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DARWIN TROPICAL DIAGNOSTIC STATEMENT

JANUARY 1990

ISSUED BY DARWIN RSMC

SUMMARY

Seasonal indicators in general implied near-average conditions. The SOI remained near zero. The summer monsoon was poorly developed in the Australian region while in the central and east Indian Ocean it was enhanced. In the southwest Pacific the monsoon was active later in the month. The northwest Pacific was notable for a typhoon, not a common event for January. Weak warm SST anomalies characterised most of the tropical band of the RSMC area; further east they were mostly weakly negative.

INDICES

1. Darwin mean MSL pressure, January 1990 : 1006.9 hPa
pressure anomaly (1882 - 1985 mean) : +0.6 hPa
2. Tahiti mean MSL pressure, January 1990 : 1011.1 hPa
pressure anomaly : +0.2hPa
3. Troup's Southern Oscillation Index : -2
5-month mean (centred upon November) : +1

4. Time series of Troup's SOI :

| | Jan | Feb | Mar | Apr | May | Jun | July | Aug | Sept | Oct | Nov | Dec |
|------|-----|-----|-----|-----|-----|-----|------|-----|------|-----|-----|-----|
| 1988 | -2 | -6 | +1 | -1 | +10 | -4 | +11 | +14 | +20 | +16 | +20 | +10 |
| 1989 | +12 | +8 | +5 | +18 | +15 | +6 | +9 | -6 | +6 | +8 | -2 | -6 |
| 1990 | -2 | | | | | | | | | | | |

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

The SOI has risen marginally from last month, continuing a tendency to fluctuate near zero. The steady falling trend evident in the smoothed SOI for the past 8 months has been arrested. Darwin's pressure anomaly, while still positive, has fallen significantly from December. The index implies a near-average state of the Walker circulation for the month.

TROPICAL CYCLONES

Unofficial tracks of all named tropical cyclones (TC) analysed in the Darwin RSMC area of responsibility during January are shown in Fig. 2. The south Indian Ocean was by far the most active basin. One typhoon developed in the northwest Pacific, an event occurring less than once in three years.

Baomavo began as a TD in the monsoon trough well to the west-northwest of Cocos Island in the first days of the new year. At first it intensified slowly, under the influence of divergent easterlies north of the upper ridge, while drifting southwest. TC intensity was reached on 3rd. Intensification

continued as Baomavo moved south into the upper ridge axis, peaking on 6th. After traversing the upper ridge it recurved to the southeast and became sheared in an interaction with a front.

Rosita and Sam developed almost simultaneously toward mid-month. Rosita was generated from a depression which meandered slowly south in the area between Cocos and Christmas Islands during the previous week. The depression intensified to a TC very early on 14 January, reaching its maximum intensity the same day. Meanwhile TC Sam was also developing, and moving parallel to the northwest Australian coast, under middle/upper level east to northeasterly flow. Sam had its genesis from a depression which moved over the sea from north Australia. As it approached the circulation of Rosita during 15th there appears to have been a weak Fujiwhara interaction, though the latter was already weakening. Arrested upper outflow also weakened Sam temporarily at this stage. It subsequently moved south over colder water, eventually recurving in a frontal interaction.

Tina was a complex monsoonal depression (making positioning difficult) for most of its life, forming in the monsoon trough south of Java. It was located under an upper northeasterly regime for the first few days and intensified only slowly. Gale force winds were experienced over a broad area for several days, but the system lacked a tightly organised central structure. During 27th it briefly attained TC status before crossing the Western Australian coast near Exmouth, subsequently producing widespread heavy rain as it moved south.

During the last third of the month the monsoon was active over the southwest Pacific. A depression, causing widespread gales, moved southeast over the New Caledonia area between 20th and 25th. This was followed by another system, first analysed south of the Solomon Sea about 25th, which slowly intensified over the next few days to become TC Nancy. Its subsequent history will be dealt with in the February issue.

Typhoon Koryn formed in the low latitude northern hemisphere monsoon trough about 10th, moving west under a strong middle/upper easterly stream. By 13th, the system was in a more divergent upper environment, and intensified as a result. It tracked north through a weakness in the mid level ridge, briefly reaching typhoon intensity during 15th, before weakening and becoming extra-tropical over cooler water, and was eventually sheared in an interaction with an upper trough.

SEA SURFACE TEMPERATURE

The mean SST and anomaly fields for January are shown in Figs. 3 and 4.

The equatorial region remained dominated by positive anomalies. The cool area in the south Indian Ocean extended east from December. Temperatures were generally near normal around the southwest Pacific and most of tropical Australia but remained warm about its southern coast.

Operational ten-day mean SST anomaly charts from JMA Tokyo during the month generally supported the near-zero SOI by showing small values in the equatorial central Pacific. Cool anomalies tended to persist in the east.

MSL PRESSURE AND GRADIENT LEVEL FLOW

Mean MSL pressure and anomaly charts for January are shown in Figs. 5 and 6, and the gradient level (950 hPa) streamline and vector wind anomaly charts in Figs. 7 and 8. The MSLP anomaly chart was produced by blending data from CLIMAT messages with anomalies from the Davidson and

McAvaney (1981) tropical analysis scheme (TAS) (1983-9 climatology). The TAS anomaly field was essentially consistent with CLIMAT data.

Anticyclonic and high pressure anomalies about the Arafura and Timor Seas implied a weak monsoon trough in this region. Further west, an enhanced monsoon circulation was evidently driven predominantly by the dynamics of the Hadley cell in the southern hemisphere, as the northeast flow through the Bay of Bengal was lighter than normal, although there was a cross equatorial surge prior to the genesis of TC Rosita. Low pressure and cyclonic anomalies off the northwest Australian coast spanned the region of maximum tropical cyclone activity.

Although positive pressure anomalies over Australia have generally eased, becoming weakly negative over the southwest quarter, a comparatively strong ridge persisted from northeastern Australia to the Tasman. A cyclonic inflow over the southwest Pacific was west of its climatological position, with little sign of the usual low latitude ridge to its north.

In the northwest Pacific, the northeast trades were enhanced by the strong subtropical ridge near the dateline, a marked change from December. Low pressures have spread southeast from central Asia to the Philippines, maintaining a below-average east to northeast monsoon over south Asia.

850 hPa DAILY MEAN ZONAL AND MERIDIONAL WINDS AT DARWIN

Figs. 9 (a) and (b) are respectively plots for January of the 3-day running means of 850 hPa zonal and meridional winds at Darwin. These are presented as an index of the strength of the Australian region monsoon (e.g. Holland 1986); 3-day running means are used for ease of processing.

The first week was characterised by zonal easterlies, which began late in December. A relatively short burst of the northwest monsoon followed, which included the genesis of TC Sam. The zonal wind curve represents a mainly easterly departure from climatology (January mean +3.25 kn), and a slight predominance of break period easterlies over active period westerlies, a condition which might be expected to be associated with a weak negative SOI and average to below-average north Australian rainfall.

WIND CROSS SECTION

The equatorial cross section of meridional wind for January is at Fig. 10.

The low level pattern is similar to the long term mean, now available from TAS. It confirms anomalous northerly components west of 90°E, where the Hadley circulation was best developed. Near 115°E a narrow band of southerly flow, normally evident at mid levels, extended downward almost to the surface, another indication of below-average cross-equatorial inflow to the Australian region monsoon.

UPPER LEVEL FLOW

The mean 200 hPa streamline and vector wind anomaly charts for January are given in Figs. 11 and 12 respectively.

The low latitude easterlies in the southern hemisphere were generally below average except west of 85°E. The ridge in the northern hemisphere was near its mean position but small easterly anomalies around 20°N over much of the longitude range indicate a slightly weakened outflow into the westerlies.

