



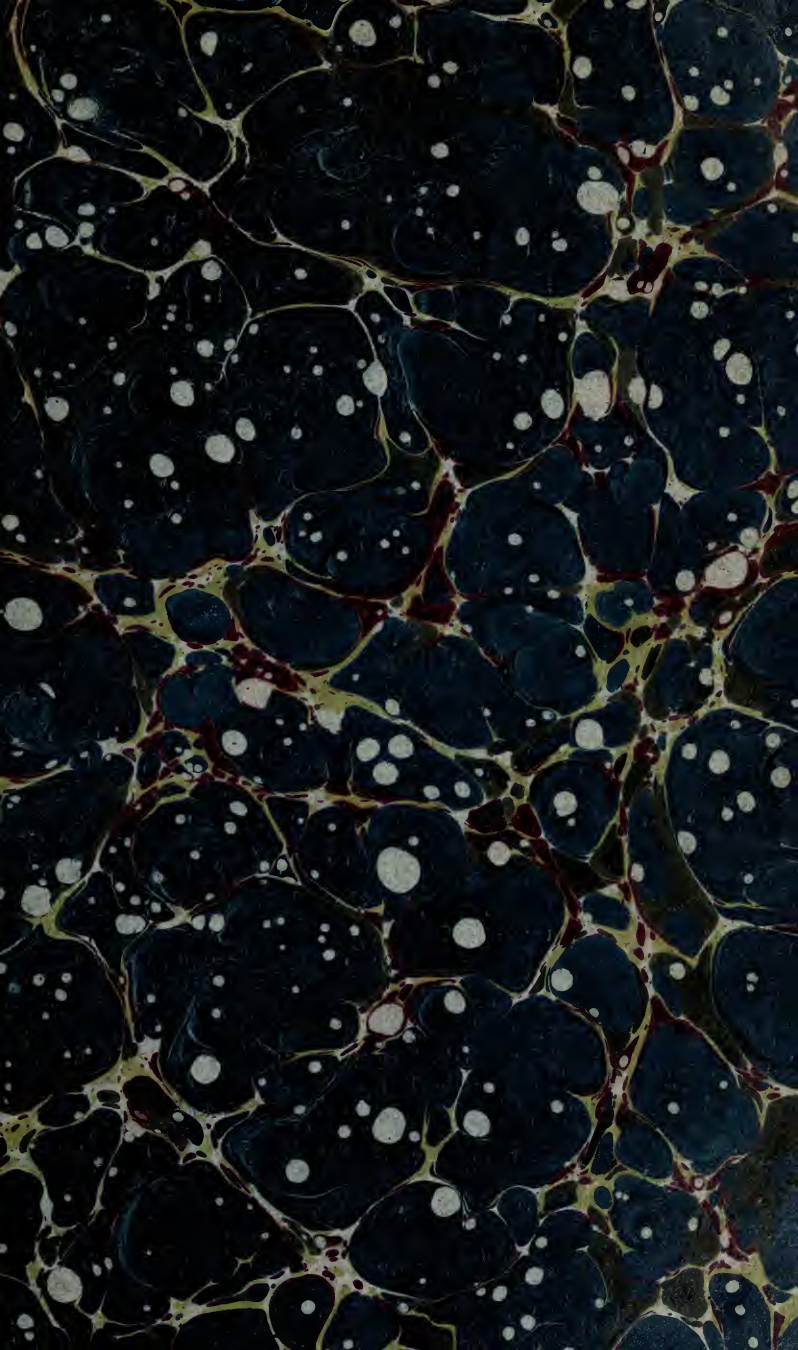
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**THE LAW**  
OF  
**STORMS:**

*The various  
phenomena by which  
their approach can be ascer-  
tained with certainty, and prac-  
tical directions to mariners  
for the avoidance of  
their fury.*

COMPILED FROM VARIOUS SOURCES

BY

**CAPT. JOHN ROSS.**



A. ROMAN & COMPANY,  
BOOKSELLERS, PUBLISHERS AND IMPORTERS,  
417 and 419 Montgomery Street, San Francisco.  
27 HOWARD ST., NEW YORK.

1869.

