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WIND VARIATION FEATURES OF SYOWA AND ASUKA STATIONS, EAST ANTARCTICA

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Abstract: Wind speed and direction at Syowa and Asuka Stations, East Antarctica have been analyzed. From monthly mean wind speed, Asuka was classified in the inland area type of J. INOUE (Nankyoku no Kagaku, 3. Kishô, ed. by Natl Inst. Polar Res., Tokyo, Kokon Shoin, 57, 1988). To reveal diurnal variations of the two stations' winds, hourly wind data of the day, when the daily mean cloud amount was less than 5 in tenths, were selected to avoid the influence of large scale disturbances. Wind speed shows large diurnal variation at both stations on summer clear days but not on clear winter days. Prevailing wind direction at Syowa is NE and at Asuka is ESE. At Syowa, diurnal variation of wind direction is seen on clear summer days; a secondary direction appears on clear winter days. At Asuka on clear summer days, the variation of wind direction is small and the same as that of inland observations.

1. Introduction

The Japanese Antarctic Research Expedition (JARE) has done meteorological observations at three stations, Syowa, Mizuho and Asuka. Syowa Station (69°00′S, 39°35′E) is located on East Ongul Island, 4 km offshore of East Antarctica; Mizuho (70°42′S, 44°20′E) is an inland station at 2230 m. Asuka (71°32°S, 24°08′E) is in Queen Maud Land, East Antarctica. It is 930 m above sea level and 120 km from the coast.

From geographical features, INOUE (1988) classified the annual variations of wind speed at Antarctic stations. According to him, Syowa is the east coast (B) type, characterized by small seasonal change of wind speed. This type is separated into two groups, with strong and weak wind speed, Syowa belongs to the weak group. Mizuho is the inland area type, in an especially strong wind area. The other types are the east coast (A), large seasonal wind speed variation type and the west coast type, weak wind speed area. At Asuka the observations started in 1987 and were halted at the end of 1991. Here, using 5 years wind data at Asuka, INOUE's classification is applied.

Diurnal variation is an important feature of wind. MORITA (1968) reported on the diurnal variation of wind speed at Syowa. He found that in summer the maximum appears in the early morning. He pointed out that the seaward extension of the katabatic wind cannot win the distance enough to affect Syowa in the daytime of summer season. This analysis was done using all the data observed in all weather making it difficult to distinguish the katabatic wind from

synoptic disturbance wind. Diurnal variation of wind at the inland camp on Mizuho Plateau was reported by KIKUCHI *et al.* (1988). It was found that the variation is large in summer with noon peak wind and midnight weak wind. At Asuka, diurnal variation of wind speed has been experienced (AYUKAWA, 1989) but the details have not been reported. Here we are going to analyze diurnal variation of wind at Syowa and Asuka using selected wind data.

2. Data and Results

Wind observations were done at both Syowa and Asuka Stations with a windmill type wind vane and anemometer 10 m above ground level. To see the annual change, monthly mean wind speed is based on all daily mean wind speeds. At Asuka, data were obtained from February 1987 to November 1991. Wind speed and direction, used to see the diurnal variation, are 10 min means. To prevent the influence of large scale disturbances, wind data on days when daily mean cloud amount is less than 5 in tenths are used. At Asuka, the cloud observations in tha same format as at Syowa were started in 1989, so 1989–1991 data are used. Summer is November, December and January; winter is June, July and August in this paper.

Figure 1 shows the monthly mean wind speed of Syowa and Asuka in 1987–1991 and of Mizuho in 1977–1985. The annual variation at Syowa is generally the same as that of INOUE (1988). That at Asuka is characterized by two peaks of wind in March and June. The Asuka wind exceeds the Mizuho wind through the year except in May.

