

ELLESMERE ISLAND ICE SHELF METEOROLOGICAL PROGRAM*

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The purpose of this talk is to give a brief outline of the meteorological and micrometeorological work carried out during the summer of 1959 on the Ellesmere Island Ice Shelf. The emphasis throughout will be on the establishment and running of the stations, some of the problems involved, and suggestions for the program in 1960. No attempt will be made to discuss the results of the meteorological program in any detail.

The only other meteorological work done in the area was carried out in 1954 by the joint Canadian Defence Research Board - United States Expedition led by Dr. Hattersley-Smith. The members of the expedition carried out a program of synoptic observations at noon and midnight, and these figures are the only exact ones that we have on the weather of the area. In the spring of 1876, the coast was first explored by Lieutenant Aldrich and a crew from H. M. S. ALERT. Aldrich tramped round this coast, one thermometer on his chest and another on his back, and his observations, though scanty, are valuable. In 1906, Robert E. Peary sledged down this coast, cursing and swearing as he was caught in the summer melt. The 1959 program represents the first full study of the meteorological, micrometeorological and radiation factors in this area - the farthest north region of North America.

The initial landing was made by USAF C-130 on the ice rise north of Ward Hunt Island, 83°05' North. The first problem, as usual, was to know where to locate the meteorological station so that it would be typical of the area. The location of the station was in fact determined by the position of the grid of aluminum ablation stakes. This was set out north of Ward Hunt Island, covering a portion of the ice rise and the ice shelf. The main meteorological station was erected approximately in the center of this grid, on a slight, north-facing slope, which was in fact the northern edge of the ice rise, some three miles north of Ward Hunt Island. On May 23rd, the aluminum trailer which was to be used for accommodation was loaded with equipment, and towed out to the site. Work on setting up the station was begun; a thirty foot mast was erected for the thermocouples; the screen was put up, and various radiation instruments set out around the trailer.

A week was spent in setting up the station, and running in and checking out the instruments. The main station began operation at 0100 hours, EST on June 1st, and was operated by myself and Pfc Turnbull of the U. S. Army Quartermaster Research and Engineering Center. The observations comprised the following, at two hourly intervals: temperature in the screen by standard thermometer; relative humidity by psychron; wind and temperatures at four levels above the surface - 10 centimeters, 1 meter, 3 meters and 10 meters; sky cover and cloud type; surface

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wind direction; visibility and obstructions to visibility. Full synoptic observations were carried out at 0100, 0700, 1300 and 1900 hours EST, and comprised, in addition to the two-hourly observations, the six-hourly maximum and minimum temperatures in the screen, temperature by thermograph in the screen, relative humidity in the screen by hygograph, pressure by aneroid barometer and barograph, and six-hourly amounts of precipitation. A record was kept of the times of beginning and ending, and the forms of precipitation. Notes were made on such phenomena as fog bows (which were very common) and hoar frost accretion.

Radiation readings were also taken at the times of the synoptic observations. These consisted of incoming and outgoing short wave radiation measured by Eppley pyrhelimeter, net radiation flux and total hemisphere radiation measured by Beckman and Whitley radiometers. A continuous record was kept of incoming short wave radiation, and duration of sunshine was recorded.

The meteorological program at the main station continued for a hundred days, ending at 2300 hours on September 8th. There were some short interruptions in the records when the 10 centimeter anemometer drifted up, and the 10 meter anemometer froze up in early September, but the synoptic and micrometeorological record is fairly complete. The Beckman and Whitley radiometers could not be used when precipitation was falling. Later in the season, due to the low angle of the sun's rays, results from the Eppley and the radiometers were unsatisfactory.

Four ablation stakes were set in near the meteorological mast, and read each day at 0800 and 2000 hours. Although this method of measuring ablation and accumulation is of limited use, since it does not take density changes into account, the stakes gave some indication of the day-to-day ablation and accumulation at the station.

It was found to be almost impossible to measure the snowfall during the summer. Falls of snow were usually associated with blizzards and strong winds, the whole world becoming a white, blotted-out emptiness at times like these. Snow was driven horizontally over the rim of the rain and snow gauge, and packed when it settled on the surface. By measuring the accumulation at the stakes near the meteorological mast, by random sampling near the trailer, by taking careful note of when snowfalls began and ended, and by noting the intensity of the fall and the size of the flakes, it was possible to come to some approximate idea of the amount of snow that fell. At best, measurements of snowfall in conditions like those experienced during the summer of 1959 is a refined form of guesswork. Every attempt was made to get an accurate estimate of the snowfall during the season, but some of the difficulties involved are insuperable.

