cluding a dwelling hut, and observer's hut, three years' provisions, stores, fuel, sledges, and dogs.

(*c*) No landing party is to be established on any other part of the coast than that between Cape Johnson and Cape Crozier, as it is above all things essential that in case of accident the approximate position of the party should be known.

(*d*) Before it is so late as to endanger the freedom of your ship, you will proceed north of the pack and carry out magnetic observations with sounding and dredging over as many degrees of longitude (and as far south) as possible, so long as the season and your coal permit, and then return to your base station, whence you will telegraph your arrival and await further instructions.

The National Geographic Magazine for November, 1901, has the following note:

The *Antarctic*, carrying the Swedish south polar expedition, sailed from Gothenburg October 16. Prof. Otto Nordenskjold, the leader of the party, states that they will proceed to Buenos Ayres and Terra del Fuego and then push as far south as is found possible. When winter comes on a party of six under Nordenskjold will land and spend the winter making scientific observations. The *Antarctic* meanwhile will return to Terra del Fuego in charge of one of the scientists of the party, who will conduct researches in that little explored country. Thus, while the Germans are exploring the regions south of the Indian Ocean and the British that south of the Pacific Ocean, Dr. Nordenskjold and his party will be at work in the regions south of the Atlantic Ocean. Professor Ohlin and M. K. A. Anderson go as zoologists, Dr. Bodman as hydrographer, Dr. Skottoberg as botanist, and Dr. Ekolof as medical officer.

With these three well equipped expeditions in the antarctic regions and the numerous expeditions actively engaged in the far north,[1] we may reasonably hope that our knowledge of geography and meteorology will be materially advanced.—*H. H. K.*

ANSWERS TO CORRESPONDENTS: POPULAR QUERIES ABOUT RAIN, HAIL, WIND, AND FROST.

A correspondent from Northfield, Mass., writes as follows:

The following is a list of remarkable phenomena I have noted from successive readings of different weather periodicals. Some may interest you and some you may be able to explain.

1. Fifty nine voluntary observers in New York State reported snow every month last winter between October and May, and the following reported a total fall of more than 100 inches:

	Inches.
Adams	334.5
Watertown	184.3
Jamestown	161.0
Gabriels	142.0
Humphrey	135.2
Honnedaga Lake	128.4
Bouckville	118.2
Alden	108.5
Lowville	105.4
Keene Valley	103.5
Brockport	102.5

It is not remarkable that one storm, or a succession of storms, should give one or more stations more rainfall than others; but last winter was dry, with light snowfall, in the northeastern United States. Several mornings I noticed cirrus streaks radiating from a point beyond the western horizon. As the sun rose they burned off and the day became clear, and no more signs of the storms were observed; but the following daily papers always told of a great snowfall in some section in New York State, about the size of a county, several hundred miles west of here.

If local rainfalls in the lower Lake region are explicable by the proximity of large bodies of water, how are local snowfalls to be explained when this water is frozen over? Why do we not get local snowfalls of similar depths in the Northeast when our snow covering is equal to that of New York State?

2. What causes Amarillo, Tex., to have comparatively frequent terrific gales? Those from the westerly quarter are often 80 miles per hour. (April 4, 1901, 80 miles nw.) The papers never mention them, so presumably the inhabitants are acclimated; but how do the crops stand it?

3. Why does a northeast storm always give light precipitation at Nantucket and heavy at Block Island?

4. Why is the wind velocity and the total movement always less at Nashua, N. H., than at the other northeastern stations?

5. What is a "dry thunderstorm"? (Recent Washington Weather Bureau Bulletin).

6. Why is Marquette, Mich., a great snow center (as well as Rochester, N. Y.)?

7. Is not the limit of thunderstorm frequency the limit of the seabreeze?

8. But for the alleviation afforded by local climatic peculiarities, would not a hot wave in the Northeast be as destructive as in the West, being identical?