Over central Asia the jet was displaced north of the mean and was stronger, due to the persistent trough about northeast China.

A blocking pattern existed over eastern Australia, with a persistent marked trough off the east coast. The anticyclone in the southwest Pacific lay well north of its climatological position, a possible explanation, from a vertical wind shear viewpoint, of the comparatively quiet month for tropical cyclones, despite some long-lived depressions.

VELOCITY POTENTIAL

Charts of the velocity potential fields at 950 hPa and 200 hPa for January are given in Figs. 13 and 14 respectively. The time-longitude cross-section of 5-day running means of 200 hPa velocity potential, averaged between 5°N and 15°N, is shown Fig. 15 and between 5°S and 15°S in Fig. 16.

The ridge of maximum low level velocity potential has continued to shift slowly south with the season. In the east it was close to the axis of the active monsoon trough. Over much of Indonesia, however, it was closer to the equator, showing that convergence was concentrated in the lower latitude westerlies.

At high level, strong divergence was evident from the anticyclone near Solomon Islands, with an axis extended south toward New Caledonia, over an active region. Further west upper divergence was represented by a diffluent easterly stream, well north of the Western Australian anticyclone.

The northern hemisphere time series shows the active period which culminated in typhoon Koryn. In the southern hemisphere tropical depression/cyclone events also dominate the pattern, particularly in the first half of the month. Around 20th a monsoon surge prevailed briefly at middle longitudes; this is also seen on Darwin's 850 hPa wind graphs. TC Tina and Nancy were generated following this event, one on either side of the continent.

RAINFALL

Monthly rainfall quintiles for selected stations in January are given in Fig. 17.

(Note: Time-longitude cross-sections of OLR are not shown this month. Previously given time sections assigned a temperature value of 300 K to all area-averages over 270.5 K. This contaminated the 5-day running means of the OLR at warmer temperature (high OLR) ranges. Series published in Diagnostics from July to December 1989, should still be reliable at the low OLR ranges, but less so at warmer ranges.)

High quintiles were generally evident over much of central Asia, southeast India and parts of the southwest Pacific, consistent with below-average pressures. Much of eastern Australia was dry, in line with the persistent ridge, while high values over southwestern Australia reflected the passage of TC Tina.

References

Davidson, N.E., and McAvaney, B.J. 1981. The ANMRC tropical analysis scheme. Aust. Met. Mag., 29, 155-168.

Holland, G.J. 1986. Interannual variability of the Australian summer monsoon at Darwin: 1952-82. Mon. Weath. Rev., 114, 594-604.

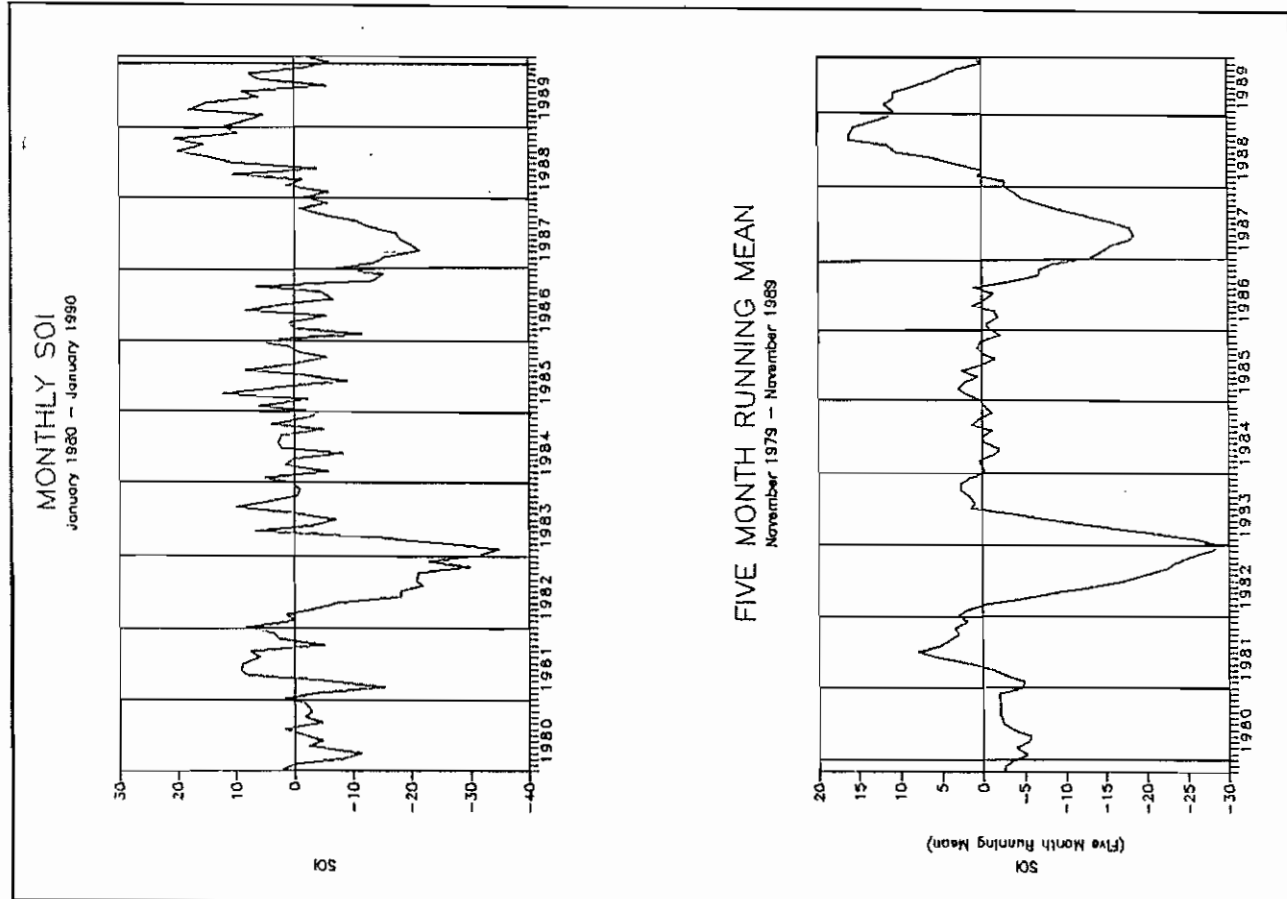


Fig.1 SOUTHERN OSCILLATION INDEX (1980-1990)
Monthly SOI and 5-month running mean SOI

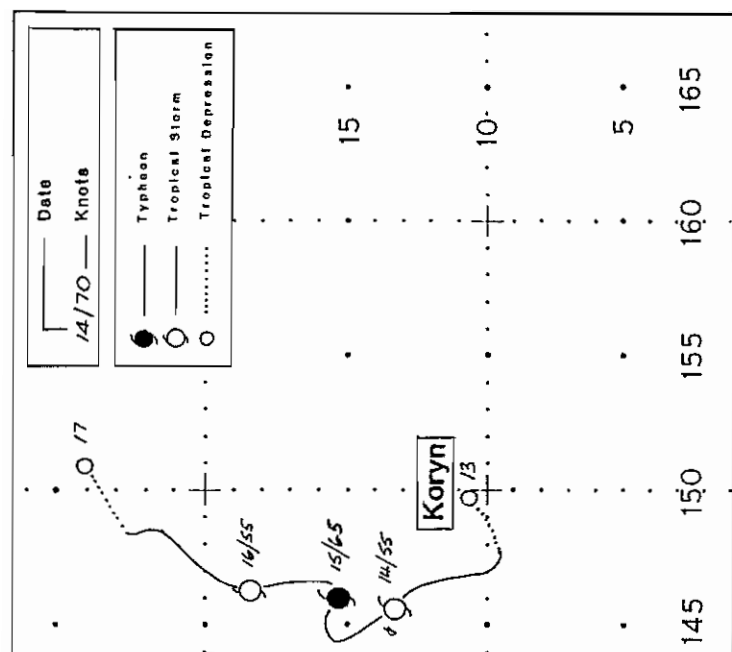


Fig. 2 (a)
UNOFFICIAL TRACK OF CYCLONE
KORYN (JANUARY 1990)
Date (DD) and maximum
sustained wind (ff)
in knots denoted by DD/ff