An instrument shelter was erected, and instruments installed, on the crest of one of the rolls of the ice shelf, approximately one mile north of the main meteorological station. Readings here were begun on the same day as those at the ice rise station, June 1st, and the station was visited at 0800 hours and 2000 hours every day until the melt began. Observations comprised the standard screen readings, a cumulative wind speed, and readings at two ablation stakes set in near the screen.

Daily readings at the ice shelf station ended at 2000 hours on July 8th, as by that time it was often necessary to wade waist deep in slush to reach the shelter.

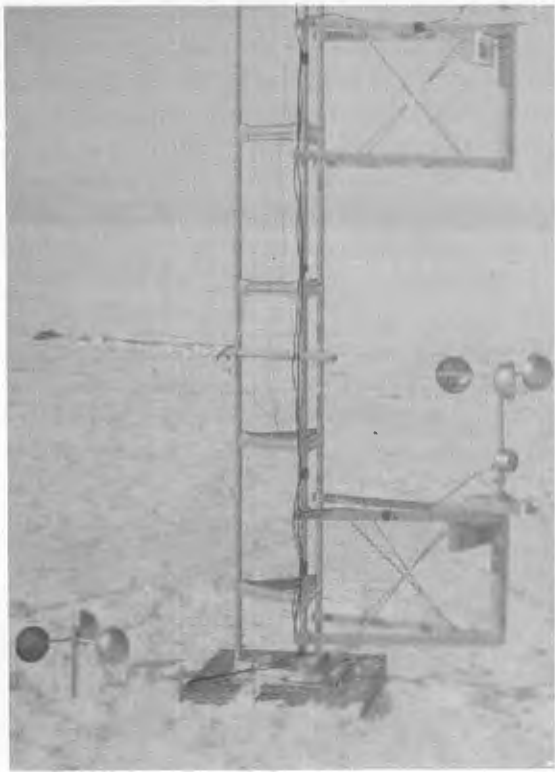


Fig. 1. Base of the micrometeorological mast, showing anemometers and shielded thermocouples.



Fig. 2. The meteorological trailer and micromet mast.

