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# DARWIN TROPICAL DIAGNOSTIC STATEMENT

## DECEMBER 1992

## ISSUED BY DARWIN RSMC

## SUMMARY

The first broadscale burst of equatorial westerlies for the southern hemisphere summer occurred during December. The divergent circulation and active tropical weather moved eastward in a pattern typical of the 40-50 day oscillation, and two cyclones (Nina and Kina) formed in association with it. Continuing small values of the SOI point to the lack of any strong El Niño/Southern Oscillation anomalies in the tropical atmosphere. Tropical cyclone numbers were in general near average in all ocean basins.

## INDICES

| | | |
|---|---|---|
| 1. Darwin mean MSL pressure, December 1992 | : | 1007.3 hPa |
| pressure anomaly | : | +0.1 hPa |
| 2. Tahiti mean MSL pressure, December 1992 | : | 1009.7 hPa |
| pressure anomaly | : | -1.2 hPa |
| 3. Troup's Southern Oscillation Index | : | -7 |
| 5-month mean (centred upon October) | : | -6 |

4. Time series of Troup's SOI:

| | Jan | Feb | Mar | Apr | May | Jun | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1990 | -2 | -18 | -8 | -1 | +14 | 0 | +5 | -4 | -7 | -1 | -5 | -4 |
| 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 |

*During the latter part of November it was discovered that Darwin barometer was in error. As a result of subsequent investigations, the monthly mean pressure for November was revised from 1010.0 to 1009.5 hPa. The SOI was adjusted to -7.

Figure 1 gives graphs of the monthly SOI and its five month running mean for the past ten years. While the SOI remained the same as last month, there was variability within December which saw low values of Darwin pressure and high values of Tahiti pressure early in the month. Low pressure at Tahiti towards the end of the month reflects the development of another long wave trough near the dateline.

Note: Climatology used in SOI calculations has been updated to include years 1882-1991 inclusive.

## TROPICAL CYCLONES [Fig. 2]

Five cyclones were analysed during December; one each in the northern and southern Indian Ocean, and three over the southwest Pacific.

In general, cyclone numbers were near the monthly average in all ocean basins. Climatology as derived from the 1991 Annual Tropical Cyclone Report, published by JTWC Guam, gives the following statistics for December: for the northwest Pacific, a 32-year mean of 1.2 cyclones (including 0.6 typhoons); for the north Indian Ocean, a 17-year mean of 0.5 cyclones; for the Southern Pacific and Indian Oceans, an 11-year mean of 3 cyclones.

### TC 11A

11A was a short lived system that developed from a disturbance within the NET south of Sri Lanka. The system attained cyclone intensity under an upper level ridge, and took up a westward track. It soon dissipated over water as it moved away from the upper level ridge, into an environment of upper level shear.

### Severe TC Joni

A tropical disturbance within the monsoon trough developed under an upper level ridge over a period of 3-4 days. Tropical cyclone intensity was attained in the vicinity of the island group of Tuvalu, and Joni intensified as it tracked to the southwest, steered by the low/middle level flow. A weakness in the STR, caused by a westerly trough, allowed the system to recurve as it skirted the west coast of Fiji. Soon after recurving the system dissipated, in an environment of cooler waters and increasing upper level shear.

### TC Ken

Ken was a weak, miniature system which developed from a disturbance within the monsoon trough near Cocos Island. While the initial disturbance was associated with a region of enhanced convection, development into a cyclone did not occur until the low level circulation passed under the upper level ridge. Steered to the west by the low/middle level flow the system soon dissipated in an environment of increasing upper level shear.

### Severe TC Nina

The active phase of the 40-50 day oscillation was assisted by a cross-equatorial surge during mid-December, reinforcing the enhanced convection across northern Australian and the western Pacific. Nina developed at this time over the warm waters of the Gulf of Carpentaria, where upper level support was favourable. An upper level trough steered Nina to the southeast before it made landfall on the Cape York peninsula. The system weakened as it moved over land, and was a tropical depression as it emerged into the Coral Sea. Reorganisation and intensification occurred under an upper level ridge, and the influence of Kina to the east kept Nina on a northeastward track towards the Solomon Islands.

### Severe TC Kina

Kina was the second system to develop in association with the active 40-50 day wave. An upper level ridge combined with a low level cross-equatorial surge to provide the conditions favorable for the development of a circulation within the monsoon trough. Under the influence of the middle/upper level flow the system drifted towards Fiji as it intensified.

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

Over northern subtropical regions, cold water anomalies along the Asian coastline and Philippine Sea have receded, while cold anomalies in the northwest Pacific have spread and deepened since last month.

In equatorial waters anomaly patterns are generally similar to last month, with warm anomalies across Indonesia and near the dateline. Notable exceptions are the appearance of warm anomalies about eastern PNG and the SPCZ.

The NMC Melbourne satellite-derived SST anomalies for December (not shown) reveal a mixed pattern of weak anomalies over the eastern equatorial Pacific.

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

In the northern hemisphere the most significant anomalies relate to a weakened Siberian high and stronger than normal ridging eastward into the Philippine Sea. A surge of northeasterly tradewinds in mid-December consequently occurred further east than normal, resulting in anomalously weak northeasterlies through the South China Sea.

It is interesting that the northeasterly surge occurred further east than normal at the same time that the 40 to 50 day oscillation had shifted the active tropical weather eastwards into the southwest Pacific. A further surge of northeasterlies in the first days of January occurred even further east (near the dateline). This again was the region of active tropical weather in the southern hemisphere associated with the 40 to 50 day wave. These coincidences seem to imply some connection between the 40 to 50 day cycle in the tropics, and mid-latitude systems.

Anomalous ridging was evident over the Indian sub-continent, with enhanced northeasterly cross-equatorial flow to the south.

In the southern hemisphere, cyclonic wind anomalies about northeast Australia and in the vicinity of the SPCZ reflect the occurrence of cyclones Nina and Kina. Stronger than normal ridging was evident south of the Australian continent.

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

While the zonal winds fluctuated about the mean, the meridional winds were predominantly southerly. This was due to the monsoon trough remaining north of Darwin. Rainfall in Darwin was near average with a total of 240 mm for the month. Significant falls were associated with the passage of squall lines approaching from the south.

## CROSS-EQUATORIAL INTERACTION [Fig. 10]

In general the meridional wind cross-section is similar to the mean pattern, with low level northerlies reflecting the seasonal transition of the monsoon trough to the southern hemisphere. This transition is also reflected by the coupled return flow in the upper levels.

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

The dominant feature of these charts is the greater than normal meridionality of the mid-latitude westerly flow in each hemisphere. In the north the westerly trough occurred further west than normal over Asia, and an anomalous trough appeared to the east of Japan. In the south, trough axes are evident over Australia and the southwest Pacific.

A consistent southerly component along the equator in the anomaly chart shows that the Hadley circulation was slightly stronger than normal.

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

In general both the upper and lower velocity potential charts are near normal with upmotion evident over most equatorial regions. This is most prominent in the southern hemisphere particularly over the Indian and Pacific basins where cyclone numbers were near average. The only notable departure from the mean charts is evident over the Indian continent where subsidence is more prominent than normal.

An active phase of the 40-50 day oscillation, the first for the southern season, was the prominent feature of the tropical atmosphere this month. While the event was evident in both time longitude series it was most pronounced in the southern series. The movement from west to east across the domain through December is clear, though a cross equatorial surge of the northeastly trade winds resulted in a superimposed pulse in the middle of the month.

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

While the time longitude plots show similar features to those of velocity potential, most of the convective activity was focused over the western equatorial and southern Pacific. The eastward propagation of the 40-50 day wave is clearly evident in the southern series. The northern series shows hints of smaller scale westward motion during the event.

Record high rainfall occurred over parts of southeast Australia, reflecting the low pressure anomalies in that area. Low quintile values about the eastern Malay Peninsula and northern Borneo were probably due to a weaker than normal northeast monsoon. Zero rainfall was reported by many Indian stations, as is normal for December.

High rainfall quintiles at Cocos Is, northeastern Australia and Fiji reflect the passage of cyclones Ken, Nina and Joni respectively.

