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DARWIN TROPICAL DIAGNOSTIC STATEMENT

FEBRUARY 1987

ISSUED BY DARWIN RMC

INDICES

Darwin's mean MSL pressure for February was 1007.4 hPa (0.9 hPa above the 1882-1985 mean). Tahiti's mean MSL pressure was 1009.3 hPa -(2.0 hPa below the long-term mean). This gives a Southern Oscillation Index of minus 14; the 5-month running mean SOI (centred on December) being minus 9.

TROPICAL CYCLONES

Six tropical cyclones occurred between 70 E and 180 during February. Unofficial tracks are shown in figs.1a-d.

Cyclone 01B formed in the southern Indian Ocean after a surge in the southeasterly trades. It dissipated two days later over water.

Cyclone Damien formed off the Northwest Australian coast and moved slowly and erratically southwestwards, dissipating finally over water.

Jason developed in the Gulf of Carpentaria and moved erratically under the influence of a complex upper air pattern. Jason moved slowly westwards at first, and made landfall on the 9th of the month. After remaining almost stationary overland for 36 hours, the system had weakened so that its status as a tropical cyclone was uncertain. However, at this time, it began an east- southeastwards movement which took it back over water. Reintensification took place, and typhoon intensity was attained before the system made landfall on the 13th February.

Cyclones Uma and Veli were notable because they both formed in the monsoon trough near 165 E within 48 hours of each other. Furthermore, Veli followed almost the same track as Uma had traced only 24 to 48 hours peviously. While Veli was short lived and only attained wind speeds of 45 knots, Uma reached wind speeds of 90 knots and caused considerable damage about the New Hebrides Islands in the southwest Pacific. Both systems dissipated within 150 nautical miles of each other on the 9th of the month.

Cyclone Elsie developed when a low pressure system which had existed over the northwest Australian mainland for a number of days, crossed the coast into the Indian Ocean. Elsie attained typhoon intensity before making landfall two days later.

SEA SURFACE TEMPERATURES

Figures 2 and 3 show mean Sea Surface Temperatures (SST's) and their associated anomalies during February 1987. The SST anomaly chart shows few significant features.

The warm anomaly which was evident around Indonesia in January had cooled in February. This was probably due to active convection in the area during the month with extensive cloud cover. The broad band of cool anomaly over the Northwest Pacific Ocean evident during January weakened during February. This pattern change is consistent with below average northeasterly trades in the area (see later).

MSL PRESSURE AND THE GRADIENT LEVEL FLOW

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

The predominance of easterly wind anomalies between the equator and 10 S suggests that the zonally averaged strength of the northwest monsoon was below average. Over the Indian Ocean, the monsoon trough was much less developed than normal, with a very reduced cross-equatorial component of flow. This was supported by satellite imagery which showed a marked suppression of tropical convection and cyclogenesis, in what is normally a very active area. In contrast, monsoonal surges and tropical cyclogenesis were notable over the southern Arafura Sea and the Gulf of Carpentaria, (for example, Darwin's February rainfall of 381.4 mm was in the 8th decile). The easterly wind anomalies over Indonesia reflect a southward displacement of the westerly wind maximum. (This was indeed fortunate for the AMEX/EMEX/STEP experiments which were succesfully concluded by the middle of the month). Anomalous northerly winds through the South China Sea contributed to the maintenance of persistent monsoonal convection over Indonesia.

Over the Northwest Pacific, the subtropical ridge was weaker than normal, with the westerly wind anomalies from the equator to 10 N indicating below average northeast trades. Cyclonic wind anomalies over the Bay of Bengal and India reveal a similar pattern in that region also.

The high over the Tasman Sea was well north of its mean position, and a broad area of positive pressure anomaly extended westwards across much of Australia.

The negative pressure anomalies over Western Australia were due to a deeper WA trough displaced westward to the coast (it is located further inland in the climatic mean). In conjunction with the northward displacement of the Indian Ocean subtropical ridge by some 10 degrees, the increased pressure gradient generated a vigorous west coast "jet" which shows up very well on the vector wind anomaly chart. This configuration also resulted in weaker than average trade winds over the Indian Ocean west of 110 E.

Although pressures were high over eastern Australia, the presence of anticyclones in the Great Australian Bight and the Tasman Sea induced a well developed easterly dip, with significant northwesterly wind anomalies over northeastern Australia. The low-level air reaching eastern Australia appears to have been of a southerly origin (rather than of the more easterly origin evident on the long-term mean flow), and this was reflected by the continuing below average rainfall there particularly in coastal areas of northern Queensland. Associated with this pattern was an eastward displacement of the upper level east coast trough to around longitude 160 E.

200 hPa FLOW

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

On the whole, these charts show little change from January. The anticyclonic anomaly pair straddling the equator in the West Pacific was more pronounced, consistent with the -1.4 standard deviation of the SOI. The anticyclone over the equatorial SW Pacific continued to encourage above average convection and lower surface pressures in the monsoon trough near the dateline.

Southerly wind anomalies over the South China Sea suggest a link between the outflow from the Indonesian monsoon and the strengthening of the northern hemisphere subtropical jet (shown by westerly wind anomalies over the North West Pacific).

An axis of cyclonic wind anomaly continued from north of New Zealand to the Gulf of Carpentaria, associated with the TUTT-like trough which was a dominant feature of daily upper wind analyses. Coincident with the weaker low-level cross-equatorial flow, (except over the Indonesian-Australian tropics), the high-level return flow was much less than in the long-term mean, with westerly anomalies common between the equator and 10 S.

Along the equator east of New Guinea, the Walker circulation appeared to be weaker than normal.

VELOCITY POTENTIAL AND DIVERGENT WIND

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

The velocity potential minimum at 200 hPa was centred near Sulawesi, and extended east-west between the equator and 5S, and into the Arafura Sea. The velocity potential maximum at 950 hPa lay in a broad area around New Guinea and Indonesia. This pattern places the main ascending branch of the Hadley cell over the Arafura Sea. The subsiding branches of the Hadley cell are focussed over Korea, near Midway Island, and to the southwest of Australia.

WIND CROSS-SECTIONS

Cross-sections of zonal wind along 100 E, 130 E and 160 E 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 the subtropical jet core was strongest near 130 E in the southern hemisphere, and near 160 E in the northern hemisphere. Quasi-barotropic easterly "trade" winds between the equator and 20 N display a gradual strengthening as one progresses eastwards.

The latitudinal cross-section shows that the strongest meridional return flow is between 100 E and 150 E, with a broad area of lower tropospheric northerlies which have maxima at 130 E and at 150 E near gradient level.

SUMMARY

Despite the active monsoonal conditions over the Indonesian-North Australian region, the influence of the El Nino has led to cross-equatorial flow which was less pronounced than normal. The rainfall distribution in February was unusual in that good falls were recorded over northwestern Australia but the monsoon trough did not become established over Queensland and the western Coral sea thus resulting in rainfall deficiencies in these areas. The northern subtropical ridge was weaker than normal; the southern hemisphere high pressure belt was displaced approximately 10 degrees equatorward of its mean position.

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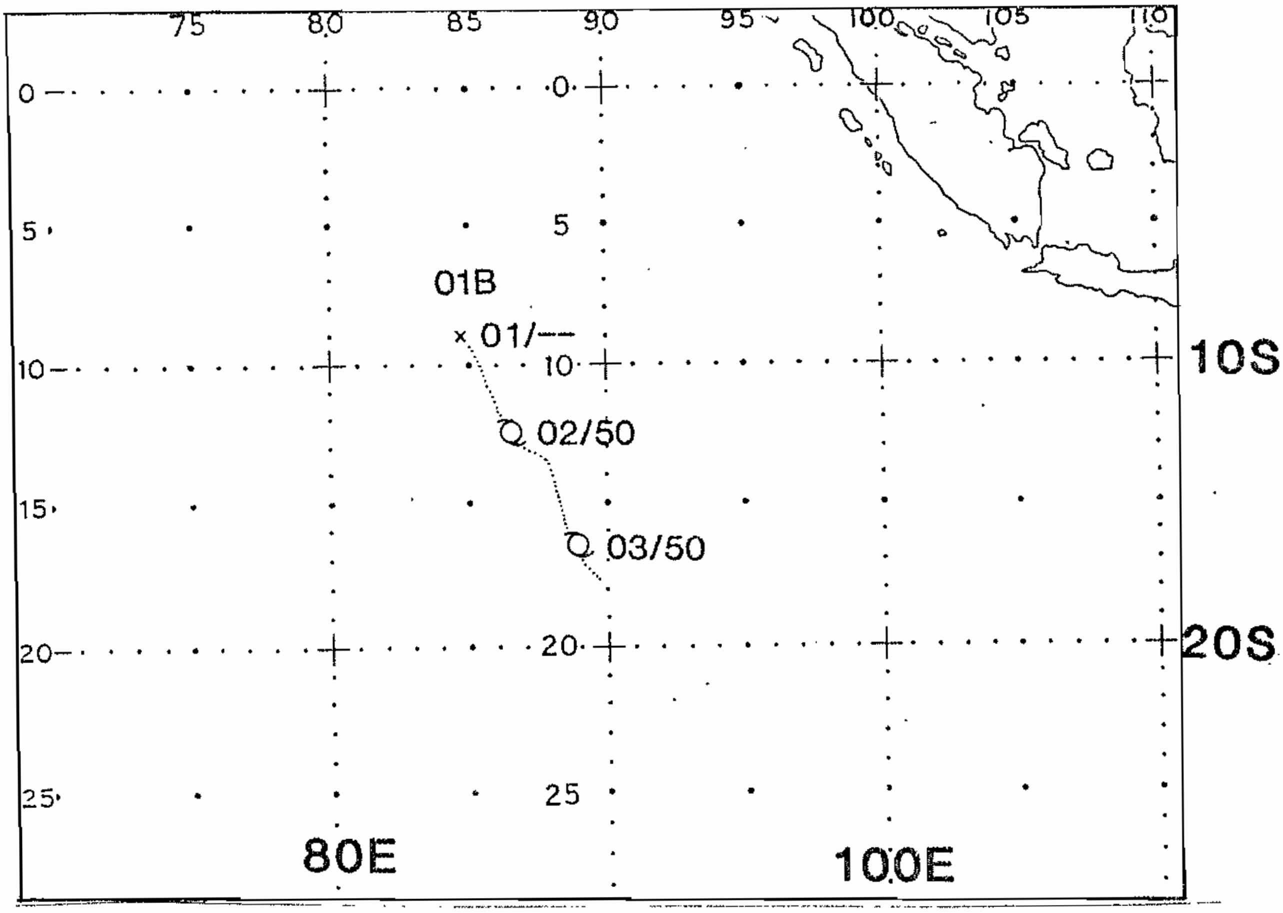

