7. CYCLONE TRACKS IN THE HIGH LATITUDES IN NOVEMBER 1969 AND JUNE 1970

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The frequency of occurrence of cyclones and anticyclones has already been discussed, but an examination of cyclone tracks through each month in the vicinity of the Antarctic continent (*ie*, south of about 55°S) has been made.

In the first five days of November 1969 (Fig 7.1(a)) most cyclones showed a pronounced zonal movement in all sectors. During the second five-day period (Fig 7.1(b)) some centres showed rather more marked meridional, and slower, movement, whilst in the third period (Fig 7.1(c)) rapid zonal displacement was again observed particularly across the South Pacific ocean *ie*, in the sector off West Antarctica. In the latter half of the month (Fig 7.1(d), (e), (f)), some centres in almost all sectors showed marked zonal displacement, but this was generally more evident in the western than in the eastern hemisphere. Fast moving centres in the eastern hemisphere were generally short lived.

November is the month during which the breakdown of the Antarctic stratospheric polar vortex can generally be observed over the continent. Investigations have shown (*eg*, Phillpot, 1969) that during the breakdown process, warm stratospheric air first invades East Antarctica whilst the vortex is displaced towards the South American sector where it persists for some time. The general pattern of surface cyclone behaviour in November 1969 suggests that the observed changes may have been related to the vortex changes.

No detailed study has been made of the 1969 southern spring stratospheric warming, but Fig 7.2 shows the temperature change between 1 August and 15 December 1969 at the 30 mb level for Mirny (66° 33'S 93° 01'E) where the average temperature through the season has also been assessed (Phillpot, 1969). Through most of September and October 1969, the 30 mb temperature was well below normal, although it increased rapidly with a change to the summer regime around 5 November. However there were two short lived cold spells (14 and 24 November) during the month.

From similar plots of available 30 mb temperature at other Antarctic stations it appears that the main warming at 30 mb occurred early in November over East Antarctica from about Syowa to Hallett and extended inland to about Vostok, but no strong warming occurred over the South American sector of the continent until late in November.

This preliminary inspection of the conventional observations suggests that the behaviour of the polar vortex can be related to that of the surface cyclones, but a much more detailed study of the stratosphere (employing also the SIRS observations) would be necessary before any more positive statement could be made. It is interesting to note that at the 100 mb level where the temperature behaviour at Mirny can be compared with that in twelve earlier years (Phillpot 1969), the temperature was well below normal except for the first ten days of November 1969. This suggests that in this sector at least, November 1969 might not have been a "normal" year.

In June 1970, cyclone tracks south of about latitude 55° showed zonal movement generally for the first 5 days (Fig 7.3(a)). During this period, a quasi-stationary system was apparent in the vicinity of the Pole. Zonal movement continued throughout the next 5 days (Fig 7.3(b)) over most longitudes but more meridional (southward) displacement became apparent between about 150°E and 120°W. Over the Antarctic, one system moved well inland from near McMurdo. From about 10 to 20 June (Fig 7.3(c) and (d)) pronounced meridional flow was apparent in all longitudes apart from the sector from about 10°E to 80°E. Slow moving centres were observed between the Pole and the Ross Ice Shelf (11 and 12 June) and near the Pole (18 to 20 June).

Meridional movement continued over most sectors from 20 to 25 June (Fig 7.3(e)) with two tracks penetrating well into Antarctica: one moved across the Ross Sea and Ice Shelf into West Antarctica and towards the Pole, whilst the other moved south to southeast across the coast between 10°E and 30°E. The quasistationary low remained near the Pole until 22 June. In the final five day period (Fig 7.3(f)) more zonal movement was shown in most sectors although some systems were quite slow moving.

To see whether any relationship could be established between the general behaviour of the surface cyclones and the 200 mb circulation, which, particularly at this time of the year over the Antarctic, can be used to illustrate the behaviour of the polar vortex, the 200 mb geopotential at 70°S was plotted through the month on a Hovmoller-type diagram (Fig 7.4(a)).

This showed:

- Marked low values of geopotential through the month between about 40°W and 80°E (*ie,* through 0°), with higher values over the remainder of the hemisphere. When high geopotential values were observed between 40°W and 80°E they were not as great as those found elsewhere. Similarly the lows were generally deeper.
- In the first ten days of the month there was no very marked variation in geopotential around the hemisphere *ie,* there were no very well defined ridges or troughs, and the high values tended to follow the latitude parallel. The circulation is illustrated in Fig 7.5(a).
- In the second ten-day period there was some persistence of high geopotential in the 80°W - 40°W sector, but on the whole there was a three-wave regime, one of the troughs being particularly well defined. The circulation is illustrated in Fig 7.5(b).
- In the third ten-day period (illustrated by Fig 7.5(c)) there was an essentially bi-polar regime with two very well defined troughs about 150° longitude apart. The persistence of high geopotential in this period was in about 100°E.
- During the period 10-30 June, a geopotential maximum appeared to move downstream from about 120°E on 13 June to 70-80°W on 29 June *ie,* on the average about 10° longitude per day.

