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TRIAL OPERATION OF A SIMPLE AUTOMATIC WEATHER STATION AT ASUKA CAMP, ANTARCTICA

Tatsuo ENDOH[1], Gorow WAKAHAMA[1], Sadao KAWAGUCHI[2], Masashi SANO[2] and Tokio KIKUCHI[3]

[1]*Institute of Low Temperature Science, Hokkaido University, Kita-19, Nishi-8, Kita-ku, Sapporo 060*
[2]*National Institute of Polar Research, 9–10, Kaga 1-chome, Itabashi-ku, Tokyo 173*
[3]*Faculty of Science, Kochi University, 5–1, Akebonocho, 2-chome, Kochi 780*

Abstract: A tentative unmanned observation was carried out at Asuka Camp in 1985 by means of a data logger equipped with a thermometer and an anemometer. The data logger, run by Lithium batteries, was buried in the surface snow without any heater. Although the sensors were covered by heavily drifting snow during the later period of observation, the desired recordings were performed successfully. Analyses of the obtained data provided information on diurnal variations of air temperature, periods and behavior of disturbances, monthly mean air temperature and depth of snow drift at Asuka Camp in 1985.

1. Introduction

One of the most important subjects planned as a Japanese program of Antarctic Climate Research (ACR) is year-by-year changes of the atmosphere of Antarctica. Another subject is the relationship between the atmosphere and the ocean or sea ice. To investigate the year-by-year and seasonal variations of the Antarctic climate, which is composed of regional climates of the ocean, coastal region, sloping zone of high plateau, and inner continental zone or domes, it is desired many automatic weather stations with long operating life be distributed widely in the area to be examined. Each station should be simply and economically constructed, durable and maintainable for a long duration at a low cost.

One of the high priorities of the 26th Japanese Antarctic Research Expedition (JARE-26) operations was the settlement of a new camp, named Asuka Camp, in the Sør Rondane area, where no continuous meteorological observations have ever been carried out.

Accordingly, plans were made to measure and record two meteorological elements, air temperature and wind velocity, at the station in order to obtain data that can be used in logistic problems in future operations.

2. Methods

The automatic weather station was equipped so as to measure and record air

temperature and wind velocity by means of a data logger of C-MOS type, which was confirmed to be able to operate with Lithium batteries at a temperature as low as −32°C in a cold room of the Institute of Low Temperature Science, Hokkaido University. At Asuka Camp the annual mean air temperature is expected to be −20∼−30°C. Therefore, the data logger was buried in snow at the depth of more than 3–5 m without any heaters.

Air temperature was measured by a thermometer sensor of platinum resistance equipped with bridge circuits. Since the heat capacity of the sensor was relatively large, the values of measurement were considered not to change quickly. On the other hand, since wind velocity has a large deviation, it was measured by a three-cups type anemometer with larger inertia. The wind cup rotated an AC dynamo. The alternative currents generated were rectified and smoothed out by a bridge circuit of diodes and a CR relaxation circuit, respectively. The relaxation time of the circuit was 65 s.

Recording duration was set at two years for measuring the two meteorological elements, in addition to another element, environmental temperature, and recordings were made by the data logger every 3 h, respectively. The measurements and recordings were begun on 4th January 1985 at a snow depth of 2.5 m. At the end of the observation period, the data logger was dug out on 28th December 1985 from a depth of 8 m of heavily accumulated drifting snow and brought to the Institute of Low Temperature Science, by a conveyance of the National Institute of Polar Research. The data was read out successfully by a host computer in April 1986.

3. Results

Initially the sensors of the thermometer and the wind cup were set at 2.8 and 4.6 m above the surface, respectively. However, after an absence of a few weeks it was discovered that heavily drifting snow had covered the thermometer sensor. Therefore, the sensor and wind cup were raised by 1 m, respectively.

Obtained results are shown in Fig. 1, where the upper and lower halves are mean wind velocity and air temperature with environmental temperature. As can be seen, some recordings by the wind cup indicate disturbances, so the recordings were stopped immediately after the discovery and the wind cup was repaired in February. Since then, the recordings of wind velocity were smoothly carried out. The peak values of mean wind velocities in winter (about 14 m/s) are larger than those in summer (about 7 m/s).