Fig. 1a UNOFFICIAL TRACK OF CYCLONE 01B FOR FEBRUARY 1987

Date DD and maximum sustained wind (ff) in knots denoted by DD/ff.

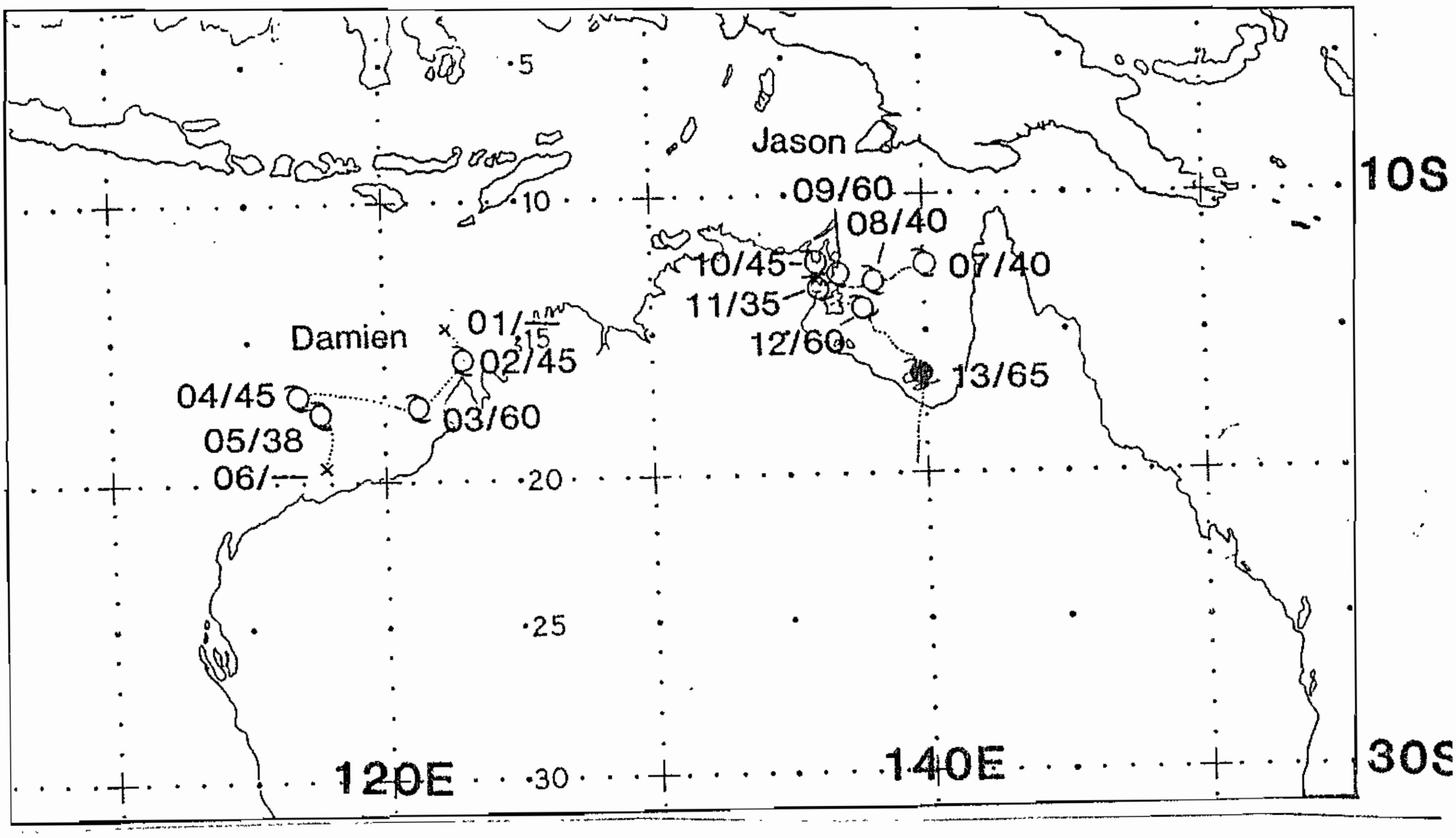

Fig. 1b UNOFFICIAL TRACKS OF CYCLONES DAMIEN AND JASON FOR FEBRUARY 1987

Date DD and maximum sustained wind (ff) in knots denoted by DD/ff.

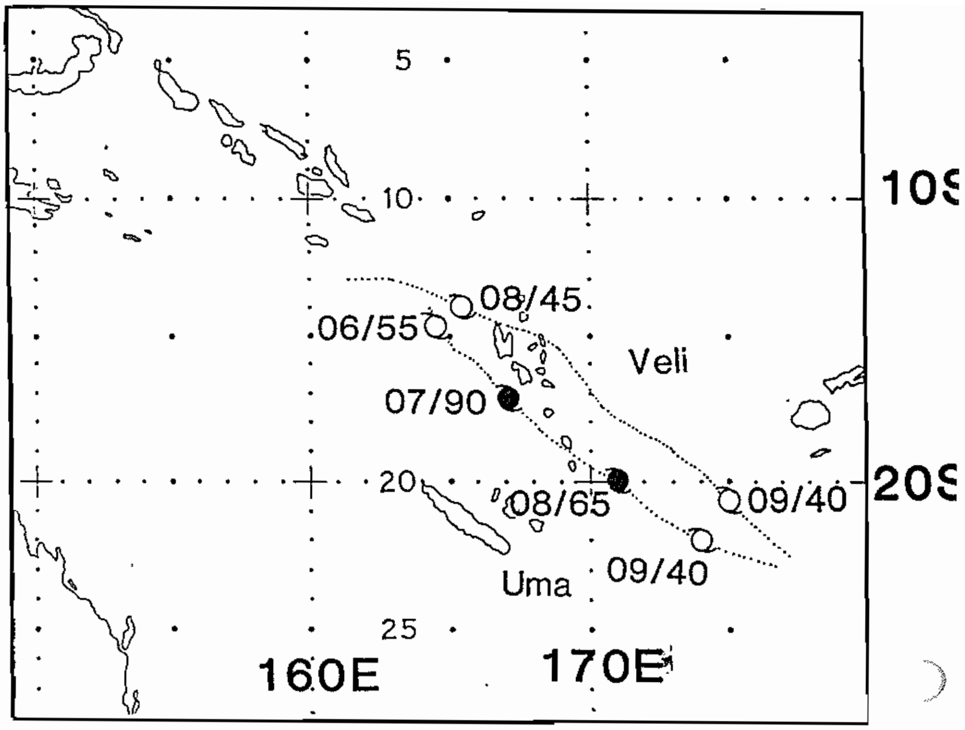

Fig. 1c UNOFFICIAL TRACKS OF CYCLONES UMA AND VELI FOR FEBRUARY 1987

Date DD and maximum sustained wind (ff) in knots denoted by DD/ff.