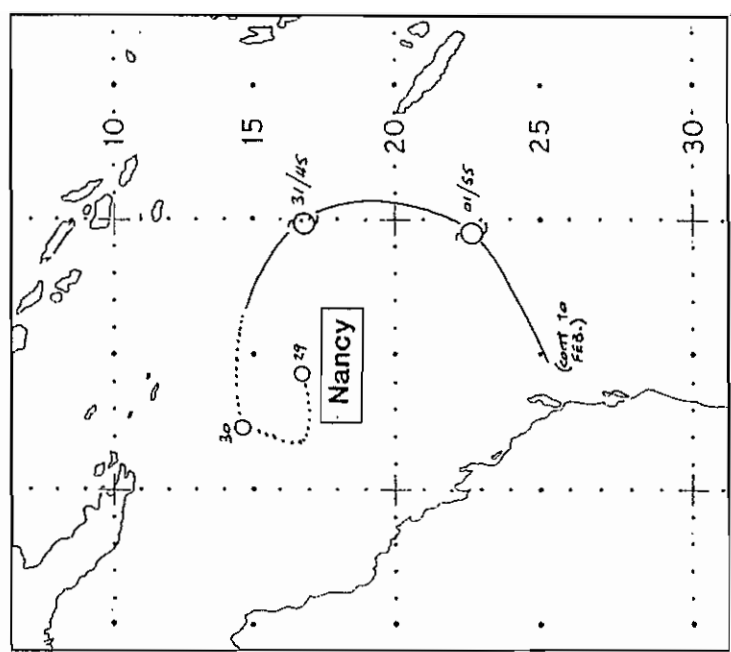


Fig. 2 (b)
UNOFFICIAL TRACK OF CYCLONE
NANCY (JANUARY 1990)
Date (DD) and maximum
sustained wind (ff)
in knots denoted by DD/ff

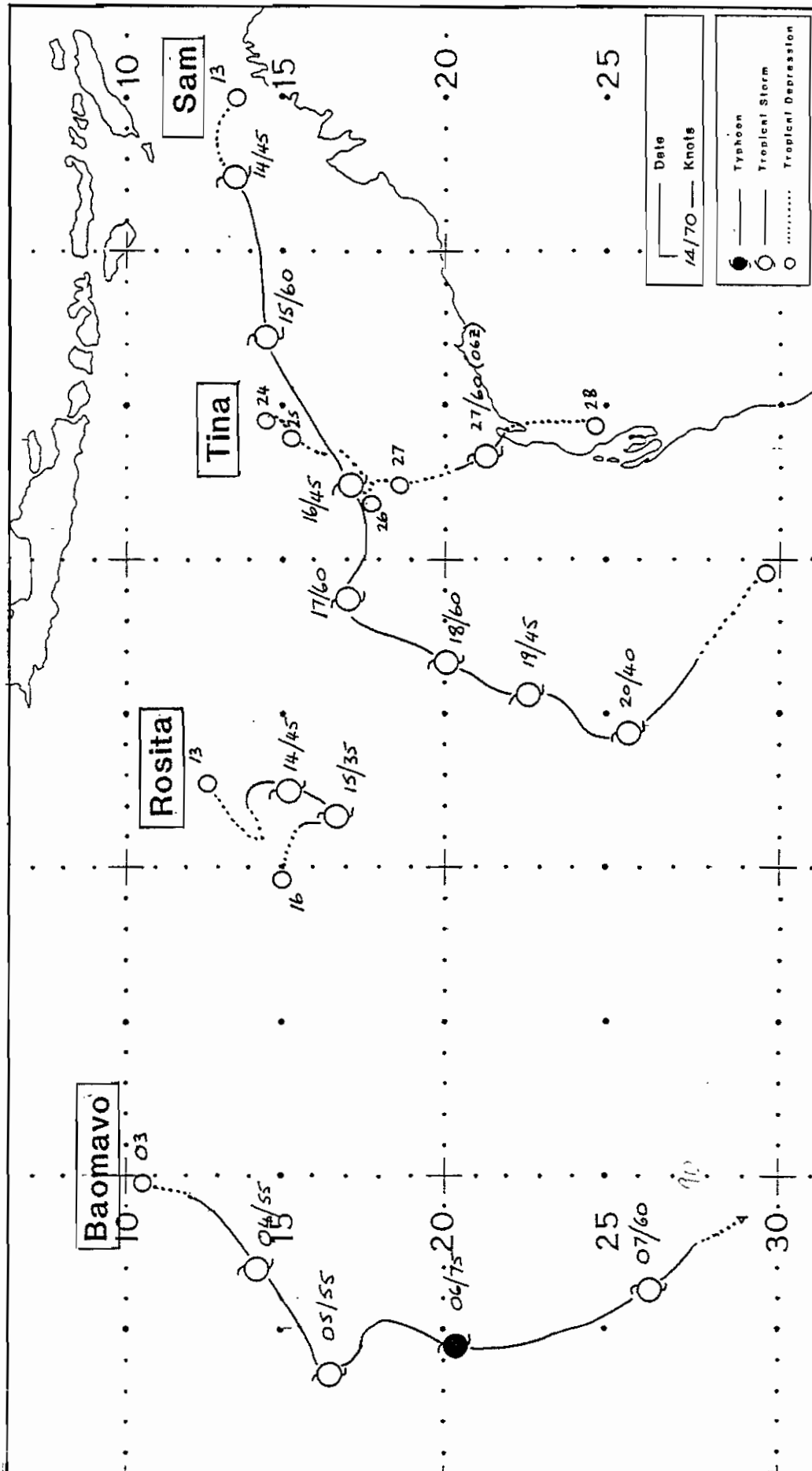


Fig.2 (c) UNOFFICIAL TRACKS OF CYCLONES BAOMAVO, ROSITA, SAM AND TINA (JANUARY 1990)
Date (DD) and maximum sustained wind (ff) in knots denoted by DD/ff

