves was at sametime whilst, during the 5 days after, the ground waves was eliminate 20 seconds every 25 seconds of transmission, to be not placed upon the echoes.

Figure 1 shows the results obtained during the eclipse from $13^h25^m00^s$ to $13^h26^m19^s$, at about 6 minutes from the end of the totality at 100 km. In figure 1 the abscissae are the time U.T. (Universal Time) and the ordinates are the Ratios between the modulation percentages of the echoes (with the envelopes completely sinusoidal) M' and of the ground wave M. The measurements of modulation depth have been made by the envelope method with an error of about 10%. As we can see, the ratio is almost always greater than 1.0 and less than 1.5. Therefore the echoes are overmodulated, that is, they have a modulation depth higher than that transmitted. Fig. 2 is an example of an oscillogram recorded during the eclipse (on the left there is the ground wave, on the right, smaller, the echoes).

The study of the distorted echoes will be made later and so we will learn if after this time they are still overmodulated or demodulated.

We continued the experiments on 9, 10, 11, 12 March in the morning at the same time and in the afternoon. No echoes were observed on 9 and 10 with the carrier frequencies 1275, 1305, 1315, 1325, 1335, 1345 kc/sec. Big echoes were recorded on the contrary on 11 and 12 March (carrier frequency 1345 kc/sec, modulation frequency 1680. During the experiments of 11 we observed undistorted echoes only in the after noon from $19^h6^m23^s$ to $19^h7^m2^s$ with percentages of modulation lower than those transmitter that is demodulated. The same results were obtained on 12 March from $17^h11^m21^s$ to $17^h16^m18^s$. The ratios M'/M were 0,73 and 0,98 respectively. The reflections of the signals took place between 97 and 100 km on 11 and at 108 km on 12 March.

A complete report of the experiments made during and after the solar eclipse and their interpretation will be published later.

We are hoping to continue the experiments on wave selfmodulation in Florida in the very near future.

The present experiments were made in collaboration with the Technical Physics Institute of the Department of Architecture of the University of Naples (Italy) and The Study Center of Radiopropagation.

1970 SOLAR ECLIPSE PROJECT NO. 3.5-F-05.02

Institution : University of New Hampshire, Electrical Engineering Department, Antenna Systems Laboratory

Investigators : R. R. CLARK, A. D. FROST and F. H. GLANZ

Title : Meteor Radar Surveillance of Lower Ionospheric Motions During 1970 Solar Eclipse

Purpose : There has been much interest generated in recent years the existence and production of gravity waves in the upper atmosphere. At the recent International Symposium on Atmospheric Waves held at the University of Toronto, a monitoring program was suggested during the solar eclipse in order to detect any low frequency gravity waves produced by the supersonic velocity of the cooling region. It is believed that at inospheric heights this so-called bow wave should be detectable many thousands of kilometers off the path of the eclipse.

Description : We operated our meteor trails radar wind measuring equipment (36 MHz) for a three week period centered on the eclipse. This equipment measures radial speed, range and the direction angles associated with a meteor echo. Our meteor rates near the eclipse time are approximately one every two minutes which will reduce the possibility of seeing a disturbance. The data is presently being processed.

References : Lindzen. R. S., 1967, "Thermally Driven Diurnal Tide in the Atmosphere". Quarterly Journal Royal Meteorological Society., 93, 18-42.

Hines, C. O., 1968, "Tidal Oscillations, Shorter Period Gravity Waves and Shear Waves". Meteor. Monographs, Vol. 9, No. 31, 114-121.

Chimonas, G., 1970, "The Generation of Waves in the Atmosphere by Natural Processes". Paper presented at the International Symposium on Atmospheric Winds held at the University of Toronto, January 1070.

Location : University of New Hampshire, Durham, N. H. 03824

Dates : March 5 to March 21, 1970

Equipment : U.N.H. Meteor Trails Radar

Cooperating Groups : H. G. Muller at the University of Sheffield, Sheffield, England was also operating his equipment in an effort to obtain a measurement further from the eclipse path.

Special Comments and Needs :

Station Prob :

Funds :

SUMMARY OF PRELIMINARY RESULTS

The meteor wind equipment records the raw wind data; which consists of range, doppler frequency and direction angles; on magnetic tape. The first stage of processing unpacks the tapes and converts the raw data to altitude, horizontal speed elevation and azimuth angles of the returned echo. This preliminary processing has been completed for the eclipse data. However, tidal components must be computed and removed so that the residual motions can be studied.

1970 SOLAR ECLIPSE PROJECT NO. 3.5-E-08.00

Institution : Air Force Cambridge Research Laboratories
Ionospheric Physics Lab., Boundary Interactions Branch (CRPC)

Investigators : GASSMANN, G.J. and BUCHAU, J.

Title : D-Layer Response from Echo Amplitude Recordings

Purpose : To obtain an electron density profile versus eclipse time for height range from 50 to 90 km. The results will constitute an input toward clarifying the reaction chemistry in the height range where radio propagat is strongly affected by absorption.

Description : Pulse amplitude measurements will be made on selected frequenci Ionograms between 2 MHz and 16 MHz will be recorded also.

Loran A stations will be received and ionospherically propagated signals wi be recorded. The propagation paths lie within the path of the D-region totality; thus the amplitude changes are valuable supplements to the sound measurements.

The evaluated data will allow a deduction of a coarse electron density prof of the D-layer, provided that the profile between 90 and 130 km will be mea by other means. The deduction also depends critically on the exact knowle the neutral density profile which must be available from other measurement

The aircraft carrying the equipment will be positioned on the ground, so th is near the location at totality where the above-mentioned supplementary me ments are performed (Wallops Island). Two weeks of control measurements a anticipated.

Reference : Buchau, Gassmann, Eclipse Symposium. San Jose, February 1968

Location : Oceana NAS, Va., 36°49'N, 76°02'W

Dates : March 2 - 15, 1970, for control data and eclipse measurements.

Equipment : Ionosonde and Loran A receiver installed in KC-135-131.

Special Site Requirements : Desired basing at available bases.

Number & Names of People : J. Buchau, R. Gowell, J. Waaramaa, G. MacNeil, J. Doody and G. Gassmann

Cooperating Groups : AFCRL - Champion

We expect to compare our data with ground experiments on Wallo Island and use data from rocket experiments as input. (See und description)

Special Comments and Needs :

Station Prob. : 1.0

Funds :

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE PROJECT NO. 3.5-D-09.00

Institution : Air Force Cambridge Research Laboratories (AFCRL)

Investigator : SALES, Dr. Gary S.

Title : Low Frequency Sounder

Purpose : Changes in the D-region which occur under the relatively controlled conditions of a solar eclipse offer an opportunity to determine some of the important aeronomical parameters effecting D-region behavior. The lower ionosphere can be continuously observed using the ionospherically reflected radio pulses from a multi-frequency sounder covering the range 30 KHz to 500 KHz.

Description : A solid state 20 KW peak power pulsed transmitter using four frequencies 30 KHz, 66 KHz, 180 KHz and 525 KHz, a pulse width of 100 μsec, and a repetition rate of 400 pulses per second will be used to sound the lower ionosphere continuously during the eclipse. Receiving the skywave signals on crossed loop antennas, the signal will be recorded and later processed to give a complete description of the reflected signals as a function of frequency. This data will then be used to generate electron density profiles of the D-region of the ionosphere.

Reference : None

Location : In the area of Eastern Massachusetts

Dates : 15 Jan 70 to 15 Mar 70

Equipment : All equipment is contained in one 2.5 ton van. Valuation approximately $100,000.

Special Site Requirements : Sufficient area to establish the transmitting antenna. (Several miles of wire must be laid on the ground. Power requirements: 220-110 single phase, 30 KW, 60 cycle.

Number & Names of People : 3

Cooperating Groups : None

Special Comments and Needs : This experiment uses a pulsed transmitter and will generate wide-band noise over the low frequency range.

Station Prob : 0.5

Funds : Air Force sponsored

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE - PROJECT NO. 3.5-F-11.00

Institution	:	The Pennsylvania State University Department of Electrical Engineering University Park, Pa.
Investigators	:	FERRARO, A. J. and LEE, H. S.
Title	:	Wave Interaction D-Region Measurements
Purpose	:	Measurement of Amplitude and phase interaction for the purpose of determining electron density and collision frequency profiles as well as the energy loss coefficient G of the D-region.
Description	:	Operation involves use of a 4.5 mc/s pulse transmitter of effective radiated power of 12.5 megawatts and a wanted transmitter on 2.2 mc/s. The method has been in operation for studies of diurnal features, solar flares sunrise effects, and stratospheric warmings.
Reference	:	Capability of a High Power Wave Interaction Facility JGR -Vol 73, No. 13, July 1, 1968. Electron Density and Collision Frequency Measurements of the D-region with Radio Wave Phase and Amplitude Interaction, Proceedings of NATO Advanced Study Institute. North Holland Publishing, 1966.
Location	:	Near State College, Pa., Lat. 40° 47' N, Long. 77° 55' W
Dates	:	Above is permanent site at which routine operations are done.
Equipment	:	Wave Interaction System permanently installed. No change of site anticipated.
Special Site Requirements	:	None
Number and Names of People	:	A. J. Ferraro, H. S. Lee, R. Bryant, R. Kmetovicz, W. Miller, G. Palatucci, J. Rowe, A. Cole, D. Cohen
Cooperating Groups	:	None
Special Comments and Needs	:	None
Station Prob	:	1.0
Funds	:	NSF

MARY OF PRELIMINARY RESULTS - PROJECT NO. 3.5-F-11.00

Tentative results of D-region electron density measurements made at the Pennsylvania State University during the solar eclipse of 7 March 1970 are presented. These measurements were made by the wave interaction technique described by Lee and Ferraro.[1]

At The Pennsylvania State University, the eclipse was partial with about 90% obscuration of the solar disk at maximum, which occured about 1838 U.T. No data was obtained prior to 1809 U.T. because of a power failure, hence pre-eclipse conditions are not known. The time used to obtain a profile was about 7 minutes, since rapid changes in electron density were not expected because the eclipse was only partial. An experiment to measure the electron energy loss coefficient, requiring about 20 minutes, was performed after every third electron density measurement; as a result, electron density measurements were not made continuously.

The figure shows electron density profiles for 1809, 1828, and 1913 U.T. on March 1970; also 1810 U.T. on 11 March 1970 for comparison with a normal day. These times refer to the center of the measurement interval of 7 minutes. The major eclipse effect appears to be above 70 kilometers, with the lower height electron density remaining approximately constant until the event after the eclipse.

The interpretation of these results in terms of D-region chemistry is affected by at least two factors, the absence of pre-eclipse data at this location and the fact that the sun was active during the period of the eclipse. The latter fact may be beneficial in that the covering and uncovering of active areas of the sun may cause the 1-8A x-ray emission and the Lα emission to vary differently during the eclipse and allow their effects to be sorted out.

The energy loss factor G has been measured during the eclipse. Earlier measurements have shown seasonal variations in G showing a decrease in winter. It is believed that this is a temperature effect and for this reason measurements were made during the eclipse. The conclusion is that there is a possible G change of probably more than 0.3×10^{-3}, if at all.

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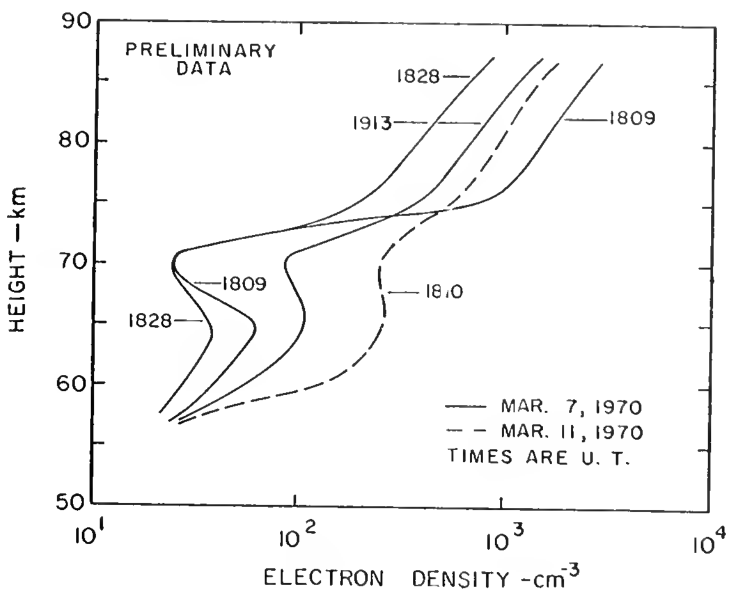
[1]Lee, H. S. and A. J. Ferraro, J. Geophys. Res. 74 1184 (1969).



1970 SOLAR ECLIPSE PROJECT NO. 3.5-E-11.02

Institution	:	Universidad Nacional Autónoma de Mexico, Instituto de Astronomía and Instituto de Geofisica
Investigators	:	GALL Ruth, (UNAM), ALONSO J. Manuel, (UNAM and Instituto Politécnico Nacional)
Title	:	Riometer Ionospheric studies
Purpose	:	Measurements of ionospheric absorption of cosmic noise before, during and after the eclipse, will be performed using three riometers operating at 15, 20 and 30 MHz.
Description	:	
References	:	
Location	:	Mexican Observation Station at Km. 115 of road from Oaxaca to Puerto Angel.
Dates	:	February 15 - March 30, 1970.
Equipment	:	
Special Site Requirements	:	
Number & Names of People	:	4, ALONSO J.M., CANALES S. and assistants.
Cooperating Groups	:	Harvard College Observatory
Special Comments and Needs	:	
Station Prob	:	1.0
Funds	:	Universidad Nacional Autónoma de México, Harvard College Observatory and Instituto Pan Americano de Geografía e Historia.

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE PROJECT NO. 3.5-D-12.00

Institution : Ionospheric Telecommunication Lab.
ESSA Research Laboratories
Boulder, Colorado 80302

Investigator : WIEDER, Bernard

Title : D-region Sky Wave Studies

Purpose : The objective is to determine the D-region electron density distributions as a function of the time of eclipse through measurements of reflection coefficients in the L. F. (90 - 110 kHz) range.

Description : Measured reflection coefficients are compared with coefficients calculated through full wave solutions of the reflection of LF waves from model ionospheric electron density distributions. The model distributions are modified until the differences between the measured and calculated reflection coefficients are minimized, thereby determining the electron-density distribution responsible for the reflections.

Reference : "Rapid Calculations of Ionospheric Reflection Coefficients at Low Frequencies" by B. Wieder, submitted for publication in Radio Science.

Location : A location approximately 50 km from a Loran-C transmitter located at Cape Fear, North Carolina

Dates : A site is already in operation near Cape Fear. Will run January - April for eclipse purposes.

Equipment : L. F. receivers mounted in Van. Valuation approximately $50,000

Special Site Requirements :

Number & Names of People : 3

Cooperating Groups : None

Special Comments and Needs : Good, low noise receiving site desirable.

Station Prob : 99 percent

Funds : ESSA

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

(However, see: Nature, 226, p. 1117, June 20, 1970)

1970 SOLAR ECLIPSE PROJECT NO. 3.5-F-13.00

Institution : U.S. Naval Electronics Laboratory Center (NELC), San Diego, Calif.

Investigators : NOONKESTER, V. R. and SAILORS, D. B.

Title : D-region Charge Density Variations Deduced by VLF Propagation and Computer Modeling

Purpose : Evaluate the effects of electron density profile variations on VLF propagation in an inhomogeneous waveguide created by a solar eclipse and compare prediction with measurements. The profiles will be modeled at NELC and will be deduced by other experimenters. The VLF measurements and predictions will be mad by NELC.

Description : Sets of electron density profiles for VLF paths through the eclipse region deduced by others and by NELC will be used as inputs to VLF propagation pr gram for various postulated paths and frequencies. These calculations will produ the variation in relative phase and amplitude as a function of time during the e and will be compared with NELC VLF measurements. VLF transmissions from NAA, NB OMEGA Forestport, and OMEGA Trinidad will be monitored at Aztec, Arizona. The s of electron density profiles which produce VLF predictions comparable to the obs will be assumed to represent the profiles through the eclipse region.

References : Sheddy, C.H. et al., A Fortran Program for Mode Constants in an Ea Ionosphere Waveguide, Interim Report No. 683 on DASA Subtask RHA 2042, 31 May 19

Moler, W. F., and Gough, Y. A., VLF Waveguide Propagation in a Nuclear Environme Special Report to DASA, DASA No. 1958, 1 June 1967

Location : Aztec, Arizona

Dates : March 5, to March 10, 1970

Equipment : NELC portable on-hand equipment

Number and Names of People : 3, W. F. Moler, D. R. Jensen, V. R. Noonkester

Funds : Local

SUMMARY OF PRELIMINARY RESULTS:

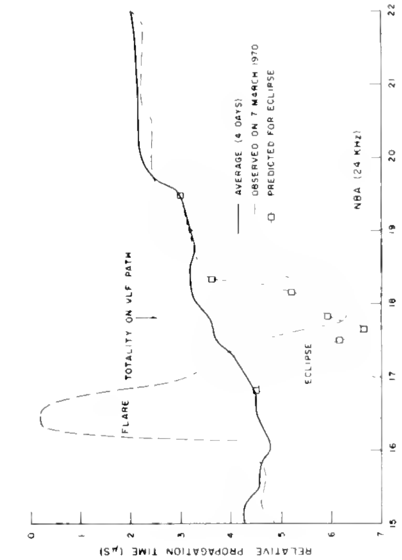
The change in the phase or propagation time was computed for VLF signals transmitted from NAA, NBA, Omega Forestport, and Omega Trinidad to Aztec,Arizona for the eclipse on 7 March 1970. Vertical electron density profiles along each VLF path were computed as a function of time during the eclipse using an aeronom model (WEPH IV) and a simple equation giving the fraction of the solar disk visible along the VLF paths. The profiles were used as inputs to an NELC VLF propagation prediction program which calculated the relative propagation time for each VLF path.

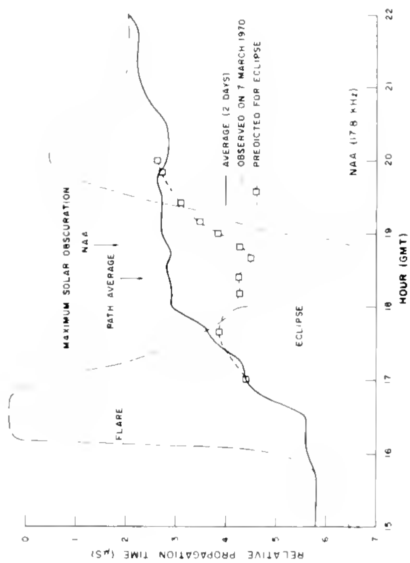
Using a rubidium standard as a local frequency reference for VLF radio receivers the four VLF stations were monitored at Aztec, Arizona from 5-10 March 1970. The figures below show the average, the observed, and the predicted relative propagation time as a function of GMT. The observed relative propagation time was assumed to be the same at 2200 GMT each day. The predicted propagation time was assumed to equal the average at the latest prediction time shown in the figures. The measurement error is about 1 μs.

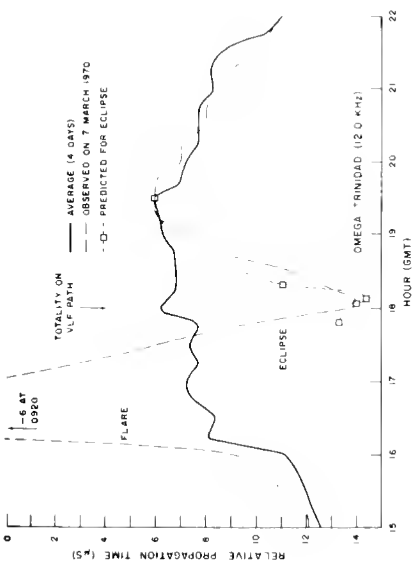
Unfortunately for this experiment a flare occurred near 1600 GMT. The effect of the flare on the propagation time should have been negligible after about 1745 GMT. Thus, the prediction error cannot be determined prior to 1745 GMT. Because the near coincident VLF paths from NAA and Omega Forestport appeared to have disturbed records for several days near the eclipse, the average propagation time may not be reliable. A post eclipse disturbance is also apparent in these records and is not yet explained.

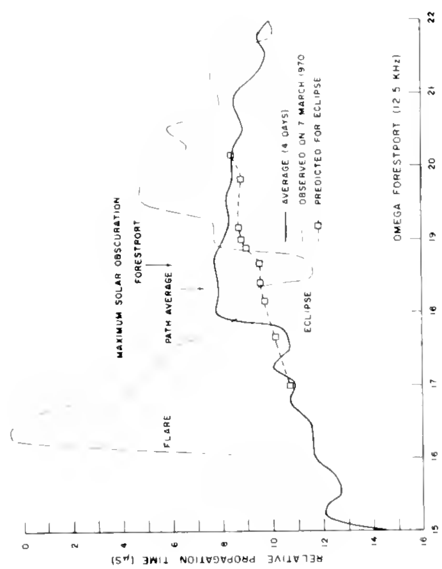
The prediction errors for the model ionosphere are almost equal to the measurement error of about 1 μs for the two southern paths (NBA and Omega Trinidad) but are greater than the measurement error for the two northern paths (NAA and Omega Forestport). The reason for the greater prediction error for the two northern paths is still undetermined.

When experimentally determined electron density profiles for the eclipse are available similar predictions in the propagation time will be determined for these VLF paths. The set of profiles which produces the best VLF prediction will be assumed to represent the eclipse region.









1970 SOLAR ECLIPSE PROJECT NO. 3.5-D-14.00

Institution : Air Force Cambridge Research Laboratories (AFCRL)

Investigator : RASMUSSEN, John E.

Title : VLF Scattering

Purpose : The effective height of the ionosphere for VLF reflection will be raised near the center of totality, forming a dome. Due to differences in the recovery and ionization times, the dome should be asymmetric along the path of totality, but approximately symmetric in a section transverse to the path. Since VLF waves from a distant transmitter propagate between the earth and the ionosphere somewhat as in a wave-guide, mode conversion (analogous to scattering) will occur at the dome.

For this particular eclipse the path of totality is approximately a great circle passing through the VLF transmitter GBR/GBZ. To a fixed observer in the path of totality, the center of scatter will appear to pass overhead, and to recede in the direction of the transmitter, thus allowing the amplitude and phase of scattered signal to be observed as a function of radial distance.

Description : Phase track receivers will be placed at two sites near the center line of totality, to measure amplitude and phase of the transverse magnetic field of the wave, and recorded on strip chart. The frequency will be that of GBR or GBZ at the time.

Reference : Rasmussen, J. E., and Lewis, E. A., "Phase Comparison of VLF Signals Propagated over Adjacent Paths", MF, LF, and VLF Radio Propagation, Conf. Pub. No. 36, Inst. Elec. Eng., London, p. 174, 1967.

Location : One site near Apalachicola, Florida, and another near Norfolk, Virginia.

Dates : Time of site - 10 days (5 days prior to eclipse and 5 days after.)

Equipment : Phase lock receiver, receivers already on hand. To be transported by station wagon.

Special Site Requirements : 115v AC power, 60~, 50A, telephone

Number & Names of People : Four (two at each site).

Cooperating Groups : N/A

Special Comments and Needs : Low VLF background noise

Station Prob : 0.9

Funds : Air Force

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE PROJECT NO. 3.5-F-15.00

Institution	:	ESSA Research Labs., Boulder, Colorado 80302
Investigators	:	DOHERTY, Robert H.
Title	:	Monitoring Loran -C (Low Frequency Pulse) phase and amplitude during the eclipse.
Purpose	:	LF phase and amplitude measurements made during the 1963 solar eclipse appear to correlate with ozone and atomic oxygen changes predicted to occur during an eclipse. The 1970 eclipse should allow a check on these effects as a function of geomagnetic or geographic latitude.
Description	:	Operational Loran-C stations along the East Coast of the continental U.S. make special sky wave measurements continuously. These stations transmit and receive 100 kHz pulse signals. During the solar eclipse, stations, in addition to those normally monitoring sky wave signals, will be requested to make special measurements.
Reference	:	R. H. Doherty, LF phase and amplitude measurements during 1963 solar eclipse, Third Aeronomy Conference, U. of Ill., April 1969. R. H. Doherty, Importance of associative detachment and dissociative attachment in the lower ionosphere as shown by LF radio measurements, JGR, 73, 2429-2440, 1968.
Dates	:	Approximately March 1 to March 15.
Equipment	:	Existing plus two special purpose receivers were borrowed from A.G.M.C. Newark Air Force Station
Special Site Requirements	:	Existing monitoring sites were used.
Number & Names of People	:	
Cooperating Groups	:	U.S. Coast Guard will make measurements at operational Loran-C stations.
Special Comments and Needs	:	
Station Prob	:	Probability of monitoring by existing Loran-C station
Funds	:	U.S. Coast Guard Sky Wave Navigation Program

SUMMARY OF PRELIMINARY RESULTS PROJECT NO. 3.5-F-15.00:

Comparison of 100 kHz Pulse Propagation During Solar Eclipses

Phase and amplitude observations of one-hop, ionospherically reflected LF pulse signals have been obtained for the period 1-14 March 1970 for the following propagation paths:

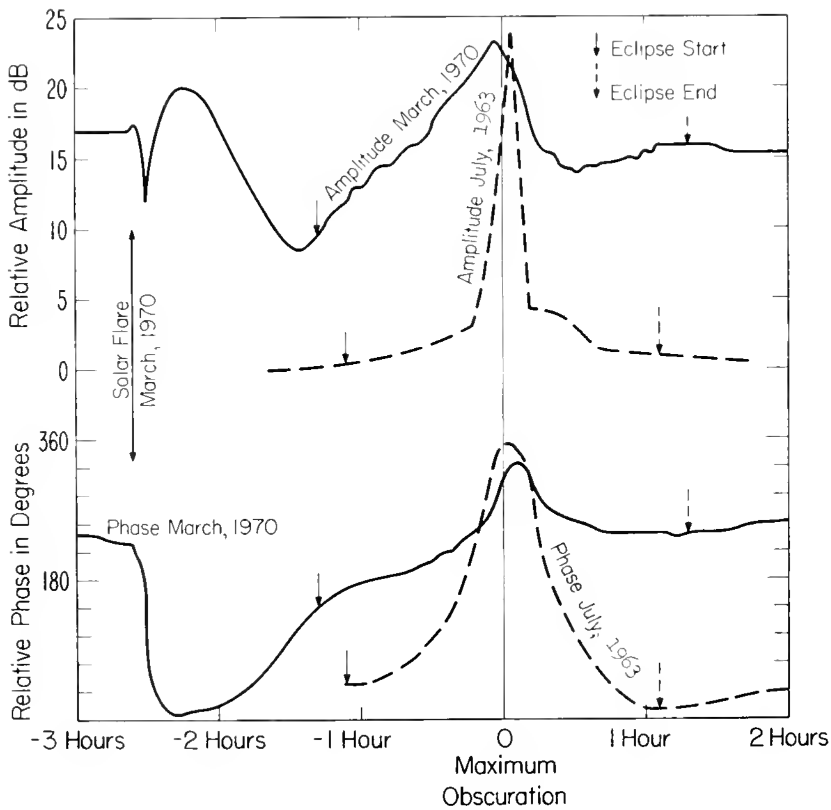
Jupiter Inlet, Florida to Nantucket, Massachusetts
Nantucket, Massachusetts to Jupiter Inlet, Florida
Dana, Indiana to Jupiter Inlet, Florida
Jupiter Inlet, Florida to Dana, Indiana
Dana, Indiana to Bermuda
Dana, Indiana to Cape Race, Newfoundland
Cape Race, New foundland to Nantucket, Massachusetts
Cape Race, Newfoundland to Sandur, Iceland
Sandur, Iceland to Cape Race, Newfoundland

Phase and amplitude changes observed on all of these paths are best exemplified by the following brief discussion and comparison with previous eclipse measurements.

In July 1963, the path of a solar eclipse swept across the Aleutian Islands of Alaska. Low frequency (100 kHz) pulse transmissions of the U.S. Coast Guard Alaskan Loran-C chain were observed in the one-hop sky-wave propagation mode for paths of near solar eclipse totality. The phase of the ionospheric signal retarded nearly proportionally to the increasing solar obscuration, indicating a maximum obscuration, the phase advanced with an overshoot following the end of the eclipse (see fig. 1). The amplitude of the LF pulse signal increased rapidly near the eclipse totality and reached a maximum value 4 min following the time of totality.

During the March 1970 solar eclipse, LF pulse observations were made over several (listed above) of totality or near totality along the U.S. East Coast, again using the Coast Guard Loran-C facilities. The path mid-points ranged from 34° to 56° N latitude, and the path lengths ranged from 1000 to 3000 km. The effects observed during this eclipse were considerably different from those observed in July 1963 (see fig. 1). The March 1970 data shown in the figure (Dana, Indiana to Bermuda path) are typical of the effects monitored for all paths. Rather rapid phase retardations were observed in the signals near the eclipse totality, with the maximum apparent height of reflection occurring 5 min after totality, and a rather small amplitude change with the maximum signal level occurring slightly before the eclipse totality. It should be pointed out that on March 7, 1970 a solar flare occurred less than 1 hr before the eclipse started. This flare appreciably affected all the LF sky-way signals, which were not fully recovered by the time the solar eclipse began as shown in the figure. The flare effects may partly account for the amplitude maximum occurring before the time of maximum obscuration, but a complete explanation of this phenomenon is not easy.

For more complete detail, see the Eclipse issue of Nature, 226, p. 1129, June 20, 1970.



1970 SOLAR ECLIPSE - PROJECT NO. 3.5-F-17.00

Institution	:	Aeronomy Laboratory, ESSA
Investigator	:	GADSDEN, M.
Title	:	Sodium Dayglow
Purpose	:	To search for rapid changes in the abundance of atomic sodium at the 90 km level. Relevance is to see if photodissociation of sodium oxides is significant in the overall sodium chemical problem.
Description	:	Scanning spectrometer used to monitor twilight and dayglow radiances at 5890/5896 Å. Standard nightglow photometer.
Location	:	Miahuatlan
Dates	:	February 16 - March 11, 1970.
Equipment	:	Three trailers airlifted to Ixtepec, thence by road to site
Special Site Requirements	:	110 volt ac, approximately 5 kilowatts. Zenith observation only.
Number and Names of People	:	Five - Gadsden, Marovich, Purdy, Smith, Mills.
Cooperating Groups	:	Mexico City University (Baez + colleague)
Special Comments and Needs	:	Clear skies.
Station Prob	:	1.0
Funds	:	In house.

SUMMARY OF PRELIMINARY RESULTS

Experiment was performed

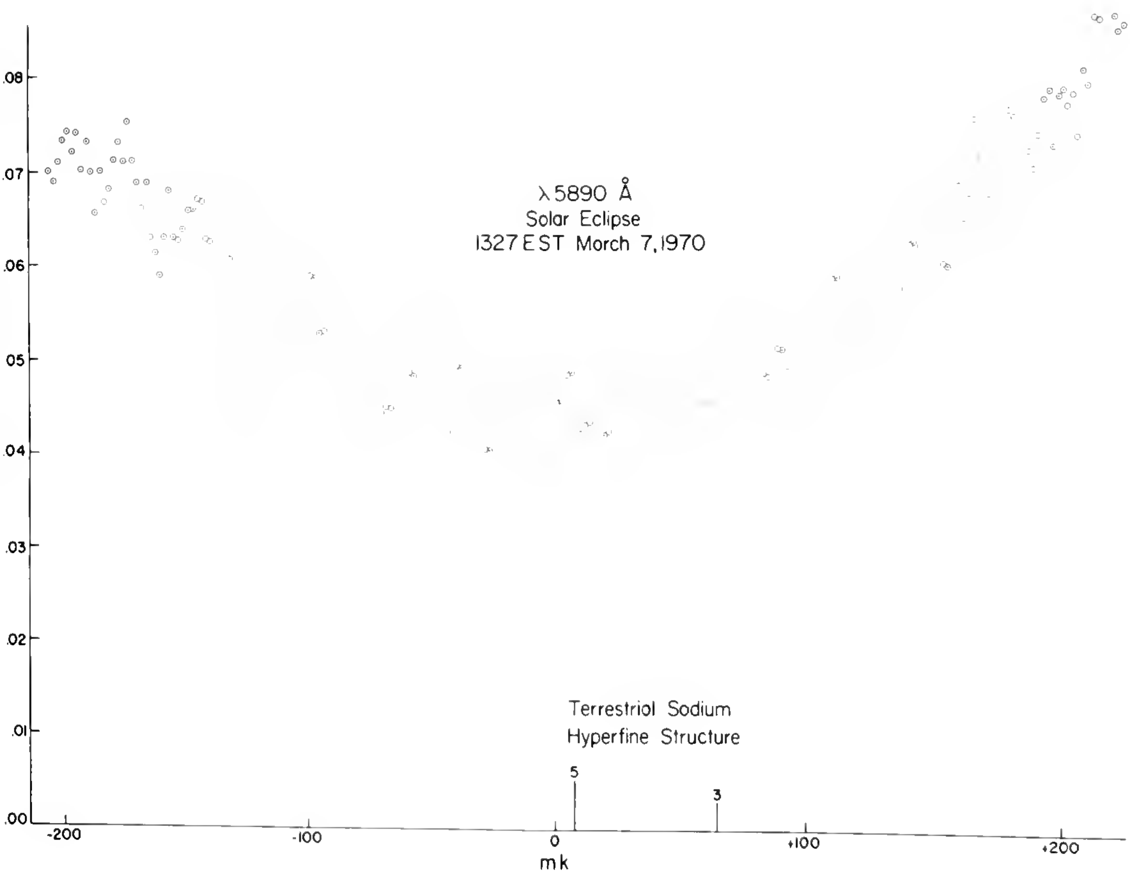
No report of preliminary results

1970 SOLAR ECLIPSE PROJECT NO. 3.5-F-17.01

Institution	:	Florida Atlantic University Department of Physics Boca Raton, Florida
Investigators	:	SIDES, V., LASHER, R., and BURNETT, C. R.
Title	:	Spectroscopic Absorption Measurements of Upper Atmospheric Sodium during Partial Solar Eclipse.
Purpose	:	Search for short-time variations of ground-state sodium atoms which might be caused by a charge in the photochemical reaction rate in the upper atmosphere during the change in incident sunlight.
Description	:	Spectroscopic absorption measurements using direct sunlight are to be made with a Pepsios spectrometer performing line scans on the bottom of the $\lambda 5890 \mathring{A}$ sodium absorption line. This technique has been well established in observations at Boca Raton since 1966. Sufficient spectral resolution is available to observe the hyperfine structure identifying the cold terrestrial sodium at 85 km altitude and quantitative measurements of the sodium abundance can be derived from the line profiles. In order to observe possible variations in the sodium abundance during the eclipse, line scans of two minute duration will be taken consecutively during the eclipse period. Since Boca Raton is in an area of partial solar eclipse, the direct sunlight will be continuously available for the observations.
Reference	:	"Upper Atmospheric Sodium at Boca Raton, Florida, 1967-1968," (with W. Thomas Novak), Bull. Am. Phys. Soc. Ser II; 13, 1457 (1968). "Computer Analysis of High-Resolution Upper-Atmospheric Sodium Absorption," (with W. J. Brown; J. B. McGuire) Southeastern Section of the American Physical Society Meeting, Gainsville, Florida, November 1969.
Location	:	Florida Atlantic University, Boca Raton, Florida, Lat. 26.4°N, Long. 80.1°W.
Dates	:	Above site is permanent location for spectroscopic measurements initiated in 1966.
Equipment	:	Pepsios spectrometer and related electronics permanently installed
Special site Requirements	:	Standard laboratory facilities.
Number & Names of People	:	V. Sides, R. Lasher, N. Marstad, C. R. Burnett.
Cooperating Groups	:	None
Special comments and needs	:	None
Station Prob	:	1.0
Funds	:	NSF # GA 19361

SUMMARY OF PRELIMINARY RESULTS-PROJECT NO. 3.5-F-17.01

A series of two minute line scans of the λ5890Å Solar D_2 line were taken with the Pepsios spectrometer beginning at 0730 EST continuing through the period of the eclipse to 1410 EST. Intermittent clouds associated with an intense low pressure area approaching Boca Raton interrupted the observations from 1230 EST to 1315 EST and terminated the measurements at 1410 EST. In addition to the observations made on the day of the eclipse, the upper atmospheric sodium abundance was monitored during the weeks and months before and after the eclipse in an ongoing experiment to accumulate data on the seasonal variation of upper atmospheric sodium. Definitive results on the variation of sodium during the eclipse are limited by the fact that the eclipse occurred near the beginning of the seasonal minimum of sodium abundance at Boca Raton and at small zenith angle which minimizes the slant path through the sodium layer at 85 km. Computer analyses of the data yield abundances which apparently decrease during the eclipse and increase immediately after the eclipse. However, this variation is comparable to the calculated uncertainties and the observed scatter in abundances before and after the eclipse. Attempts are being made to eliminate some of the uncertainties caused by clouds and by spurious effects in the computer analysis.