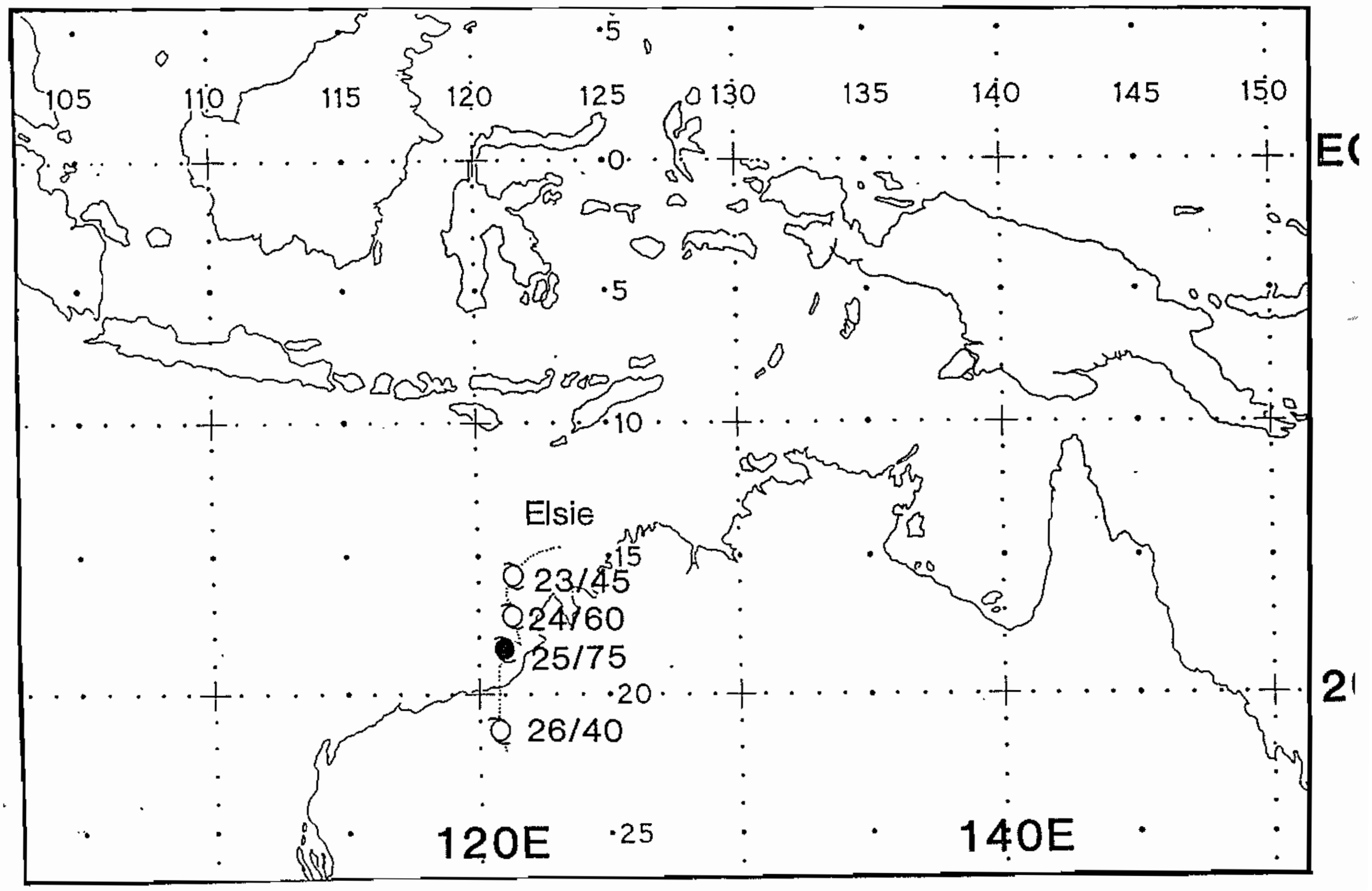

Fig. 1d UNOFFICIAL TRACK OF CYCLONE ELSIE FOR FEBRUARY 1987

Date DD and maximum sustained wind (ff) in knots denoted by DD/ff.

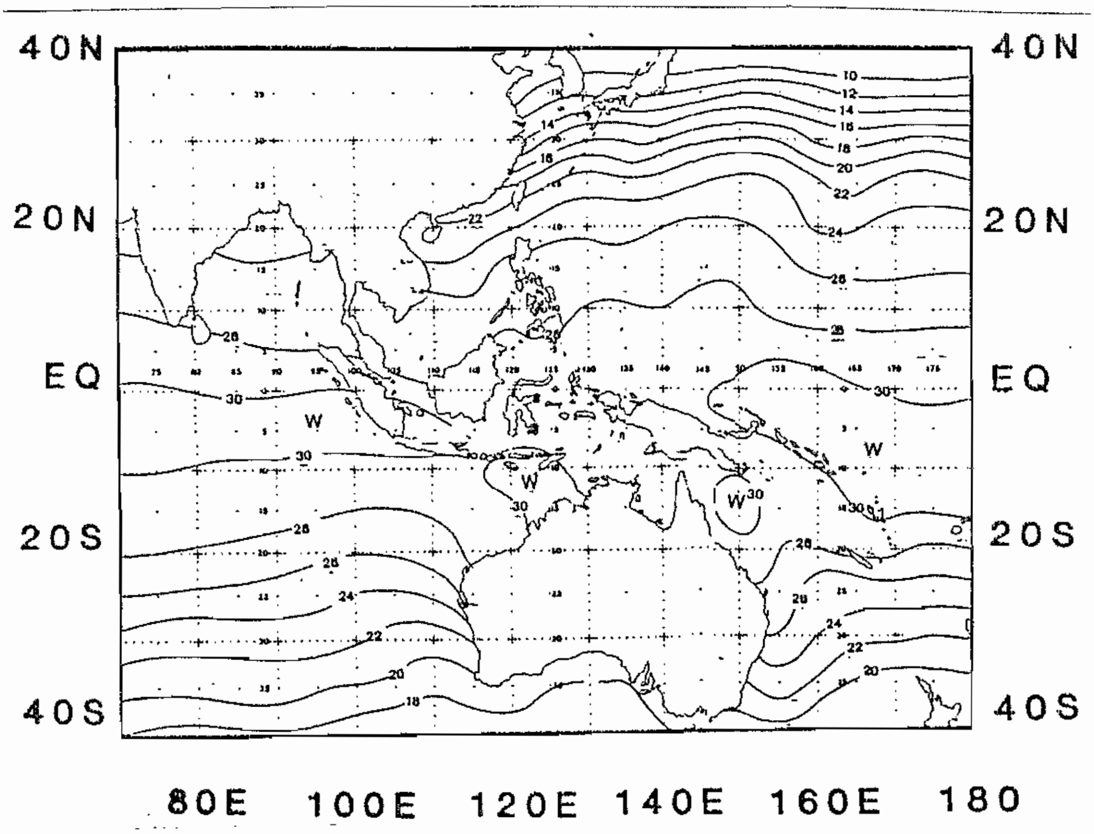

Fig. 2 MEAN SEA SURFACE TEMPERATURES, BASED ON DARWIN RMC ANALYSES AVERAGED OVER THE PERIOD 3rd. to 24th. FEBRUARY, 1987. Isotherm interval 2 deg C.

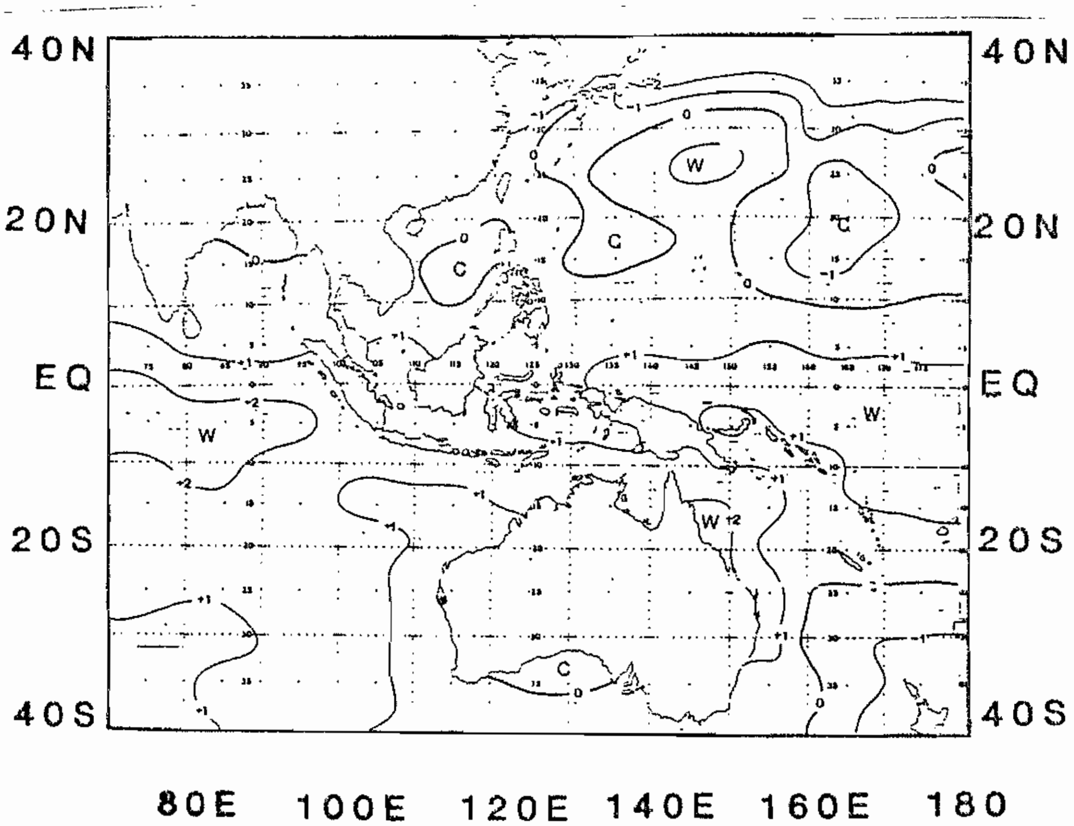

Fig. 3 SST ANOMALY CHART, BASED ON FIG. 2 AND THE CLIMATOLOGY OF REYNOLDS, NOAA REPORT NWS 31, 1983. Isotherm interval 1 deg C.