The average value of the 200 mb geopotential around lat 70°S each day is shown in Fig 7.4(b). The long term average (Taljaard *et al,* 1969) is 10,800 m, but the values through June 1970 were generally higher. The lowest values occurred on 11 and 26 June; in the former case there was a 3-wave, and in the latter a 2-wave, regime, but the most notable features were deep low centres and only weak ridges.

This inspection of the surface cyclone behaviour suggests that a marked zonal displacement is indicative of a relatively undeformed polar vortex whilst marked meridional displacement is observed when the vortex, even at the 200 mb level, is characterised by wave numbers two and three. If this could be established more positively, tropospheric-stratospheric coupling in association with stratospheric temperature variations could be demonstrated.

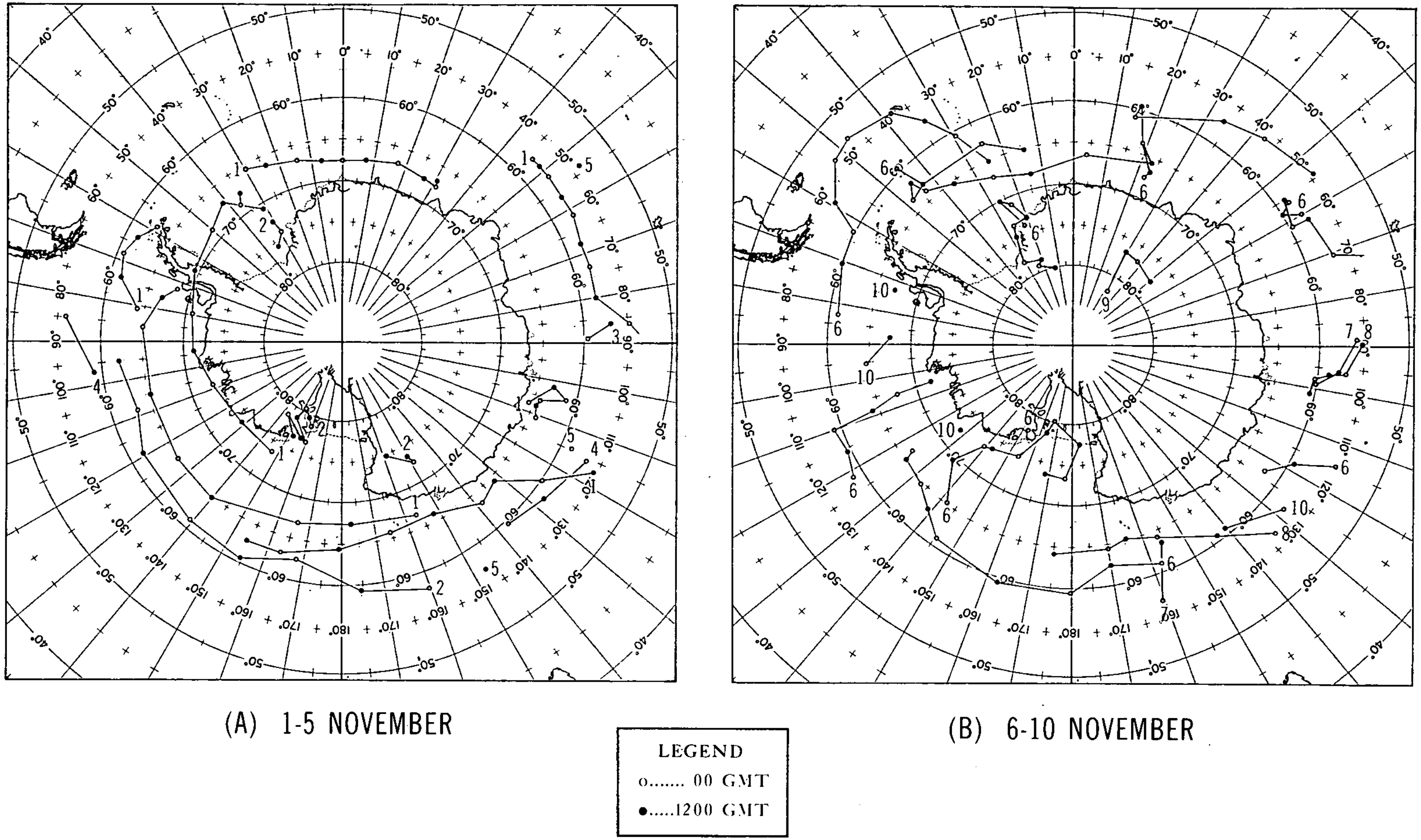
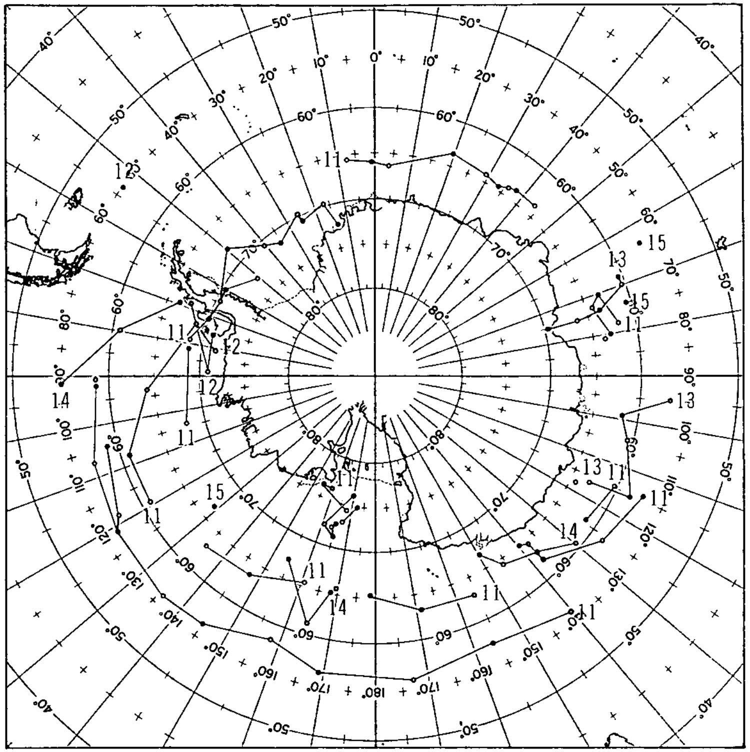
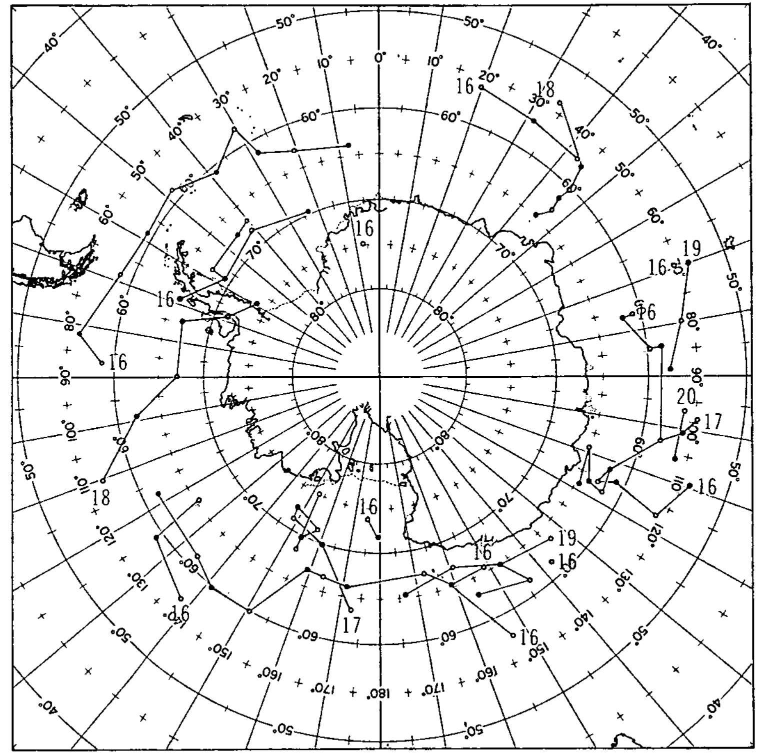


