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DARWIN TROPICAL DIAGNOSTIC STATEMENT

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DARWIN TROPICAL DIAGNOSTIC STATEMENT

NOVEMBER 1987

ISSUED BY DARWIN RMC

SUMMARY

The Southern Oscillation Index (SOI) has continued its rising trend towards zero. The Tahiti pressure anomaly is rather weak, and its behaviour over the last few months indicates that the pressure field in the Central Pacific is not responding to the reported high sea surface temperatures off South America. Over northern Australia, despite below average rainfall at Darwin, diurnal convection no longer appears suppressed as it did in October. The overall impression from analyses and satellite photographs is that the situation in the vicinity of the maritime continent is tending towards near normal, and the influence of the El Niño event will be minimal this wet season.

INDICES

1. Darwin mean MSL pressure November 1987: 1008.9 hPa
   pressure anomaly (1882-1985 mean): 0.0 hPa
2. Tahiti mean MSL pressure November 1987: 1011.6 hPa
   pressure anomaly: -0.2 hPa
3. Troup's southern oscillation index November 1987: -1
   5-month running mean SOI (centred upon September): -10

4. Troup's SOI for the last 23 months:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1986	7	-12	0	1	-6	8	2	-7	-5	6	-13	-16
1987	-7	-14	-15	-22	-20	-18	-18	-13	-11	-6	-1	

TROPICAL CYCLONES

Unofficial cyclone tracks are shown in Figs. 1a to 1c.

Two tropical cyclones developed in the Bay of Bengal in November (the JTWC Guam average for 1975-86 is 1.4). This year has been one of the more active cyclone seasons for the area. Tropical Cyclone "05B" continued from October; this was a weak system that crossed the eastern coast of India on the 3rd. For a short period there was a cross-equatorial cyclone pair when Tropical Cyclone "01S" formed on the 2nd of the month: the first southern hemisphere cyclone over our analysis area this season. It moved generally westward and off our charts on the 5th. Tropical Cyclone "06B" developed in the Bay of Bengal on the 12th; this fast moving system followed a similar path to "05B", making landfall in approximately the same area of India on the 13th.

Three cyclones were named in the northwest Pacific during the month; all formed in the monsoon trough, and one reached typhoon intensity. JTWC Guam statistics in this basin for November (1959-86) show 2.8 "typhoons, tropical cyclones and tropical depressions", of which 1.7 are typhoons. Tropical Storm Maury was a weak cyclone that formed in the South China Sea on the 16th and moved on a sinuous westward path until landfall over Viet Nam on the 19th. While Maury was dissipating, Typhoon Nina was forming out near 160^{o}E: this system followed a well-behaved west northwest track, reaching typhoon force on the 23rd and causing much destruction and loss of life crossing Luzon in the Philippines at peak intensity (maximum winds around 95 knots) during the 25th. Nina interacted with the upper westerlies upon reaching the South China Sea and dissipated on the 29th. Tropical Depression Ogden formed north of Borneo near 11^{o}N 114^{o}E on the 23rd and may have just reached cyclone force during the 24th as it headed west towards Viet Nam, landfalling on the 25th. Because of doubts about it reaching cyclone intensity (as judged by satellite imagery and observations), its track has not been plotted.

SEA SURFACE TEMPERATURE

The mean sea surface temperature (SST) field and anomaly pattern for November are shown in Figs. 2 and 3. Figure 2 shows that the axis of warmest water has moved south from along 10^{o}N last month to about 5^{o}N. The anomaly distribution in Fig. 3 is approximately the same as in October, with the warmest anomalies of 2 to 3 degrees in the South China Sea and south of Korea. Weak warm anomalies persist over the Indian Ocean. The weak cold anomalies over the northwest Pacific and in the South Pacific are decreasing. A cool anomaly off the northwest coast of Australia has increased since October.

MSL PRESSURE AND GRADIENT LEVEL FLOW

Mean MSL pressure and anomaly charts for November are shown in Figs. 4 and 5, and the gradient level (950 hPa) streamline analysis and vector wind anomaly charts in Figs. 6 and 7.

The Australian heat low and associated trough were larger and further inland than in the mean, and the ridging along its northwest oceanic flank was correspondingly stronger. This resulted in westerly wind anomalies right across northern Australia. Pressures were generally higher over the Indian Ocean, notably near the cold SST anomaly off northwest Australia, however the southeast trades were weaker than normal (with the exception of the southerly wind maximum west of Perth). The large negative pressure anomaly and cyclonic wind anomaly over New Zealand reflected the frequency of deep cut-off low pressure systems forming in that area of the Tasman Sea.

The monsoon trough from India to the Philippines was located 5^{o} further north than in the mean, and a broad band of lower than normal pressure extended from central India to Luzon, presumably due in part to the bias of low pressures along the previously described cyclone tracks. Over inland India, it suggests a delay in the onset of late transition season anticyclogenesis. This is supported by the predominance of westerly anomalies in a broad belt from the equator to 20^{o}N, and the observations of generally well above average rainfall over northern India (Fig. 18). The pressure anomaly pattern is also consistent with the weaker than average northeast trades blowing over the South China Sea.

The northeast trades in the Pacific east of the Philippines were stronger than normal between latitudes 25^{o} and 15^{o}N. Westerly wind anomalies that overlaid the monsoon trough along 5^{o}N imply less low level vorticity than average at that latitude. Westerly equatorial wind anomalies near the dateline reveal that below average easterlies continued over that area.

UPPER LEVEL FLOW

The mean 200 hPa streamline analysis and vector wind anomaly charts for November are displayed at Figs. 8 and 9.

Of note in the northern hemisphere is that the Tropical Upper Tropospheric Trough (TUTT) was not as well developed as in the mean, and was in fact frequently absent from daily analyses (in marked contrast to the situation last month). This factor was responsible for the strong southwest wind anomalies in the northeast of Fig. 9, and has permitted the re-emergence of the anticyclonic wind anomaly pair near the dateline, however it is felt that this is more due to the behaviour of the TUTT than any strengthening of the circulation to the east of the dateline. In the Southwest Pacific the major anticyclone was centred east of the dateline, causing a continuation of the anticyclonic anomaly pattern that has characterised the past months of this El Niño event.

Cross equatorial flow at the upper levels elsewhere is near normal and generally weak. The anticyclonic anomaly over Australia indicates more amplitude in the westerlies than usual, with a major anomalous trough over the Tasman Sea (and some evidence for a split in the flow over New Zealand), and a secondary trough along the west coast. Over Australia, the subtropical jet was displaced further south than normal.

The outflow over the Philippines was located further west than in the mean, causing the anticyclonic anomaly pattern over southern China. The midlatitude westerly anomalies over China imply a stronger subtropical jet than average.

VELOCITY POTENTIAL AND DIVERGENT WIND

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

The major area of low level convergence was centred over the Philippines and the South China Sea, and extended along 5^{o}N to the east, and towards the equator in the west. The focus for high level divergence was not coincident with the Philippines, but was instead concentrated to the west of Sumatra, with a broad axis along about 5^{o}N. Therefore the upward branch of the Hadley cell was in the general area from west of Sumatra to the Philippines. An examination of daily Japanese GMS satellite photographs showed that the equatorial Indian Ocean (5^{o}N to 10^{o}S) had very active convection for the first two weeks and for the last week of the month. The equatorial Pacific generally showed less active convection (apart from periods of cyclone genesis). The area east of the dateline showed most activity during the first two weeks of the month.

The descending branch of the Hadley cell was located over the Tasman Sea and Coral Sea where the maximum upper convergence-low level divergence patterns were coincident and therefore deep tropospheric mean subsidence was diagnosed. A weaker descending branch was located in the northeast corner of the chart, and north of India.

The divergent wind analyses suggest that the ascending arm of the Walker Circulation was still centred east of New Guinea (on the equator near 160^{o}E), and perhaps less well defined than last month. There is evidence on the velocity potential charts of the South Pacific Cloud Zone oriented northwest-southeast to the east of the Solomon Islands, but daily satellite photographs showed generally disorganised convection within the equator to 10^{o}S latitude band east of New Guinea.

WIND CROSS SECTIONS

Cross sections of zonal wind along 100^{o}E, 130^{o}E and 160^{o}E are shown in Figs. 14, 15 and 16 respectively; an equatorial cross section of meridional wind is shown in Fig. 17.

Figure 14 shows that the monsoon current was best developed along 100^{o}E (and by extrapolation, westwards) from 5^{o}S to 10^{o}N. The northern hemisphere subtropical jet was 25 to 35 knots stronger in November at 100^{o}E and 130^{o}E than the previous month, while the jet maximum at 160^{o}E showed little change. In the southern hemisphere, there was no distinct subtropical jet core along 100^{o}E.

The equatorial cross-section shows that east of Sumatra, northerly flow dominated the low and middle levels, with weak flow aloft. To the west, as expected in the region of the better developed monsoon circulation, the low level flow was chiefly from the southern to the northern hemisphere with light northerly flow aloft.

RAINFALL

Figure 18 is a map of selected monthly mean rainfall quintiles as decoded from real time CLIMAT messages. This chart gives a qualitative impression of the distribution of rainfall throughout some of the analysis area. It shows for the month of November that there was near or above average rainfall over all of India, except for the west coast and the far south. Below average rainfall was recorded over the northern fringe of Australia to Cape York Peninsula and Papua-New Guinea; over South Australia, Cocos Island and to the north of Fiji.