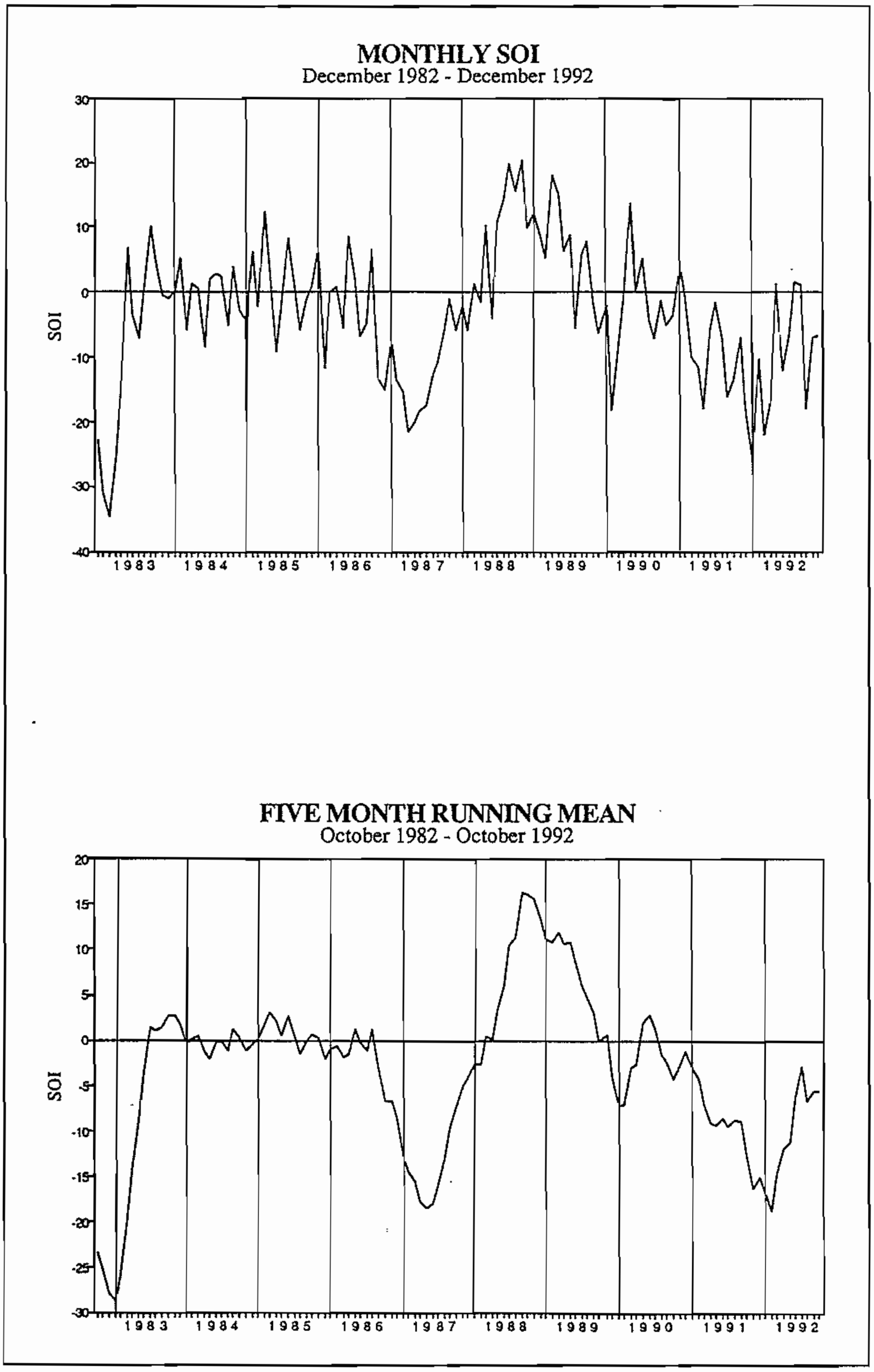



Fig.1 SOUTHERN OSCILLATION INDEX 1982 - 1992.
Monthly SOI and 5-month running mean SOI.

