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Bureau of Meteorology

DARWIN TROPICAL DIAGNOSTIC STATEMENT

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DARWIN TROPICAL DIAGNOSTIC STATEMENT

MARCH 1987

ISSUED BY DARWIN RMC

INDICES

Darwin's mean MSL pressure for March 1987 was 1010.7 hPa which was 3.1 hPa above the long term (1882-1985) mean. This is the second highest March pressure in the 106-year Darwin record (the maximum of 1010.8 hPa was recorded in 1905). Tahiti's mean MSL pressure of 1011.5 hPa was near normal, (0.2 hPa below the long term mean).

These give a Troup's Southern Oscillation Index (SOI) of minus 16, and a five month running mean (centred upon January) of minus 13. These values are significantly negative, and are indicative of the occurrence of a warm ENSO (El Nino - southern oscillation) event.

TROPICAL CYCLONES

Two tropical cyclones occurred between 70E and 180 during March. Unofficial tracks are shown in figs. 1a and b.

Cyclone 'Daodo' formed in the Indian Ocean as a result of a south-easterly surge in the low to middle levels. Potential for further development was not good and the winds about Daodo did not intensify to greater than 60 knots during the system's ten day lifetime. Daodo was eventually caught up in the midlatitude westerlies and dissipated over the cooler southern Indian Ocean.

Cyclone 'Yali' was a short lived system which formed near Vanuatu as a result of a southerly surge at middle levels. Although an upper ridge was present over the system during intensification, it moved northwards of Yali over the following 24 hours; the cyclone dissipated over water soon afterwards.

SEA SURFACE TEMPERATURES

Figures 2 and 3 show mean sea surface temperatures (SST's) during March 1987, and their associated anomalies.

Weakly negative anomalies continue over the southwest Pacific - this situation may have been aided by the presence of a cloud band which persisted through the region during the first half of the month, and cyclone Yali.

The Indian Ocean possesses the most marked anomalies, with a broad area of warmer than average water evident.

The slightly cool anomaly over the southern Arafura Sea reflects the continuation of a cooling trend that has taken place over the past 3 months. This is the first time a negative anomaly has appeared in the area since February 1986.

MSL PRESSURE AND THE GRADIENT LEVEL FLOW

The March mean MSL pressure and anomaly charts are shown in figs. 4 and 5; the gradient level (950 hPa) streamline and vector wind anomaly charts at figs. 6 and 7.

Of note in figs. 4 and 5 is the absence of the mean high cell in the Tasman Sea causing lower pressures over New Zealand, the more intense high in the Great Australian Bight, and the much weaker low pressure system over northwest Australia. Positive pressure anomalies dominate the southern hemisphere of the chart, and extend east to the dateline. Over Western Australia, the climatological inland trough has moved offshore (this is also evident on fig. 6) - the westward displacement of the WA trough in February was commented upon in last month's diagnostic statement. Lower pressures west of 100E are in part due to cyclone Daodo and the eastward displacement of the Indian Ocean high. The long-wave pattern over Northern China appeared to have a more pronounced trough than normal, causing weaker Siberian highs and negative pressure anomalies over China.

The most striking changes in figs. 6 and 7 since February have occurred in the latitude belt from the equator to 10S, where the monsoon trough has weakened considerably west of New Guinea. The streamline pattern in this area is more like that of the April-May mean. Pronounced easterly anomalies lie between 80E and 170E. Figure 18 is a graph of the time series of the 3-day running mean 850 hPa zonal wind component (m/s) at Darwin, recognised as a reliable measure of the flow over northern Australia. It may be seen that the date of retreat of the northwest monsoon for 1987 (ie the transition from westerlies to easterlies) occurred on March 4th.

The absence of a monsoon trough over the Indian ocean tropics, and the persistence of a well-developed trough over the southwest Pacific near the dateline, indicate the eastward displacement of the seat of the Walker circulation in support of the El Nino hypothesis.

Also notable in fig. 7 is the marked band of westerly anomalies south of 20S caused by stronger westerlies and weaker easterlies in response to the high pressure anomaly pattern over Australian longitudes, and the northward movement of the ridge over the Indian Ocean.

In the equatorial Northwest Pacific, westerly anomalies imply weaker northeast trade winds there. The anticyclonic outflow over the Bay of Bengal was stronger than normal, as was the trough between Japan and Taiwan (in the long-term mean there is an anticyclone across Taiwan).

200 hPa FLOW

The mean 200 hPa streamline and vector wind anomaly charts for March are shown in figs. 8 and 9.

Fig. 8 reveals that considerable rearrangement of the upper flow has taken place since February. Over Australian longitudes, the upper ridge is located some 5 to 10 degrees north of the March mean (cf the large outflow over northwest Australia in February). This has resulted in strong westerly anomalies in the southern hemisphere tropics. On the other hand, little change has occurred near the dateline, where the upper ridges in both hemispheres continue to be more pronounced than normal (with the characteristic anticyclonic anomaly pair in fig. 9 consistent with the negative SOI). Over the Tasman Sea, strong westerly anomalies are due to the stronger mean jet-stream located more north than normal. The cyclonic anomaly over the southwest of Australia is due to a weak westerly trough rather than the mean ridge, and also the northward movement of the midlatitude westerly wind maximum.

West of the Philippines, the subtropical ridge is 5 to 10 degrees south of the climatological mean, resulting in strong westerly anomalies from India to north of New Guinea.

VELOCITY POTENTIAL AND DIVERGENT WIND

Charts of the 950 hPa and 200 hPa velocity potential and divergent wind for March are shown in figs. 10, 11, 12 and 13.

The diagnosed major ascent branches occur in the southern hemisphere, over the Indian Ocean and the Solomon Islands. This split outflow configuration (in contrast to the outflow maximum over the Arafura Sea in February) is consistent with the pattern observed during ENSO events. Also of note is the secondary ascent branch which has developed in the northern hemisphere, over the Indochina area. Marked high level convergence and subsidence are evident over southeast Australia and the northwest Pacific, while secondary subsidence centres lie over India and New Zealand.

WIND CROSS SECTIONS

Cross-sections of zonal wind along 100E, 130E and 160E are shown in figs. 14, 15 and 16 respectively; an equatorial cross-section of meridional wind is at fig. 17.

The longitudinal cross-sections show that in southern hemisphere the strongest low-level trades lie between 100E and 160E, while the subtropical jet was strongest at 160E. In the northern hemisphere, the easterly trade wind maximum was at 160E and the mean jet stream was strongest at 130E.

The latitudinal cross-section shows that at the low levels there was very weak northerly flow, while at upper levels there was a moderate southerly return flow. These suggest that the cross-equatorial flow was again weaker than normal.

SUMMARY

There was a rapid transition from monsoonal conditions to trade wind flow over the Indonesian-north Australian region between February and March. Below average rainfall occurred over all of tropical Australia. Darwin's near-record high March pressure resulted in the continuation of the SOI around minus one and a half standard deviations: wind anomalies at low and high levels, and admittedly weak SST anomalies, are strongly suggestive of the persistence of an El Nino-type event over the region.

CORRESPONDENCE REGARDING THIS PUBLICATION SHOULD BE ADDRESSED TO:

The Regional Director
Bureau of Meteorology
P.O.Box 735
DARWIN N.T. 5794
AUSTRALIA