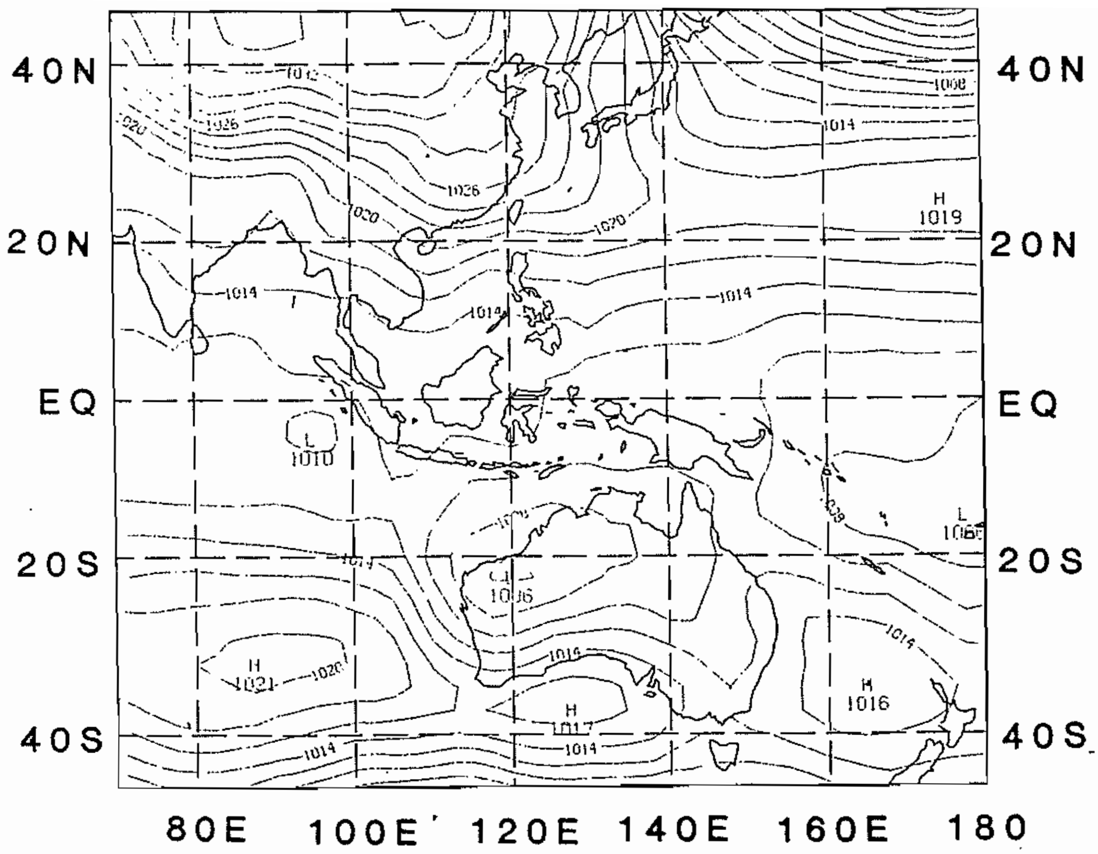

Fig. 4 MONTHLY MEAN MSL PRESSURE, FEBRUARY 1987.
Isobar interval 2 hPa.

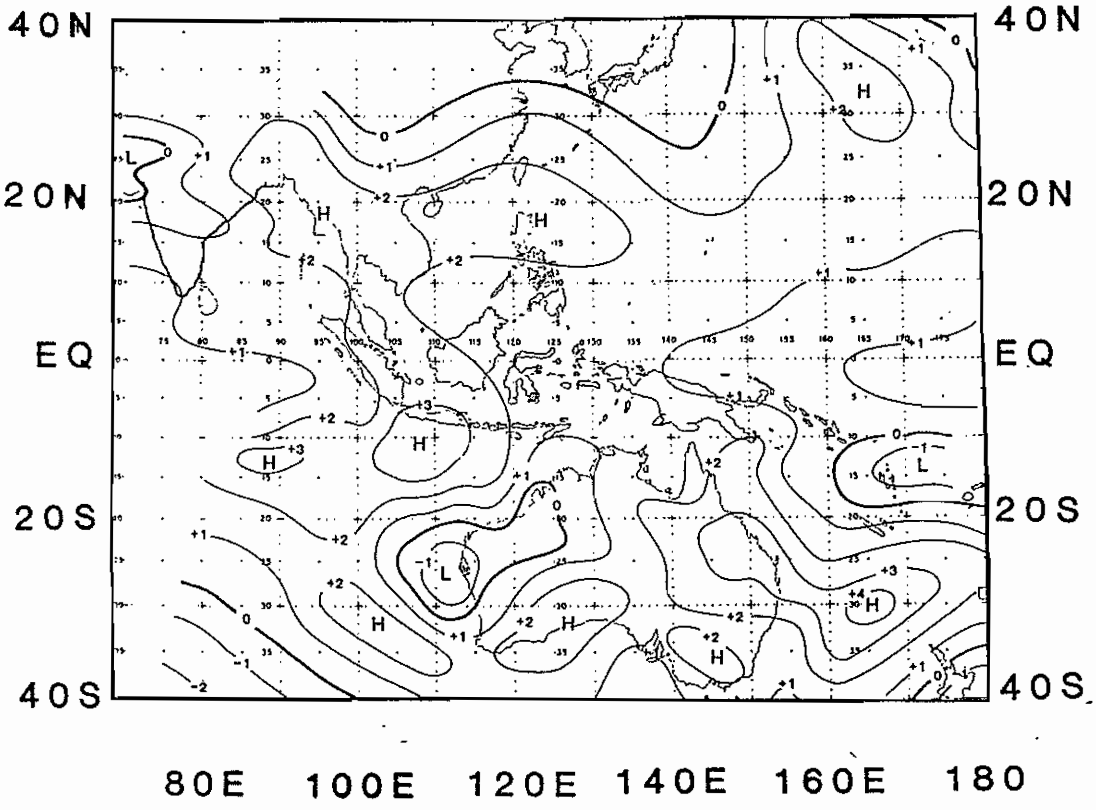

Fig. 5 MSL PRESSURE ANOMALY BASED ON CLIMAT MESSAGES
(AND MELBOURNE WMC DATA)
Contour interval 1 hPa.

