**Australian Government**

**Bureau of Meteorology**


**DARWIN REGIONAL SPECIALISED METEOROLOGICAL CENTRE**

# March 1993, VOL 12 No 03



ISSN 1321 - 4233

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**DARWIN TROPICAL DIAGNOSTIC STATEMENT**

**MARCH 1993**

**ISSUED BY DARWIN RSMC**


**SUMMARY**

The 40-50 day oscillation did not effect the tropical atmosphere during March. Tropical convection within the RSMC area was generally suppressed; this was reflected in the below average number number of cyclones. All of the cyclones which were analysed developed in the western Pacific, the region where convection was most active.

The SOI remained negative but not large in value. Associated SST, wind and tropical weather anomalies reflected weak warm ENSO conditions.


**INDICES**

1. Darwin mean MSL pressure, March 1993 : 1010.1 hPa
   pressure anomaly (1882 - 1991 mean) : +2.5 hPa
2. Tahiti mean MSL pressure, March 1993 : 1012.5 hPa
   pressure anomaly (1882 - 1991 mean) : +0.8 hPa
3. Troup's Southern Oscillation Index : -8
   5-month mean (centred upon January) : -8

4. Time series of Troup's SOI:

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1991 | + 4 | 0 | -10 | -12 | -18 | - 6 | -2 | -7 | -16 | -13 | -7 | -18 |
| 1992 | -26 | -10 | -22 | -17 | + 1 | -12 | -7 | +2 | + 1 | -18 | -7 | - 7 |
| 1993 | - 9 | - 9 | - 8 | | | | | | | | | |

Figure 1 shows the monthly SOI and its five month running mean for the past ten years.

The SOI has been consistently in the -5 to -10 range since November. Up until March this was due mainly to anomalously low pressures at Tahiti rather than high pressures at Darwin; during March high pressures at Darwin were the main cause.

The National Climate Centre in Melbourne is predicting a return of the SOI towards zero, based on analogue patterns in past years.

**TROPICAL CYCLONES [Fig. 2]**

Cyclone numbers were well below average in the southern hemisphere. Genesis was confined to a region of persistent deep convection over the warm waters of the equatorial western Pacific. Climatology as derived from the 1991 Annual Tropical Cyclone Report, published by JTWC Guam, gives an 11-year mean of 4.6 cyclones for March over the southern Pacific and Indian Oceans.

TC Irma and TC Roger were a cyclone pair: both circulations began to develop in a broad area of convection straddling the equator. Each system moved poleward while intensifying into a tropical cyclone.

**TC Roger**

A broad area of deep convection over the equatorial western Pacific induced the development of a monsoon circulation south of Solomon Islands. The system intensified as it moved towards the southwest under the influence of middle level northeasterly flow. At the same time a high pressure system moved into the Tasman Sea producing a surge in the southeast trade flow which assisted in Roger's development. A second high pressure cell moved into the Tasman and pushed Roger to the northeast,away from the Australian coastline. Roger dissipated over water in an environment of cooler SST and increasing upper level shear associated with an approaching trough.

**TS Irma**

While Irma was the first cyclone of the northern hemisphere 1993 season, it was the second system induced by a broad area of deep convection across the equatorial western Pacific. The low level circulation was first analysed within the NET, in the vicinity of the Marshall Islands. Development was initially hindered by moderate upper level shear south of the upper level ridge. Steered by the middle level flow Irma tracked northwest towards a weakness in the STR, ahead of an approaching midlatitude trough. Irma dissipated over water soon after recurving in a sheared environment, north of the STR.

**Severe TC Prema**

Prema was an intense compact system which developed from a circulation within an otherwise inactive monsoon trough over the southwest Pacific. The passage of a high pressure cell across the Tasman, assisted genesis under an upper level ridge near Vanuatu. Further intensification continued at a rapid pace as the system tracked southwest, across warm water, towards a weakness in the middle level STR. The system became extra-tropical as it accelerated southeast into an environment of cooler water and increasing upper level shear, ahead of a approaching frontal system.

**SEA SURFACE TEMPERATURE [Figs. 3 and 4]**

While water temperatures in the southern hemisphere have changed little since February, some warming is evident in equatorial and northern waters. This is a seasonal change consistent with the northward passage of the sun. Cold water anomalies off the southeast tip of PNG and in the northwest Pacific have in general weakened and contracted since last month.

Over the Indian Ocean and to the north of Australia warm water anomalies continue to spread; this is mainly a result of continuing suppressed convective activity and increased insolation. Warm water anomalies persist to the south and east of Australia.

The Melbourne satellite-derived SST anomalies for March (not shown) reveal a general broad area of warm SST anomalies near and east of the dateline.

**MSL PRESSURE AND GRADIENT LEVEL(950 hPa) FLOW [Figs. 5, 6, 7 and 8]**

While the broadscale features (STR, monsoon trough) were generally near their mean positions, some variation in the location of the monsoon trough is apparent. This is most evident over the Indian and Pacific basins where the trough was respectively south, and north of its seasonal position.

El Niño-like anomalies evident over equatorial waters east of Australia, are consistent with persistent deep convection, and cyclone activity observed in the western Pacific.

In other regions anomalies are primarily associated with a stronger than normal trough east of Japan, and the passage of cyclone Roger off the east Australian coast.

**850hPa WIND COMPONENTS AND DAILY RAINFALL AT DARWIN [Figs. 9(a), (b)]**

The most significant feature of theses charts relates to the seasonal retreat of the north Australian monsoon. This is clearly reflected in the easterly transition early in March.

Daily rainfall at Darwin was predominantly related to squall line activity associated with land-based diurnal convection. This activity mainly occurred in the first week of the month. A total of 168.4mm was recorded for the month, which is well below the monthly average of 315mm. Darwin's seasonal falls to date are near average.

**CROSS-EQUATORIAL INTERACTION [Fig. 10]**

While the meridional wind cross-section shows some resemblance to the mean pattern of low level northerlies and upper level southerlies, the classical Hadley circulation is not clearly defined over the whole longitudinal domain. Upper level northerlies near 120°E and 160°E highlight a general weakness in the circulation. Exceptions are the western Pacific and the eastern Indian Ocean. This is consistent with the suppressed convective activity observed in most tropical regions.

**UPPER LEVEL FLOW [Figs. 11 and 12]**

In general the equatorial Pacific was dominated by El-Niño like anomalies associated with stronger than normal divergence in the easterlies near the dateline, and strong STRs in both hemispheres which were poleward of their mean positions. This is in agreement with the deep convection and tropical cyclone activity observed in this region throughout the month. Anomalies over the equatorial Indian ocean reflect a strengthened easterly flow related to the unseasonal position of the northern hemisphere STR over southern India.

Anomaly patterns about the mid-latitudes of the northern hemisphere are primarily related to a persistent upper level trough over Japan.

**VELOCITY POTENTIAL [Figs. 13, 14, 15(a), 16(a)]**

While uplift in tropical latitudes dominate the velocity potential charts, a number of atypical features were identified over the ocean basins. Uplift over the Indian Ocean was in general near normal but displaced south of its climatological position. The atypical pattern over waters east of PNG relates to the continued northward displacement of uplift normally evident over the Solomon Islands and SPCZ. Broad scale subsidence over the southern Indian Ocean and Japan is associated with a well developed STR and an upper level trough respectively.

The time-longitude series reflect the breakdown of the typical 40-50 day cycle, which has been a dominant feature of the tropical atmosphere in recent months. Persistent convective activity over the equatorial Pacific may have played a role in this breakdown. Upper level divergence evident over the southern equatorial Indian Ocean is related to convective activity assisted by warm SSTs.

**RAINFALL AND CLOUD COVER [Figs. 15(b), 16(b), 17 and 18]**

The time-longitude plots illustrate the persistant convection observed over the Pacific. This is most notable in the southern series where convection associated with the development of cyclones Roger and Prema is evident. While convection over the Indian Ocean was reflected in the equatorial and southern series it was in general weak.

While available rainfall quintiles in the northern hemisphere were in general average, above average falls were recorded across northern China, a region dominated by negative pressure anomalies. The development of a heat trough over the Indian continent also contributed to the above average falls recorded at some locations.

Average to below average falls across northern Australia reflect the weaker than normal convection and Hadley circulation. Some good falls across southern Australia reflect the passage of a number of frontal systems.