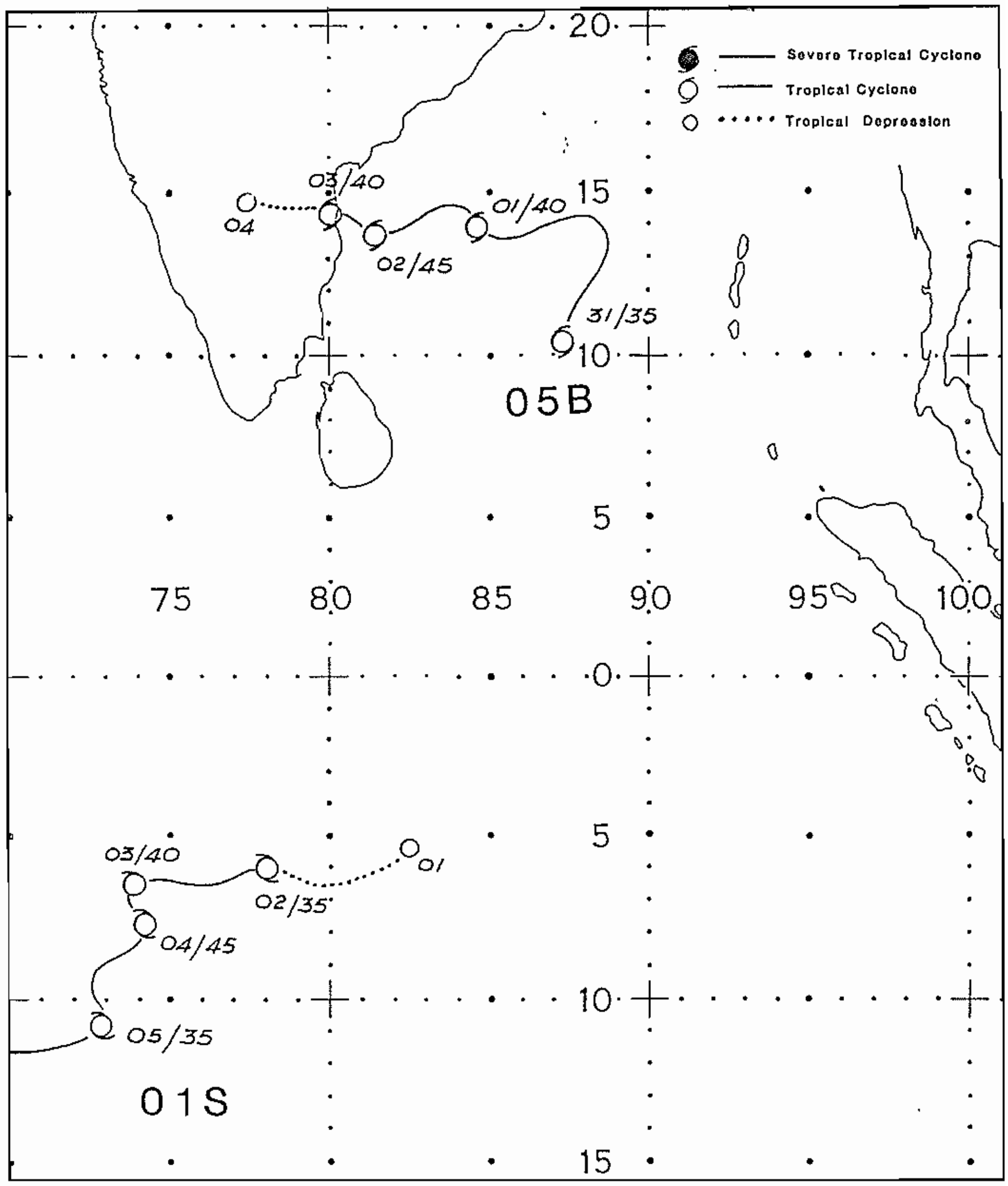

Fig. 1a UNOFFICIAL TRACKS OF CYCLONES 05B AND 01S (NOVEMBER 1987)
Date (DD) and maximum sustained wind (ff) in knots denoted by DD/ff.

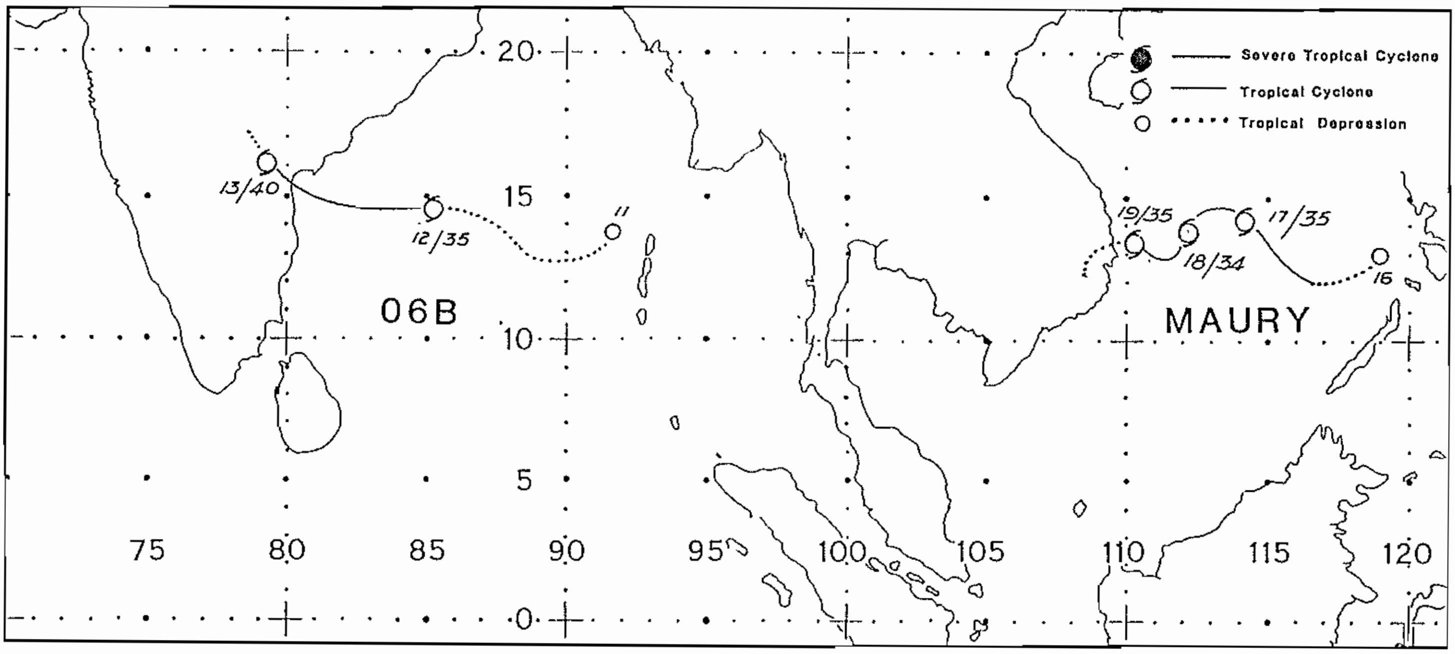

Fig. 1b UNOFFICIAL TRACK OF CYCLONE 06B AND MAURY (NOVEMBER 1987)
Date (DD) and maximum sustained wind (ff) in knots denoted by DD/ff.

