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DARWIN TROPICAL DIAGNOSTIC STATEMENT

FEBRUARY 1989

ISSUED BY DARWIN RMC

SUMMARY

Although the Southern Oscillation Index (SOI) has fallen to +8, the 'La Nina' effect is still well defined in terms of sea surface temperature. However the falling SOI and sea surface temperature (SST) changes indicate that the current 'cool' event is coming to an end. It is likely that the atmosphere will return to a more average state over the next few months.

Rain for February was below average across most of northern and inland Australia, continuing the trend set in January. It is thought that this is largely because the period of monsoon rain during late January and the first days of February, which occurred near a peak in the 40/50 day oscillation, fell during a synoptically unfavourable period.

INDICES

The Southern Oscillation Index continues to fall from its peak during the southern spring. The value for February was +8. The monthly mean pressure for Darwin was slightly above average for the first time since June 1988. This is thought to be partly due to the fact that the Madden and Julian 40/50 day cycle appeared to reach a trough around the middle of the month. The amplitude of the 40/50 day cycle in pressure is about 1 hPa (Madden and Julian 1972), and appears to be out of phase with the variation of cloudiness and rain.

1. Darwin mean MSL pressure, February 1989	:	1006.8 hPa
pressure anomaly (1882-1985 mean)	:	+ 0.3 hPa
2. Tahiti mean MSL pressure, February 1989	:	1013.3 hPa
pressure anomaly	:	+2.0 hPa
3. Troup's Southern Oscillation index	:	+8
5-month mean (centred upon October)	:	+13

4. Troup's SOI for the last 26 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	+8										

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

TROPICAL CYCLONES

Five tropical cyclones occurred between 70E and 180E during February. Two occurred in the southwest Pacific region and three in the Indian Ocean. As well as these a tropical low nearly reached cyclone status prior to crossing the northwest coast of Australia. Unofficial tracks are shown in figures 3(a) and 3(b).

Two cyclones, Harry and Ivy, developed in the Fiji/New Caledonia region. Harry maintained cyclone status from the 9th until the 18th, reaching a peak mean sustained wind of 100 knots on the 15th. In terms of sustained wind, Harry is the most severe tropical cyclone in the Australian region since Sandy in March 1985 in the Gulf of Carpentaria. As Harry intensified toward its most severe stage it moved in a generally westward direction for about five days, and threatened to affect the Queensland coast. During the 15th and 16th Harry became almost stationary as it came under the influence of a major upper trough which was moving across eastern Australia. During the following days it moved southeastward and weakened in the more sheared environment ahead of the trough.

The only other cyclone in the Australian region was Kirrily which formed near 12S to the south of Java. It moved southward at 5 to 10 knots, but never threatened the Australian coast. It weakened near 25S about 600 nm to seaward from the Western Australian coast.

Two other cyclones were analysed on Darwin RMC charts during February - Gizela, which was west of 80E, and Leon, which was west of 90E and was renamed Hanitra by Mauritius when it crossed 80E.

SEA SURFACE TEMPERATURE

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

Sea surface temperature anomalies in tropical regions are little changed from January. Positive anomalies of around one degree predominate west of 165E. Over the maritime continent and northern Australian waters positive anomalies are slightly smaller than in January. This is probably because this region was relatively free of convective cloud in January compared to both December and February, causing solar insolation to produce unusually high warming. This can be seen in Fig 16, the time series of cold cloud cover.

Based on information received from the National Climate Centre in Melbourne, negative anomalies are still evident in satellite SST analyses over the central Pacific, These have shown little sign of decreasing over recent months. Of note is the development of positive anomalies along the south American coast, possibly indicating the start of the breakdown of negative anomalies in the central Pacific.

MSL PRESSURE AND GRADIENT LEVEL FLOW

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

Southerly gradient level anomalies through northern Australia and Indonesia reflect a southwest flow due to the continental heat trough rather than inter-hemispheric northwesterlies. The tendency for gradient level convergence to shift well northward in Australian longitudes is consistent with this structure. After the second day of the month convection across most of northern Australia started to decrease and by the fifth little activity was evident south of 10^{o}S.

The most notable feature of the pressure anomaly chart is the minimum around New Caledonia caused by the presence of tropical cyclones Harry and Ivy. Anomalies around the Australian region are characterised by their small magnitude. The negative anomalies in the Phillipines are probably a function of the presence of a depression which was quite persistent over the sea to the east of the islands during the first half 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 February.

At the start of the month the second active period of the wet season in northern Australia was just finishing. This can be seen in the time series of cold cloud cover, Fig 16. Although gradient level wind remained mostly westerly during the first half of the month, these westerlies were shallow. As can be seen the 850 hPa wind maintained an easterly component through most of the month. The meridional wind component was fairly small during February.

WIND CROSS SECTION

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

Apart from moderate northerlies in the low levels in the Indonesian region and high level southerlies near the dateline, cross equatorial flow during February was fairly insignificant.

UPPER LEVEL FLOW

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

The paucity of 'active' monsoon conditions in the Australian/Indonesian region during February is borne out by the northerly component in the upper level wind. This is similar to conditions last month. Significant cross equatorial return flow can be seen emanating from the South Pacific Convergence Zone, New Guinea and the northern Indonesian region. The occurrence of this return flow is directly linked to pulses in the Hadley cell produced by monsoonal convection.

VELOCITY POTENTIAL

Charts of the velocity potential fields at 950 hPa and 200 hPa for February are given in Figures 14 and 15. A time-longitude cross section of velocity potential, averaged between 5°S and 15°S, is in Figure 17.

At 950 hPa the pattern of velocity potential has changed little from last month. Marked divergent wind components are still directed into the maritime continent. At 200hPa the centre of divergence is located just south of the equator. This is another indication of the predominance of 'break' conditions in the north Australian/Indonesian monsoon.

The time-longitude section shows no definite features since the maximum in the Australian region toward the end of January. It is fairly obvious that the velocity potential between 5°S and 15°S is exhibiting some reflection of the equatorial, Madden and Julian oscillation.

RAINFALL AND CLOUD COVER

Monthly rainfall quintiles for selected stations in February are given in Figure 2. A time series of 5 day running mean of percentage of cloud cover with equivalent black body temperature less than -40°, from 100°E to 160°E, and between the equator and 7°S, is shown in Figure 16.

As was the case in January, below average rain predominated across northern Australia. The period of monsoonal rain at the end of January and early February produced the heaviest falls in eastern Arnhemland and land areas adjacent to the Gulf of Carpentaria where no rainfall quintile is available. The monsoonal low off the northwest coast produced substantial rain through the Pilbara. So although rain has been below average during January and February over the majority of northern Australia, this is not the case in all areas. After the first week of March, during preparation of this statement, the third 'active' period of the north Australian monsoon started and extensive heavy rain was falling across much of the area north of 18°S.

The cold cloud cover shows how the equatorial tropics west of the Australian region were quite active during February. At the end of the month there is clear evidence of an increase in convection over the region between the equator and 7°S.

REFERENCE

Madden, R.A., and Julian, P.R., 1972. Description of global-scale circulation cells in the tropics, with a 40-50 day period. J. Atmos. Sci., 29, 1109-1123