9. Is not a hailstorm a whirlwind in the clouds?

10. Is not a western whirlwind a cyclone in miniature?

11. Would a West Indian hurricane wind not badly damage the solidly built structures of the northern United States, apart from wave force? I understand that southern buildings are generally light and poorly constructed.

12. Are not Vermont blizzards as severe as those of Dakota, excepting that they are broken by mountains, while the population is not so scattered and liable to lose individual members?

13. How accurately can extreme wind pressure be measured by a Weather Bureau anemometer? If one mile of wind passed at the rate of — miles per hour, as in the Galveston hurricane, what should you call the extreme velocity?

14. It is reported that the temperature at Fort Kent, Me., was once measured at 60° below zero. Would not this prove the East liable to the same degree of cold as the West?

15. Is not the wind velocity during a northeast storm at Block Island occasionally as great as in a West Indian hurricane, and do not buildings escape damage only because they are erected beyond the reach of wave force?

16. Although thunderstorms run independently of river valleys, do not their cumulus portions choose such valleys whenever convenient?

17. Why is Grafton, N. H., the great frost center of the northeastern weather service?

18. Does not the snowfall at Jacksonville, Vt., and other places in the Appalachians compare favorably with that of the Pacific coast range?

19. Are not the droughts and the deluges of the East similar to those of the West, allowing that the droughts may be more local in the East and the cloudbursts less extensive in the West?

These queries are just such as may occur to many others and in replying to them an attempt will be made to give general explanations; we may, therefore, sometimes include several under the same heading.

1, 6, and 18. The Great Lakes do not entirely freeze over during the winter. Immense ice fields form near the shores and are carried back and forth by the wind, accumulating in great quantities on the windward shore, whichever that may chance to be. Whatever influence the lake water exerts upon rainfall in summer it may therefore exert upon snowfall in winter. In fact, an onshore wind in winter usually causes cloudiness over the land, since it has been warmed and dampened while passing over the water, only to become cooled, and in consequence have its moisture condensed when it reaches the land. The cloudiness in winter at stations on the east and south shores of the Great Lakes is proverbial, as also the number of days with snowfall. But the excessive snows referred to by our correspondent cannot be attributed to proximity to large bodies of water alone. The complete answer to this question would require an exhaustive treatise on precipitation. It is sufficient to say here that the topography of any given section, as also its position relative to the normal path of storm centers has much to do with the amount of snowfall. Local topography is often not so important as are general atmospheric conditions. In general, mountains are known to favor the formation of cloud and rain or snow because they force the winds to rise up as they pass over them, and it is rising air that cools to cloud and rain. This is the primary cause of heavy rain and snow up to certain altitudes in mountainous countries. A gently rising low shore line accomplishes the same end because winds blowing toward it from the water meet with greater resistance and turn upward as they surmount the sluggish air near the ground. Winds blowing parallel to the long axes of such lakes as Michigan, Erie, and Ontario acquire great velocity over the water surface and must pile up the air in great volumes at the leeward ends where the cloud and snow are observed. The rainfall in these localities can scarcely be called local rains, unless we

[1] See the National Geographic Magazine for May, 1901, which mentions eight arctic expeditions now in the far north, or planning for active work in that region.

give the term local a much greater extension than is ordinarily done. When southerly winds preceding a low pressure are underrun by cold northerly winds, the former air is elevated and snow or rain results. The presence of a lake may increase the precipitation, but is not the sole cause of it.

It is not correct to call the storms that occurred in New York during the winter of 1900–1901 *local;* they were general storms, but were much more severe in some sections than in others. New England has similar storms, but in general the total snowfall is greater in northern New York and Michigan than in States farther east. The precipitation on the mountains of the Pacific coast is heavier than in any other part of the United States, and in the elevated portion of this region the snowfall is heavier than on the Appalachian Mountains. This is as one would expect, since in the United States the prevailing winds are from the west, and therefore the Pacific coast mountains, besides being higher than the Appalachians, are more directly exposed to oceanic winds.