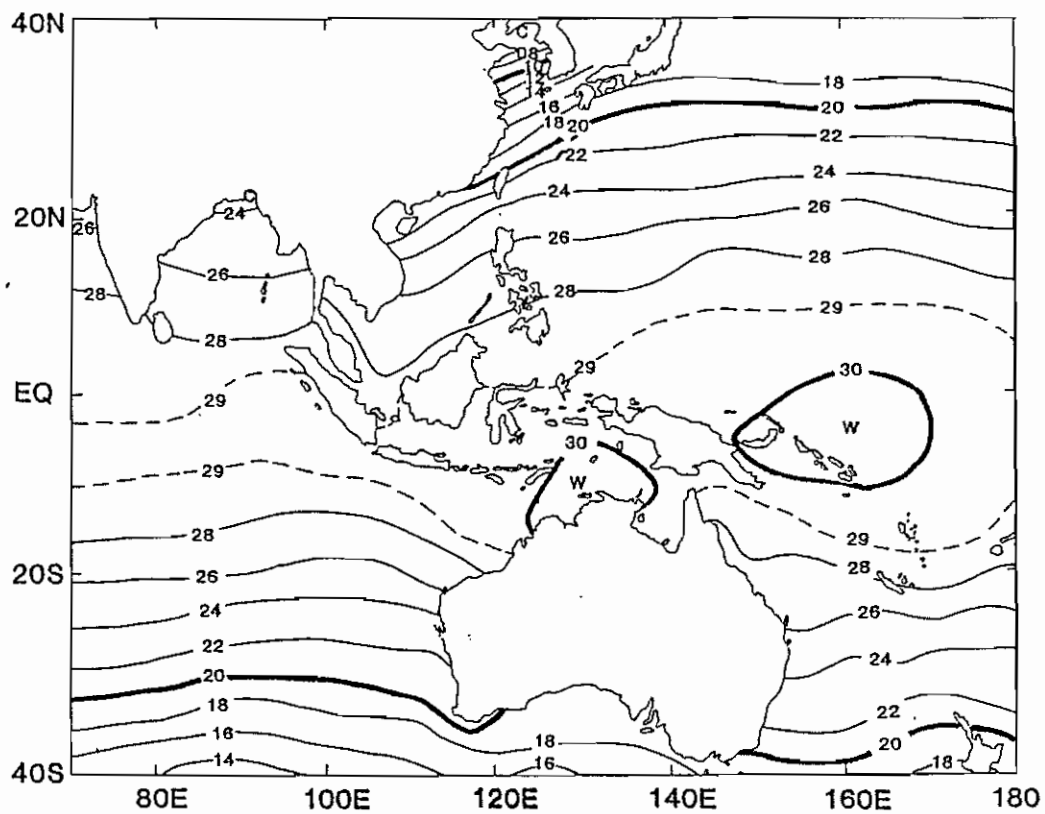


Fig. 3 MEAN SEA SURFACE TEMPERATURES, BASED ON WEEKLY DARWIN RMC ANALYSES AVERAGED OVER THE MONTH, JANUARY 1990. Isotherm interval 2°C .

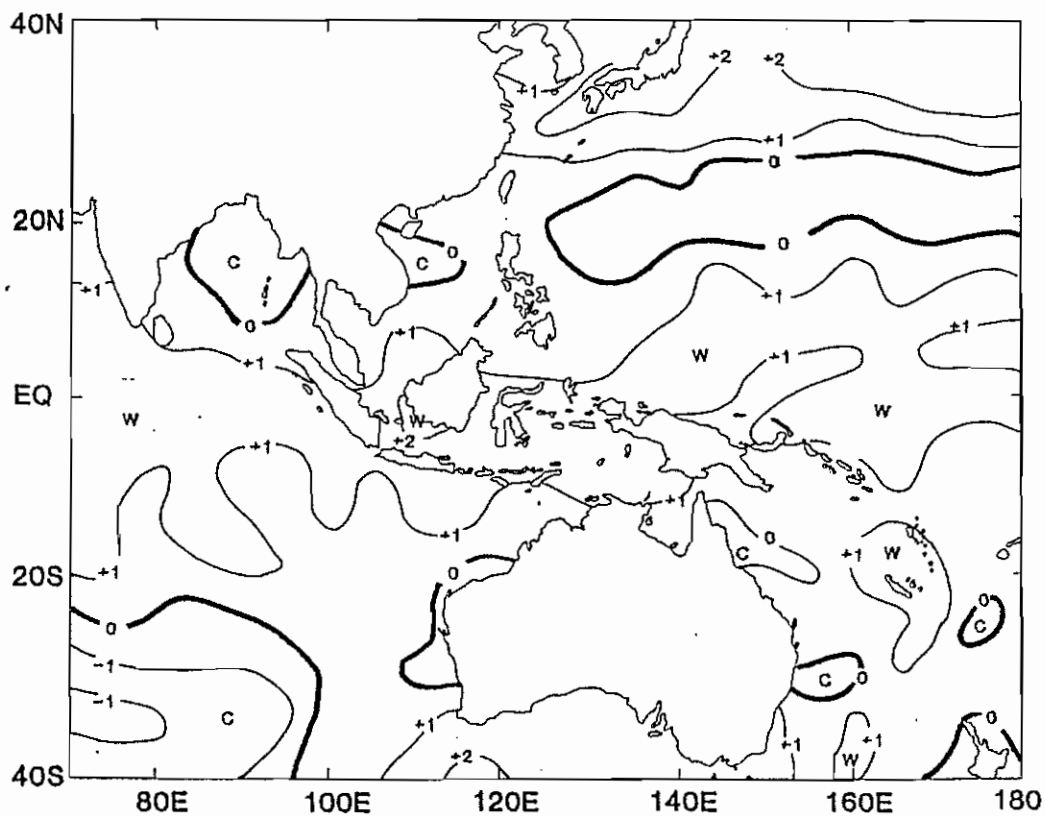


Fig. 4 SST ANOMALY CHART, BASED ON FIG. 3 AND THE CLIMATOLOGY OF REYNOLDS, NOAA REPORT NWS 31, 1983 Isotherm interval 1°C .