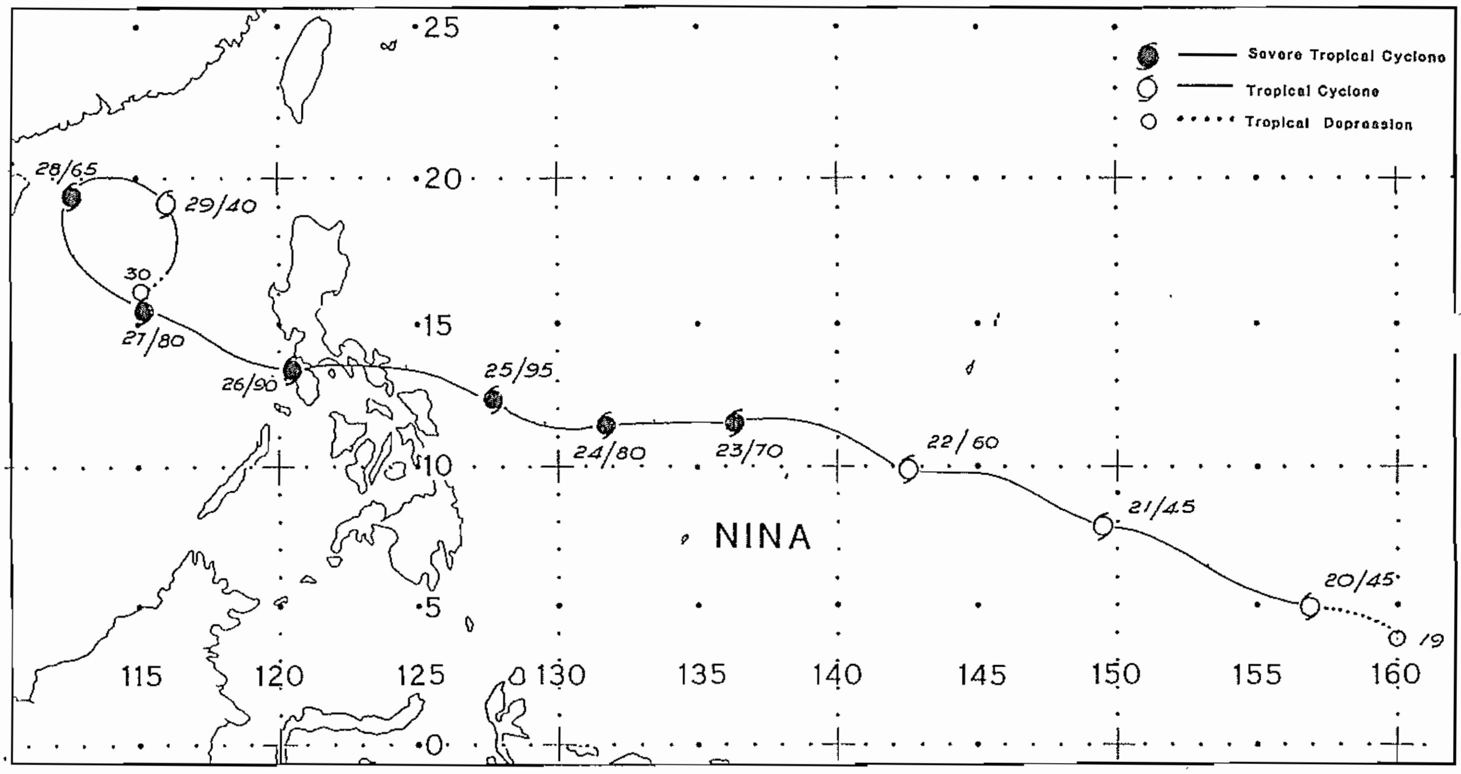

Fig. 1c UNOFFICIAL TRACK OF CYCLONE NINA (NOVEMBER 1987)
Date (DD) and maximum sustained wind (ff) in knots denoted by DD/ff.

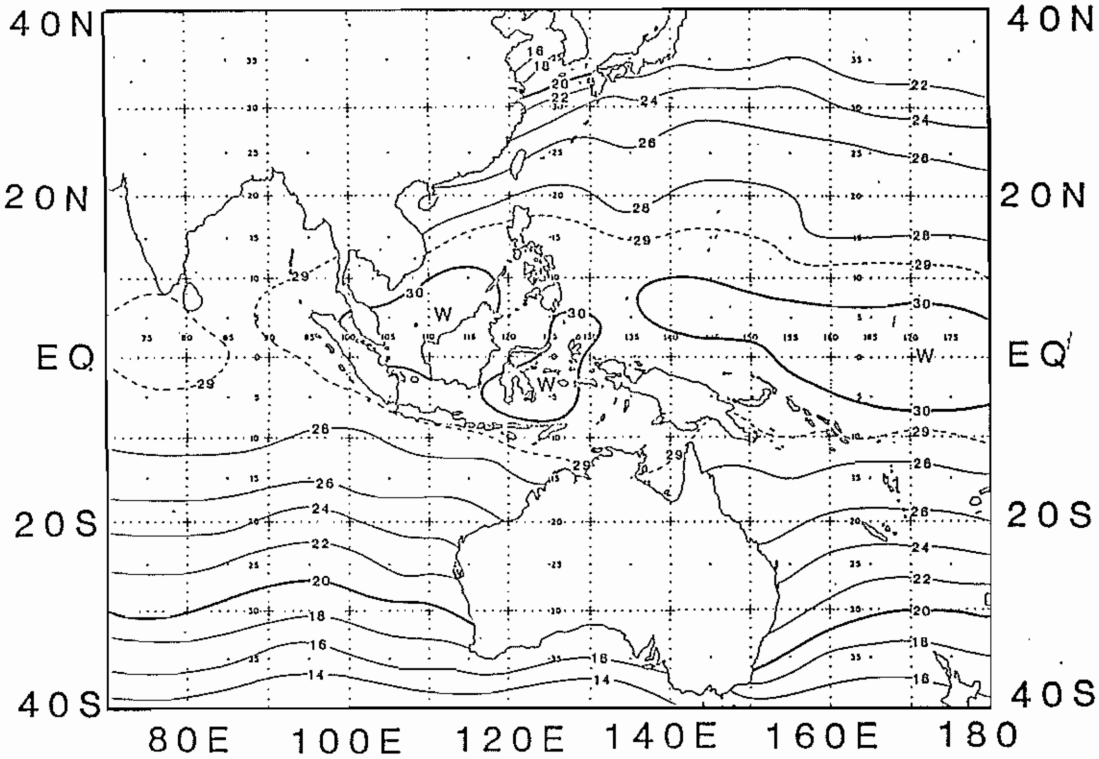

Fig. 2 MEAN SEA SURFACE TEMPERATURES, BASED ON DARWIN RMC ANALYSES AVERAGED OVER THE MIDDLE THREE WEEKS OF NOVEMBER 1987
Isotherm interval 2° C.

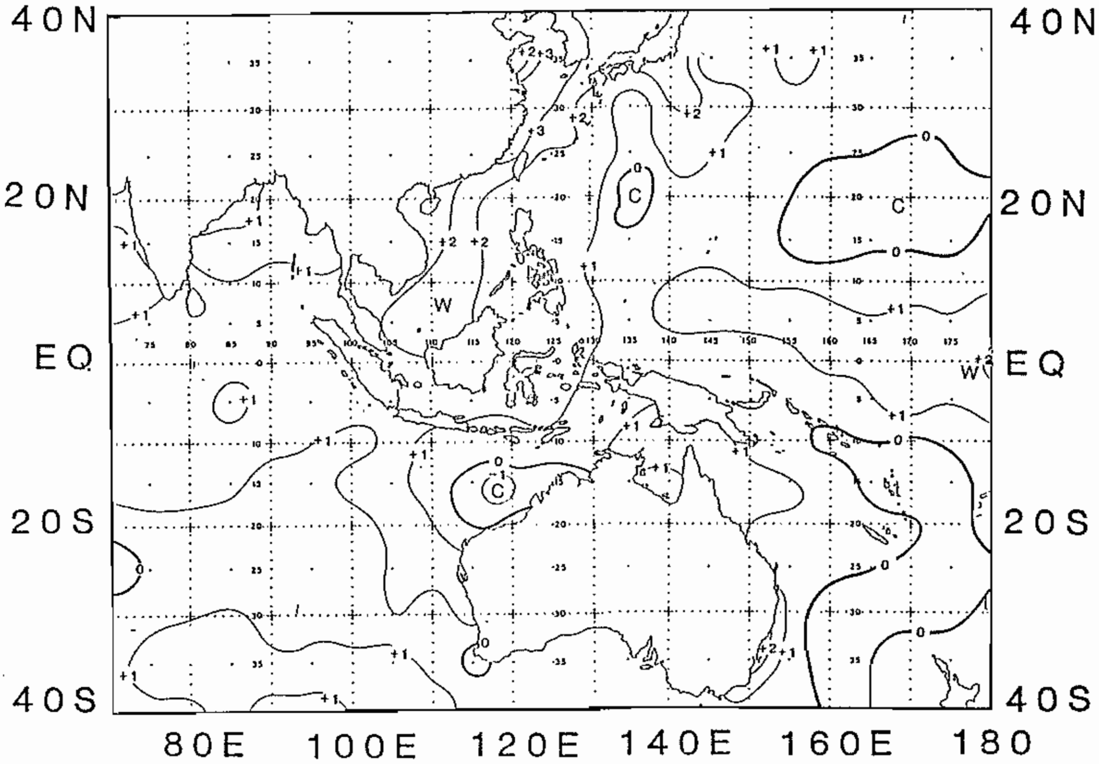

Fig. 3 SST ANOMALY CHART, BASED ON FIG. 2 AND THE CLIMATOLOGY OF REYNOLDS, NOAA REPORT NWS 31, 1983
Isotherm interval 1° C.

