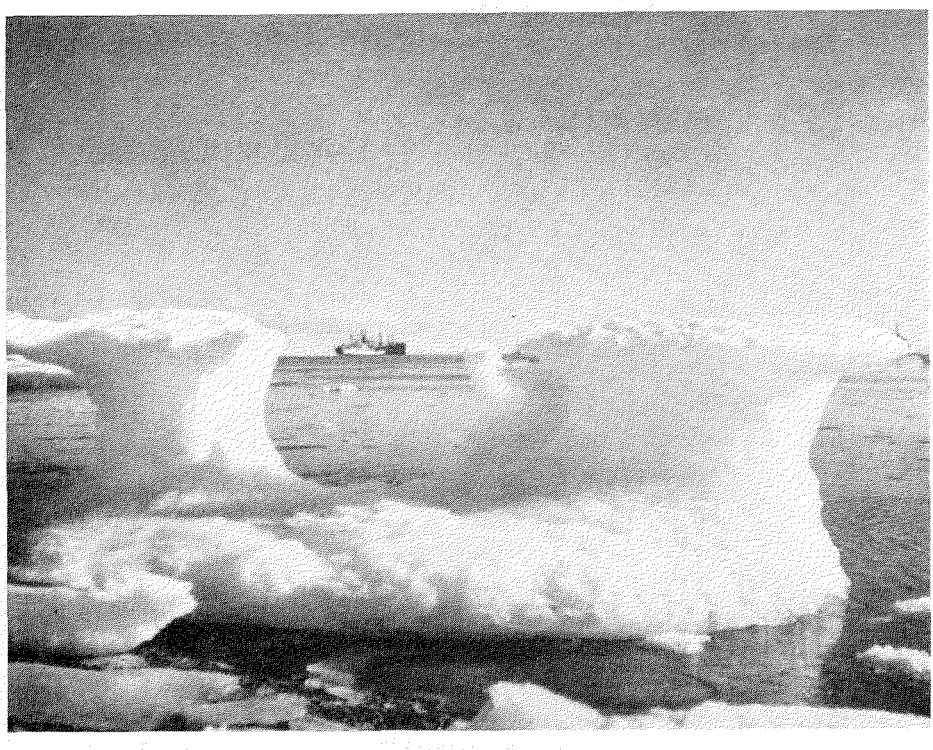

The U.S.S. *Wyandot* in Resolute Bay, August 1948.

JOINT ARCTIC WEATHER PROJECT

By R. W. Rae*

SINCE Christmas Eve in 1839, when Lieut. C. J. B. Riddell of the Royal Artillery inaugurated a systematic program of meteorological and magnetic observations at old Fort York in Toronto, the Meteorological Division of Canada has grown steadily in importance in providing service to the people of Canada. The science of weather forecasting, although not infallible as yet by any means, has improved considerably since the first storm warning was issued from the Toronto office in 1876. The improvement in the accuracy of daily weather forecasts is due not only to advances in meteorological theory but also to a vast increase in coverage provided by weather observing stations.

The most important periods of growth of the Meteorological Division occurred during the following years: In the 1880's, when telegraphic reporting stations were opened up across the western provinces concurrently with the westward extension of the Canadian Pacific Railway;

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in the 1920's, when advances in the technique of radio transmission made it possible to install radio reporting stations along the Mackenzie River and in the Hudson Bay and Strait area; and during the years 1947-50, when radio reporting stations were established on some of the remote islands of the Arctic Archipelago.

For many years the region covered by Canada's Arctic Islands appeared on weather maps as a large blank area. The need for weather reports from this blind spot was recognized but the difficulty and expense involved in the establishment and maintenance of communities in these inaccessible regions were prohibitive.

