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DARWIN TROPICAL DIAGNOSTIC STATEMENT

MARCH 1986

ISSUED BY DARWIN RMC

INDICES

The Darwin mean MSL pressure for March was 1008.4 mb, 0.9 mb above the 1932/1983 mean. The Tahiti mean MSL pressure for March was 1012.5 mb, also 0.9 mb above the 1932/1983 mean. These give Troup's Southern Oscillation Index as zero, with a five month running mean, centred on January, of -1.

TROPICAL CYCLONES

Four tropical cyclones were named in the southern hemisphere between 70 and 180 E during March 1986. Two of these affected the area between 105 and 165E. This is slightly below, but consistent with the long term mean of 3.9. No tropical cyclones formed in the Northwest Pacific during March, where the long term mean is 0.5. Unofficial tracks are shown in figs. 1a-c.

Tropical cyclone Victor was named on the 3rd March, just off the northern West Australia coast, tracked southwestwards, and ultimately dissipated over water south of 20S.

Tropical cyclones "Alfred" and "Lusi" both formed in the monsoon trough east of Australia on the 7th March, as a surge in the southeasterly trades led to a short lived maximum of vorticity in the monsoon trough. Both systems moved rapidly southeastwards, and dissipated soon afterwards over the cooler ocean south of 25S.

Cyclone "Jefotra" formed in the Indian Ocean on the 26th March and moved steadily westwards. This system attained severe tropical cyclone status during the 28th March. It moved west of 70E on the 29th March, and subsequently dissipated due to being sheared off in the middle levels.

SEA SURFACE TEMPERATURES

The mean sea surface temperature (SST), during March 1986, and SST anomalies averaged over the middle two weeks of March 1986 are shown in figs. 2 and 3.

Possibly the area of greatest interest is the weak warm SST anomaly over the southeast Asian equatorial region. This is consistent with the March value of the southern oscillation index of zero, in that neither one is indicative of the onset of an El Nino event. Furthermore, the warm anomaly over the central Pacific equatorial area indicated in February, appears to have weakened in March.

A persistent long wave trough over western Australia during March 1986, led to a stronger southerly component to the winds over the southeastern Indian Ocean than is usual at this time of year, and explains the cool SST anomaly in this region.

MSL AND GRADIENT LEVEL FLOW

The mean MSL pressure and anomaly charts for March 1986 are shown in figures 4 and 5, and the gradient level (950 mb) streamline and anomaly charts at figures 6 and 7.

Unfortunately, no data were available to us concerning MSL pressure anomalies over the northwestern Pacific.

The Tasman Sea to the east of the Australian continent is of interest. The high pressure anomaly is responsible for the enhanced southeasterly trade winds indicated in fig.7.

The South Pacific Convergence Zone (SPCZ) appears to be slightly stronger than usual as shown by the troughing indicated on the gradient level (950 mb) anomaly chart, and supported by a reduction of the high anomaly in fig.5. A possible explanation for this could be derived from enhanced vorticity in the SPCZ produced by the stronger than usual southeasterly trades to its south and west.

The well defined easterly 950 mb wind anomaly at low southern latitudes east of 130E is not consistent with flow normally expected during El Nino years (see Rasmusson and Carpenter, 1982).

Higher than normal pressures in the southern Indian Ocean near 32S 98E together with the persistent long wave trough over western Australia, led to an enhanced southerly 950 mb airstream off the west coast of Australia during March 1986. The cool SST anomaly in this region (see fig.3) is conistent with this southerly wind regime.

500 MB FLOW

Mean 500 mb streamline analysis and geopotential height anomaly charts are shown in figs. 8 and 9 respectively.

Again, a shortage of data in the northern hemisphere presents difficulties in defining significant anomalies south of the equator.

The most obvious feature of the 500 mb geopotential height anomaly chart is the trough near 115E which supports the low level wind, and SST anomalies as discussed previously.

The strengthening of the high anomaly over continental Australia is probably due to persistent warm air advection in the lower levels during most of March.

The negative 500 mb height anomaly along the east Australian coast results from the persistent southeasterly low level wind anomaly in this region advecting cool air.

The weak negative anomaly near 20S 175E is consistent with the stronger than normal SPCZ.

200 MB FLOW

The mean 200 mb streamline analysis for March 1986 and the vector wind anomaly, are shown in figs. 10 and 11 respectively.

The northern hemisphere sub tropical jet stream (STJ) was slightly stronger during March 1986 than is usual during this month, although its position was typical of the long term mean. The stronger than average southern hemisphere STJ during February had reduced in strength to a March value close to the mean.

The long term mean 200 mb flow for March shows east-southeasterly cross-equatorial flow everywhere between 70 and 180 degrees E. However, fig. 10 shows an east-northeasterly cross equatorial flow occuring between 130 and 170E. This anomaly can be clearly seen in figue 11 which indicates a northeasterly vector wind anomaly in the area. This is consistent with the southerly 950 mb wind anomaly mentioned previously. Caution must be used however before drawing any conclusions about the strength of the southern hemisphere monsoon. The equatorial region west of 130E shows a southerly 200 mb vector wind anomaly. Thus, the overall strength of the southern hemisphere monsoon may not conclusively be inferred to have deviated from normal during March 1986 if one considers the area from 70 to 180E in entirity, particularly as the southern oscillation index was zero, and the number of tropical cyclones in the southern hemisphere during March 1986 was not significantly less than the mean.

VELOCITY POTENTIAL AND DIVERGENT WIND

Charts of the 950 and 200 mb velocity potential, and the 950 and 200 mb divergent wind, are shown in figs. 12,13,14 and 15 respectively.

The charts suggest a northward movement of maximum convective activity, from near New Guinea during February, to near the equator during March. Observations from satellite imagery and surface data support this view, with increased cloudiness at low northern latitudes around this longitude. This is a normal phenomenon at this time of year.

The velocity potential and divergent wind charts indicate maxima of convection extending east-southeastwards over the Tasman Sea, and west-southwestwards over the southern Indian Ocean. These locations are consistent with the mean position of the southern hemisphere monsoon trough during March 1986 (see fig. 6).

WIND CROSS-SECTIONS

Cross sections of zonal wind taken through 100, 130 and 160E together with a cross section of latitudinal wind taken along the equator, are shown at figs. 16,17, 18 and 19 respectively.

These charts corroborate remarks made about the various levels earlier in the report.

Probably the most evident feature shown on the latitudinal cross section chart, is the northerly component to the flow above the 300 mb level. All winds above this level were southerly in February. This feature has been discussed in the preceeding section concerning 200 mb flow.

SUMMARY

The southern oscillation index for March 1986 was zero. This result shows a return to more normal values after the negative value of -11 during February 1986. Lack of significant SST cooling near Indonesia, casts doubt upon the prognostication of an 'El Nino' or 'Warm Event' developing.

Overall, March 1986 appeared to be quite normal, and did not exhibit strong indications of El Nino onset. It must be remembered, however, that a typical El Nino or Warm Event would only be in an embryonic stage during March, particularly in the western Pacific region.

References:

Rasmusson & Carpenter (1982)
"Variations in Tropical Sea Surface Temperature and Surface Wind Fields Associated with the Southern Oscillation/El Nino".
(Mon.Wea.Rev. V110. No.5 1982)

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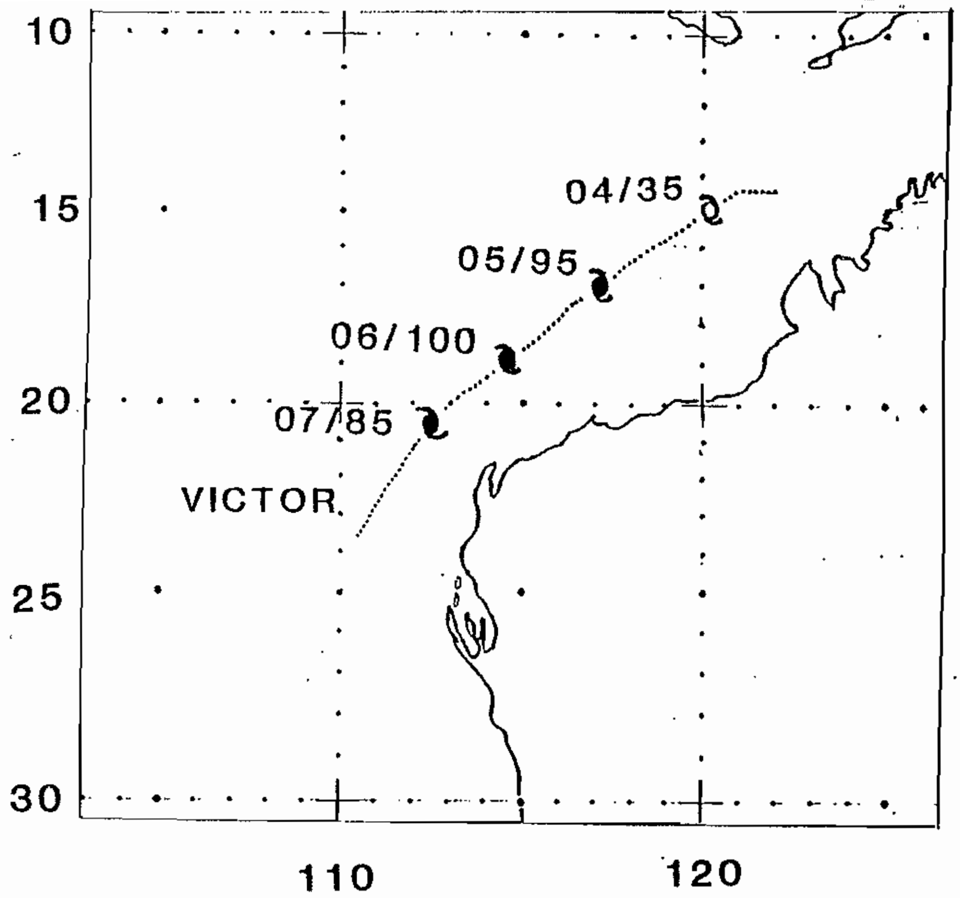

