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DARWIN TROPICAL DIAGNOSTIC STATEMENT

JANUARY 1989

ISSUED BY DARWIN RMC

SUMMARY AND OUTLOOK

Rain for January was below average across most of northern and inland Australia. This is largely a reflection of the fact that most of the month fell in a 'break' period of the northern Australian monsoon. Rain over these areas is still mostly above average for the 'wet' season as a whole, indeed well above in some areas.

The La Nina effect is still well defined in terms of sea surface temperatures and pressure anomalies. Sea surface temperatures remain below average in the central Pacific equatorial region and above average across the northern Australian and Indonesian area. Significant negative pressure anomalies remain across northern Australia. Based on these patterns it is likely that rainfall across northern Australia will be mostly above average for the rest of the 'wet' season. However some caution must now be shown in assessments of rain potential over inland areas of eastern Australia. The relationship between the strength of the Walker circulation at this stage in the year and rain in those areas is not as firm as it is early in the 'wet' season.

INDICES

The Southern Oscillation Index for January is +12. It has now been over one standard deviation (10) above average for seven months. The 5 month running mean of the SOI remains at +16. Both the contributions of Darwin and Tahiti to the SOI remain significant.

1. Darwin mean MSL pressure, January 1989	:	1005.4 hPa
pressure anomaly (1882-1985 mean)	:	-0.9 hPa
2. Tahiti mean MSL pressure, January 1989	:	1012.6 hPa
pressure anomaly	:	+1.7 hPa
3. Troup's Southern Oscillation index	:	+12
5-month mean (centred upon October)	:	+16

4. Troup's SOI for the last 25 months:

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
1987	-7	-14	-15	-22	-20	-18	-18	-13	-11	-6	-1	-6
1988	-2	-6	+1	-1	+10	-4	+11	+14	+20	+16	+20	+10
1989	+12											

Graphs of the monthly SOI and the five month running mean SOI for the past ten years are given in Figure 1.

TROPICAL CYCLONES

Four tropical cyclones occurred between 70E and 180E during January. One cyclone occurred in the NW Pacific, one near New Caledonia and the other two in the Indian Ocean. The Australian coastal region still remains remarkably devoid of cyclones in view of the proven relationship between high values of the SOI and cyclones (Nicholls 1984). Unofficial tracks are shown in figure 3.

The first cyclone during January was Delilah which first appeared as a depression off the north Queensland coast. It moved eastward and reached severe tropical cyclone status as it approached New Caledonia during the second of the month. Delilah then moved into a sheared upper wind environment and weakened rapidly after the third.

Tropical cyclones Winona, in the northwest Pacific, and John, in the northeast Indian ocean, were only weak storms. They lasted only two or three days and barely reached gale force.

The cyclone with the highest estimated maximum sustained wind was cyclone Edme in the central Indian ocean. It was first analysed as a depression about 150 nm west of Cocos Island on the 19th and moved in an erratic manner in a broadly southwest direction. By the 22nd it had moved to a position under the upper level ridge and intensified steadily. The highest estimated sustained wind of 75 knots was reached on the 24th. During the following two days it weakened rather quickly. Judging from satellite imagery the shear caused by the passage of a substantial trough in the westerlies appears to have been the cause of this dissipation.

SEA SURFACE TEMPERATURE

The mean sea surface temperature and anomaly fields for January are shown in Figures 4 and 5.

Sea surface temperature anomalies in the northwest Australia and Indonesian region are about a degree more positive than December. This is probably a reflection of the predominance of wet season 'break' conditions causing warming by the sun. In comparison December was more cloudy in that region as can be seen in the time series of cold cloud in Fig. 16. Other changes in the anomaly field are small and not significant.

MSL PRESSURE AND GRADIENT LEVEL FLOW

Mean MSL pressure and anomaly charts for January are shown in Figures 6 and 7, and the gradient level (950 hPa) streamline and vector wind anomaly charts in Figures 8 and 9.

A significant feature of the pressure anomaly chart is the positive values south of the Australian continent indicating that the subtropical ridge was more persistent than normal. The centre of negative anomalies south of New Caledonia results from above average activity of the South Pacific Convergence Zone and the presence of two synoptic scale lows in the area during the month. Also of note are the significant negative anomalies through Indochina and the Indian subcontinent. No obvious reason can be seen for this feature.

The absence of strong cross equatorial flow from the northern hemisphere in Australian longitudes coincides with a lack of strong convection during most of the month in that area. Widespread southerly anomalies across most of the southern hemisphere reflect the strong subtropical ridge and the low pressure in the monsoon trough which was near the northern tip of Australia for most of the month.

850 hPa DAILY MEAN ZONAL AND MERIDIONAL WINDS AND AT DARWIN

Figures 10 (a) and (b) are plots of the 3-day running means of 850 hPa zonal and meridional winds at Darwin, for January.

In December the monsoon trough moved well south into inland Australia. Then during the first week of January the trough gradually weakened and retreated northward. By the 6th of the month convection over northern Australia was once again disorganised and diurnal in nature, heralding the start of a 'break' period in the monsoon. It can be seen that around this time the zonal wind component at Darwin turned from westerly to easterly, and stayed easterly until near the end of the month.

The last week of January saw the onset of the next 'active' period of the wet season. On about the 23rd convection over the sea to the north of Australia started to increase, and a trough was drawn on MSL analyses. A depression then formed off the north coast, causing strengthening southeasterlies which can be seen on the wind component plots. On the 29th the trough and depression moved southward over the coast, producing widespread heavy rain throughout the 'Top End' and areas around the Gulf of Carpentaria.

WIND CROSS SECTION

The equatorial cross section of meridional wind for January is given in Figure 11.

The most notable feature is the lack of any significant cross equatorial flow. The only exception is the upper southerlies near the dateline which is normally present at this time of the year (Sadler, 1975).

UPPER LEVEL FLOW

The mean 200 hPa streamline and vector wind anomaly charts for January are given in Figures 12 and 13.

The paucity of 'active' monsoon conditions in the Australian/Indonesian region during January is borne out by the northerly component in the upper level wind. This is in contrast to the previous month. Also it can be seen that westerly wind predominated across northern Australia in line with the northward retreat of the monsoon. A distinct centre of 200hPa divergence can be seen over the Indonesian region.

VELOCITY POTENTIAL

Charts of the velocity potential fields at 950 hPa and 200 hPa for January are given in Figures 14 and 15.

At 950 hPa the pattern of velocity potential has changed little from last month. The maximum is centred to the east of the Philippines, with ridges across the equator in Indian longitudes and into the Coral sea.

At 200hPa the centre of divergence has moved southward from December into the Indonesian region. This coincides with the divergent area on the streamline chart. Of interest is the decrease in the magnitude of the values of the maximum and minimum over China and Indonesia respectively, indicating a decrease in the southerly divergent wind component through southeast Asia. Perhaps this is a reflection of the predominance of 'break' conditions in the southern monsoon.

A new feature of this diagnostic statement is the time-longitude cross section of 200 hPa velocity potential. It is shown as Fig. 17. The values are obtained on a daily basis in the Darwin RMC by using a personal computer to run a program on a mainframe in Melbourne. This program performs spatial averaging of the velocity potential fields which are output from the Davidson-McAvaney tropical analysis scheme. The averaging is done between 5°S and 15°S latitude and in 10 degree segments between 90°E and 170°E. The main purpose of this display is an attempt to depict the 40/50 day, Madden and Julian, oscillation. As can be seen in the diagram the two maxima are separated by about 55 days. This confirms the findings in several studies (eg Krishnamurti, Oosterhof and Mehta, 1987) that this oscillation does not always remain within the period between 40 and 50 days.

RAINFALL AND CLOUD COVER

Monthly rainfall quintiles for selected stations in January are given in Figure 2.

In contrast to December, below average rainfall predominated across northern and central Australia. Cumulative rain for the 'wet' season remains above average. The low values during January are more a reflection that most of the month fell into a 'break' period as determined by the Madden and Julian (1972) 40/50 day oscillation.

Fig. 16 is another new feature of this diagnostic statement. It has been obtained by processing digital infrared GMS satellite data as received at Darwin RMC. The processing program counts the percentage of the cloud cover with temperature less than -40°C from the equator to 7 degrees south in 5 degree longitude segments from 100°E to 160°E. A 5 day running mean is then constructed from this field, and the result manually analysed. As good correlations exist between amount of cold cloud cover and tropical rainfall of convective origin, this diagram in fact shows the temporal variability of rain during the wet season as averaged between the equator and 7°S. It can be seen that there is good spatial and temporal coherence between cold cloud cover and 200 hPa velocity potential.

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Krishnamurti, T.N., Oosterhof, D.K. and Mehta, A.V. 1987. Air-Sea Interaction on the Time Scale of 30 to 50 days. J. Atmos. Sci., 45, 1304-1322.

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Nicholls,N. 1984. A system for Predicting the Onset of the North Australian Wet Season. J. of Clim. Vol 4, 425-435.