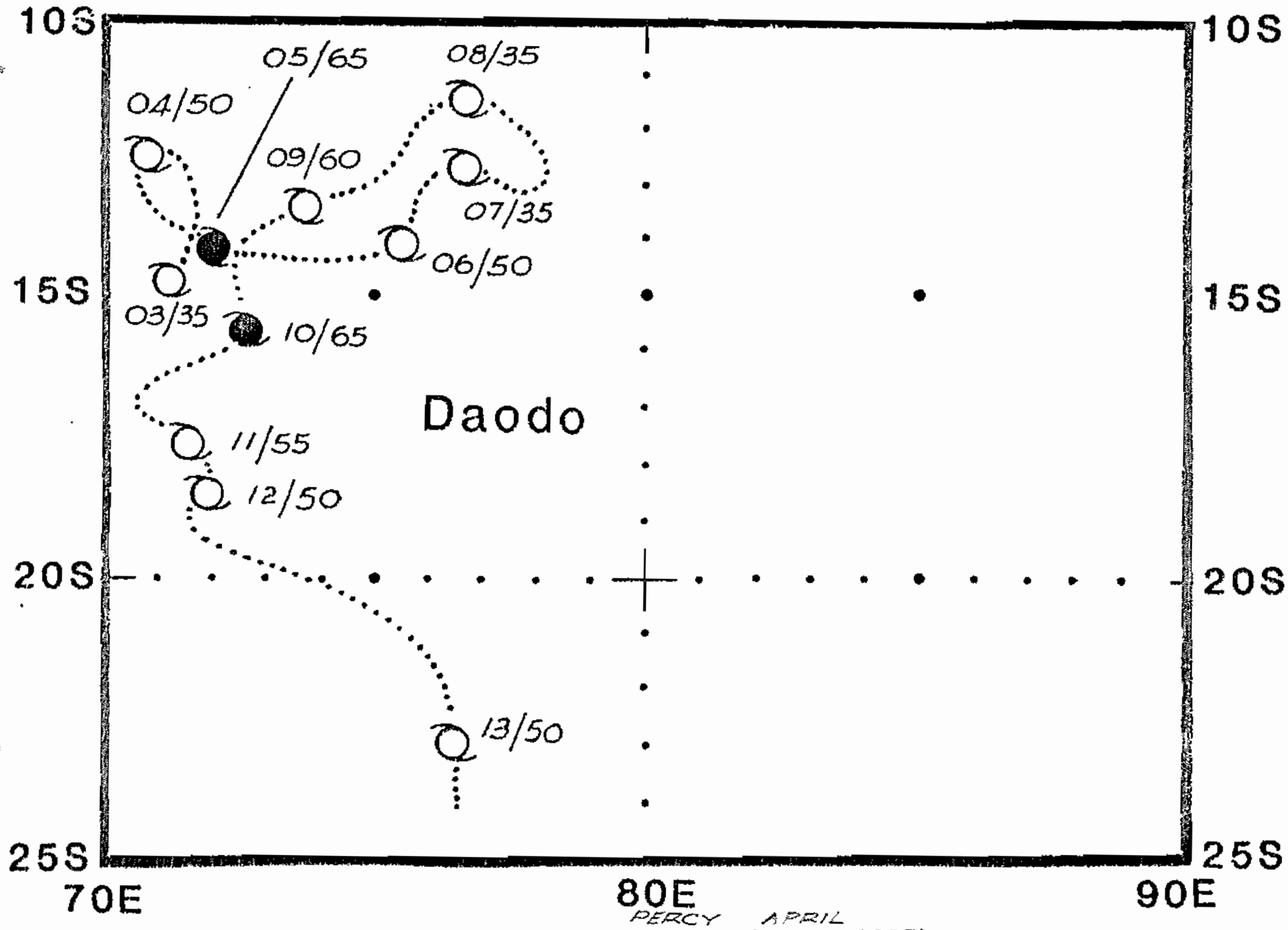


Fig. 1a UNOFFICIAL TRACK OF CYCLONE ~~DAODO~~ PERCY (~~MARCH~~ APRIL 1987)
Date (DD) and maximum sustained wind (ff) in knots denoted by DD/ff.

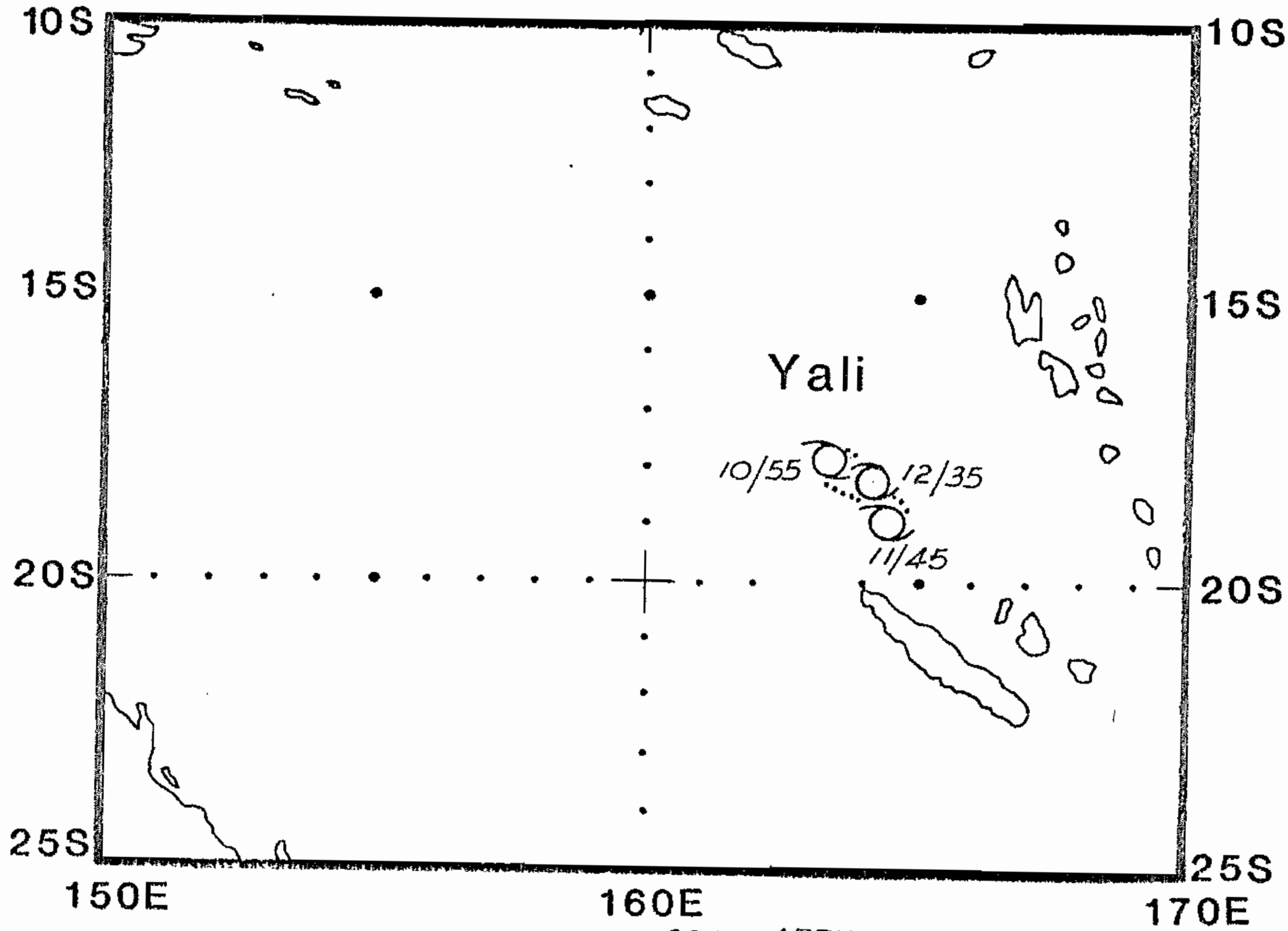


Fig 1b UNOFFICIAL TRACK OF CYCLONE ~~YALI~~ S26 (~~MARCH~~ APRIL 1987)
Date (DD) and maximum sustained wind (ff) in knots denoted by DD/ff

Fig 1c UNOFFICIAL TRACK OF CYCLONE KAY (APRIL 1987)
Date (DD) and maximum sustained wind (ff) in

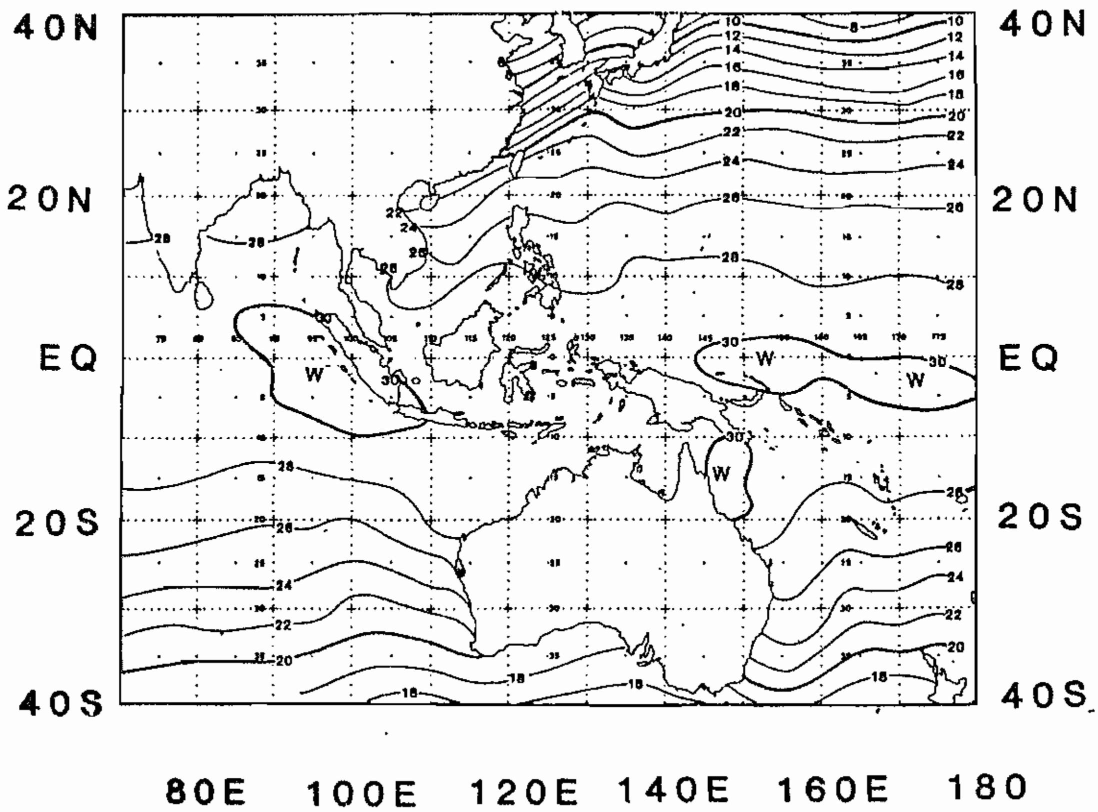


Fig. 2 MEAN SEA SURFACE TEMPERATURES, BASED ON DARWIN RMC ANALYSES AVERAGED OVER THE MIDDLE TWO WEEKS OF ~~MARCH~~ APRIL 1987
Isotherm interval 2 deg C.

