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Summer weather characteristics on the Grove Mountain of East Antarctica

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Abstract The summer weather characteristics of the Grove Mountain, East Antarctica, are presented based on the data obtained by Chinese National Antarctic Expedition (CHINARE) in January 1999. The result shows that the pattern of daily variation of temperature and the prevailing wind direction in Grove is similar to that of Zhongshan Station. However, the daily range of temperature and strong wind frequency are much higher than those of Zhongshan Station. The change of wind direction is close to the weather system that impacted the Grove Mountain. The warm and wet air from northern parts often causes the precipitation. The clear weather appears when controlled by eastern winds in January.

Key words Eastern Antarctica, Grove Mountain, weather characteristics.

1 Introduction

The Antarctica is one of the regions with extreme deficit of meteorological data on a global basis. Because of the limited number of observing stations in the extensive continent, field expedition is the main approach to scientific research. In 1997 Chinese scientists went there (on mission 13) for research purposes and since then China has carried out such programs of the inland ice cap survey more than once, and in 1998 (on mission 15), the survey included programs of Dome-A inland snow/ice condition and geology survey in the Grove. Preliminary study is conducted of the weather characteristics over the Grove Mountains (73°S, 75°E) in East Antarctica in the context of 1998 - 1999 meteorological record made during the geological survey and with the aid of a sequence of conventional synoptic charts.

2 Observation

The investigated region is > 2000 m, above sea level, on the average, roughly 400 km from the Zhongshan Station and in the way to the inland of Antarctica. Scattered with a lot of mountain and ice-source peaks, at the maximum height of 2792 m, the Grove area is a blank in Antarctic lithosphere study. During the geological survey in

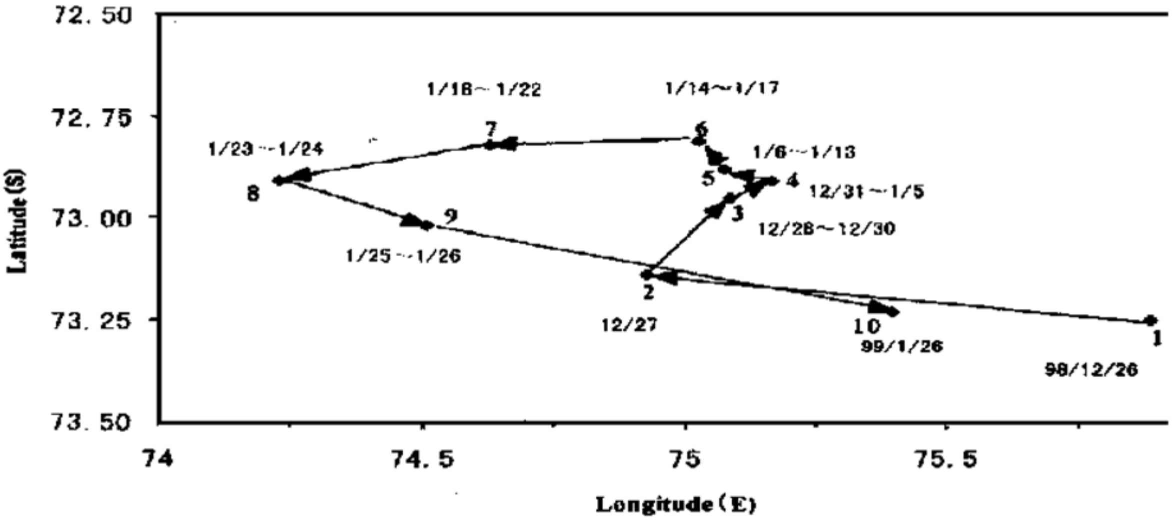


Fig. 1. The expedition path in the Grove Mountain area (From 26 December 1998 to 26 January 1999).

December 26, 1998 – January 26, 1999, the ice cap team made meteorological observation all the way. The conventional instruments consisted of Assmann ventilated psychrometer, portable anemograph, maximum and minimum thermometers that had been calibrated in Beijing, reaching the required accuracy specified in the meteorological observation norm. In the 32-day journey the team made weather measurement 58 times at 10 sites of which 32 operations were done at 2000 LT, 6 at 1100 LT, 13 at 0500 LT, 2 at 2300 LT, 2 at 1700 LT, 2 at 0200 LT and 1 at 0800 LT, and observed elements were wind speed/direction, air temperature, snow surface (0 – cm) temperature and weather phenomena, with additional maximum/minimum temperatures measured in some of the observing sites.