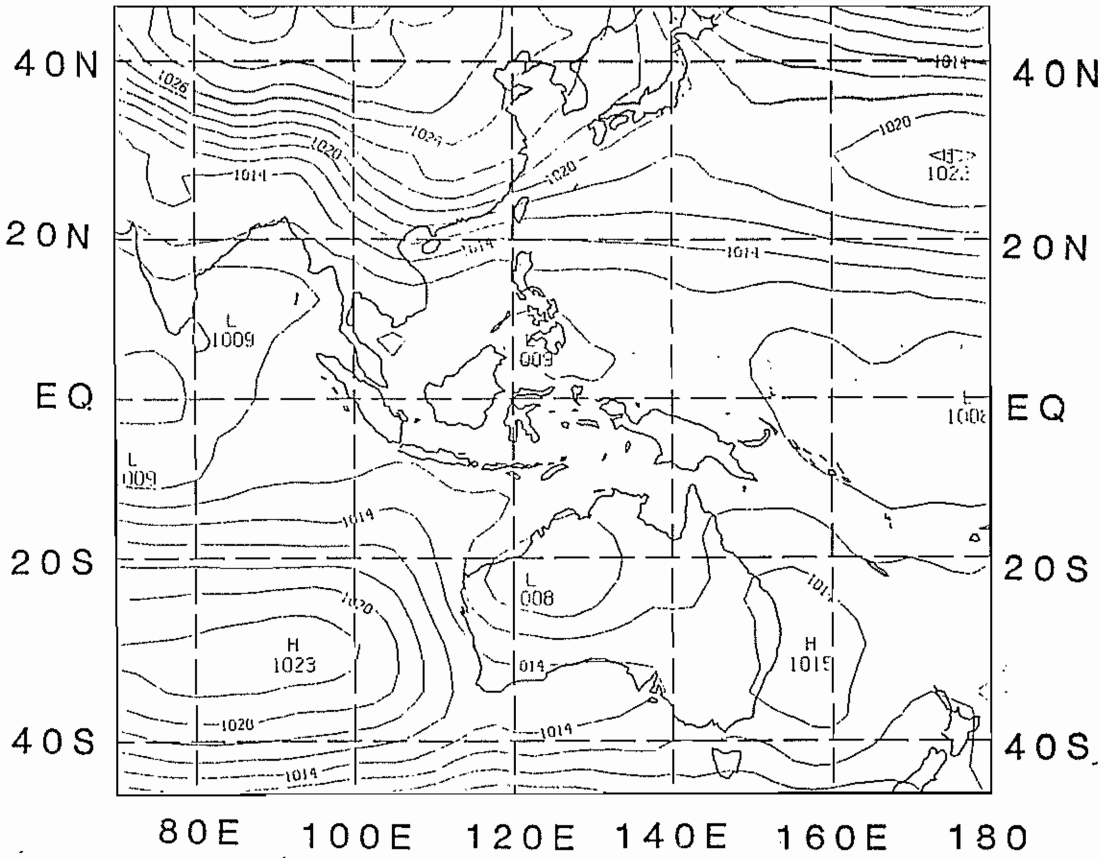

Fig. 4 MONTHLY MEAN MSL PRESSURE, NOVEMBER 1987
Isobar interval 2 hPa.

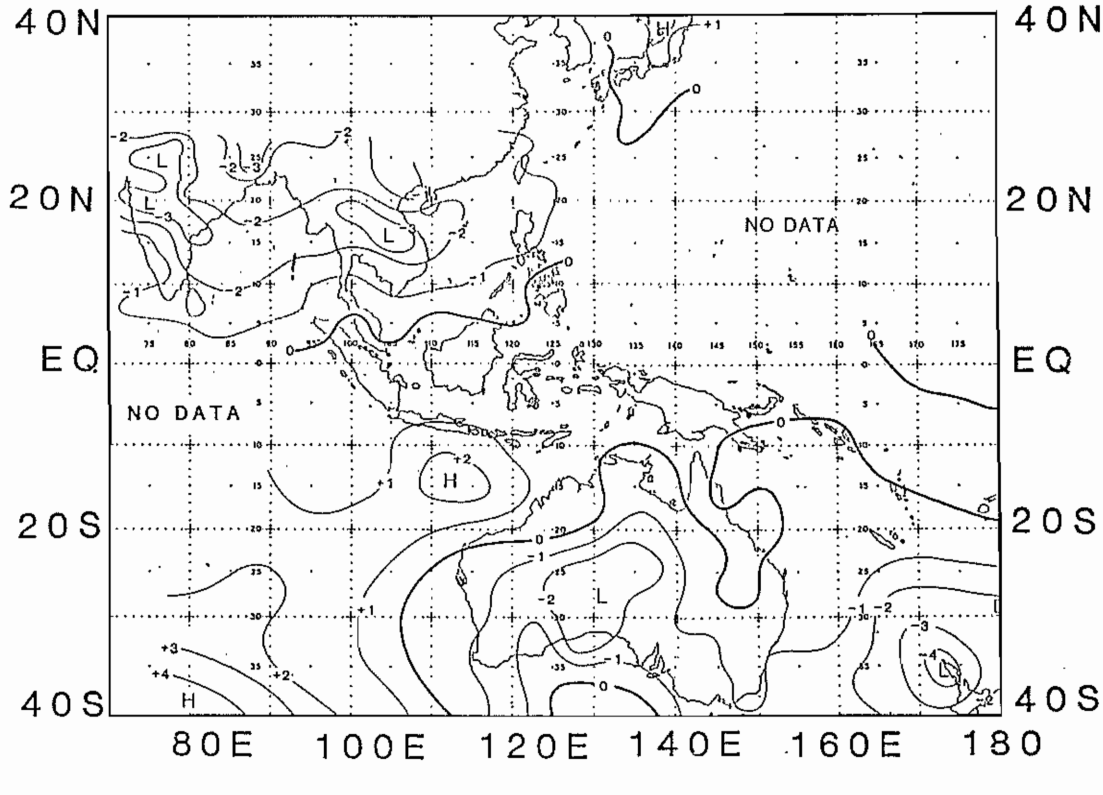

Fig. 5 MSL PRESSURE ANOMALY BASED ON CLIMAT MESSAGES
(AND MELBOURNE WMC DATA SOUTH OF 10^{o}S)
Contour interval 1 hPa.

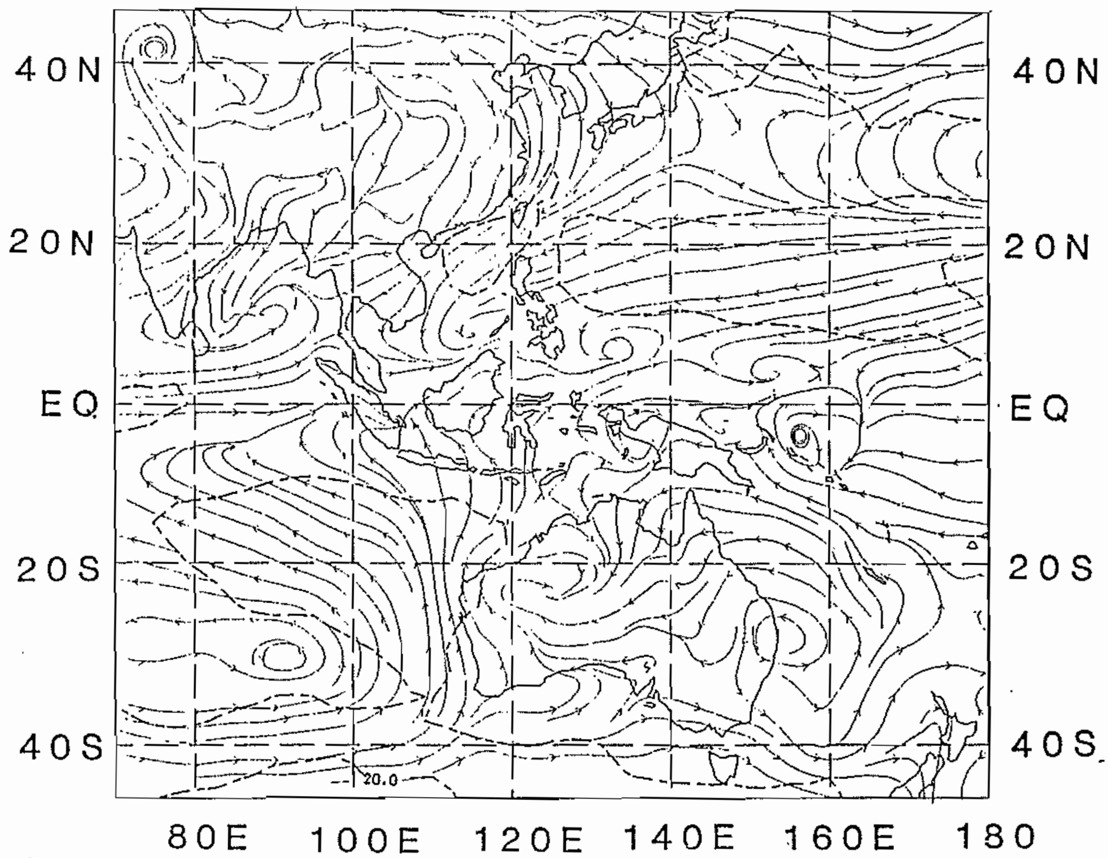

Fig. 6 950 hPa STREAMLINE ANALYSIS, NOVEMBER 1987
Isotachs (dashed line) at 10 knot intervals.