2. Texas is more or less under the influence of monsoon winds that blow from the continental cold regions of high barometric pressure, southward toward the Gulf in winter and from the Gulf toward the interior or continental low in summer. During the passage of special areas of marked high or low barometer these winds are greatly augmented, causing severe cold waves in winter and drying winds or droughts in summer.

The maximum wind velocity (80 miles per hour) reported from Amarillo in the April REVIEW appears to be correct, but such a velocity is very rare and the question is not based on facts.

3. The exposure of rain gages has much to do with the catch of rain. Unfortunately, it is not always possible to expose Weather Bureau gages in the best manner or the best locations. The annual catch of the gage at the Block Island station is greater than at the Nantucket station without any apparent cause, and it may be due to differences in exposure. In general, the distribution of rainfall and the catch of the gages vary with the wind quite independently of each other.

4. The exposure of anemometers, and particularly their height above ground has very much to do with their records of the wind. The instruments must also be kept well oiled and in perfect condition. The Weather Bureau has no anemometer at Nashua, N. H., and it is not known how reliable are the records that are obtained there. Professor Marvin has shown that gusty winds give higher records than steady winds of the same average velocity.

5. Frequently thunder will be heard from a heavy cumulus cloud, and there may be a strong wind blowing out from it, raising a great cloud of dust, and causing a marked fall in temperature, but without any rainfall. We thus have all the phenomena of the ordinary thunderstorm except the rainfall. Such storms may be called dry thunderstorms. The term has been employed by the Weather Bureau to signify that thunder has been heard or lightning seen at a station, but no rain has fallen there, although it may have fallen at a distance.

7. There does not appear to be any relation between thunderstorm frequency and the limit of the sea breeze. As is well known, thunderstorms are frequent and severe on our central plains.

8. The States east of the Mississippi are not subject to long-continued descending hot, dry foehn winds, such as sometimes sweep some of our western States. Furthermore, the greater humidity of the air on the Atlantic seaboard and the greater cloudiness by day cuts off a greater percentage of the direct solar radiation and prevents the soil and lower atmosphere of the Atlantic coast district from becoming so intensely hot. All these causes also retard evaporation from the earth. In consequence, even if the rainfall on the Atlantic coast were no greater than on the western plains, the coast would not suffer so much from drought.

9. Hail usually occurs with thunderstorms of marked severity, probably because the cumulo-nimbus clouds extend to unusual heights, where the temperature is below freezing. There is often a cyclonic circulation about a thunderstorm, and to this extent a hailstorm is a whirlwind in the clouds, but in many thunderstorms and hailstorms the air rolls over and over without a local whirlwind. A good description of hail clouds is given in the MONTHLY WEATHER REVIEW, Vol. XXII, p. 292.

10. By a "western whirlwind" the author probably means a tornado. This must not be confounded with a cyclone, since they are entirely distinct phenomena. It is not precise to say a tornado is a miniature cyclone or a miniature hurricane. The following are the definitions for hurricane, tornoda, and cyclone, as given by the Editor in the MONTHLY WEATHER REVIEW, Vol. XXI, p. 225:

A hurricane or "typhoon" is a large stormy area, often several hundred miles in diameter, within which violent winds circulate around a center. The center of a hurricane or "typhoon" is a comparatively calm region, where even the clouds break away and the rain ceases, whereas the center of a thunderstorm is the region of greatest intensity of wind, rain, or lightning. A tornado is a very much smaller region, usually less than 2 miles in diameter, within which even more violent winds prevail. In the typical tornado these violent winds circulate about a central axis, rapidly ascending at the same time and forming a funnel-shaped cloud whose base is at the average cloud level; but many destructive winds have been classed as tornadoes which are not circulating about such a funnel-shaped cloud or vertical axis, but which are either blowing straight ahead on the earth's surface, as in the "derecho" or straight line wind, or which have a quasi rotation around a horizontal axis, as in the blast that accompanies the front of a "norther" or the gust in front of the heavy rain of a thunderstorm. We shall endeavor, as far as possible, to separate the true tornado, which is rare, from the numerous destructive winds, squalls, and gusts which are popularly called tornadoes, hurricanes, cyclones, tourbillons, and other high-sounding names.