Around 73°S the inter-longitudinal space is about 32.5 km and the route that the team travelled is approximately along the circle of the latitude (see Fig. 1). And the easternmost site 1 was 1.66 degrees of longitude or 54 km away from the westernmost site 8. Relative to synoptic scale we excluded the space variation of data, but made analyses of the Groves snow cover weather characteristics from the averaged data of 10 sites, and made an comparison of them with the measurements from Zhongshan Station.

3 Daily variation of mean air temperature and snow cover surface temperature

Fig. 2 illustrates the daily variation of mean air temperature and snow cover surface temperature (SCST) in fine weather over the research area, indicating that both have a remarkable daily variation in the measuring period, with the daily mean of − 18.5℃ and − 17.9℃ for the (air) temperature and SCST, respectively. While the mean air temperature differs by 3.2℃ between 0200 LT and 1100 LT, the daily mean range reaches 9.5℃, as calculated from the mean maximum (− 13.1℃) and minimum (− 22.6℃) temperature over the period, a fact that agrees with Schwerdtfeger (1984) who stated that "the near-surface temperature has a big daily variation every day". During the survey the SCST has ~1℃ daily range which is nothing to that of air temperature, with its minimum (maximum) emerging between 0200 LT to 0500 LT (1100 LT to 1700 LT). When comparing to the temperature measurements from the Zhongshan Station (69.37°S, 76.37°E) 4 degrees of latitude to the north at almost the

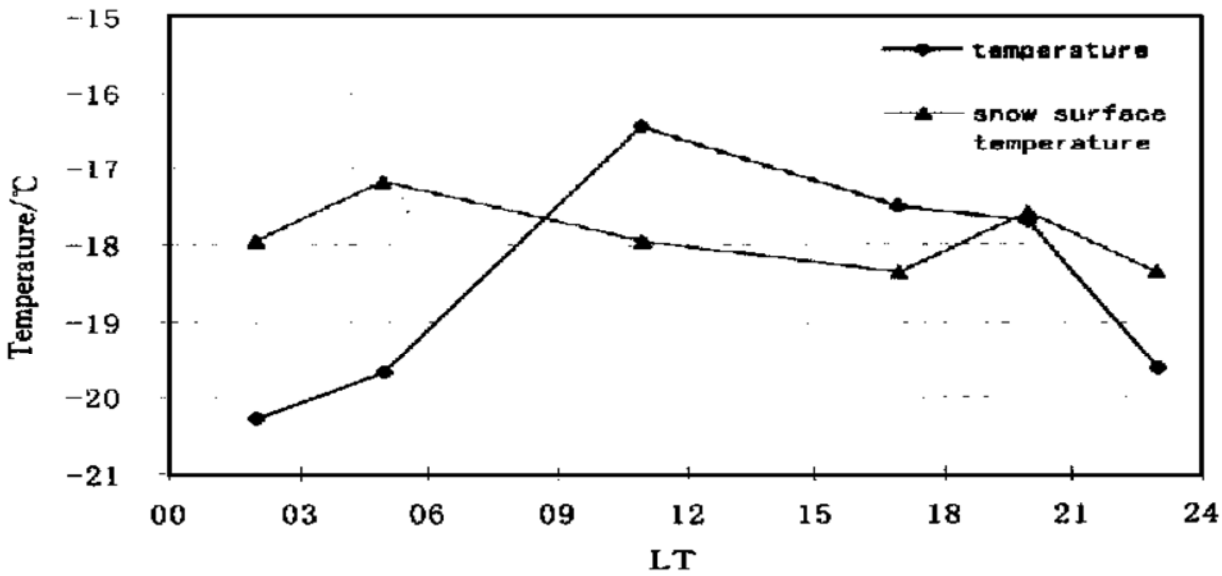


Fig. 2. Average daily variation of air temperature and snow surface temperature in the Grove Mountain in January, 1999.