On the other hand, the recordings of air temperature and environmental temperature were sustained for almost a whole year without any trouble. But about 100 days after the start of the experiment, the recording curve of air temperature changed to a smooth shape. One explanation is that the sensor was buried by drifting snow, so that when the data logger was dug out finally, only the wind cup was discovered just above the snow surface. Therefore, the data were considered to be those of air temperature until about 100 days after the start of experiment, after that, they refer to snow temperature.

More detailed records of every 30 days are shown in Figs. 2, 3 and 4. In the

records of January, as shown in Fig. 2, typical diurnal variations of air temperature due to the sunlight effect are recognized every day, indicating that the weather was fine on these days. One interesting finding, in the records of environmental temperature of the data logger, is that the initial temperature with surface snow revealed a

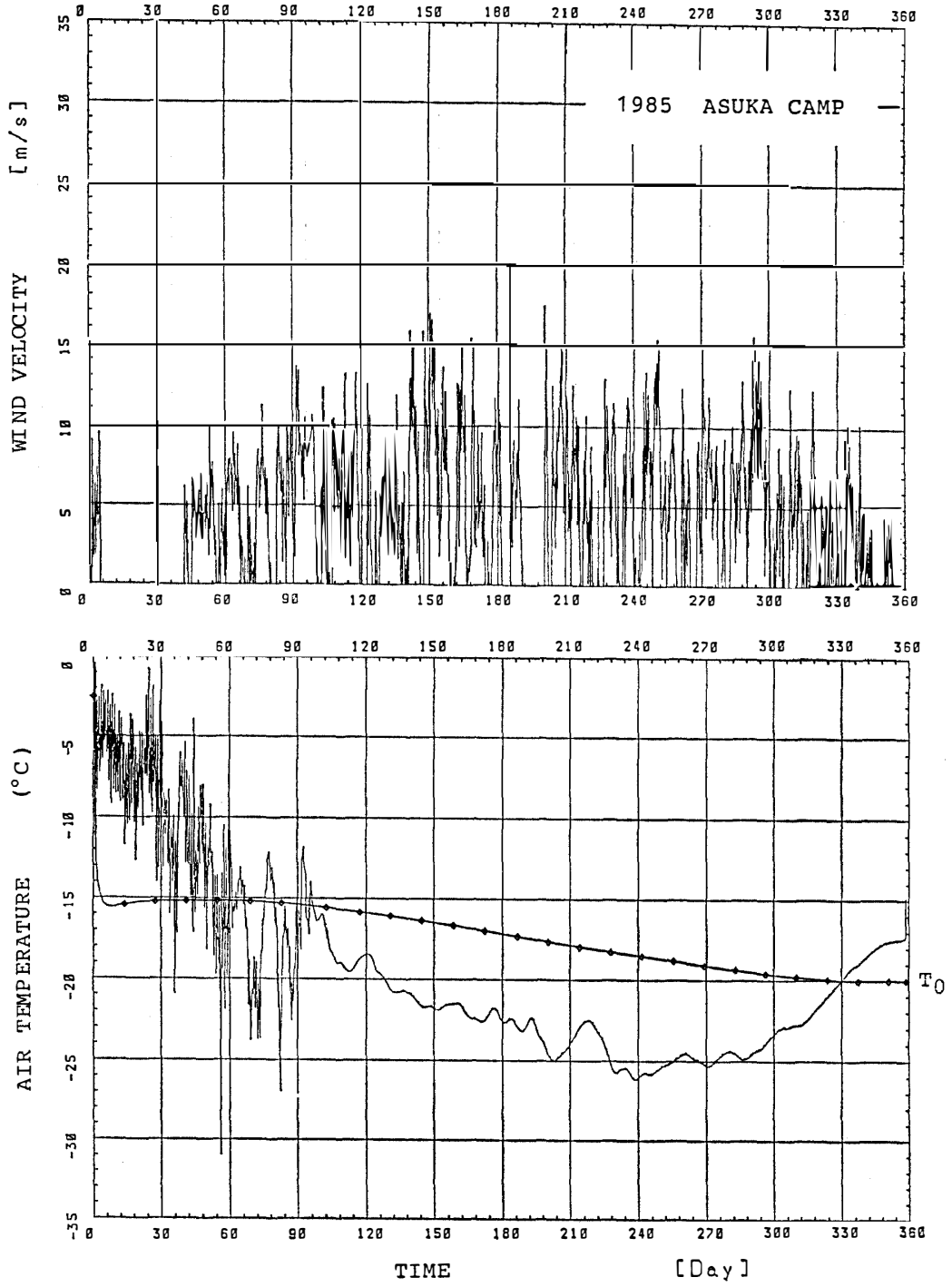

Fig. 1. Obtained records of wind velocity (upper), air temperature and environmental temperature of the data logger (lower) at Asuka Camp in 1985.

lowered value at the depth of 2.5 m 4 days after the start of the experiment.

In the records of February, as shown in Fig. 3, although diurnal variations are also recognized clearly, another kind of changes, indicating disturbances, is seen during the period of 4 or 5 days. A sharp temperature drop to less than −30°C 56 days after and wind velocity of almost zero are notable. These may have been due to