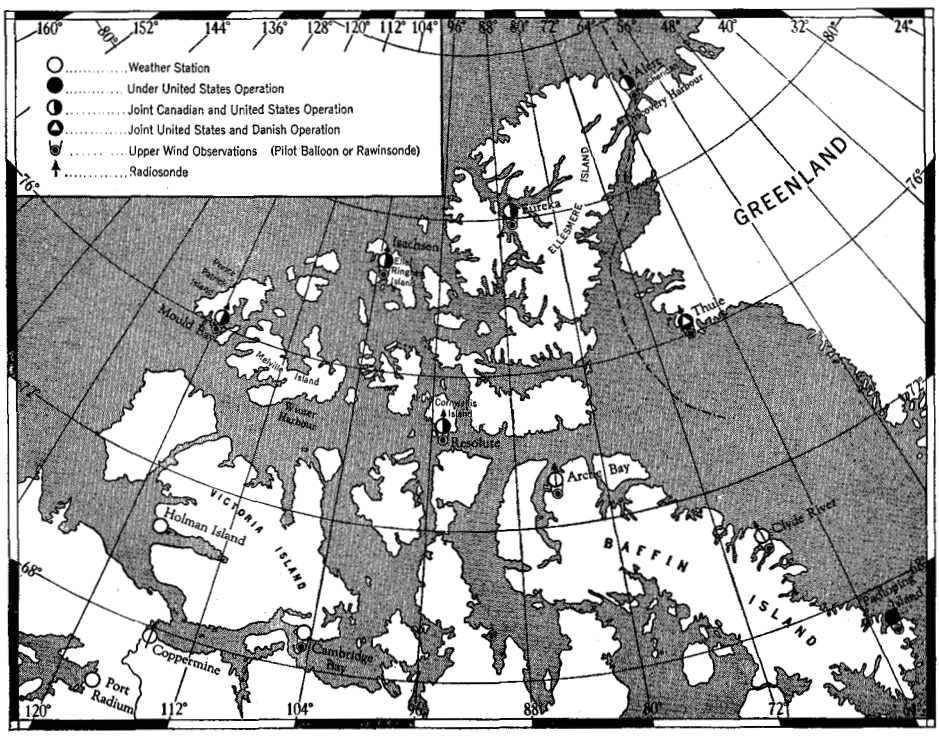
The Second World War aroused renewed interest in the Arctic, and shortly after the termination of hostilities Canada and the United States formulated a plan whereby a number of weather stations at approximately 500-mile intervals across the Arctic Archipelago would be established and operated jointly by the two countries. It is interesting to note that this cooperation between the Canadian Meteorological Service and the United States Weather Bureau for obtaining weather reports from the Canadian North had an early precedent. In 1882, the Chief Signal Officer in Washington wrote to the Director of the Canadian Meteorological Service offering United States assistance in paying the salaries of observers at Fort Chipewyan and Prince Albert. The financial assistance of the United States was not required in this instance for the observer's allowance at Fort Chipewyan was a modest $60 per annum. However, the expense of the present arctic project is so great that it could not be carried out by the Meteorological Division unassisted.

The over-all plan called for the establishment of a central control station with a number of smaller satellite stations which would transmit their reports to the control station for relay to the mainland. It was intended that the main base would be located at Winter Harbour on Melville Island and on 16 July 1947, the U.S.S. *Wyandot*, accompanied by the icebreaker U.S.S. *Edisto*, sailed from Boston for this destination.

Ice conditions in the Western Arctic proved to be much more severe than had been anticipated, and in spite of repeated attempts during August, the icebreaker was unable to force her way through to Winter Harbour. Previous reconnaissance had indicated a suitable alternative site at Resolute Bay on the south shore of Cornwallis Island. This spot is very close to the geographical centre of the Canadian Arctic Islands and was considered to have some advantage over the Winter Harbour location from the standpoint of accessibility by sea and nearness to a suitable airstrip site. Consequently it was agreed that it would be preferable to establish the station at Resolute Bay rather than to postpone the project for a year. This proved to be a wise decision as in 1948 another icebreaker, the

U.S.C.G.C. *Eastwind*, was unable to reach Winter Harbour.