same longitude and from the Morson Station on the Morson Sea to the northwest (67.6°S, 62.9°E, see Bian *et al*. 1998), we find that the Groves mean temperature over January is much lower than that of 0℃ averaged over the months in 1989 – 1996, as calculated for the Zhongshan and Morson Stations and that the daily range of temperature is by far larger as compared to the mean in the order of 4℃ at the two stations. The range of daily air temperature in the polar-day period has a close relation to the elevation above sea level where observation was made. Fig. 3 depicts the daily variation in mean temperature over January for the stations of Zhongshan, Syowa, Asuka and Dome-C set up by Japanese meteorological Agency in 1983 (Japan Meteorological Agency 1993; Keller *et al*. 1995). It is obvious that the higher the elevation, the bigger the daily variation.

4 Daily variation of wind speed and direction

Fig. 4a delineates the daily variation of the summertime wind speed, showing that the maximum is at 0500 LT and minimum probably around 1700 LT, with the trend similar to that observed at the Zhongshan Station where the maximum emerges at about 0500 LT and minimum at 1600 LT – 1700 LT. The station is within a region of katabatic winds on the shoreline of the SE Antarctica and the inland Grove mountains are also under the effect of the katabatic wind. Observation shows that the more inland, the stronger the wind. As a result, the Zhongshan Station (ashore) and Grove Mountains (inland) are under different stress of the katabatic wind, the latter suffering considerably more. The wind direction is practically unchanged on a daily basis, measured at the Groves except under the control of a large-scale circulation system that makes a related weather phenomenon to be changed with wind direction.

5 Prevailing wind and strong wind frequency

Table 1 gives the wind direction analysis, indicating that in January the prevailing