Sadler, 1975. The Upper Tropospheric Circulation over the Global Tropics. Dept. of Meteorology, University of Hawaii.

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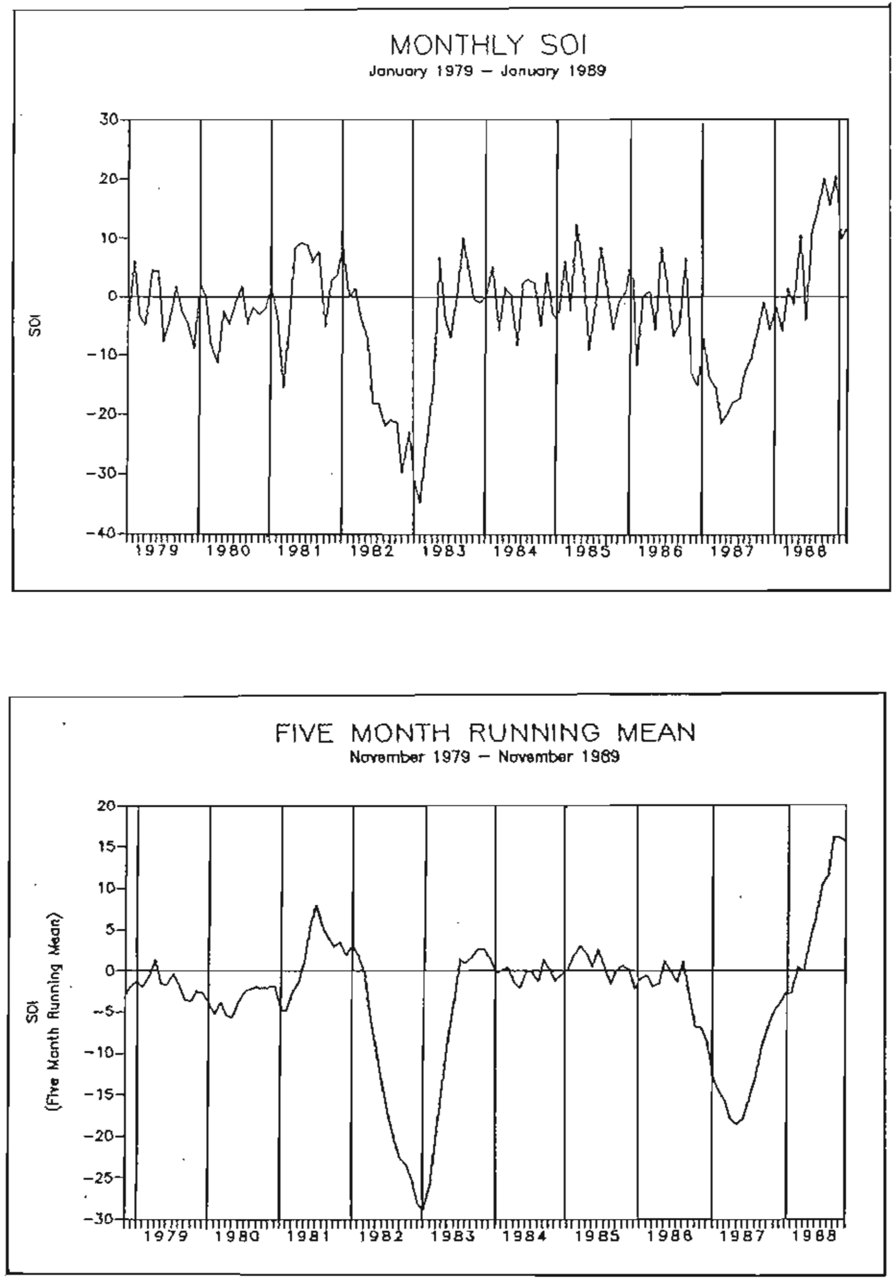


Fig.1 SOUTHERN OSCILLATION INDEX (1978-1989)
Monthly SOI and 5-month running mean SOI

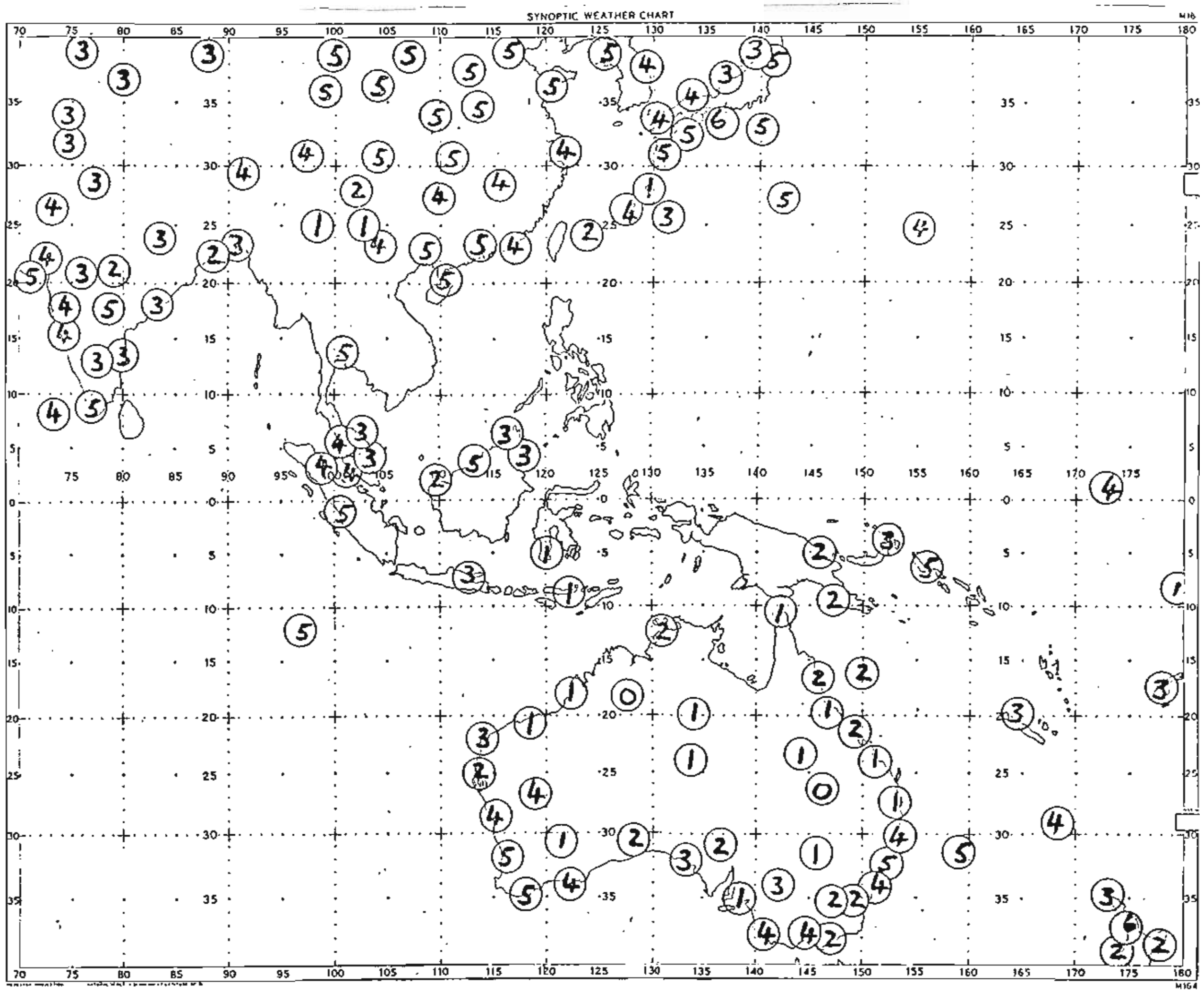


Fig.2 * MONTHLY MEAN RAINFALL QUINTILES from selected climat stations (JANUARY 1989)