Fig. 1a UNOFFICIAL CYCLONE TRACK OF VICTOR FOR MARCH 1986
Date (DD) and maximum sustained wind in knots (ff) are given as DD/ff.

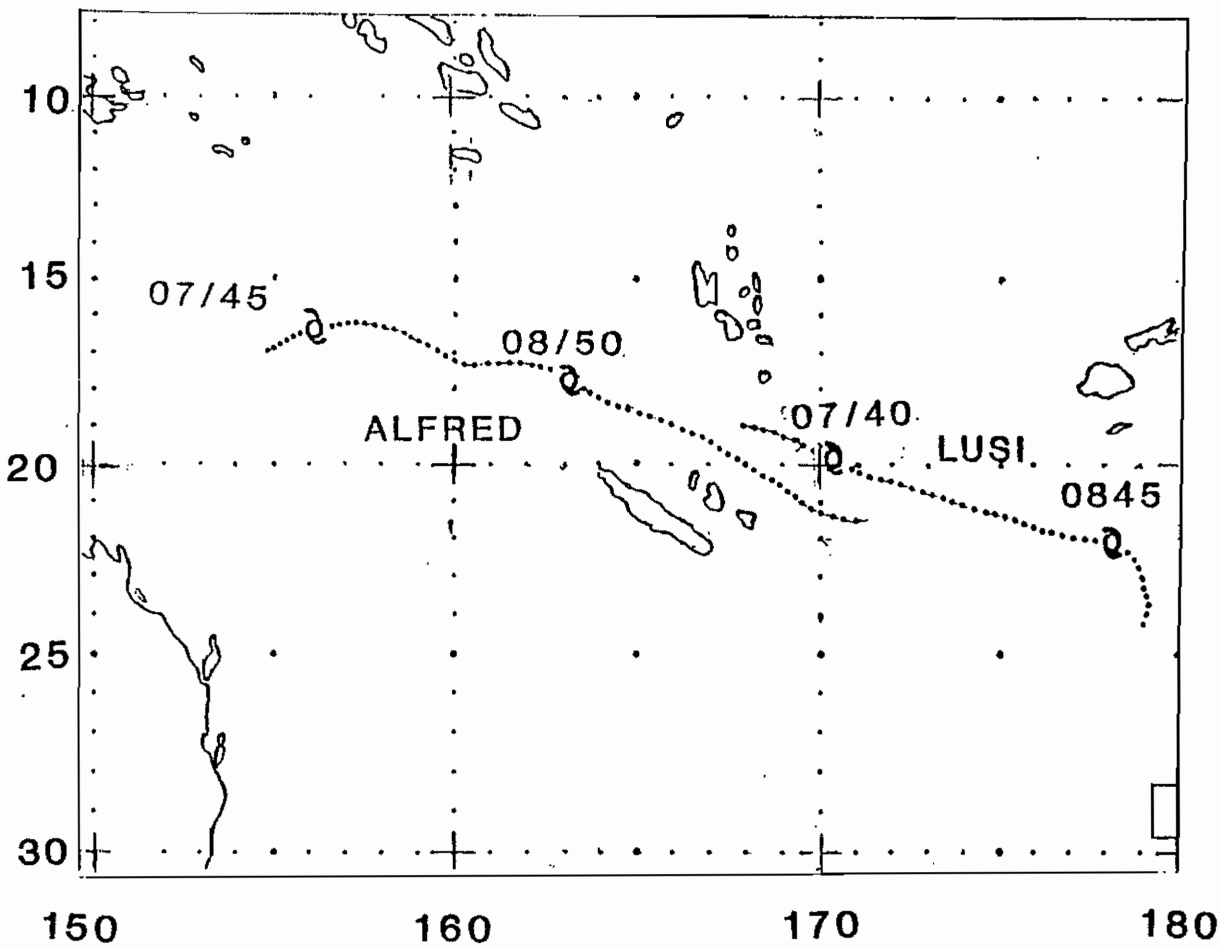

Fig.1b UNOFFICIAL CYCLONE TRACKS OF ALFRED AND LUSI FOR MARCH 1986.
Date (DD) and maximum sustained wind in knots (ff) are given as DD/ff.

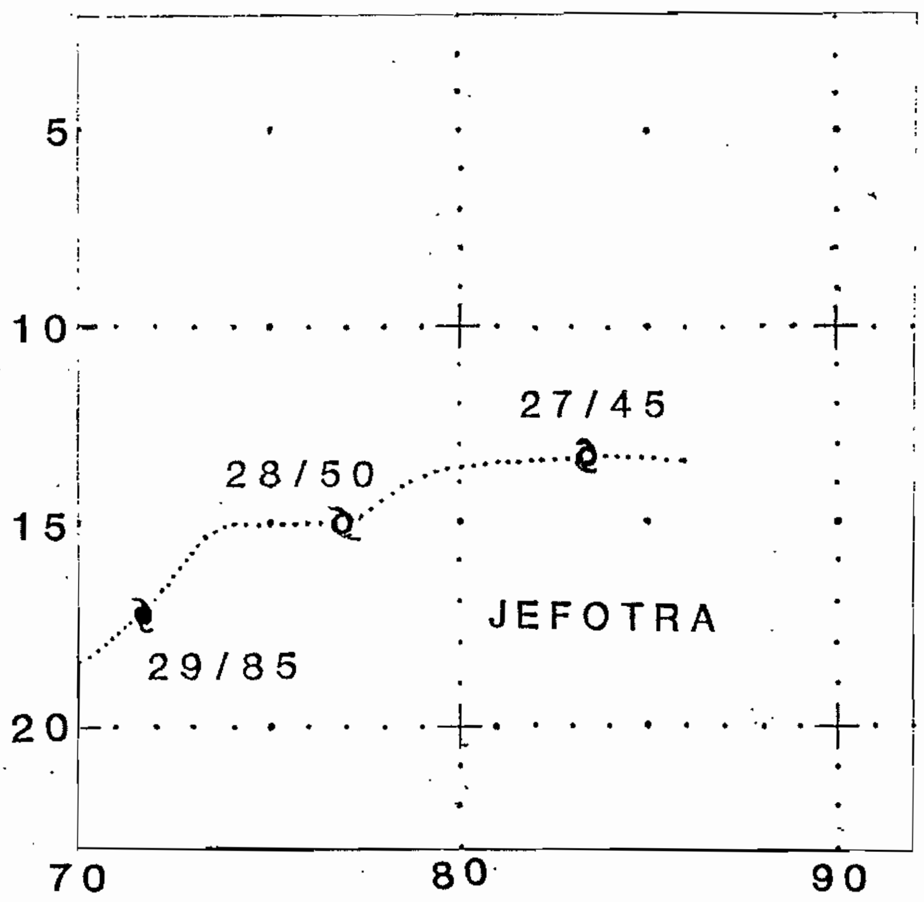

Fig. 1c UNOFFICIAL CYCLONE TRACK OF JEFOTRA FOR MARCH 1986.
Date (DD) and maximum sustained wind i.e. knots (ff) are given as DD/FF