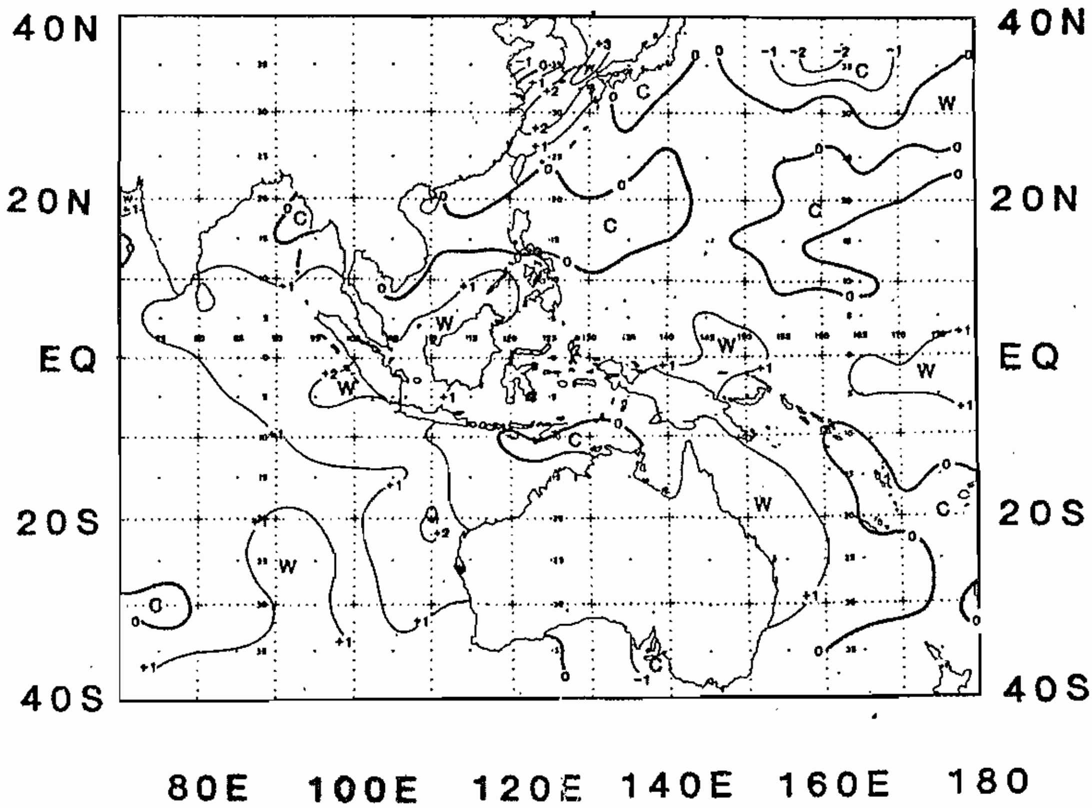


Fig. 3 SST ANOMALY CHART, BASED ON FIG. 2 AND THE CLIMATOLOGY OF REYNOLDS, NOAA REPORT NWS 31, 1983
Isotherm interval 1 deg C.

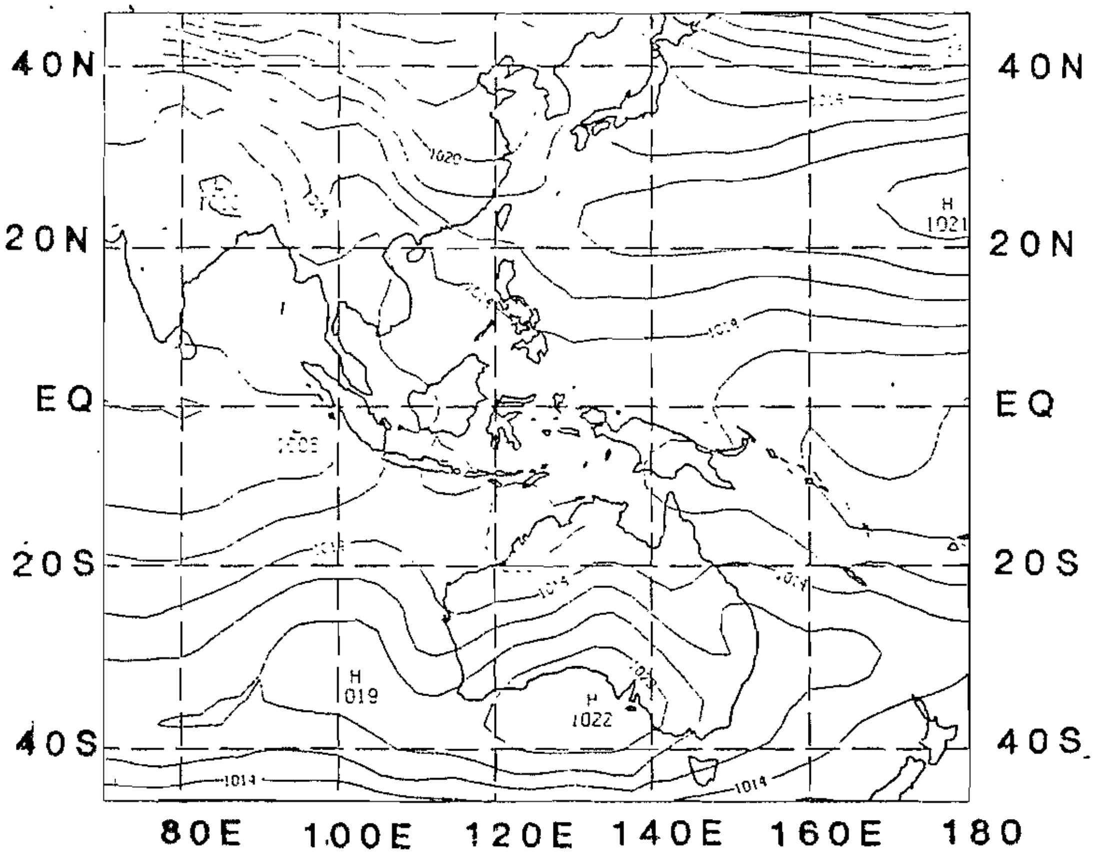


Fig. 4 MONTHLY MEAN MSL PRESSURE, ~~MARCH~~ APRIL 1987
Isobar interval 2 hPa.