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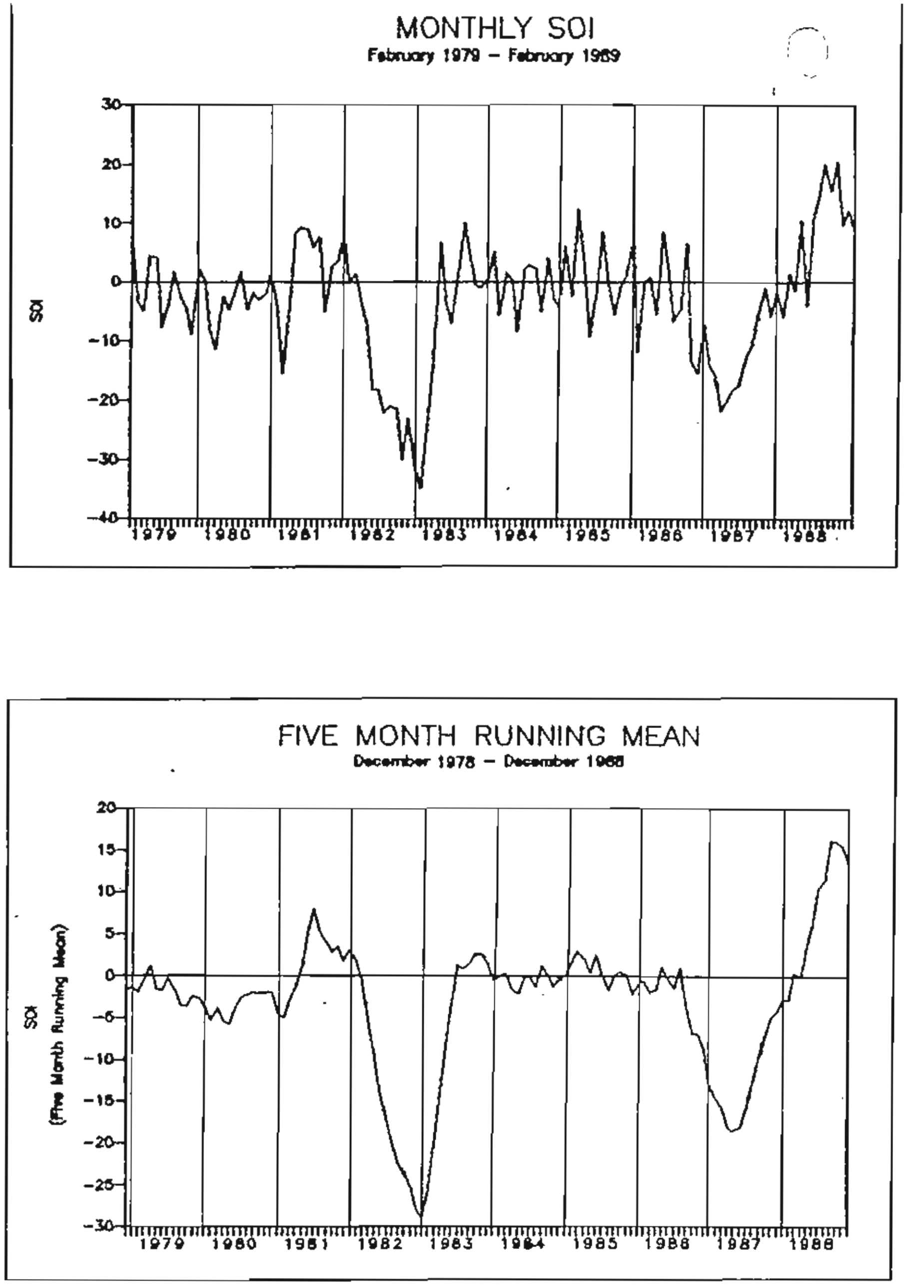


Fig.1 SOUTHERN OSCILLATION INDEX (1978-1989)
Monthly SOI and 5-month running mean SOI

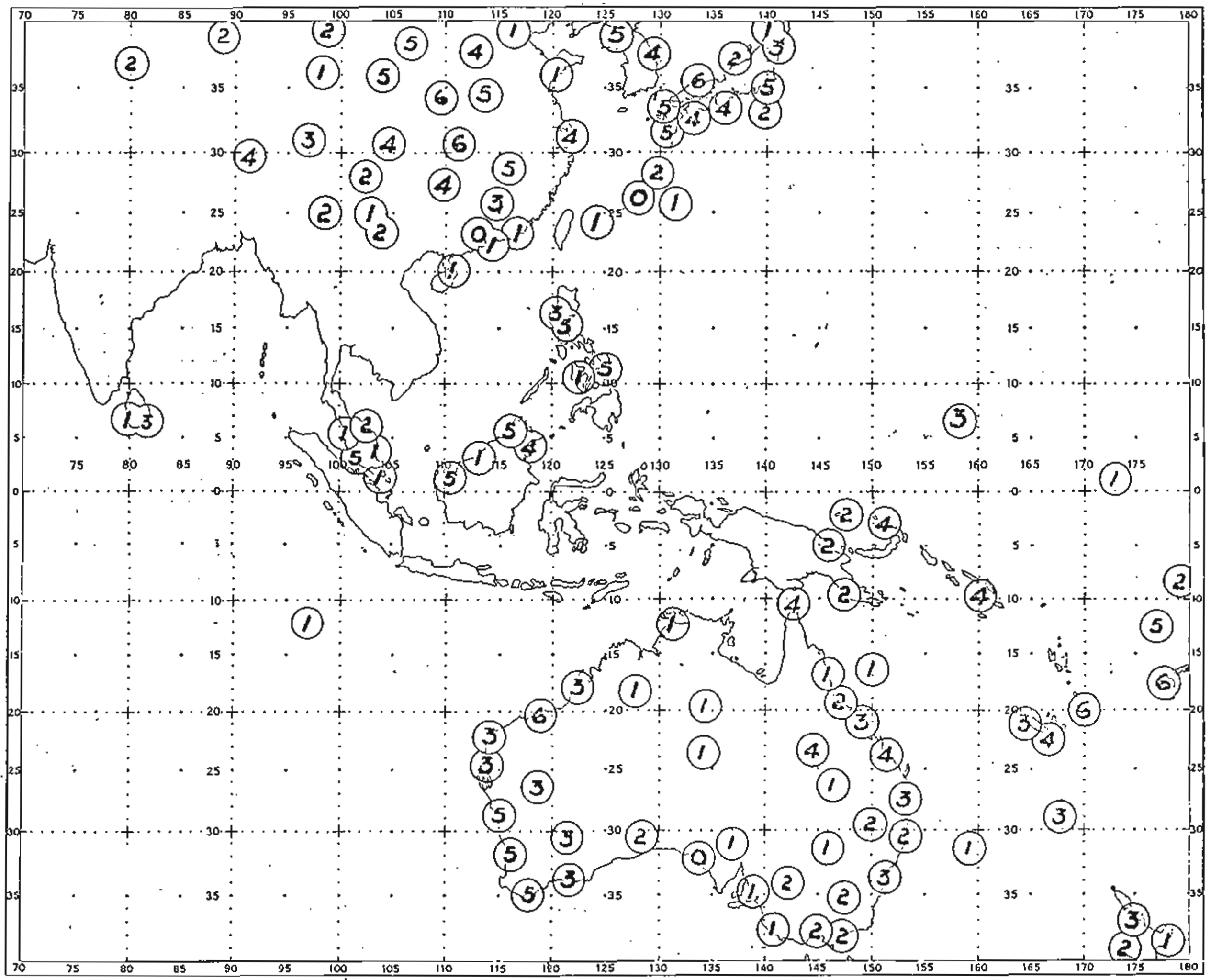


Fig.2 * MONTHLY MEAN RAINFALL QUINTILES from selected climat stations (FEBRUARY 1989)