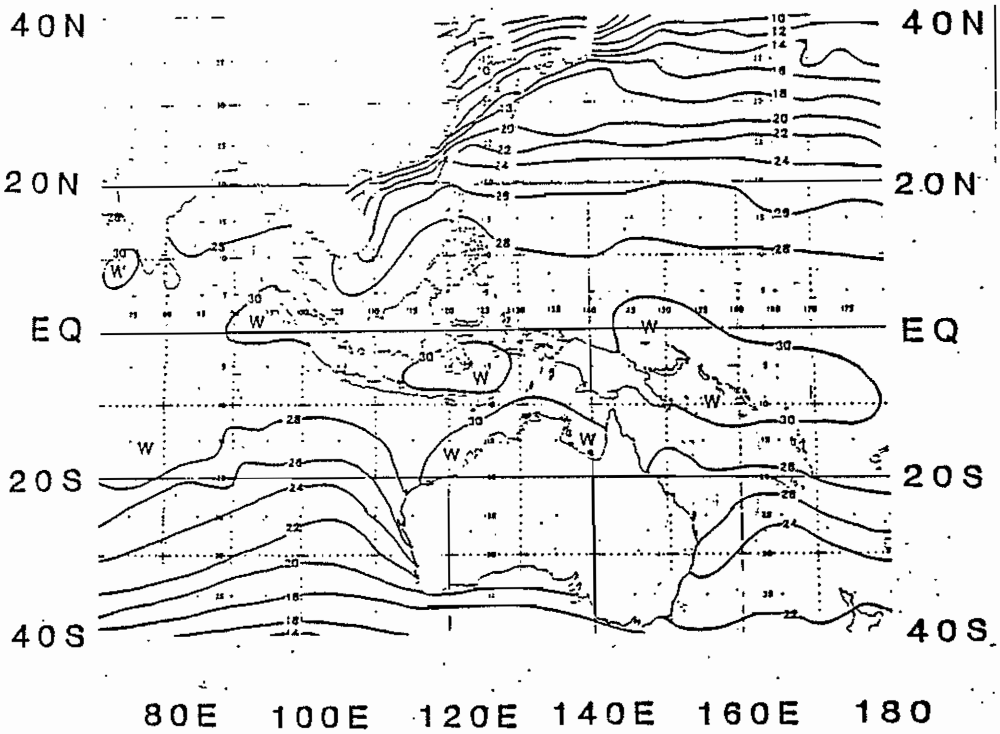

Fig.2 MEAN SEA SURFACE TEMPERATURES, BASED ON DARWIN RMC ANALYSIS AVERAGED OVER THE MIDDLE 2 WEEKS OF MARCH 1986. (CONTOUR INTERVAL 2°C).

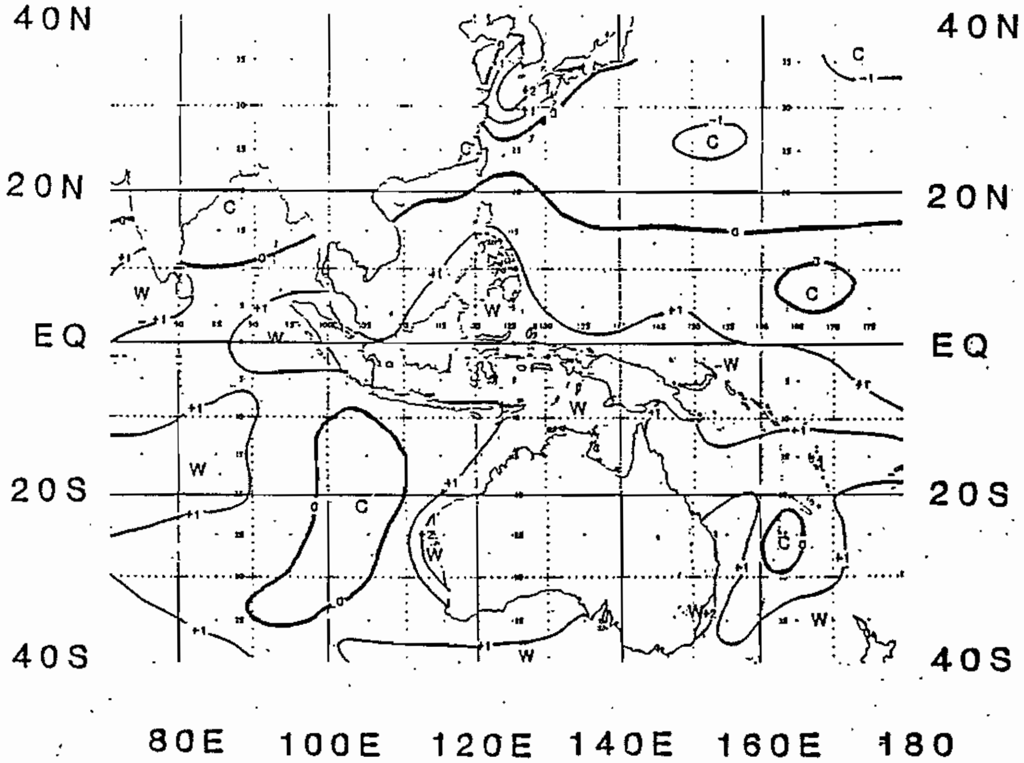

Fig. 3 SST ANOMALY CHART, BASED ON FIG.2 AND THE CLIMATOLOGY OF REYNOLDS, NOAA REPORT NWS 31, 1983. (CONTOUR INTERVAL 1°C).

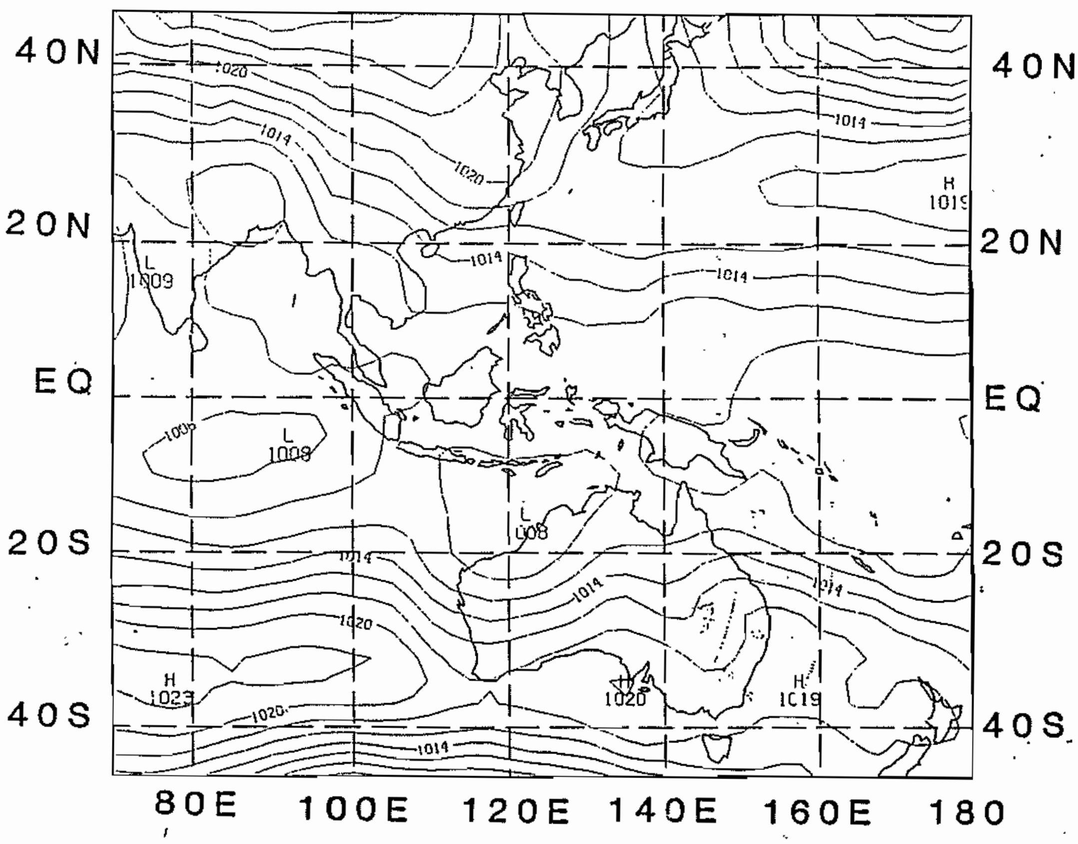

Fig. 4 MARCH 1986 MONTHLY MEAN MSL PRESSURE (CONTOUR INTERVAL 2 mb).