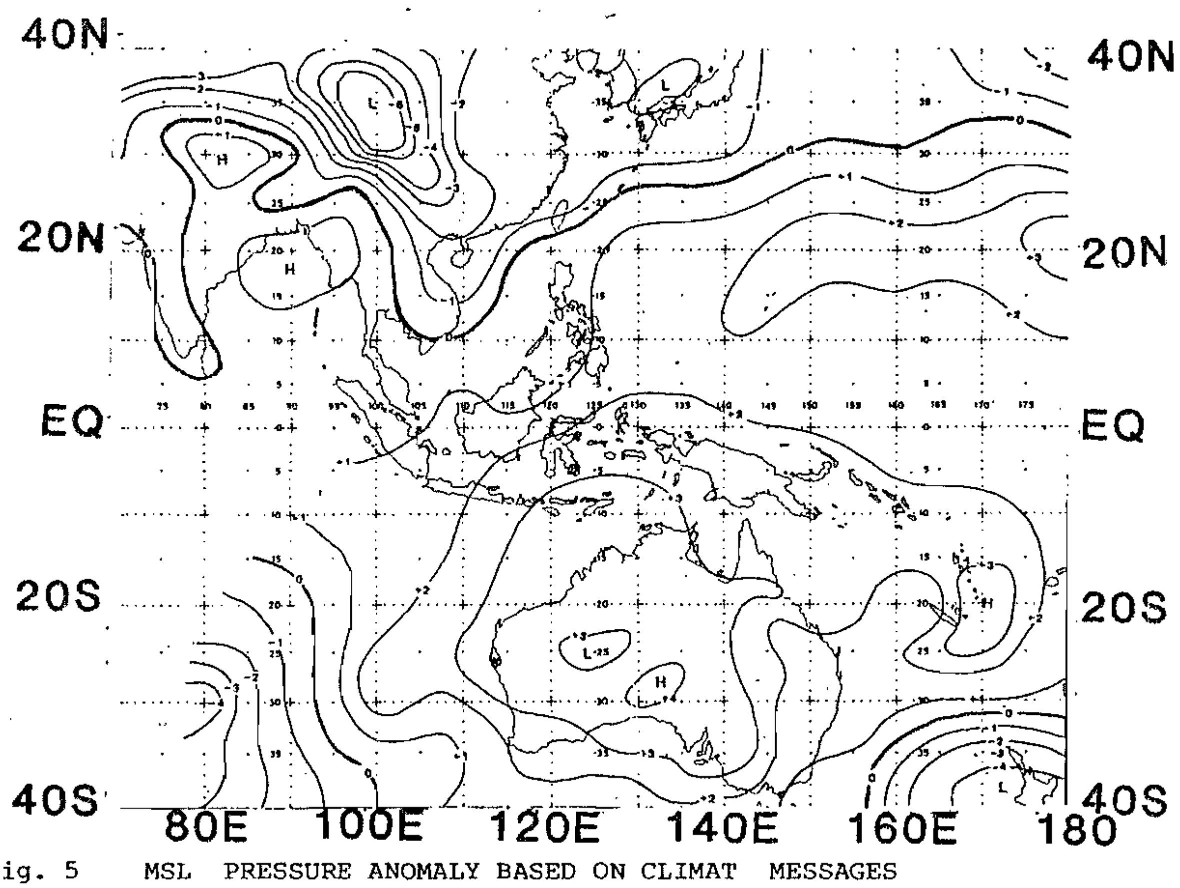


Fig. 5 MSL PRESSURE ANOMALY BASED ON CLIMAT MESSAGES
(AND MELBOURNE WMC DATA SOUTH OF 10 S)
Contour interval 1 hPa.

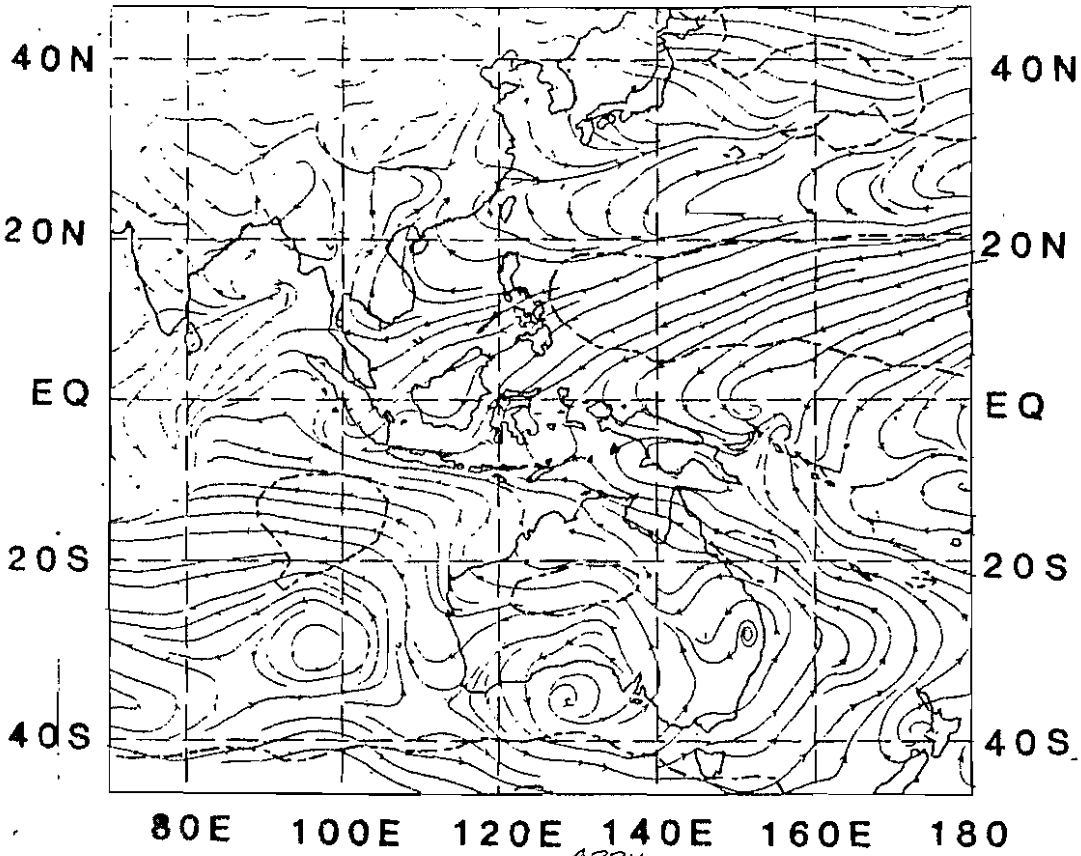


Fig. 6 950 hPa STREAMLINE ANALYSIS, ~~MARCH~~ APRIL 1987
Isotachs (dashed line) at 10 knot intervals.

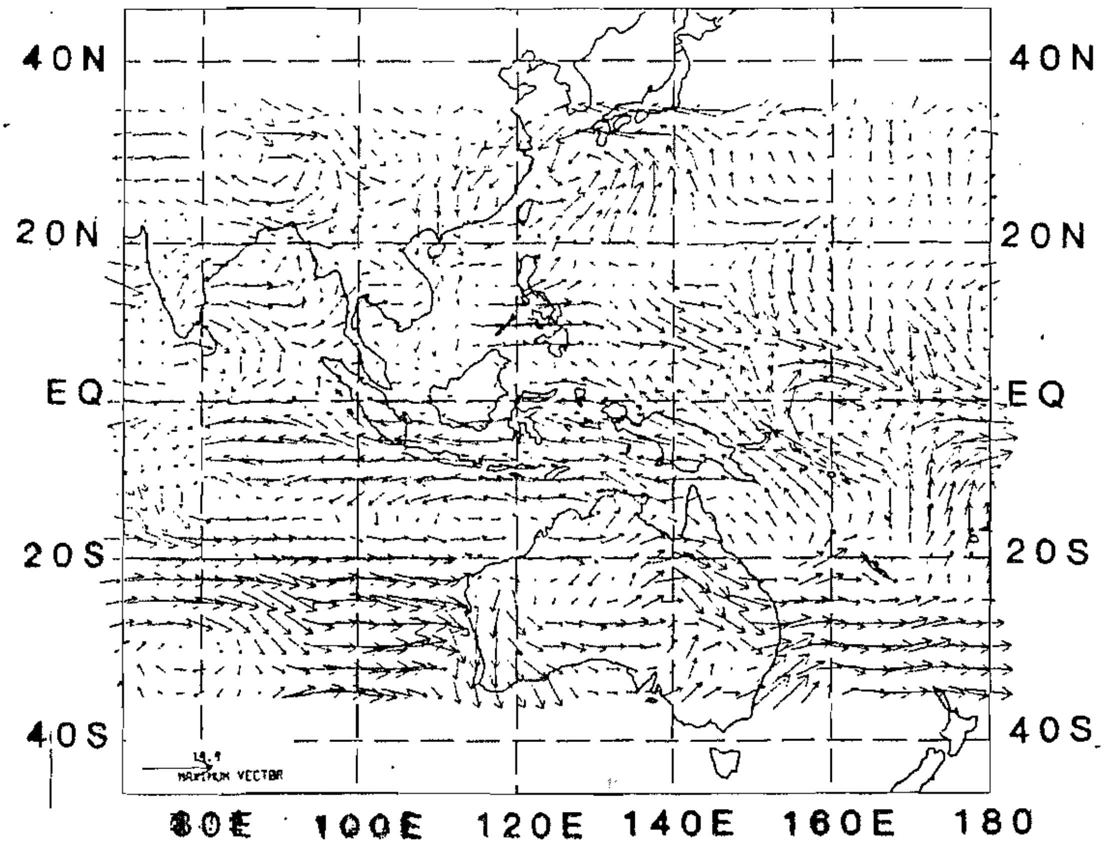


Fig. 7 950 hPa VECTOR WIND ANOMALY BASED ON FIG. 6
(Arrow length indicates magnitude).