It was especially important that the main station be located near a possible airstrip since it was intended that it serve as an advance base for the establishment and re-supply of the smaller stations by air. The procedure which was adopted for the establishment of these stations requires a considerable amount of skill and courage on the part of the aircrews, since a large proportion of the landings and take-offs must be made on airstrips which have had little or no preparation. The operations are



Weather reporting stations, April 1951.

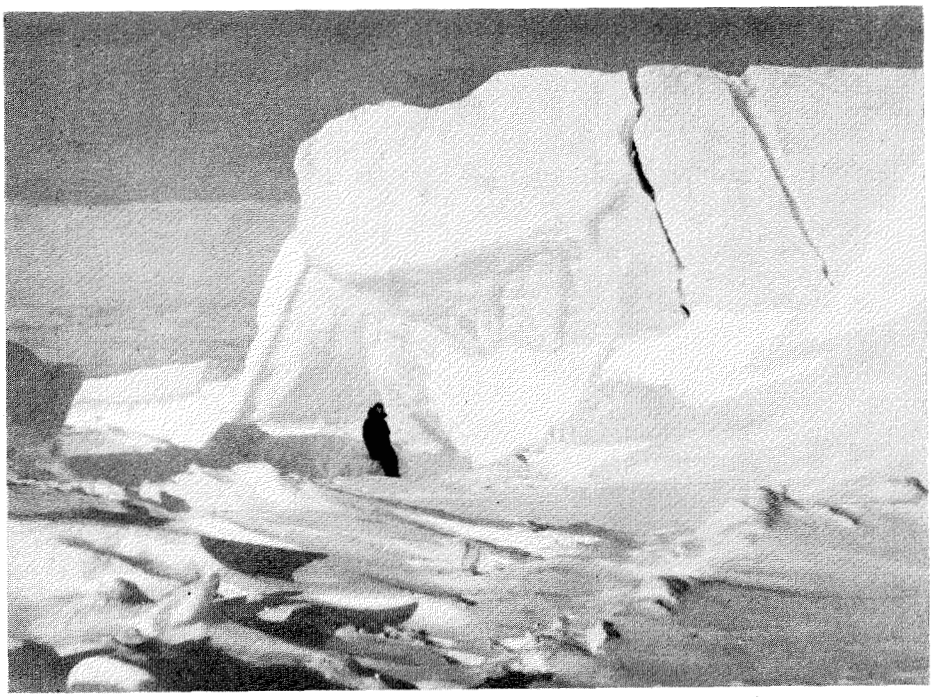
made possible only by the extensive ice areas in the Arctic, which present a relatively smooth landing surface except for shallow snow drifts.

The region where a new station is to be located is thoroughly surveyed by low-level reconnaissance flights to pick out possible landing areas on the ice. When a likely place has been found an initial landing is made with ski-equipped aircraft and a ground party checks the location to ensure that it meets all requirements such as satisfactory exposure for meteorological instruments and nearness to a supply of fresh water.

If the site is approved, ski-equipped aircraft fly in a small amount of airborne grading equipment to break up and level out the larger snowdrifts in the landing area. As soon as this has been completed, large transport

feet of ice every few days. This was accomplished by a method which is not used anywhere else as far as we know.

In the fall when the ice was between one and two feet thick, a 9-foot length of 3-inch pipe was frozen into the ice with its top end just above the surface. Then a 3-foot extension was screwed to the top. This 3-foot length provided sufficient pressure head that when aviation gasoline was poured in, the gasoline forced the water completely out of the pipe. Instead of a pipe full of water, there was now a pipe full of gasoline



Ice in Resolute Bay, off Martyr Point, March 1949.

embedded in the ice. When it was necessary to haul water, the extension was unscrewed and the water pressure from below forced the gasoline out of the pipe, which was then linked to the intake hose and pump. In below-zero weather the intake hose and pump were kept from freezing by means of a Herman-Nelson aircraft heater.