Composite of three two-minute line scans of the sodium D_2 line made with the Pepsios spectrometer at Boca Raton during the partial solar eclipse March 7, 1970. Terrestrial sodium is not observable.

1970 SOLAR ECLIPSE PROJECT NO. 3.5-E-20.00

Institution	:	Air Force Cambridge Research Labs.
Investigators	:	WEEKS, L. H.
Title	:	Rocket-Borne Optical Measurements
Purpose	:	Studies will be made of certain atmospheric species, total density, the solar chromosphere, coronal x-ray sources, and IR airglow by making the pertinent optical measurements shortly before totality, during totality, and at last contact.
Description	:	The technique of ultraviolet absorption spectroscopy will be used to measure ozone and molecular ozygen, and infrared emission spectroscopy will be used to measure the hydroxyl airglow and the $^1\Delta_g$ state of molecular oxygen. Information on the solar chromosphere at Lyman-X will also be obtained. Soft X-ray photometers will be used to obtain information on solar X-ray sources at totality and total densities at last contact.
References	:	L. G. Smith, C. A. Accardo, L. H. Weeks, and P. J. McKinnon, J. Atmos. Terr. Phys. 27, 803-829, 1965. L. H. Weeks and L. G. Smith, J. Geophys. Res. 73, 4835-4849, 1968. L. H. Weeks and L. G. Smith, Planet Space Sci. 16, 1189-1195, 1968 L. H. Weeks and L. G. Smith, Trans. AGU 50, 665, 1969
Location	:	Site D3 of Eglin AFB, Fla.
Dates	:	23 Feb. to 8 March, 1970
Equipment	:	Two Niro rockets, two payloads, launch control and support equipment. Max. weight approx. 600 lbs.
Special Site Requirements	:	Three 110 liter liquid N_2 tanks, two 2000 PSI dry N_2 tanks, access to payloads $\frac{1}{2}$ hour prior to launch
Number & Names of People	:	9 people, including L. H. Weeks, C. Doiron, J. F. Geary Jr., M. B. Patterson, and R. L. Champlin
Cooperating Groups	:	A. C. Faire - Falling Sphere (4 Niros) W. S. Hering - Balloon Ozonesonde (3)
Special Comments and Needs	:	
Station Prob	:	1.0
Funds	:	USAF

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE PROJECT NO. 3.5-D-21.00

Institution : AF Cambridge Research Lab. (CRAA) L. G. Hanscom Field, Bedford, Mass.

Investigators : LLOYD, J. W. F. and HALL, W. N.

Title : Sky Brightness

Purpose : To find out more about the nature and causes of the spectral and intensity changes in the sky light during a total eclipse. Attempt to separate the airglow emissions from the absorption lines and bands in the sky continuum.

Description : The intensity and spectral distribution of the zenith sky light will be measured in the visible portion of the spectrum. A scanning photo-electric spectrometer will be used with a spectral resolution of the order of 5 A°.

References : "Zenith Skylight Intensity and Color During the Total Solar Eclipse of 20 July 1963" W. E. Sharp, J. W. F. Lloyd, S. M. Silverman. Appl. Opt 5 787 (1966)

"Measurements of the Zenith Sky Brightness and Color During the Total Solar Eclipse of 12 November 1966 at Quehua, Bolivia", B. S. Dandekar, Appl. Opt. 7 705 (1968).

"A Review of Sky Brightness Measurements During Eclipses of the Sun", W. E. Sharp, J. W. F. Lloyd, S. M. Silverman, to be published in the preceedings of the C.N.A.E. Eclipse Symposium, Feb. 1968 Brazil.

Location : Ground based site in continental U.S.

Dates : One week either side of eclipse day.

Equipment : Three boxes total weight 400 lbs.

Special Site Requirements : 115V 1ϕ 1KW 60Hz

Number & Names of People : Two people. J. W. F. Lloyd, W. N. Hall

Cooperating Groups : None

Special Comments and Needs : None

Station Prob : 0.75

Funds : Air Force sponsored

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE - PROJECT NO. 3.5-F-21.01

Institution : Air Force Cambridge Research Laboratory
Aeronomy Division, Polar Atmospheric Processes Branch

Investigators : DANDEKAR, B. S. and TURTLE, J. P.

Title : Brightness, Color and Polarization of daysky at the totality of the Solar Eclipse of March 7, 1970

Purpose : Day-sky brightness and its polarization is due to the primary and multiple scattering of the incident solar radiation during its passage through the atmosphere. Both phenomena are a function of the spectral character of incident radiation, the distribution of the total particle concentration with altitude, their size distribution, and their scattering and absorption characteristics. Therefore the study of sky brightness and its polarization are needed for improving our knowledge about these parameters. The important role of multiple scattering can be studied from ground during a total solar eclipse when the primary scattering is absent in the umbral region.

Description : The sky brightness was measured in the zenith with two Fastie-Ebert spectrometers, one covering a range from 4100-6300 A, and the other from 6300-8100 A. The slit-widths dictated by the optimum instrumental performance 2343 8 A for the former and 20 A for the latter. The scanning for each was 50 seconds/scan.

Polarization was measured at 90° away from the sun, at an azimuth of 180° with respect to the sun. Observations were conducted with polarimeters at two wavelengths 4750 and 6000 A, selected by optical interference filters, each having a half transmission bandwidth of 60 A. The field of view for each polarimeter was 5° and the angular speed of each polarizer was 2 revolutions/scan.

The optical signals were detected by electron photomultipliers, amplified by electrometers and displayed on chart recorders.

Reference : (1) B.S. Dandekar, Applied Optics 7, 705, 1968. (2) Sharp, W.E., Lloyd, J.W.F., and Silverman, S.M., Applied Optics 5, 787, 1966. (3) E. de Bary, K. Bullrich, and D. Lorentz, Geofisica Pura and Applicata 48, 193, 1961. (4) J.G. Moore and C.R.N. Rao, Anns. de Geophys. 22, 147, 1966.

Location : Kinston, North Carolina, U.S. (geog. lati. 35 16.6 N, geog. longi. 77 34.4 W. altitude 20 meters above M.S.L.)

Dates : March 1 to March 8, 1970

Equipment : Eight packages, 1400 lbs. total, shipped by air

Special Site Requirements : 110 V AC power

Number and Names of People : Two, B. S. Dandekar and J. P. Turtle

Special Comments and Needs : Clear sky condition

Funds : AFCRL

SUMMARY OF PRELIMINARY RESULTS:

At totality the zenith skybrightness reduced by about four orders of magnitude as compared to that on a normal day. The spectral distribution of the skybrightness is shown in Figure 1 for totality, control days and twilight. A shift in the spectral distribution towards the shorter wavelength is seen at totality as compared to that at twilight or the control days. The shift towards the shorter wavelength is due to the absence of primary scattering in the umbral region, revealing the effect of multiple scattering on the spectral distribution

The upper limits for the brightness of [OI]5577, [OI] 6300 and Na-D lines at totality, obtaine from the signal, and signal/noise considerations are 1, 1.5 and 3 kR respectively. Such measurements are useful in separating the mechanisms responsible for these emissions.

Outside the period of totality the polarization for 4750 and 6000 A was about 42%. At totalit the respective polarizations were 4% and 0.6% respectively. The change in the plane of polari zation is shown in Figure 2. For both colors the plane of polarization changed by about 50 at totality. From this change it is estimated that the contribution of primary scattering in the direction of the polarimeter look angle, reduced by a little less than an order of magnitude at totality.

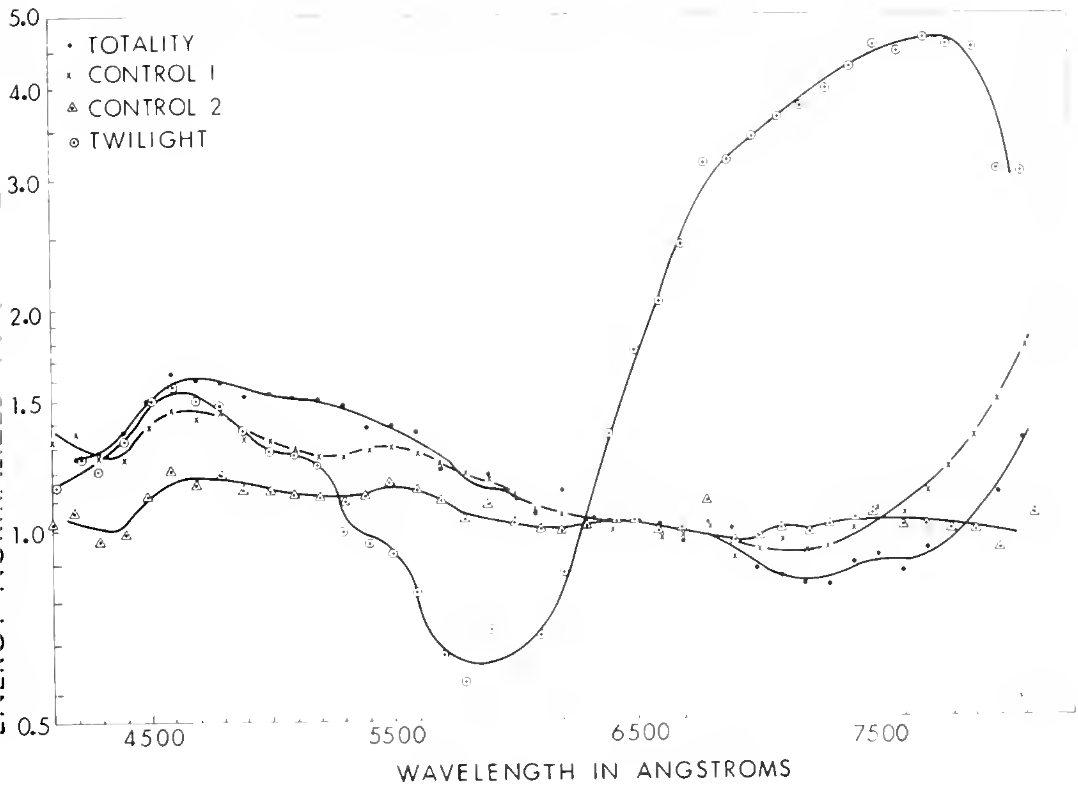


Figure 1. Spectral distribution of the sky brightness normalized with respect to 6300 A, for totality, normal day: (a) (March 7, 1970 solar elevation 49°)-control 1, (b) control-2 (March 6, 1970 solar elevation 46°), and twilight. The respective blackbody temperatures are 11,000, 9700, 8900 and 5000 °K.

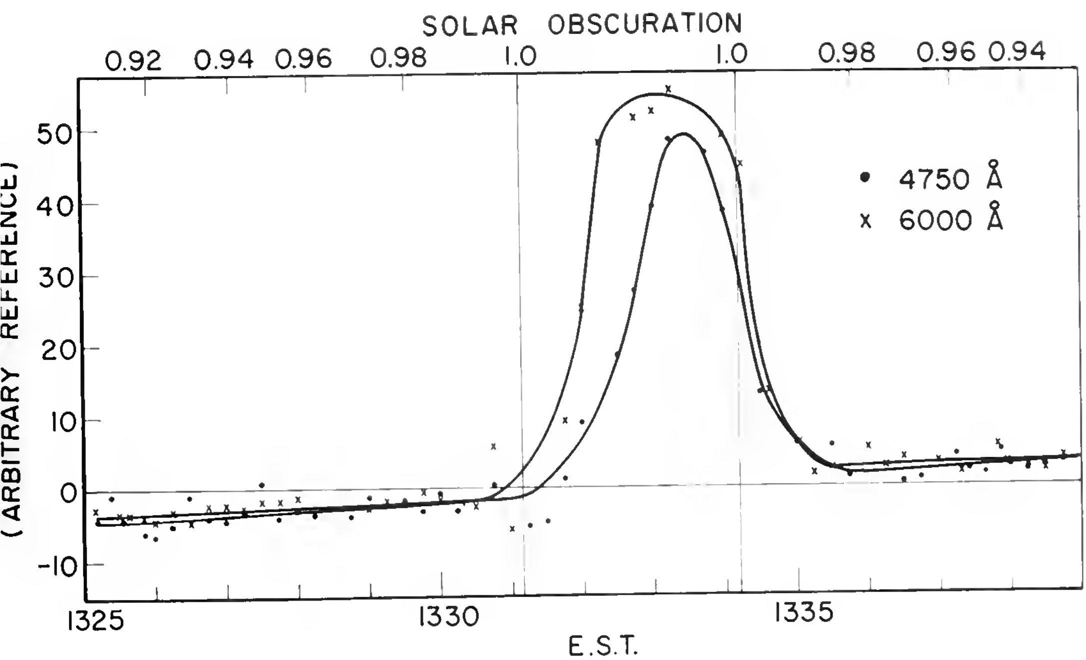


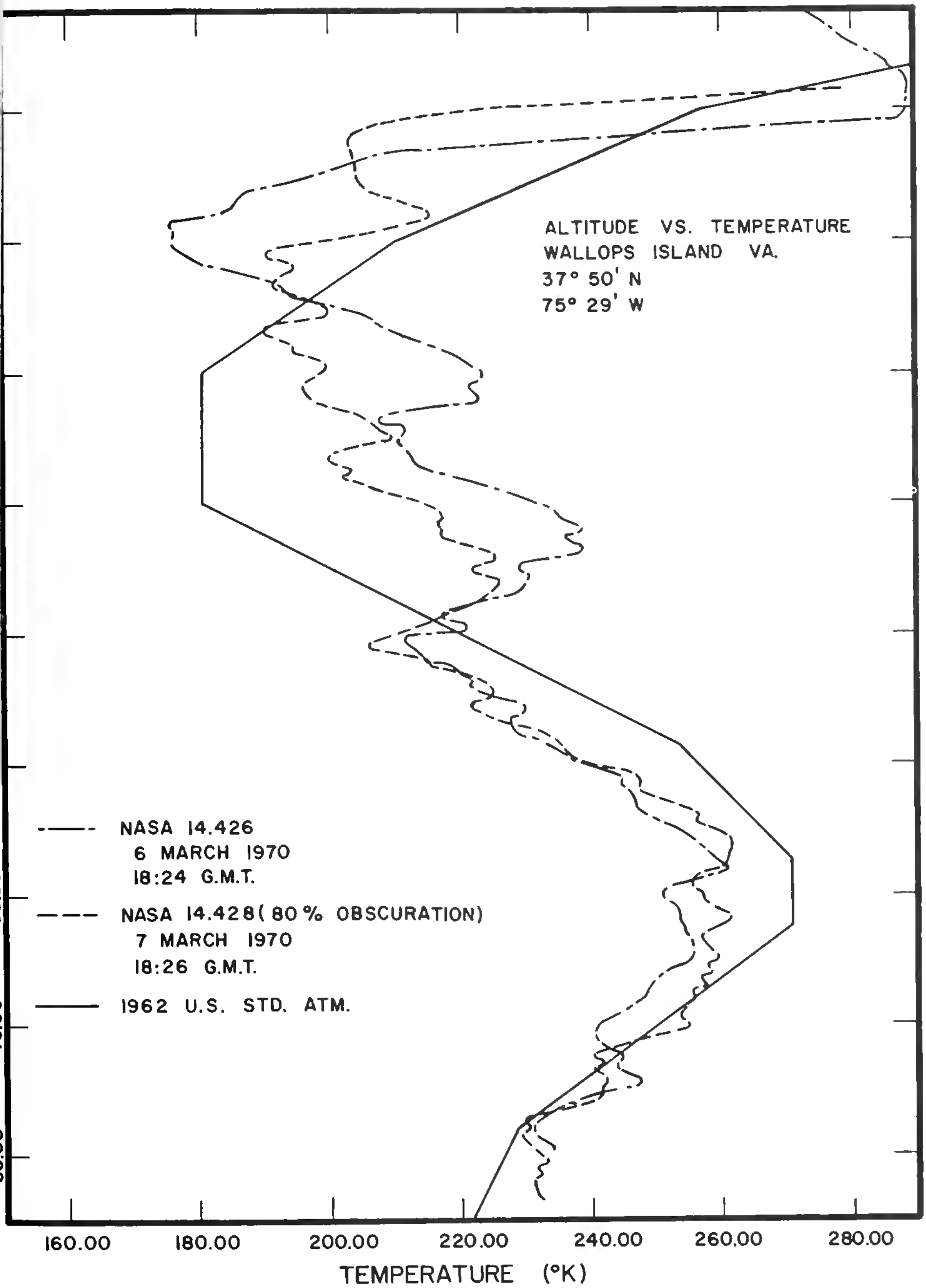
Figure 2. Change in the plane of polarization at 4750 and 6000 A.

1970 SOLAR ECLIOSE PROJECT NO. 3.5-F-22.00

Institution	:	Goddard Space Flight Center, University of Michigan
Investigators	:	HORVATH, J., SMITH, W., and THEON, J.
Title	:	Temperature, Pressure, Density Measurements of Neutral Atmosphere
Purpose	:	The purpose of these experiments is to measure the meteorological parameters of temperature, pressure and density in the atmosphere between 30 and 125 km using a pitot probe flown on a Nike Apache rocket. It is anticipated that the data resulting from these experiments will have considerable value not only in the study of the variation of the meteorological structure of the stratosphere, mesosphere and lower thermosphere, but also in support of experiments in other disciplines where neutral temperature enters into the computation of rate coefficients (i.e., decay and reformation of ionosphere D and E layers, composition measurements, etc.).
Description	:	A total of five Pitot probes were successfully launched from Wallops Island on 6, 7, and 8 March 1970. Three such experiments were carried out on eclipse day. The first two eclipse day launches preceded totality, coinciding with solar obscurations of 40% and 80%. The third eclipse day launch followed totality by approximately one (1) minute. The remaining two Pitot probes were launched plus and minus 24 hours with respect to the 80% obscuration launch.
Reference	:	Rupert, G. F., "Engineering Design of a Pitot Static Probe Payload" University of Michigan Report #05776-2-E, April, 1967. W. Smith, J. Theon, P. Swartz, L. Katchen and J. Horvath "Temperature Pressure density and Wind Measurements in the Stratosphere and Mesophere 1966" NASA Technical Report R-288, August 1968. J. Theon and J. Horvath, "Observations of the Southern Hemisphere Stratosphere and Mesophere," J. Geophys. Research. 73 (14), 4475-4480, 1968.
Location	:	Wallops Island, Virginia
Dates	:	March 6, 7 and 8, 1970
Equipment	:	No special equipment required.
Special site Requirements	:	None
Number & Names of People	:	3 - 4 personnel in Wallops Island area.
Cooperating Groups	:	GSFC - Ozone Experiments - Hilsenrath, Smith. GSFC/Univ. of Mich./Yale Univ. - Thermosphere Probes - Spencer, Brace, Carignan, and Walker. GSFC - Airglow Experiment - Heath.
Special Comments and Needs	:	None
Station Prob	:	1.0
Funds	:	Existing NASA Meteorological Sounding Rocket Program.

UMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.5-F-22.00

Preliminary data reduction from two of the five pitot probe launches has been completed. Neutral particle pressure, temperature, and density profiles (Fig.) have been derived for 6 March 1970 and 7 March 1970 (80% solar obscuration) between altitudes 30 Km and 125 Km. Results from the 40% obscuration launch will be forthcoming. Completion of the preliminary data reduction for all five Pitot probe flights is expected by 15 August 1970. No serious attempt has been made to analyze the comparative differences in the two reduced temperature profiles in terms of a response to solar input.



1970 SOLAR ECLIPSE PROJECT NO. 3.5-E-23.00

Institution : AF Cambridge Research Labs, Hanscom Field, Bedford, Mass.

Investigator : FAIRE, A. C.

Title : Neutral Density Rocket Measurements (High Altitude Falling Sphere)

Purpose : It is proposed to launch three falling sphere rockets during the 1970 Solar Eclipse in order to determine neutral density, temperature and pressure in the altitude range 40 to 120 km. The objectives are to obtain measurements of atmospheric structure parameters and to investigate atmospheric dynamics under the unique short-term transient conditions afforded by a total solar eclipse. The first falling sphere rocket will be launched near first contact. The second will be launched near commencement of totality and in addition will carry a chemical release experiment to investigate atmospheric motions (sodium and lithium). The third falling sphere rocket wi be launched near the time of fourth contact.

The falling sphere rockets will be launched from Eglin AFB Launch Site D-3 near Cape San Blas, Fla. The results will be directly correlated with measurements of O_2, O_3, and OH from optical payloads to be also launched from D3. The atmospheric perturbations observed from measurements at Eglin will be compared with those made at the Wallops Island Launch Site. The related optical experiments (L. Weeks) will be launched at the peak of totality and about one hour following last contact (see 3.5-E-20.00).

Description : The high altitude falling sphere is instrumented with telemetry and an omni-directional accelerometer which senses atmospheric drag experienced by the sphere during its free flight following ejection from a suitable rocket vehicle during ascent (ejection altitude 50-60 km). A frequency allocation of 730 MHz is required for special telemetry support supplied by the project. Radar tracking of the rocket vehicle and sphere and meteorological support (rocket-sondes and rawinsondes) are required for greatest accuracy in the experimental results.

References : A partial list of pertinent references is given below:

A.C. Faire and K.S.W. Champion in: Space Research V(North-Holland, Amsterdam, 1965) p. 1039.

A.C. Faire and K.S.W. Champion, in: Space Research VI(Spartan Books, Washington, D. C. 1966) p. 1048

A.C.Faire and K.S.W. Champion, in: Space Research VII(North-Holland, Amsterda 1967) p. 1046.

A. C. Fair, AFCRL Rigid Falling Sphere Program, in: IQSY Instruction Manual No. 9, Sounding Rocket Research Techniques, IQSY Secretariat, London (1964) p. 40.

A.C. Faire, New Falling Sphere Instrumentation for Aerospace Density Determination, 1966 National Telemetering Conf. Proc., Boston, Mass. (1966)p. 70.

A.C. Faire, AFCRL 7-inch Rigid Sphere Instrumentation, Falling Sphere Method for Upper Air Density, Temperature and Pressure, COSPAR Techniqual Manual Series (COSPAR Secretariat, Paris, 1967) p. 91.

A.C. Faire and K.S.W. Champion, in: Space Research VIII(North-Holland, Amsterdam, 1968) p. 845

A.C. Faire and K.S.W.Champion in: Space Research IX (North-Holland, Amsterda 1969) p. 341.

Location : Site D-3 of Eglin AFB, Fla. is desired launch location.

Date : 7 March 1970

Equipment : Ground based equipment will consist of an electronically equipped Air Force van and preflight preparation equipment (including payloads) which is estimated to be approximately 5000 pounds, 300 cubic feet in 25 boxes.

Special Site Requirements : Power requirements:

a. Preparation area: 2 lines, 115 VAC, 30 amps each.
b. Van: 3 wire, single phase, 115 VAC, 31 KVA. Van should be located so that antennae have line-of-sight to rocket launchers.

PROJECT NO. 3.5-E-23.00

Number and Names of People : Approximately 8 people. Names of key personnel follow. Other names to be supplied at later date.

E. A. Murphy	M. Baratz
Gustave Stromberg	Russell Smith
Paul Mundis	A. C. Faire

Cooperating Groups : AFCRL scientists conducting experiments in:
  a. Measurements of O_2 and O_3 density (L. Weeks)
  b. Measurements of OH concentration (R. Cuikay)

Special Comments and Needs : Hard-line communications links are required between project preparation area, launcher and participating range sites. High gain pre-amplifiers are susceptible to electromagnetic interference and ignition noises. Detailed notes to be supplied in a later communication.

Station Prob : A participation probability of 0.9 is estimated.

Funds : The most probable source of funds for the Solar Eclipse (1970) is USAF

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION
(However see: Nature, 226, p. 1110, June 20, 1970)

1970 SOLAR ECLIPSE PROJECT NO. 3.5-E-24.00

Institution	:	Goddard Space Flight Center
Investigators	:	HILSENRATH, E. and SMITH, W.
Title	:	Ozone Measurements in the Stratosphere and Mesosphere.
Purpose	:	The purpose of this experiment is to determine the photochemical response of the important trace constituents in the mesosphere. The characteristic times for the three forms of oxygen in this region is of the order of several minutes. A measurement of ozone before, during and after a solar eclipse affords a unique opportunity to evaluate the condition of photochemical equilibrium as opposed to atmospheric dynamics. These data will be coordinated with measurements of the neutral temperature structure.
Description	:	The experiment proposed is the chemiluminescent ozone sonde The concentration profile is obtained via a parachute desce Three experiments are proposed during a 3 hour period cente on the time of closest approach of the eclipse to Wallops Island.
Reference	:	
Location	:	Wallops Island, Virginia
Dates	:	March 6, 7 and 8, 1970.
Equipment	:	No special equipment required.
Special Site Requirements	:	None.
Number & Names of People	:	3 - 4 personnel in Wallops area.
Cooperating Groups	:	GSFC/Univ. of Michigan - pitot probes - Horvath, Smith, The GSFC - Airglow Experiment - Health.
Special Comments and Needs	:	None
Station Prob	:	1.0
Funds	:	Existing NASA Meteorological Sounding Rocket Program.

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE PROJECT NO. 3.6-F-01.00

Institution : Institute for Exploratory Research
U. S. Army Electronics Command
Fort Monmouth, N.J. 07703

Investigators : BOMKE, Dr. H. A. (Leader), HARRIS, A. K., SHEPPARD, D. and BLAKE, H. A.

Title : Eclipse-Induced Geomagnetic Effects

Purpose : The reduction of ionospheric conductivity during an eclipse results in modification of the electric current in the ionosphere. We plan to measure its resulting geomagnetic field changes. Analysis of the geomagnetic eclipse data enables one to study such phenomena as ionospheric recombination, distribution and intensity of X-ray active areas on the sun, ionospheric wind patterns, and ion drifts. It also allows one to check predictions based on different versions of the ionospheric dynamo theory and so to arrive at a better understanding of ionospheric electrodynamics.

Description : During the 12 November 1966 eclipse, an electron-spin-resonance magnetometer proved to be well suited for eclipse investigation. In its 1966 version, this instrument could measure only the component of the magnetic field disturbance in the direction of the total geomagnetic field. In Peru, this was no disadvantage, since near the magnetic equator the eclipse-induced magnetic effects happen to lie predominantly in that direction. However, for an eclipse in middle-latitudes such as the 1970 eclipse, the ionospheric-current pattern is different, and all three orthogonal magnetic components are needed. We will therefore use our recently invented device which allows the measurement of three components but retains the advantages inherent to the spin-resonance principle. It will have a bandwidth of 0 to 50 Hz and a sensitivity of 10^{-7} Gauss.

References : Bomke et al "Recombination Coefficient and Coronal Contribution to E-Layer Ionization from Magnetic Observations of a Solar Eclipse", Journal of Geophysical Research, Vol. 72, pp. 5913-5918 (1967).

Bomke et al "Magnetic Observations in Peru During the Total Solar Eclipse of 12 Nov. 66 and Resultant New Information on the E Layer and on Solar Emission", International Eclipse Symposium 5-11 Feb. 68 CNAE-Sao Jose dos Campos, Brazil.

Location : We plan to make our observations in Osceola National Forest, about 40 miles west of Jacksonville, Florida. Our original plan to locate in Mexico was abandoned.

Dates : We will start taking background data about 10 days prior to the eclipse. Starting about 30 hours before the eclipse, data will be taken continuously for sixty hours. The site will be dismantled about 3 days after the eclipse.

Equipment : The equipment is housed in a shelter carried on a truck. Power for the system is provided by dual generators mounted on a trailer.

Special Site Requirements : Electrically quiet location, free from manmade low-frequency noise (commercial electric machinery, high voltage-power lines, electric railroads).

Number & Names of People : Five to six, namely Dr. Bomke, Mr. Sheppard, Mr. Harris, and 2 or 3 technicians.

Cooperating Groups : No special support is required. However it is intended to establish liaison with any group that might plan to conduct ionospheric observations in the general area of our sites.

Special Comments and Needs : None

Station Prob : Florida Site: 1.0.

Funds : Will be provided by U. S. Army Electronics Command

SUMMARY OF PRELIMINARY RESULTS -PROJECT NO. 3.6-F-01.00:

The geomagnetic-field changes occurring during the March 1970 solar eclipse were recorded as planned at a field site in Osceola National Forest, Florida. Three orthogonal magnetic components were recorded using a new electron-spin-resonance device developed by our group. The instrument worked well but due to unpredicted solar disturbances that started before the eclipse, increased in severity, and lasted through the day after the eclipse, our data unfortunately show the effects of the distrubances more than those of the eclipse. We plan to use, in addition to our own data, geomagnetic data recorded both on the fringe and outside of the eclipse path in order to differentiate between effects due to the eclipse and those due to the solar disturbances. In view of the very large amount of data that consequently must be reduced and analyzed, we are not in a position to state any results at this time. We anticipate, however, that our data analysis will have been completed by early 1971, and we are hopeful that we will have results that will warrant presentation at the 1971 eclipse symposium. In the meantime, we would appreciate hearing from any group that made magnetic measurements during the eclipse, either inside or outside of the eclipse path, in order to discuss the possibility of exchanging data for our mutual advantage.

1970 SOLAR ECLIPSE PROJECT NO. 3.6-F-02.00

Institution	:	Institute of Geophysics, National Autonomous University of Mexico (N.A.U.M.)
Investigators	:	DEL CASTILLO, Luis, M.Sc. Dept. of Geophýsical Exploration
Title	:	Geomagnetic measurements
Purpose	:	Magnetic periodic variations are grouped diurnal, annual, and secular changes. Of these only diurnal variations is of interest in this magnetic project. The two latter have a larger period. On the other hand diurnal variation has a 24 hours period, so any change in magnetic intensity it could be related in some extent to different phenomena. Sudden irregular changes or magnetic storms occur at intervals in the magnetic field of the earth. Up to now, it has been impossible to predict the occurrence or exact character of such storms. The ability to detect, detail and interpret these anomalies, together with an appreciation for and knowledge of associated spatial information, often leads to the discovery of valuable correlations.
Description	:	Variations of the geomagnetic horizontal field, during and after the eclipse, using an Askania magnetometer model Giz adapted to register diurnal variation. Results will be analyzed making use of harmonic properties of potential field and comparing observations done by other magnetic stations outside of total eclipse area even from other countries.
Reference	:	Mateo Casaverde, Total Solar Eclipse in South America, November, 1967.
Location	:	Mexican Observation Station, Miahuatlan, Oax. (about - 100 m from the last electric post at the town of Miahuatlan).
Dates	:	March 2 - March 11, 1970
Equipment	:	Value $20000. One small jeep. Weights about 300 pounds distributed into 7 packages.
Special site Requirements	:	Quiet place. It means free of disturbing magnetic field. Two small unmagnetized houses (lumber) are required -- (8' X 8). Power Line: 110 volts, 60 cps.
Number & Names of People	:	Luis Del Castillo, M. Sc., Ing. Carlos Cañón Amaro, and Francisco García Méndez.
Cooperating Groups	:	A cooperative effort from Scintrex Ltd. Co. is expected consisting in a high precision magnetometer and coupled recorder.
Special Comments and Needs	:	No magnetic disturbances near (cars, radios, pipelines, etc).
Station Prob	:	1.0
Funds	:	Institute of Geophysics and private endowments.

SUMMARY OF PRELIMINARY RESULTS PROJECT NO. 3.6-F-02.00

Records from Miahuatlan magnetic station are not clear as the one obtained at the magnetic observatory of Teoloyucan, Mex. On - the basis of the horizontal magnetic intensity data and some information from other magnetic observatories, the authors present the following observed statements.

1. - On March 7, 1970 a solar impulse (s.i.) was recorded at 3.44 hrs (90° west of Greenwich). In the mean time, the graph showed conspicuous changes as a few days before total eclipse. This effect can be associated to three solar spots on the sun which appeared several days before the expected event.
2. - From 8.21 to 13.5 hrs. records show pulsations type p.i.2, but not so clear as they usually are (notice this period includes the total eclipse).
3.- At 13.5 hrs. a magnetic storm m.s. (moderate-severe) started; however, it does not show a defined starting point. The latter storm reached a K index equal 6 including great number of s.i.'s. In spite of this fact, the above storm got through by 18.15 hrs.
4.- The records kept on continuous strong magnetic variations from 18.15 hrs. up to next day morning.
5.- On March 8, 1970 a severe magnetic storm S started at 8.15 hrs. which had a K index equal to 8. No major peaks obtained thereafter.
6.- In general, most of the magnetic observatories whose data are sent to I.S.G.I. (International Service of Geomagnetic Index) reported instability in the magnetic field several days before eclipse.
The following brief conclusions can be made at the present time:

1.- The geomagnetic field was disturbed before and after eclipse. The disturbances were of planetary character since they were recorded in different countries on the earth. As it can be seen a perturbation was due to the great solar activity during those days.
2.- It is well known that particles emitted by the sun travel at different rates of velocity which varies from 8 min. to 48 hours. Considering this fact, the earth received a lot of particles along total eclipse (before, during, and after event), which distorted the geomagnetic field. Therefore, it seems that results are obscured seriously by the effect produçed by the foretold particles. Consequently, it is not possible to define yet whether the phenomenon was subdued or not. It is necessary to go over records again once more.

1970 SOLAR ECLIPSE PROJECT NO. 3.6-F-03.00

Institution	:	Lamont-Doherty Geological Observatory Columbia University
Investigators	:	COTTEN, D., CHUTE, J.
Title	:	Magnetic Variations
Purpose	:	To test a model of the mechanism whereby the eclipse of the ionosphere produces geomagnetic variations
Description	:	
References	:	
Location	:	Kinston, North Carolina
Dates	:	March 5 - 9, 1970
Equipment	:	Three-component Rb vapor and flux-gate magnetometer system
Special Site Requirements	:	Magnetically quiet with 110v A.C.
Number and Names of People	:	
Cooperating Groups	:	Lamont-Doherty Geological Observatory, Columbia University and Queensborough Community College, Bayside, New York
Special Comments and Needs	:	
Station Prob	:	
Funds	:	National Science Foundation and Department of Defense

SUMMARY OF PRELIMINARY RESULTS:

Ambiguous due to magnetic storm, but not in disagreement with model.

1970 SOLAR ECLIPSE - PROJECT NO. 3.6-F-04.00

Institution	:	Bell Telephone Laboratories
Investigators	:	LANZEROTTI, L. J.; MACLENNAN, C. G.; MEDFORD, L.V.; TARTAGLIA, N. A.
Title	:	Geomagnetic Field Changes and Pulsations
Purpose	:	(1) Observations of possible changes in mid-latitude field component intensities. (2) Observations of possible changes in the sense of polarizations of geomagnetic pulsations for frequencies $\lesssim 0.03$ sec^{-1}
Description	:	A three axis Serson-type fluxgate magnetometer is used with chart recording at 5 cm/min. The charts are subsequently digitized at six second intervals for computer processing and analysis.
Reference	:	Egedal, J., and N Ambolt, J. Atmos. Terr. Phys., 7, 40, 1955. Bomke, H. A., H. A. Blake, A. K. Harris, W. H. Hulse, D. J. Sheppard, A. A. Giesecke, and A. Pantoja, J. Geophys. Res., 72, 5913, 1967. Kato, Y., Sci. Reports Tohoku Univ., Geophys., 7, 37, 1956; 16, 49, 1965 and 16, 63, 1965. Chapman, S., Terrest Mag., 38, 175, 1933.
Location	:	Crawford Hill, Holmdel, New Jersey
Dates	:	March 6-9, 1970
Equipment	:	One Econoline van containing electronics
Special site Requirements	:	120 volt, 60 cps power geomagnetically quiet location
Number and Names of People	:	L. J. Lanzerotti, L. V. Medford
Cooperating Groups	:	None
Special comments and needs	:	None
Station Prob	:	1.0
Funds	:	Bell Telephone Laboratories

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.6-F-04.00

Geomagnetic Pulsations at Mid-Latitudes During the March 7, 1970 Eclipse

by

L. J. Lanzerotti, C. G. Maclennan, L. V. Medford, N. A. Tartaglia

Bell Telephone Laboratories, Murray Hill, New Jersey 07974

Three axis (H,D,Z) measurements of the earth's magnetic field were made at Holmdel, New Jersey ($\sim$97% totality) during the March 7, 1970, solar eclipse. The original intent of the measurements was two-fold. The first was to observe possible changes in the mid-latitude field component intensities due to decreased ionosphere conductivity during the eclipse period (Chapman, 1933; Egedale and Ambolt, 1955; Bomke et al., 1967.) The second was to observe possible changes that might occur in the sense of polarization of geomagnetic pulsations through the eclipse period (Kato, 1956, 1965 a,b).