The term "whirlwind" is applied to any revolving mass of air, and includes at one extreme the hurricane and at the other extreme the dust whirl of our street corners.

A "cyclone" is a mass of air circulating around a center; the lower portion of the air near the earth's surface has a vorticose movement in toward a center, while the upper layers have a movement out from a center; the line joining the upper and lower centers is the axis of the cyclone; the direction of rotation is the same in both upper and lower layers. In the Northern Hemisphere this rotation is said to be in a negative direction, or opposite to the diurnal motion of the sun in azimuth, and opposite to the movement of the hands of a watch lying with its face uppermost.

The term cyclone includes the idea of an outflow overhead and a rotation in a specific direction.

11. While the best modern types of buildings of steel and stone would undoubtedly be able to stand in the face of such violent hurricanes, and even tornadoes, yet their windows and roofs would undoubtedly suffer, and then damage to the interior would follow. Gen. E. P. Alexander, of Georgetown, S. C., has written interestingly on this subject in the MONTHLY WEATHER REVIEW for May, 1896, Vol. XXIV, p. 153.

12 and 14. The terrific winter gales of the Dakotas, accompanied by stinging cold and blinding snow, have no counterpart in the East. Vermont experiences low temperatures, high winds, and heavy snows, but never the combination that is met with on the plains in the Northwest. It is difficult to state what the winds would be in Vermont "if they were not broken by mountains;" observations are wanting and queries would be useless.

The New England States do not experience such low temperatures as have been reported in Montana and Dakota. How can the report from Fort Kent be substantiated?

13. Various investigations have shown that in taking the average wind movement, as recorded by the Weather Bureau or small-size Robinson anemometer, the variations are averaged out, and that these variations are fully 33 per cent above and below the mean; that is to say, if a single mile of wind

is observed to blow at the rate of 72 miles per hour, there will be moments during the passage of the mile in question in which the velocity will probably be as high as 96 miles per hour and at other moments as low as 48 miles per hour. (See Professor Marvin's Bulletin on Anemometry, Circular D, Instrument Division).

15. The highest velocity ever recorded at Block Island is 84 miles per hour. At Hatteras, in 1899, 105 miles, and at Galveston, in 1900, 84 miles per hour were recorded before the instruments were blown down, but it is estimated that at Galveston the wind attained a velocity of at least 120 miles per hour.

The highest velocity actually recorded on self-registers in the United States, except at Mount Washington and Pikes Peak, is 138 miles per hour at Cape Lookout, N. C., August 18, 1879, just before the anemometer was blown away. The estimated velocity after the anemometer was blown down was 165 miles per hour. At Mount Washington 186 miles was observed with a heavier anemometer than we now use, and needing a large correction.

Our anemometers do not generally withstand the terrific force of West Indian hurricanes or of the true tornadoes, but this is not wholly due to the great horizontal speed of the wind; it is largely owing to such other matters as the following: (1) The rapid rotation sets up strains within the anemometer that tear it to pieces; (2) the horizontal wind alternates with violent up or down gusts that cause the revolving arms to lift the spindle up out of its socket; (3) the inertia and pressure of the wind against the hemispheres is often doubled by the impact of the raindrops carried along with the wind; (4) the cup and arms become clogged with snow or frost formations, and thus offer a much greater resistance than the instrument was intended to bear; (5) the debris of buildings and trees carried along by hurricane winds tear the anemometer from its supports.