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Entered according to Act of Congress, in the year 1869,

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# ON HURRICANES

## AND THE

# LAW OF STORMS.

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In the Northern Hemisphere, when the Polar and Equatorial currents of air are alternating with each other, the regular shifting of the wind round the compass will be through S., S. W., W., N. W., N., N. E., E., S. E., S.—and the changes will take place oftener between south and west, and between north and east, than between west and north, and between east and south.

Similarly in the Southern Hemisphere, it may be inferred that when Polar currents of air alternate with Equatorial, the regular shifting of the wind round the compass will be successive through S., S. E., E., N. E., N., N. W., W., S. W., S.

This is Dove's "Law of Gyration," (or the law of the rotation of winds). And collecting the main points into a few general propositions, it may be laid down, that all steady winds are modified by the rotation of the earth, in such a manner that Equatorial currents of air receive a westerly deflection, and Polar currents an easterly deflection; but latitudinal currents suffer no change. The N. E. and S. E. Trade Winds are steady Polar currents. The Monsoons are alternations

of a Polar and an Equatorial current, twice during the year. Therefore they are N. E. and S. W. in the Northern Hemisphere, and S. E. and N. W. in the Southern Hemisphere.

The S. W. passage winds of the Northern Hemisphere, and the N. W. passage winds of the Southern Hemisphere, are Equatorial currents.

Bodies of air set in motion from a state of rest, turn the wind-vane in the direction of the meridian as follows:

The Polar current in the Northern Hemisphere from N. to E.

The Polar current in the Southern Hemisphere from S. to E.

The Equatorial current in the Northern Hemisphere from S. to W.

The Equatorial current in the Southern Hemisphere from N. to W.

In general the winds in the Northern Hemisphere are as follows:

Those from N. to E. the Polar currents.

Those from E. to S. the transition of the Polar to the Equatorial.

Those from S. to W. the Equatorial current.

Those from W. to N. the transition of the Equatorial to the Polar.

Also, in the Southern hemisphere, the winds are as follows:

Those from S. to E. the Polar currents.

Those from E. to N. the transition of the Polar to the Equatorial.

Those from N. to W. the Equatorial current.

Those from E. to S. the transition of the Equatorial to the Polar.

Thus, a complete revolution of the wind-vane in the Northern Hemisphere is therefore S. W., N. E., S. with the sun, and in the Southern Hemisphere the rotation is S. E., N. W., S., with the sun, also, in that region.

When the course of a steady wind is obstructed in such a manner as to produce a Hurricane, or Cyclone, the wind has a rotary or whirling motion (as it were, on an axis), while the storm itself has a progressive motion.

N. B.—The rotation of the wind during a hurricane, in the Northern Hemisphere, is in a direction contrary to that in which the hands of a watch move. In the Southern Hemisphere, the rotation is in the same direction as that of the hands of a watch. And hence the following shiftings of the vane: In the Northern Hemisphere, when the vortex (or center) of the storm passes to the westward of the place of observation, the rotation is S. W., N. E., S., with the sun; when the vortex passes to the eastward of the place of observation, the rotation is S. E., N. W., S., against the sun.

In the Southern Hemisphere, if the vortex passes to the westward of the place of observation, the rotation is S. E., N. W., S., with the sun.

If the vortex passes to the eastward of the place of observation, the rotation is S. W., N. E., S., against the sun.

### On Hurricanes or Cyclones.

Thus, in both Hemispheres, the passage of an equatorial whirlwind storm on the west side of the place of

observation, produces normal revolutions in accordance with the law of gyration; while, on the other hand, its passage on the east side produces anomalous revolutions contrary to the law of gyration. When the vortex of a whirlwind storm passes over the place of observation, the vane may shift from one direction to that immediately opposite to it.

Generally, if the whirlwind storm is an equatorial one in the Northern Hemisphere, it progresses from S. E. to N. W. in the Torrid Zone; it recurves at the outer edge of the N. E. trade wind, and thence moves from S. W. to N. E. But in the Southern Hemisphere an equatorial storm moves first from N. E. to S. W.; recurves at the outer edge of the S. E. trade wind, and then advances from N. W. to S. E.—bearing in mind the direction of the rotation of the wind in each hemisphere, viz: against watch hands in the Northern, but with watch hands in the Southern Hemisphere. Certain portions of the storms are characterized by certain hurricane winds, and dividing the storm by diameters drawn from the northern to the southern margin, and again from the eastern to the western margin, we find that in the Northern Hemisphere, on the northern margin, the wind will be easterly; on the eastern margin, southerly; on the southern margin, westerly; and on the western margin, northerly;—each portion of the cyclone possessing its appropriate wind.