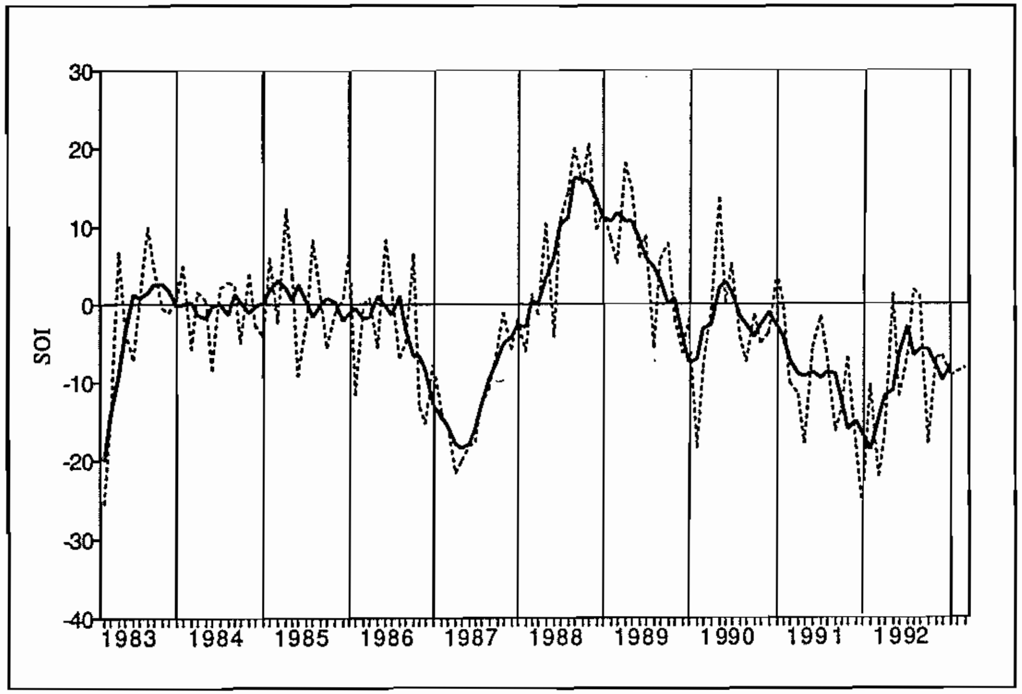



Fig.1 SOUTHERN OSCILLATION INDEX 1983 - 1993.
Monthly SOI (dashed line) and 5-month running mean SOI (solid line).

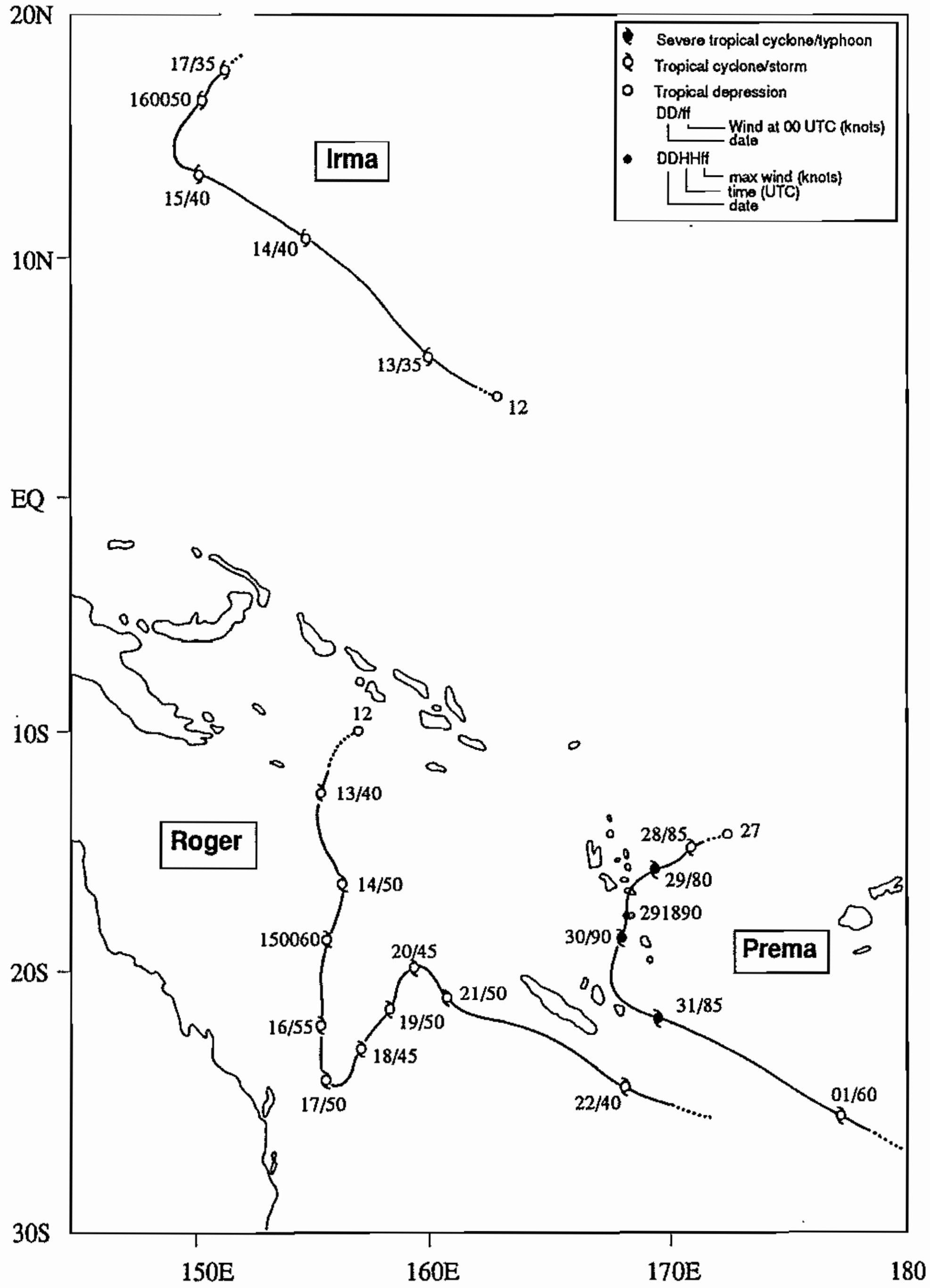



Fig.2 UNOFFICIAL TRACKS OF CYCLONES: ROGER, IRMA AND PREMA, MARCH 1993

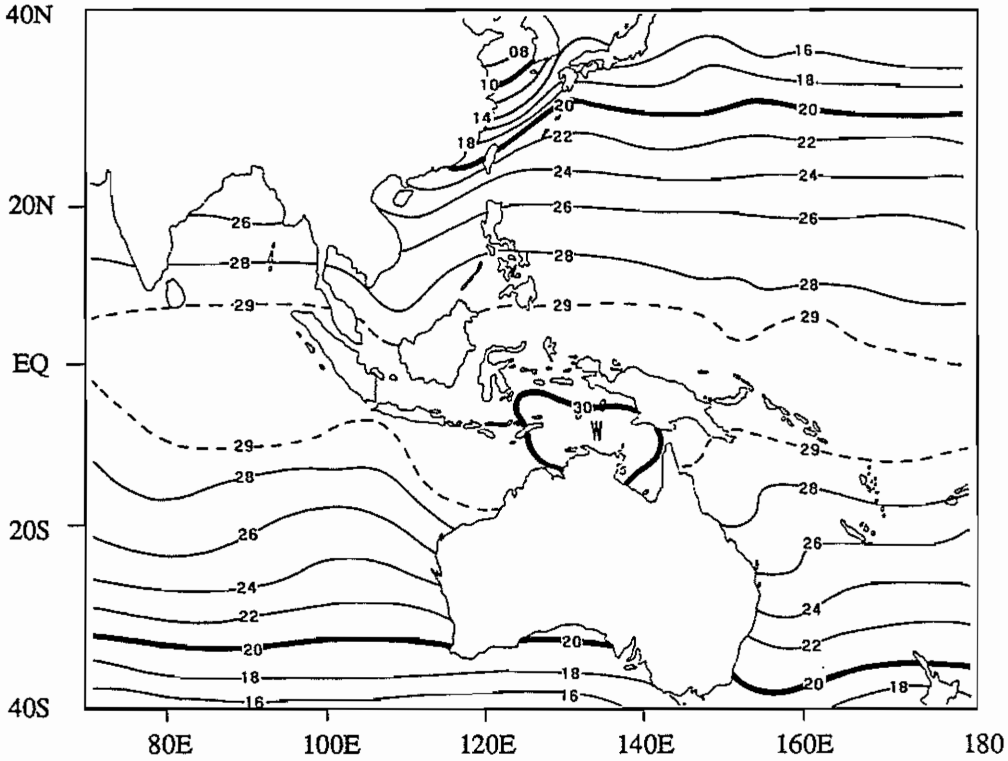



Fig.3 MEAN SEA SURFACE TEMPERATURE, MARCH 1993, based on weekly Darwin RSMC analyses averaged over the month.
Isotherm interval 2°C.