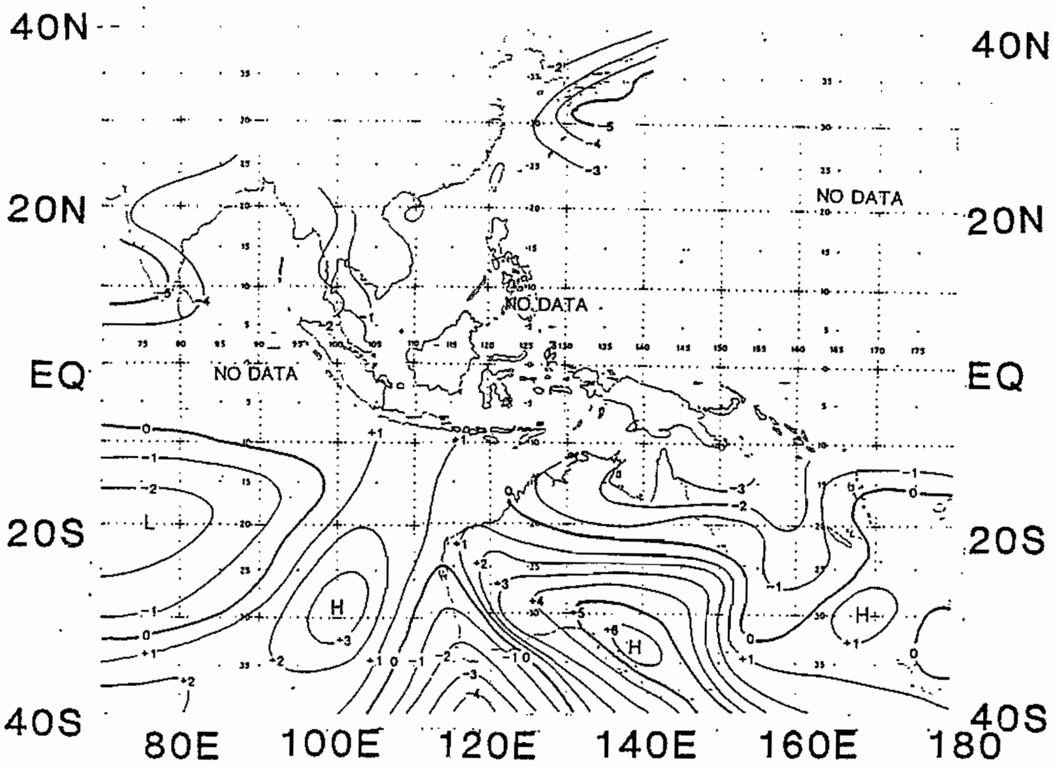

Fig. 5 MSL PRESSURE ANOMALY BASED ON MELBOURNE WMC DATA SOUTH OF 10°S, ADJUSTED TO FIT CLIMATE MESSAGES WHERE AVAILABLE. (CONTOUR INTERVALS 1 mb).

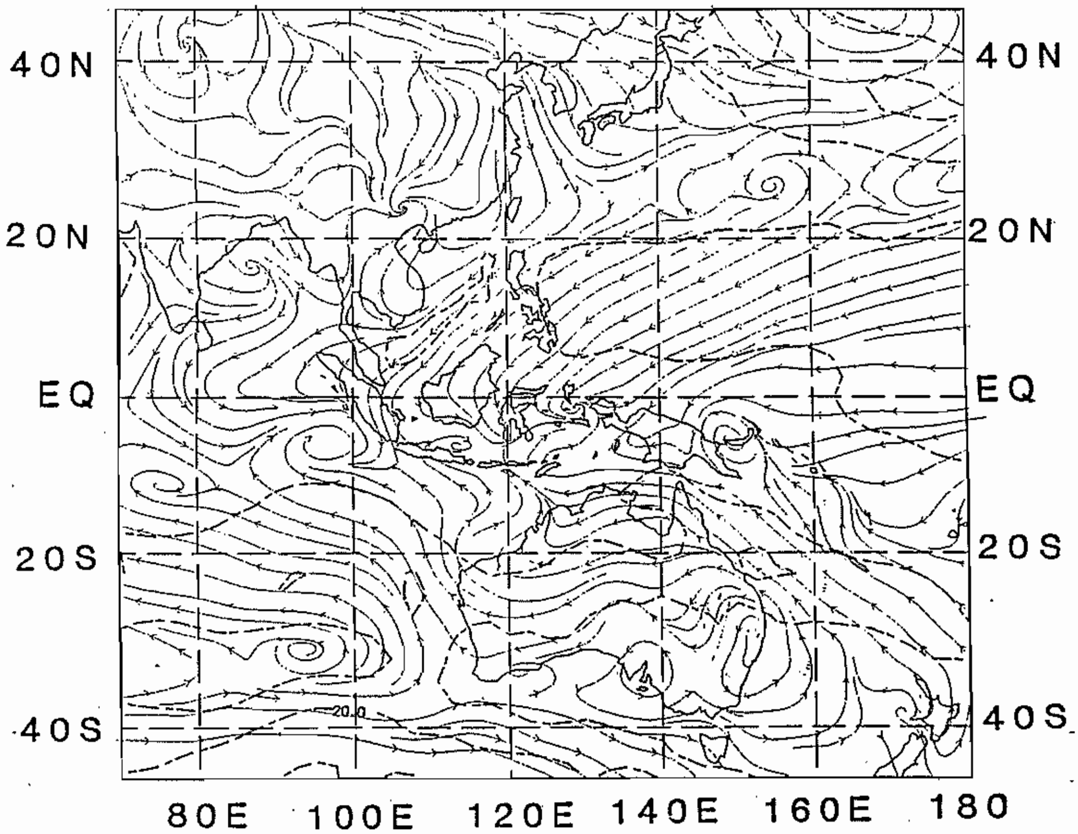

Fig. 6 MARCH 1986 950 mb STREAMLINE/ISOTACH ANALYSIS. (10 KNOT INTERVAL ISOTACHS DASHED LINE).

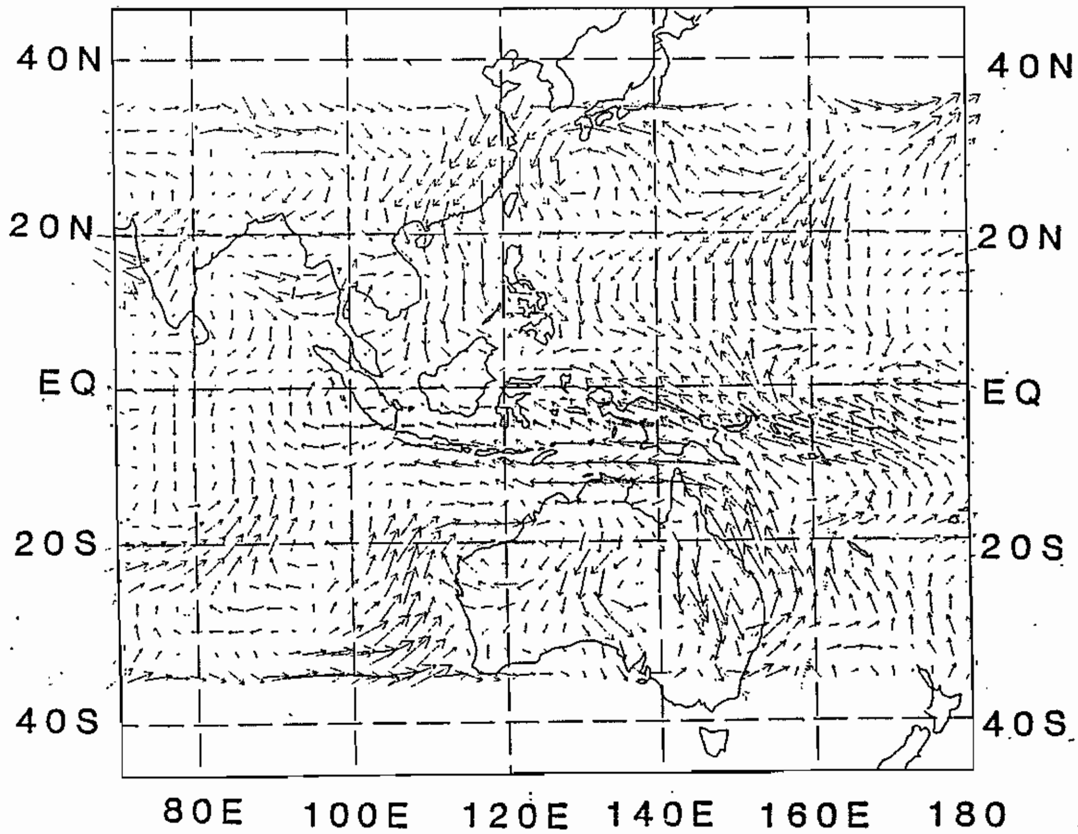

Fig. 7 950 mb VECTOR WIND ANOMALY BASED ON FIG. (ARROW LENGTH INDICATES MAGNITUDE).