The relations of the winds to the margin in the Southern Hemisphere, will be exactly the reverse of their relation in the Northern. Thus: It is the southern margin of the storm south of the Equator, that exhibits an easterly; the western margin a southerly; the northern margin a westerly, and the eastern margin

a northerly wind. Hence, each portion of the hurricane having its appropriate wind, there results, according to the law of the rotation of revolving gales, a very simple rule for determining the bearing of the center of the storm from the ship, viz: Look to the wind's eye and set its bearing by compass, the *eighth* point to the right thereof when in the Northern Hemisphere; but to the left of the wind's direction when in the Southern Hemisphere, will be the bearing of the storm's center. Thus, in the Northern Hemisphere, from an easterly wind, which characterizes the northern margin of the storm, its center will bear south; from a northerly wind the center will bear east; from a westerly wind it will bear north, and from a southerly wind, west. But in the Southern Hemisphere, from an easterly wind, the center of the storm bears north; from a southerly wind the center bears east; from a westerly wind, south; and from a northerly wind, west.

The above rule is perfectly clear and definite; but as it is especially important to avoid the center of the storm,—its most dangerous part,—the following table shows at a glance its relative bearing in each Hemisphere.

IN THE NORTHERN HEMISPHERE.		IN THE SOUTHERN HEMISPHERE.	
If the wind be—	The center of the storm will bear from the ship—	If the wind be—	The center of the storm will bear from the ship—
North.	East.	North.	West.
N by E	E by S	N by E	W by N
N N E	E S E	N N E	W N W
N E by N	S E by E	N E by N	N W by W
N E	S E	N E	N W
N E by E	S E by S	N E by E	N W by N
E N E	S S E	E N E	N N W
E by N	S by E	E by N	N by W
East.	South.	East.	North.
E by S	S by W	E by S	N by E
E S E	S S W	E S E	N N E
S E by E	S W by S	S E by E	N E by N
S E	S W	S E	N E
S E by S	S W by W	S E by S	N E by E
S S E	W S W	S S E	E N E
S by E	W by S	S by E	E by N
South.	West.	South.	East.
S by W	W by N	S by W	E by S
S S W	W N W	S S W	E S E
S W by S	N W by W	S W by S	S E by E
S W	N W	S W	S E
S W by W	N W by N	S W by W	S E by S
W S W	N N W	W S W	S S E
W by S	N by W	W by S	S by E
West.	North.	West.	South.
W by N	N by E	W by N	S by W
W N W	N N E	W N W	S S W
N W by W	N E by N	N W by W	S W by S
N W	N E	N W	S W
N W by N	N E by E	N W by N	S W by W
N N W	E N E	N N W	W S W
N by W	E by N	N by W	W by S

The path which the axis of rotation describes is not inappropriately termed the "Axis Line." On the "Axis Line" there is no change of wind until the center has passed, when, after a brief interval of calm, the wind springs up with great fury from the opposite quarter.

It has been remarked by Piddington, "that he who watches his barometer, watches his ship." This invaluable instrument, if well understood, invariably announces the approach of a revolving storm; shows whether the vessel is plunging into the vortex, or if she be receding from it; and hence, by carefully noticing its indications, the disastrous consequences of a hurricane may, to a great extent, be avoided,—for the laws of its oscillations are very distinctly marked. The barometer often stands unusually high before the commencement of a cyclone, and frequently (if not always) just around the storm. And conceiving the cyclone to be divided into two parts by a diameter at right angles to its path, it may be noted that the barometer always falls during the passage of the advancing semi-circle of a revolving storm. The barometer always rises during the passage of the receding semi-circle of a revolving storm. In cases of manœuvring to take advantage of the hurricane winds, and to keep just within the verge of the storm, the barometer is of signal benefit,—it should be kept as high as possible, without losing the wind. In whatever position the ship may be, the rising of the mercury announces that the first (or dangerous) half of the storm has passed.

The barometer is a faithful guide in the zone of the Trade Winds. Its ordinary variations are so small that any deviation from its normal height requires attention.