The magnetic field data were obtained with a Serson-type fluxgate magnetometer system with an RMS noise level of $\sim 0.2\gamma$. The chart records were subsequently digitized at six second intervals. Any hope of detecting an ionospheric effect by observing a decrease in H or an overall change in D (Bomke et al., 1967; Egedal and Ambolt, 1955) was eliminated by the unfortunate occurrence of a disturbed magnetic period during the time of the eclipse. Analysis of the pulsation data for frequencies $\lesssim 0.03$ sec^{-1} has continued in order to search for possible eclipse-associated polarization changes.

A dynamic power spectral analysis was performed on the digitized data. Pulsations that occurred in certain specified frequency bands during and before the eclipse were then selected and a sliding band-pass filter was applied to the data. After filtering, the H and D components of the selected bands were plotted as vector plots and the axes of orientation of the pulsations were determined.

Preliminary analysis of pulsation polarizations at maximum amplitude in the frequency band between $\sim$0.02-0.015 sec^{-1} have been made. The pulsations show no large changes in the orientation of the major axis of the H-D ellipses during the period of the eclipse. This preliminary result is different from the results of Kato (1965 a,b) who reported observing an approximately 90^{o} shift in the orientation of the pulsation major axis during two eclipses for pulsations of about the same frequency range as reported here.

One of Kato's pulsation measurements was made in the auroral zone (Northway, Alaska) during the eclipse of 20 July 1963 (Kato, 1965 a). Kato's second eclipse measurement was made near the equator at Lae, New Guinea, during the eclipse of 5 February 1962 (Kato, 1965 b). He reports that a sudden commencement magnetic storm began the day before the 1962 eclipse and that the period during the eclipse was magnetically disturbed. He reported observing the same, approximately 90^{o}, shift in direction of the principle axis of the pulsation vector diagram during both eclipses.

A large number of possibilities could be invoked to explain the differences between the present observations and those of Kato. A careful examination of Kato's data has suggested that possibly the largest contributing factor to the differences between his results and those reported here is the method of approach used in examining, analyzing and interpreting the data.

The preliminary results reported here are interesting in that only small changes were observed in the pulsation major axis orientation during the eclipse. It is difficult to conceive of a mechanism occurring in the ionosphere during the disturbed magnetic period that would exactly cancel out a large, eclipse-induced, 90^{o} phase shift. This suggests that the eclipse-darkened ionosphere has little or no significant effect in changing the polarization of $\sim$1 min. period pulsations.

This preliminary study of the darkened-ionosphere data will be continued by studying additional bands of pulsations through the eclipse period. In addition, experimental pulsation data will be obtained during the coming year at conjugate points, one of which will be in continuous daylight and the other in darkness for a period of time. Such measurements may yield further insights into the transmission properties of the ionosphere for low frequency waves.

1970 SOLAR ECLIPSE - PROJECT NO. 3.6-F-05.00

Institution	:	University of South Carolina
Investigators	:	SAFKO, John L; CATHEY, LeConte; GILES, Frederick H.
Title	:	Melton Memorial Observatory 1970 Eclipse Expedition
Purpose	:	Measurement of Variations in Magnetic Field due to Eclipse
Descriptions	:	1) Proton magnetometer of standard design (see refere 2) A rotating rod magnetometer was designed to measur field components and avoid 60 cycle hum problem. consists of a 56 inch long mumetal rod surrounded seven coils of 10,000 turns each. This rod rotate about an axis perpendicular to its length and midw from its ends. A rotation speed of 2 rps in the earth's field produces an alternating signal of ab 8 volts (rms.). The axis of rotation can be chang to any position from vertical to horizontal.
References	:	G. S. Waters and P. D. Francis, "A Nuclear Magnetomete Jour. of Sci. Instr. 35, 88 (1958). H. A. Bomke, H. Blake, A. K. Harris, W. H. Hulse and D. J. Sheppard with A. A. Giesecke and A. Pantoja, J. Geophys. Re. 12, 5913 (1967)
Location	:	Givhans Ferry State Park, South Carolina, USA
Dates	:	7 March 1970
Equipment	:	1) proton magnetometer 2) rotating rod magnetometer
Number and Names of People	:	(6) L. Cathey, F. H. Giles, P. A. Karnazes, J. L. Seel G. Ryland, S. Finklea
Special Comments	:	(1) rotating rod magnetometer not finished in time for eclipse -- now being finished
Funds	:	2/3 State of South Carolina; 1/3 NSF Grant GA-16771

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.6-05.00

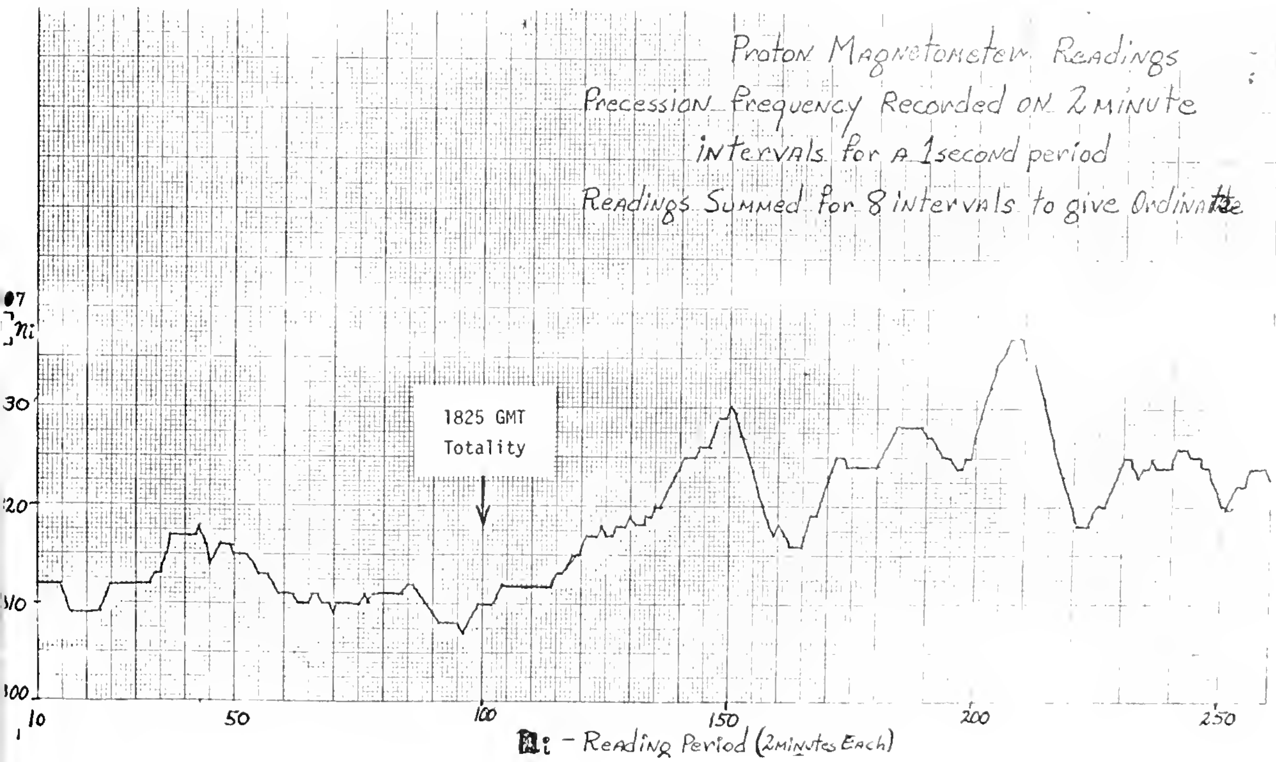
(1) A proton magnetometer with a counting system was operated during the solar eclipse observed at Givhan's Ferry, South Carolina. The Automatic data handling scaler system failed due to the trip from Columbia to the observational site, and we were unable to repair the system during the eclipse period. Data was taken with a frequency meter at two minute intervals during the eclipse period.

The proton precession frequency was nominally 2290 Hz. If we assume that this corresponds to the total earth's field, we will have an expected variation due to the diurnal change of about 6.6 Hz if we have an average change of 150 γ due to the solar effects. This is a small change in a basic frequency of 2290 Hz.

A plot of the observed data is attached in the form of an averaged curve. The average is computed using the sum of eight individual readings. The sum is shown in the plot. The maximum diurnal variation should be about 53 Hz on this type of plot. Notice also that there is no pronounced variation associated with the eclipse event that occurred at the 100th reading period. We understand, unofficially, that a solar flare created a magnetic disturbance during this period so that the eclipse effects were probably washed out due to these anomalies.

No curve of the average diurnal variation of the earth's field is available for this location. In addition the automatic data system has not operated satisfactorily since the trip. A new data system is being constructed so that representative daily magnetic variations can be plotted.

(2) The rotating rod magnetometer was not completed in time for use during the eclipse. This equipment is presently being completed.



1970 SOLAR ECLIPSE PROJECT NO. 3.7-D-02.00

Institution : Atmospheric Sciences Laboratory, White Sands Missile Range, N

Investigators : WILLIAMS, Ben H.; KAYS, Marvin D.

Title : Stratospheric Eclipse Structure

Purpose : To explore eclipse effects on the structure of the neutral atmosphere by determining quantitatively, the degree of vari- ability and thus the induced perturbation created in the uppe atmosphere during a solar eclipse. Meteorological rocket firings will provide measurements of wind, temperature, and ozone in the stratosphere and mesosphere.

Description : Arcas meteorological rockets will be fired at Eglin AFB, Flo (near Apalachicola), during a 48 hour period before, during a after a solar eclipse on March 7, 1970. Payloads will consis of temperature-ozonesondes. Firings will commence on 1812 G 6 March 1970 and will continue on 7 March one hour before an after sunrise, one hour before, thirty minutes before, durin thirty minutes after, and one hour after eclipse and one hou before and after sunset, and will be terminated at 1812 GMT 8 March 1970.

Reference : Ballard, H. N., J. S. Randhawa and W. L. Webb, 1966: "Strat spheric Circulation Response to a Solar Eclipse," ECOM Rpt. 5082, Oct. 66, and ECOM Rpt 5189, March 68.

Webb, W. L., J. Giraytys, H. B. Tolefson, R. C. Forsberg, R. Vick, O. H. Daniel and L. R. Tucket, 1966: "Meteorological Rocket Network Probing of the Stratosphere and Lower Mesosp Bulletin of the American Meteorological Society, Vol. 47, No. 10, pp 789-799.

Webb, W. L., 1964: "Stratospheric Solar Response," Journal of the Atmospheric Sciences, 21, pp 582, 591.

Location : Eglin AFB, Florida, near Apalachicola -- Code name D-3.

Dates : 6- 8 March 1970

Equipment : Two Arcas launchers, GMD's and TMQ recorders will be furnish on-site by Air Force.

Special Site Requirements : None

Number and Names of People : B. H. Williams and M. D. Kays

Cooperating Groups : U.S. Air Force

Special Comments and Needs : None

Station Prob : 0.9

Funds : N/A

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE PROJECT NO. 3.7-F-03.01

Institutions	:	NASA, Langley Research Center
	:	ESSA, National Meteorological Center
Investigators	:	HENRY, R.M. (LRC), and QUIROZ, R.S. (Nat. Meteoro. Centr., ESSA)
Title	:	Investigation of Stratospheric and Mesospheric Neutral Parameters During Eclipse Period
Purpose	:	To determine the perturbations in the temperature and wind patterns of the middle atmosphere (30-60 km) which are associated with a solar eclipse.
Description	:	Eight carefully calibrated meteorological rocket payloads were launched from Wallops before, during, and after the eclipse to measure the temperature and wind structure of the middle atmosphere. The temperature measurements were telemetered by the payload through available Wallops ground receiving and recording equipment. These temperature data will be corrected for errors due to radiation, conduction, and aerodynamic heating on the basis of theoretical studies and wind-tunnel calibrations of the test payloads. The wind measurements and time-altitude information were obtained through radar tracking of the descending parachute-payload system.
Reference	:	Ballard, Harold N., Randhawa, Jagir S., and Webb, Willis L.: Stratospheric Circulation Response to a Solar Eclipse. Atmospheric Sciences Laboratory, White Sands Missile Range, New Mexico, March 1968.
		Staffanson, Forrest L.: Theoretical Comparison of Beads, Wires, and Films as Rocketsonde Temperature Sensors in the Mesosphere. NASA CR-1286, February 1969.
		Haak, E.L., and Noreen, R.A.: Wind-Tunnel Calibration of the "Arcasonde I-A" at Simulated Altitudes Between 35 and 56 KM. NASA CR-66638, May 1968.
		Lacey, W.W., and Staffanson, F.L.: A Data Reduction Program for a Rocketsonde Temperature Sensor. NASA CR-66895, 1970.
Location	:	Wallops Island, Virginia
Date	:	March 6-8, 1970
Equipment	:	Eight Arcas rockets and payloads and currently installed Wallops ground equipment
Special Site Requirements	:	None
Number and Names of People	:	3 - R.M. Henry, and J.C. Manning (LRC), and R.S. Quiroz (ESSA)
Cooperating Groups	:	Groups from Goddard, University of Michigan, or other agencies investigating the thermal balance and photo chemistry of the upper atmosphere
Special Comments and Needs	:	Timing of the launchings before, during, and after eclipse period is of prime importance, both within this series of firings and among other cooperating groups. Radio frequency clearances within the 1680 MHz band and availability of FPS-16 (or equivalent) tracking radars are critical.
Station Prob.	:	1.0
Funds	:	Langley Meteorology Rocket Program

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.7-F-03.01:

In order to better define the eclipse related changes in the neutral atmosphere, a series of ARCAS meteorological rockets was fired from the Wallops Island (37° 50'N, 75° 29'W) before, during, and after the March 7, 1970, solar eclipse. Because of conflicts with the many other eclipse experiments at Wallops Island, it was not possible to schedule all of the most desirable launch times, but the eight launches scheduled give good temporal coverage, and, with the addition of data from the pitot tube experiment, should provide a clear picture of changes in the stratosphere and mesosphere. All of the rockets were launched at the scheduled times, with excellent trajectories, radar trackings, and telemetry for all but one rocket. The telemetry signal of the final, post-eclipse-day rocket was unsatisfactory and a backup launch was required.

All of the temperature data will be corrected for aerodynamic heating, radiation, and other errors using the procedures described in NASA CR-66895. However, these corrections, as well as the wind computations, require use of the processed radar tapes which have been delayed; therefore, the present preliminary analysis is based on uncorrected temperature data. The analysis is shown in the form of a time-height cross-section in figure 1 and in the form of temperature-altitude plots in figure 2. In figure 2-b, a smoothing in the form of an overlapping running mean has been applied.

The salient features of this preliminary analysis are (1) a perturbation of the temperature field essentially contained within the period of the eclipse, and mainly within the 40-60 km layer; (2) maximum amplitudes of 5-7°C at 45-55 km, with minimum temperatures indicated a few minutes after totality; (3) rapid warming just before the end of the eclipse.

Final conclusions must await not only the refinement and correction of the present data but also comparison with other results, especially the pitot tube measurement and ozone measurements at Wallops Island, and other eclipse meteorological measurements at Eglin AFB, Florida, and in Mexico. A more complete discussion of the preliminary analysis will be published in Nature Magazine.

(See also: Nature, 226, p. 1108, June 20, 1970)

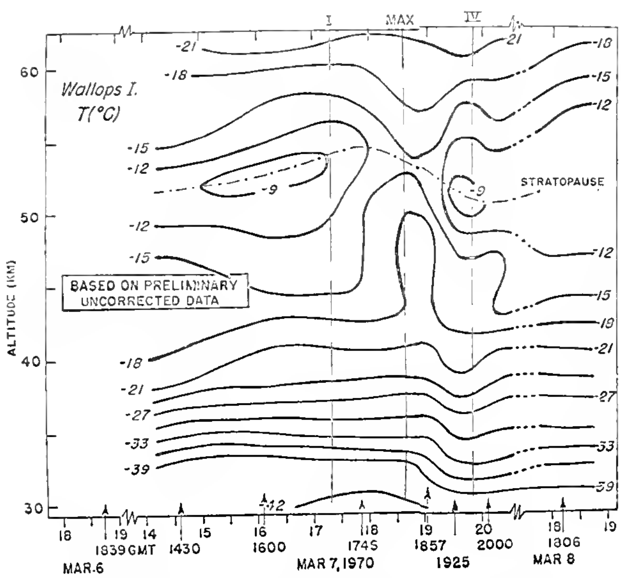


Figure 1.- Preliminary analysis of rocketsonde temperatures for Wallops Island, Va., for solar eclipse of March 7, 1970.

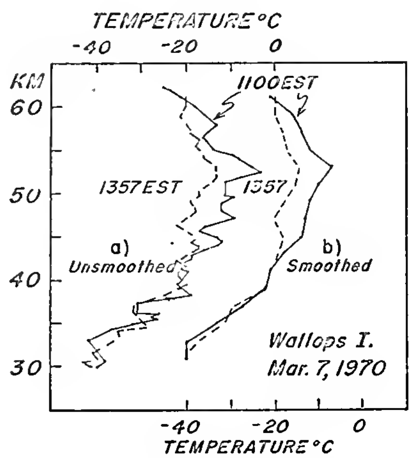


Figure 2.- Temperature profiles before (11.00 EST) and during (13:57 EST) solar eclipse of March 7, 1970 (based on preliminary uncorrected data)

1970 SOLAR ECLIPSE PROJECT NO. 3.7-E-06.00

Institution	:	Atmospheric Physics & Chemistry Laboratory, ESSA Research Laboratories, Boulder, Colorado
Investigators	:	Drs. WEICKMANN, H. K.; KUHN, P.M. and Messrs. PHILLIPS, B.B. and KELLY, J. J.
Title	:	Analyses of Atmospheric Radiation budget and Atmospheric Electric Parameters in path of totality, 1970 Solar Eclipse.
Purpose	:	To determine correlations between infrared and solar radiation and the onset of totality coincident with changes in atmospheric cloud conditions. Vertical profiles of upward and downward total radiation (solar plus infrared), surface incident and reflected solar radiation and surface net radiation measurements are to be combined with satellite photo coverage to determine effects of the eclipse on the pre and post eclipse radiometric budget and the zenith downward radiance. Electric field variations will be determined during the eclipse.
Description	:	A spectrally selective chopper bolometer radiometer operating over the spectral regions 8.0-13.0μ 5.5-26.0μ is the principle narrow field radiance detector. Two Eppley-type spectrally selective hemispheric pyranometers provide the incident and reflected solar measurements. Six balloon-borne radiometersondes will furnish measurements of upward, downward, net and total radiant emittance.
References	:	Kuhn, P.M., and H.K. Weickmann, Jour. of Appl. Meteorol. 8, 1, 147-154. 1969. Kuhn, P. M., M.S. Lojko, and E.W. Peterson, Nature, Vol 223, No. 5205, pgs. 461-464. Kuhn, P. M., L. P. Stearns and J. R. Stremikis, Atmospheric infrared radiation over the Antarctic, Tech. Report ESSA-ERL-IAS 2, 1967.
Location	:	Oaxaca, Mexico
Dates	:	4 - 10 March 1970.
Equipment	:	1 Radiometer, chopper bolometer, multichannel, ESSA Sr. #867 2. Hemispheric, spectrally selective pyranometers Sr. # 9895F4, 9896F4 1 Radiometer, ventilated net total Sr. #107 6 Radiometer, balloon-borne (up, down, net & total) expendable 1 Electric field sensor with recorder.
Special Site Requirements	:	None
Number & Names of People	:	Three: Kuhn, Phillips, Kelly
Cooperating Groups	:	National Environmental Satellite Center, ESSA
Special Comments and Needs	:	None
Station Prob	:	None
Funds	:	ESSA

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE PROJECT NO. 3.7-D-09.00

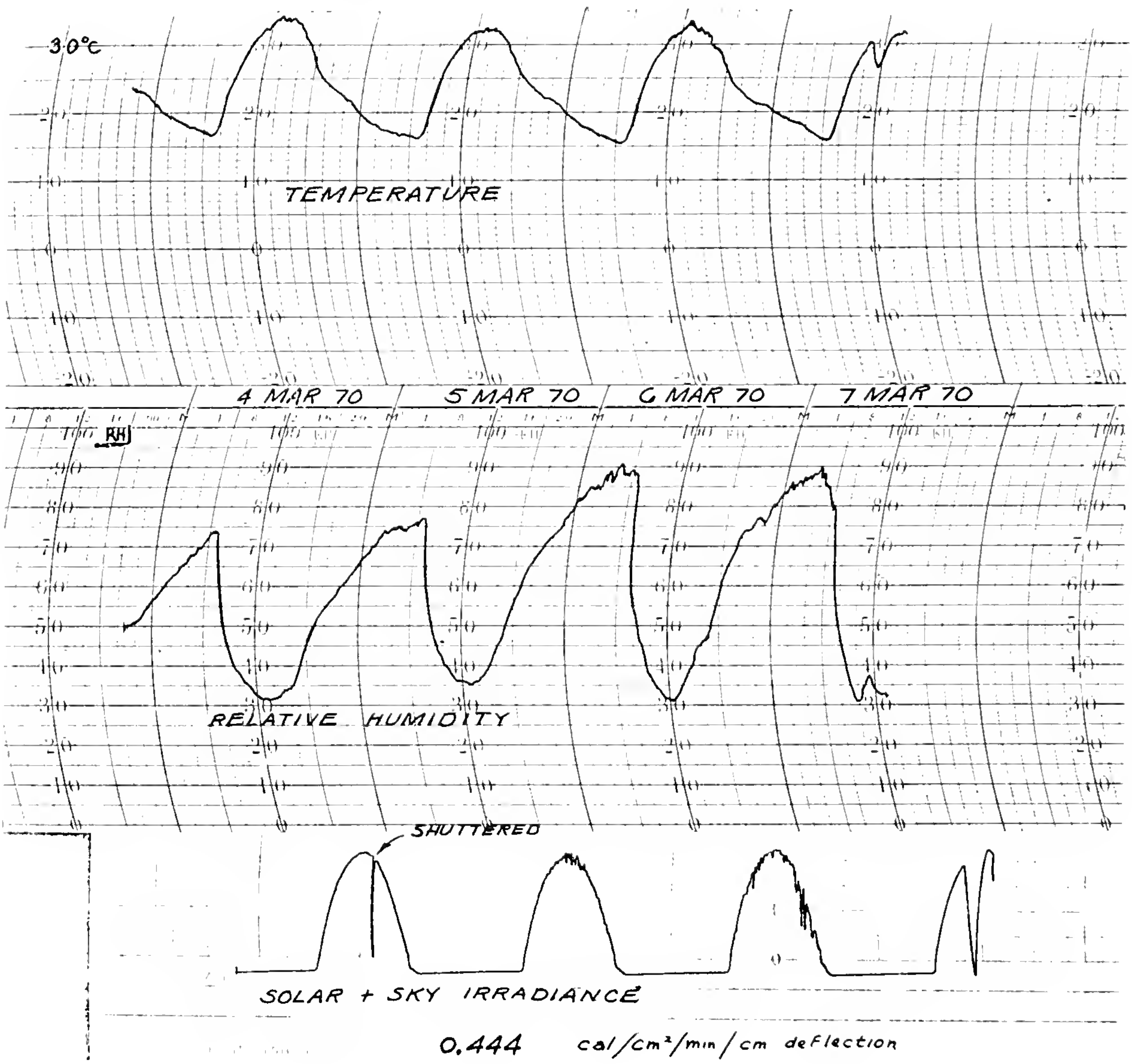
Institution	:	Douglas Advanced Research Laboratories McDonnell Douglas Corporation
Investigators	:	HALL, F. F., and AGENO, H. Y.
Title	:	Infrared Radiance Measurements of Stratospheric Ozone at 9.6 μm.
Purpose	:	To determine if the cutoff of solar irradiance of the ozone layer during an eclipse leads to detectable changes in 9.6 μm ozone radiance viewed from the ground.
Description	:	A two channel, 10 cm aperture bolometer detector radiometer will be used to measure the absolute radiance in bands 8-13 μm and 9.3-9.8 μm. A portable generator is used for power.
Reference	:	Hall, F. F., Applied Optics 7, 891 (1968) Randhawa, J. S., J. Geophys. Res. 493 (1968)
Location	:	Mountains southeast of San Carlos, Yautepec, Mexico
Dates	:	February 28 - March 8, 1970
Equipment	:	500 lb., 30 cu. ft., $15,000; transport by truck, entering at Mexicali
Special Site Requirements	:	No special requirements, truck is self-contained
Number and Names Of People	:	Hall, F. F. and Ageno, H. Y.
Cooperating Groups	:	None
Special Comments and Needs	:	None
Station Prob	:	1.0
Funds	:	McDonnell Douglas Corporation

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.7-F-09.00:

The project was accomplished as planned. Infrared radiance in the bands 8-13 μm and 9.3-9.8 m were recorded on the three days prior to the eclipse and on eclipse day. The photograph shows the dual channel radiometer set up in the mountains southeast of San Carlos Yautepec. The site was adjacent to the uncompleted new road to the village.

Preliminary evaluation of the data indicates that no change was observed in ozone radiance in the 9.3-9.8 μm channel. This was the expected result since only the lower levels of the ozone layer can be monitored when viewed from below.

A slight decrease in overall window radiance in the 8-13 μm channel was measured which probably corresponds to the decrease in temperature of the lower, more moist atmospheric boundary levels during the eclipse. The temperature, relative humidity, and solar plus sky irradiance were monitored during the four days on site and the results are shown in the copies of the instrument recordings. To further evaluate the change in window radiance it would be desirable to know the vertical distribution of water vapor in the region near the site. If any radiosondes were flown near San Carlos, we would be grateful to have a copy of the temperature and humidity profile on the eclipse day. This would enable a more complete understanding of the window radiance change during the eclipse.



1970 SOLAR ECLIPSE PROJECT NO. 3.7-F-10.00

Institution : Ball State University

Investigators : HULTS, Mr. Malcom E.; BURGESS, Mr. Roger D.; and VIDAL, Professor Juvenal I

Title : Photoelectric Detection and Analysis of Shadow Bands

Purpose : A comprehensive study of the shadow band phenomenon which occurs just befo and after the total phase of a solar eclipse. (1) Photoelectric detection of shadow bands; (2) visual observation of shadow bands; (3) photography of band structure with still and motion picture cameras.

Description : By using narrow band-pass filters (to isolate particular spectral lines of the flash spectrum), a series of photocells and amplifiers, tape recorders to record the modulation of a carrier wave due to the motion of the shadow bands across the photocells, a permanent record of the relative intensity and spacing of the bands should be secured. This record will be compared with theoretical intensity curves for such phenomena as single-slit diffraction patterns and interference fringes of various types. The orientation of the bands will be obtained visually. This analysis should help to determine the true cause of the so-called shadow bands.

References : Burgess and Hults, "A Shadow Band Experiment," Sky and Telescope, August, 1969, page 95. Hults, "Ground Observers Report on November's Eclipse (Taim, Brazil)," Sky and Telescope, March, 1967, pages 147-8.

Location : Greenville, North Carolina

Dates : March 5, 6 and 7, 1970

Equipment : Narrow band filters, photocells, transisterized amplifiers, tape recorders wave generators, shadow band screens (five feet square), still and motion picture cameras.

Special Site Requirements : None

Number & Names of People : Probably 7: Burgess, Hults, Vidal and 4 graduate students

Cooperating Groups : Department of Physics, East Carolina University, Greenville, North Carolin

Station Prob : 0.99

Funds : NSF

SUMMARY OF PRELIMINARY RESULTS

ECLIPSE SHADOW BANDS DETECTED VISUALLY, PHOTOGRAPHICALLY AND PHOTOELECTRICALLY AT THE 7 MARCH 1970 SOLAR ECLIPSE*

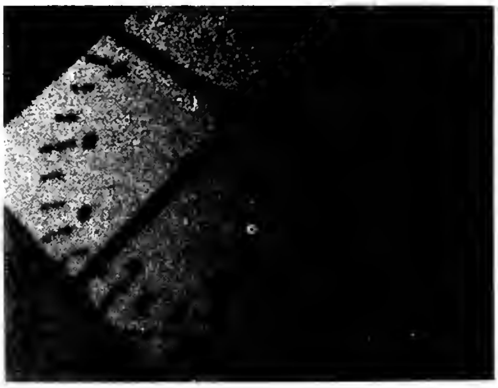
Malcom E. Hults. Roger D. Burgess, Daniel A. Mitchell, Duane W. Warn
Department of Physics, Ball State University, Muncie, Indiana

Visual observations of the shadow bands at the 7 March 1970 eclipse in the Greenville, North Carolina area showed that they were oriented roughly tangent to the shadow cone, moved at a velocity of 2 to 3 m/sec more or less in the direction of motion of the shadow cone, both before and after totality with respect to the ground. With respect to the shadow cone itself they were moving toward the shadow before and away from the shadow after totality. The bands were spaced approximately 10 cm apart (center to center).

Figure 1 indicates the shape of the elliptical shadow and the results obtained at three different observing sites by Ball State University personnel (G: Greenville, N.C., S. Suffolk, Va., V: Vanceboro, N.C.

The shadow bands were successfully photographed, possibly for the first time. Still photographs using Kodak 2475 recording film, Super 8 (Tri-X) movie film and ANSCO D200 film all show the shadow bands. Figure 2 shows the band pattern obtained by using Kodak 2475 recording film force developed to 4000 ASA. The band structure can most easily be seen by sighting along the length of the bands (lower right to upper left) with the plane of the paper nearly parallel with the line of sight. The 10 cm wavelength as measured in the photographs closely agrees with visual observations.

›electric detection was accomplished but the recordings on a strip chart recorder are : complicated suggesting that the shadow bands may involve a combination of many fre- :ies. From photoelectric work and visual work it appears there may be frequencies ing from 4 to 30 cycles/sec and possibly higher. Figure 3 shows the photoelectric :ting system and Figure 4 shows photoelectric strip chart records of shadow bands, 3 minutes before totality showing very little activity and (b) 96 seconds before lity showing definite shadow band activity.



'ig. 1.
:lliptical shadow and experimental hadow band results compared with eometrical tangents at Greenville nd Vanceboro, N.C., and Suffolk, Va.

Fig 2.
Shadow bands as seen on a shadow band viewing screen

'ig. 3.
'hotoelectric detecting system used y Ball State Univ. students.

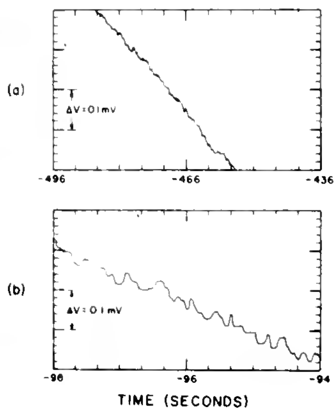


Fig. 4.
Photoelectric strip chart records of shadow bands. (a) 8 minutes before totality and (b) 96 seconds before totality.

:arch supported by the Atmospheric Sciences Section, National Science Foundation, Grant GA-21168

1970 SOLAR ECLIPSE - PROJECT NO. 3.7-F-10.01

Institution	:	Air Force Cambridge Research Laboratories Terrestrial Sciences Laboratory
Investigators	:	WIRTANEN, Theodore E. and ILIFF, Robert L.
Title	:	Photoelectric Shadow Band Recording
Purpose	:	To measure the magnitude of change in incident sunlight caused by atmospheric inhomogenities
Description	:	A sidereally-driven array of three photomultipliers was used to measure the duration, interval, direction and magnitude of changes in incident sunlight during the occurrence of shadow bands immediately surrounding the period of totality of the eclipse.
Reference	:	Sky and Telescope, Vol. 39, No. 2, February 1970 Natural History, Vol. 79, No. 2, February 1970
Location	:	One unit was located in the path of totality at Sankaty Head, Nantucket Island, Nantucket County, Massachussets. A similar unit was located at AFCRL, Bedford Massachusetts.
Dates	:	The sites were available for occupation on 6 and 7 March 1970. Bedford site dismantled 7 March; Nantucket site dismantled 9 March.
Equipment	:	(each site) Sidereal Mount, Unitron #152, 4 cu. ft. 30 lbs. Photomultiplier array. 1 cu. ft. 3 lbs. All auxiliary timing and power equipment is integral to the transporting van, or laboratory area. The equipment was transported by CRJ Shop Van #68B5873. This vehicle departed Woods Hole, Mass. on 6 March via ferry - destination Nantucket.
Special site require Requirements	:	Clear view from zenith to south and west. Separated from other observers to the extent that our van will not obstruct their viewing and blowing sand will not affect our viewing. (see summary)
Names & Number of People	:	(total - both sites) 5: T. E. Wirtanen, R. L. Iliff, G. O. Smith, L. B. Thompson, and J. C. Herring.
Cooperating Groups	:	U. S. Coast Guard, Brant Pt. Station, provided all transportation for the experiment personnel while on Nantucket.
Special comments and needs	:	Experiment is self-contained.
Station Prob	:	0.7
Funds	:	Cost of experiment was limited to items which can be borne by laboratory budget, except for water transportation of vehicle and any other expenses generally accounted for on an AFCRL-wide basis.

SUMMARY OF PRELIMINARY RESULTS-PROJECT NO. 3.7-F-10.01:

Data was taken in the form of oscillograph charts covering the period of totality and at least one minute before and after totality. While visual observations of the shadow bands were made at the Nantucket site, radio frequency emissions, for which no provisions could have been made in early tests of the experiment, saturated the signal of the recorders. This eliminated any possibility of recording the shadow bands.

1970 SOLAR ECLIPSE PROJECT NO. 3.7-F-10.02

Institution	:	NASA Langley Research Center
Investigators	:	**PATE, Jr., Harris B.**
Title	:	Shadow Band Cinematography
Purpose	:	To obtain motion pictures of solar eclipse shadow bands
Description	:	A 16 mm Milliken cine camera photographed shadow bands as they occurred prior to totality on a horizontal white lenticular projection screen. Focal length was 50mm. Frame rate was 24 frames per second. Exposure time was 1/120 second per frame. Ektachrome film was used with normal development. Further details are given on attached sheet entitled, "Shadow Band Movie Data."
References	:	Kodak Customer Service Pamphlet AM-10 entitled, "Solar Eclipse Photography for the Amature," p. 5.
Location	:	NASA Langley Research Center
Dates	:	March 7, 1970
Equipment	:	16 mm Milliken cine camera and white lenticular projection screen
Number and Names of People	:	David Adamson Sheila A. T. Long Robert C. Costen
Station Prob	:	1.0
Funds	:	NASA Langley Research Center

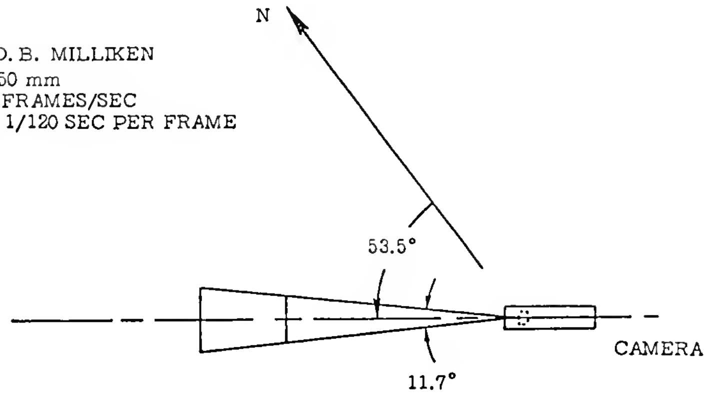
SUMMARY OF PRELIMINARY RESULTS:

A 16 mm Ektachrome movie is enclosed of shadow bands which occurred prior to totality at NASA Langley Research Center, Hampton, Virginia, during the solar eclipse on March 7, 1970. (The shadow bands which after totality were not photographed.) The shadow bands were photographed as they appeared on an approximately horizontal white lenticular projection screen by Harris B. Pate, Jr. (NASA Langley Research Center). Photographic information and an approximate sketch of camera orientation is enclosed on a sheet entitled, "Shadow Band Movie Data." Although the shadow bands are clearly visible when the enclosed film is projected on a screen, they are most distinct when the 16 mm film is viewed directly with the eye against an illuminated white background.

Also enclosed are two maps, one showing an overlay of the moon's umbral shadow at 1:36 p.m. EST and the other showing the orientation and direction of motion of the umbral shadow edge at the beginning and end of totality at Langley Research Center. A preliminary study shows that the shadow bands photographed were approximately alined with the edge of the umbral shadow at the beginning of totality.