Fig 7.1 Tracks of cyclones south of 55°S during November 1969.



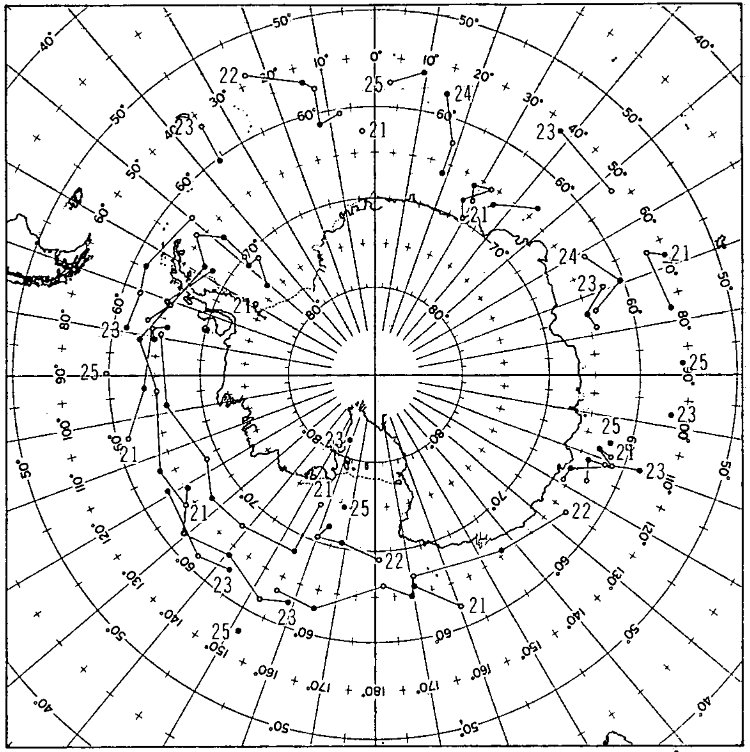
(C) 11-15 NOVEMBER



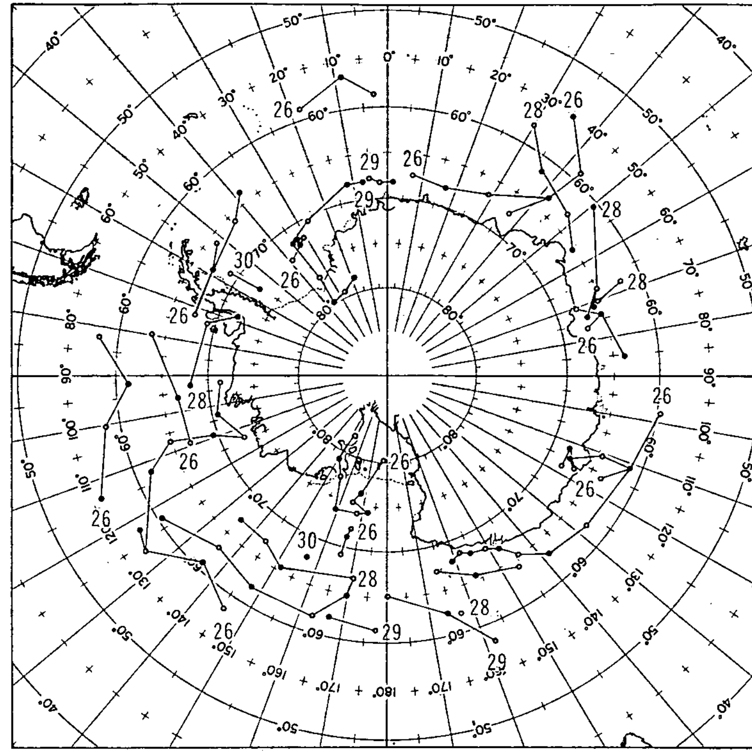
(D) 16-20 NOVEMBER

LEGEND
o .... 00 GMT
● .....1200 GMT

Fig 7.1 (continued)



(E) 21-25 NOVEMBER



(F) 26-30 NOVEMBER

LEGEND
o .... 00 GMT
● ......1200 GMT

Fig 7.1 (continued)