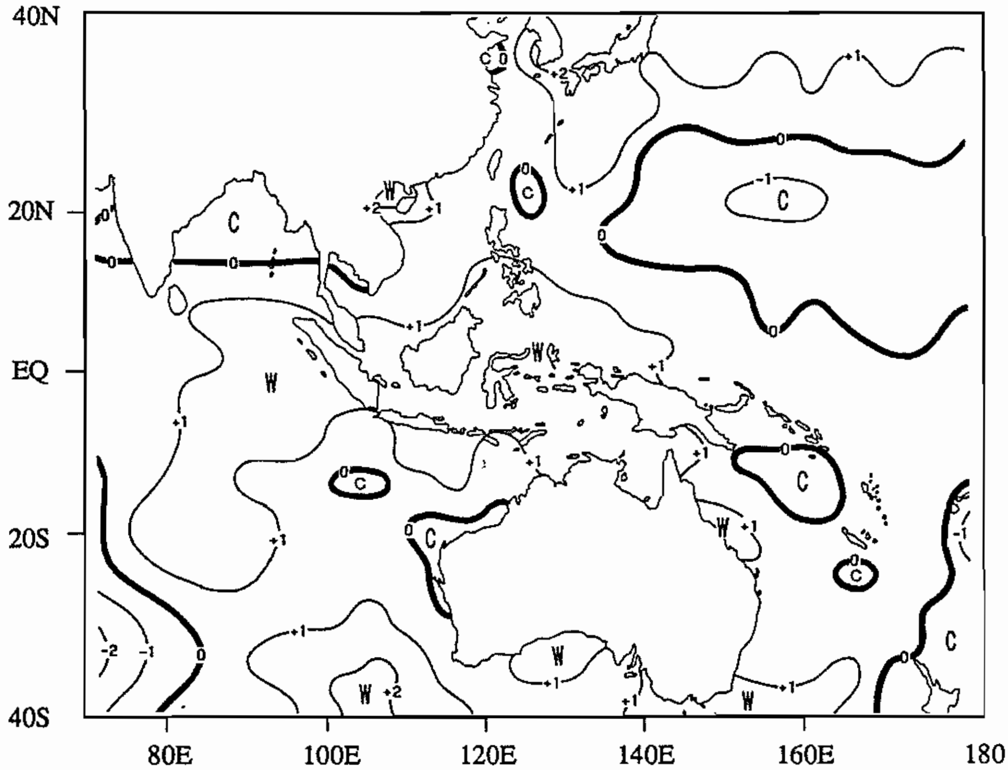



Fig.4 SST ANOMALY, based on Fig.3 and the climatology of Reynolds (NOAA Report NWS 31, 1983).
Isotherm interval 1°C.

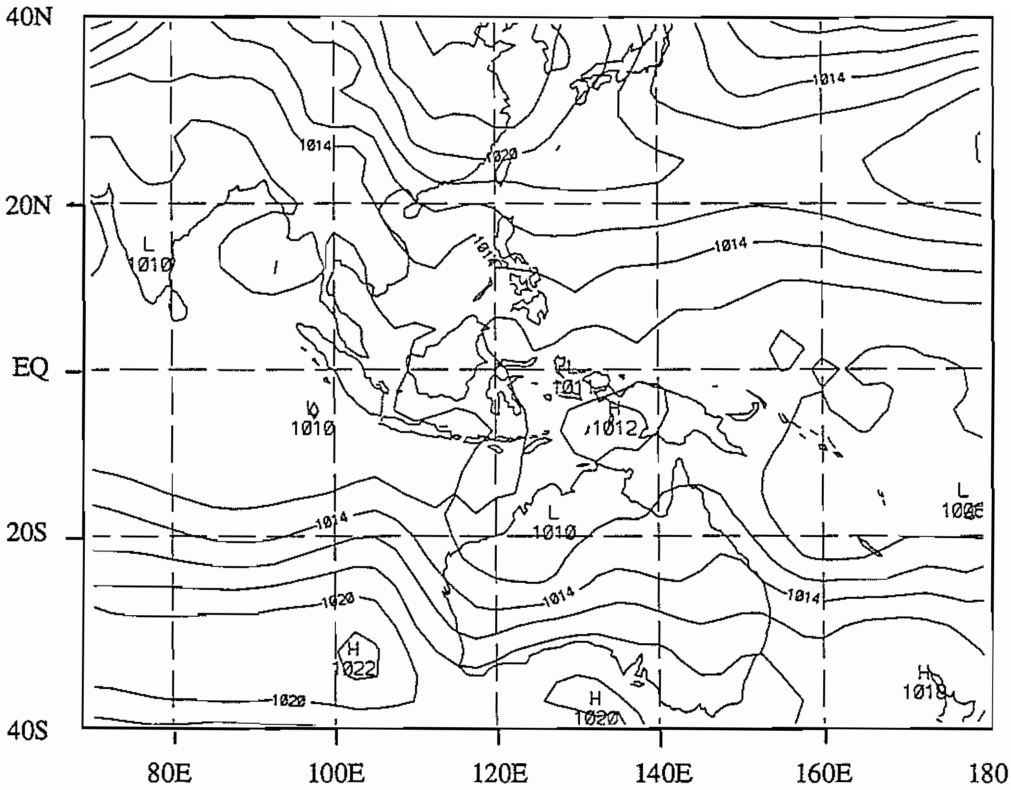



Fig.5 MEAN MSL PRESSURE, MARCH 1993.
Isobar interval 2 hPa.

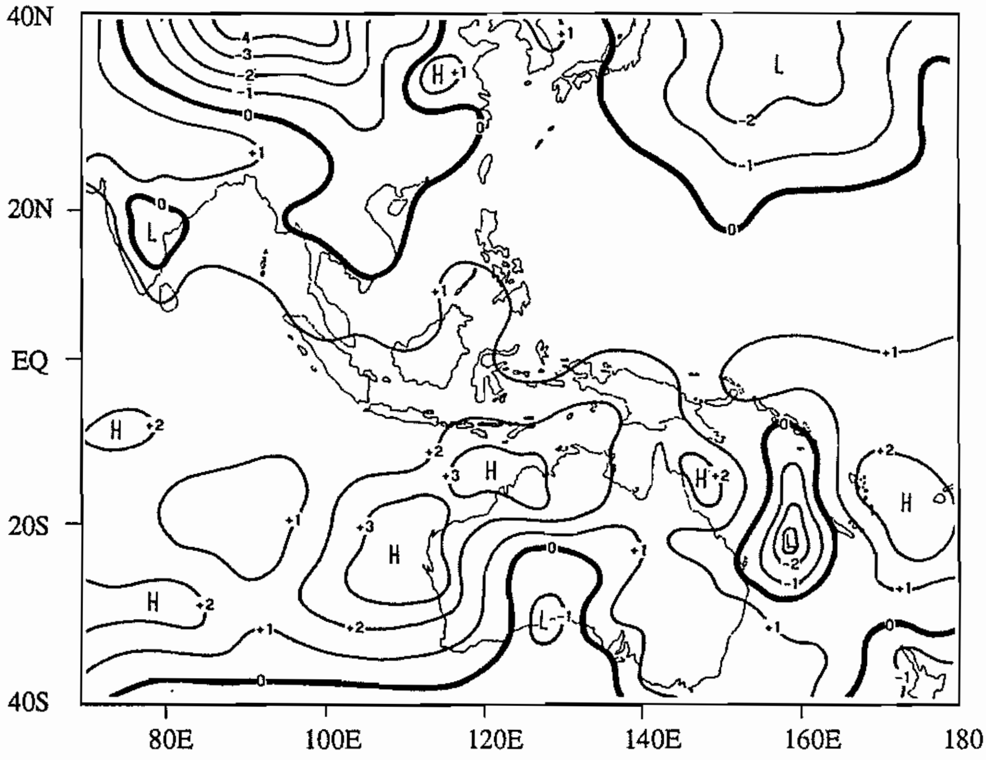



Fig.6 MSL PRESSURE ANOMALY, MARCH 1993, based on CLIMAT messages, and Fig.5 with 6-year climatology.
Contour interval 1 hPa.

