where it finally disappeared. Some persons are accustomed to estimate angles so that they can give this data directly, others know the names of the stars and constellations and can describe several points in the meteor's path by mentioning the neighboring stars, but in this case the exact time of day must also be given. Occasionally a bright meteor will cast the shadows of buildings and trees on the ground or of window sashes on the floor or of the observer himself, and by marking at once the location of such shadows and by measuring subsequently the observer may determine the altitudes and azimuths of several points in the path of the meteor. These angular measurements give us the apparent altitude and azimuth of a portion of the path of the meteor, and are the data of most importance. When several observers at different stations report such measurements as these, they are easily combined together and give us a fair determination of the true altitude and motion of the meteor.

If the meteor is a very bright one, the observer is almost certain to hear a noise—it may be a very loud one—within a few minutes after the meteor disappears, but not, strictly speaking, at the time of the meteor, as some observers mistakenly imagine. It is therefore best for the observer to hold his watch before him as soon as the meteor appears and record the minutes and seconds of its appearance; then wait a few minutes until the sound is heard, when the minutes should be again recorded. If the watch has no second hand, the observer has but to look sharp at its face, and he will see that he can subdivide the spaces between the minute dots into small fractions and can record the minutes and fractions of minutes, which will be almost as good as the seconds themselves. With very little practise, one may accustom one's self to making the records in minutes and tenths of minutes in the ordinary decimal style.

Photographs of meteor tracks, showing also the stars in their proper relations, are made at Yale College Observatory during the important showers of meteors. Those who desire to do similar work should consult the director, Professor Elkins, as to the apparatus and methods.

As meteors become luminous at 50 to 150 miles above the earth's surface, where the gaseous pressure is inappreciable, it is plausible that the heat is produced by the collision of the meteor with minute particles of matter that attend the earth in its annual course and correspond to the upper atmosphere, whose existence is made plausible by the recent studies of Prof. R. S. Woodward. From these particles we may receive the reflected sunlight that is observed as the zodiacal light.—*C. A.*

THE SOUTH POLAR EXPEDITIONS.

We quote the following from an article published in the National Geographic Magazine for October, 1901, by Dr. Georg Kollm, Editor and Secretary of the Geographical Society of Berlin:

The object of the German Antarctic Expedition is the scientific exploration of the south polar regions, particularly on its Indo-Atlantic side.

In pursuance of this object, it left Germany on the 11th of August, 1901, and is proceeding to Three Island Harbor, Royal Sound, in the Kerguelen Islands, where a base station will be established. In December, 1901, it is expected that the expedition will be ready for its real work of exploration and will push on toward the south as far as practicable. Should land be reached, a station will be founded and maintained for a year and the ship wintered there. Whether any later attempt to push still farther south will be made is not yet determined. It will not, at all events, be undertaken unless the conditions should prove particularly favorable.

The expedition has general orders to remain until its tasks are satisfactorily executed, but in any case not to remain beyond June, 1904, at which date it must report at some harbor in communication with home. Should no news be received of the expedition by the first of June of that year, it will be in order to consider the expediency of fitting out a relief ship.

The leader of the expedition, Dr. Erich von Drygalski, of Berlin, was appointed by His Majesty the Emperor, and has thoroughly studied the problems of the south polar regions. He has been placed in absolute control of the south polar ship *Gauss*, its personnel and equipment. All the arrangements for the work to be carried on from the time the ship left Germany are under his direction and subject entirely to his control. Marine laws regulate the position of the ship's company toward its leader.

The expedition is an undertaking of the German Empire and is fitted out through the Secretary of State for the Interior, Herr Dr. Graf von Posadowsky-Wehner. It sails under the Imperial Service flag, and its officers and men bear special service designations authorized from the highest quarters. It is thoroughly well equipped, both scientifically and practically, for its mission. In addition to the funds provided by the Empire, about 40,000 marks ($10,000) in small amounts have been contributed by private societies. The interest aroused in the expedition throughout the Empire has been very great, and has led to the presentation of many gifts and offerings which will add much to the efficiency of the equipment.

* * * * * * *

The scientific members of the expedition are Prof. Dr. E. Vanhoffen, Kiel, for zoology and botany; Dr. H. Gazert, Munich, physician and bacteriologist; Dr. E. Philippi, Breslau, for geology and chemistry; Dr. F. Bidlingmaier, Lauffen, for terrestrial magnetism and meteorology.

* * * * * * *

The personnel selected for the Kerguelen station consists of Dr. E. Werth, from Munster, as biologist; Dr. K. Luyken, from Munich, as meteorologist, and two seamen.

The Kerguelen station is chiefly intended for magnetic and meteorological observations, which, as well as similar work conducted by the German chief expedition, will be carried on in accordance with the international program agreed on with England. This program has been sent to all States having magnetic-meteorological stations, as well as to the stations themselves, with the request for cooperation. Many have already signified their readiness to do so. It will also be followed at the station established by the Argentine Republic on Staten Island. Cooperation in all other sciences with the English expedition and all other expeditions to be sent out by other States has been regulated in the best manner by the division into departments of work.

Mention has already been made of the kite work that will be undertaken by this expedition.[1]

On August 6, 1901, the *Discovery* sailed from Cowes carrying the British National Antarctic Expedition under command of Com. Robert F. Scott, R. N., with Dr. George Murray as scientific director.

The proposed work of the party has been carefully outlined by the presidents of the Royal Society and of the Royal Geographical Society, and we quote from sections 1, 2, 10, 11, and 19 of their instructions to the commander of the expedition.

1.—The Royal Society and the Royal Geographical Society, with the assistance of His Majesty's Government, have fitted out an expedition for scientific discovery and exploration in the antarctic regions, and have entrusted you with the command.

2.—The objects of the expedition are: (*a*) To determine, as far as possible, the nature, condition, and extent of that portion of the south polar lands which is included in the scope of your expedition, and (*b*) to make a magnetic survey in the southern regions to the south of the fortieth parallel, and to carry on meteorological, oceanographic, geological, biological, and physical investigations and researches. Neither of these objects is to be sacrificed to the other.

10.—You will see that the meteorological observations are regularly taken every two hours, and, also, in accordance with a suggestion from the Berlin committee, every day at Greenwich noon. It is very desirable that there should, if possible, be a series of meteorolcgical observations to the south of the seventy-fourth parallel.

11.—As regards magnetic work and meteorological observations generally, you will follow the program arranged between the German and British committees, with the terms of which you are acquainted.

19.—If, on the other hand, you should decide not to winter, you will bear in mind that it is most important to maintain scientific observations on land throughout the winter, and therefore, if you are able, in consultation with the director, to find a suitable place for a landing party between Cape Johnson and Cape Crozier, and decide that such a party can be landed and left without undue risk, the following instructions will apply:

(*a*) You will land a party under the command of such person as you may appoint. Such party shall include the director, the physicist, and one of the surgeons, and such other persons as you may consider desirable, but no person is to be left without his consent in writing, which you will be careful to obtain and preserve.

(*b*) You will give every practicable assistance in establishing on land this party, which you will supply with all available requisites, in-

[1] See MONTHLY WEATHER REVIEW for April, 1901, p. 177.

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.