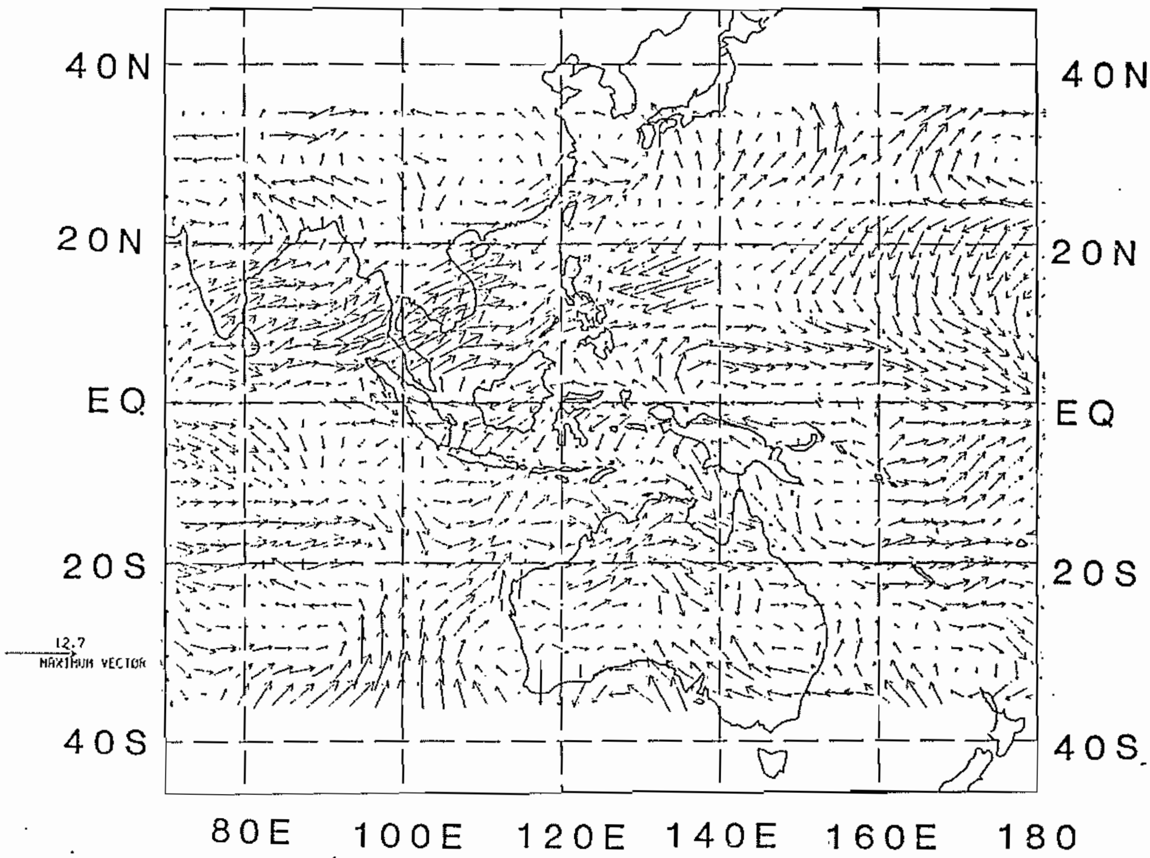

Fig. 7 950 hPa VECTOR WIND ANOMALY BASED ON FIG. 6
(Arrow length indicates magnitude).

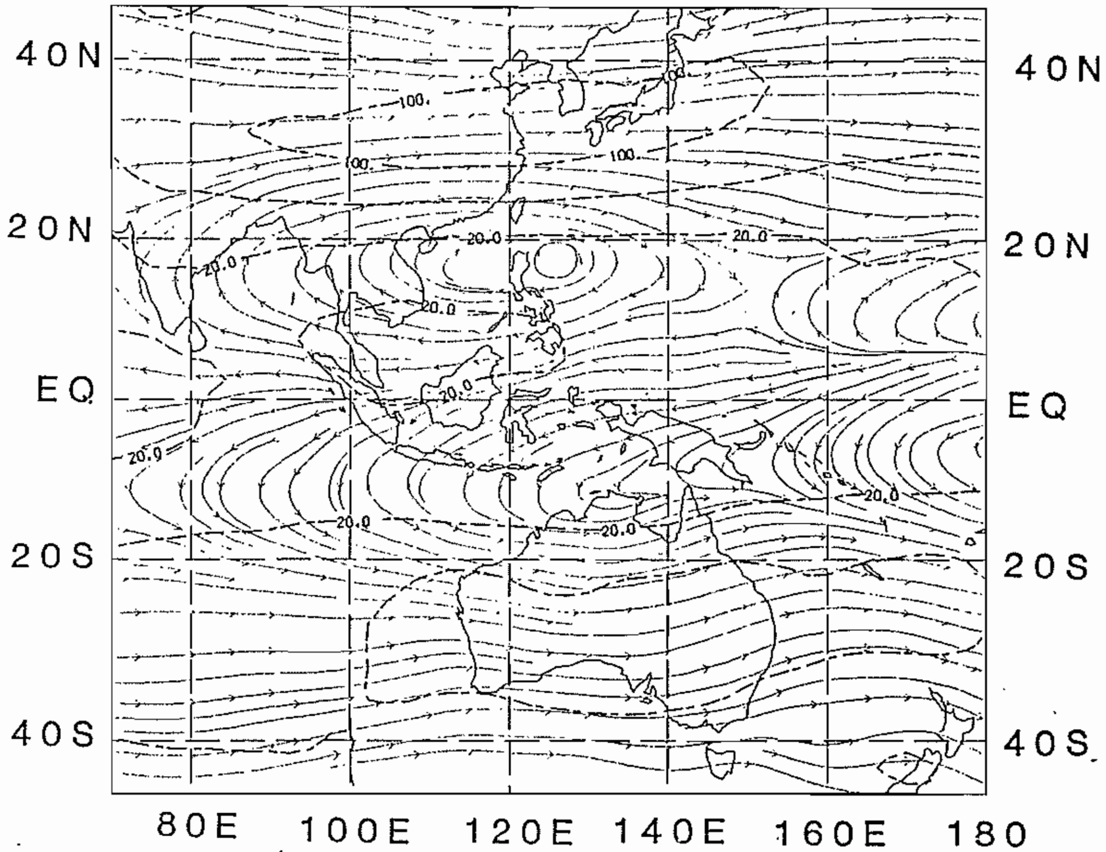

Fig. 8 200 hPa STREAMLINE ANALYSIS, NOVEMBER 1987
Isotachs (dashed line) at 40 knot intervals.

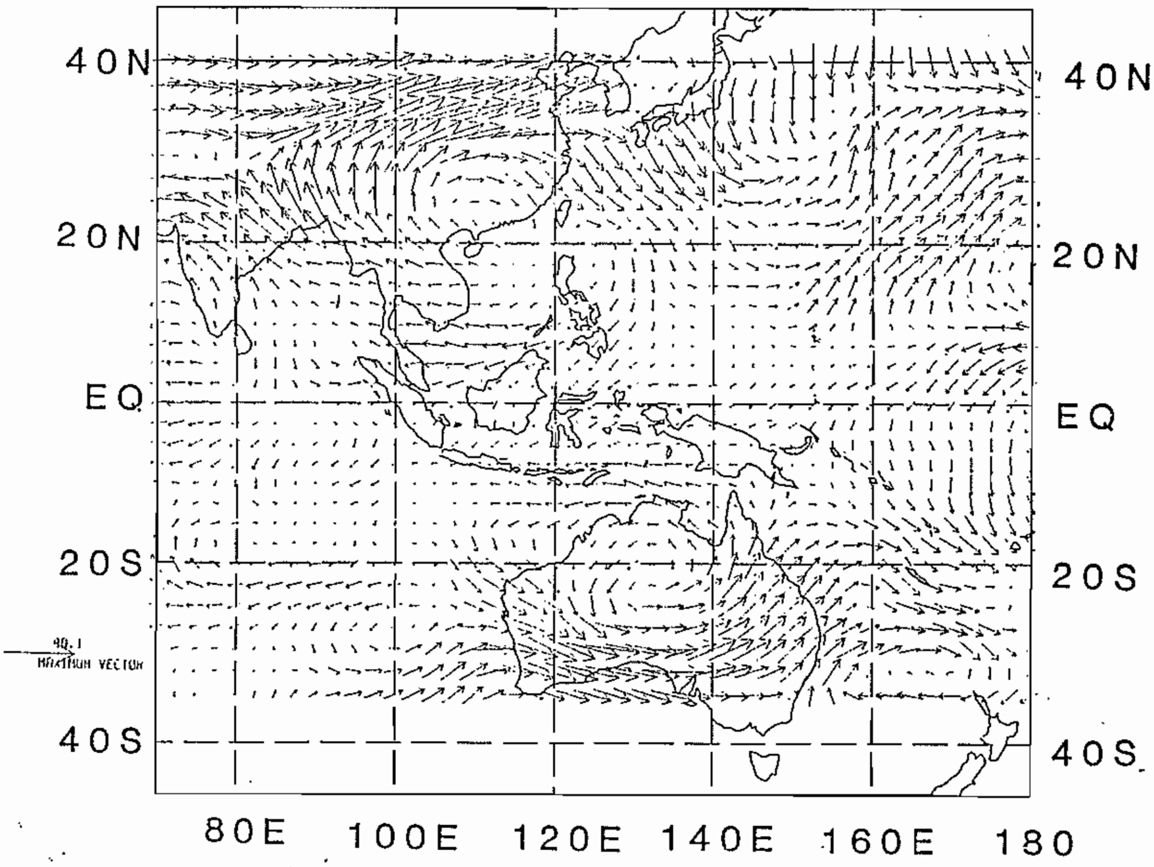

Fig. 9 200 hPa VECTOR WIND ANOMALY BASED ON FIG. 8
(Arrow length indicates magnitude).