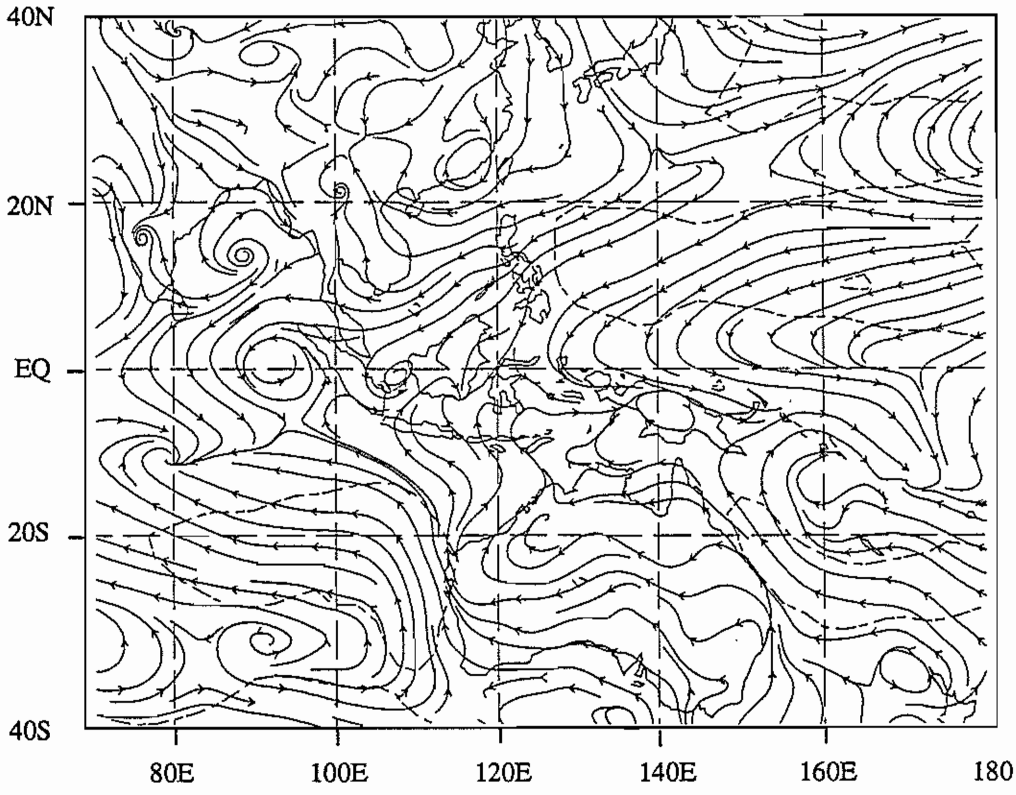



Fig.7 950 hPa MEAN STREAMLINE ANALYSIS, MARCH 1993.
Isotachs (dashed line) at 10 knot intervals.

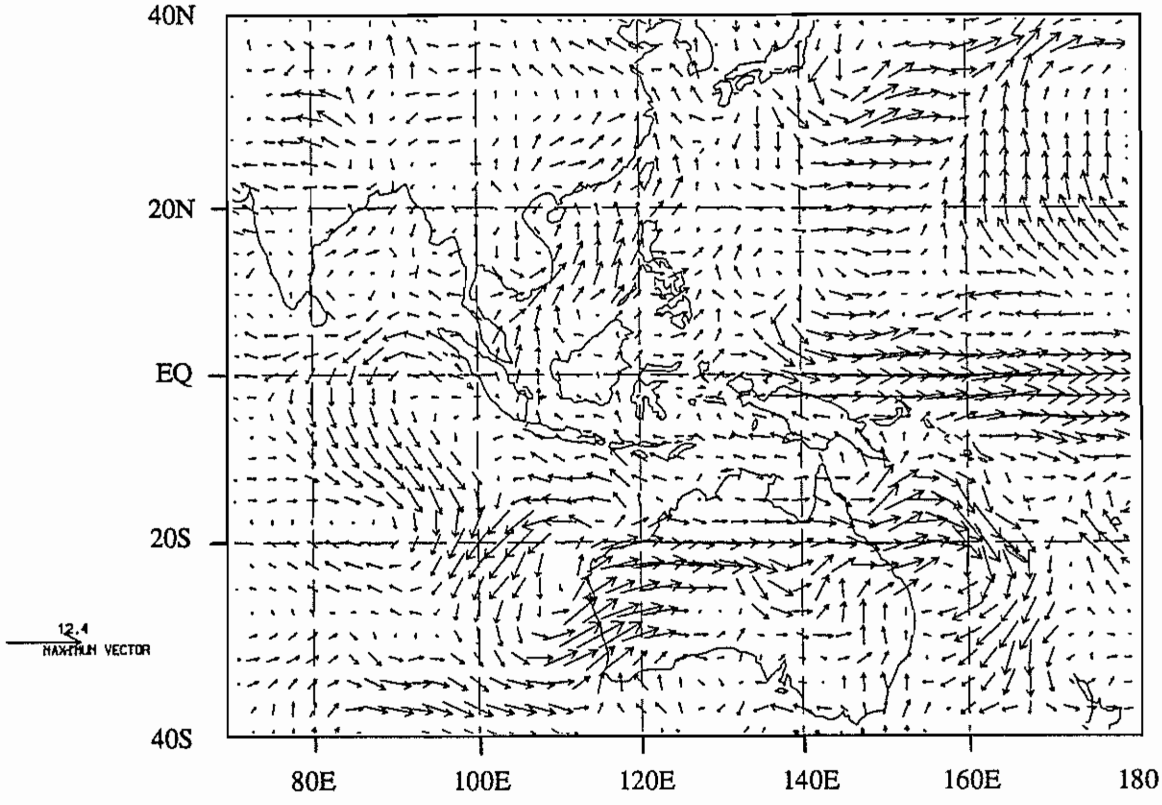



Fig.8 950 hPa WIND ANOMALY, based on Fig.7.
Isotachs (dashed line) at 10 knot intervals.

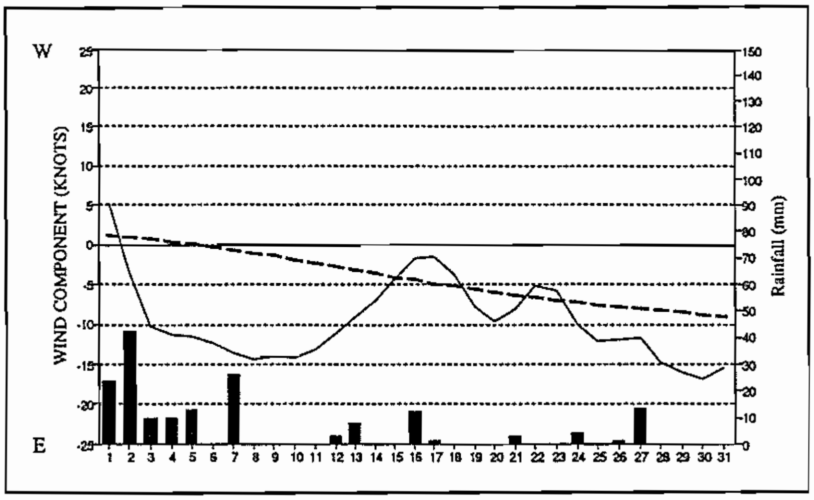
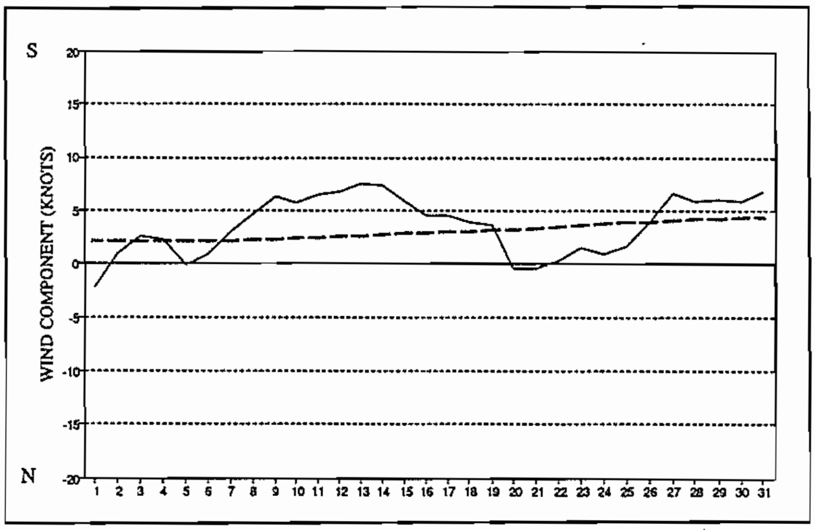



Fig.9(a) DARWIN 850 hPa 3-DAY SYMMETRICAL MEAN ZONAL WIND AND RAINFALL, MARCH 1993. Dashed line represents the mean seasonal zonal wind cycle.




(b) DARWIN 850 hPa 3-DAY SYMMETRICAL MEAN MERIDIONAL WIND, MARCH 1993. Dashed line represents the mean seasonal meridional wind cycle.