SHADOWBAND MOVIE DATA
NASA LANGLEY RESEARCH CENTER
HAMPTON, VA. 23365

CAMERA: 16 mm D. B. MILLIKEN
FOCAL LENGTH: 50 mm
FRAME RATE: 24 FRAMES/SEC
EXPOSURE TIME: 1/120 SEC PER FRAME

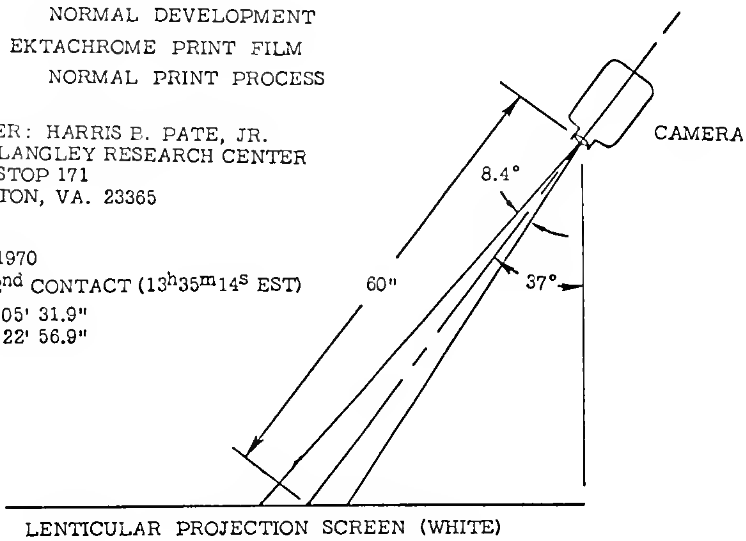


TOP VIEW

ORGINAL FILM: EKTACHROME COLOR FILM (16 mm)
NORMAL DEVELOPMENT
PRINT FILM: EKTACHROME PRINT FILM
NORMAL PRINT PROCESS

PHOTOGRAPHER: HARRIS B. PATE, JR.
NASA LANGLEY RESEARCH CENTER
MAIL STOP 171
HAMPTON, VA. 23365

DATE: MARCH 7, 1970
TIME: PRIOR TO 2nd CONTACT ($13^h 35^m 14^s$ EST)
LOCATION: N 37° 05' 31.9"
W 76° 22' 56.9"



SIDE VIEW

1970 SOLAR ECLIPSE PROJECT NO. 3.7-F-10.03

Institution : NASA, Goddard Space Flight Center

Investigators : QUANN, J.; DALY, C.; WULFF, F.; GAULT, A.; RICKARD, P.

Title : Photoelectric Detection and Analysis of the Shadow Band Phenomenon

Purpose : A study of the shadow band phenomenon which has been detected immediately prior to and following totality. This experiment will be performed in an area of 99.9% eclipse rather than directly in the path of total eclipse in order to provide for uninterrupted viewing of the shadow bands.

Description : (A) Six photocell detectors with spectral responses ranging from the UV to the IR. The output from each detector will be amplified and will frequency modulate a carrier; the information will be recorded with time (GMT) and voice onto magnetic tape. Cells I, II, and III have peak responses in the green-yellow portion of the spectrum, cell IV in the blue, cell V in the ultraviolet, and cell VI in the infrared. In addition, cells II and III have plane polarizing filters phased 90°.

(B) The orientation of the bands will be measured visually and mechanically as they move across a large, non-reflective white surface normal to the sun line.

References : Burgess and Hults, "A Shadow Band Experiment", Sky & Telescope-August 1969; E. M. Paulton, "Recording Shadow Bands at the March Eclipse", Sky & Telescope-February 1970; A. T. Young, "Photometric Error Analysis. VIII. The Temporal Power Spectrum of Scintillation" , Applied Optics-May 1969 pp. 869 - 885.

Location : Wallops Station, Virginia

Dates : March 7, 1970

Equipment : CEC VR-3400 tape recorder, FR-1300 tape recorder, photocells, filters, batteries, power supply, amplifier, viewing surface, time code generator, microphone, cameras, clock, and miscellaneous

Special Site Requirements : Power, CEC VR-3400 tape recorder, time code generator

Number and Names of People : (5) Quann, J.; Daly, C.; Wulff, F.; Poole, E.; Haerer, R.

Cooperating Groups : Goddard Space Flight Center, Wallops Island

Funds : None direct

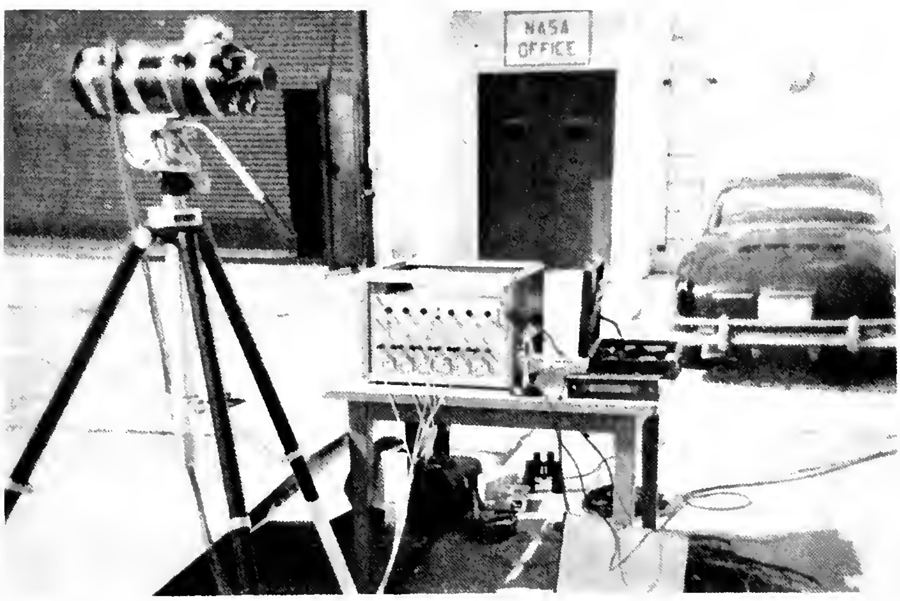


Figure I - Shadow Band Experiment Apparatus at Wallops Station, Virginia

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.7-F-10.03

A. The orientation of the shadow bands is tangent to the non-eclipsed crescent of the sun, the direction changing in direct relation to the change in the orientation of the crescent. With respect to the location of the experiment at Wallops Station, between the times of 18:36Z and 18:39Z, the crescent of the sun rotated from an initial angle of 12° (measured from solar north) to an angle of 283°... a rotation of almost 90°. This corresponded to the measured rotation of the bands through the same angle.

B. Little polarization of the shadow bands is evident.

C. Shadow bands distinctly different in width, velocity, and frequency are present simultaneously. Two types of bands were easily discernable to the eye:
1) width of bands: 1 ft, distance between bands: 6 ft, velocity as projected on viewing plane: 50 ft per second.
2) width of bands: 1.5 inches, distance between bands: 3 inches, velocity as projected on viewing plane: 10 ft per second.
These observations are in agreement with the data recorded from the photocells.

D. While the orientation of the shadow bands could be measured to a reasonable accuracy, the absolute direction of travel of the bands could not. The most that can be said with certainty is that they moved from west to east. The winds aloft as measured from a rawinsonde launched at 1630Z show the winds at all altitudes to 134,000 feet to be out of the west.

E. Recorded frequencies range from 1 - 50 hz, with the higher frequencies beginning later and terminating earlier than the lower frequency components. Plots of the power spectrum of the data, i.e. amplitude vs frequency, show that the majority of the energy is concentrated in the lower frequencies and appears not unlike plots of scintillation spectra.

F. The onset, amplitude, and duration of the shadow bands seem to be spectrally related to the limb darkening of the sun's photosphere. The shorter the wave length, the sooner the bands appear and the longer they last. In the cases of both the blue and the UV cells, maximum banding occurred on both sides of maximum eclipse (18:37:51Z). At maximum eclipse, both these cells experienced a cut-off with the dead time for the UV cell lasting for twice that of the blue cell. The duration of the shadow bands, as seen by the green-yellow photocells, was somewhat in excess of four minutes, while that recorded by the blue and UV cells exceeded seven minutes. No bands were detected by the IR cell.

G. The shadow band effect can be illustrated rather well using a light bulb with a long filament, two candles, a white wall, and a dark room. The heat from the candles will act as areas of atmospheric turbulence, while the long filament of the light bulb serves as the crescent sun. With this apparatus, shadow bands will appear against the wall. Rotation of the bulb and hence of the filament will cause a rotation in the orientation of the bands. Perturbing the air currents above one candle produces relative motion of these bands with respect to those caused by the other candle.

H. Assuming atmospheric turbulence to be the cause, calculations based upon the effective width of a crescent sun at 99.5% eclipse reveal that those shadow bands spearated by three inches could be generated at altitudes no greater than 500 feet; those shadow bands separated by six feet could be generated at altitudes no greater than 12,000 feet. The wind speeds as determined from the rawinsonde at these altitudes do not conflict with the measured speeds of the shadow bands.

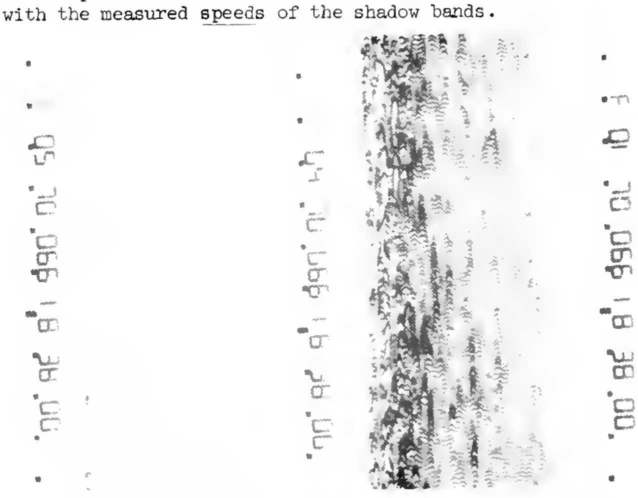


Fig. II- From left to right: Plots of time - frequency - amplitude for channels V, IV, I. Time is 18:38Z, immediately after maximum eclipse. Channel I is very active and is detecting strong bands; channel IV is just starting to react after experiencing a cut-off; channel V is quiescent. Frequency range is from 0 - 50 hz (left to right). Time is advancing from top to bottom, each marker representing 1 second.

1970 SOLAR ECLIPSE - PROJECT NO. 3.7-F-10.04

Institution	:	University of Washington, Physics Department, Seattle, Washington
Investigator	:	CLARK, Dr. Kenneth C.
Title	:	Broadly Viewed Shadow Bands: Details and Inferences
Purpose	:	Field description, model testing
Location	:	Assateague Island, Virginia, beside Wallops Island
Dates	:	March 7, 1970

SUMMARY OF PRELIMINARY RESULTS:

I visually observed and made notes of moving dark bands of decreased illumination on the occasion of the total solar eclipse of March 7, 1970, at Assateague Beach (37.9°N, 75.3°W) five miles east of Wallops Island, Virginia. The cause seems clear. It is consistent not only with these observational data but also with local measurements of another kind. This simple account seems adequate in spite of the variety of conjecture which the fleeting phenomenon can sometimes evoke.

I stood in a sand field of uneven flatness with grass clumps and small bumps, located about 10 miles inside the northern edge of the path of totality, which was about 83 miles wide. Totality occurred at 1:37 local EST and lasted for two minutes. At the start as the last edge of the solar disc disappeared and at the end as the edge first reappeared, dark shadow lines were seen moving rapidly across the ground during a period of 10 to 15 seconds. They were irregular lines oriented roughly in the direction of the sun and noticeable over the range of 50-100 m. It was not an array with regular separation, but the common interval was about 2 m. The width of each dark line was roughly 20 percent of the separation, and the illumination was less by an order of magnitude. No color was observed. Each line seemed not to maintain its identity over a length of more than 10-15 m and was part of a somewhat random superposition pattern; this observation was only slightly compromised by the irregularity of the ground. When attention followed the moving pattern for periods between 1 and 2 seconds, relative constancy of the pattern was observed. The motion of the array of irregularly aligned dark bands was identically about 8-10 m/sec from west to east both during solar disapperance and also during solar appearance. No systematic changes of average separation, orientation, or speed were seen during the period of occurrence.

It seems entirely satisfactory to attribute these shadow bands to atmospheric refraction at a high layer of wind-driven density fluctuations. The sun served twice as a small but major light source, and the ground illumination showed effects of refraction. The linear nature of the bands was controlled by the long shape of the curved source slit and by the existence of density gradient components normal to its effective orientation. Noticeable motion of the pattern would be largely normal to the bands and indicative of transverse wind components.

While the eclipse band passage should be present on any quantitative photoelectric record of the total eclipse at a fixed station, the panoramic viewing of such an illumination pattern affords discrimination of position and time. The twinkling of starlight, which is the similar effect, is not seen as a pattern on the ground only because a single star is not the major source of illumination.

Rough numerical estimates indicate the reasonableness of this interpretation and argue against more elaborate models. Any optical diffraction by the moon could only produce fringe separations of the order of width of Fresnel zones, the first of which at the moon would be 14 m. Furthermore, the breadth of the solar disc would blur any such pattern. The irregularity of the long lunar edge profile greatly exceeds this and would smooth out possible diffraction to a much fuller extent than for a stellar point source. In any case, the full width of the sun would destroy the fringes. An even more obvious argument against lunar diffraction is the speed of motion: the passage of the eclipse shadow is two orders of magnitude faster than that of the observed bands.

The disappearing or emerging solar crescent would show angular motion around the perimeter of the moon which would conceivably cause a fixed refractive region of the atmosphere to trace a pattern on the ground moving in the proper direction. The speed would depend geometrically upon the excess of lunar over solar angular diameters and the location of the observer within the zone of totality. Extreme choices of this geometry could increase the speed of this crescent center to about that of the apparent motion of the sun in the sky. However, for a stationary refractive atmospheric region at an altitude of several km the resulting ground shadow would move too slowly by an order of magnitude. Wind is needed.

The simplicity and contrast of the bands imply a low order of multiple refractions in the atmospheric path. The length of the shadow bands relates to the length of the refractive cell, while their separation derives either from a narrow cell separation in a single layer or from vertical superposition of the effects of several independent cells of greater width. The fair regularity of separations, as opposed to a random distribution, argues for not a large number of vertically distributed cells. The shape of the cell, however, is not necessarily proven by either the slit or the band orientation alone. Disappearance of the pattern for increasing exposure of the solar disc is probably governed by the curving extent of the disc transverse to the bands. For a pattern of 2 m width at a location well off the center path of totality, formed by refraction at several km altitude, the slanting crescent subtending transversely about 10^{-3} radian would cause blurring. This growth occurred in a time of the order of 10 sec and is consistent with the reported duration of the shadow bands.

The sharpness of band width is pointless to pursue, as many configurations of refractive regions can produce concentration of either bright or dark fringes as well as sinusoidal distributions. It is puzzling that bright bands are not reported. A rippled water surface transmitting light from a small source to an underlying surface illustrates this variety.

Reasonableness of this explanation can be confirmed using a rough model of atmospheric refractivity. Approximate numbers are in order. Assume a cell width of the order of D=10 m to be consistent with the band lengths seen in the ground pattern. A transverse horizontal density gradient over a width D/2 and columnar height D/2 would give a typical angular deviation of s/4h, if s is the band separation and h is the altitude. The reduced refractive index (n - 1) is proportional to density. The adiabatic density change estimated from either the pressure decrease due to vortex winds of a few m/sec or a temperature change of about 10^{-1} degree would produce an angular deviation of about 3×10^{-4}.

The predicted deviation in the atmosphere can be matched to the deviation implied by the ground pattern and this comparison of estimated cause and effect provides a rough estimate of the altitude h of the cell. If 3×10^{-4} is used for s/4h and if s is taken as 2 m, then a height of 2 km is the result.

There are three classes of looseness in these estimates. Primarily, the features of the ground pattern are fixed as direct observations. Next, the size and layering of assumed refractive cells relate to dimensions of the ground pattern and are geometrically controlled within reasonable limits. Least well bounded is the derived estimate of the height which depends upon acceptable but broad guesses of the thermodynamic fluctuations in the cell and of the density distribution within it. That there is a reasonable value of this height affords some support for the refraction model.

A crucial check on the previous estimates comes recently from the records of atmospheric sounding by the Weather Bureau sonde at the NASA Wallops Station, which passed 5000 ft at 1:53 EST, rising at 700 ft/min. The wind of several m/sec was shown to have a substantially constant west-to-east direction of 280 ± 10° over the entire flight. The only abrupt change in wind speed occurred in the interval from 4000 to 6000 ft, the measured speeds from 2000 ft in 1000 ft intervals being 3, 2, 2, 6, 9, 9 m/sec. The eastward direction of 280°, the speed change from 2 to 9 m/sec, and the balloon height of 1.5 km at which the overriding wind could produce slowly travelling vortices all add to the credibility of the simple model proposed.

1970 SOLAR ECLIPSE - PROJECT NO. 3.7-F-10.05

Institution	:	Department of Physics East Carolina University Greenville, North Carolina
Investigator	:	SEYKORA, Edward J.
Title	:	Search For Shadow Band Structure At Radio Frequency
Purpose	:	The prime purpose of the radio noise observations was to ascertain whether "shadow band" structure occurs at radio frequencies.
Description	:	During the March 7, 1970, solar eclipse, noise measurements were carried out at a frequency of 200 MHz as the center line of the eclipse passed through Greenville, North Carolina. This radio telescope system consisted of two vertically polarized Yagi arrays each having ten elements. A 200 MHz to 25 MHZ RF amplifier-converter was used at the antenna site, and its output connected to a Hallicrafters SX-130 receiver. The receiver output was recorded on magnetic tape and a chart recorder with an integration time constant of 1 second. Shadow bands were observed visually during this eclipse for approximately one minute before and after totality. The solar noise data recorded on magnetic tape was reviewed by observing the time dependence of the noise with an oscilloscope. These observations, of solar noise at 200 MHz, showed no shadow band structure.
Reference	:	None
Location	:	Greenville, North Carolina
Date	:	March 7, 1970
Equipment	:	See Description
Special Site Requirements	:	None
Number and Names of People	:	3 E. J. Seykora, L. A. York, F. M. Read
Cooperating Groups	:	None
Special Comments and Needs	:	None
Station Prob	:	None
Funds	:	Physics Department, East Carolina University, Greenville, North Carolina

SUMMARY OF PRELIMINARY RESULTS

See Description

1970 SOLAR ECLIPSE PROJECT NO. 3.7-E-11.00

Institution	:	Institute of Geophysics, National Autonomous University of Mexico (N.A.U.M.) and National Mexican Space Commission.
Investigator	:	MOSINO, Ing. Pedro A., Dept. of Meteorology
Title	:	Standard Meteorological Observations.
Purpose	:	
Description	:	Estimate of standard meteorological parameters before, during and after the eclipse, using portable equipment
References	:	
Location	:	Mexican Observation Station, Miahuatlán, Oax., and surrounding convenient sites.
Dates	:	Febr. 1 - March 15.
Equipment	:	
Special Site Requirements	:	
Number & Names of People	:	Ing. Pedro A. Mosiño and assistants.
Cooperating Groups	:	
Special Comments and Needs	:	
Station Prob	:	
Funds	:	Institute of Geophysics, National Mexican Space Commission and private endowments.

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE PROJECT NO. 3.7-F-11.01

Institution	:	University of Virginia Charlottesville, Virginia 22903
Investigators	:	OUTCALT, Dr. S. I. and MEISEL, Dr. D. D.
Title	:	Micrometeorological Observations During the March 07, 1970, Eclipse.
Purpose	:	Automatic acquisition of micrometeorological data during the solar eclipse at a location near the path of totality.
Reference	:	Gringorten, I. I. and Kantor, A. J. 1965, "Handbook of Geophysics and Space Environments" ed. Shea L. Valley, p. 3-17.
Location	:	Leander McCormick Observatory University of Virginia, Charlottesville, Virginia.
Dates	:	0000-2400 hours GMT March 04-09, 1970.
Equipment	:	See Outcalt (1969) in Water Resources Research 5, 1377.
Special site Requirements	:	
Names and Number of People	:	None--Automatic Station.
Cooperating Groups	:	
Special comments and needs	:	
Station Prob.	:	1.0
Funds	:	Internal including NSF Institutional Subgrant.

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.7-F-11.01

Simultaneous observations of net radiation and temperature for the entire partial eclipse were obtained at a site with maximum obscuration of 92% of the direct solar radiation. A strongly negative net radiation of -96 mly/min comparable to nocturnal conditions (-110 mly/min) was found at minimum light. Since low-light levels under normal daytime conditions (thick clouds) coincide with weak temperature gradients, organisms with both optical and thermal sensors may show confused behavior under eclipse conditions. The contribution of direct solar radition to the net radiation was computed using limb-darkened solar eclipse functions which show considerable departures from the uniform disk approximation. Full paper has been submitted to the Archives for Meteorology, Geophysics, and Bioclimatology.

After September 01, 1970, inquiries may be directed to Outcalt at the Department of Environmental Sciences at University of Michigan, Ann Arbor or to Meisel at Department of Physics, SUNY-College, Geneseo, New York.

1970 SOLAR ECLIPSE PROJECT NO. 3.7-F-12.00

Institution	:	University of Washington, Department of Atmospheric Sciences
Investigators	:	BADGLEY, Franklin I. and FLEAGLE, Robert G.
Title	:	Search for eclipse-induced atmospheric waves.
Purpose	:	Detect pressure wave at surface produced by eclipse.
Description	:	Pressures will be read from mercury barometer to about .02 at 5 minute intervals between 0800 and 1600 PST, March 7,1970. A microbarometer will be adaped to indicate fluctuations of .01 and will be run during the period of mercury barometer observations. Suitable damping will be provided.
References	:	
Location	:	University of Washington, Seattle.
Dates	:	March 1, 1070.
Equipment	:	Mercury barometer, microbarograph.
Special Site Requirements	:	
Number & Names of People	:	F. I. Badgley, R. E. Fleagle, 10 to 15 graduate students.
Cooperating Groups	:	
Special Comments and Needs	:	
Station Prob	:	1.0
Funds	:	None.

SUMMARY OF PRELIMINARY RESULTS:

No report

1970 SOLAR ECLIPSE PROJECT NO. 3.7-F-12.01

Institution	:	Sandia Laboratories, Albuquerque, New Mexico 87115
Investigator	:	REED, Jack W.
Title	:	Microbarograph Measurements
Purpose	:	Attempt to record air pressure waves from the eclipse, at ground level, from the heating disturbance and resulting gravity waves expected at high altitude during the eclipse passage.
Description	:	Sandia microbarographs, used for recording explosion airblasts at ranges to 150 miles, use Wiancko twisted bourdon-tube sensors, and give calibrated response to air pressure waves of amplitudes between about 5×10^{-4} millibar and 96 millibars, at frequencies between about 0.02 Hz and 30 Hz. One set will be operated at Albuquerque from about 0900 MST to 1300 MST (1600-2000) to include before and after backgrounds. Brush paper recording will be obtained at 0.5 cm/sec (60 ft/hr).
Reference	:	E.F. Cox, H.J. Plagge, and J.W. Reed, "Meteorology Directs Where Blast will Strike," Bull, Am. Meteorol.Soc., Vol. 35,
Location	:	Sandia Base, Albuquerque, New Mexico
Date	:	March 7, 1970
Equipment	:	Not applicable
Special Site Requirements	:	None
Number and Names of People	:	1 investigator
Cooperating Groups	:	Equipment is property of the USAEC
Special Comments and Needs	:	None
Station Prob	:	0.9
Funds	:	None

SUMMARY OF PRELIMINARY RESULTS-PROJECT NO. 3.7-F-12.01:

The microbarograph operated at Sandia Laboratories from 0920 MST to 1535 MST at recorded sensitivity of 1 mb = 6 cm on a Brush Recorder, paper speed of 6 cm/minute or 0.1 cm/sec. Attempts to set the bleed plug for at least one minute decay time were unsuccessful and the plug closed completely. The diurnal pressure wave was the primary change recorded, shown in Figure 1. An inset shows the appearance of wind noises which were very small during the eclipse period. There were no obvious sinusoidal waves which could not be attributed to local wind noise or aircraft in the vicinity (1.5 miles from the east end of Kirtland Field). A 0.04 mb amplitude wave at 0.02 Hz, for example, would have been easily noticed on this record.

We do not have parallel magnetic tape recordings for this microbarograph system. Power spectral analysis of this record would require digital read-out and this does not appear to be worthwhile unless there is some independent indication that useful results might obtain.

1970 SOLAR ECLIPSE PROJECT NO. 3.7-F-12.02

Institution	:	Lamont-Doherty Geological Observatory (Columbia University)
Investigators	:	DONN, W., BALACHANDRAN, N. K., HERMAN, J.
Title	:	Atmospheric gravity waves
Purpose	:	Investigation of possible gravity waves radiating from eclipse shadow path.
Description	:	Detection of gravity waves by means of surface pressure peturbations at multipartite array of microbarographs at Lamont and a single station in Burlington, Mass.
Reference	:	Chimonis, G. and C. O. Hines, J. Geophys Res. 75, 875, 1970.
Location	:	Palisades, N. Y. and Burlington, Mass.
Dates	:	Palisades (Lamont) instruments operate continuously; Burlington station operated from March 6-8, 1970
Equipment	:	Six (6) Lamont-Wallace U-tube monometers (microbarovariographs) operating period range 1 to 2000 sec., analog tape and oscillograph recorders.
Special Site Requirements	:	None
Number and Names of People	:	
Cooperating Groups	:	Lamont-Doherty Geological Observatory of Columbia University and Analytical Systems, Burlington, Massachusetts
Special Comments and Needs	:	
Station Prob	:	
Funds	:	National Science Foundation

SUMMARY OF PRELIMINARY RESULTS:

Negative in the period range operated

Institution : University of Florida, Department of Aerospace Engineering

Investigators : ANDERSON, Dr. R. C.; KEEFER, Dr. D. R.; MYERS, Dr. O. E.

Title : Eclipse Meteorology

Purpose : To observe the effects of a solar eclipse pulse on the atmosphere: pressure, temperature, light intensity, and winds.

Description : Absolute pressure measurement, using MKS Barotron and Moseley two-pen strip-chart recorder to measure pressure from a vane-mounted pitot head, at a sensitivity of $<1\ \mu$ bar and an overall time constant of <100 msec. Silicon photocell for light intensity. Electric anemometer. Time signals synchronized with WWV and CHU.

Location : Near Lee, Florida, 30°23.1'N, 83°18.8'W.

Dates : March 6 and 7, 1970

Equipment : 900 lbs., valuation $8000, by private panel truck and auto.

Site Requirements: Center of eclipse path

Number and Names of People : Nine: three faculty, six undergraduates: Mr. Gerald Collins, Mr. C. Brad Green, Mr. Bruce Schnitzler, Mr. Charles Shaffer, Mr. James C. Swingle, and Mr. Wesley Whitley.

Special Needs : Moderate weather

Station Prob : 1.0

SUMMARY OF PRELIMINARY RESULTS:

Barometric pressure, surface air temperature, humidity, normal incident light intensity, and wind velocity were monitored during 7 March, 1970 near Lee, Florida at 30°23.1'N, 83°18.8'W. The site was at an elevation of 90 ft, remote, in uniformly clear terrain, and near the center of the eclipse path. An alto-stratus cloud deck, overcast at 3500 ft, obscurred visual observation. A cold front was approaching from the north and light rainfall began at 22:00 GMT. Winds were dead calm.

For pressure measurement, a vane-mounted pitot static head, twelve feet above the ground, was connected by copper tubing to the sensor of an MKS Barotron. Sensor and reference volume were insulated with styrofoam. Reference pressure was monitored by means of a calibrated altimeter. A Moseley two-pen strip-chart recorder was used, with timing corrected by signals from WWV, 10 and 15 MHz, or CHU, 7.335 and 14.670 MHz. A trace at 130 μ bar full-scale with noise less than one μ bar was achieved. The overall time constant was <100 msec. Surface air temperature was measured with a flow-type thermistor bridge one foot from the ground. A silicon photocell was used to monitor light intensity. CHU was remarkably clear for half an hour after totality.

Analysis of Pressure Data: Reliable measurements were obtained during the period 16:40 through 21:20 GMT on 7 March 1970. Earlier data were rejected because thermal equilibrium could not be demonstrated in the reference volume of the Barotron sensor. After correction to WWV timing, the data from the strip chart record were converted manually to a deck of input cards, relative pressure vs. time at one minute intervals. This constitutes 280 minutes only of the thermal tide, an approximately known variation of period about twelve hours and magnitude the order of one millibar, tropospheric change because of the approaching cold front, and the smaller eclipse pulse.

Direct analysis by means of a Fourier transform will introduce "ringing" which will swamp any details of the desired information. A preliminary "filtering" was accomplished by subtraction of the best least-squares fit to a curve of the form

$$P = \alpha + \beta t + \gamma \cos\theta t + \delta \sin\theta t$$

for values of $\theta \geq 600$ minutes. Minimum residual (the implicit least-squares technique) occurred at θ=750 minutes. The result is shown in Fig. 2. The shaded curve of Fig. 2 is from Ref. 1, for a remarkably similar eclipse (one Saros unit earlier), except that at Tel Aviv the eclipse was just 80%, and of shorter duration. Note that there is little evidence of a disturbance until midway between first and second contact.

The curve of Fig. 2 was further treated by discrete autocorrelation and fast Fourier transform (Ref. 2, 3). The result is its spectral power density. A sharp peak occurs at a period of 89 ± 4 minutes, with essentially no evidence for any longer period, despite the simplicity of the "filtering" described above. Elimination of a Nyquist frequency which arises from the drift 90 minutes after fourth contact uncovers other power densities with periods of 57, 45, 51, 38, 20.3, 18.2, 15.7, and 12.3 minutes. However, the reliability of these numbers must be gauged by the above and the observation that their amplitudes are less than 80 μ bar in the presence of a 250 μ bar pulse and about 1500 μ bar of lower frequencies.

The similarity to the 1952 result at Tel Aviv lends confidence that an atmospheric pressure pulse did occur during the 7 March, 1970 eclipse with a magnitude of about 250 μ bar and a principal period of 89 minutes. Other oscillations of shorter period and lesser amplitude seem to have been generated. Further analysis of these data are justified, but, more important: further eclipse studies of this nature would permit a better understanding of the dynamics of the atmosphere.

1. Klein, M., and Robinson, N., Meteor. Notes #11, 1952 State of Israel, Meteorological Sv.
2. Cooley, J. W., and Tukey, J. W., Math. Comput. 19, 297 (1965)
3. Bremer, G., and Majors, R., Univ. Fla., Dept. of Elec. Engrg., 3/31/69

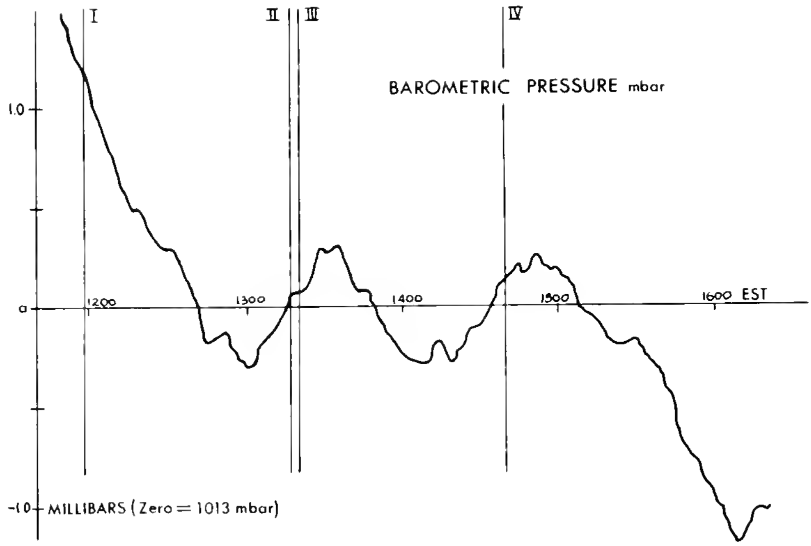


Figure 1
Barometric pressure variations, including drift, on March 7, 1970
at Lee, Florida

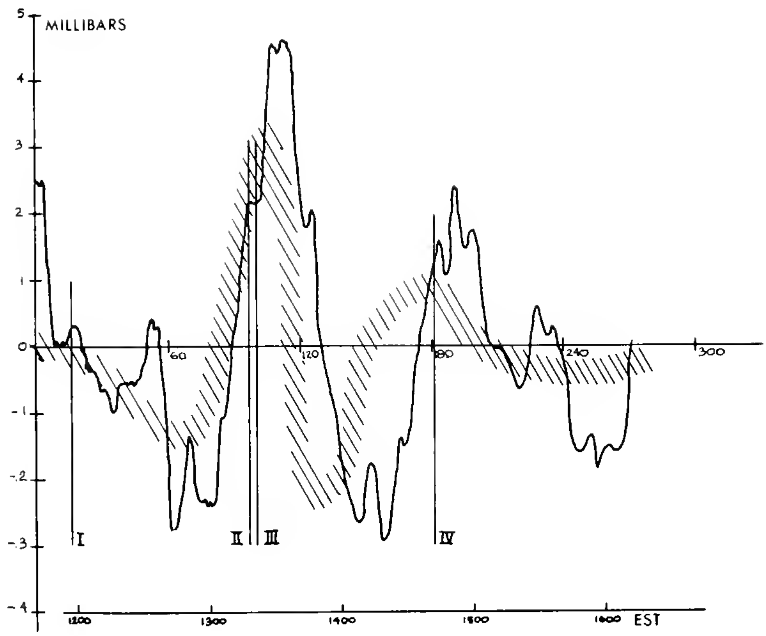


Figure 2
Corrected barometric pressure variations on March 7, 1970 at Lee, Florida

1970 SOLAR ECLIPSE - PROJECT NO. 3.7 -F- 12.04

Institution	:	University of Miami, Institute of Atmospheric Science
Investigator	:	LANHAM, Donald
Title	:	Search for Gravity Waves Generated by the Eclipse
Location	:	southern Florida
Dates	:	March 7, 1970

DESCRIPTION AND SUMMARY OF PRELIMINARY RESULTS

We operated three instruments of the required sensitivity during the solar eclipse. Two of these instruments were absolute pressure unit designed to track each other with a standard deviation of forty microbars. The third unit was a differential pressure transducer connected to a large backup volume which was periodically equalized.

The two absolute units were placed one at the University's campus, i. e. in Miami and the other at Flamingo which is on the tip of the Florida peninsula some sixty miles away in a direction perpendicular to the path of the eclipse. The differential unit was placed at the Miami location.

No clear-cut evidence of the gravity waves described by Chimonas and Hines can be seen in these records. We would be glad to supply these records for examination if you would like to see them.

1970 SOLAR ECLIPSE - PROJECT NO. 3.7-F-12.05

Institution	:	Lake Ontario Environmental Laboratory State University College, Oswego, New York 13126
Investigator	:	SYKES, Jr., Robert B.
Title	:	Microbarographic Measurements during the Eclipse
Purpose	:	Search for atmospheric gravity-waves
Location	:	Oswego, N. Y. Area and Halifax, Nova Scotia
Dates	:	March 7, 1970

DESCRIPTION AND SUMMARY OF PRELIMINARY RESULTS

An associate at State University Albany, Mr. Raymond Falconer, forwarded to me on March 4th a copy of your January 16th, 1970 letter pertaining to possible atmospheric gravity waves to be generated by the Solar Eclipse, with special reference to the March 7th Eclipse. My younger son and I had already scheduled to attempt to get to a center line location with departure on the afternoon of Thursday, March 5th. As a meteorologist here at State University Oswego, and on the basis of the information that was available, I chose to go to Nova Scotia. We journeyed to S.W. Nova Scotia on the local advice of the Meteorological Staff at Halifax International Airport and were very fortunate to have a "no cloud in the sky" view close to the center line.

I have in the general Oswego Area a microbarograph meso-scale network for the study of Lake Ontario Effect Snow Situations. A scheme was effected whereby an associate contacted about 12 locations for these selected barograph records. At my residence, a microbarovariograph (recorder for rate of pressure change) was installed and operating from about 1600 through 2100 Greenwich. Paper transport was set at 120" per hour as an attempt to obtain detail. It appears as though the range from 0 change in the center of the paper is around 1/2 millibar over a linear distance of about 1 1/2" of paper width. Installed microbarograph was set so as to turn once every 6 hrs. which means that about an 1/8 of an inch in record is 2 1/2 minutes in time.