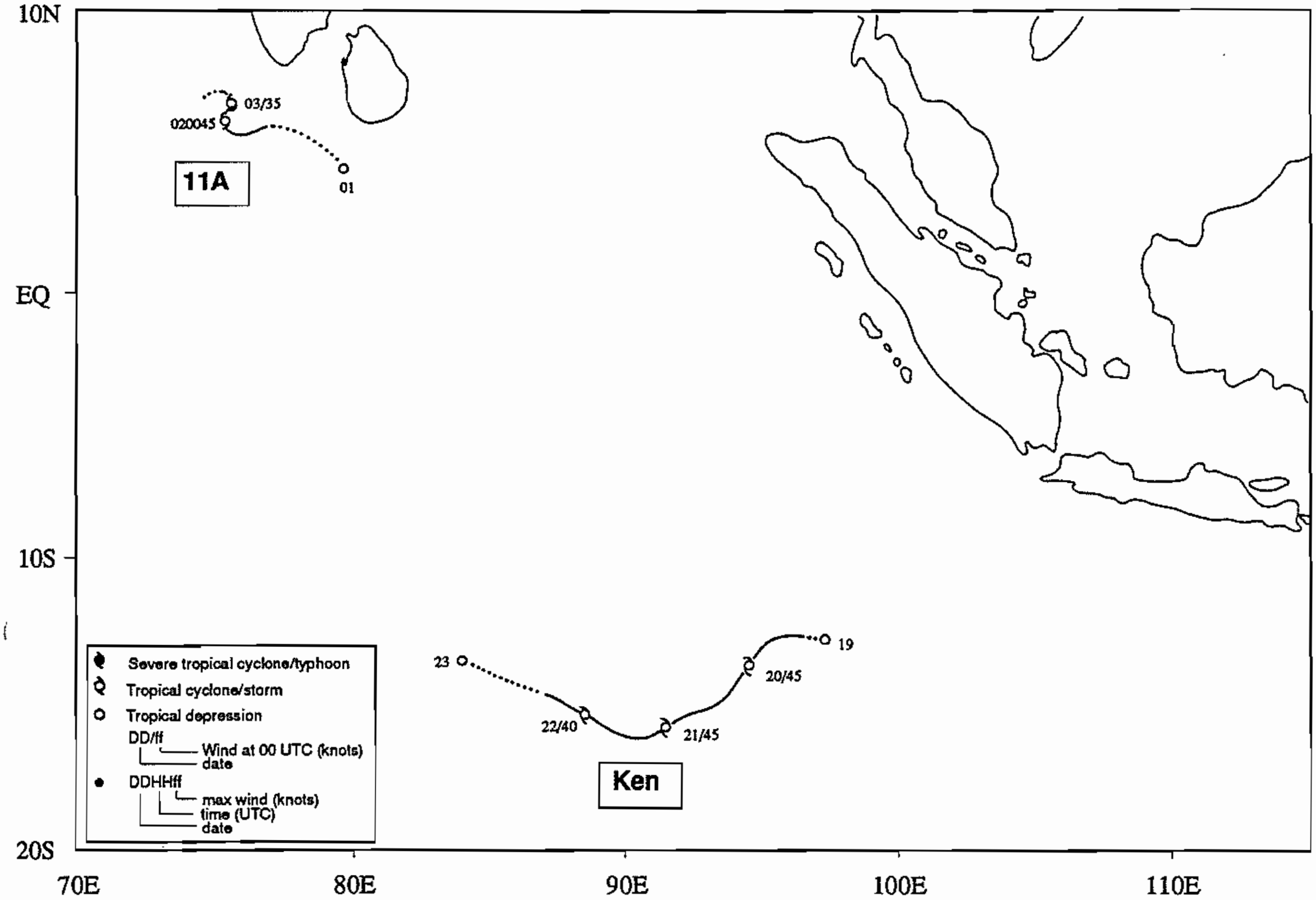



Fig.2(a) UNOFFICIAL TRACKS OF CYCLONES: 11A and KEN, DECEMBER 1992

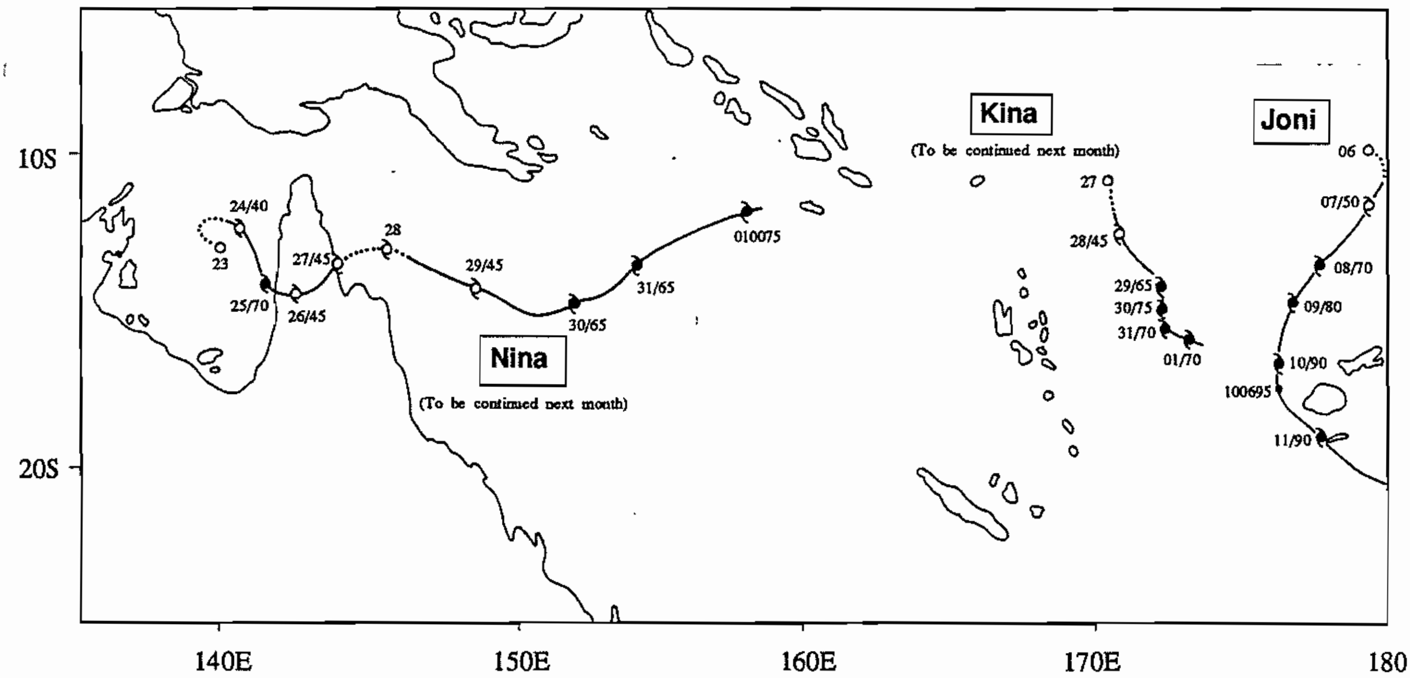



Fig.2(b) UNOFFICIAL TRACKS OF CYCLONES: JONI, NINA and KINA, DECEMBER 1992

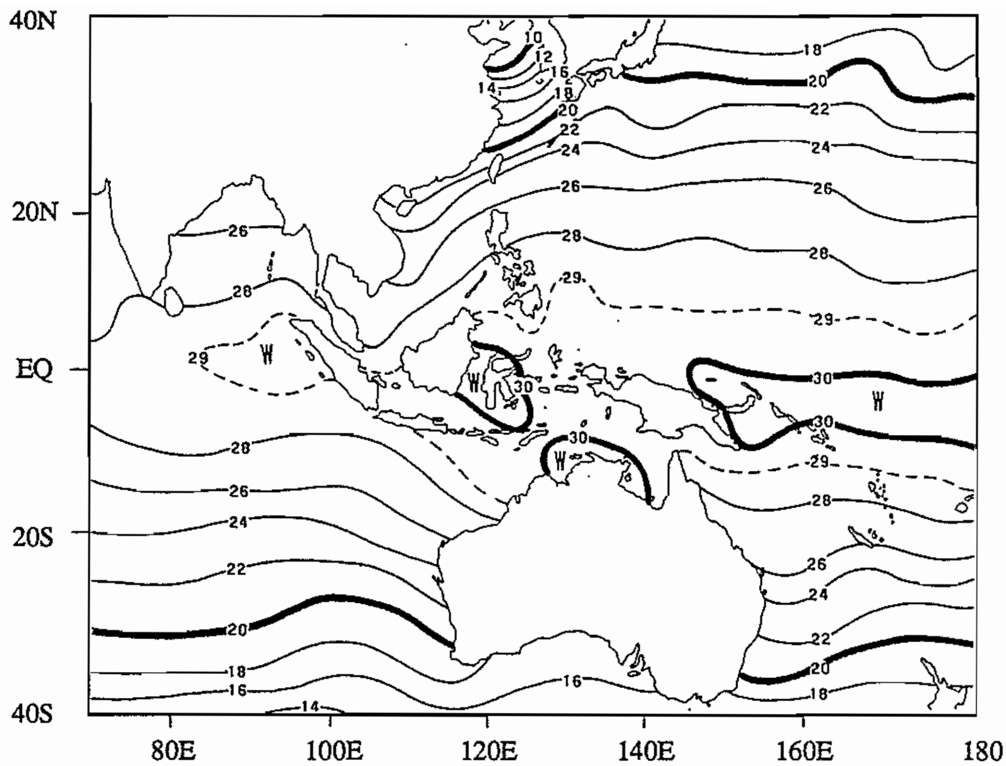



Fig.3 MEAN SEA SURFACE TEMPERATURE, DECEMBER 1992, based on weekly Darwin RSMC analyses averaged over the month.
Isotherm interval 2°C.

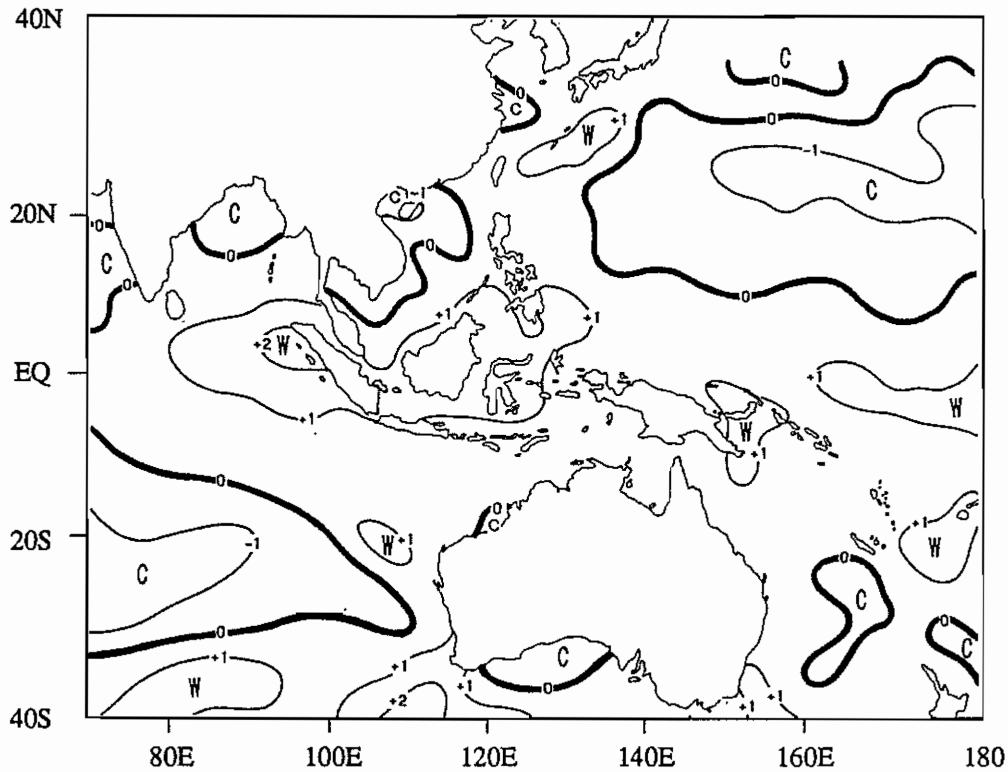



Fig.4 SST ANOMALY, based on Fig.3 and the climatology of Reynolds (NOAA Report NWS 31, 1983).
Isotherm interval 1°C.

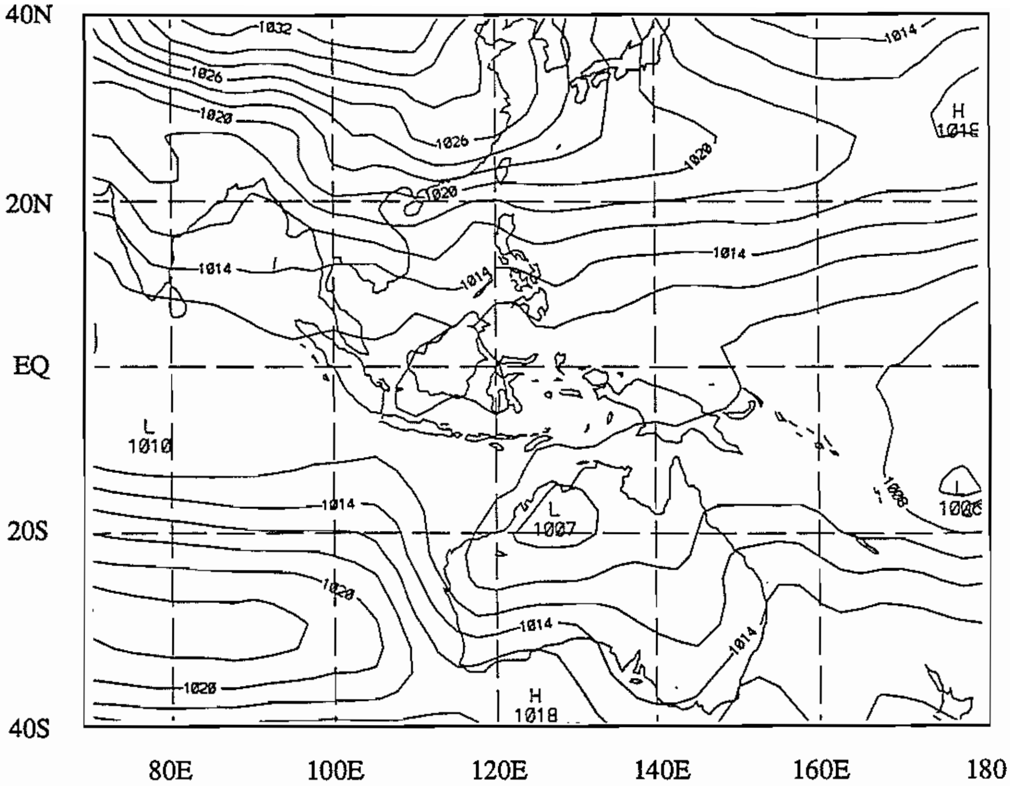



Fig.5 MEAN MSL PRESSURE, DECEMBER 1992.
Isobar interval 2 hPa.