Its fluctuations are larger beyond the Tropics ; but the indications are scarcely less certain if used in conjunction with the thermometer and hygrometer,—hence, more watchfulness is required on the part of the navigator ; and it is of the utmost importance to have such a knowledge of the Law of Storms, of storm instruments, and of the signs of the weather, as to be able to detect the presence of a hurricane or cyclone, when as yet sky and sea betoken but little of that blind fury, during the height of which it is so difficult to guide the vessel in safety. One great advantage of such knowledge is a quick apprehension of the indications which forewarn, to make all snug in time.

The meteorological signs indicating the approach of a hurricane or cyclone, have been collected from various sources by Mr. Birt, and are enumerated and classed according as the phenomena may be presented to the external sensations of feeling, sight, or hearing.

#### METEOROLOGICAL SIGNS RECOGNIZED BY THE FEELINGS.

1. A sultry, oppressive state of the atmosphere.
2. A calm.

#### METEOROLOGICAL SIGNS RECOGNIZED BY THE EYE.

1. A remarkably clear state of the atmosphere, so that the stars may be seen to rise and set with nearly the same distinctness as the sun and moon.
2. A peculiar white appearance in the zenith, more or less of a circular form.
3. A remarkably red or fiery appearance of the



sky. This is not unfrequently of such intensity as to tinge all the surrounding objects with a deep crimson; and when this is seen there can be no question that the violent portion of the cyclone is not far from the vessel. When this red light is seen at night, the impression on the seaman's mind is that day has broken before its time.

4. A peculiar coloring of the clouds, more especially of an olive green. This is generally the precursor of a most violent and terrific hurricane.

5. A thick, hazy appearance in that quarter of the horizon in which the cyclone is raging.

6. A remarkable and peculiar appearance of the heavenly bodies. When shining through a haze they are said to shine with a pale, sickly light, and are not unfrequently surrounded by rings of light, or halos. Some observers describe the stars "as looking big, with burs about them"; others speak of their "dancing," and generally they have been noticed as being remarkably bright and twinkling.

7. The sun, on some occasions, has exhibited a blue appearance, and white objects have been seen of a decided light blue color. The sun has also been observed of a pale and somewhat similar appearance to that of the full moon.

8. A dense, heavy bank of cloud in the direction of the hurricane.

9. A peculiar appalling appearance in this bank, more particularly as if it were a solid wall, drawing down upon and closing around the ship.

10. A darting forward of portions of this bank, as if torn into rags and shreds by some violent force, and driven before, not borne, by the wind. When this indication

is distinctly recognized, a run of about two hours toward the center will involve the vessel in a destructive hurricane.

11. A peculiar motion exhibited by small bodies, as branches of trees when agitated by the wind, consisting of an apparent whirling, not a bending forward, as if bent by a stream of air.

12. Lightning of a remarkable columnar character, shooting up in stalks from the horizon with a dull glare; also like flashes from a gun, and sparks from a flint and steel.

#### METEOROLOGICAL SIGNS RECOGNIZED BY THE EAR.

1. A distant roar (probably of the hurricane itself) as of wind rushing through a hollow vault.
2. A peculiar moaning of the wind, indicative of the close proximity of the violent portion of the hurricane.

#### THE METEOROLOGICAL PHENOMENA ACCOMPANYING A REVOLVING STORM MAY ALSO BE ENUMERATED THUS:

1. A very rapid motion of the air constituting the hurricane, and increasing in velocity as the center is approached.
2. A fitful variation of intensity in the force of the wind, which sometimes blows with fearful violence, carrying away everything that opposes its progress; then sinking to a gentle breeze, or even lulling to a calm, but almost immediately afterwards springing up with greater violence than before. The hurricane winds are

nearly if not entirely, without exception, puffy, violent, and blowing in gusts.

3. An immense condensation of aqueous vapor, forming large banks of cloud, which precipitate torrents of rain. The condensation appears to be so exceedingly rapid that large quantities of electricity are generally developed, giving rise to incessant flashes of lightning.

4. A general darkness and gloominess within the area of the cyclone, relieved only by the fitful glare of the lightning, or the appearance of the imperfect circle of light near the center or axis of the storm.

5. A separation of the clouds in or near the center of the hurricane, so as to produce in the immediate neighborhood of the axis a clear sky, through which the sun and stars are often seen with great brilliancy.