We set up microbarovariograph and a microbarograph at the Halifax Airport Weather Station with their kind cooperation. Our viewing site was some 125 road miles S.W. of Halifax and close to the S. E. Coast. Unfortunately, we had only about 1/2 hr. before totality (for set-up time). There we set up a barograph and a hygrothermograph, unfortunately with a rather short pre-history and about 3/4 hour past-history. Eclipse photography was with a QUESTAR (inner corona, etc.) and with lesser focal lengths for some other effects.

Both microbarographs worked quite well although the Halifax record did not have as much variation as I had expected, perhaps due to the results of the long auto trip of some 1200 miles. Upon returning I set both instruments together and obtained many meters of simultaneous recordings for comparisons.

I believe that personnel from the State University at Albany had similar microbarovariographs at the Albany, Whiteface Mountain and perhaps at one other location. However, I believe such records were made at much lower speed of paper movement with the result that detail would be different than from those referenced above. Therefore, I do not know whether records are comparable. I have not yet picked up the various selected microbarograph records. Some instruments are on "6 hour gears" which means about 2" of record per hour. Ohters are on 12 hour gears or about 1" per hour of record.

It should be recognized, I am sure, that neither the microbarograph or the microbarovariograph have been calibrated according to previous references. Nevertheless, the records do exist and I thought it appropriate to advise you accordingly.

While I had set up this scheme for recordings before I received the copy of this January 16th letter, it seems possible that perhaps something might be detectable here and at the "Site". As I do not know exactly what to look for, I cannot know whether any of our instrumentation was operating within your sensitivity range.

1970 SOLAR ECLIPSE PROJECT NO. 3.7-F-13.00

Institution : State University of New York, Albany, New York

Investigators : MARKSON, Ralph and KAMRA, A. K.

Title : Atmospheric Electric Field Measurements Made from an Airplane and on the Ground During a Total Solar Eclipse

Purpose : To make airborne measurements of reported anomalous behavior of the earth's electric field during an eclipse. A survey of previous findings indicates that generally the atmosphere electric field measured at ground level decreases during an eclipse although some increases or no effect have been reported. Also unusual "agitation" and variations of the electric field have been noted and atmospheric conductivity and ion production rate have shown anomalous behavior. All previous atmospheric electric eclipse measurements have been made on the ground (except one balloon flight). Most investigators have considered convection of space charge to be the cause of these effects but no specific mechanism has been demonstrated. The significance of airborne measurements is to see if an effect is present well above the mixing layer where the influence of convection is minimal.

Description : A ground level measurement of the atmospheric electric field was made during the eclipse. Comparative values were established with measurements made on the day before and day after the day of the eclipse. Airborne measurements of the electric field were made at 4.1 km during the eclipse and three hours later. This height was 1 km above the top of the mixing layer.

Location : Near Norfolk, Virginia

Dates : March 6 - 8, 1970

SUMMARY OF PRELIMINARY RESULTS:

Our measurements do not show conclusive evidence that the eclipse influenced the atmospheric electric field. However, the data gives hints of three factors that could be investigated in the future: (1) There may be an enhanced electric field above the mixing layer and a decreased electric field on the ground during an eclipse. (2) The electric field above the mixing layer may be enhanced during the total part of an eclipse compared to the partial phases before and after. (3) Electrical agitation may increase aloft during an eclipse, particularly near totality.

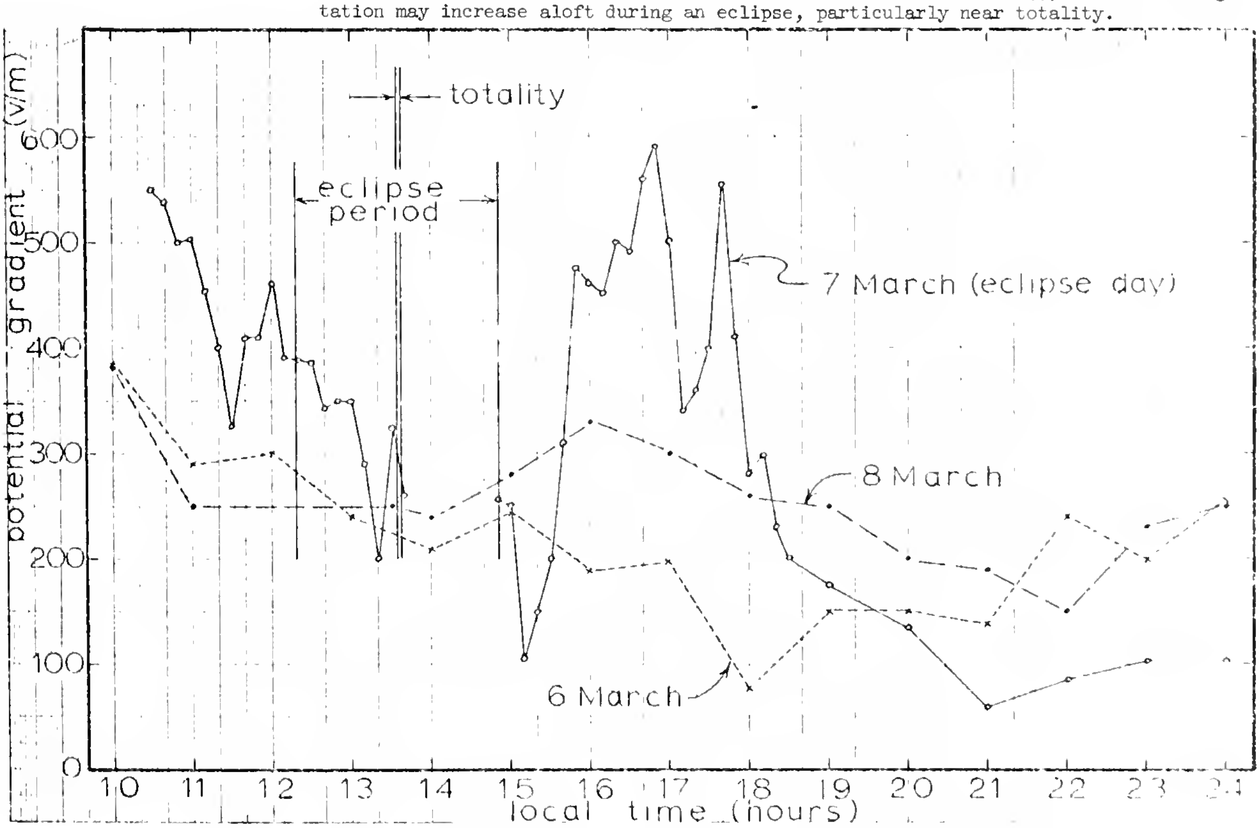


Figure 1. Uncorrected electric field measurements on the ground at Norfolk, Virginia, on 6,7 and 8 March 1970.

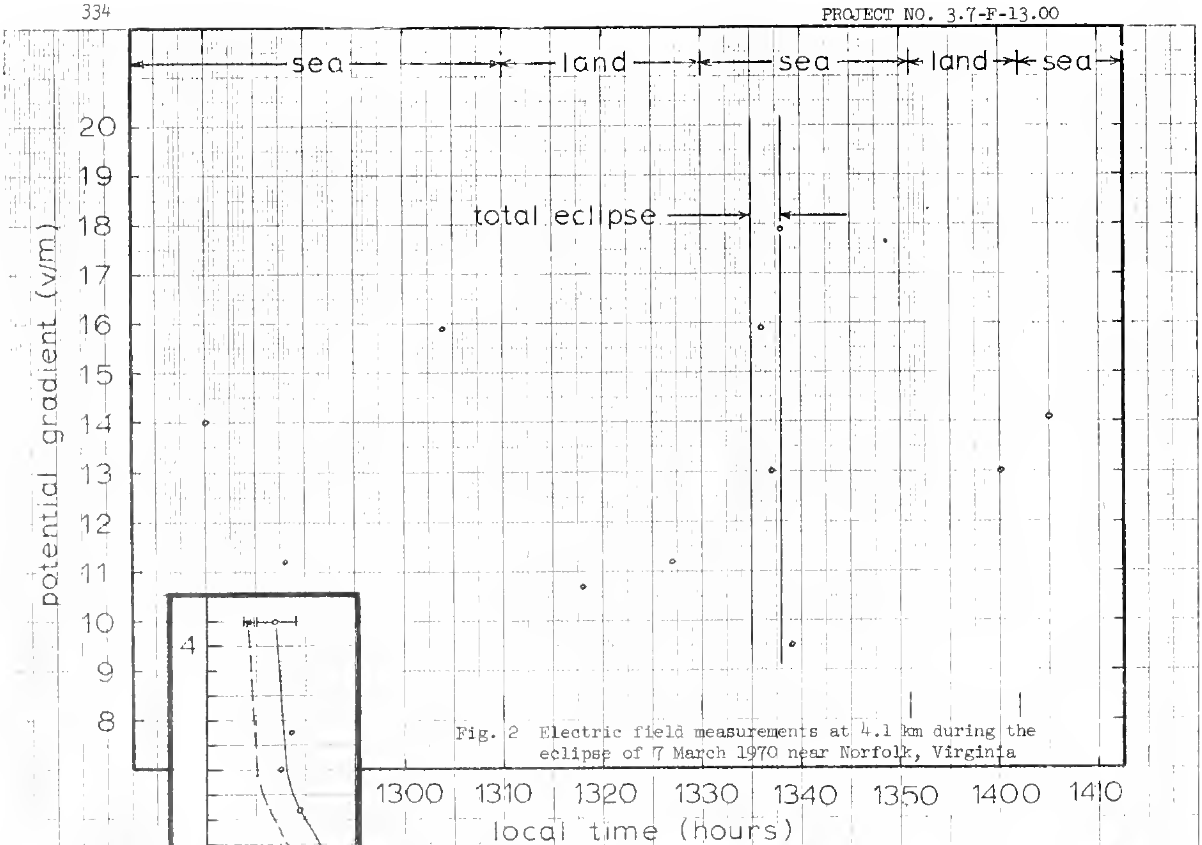


Fig. 2 Electric field measurements at 4.1 km during the eclipse of 7 March 1970 near Norfolk, Virginia

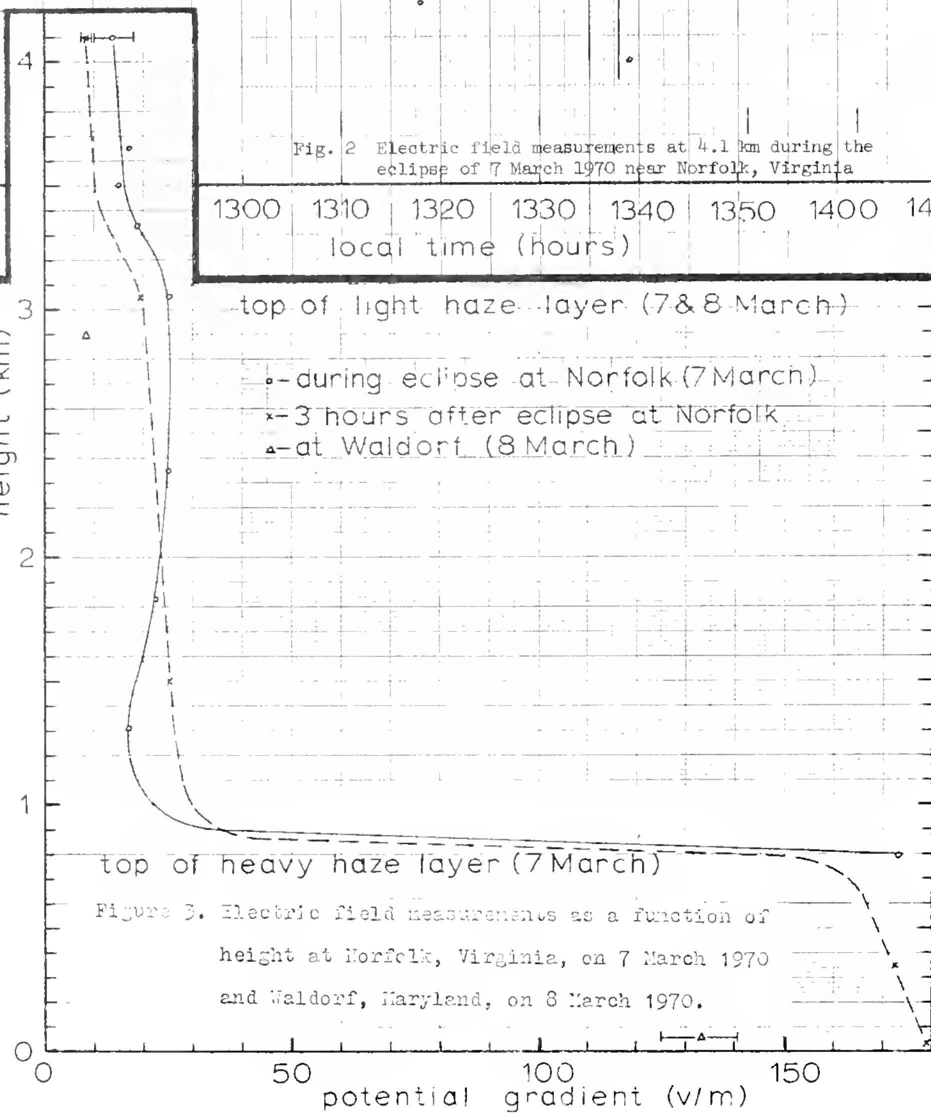


Figure 3. Electric field measurements as a function of height at Norfolk, Virginia, on 7 March 1970 and Waldorf, Maryland, on 8 March 1970.

1970 SOLAR ECLIPSE PROJECT NO. 3.7-F-13.01

Institution : Naval Research Laboratory, Atmospheric Physics Branch, Code 8325

Investigators : Robert V. ANDERSON, NRL Code 8325; Hans DOLEZALEK, ONR Code 412

Title : Atmospheric Electricity Measurements at the NRL Waldorf, Maryland Observatory

Purpose : The relative abrupt cessation of solar heating of the atmosphere which occurs in an eclipse provides an accelerated analogue of the phenomena which regularly occur with sunrise and sunset. Both the distribution of electrified particles in the lower atmosphere, and the turbulent motions which operate to modify these distributions can be expected to be strongly dependent on the rate of input of solar heat and on the stability of the lower atmosphere. A "sunrise effect" has been recognized by several investigators in atmospheric electricity which exhibits characteristic patterns of variation in recordings of electrical parameters that can be explained in terms of a breakup of an extent stably stratified situation and the resumption turbulent convection. The purpose of this investigation is to measure as many presumably pertinent variables as possible through the eclipse period and observe whether they are occurrences which can be attributed to the changes in solar input caused by the eclipse.

Description : The Waldorf observatory is located some 25 miles South of Washington, D.C in gently rolling tidewater farmland. The land to the immediate North of the observatory is wooded swamp; while a horse farm surrounds the site on the other three sides. Sensing probes and antennas are located in a flat, grassy meadow several acres in size and are connected to the requisite electronics and recorders in an underground room by buried cables. Recordings are made of electric field (both field mill and radioactive collector), atmospheric conductivity (Gerdien condenser), total vertical electric current density (Wilson plate antenna - several types of exposed surface), space charge density (Obolensky filter), temperature (shield thermistor), general brightness (vertically facing photo-voltaic cells), and winds. Provision is available to measure field, conductivity, and space charge at heights of up to five meters as well as at ground level. The quantitative amount of solar obscuration is obtained by periodic measurement of a suitably oriented pinhole image.

Reference : Israel, H. and G. Fries, Zeit. f. Geophysik, 20 (1955), 137. Israel, H., Atmospharaische Elektrizitat, Teil II, Leipzig, 1961. Anderson, R., J. Geophys. Res., 71, (1966), 5809. Gatham, S. and R. Anderson, R. Sci. Inst., 36 (1965), 1490. Kawano, M., J. Geomag. Geoelect., 9, (1958), 210.

Location : Waldorf, Maryland (95% totality) 38° 38' N - 77° 00' 44.5" W

Dates : 7-8 March 1970

SUMMARY OF PRELIMINARY RESULTS:

Atmospheric electric measurements were made as planned at the NRL Waldorf, Maryland observatory on March 7 and 8, 1970. The electric field, current density, and polar conductivity were measured at ground level, and space charge density was measured with an Obolensky filter at an elevation of 1.25 meters. All variables were recorded on a sequential multi-point recorder which operated at a speed of one point every six seconds. In addition, the space charge density was recorded on a rapidly running analog strip chart recorded with a 3 db frequency cutoff of about 1.5 cps in order to have data suitable for spectral analysis. Temperature and general brightness were also recorded on the multi-point instrument; but an equipment failure necessitated recourse to manual observations of winds.

A photograph of the pertinent portion of the multi-point recording is seen in Figure 1. A common zero line is indicated near the center of the chart which applies to all of the channels. Time marks are shown at the top of the chart at ten minute intervals. Electric field is distinguished by the symbol E_G and by the printed numeral 7. The recordings of vertical current density are labelled i_2 through i_5 and have corresponding printed numerals 2 through 5. Space charge density has the symbol ρ_{OB} and numeral 11 - the apparent peaks at 1829Z and 1908Z are not real and should be disregarded. In the lower half of the chart are found the negative conductivity (λ-, 13), temperature (T, 19), and general brightness B, 20). There are also some other lines on the chart which correspond either to improperly functioning apparatus or to "service" channels included for operator convenience. All of these may, hence, be disregarded.

Examination of Figure 1 indicates three significant features. There is an increase in measured conductivity during the obscuration, a persistent decrease in conductivity to a value lower than observed prior to the eclipse which begins some minutes after an appreciable level of sunlight has been restored, and a maximum in field, current density, and space charge which has a time delay comparable to that of the conductivity decrease and duration of five to six minutes. The general form of these variation patterns is similar to those observed as sunrise effects, and an initial tentative explanation in terms of stratification and subsequent mixing has been made. More detailed analysis of the data and of precedents in the literature is yet to be done.

As mentioned, the recordings from the Obolensky type space charge filter were spectrally analyzed. This was accomplished by manual digitizing of the record and subsequent digital computation using the fast Fourier transform. The raw periodogram formed by the absolute squares of the discrete Fourier coefficients was numerically smoothed to give meaningful points, and the results were mechanically plotted against frequency on fully logarithmic coordinates. These spectral plots were observed to exhibit a good linear fit at higher frequencies, indicating an f^n behavior. The value of the exponent n was determined from the slope of the best fitting line. Figure 2 (not reproduced) shows the variation in n with time through the time of the eclipse.

Two features are seen in Figure 2: the constancy of the exponent before the eclipse, and the large increase in its magnitude from -2.7 to -3.4 some 25 minutes after the maximum obscuration. It is also seen that n apparently returns to its pre-eclipse value at the end of the observation period. It has also been possible to reach a tentative theory for this effect which is consistent with the conclusions reached in the foregoing discussion. A dimunition of turbulent activity followed by some degree of stratification which is then destroyed by a resumption of normal turbulence does appear to provide an adequate framework within which to account for all of the observed phenomena; but, again, an appreciably more thorough analysis is necessary to provide an adequate validation of these conclusions.

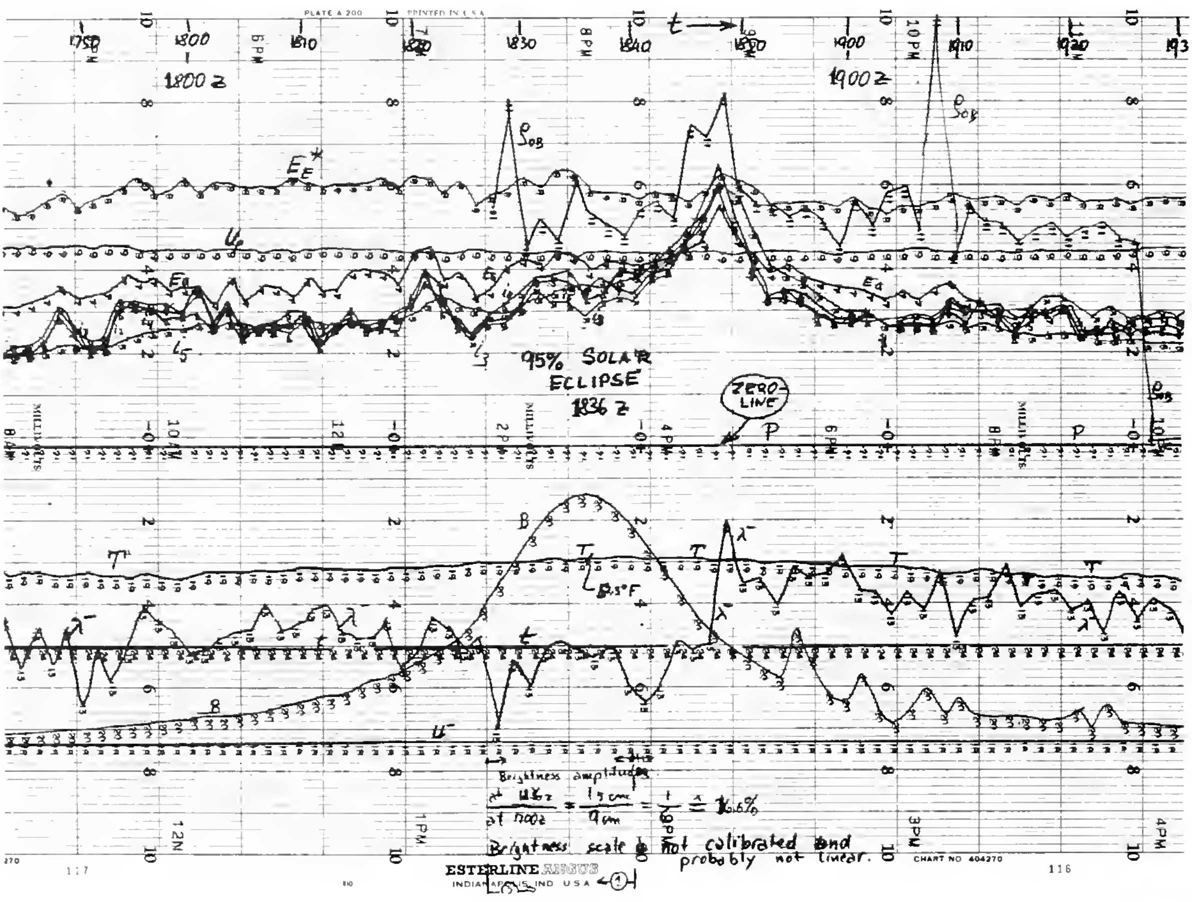


Figure 1. Multipoint Recorder Chart from 7 March 1970.

Institution : Fernbank Science Center

Investigators : KNAPPENBERGER, P. H.

Title : Astronomical, Meteorological and Ecological Observations of Solar Eclipse.

Purpose : To obtain information in the areas of astronomy, meteorology and ecology related to the phenomenon of a solar eclipse which can be used in educational programs. NBC network was also supplied information and professional comment in these areas by Fernbank staff.

Description : Astronomical observations were to be recorded on video tape and film, showing partial phases, Bailey's beads, solar prominences and coronal structure. Meteorological surveys were to be conducted recording temperature, presssure,humidity, wind parameters and solar radiation. Biological studies of animal and plant reactions to the eclipse in their native habitat were to be made.

References : Educational releases from Fernbank, ETV and NBC.

Location : Ft. Stewart, Georgia, Butler's Island (Darien, Georgia), Okefenokee Swamp (Waycross, Georgia)

Dates : March 7, 1970 (Control dates, February 21, and 28, 1970)

Equipment : Portable telescope equipped with filters, gratings, photographic and video tape cameras. Recording microbarographs, thermometers, wind indicators, solar radiation detectors. Video and audio portable tape units.

Special Site Requirements : Native habitat of abundant and selected wildlife species.

Number & Names of People : 86 participating staff, teachers and students from DeKalb County School System. Don Lucas, Meteorological Coordinator; David Funderburk, Ecology Coordinator; Paul Knappenberger, Astronomy Coordinator

Cooperating Groups : Georgia ETV, NBC Television, Okefenokee Swamp Park, Georgia State Game and Fish Commission, Okefenokee Swamp Science Project

Funds : Local, Georgia ETV, and NBC

SUMMARY OF PRELIMINARY RESULTS:

Fernbank Science Center conducted meteorological, biological, and astronomical studies related to the total solar eclipse on March 7, 1970. Fernbank Science Center, as a part of the DeKalb County School System, near Atlanta, Georgia, had as a main objective for its studies, the assimilation of data and audio-visual aids which could be incorporated into educational programs within the Country school system and for state-wide, as well as nation-wide distribution. To this end, Georgia ETV and NBC-TV were also participants with Fernbank Science Center in the eclipse observations.

Three sites were chosen as observing locations based on the requirements of the programs outlined by the meteorology, biology and astronomy departments of the Science Center. Prime site for astronomical observations was at Ft. Stewart, Georgia, centrally located within the path of totality. Butler's Island, a wildlife refuge among the estuaries on the eastern coast of Georgia, was one location chosen for biological-ecological studies during the eclipse, while the Okefenokee Park in Waycross, Georgia was the other area chosen for these studies. A number of astronomy experiments were also conducted at the Okefenokee Park, while meteorological observations were made from high towers in the Okenokee Swamp, at Ft. Stewart and at the Butler's Island site.

Weather conditions during the eclipse prevented the collection of extensive data in astronomy, but the meteorological and biological experiments produced much scientifically interesting and educationally beneficial information. The total of 86 persons who participated in eclipse observations for Fernbank Science Center included the Center's own staff, teachers and students from DeKalb County School System, teachers and students from other area schools and scientists from Emory, Georgia Tech and Georgia State University. The following are brief descriptions of the experiments and preliminary results in the three areas of research.

ASTRONOMY - As an overview of total solar eclipse, time-lapse 16mm movies of the entire eclipse, from first through fourth contact, were attempted, along with a video tape recording of the event. Due to the heavy overcast during the eclipse, correct exposure times and focusing were difficult to achieve, and the only useable results were obtained on 1-inch video tape which show the partial phases, Bailey's Beads and diamond ring effect. The shadow band experiment, comet-search photography, flash spectrum photography and detailed examinations of the corona using polaroid filters, were all curtailed to such an extent that only very limited data could be collected. However, through the cooperation of students and friends of Fernbank who were fortunate enough to be at clear observing sites, many photographs and other materials were received for use in our educational programs. The photography of the eclipse yielded some results, but the excitement of having been at an eclipse and the aweinspiring envelope of darkness which swept over the eclipse sites were recorded on video tapes and 16mm movie film and have already been incorporated in several class programs on the eclipse. The experience and insight gained by the teachers and students who helped design and construct the various astronomical experiements will serve to further the understanding and classroom teaching of the event itself.

METEOROLOGY - Some interesting measurements and observations were made during the March 7 eclipse by a meteorological group from Fernbank Science Center. Activities varied from making temperature measurements at a height of 3 feet at three sites in southeast Georgia to measuring the amount of solar radiation incident on a radiometer located on top of a 90-foot tower in the middle of Okefenokee Swamp. Students and teachers from the DeKalb County School System were used as research scientists to record atmospheric variations during the eclipse. Wind speed and wind direction, relative light level, temperature at various levels, relative humidity and solar radiation were the parameters under surveillance. Of these, temperature, light level and humidity measurements were duplicated at each of the three primary observation sites; Ft. Stewart, Butler's Island and the Okefenokee Swamp Park in Waycross. All of these measurements are being evaluated in coordination with the biological experiments. Some of the more interesting meteorological variations were temperature decreases at the 3-foot level of some 9.5°F. at Ft. Stewart, Georgia and 9.0°F at Waycross. However, in addition to the eclipse occurrence, one must also consider decreasing elevation of sun and amount of cloudiness. The relative humidity responded to the cooling as would be expected and an increase of some 23 percent was observed during totality. Also a rise in pressure of approximately 1 mb. during totality was observed. Relative light level and solar radiation measurements show very symmetric record approaching and departing from the time of totality. Two very interesting and dramatic phenomena occurred previous to, after and during totality. Cloud dissipation was observed to occur approximately 2 minutes prior to totality and continuing until about 10 minutes after totality. It has been proposed that this may be partially attributed to several phenomena, but probably one of the most feasible is that the net cooling resulted ultimately in subsidence, adiabatic warming and thus cloud evaporation. The second phenomena that was observed at totality can tentatively be called a 360° sunset. Without the clouds which inhibited astronomical observations, we could not have observed this unusual event.

BIOLOGY (Okefenokee Swamp Park) - Six teams consisting of one student and one teacher were stationed at various locations in the Okefenokee Swamp Park to observe reactions of animals before, during and after the solar eclipse on March 7, 1970. Each team had written instructions concerning what animals were near each station. Tape recorders recorded the sounds of the animals and surrounding activity. Below are the results of the significant changes in behavior of caged and wild animals.

1. The team in a tower overlooking a vulture roost reported that about twenty vultures returned to their roost. The night before the eclipse approximately fifty-five vultures were in the trees.

2. The team observing alligators restrained in a small pond reported that half of the alligators which were sunning on the bank returned to the water either immediately before or during the eclipse.

3. Red-winged blackbirds increased their vocal activity and a large number returned to the trees where they had roosted the night before the eclipse.

4. Mosquitoes became quite active as the eclipse time neared and began to feed on the people at the eclipse site.

5. Some white-tailed deer that were caged lay down as the eclipse became total.

BIOLOGY (Butler's Island) - Butler's Island is a marshy nesting area for many different species of birds on the Georgia coast. At sunset flocks of birds come to this island which is protected by Georgia Game and Fish Commission. The DeKalb County students and teachers went to Butler's Island during the eclipse were interested in finding out what reactions these birds might have to a 1:00 p.m. sunset.

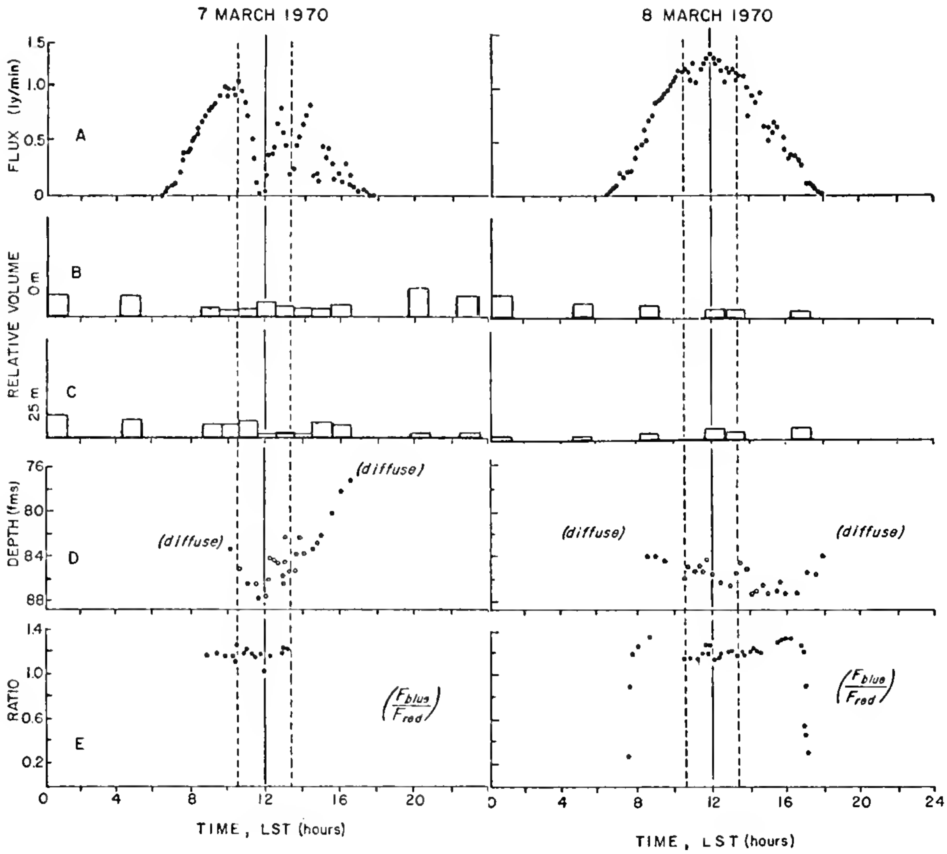
The results were that birds, normally active in the daytime, were active up until totality. During totality all the birds, insects, frogs and other animals were out of sight and quiet. However, no flocks of birds came to the island in their usual nightly migration.

1970 SOLAR ECLIPSE - PROJECT NO. 3.7-F-15.00

Institution	:	Texas A&M University Department of Meteorology and Oceanography
Investigators	:	FRANCESCHINI, G.A.; VASTANO, A.; CARUTHERS, J.; BRIGHT, T.; KENT, J.
Title	:	Influence of the Solar Eclipse on Near-Surface Conditions in Air and Water, Gulf of Mexico
Purpose	:	To determine the physical and biological changes occurring at sea during this "short night." Observations (before, during and after totality) will include: a) Air temperature, dew point, and pressure b) Total incoming solar radiation c) Spectral distribution of insolation d) Physical and chemical properties of water e) Primary productivity f) Depth of deep scattering layer g) Vertical migration of zooplankton (0-150m) h) Documentary eclipse photographs
Description	:	Related instruments employed, respectively: a) Thermistor, optical dew point sensor and microbarograph (all recording continuously) b) Pyranometer (continuous recording) c) Spectroradiometer, 0.38 to 1.05 microns (continuous sequential scans, 1 per 3 min.) d) Standard hydrocasts and BT's e) Standard C^{14} uptake and Cl determinations f) Pulsed transducer, 12 kHz, PDR display g) Clarke-Bumpus 12 in. plankton samplers and 12 in. plankton net (both size "0" mesh) h) Tripod mounted 35mm still camera, K-II and Tri-X film
Reference	:	Effects on Migrations of Marine Organisms in the Gulf of Mexico. NATURE, 20 June 1970.
Location	:	Gulf of Mexico aboard the R/V ALAMINOS, Cruise 70-A-4. Location -- 24.0 N, 89.5 W.
Dates	:	Departed Progreso, Mexico, March 5, and arrived Galveston, Texas, March 10. On-station 6,7,8 March.
Equipment	:	All equipment was put aboard the R/V ALAMINOS when it left Galveston, Texas in February for preceding cruise.
Special site Requirements	:	
Number & Names of People	:	In addition to principal investigators: R. Tucker, J. Linn, R. Thompson, F. Ferrari, C. Brunson, W. Burns, D. Duis, W. Dill, W. Hathaway, plus 18 ship's crew.
Cooperating Groups	:	Support function, Texas A&M Research Foundation
Special Comments and Needs	:	
Station Prob	:	
Funds	:	National Science Foundation, Texas A&M University, Office of Naval Research

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.7-F-15.00

Preliminary results of the measurement program are shown in figure 1. Totality occurred at approximately local solar noon.



Diurnal variations of:

A - total solar radiation;
B - relative volume of zooplankton in samples collected near the surface;
C - relative volume of zooplankton in samples collected at 25 m;
D - depth of a deep-scattering layer;
E - ratio of blue to red solar radiation.

Observations made aboard the R/V ALAMINOS (Figure 1), 7-8 March 1970, Gulf of Mexico (24°N, 89.5°W).

(See also: Nature, 226, p. 1155, June 20, 1970)

1970 SOLAR ECLIPSE PROJECT NO. 3.7-F-16.00

Institution : NASA, Langley Research Center - GRIB - PMS

Investigators : LAWRENCE, Jr., James D. and Ocheltree, Stewart L.

Title : Laser Radar Studies of the Atmosphere During the 1970 Solar Eclipse

Purpose : To make measurements of aerosol scattering of the 20 km region during daylight; to attempt to observe cooling effects in the lower atmosphere during eclipse.

Description : The measurements to be made consist of vertical backscattering profiles of the atmosphere at 6943A°. A ruby laser transmission consisting of nominal 1.0 joule pulse of 20 nsec duration is introduced vertically into the atmosphere; the radiation backscattered by the molecular and particulate or aerosol components of the atmosphre is collected by mirror and the collected radiation illuminates a photomultiplier detector. The photomultiplier current is a function of time after laser transmission is recorded by means of an oscilloscope, and is used to compute a relative backscattering function for the atmosphere as a function of height.

References : Optical Radar Studies of the Atmosphere, J. D. Lawrence; M. P. McCormick; S. H. Melfi 5th Symposium on Remote Sensing of Environment, 1968.

Location : Wallops Island Station.

Equipment : Equipment already on site

Special Site Requirements : Equipment installation completed in November 1969 for another experiment. No changes necessary.