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

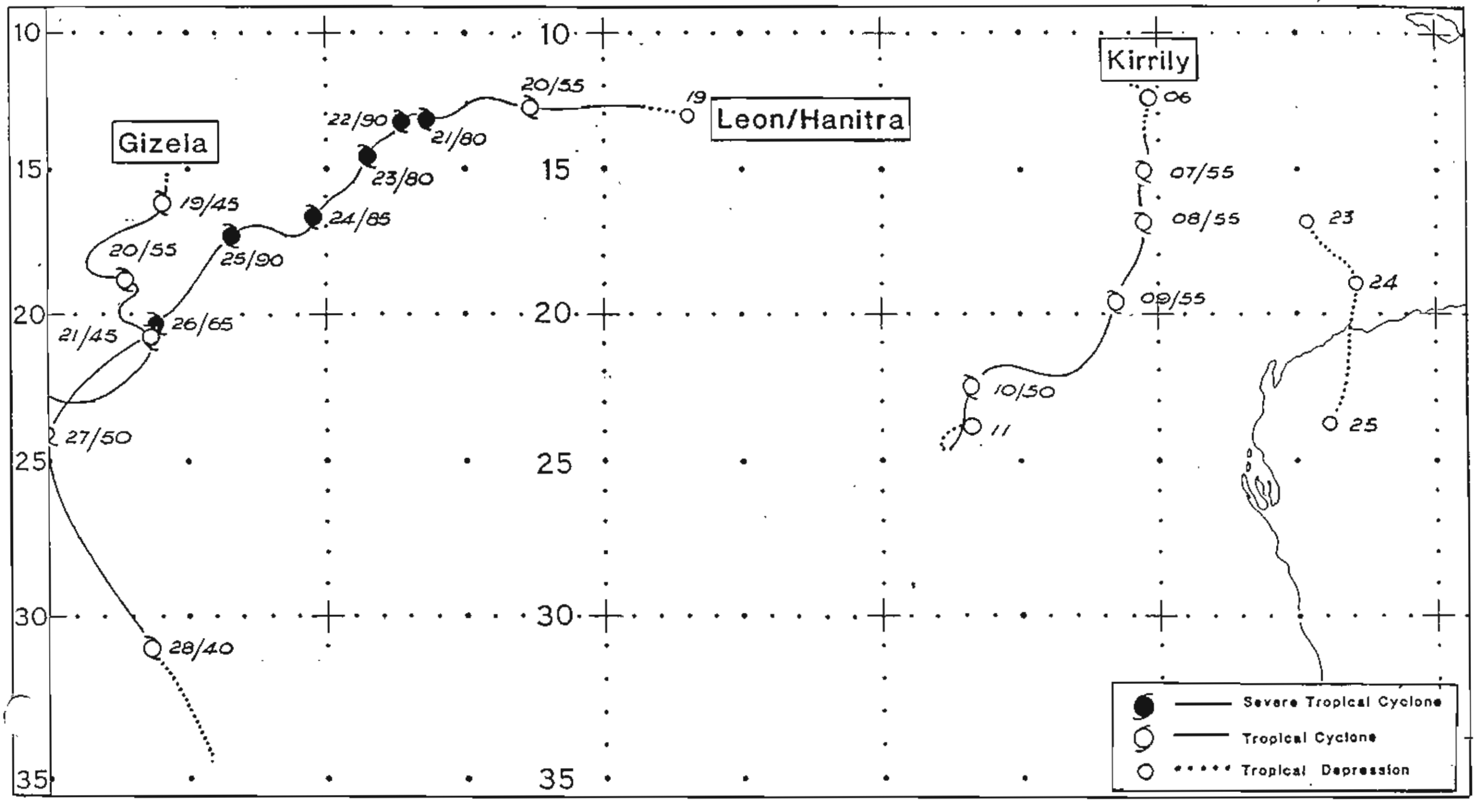


Fig.3(a) UNOFFICIAL TRACKS OF CYCLONES KIRRILY, GIZELA, LEON/HANITRA AND MONSOONAL LOW (FEBRUARY 1989)
Date (DD) and maximum sustained wind (ff) in knots denoted by DD/ff.

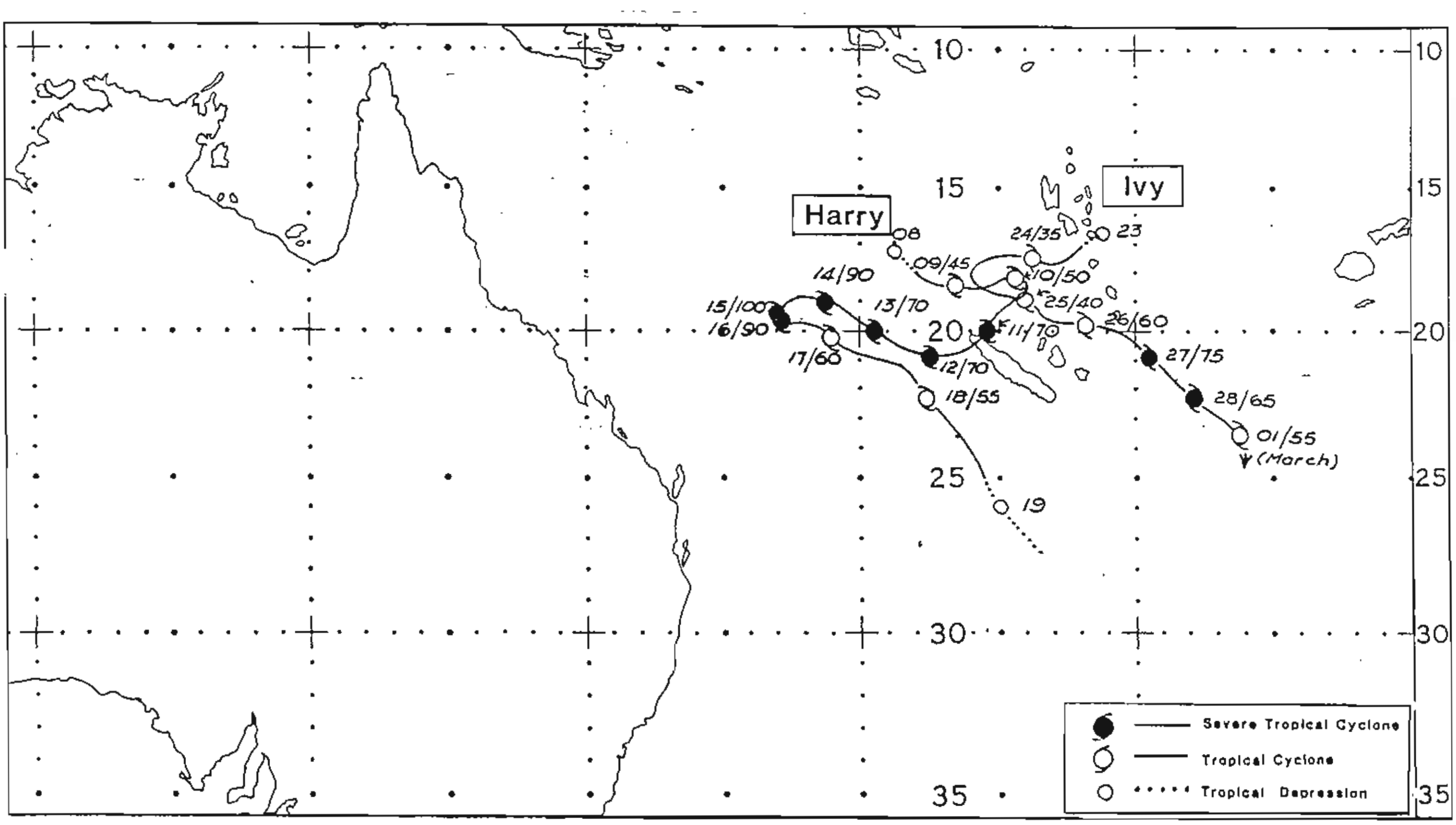


Fig.3(b) UNOFFICIAL TRACKS OF CYCLONES HARRY AND IVY (FEBRUARY 1989)
Date (DD) and maximum sustained wind (ff) in knots denoted by DD/ff.

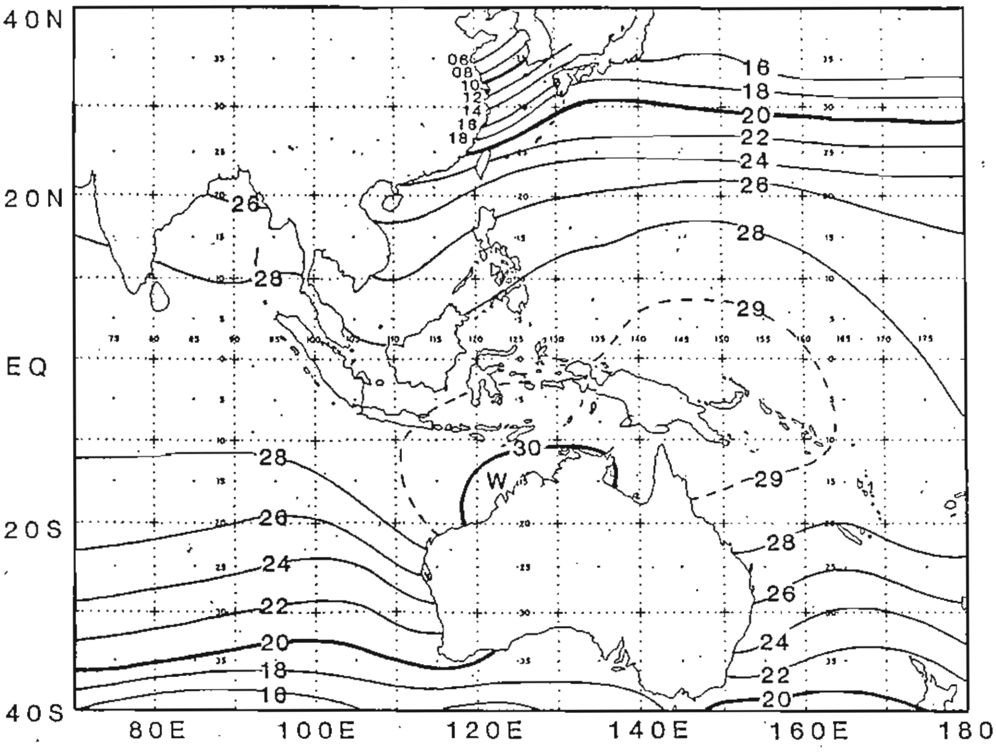


Fig. 4 MEAN SEA SURFACE TEMPERATURES, BASED ON WEEKLY DARWIN RMC ANALYSES AVERAGED OVER THE MONTH, FEBRUARY 1989. Isotherm interval 2^{o} C.