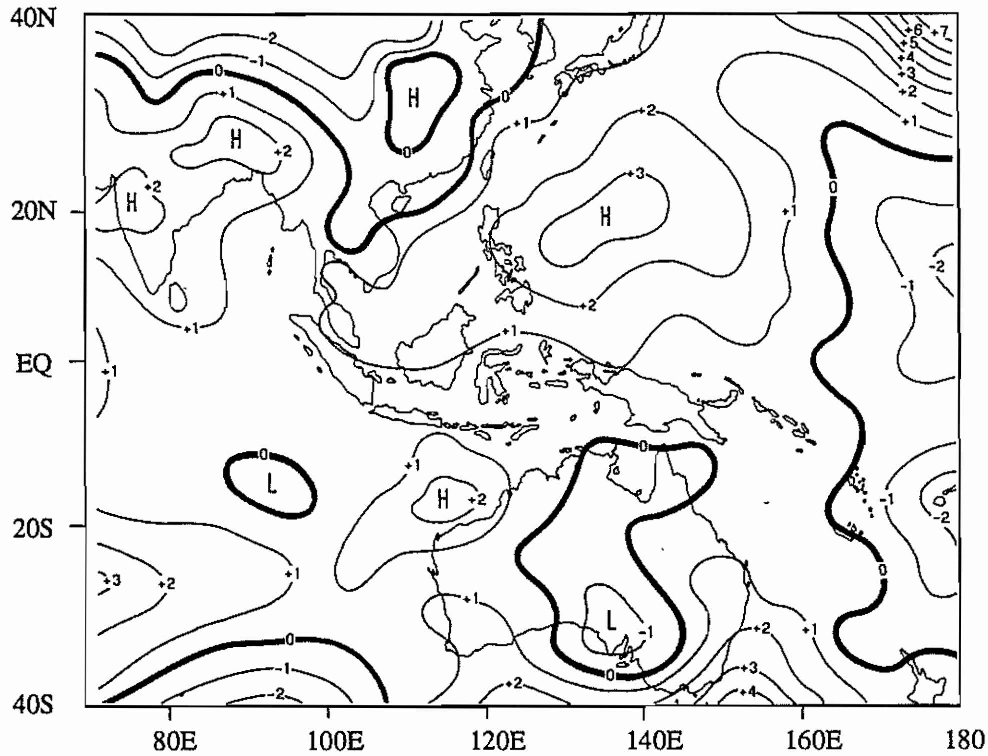



Fig.6 MSL PRESSURE ANOMALY, DECEMBER 1992, based on CLIMAT messages, and Fig.5 with 6-year climatology.
Contour interval 1 hPa.

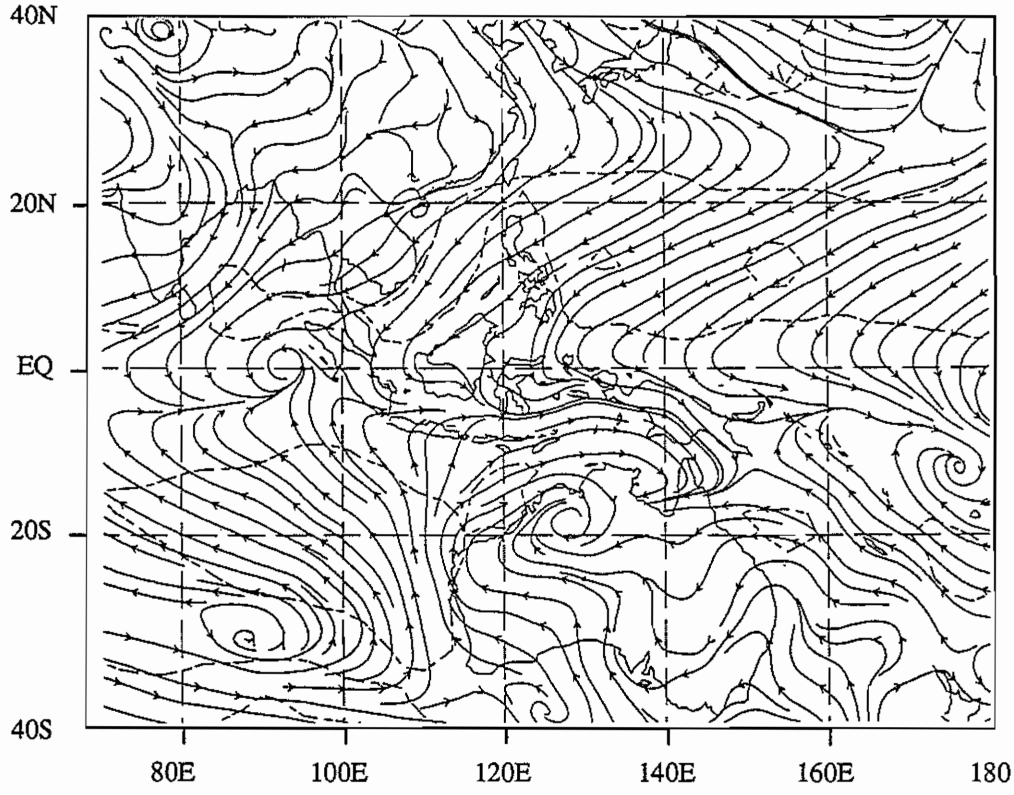



Fig.7 950 hPa MEAN STREAMLINE ANALYSIS, DECEMBER 1992.
Isotachs (dashed line) at 10 knot intervals.

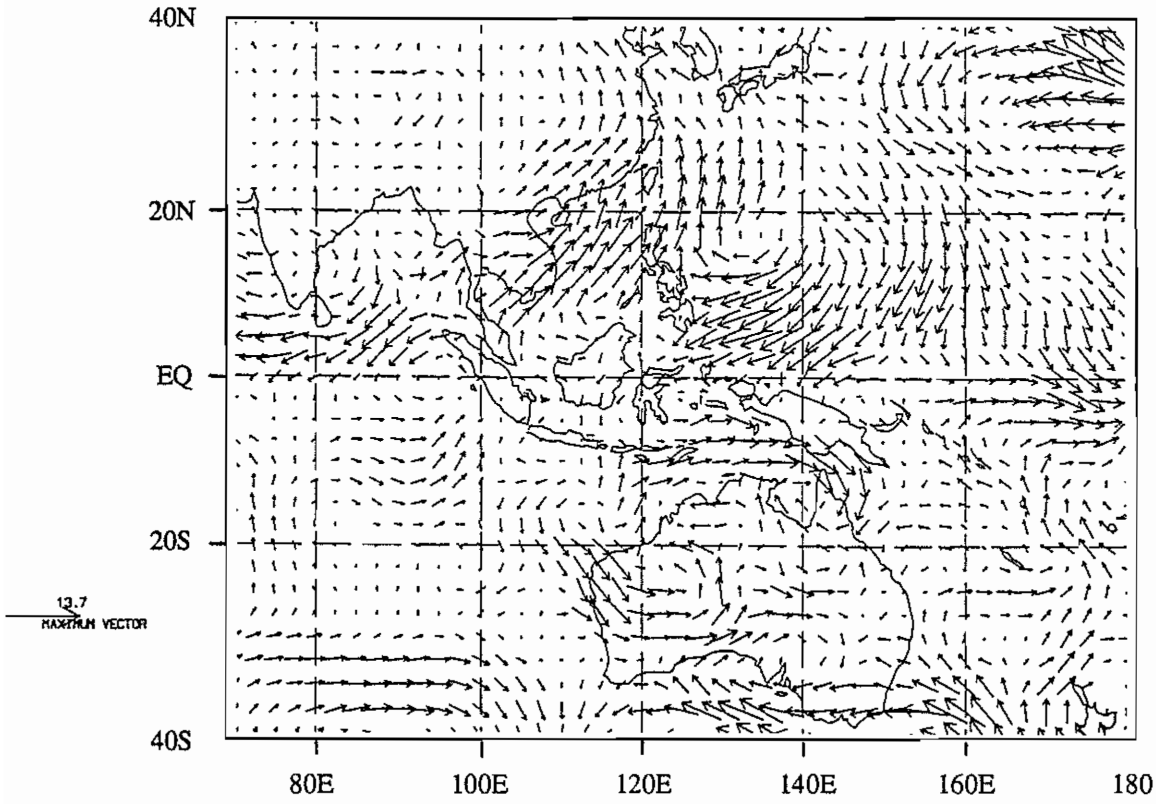



Fig.8 950 hPa WIND ANOMALY, based on Fig.7.
Isotachs (dashed line) at 10 knot intervals.

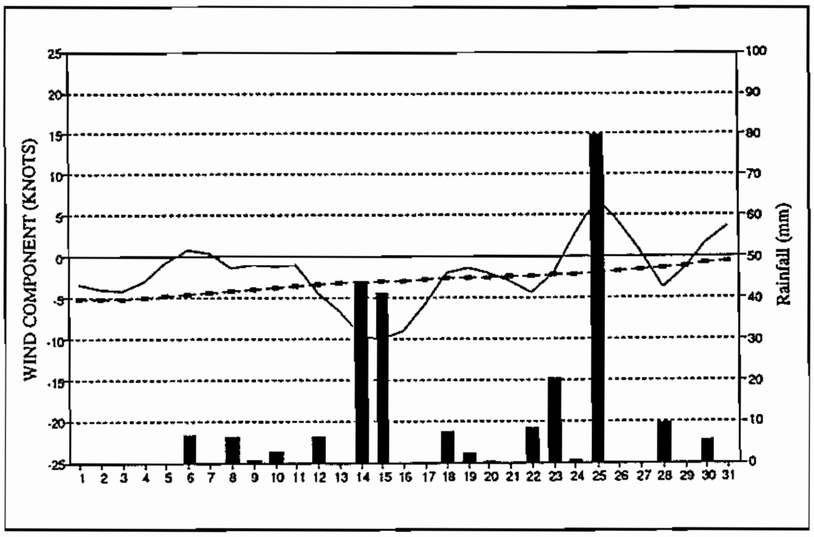
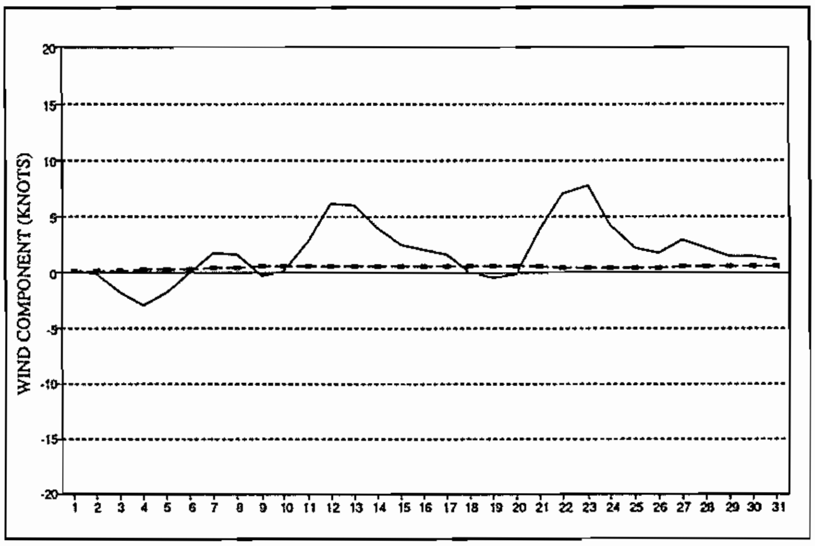



Fig.9(a) DARWIN 850 hPa 3-DAY SYMMETRICAL MEAN ZONAL WIND AND RAINFALL, DECEMBER 1992. Dashed line represents the mean seasonal zonal wind cycle.