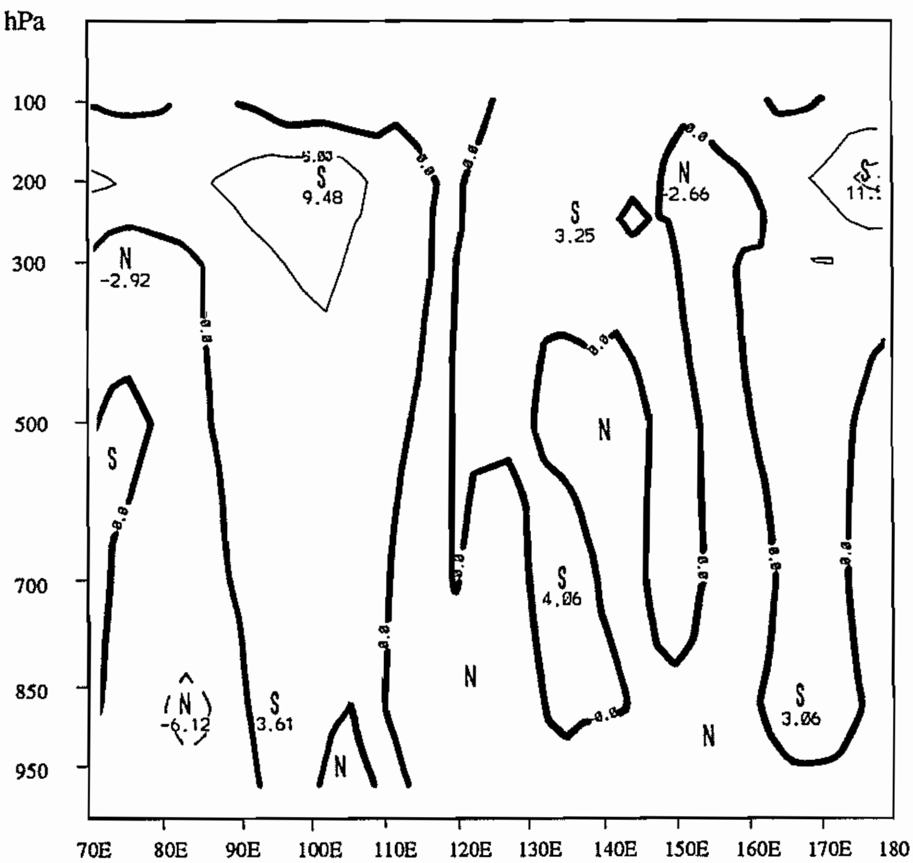



Fig.10 EQUATORIAL CROSS-SECTION OF MERIDIONAL WIND, MARCH 1993.
Isotachs at 5 knot intervals.

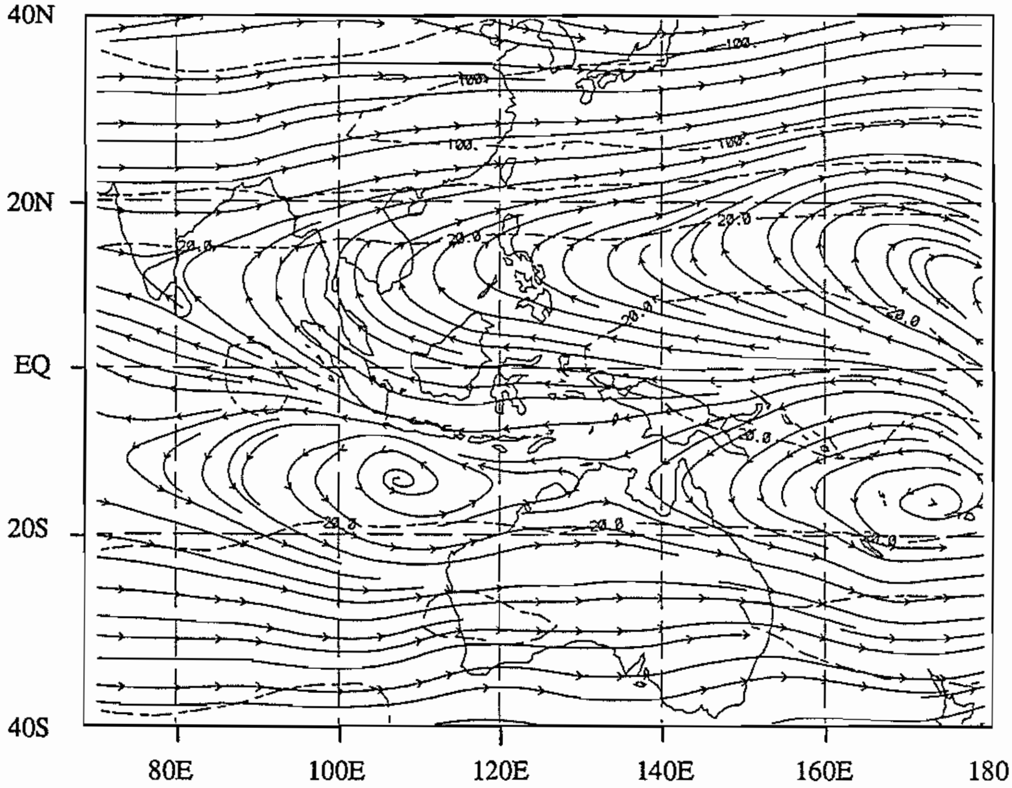



Fig.11 200 hPa STREAMLINE ANALYSIS, MARCH 1993.
Isotachs (dashed line) at 40 knot intervals, minimum 20 knots.

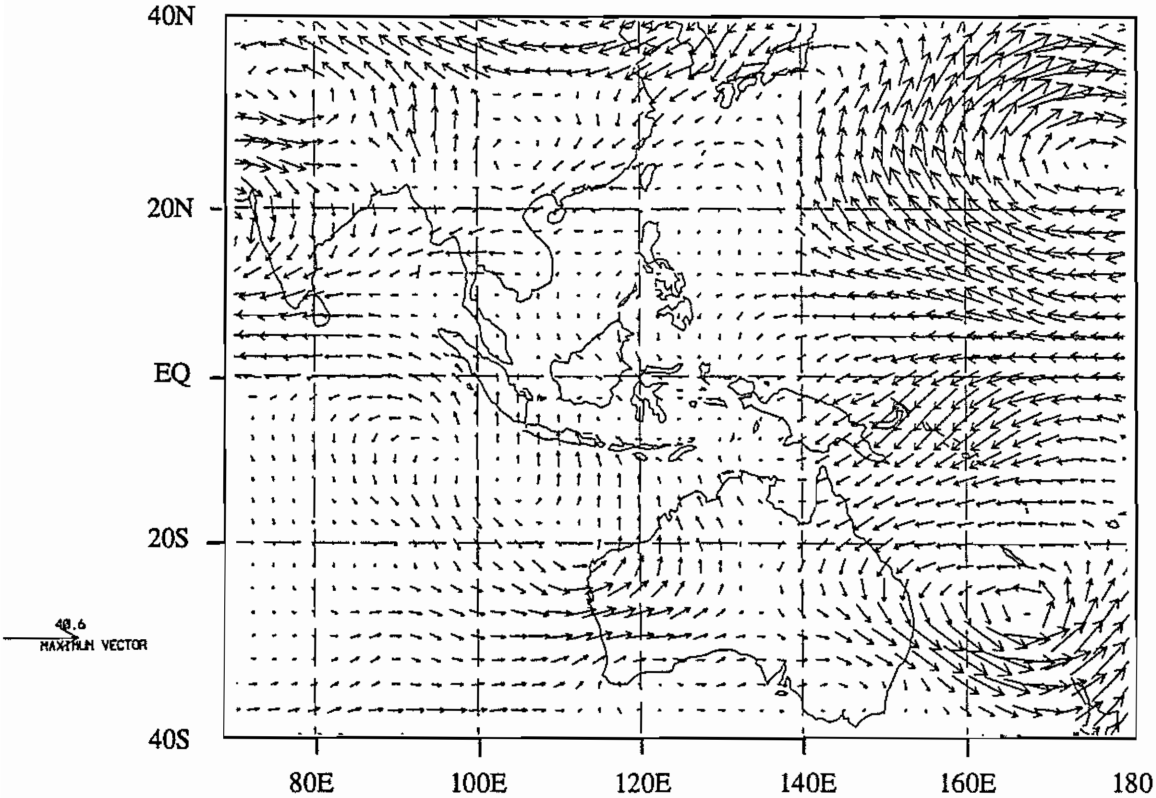



Fig.12 200 hPa WIND ANOMALY, based on Fig.11.
Isotachs (dashed line) at 20 knot intervals