Maintenance of morale depends largely on the type of personnel at the station. Great care must be exercised in screening applicants for these posts since one unsuitable individual can disrupt the harmony of the entire station. In addition to having a thorough technical knowledge of the work, personnel for isolated arctic duty should be cheerful and considerate, willing to cooperate with others, and prepared to keep living and working quarters clean and tidy.

aircraft on wheels provide a continuous shuttle service to ferry in the men and supplies.

These operations are usually carried out in April since flying conditions in the Arctic are excellent during this month, with winds light and skies mostly clear. Moreover, the thickness of both bay and lake ice in the spring is sufficient to support the weight of the largest aircraft. An additional advantage is that operations can be carried out around the clock since there is continuous daylight or twilight.

The major part of the arctic program has now been completed with the establishment of the following five stations:

Eureka, Ellesmere Island (80°13N., 86°11W.), established in April 1947 by airlift from Thule, Greenland.

Resolute, Cornwallis Island (74°41N., 94°55W.), established in September 1947 by sea transport.

Isachsen, Ellef Ringnes Island (78°47N., 103°32W.), established in April 1948 by airlift from Resolute.

Mould Bay, Prince Patrick Island (76°14N., 119°50W.), established in April 1948 by airlift from Resolute.

Alert, Ellesmere Island (82°29N., 62°15W.), established in April 1950 by airlift from Thule, Greenland.

Establishment of Alert

Alert, the newest of the joint arctic weather stations is situated on northern Ellesmere Island, near the most northerly point of land in North America. The choice of the name "Alert" for the weather station was a fitting one for it serves as a reminder of the expedition which made the greatest contribution towards an accurate survey of this coast.

In 1875, a British expedition consisting of two ships, the *Alert* and the *Discovery*, under the command of Captain (later Admiral Sir) George Nares, wintered on the north coast of Ellesmere Island. The *Discovery* made her winter quarters at Discovery Harbour (81°44N., 65°03W.) where Greely later established Fort Conger. The *Alert* forced her way farther northward until difficult ice conditions brought her to a halt in latitude 82°24N., near Cape Sheridan. Numerous sledge trips were made from the ship during the winter to survey and map the north coast of Ellesmere Island and the northeast coast of Greenland. Several years later, Her Majesty's Government re-fitted the *Alert* to provide assistance in the rescue of the ill-fated Greely expedition. When she was no longer required for this purpose, she was handed over to the Dominion Government and was used in the years 1885 and 1886 on the Canadian Government expeditions to Hudson Bay and Strait.

The preliminary reconnaissance for a weather station site on the north coast of Ellesmere Island was carried out by icebreaker in the summer of 1948, and some supplies were left cached there such as fuel, emergency rations, temporary shelters, and a small tractor. However, the final phase of the establishment of the station was not undertaken until the spring of 1950. The initial landing was made on Easter Sunday and construction work was begun immediately. As soon as the tractor could be started, it was used to improve the landing area on the ice and the remainder of the supplies were ferried from Thule in a round-the-clock airlift.

It may be mentioned that Alert is now the most northerly post office in the world, a distinction that was previously held by Eureka. Mail delivery to the joint arctic stations is accomplished by air about every month or so on the average. Consequently, they are isolated only to the extent that they are far removed from settlements of any kind. Each station has an island to itself with the exception of Alert and Eureka which are both on Ellesmere Island. Today there are no Eskimo on the far northern islands though there is ample evidence of sizable Eskimo settlements in the past, especially along the shores of Barrow Strait and Lancaster Sound.

Special Arctic Problems

Many special problems are encountered in the operation of an isolated arctic station. The following three problems are among the most important:

Fire protection
Winter water supply
Morale.