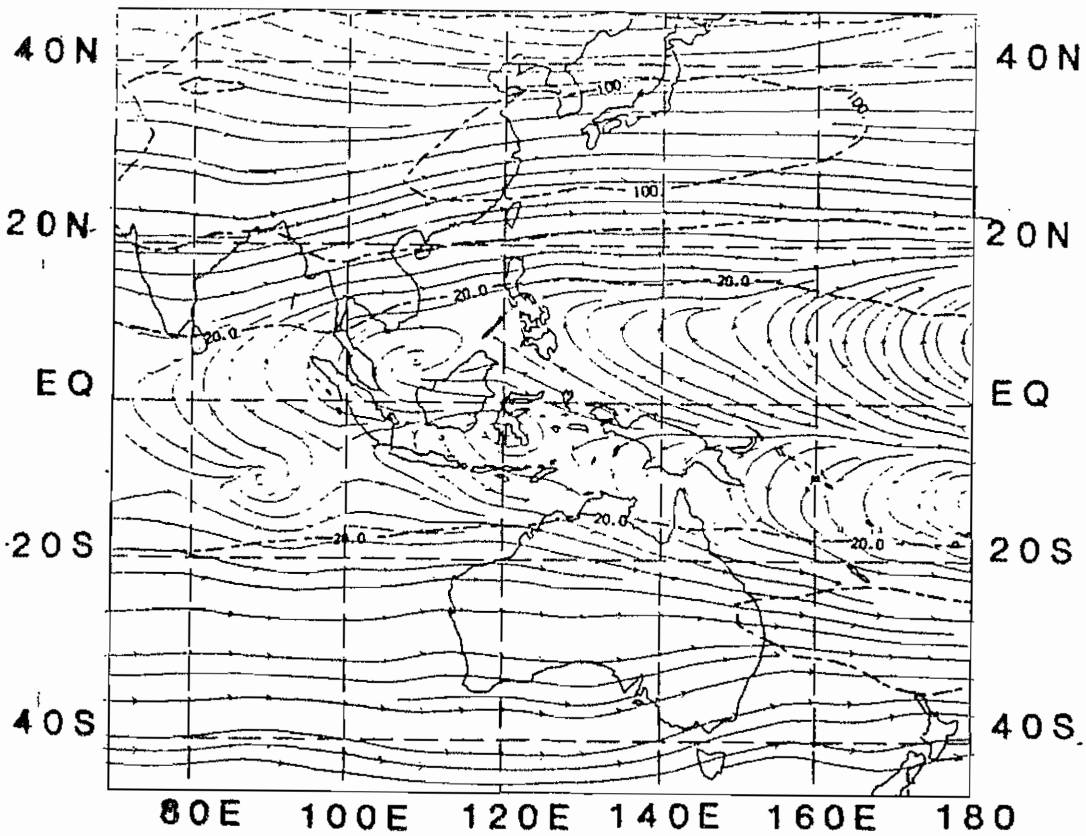


Fig. 8 200 hPa STREAMLINE ANALYSIS, ~~MARCH~~ APRIL 1987
Isotachs (dashed line) at 40 knot intervals.

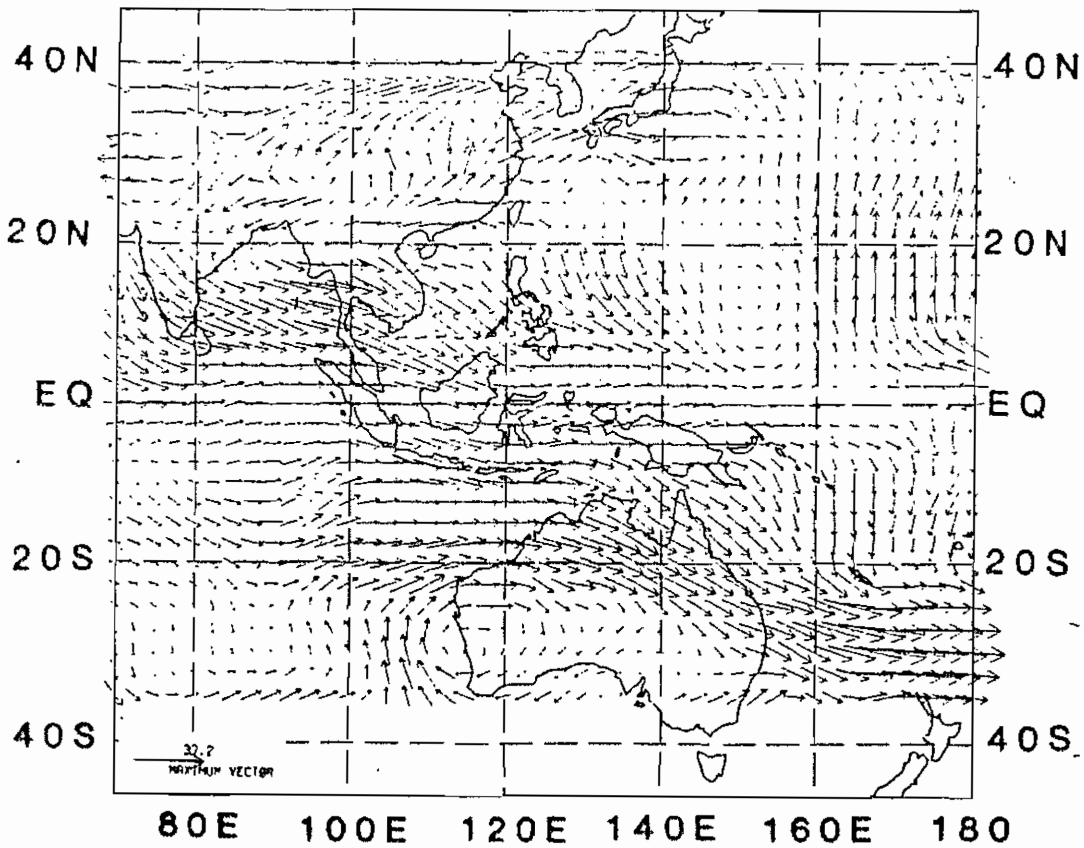


Fig. 9 200 hPa VECTOR WIND ANOMALY BASED ON FIG. 8
(Arrow length indicates magnitude).

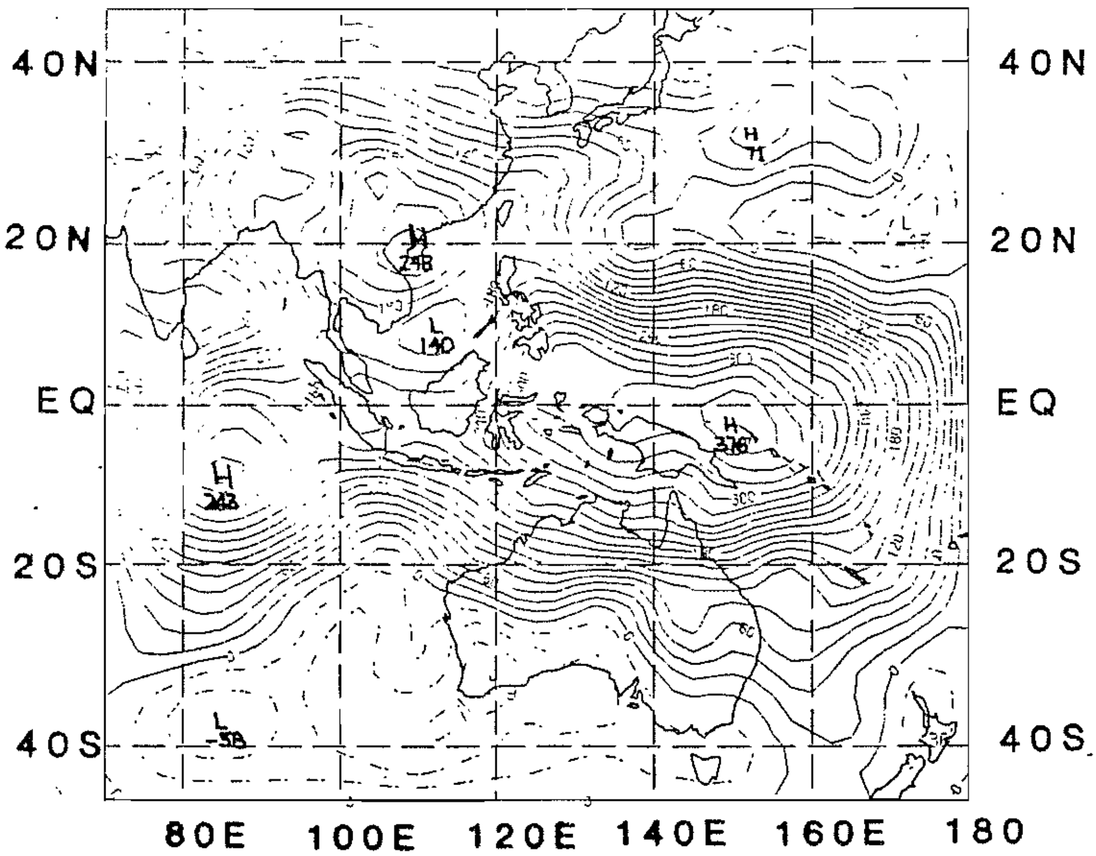


Fig. 10 950 hPa VELOCITY POTENTIAL, ~~MARCH~~ APRIL 1987
Contour interval ~~40~~ 30 x 10^5 m^2 /s