Figure 2 shows hourly mean wind speed at Syowa and Asuka on clear days in summer and winter as classified above. At Syowa and Asuka, the summer season is characterized by large diurnal variation of wind speed, but in winter, diurnal variation of wind speed is not observed. At Syowa, the summer peak wind is greater than winter wind speed, but at Asuka, summer peak wind is slightly less than winter wind speed. At Syowa, a small peak is seen at 18 LT on summer clear days. Another difference between both stations is peak occurrence time of summer wind. At Syowa, the time is 03–04 LT, but at Asuka, it is 11–12 LT. Local times at both stations are UTC +3 hours but there is a longitudinal difference between Syowa and Asuka of about 15 degrees. So the time lag

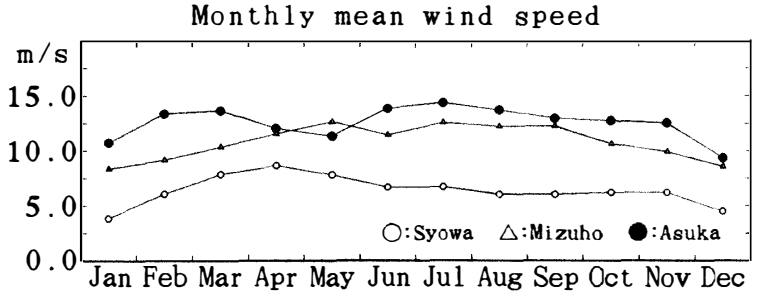

Fig. 1. Monthly mean wind speed of Syowa and Asuka Stations in 1987–1991 and Mizuho Station in 1977–1985.

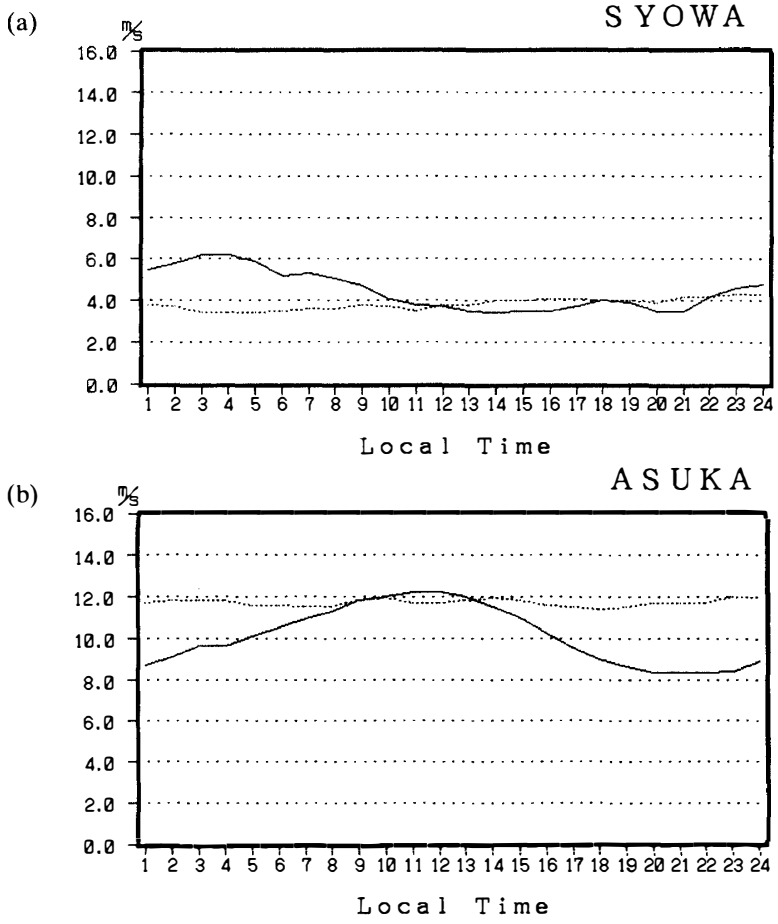

Fig. 2. Hourly mean wind speed at Syowa (a) and Asuka (b) Stations on clear days. Summer (solid line) is November, December and January, and winter (dotted line) is June, July and August.

between the two peaks in astronomical local time is about 7 hours.