6. A calm in the center of the cyclone.

#### INDICATIONS OF APPROACHING OR EXISTING HURRICANES, MANIFESTED BY THE OCEAN, OF ESPECIAL UTILITY TO VESSELS AT ANCHOR IN ROADSTEADS.

1. A swell, produced by the storm-wave, rolling in upon the shore, at first of a gentle character. The direction of this swell will pretty surely indicate the bearing of the storm, and its changes will point out in some localities the course the hurricane may be pursuing.

2. A swell rolling in, without changing its direction, may be regarded as indicative of a hurricane approaching the shore. The same phenomenon met with at sea (the ship's course being taken into account) will indicate the bearing down of the cyclone on the vessel.

3. A dirty green appearance of the ocean ; on some occasions its assuming a muddy or brown color, on others its being remarkably clear, its temperature increasing, and its swellings stronger than at other times,—are all indications of the proximity of a cyclone.

The area over which these rotary storms have been known to expand, varies from 30 to 40 to 1,000 miles; but while the diameter, so long as the storm is within the tropics, expands but very gradually, it suddenly increases in a remarkable manner after recurving. The rate at which they travel on their onward course also varies greatly, not only in different parts of the globe, but even in the same locality, and at the same season. Generally, however, the rapidity with which the vortex of the hurricane progresses is greater as the storm recurves on reaching the outer edge of the trade winds. Thus, the hurricane of August, 1853, traversed 6,276 English miles in about twelve days, with a mean progressive velocity of twenty-six miles per hour ; but after it arrived at the Banks of Newfoundland this velocity was increased to about fifty miles per hour.

Within the area of the cyclone the moving body of air frequently attains a rotatory velocity of from seventy to one hundred miles an hour.

TABLE SHOWING THE DIFFERENT MONTHS OF THE YEAR IN WHICH HURRICANES AND CYCLONES HAVE BEEN RECORDED IN VARIOUS REGIONS.

LOCALITY.	JAN..	FEB..	MAR..	APRIL	MAY..	JUNE.	JULY..	AUG..	SEPT.	OCT...	NOV..	DEC..
No. Atlantic and W. I..	5	7	11	6	5	10	42	96	80	69	17	7
South'n Indian Ocean & Mauritius. ....	9	15	15	8	4	...	...	...	1	1	4	6
North'n Indian Ocean; Bay of Bengal—												
N. E. Monsoon.....	1	..	3	...	...	...	...	...	...	12	7	6
S. W. Monsoon.....	..	..	..	6	16	4	1	2	1	...	...	..
Arabian Sea & Bomb'y—												
N. E. Monsoon.....	1	1	1	...	...	...	...	...	8	12	9	5
S. W. Monsoon.....	..	..	..	5	9	2	4	5	...	...	...	..
China Sea and No. Pacific—(western part)..	..	1	..	..	2	2	12	5	18	14	12	1
Java Sea and Northwest Coast of Australia....	3	5	1	1	2	...	...	...	...	...	...	2

From this table it appears that the hurricane seasons in the several localities are as follows:

1. In the North Atlantic, from June to November, the greater number occurring in July, August, September, and October.

2. In the Bay of Bengal they are most prevalent in October, November and December, when the N. E. Monsoon is strongest; they occur also during the S. W. Monsoon, especially in April, May or June.

3. In the Arabian Sea they have been experienced during both Monsoons.

4. In the China Sea they are prevalent on the coast between June and October; but in the central part of that sea during September, October and November.

5. In the Southern Indian Ocean they may be expected between November and April, but they are most prevalent during January, February and March.

6. In the Java Sea, and on the N. W. Coast of Australia they have been recorded during December, January and February.

#### RULES FOR TRIMMING THE SHIP IN A HURRICANE.

Piddington long ago said: "That all positive rules tend to mislead." Every ship must have its own peculiar management depending on the four great elements of the problem, which are—

1. The ship and her sea room.
2. The track of the cyclone.
3. Its rate of traveling.
4. The ship's run and drift.

While, on the part of the commander, caution and watchfulness are essentially requisite, still all the circumstances being favorable, rules may be given in a very brief compass for trimming a vessel to the hurricane winds. These are embodied in the following tables. Where the directions of the wind vane, as set set down in the first column are tangents to the whirlwind in its course, these indicate the quarter from which the storm sets in. The points of the compass in the second column show the position of the storm's cen-

ter as regards the vessel. The fourth column gives the direction in which to steer when the wind shifts as indicated in the third column ; but if it shifts as indicated in the fifth column, then bear away as told in the sixth column.

