# The Effect of Sea Ice upon the Climate of Syowa Base

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# 昭和基地の気候に及ぼす海氷の影響について

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第1次および第3次越冬気象観測の結果から，昭和基地の気候特性は大局的には，東方の隣接基地モーソンやデービスなどとよく似ているが，秋の気温がそれらの基地よりも高く，春の気温が低いという相違が見出される．この原因は，昭和基地沖合の海氷域の年変化が大きいためと考えられる．すなわち，ウエッデル海から北上して偏西海流によって東方に伸びる流氷舌が冬から春にかけて発達し，あたかも氷雪に掩われた陸地が拡大したかのようになり昭和基地は海洋から遠ざかることになるので，その流氷舌の影響のない西方の沿岸基地に比し低温となる理である．これを立証するため，昭和基地の風向別気温頻度分布および，各基地の気温と，基地から流氷縁までの距離の関係をしらべた結果，予期通りの結果が得られ，昭和基地の春秋の気温異常値は海氷の影響であることが確かめられた．

## 1. Preface

The meteorological observations at Syowa Base has been carried out since February 1957 and two full year's data were obtained during three years ending in February 1960 (The base was closed for about one year from February 1958 to January 1959).

As the result of the climatological research for the above data the effect of sea ice upon the annual variation of temperature was disclosed, the brief report of which is given in this paper. Detailed paper will appear in "TENKI", Japan Meteorological Society.

## 2. The climatic characteristic of Syowa Base in comparison with the neighbouring stations

The distribution of the annual mean temperature over the Antarctic coastal region is given in Fig. 1. In this figure it is pointed out that

a. The annual mean temperature is nearly same, regardless of the latitude, at the coastal stations of the Indian Ocean Sector, east of Syowa Base;
b. To the west of Syowa Base the remarkable decrease of temperature is seen as the Weddel Sea is approached.

So far as we pay attension to the annual mean, extreme maximum, and extreme minimum temperatures, the climatic characteristic of Syowa Base is quite similar to

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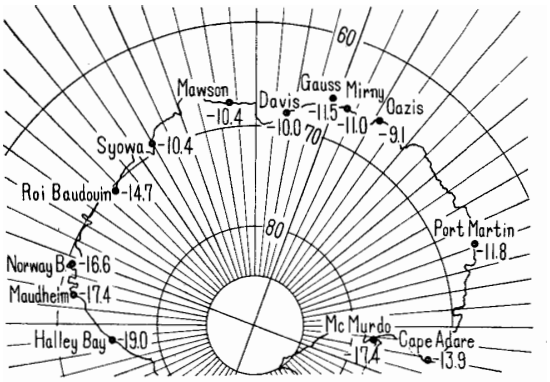


Fig. 1. Annual mean temperature at the coastal region of the East Antarctica.

that of Mawson Base. But, inspecting the annual variation of temperature, there is found a distinct difference in spring and autumn, i.e. it is much warmer at Syowa Base than the Mawson Base in March and April and vice versa in August, September, October and November, as is seen in Fig. 2. Such a trend is not regarded as accidental but seems to be climatologically significant, because it is almost same for the data of 1957 and that of 1959, moreover, the same is found for the comparison with Davis station but is not found for the comparison with Roi Baudouin Base and Norway Base which situate to west of Syowa Base.

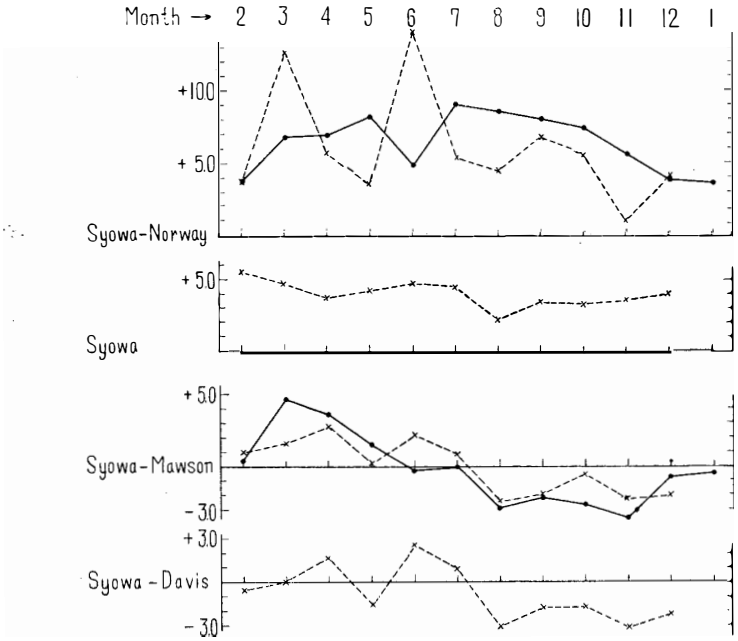


Fig. 2. Difference of monthly mean temperature between Syowa Base and neibouring stations.