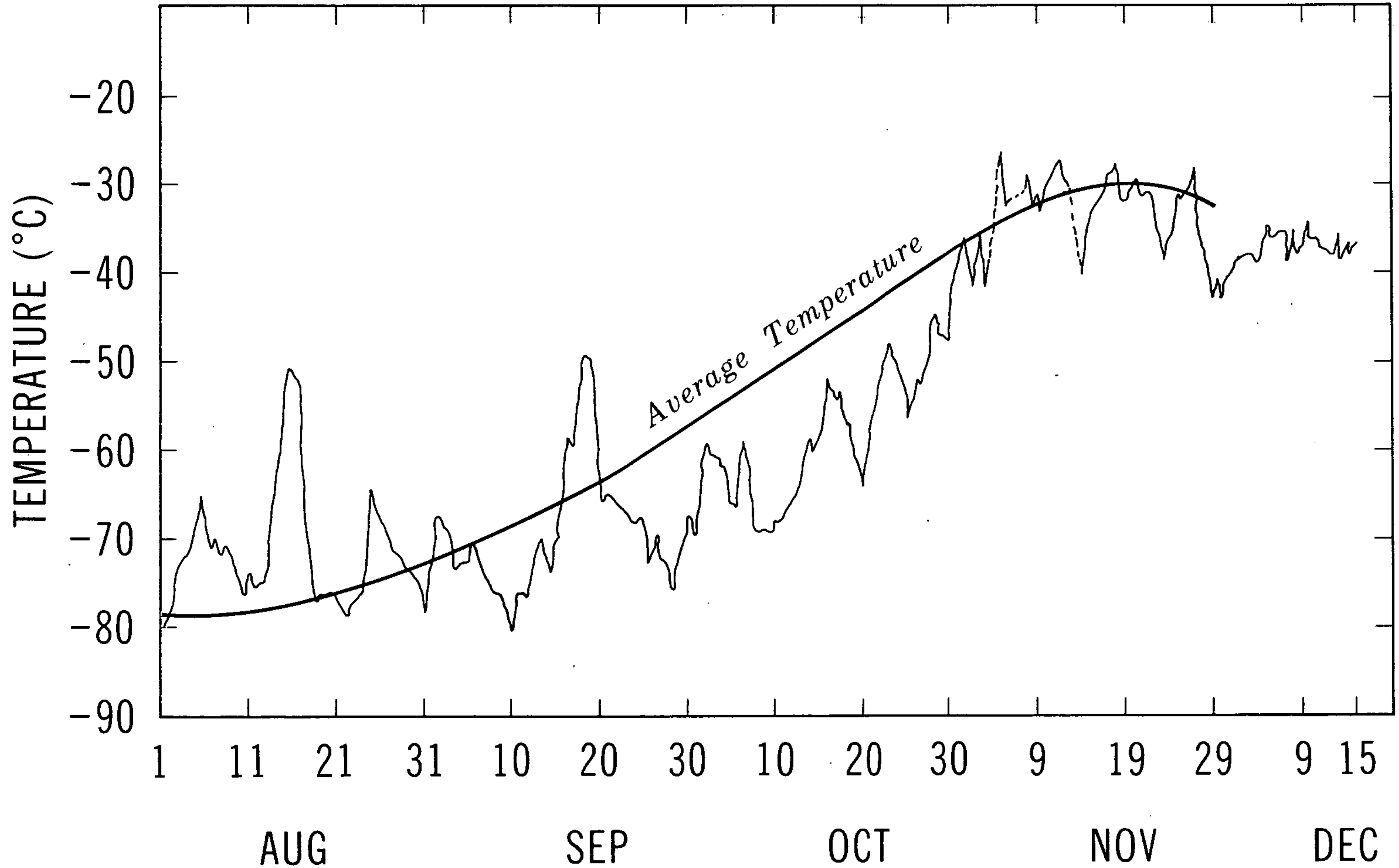
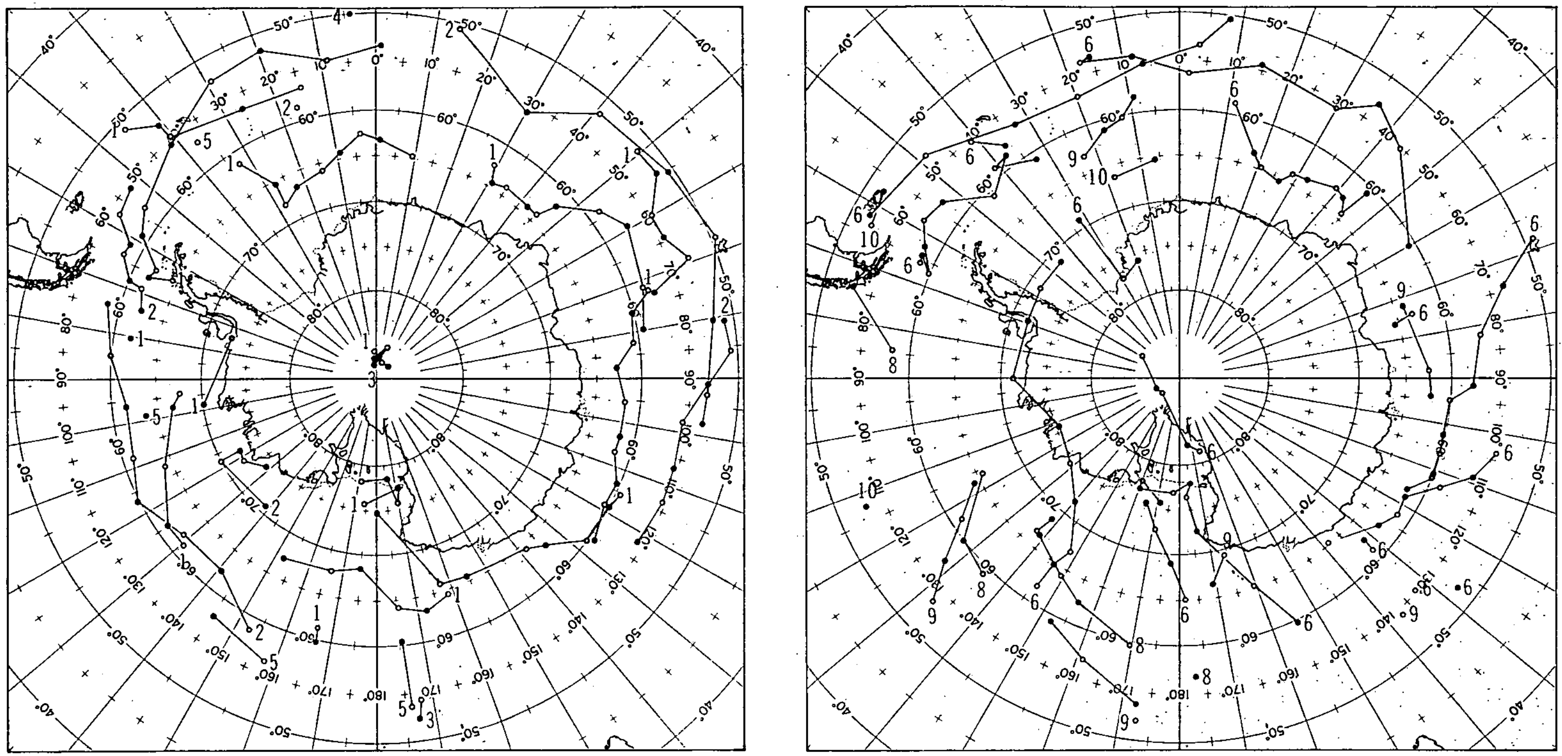


Fig 7.2 Temperature variation at the 30 mb level at MIRNY (66° 33′S; 90° 01′E) between 1 August and 15 December 1969.