I.—FOR THE NORTHERN HEMISPHERE.

Direction of wind at commencement of storm.....	If the center (or vortex) bears..	And the wind shifts from.....	STEER.....	But if the wind shifts from.....	Put the ship on the Starboard Tack.
North. N by E NNE NE by N NE NE by E ENE E by N East. E by S ESE SE by E SE SE by S SSE S by E South. S by W SSW SW by S SW	East. E by S ESE SE by E SE SE by S SSE S by E South. S by W SSW SW by S SW SW by W WSW W by S West. W by N WNW NW by W NW NW by N NNW N by W North. N by E NNE NE by N N	N to W N by E to N NNE to N NE by N to N NE to N NE by E to N ENE to N E by N to N E to N E by S to E ESE to E SE by E to E SE to E SE by S to E SSE to E S by E to E S to E S by W to S SSW to S SW by S to S SW to S	South. S by W SSW SW by S SW SW by W WSW W by S West. W by N WNW NW by W NW NW by N NNW N by W North. N by E NNE NE by N NE	N to E N by E to E NNE to E NE by N to E NE to E NE by E to E ENE to E E by N to E E to S E by S to S ESE to S SE by E to S SE to S SE by S to S SSE to S S by E to S S to W S by W to W SSW to W SW by S to W SW to W	

## II—FOR THE SOUTHERN HEMISPHERE.

Direction of wind at commencement of storm.	If the center (or vortex) bears...	And the wind shifts from.....	STEER.....	But if the wind shifts from.....	Put the ship on the Port Tack.
South. S by E SSE SE by S SE SE by E ESE E by S East. E by N ENE NE by E NE NE by N NNE N by E North. N by W NNW NE by E NE NE by N NNE N by E North. N by W NNW NW by N NW NW by N NW	East. E by N ENE NE by E NE NE by N NNE N by E North. N by W NNW NW by N NW NW by W WNW W by N West. W by S WSW SW by W SW SW by S SSW S by W South. W by S WSW SW by W SW	S to W S by E to S SSE to S SE by S to S SE to S SE by E to S ESE to S E by S to S E to S E by N to E ENE to E NE by E to E NE to E NE by N to E NNE to E N by E to E N to E N by W to N NNW to N NW by N to N NW to N	North. N by W NNW NW by N NW NW by W WNW W by N West. W by S WSW SW by W SW SW by S SSW S by W South. S by E SSE SE by S SE	S to E S by E to E SSE to E SE by S to E SE to E SE by E to E ESE to E E by S to E E to N E by N to N ENE to N NE by E to N NE to N NE by N to N NNE to N N by E to N N to W N by W to W NNW to W NW by N to W NW to W	

ADMIRAL FITZROY'S INSTRUCTIONS ON THE USE OF  
THE BAROMETER IN NORTH LATITUDE.

## THE BAROMETER RISES:

For northerly wind (including from N. W. by the north to the eastward), for dry, or less wet weather, for less wind, or for more than one of these changes—except on a few occasions when rain (or snow) comes from the northward, with strong wind.



## A THERMOMETER FALLS:

For change of wind towards any of the above directions.

## THE BAROMETER FALLS:

For southerly wind (including from S. E. by the south to the westward) for wet weather, for stronger wind, or for more than one of these changes—except on a few occasions when moderate wind with rain (or snow) comes from the northward.

## A THERMOMETER RISES:

For change of wind towards the upper directions only. Moisture or dampness in the air (shown by a hygrometer) increases before or with rain, fog or dew.

On Barometer Scales the following contractions may be useful in North Latitudes.

And the following Summary may be useful generally throughout the world.

RISE FOR N E by N W-N-E Dry or less wind—except wet from N E	FALL FOR S W by S E-S-W Wet or more wind—except wet from N E	RISE FOR Cold, dry or less wind—ex- cept wet from cold side.	FALL FOR Warm, wet or more wind— except wet from cold side.
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In south latitudes substitute south or southward for north, northward, etc.



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
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
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