## 3. The seasonal variation of sea ice distribution and its effect upon the climate of coastal stations

With respect to the physical cause, which is suggested from the characteristic of the temperature distribution and the annual variation of temperature, the effect of seasonal variation in the sea ice distribution is considered. In general, on the coastal region of Antarctica, the heat loss by radiation is to be compensated with the advection of warm air from the northern ocean throughout the year except a short period of mid-summer. The ocean is thus regarded as a powerfull source of heat. If

the area of sea ice, which enclose Antarctica, should extend further northwards and be covered with snow, the distance from the station to the ice edge would become long as if the prolongation of the coastal line is realized. It causes the thermal effect upon the climate of the station in the following matter. As snow is a bad conductor of heat and a good reflector for incoming solar radiation, the cooling at the surface of sea ice covered with snow becomes large, leading to reduce the temperature at the coastal station as the result of the heat balance for incoming and outgoing radiation and advection of warm air from the northern ocean. And vice versa for the case when the area of sea ice is constricted. The coverage area of sea ice reaches to its maximum in late winter or in spring and minimum in autumn. Therefore it can be said that where the annual variation of sea ice area is large, the relative lowering of temperature in spring and relative rise in autumn may be expected.

Now we fix our eyes upon the charts of pack-ice distribution in the region concerned, which are based on the U.S. Navy Hydrographic Office, it is known that there is

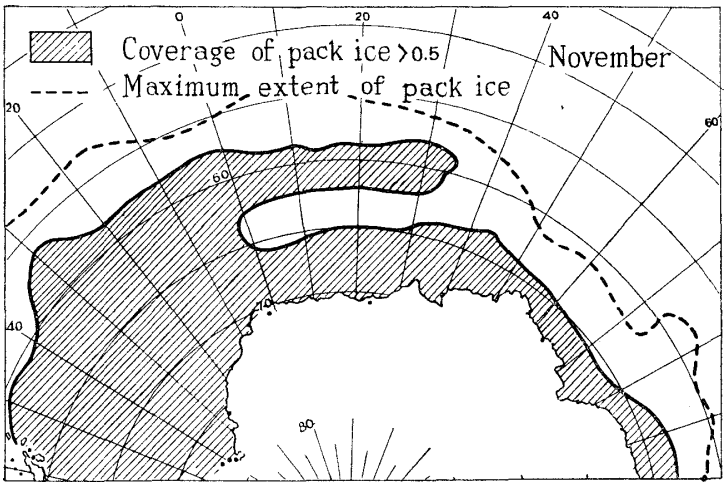


Fig. 3. The distribution of pack-ice in spring.

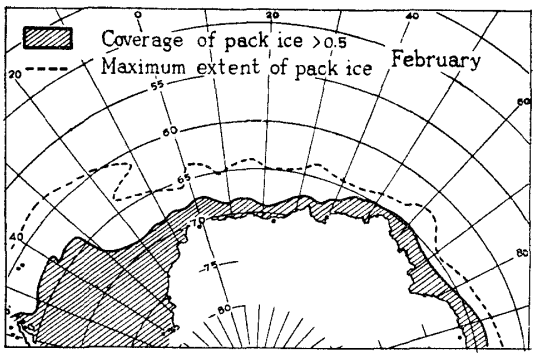


Fig. 4. The distribution of pack-ice in autumn.

formed a vast field of close pack-ice off Lützow-Holm Bay in spring. It refers to the enormous ice tongue which has flown northward from the western Weddel Sea and is carried eastwards by the westerly current, then expanding as far as 60°S, 40°E, as is seen in Fig. 3. In autumn the tongue disapears and the northern limit of pack-ice is recessed to the south, as shown in Fig. 4. Thus the amplitude of the pack-ice area is very large off Lützow-Holm Bay including Syowa Base. While, the amplitude in the offing Mawson Base and the neighbouring coast is much smaller than that in the vicinity of Syowa

Base. The difference between the annual variation of temperature at Syowa Base and that at the Mawson Base can be explained by the above consideration.

## 4. Analysis of the temperature at Syowa Base in spring and autumn

In order to ascertain the above discussion, the statistic analysis for the temperature at Syowa Base in October (spring) and in April (autumn) has been made. The hourly readings of temperature were classified according to whether the wind direction at the time of observation is northerly (from ocean side) or not, and the frequency distribution of temperature was obtained as is seen in Fig. 5. At a glance in Fig. 5 it is evident that the relative coldness in october is mainly due to the low temperature of the air from north, the ocean side, than that in April. Here it is noteworthy that the relative coldness in October is not caused by the smaller frequency of northerly wind, which is generally warmer than the southerly, but by the relative low temperature of northerly wind itself. This is enough to explain the reason of relative coldness in spring as the effect of sea ice rather than as the accidental irregularity of synoptic pattern in the period concerned.