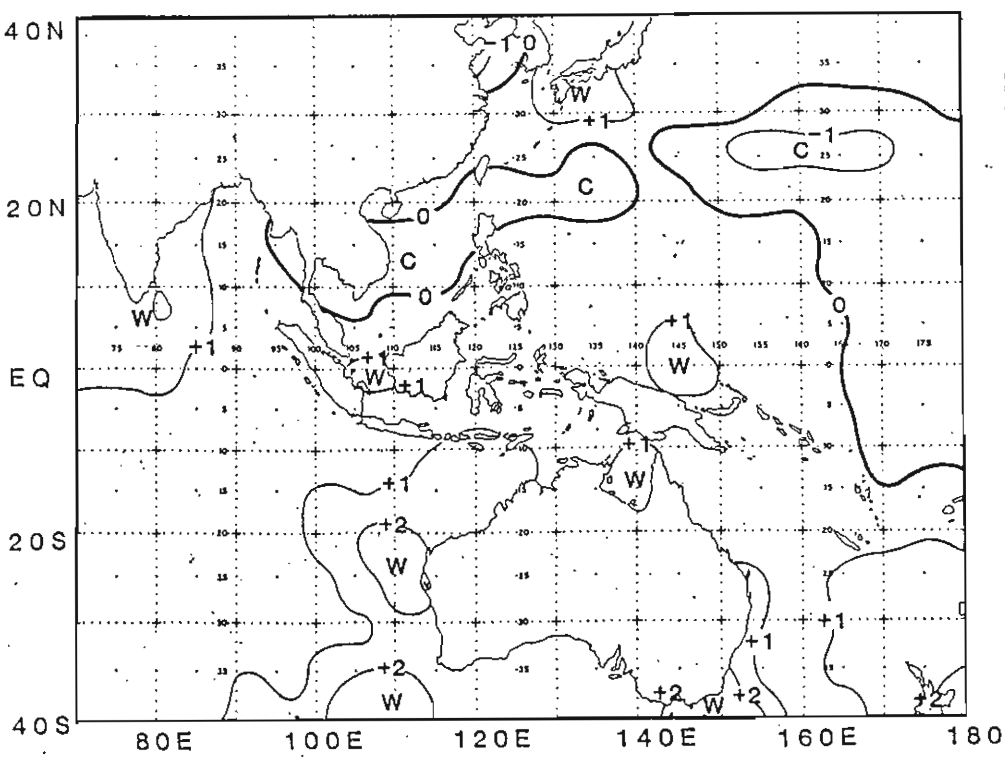


Fig. 5 SST ANOMALY CHART, BASED ON FIG. 4 AND THE CLIMATOLOGY OF REYNOLDS, NOAA REPORT NWS 31, 1983 Isotherm interval 1^{o} C.

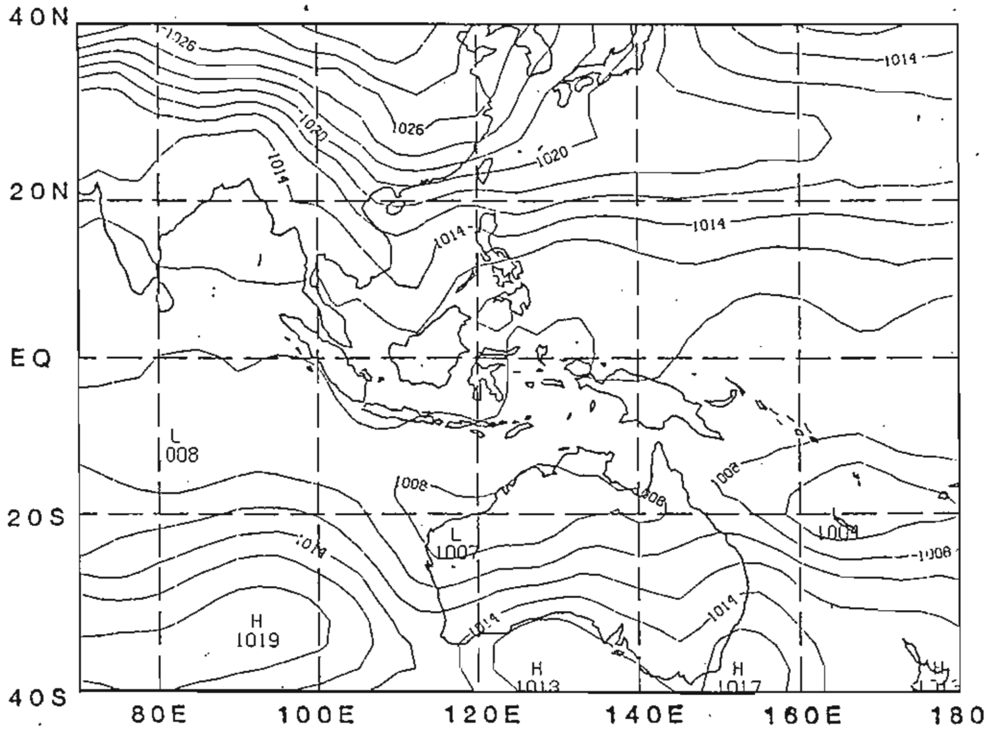


Fig. 6 MONTHLY MEAN MSL PRESSURE, FEBRUARY 1989
Isobar interval 2 hPa

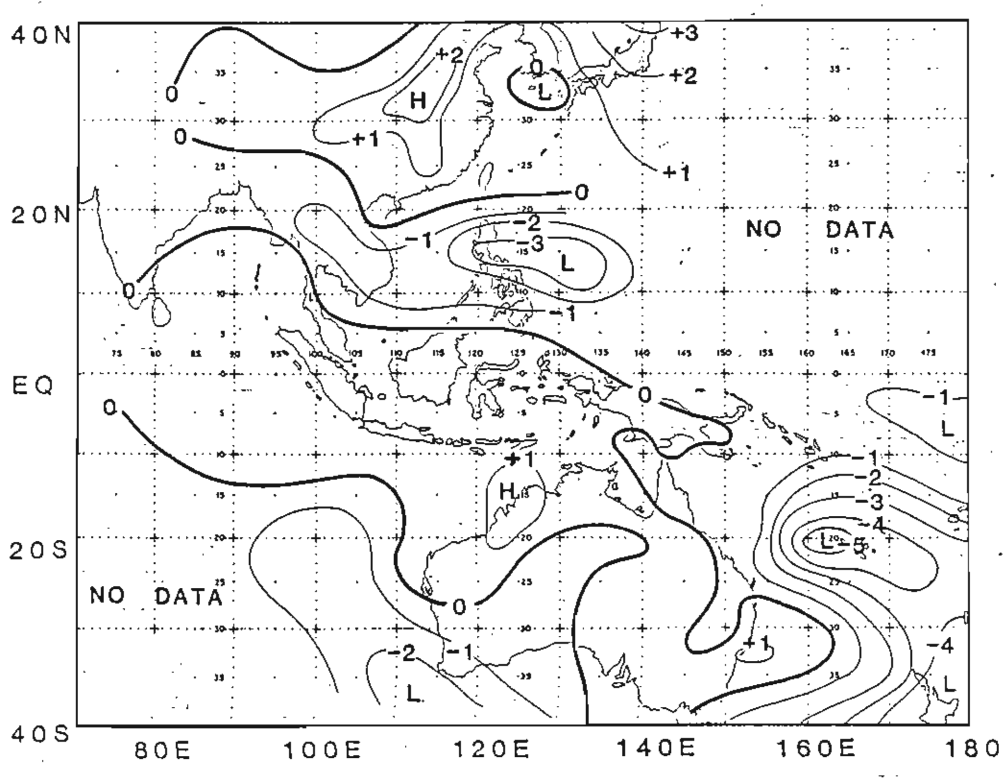


Fig. 7 MSL PRESSURE ANOMALY BASED ON CLIMAT MESSAGES
(AND MELBOURNE WMC DATA SOUTH OF 10^{o}S)
Contour interval 1 hPa.