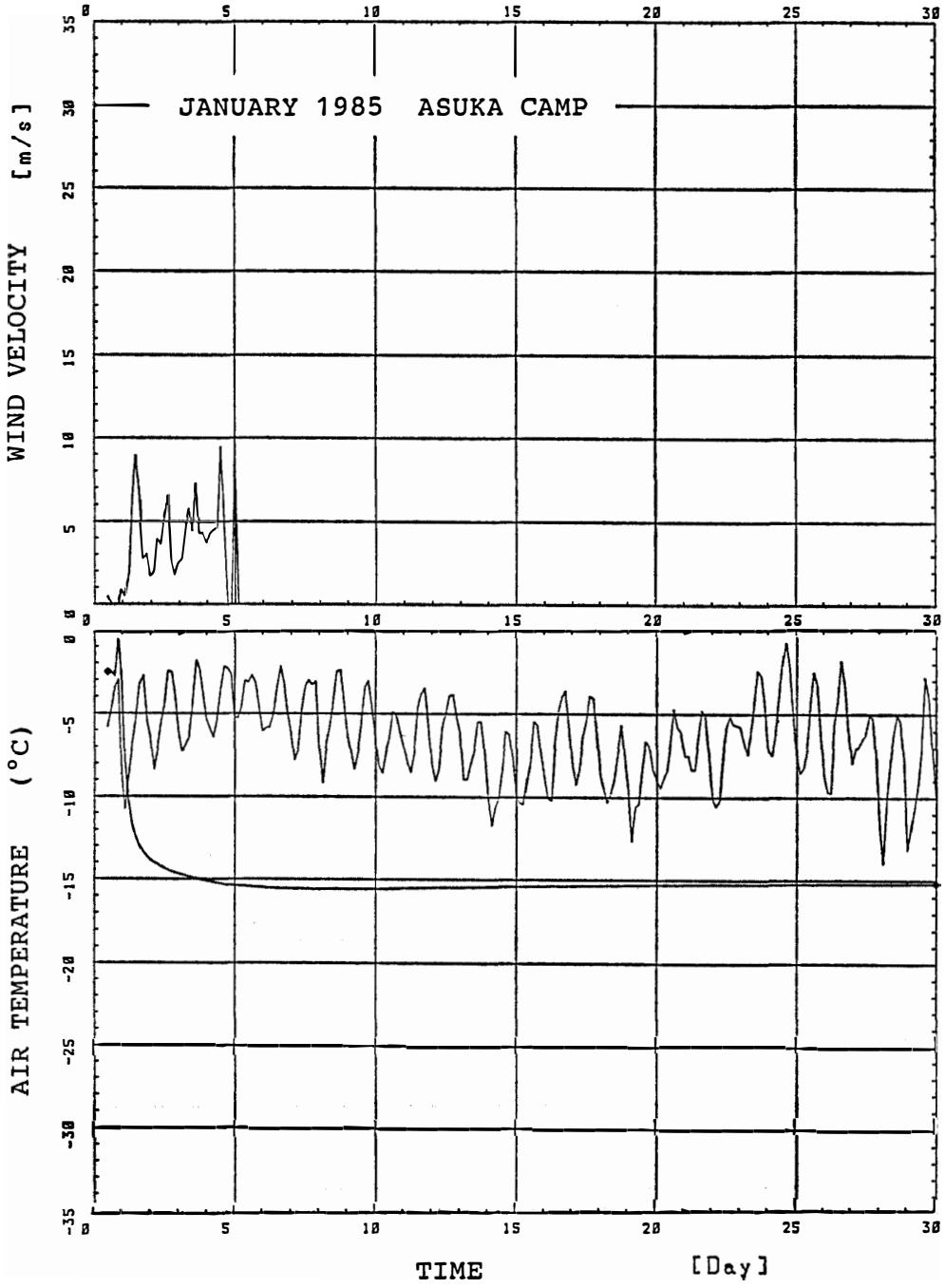

Fig. 2. Same as Fig. 1, except more detailed records are given for January.

radiation cooling on those clam nights.

In the records of March shown in Fig. 4, diurnal variations become weak due to lower elevation of the sun. On the other hand, some disturbances are noted, which were associated with higher temperature and windy duration.