(b) DARWIN 850 hPa 3-DAY SYMMETRICAL MEAN MERIDIONAL WIND, DECEMBER 1992. Dashed line represents the mean seasonal meridional wind cycle.

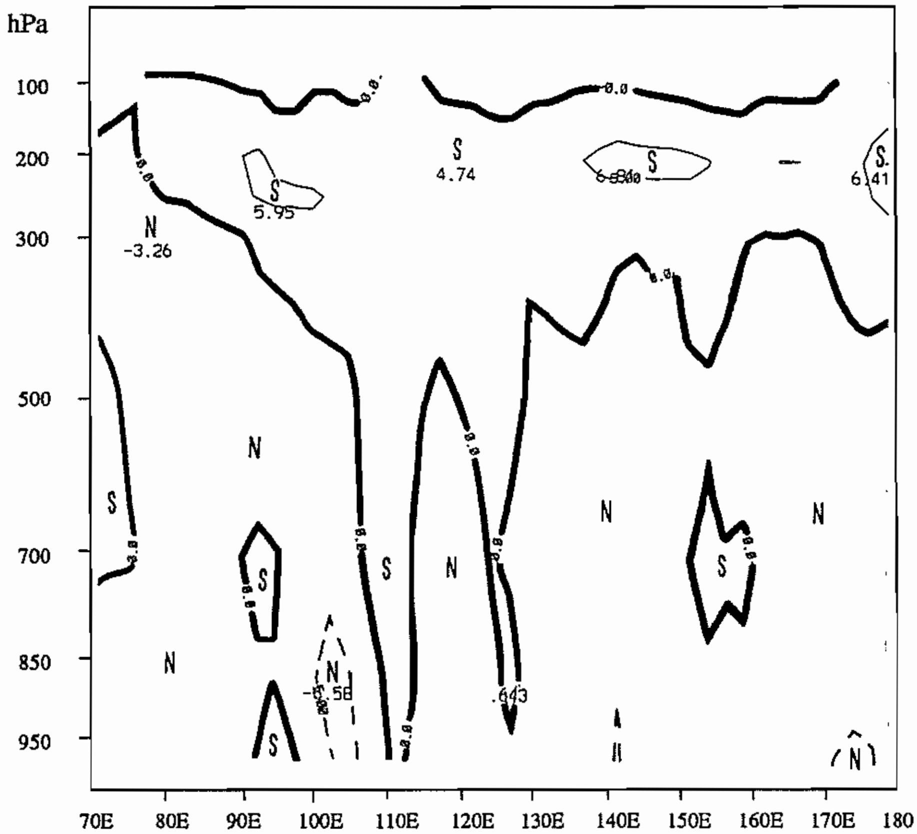



Fig.10 EQUATORIAL CROSS-SECTION OF MERIDIONAL WIND, DECEMBER 1992.
Isotachs at 5 knot intervals.

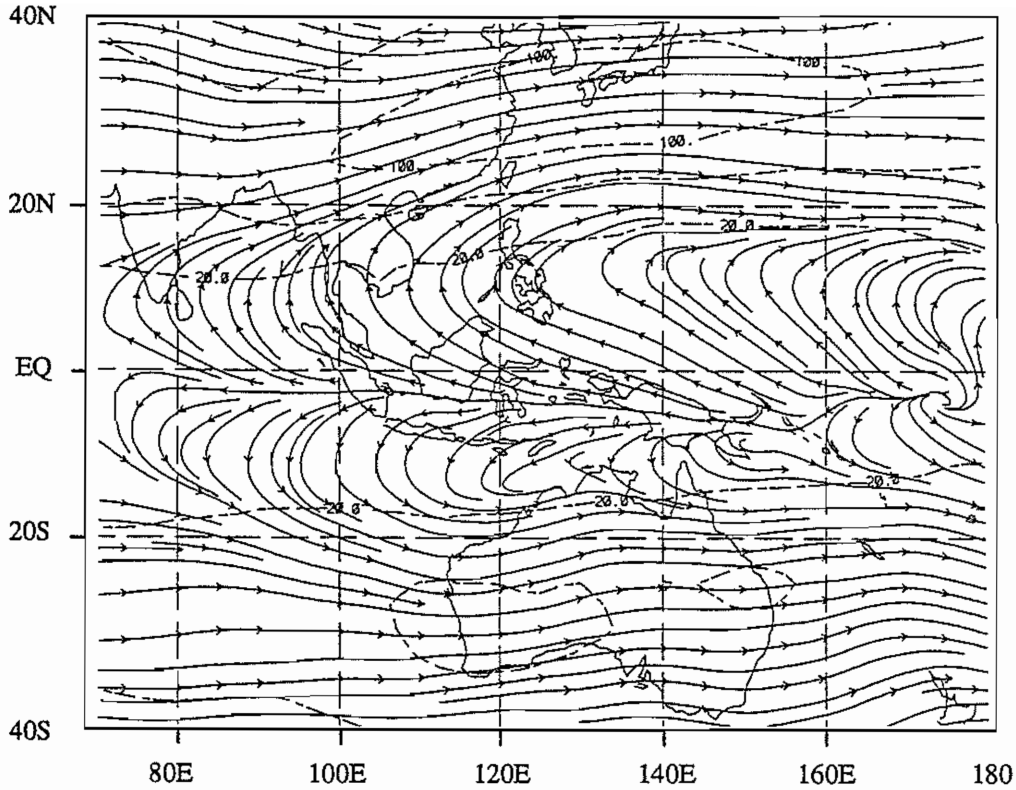



Fig.11 200 hPa STREAMLINE ANALYSIS, DECEMBER 1992.
Isotachs (dashed line) at 40 knot intervals, minimum 20 knots.

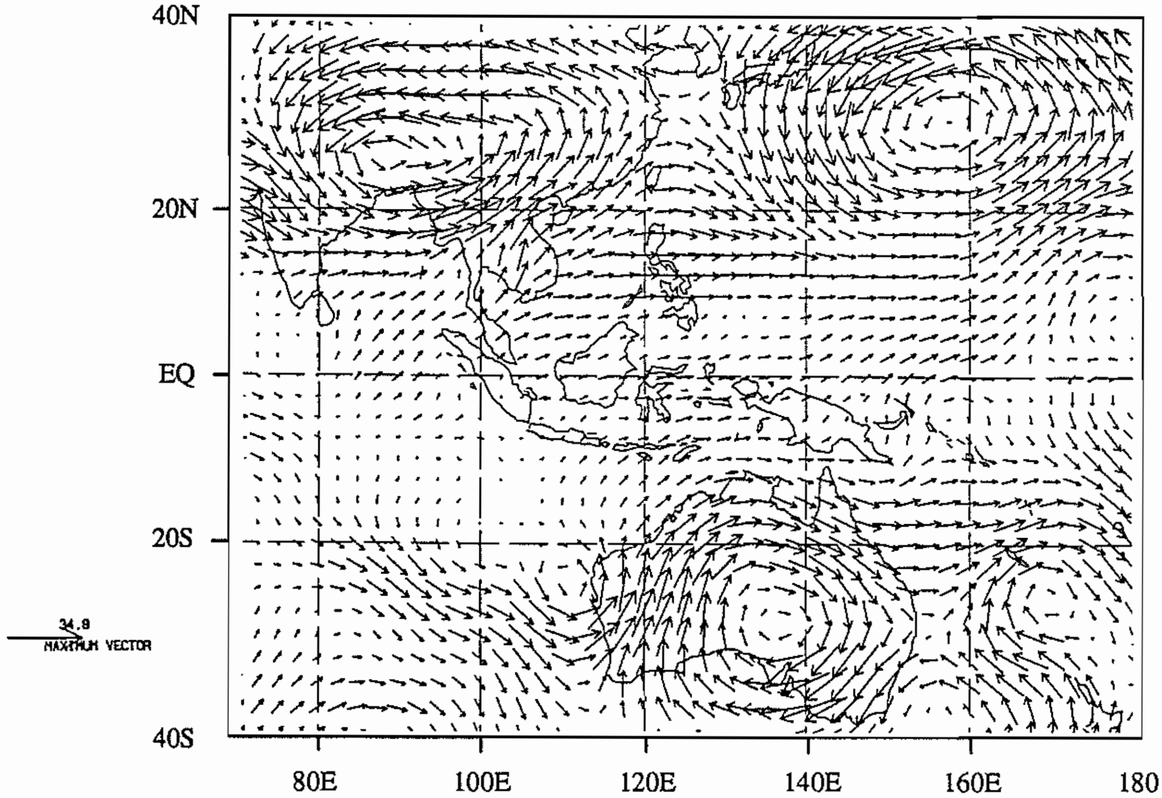



Fig.12 200 hPa WIND ANOMALY, based on Fig.11.
Isotachs (dashed line) at 20 knot intervals