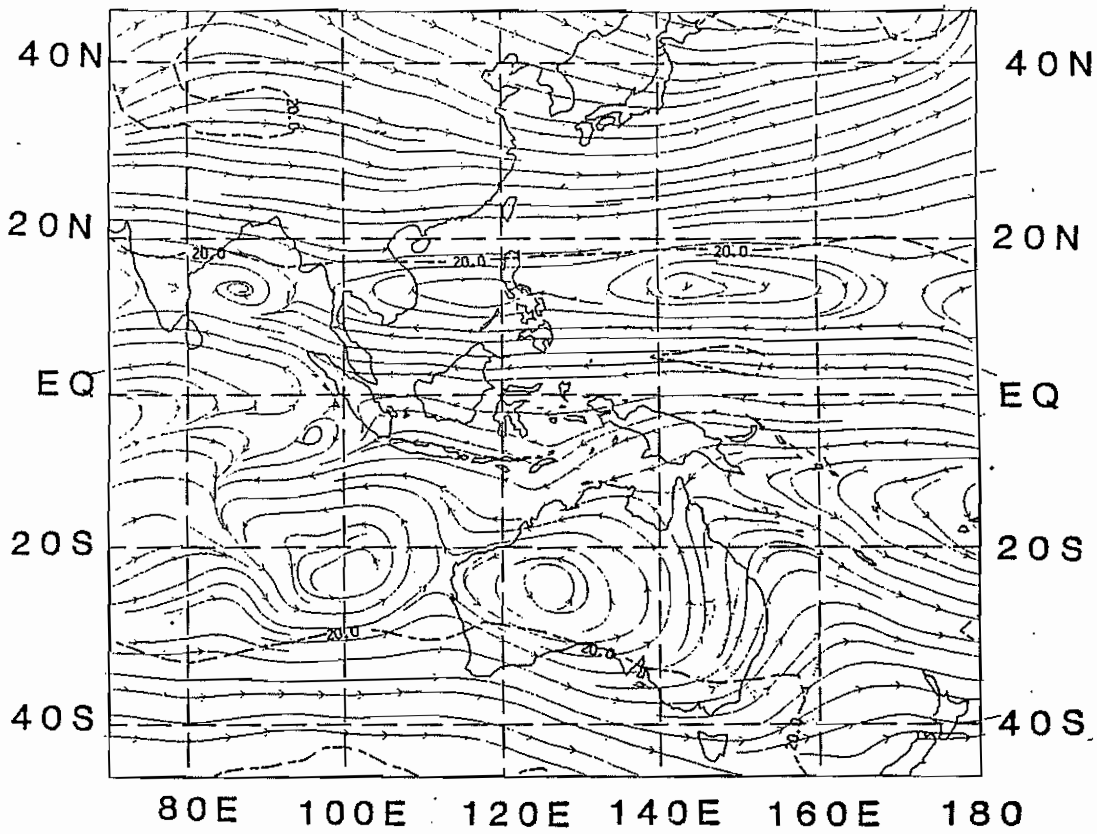

Fig. 8 MARCH 1986 500 mb STREAMLINE/ISOTACH ANALYSIS. (10 KNOT INTERVAL ISOTACHS DASHED LINE).

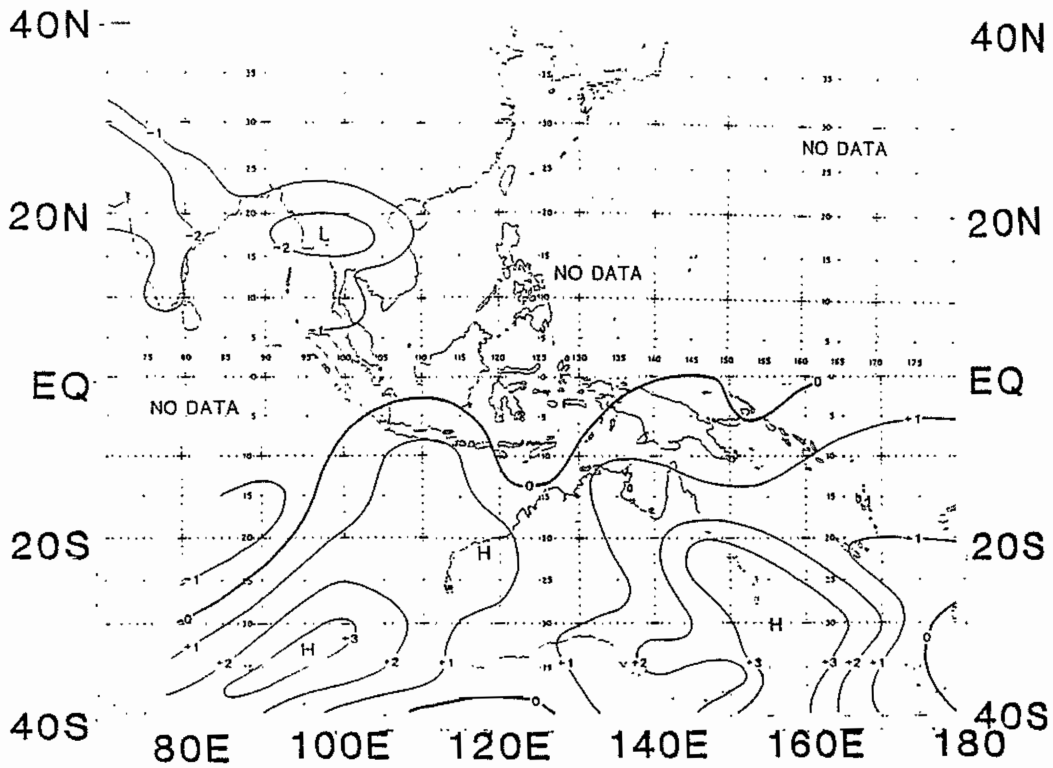

Fig. 9 MARCH 1986 500 MB GEOPOTENTIAL HEIGHT ANOMALY. (CONTOUR INTERVAL 1 gpdm) (DATA BASE AS PER FIG. 5).

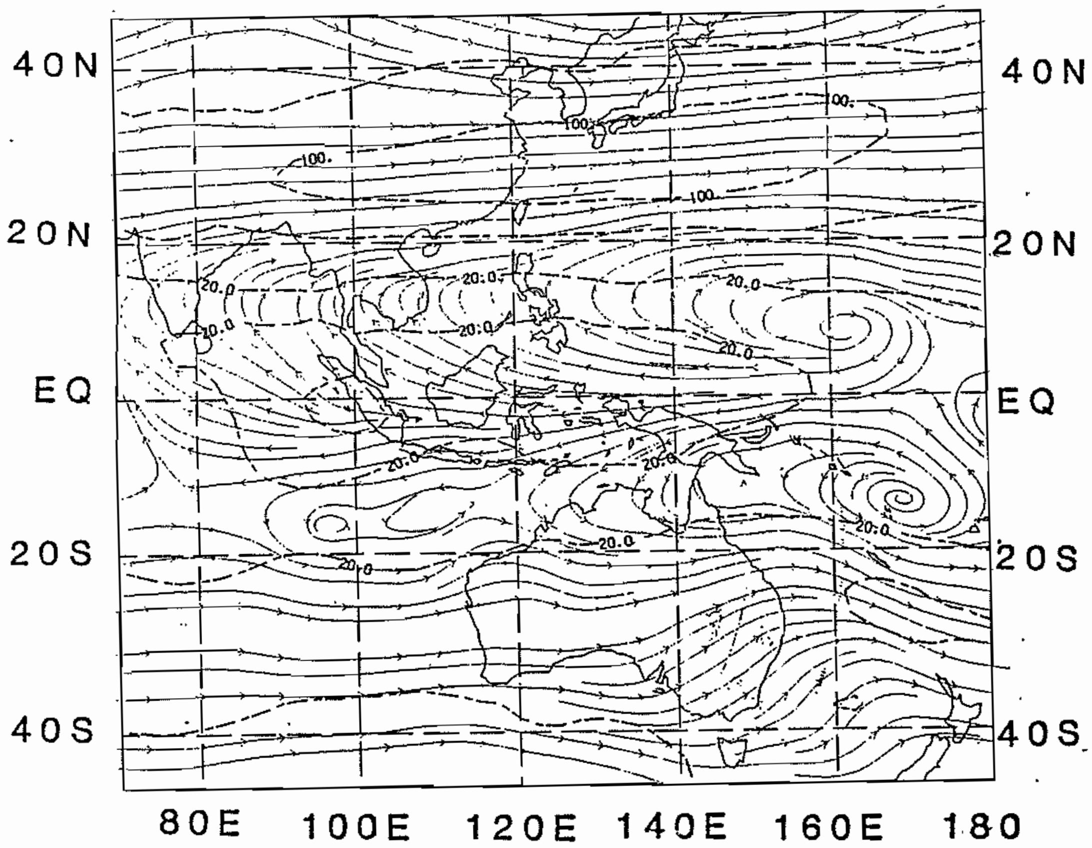

Fig. 10 MARCH 1986 200 mb STREAMLINE/ISOTACH ANALYSIS. (40 KNOT INTERVAL ISOTACH DASHED LINE).