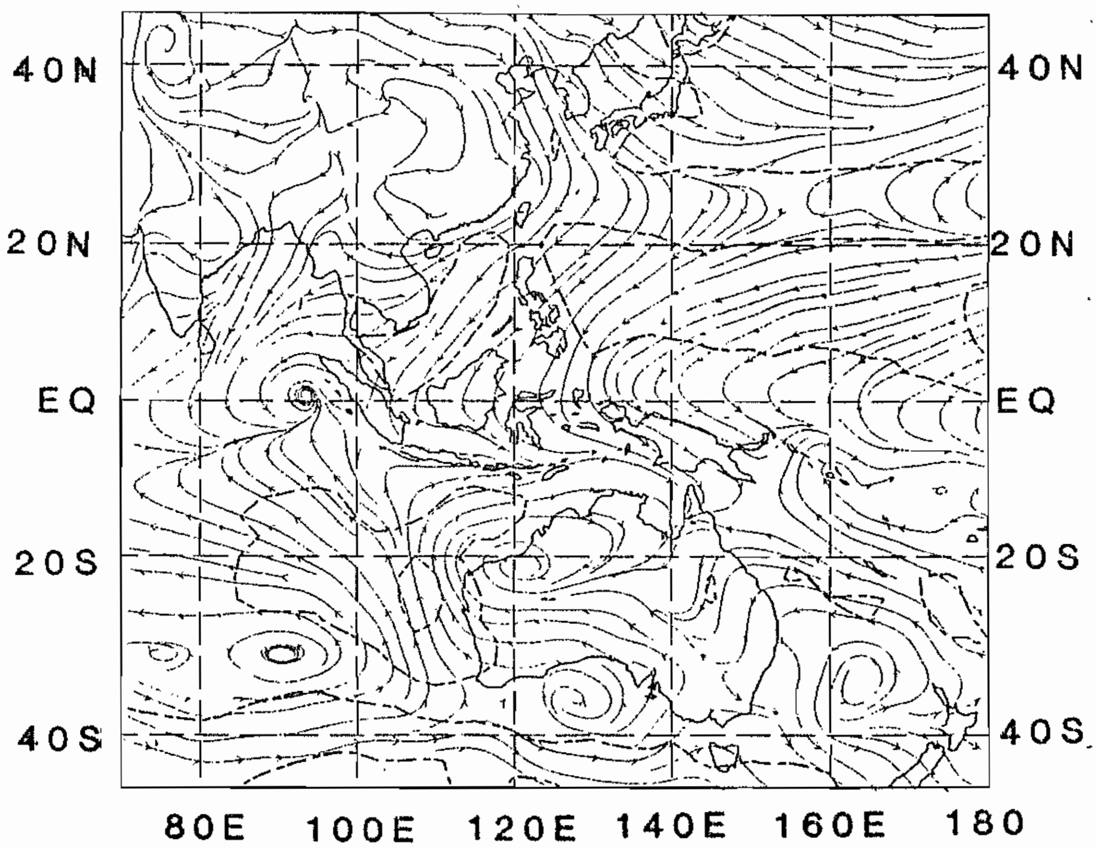

Fig. 6 950 hPa STREAMLINE ANALYSIS, FEBRUARY 1987
Isotachs (dashed line) at 10 knot intervals.

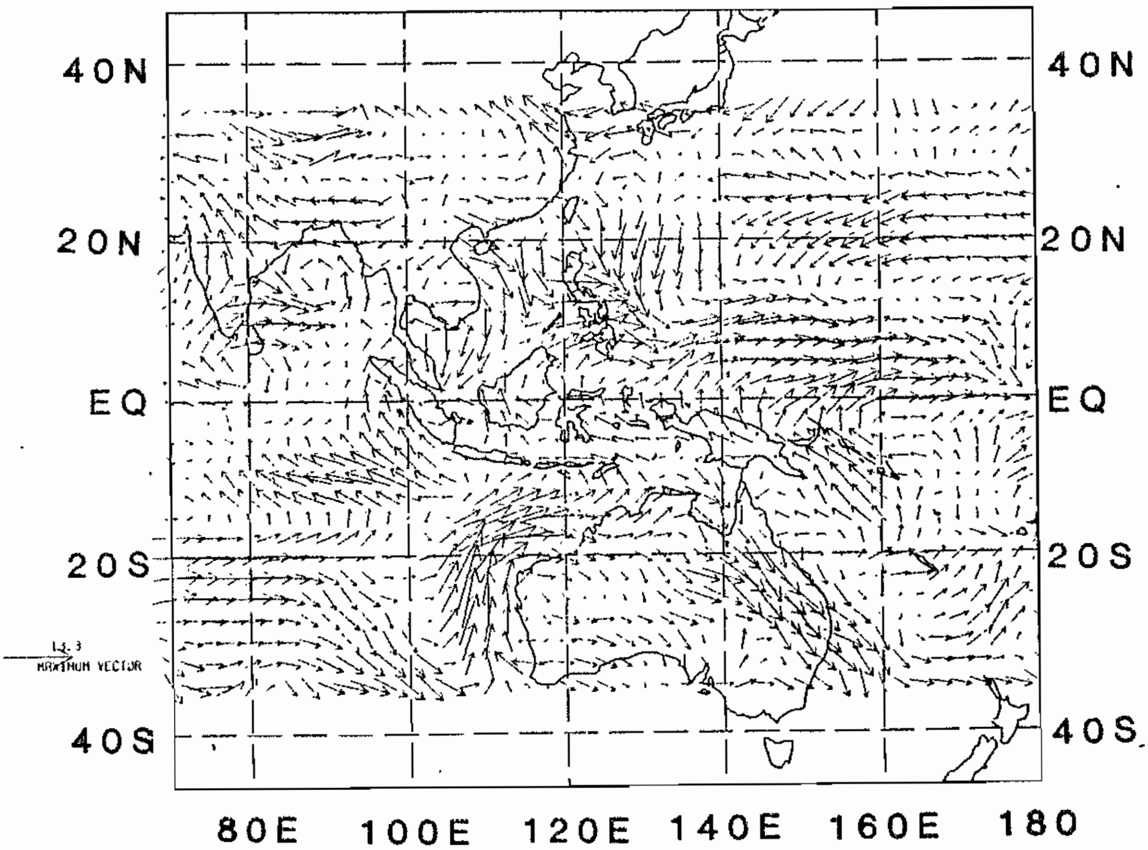

Fig. 7 950 hPa VECTOR WIND ANOMALY BASED ON FIG 6.
(Arrow length indicates magnitude)

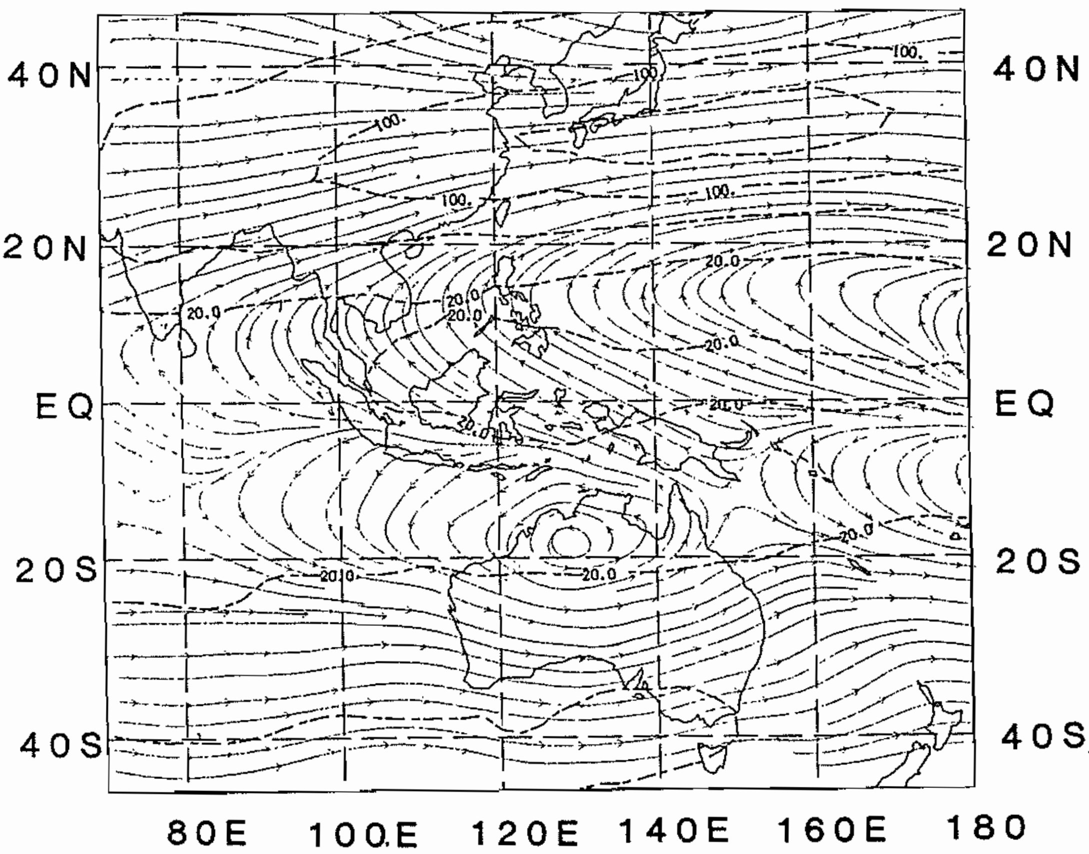

Fig. 8 200 hPa STREAMLINE ANALYSIS, FEBRUARY 1987.
Isotachs (dashed line) at 40 knot intervals.