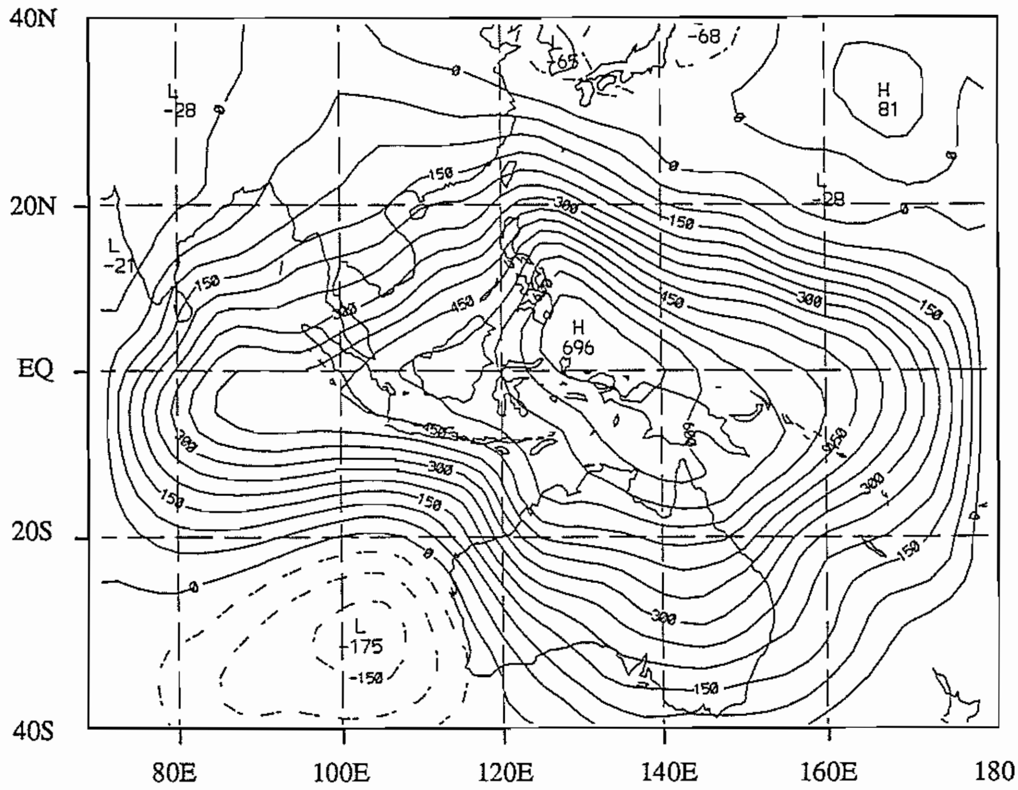



Fig.13 950 hPa VELOCITY POTENTIAL, DECEMBER 1992.
Contour interval 50 x $10^4$ $m^2$ $s^{-1}$.

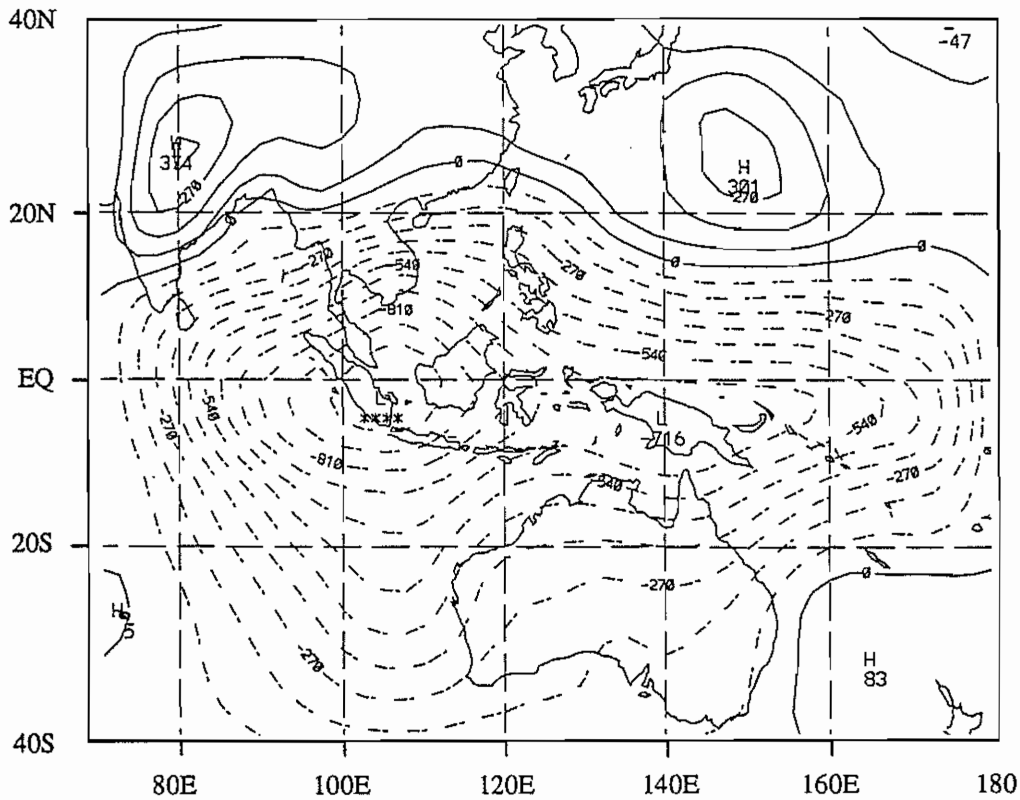



Fig.14 200 hPa VELOCITY POTENTIAL, DECEMBER 1992.
Contour interval 90 x $10^4$ $m^2$ $s^{-1}$.

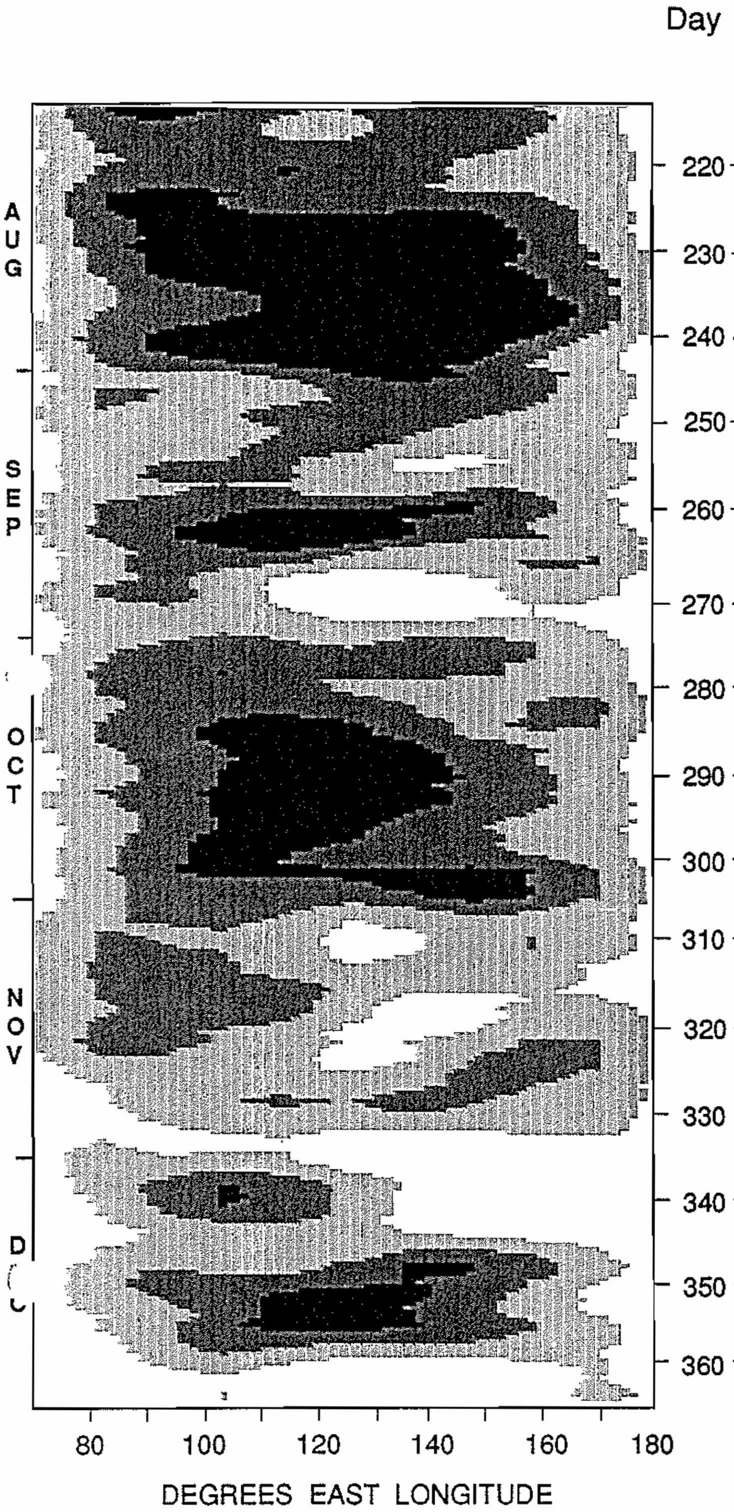



Fig.15 (a)