* Quintile 0 denotes record low rainfall
Quintile 6 denotes record high rainfall

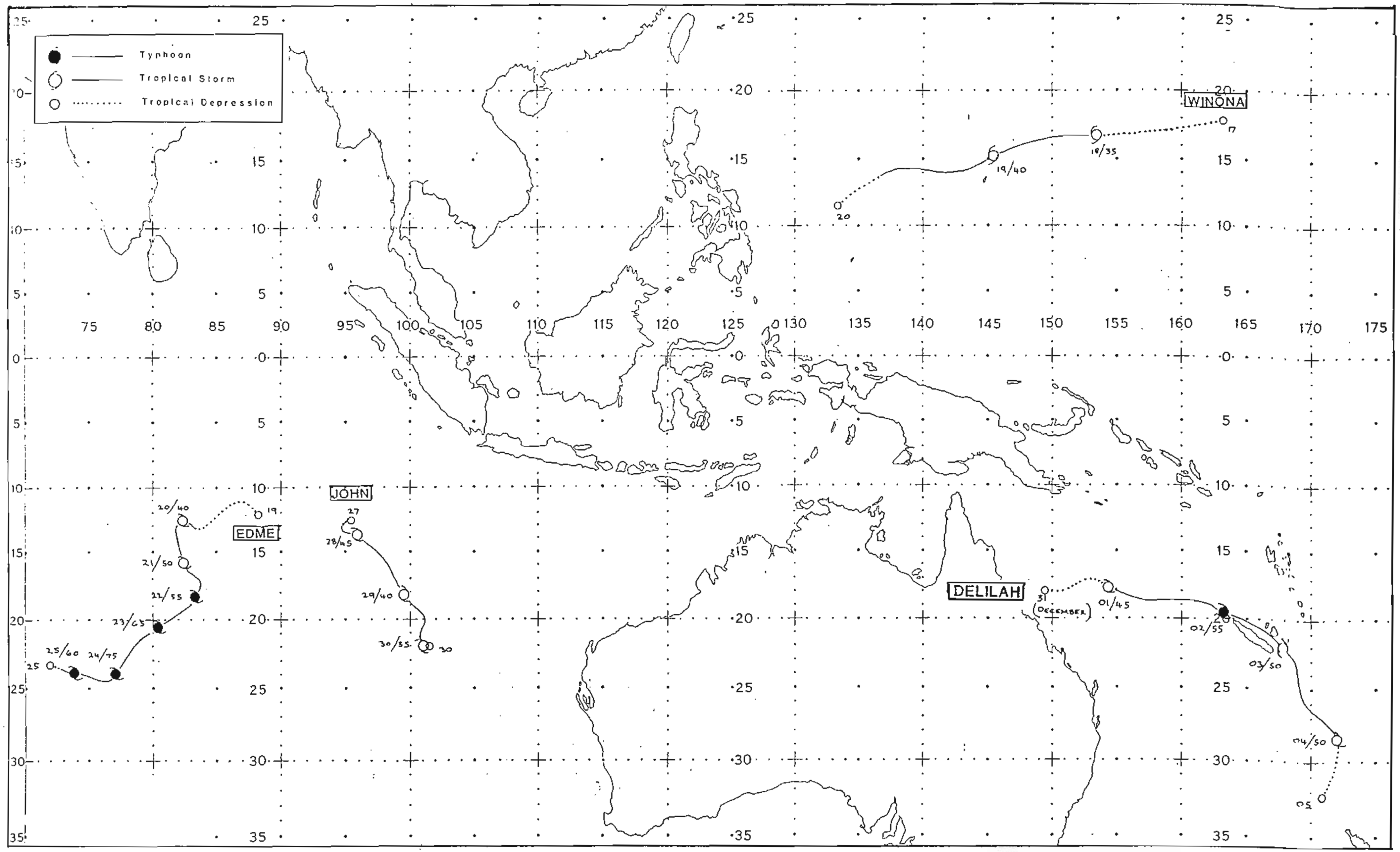


Fig.3 UNOFFICIAL TRACKS OF CYCLONES DELILAH, WINONA, EDME AND JOHN (JANUARY 1989)
Date (DD) and maximum sustained wind (ff) in knots denoted by DD/ff.

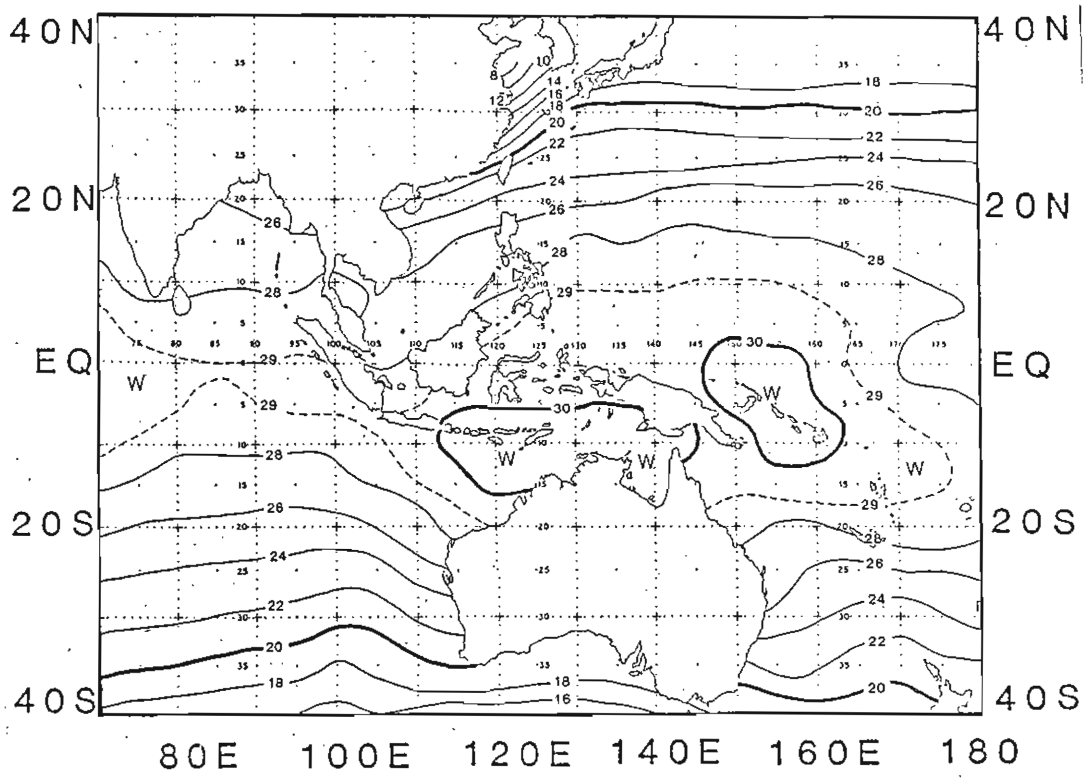


Fig. 4 MEAN SEA SURFACE TEMPERATURES, BASED ON WEEKLY DARWIN RMC ANALYSES AVERAGED OVER THE MONTH, JANUARY 1989. Isotherm interval 2° C.

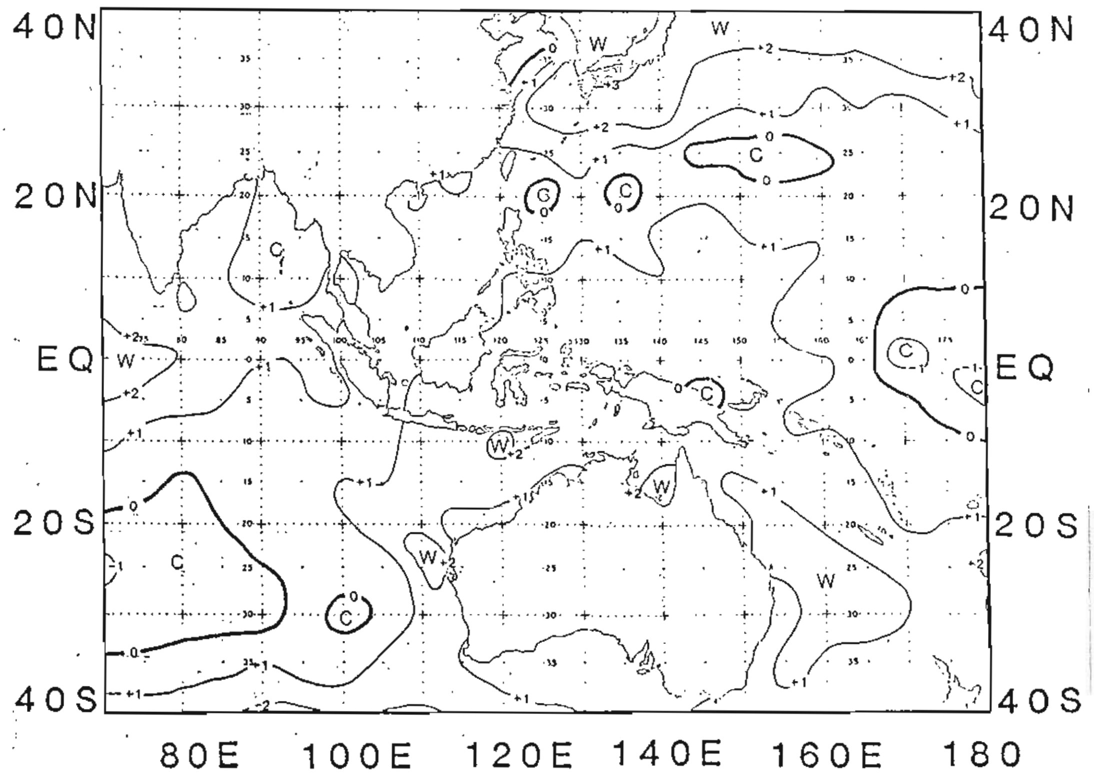


Fig. 5 SST ANOMALY CHART, BASED ON FIG. 4 AND THE CLIMATOLOGY OF REYNOLDS, NOAA REPORT NWS 31, 1983 Isotherm interval 1° C.