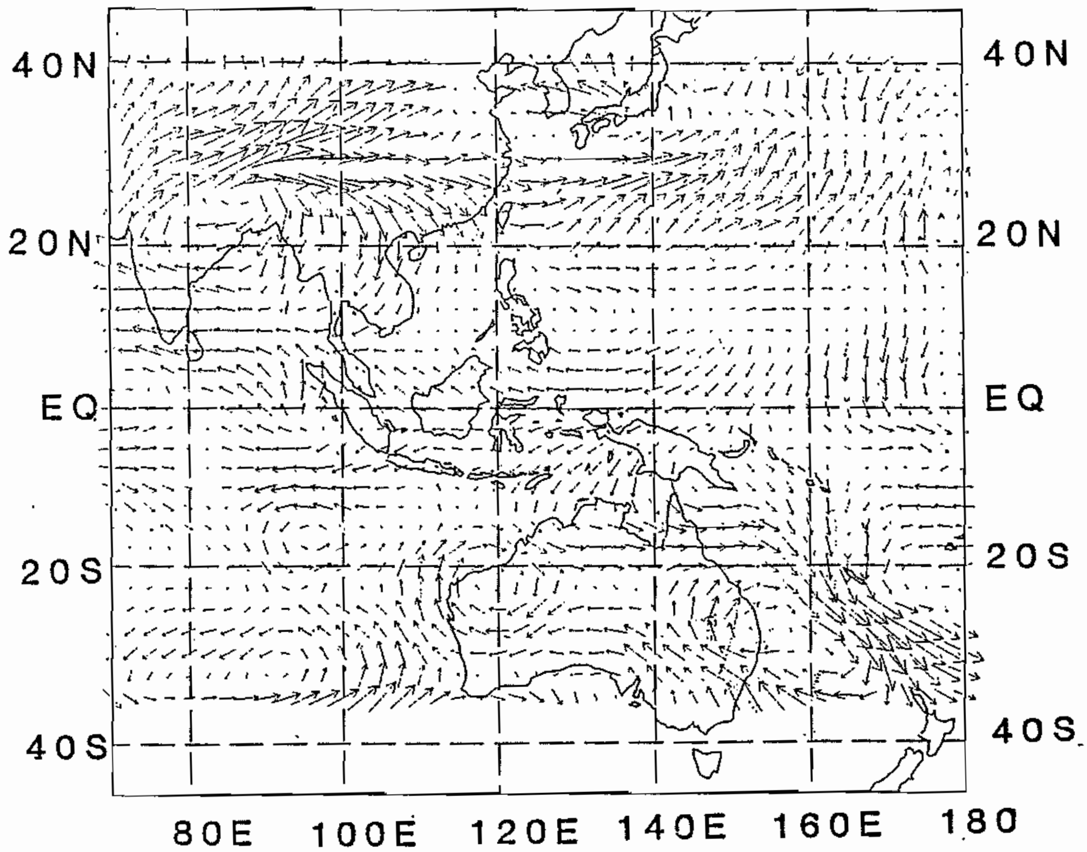

Fig. 11 MARCH 1986 200 mb VECTOR WIND ANOMALY. (ARROW LENGTH INDICATES MAGNITUDE).

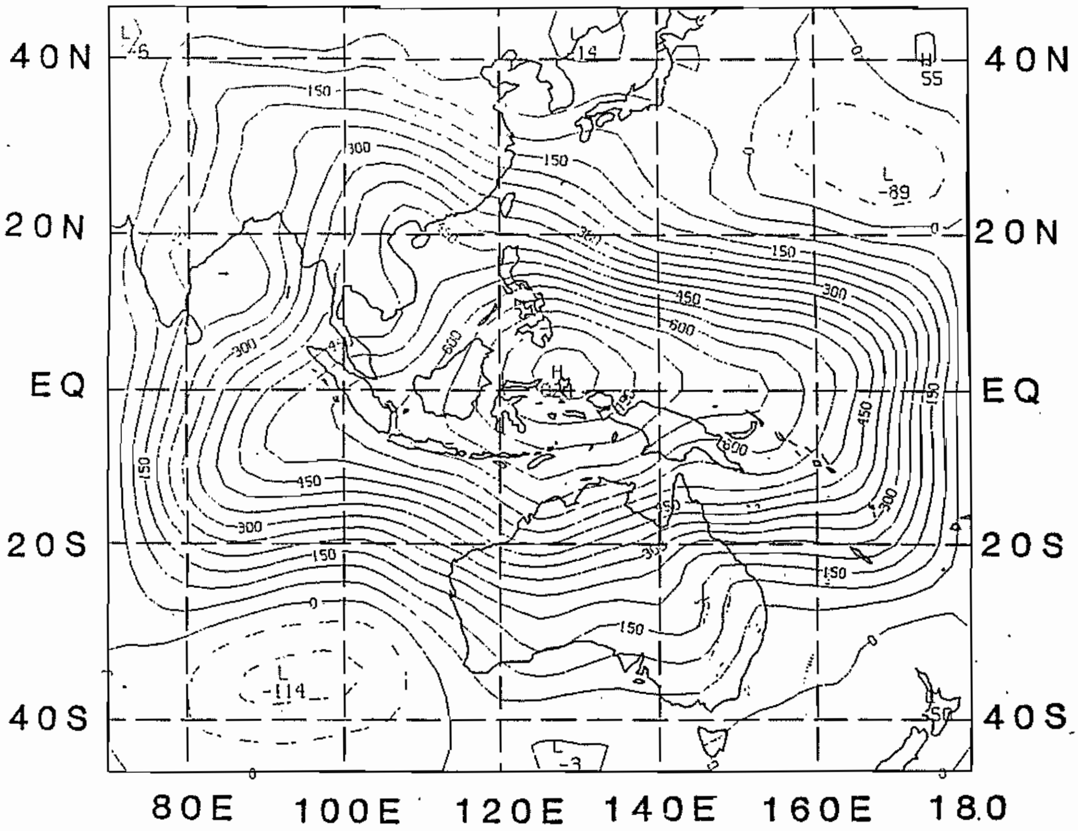

Fig. 12 MARCH 1986 950 mb VELOCITY POTENTIAL.
(CONTOUR INTERVAL 60 x $10^5 M^2 S^{-1}$).

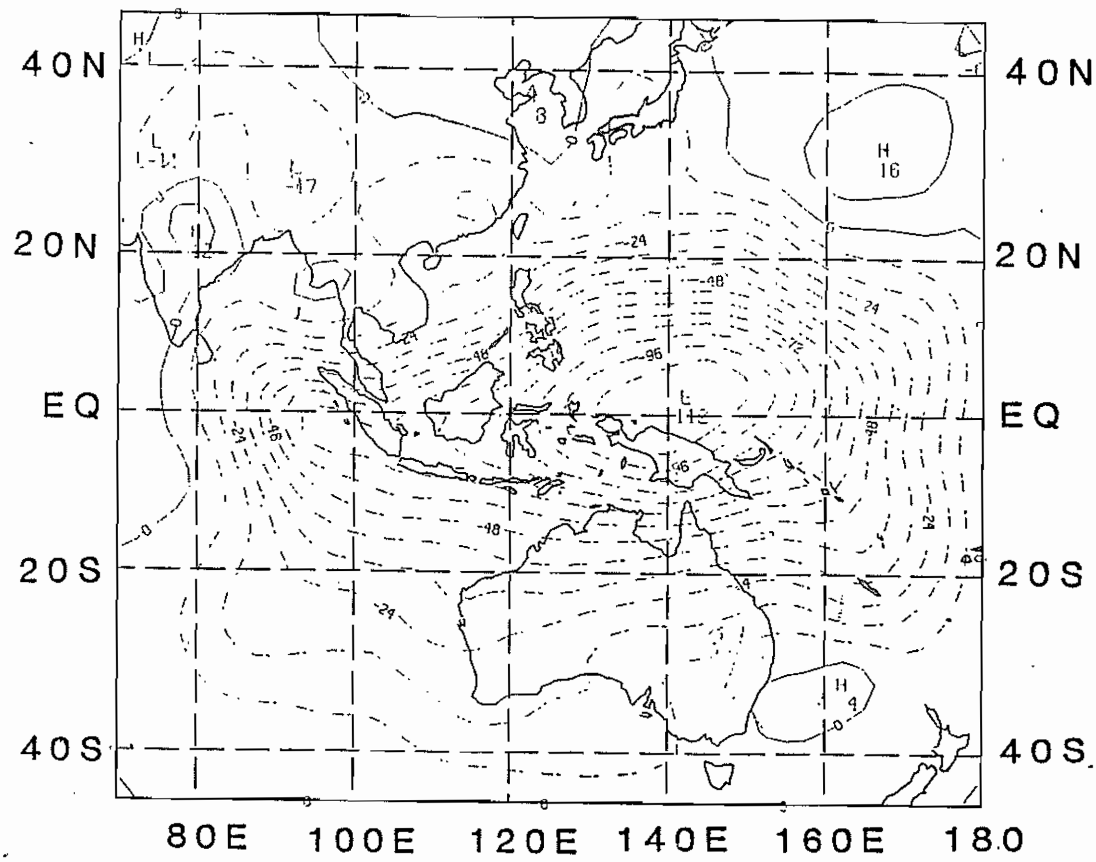

Fig. 13 MARCH 1986 200 mb VELOCITY POTENTIAL
(CONTOUR INTERVAL $10 \times 10^5 M^2 S^{-1}$).