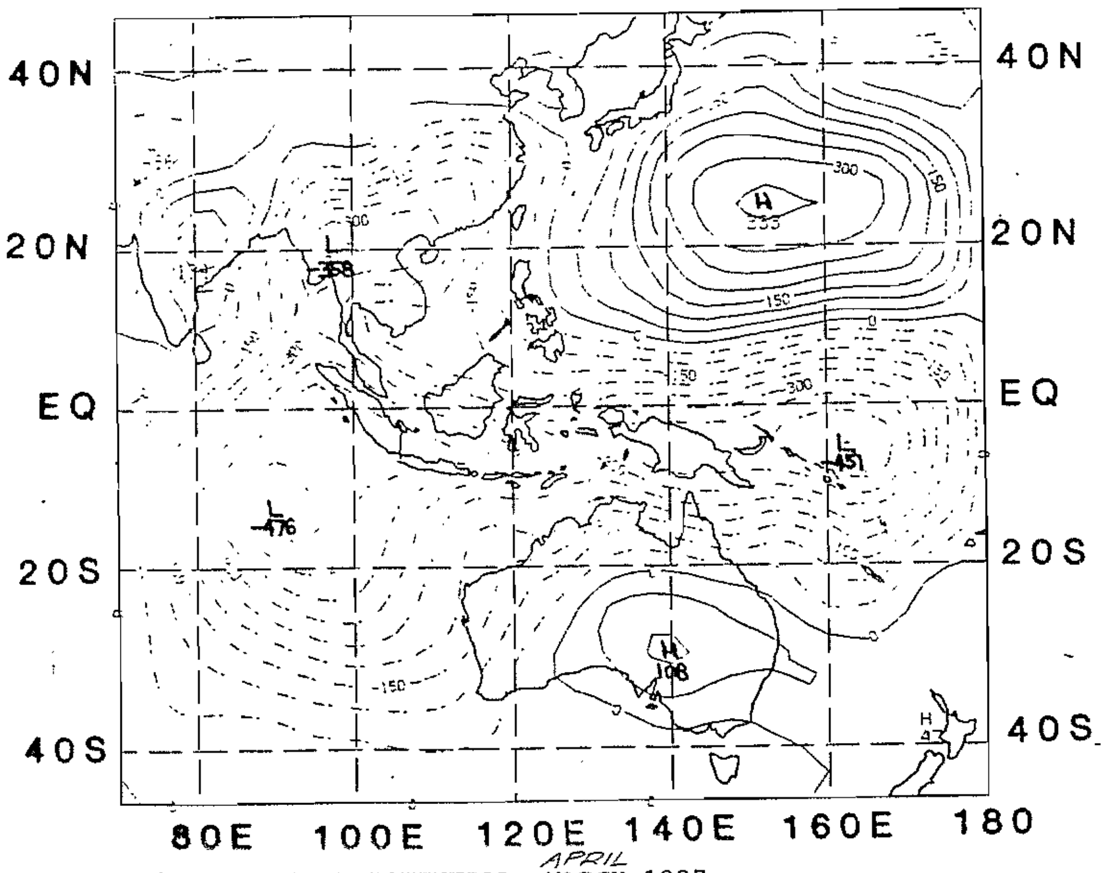


Fig. 11 200 hPa VELOCITY POTENTIAL, ~~MARCH~~ APRIL 1987
Contour interval 8 x 10^5 m^2 /s

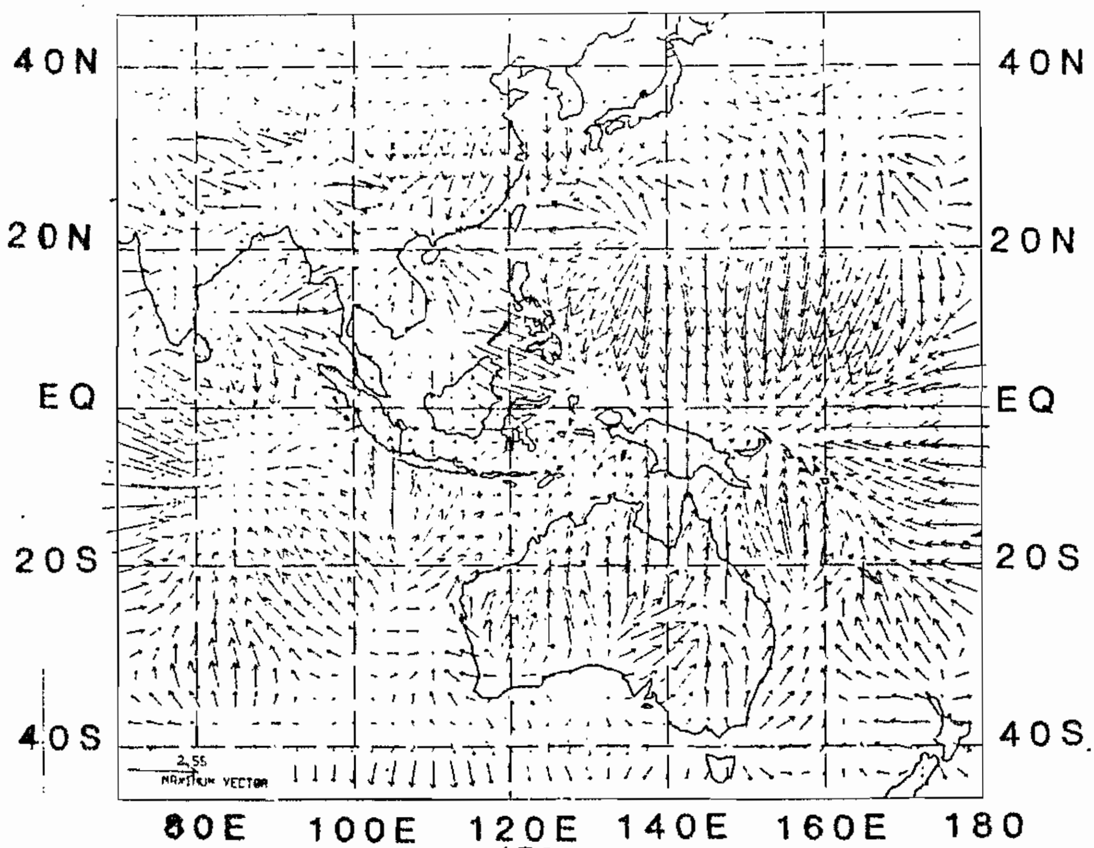


Fig. 12   950 hPa DIVERGENT WIND, ~~MARCH~~ APRIL 1987
(Arrow length indicates magnitude).