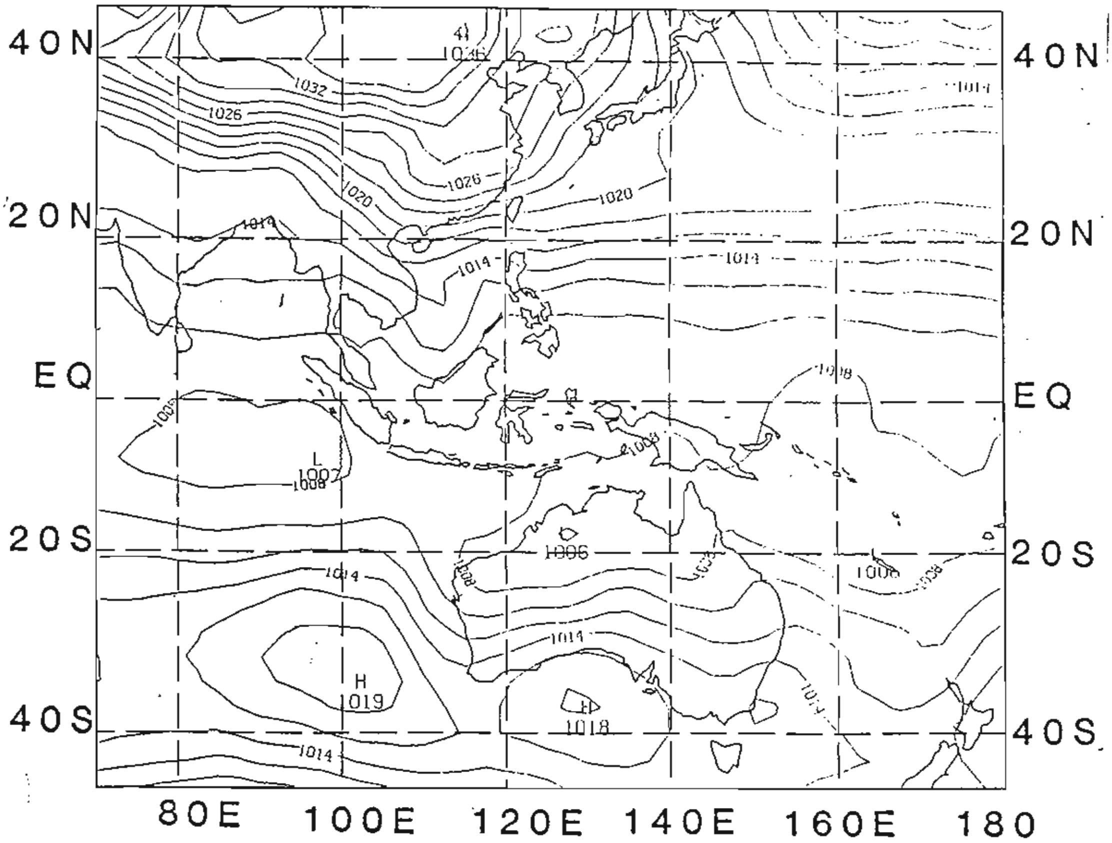


Fig. 6 MONTHLY MEAN MSL PRESSURE, JANUARY 1989
Isobar interval 2 hPa

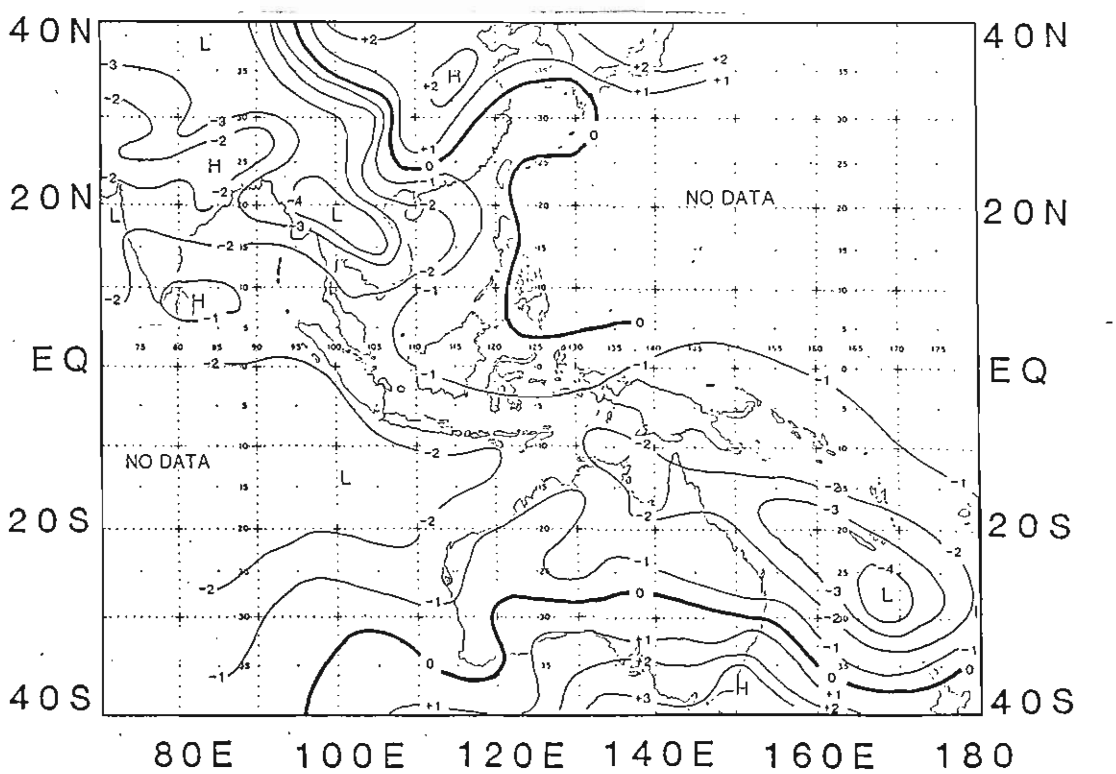


Fig. 7 MSL PRESSURE ANOMALY BASED ON CLIMAT MESSAGES (AND MELBOURNE WMC DATA SOUTH OF $10^{o}S$)
Contour interval 1 hPa.

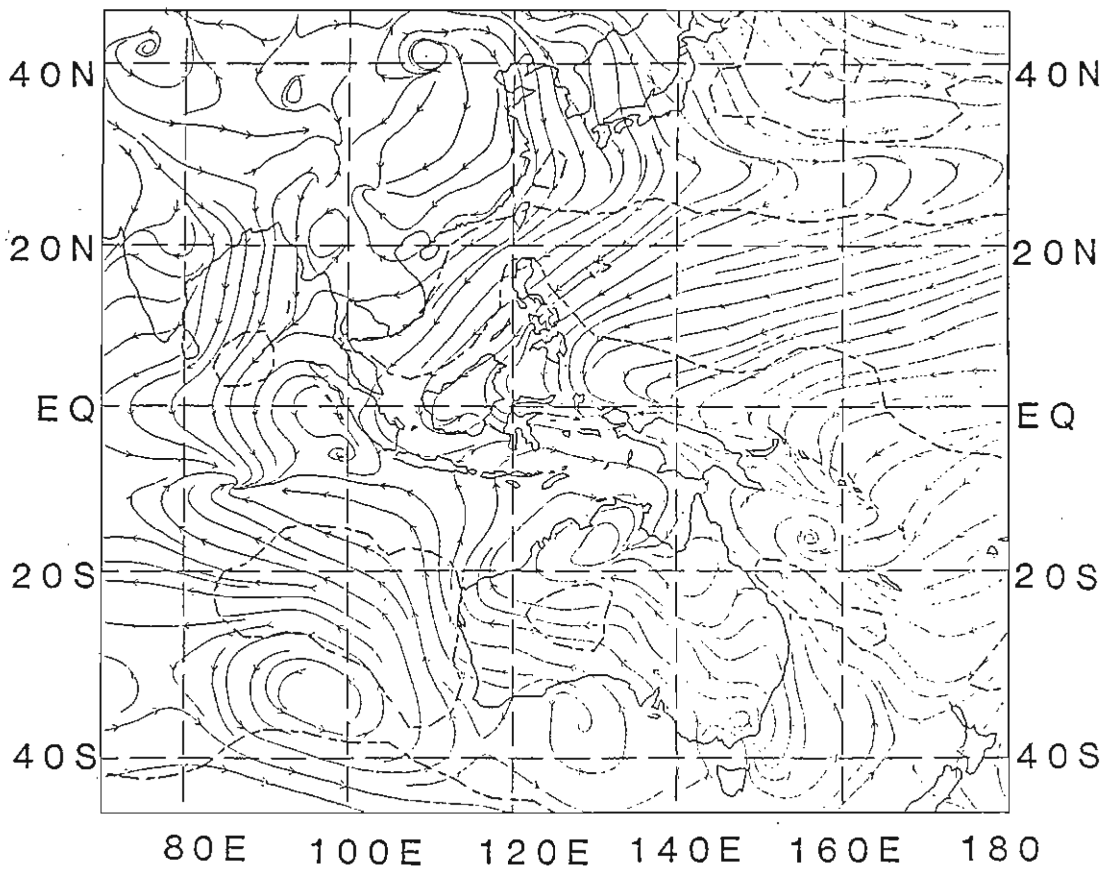


Fig. 8 950 hPa STREAMLINE ANALYSIS, JANUARY 1989
Isotachs (dashed line) at 10 knot intervals