(A) 1-5 JUNE

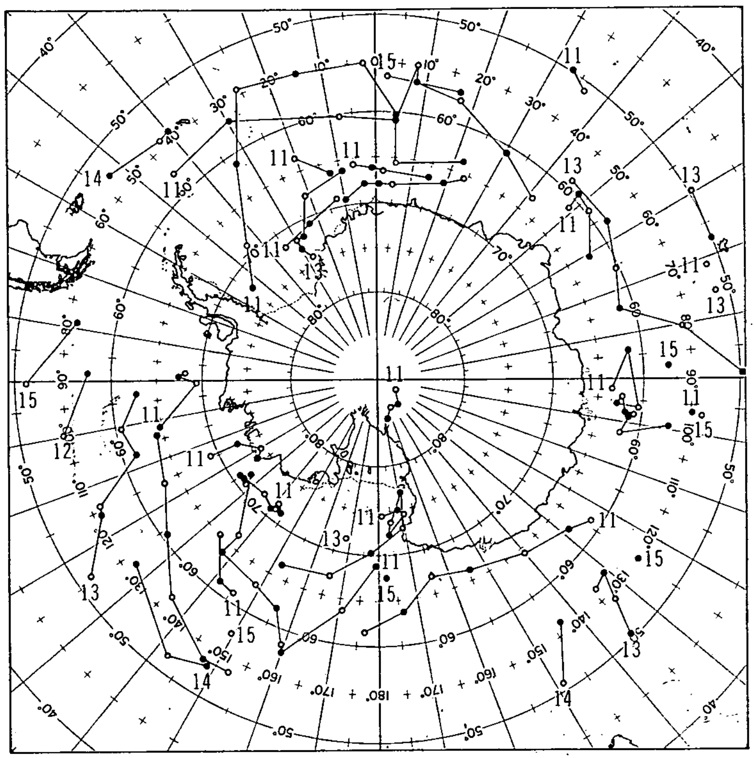
(B) 6-10 JUNE

LEGEND

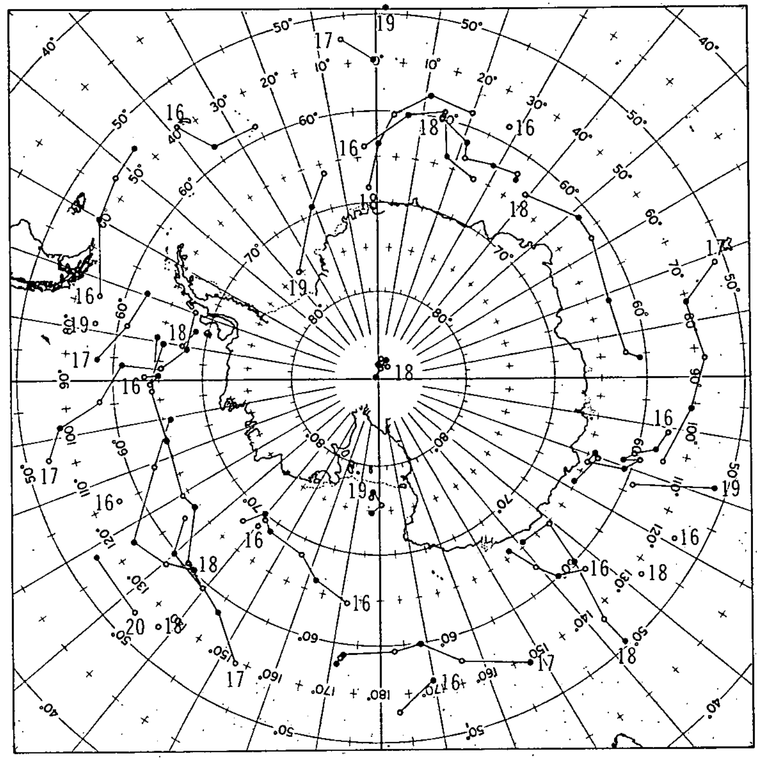
o........ 00 GMT

●..... 1200 GMT

Fig 7.3 Tracks of cyclones south of 55°S during June 1970.