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

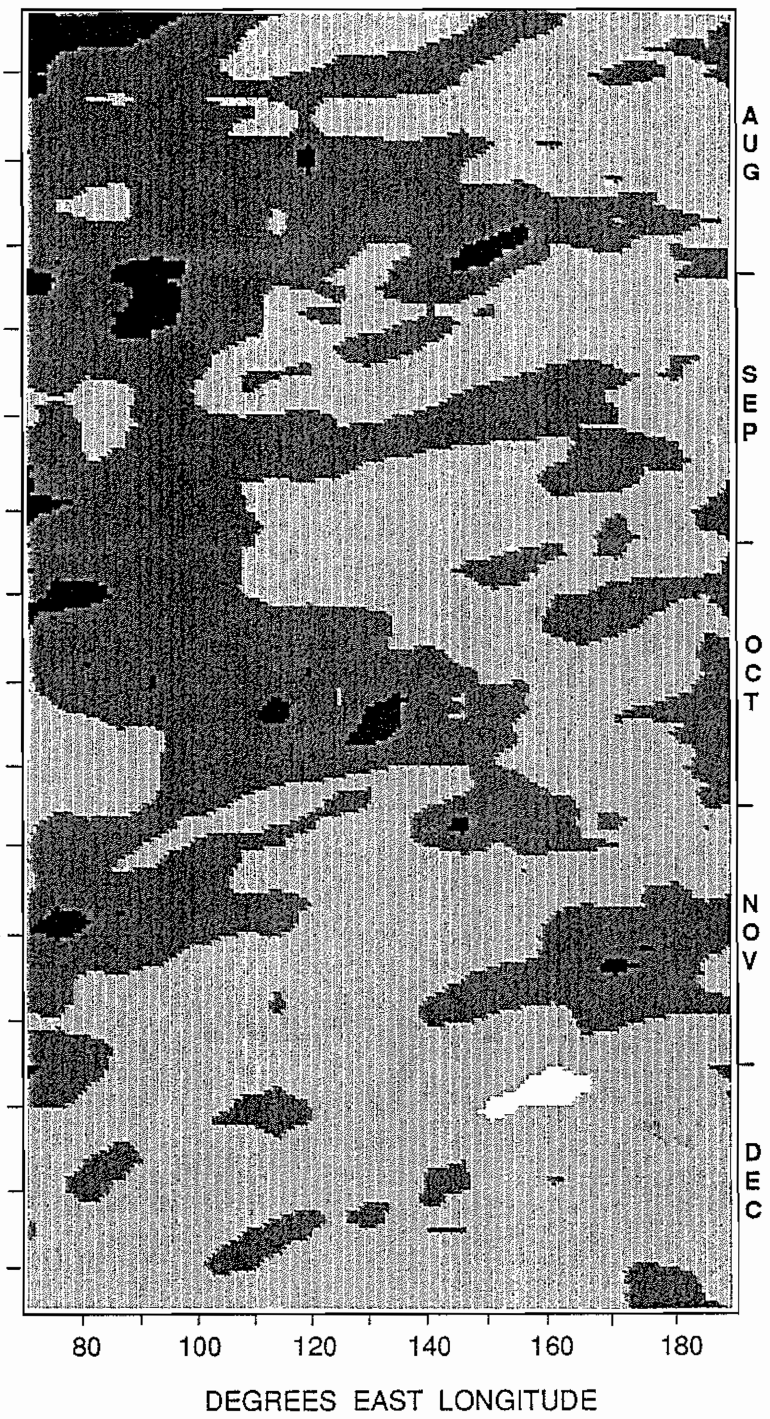



Fig.15 (b)

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

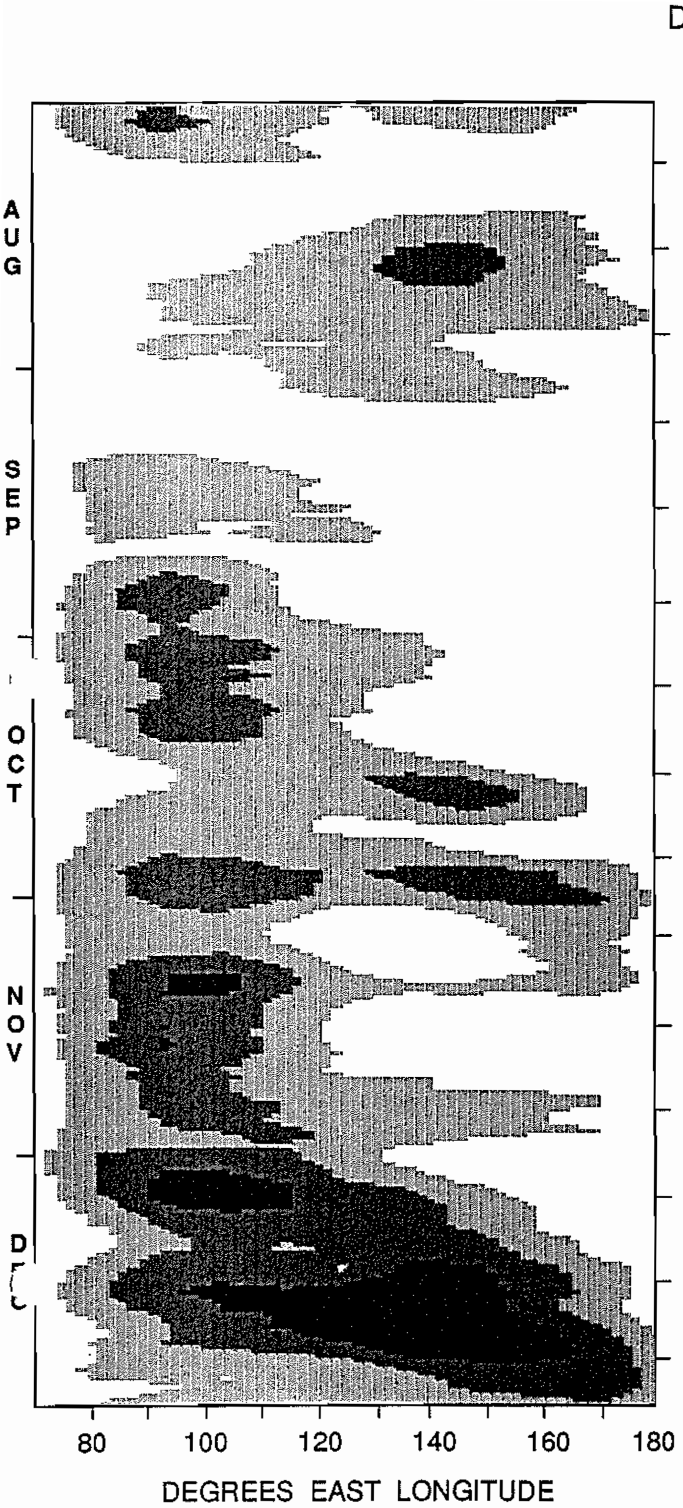



Fig.16 (a)

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

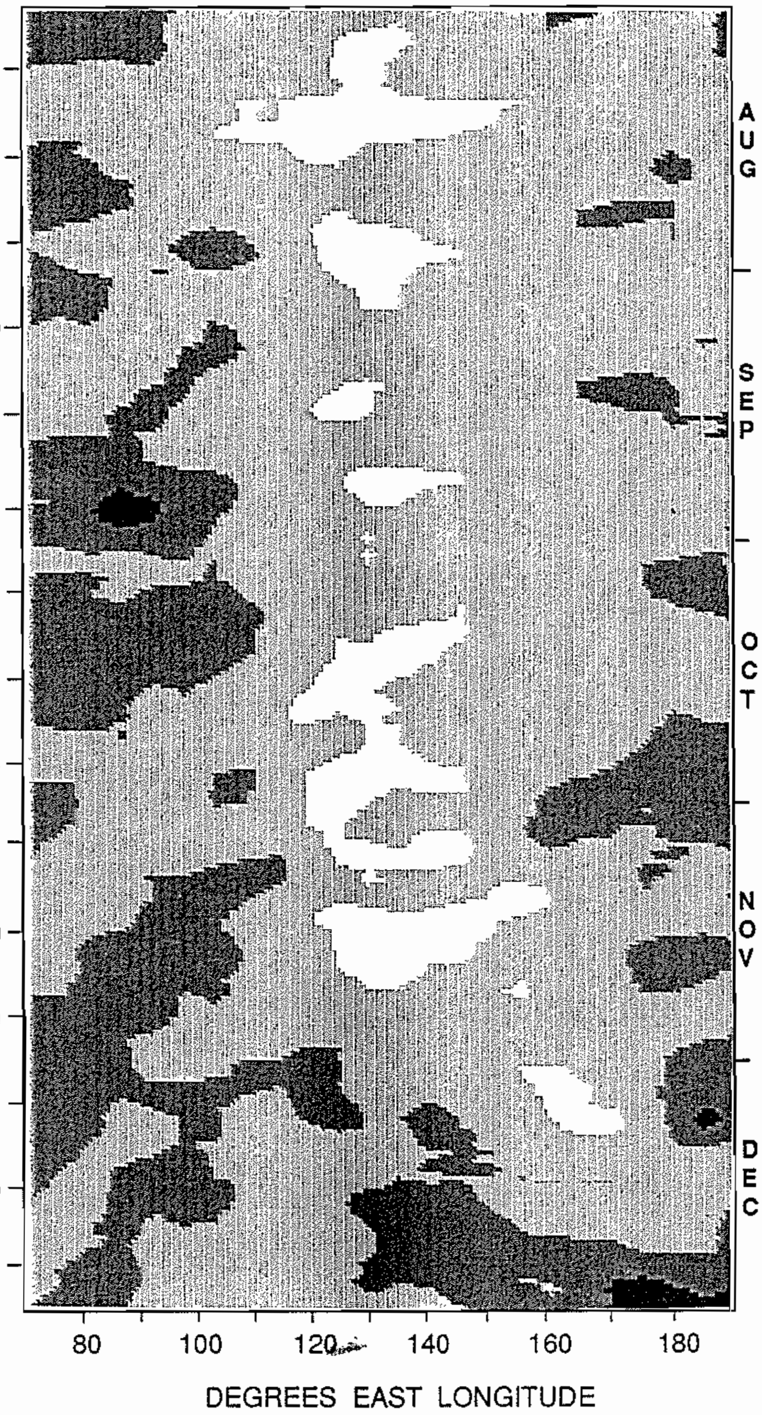
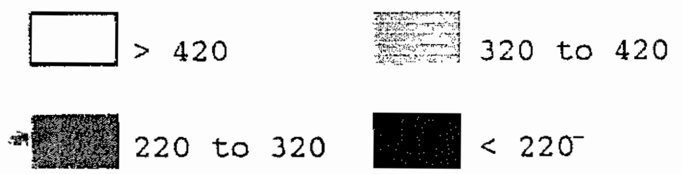