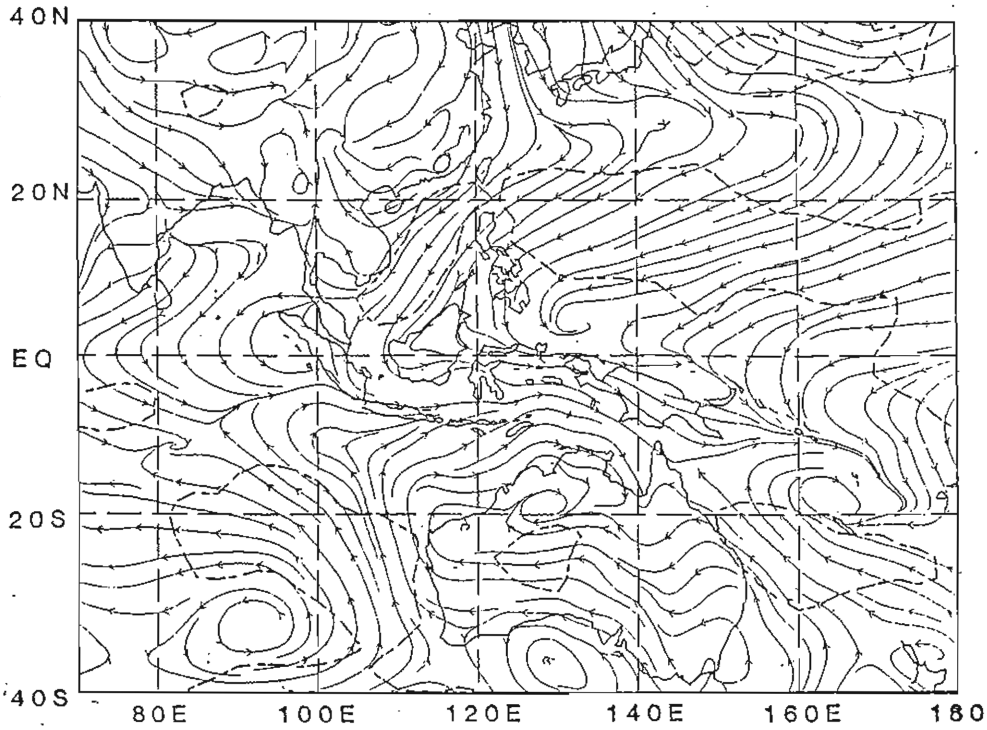


Fig. 8 950 hPa STREAMLINE ANALYSIS, FEBRUARY 1989
Isotachs (dashed line) at 10 knot intervals

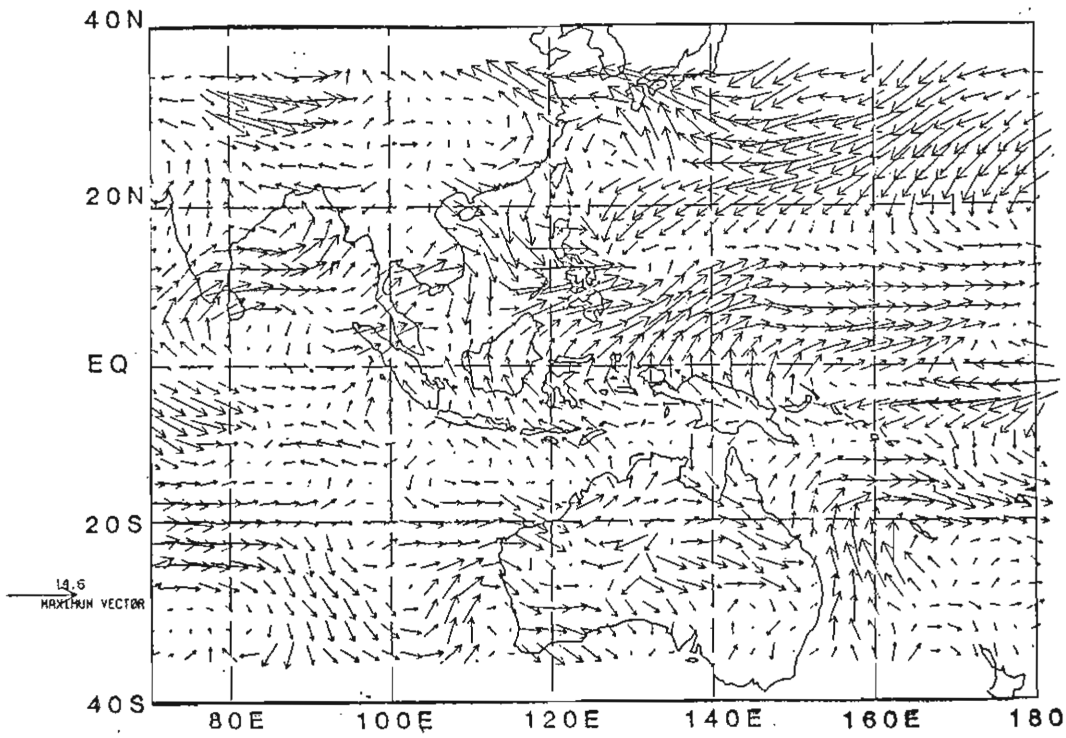


Fig. 9 950 hPa VECTOR WIND ANOMALY BASED ON FIG. 8
(Arrow length indicates magnitude)