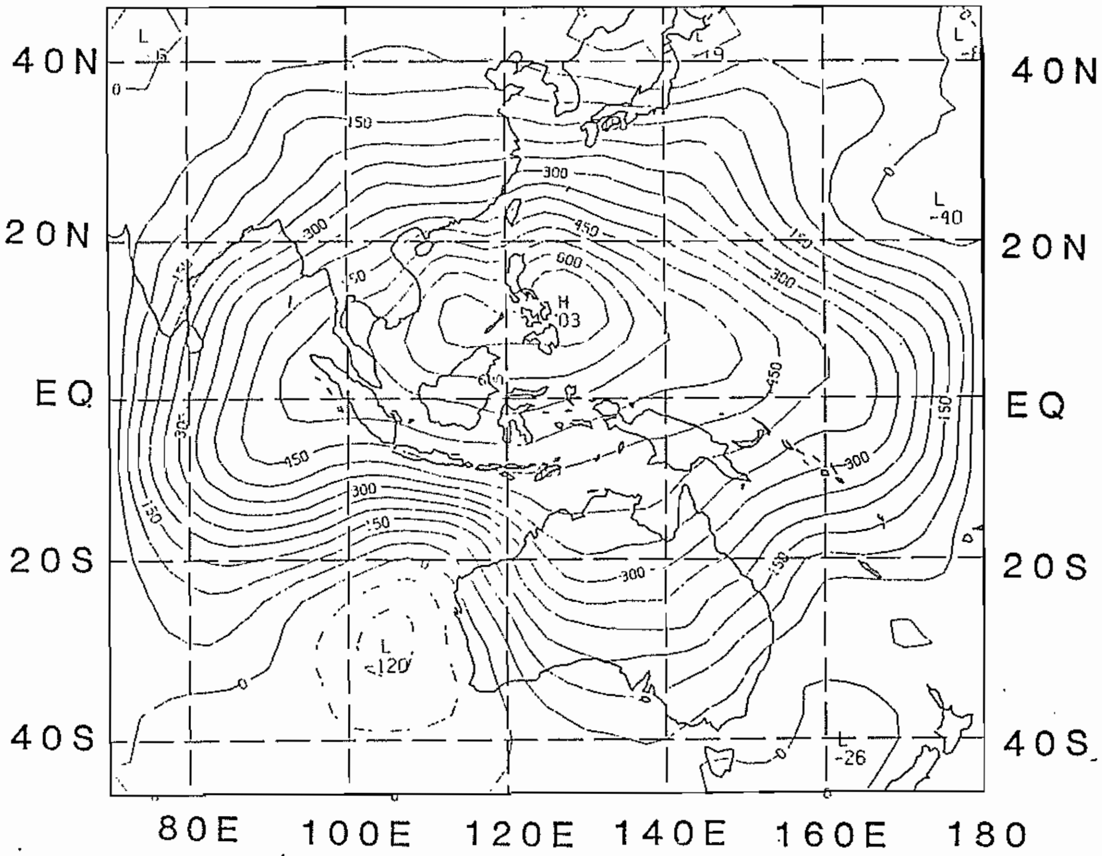

Fig. 10 950 hPa VELOCITY POTENTIAL, NOVEMBER 1987
Contour interval 40 x 10^5 m^2 s^{-1}

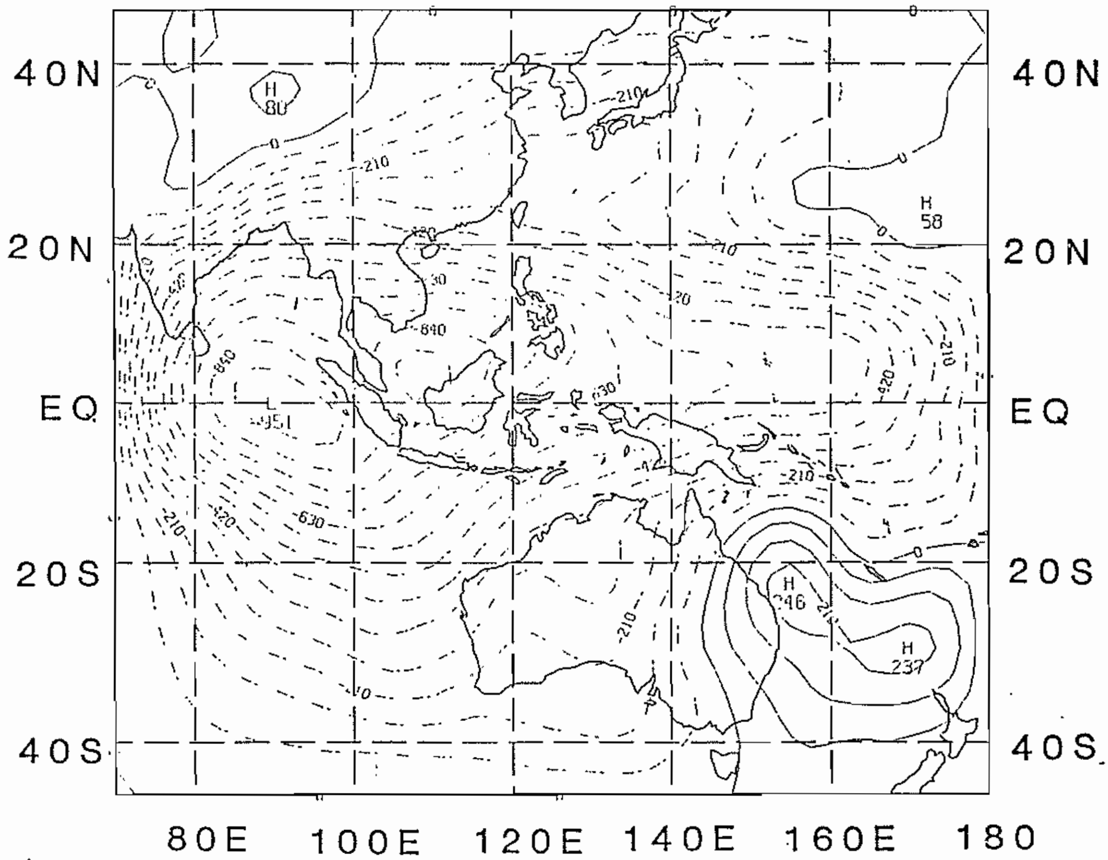

Fig. 11 200 hPa VELOCITY POTENTIAL, NOVEMBER 1987
Contour interval 6 x 10^5 m^2 s^{-1}

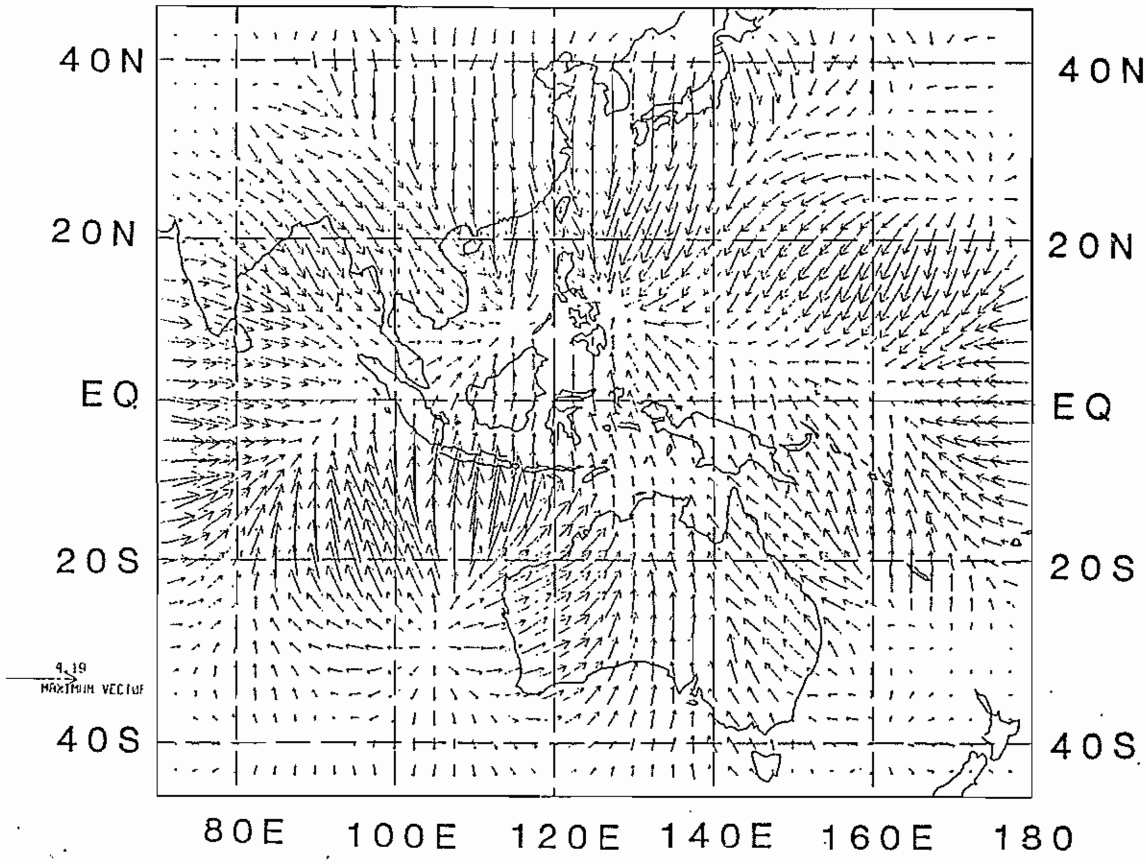

Fig. 12 950 hPa DIVERGENT WIND, NOVEMBER 1987
(Arrow length indicates magnitude).