16. Observations do not generally show that thunderstorms follow valleys. We would hardly expect them to do so when we remember that the base of a thunderstorm cloud is about half a mile above the surface and its summit from 2 to 6 miles above. The thunderstorm cloud may start in a valley, but soon outgrows the influence of small local features. The study of thunderstorms requires a thick network of stations and large topographic maps. It would be well if such study could be carried out in greater detail for specific small areas of 10 or 20 miles in diameter.

17. Grafton, N. H., has an elevation of over 300 feet, which is considerably above the valleys of the Merrimac and the Connecticut rivers, between which it lies. Its altitude is, therefore, conducive to frosts, since the rate of radiation of heat from the earth at night increases with the elevation. Hills and mountains are not so liable to frosts as lowlands at their immediate foot, since the cold air gravitates down the sides of the former to the valleys below, thus causing early frosts in the valleys. Does not the Grafton station receive such cold air drainage from neighboring higher land? There must be many similar frosty spots in New Hampshire and Vermont, not provided with voluntary observers, therefore we doubt whether Grafton really is a "great frost center."

19. The average rainfall diminishes rapidly as we go west from the Mississippi, but so-called cloudbursts occur in all sections alike, the most intense being among the mountains of the far west. The Gulf coast is liable to excessive rainfalls, and so are all the States east of the Rocks Mountains, but principally during thunderstorms or hurricanes. For a full discussion of this subject, see Weather Bureau Bulletin D, p. 52.

For a more complete discussion of these various subjects, the reader is referred to the special publications of the Weather Bureau, a list of which is given in the MONTHLY WEATHER REVIEW for May, 1901, p. 216.—*H. H. K.*

WEATHER BUREAU MEN AS INSTRUCTORS.

Mr. H. W. Richardson, Local Forecast Official, Duluth, Minn., has arranged to deliver a course of lectures before the West Superior (Wisconsin) Normal School during the present school year.

The first of the series was given in the Weather Bureau office at Duluth before the class in physiography, and such subjects as instruments and observations, the weather elements, the general movements of highs and lows, and weather maps and weather forecasting were very briefly considered.

On September 24 the second lecture of the series was delivered at the Assembly Hall of the school before the faculty and students to the number of about 300, the subject being the United States Weather Bureau.

Mr. J. Warren Smith, Section Director, Columbus, Ohio, lectured upon "Weather" before the seventh grade teachers' association of that city on September 28. This lecture was to be followed by two others, on October 1 and 3, respectively, before this same association of teachers, who now have meteorology included among the subjects they are to teach.—*H H. K.*

CORRIGENDA.

MONTHLY WEATHER REVIEW for July, 1901, p. 299, line 10, for "Ammerschweid" read "Ammerschweier." In the table on same page, line 1, under barometer (corrected) for "756.5" read "759.0." In the same column, opposite 9.05 a. m., insert "746.5."

Under "Remarks," opposite 11.23½ a. m., insert "We approach the cumulus turrets that rise from the cloud sea much higher than the balloon."

MONTHLY WEATHER REVIEW for July, 1901, p, 317, column 1, line 12, dele "Wis." Back cover, table of contents, column 2, line 11, dele "Wis."

MONTHLY WEATHER REVIEW for August, 1901, page 354, column 1, line 18, for "mentioning" read "maintaining."

THE WEATHER OF THE MONTH.

By ALFRED J. HENRY, Professor of Meteorology.

CHARACTERISTICS OF THE WEATHER FOR SEPTEMBER.

The rainfall of September was heavier than it has been in any September during the last ten years. In other respects the weather was not greatly different from the normal for the season. There were no destructive storms of a general nature and few severe local storms.

In the South Atlantic States, away from the coast, the rains were unusually heavy as in the preceding month, and in the middle Missouri and middle Mississippi there was a second area of heavy rains, culminating in eastern South Dakota with a fall of about four inches above the seasonal average. The rain on the middle and south Pacific coasts was also in excess of the seasonal average.