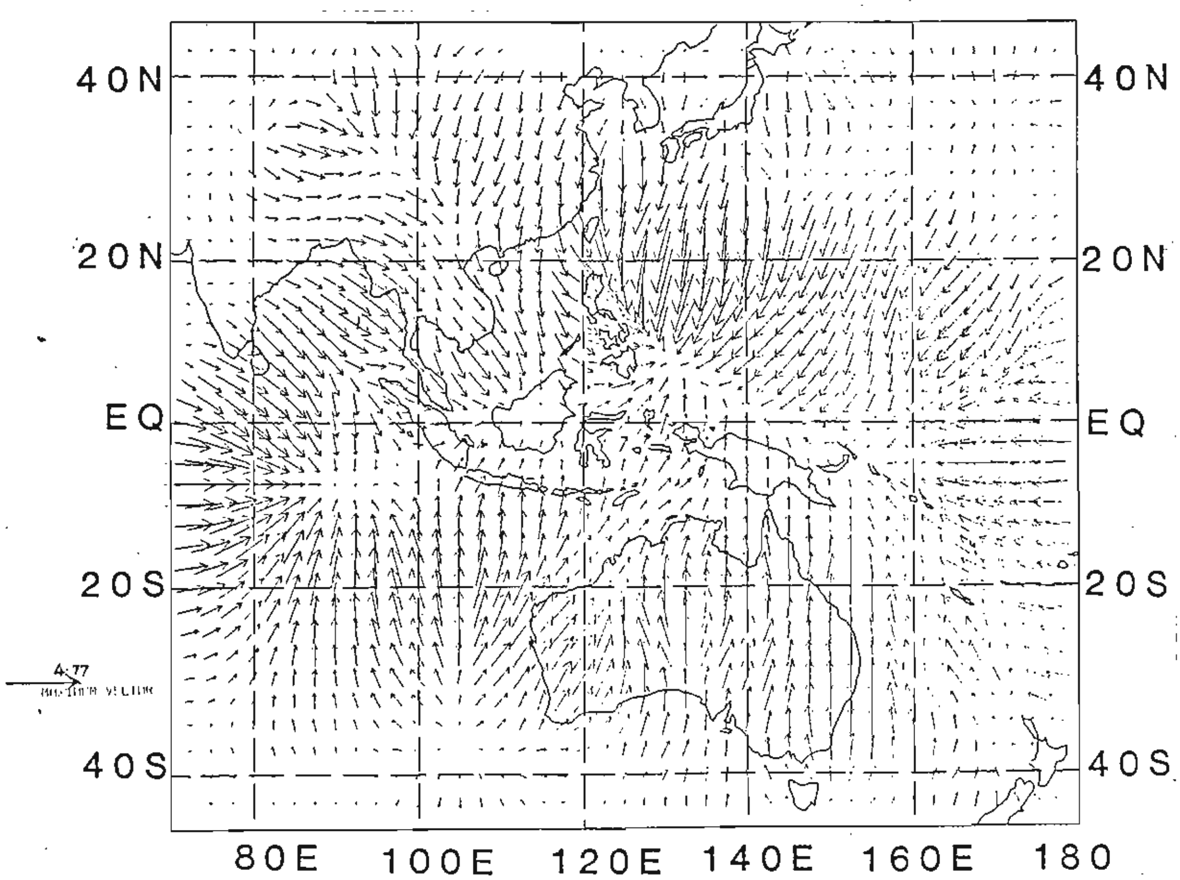


Fig. 9 950 hPa VECTOR WIND ANOMALY BASED ON FIG. 8
(Arrow length indicates magnitude)

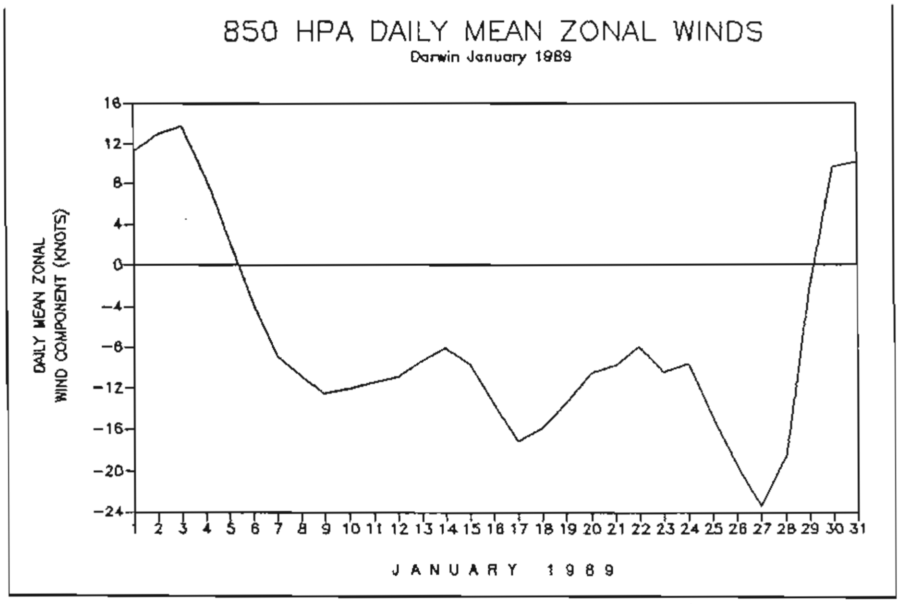
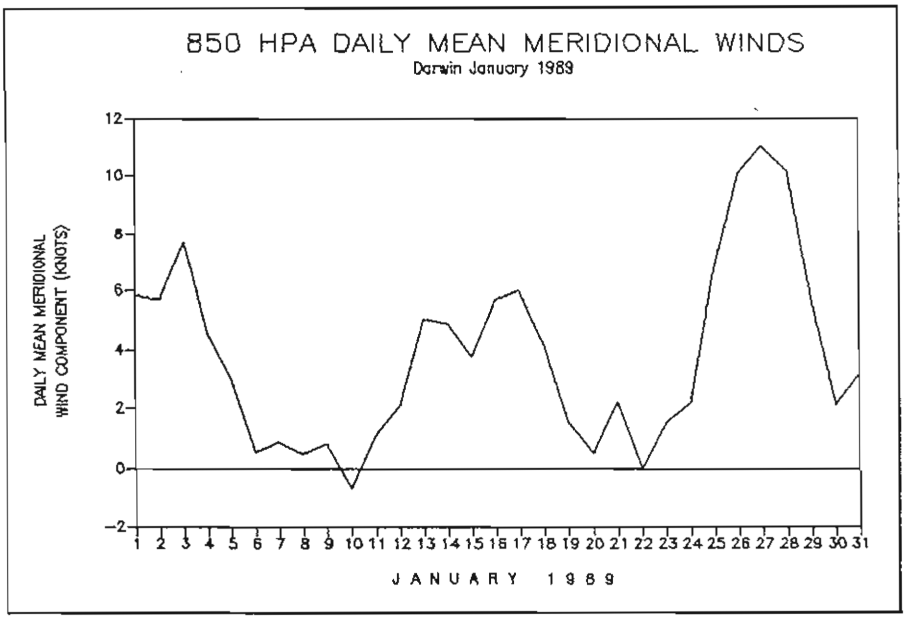


Fig.10 (a) DARWIN 850 hPa 3-DAY MEAN ZONAL WIND, JANUARY 1989



(b) DARWIN 850 hPa 3-DAY MEAN MERIDIONAL WIND, JANUARY 1989

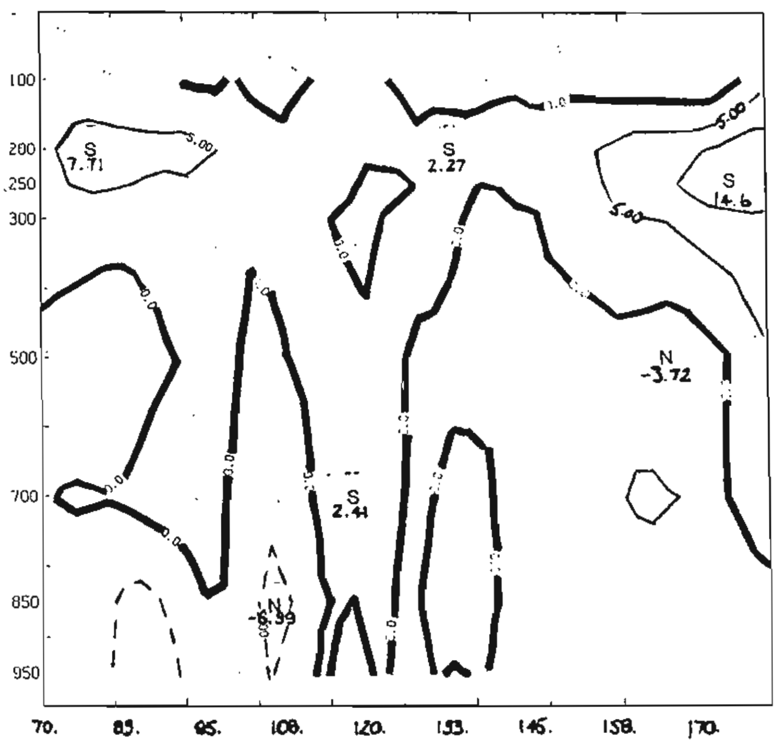


Fig.11 EQUATORIAL CROSS-SECTION OF MERIDIONAL WIND BETWEEN 70°E AND 180°E, JANUARY 1989. 5 knot isotachs.