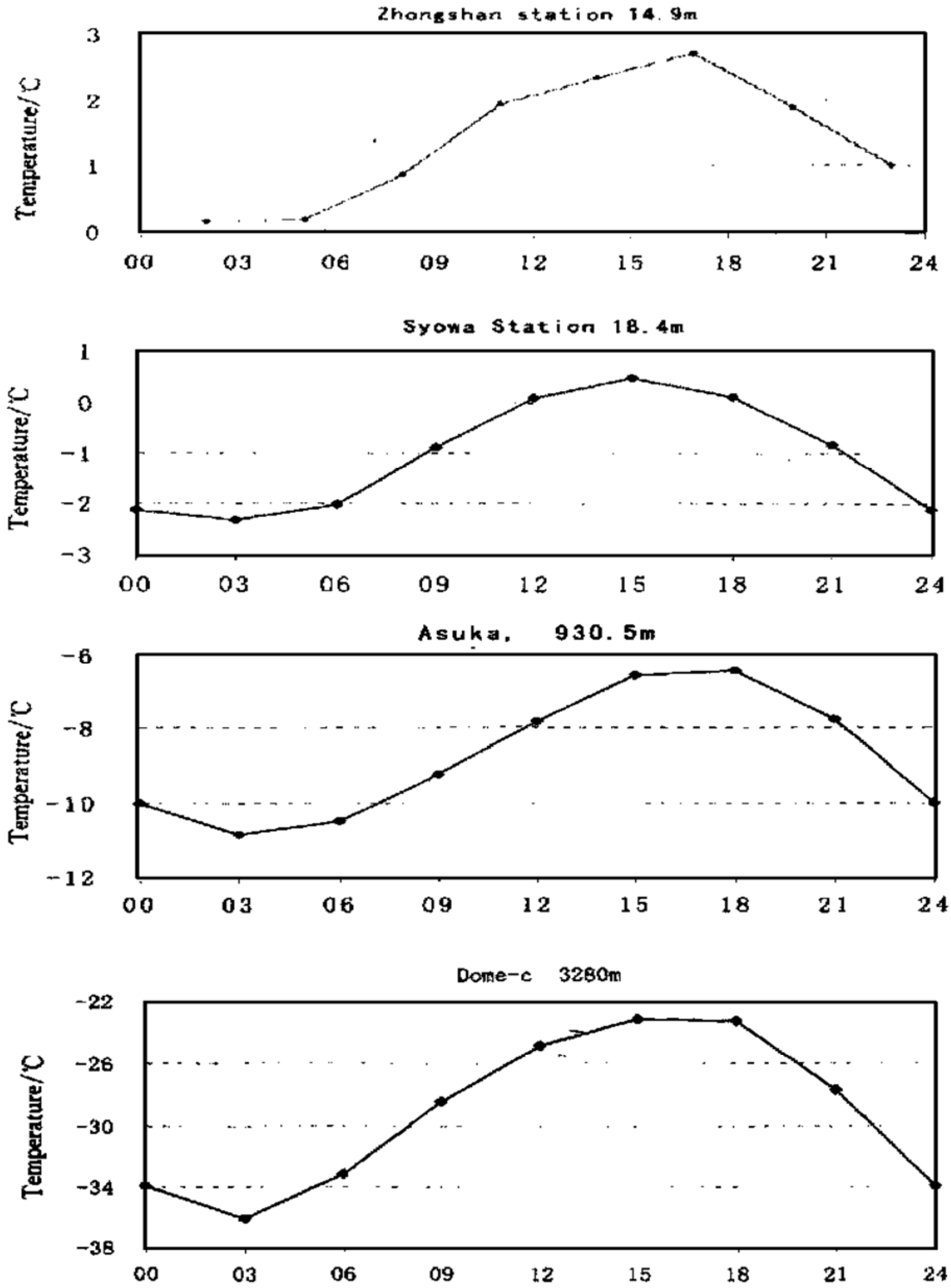
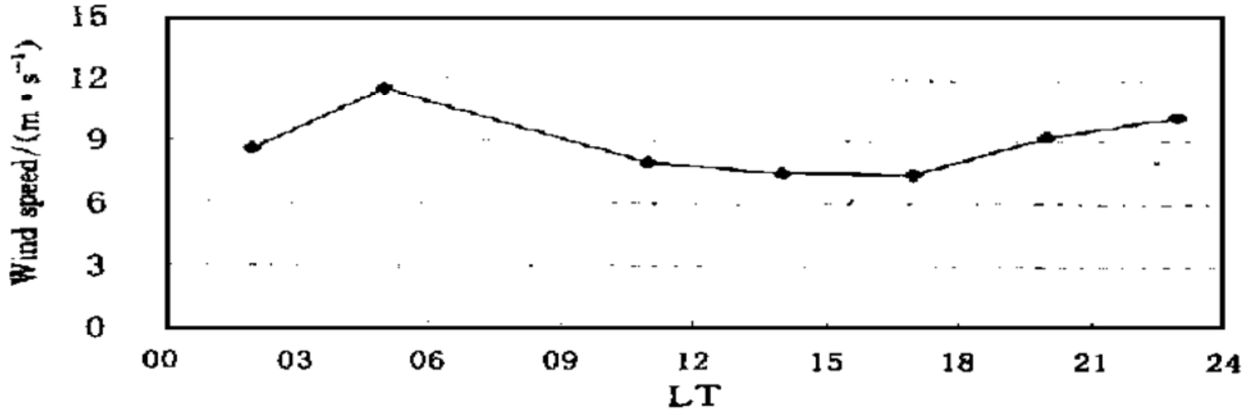


Fig. 3. Average daily variation of temperature at some stations in Antarctica in January.

winds are the same as that of the Zhongshan Station, i.e., northeast and east winds that make up 50% and 28.95%, respectively, over the Grove Mountains, and that fine weather is dominant when the east wind blows and snow falls quite often when the northeast and north winds emerge. The table also shows that of the 11 snowfall events during the 38-day journey, 10 occur under the influence of northeasterly and northerly flows. As an east wind blows, the mountainous region is under the control of the wind at the brim of a polar high pressure, suggesting the predominance of sunny days. In