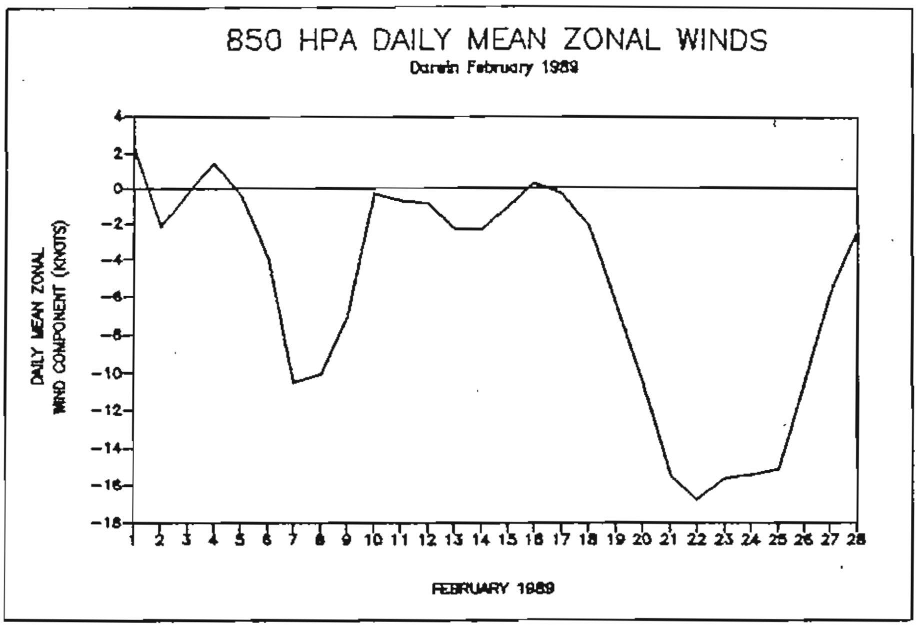
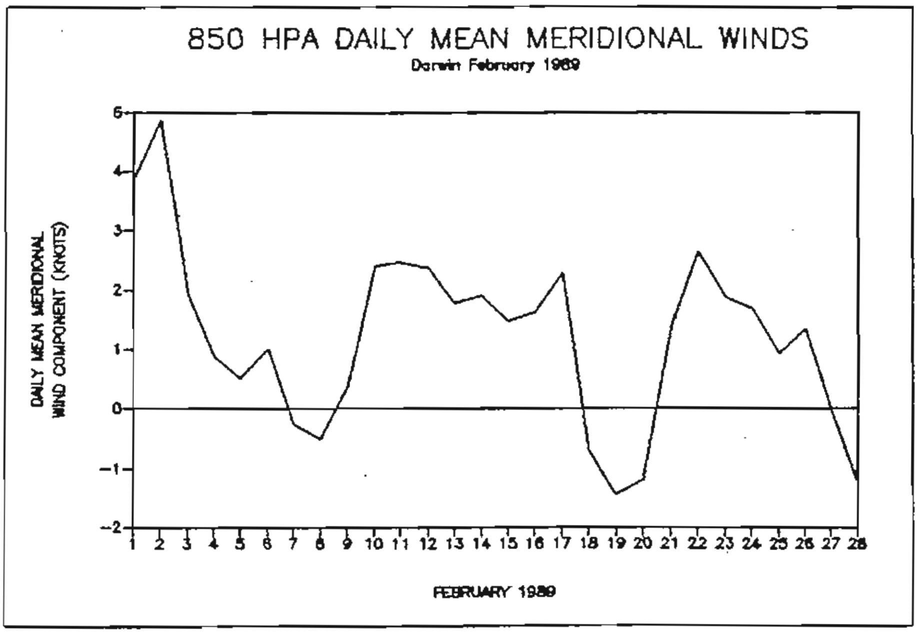
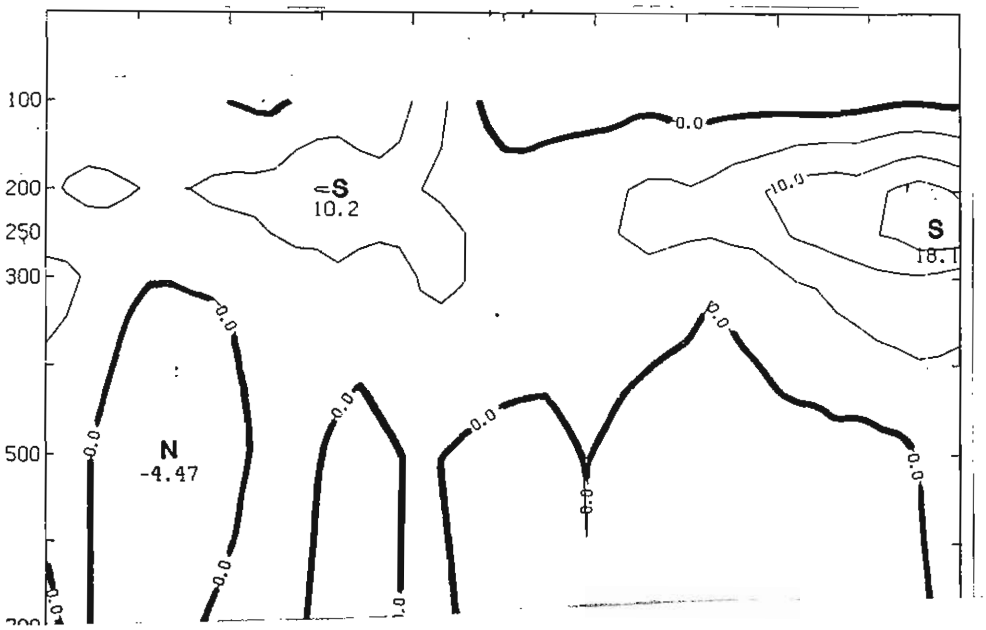


Fig.10 (a) DARWIN 850 hPa 3-DAY MEAN ZONAL WIND, FEBRUARY 1989



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



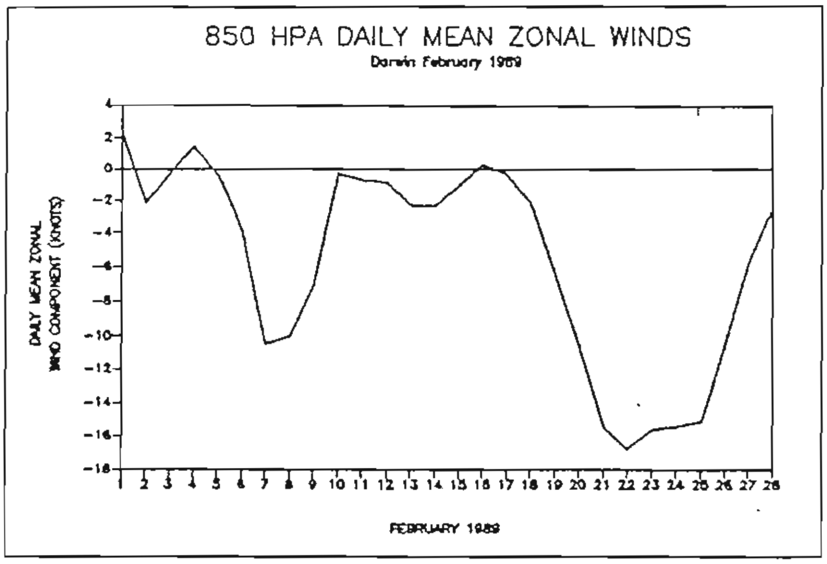
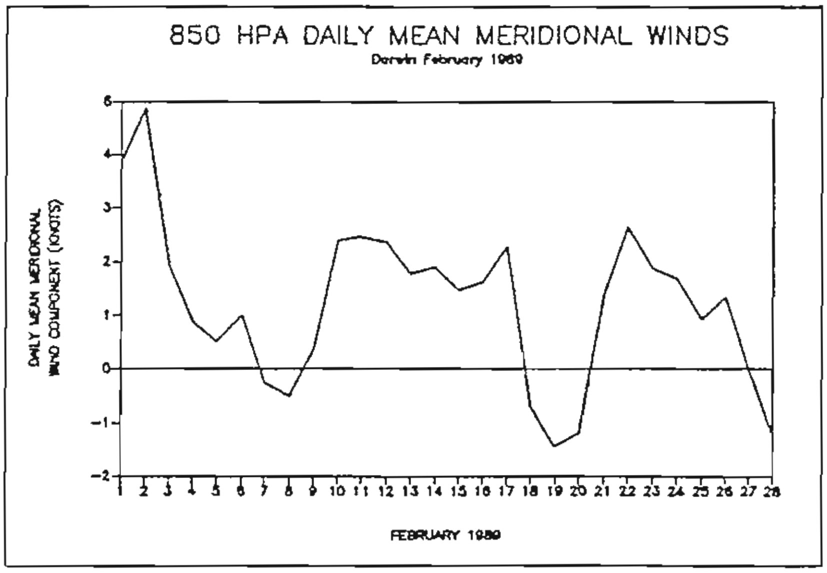