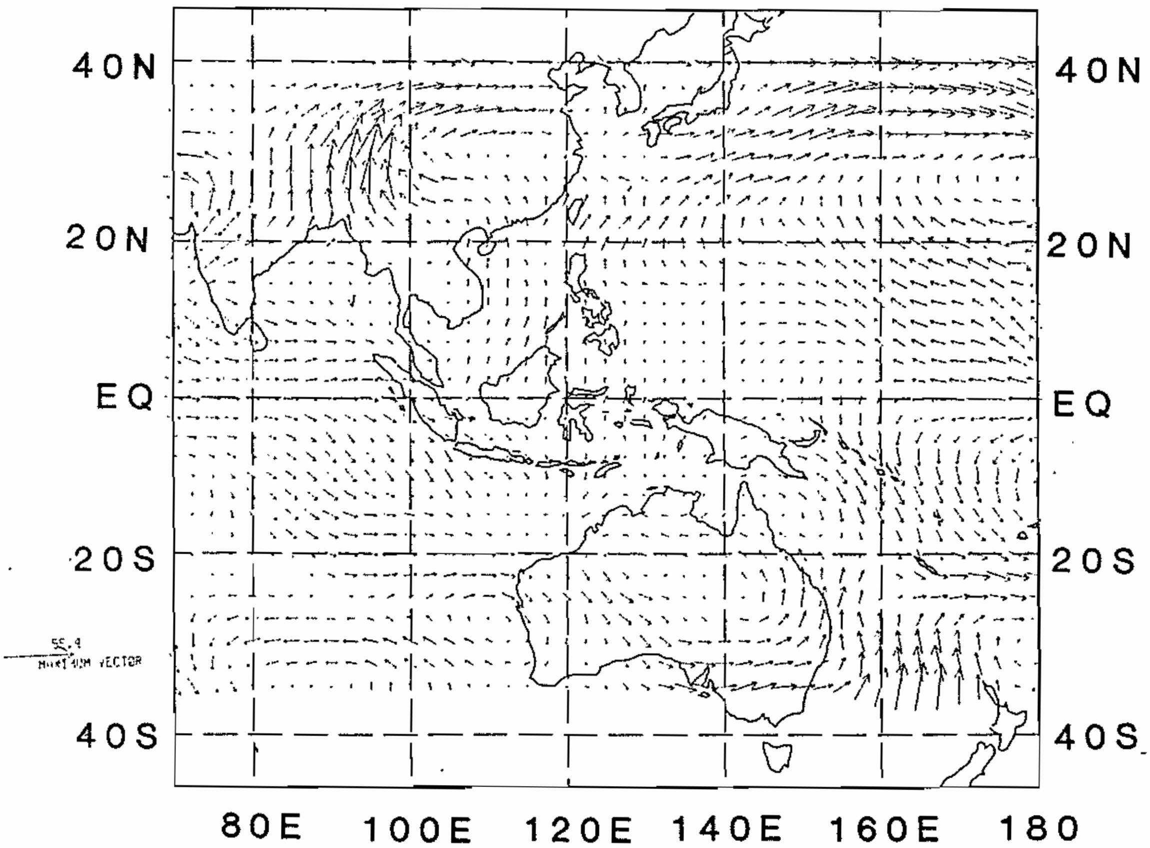

Fig. 9 200 hPa VECTOR WIND ANOMALY BASED ON FIG. 8.
(Arrow length indicates magnitude).

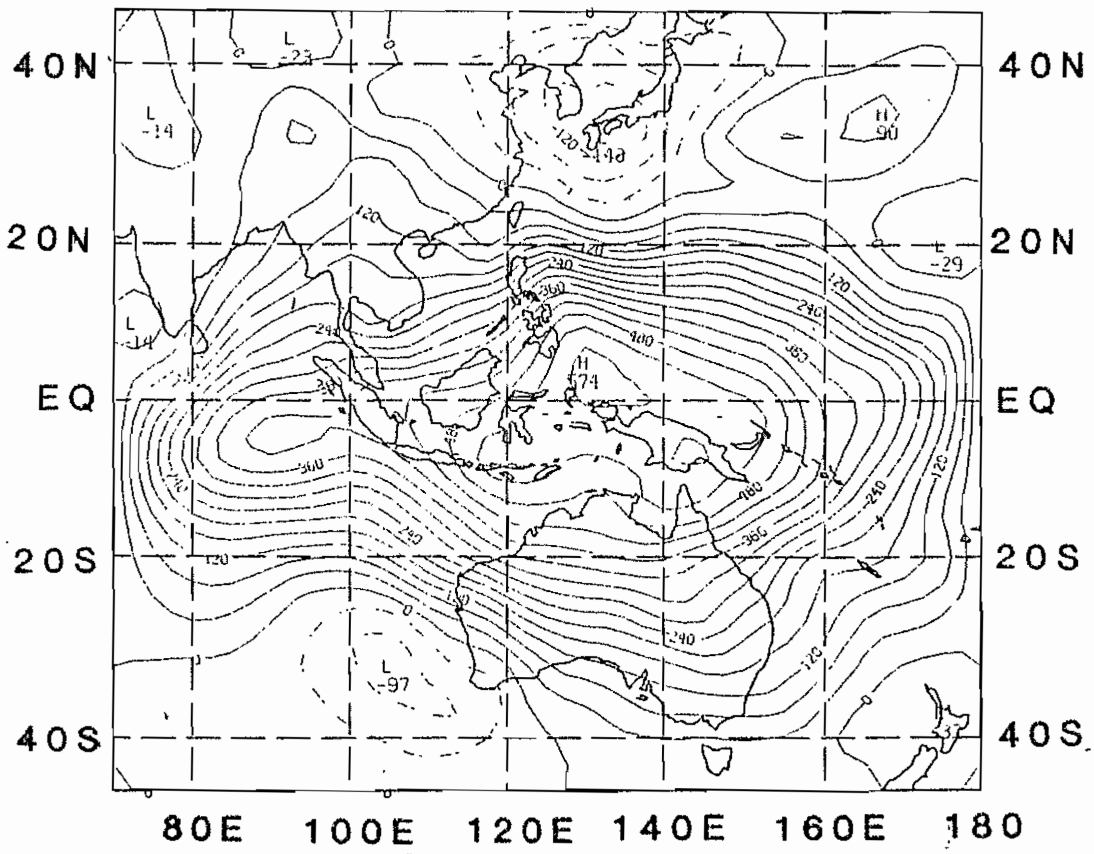

Fig. 10 950 hPa VELOCITY POTENTIAL, FEBRUARY 1987.
Contour interval 50 x 10^5 m^2 /s

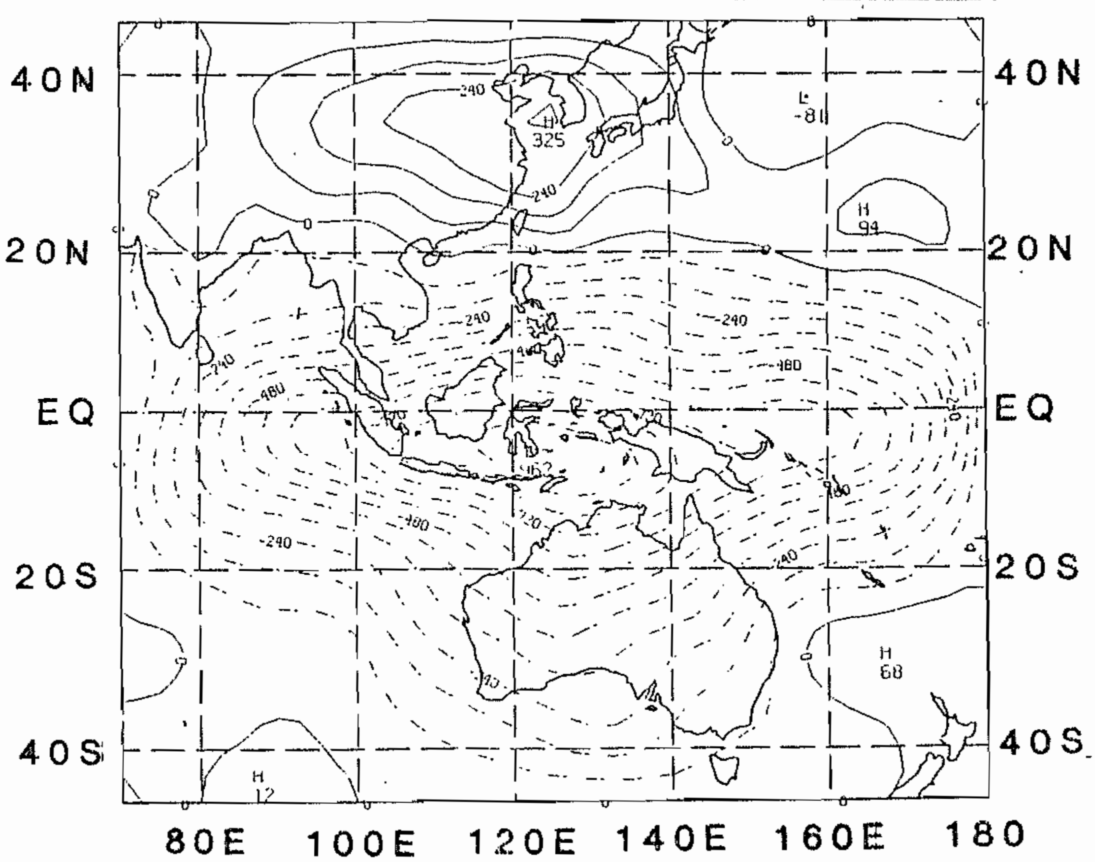

Fig. 11 200 hPa VELOCITY POTENTIAL, FEBRUARY 1987.
Contour interval 7 x 10^5 m^2 /s