Number & Names of People : James D. Lawrence, Jr., William H. Fuller, Courtney E. Russ

Station Prob : 1.0

Funds : NASA

SUMMARY OF PRELIMINARY RESULTS

Laser radar measurements of the lower atmosphere were performed by the Langley Research Center during the 1970 solar eclipse at Wallops Island. Vertical backscattering profiles of the atmosphere at the ruby laser wavelength were compiled to altitudes of 8 km throughout the period of eclipse. The objectives of these experiments were: (1) to make daytime observations of particulates in the 20 km region of the atmosphere, and (2) to attempt to observe cooling effects in the atmosphere as indicated by changes in the vertical profile of aerosols.

Efforts to observe to altitudes as high as 20 km were unsuccessful. The minimum background intensity which occurred at Wallops was approximately a factor of 10 too high to permit observations to altitudes of 20 km. A number of observations of the lower atmosphere to altitudes of 8 km were made, however. Shown in figure 1 is an aerosol feature whose base is located at about 4000 feet which showed significant changes during the period of the eclipse. This aerosol feature is undoubtedly produced by the thermal structure of the atmosphere in that region (probably a temperature inversion) and changes in this feature reflect changes in the stability of the region during the eclipse. An analysis of the laser radar data obtained for this altitude region is in progress and an attempt will be made to correlate changes with thermal effects produced by the eclipse.

In addition accurate measurements of the height and vertical extent of cloud systems present at Wallops Island during the eclipse were also made which may be of interest to other investigators. Figure 2 is a typical laser radar measurement of a thin cloud system which occurred over Wallops Island during the eclipse.

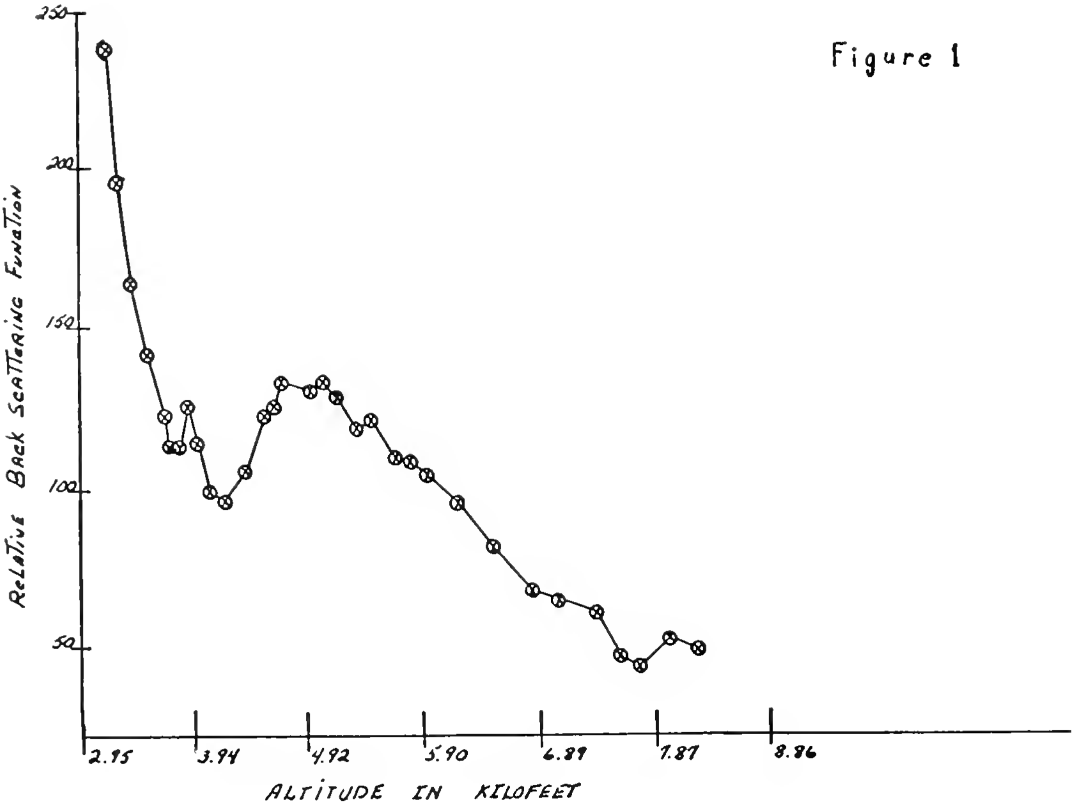


Figure 1

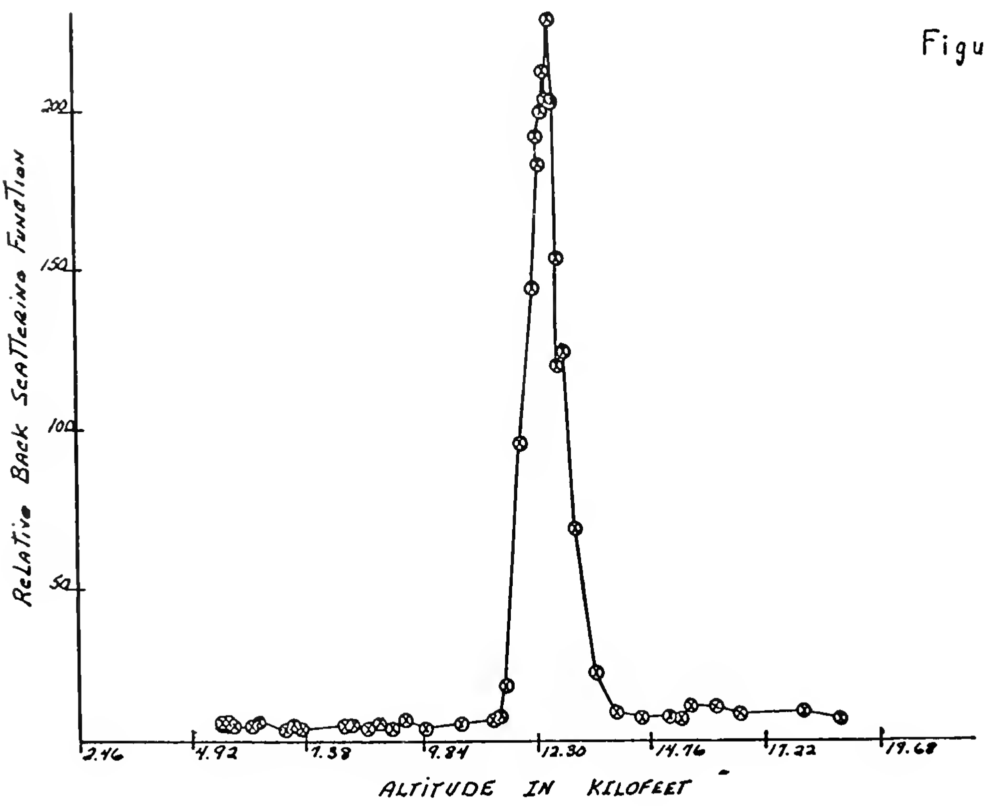


Figure 2

1970 SOLAR ECLIPSE PROJECT NO. 3.7-F-17.00

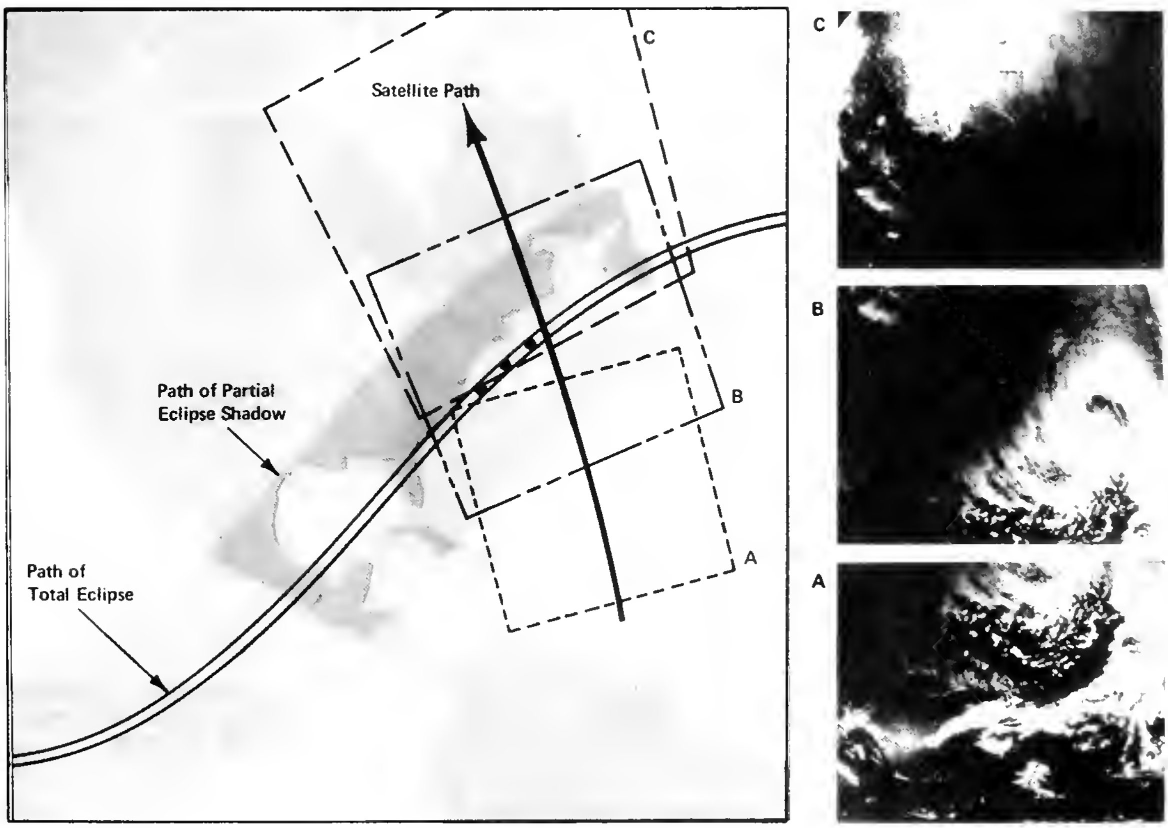
Institution : NASA Goddard Space Flight Center

Investigator : BULLOCK, Gilbert D. and THOMAS, Robert Jr.

Title : Photography of Eclipse Shadow from the ITOS 1 and ATS-3 Satellites

SUMMARY OF PRELIMINARY RESULTS:

ITOS 1 Satellite
Tracking Solar Eclipse of March 7, 1970
(APT Pictures Received at RCA Ground Station)

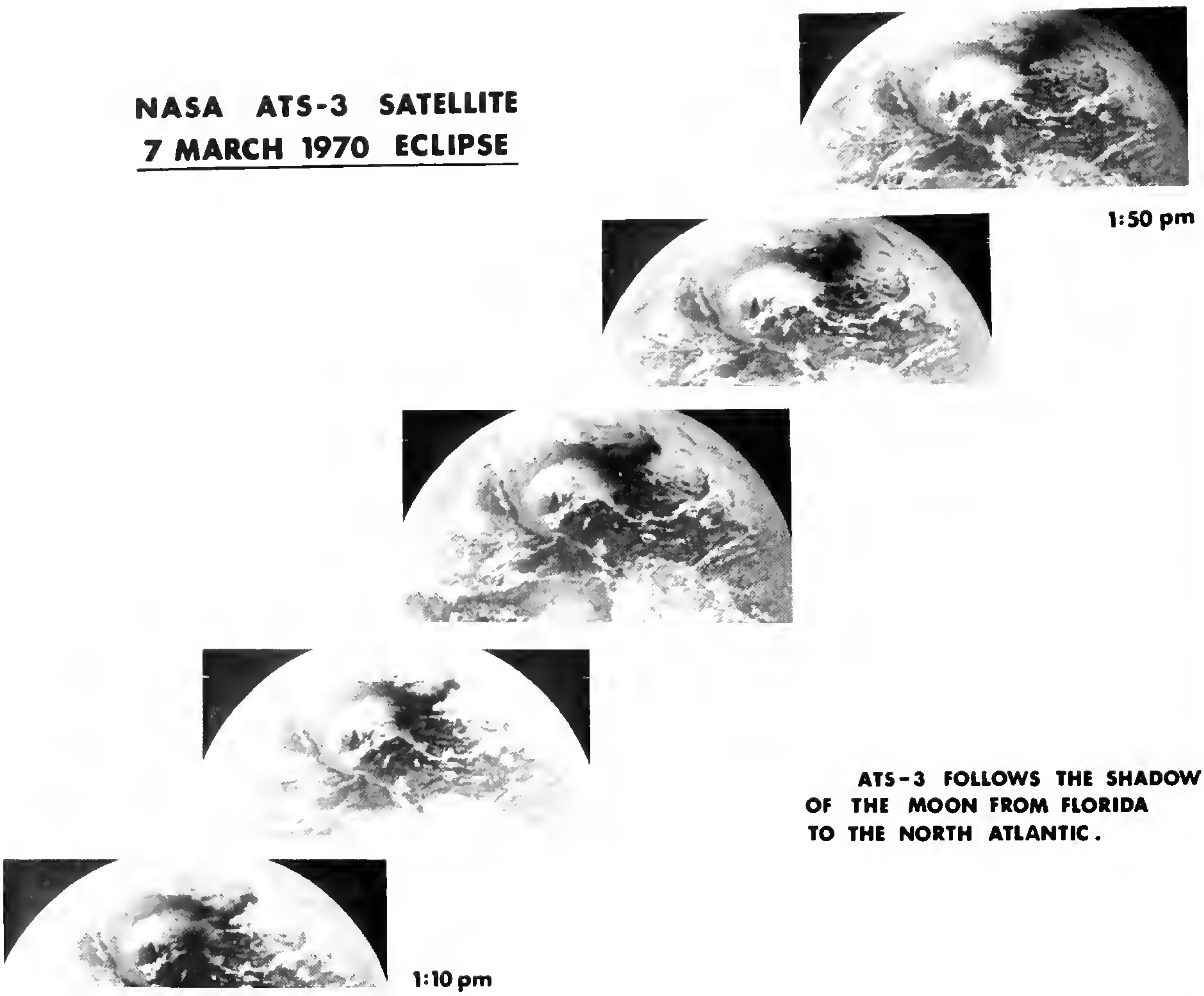


PROJECT NO. 3.7-F-17.00

NASA ATS - 3 SATELLITE - 7 MARCH 1970 SOLAR ECLIPSE

To engage in experiments during the March 1970 solar eclipse, NASA positioned an Application Technology Satellite (ATS-3) at 70 degrees west longitude. The primary objective was to allow personnel of the ATS Project Office, located at Goddard Space Flight Center, and associated participants to perform atmospheric measurements through the eclipse umbra.

During performance of the experiments, the spin scan cloud camera aboard the satellite recorded a sequence of photographs showing the shadow of the moon traversing the earth's surface. A compilation of these photographs, taken at 22,300 miles from the earth, are shown in the figure below.



1970 SOLAR ECLIPSE - PROJECT NO. 3.8-F-01.00

Institution	:	Institute of Geophysics, National Autonomous University of Mexico, (N.A.U.M.) (Department of Geodesy)
Investigator	:	MEDINA PERALTA, Ing. Manuel
Title	:	Geographical Location of the Mexican Observation Station and Time Service during the Eclipse.
Purpose	:	
Description	:	The determination of geographical longitude, latitude and altitude of the Mexican Station and time signals every 30 seconds, during the eclipse.
Reference	:	Previous similar observations at Gerbanis, Zacatecas (1923), and Chihuahua, Chih. (1940).
Location	:	Mexican Observation Station, Miahuatlan, Oax.
Dates	:	January 17-27, 1970 and March 7, 1970.
Number and Names of People	:	Ing. Manuel Medina Peralta, Ing. Carlos Canon Amaro, Ing. Pedro A. Mosino and assistants.
Funds	:	Institutes of Astronomy and of Geophysics of the N.A.U.M., in collaboration with the Pan-American Institute of Geography and History and private endowments.

SUMMARY OF PRELIMINARY RESULTS

No report of results

1970 SOLAR ECLIPSE PROJECT NO. 3.8-E-02.00

Institution	:	Universidad Nacional Autonoma de México. Instituto de Astronomía.
Investigators	:	MENDEZ, Manuel (U.N.A.M.), VASILEVSKIS, S. (U.C. Sta. Cruz)
Title	:	Bending of the star light in the gravitational field of the sun.
Purpose	:	To improve on past determinations of the Einstein deviation.
Description	:	A twin telescope will be used, with Ross objectives designed and built exclusively for this purpose at the Institute's optical shop, two plane mirrors will be used to photograph a stellar field 60° away from the sun.
References	:	
Location	:	Two hundred meters off the post marking Km. 115 of the road Oaxaca-Puerto Angel.
Dates	:	February 1st - October 1st.
Equipment	:	
Special Site Requirements	:	
Number & Names of People	:	5, Mendez M., Vasilevskis S., Alba J., Dominguez L., Cardona O.
Cooperating Groups	:	University of California Sta. Cruz.
Special Comments and Needs	:	
Station Prob	:	1.0
Funds	:	Universidad Nacional Autónoma de México.

NO REPORT OF RESULTS OR UPDATED PROJECT DESCRIPTION

1970 SOLAR ECLIPSE - PROJECT NO. 3.8-F-03.00

Institution	:	Geophysical Institute, University of Alaska
Investigators	:	WILSON, Dr. Charles R. and JOHNSON, Mr. Roland
Title	:	Infrasonic Waves and Traveling Ionospheric Disturbances
Purpose	:	1) To observe traveling pressure waves in the auroral zone from auroral, volcanic, magnetic and aerodynamic (solar eclipse) sources. To develop the morphology of the auroral infrasonic substorm. 2) To observe traveling ionospheric disturbances generated by the same sources.
Description	:	1) Capacitor microphones with noise reducing pipe arrays are used to measure pressures of one dyne per cm^2 in the bandpass from 1 Hz to 0.01 Hz. Analogue recording of pressure waves are made on paper chart and magnetic tape recorders. 2) Faraday rotation receiver for the ATS III satellite beacon (136 MHz) to detect TID's passing beacon penetrating point at 300 Km height over Gulf of Alaska.
Reference	:	Wilson, C. R., Auroral Infrasonic Waves, J. Geophys. Res., 84, 1812-1836, 1969. Wilson, C. R., Two-Station Auroal Infrasonic Wave Observations, Planet and Space Sci., 17, 1107-1120.
Location	:	College, Alaska and Inuvik, N.W.T.
Dates	:	Operates continuously.
Equipment	:	-
Special Site Requirements	:	-
Number and Names of People	:	-
Cooperating Groups	:	ESSA, Geoacoustics Group
Special Comments and Needs	:	-
Station Prob	:	1.0
Funds	:	ARPA

SUMMARY OF PRELIMINARY RESULTS

We monitored the infrasonic wave spectrum from 10 to 100 sec. period at Inuvik and College and from 100 to 1000 sec period at College for gravity waves from 1600 U.T. 7 March until 0200 U.T. 8 March 1970. We did not see any ground level pressure waves that could be associated with the eclipse either at College or Inuvik.

In addition a farady rotation experiment ran continuously for several weeks on each side of the eclipse event. Because of a large geomagnetic storm, ionospheric electron content fluctuations were so large due to other effects that we could not determine if there was a gravity wave in the ionosphere from the eclipse.

Thus there was not detectable pressure wave effect at College or Inuvik and we could not determine if there was any ionospheric electron content fluctuation associated with an eclipse gravity wave.

1970 SOLAR ECLIPSE PROJECT NO. 3.8-F-03.01

Institution	:	Washington State University and University of Idaho
Investigators	:	CRAINE, Professor L.B.; and THOMAS, Professor Joe
Title	:	Infrasonic Waves
Purpose	:	Observe Amplitude Period and Direction of Arrival of Infrasonic Signals Propagating in the Atmosphere
Description	:	Ground-level detection of pressure waves in the atmosphere of periods 1-1000 seconds, maximum HF signal sensitivity 0.1 Dyne/CM to 2 Dynes/CM (LF). Observatory operates continuously. Signals presently detected by visual correlation of chart records from four pressure transducers with filter systems
References	:	Matheson, Instructions for Operation of NBS Infrasonic Equipment. U.S. Department of Commerce, National Bureau of Standards, Publication 8519
Location	:	Pullman, Washington
Dates	:	Operation Spans Eclipse Times
Equipment	:	NBS Infrasonic System
Special Site Requirements	:	None
Number and Names of People	:	Professor L. B. Craine and Professor Joe Thomas
Cooperating Groups	:	Similar stations at Boulder, Colorado, Washington, D.C. and College, Alaska
Special Comments and Needs	:	
Station Prob	:	.99
Funds	:	NSF Grant and both universities

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.8-F-03.01

Chimonos and Hines (JGR-Feb. 1, 1970, p 875) suggested that if the earth's atmosphere is subjected to a localized time dependent heating or cooling action, wave motions are likely to result. They pointed out that a solar exlipse, by interfering with the heat balance can be expected to generate a pressure wave signal of a magnitude that may be detected both at ground level and at ionospheric heights, even at some distance from the path. They estimated these waves would be observable on microbarographs.

The infrasonic observatory operated jointly by Washington State University and the University of Idaho through funding by the National Science Foundation and the two Universities, measures ground level variations in atmospheric pressure. An array of four sensitive microphones records signals with periods between 1 and 1000 seconds. The azimuth, amplitude, period, and horizontal velocity across the array can be determined from these four signals. Two filters are used, a high frequency covering about 1 to 1000 second periods, with a 10 second period sensitivity of 0.1 dyne/cm^2 per min chart deflection, and a low freqquency filter, generally 100 to 1000 seconds, with a sensitivity of 2 dynes/cm^2 per min. Signals are deteoted by a visual correlation process using the four translucent recording charts. Local wind at each site provides an interfering useless signal, although a long pipe acoustic filter reduces these fluctuations. Several different types of signals may appear at the same time.

The system was properly operating on eclipse day, however wind noise predominated during the times of interest for possible eclipse signals. The visually correlated signals obtained for March 7, 1970 were:

HIGH FREQUENCY FILTER

TIME UT	CORRELATION QUALITY	PERIOD (SEC)	AMPLITUDE DYNES/CM^2	AZIMUTH DEGREES	VELOCITY M/SEC	REMARKS
0001-0004	Poor	120	22	331	274	P to P
1635-1637	Poor	60	off scale	337	416	all channels Noise
1640-1710	Poor	60/120	off scale(2) 30-40(2)	127	404	P to P 2 channels Noise
1800-1815	Poor	40/100	off scale	265	675	P to P 90% of time Noise
2025-2040	Poor	40/50/60	30	132	425	Noisy
2050-2400 (5 Sets of Signals)	Poor	30/40/60	off scale	169 (Ave)	390 (Ave)	Very Noisy

LOW FREQUENCY FILTER

TIME UT	CORRELATION QUALITY	PERIOD (SEC)	AMPLITUDE DYNES/CM^2	AZIMUTH DEGREES	VELOCITY M/SEC	REMARKS
1340-1530	Good	300/480/600	40	291	22	
1100-1800	Fair to Good	480	25	246	41	Note 1
1800-2400	Fair	540/720	15	232	56	
(8)0205-0300	Fair to Good	600/840/960	15	215	55	

Note 1. This signal has two nice cycles of 480 seconds for 1627-1650. This signal can be followed from 1100. At 1300 there was a 980 sec. signal.

Magnetic tape recorded data for the eclipse even is now being mechanically correlated in an effort to reduce the effects of the noise.

1970 SOLAR ECLIPSE PROJECT NO. 3.8-F-03.02

Institution	:	Lamont-Doherty Geological Observatory (Columbia University)
Investigators	:	DONN, W., KASCHAL, G.
Title	:	Infrasonic Waves 0.1 to 10 hz
Purpose	:	Investigate possible occurrence of infrasonic waves generated by the shock effect of the supersonic eclipse shadow.
Description	:	Use of multipartite arrays of microphones at Lamont and Fort Monmouth to detect infrasonic waves as generated by auroral shocks. The systems were tuned primarily to a bandpass of 0.1 to 10 hz but signal detection to 0.01 hz was possible.
Location	:	Palisades, N. Y. and Eatontown, N. J.
Dates	:	Instruments operated on a regular basis at all times.
Equipment	:	Microphones to record acoustic pressure perturbations, bandpass filters per sensor, analogue tape and visual recorders.
Site Requirements	:	None additional; installations are permanent.
Cooperating Groups	:	Lamont-Doherty Geological Observatory and U. S. Army Electronics Command, Fort Monmouth, N. J.
Funds	:	NSF and DOD

SUMMARY OF PRELIMINARY RESULTS:

Negative, but signals from rockets launched at Wallops Island, Va. into shadow were detailed.

1970 SOLAR ECLIPSE - PROJECT NO. 3.8-F-03.03

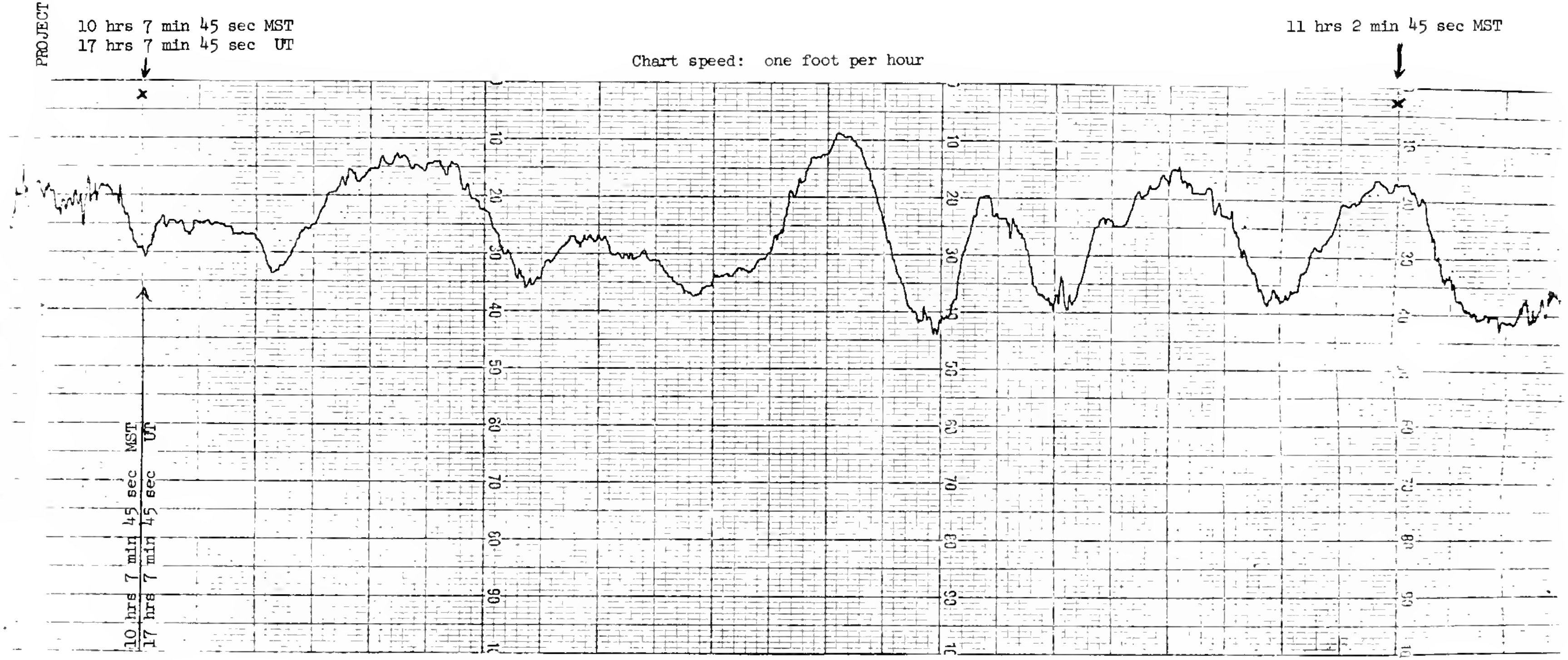
Institution	:	Colorado School of Mines, Golden, Colorado 80401
Investigator	:	JORDAN, A. RAYMOND
Title	:	Search for Gravity Waves Generated by the Solar Eclipse
Description	:	The instrumentation consists of an infrasonic microphone (Conversion of a T-21 sound ranging microphone) recording at 5 minutes per inch on a Varian chart recorder, and possibly a Gill anemometer operated in conjunction. Three such stations will be operated.
Location	:	Principal station is located in southeast Denver.
Dates	:	Operates routinely

SUMMARY OF PRELIMINARY RESULTS

This is a brief note to report that we were unable to detect any eclipse-induced atmospheric gravity waves in the period of hours of the March 7, 1970 eclipse. I had detected waves at one station out of the three which I had in operation which might well have been due to a gravity wave, but I have been unable to relate this to any other signals obtained in this region. I have forwarded a copy of my record to Mr. Vernon Goerke of ESSA (Boulder Laboratory) and if by chance he finds that my record can be related in any way to signals which he obtained, we will respond in the very near future.

At the moment, it would thus appear that we can only report negative results.

PROJECT NO. 3.8-F-03.03



Record of a Gravity Wave Observed During the March 7, 1970 Solar Eclipse
at Colorado School of Mines, Golden, Colorado
(Sensitivity: approx. 100 microbars per inch)

1970 SOLAR ECLIPSE PROJECT NO. 3.8-F-03.04

Institution	:	Geoacoustics Group of ESSA Research Laboratories
Investigators	:	COOK, Richard K., and GREENE, Gary E.
Title	:	Atmospheric Infrasonic Waves
Purpose	:	The object is detection and measurement of any infrasonic waves that might be generated by the eclipse shadow. There is a cessation of atmospheric heating, and cessation of ground-surface warming as well, during the passage of the lunar shadow at supersonic speed over the earth's surface. This can be expected to generate sound waves in the atmosphere, with most of the energy at infrasonic frequencies much less than 1.0 hertz. Measurements on the sound wave could yield estimates of the source strength which can be expressed in terms of atmospheric cooling attributable to the shadow passage
Description	:	The propagation of sound waves at infrasonic frequencies (oscillation periods 1.0 - 1000 seconds) in the atmosphere is measured at ten stations separated geographically by distances of the order of thousands of kilometers. One of the typical stations, in Washington, D. C., has an array of five microphones separated by distances of about 7 kilometers. Each microphone is at ground level and is connected to the central station by means of a leased telephone line. In effect the array is "steered" to look for sound waves in a programmed sequence of search directions. Each station measures the following characteristics of infrasonic waves passing it: (1) the amplitude and waveform of the incident sound pressure, (2) the direction of propagation of the wave, (3) the horizontal phase velocity, and (4) the distribution of sound wave energy at various frequencies of oscillation.
Reference	:	Richard K. Cook, "Atmospheric Sound Propagation." Atmospheric Exploration by Remote Probes, Proceedings of the Scientific Meetings of the Panel on Remote Atmospheric Probing, Vol. 2, pp. 633 - 669. Published by the Committee on Atmospheric Sciences NAS/NRC, Washington, D. C. (January 1969). G. Chimonas and C. O. Hines, "Atmospheric Gravity Waves Induced by a Solar Eclipse." J. Geophys. Res. 75, 875 (1970)
Location	:	Geographical locations of stations are as follows: (1) Washington, D. C. (2) Boulder, Colorado. (3) Pullman, Washington. (4) San Diego, California. (5) Boston, Massachusetts. (6) College, Alaska. (7) Inuvik, Northwest Territories. (8) Huancayo, Peru. (9) La Paz, Bolivia. (10) Tel Aviv, Israel.
Dates	:	Most of the above stations were operational on March 7, 1970
Cooperating Groups	:	The professional geophysical staffs at the station location listed above.
Special Comments and Needs	:	-
Station Prob	:	
Funds	:	-

SUMMARY OF PRELIMINARY RESULTS- PROJECT NO. 3.8-F-03.04

The infrasonic station at Washington, D. C. had its microphones located approximately 250 km from the centerline of the path of totality on the eastern seaboard of the U.S.A. No identifiable infrasonic waves were present during the two-hour interval immediately after the closest approach of the shadow.

Microphones at an infrasonic station are subject to random pressure fluctuations (noise) caused by wind, rising columns of air heated by the ground on a sunny day, etc. The pressure variations of the noise were as follows at the time of the eclipse:

Passbands, seconds	Gain at 900 sec (relative to max. gain), dB	Zero-to-peak pressure, dyn/cm^2
7 to 40	-66	0.7
50 to 450	- 8	20

Present data-processing techniques, for atmospheric sound waves in the presence of noise with similar spectral content, cannot reveal the presence of signals at signal-to noise ratios < 0.5

We infer that any sound waves, caused by the passage of the eclipse shadow 250 km from Washington, must have had sound pressures no greater than about one-half of those tabulated above.

1970 SOLAR ECLIPSE - PROJECT NO. 3.8-F-04.00

Institution	:	U. S. Bureau of Commercial Fisheries Biological Laboratory West Boothbay, Harbor, Maine
Investigators	:	SHERMAN, Kenneth and HONEY, Kenneth A.
Title	:	Vertical Movements of Zooplankton During A Solar Eclipse
Purpose	:	To examine the reactions of zooplankton to rapid changes in light intensities. Light is considered the primary stimulus to vertical movement in planktonic crustaceans. The basic pattern of diurnal distribution is a rise to the surface in the late afternoon in response to decreasing light intensity, followed by a sinking in the absence of a light gradient at night; as light increases at dawn the zooplankton moves upward to the source of light change, and then downward away from the increasing intensity of daylight. The general pattern of movement can vary, however, under the influence of various exogenous and endogenous conditions. The solar eclipse provided the opportunity to identify changes in the vertical movements of some crustaceans as an exogenous response to light change rather than an endogenous behavioral rhythm.
Description	:	Zooplankton was collected simultaneously at the surface and at 10 m and 30 m down, using 20 cm Clarke-Bumpus closing samplers hauled between 2 and 3 knots for 15 min. Tows were made at approximately hourly intervals from morning to evening on the pre-eclipse (control) and eclipse days. In the laboratory, the zooplankton was sorted into major taxa, and the numbers of each taxon per 10 m^3 of water per sample was calculated. Environmental measurements included atmospheric light measurements (Gossen Light Meter), bathythermograph and Nansen bottle casts, secchi disc readings, and standard marine meteotological observations to accompany the bathythermograph casts.
References	:	Backus, R. H., Clark, R. C., and Wing, A. S., Nature 205, 989 (1965). Bainbridge, R., in The Physiology of Crustacea edited by Waterman, T. H., II, 431 (Academic Press, 1961). Banse, K. in Progress in Oceanography edit. by Sears, M., 2, 53, (Pergamon Press, 1964). Clarke, G. L., Biol. Bull. 65(3), 402 (1934). Harris, J. E., J. Mar. Biol. Ass. U. K. 43(1), 153 (1963). Petipa, T. S. Dokl. Akad. Nauk SSR 104, 323 (1955). Skud, B. E., Fish. Bull., U. S. Fish. Wild. Serv. 66, 259 (1968).
Location	:	Sampling was done from a surface vessel over 33 to 35 m of water off Boothbay Harbor, Maine, 43° 48' N; 69° 38' W.
Dates	:	March 6 and 7.
Equipment	:	Clarke-Bumpus closing samplers and depressor; Nansen bottles; Bathythermograph; Secchi disc; Gossen Light Meter.
Special Site Requirements	:	Small surface vessel (ca. 12 m long) outfitted with a sampling davit and winch for towing plankton samplers.
Number and Names of people	:	Kenneth Sherman, Fishery Biologist Kenneth A. Honey, Fishery Biologist Paul Ruhlman: Marine technician Gordon Trask: Vessel Operator
Funds	:	U. S. Bureau of Commercial Fisheries.

SUMMARY OF PRELIMINARY RESULTS - PROJECT NO. 3.8-F-04.00

There were 19 taxa in the samples, five of them in abundance, accounting for over 90 percent of the plankton-copepods, decapod larvae, chaetognaths, cirriped larvae, and gastropod eggs. Copepods were dominant constituting 70 percent of the total. Of the 16 species in the samples only two were numerous--Pseudocalanus minutus and Calanus finmarchicus (85 percent of the copepod species).

Among the zooplankton in our samples, P. minutus elicited the responses that was synchronized most closely with the exogenous changes of light during the eclipse. It had a vertical distribution similar to the classic description of the diurnal migration of crustacean plankton by Bainbridge, but on a shorter time scale. Changes in the vertical distribution of the other zooplankton revealed varying degrees of threshold response to light changes. The threshold of C. finmarchicus was the lowest, responding to changes in light intensity within a 1000 ft. candle range on the pre-eclipse day at a time period coincident to a 6,000 ft. candle decrease in light during totality. An alternative explanation for the coincident occurrence of C. finmarchicus at the surface can be found in the results of Harris, who observed an endogenous rhythm of vertical distribution of the cogeneric species, C. helgolandicus. The similarity in the upward movement of Calanus to the surface at dusk on both days and the subsequent distribution toward bottom after sunset support our argument for the observed differences in the vertical movements of Calanus as an exogenous response rather than an endogenous rhythm. Calanus can move in short bursts of about 66 m/hr., (2 min.) and at 15 m/hr. over a longer time period (1 hour).