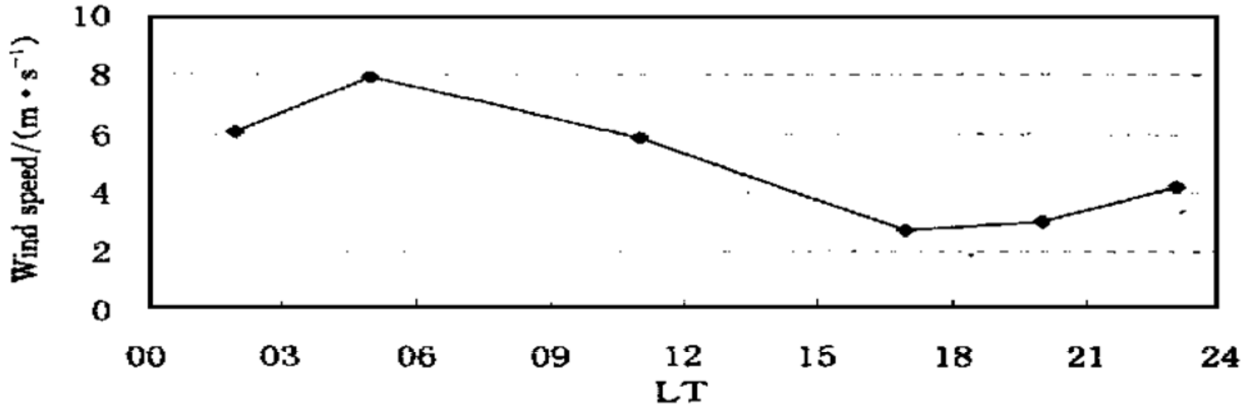


Fig. 4. Average daily variation of wind speed in Grove Mountain (a) and Zhongshan Station (b) in January.

contrast, when mid-latitude northeast and northerly warm, moist air current flows to the study area, snowfall and even a blizzard will probably take place. Consequently, it is likely to foresee snowfall happening, on the whole, just from the change of the local wind direction.

Table 1. The wind frequency and weather phenomena in the Grove Mountain in January

	E	NEE	NE	N
Wind direction frequency/%	28.95	15.80	50.00	5.30
Frequency in dry/d	11	6	19	2
Frequency in clear day/d	10	6	6	0
Frequency in cloudy/d	0	0	5	0
Frequency in snow/d	1	0	8	2

Fig. 5 shows the distribution of maximum winds recorded on a daily basis in the 32-day trip. Statistics indicate that the summer mean wind speed is 10 m/s (Beaufort wind scale 5) and winds below scale 5 occur on 16 days (50%), above scale 6 (12 m/s) on 14 days (43.75%) and above scale 7 (14 m/s) on 8 days (25%). In contrast, the frequency for the station of Zhongshan is 80% and 6%, respectively, for winds below scale 5 and above scale 6, as shown in the long-term means. As such, the summer winds are by far greater in the Grove region than at Zhongshan Station, with the frequency of gales much higher as compared to the latter, leading to the fact that the inland Grove Mountains fall into a typical area of katabatic winds.

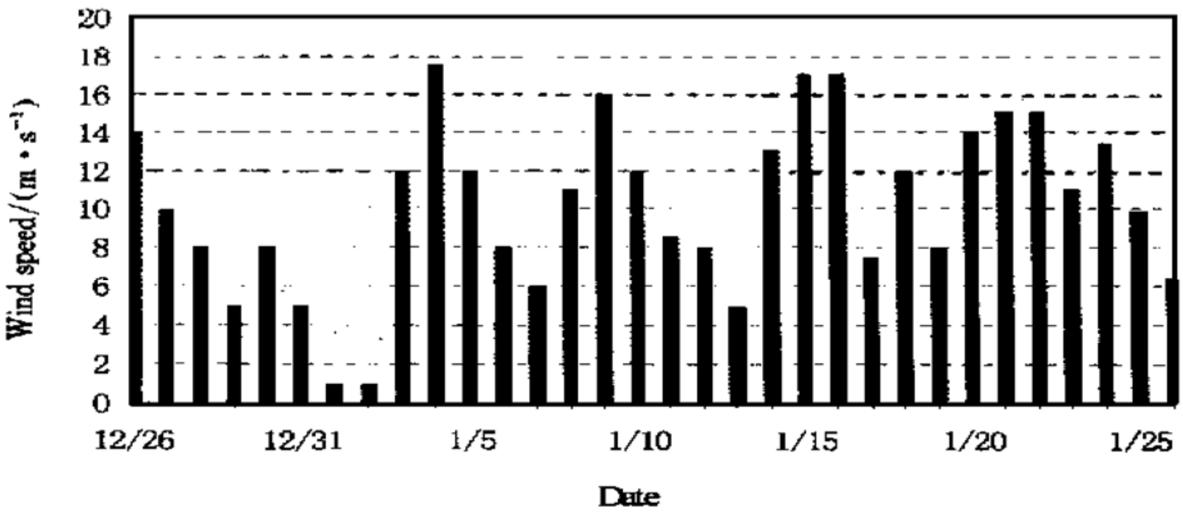


Fig. 5. The strongest wind speed time series in the Grove Mountain.