Figure 3 shows wind roses of both stations. The prevailing wind direction at Syowa on summer clear days is early morning large peak wind (03 LT) is ENE, noon weak wind (12 LT) is NNE, afternoon small peak wind (18 LT) is NNE and S, and afternoon weak wind (21 LT) is NNE. At Asuka, the prevailing wind direction is noon peak wind (12 LT) and late afternoon weak wind (21 LT) is ESE, and while wind speed is increasing (24, 03 LT), the wind is SE. On clear winter days, the Syowa wind direction is bi-modal, the most frequent direction being NE or ENE and the second most frequent SE. This feature of Syowa is a pronounced characteristic and was not reported in MORITA (1968). Asuka on clear winter days has only one prevailing direction, ESE, throughout the day.

3. Discussion

The annual wind speed pattern at Asuka may be classified as east coast type or inland type. From Fig. 1, the seasonal change of wind speed is not so large

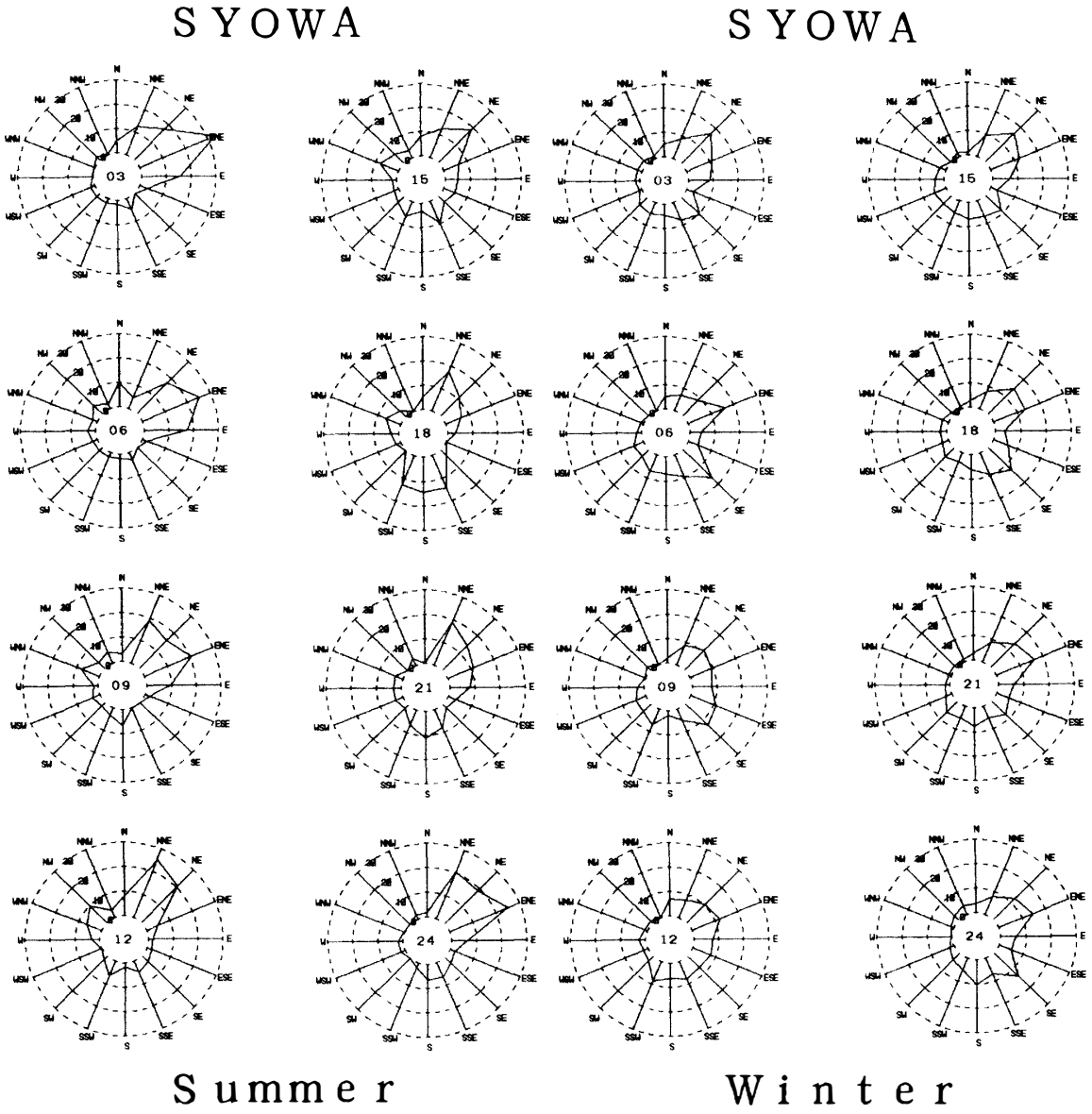

Fig. 3a. 3-hourly wind roses at Syowa Station on clear days. The 8 roses on the left are summer and those on the right are winter. Characters at the center of each rose show local time.