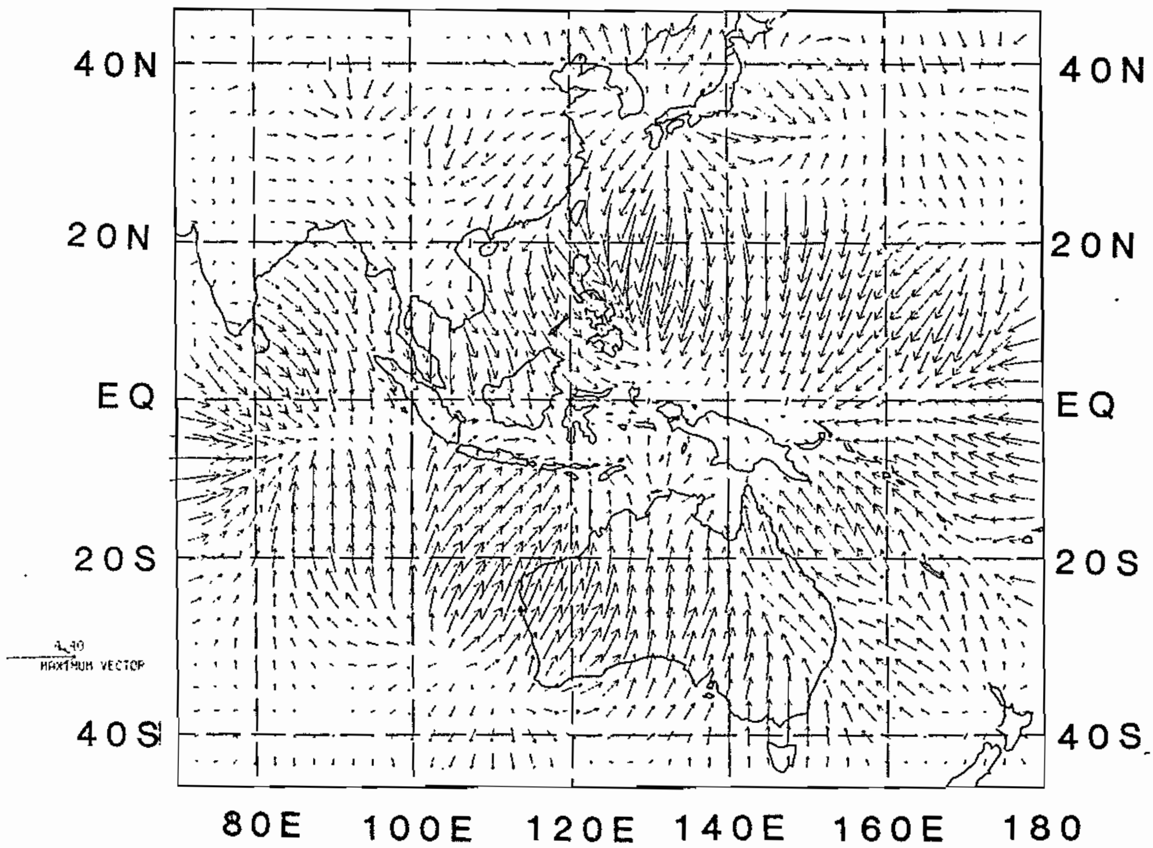

Fig. 12 950 hPa DIVERGENT WIND, FEBRUARY 1987
(Arrow length indicates magnitude)

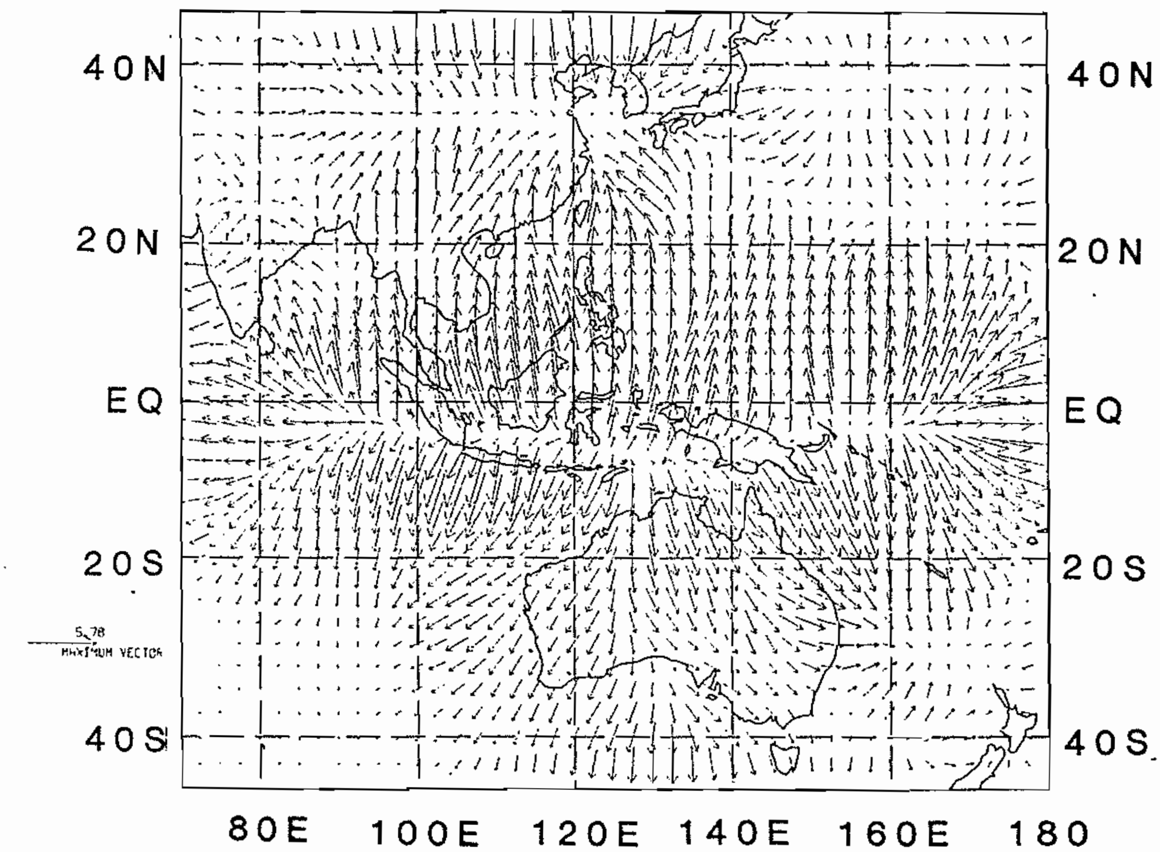

Fig. 13 200 hPa DIVERGENT WIND, FEBRUARY 1987.
(Arrow length indicates magnitude)

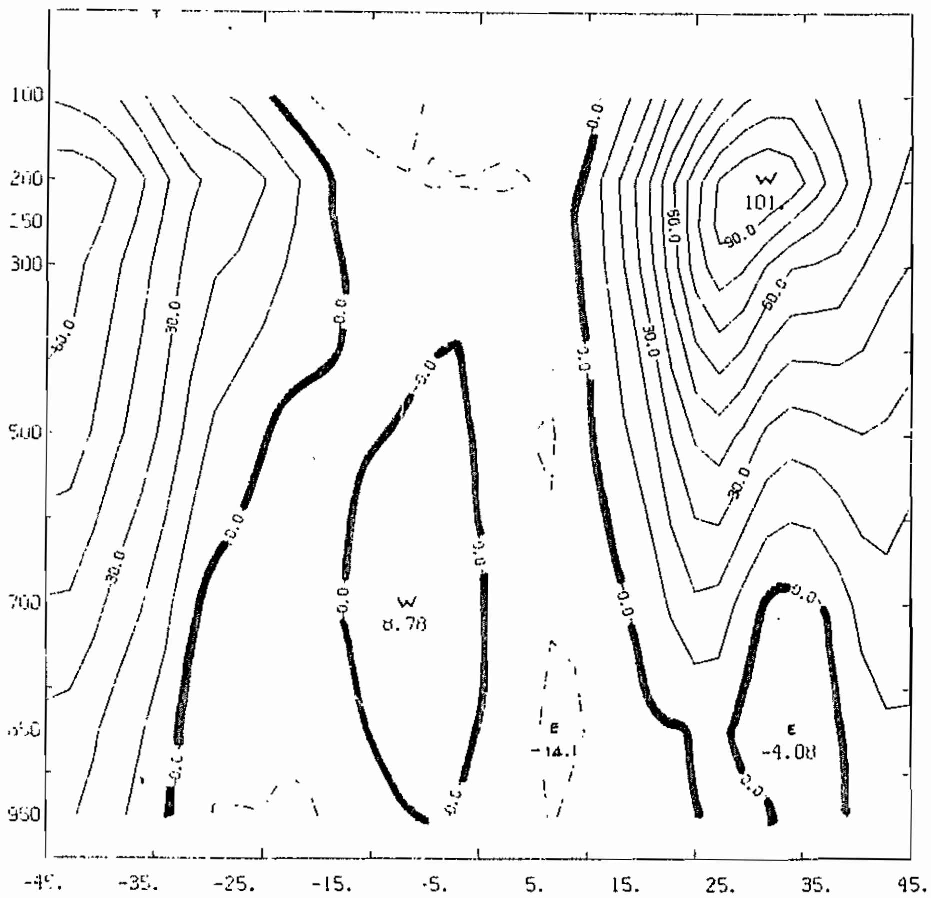

Fig. 14 CROSS SECTION OF ZONAL WIND ALONG 100E, DEC 1986. Isotach interval 10 knots.