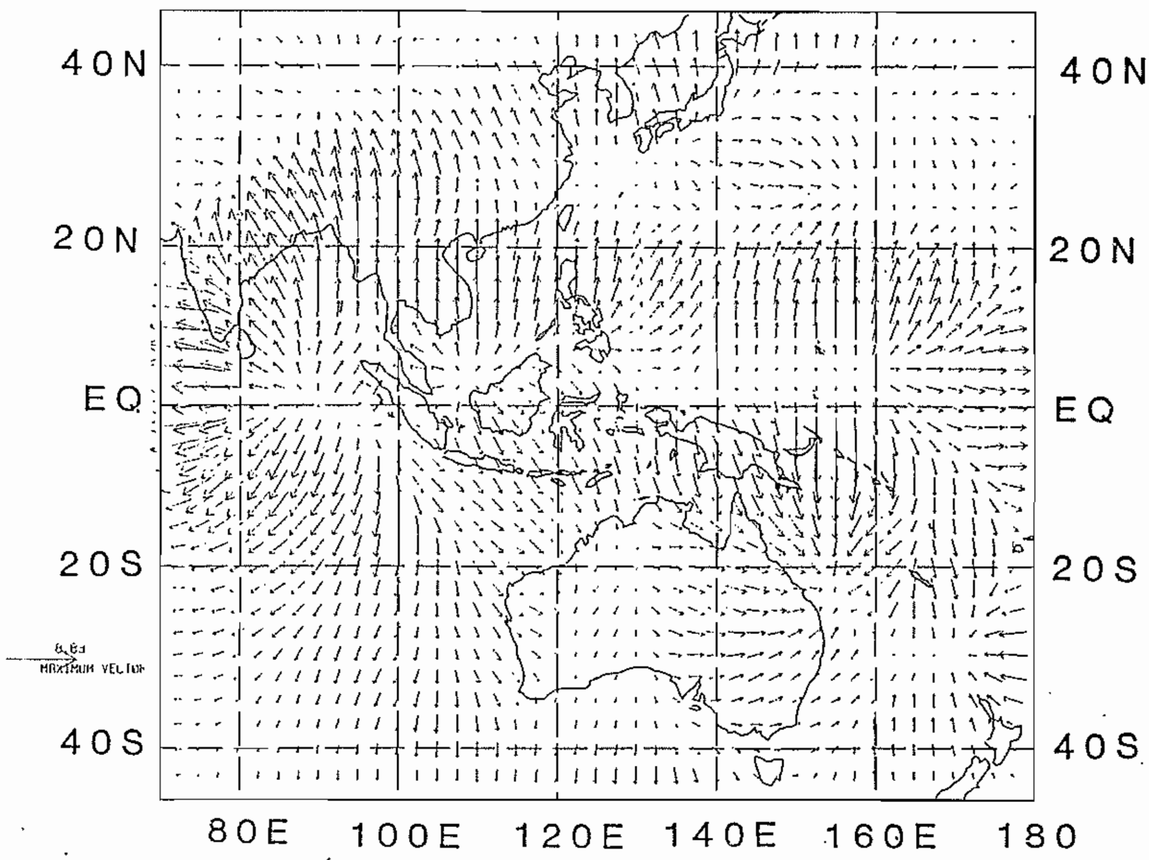

Fig. 13 200 hPa DIVERGENT WIND, NOVEMBER 1987
(Arrow length indicates magnitude).

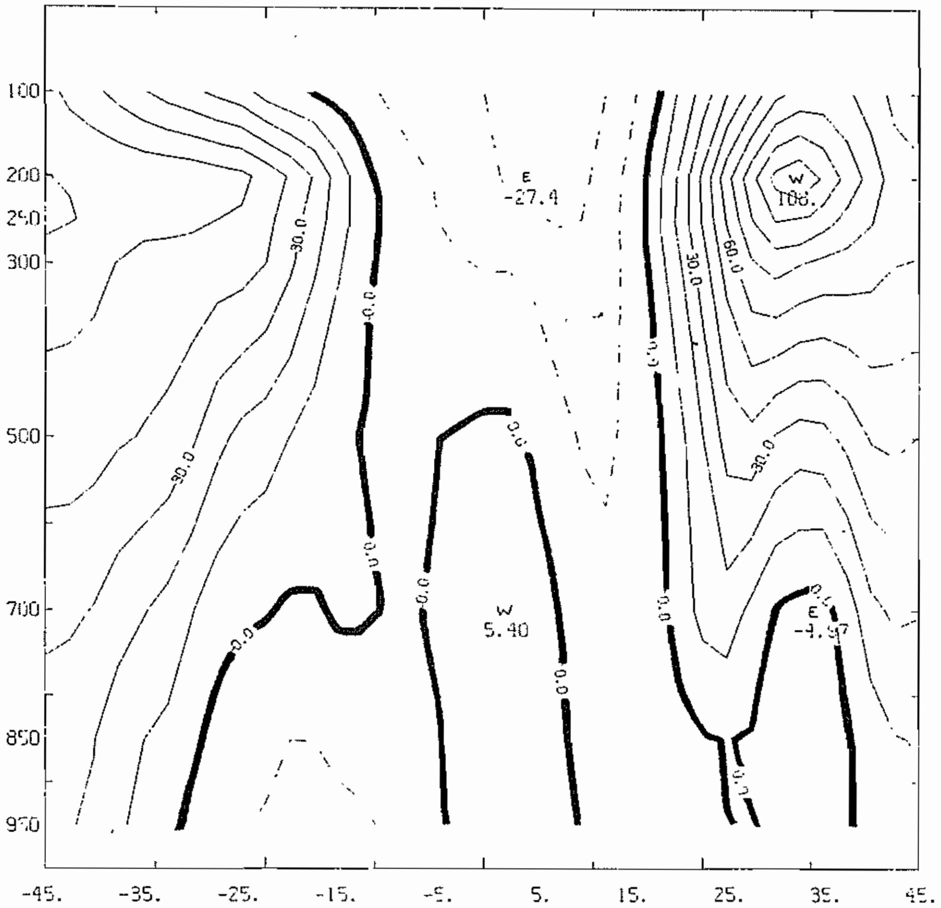

Fig. 14 CROSS-SECTION OF ZONAL WIND ALONG 100°E, NOVEMBER 1987
Isotach interval 10 knots.

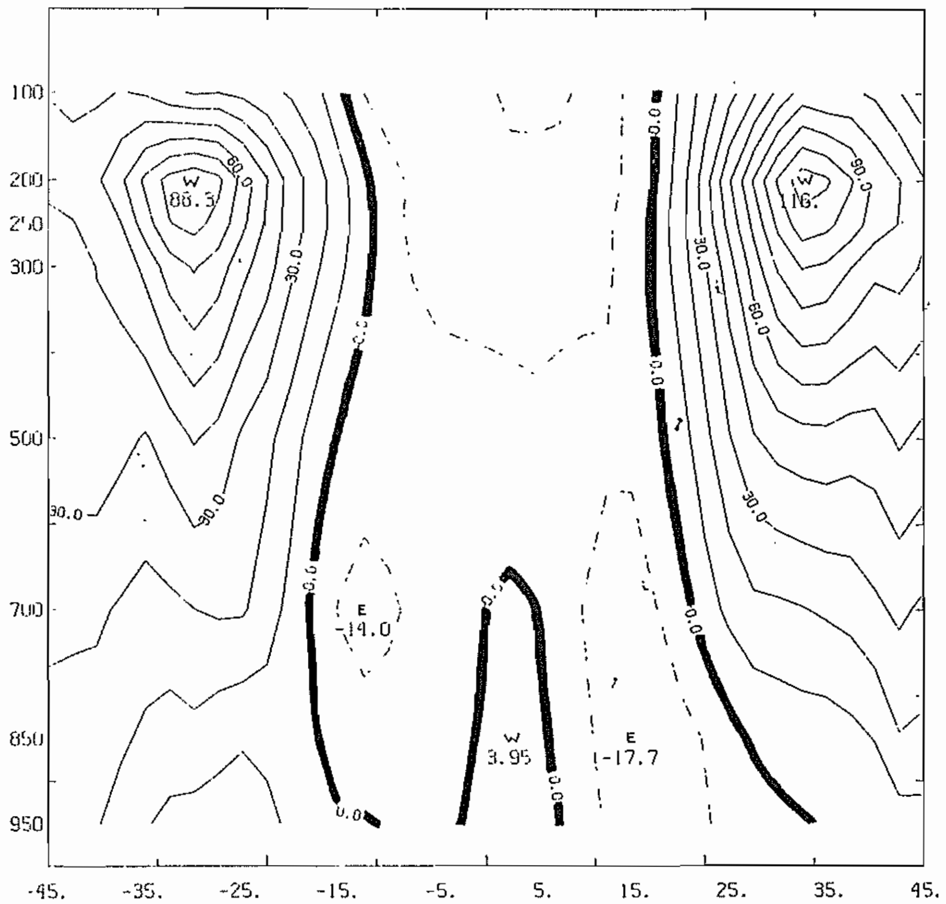

Fig. 15 CROSS-SECTION OF ZONAL WIND ALONG 130°E, NOVEMBER 1987
Isotach interval 10 knots.