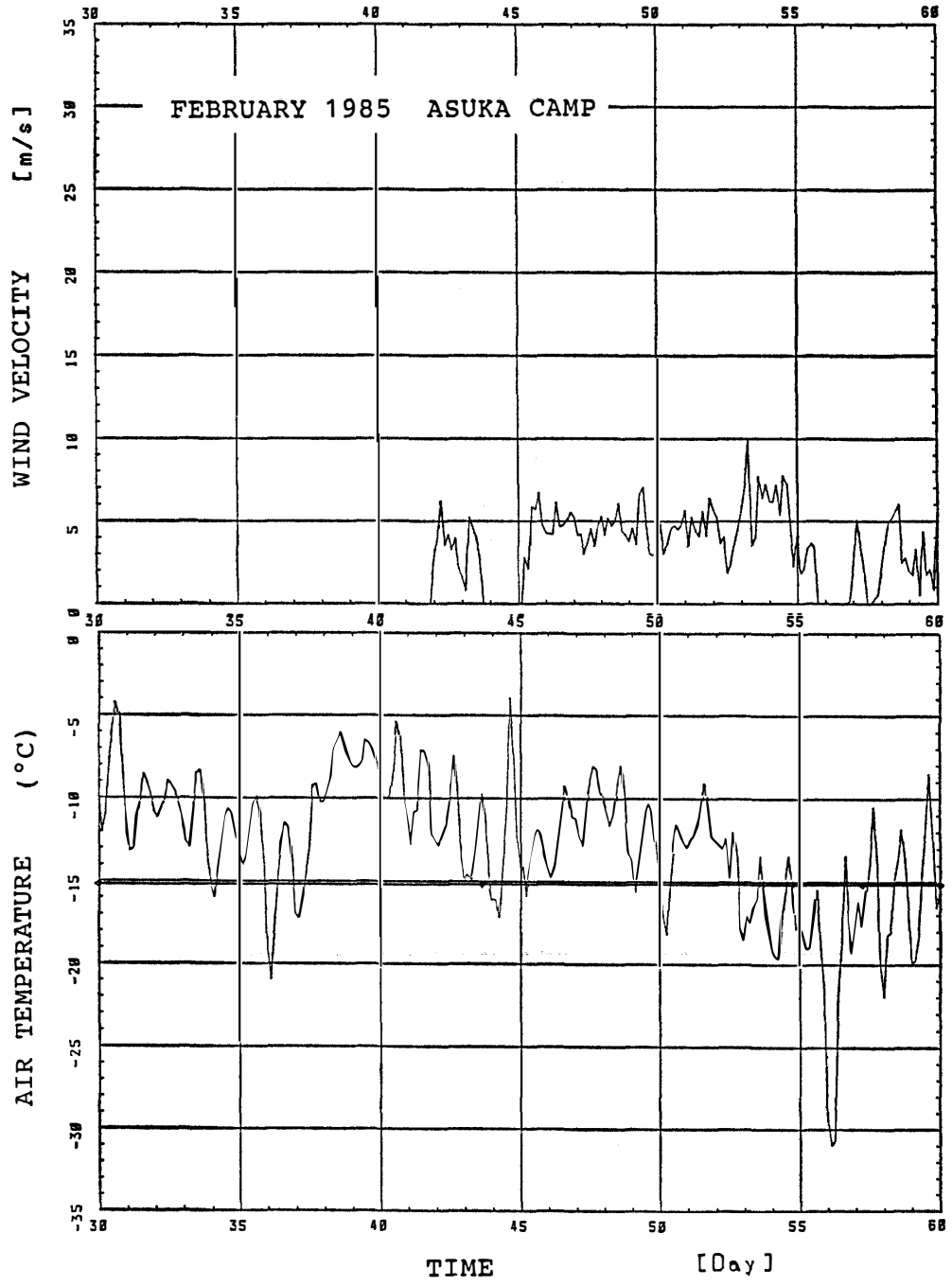

Fig. 3. Same as Fig. 2 but for February.