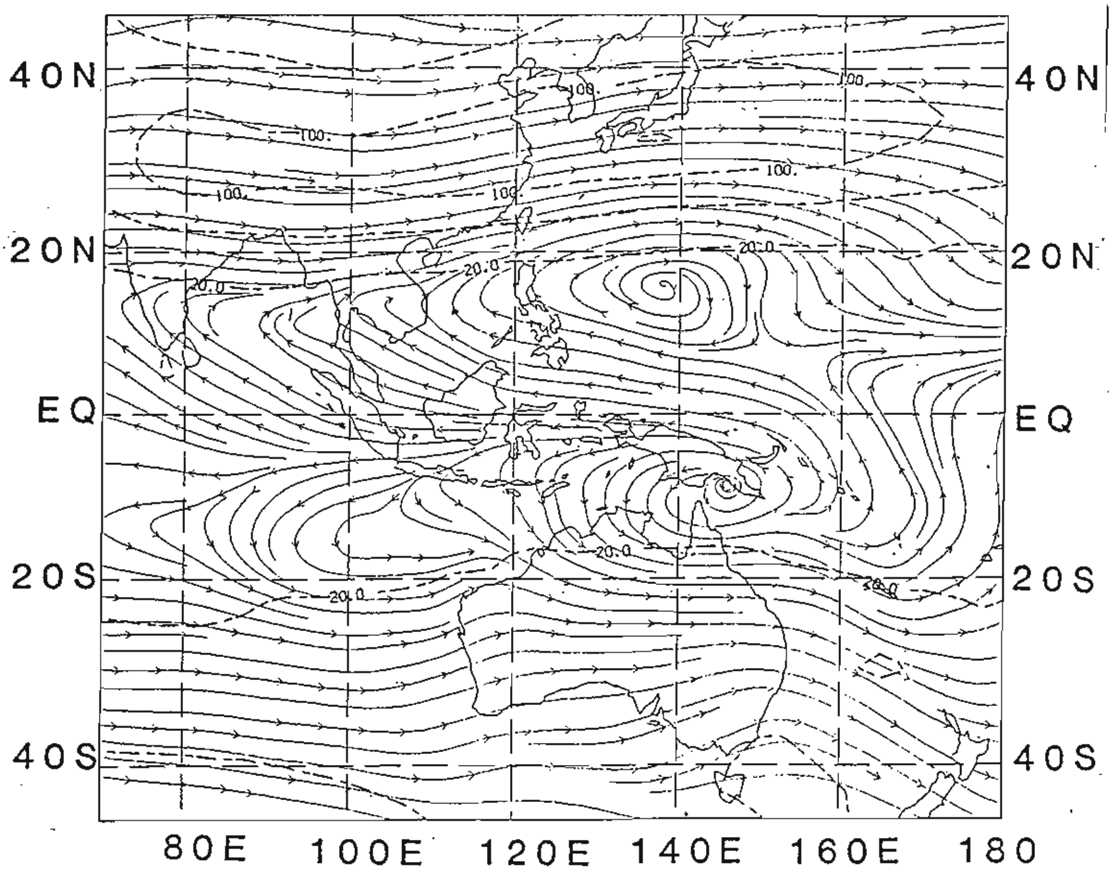


Fig.12 200 hPa STREAMLINE ANALYSIS, JANUARY 1989
Isotachs (dashed line) at 40 knot intervals.

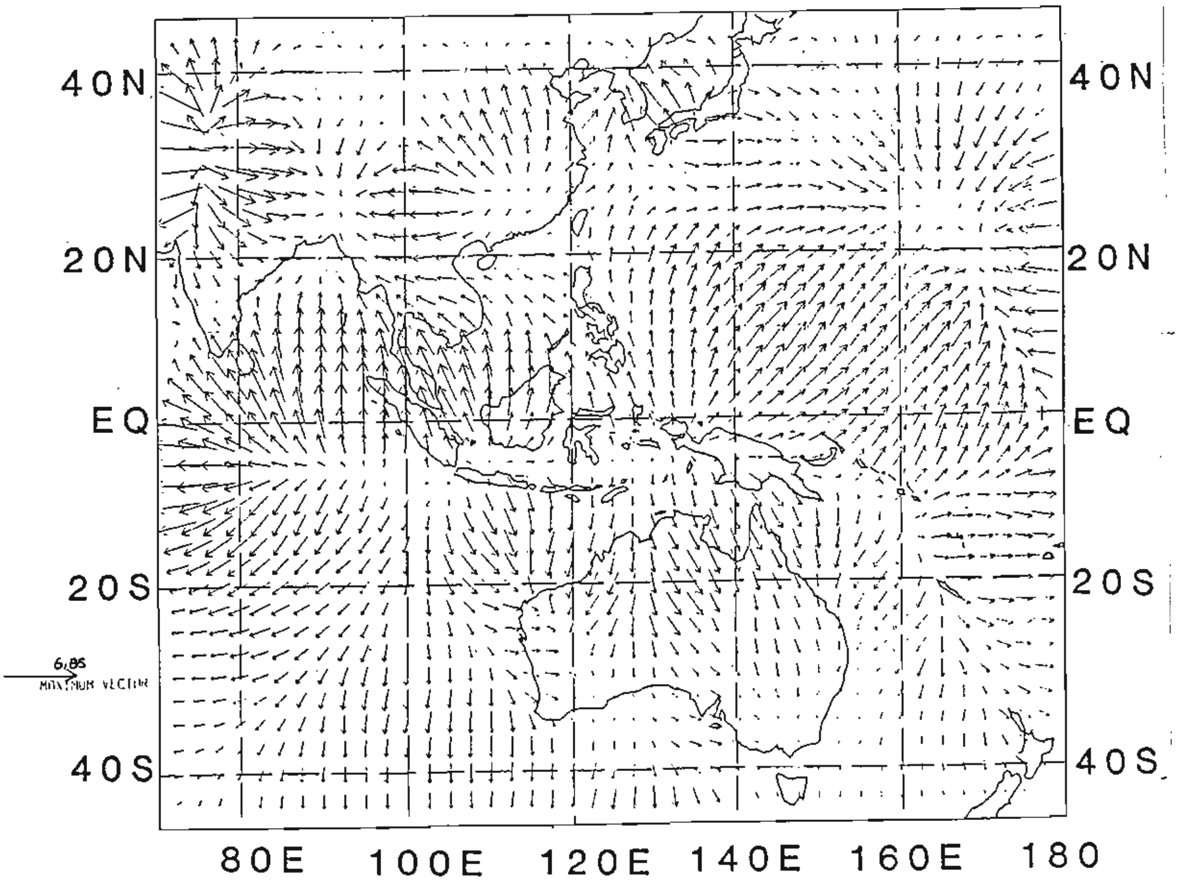


Fig.13 200 hPa VECTOR WIND ANOMALY BASED ON FIG. 12
(Arrow length indicates magnitude).