Fig.10 (a) DARWIN 850 hPa 3-DAY MEAN ZONAL WIND, FEBRUARY 1989



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

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

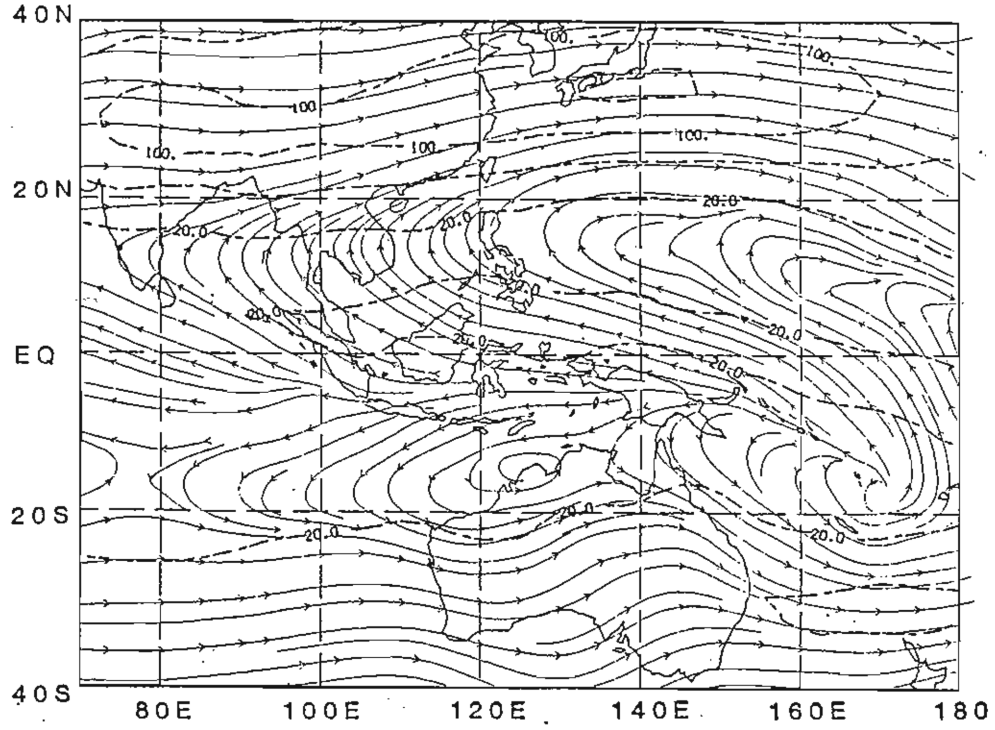


Fig.12 200 hPa STREAMLINE ANALYSIS, FEBRUARY 1989
Isotachs (dashed line) at 40 knot intervals.

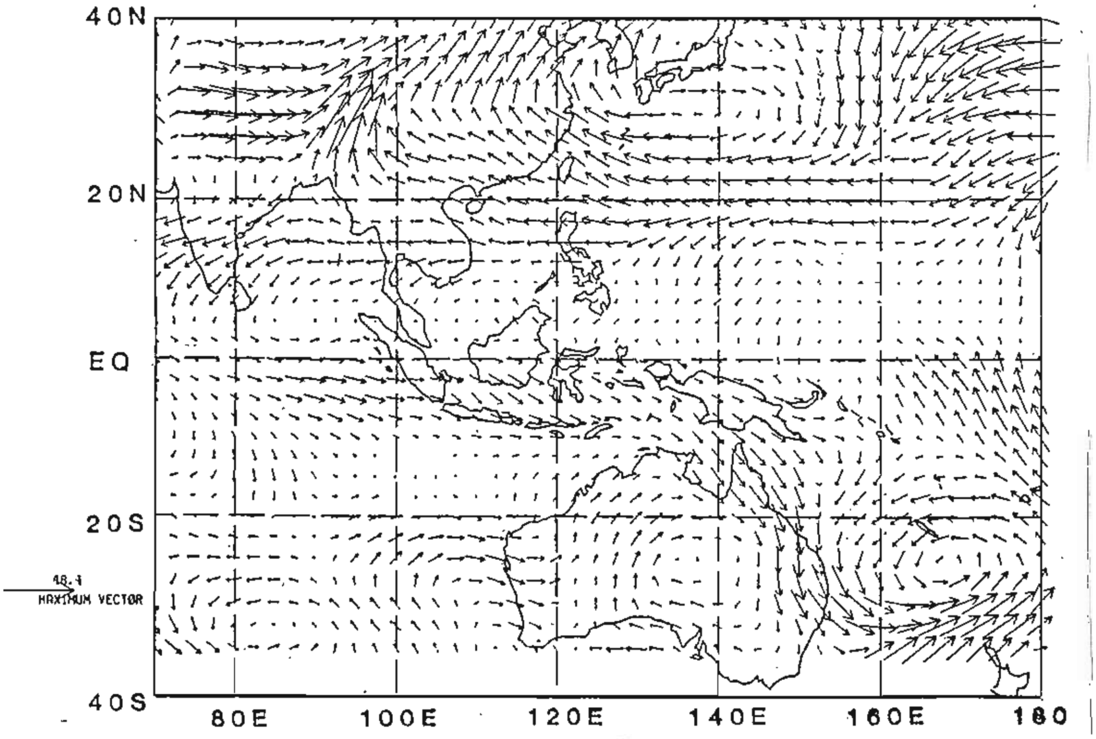


Fig.13 200 hPa VECTOR WIND ANOMALY BASED ON FIG. 12
(Arrow length indicates magnitude).

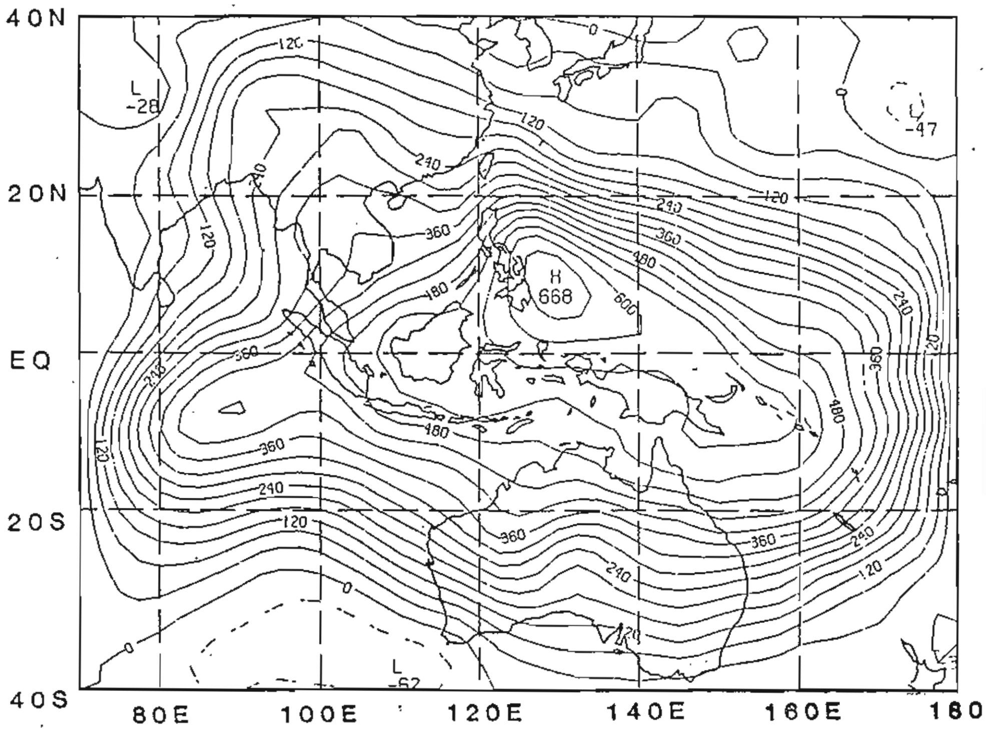


Fig.14 950 hPa VELOCITY POTENTIAL, FEBRUARY 1989
Contour interval 40×10^{5} m^{2} s^{-1}