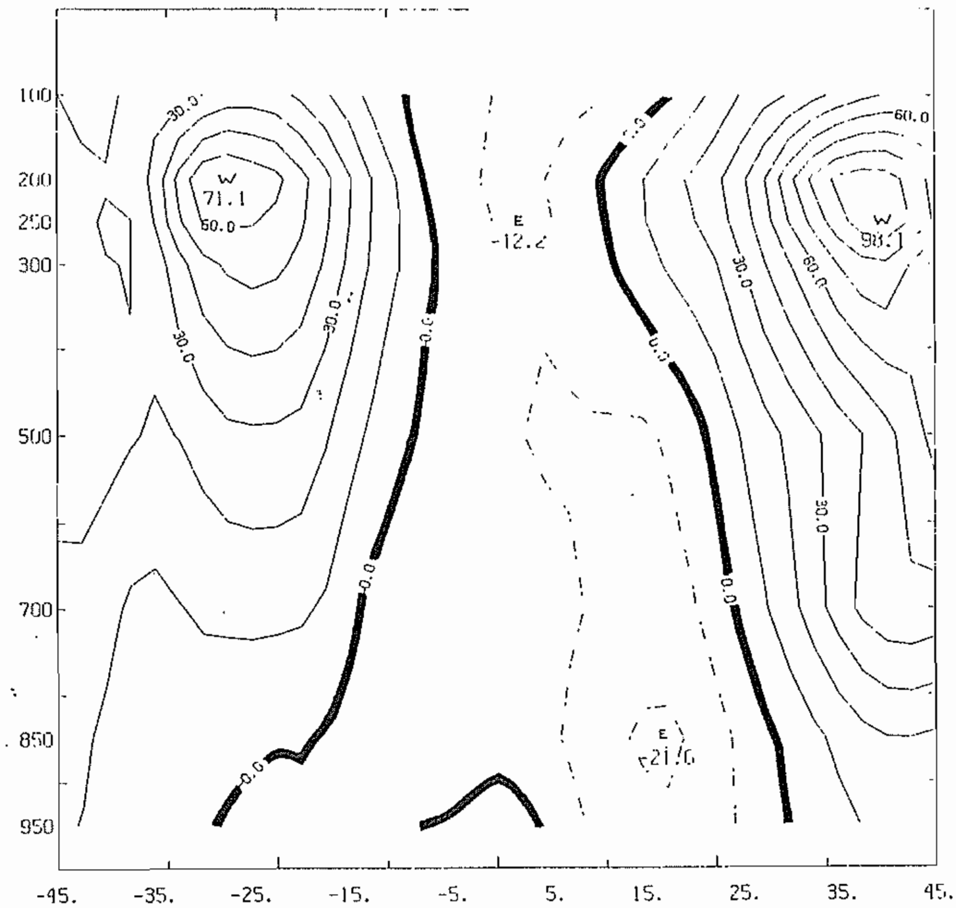

Fig. 16 CROSS-SECTION OF ZONAL WIND ALONG 160° E, NOVEMBER 1987
Isotach interval 10 knots.

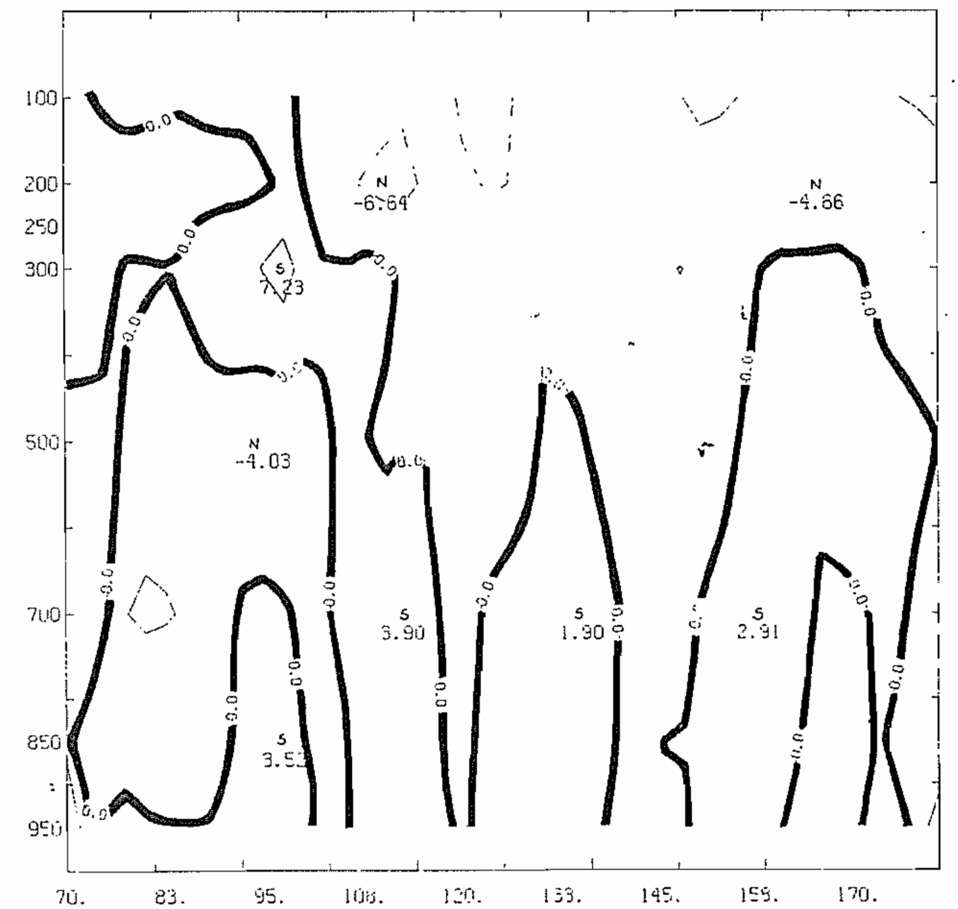

Fig. 17 EQUATORIAL CROSS-SECTION OF MERIDIONAL WIND BETWEEN 70°E AND 180°E, NOVEMBER 1987. 5 knot isotachs.

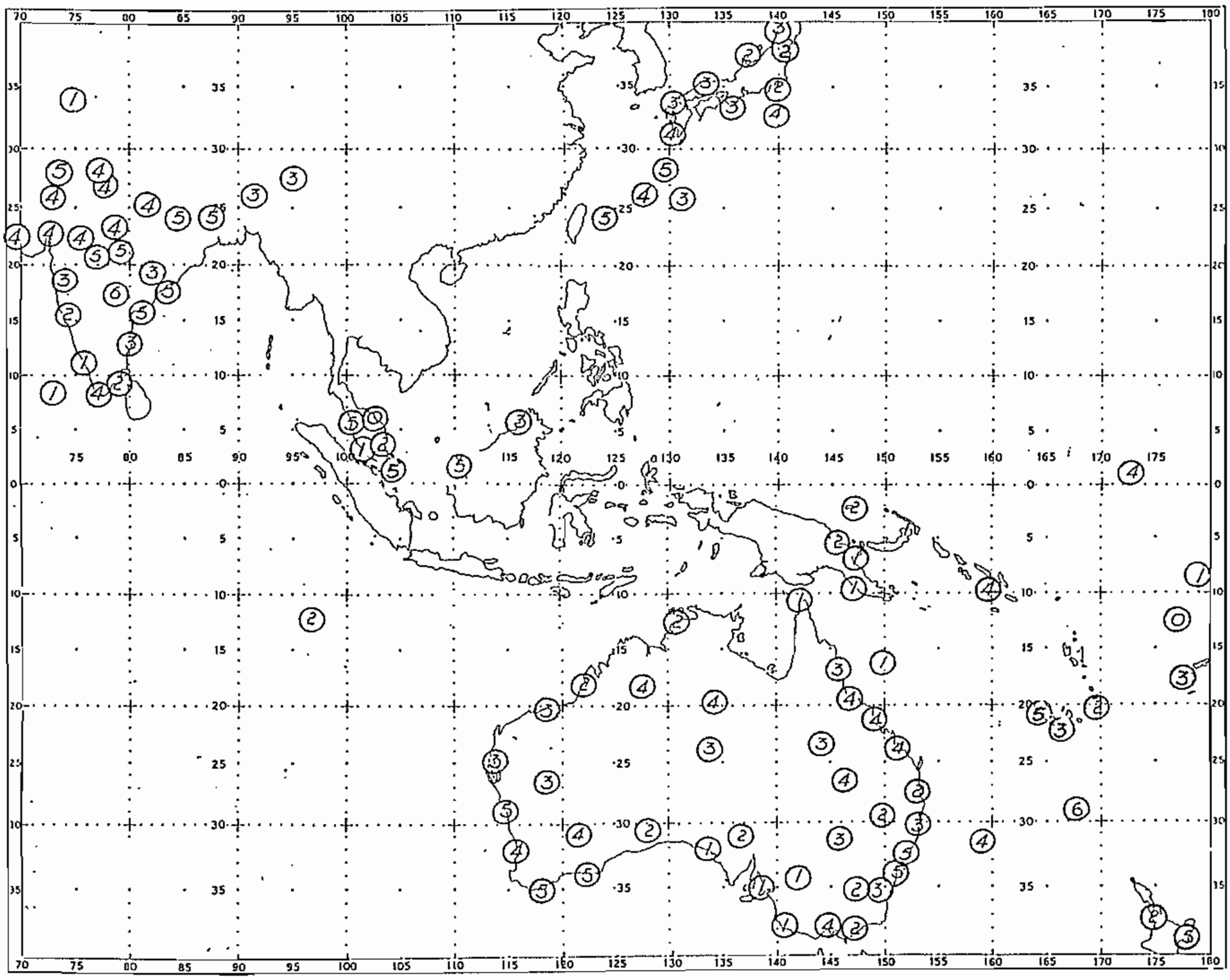

Fig. 18 MONTHLY MEAN RAINFALL QUINTILES from selected climat stations NOVEMBER 1987

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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

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

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95.50 (86.80 ex GST)	12.00 (Australia)	107.50
	24.00 (Asia/Pacific)	110.80
	36.00 (Rest of the world)	122.80

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