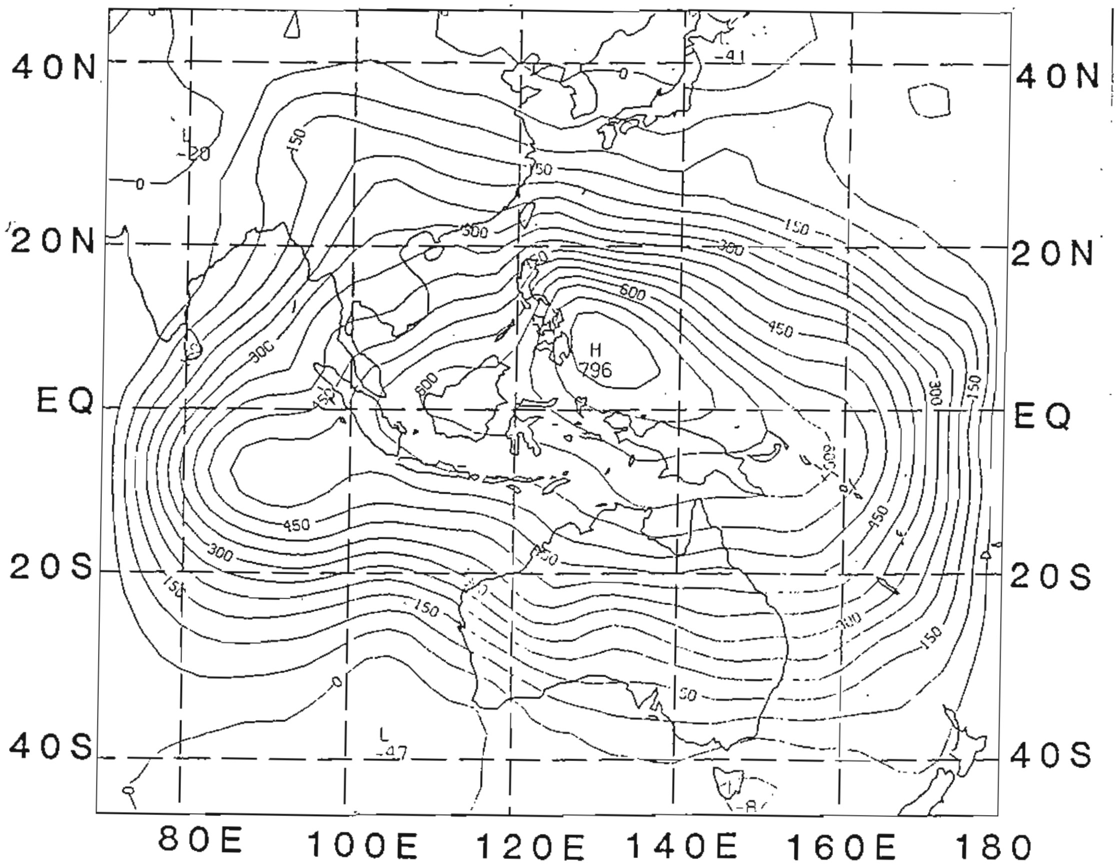


Fig.14 950 hPa VELOCITY POTENTIAL, JANUARY 1989
Contour interval 50 x 10^5 m^2 s^{-1}

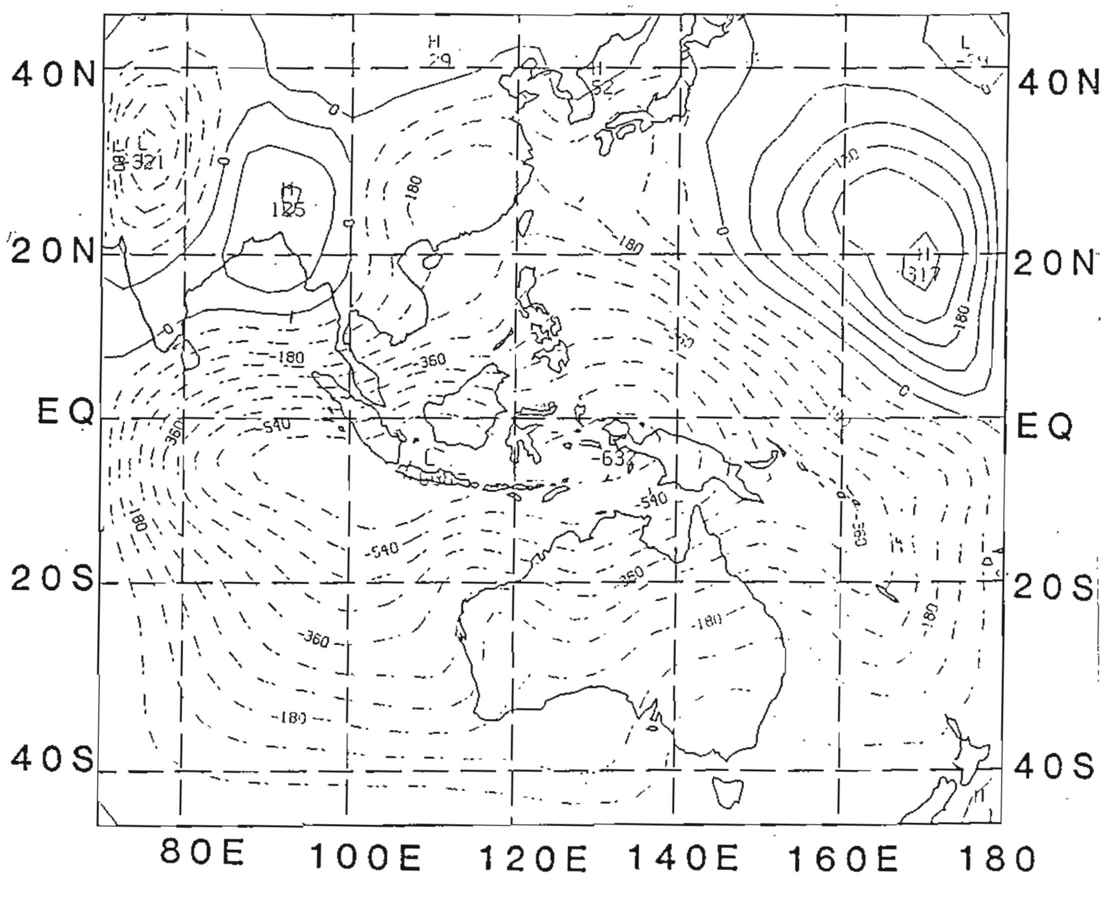
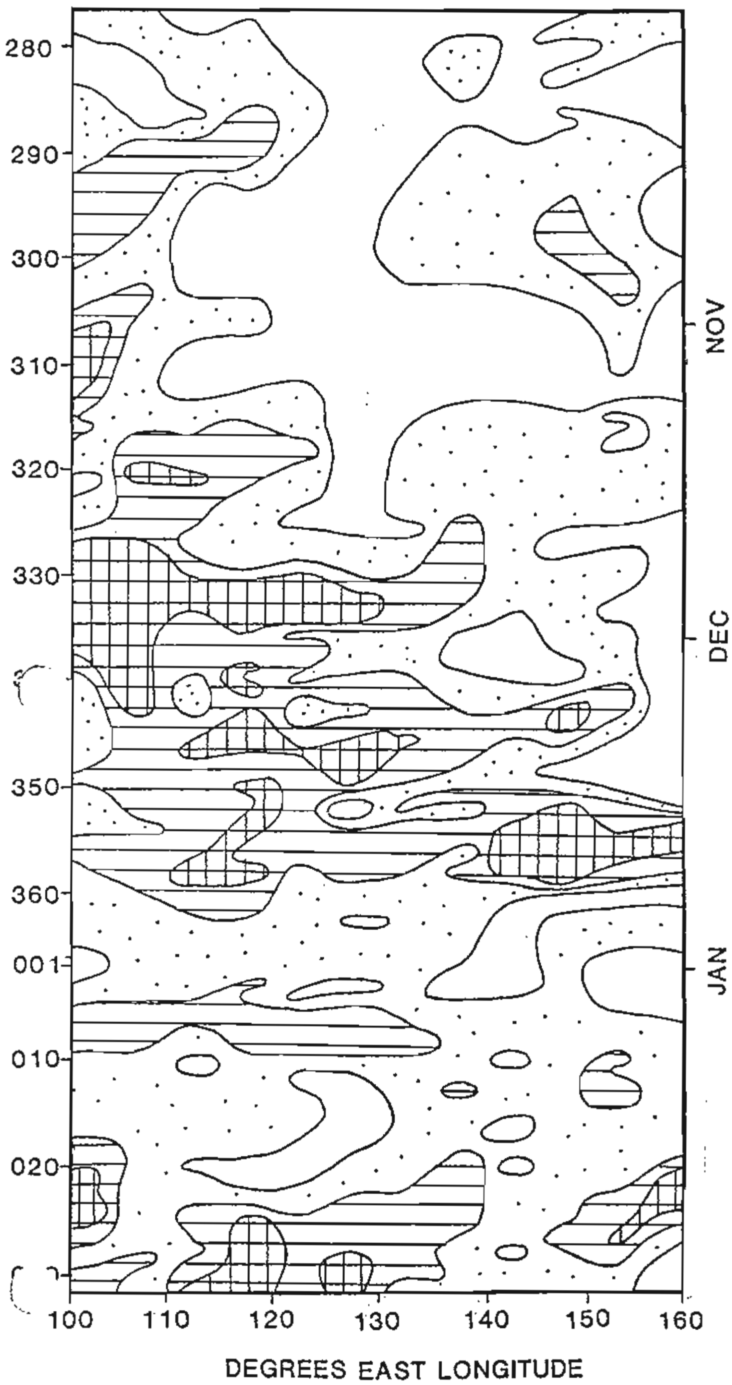