Fire is a very real and serious hazard at an arctic station. This is especially true during the winter months when the low temperatures require heating units to be operated at, or near, their maximum output. Moreover, the cold winter air dries out the wood to such an extent that if a fire starts it is almost immediately out of control. For this reason the buildings should be spaced some distance apart so that if a fire occurs in one building it will not spread to the others.

In the Arctic the usual procedure for obtaining fresh water in winter is to melt snow or ice. However, it was found at Resolute that this method required so much time and heat that it was necessary to ration water during the first winter for such uses as washing clothes and bathing. An improved system was devised the second year which permitted fresh water to be hauled from a nearby lake all winter, even when the thickness of the lake ice had increased to eight feet. The main problem was to keep a water hole open and so avoid the necessity of chopping through several

Scientific Program

The scientific work at the joint arctic weather stations includes a very full program of meteorological observations, both surface and upper air. These observations are collected by radio at Resolute and transmitted to Edmonton where they are immediately put on the teletype circuits which feed meteorological information to the forecast offices in Canada and the United States. The arctic observations are also made available to European centres by means of radio-teletype from New York to Paris.

Many special scientific investigations are being carried out in addition to the regular observing program, not only by the station staff but by visiting scientists as well. For example, the following investigations were carried out by the staff at Resolute during the first two years of operation:

Measurements of the rate of accretion of sea ice.

Determination of temperature gradients in sea ice.

Observations of the temperature gradient in the lower layers of the atmosphere from ground level to a height of 75 feet.

Measurements of temperature gradients in soil and permafrost, and the depth of the active layer.

Determination of the tidal range.

Investigation of the relative merits of two types of prefabricated arctic buildings.

Winter test of special arctic clothing.

Observations of snow characteristics.

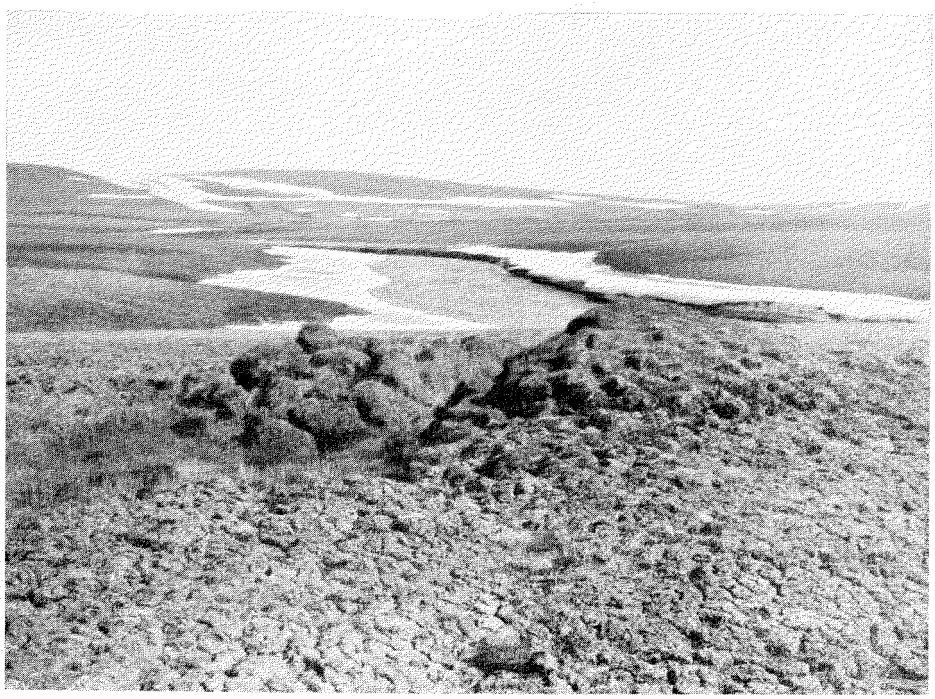
Climatic Notes

Average winter temperatures throughout the Arctic Islands are consistently low. For seven months of the year, from October to April, mean monthly temperatures are well below zero. From 11 November 1948 to 17 April 1949 the temperature at Eureka rose above zero on only three occasions. Some idea of the temperature difference between this region and the southern parts of Canada may be obtained from the fact that the mean annual temperature at Toronto, for example is 45°F, whereas the corresponding average temperature at Eureka is -3°F.

