

# THE DANISH METEOROLOGICAL SERVICE IN GREENLAND

By HELGE PETERSEN

*Director of the Danish Meteorological Institute*

SINCE the establishment of the Danish Meteorological Institute in 1872 a regular meteorological service has been maintained in Greenland, and from 1873 on climatic data from Greenland have to an ever increasing extent been published in the Institute's Yearbooks.

## *Location of Stations*

During the first twenty years, Greenland Meteorological stations were all situated on the west coast. This was due to the fact that navigation of the east coast during the greater part of the year is practically impossible on account of the masses of ice, the so-called *Storis* ("big ice"), accumulating in the sea outside. Angmagssalik, the first settlement on the east coast, was established in 1894. Regular meteorological observations are dependant on a fixed population; as the east coast, in contrast to the west coast, has a very sparse population, the establishment of meteorological stations there has only been made possible gradually as settlements (Angmagssalik and Scoresbysund) came into existence. When, owing to the development of the meteorological service, additional observations became important, settlements were established for the sole purpose of providing meteorological observations. These are the east coast stations shown on Fig. 1. In the early days observations were undertaken by the local Danish officials; subsequently it proved possible to let the natives, as they began to participate in the administration of Greenland, take part in this work too.

In considering the extent of the network of meteorological stations and their location, it should be borne in mind that in so sparsely populated a country it is not always possible to locate stations where the meteorologists would like them. The first step is to find places with a settled population sufficiently large to ensure that observations are taken regularly. The location of a station is thus primarily contingent on there being favourable conditions for habitation. This may lead to observations, in particular of such elements as temperature and wind, being unrepresentative of a large area. For example, these elements are very frequently different at the mouth and at the inner end of the numerous long fiords. A very dense network of stations in Greenland will, therefore, only be of interest as providing details of the local climate.

The number of climatic stations in Greenland was:

- 1873: 4 (on the west coast).
- 1900: 9 (one of which was on the east coast).
- 1925: 12 (two of which were on the east coast).
- 1939: 16 (two of which were on the east coast).

Observations from climatic stations in Greenland are published in Annual Reports of the Danish Meteorological Institute, (Part 11). Comprehensive climate descriptions are to be found in the work: *Greenland*, published by the Commission for the Direction of the Geological and Geographical Investigations of Greenland. Vol. I 1928. (C. A. Reitzel, Copenhagen, and Humphrey Milford, London), and in: W. Köppen und R. Geiger: *Handbuch der Klimatologie*, Bd. II, Teil K. 1935 (Gebrüder Borntraeger, Berlin).—Special Climatic reports are to be found in the series: *Meddelelser om Grönland*, (C. A. Reitzel, Kobenhavn).

In addition to these long periods of observations, which in the case of some stations are for 75 years, a great number of earlier observations have been taken since the end of the eighteenth century, but only for short periods of a few years.

#### *Terrestrial Magnetism*

Greenland is of special interest on account of its favourable position for the investigation of earth magnetism. Because of this a permanent magnetic observatory with complete recording equipment was established in 1926 at Godhavn on Disko Island off the station of Jakobshavn. Since its establishment the Observatory has been operated without interruption. Observations are published in the Danish Meteorological Institute's Magnetic Yearbook for Godhavn.

#### *Radio Transmission Begins*

The establishment of radio stations in Greenland for the purpose of communicating with Denmark, made it possible to send meteorological data for use in the synoptic service. Special transmitting stations were therefore established in 1926 and 1927 at *Godhavn*, *Godthaab*, and *Julianehaab* on the west coast and at *Angmagssalik* and *Scoresbysund* on the east coast.

This service did not work very satisfactorily because of unfavourable conditions. The southern tip of Greenland is situated in the area with the greatest frequency of aurora borealis, and because of this radio connection with Denmark was very often rendered ineffective, and this caused a delay in reception of the messages. Apart from this, communication at that time was a long way from the degree of perfection which it has since attained. Finally the synoptic service in those days was not as important as it is today, so the demand for Greenland observations was then, though fully justified, less widespread.

The enormous development of air traffic has however altered the picture out of all recognition. During the war Denmark was prevented from taking any steps in Greenland to keep up with this development. But since the end



*Above:* Interior of terrestrial magnetism observatory, Godhavn, Disko, Greenland.



*Above:* Danish meteorological station, Thule, Greenland, with Thule Fjeld in the background.



*Left:* Release of radiosonde instrument at Thule, Greenland.

*Photos: Danish Meteorological Institute.*

of the war Denmark has undertaken the task of providing meteorological observations from Greenland to the extent deemed necessary.

### *Distribution of Synoptic Stations*

The earliest synoptic stations in Greenland, established in 1926, were not at first run in connection with the existing climatic stations. For practical purposes it was found better that the personnel of the radio station, who were to transmit the reports, should also act as observers. This practice of keeping the synoptic and the climatic stations apart has been followed ever since.

It would be extremely difficult to state exactly how many synoptic stations there should be in Greenland to provide adequate coverage. If Greenland, was to have the same density of stations, in proportion to its area, as countries in lower latitudes, the number of stations would admittedly be very high. However, this would not be practicable for the very reason that only a narrow coastal strip is habitable. To establish a permanent station on the inland ice is a hazardous enterprise which would not be justified, however interesting it might be from a scientific point of view.