Fig.15 200 hPa VELOCITY POTENTIAL, JANUARY 1989
Contour interval 80 x 10^5 m^2 s^{-1}



ig.16 TIME-LONGITUDE CROSS SECTION OF 5 DAY MEAN COLD CLOUD AMOUNT BETWEEN EQUATOR AND 7°S
(Amount is percentage of area having equivalent black body temperature less than -40°C)

0 - 10 | 10 - 20
20 - 30 | > 30

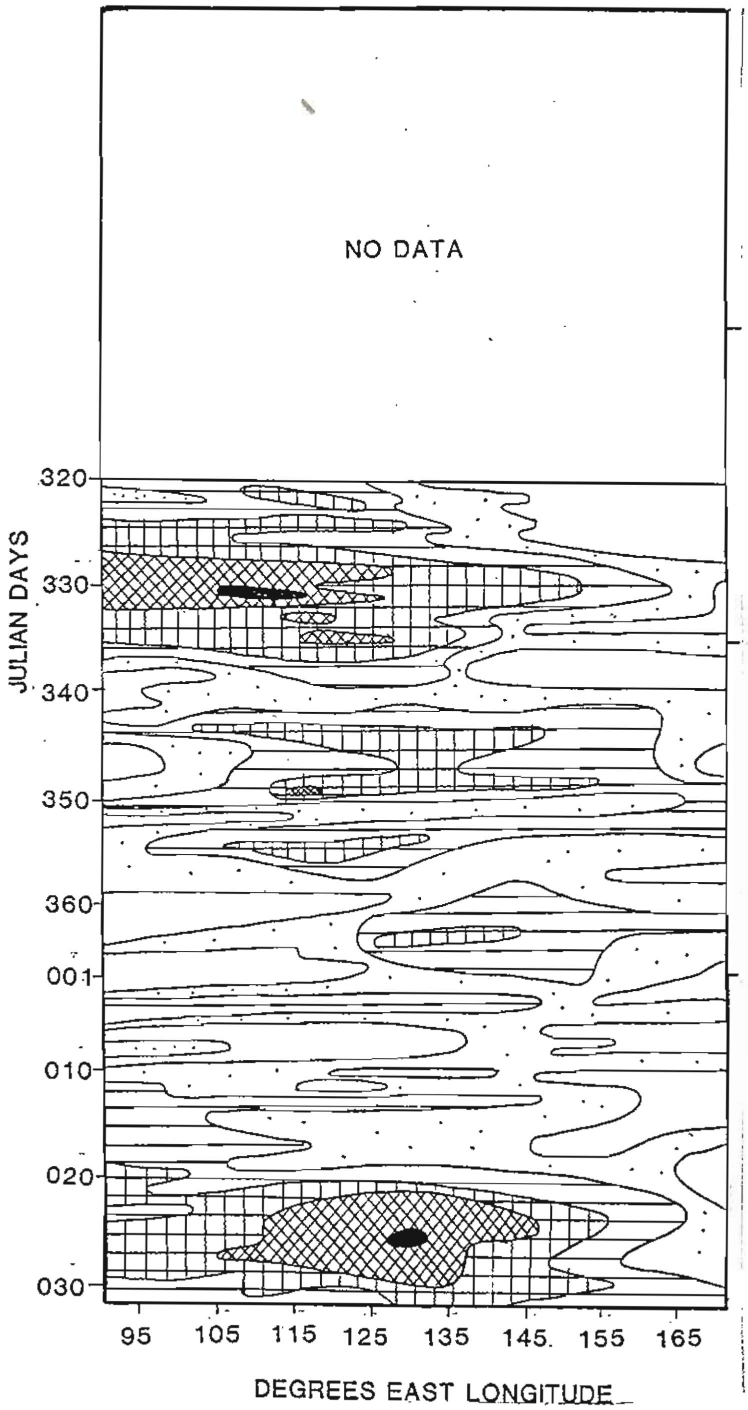


Fig.17 TIME-LONGITUDE CROSS SECTION OF 200 hPa VELOCITY POTENTIAL (Values are obtained by spatial averaging across 10° longitude sections between 5°N and 15°S using the Davidson-McAvaney analysis scheme)

< - 20 m^2/sec
- 20 - 60 m^2/sec
- 60 - 100 m^2/sec
-100 - 140 m^2/sec
-140 - 180 m^2/sec
> - 180 m^2/sec

Explanatory Notes

1. **Darwin Tropical Diagnostic Statement** is a near real-time monthly diagnostic summary of the major tropical circulations within the Darwin Regional Specialised Meteorological Centre (RSMC) area of analysis responsibility, which covers 40°N-40°S, 70°E-180°. Caution does need to be exercised when quoting from this publication as not all information within it has been confirmed.

2. **Features** discussed generally include:

- El Niño - Southern Oscillation (ENSO) aspects
- Tropical cyclone (TC) occurrence
- Sea surface temperature (SST)
- Mean sea level pressure (MSLP).
- Lower and upper level wind
- Up-motion and convection
- Intra-seasonal variability

3. **Data sources:**

(i) $SOI = 10 \times (\Delta P_{TAH} - \Delta P_{DAR}) / \sigma$

where ΔP_{TAH} =Tahiti (91938) monthly pressure anomaly (monthly mean minus 1933-1992 mean, averaging 3-hourly observations)

ΔP_{DAR} = Darwin (94120) monthly pressure anomaly (monthly mean minus 1933-1992 mean, averaging 0900, 1500LT observations)

σ = monthly deviation of the difference.

(ii) Operational tropical cyclone tracks based upon Darwin RSMC manual operational analyses. A tropical cyclone or cyclonic storm is defined as having mean wind > 17 ms^{-1} (34 kn) or a named system. Standard practice is to accept intensity and position as promulgated by the responsible warning agency, whenever possible. This may cause apparent discontinuities in intensity or track when cyclones cross warning area boundaries. Limited post analysis may sometimes be performed when warranted. A severe TC (equivalent to typhoon or hurricane) or very severe cyclonic storm is defined as having mean wind > 32 m s^{-1} (63 Kn).

(iii) Tropical cyclone climatology for the northwest Pacific and the south Indian and Pacific Oceans is based on *2004 Annual Tropical Cyclone Report*, by Atangan, J.F. and Preble, A., (2004), US Naval Pacific Meteorology and Oceanography Center/ Joint Typhoon Warning Center, Pearl Harbour, Hawaii, USA, (available at https://metoc.npmoc.navy.mil/jtwc/atcr/2004atcr/), which contains a climatology of 59 years. North Indian Ocean records are taken from WMO *Technical Document No. 430, Tropical Cyclone Report No.TCP-28* (Mandal, 1991), which contains a 99 year climatology.

(iv) SST analysis based on Darwin RSMC automated operational analyses (RSMC subset of the Australian National Meteorological and Oceanographic Centre (NMOC) global analysis: blended *in situ* and satellite data, 1°C resolution). The 1°x 1° global SST climatology from the US National Centers for Environmental Prediction (Reynolds and Smith 1995). A high resolution global sea surface temperature climatology, *J. Clim., 8*, 1571-1583 is used for the calculation of anomalies and as the default field for the analysis first guess.

(v) Mean MSLP, upper wind data, anomalies and velocity potential data from the Bureau of Meteorology's Global Assimilation and Prediction System (GASP - refer Bourke et al 1990. The BMRC global assimilation and prediction system. *ECMWF Seminar proceedings: Ten years of medium-range weather forecasting*, Sep 89) and NCEP2 22 year climatology, 1979-2000. MSLP anomaly analysis modified using CLIMAT messages.
Upper level equatorial cross section derived from Darwin RSMC real-time Tropical Limited Area Prediction Scheme (TLAPS - refer Puri et al, 1996, *BMRC Research Report No. 54, 41*).

(vi) The mean seasonal cycles for the Darwin 850 hPa wind components were constructed by averaging daily values over 39 years (1950 to 1988), each curve smoothed with 600 passes of a three day running mean weighted 1-2-1.

(vii) OLR time longitude plots and maps derived from the US National Oceanic and Atmospheric Administration.

4. **Some commonly-used acronyms:**

ISO	- Intra-seasonal oscillation
JMA	- Japan Meteorological Agency
JTWC	- Joint Typhoon Warning Center, Pearl Harbour
MT	- Monsoon trough
NET	- Near-equatorial trough
PAGASA	- Philippine Atmospheric, Geophysical and Astronomical Services
PNG	- Papua New Guinea
RSMC	- Darwin Regional Specialised Meteorological Centre (see note 1)
SCS	- South China Sea
SPCZ	- South Pacific convergence zone
STR	- Subtropical ridge
TD	- Tropical depression
TC	- Tropical cyclone (see note 3(ii))
STC	- Severe tropical cyclone
CS	- Cyclonic storm
VSCS	- Very severe cyclonic storm
TS	- Tropical storm (generally used for TC in northern Hemisphere sector)
TUTT	- tropical upper tropospheric trough

5. **Subscription rates** All costs in $AUSTRALIAN:

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	36.00 (Rest of the world)	122.80

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