Among the other taxa, chaetognaths showed little change in vertical distribution. Decapod larvae did not respond to light changes of the eclipse, but did move up in the water column after sunset. Distribution of larval cirripeds was more variable; although they did not respond to the eclipse, this group is known to be phototactic, and appeared to be maintaining themselves at 10 m for a sustained period during daylight.

Our observations on the movements of P. minutus are in agreement with the results of Skud made during the solar eclipse of 20 July, 1963. He found that P. minutus moved toward the source of light change during totality. The increased response of female C. finmarchicus over males to light changes was also reported by Clarke during his studies of diurnal vertical migration in the Gulf of Maine. The strong responses reported by Petipa of chaetognaths and decapod larvae to light changes during the eclipse of 30 June, 1954, in Sevastopol Bay differed from our results. This can be attributed to differences in the environmental conditions and species composition of the zooplankton.

1970 SOLAR ECLIPSE - PROJECT NO. 3.8-F-05.00

Institution	:	University of South Carolina
Investigator	:	AVIGNONE, F. T.
Title	:	Melton Memorial Observatory 1970 Eclipse Expedition
Purpose	:	Cosmic Ray Muons During Lunar Eclipse
Description	:	An attempt was made to detect a small fluctuation in the cosmic ray produced muon flux at the earth's surface during the lunar eclipse. The muons were detected in a 10 inch diameter by 12 inches long Nuclear Enterprise (NE-102) organic scintillator. The through peak occurs at about 40 MeV, far above any interference events due to natural background. The through peak was identified and an integral discriminator set at approximately 20 MeV discriminated against lower energy events.
Location	:	Givhans Ferry State Park, South Carolina, U. S. A.
Dates	:	6-7 March 1970
Equipment	:	Nuclear Enterprise (NE-102) organic scintillator and associated electronics.
Number and Names of People	:	(1) F. T. Avignone
Funds	:	State of South Carolina

SUMMARY OF PRELIMINARY RESULTS

A possible power drag may have caused erratic operation of equipment just at totality; however, the data taken from 18:35 to 20:30 GMT shows no fluctuation in the muon flux greater than 0.5%. The data immediately before totality shows several fluctuations on the order of 5%; however, there is a large probability that this was introduced by a power drag problem.

The rate of muon events above the discriminator level was $\sim$ 1260 counts/min. A more logical place to look for eclipse introduced fluctuations in the cosmic ray events would be the so-called hard cosmic ray component.

HAPTER 4.8 - PRELIMINARY SURVEYS OF THE 1972 AND 1973 SOLAR ECLIPSES

n response to many requests for preliminary information on eclipses n the near future, certain information has been assembled. Astrono-ical data on coming eclipses have been contributed by the U.S. Naval bservatory. A discussion by Dr. Pasachoff on potential sites for clipses in 1972 and 1973 is included in this chapter. In June-July 970, Drs. Menzel and Pasachoff visited many of the possible sites in frica. Summaries of their trip reports are reproduced herein.

ne of the best sources for general and political up-to-date informa-ion on a country is the U.S. Department of State. Through the Office f International Scientific and Technological Affairs of the U.S. epartment of State, Dr. John K. Rouleau surveyed the various embassies long or near the path of the eclipse. Credit is due to the representa-ives of the U.S. in Africa for their comments that are pertinent at his time to the planning of future expeditions.

he third section of this chapter includes climatological data for each ountry under or near the eclipse in Africa in 1973. It is evident that ry, hot weather is the most likely condition in the Sahara Desert and hat cloudiness is likely over the eastern portion of the eclipse path n June 30, 1973. Thanks are due Clarence E. Everson, Chief Climatolo-ist, Aerospace Sciences Division, Headquarters of the Fourth Weather ing of the U.S. Air Force, for his comprehensive analyses.

UNITED STATES NAVAL OBSERVATORY

CIRCULAR NO 101

U. S. Naval Observatory, Washington, D. C. 20390 July 29, 1964

SOLAR ECLIPSES, 1971 – 1975

by

Julena S. Duncombe

At the request of Commission 12a of the International Astronomical Union, the American Nautical Almanac Office agreed to publish advance information on solar eclipses, computed from tabular positions of the Sun and Moon prepared for the purpose in the British Nautical Almanac Office.

This *Circular* gives the results of the definitive calculations for all solar eclipses in 1971, 1972, 1973, 1974, 1975.

The arguments are given in Ephemeris Time (E. T.), and the longitudes are referred to the " Ephemeris Meridian " (see *Explanatory Supplement to the Astronomical Ephemeris and the American Ephemeris and Nautical Almanac*).

Once the value of Δ T is known, the accurate position of the track may be obtained in the following manner.

Change all time – arguments into Universal Time by setting.

$$\text{E. T.} = \text{U. T.} + \Delta \text{T}$$

Leave latitudes unchanged, and refer the longitudes to the meridian of Greenwich by applying $-1.002738\,\Delta$ T as a correction to the tabulated longitudes.

East longitudes are negative.

SOLAR ECLIPSES, 1971 – 1975

PARTIAL ECLIPSE OF 1971 FEBRUARY 25

Geocentric conjunction will occur in right ascension $22^h31^m47^s.51$, at E.T. $25^d10^h37^m13^s.9$, the declination of the Sun being $-9^\circ14'52''.0$. The greatest eclipse will have a magnitude of 0.788 at longitude $+33^\circ40'$, latitude $+61^\circ35'$.

The eclipse will be observable in the eastern part of Greenland, Europe, the western part of Asia, and the northwestern part of Africa.

PARTIAL ECLIPSE OF 1971 JULY 22

Geocentric conjunction will occur in right ascension $8^h04^m08^s.78$, at E.T. $22^d08^h38^m38^s.2$, the declination of the Sun being $+20^\circ23'02''.6$. The greatest eclipse will have a magnitude of 0.069 at longitude $-177^\circ01'$, latitude $+63^\circ36'$.

The eclipse will be observable in the northwestern part of Alaska, and the northeastern part of Asia.

PARTIAL ECLIPSE OF 1971 AUGUST 20-21

Geocentric conjunction will occur in right ascension $9^h57^m58^s.89$, at E.T. $20^d23^h50^m24^s.6$, the declination of the Sun being $+12^\circ24'52''.3$. The greatest eclipse will have a magnitude of 0.508 at longitude $-135^\circ15'$, latitude $-61^\circ48'$.

The eclipse will be observable in the southeastern part of Australia, New Zealand, and parts of Antarctica.

SOLAR ECLIPSES, 1971 – 1975

ANNULAR ECLIPSE OF 1972 JANUARY 16

Central Line

Ephemeris Time		Latitude		Ephemeris Longitude		Duration		Width of Path	Altitude of Sun
h	m	°	′	°	′	m	s	mi	°
Limit		-68	36	+143	24	.	.. .	...	..
10	30	78	09.3	147	18.5	1	53.9	235	9
	35	81	59.7	+162	42.4	1	53.0	218	13
	40	83	37.8	-170	28.6	1	52.3	207	16
	45	83	09.6	142	19.0	1	51.8	200	17
	50	81	22.6	124	23.6	1	51.3	196	19
	55	79	04.6	114	46.6	1	51.0	194	20
11	00	-76	35.6	-109	36.4	1	50.7	194	20
	05	74	02.3	106	49.6	1	50.5	196	20
	10	71	26.5	105	27.8	1	50.4	200	20
	15	68	47.9	105	02.8	1	50.4	205	19
	20	66	05.0	105	21.6	1	50.5	212	18
	25	63	15.2	106	20.3	1	50.7	222	16
11	30	-60	13.5	-108	04.0	1	51.1	233	14
	35	56	48.6	110	54.1	1	51.7	247	11
	40	52	14.5	116	33.8	1	52.8	262	6
Limit		-48	48	-123	05	.	.. .	...	..

Geocentric conjunction will occur in right ascension $19^h49^m26\overset{s}{.}86$, at E.T. $16^d10^h33^m13\overset{s}{.}3$, the declination of the Sun being $-21°03'49''.2$.

SOLAR ECLIPSES, 1971 – 1975

TOTAL ECLIPSE OF 1972 JULY 10

Central Line

Ephemeris Time	Latitude	Ephemeris Longitude	Duration	Width of Path	Altitude of Sun
h m	° ′	° ′	m s	mi	°
Limit	+51 02	−143 46	. .. .	...	..
18 30	54 13.6	150 40.8	1 25.1	91	5
35	60 17.5	165 32.3	1 41.8	98	16
40	63 25.5	−175 20.0	1 51.7	101	22
45	65 36.1	+175 53.7	1 59.5	103	26
50	67 10.4	167 29.3	2 06.1	105	30
55	68 16.6	159 14.8	2 11.7	105	33
19 00	+68 59.1	+151 09.3	2 16.7	106	35
05	69 20.6	143 16.4	2 20.9	107	38
10	69 23.7	135 41.7	2 24.6	108	40
15	69 10.5	128 31.1	2 27.7	109	41
20	68 43.0	121 48.7	2 30.2	109	43
25	68 03.3	115 36.8	2 32.3	109	44
19 30	+67 13.2	+109 55.8	2 33.8	110	45
35	66 14.2	104 44.5	2 34.9	110	46
40	65 07.8	100 00.8	2 35.5	111	46
45	63 54.9	95 41.9	2 35.6	111	46
50	62 36.5	91 44.9	2 35.3	112	46
55	61 13.2	88 06.5	2 34.5	112	46
20 00	+59 45.4	+ 84 44.1	2 33.2	113	46
05	58 13.4	81 34.8	2 31.5	113	45
10	56 37.5	78 35.9	2 29.3	113	44
15	54 57.5	75 44.9	2 26.7	113	42
20	53 13.3	72 59.4	2 23.6	113	41
25	51 24.5	70 16.7	2 20.0	113	39
20 30	+49 30.6	+ 67 33.9	2 15.9	113	37
35	47 30.7	64 47.9	2 11.3	113	35
40	45 23.2	61 54.2	2 06.0	112	32
45	43 06.1	58 47.0	2 00.1	110	28
50	40 35.2	55 16.4	1 53.2	108	25
55	37 42.5	51 03.2	1 45.0	105	20
21 00	+34 05.5	+ 45 14.4	1 34.2	98	13
Limit	+27 40	+ 32 22	. .. .	...	..

TOTAL ECLIPSE OF 1972 JULY 10 *(Continued)*

Geocentric conjunction will occur in right ascension $7^h 20^m 36\overset{s}{.}31$, at E.T. $10^d 19^h 29^m 05\overset{s}{.}0$, the declination of the Sun being $+22^\circ 09' 05\overset{''}{.}0$.

ANNULAR ECLIPSE OF 1973 JANUARY 4

Central Line

Ephemeris Time	Latitude	Ephemeris Longitude	Duration	Width of Path	Altitude of Sun
h m	° ′	° ′	m s	mi	°
Limit	-25 01	+128 18	. .. .	...	..
13 55	29 02.6	118 47.5	5 43.0	212	10
14 00	-32 37.1	+109 51.1	6 00.1	203	19
05	34 43.5	104 04.2	6 12.5	197	25
10	36 15.4	99 25.2	6 23.1	193	30
15	37 26.4	95 23.9	6 32.6	189	35
20	38 22.7	91 47.2	6 41.4	185	39
25	39 07.6	88 28.2	6 49.5	183	42
14 30	-39 43.2	+ 85 22.7	6 57.0	180	45
35	40 10.9	82 28.1	7 03.9	178	48
40	40 31.6	79 42.4	7 10.4	176	51
45	40 46.2	77 04.4	7 16.3	174	54
50	40 55.2	74 33.0	7 21.6	173	57
55	40 59.2	72 07.6	7 26.4	171	59
15 00	-40 58.4	+ 69 47.6	7 30.7	170	62
05	40 53.3	67 32.5	7 34.4	170	64
10	40 44.0	65 21.8	7 37.6	168	66
15	40 30.9	63 15.4	7 40.2	168	68
20	40 14.1	61 12.9	7 42.2	167	70
25	-39 53.8	+ 59 13.9	7 43.7	166	71

ANNULAR ECLIPSE OF 1973 JANUARY 4 *(Continued)*

h m	° ′	° ′	m s	mi	°
15 30	-39 30.1	+ 57 18.4	7 44.6	166	73
35	39 03.3	55 26.0	7 45.0	166	74
40	38 33.3	53 36.4	7 44.8	166	74
45	38 00.4	51 49.5	7 44.1	166	75
50	37 24.5	50 05.0	7 42.8	166	75
55	36 45.7	48 22.7	7 41.1	167	74
16 00	-36 04.2	+ 46 42.2	7 38.9	167	73
05	35 19.8	45 03.3	7 36.3	168	72
10	34 32.7	43 25.7	7 33.2	169	71
15	33 42.7	41 49.1	7 29.7	170	69
20	32 49.9	40 13.1	7 25.9	171	67
25	31 54.2	38 37.3	7 21.6	172	65
16 30	-30 55.6	+ 37 01.2	7 17.1	174	63
35	29 53.8	35 24.4	7 12.2	175	60
40	28 48.7	33 46.2	7 07.0	177	58
45	27 40.1	32 06.0	7 01.6	179	56
50	26 27.8	30 22.9	6 55.8	181	53
55	25 11.2	28 36.0	6 49.8	183	50
17 00	-23 49.9	+ 26 43.8	6 43.5	185	47
05	22 23.2	24 44.7	6 36.9	189	44
10	20 50.0	22 36.5	6 30.0	191	40
15	19 09.0	20 15.6	6 22.7	194	37
20	17 17.8	17 36.9	6 14.9	197	33
25	15 12.6	14 31.6	6 06.4	201	28
17 30	-12 45.7	+ 10 42.1	5 57.0	205	23
35	9 36.2	+ 5 20.0	5 45.4	209	15
Limit	- 3 13	- 7 46	. .. .	...	..

Geocentric conjunction will occur in right ascension $19^h01^m30^s.18$, at E.T. $4^d15^h39^m48^s.2$, the declination of the Sun being $-22^\circ41'26''.5$.

TOTAL ECLIPSE OF 1973 JUNE 30

Central Line

Ephemeris Time	Latitude	Ephemeris Longitude	Duration	Width of Path	Altitude of Sun
h m	° ′	° ′	m s	mi	°
Limit	+ 4 25	+ 60 02	. .. .	...	..
10 00	10 18.9	46 14.1	3 53.5	136	16
05	12 59.7	39 35.7	4 18.4	140	24
10	14 47.1	34 49.3	4 38.4	143	30
15	16 07.9	30 54.9	4 55.8	146	35
20	17 11.4	27 31.9	5 11.5	148	40
25	18 02.3	24 30.4	5 26.0	150	44
10 30	+18 43.2	+ 21 44.6	5 39.3	151	48
35	19 15.9	19 10.8	5 51.7	153	51
40	19 41.6	16 46.7	6 03.1	155	55
45	20 01.1	14 30.4	6 13.5	155	58
50	20 15.1	12 20.6	6 23.0	157	61
55	20 24.0	10 16.4	6 31.5	158	64
11 00	+20 28.3	+ 8 16.8	6 39.0	159	67
05	20 28.2	6 21.2	6 45.6	159	70
10	20 24.0	4 29.2	6 51.2	160	73
15	20 16.0	2 40.1	6 55.8	160	76
20	20 04.2	+ 0 53.7	6 59.4	161	79
25	19 48.8	– 0 50.5	7 01.9	161	81
11 30	+19 30.0	– 2 32.9	7 03.4	161	83
35	19 07.7	4 13.6	7 03.8	161	85
40	18 42.0	5 53.1	7 03.3	161	85
45	18 13.0	7 31.7	7 01.8	161	84
50	17 40.7	9 09.7	6 59.4	161	82
55	17 05.0	10 47.4	6 55.9	160	80
12 00	+16 25.9	– 12 25.1	6 51.6	160	77
05	15 43.4	14 03.4	6 46.4	159	74
10	14 57.3	15 42.5	6 40.3	159	72
15	14 07.5	17 23.0	6 33.4	158	69
20	13 13.8	19 05.5	6 25.7	157	66
25	+12 16.0	– 20 50.5	6 17.2	156	63

TOTAL ECLIPSE OF 1973 JUNE 30 *(Continued)*

h m	° ′	° ′	m s	mi	°
12 30	+11 13.8	− 22 39.0	6 08.0	155	60
35	10 06.7	24 31.9	5 58.1	155	56
40	8 54.2	26 30.4	5 47.3	154	53
45	7 35.6	28 36.1	5 35.9	152	49
50	6 09.9	30 51.4	5 23.6	151	46
55	4 35.6	33 19.2	5 10.4	149	42
13 00	+ 2 50.6	− 36 04.5	4 56.2	147	37
05	+ 0 51.2	39 14.9	4 40.6	145	33
10	− 1 29.2	43 05.1	4 23.2	142	27
15	4 26.4	48 10.0	4 02.4	138	20
20	9 10.4	57 07.9	3 32.0	131	9
Limit	−12 49	− 65 00	. .. .	...	..

Geocentric conjunction will occur in right ascension $6^h37^m08^s.60$, at E.T. $30^d11^h40^m00^s.1$, the declination of the Sun being $+23^\circ10'06''.3$.

ANNULAR ECLIPSE OF 1973 DECEMBER 24

Central Line

Ephemeris Time	Latitude	Ephemeris Longitude	Duration	Width of Path	Altitude of Sun
h m	° ′	° ′	m s	mi	°
Limit	+16 20	+101 25	. .. .	...	..
13 15	14 11.2	96 35.1	7 32.8	229	5
20	9 52.5	86 56.4	8 10.3	222	17
25	7 43.9	82 03.1	8 34.7	219	23
13 30	+ 6 12.1	+ 78 25.7	8 55.6	216	28
35	5 00.5	75 27.8	9 14.6	216	32
40	4 02.6	72 55.2	9 32.3	214	36
45	3 14.8	70 40.1	9 49.0	213	39
50	2 35.0	68 38.1	10 04.8	213	42
55	2 01.8	66 46.3	10 19.7	213	45
14 00	+ 1 34.2	+ 65 02.5	10 33.7	213	48
05	1 11.6	63 25.3	10 46.8	213	50
10	0 53.4	61 53.5	10 58.9	213	53
15	0 39.3	60 26.2	11 10.1	213	55
20	0 28.8	59 02.8	11 20.2	213	57
25	+ 0 21.8	+ 57 42.5	11 29.2	213	58

SOLAR ECLIPSES, 1971 – 1975

ANNULAR ECLIPSE OF 1973 DECEMBER 24 *(Continued)*

h m	° ′	° ′	m s	mi	°
14 30	+ 0 18.0	+ 56 25.0	11 36.9	214	60
35	0 17.3	55 09.7	11 43.5	214	61
40	0 19.6	53 56.4	11 48.8	214	63
45	0 24.7	52 44.6	11 52.8	213	64
50	0 32.6	51 34.1	11 55.5	213	64
55	0 43.3	50 24.5	11 56.8	213	65
15 00	+ 0 56.6	+ 49 15.6	11 56.8	212	65
05	1 12.6	48 07.2	11 55.6	212	65
10	1 31.3	46 58.9	11 53.0	212	65
15	1 52.7	45 50.5	11 49.3	211	64
20	2 16.8	44 41.8	11 44.4	210	64
25	2 43.7	43 32.3	11 38.3	209	63
15 30	+ 3 13.5	+ 42 21.9	11 31.3	208	62
35	3 46.3	41 10.1	11 23.3	208	60
40	4 22.1	39 56.5	11 14.3	208	58
45	5 01.3	38 40.8	11 04.5	207	57
50	5 43.9	37 22.3	10 54.0	207	55
55	6 30.3	36 00.6	10 42.8	207	53
16 00	+ 7 20.8	+ 34 34.7	10 30.9	207	50
05	8 15.8	33 03.8	10 18.3	207	48
10	9 15.8	31 26.8	10 05.2	208	45
15	10 21.8	29 41.9	9 51.4	208	42
20	11 34.6	27 47.2	9 37.1	209	39
25	12 55.8	25 39.5	9 22.1	210	36
16 30	+14 27.6	+ 23 14.2	9 06.2	212	32
35	16 13.7	20 23.5	8 49.2	214	28
40	18 21.2	16 52.7	8 30.6	216	23
45	21 06.9	12 05.8	8 08.9	220	17
50	25 55.4	+ 2 58.3	7 36.8	228	7
Limit	+28 54	- 3 22	. .. .	...	..

Geocentric conjunction will occur in right ascension $18^h 11^m 39\overset{s}{.}66$, at E.T. $24^d 15^h 08^m 44\overset{s}{.}1$, the declination of the Sun being $-23^\circ 24' 55\overset{''}{.}8$.

SOLAR ECLIPSES, 1971 – 1975

TOTAL ECLIPSE OF 1974 JUNE 20

Central Line

Ephemeris Time	Latitude	Ephemeris Longitude	Duration	Width of Path	Altitude of Sun
h m	° ′	° ′	m s	mi	°
Limit	−45 25	− 59 04	. .. .	...	..
3 50	43 00.6	64 05.0	3 16.6	159	4
55	38 24.2	74 06.7	3 46.8	171	14
4 00	−36 17.2	− 79 14.6	4 04.7	180	19
05	34 52.4	83 06.1	4 18.7	187	22
10	33 51.3	86 18.5	4 30.3	193	25
15	33 06.4	89 06.6	4 40.1	200	28
20	32 33.8	91 38.6	4 48.4	205	30
25	32 11.3	93 59.1	4 55.1	209	31
4 30	−31 57.4	− 96 11.4	5 00.5	213	32
35	31 51.3	98 17.8	5 04.5	216	33
40	31 52.4	100 20.3	5 07.2	217	34
45	32 00.3	102 20.4	5 08.6	217	34
50	32 14.9	104 19.5	5 08.7	216	34
55	32 36.3	106 18.9	5 07.6	215	34
5 00	−33 04.6	−108 20.1	5 05.1	212	33
05	33 40.3	110 24.5	5 01.4	208	33
10	34 24.0	112 33.9	4 56.3	204	31
15	35 16.8	114 50.7	4 50.0	199	30
20	36 20.3	117 18.0	4 42.2	194	28
25	37 36.7	120 00.1	4 33.0	189	26
5 30	−39 10.1	−123 04.5	4 22.0	183	23
35	41 08.2	126 44.4	4 08.9	177	20
40	43 48.2	131 30.9	3 52.4	170	15
45	48 21.5	139 33.3	3 27.8	162	7
Limit	−53 10	−148 19	. .. .	...	..

Geocentric conjunction will occur in right ascension $5^h53^m27^s.56$, at E.T. $20^d04^h55^m25^s.2$, the declination of the Sun being $+23°26'00''.6$.

PARTIAL ECLIPSE OF 1974 DECEMBER 13

Geocentric conjunction will occur in right ascension $17^h22^m01\overset{s}{.}35$, at E.T. $13^d16^h17^m18\overset{s}{.}1$, the declination of the Sun being $-23^\circ09'16\overset{''}{.}0$. The greatest eclipse will have a magnitude of 0.827 at longitude $+69^\circ34'$, latitude $+66^\circ46'$.

The eclipse will be observable in North America except the northwestern part, the northern coast of South America, the southern part of Greenland, the southern part of Ireland, and Portugal.

PARTIAL ECLIPSE OF 1975 MAY 11

Geocentric conjunction will occur in right ascension $3^h10^m14\overset{s}{.}68$, at E.T. $11^d07^h38^m38\overset{s}{.}2$, the declination of the Sun being $+17^\circ44'39\overset{''}{.}4$. The greatest eclipse will have a magnitude of 0.864 at longitude $+80^\circ33'$, latitude $+69^\circ47'$.

The eclipse will be observable in western Africa, Europe, Greenland, northern Asia, and the northwestern part of Alaska.

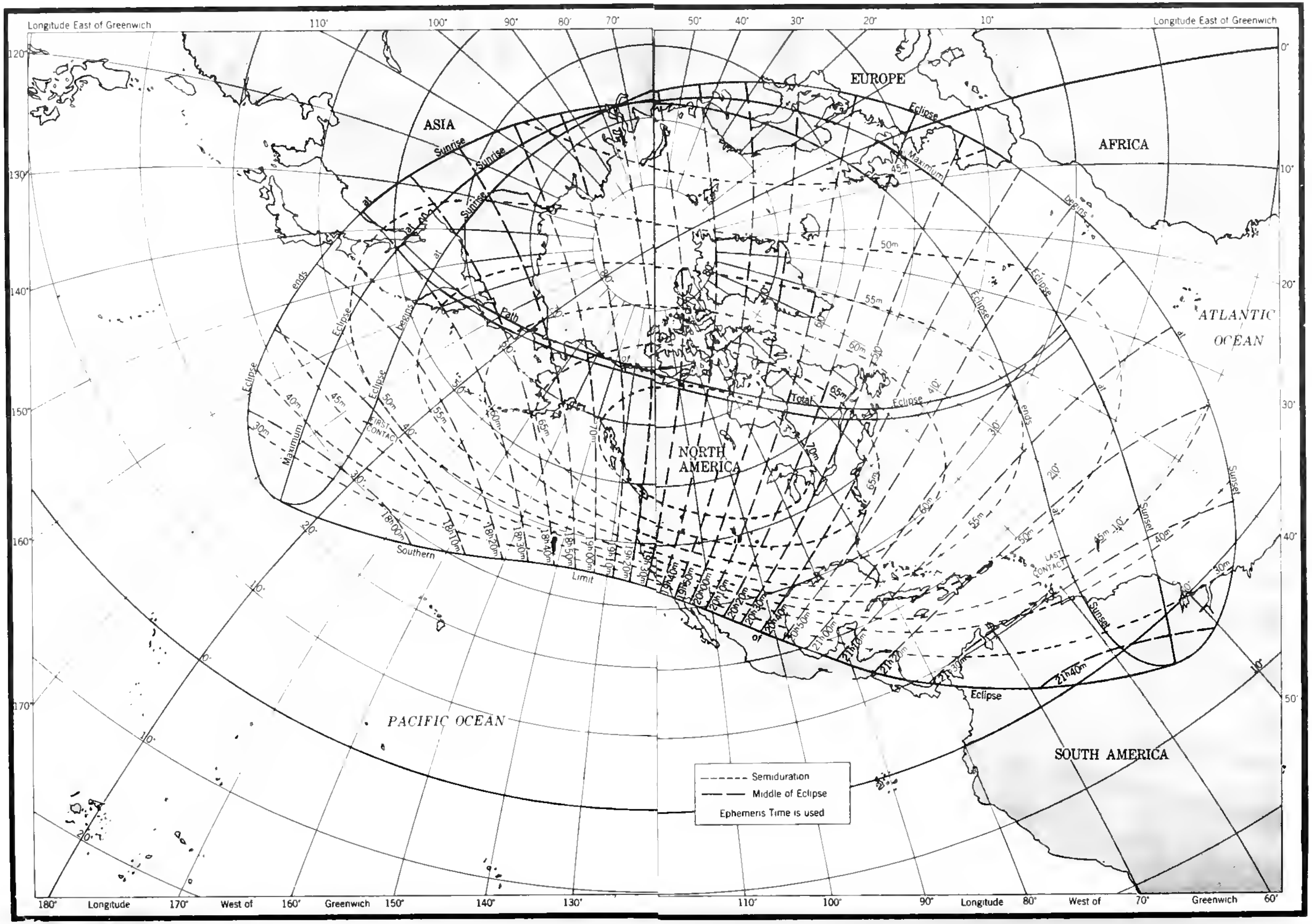
PARTIAL ECLIPSE OF 1975 NOVEMBER 3

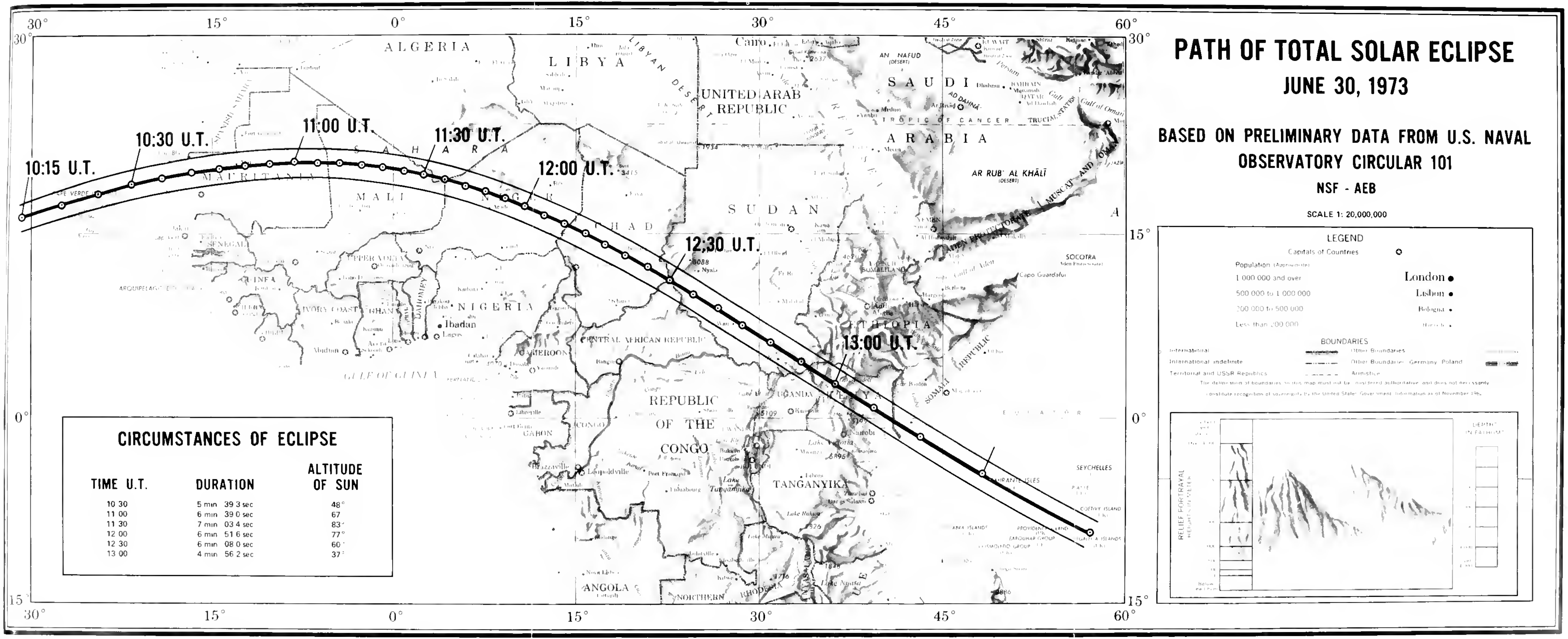
Geocentric conjunction will occur in right ascension $14^h32^m22\overset{s}{.}42$, at E.T. $3^d13^h40^m04\overset{s}{.}2$, the declination of the Sun being $-14^\circ58'32\overset{''}{.}9$. The greatest eclipse will have a magnitude of 0.959 at longitude $+162^\circ05'$, latitude $-70^\circ30'$.

The eclipse will be observable in southern South America, and most of Antarctica.

The eclipse will be total in the ionosphere at 200 km, and 300 km.

TOTAL SOLAR ECLIPSE OF 1972 JULY 10





CIRCUMSTANCES OF ECLIPSE

TIME U.T.	DURATION	ALTITUDE OF SUN
10 30	5 min 39 3 sec	48°
11 00	6 min 39 0 sec	67
11 30	7 min 03 4 sec	83°
12 00	6 min 51 6 sec	77°
12 30	6 min 08 0 sec	60°
13 00	4 min 56 2 sec	37°

SITES FOR THE TOTAL SOLAR ECLIPSES OF 1972 AND 1973

Jay M. Pasachoff
Harvard College Observatory
Cambridge, Massachusetts 02138

With the marvels of the 1970 eclipses still fresh in memory, many astronomers will plan observations of the next two eclipses, the first, in some cases, because of its convenient location, and the other because of seven minutes of totality.

On 10 July 1972, the path of totality (Figure 1) will begin in the Sea of Okhotsk and cross the Koryakski Khrebet in the Soviet Union, hit the United States in northern Alaska, and sweep southeast across Canada. It will pass near the route taken by the exploratory oil tanker "Manhattan" near Demarcation Point as it attains $2\frac{1}{2}$ minutes of duration. The central line will pass near Baker Lake, where there is a military station and an airstrip, and cross Hudson Bay before the duration again dips below $2\frac{1}{2}$ minutes. Maximum totality is 2 minutes and 35 seconds. The path will next cross the city of Great Whale River in northwestern Quebec on the shore of Hudson Bay, and then will come to more populated and accessible regions of eastern Canada. Many will wish to set up in Godbout or Baie Trinité on the western bank of the St. Lawrence, or near Cap Chat on the Gaspé pensinsula, for roads and airports are nearby. The central line will pass just south of Shippegan, New Brunswick, right through Charlottetown, Prince Edward Island, and across eastern Nova Scotia and the 1970 eclipse track, with totality still lasting longer than 2 minutes and 6 seconds. Since the variation in the length of totality is so small, many will opt for the accessibility of eastern Canada. It is unfortunate that the press, in hailing the 7 March 1970 occurrence as what could be properly specified as "the last total eclipse passing directly over populated regions of the eastern United States this century," neglected to point out the nearness of totality to New England in 1972.

At first glance, the weather across this route does not seem favorable, particularly since clouds will have a chance to build up in Quebec, Prince Edward Island and Nova Scotia by the afternoon hour of 2030 UT when the eclipse occurs. Weather data will be of great interest. The sun will only be at a maximum elevation of 46°, at 37° on the Gaspé peninsula, and down to 32° when the eclipse passes out to sea.

The eclipse of 30 June 1973 in Africa will occur under much more favorable circumstances from the astronomical point of view, although its remoteness for American observers will discourage many (and encourage some). It is interesting to note that the great circle distance from New york to Dakar, Senegal is roughly the same as that from New york to Paris, France.

Since the eclipse occurs near the equator near noon, totality will surpass seven minutes in Mali and Niger. The eclipse will begin in Brazil, and by the time it has crossed the Atlantic and hits Mauritania, it will have surpassed 6 minutes of totality. The path then will cross northern Mali and northern Niger, central Chad, and, as totality decreases, cross the southern Sudan, northern Uganda and northern Kenya. Since our preliminary studies indicate that we encounter the rainy season in Chad, and totality has decreased to 4½ minutes by Kenya, we have concentrated on Mauritania, Mali and Niger.

In the first two thousand miles of the eclipse path in Africa, only three areas with roads, none of them paved, are crossed. The track crosses some of the most isolated terrain in the world: the Sahara desert. It is unfortunate that we cannot average in the temperature in Alaska from the 1972 eclipse. The region under investigation is the former French West Africa, and French is the lingua franca. I have gathered information from a number of sources, including available books, several persons who have lived or travelled in this area, the <u>New York Times</u>, and the United States Department of State. A first summary of this information follows.

Two of the roads are in the central portion of the eclipse, with more than seven minutes of totality. The first leads north from Agadez in Niger. One can fly to Niamey, the capital, in a 727, 707 or DC-8 from Paris or Madrid. At the moment, there is only one flight a week, a DC-3, flying between Niamey and Agadez. Agadez lies on the southern edge of the 160-mile wide band of totality. Readers may enjoy the pictures of sand and camels in Victor Englebert's article, describing a Saharan salt caravan to Agadez in the November 1965 issue of <u>National Geographic</u>. Mr. Englebert has been very helpful to my investigation.

Niger has a population of about 5 million, and covers an area larger than Texas and California combined. 97 per cent of the population is rural, and the percapita income listed in the 1968 <u>New York Times Economic Review</u> was $82.

One could use Agadez as a base, though it seems much less developed than Miahuatlán, Oaxaca, Mexico. At an altitude of 1706 feet, it has an average daily maximum temperature in June of 107°F and July of 104°F, and average daily minimum temperatures of 75 and 75, respectively. The average monthly rainfalls are 0.6 and 0.9 inches, and the average numbers of days with precipitation greater than 0.04 inch are 1 and 5. The averages were computed by the Meteorological Office of the French Air Ministry for 4 years out of the period 1931 to 1940 and 1949 to 1955. Since the absolute maximum temperatures listed are 115 and 113, and the absolute minima are 67 and 65, the weather conditions seem consistent from day to day. Nobody goes out at noon (although the day of the eclipse, when the sun is covered, should prove an exception). We have one estimate of a 99.9 per cent chance of clear weather, but an evaluation of astronomical seeing transparency requires a report by a trained observer.