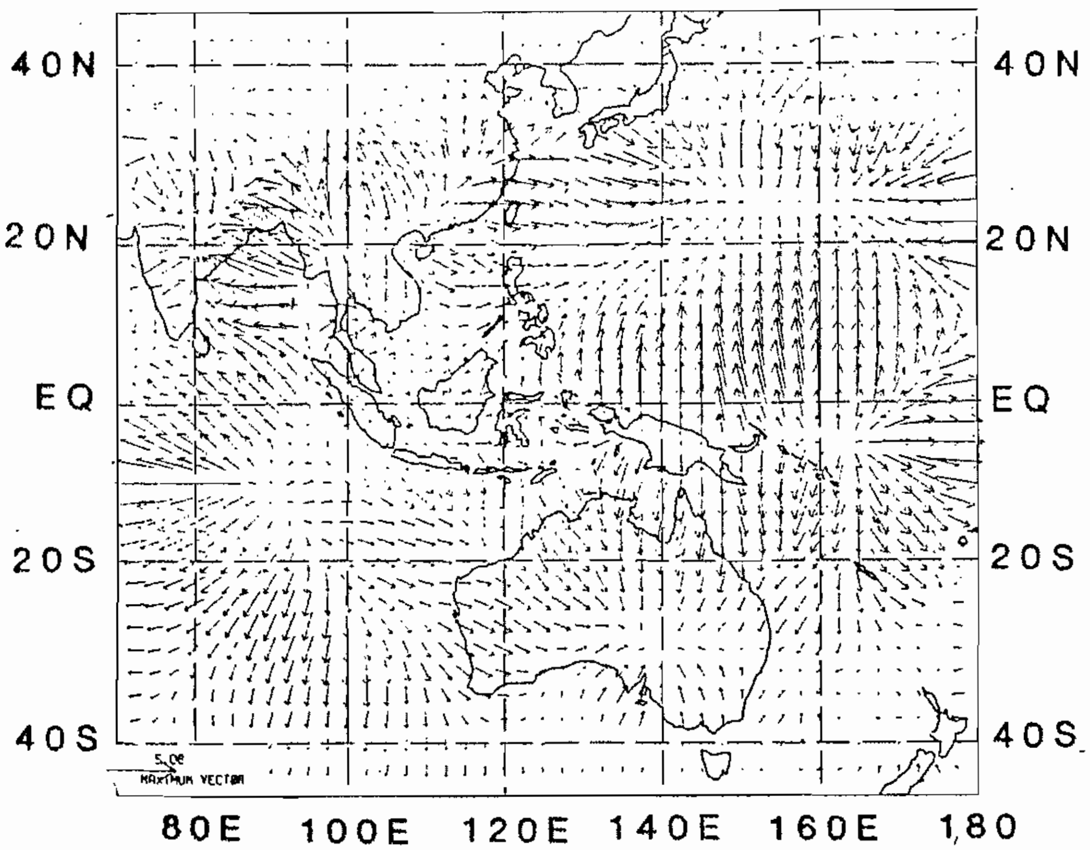


Fig. 13   200 hPa DIVERGENT WIND, ~~MARCH~~ APRIL 1987
(Arrow length indicates magnitude).

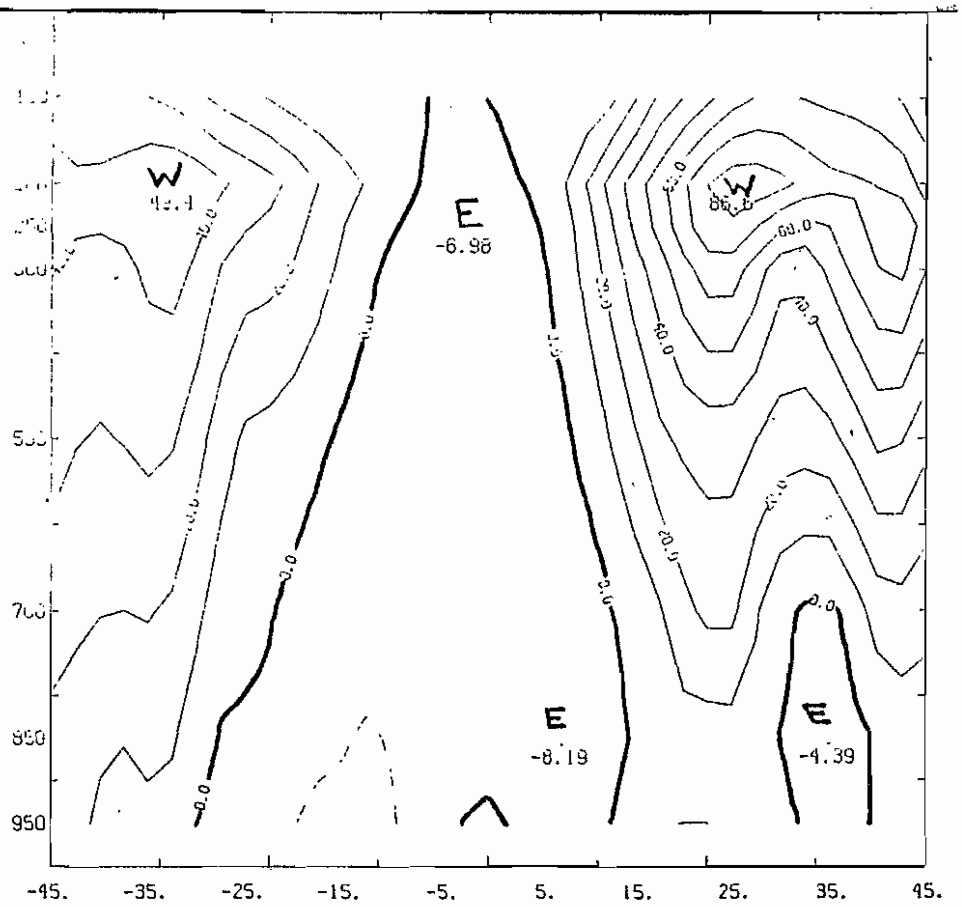


Fig. 14 CROSS-SECTION OF ZONAL WIND ALONG 100 E, ~~MARCH~~ APRIL 1987
Isotach interval 10 knots.

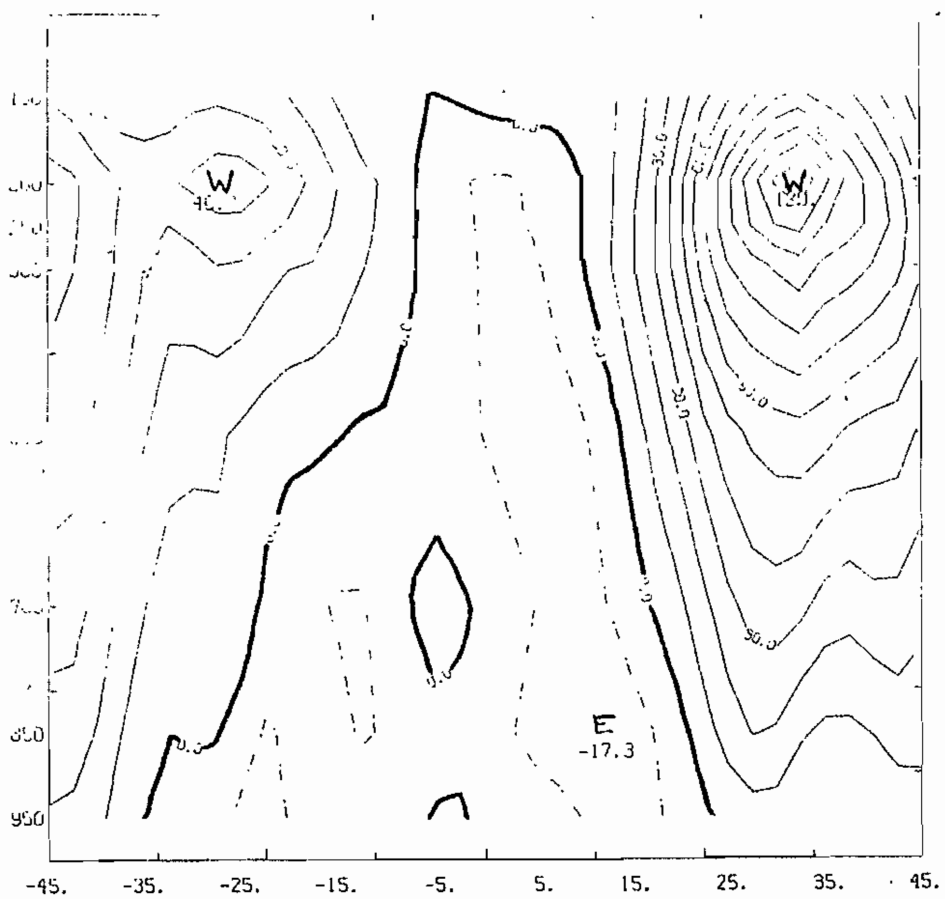


Fig. 15 CROSS-SECTION OF ZONAL WIND ALONG 130 E, ~~MARCH~~ APRIL 1987
Isotach interval 10 knots.