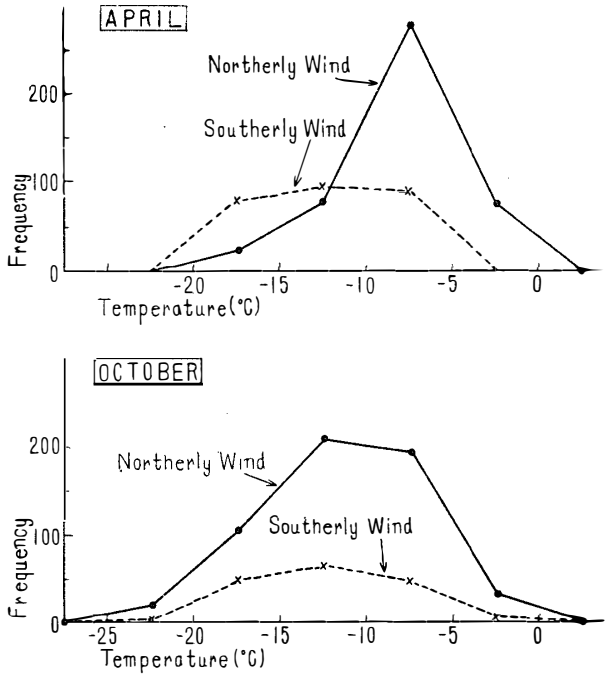


Fig. 5. Frequency distribution of temperature for northerly and southerly wind.

## 5. The relation between the temperature at costal stations and the distances from the stations to the north boader of pack-ice

The above consideration necessarily leads to assume the existence of the correlation between the temperature at coastal stations and the distances from the stations to the edge of sea ice. For trial, the monthly means of temperature at the coastal stations in October and December were plotted against the distances from the stations to the mean position of pack-ice line, available from the "METEOROLOGY OF THE ANTARCTIC", published by Weather Bureau, Pretoria, South Africa. The result is shown in Figs. 6, 7 and 8. In these figures the correlation is seen as is expected for the stations of the Indian Ocean Sector, and it is concluded that the monthly mean temperature is reduced at the rate of 0°.6 C/100 km, 3°.0 C/100 km and 3°.9 C/100 km

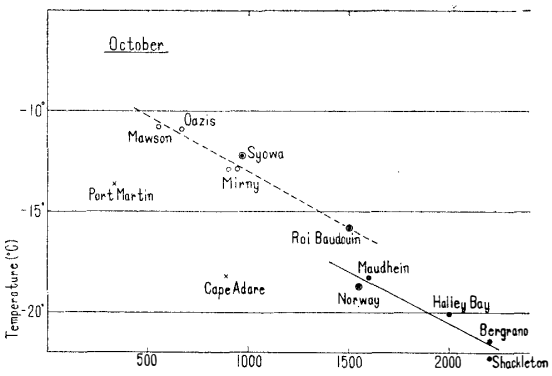


Fig. 6. Distance from the station to the pack-ice line (km).

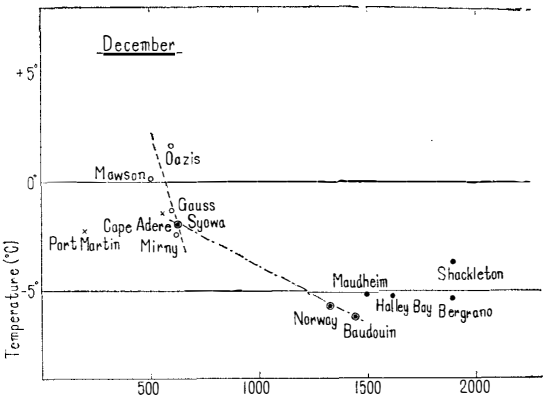


Fig. 7. Distance from the station to the pach-ice line (km).

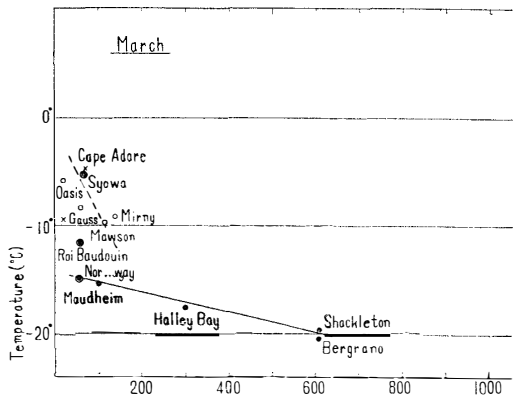


Fig. 8. Distance from the station to the pack-ice line (km).

for October, December and March respectively corresponding to the distance from the station to the mean pack-ice line is prolonged.

## 6. Conclusion

The relative coldness in spring and warmness in autumn at Syowa Base compared with the Mawson Base, is well explained as the effect of large annual variation of sea ice in the vicinity of Lützow-Holm Bay. It is proved by a statistical analysis of wind and temperature at Syowa Base and by the existence of the correlation between the temperature and the distance from the stations to the pack-ice line for the coastal stations of Indian Ocean sector.

But, further research seems to be desirable after when the Antarctic climatological data could be completed more precisely and the macroscopic distribution of sea ice for individual years could be obtained. The theoretical treatment about this problem is also desirable.