that the east coast (A) type is eliminated. Then the wind type of Asuka may be either the east coast (B), strong wind speed group or inland area type, strong wind group, because the 5 years annual mean wind speed at Asuka reaches 12.6 m/s, the largest value among the stations in Inoue's classification. Maximum monthly wind speed occurs in July at Asuka in Fig. 1. From INOUE (1988), strong wind group east coast (B) type stations have maxima in March, while inland type stations have their maxima in April or July or September. From this point of view, the annual wind speed change type of Asuka is the strong wind group inland area type.

KIKUCHI *et al.* (1988) show wind features at inland Advance Camp at 3200 m height on the Mizuho Plateau, East Antarctica. The diurnal variations of wind

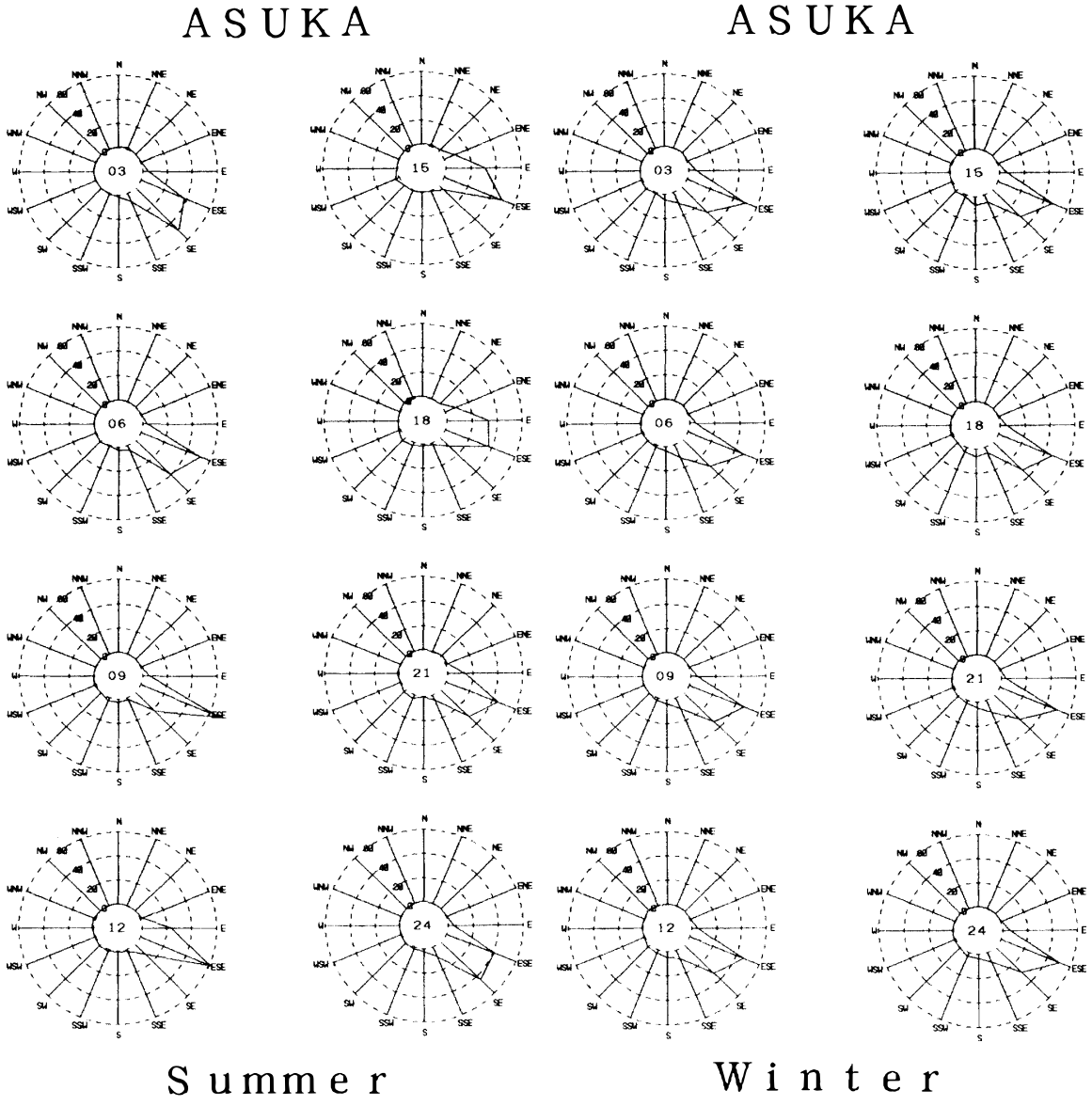

Fig. 3b. Same as Fig. 3a but for Asuka Station.

speed and direction are large in summer. The wind speed peak appears in noon and weak wind in midnight in summer. The peak wind and weak wind in summer are easterly. Before the time of peak wind, the wind has a southerly component, but after the time of peak, the wind has a northerly component. In winter, the diurnal variation of Advance Camp wind is very small. These features almost match the diurnal variation of Asuka wind (Figs. 2b, 3b). Asuka wind on clear days can be classified as inland area type also from diurnal variation features.

Syowa has two prevailing wind directions on clear winter days (Fig. 3a). The primary direction is NE or ENE; the secondary direction is SE. Previous analysis of Syowa wind showed the same two prevailing wind directions (MAKI, 1972) in May to September of 1970. On clear winter days, Syowa wind is thought to be

dominated mainly by katabatic wind. Katabatic wind is classified into two types, a principal large-scale wind and a low-level small-scale wind (INOUE, 1988). The former wind is affected by the Coriolis force; the angle between wind direction and fall line increases with blowing distance, eventually reaching 45°. In the latter case, the angle does not become so large. But this difference of wind direction is not sufficient to explain the large separation of the two prevailing wind directions of Syowa.