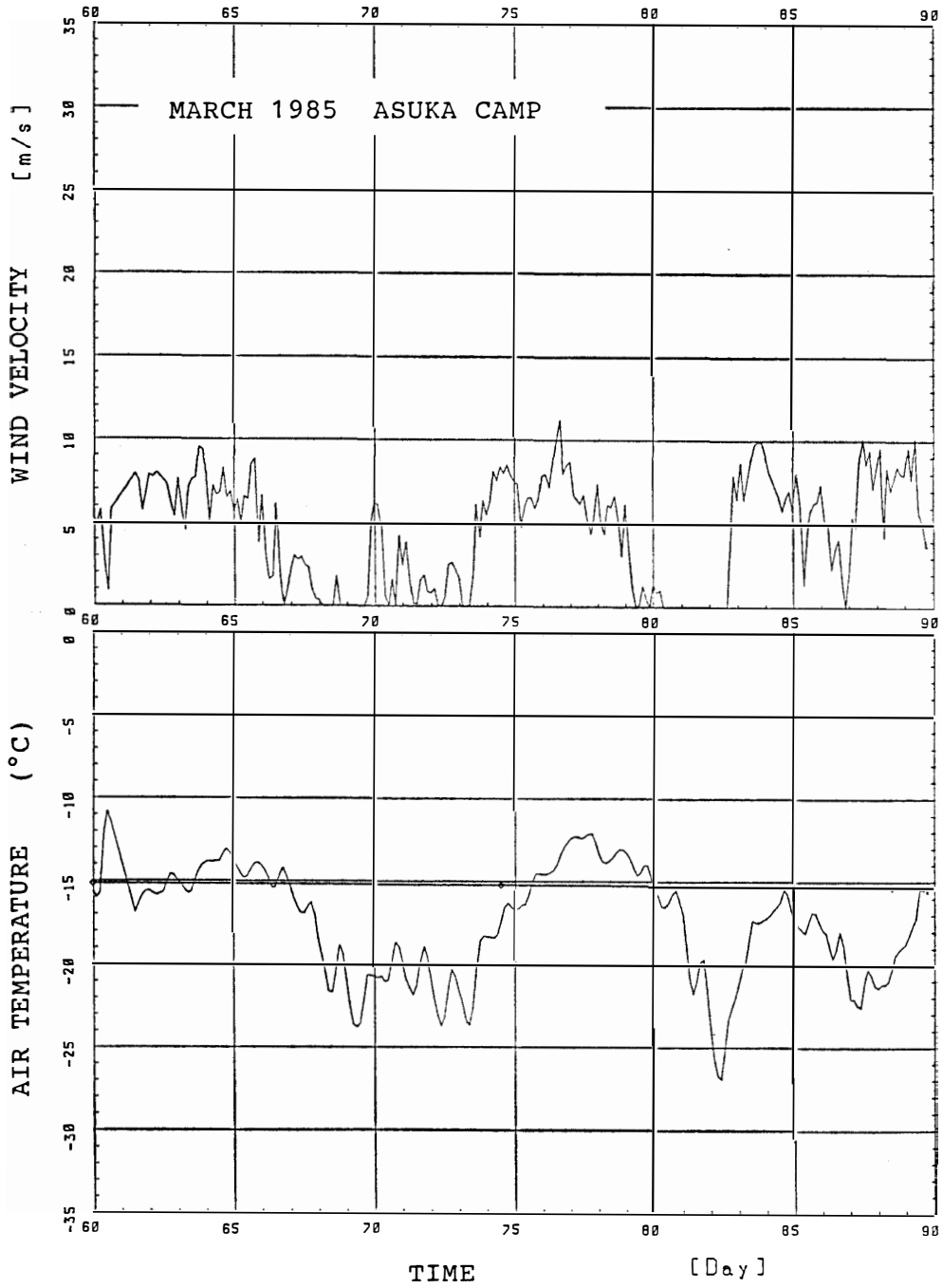

Fig. 4. Same as Fig. 2 but for March.

4. Considerations

To verify the existence and behavior of such disturbances, the daily mean air temperature changes were compared with those of other stations, namely Mizuho Station (70°42'S, 44°20'E, 2230 m) and Advance Camp (74°S, 35°E, 3190 m), as shown in Fig. 5. In February and March, some disturbances during certain periods are recognized in the records of the three observation sites. Correspondences between the changes at each site are shown by solid lines in the figure. Time lag of each disturbance is 4 days between Asuka and Advance Camps and one day between Advance Camp and Mizuho Station. Supposing that each disturbance had some frontal line or trough with a slant angle of about 30° clockwise to longitudinal line and advanced from east to west, when a disturbance arose at Asuka Camp, it was expected to arrive at Advance Camp 4 days after and finally reach Mizuho Station 5 days after. If the assumption is correct, we can interpret reasonably the time lag of daily mean air temperature changes in Fig. 5.

KIKUCHI (1983) made a profile of the seasonal changes of temperature with depth of snow at Mizuho Station. As depicted by his profile changes, surface temperature

