AREAL DISTRIBUTION OF THE HEIGHT AND DIRECTION OF SASTRUGI AT MIZUHO PLATEAU (EXTENDED ABSTRACT)

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At the surface of the ice sheet in Antarctica, there are surface features such as sastrugi, dunes and others which are formed due to erosion of the snow surface and differential accumulation of snow. The direction of the sastrugi has provided much information on the surface wind systems. The factors determining the areal distribution will be discussed.

The observations of sastrugi were made during the traverses in 1980 (JARE-21). The direction of each sastrugi was taken as the direction of the ridge, and the height as the height difference between the highest part of the sastrugi and the surrounding snow surface. The direction of sastrugi at one site is the average of several samples, and the height is the maximum at that site.

The main process in the formation of sastrugi is the erosion by the wind. The direction of sastrugi near Mizuho Station ranged from 85° to 90° (the direction is taken as the uphill direction, measured clockwise from true north). The minimum wind speed at which erosion would occur can be considered as $10\,m \cdot s^{-1}$, as above this value drifting snow always occurs. The average wind direction for cases with wind speed of more than $10\,m \cdot s^{-1}$ is 88°, which coincides well with the actual direction of sastrugi. The frequency of winds stronger than $10\,m \cdot s^{-1}$ is 41% for January and 98% for July, which means that the sastrugi are being formed throughout the year.

In Fig. 1, the height and direction of sastrugi, snow accumulation data taken from the past JARE Data Reports, and the elevation is shown for the higher half of the Z route. The distance from Z50 to Z102 is 42 km. The sastrugi at Z64, Z72 and Z100, where their heights are higher than the surrounding sites, corresponds to clockwise turning in the direction of sastrugi, and low snow accumulation area. Also it corresponds to sites near a low ridge, recognized from the elevation data. A similar figure for a part of L route is shown in Fig. 2. In this part snow accumulation data were not available, because this was a newly established route in 1980. The position of the L route is shown in KOBAYASHI *et al.* (1982). High sastrugi nearly 1 m high were observed along this route. The direction of sastrugi gradually increases from L27 to L47, due to the change in the average orientation of the surface of the ice sheet. Superimposed on the gradual increase, there are small variations in the direction which corresponds to the variation in the height of the sastrugi. At sites such as L35–36 and L38, high sastrugi—clock-

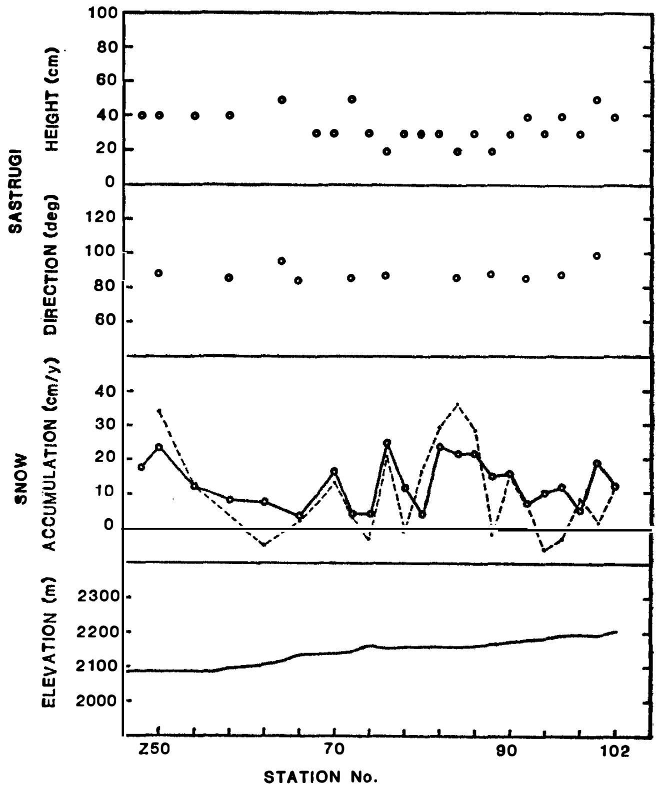

Fig. 1. Height and direction of sastrugi, snow accumulation data and surface elevation along the higher part of the Z route. The solid line and broken line in the snow accumulation data show the average values of more than 6 years in the past 10 years and the values of one year in 1980, respectively.