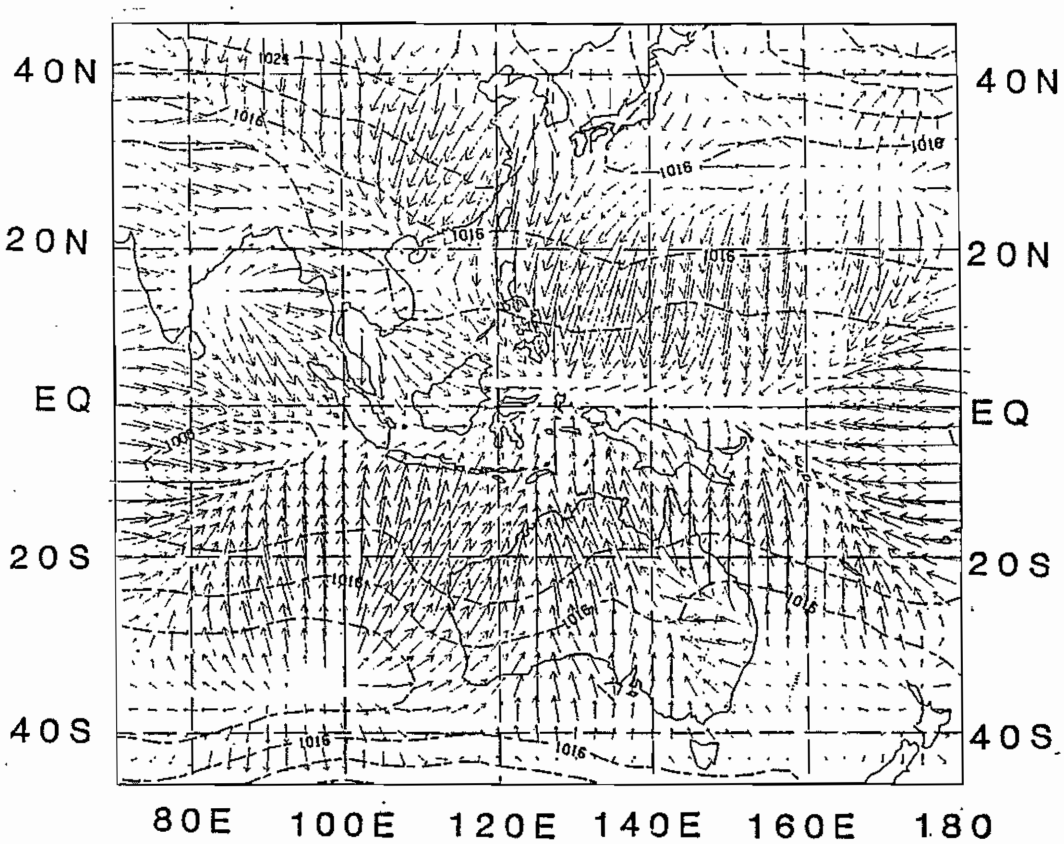

Fig. 14 MARCH 1986 950 mb DIVERGENT WIND.
(ARROW LENGTH INDICATES MAGNITUDE).

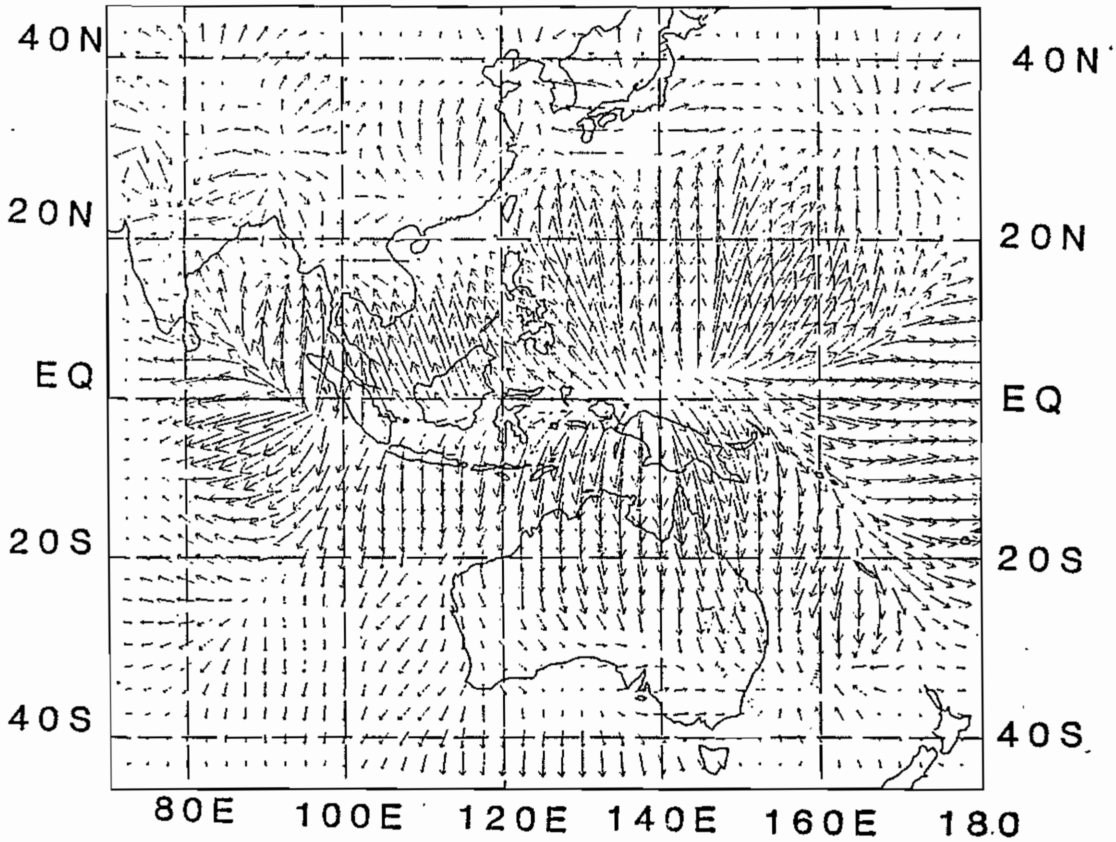

Fig. 15 MARCH 1986 200 mb DIVERGENT WIND.
(ARROW LENGTH INDICATES MAGNITUDE).

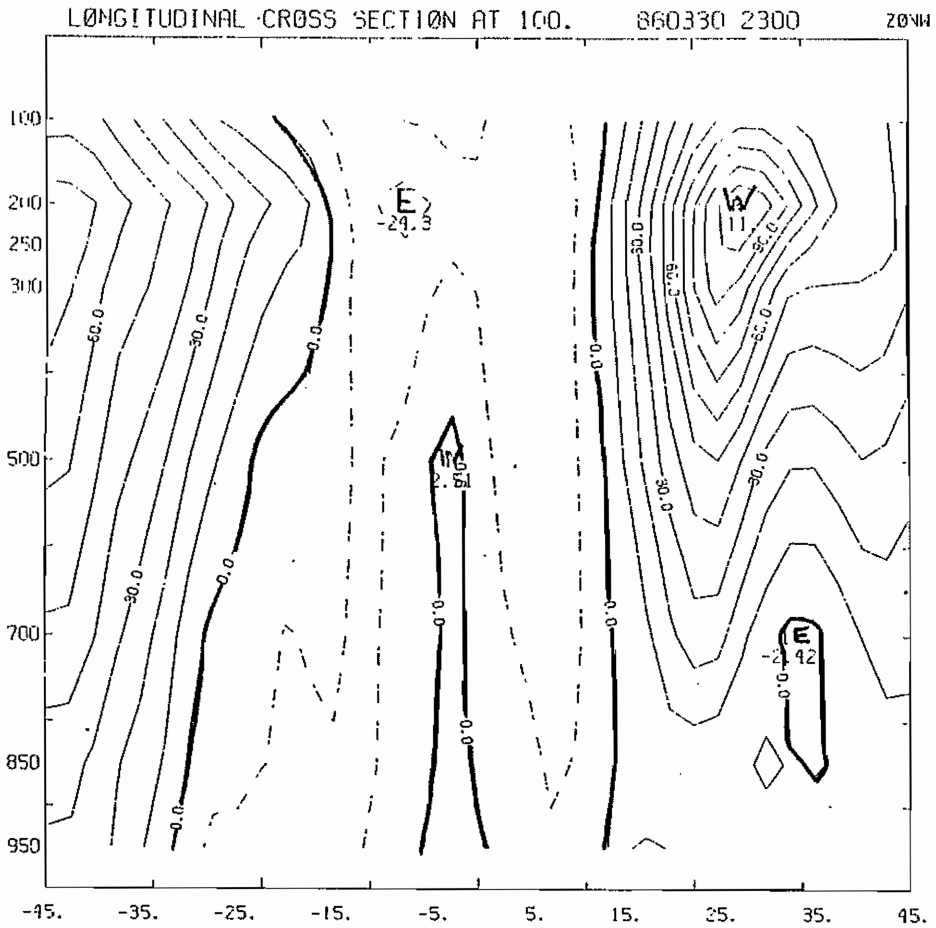

Fig. 16 MARCH 1986 CROSS SECTION OF ZONAL WIND ALONG 100°E (CONTOUR INTERVAL 10 KNOTS).