Therefore, at least for the present, we are only concerned with stations in the coastal districts which are indented by many long fiords. The stations which broadcast internationally are shown on Fig. 1. It is noticeable that there are far more stations on the west coast than on the east coast. This is for reasons already mentioned, that the west coast is more easily accessible than the east coast, coupled with the fact that climatic conditions make the west coast more fit for human habitation. It has been possible to establish stations on the west coast in places already inhabited, whereas several stations on the east coast have no other inhabitants than those who run the meteorological station. It goes without saying that it is extremely difficult to run a station under such conditions.

### *Influence of Local Conditions*

An outstanding feature of Greenland stations is that at practically all of them the meteorological conditions are greatly influenced by local factors. Nothing can be done to alter this state of affairs, it being due to topographical conditions, but it is important that this be emphasized to enable a reliable estimate of the value of the observations.

The observations most influenced by local conditions are those of the wind, which both as regards direction and force may differ greatly from the conditions met with over the sea off the coast. The station may for instance be sheltered so that the indicated wind force is too low or the station may be exposed to a strong local wind which may not reach the sea. Stations situated on a long fiord experience as a rule only winds blowing

in and out of the fiord; the direction of the wind may, therefore, often deviate radically from the direction of the wind indicated by pressure conditions.

With regard to observations of temperature it should be remarked that foehn winds occur comparatively frequently in Greenland; these winds may give rise to so rapid local variations in the temperature (up to  $20^{\circ}\text{C}$  in the course of 24 hours) that the observations are entirely devoid of any synoptic significance. Only pressure observations may be assumed to be entirely unaffected by local conditions and must consequently be regarded as the observations which can most reliably be fitted into the synoptic network of stations. These conditions typical of the Greenland stations have been more elaborately dealt with in Köppen und Geiger's *Handbuch der Klimatologie* mentioned above. However, it is intended whenever practicable, to move stations which are most strongly influenced by unfavourable conditions to nearby places, where the meteorological observations may be expected to be more representative of the conditions in the free atmosphere.

The meteorological data comprise of course primarily the normal surface observations, atmospheric pressure, temperature, etc., which are taken eight times in every 24 hours at the hours recommended internationally. To these are added upper air observations, viz., Pibal observations at most stations and radiosonde observations at some stations, a few of which also take rawin observations. When all the stations have seen establishment, it is planned to operate six radiosonde stations in all; these are to be distributed along the entire coast line from Thule in the north-west to Danmarkshavn in north-east. This service is, however, confronted with the difficulty common to arctic stations, of providing hydrogen for the balloons. It is intended to limit the number of ascents to two in every 24 hours, but even with this restriction the consumption of hydrogen will be



Map from Danish Meteorological Institute.

Fig. 1—Distribution of Danish meteorological stations in Greenland, December, 1947.

so large that it appears to be most practical to manufacture the hydrogen at each station.

All existing plants for the manufacture of hydrogen contain water and require absolutely frost-free conditions. If freezing occurs in the course of the winter, it will make continuance of the upper air service difficult. But it is hardly possible to ensure absolutely frost-free conditions in Greenland without unreasonably extensive measures being taken. Consequently the task of providing upper air observations there as regularly as from stations in lower latitudes is at present extremely difficult, and it is to be expected that it will take some time to find a really practical solution of all the problems involved.

#### *Difficulties of Radio Transmission*

When in 1926 Denmark commenced transmitting synoptic messages from Greenland to meteorological institutes all over the world, it was hailed as a great step forward. But the difficulties of transmission over such large distances as from Greenland to Denmark were then so great that the messages were often received too late to be used for forecasting. The cause of the difficulty is not only the long distances, as has been mentioned, there is the fact that the south point of Greenland is situated exactly in the area with the greatest frequency of auroras with the attendant magnetic disturbances. This gives rise to frequent irregularities in transmission. In periods of sunspot maximum, even though the most modern technical equipment is used, the connection may be broken off completely and not be re-established until conditions in the ionosphere have again calmed down. To ensure that such interruptions do not occur, it will be necessary to have available long, as well as short wave lengths for transmission.

Finally, experience since 1926 both with the service in Greenland and from radio communication with ships operating in Greenland waters has shown that Greenland itself exerts a great influence on transmission conditions, and this has to be taken into account when the transmission system is being set up.

In the planning and developing of the radio system Denmark has been able to exploit fully the experience accumulated in the course of the preceding twenty years. Owing to the difficulties at present prevailing everywhere with regard to securing technical equipment of every description, it will take some time before the task is completed, but it is now possible under favourable conditions to get 90-100 per cent of the observations to Denmark in time.

Greenland observations are broadcast internationally, primarily in "Meteo Danois" which is broadcast 8 times every 24 hours (for further

details see international circulars). In order to ensure that the Greenland messages, which are of very great importance to Atlantic air traffic, are received by the terminal airports without delay, on being received at Copenhagen they are immediately sent by cable to B.A.F.O. in Frankfurt a.M. and are thus fed into the international meteorological communication system.

#### *Plans for a Complete Network of Stations*

During several centuries Denmark has acquired great experience both in navigating Greenland waters under difficult conditions and in providing the best possible living conditions for people living under the often extremely unfavourable climatic conditions found in Greenland. It may, therefore, be assumed that Denmark will be capable of maintaining in Greenland a network of synoptic stations of as permanent a character as is at all possible. Because of the abnormal conditions prevailing all over the world at present it must necessarily be some time before the system is fully established and can operate with complete efficiency.

*Below:* United States Air Force airport Bluie West One, Narsarssuak, Greenland. This wartime ferrying airport lies at the inner end of Tunugdliarfik Fjord, southwestern Greenland. Nearby are ruins of Norse settlements. The ice cap lies beyond the mountains in the background of the photograph.

*Photo: United States Air Force.*