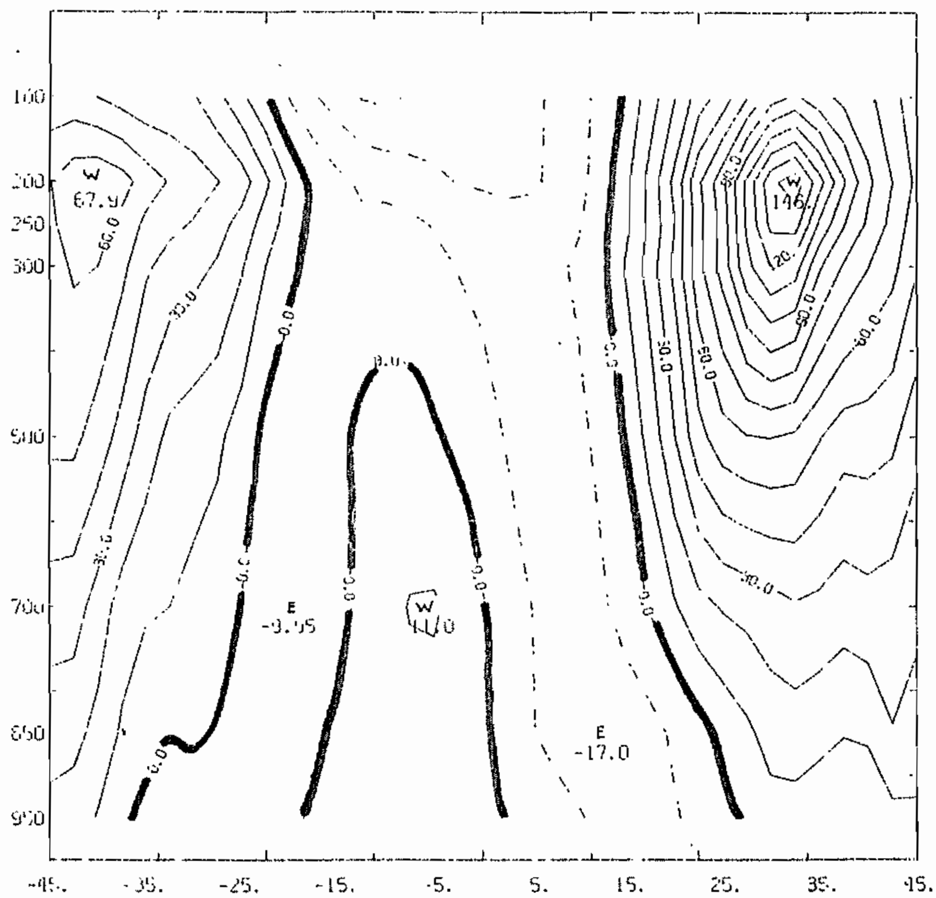

Fig. 15 CROSS-SECTION OF ZONAL WIND ALONG 130E, FEB 1987. Isotach interval 10 knots.

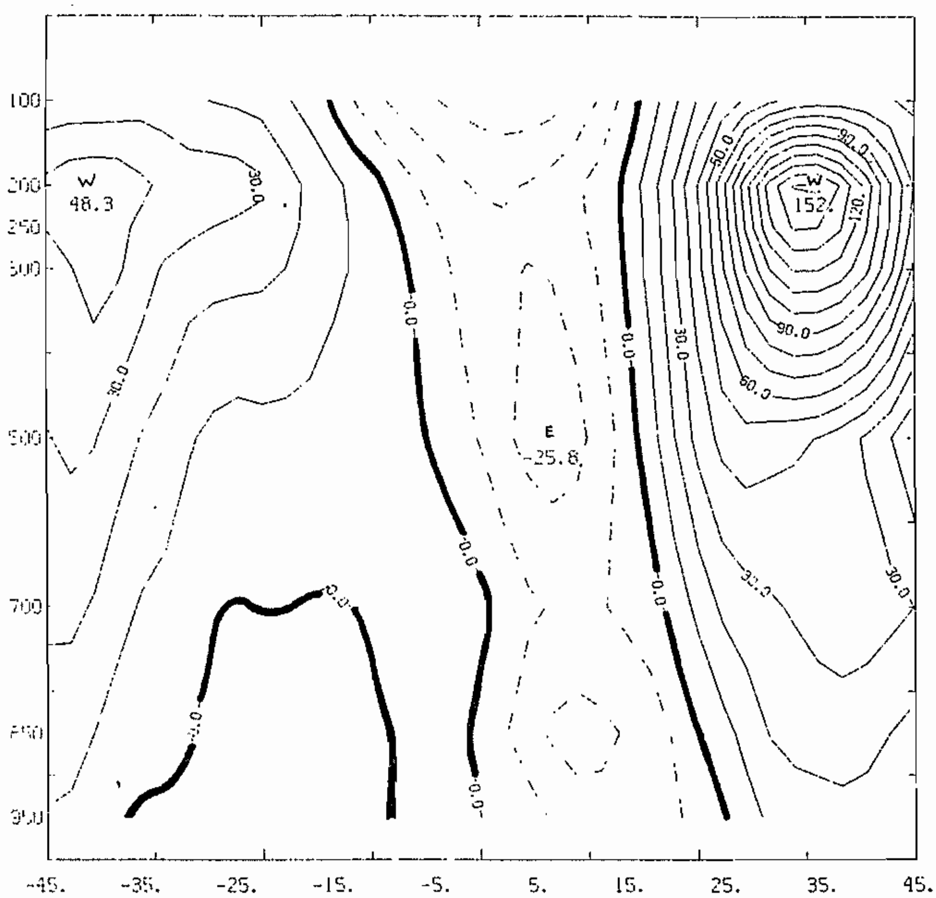

Fig. 16 CROSS SECTION OF ZONAL WIND ALONG 160E, DEC 1987
Isotach interval 10 knots.

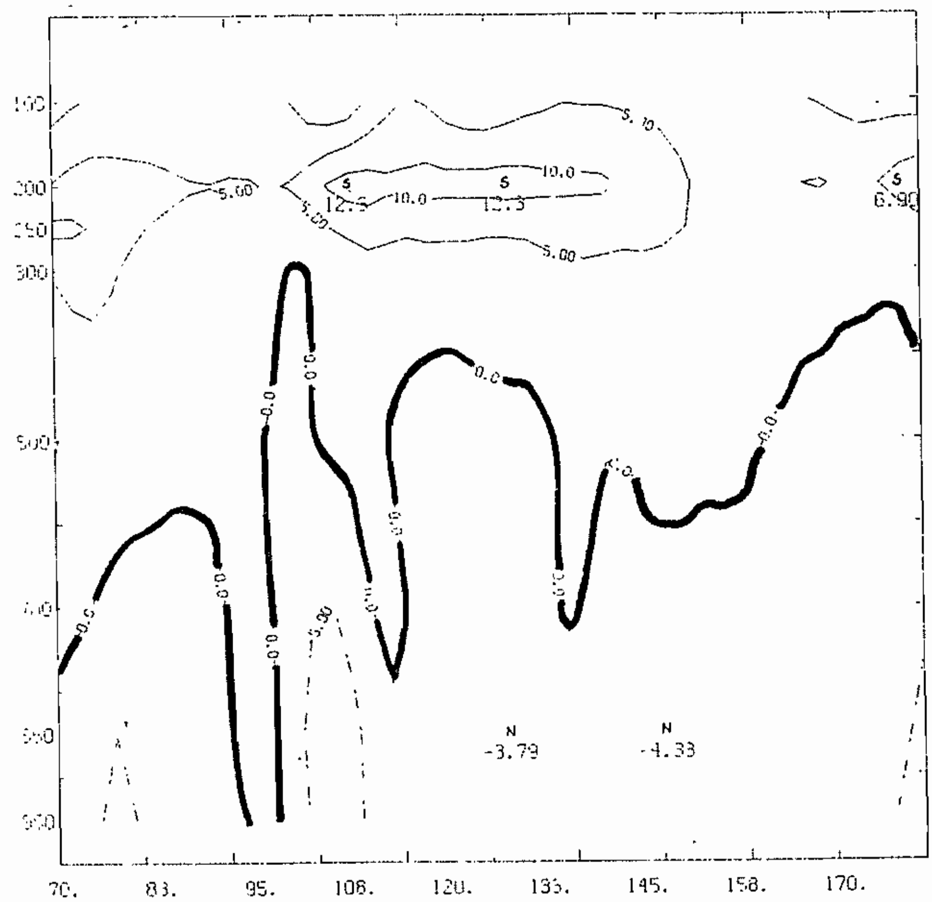

Fig. 17 EQUATORIAL CROSS-SECTION OF MERIDIONAL WIND
BETWEEN 70E AND 180, FEB 1987.
5 knot isotachs.

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

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

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