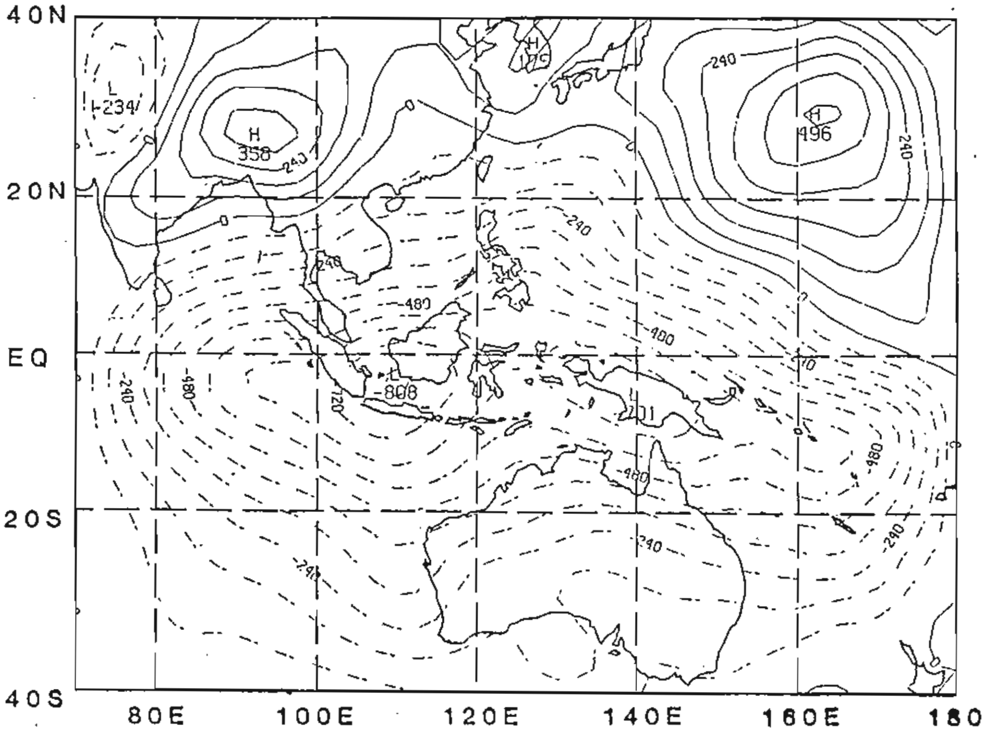
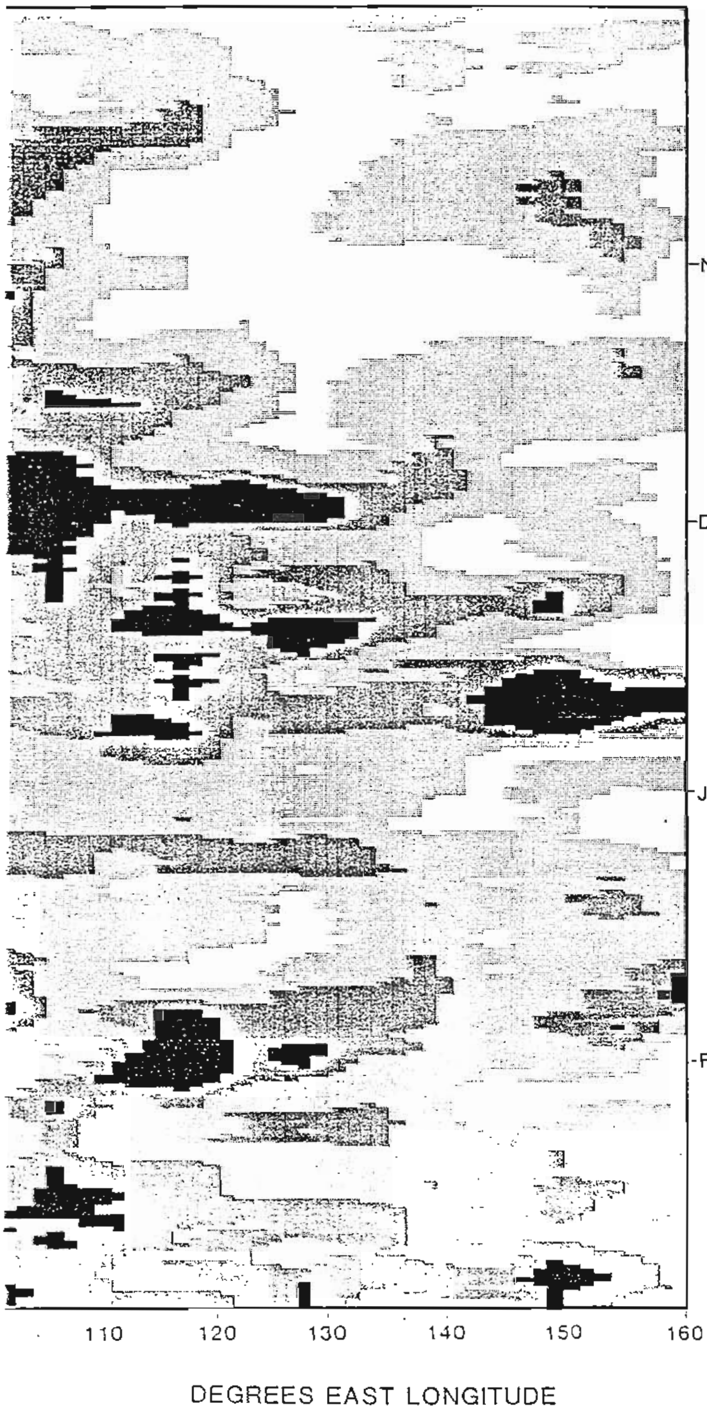


Fig.15 200 hPa VELOCITY POTENTIAL, FEBRUARY 1989
Contour interval 80×10^{5} m^{2} s^{-1}



g.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

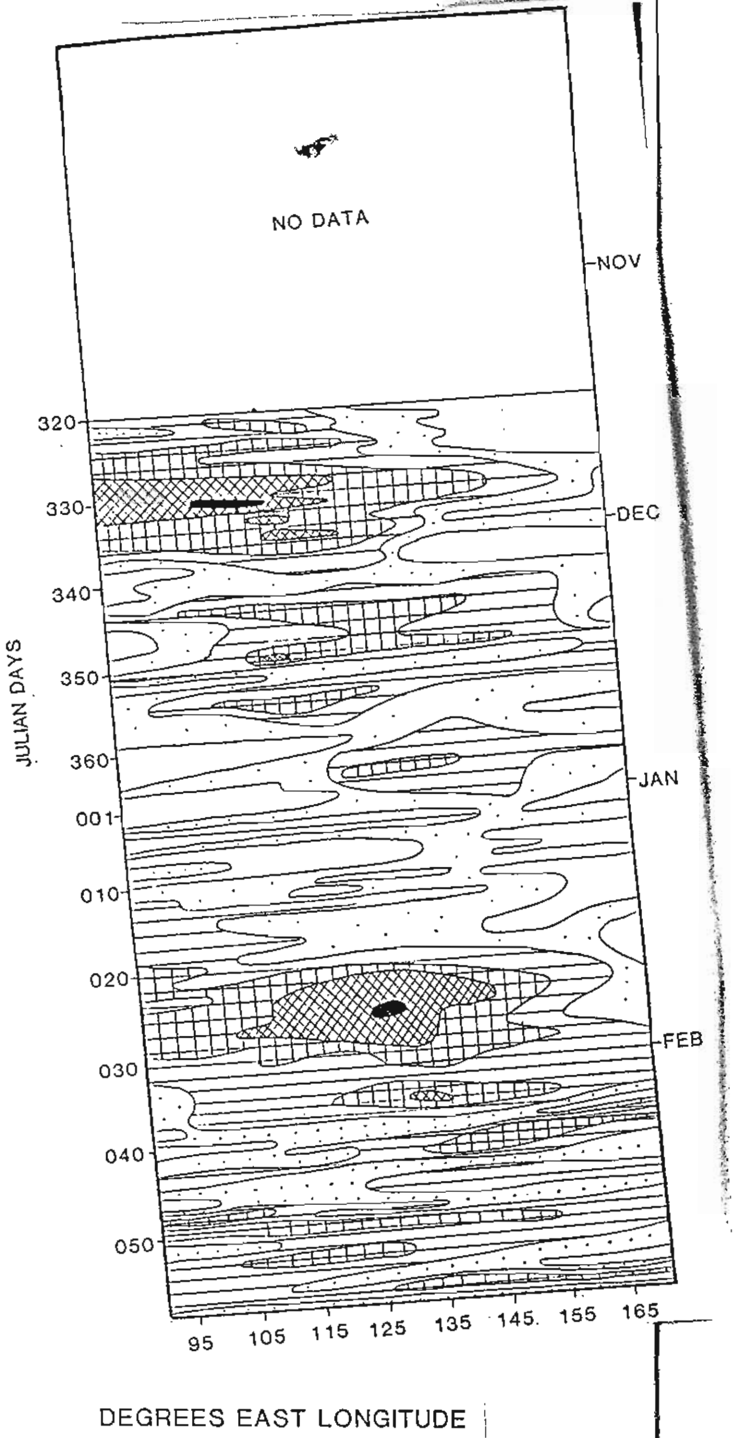


Fig.17 TIME LONGITUDE CROSS SECTION OF 200 hPa VELOCITY POTENTIAL (Values are obtained by spatial averaging across 10° longitude sections between 5°N and 15°S using the Davidson-McAvaney analysis scheme)

> - 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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	24.00 (Asia/Pacific)	110.80
	36.00 (Rest of the world)	122.80

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