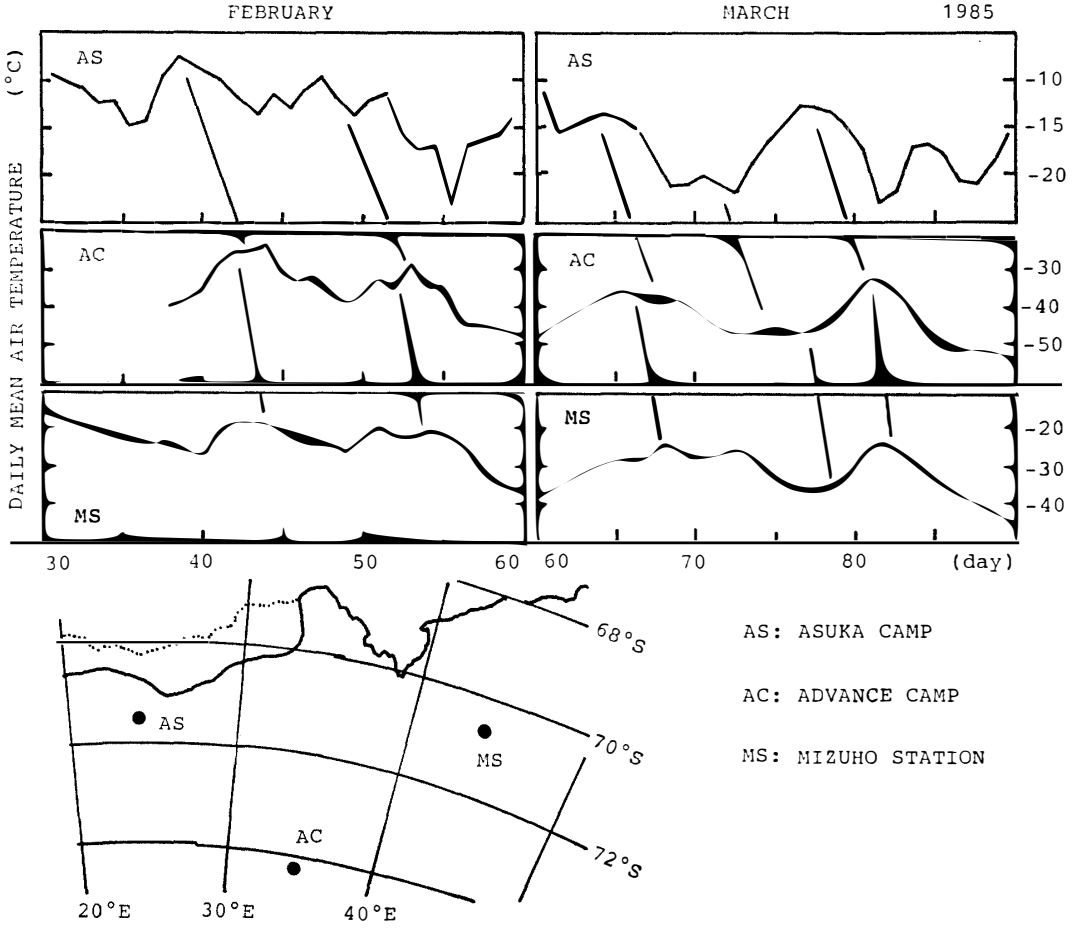

Fig. 5. Comparison of daily mean air temperature at Asuka Camp, Advance Camp and Mizuho Station.