6 Influence of large-scale weather feature on the Grove Mountains

Analysis of China NMC-provided ECMWF southern 500 hPa height and sea level pressure yields that in January the 500 hPa level is under the control of a polar vortex over the Antarctica with circumpolar westerly prevailing wind and that there is a circumpolar band of low pressure consisting of 4 – 6 east-moving large-sized depression belts and feeble high pressure ridges. As one of the troughs reaches 60 – 70℃E in its eastward journey and the related ridge is enhanced, northerly flow emerges ahead of the trough and behind the ridge, carrying with it mid-latitude warm, moist air into the Grove Mountains for snowfall happening there. Fig. 6 presents the 500 hPa circulation patterns on January 4 for snowstorm and on January 10 for fine weather, indicating that the Grove land is behind a ridge and ahead of a trough during snowfall with northerly flow prevailing at the level and that the state is reversal which happens on a sunny day.

The surface situation (figure not shown) corresponds well to the upper-air counterpart. As the leading edge of a low pressure approaches, the observed wind veers from an east into a northeast or a north wind, often accompanied by snowfall and on such days the study region is in the southeast of the low pressure and under the effect of a northeast wind, and while the mountains are under the control of a polar continental high pressure on a clear day, east winds prevail there.

7 Conclusion

Based on the analysis of observations made in the Grove Mountains and associated meteorological data, and comparison to the weather characteristics of the Zhongshan Station at the same longitude but 4 degrees of latitude to the north of the Grove, we come to the conclusions which concerns the weather characteristics of the Grove Mountain.

(1) Mean temperature over January is − 18.5℃, approximately 18℃ lower than at the Zhongshan Station; air temperature has a daily range of ~10℃, exceeding greatly that of the Zhongshan Station; the snow cover surface temperature (SCST) experiences

(a)

(b)