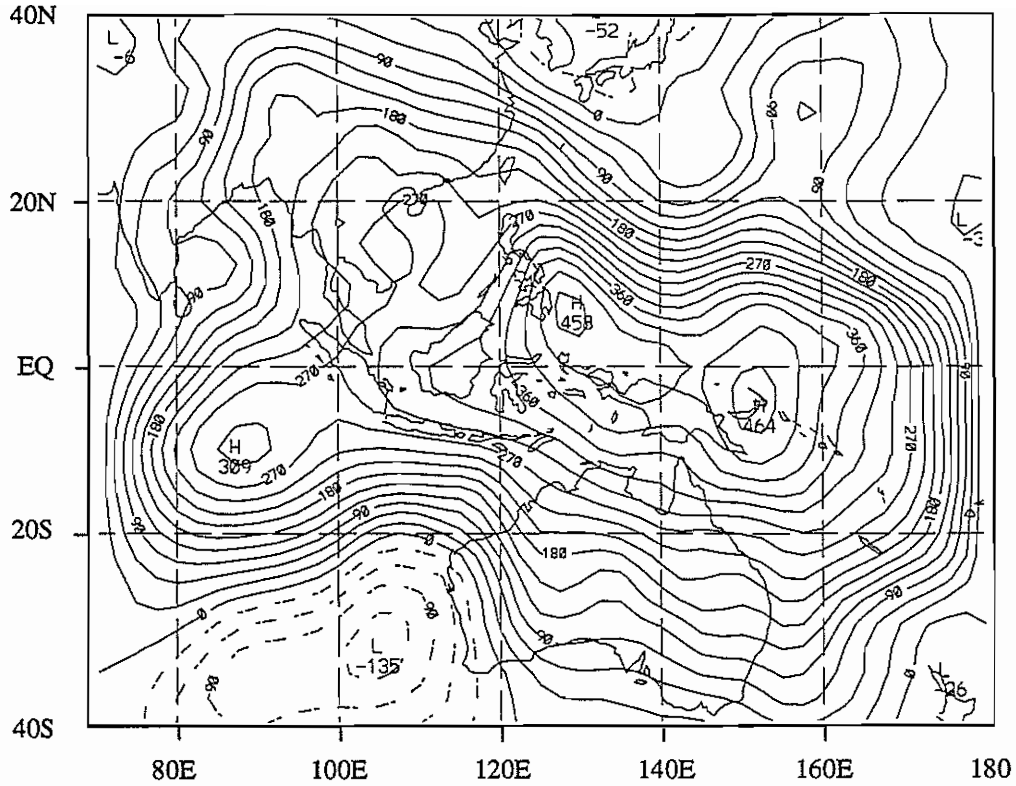



Fig.13 950 hPa VELOCITY POTENTIAL, MARCH 1993.
Contour interval 30 x $10^4$ $m^2$ $s^{-1}$.

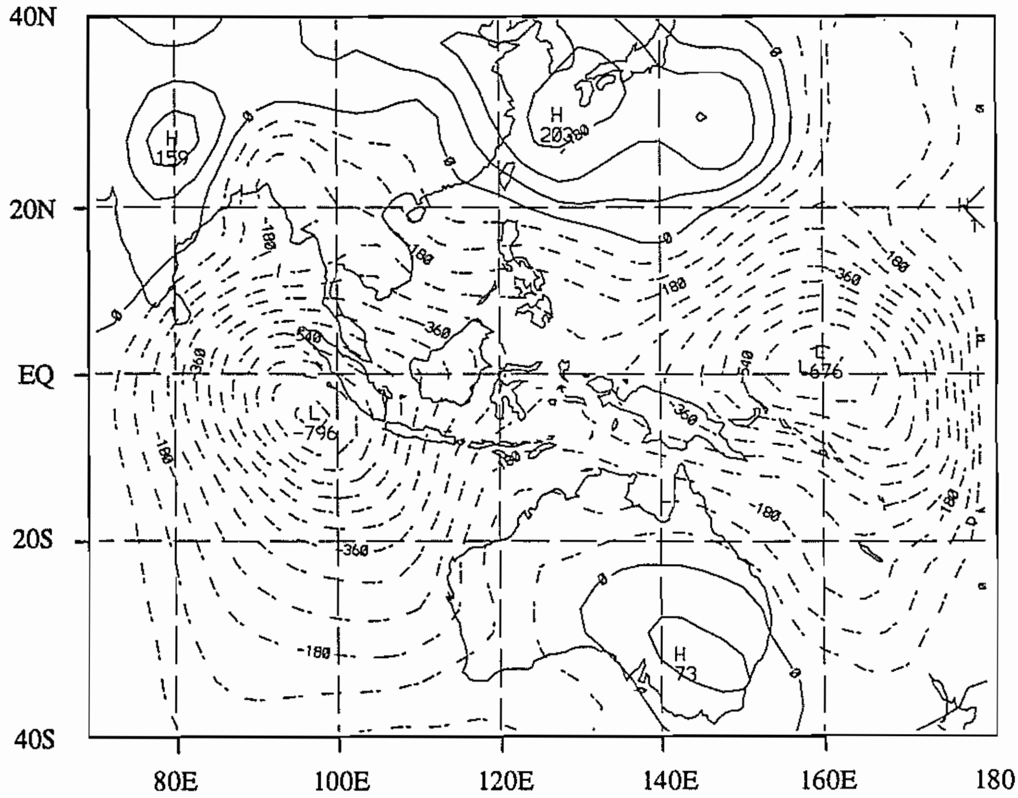



Fig.14 200 hPa VELOCITY POTENTIAL, MARCH 1993.
Contour interval 60 x $10^4$ $m^2$ $s^{-1}$.

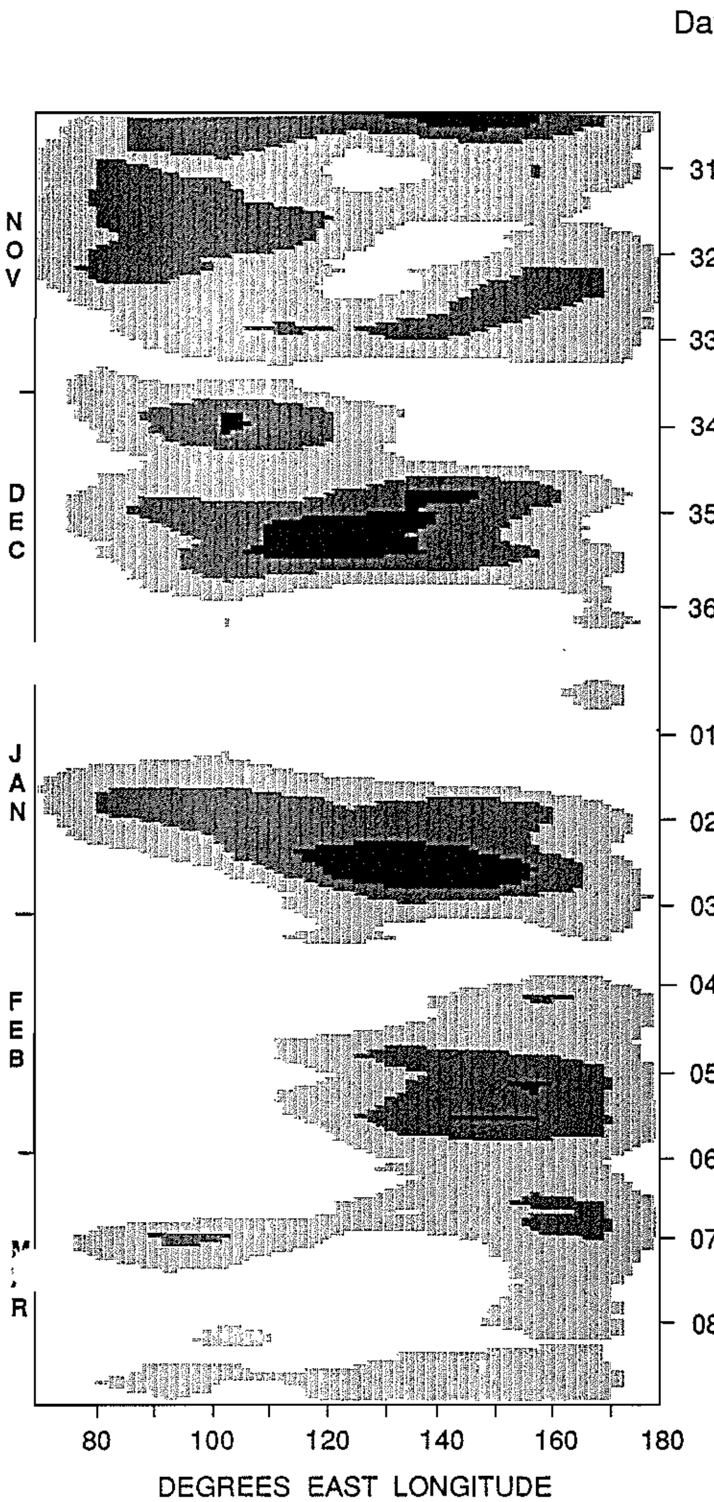



Fig.15 (a)

TIME LONGITUDE CROSS SECTION OF
200hPa VELOCITY POTENTIAL,
averaged between 5°N and 15°N,
values $10^5$ $m^2$ $s^{-1}$.