Fig.16 (b)

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



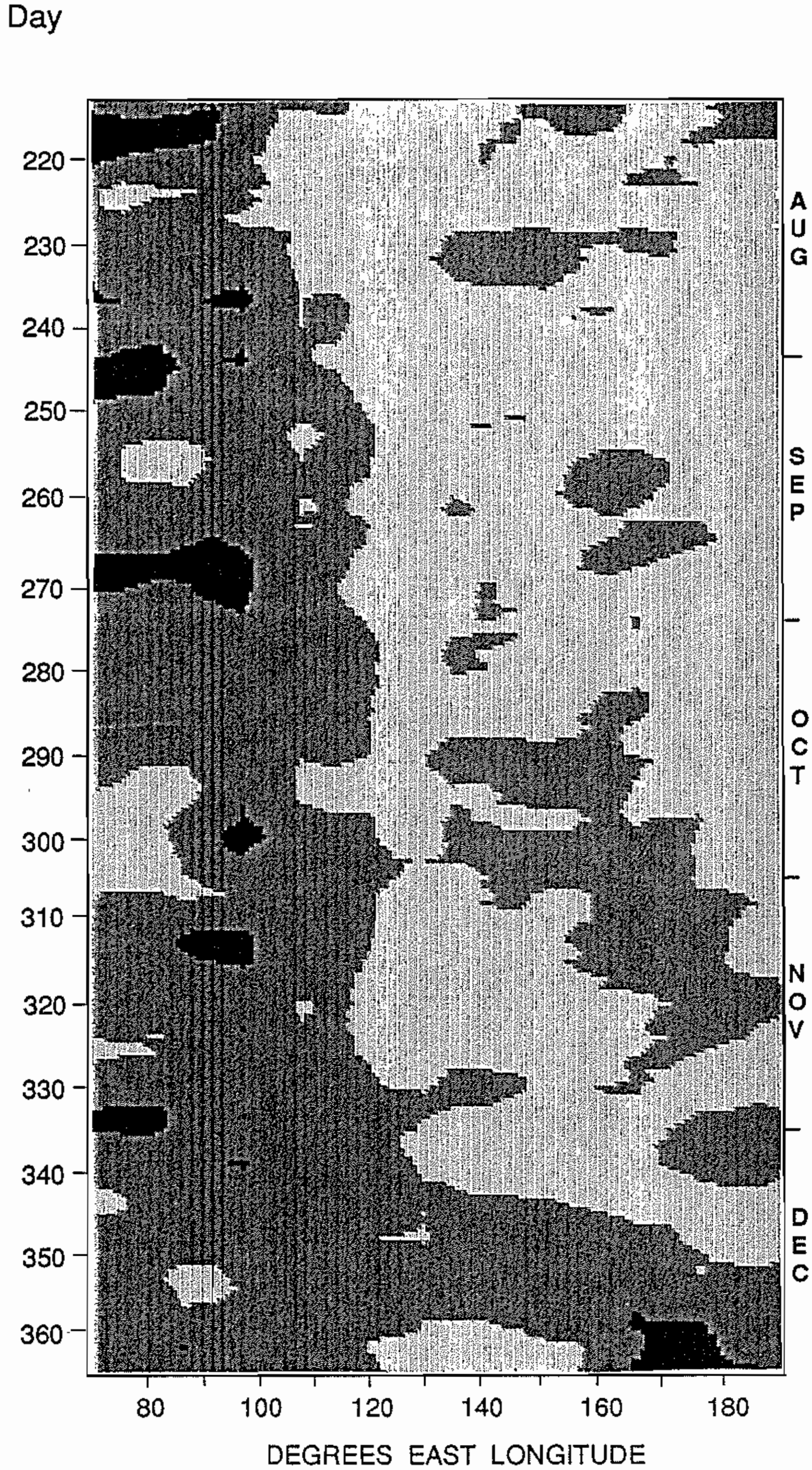



Fig.17

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

> 420

320 to 420

220 to 320

< 220

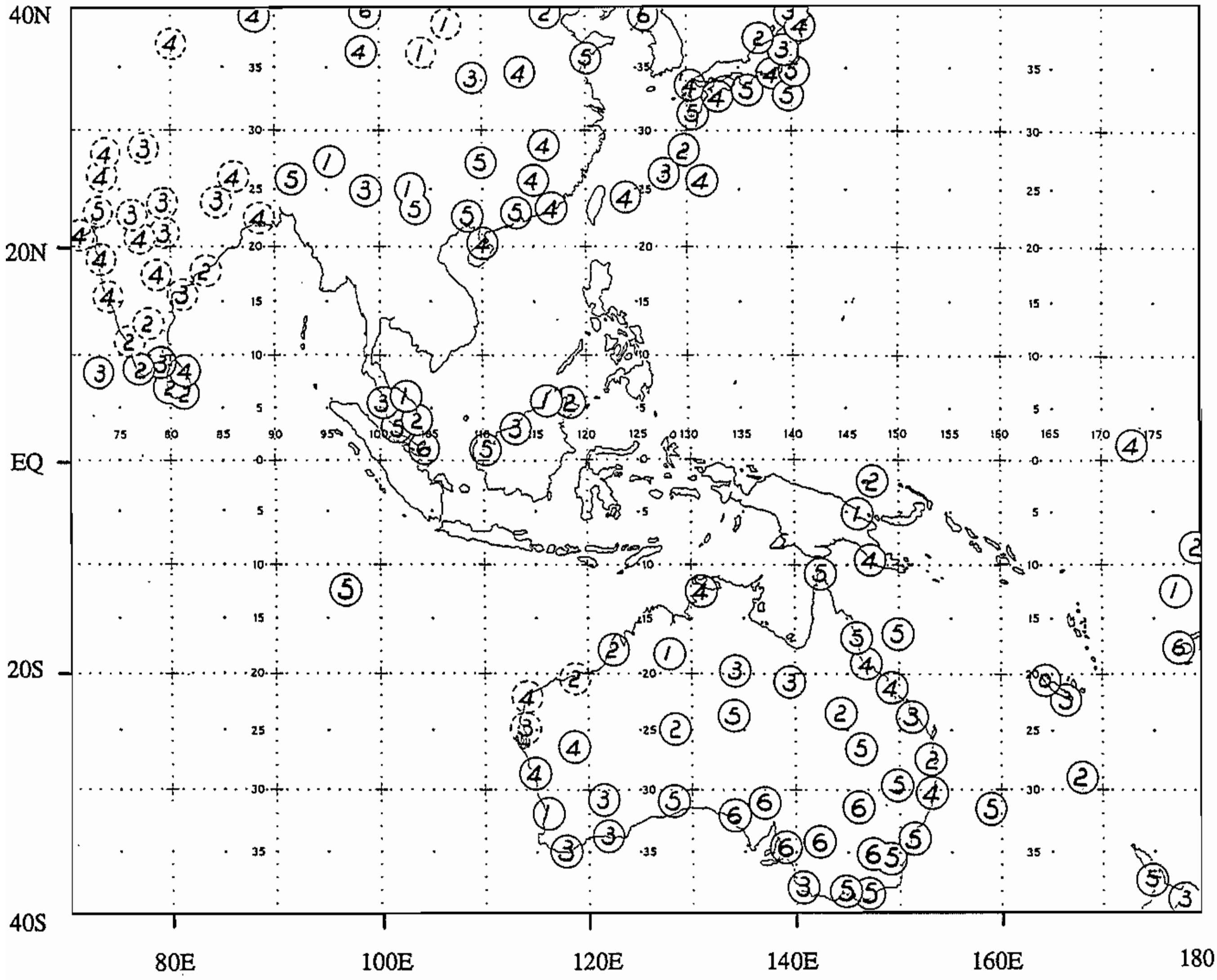



Fig.18 MEAN RAINFALL QUINTILES, DECEMBER 1992, from CLIMAT messages.

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

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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