At Syowa, the peak wind speed on a clear summer morning is much larger than on clear winter days (Fig. 2a). The afternoon wind is southerly in summer (Fig. 3a). These features are opposite to those at the inland station. The summer peak wind does not exceed the winter wind, and the wind direction even when weak is nearly the same as the direction of the peak wind. Generally the summer katabatic wind is smaller than that in winter, so it is unlikely that the morning peak wind at Syowa on clear summer days is strengthened by the katabatic wind. Rather, it is likely that the wind is strengthened by another local wind.

Syowa Station is located on the east coast of Lützow-Holm Bay. The coast line is elongated from north to south, and Shirase Glacier is south of the bay. Summer diurnal variation of the wind at Syowa may be considered in relation to these geographical features. Possible explanations of diurnal variation in summer clear days at Syowa are land and sea breeze or mountain and valley wind. These local winds require thermal contrast. In summer, open sea sometimes exists south of Syowa, and snow free mountain areas also exist south of Syowa. Thus the local wind may cause morning peak wind and afternoon southerly wind on clear summer days at Syowa.

4. Summary

The wind variation features of Syowa and Asuka are as follows.

(1) From annual change of wind speed and also from diurnal wind variation features, Asuka belongs to INOUE's inland area type strong wind group.

(2) On clear days, the diurnal variation of summer wind speed at both stations is very large; at Syowa, the summer peak wind is greater than winter wind, and at Asuka, the summer peak is the same as winter wind.

(3) From the wind direction statistics at Syowa on clear winter days, there are seen two prevailing wind directions, which are not easily explainable by the two types of slope wind.

(4) At Syowa, the summer diurnal variation features of wind speed and direction are differ from those at the inland station. The influence of local wind is suggested.

Acknowledgments

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