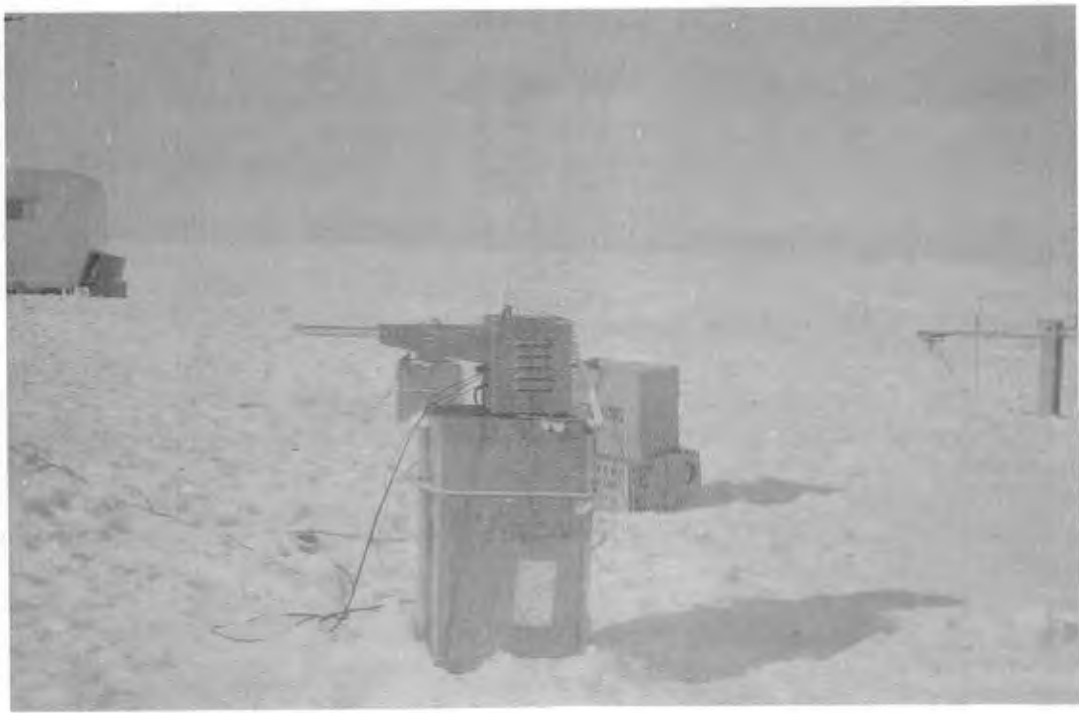


Fig. 3. The Beckman and Whitley radiometer. Met trailer in background.

After this date, the trough lakes were too dangerous to cross alone; readings were more irregular, and were usually taken when the weasel was available. An attempt was made to reach the station at least once a week to change the charts of the thermograph and the hygrograph, and to reset the maximum and minimum thermometers. The instruments at the ice shelf station were read for the last time at 1130 hours on September 7th, and then the station was dismantled. Preliminary indications are that the ice shelf is warmer during the melt period and colder during the freeze-up period than the rise; the paucity of data from the shelf station prevents further generalization at this stage.

On the whole, the meteorological equipment behaved very well during the summer. Twenty- and thirty-gauge thermocouple wire was used to read temperatures on the mast. A combination of high winds and heavy hoar frost sometimes proved too much for this thin wire, and it broke at times. The minimum gauge advisable for thermocouple wire on the mast is sixteen gauge.

There is only one point in connection with the instruments that I would like to discuss here. That is the question of shielding thermocouples in the High Arctic. I am grateful to Dr. De Percin, Mr. Sig Falkowski, and Mr. Paul Dalrymple, all of Quartermaster Research and Engineering, for much help and advice on this matter. With their help I was able to design radiation shields for the thermocouples. These shields were made up in the field. Eight pieces of "Alzak" aluminum, 0.020 gauge, were cut into 6-inch squares. These squares were then trimmed to make discs approximately 5 1/2 inches in diameter. Four cones were fashioned from the discs, with holes in the top to allow air to circulate freely. The outside of the cones, and one side of the discs, were polished, and the other side painted with black matte paint. The cones and discs were then attached to the broomsticks upon which the thermocouples were mounted, so as to shield the couple. The shields, rough though they were, served well.

The rest of this talk will be devoted to a discussion of suggestions for next year. Several unforeseen problems arose this year - the heavy hoar frost accumulation was one - that will make modifications in next year's program desirable.

The present meteorological station on the edge of the ice rise is located in the middle of the ablation stake grid. It would appear that the areas of the ice shelf, the ice rise, and Ward Hunt Island experience much local weather. In order to investigate these local differences more fully, it would be advisable to erect an instrument screen, and to take some micrometeorological observations at another point on the ice shelf. The survey line, about twelve miles west of Ward Hunt Island, would be a good location. An elaborate micrometeorological and radiation installation such as that at the main station would not be needed. A meteorological shelter should be erected on Ward Hunt Island, and synoptic observations carried out at least twice a day. Once the screen was erected, the Camp Manager or Radioman could take the synoptic observations in addition to his other duties.

By running the main station on the ice rise for 12 hours a day, instead of for 24 hours as was done in 1959, reopening the 1959 ice shelf station, putting up a shelter on Ward Hunt Island, and establishing another station on the survey line, a much better idea of the synoptic and micrometeorological picture could be obtained.

This program could be carried out by the same number of men as in 1959. The ice rise station and the survey line station could each be manned by one observer.

From all appearances, it would seem that 1959 had a cooler than normal summer in this part of the High Arctic. For instance, Lake Hazen had an eight-tenths ice cover in early August this year; in 1958 it was clear of ice except at the western end at the same time in August, and in 1957, the whole lake was ice free on August 12th. During the 1954 expedition, when it was a "warm" summer in the High Arctic, the lowest temperature recorded was -3.0°F at mid-day on September 26th, the day the party left. In 1959, the lowest temperature recorded during the period on record was -5.0°F on September 6th. -3.0°F had been recorded on September 3rd.