> -30 | -30 to -70 | -70 to -110 | < -110

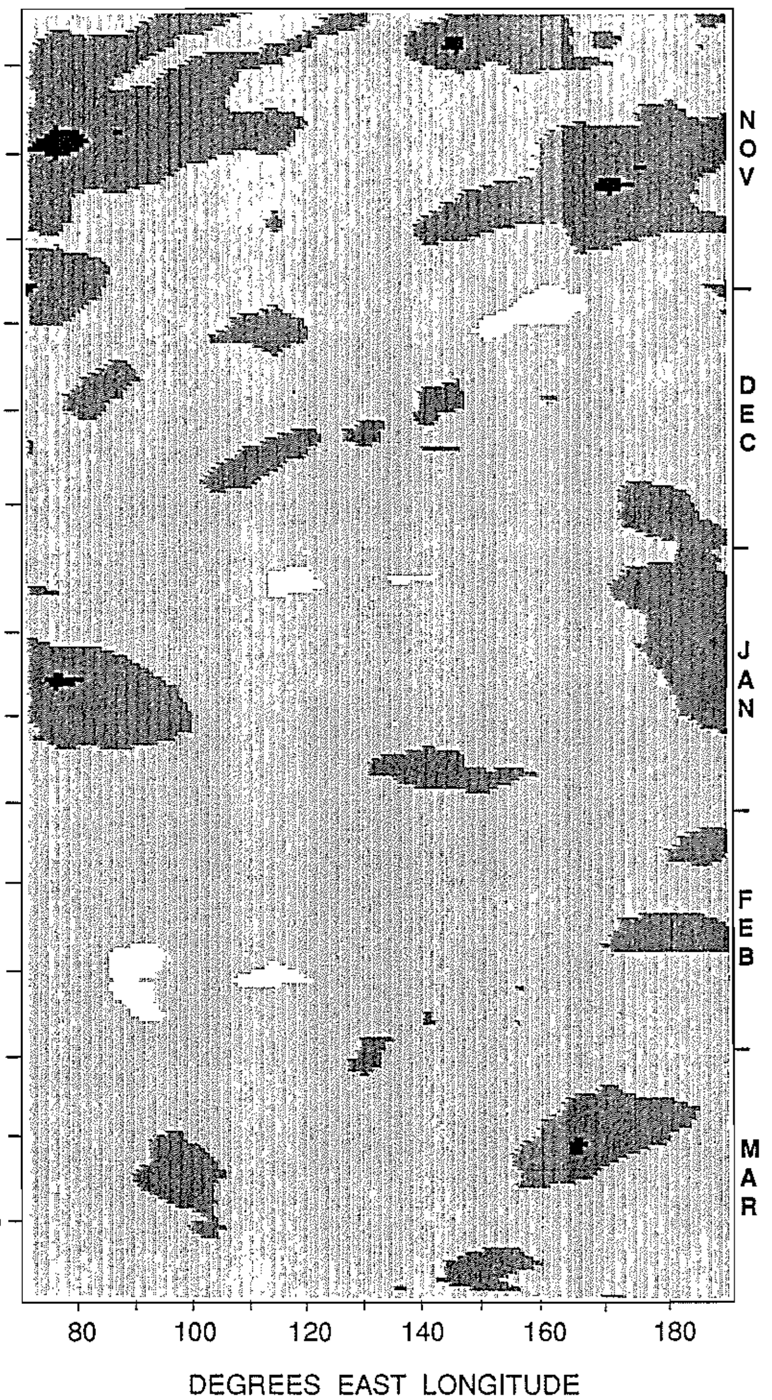



Fig.15 (b)

TIME LONGITUDE CROSS SECTION OF
OUTGOING LONG WAVE RADIATION,
averaged between 5°N and 15°N,
values watt $m^{-2}$.

> 420 | 320 to 420 | 220 to 320 | < 220

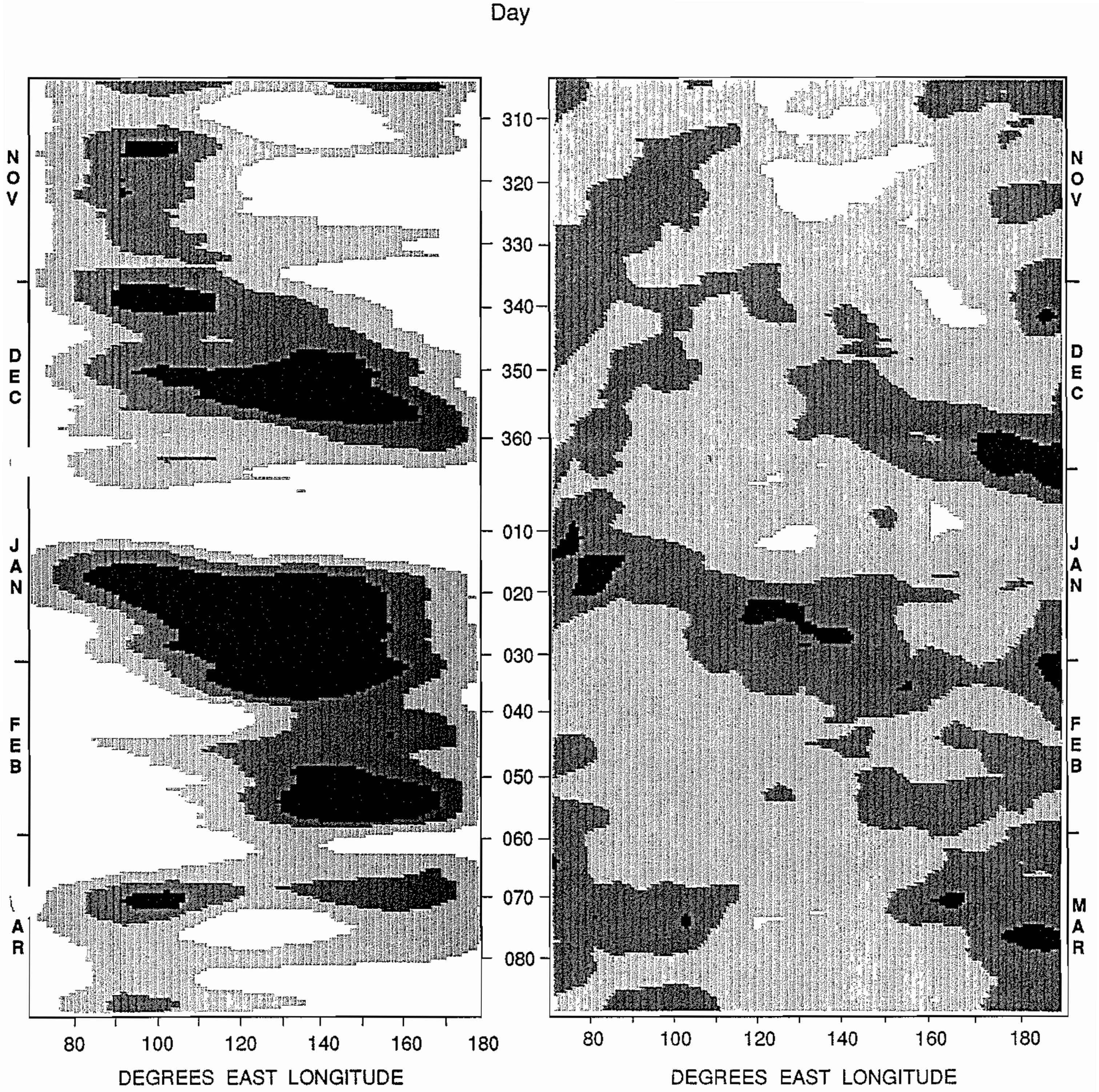



Fig.16 (a)

TIME LONGITUDE CROSS SECTION OF
200hPa VELOCITY POTENTIAL,
averaged between 5°S and 15°S,
values $10^5$ $m^2$ $s^{-1}$.

> -30 | -30 to -70 | -70 to -110 | < -110

Fig.16 (b)

TIME LONGITUDE CROSS SECTION OF
OUTGOING LONG WAVE RADIATION,
averaged between 5°S and 15°S,
values watt $m^{-2}$.