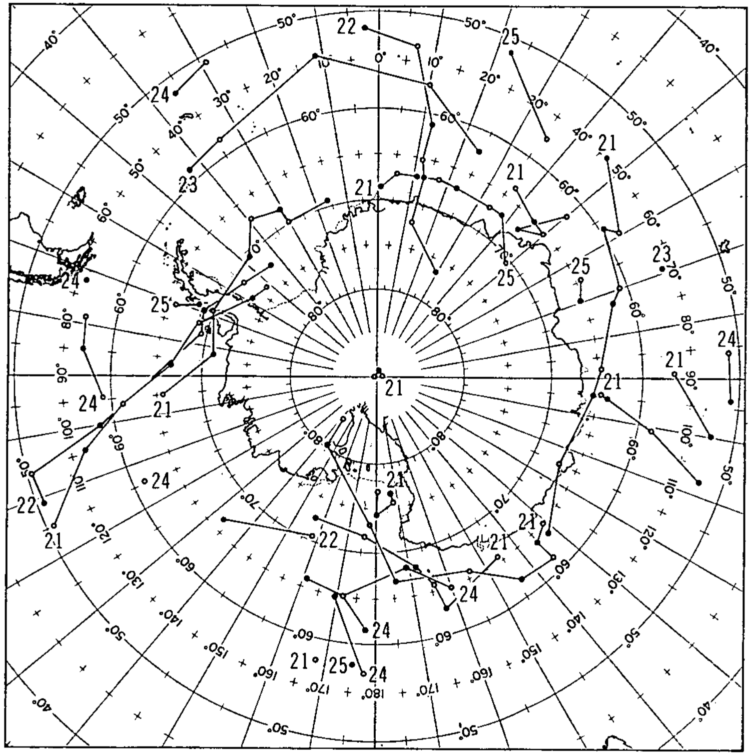
(C) 11-15 JUNE



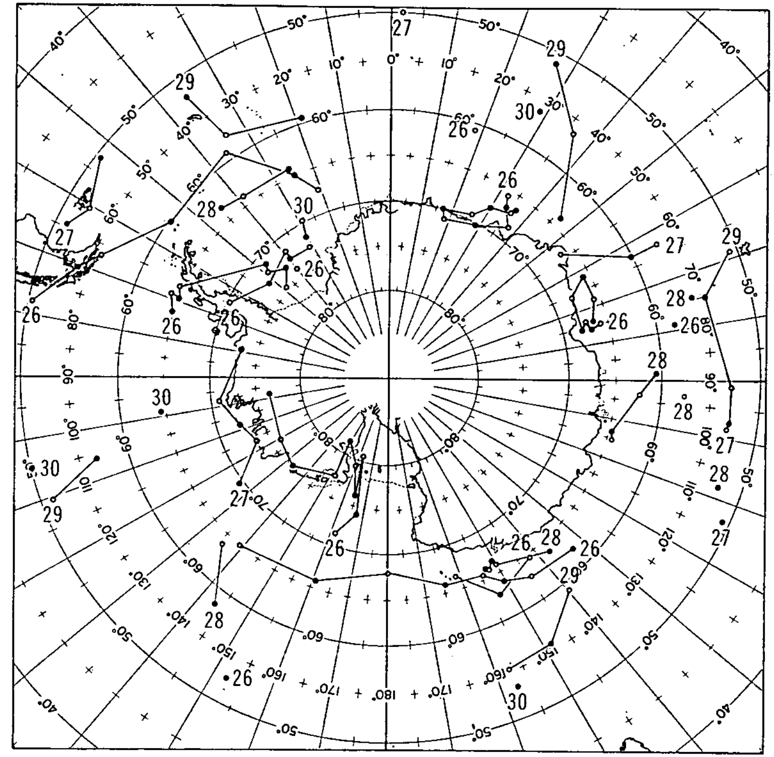
(D) 16-20 JUNE

LEGEND
o....... 00 GMT
●.....1200 GMT

Fig 7.3 (continued)



(E) 21-25 JUNE



(F) 26-30 JUNE

LEGEND

o....... 00 GMT

•.....1200 GMT

Fig 7.3 (continued)