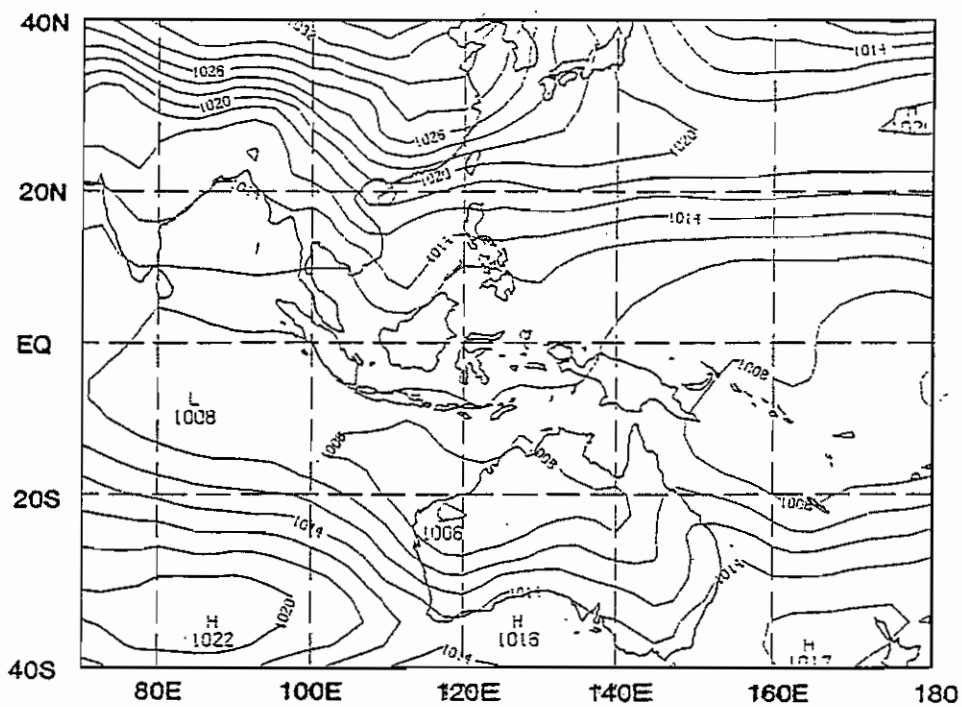


Fig. 5 MONTHLY MEAN MSL PRESSURE, JANUARY 1990
Isobar interval 2 hPa

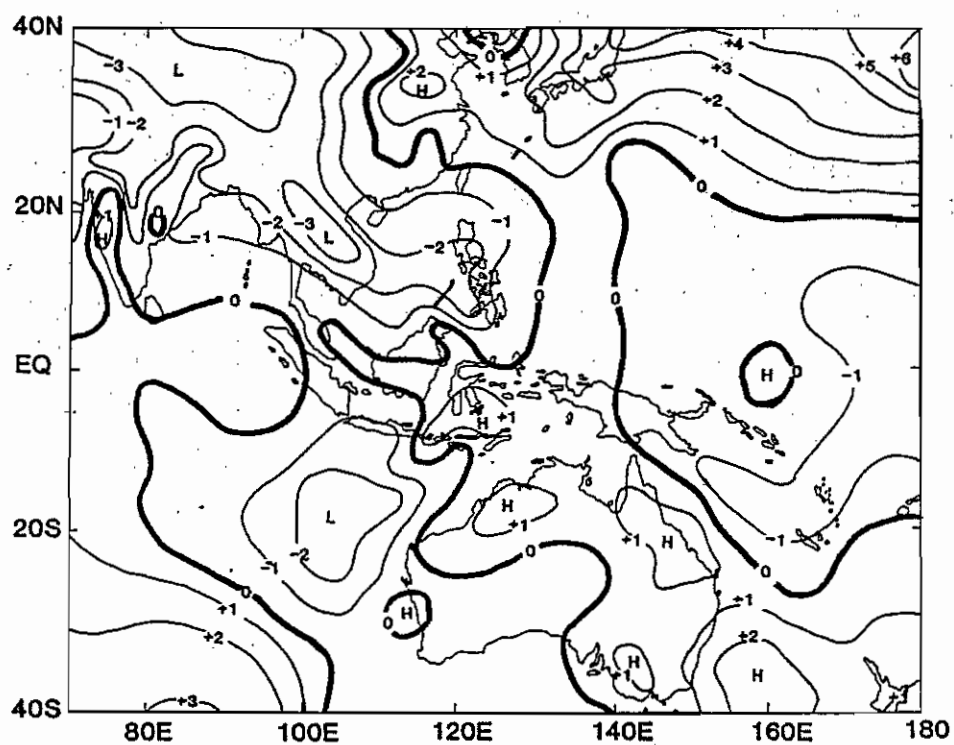


Fig. 6 MSL PRESSURE ANOMALY BASED ON CLIMAT MESSAGES
(AND TAS ANALYSIS IN DATA SPARSE AREAS)
Contour interval 1 hPa.

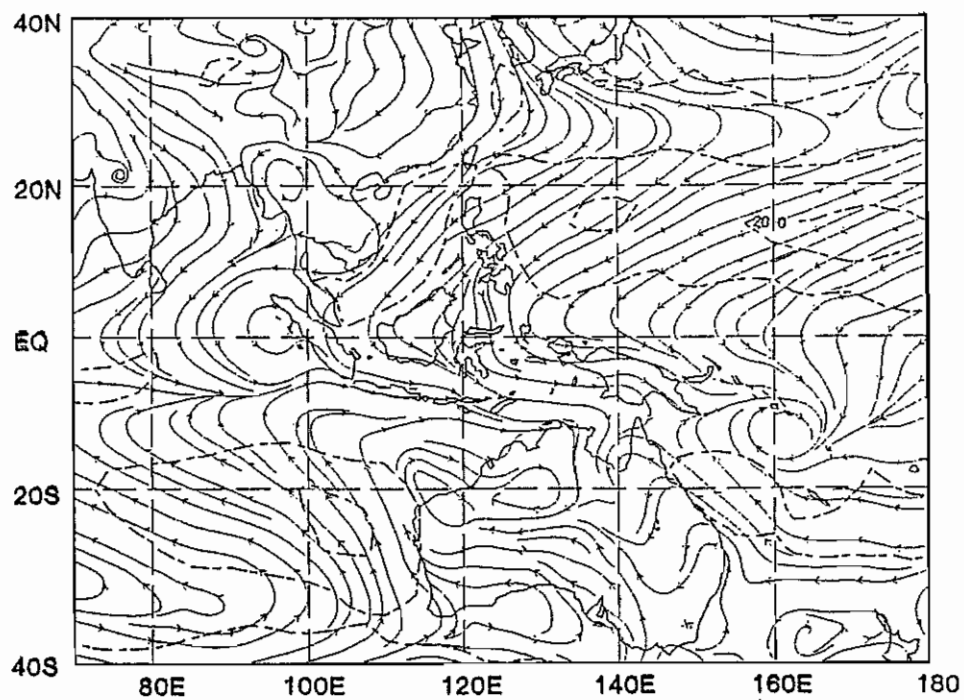


Fig. 7 950 hPa STREAMLINE ANALYSIS, JANUARY 1990
Isotachs (dashed line) at 10 knot intervals

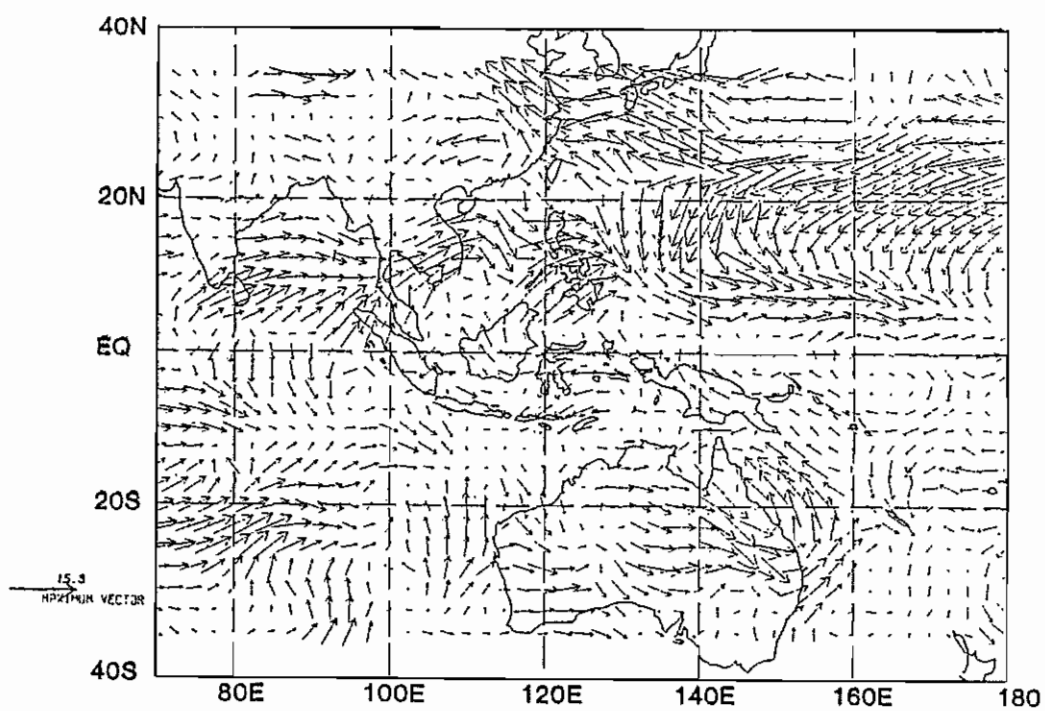


Fig. 8 950 hPa VECTOR WIND ANOMALY BASED ON FIG. 7
(Arrow length indicates magnitude)