> 420 | 320 to 420 | 220 to 320 | < 220

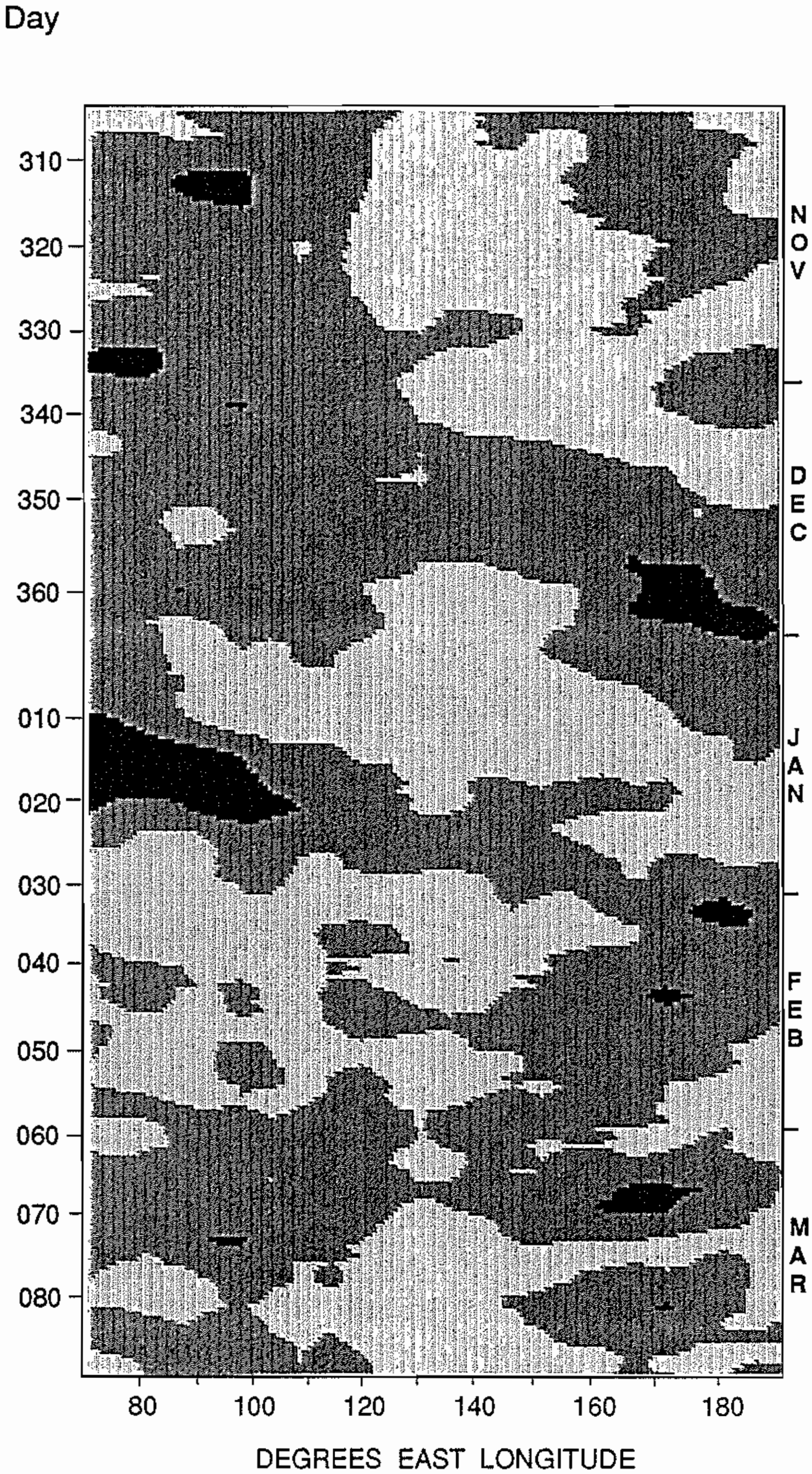
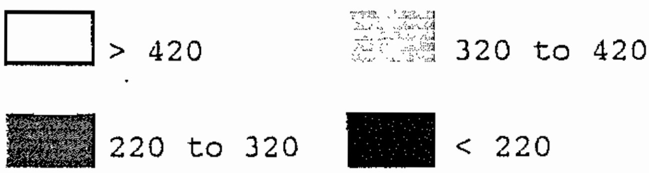



Fig.17

TIME LONGITUDE CROSS SECTION OF OUTGOING LONG WAVE RADIATION, averaged between 5°N and 5°S, values watt $m^{-2}$.



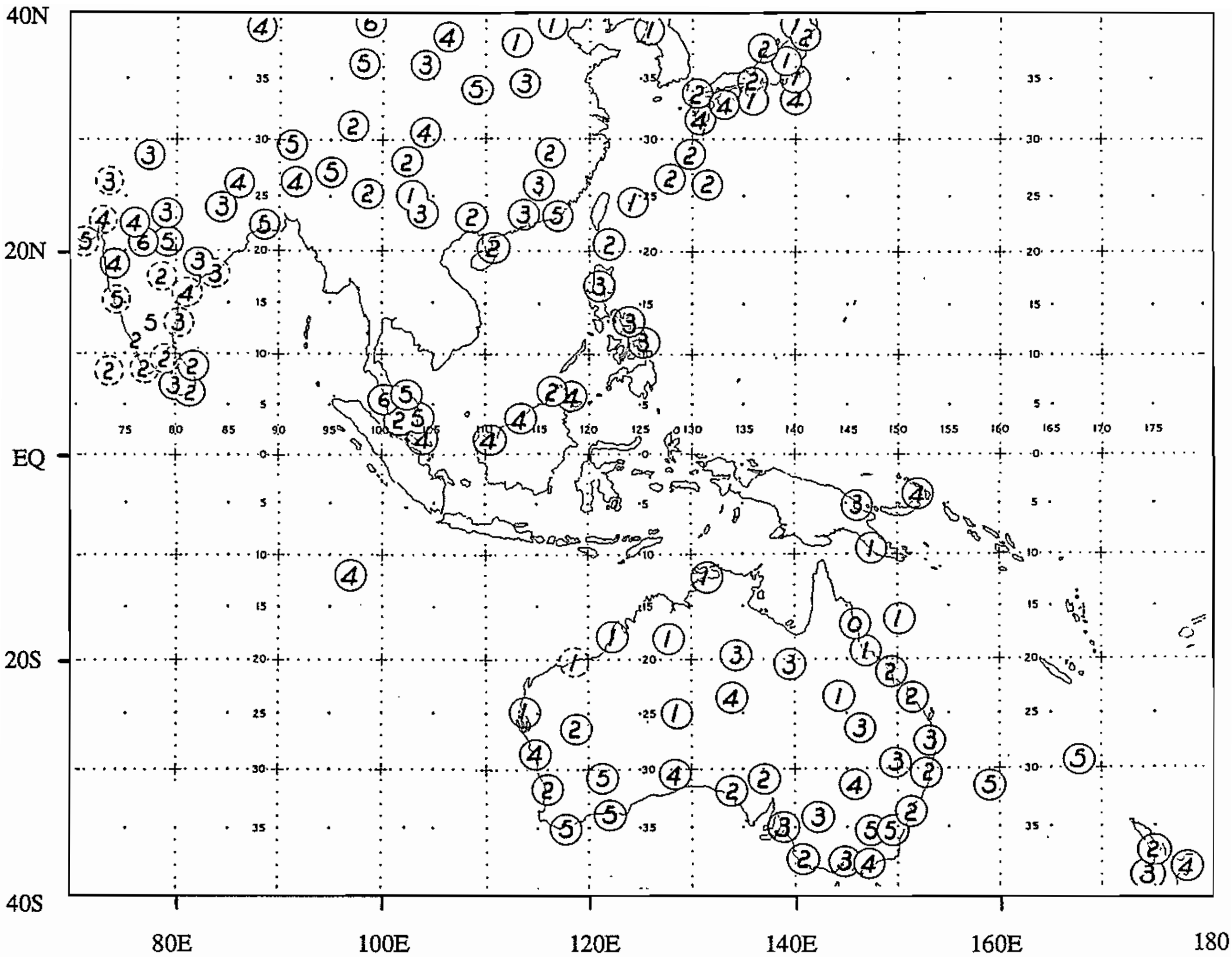



Fig.18 MEAN RAINFALL QUINTILES, MARCH 1993, from CLIMAT messages.

Quintile 0 denotes record low rainfall.
Quintile 6 denotes record high rainfall.
Indicates actual rainfall is nil.

## 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($\Delta P_{TAH}$ - $\Delta P_{DAR}$) /$\sigma$

where $\Delta P_{TAH}$ =Tahiti (91938) monthly pressure anomaly (monthly mean minus 1933-1992 mean, averaging 3-hourly observations)

$\Delta P_{DAR}$ = Darwin (94120) monthly pressure anomaly (monthly mean minus 1933-1992 mean, averaging 0900, 1500LT observations)

$\sigma$ = 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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| | 24.00 (Asia/Pacific) | 110.80 |
| | 36.00 (Rest of the world) | 122.80 |

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