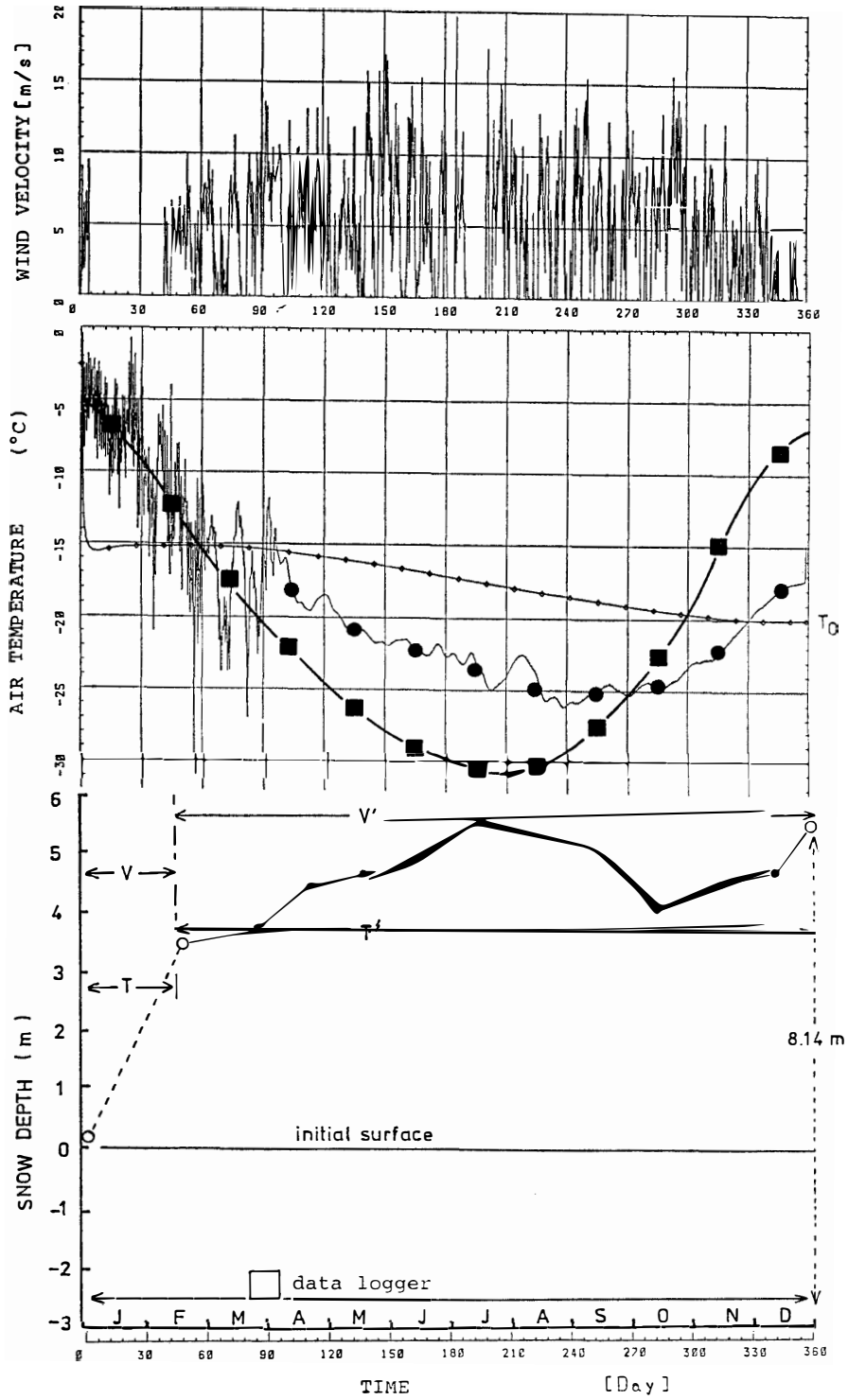

Fig. 6. Monthly mean air temperature (solid square) and surface level (smaller solid circle) deduced from obtained data at Asuka Camp, i.e., snow temperature (larger solid circle) and some assumptions. V and T show the initial heights where the wind cup and thermometer were set, V′ and T′ show the secondary heights reset, respectively.

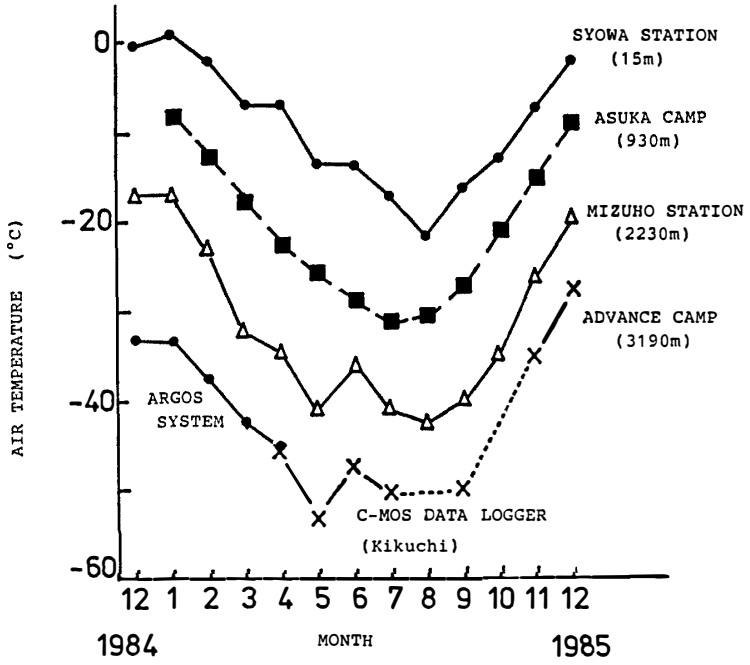

Fig. 7. Comparison of seasonal changes of air temperature at Asuka Camp obtained by the present experiment with those at Advance Camp, Mizuho Station and Syowa Station.

(solid square) and surface level of accumulated snow (smaller solid circle) may be deduced from seasonal changes of monthly average temperature in deep snow (larger solid circle) as shown in Fig. 6. Only open circles indicate the surface levels verified by observation. In midsummer (200 days), the surface level is estimated to rise to the level of the wind cup as shown in the figure. Around that time, the records of wind velocity indicate zero for about 10 days. The reason for this is considered that the wind cup was buried by drifting snow and thus stopped, but after this the snow was blown off by a strong wind and the wind cup began to operate again.

Since the depth of the data logger was finally 8.14 m, the environmental temperature recordings by the logger were considered to be the annual mean air temperature, which was −20°C at Asuka Camp in 1985. Data on seasonal variation of monthly mean air temperature at Asuka Camp were compared in Fig. 7 with those at other stations, which were collected by Dr. T. YAMANOUCHI. The curves (broken line) of Asuka Camp are seen to be of the intermediate values between those of Syowa Station and Mizuho Station. The values of monthly mean temperature are considered to be roughly proportional to the altitude.

Acknowledgments

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Reference

KIKUCHI, T. (1983): Heat flux in surface snow at Mizuho Station, Antarctica; Monthly values and errors. Mem. Natl Inst. Polar Res., Spec. Issue, **29**, 61–69.

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