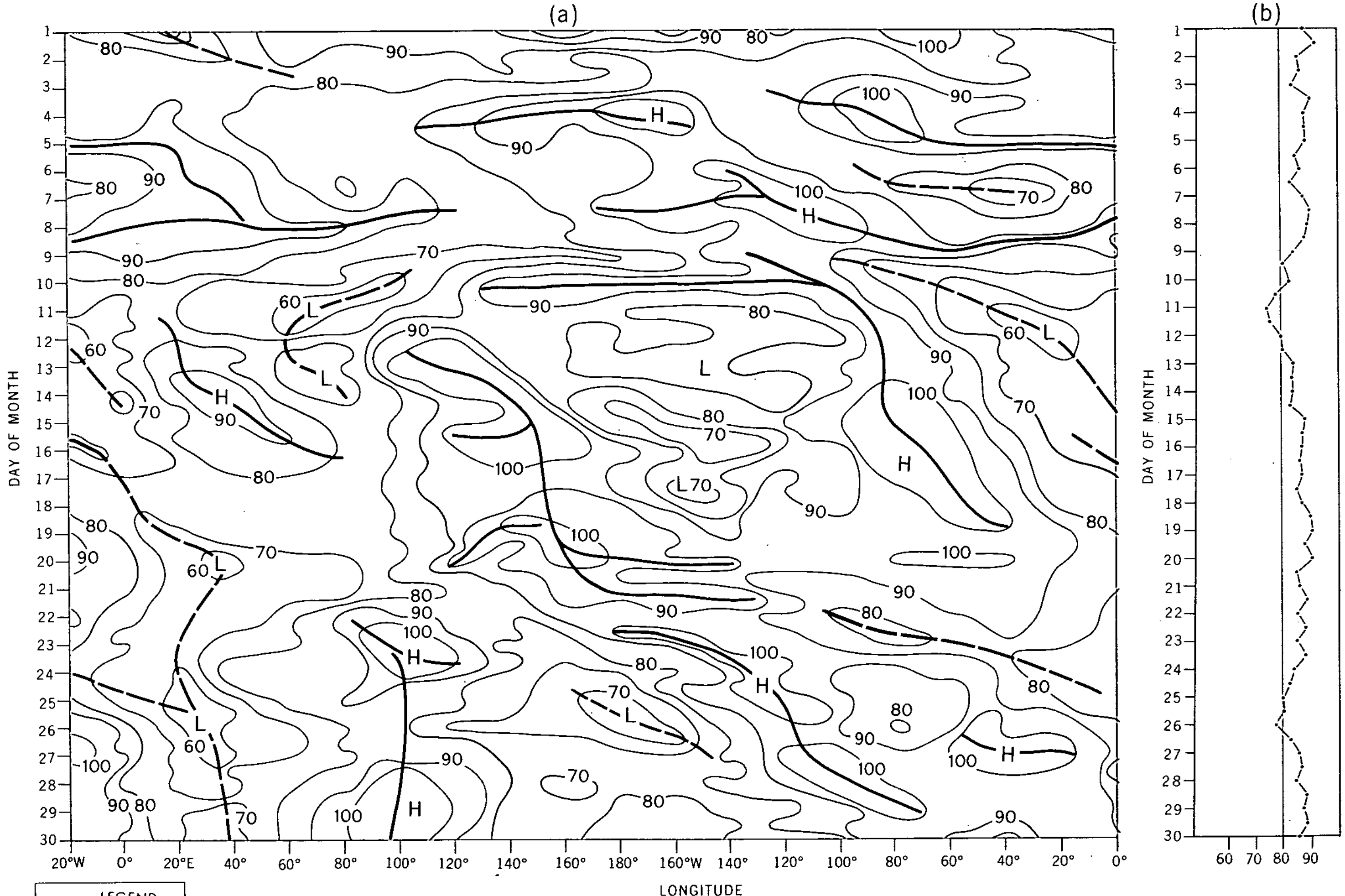
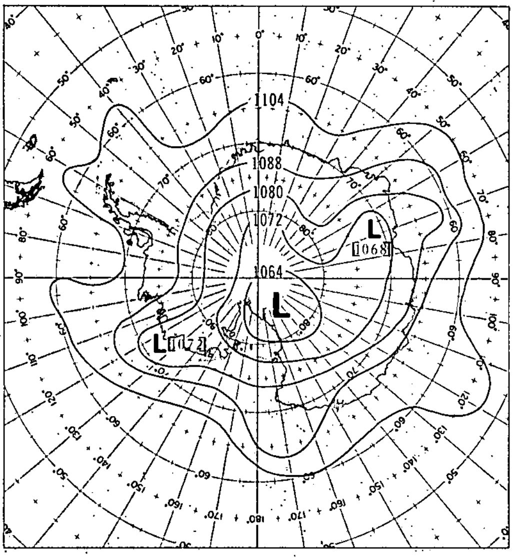
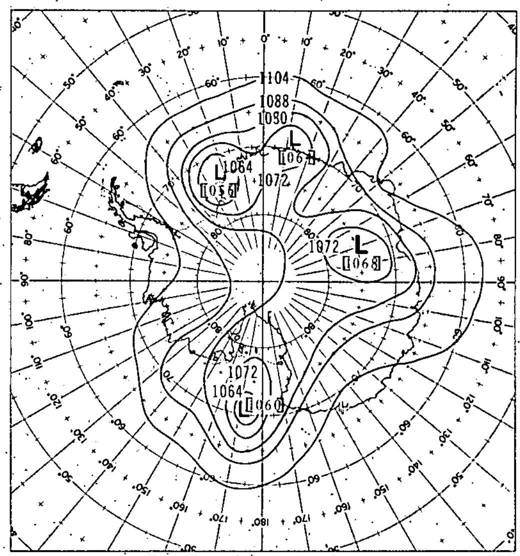


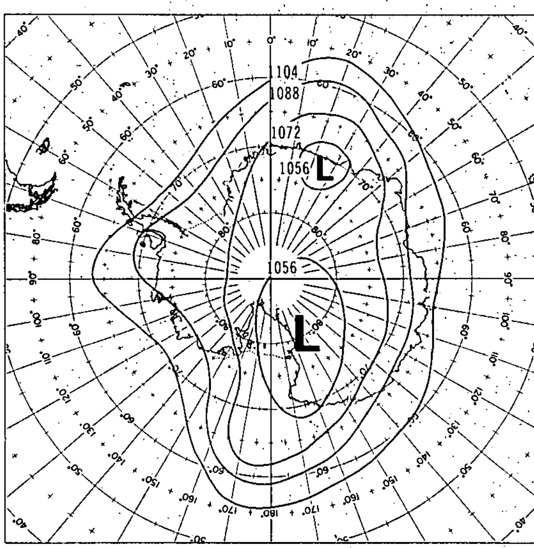
Fig 7.4 The variation through June 1970 (a) at 70°S of 200 mb geopotential with longitude and time; (b) of the average 200 mb geopotential around 70°S. Geopotentials are shown in dekametres minus 1000.



A 5 JUNE 1970



B 15 JUNE 1970



C 25 JUNE 1970

Fig 7.5 Portion of the 200mb contour analyses at 00 G.M.T.