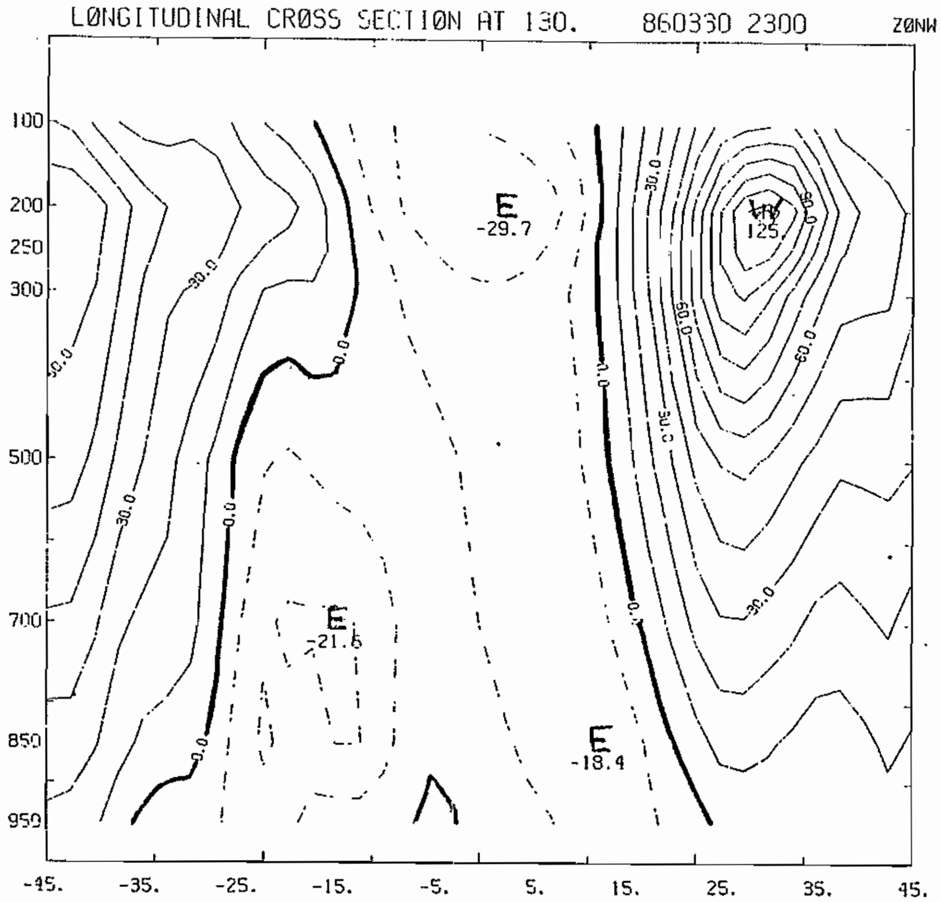

Fig. 17 MARCH 1986 CROSS SECTION OF ZONAL WIND ALONG 139°E (CONTOUR INTERVAL 10 KNOTS).

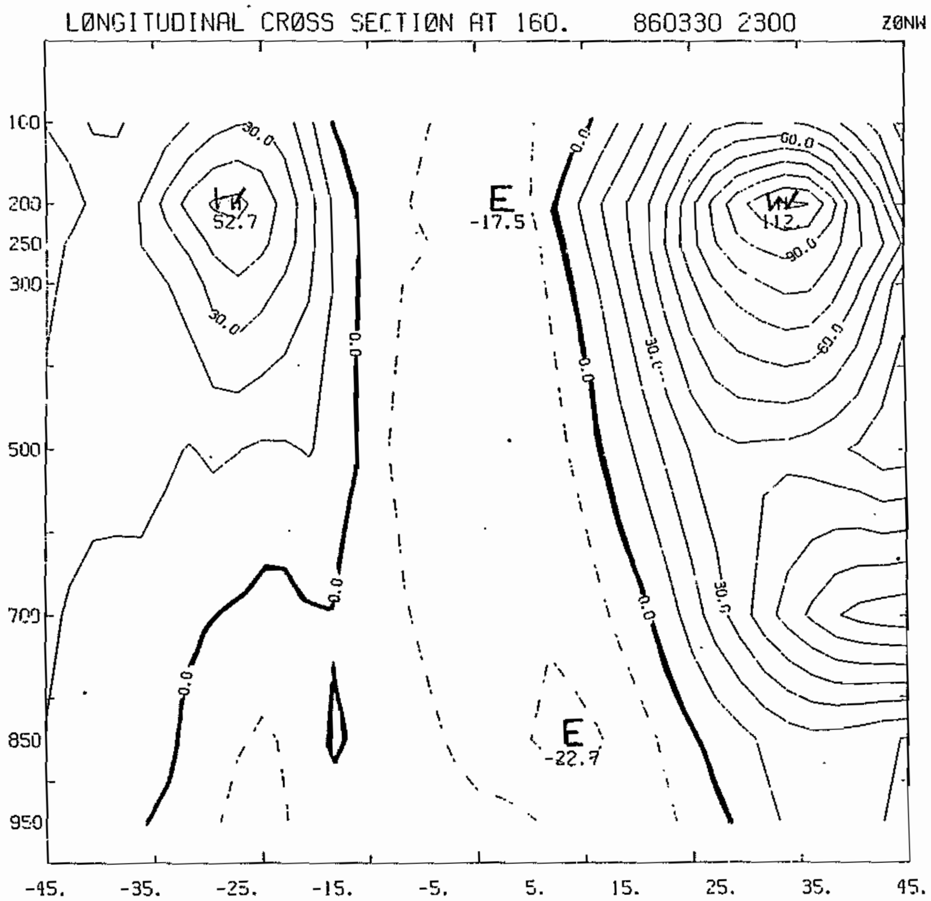

Fig. 18 MARCH 1986 CROSS SECTION OF ZONAL WIND ALONG 160°E (CONTOUR INTERVAL 10 KNOTS).

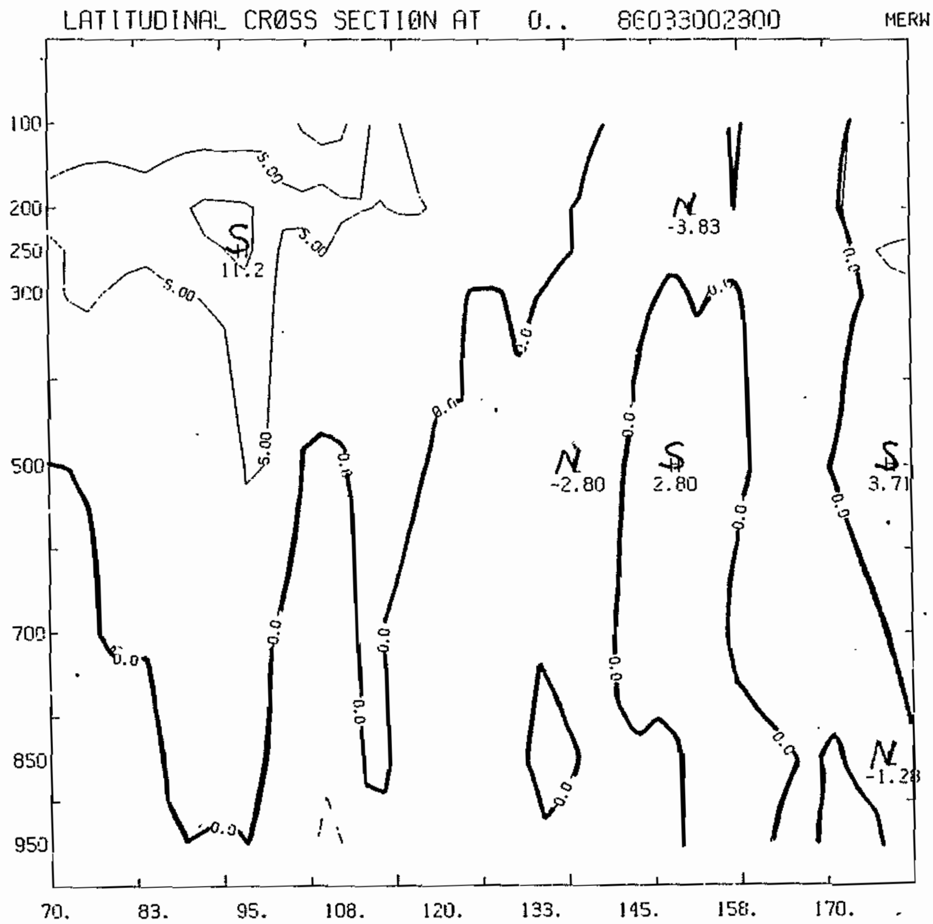

Fig. 19 MARCH 1986 EQUATORIAL CROSS SECTION BETWEEN 70E and 180E (CONTOUR INTERVAL 5 KNOTS).

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

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