If we define winter as the period from the time that the snow first stays on the ground until the time that the ground is again snow-free, winter lasts from the beginning of September to the end of June in the Arctic Archipelago. This leaves only the months of July and August for spring, summer, and fall. During the brief summer period, the ice-filled polar waters, with a surface temperature near 30°F, prevent the air in contact with them from warming up to any great extent. Moreover, any incursion of warm air from the south is cooled rapidly in its lower layers by contact with the cold water. As a result, summer temperatures

are low and the extreme high may not reach 60°F in some years. Mean summer temperatures show little variation from year to year and the average temperature of the warmest month, July, is usually near 40°F.

Annual precipitation is generally under five inches which is less than that of the driest parts of the Prairie Provinces. Snowfall is relatively light in the winter since air temperatures are so low that the amount of precipitable water vapour is extremely small. In open country the snow on the ground is rarely over 12 inches deep and the ground is bare in



Near Resolute weather station, July 1949.

many spots. However, deep compact drifts are deposited around obstacles and in hollows. These drifts form rapidly during the storms of blowing snow which occur about every two or three weeks throughout the winter. The precipitation during July and August is chiefly in the form of light rain or drizzle, although snow may fall in any month.

The station which reports the lowest annual precipitation is Eureka with a mean total of 1.62 inches over a two-year period. In temperate zones an annual figure of this magnitude is found only in desert regions.

An indication of the temperature and precipitation regime over the northern Arctic Islands may be obtained from the following records taken at the joint arctic weather stations:

Monthly and annual mean temperatures and extreme temperatures (°F)

	Eureka	Isachsen	Mould Bay	Resolute
January	-37	-37	-32	-28
February	-41	-29	-31	-35
March	-31	-27	-20	-26
April	-20	-20	-11	-11
May	13	12	11	12
June	38	31	29	33
July	43	38	38	41
August	38	34	34	38
September	21	16	18	23
October	-3	-3	0	7
November	-20	-16	-17	-6
December	-41	-37	-28	-21
Year	-3	-3	-1	2
Highest	66	64	57	59
Lowest	-63	-55	-63	-55

Mean monthly rainfall and snowfall in inches and mean annual precipitation converted to inches of water

	Eureka		Isachsen		Mould Bay		Resolute	
	Rain	Snow	Rain	Snow	Rain	Snow	Rain	Snow
January	0	1.1	0	1.4	0	0.4	0	0.4
February	0	0.6	0	0.2	0	0.5	0	1.2
March	0	1.4	0	0.7	0	1.2	0	1.6
April	0	0.1	0	0.5	0	0.4	0	1.0
May	0	2.0	0	4.6	0	1.0	0	8.0
June	0.01	0.1	trace	2.0	0.06	2.5	0.56	2.0
July	0.27	0	0.49	0.7	1.04	0.2	1.10	0.7
August	0.23	0.6	0.47	0.3	0.25	1.6	0.62	1.7
September	0	2.8	0	7.7	trace	4.7	0.32	7.4
October	0	1.0	0	2.7	0	1.2	0.01	5.2
November	0	1.0	0	4.1	0	0.6	0	2.4
December	0	0.4	0	0.1	0	0.1	0	0.5
Year	1.62		3.46		2.79		5.82	

These far northern weather stations are undoubtedly expensive and difficult to maintain. However, they provide basic meteorological data from a hitherto unknown region which will permit research to be carried out on the large scale movements of the earth's atmosphere. An improved understanding of atmospheric processes will pave the way for improved forecasting techniques. The research cannot be done without the observational data and the data cannot be obtained without the stations.