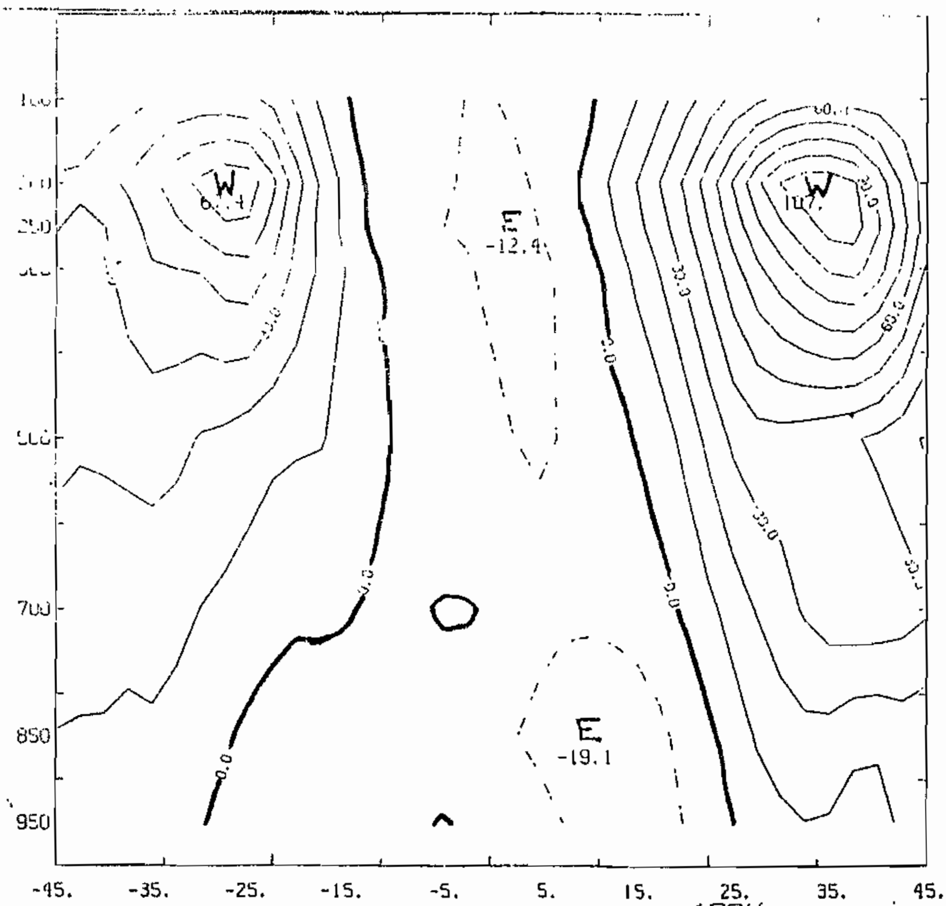


Fig. 16   CROSS-SECTION OF ZONAL WIND ALONG 160 E, ~~MARCH~~ APRIL 1987
Isotach interval 10 knots.

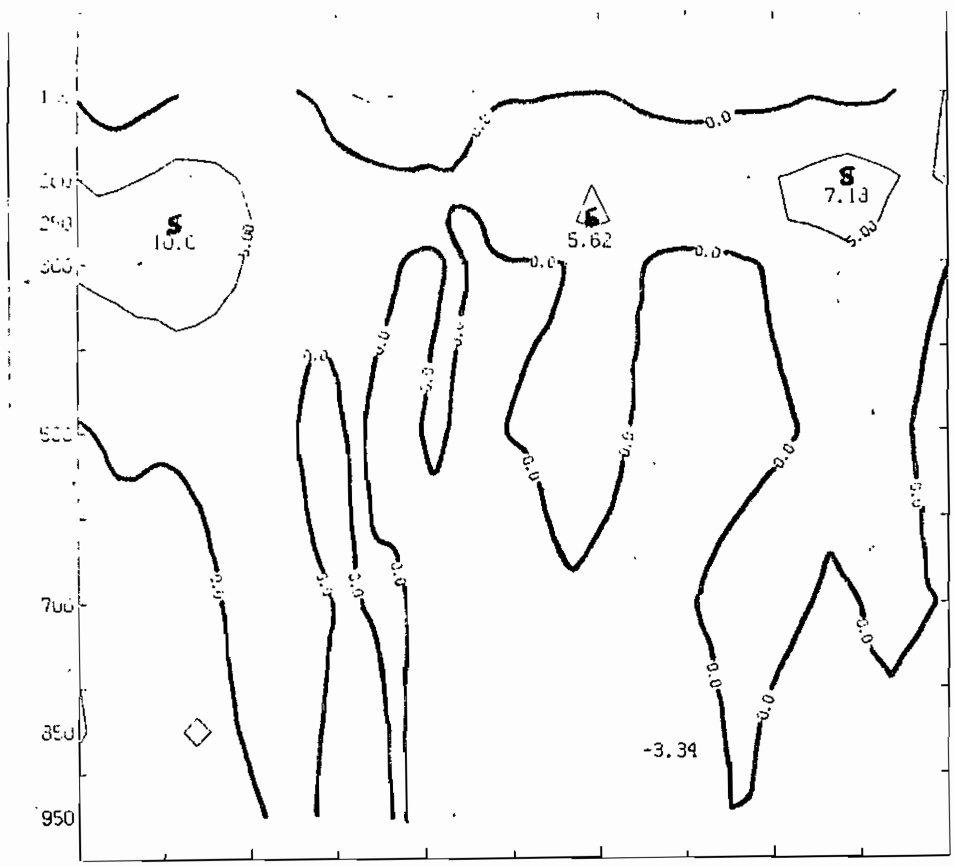
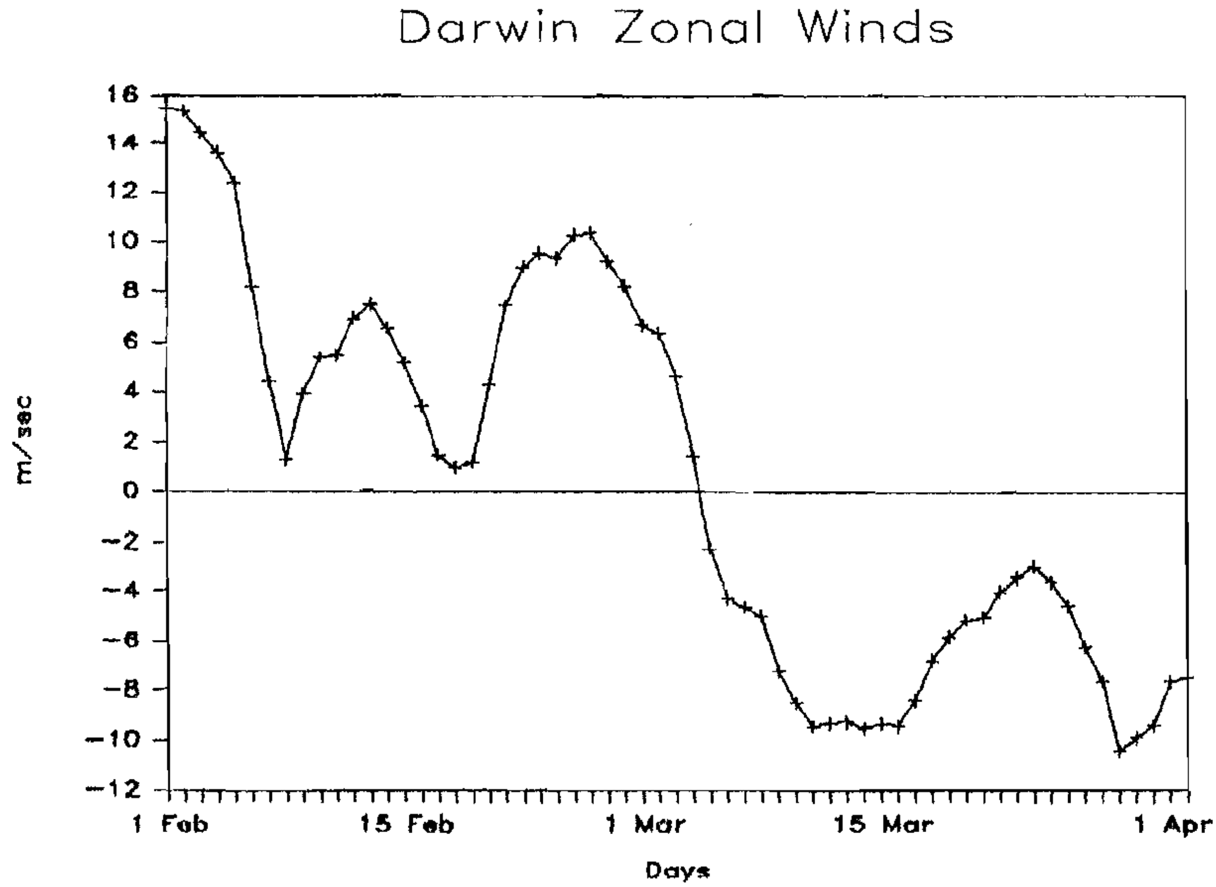


Fig. 17   EQUATORIAL CROSS-SECTION OF MERIDIONAL WIND BETWEEN 70E AND 180E, DEC 1986. 5 knot isotachs.



~~Fig. 18 TIME SERIES OF THE THREE DAY RUNNING MEAN 850 hPa ZONAL WIND AT DARWIN (1 FEB - 31 MAR 1987).~~

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 x(ΔP_{TAH} - ΔP_{DAR}) /σ

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

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6. **For further details contact:**
The Regional Director,
Bureau of Meteorology,
PO Box 40050, Casuarina,
Northern Territory 0811 AUSTRALIA
Telephone: (International: 61) (08) 8920 3813
Fax: (International: 61) (08) 8920 3832
E-mail: climate.nt@bom.gov.au