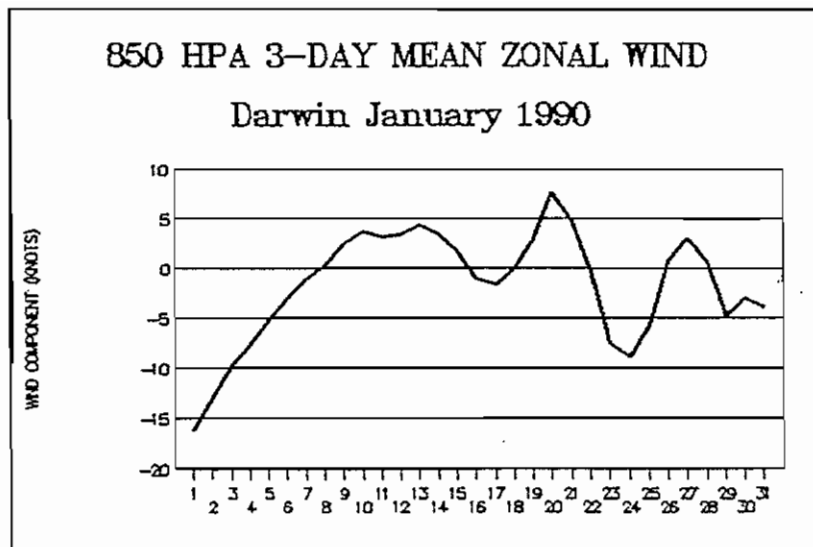
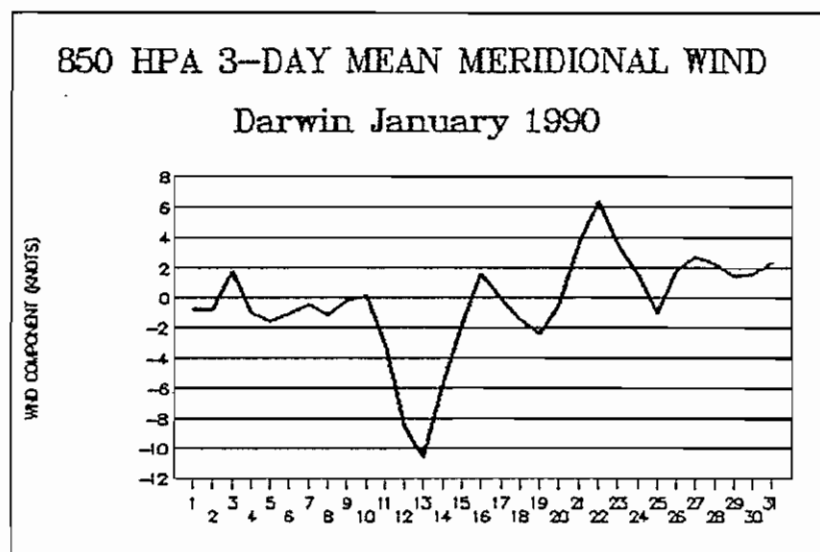


Fig. 9 (a) DARWIN 850 hPa 3-DAY MEAN ZONAL WIND, JANUARY 1990



(b) DARWIN 850 hPa 3-DAY MEAN MERIDIONAL WIND, JANUARY 1990

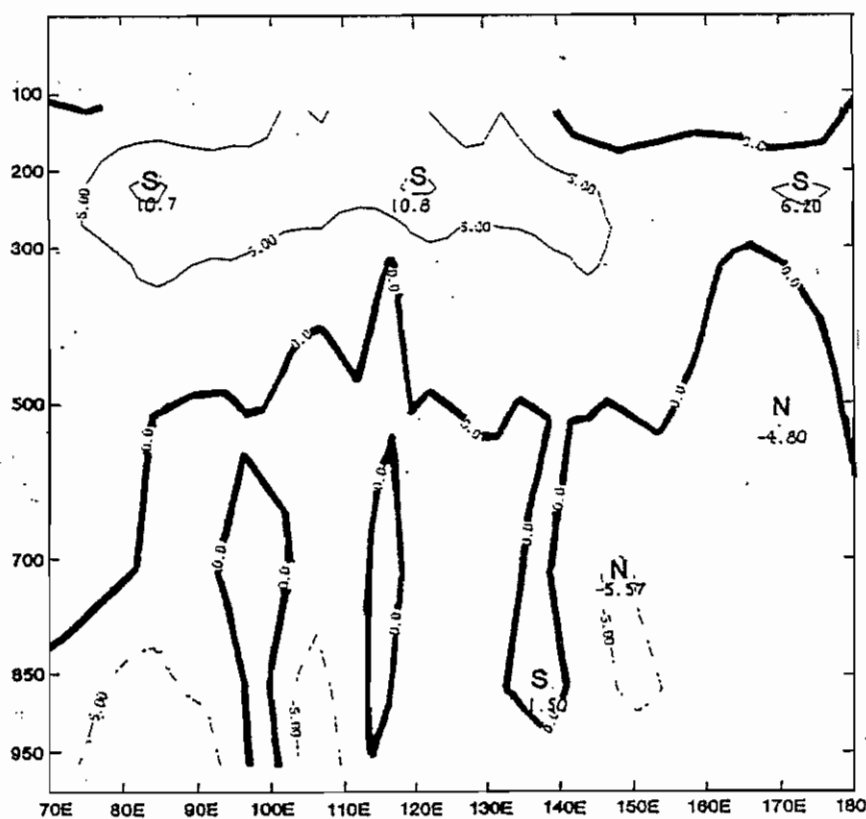


Fig.10 EQUATORIAL CROSS-SECTION OF MERIDIONAL WIND
BETWEEN 70°E AND 180°E, JANUARY 1990. (5 knot isotachs).

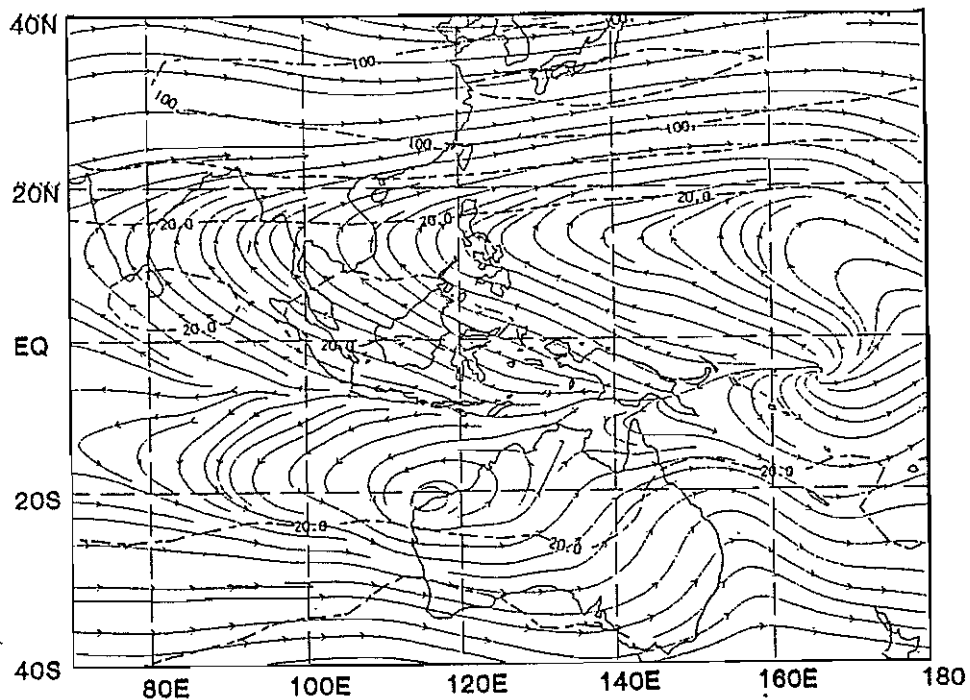


Fig.11 200 hPa STREAMLINE ANALYSIS, JANUARY 1990
Isotachs (dashed line) at 40 knot intervals.