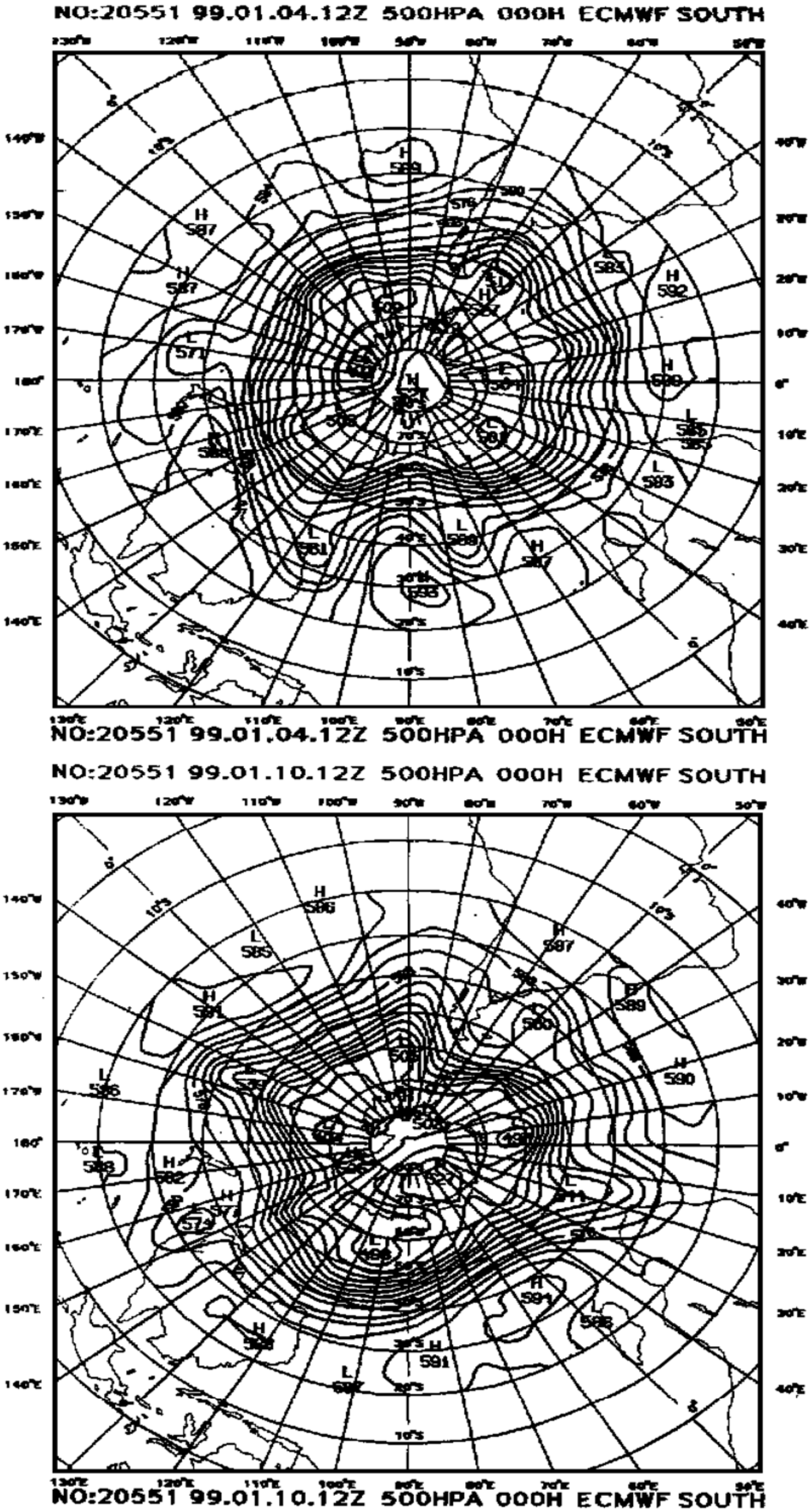


Fig. 6. The different synoptic situation on 500 hPa in January. (a) snow; (b) clear.

no marked daily variation and surpasses air temperature by 0.6℃, on average. It is the snow cover that transfers heat into air.

(2) The prevailing wind is easterly in summer (January) and under the stress of northeast or northerly warm, moist air flow from the southern mid-latitudes, snowfall often occurs and fine weather is dominant under the control of the easterly flow.

(3) The summer wind velocity undergoes great change on a daily basis and suffers seriously from katabatic winds. The mean wind speed is 10 m/s (Beaufort scale 5) and winds above scale 7 constitute 25% of the occurrence. a figure that is much bigger than at the station of Zhongshan, thus revealing that the study region is a region typical of katabatic winds.

(4) The local weather characteristics are closely related to a large-scale synoptic system. The study region, when being behind a ridge and ahead of trough at 500 hPa, will have snowfall because the situation favors the transfer of mid-latitude northerly warm, wet flow into the Antarctica. And viewed from the surface map, a corresponding low pressure is moving toward the Grove Mountains, leaving them in its southeast and under the control of a northeast wind. On sunny days, in contrast, the mountains are ahead of a ridge and behind a trough, and an east wind often comes into play over the surface.

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References

Bian LG, Xue ZF, Lu CG, Lu LH, Jia PQ (1998): Short-term climate of the Larsemann hills. Chinese Journal of Polar Research, 10(1): 37 - 46.

Japan Meteorological Agency (1993): Antarctic Meteorological Data, vol. 32, Meteorological Data At Syowa Station and Asuka camp in 1991, Tokyo, Japan Met. Agency.

Keller LM, Weidner GA, Stearns CR, Whittaker MT (1995): Antarctic automatic weather station data for the calendar year 1993, Madison, university of Wisconsion.

Schwerdtfeger W(1984): Weather and climate of the Antarctic. Development in Atmospheric Science, 15, Amsterdam: Elsevier, translated into Chinese by Jia PQ, Bian LG and Zhang YP, 1989, Beijing: Meteorological press.