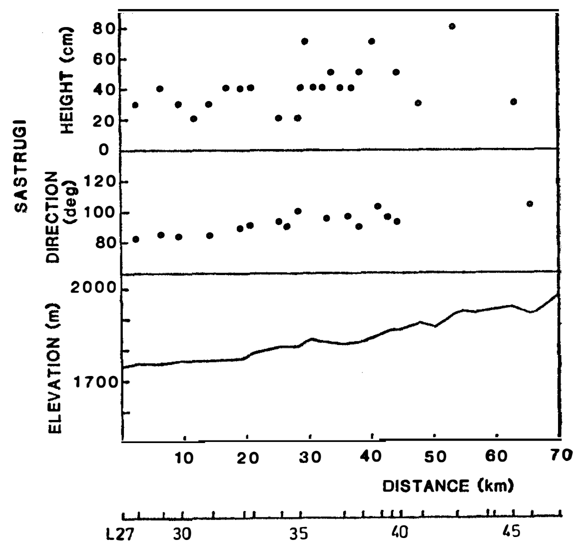

Fig. 2. Same as Fig. 1, but along the L route. No snow accumulation data are available for this route.

wise turn in the direction—large inclination relation can be seen, as was seen in the data at Z route.

The above-noted relation can be explained by the wind system in this area. The direction of sastrugi can be considered as the average direction of the katabatic wind as mentioned before. The height depends on the snow accumulation in the area, which can be considered to be low where wind is strengthening and high in the area where wind is weakening. WHILLANS (1975) showed that snow accumu-

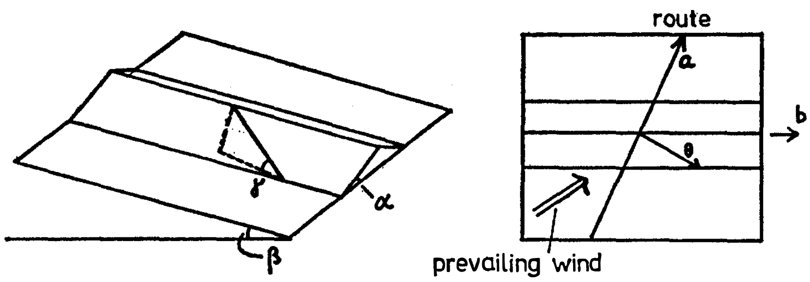

Fig. 3 Orographic model. A low ridge is placed on an inclined surface.

lation is high where the maximum slope angle is small, that is, the inversion wind is weak. Wind data are not available in order to explain the relation. However as the katabatic wind, which is the predominant wind system in this region, is sensitive to the change in the direction and angle of the snow surface, the areal variation of this wind can be roughly explained by it. Therefore an orographic model of a low ridge on a flat inclined surface was made and the change in the direction of the fall line and the maximum slope angle were obtained. Figure 3 shows this model. A low ridge α deg in inclination is placed on a plane surface, which is inclined β deg to the direction of b deg. The ridge is placed along the fall line of the plane surface. The direction of the actual route is taken as a deg. γ is the inclination of the slope on the ridge. γ will be equal to β when θ is in the direction of the ridge. β, inclination of the slope along the route $(\tan\gamma)_a$, a and b are the given factors, and the fall line angle $(\tan\gamma)_m$ and its direction θ_m can be obtained analytically. $(\tan\gamma)_m$ at the upwind and downwind sides of the ridge will be considered. The actual values were inserted for the ridge around Z64, L35–36 and another site along the L route. The changes in the direction of the fall line θ_m-b are 56°, 17° and 14°. The changes in the inclination along the fall line $(\tan\gamma)_m/\tan\beta$ are 1.1, 1.6 and 2.5. If the katabatic wind had adapted to the change in these values, the direction and strength of wind should increase according to the katabatic wind theory (BALL, 1960). However, the ridge is usually not large enough for the katabatic wind to adapt perfectly to the surface change. Near the ridge, the wind will be strong and the direction of the wind will turn clockwise. The change in the height and direction of the sastrugi seems to be explainable at least quantitatively by the present model. However, there are still som shortcomings. They may be improved by remodeling the ridges, and taking into account the orographic response of the katabatic wind.

References

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