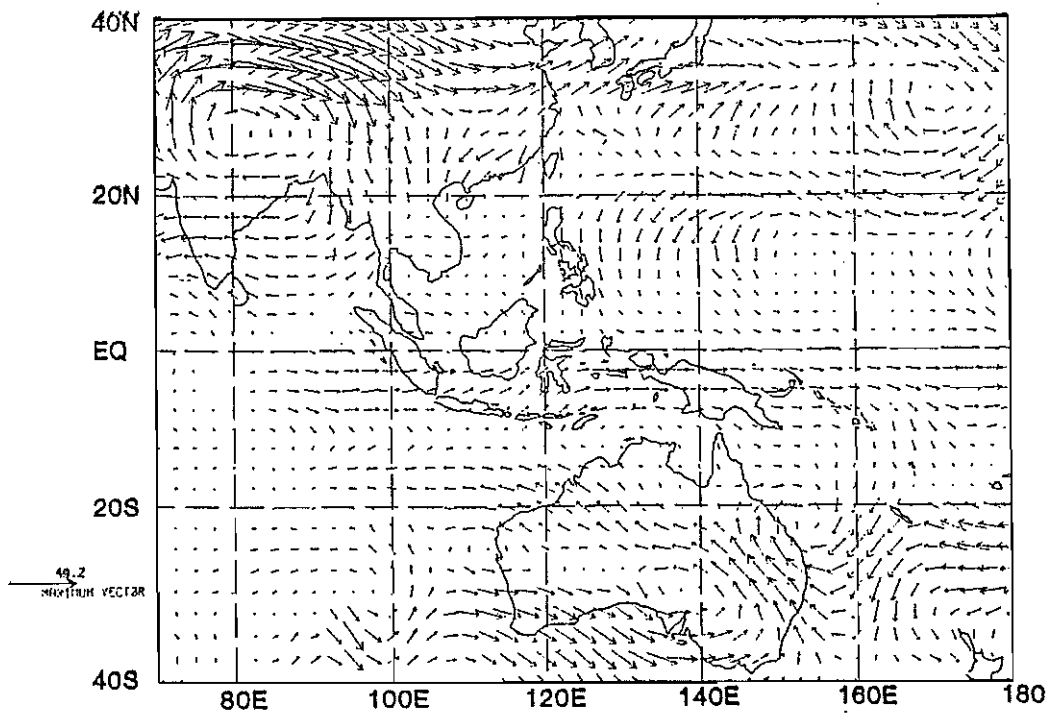


Fig.12 200 hPa VECTOR WIND ANOMALY BASED ON FIG. 11
(Arrow length indicates magnitude).

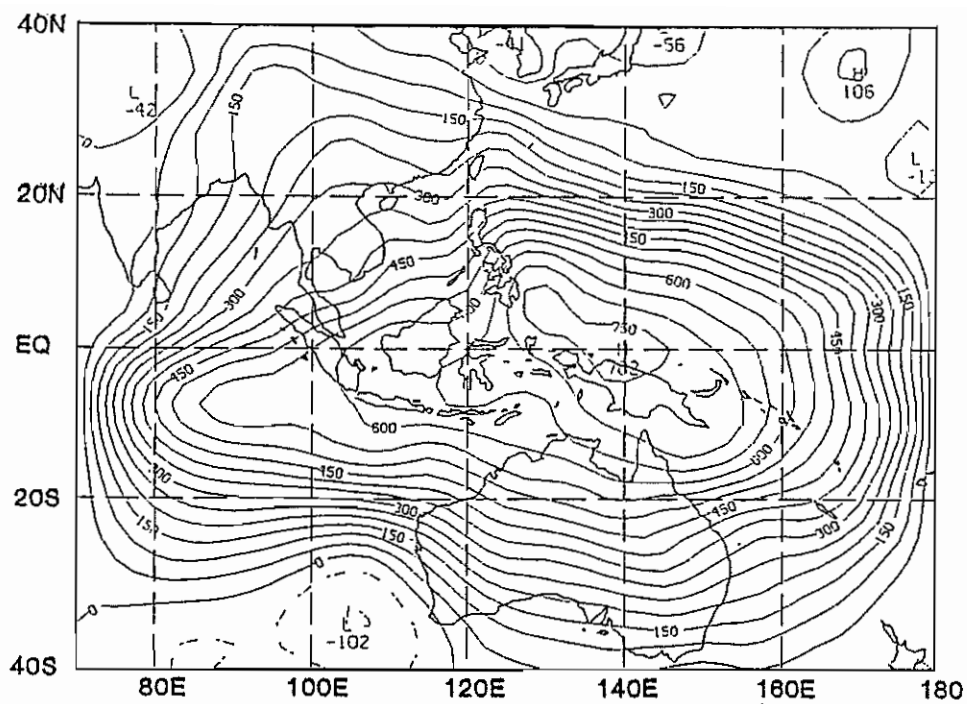


Fig.13 950 hPa VELOCITY POTENTIAL, JANUARY 1990
Contour interval $50 \times 10^5 \text{ m}^2 \text{ s}^{-1}$

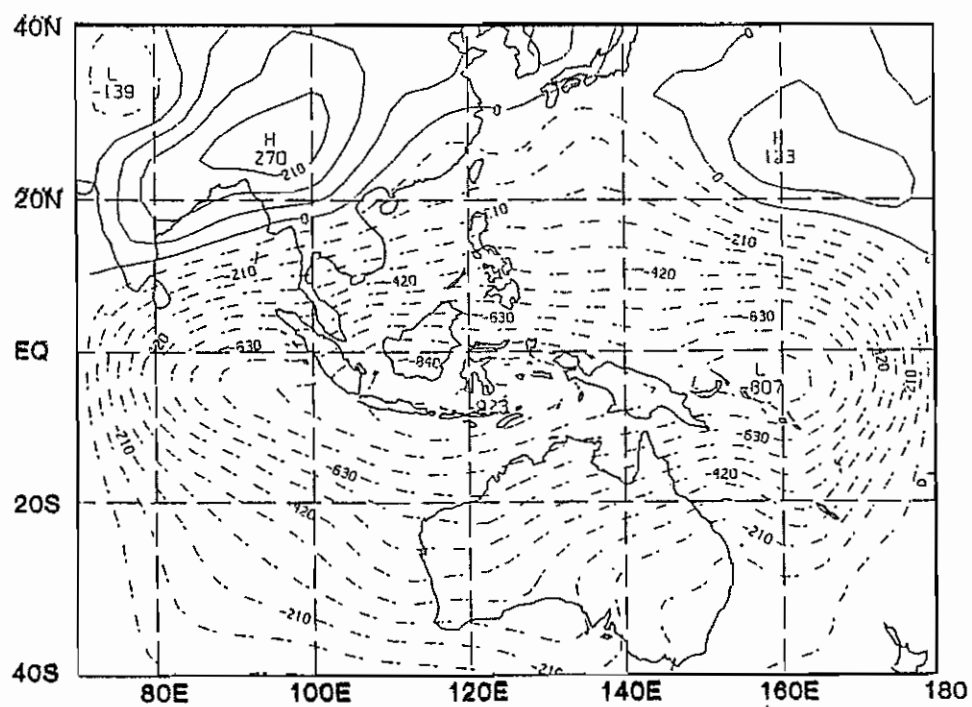


Fig.14 200 hPa VELOCITY POTENTIAL, JANUARY 1990
Contour interval $70 \times 10^5 \text{ m}^2 \text{ s}^{-1}$