North of Agadez is the Aïr Massif, a series of plateaus and mountains that are pictured in photograph S65-63158 taken from Gemini VI on 16 December 1965 and included on page 54 of NASA Publication SP-171, <u>Earth Photographs from Gemini VI through XII</u> (available from the Superintendent of Documents, Washington, D. C. 20402, for $8). The central line passes across Monts Baguezane, which has a broad plateau at an altitude of 1900 meters, with exactly 7 minutes of totality. The main road, a track up to the old French Foreign Legion outpost, Fort Laperrine, now known as Tamanrassett, passes to the west of the Aïr, but since uranium was discovered north of Agadez, a new town, Arlit, is being constructed and a road through the mountains north from Agadez is being improved.

The second route to consider, in Mali, leads north from Gao to Algeria, and has historically been the main caravan route from Timbuktu. The Mali and Songhi Empires flourished in this region from the 11th to the 15th century. More recently, it was part of French West Africa, and then gained independence in 1960. A military coup changed the government in 1968 and limited the "Socialist option" that had been under way.

Mali is about the same size as Niger, about twice that of France, and has an average yearly income quoted in 1968 as $70. One can fly to Bamako, the capital, in a Caravelle or DC-8 from Paris, Berlin or Budapest. The connection from Niamey is via Ouagadougou, Upper Volta. Internal flights change from time to time, but at the moment there are three each week from Bamako to Gao, two in an Antonov 24 and one in a DC-3. Unfortunately, it is about 250 miles through the desert from Gao up to the central line, which passes through mountains known as the Adrar des Iforas. The mountains would make an eclipse site there somewhat more hospitable than the desert, for there is some low shrubbery, but conditions would still be very difficult.

If the previous two sites prove unaccessible, or if the temperatures prove unbearable, the Mauritanian site might prove best, even though totality is only (!) 6 minutes. One can fly to Dakar, Senegal from many places around the world, and Caravelles and Antonov 24's fly to Nouakchott, the new, small, capital of Mauritania, 4 days a week. The population of Mauritania is just over one million, spread over an area four-fifths that of Alaska. The 357-mile road from Dakar to Nouakchott is scheduled to be paved by the end of 1970, so there may be some logistic advantage here. Nonetheless, the central line passes about 100 miles north of Nouakchott along the coast, but the road goes toward iron mines in the interior and takes 250 miles before reaching the center line. A site on this road would be already be in the Sahara desert, so the possible advantage of lower temperature resulting from an ocean location would have disappeared. A first-hand report on the usability of a Mauritanian site for eclipse expeditions would be very useful.

It is interesting to note that the annular eclipses of 24 December 1973 (6 months after the total eclipse), and 29 April 1976, both pass through Mauritania and Mali, crossing the 1973 track in eastern Mauritania. The 20 May 1966 annular eclipse, which many viewed from Greece, crossed along the longest dimension of Mali, passing near Bamako and Timbuktu, and through the Adrar des Iforas.

I appreciate the assistance of the Cartographic Division of the National Geographic Society and their permission to publish their copyrighted maps. The locations of the paths were taken from Circular Number 101 of the United States Naval Observatory. We are also grateful to the Mobil Oil Company for their assistance with local arrangements in Africa.

PRELIMINARY SURVEY OF AFRICAN SITES ALONG PATH OF THE 1973 SOLAR ECLIPSE

By

Donald H. Menzel and Jay M. Pasachoff

Harvard College Observatory

In late June and early July, we are visiting Niger and Mali, the two countries in which totality will surpass seven minutes on 30 June 1973. As of this moment, with the visit to Niger almost concluded, we list the following:

1. Sites in Niger seen to be more accessible than sites in Mali.

2. The weather is probably similar throughout the seven minute portion.

3. We estimate at least a 95% chance of weather clear enough to see the eclipse for seven minutes. The sky has been an ordinary light blue, with considerable brightening near the sun (but perhaps perfect conditions like those in Miahuatlan on 7 March 1970 are too much to hope for).

   The horizon was clearer on the 1st than on the 29th or 30th, but clouds formed in mid-afternoon on the 30th and 1st. The visibility, in any case, was on the order of 20 miles. And the cooling of the atmosphere by the eclipse itself should retard the cloud formation.

4. The prime sites are 135 km north of Agadez, Niger. Access will be either from Agadez or from a new town under construction, Arlit, a similar distance north of the central line west of the Aïr Mountain.

5. The center-line itself is readily accessible, and we inspected two possibilities.

   a. On June 30, we traveled 112 km, 3 hours north of Agadez by Land Rover in the Aïr Mountains, to the tiny settlement of Elmaki, the site of an open tin mine. About two hundred people live there, mostly in tents. There is more vegetation than we had supposed, and areas with shade trees appear regularly where the road crosses rain runoffs. The center-line crosses about 20 km due north of Elmaki, and would probably take another hour in a Land Rover. There is an area with trees there.

   b. On July 1, we traveled 140 km by the route to Arlit, 3 hours north of Agadez to the center-line, where there is a wooded area. We traveled in a Land Rover, although other makes would probably be satistactory. This site is probably marginally preferable to the other because of easier access.

c. A new, paved, route is soon to be constructed from Agadez to Arlit, and may be finished by 1973. If if it is ready, the best sites would probably be along it.

6. Trucks pass regularly to the tin mine in the Aïr, and trucks of up to 80 tons travel daily to Arlit by the current unpaved route. We shared the weekly DC3 we took to Agadez from Niamey with a 1m x 1m x 4m packing crate that continued to Arlit with the plane. Several seats on one side to the plane had been removed to accommodate it.

7. Expenditions would probably have to be self-contained as far as housing, water can probably be obtained in Agadez, and we shall try to work out a method of supplying food there, too.

8. The government of Niger will do everything possible to help us. We discussed the problems of several hundred astronomers and perhaps a thousand or more tourist with President Diori personally, and shall be making detailed recommendations to him.

9. There are an insufficient number of cars available in Agadez and even Niamey. Kano, Nigeria might be a good source of vehicles.

   Trucks for transporting equipment can probably be rented in Agadez.

10. The visit to the sites were worthwhile, for much of this information was unobtainable elsewhere. For example, of the 3 prime sites, two are not shown on any maps. The site we had in mind at first from maps and the Gemini photograph, les Monts Baguezane, turns out to be accessible only by camel.

We shall make a more complete report as soon as possible, and hope to discuss our survey at the IAU General Assembly in Brighton. We have many photographs of the area that should be of great assistance for those considering expeditions.

We promised President Diori that we would ask for a very preliminary estimate of the number of astronomers who would come for a period of weeks, and of tourists. Accordingly, may we ask all those interested to write us immediately at the Harvard College Observatory, Cambridge, Massachusetts 02138, U.S.A., simply stating whether you will be considering an expedition to Niger, with the number of people and for how long. Please respond immediately, preferably by 1 October 1970.

Agadez, 1 July 1970

SUPPLEMENTARY REPORT ON 1973 ECLIPSE SURVEY

By

Jay M. Pasachoff

Harvard College, Observatory*

*As of 25 September 1970, Department of Astronomy, California Institute of Technology

Continuing the investigation of conditions that Professor Menzel and I have undertaken for observing the 1973 eclipse for 7 minutes, I traveled on to Mali in early July 1970.

I was well received by M. Babba Diarra, the 2nd Vice-President, who was very cordial. We discussed the advantages of Kidal and Tessalit, and it appears that Tessalit might be a better center because of its airstrip, larger even than that of Bamako, and able to receive DC-3's and Autonov 24's. Tessalit is a military base, and, with advance notice, space could be found to lodge scientists. Water and vegetables are plentiful, but planes would have to be chartered from Air Mali to fly in supplies and other food.

There are a few occasionally annoying things about traveling in Mali, although some of the tourist opportunities, such as a visit to the Dagon country near Mopti, are fantastic. A photo permit must be obtained by tourists. I was carefully questioned at the airport before my cameras passed customs. There are occasional internal customs checks on the roads. I told the Vice-President of the eventual need to facilitate customs for astronomical equipment.

Material would have to be flown to the Tessalit site, or brought in Land Rovers by road from Gao. They could be driven to Gao from Niamey-the road from Bamako is difficult. Advance equipment could be shipped up the Niger, but this would have to be done before January 1973, for the river is too low in the spring.

Some astronomers or tourists could go to the Sahara desert north of Tombouctou. Land Rovers would be necessary but if the government should agree, a shuttle of supplies to an established camp could be run from Tombouctou in military trucks. Tourists might want to travel up from Tombouctou the day before the eclipse and spend the night on the sand, if enough Land Rovers can be sent up from Bamako in advance.

The weather should be similar to that in the Air, that is, somewhat disappointing. The sun should be visible, but with haze. The actual cloud statistics seem less encouraging, but must be looked at in detail. I made photocopies of the official meteorological records from Tessalit, Kidal and Tombouctou for the past few years.

Dr. Menzel and I would like to thank the Mobil Oil Company for facilitating our trip. MM. Harry Gasarch in New York, Ivan Kerno in Paris, Daniel Petrier in Niamey and Jacques Auneau in Bamako have been especially helpful, as well as their correspondents in Agadez, M. Abbas Kader in Tombouctou the Jahjahs in Mopti, and MM. R. Prijol and Benabdessadeq in Casablanca.

Miss Marilyn Johnson and Mr. Vincent Hovanec of the United States Information Service and Mr. Alfred Erdoos, the Charge d'Affaires were of great aid to us in Niger, and Ambassador Clarke, Mr. Joseph Christiano and Mr. Lewis Pate of the American Embassy were very helpful to me in Mali.

Casablanca, 13 July 1970

BRIEF SOCIAL AND POLITICAL SUMMARIES FROM U.S. EMBASSIES

Senegal

Of all the countries which could become involved in the observation of the June 1973 solar eclipse, Senegal is probably the most developed and affords the greatest extent of support facilities. Dakar could serve as a staging base and transit place for travelers to the interior. Dakar has a number of acceptable hotels, none of which is up to usual international standards, but most of which are adequate. Rooms are often difficult to get, so one would be well advised to make reservations in advance. There is a wide variety of good restaurants and shops in Dakar, but prices are generally equivalent to prices in the better shops and restaurants in this country without always the same degree of quality. A wide range of medical services are available from both the public hospital staffed primarily by French doctors and from the fairly numerous private physicians practicing in Dakar.

One can rent automobiles in Dakar, but would probably find it hard to find landrovers or any other type of more rugged transport. Dakar has excellent air connections with the U.S., Europe and all other parts of West Africa. There is weekly train service for passengers and freight from Dakar to Bamako, Mali. The Port of Dakar is active, receiving the visits of ships from many European ports as well as somewhat infrequent service from the East Coast of the U. S.

Senegal requires a visa and the usual inoculations of all visitors, but otherwise has no restrictions. Custons regulations are about as they are in most countries regarding art, tobacco and alcohol. Special arrangements can probably be made to cover the temporary importation of scientific equipment.

Mali

The situation in Mali is somewhat less favorable. There are few hotel rooms in Bamako, the capital, and still fewer in the countryside. The same comments apply to restaurants, shops and the availability of services. Some medical care can be had and it is possible, although difficult, to rent vehicles. Mali does not have a good system of roads although with proper equipment it is possible to travel in the interior. Air service is available between major towns. Once again visas and the usual inoculations are required. Customs regulations are standard and there have been cases of scientific equipment having been admitted under special circumstances without the payment of customs duties.

It is more important in Mali than in Senegal to make all arrangements well in advance. (See Dr. Pasachoff's and Dr. Menzel's trip reports in this chapter.)

Mauritania

The path of the 1973 solar eclipse passes over areas of Mauritania where there is no village large enough to boast hotel, restaurant or shop adequate to meet the needs of an American eclipse expedition. Nor would there be proper labor, medical or other services available within the path.

Algeria

In the area of Algeria that would be used for observation, there are no facilities and the camping would undoubtably be rough. Moreover, the observers would probably enter southern Algeria by way of Niger or Mali. We expect that the Algerian Government would probabably be very cooperative with the project, particulary if Algerians were invited to participate.

Niger

Weather conditions and the political situation are favorable. (See comments in Dr. Pasachoff's and Dr. Menzel's report based upon actual visits in June-July 1970.

Chad

The long lead time on this request for information does pose some problems with regard to Chad. It is impossible to say at this time what the situation will be in that country several years hence, but the prime fact of life in Chad today is the dissidence and rebel activity that exists in wide areas. This is a situation that has plagued Chad for a number of years, and conditions have not improved as yet to a point where one can predict any sure end to the troubles. Thus, physical security might be of very real concern to any eclipse expedition sent to Chad.

Logistics could also be a problem especially if heavy weight equipment is required. Chad has no railways and the road system is primitive at best, not to say impassable during the rainy season. Shipment by air is the only dependable way of ensuring timely delivery. There are roughly five flights per week each way between Paris and Fort Lamy and other connection possibilities on the north/south axis. Any sort of lateral traffic to other west African cities is virtually non-existent. In-country air services are sketchy.

We note that the path of the 1973 eclipse passes relatively close to Chad's capital, Fort Lamy. If Fort Lamy can be used as a base for the expedition, hotel and restaurant facilities will be adequate, although possibly overcrowed and certainly expensive. Facilities in the sparsely

Chad (continued)

populated areas to the north of the capital are simply not available. An expedition to these parts should be considered essentially as a safari-type operation. Health and hygiene precautions are an absolute necessity. At certain seasons the heat can be well above the 100 degree mark.

From information available to us, it is believed that vehicles could be rented in Fort Lamy, but possibly not if required in large numbers. Possibly--as alluded to above--a safari service might be contracted with to furnish vehicles, tents and other essentials.

Medical attention can be made available in the capital but not elsewhere. Physicians have European training. Hospital facilities themselves are likely to be rudimentary.

Visas are needed for entry into Chad. They may be obtained from the Chadian Embassy in Washington, or in countries where Chad is not represented, through the French Embassy. We do not have Chadian customs regulations at hand, but know that in previous cases involving scientific research, equipment has been allowed to enter without restriction.

Sudan

The United States does not have diplomatic relations with the Sudan. Unless there is improvement in our relations, the U. S. scientists should consider other countries where American Embassy protection would be available if needed.

Uganda

Apart from simple campsites in the Kidepo National Park, there are no facilities in the rugged, arid northeastern corner of Uganda along the 1973 solar eclipse path. It is uncertain at this point whether or not a large scientific expedition would be permitted to enter the area, which is currently considered sensitive by the Ugandan Government because the protracted insurgency in southern Sudan occasionally spills across the border.

Kenya

The portion of Kenya underlying the 1973 solar eclipse path is rugged, isolated, and almost uninhabited. The nearest population center is Meru, located about 100 miles northeast of Nairobi. Rustic but fairly comfortable accommodations may be obtained at the Pig 'n' Whistle Hotel there, and the city is accessible from Nairobi by a good paved highway.

Kenya (continued)

From Meru unsurfaced roads go north and northeast into game reserves which lie more directly in the solar path, but which offer only fairly simple, camping-type facilities. Transportation and car rentals may be arranged in Nairobi.

Somalia

If a request were sent to the Somali Government today for the use of their territory for this project, the response would likely be in the negative due to current strained relations between our two countries. It is impossible to predict what the situation will be by 1973. We will probably go through several cycles before the date of the eclipse.

As the eclipse will pass very close to Chisimaio (the capital of Mogadiscio is several hundred miles to the north of the path), some additional information on this city may be helpful. Chisimaio is a very pleasant town of about 60,000. There are, however, no hotel facilities worthy of the name and logistical support for such an operation is practically non-existent in the city. On the other hand, Chisimaio is served by an excellent, modern port, two 250 kw generators, and a portable central water system. The drive between Mogadiscio and Chisimaio takes nearly two days. The road is paved for nearly half the distance while the remainder is very rough. By 1973 the entire distance may be paved.

A final note on customs is in order. The Somalis will tax or refuse entry of items at random, depending on the current political situation, the mood of the customs officer, etc. There is little utility in delving into Somalia's customs regulations; they are likely to change on a moments notice in any event.

FIRST WEATHER SURVEY FOR THE 1973 ECLIPSE

Jay M. Pasachoff
Harvard College Observatory*

I have made photocopies of the original weather records in the Meteorological Departments of the governments of Mali and Niger, covering cloud cover and temperature for the months of June and July in past years. These must still be looked at carefully, but I have been asked to provide the following averages in time for this Bulletin:

Cloud cover is given in "eighths" and includes cirrus. I have records for the month of June in one town that breaks down the cloud cover by types.
Temperature is given in degrees centigrade. $40^{o}C=104^{o}F$.
Humidity is given in per cent.
Averages are for the period 1960-69 for Niger, 1951-1960 for Mali, both for June.

		Temperature	Humidity	Cloud Cover	
Agadez, Niger	6 am	28.9		6.3	1960-69
	noon	39.3		6.5	
	6 pm	38.4		6.6	
Arlit, Niger	6 am	32.9	32	0	1967-69
	noon	40.1	23	1	
	6 pm	41.1	18	3	
Iferouane, Niger	6 am	29.1	37	2	1960-69
	noon	39.9	20	3	
	6 pm	39.3	20	4	

Agadez is the city at the southern edge of totality, Arlit is in the desert, and Ifèrouane is in the Air Mountains.

		Cloud Cover	
Tessalit, Mali	6 am	3.7	
	noon	3.1	June 1969
	6 pm	4.4	

Mean temperatures: minimum=28, maximum=44
Mean humidities: minimum=12, maximum=26

		Cloud Cover	
	6 am	3	1951-1960
	noon	2	
	6 pm	4	
Timbuktoo, Mali	6 am	4	
	noon	3	
	6 pm	4	
Kidal, Mali	6 am	3	
	noon	3	
	6 pm	4	

* Now at the Department of Astronomy, California Institute of Technology

PRELIMINARY CLIMATIC STUDY
FOR
30 JUNE 1973 ECLIPSE

4th Weather Wing Climatology Study SS-2134

by

Clarence E. Everson
Chief Climatologist

Climatology Branch
Aerospace Sciences Division
Headquarters 4th Weather Wing
ENT Air Force Base, Colorado

8 July 1970

INTRODUCTION

The June 30, 1973 eclipse, of special importance because of its long duration, will cover a path of about 4000 nautical miles over North Africa. The purpose of this study is to present a preliminary evaluation of climatic features along its path.

GENERAL

Tropical heat characterizes the entire eclipse path. Parts of the path are very dry and practically cloudless but at times have considerable dust in the air. Other parts are humid and cloudy with frequent showers and thunderstorms. The reason for this can be understood by considering the source regions, modifications, and interactions of air masses affecting the area traversed by the eclipse path in North Africa.

The North Atlantic high, which extends into Europe and the Mediterranean, and the Asiatic low, must pronounced over southwest Asis sustain a northeasterly to easterly flow over North Africa in summer. This air becomes very hot and dry in its trajectory over the vast desert regions. Known as the "harmattan," these dust bearing winds from the northeast or east extend south of the eclipse path in west Africa during June and July.

The South Atlantic high sustains a southerly flow of moist air into west Africa. Known as the southwest monsoon, this air is carried inland by predominantly southwesterly winds and extends north of the eclipse path in Sudan during June and July and in Chad and eastern Niger in late June or early July. Considerable cloudiness, rain, and thunderstorms characterize the southwest monsoon. The southeast monsoon, or prevailing southeasterly winds from the Indian Ocean, dominate southern Somali and Kenya, and meet the southwest monsoon in Uganda. The southeast monsoon in east Africa also is characterized by cloudiness, rain, and thunderstorms, although by the time this air reaches the eclipse path in northern Kenya it has lost some of its moisture and does not produce quite as much weather in that area.

CLOUDINESS
(at eclipse time of day, along eclipse path)

The least cloudiness over the entire eclipse path is in Mauritania, Mali, and southern Algeria, where total cloud amount averages about 25% at eclipse time of day. Cloudiness increases to around 50% through Niger and to 60 or 70% in Chad. Along the path in southern Sudan, Kenya, and Somali there is 70 to 80% cloud cover on the average. The Cape Verdi Islands have an average cloud cover of 55%. Mauritania and Mali have a small increase in cloudiness from June to July. It increases considerably from June to July in Niger and Chad and is higher in July than in June in Sudan, Kenya, and Somali although not markedly so.

Mauritania and Mali have two days out of three with 25% or less total cloud amount in June and July. Niger has one day out of two in June and one day in four in July with less than 25% cloud cover. The ratio decreases from one day in three to one day in 10 from June to July in Chad with 25% or less cloud. The path through Sudan and Somali averages one day or less per month in this category, whereas in Kenya, one day out of four have 25% or less cloud cover in June and July.

Seventy-five percent or more cloud cover occurs on one day out of nine or ten in Mauritania and Mali in both June and July. Niger has one day out of three to four days in June and one out of two to three days in July. Twenty to 25 days in each month in Sudan and Somali have 75% or more cloudiness, but Kenya has less than half that many cloudy days.

PRECIPITATION
(along eclipse path)

Mauritania, Mali, and Niger have an average of 0.3 inches of precipitation in June. In July, this increases to 0.5 inches in Mauritania, between 0.5 and 1.0 inches in Mali, and 1.0 inch or more in Niger.

June precipitation increases eastward through Chad to over 5 inches in Sudan, then decreases in Kenya (0.5 to 1.0 inches) and increases again to 2 or 3 inches in southern Somali. By July, 5 to 7 inches is average along the eclipse path from Chad through Sudan. Kenya has less than 0.5 inches in the northwest and southeast part of the path and Somali 1 to 2 inches.

Days with 0.1 inch or more precipitation average less than 1 in June and 1 to 2 days in July in Mauritania and Mali. Niger has 1 day in June and 2 to 3 days in July. Chad has 2 to 6 days in June and 5 to 10 days in July. Eight to 10 days is average in Sudan for June and 10 to 12 days in July. Kenya has 1 to 5 days in the northwest and 1 day or less in the central and eastern part of the eclipse path during both June and July. Southern Somali has 1 to 5 days in June and 1 to 3 days in July with 0.1 inch or more of precipitation.

THUNDERSTORMS
(along eclipse path)

June thunderstorms occur on 1 to 3 days in Mauritania, 3 to 5 days in Mali and Niger, 5 to more than 10 days in Chad (increasing west to east), 10 to 15 days in Sudan, less than 5 days in Kenya and zero days in Somali.

In July, thunderstorm days increase to 3 to 5 in Mauritania, 5 to 10 in Mali and Niger, up to 20 days in eastern Chad and Sudan, 5 to 10 in northwest Kenya to zero in eastern Kenya and Somali.

DUST
(at eclipse time of day, along eclipse path)

Dust restricts visibility on 7 or 8 days in June and 4 to 6 days (at eclipse time of day) in July in Mautitania, Mali, and western Niger. In eastern Niger, Chad, Sudan and Somali dust occurs on an average of one day or less in each month. Northwest Kenya has two days with dust in June and also July.

TEMPERATURES
(along eclipse path)

July daily maximum temperatures average 105 to 110°F in Mauritania (85 to 95°F along the coast). Mali and Niger are equally hot and Chad only about 5 degrees less (100-105°F). Along the eclipse path through Sudan and Kenya the daily maximum averages in the lower 90's and on the Somali coast in the lower 80's. July temperatures in general are 2 to 4 degrees less than in June. The daily temperature range in both months is 25 to 30 degrees in Mauritania and Mali, 30 to 35 in Niger, 25 to 30 in Chad, about 20 degrees in Sudan and Kenya and 10 degrees on the Somali coast.

Highest temperatures exceed 115°F in Mauritania, Mali, Niger and Chad; they reach 105 to 110°F in Sudan, 95 to 100°F in Kenya and about 90°F on the Somali coast.

SUMMARY

The eclipse path weather in west Africa is under the influence of hot, dry northeast winds, often cloudless but with considerable dust in the air at times. The southwest monsoon, cloudy and rainy, becomes noticeable in Niger, increasingly so in Chad, and is predominant in southern Sudan. The southeast monsoon, also with clouds and rain affects the eclipse path in Somali, Kenya and Uganda.

More detailed information than presented is desirable for potential viewing locations. Observations at such locations and also satellite weather pictures would be invaluable. Avaliable information suggests that the mountain area in western Niger and eastern Mali is favorable for viewing sites. Also, there are probably some good locations in Mauritania. Additionally, the Cape Verdi Islands show promise. Kenya may have excellent viewing locations but this should be substained by more data along the eclipse path in that area.

On the spot study of weather conditions would be most profitable during the last week in June and first week in July. Observations during periods earlier or later will tend to bias conclusions toward better or worse conditions respectively relative to those to be expected on June 30th.

PRIMARY DATA SOURCES

1. Tables of Temperature, Relative Humididy and Precipitation for the World, Part IV, Africa, the Atlantic Ocean South of 35°N and the Indian Ocean, M.O. 617d, Meteorological Office, London, 1958.

2. Worldwide Airfield Climatic Data, Volume IX, Part 1, Africa (Northern Half), USAF Environmental Technical Applications Center, AIR Weather Service, December 1968.

3. Worldwide Airfield Climatic Data, Volume IX, Part 2, Africa (Southern Half), USAF Environmental Technical Applications Center, Air Weather Service, February 1969.

JUNE CLIMATIC DATA

	Midelo, Cape Verdi Is 16°53'N 25°00'W 52 ft	Akjoujt, Mauritania 19°43'N 14°23'W 404 ft	Atar, Mauritania 20°29'N 13°03'W 751 ft	Tidjikja, Mauritania 18°33'N 11°26'W 1312 ft	Tessalit, Mali 20°14'N 0°58'W 1621 ft	Gao, Mali 16°15'N 0°01'W 869 ft	Tamanrasset, Algeria 22°47'N 5°31'E 4603 ft	Dirkou, Niger 18°58'N 12°52'E 1273 ft	Agades, Niger 16°58'N 7°59'E 1634 ft
Average daily maximum temp (°F)	78	109	107	107	109	103	95	109	107
Average daily minimum temp (°F)	70	81	81	78	83	82	70	75	75
Average dew point (°F)	62	59	44	55	45	59	38	43	54
Average relative humidity (%)	69	38	29	33	22	37	24	20	29
Average precipitation (in)	0.00	0.12	0.28	0.43	0.28	0.94	0.10	0.04	0.39
Average days precipitation**	0	<1	1	1	1	2	< 1	<1	1
Average days with thunderstorms	0	1	2	2	4	9	2	1	3
Most frequent wind direction	NE	N	NE	NE	N		E	E	W
Average wind speed (kts)	11	10	9	6	10		7	7	6
Average days with dust *	0	7	8	4	7		4	<1	<1
Average days cloud amount ≤ 2/8*	9	22	19	18	21		17	20	9
Average days cloud amount ≥ 6/8*	11	3	4	4	4		5	5	15
Average cloud amount (oktas)*	4.3	1.5	1.8	1.9	1.9		2.6	2.1	4.6

*At approximate eclipse time.
**Days with ≥0.1 inch.

NO ENTRY MEANS DATA NOT AVAILABLE

JUNE CLIMATIC DATA Cont'd

	N'Guigmi, Niger 14°15'N 13°07'E 1011 ft	Abeche, Chad 13°51'N. 20°51'E 1788 ft	Mongo, Chad 12°11'N 18°41'E 1476 ft	Fort Lamy, Chad 12°08'N 15°02'E 975 ft	Fort Archambault, Chad 9°09'N 18°23'E 1198 ft	Juba, Sudan 4°52'N 31°36'E 1509 ft	Malakal, Sudan 9°33'N 31°39'E 1273 ft	Wau, Sudan 7°42'N 28°01'E 1437 ft	Geneina, Sudan 13°29'N 22°27'E 2640 ft
Average daily maximum temp (°F)	100	105		100	92	91	91	92	98
Average daily minimum temp (°F)	77	75		75	73	69	71	70	72
Average dew point (°F)	65	68		73	74	70	69	71	55
Average relative humidity (%)	50	43		55	50	77	71	64	41
Average precipitation (in)	0.24	1.02	3.56	2.60	5.63	4.57	4.53	6.50	1.42
Average days precipitation**	1	2	6	5	9	8	8	10	3
Average days with thunderstorms	3			10		11	13	11	14
Most frequent wind direction	W			W	S	S	S	SW	SW
Average wind speed (kts)	5			8	5	2	5	3	4
Average days with dust*	≤1					<1	<1	<1	1
Average days cloud amount ≤2/8*	13			3	3	1	1	2	6
Average days cloud amount ≥6/8*	7			16	16	23	23	20	14
Average cloud amount (oktas)*	3.3			5.4	5.4	6.2	6.3	5.9	4.8

*At approximate eclipse time.
**Days with ≥0.1 inch.

NO ENTRY MEANS DATA NOT AVAILABLE

JUNE CLIMATIC DATA Cont'd

	Gulu, Uganda 2°45'N 32°20'N 3639 ft	Morota, Uganda 2°33'N 34°36'E 4418 ft	Lodwar, Kenya 3°07'N 35°37'E 1660 ft	Wajir, Kenya 01°45'N 40°04'E 800 ft	Garissa, Kenya 0°29'S 39°38'E 128 ft	Chisimaid Somali 0°22'S 42°26'E 33 ft	Agalega, Agalega Is 10 33'S 56°45'E 10 ft
Average daily maximum temp (°F)	82		94	90	91	84	84
Average daily minimum temp (°F)	63		75	70	71	75	75
Average dew point (°F)	62		62	65	64	73	71
Average relative humidity (%)	73		51	64	61	80	78
Average precipitation (in)	5.80	3.50	0.34	0.04	0.20	2.58	8.90
Average days precipitation**	9	6	1	< 1	< 1	5	12
Average days with thunderstorms	20	6		0	0	0	0
Most frequent wind direction	SE	N	NE	S	S	S	
Average wind speed (kts)	6	4	7	10	11	11	
Average days with dust*	0		2			0	
Average days cloud amount ≤2/8*	1	3	7	7	1	≤ 1	
Average days cloud amount >6/8*	21	12	9	8	18	23	
Average cloud amount (oktas)*	6.1	4.8	4.3	4.0	5.6	6.4	

*At approximate eclipse time.
**Days with ≥0.1 inch.

NO ENTRY MEANS DATA NOT AVAILABLE

JULY CLIMATIC DATA

	Midelo, Cape Verdi IS 16°53'N 25 00'W 52 ft	Akjoujt, Mauritania 19°43'N 14 23'W 404 ft	Atar, Mauritania 20°29'N 13 03'W 751 ft	Tidjikja, Mauritania 18°33'N 11 26'W 1312 ft	Tessalit, Mali 20°14'N 0 58'W 1621 ft	Gao, Mali 16°15'N 0 01'W 869 ft	Tamanrasset, Algeria 22°47'N 5 31'E 4603 ft	Dirkou, Niger, 18°58'N 12 52'E 1273 ft	Agades, Niger 16°58'N 7 59'E 1634 ft
Average daily maximum temp (°F)	81	105	106	102	107	97	95	108	104
Average daily minimum temp (°F)	71	77	81	77	81	80	71	75	75
Average dew point (°F)	64	68	52	66	56	65	34	50	68
Average relative humidity (%)	70	55	42	50	30	49	21	25	46
Average precipitation (in)	0.01	0.28	0.28	0.91	0.91	2.76	0.10	0.12	1.69
Average days precipitation**	0	1	1	2	2	5	<1	<1	3
Average days with thunderstorms	0	2	3	3	9	12	1	1	12
Most frequent wind direction	NE	N	SW	SW	SW		E	NE	W
Average wind speed (kts)	9	8	10	6	10		8	7	6
Average days with dust*	0	3	4	4	6		4	1	<1
Average days cloud amount ≤ 2/8*	110	20	21	20	21		20	11	3
Average days cloud amount ≥ 6/8*	14	3	3	5	4		2	9	18
Average cloud amount (Oktas)*	4.4	1.8	1.9	2.2	2.0		2.1	3.6	5.4

*At approximate eclipse time.

** Days with ≥ 0.1 inch.

NO ENTRY MEANS DATA NOT AVAILABLE

JULY CLIMATIC DATA Cont'd

	N'Guigmi, Niger 14°15'N 13°07'E 1011 ft	Abeche, Chad 13°51'N 20°51'E 1788 ft	Mongo, Chad 12°11'N 18°41'E 1476 ft	Fort Lamy, Chad 12°08'N 15°02'E 975 ft	Fort Archambault Chad 9°09'N 18°23'E 1198 ft	Juba, Sudan 4°52'N 31°36'E 1509 ft	Malakal, Sudan 9°33'N 31°39'E 1273 ft	Wau, Sudan 7°42'N 28°01'E 1437 ft	Geneina, Sudan 13°29'N 22°27'E 2640 ft
Average daily maximum temp (°F)	96	96		93	88	88	88	89	89
Average daily minimum temp (°F)	76	72		73	71	68	71	69	70
Average dew point (°F)	68	72		73	73	70	70	71	65
Average relative humidity (%)	59	62		71	62	82	80	70	68
Average precipitation (in)	2.24	5.55	7.43	6.14	8.90	5.35	6.02	7.50	6.38
Average days precipitation**	4	9	11	10	12	9	10	11	10
Average days with thunderstorms	10			14		10	17	11	22
Most frequent wind direction	W			W	SW	S	S	SW	W
Average wind speed (kts)	5			9	5	2	5	5	4
Average days with dust*	<1					<1	<1	<1	<1
Average days cloud amount $\leq 2/8$*	6			0	<1	<1	<1	1	1
Average days cloud amount $\geq 6/8$*	14			26	25	25	24	24	20
Average cloud amount (oktas)*	4.7			6.7	6.7	6.3	6.4	6.3	5.8

*At approximate eclipse time

**Days with $\geq$0.1 inch

NO ENTRY MEANS DATA NOT AVAILABLE

JULY CLIMATIC DATA Cont'd

	Gulu, Uganda 2°45'N 32°20'N 3639 ft	Moroto, Uganda 2°33'N 34°36'E 4418 ft	Lodwar, Kenya 3°07 N 35°37'E 1660 ft.	Wajir, Kenya 01°45'N 40°04'E 800 ft	Garissa, Kenya 0°29'S 39°38'E 128 ft	Chisimaid, Somali 0°22'S 42°26'E 33 ft	Agalega, Agalega Is 10°33'S 56°45'E 10 ft
Average daily maximum temp (°F)	80		92	88	90	83	83
Average daily minimum temp (°F)	62		74	69	70	74	75
Average dew point (°F)	62		60	65	63	73	72
Average relative humidity (%)	76		51	67	60	84	81
Average precipitation (in)	6.68	5.60	0.50	0.16	0.08	1.57	8.70
Average days precipitation**	10	9	1	< 1	< 1	3	12
Average days with thunderstorms	21	8		0	0	0	0
Most frequent wind direction	SE	W	NE	S	S	S	
Average wind speed (kts)	6	3	7	11	11	11	
Average days with dust*	0		2			0	
Average days cloud amount ≤ 2/8*	1	1	7	5	< 1	< 1	
Average days cloud amount ≥ 6/8*	24	19	13	12	25	26	
Average cloud amount (oktas)*	6.3	5.7	4.6	4.6	6.2	6.7	

*At approximate eclipse time.
**Days with ≥ 0.1 inch.

NO ENTRY MEANS DATA NOT AVAILABLE

CHAPTER 7 - MEETINGS

The Committee on Space Research (COSPAR) of the Inter-Union Council of Scientific Unions (ICSU) has agreed, in principle, to hold a 1970 SOLAR ECLIPSE SYMPOSIUM in association with its XIVth Plenary Meeting in Seattle in June 1971. COSPAR has requested the Inter-Union Commission on Solar-Terrestrial Physics (IUCSTP) to act as its intermediary in seeking the sponsorship of interested Unions, and to assist in coordinating the organization of the Symposium. As of August 7 it appears that the relevant international scientific unions [IAGA (IUGG), URSI, IAU] are interested in co-sponsoring the Symposium. Dr. Edward R. Dyer, IUCSTP secretary, (see distribution list for his address) is coordinating the initial arrangements and should be contacted for further details.

The U. S. Coordinator has provided Dr. Dyer with the mailing list for SOLAR ECLIPSE BULLETIN F and with copies of the eclipse experimenters' replies to the June 1 questionnaire part of which requested an expression of interest regarding a 1970 SOLAR ECLIPSE SYMPOSIUM.

As of August 7, 1970, it appears that a three-day 1970 SOLAR ECLIPSE SYMPOSIUM will be held in Seattle probably on June 21-23, 1971, (or possibly on June 16-18, 1971, if scheduling conflicts develop). The IUCSTP secretariat plans to send a circular letter regarding the symposium and a call for the submission of papers sometime during the Fall of 1970.

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