Julian Day

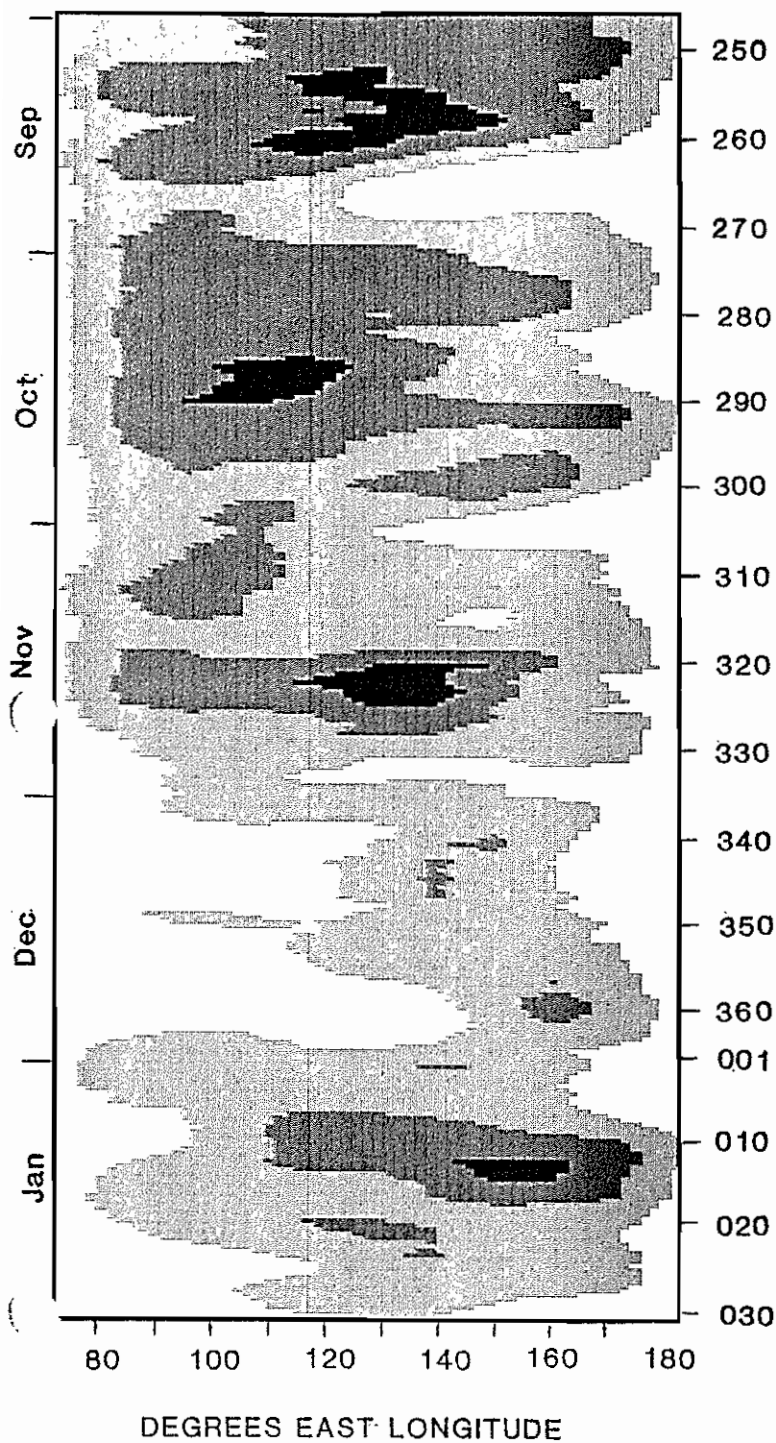


Fig.15

TIME LONGITUDE CROSS SECTION OF
200hPa VELOCITY POTENTIAL
(averaged between 5°N and 15°N in
 m^2/sec)

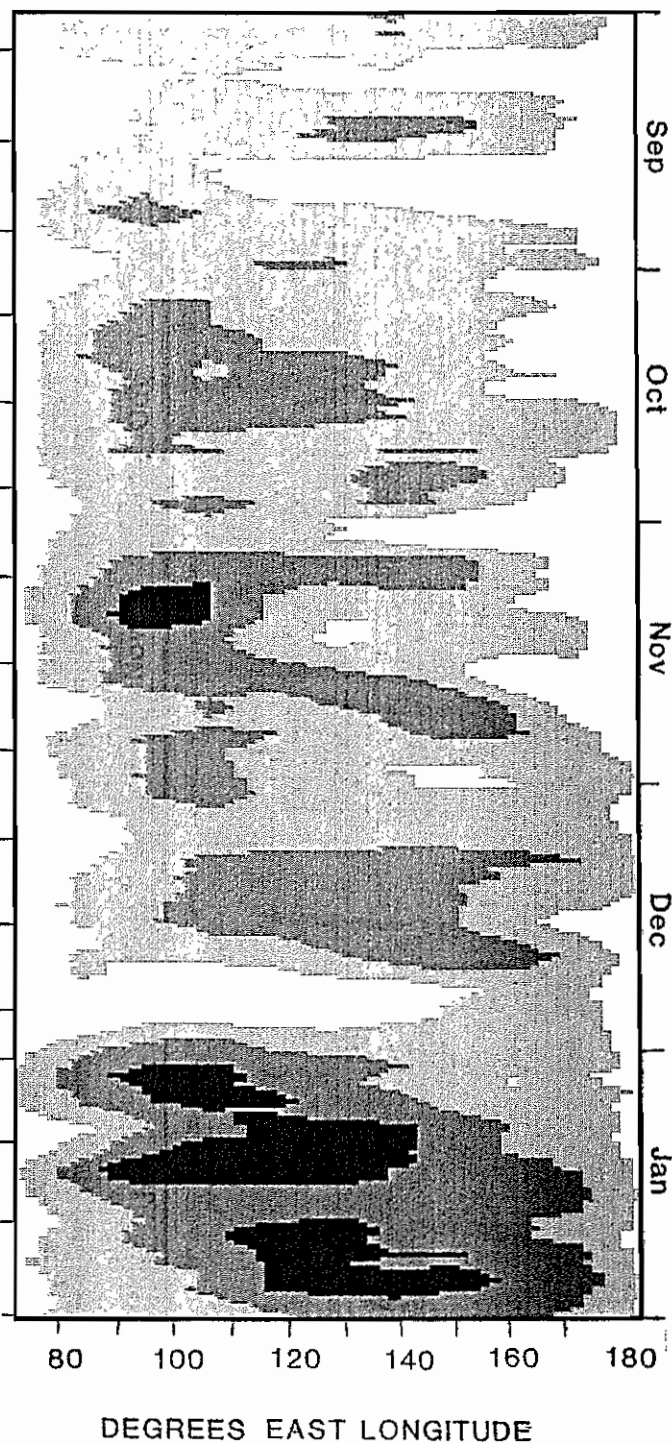
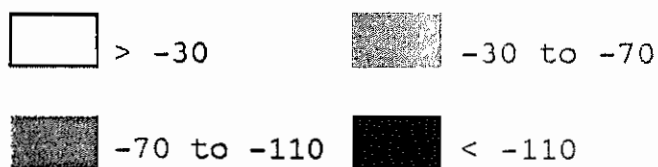


Fig. 16

TIME LONGITUDE CROSS SECTION OF
200hPa VELOCITY POTENTIAL
(averaged between 5°S and 15°S in
 m^2/sec)



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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) $SOI = 10 \times (\Delta P_{TAH} - \Delta P_{DAR}) / \sigma$

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 $> 17 \text{ ms}^{-1}$ (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 $> 32 \text{ m s}^{-1}$ (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/ater/2004ater/>), 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 |
| PNG | - Papua New Guinea | VSCS | - Very severe cyclonic storm |
| RSMC | - Darwin Regional Specialised Meteorological Centre (see note 1) | TS | - Tropical storm (generally used for TC in northern Hemisphere sector) |
| SCS | - South China Sea | TUTT | - tropical upper tropospheric trough |

5. **Subscription rates**

All costs in \$AUSTRALIAN:

| Annual subs. | Postage | Subs (incl postage) |
|----------------------|---------------------------|---------------------|
| 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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