Australian Government

Bureau of Meteorology

DARWIN TROPICAL DIAGNOSTIC STATEMENT

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DARWIN TROPICAL DIAGNOSTIC STATEMENT

JANUARY 1988

ISSUED BY DARWIN RMC

The Hadley circulations of both hemispheres were weaker than normal during January. The month saw an unseasonal retreat of the summer monsoon from the north Australian coast. The S.O.I. rose to -2 (i.e. remaining less than one standard deviation below the mean) therefore little of this anomalous behaviour is attributed to the El Niño. The number of southern hemisphere cyclones in the Australian region from the start of the season to the end of January stood at 2, well below the 21 year average of 5.7 (Lourensz 1981).

INDICES

1. Darwin mean MSL pressure January 1988 : 1007.8 hPa
   pressure anomaly (1882-1985 mean): +1.5 hPa
2. Tahiti mean MSL pressure January 1988 : 1012.0 hPa
   pressure anomaly: +1.1 hPa
3. Troup's southern oscillation index : -2
   5-month mean (centred upon November): -5

4. Troup's SOI for the last 25 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	-6
1988	-2											

TROPICAL CYCLONES

Unofficial cyclone tracks are shown in Fig. 1.

The two most intense cyclones of January, Anne and Roy, began as a cyclonic pair in the Northern and Southern hemisphere monsoon troughs.

The pre-Roy depression was first identified in the northern hemisphere close to the equator on the 7th. It reached Tropical Cyclone status on the 8th, then tracked west-northwest and continued to intensify, reaching Typhoon status on the 10th. Typhoon Roy passed just north of Guam before changing course to the west-southwest toward the Philippines on the 13th. On the 16th it made landfall to the south of Luzon Island (the third such system to cross the Philippines coast in as many months) before dissipating over the South China sea on the 19th. The average number of cyclones for January in the North West Pacific is 0.5 (JTWC Guam average 1959-1986).

There were 3 southern hemisphere cyclones in January. Severe Tropical Cyclone Anne formed in the southern hemisphere monsoon trough early on the

8th. It then tracked to the southwest and intensified, striking the northern islands of Vanuatu and causing considerable damage on the 10th. The system changed course during the 11th and subsequently crossed the southern tip of New Caledonia causing further major damage and the loss of several lives. Continuing southward it moved over colder water and was captured in the upper westerly flow before dissipating over water on the 15th.

Only two days after the formation of Anne the depression that was to become Tropical Cyclone Agi formed southwest of the Solomon Islands in the monsoon trough. This system initially tracked northwest before reaching Tropical Cyclone intensity off the southeast tip of Papua New Guinea. After remaining almost stationary for 24 hours it then tracked to the southeast and dissipated on the 15th in a similar manner to Anne.

Tropical Cyclone Frederic formed in the monsoon trough southwest of Sumatra early on the 30th and followed a meandering track to the southwest as it intensified. It passed over the Cocos Island group later on the 30th causing only minor damage.

SEA SURFACE TEMPERATURE

The mean sea surface temperature and anomaly fields for January are shown in Figs. 2 and 3.

The most significant anomaly was the large expanse of warmer water over the mid-latitude region of the northwest Pacific Ocean, with well above average temperatures near Japan. A continuation of the southward movement of the axis of warmest water was also evident, with it lying along latitude 5° south. The weak cold anomaly that was located over the northern Tasman Sea and the Coral Sea in December has persisted. A weak warm anomaly persisted in equatorial waters east of the Solomon Islands and warm anomalies also continued near India.

MSL PRESSURE AND GRADIENT LEVEL FLOW

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

The surface charts indicate the monsoon trough had retreated northward over the Indonesia-Australia region with the mean position located near 10°S. As a result easterly anomalies were evident over the southern hemisphere north of 12°S. This is consistent with the negative pressure anomalies observed over China and South East Asia, which indicate the Siberian high was weaker than average during January. Associated with this the northeast trades were weaker than normal over the northern hemisphere, with west to southwest anomalies evident between the equator and 15°N. The negative pressure anomalies observed in the northern hemisphere were consistent with the positive sea surface temperature anomalies over this region.

The cyclonic anomaly south of New Caledonia and the anti-cyclonic anomaly over the Tasman Sea, coupled with the high pressure anomalies over the Tasman Sea, suggest a strong blocking influence between 150°E and 180°E during January. This evidence is supported by the 31-day mean hemispheric blocking indices for January, which were at a relative maximum in these longitudes.

Figs 8(a),(b) and (c) are plots of the three-day running means of zonal and meridional 850hPa winds at Darwin along with 24 hour rainfall totals for January. The month was characterised by a prolonged break period (i.e. anomolous easterly flow), reflecting the northward retreat of the monsoon. GMS satellite imagery for January showed very little active convection over tropical waters in Australian longitudes.

While Darwin's rainfall for the month was in decile range 3, there were 3 more raindays than normal (24 compared to the long term average of 21). This highlights the dependence upon short periods of intense rainfall on the monthly rainfall in the tropics.

UPPER LEVEL FLOW

The mean 200 hPa streamline and vector wind anomaly charts for January are given in Figs. 9 and 10.

The strength of the easterly anomaly over equatorial regions west of 155°E is evidence that the easterly return flow of the monsoon remained weaker than normal. The continuing absence of an anomalous anticyclonic pair near the dateline confirmed a reduced El Niño influence. The anomaly pattern over southern mid latitudes was particularly meridional, with a deep anomalous trough over Western Australia. The strong easterly anomaly in the Tasman Sea with a split westerly anomaly over eastern Australia is consistent with the strong blocking noted earlier. The upper ridge over the Australian region was displaced south of the low level trough and so tropical cyclone development over this region was less favourable due to the increased vertical shear. The northern hemisphere sub-tropical jet was further north than normal, but of average intensity.

VELOCITY POTENTIAL AND DIVERGENT WIND

Charts of the velocity potential and divergent wind fields at 950 hPa and 200 hPa for December are given in Figs. 11, 12, 13, and 14.

The velocity potential fields suggest the major area of low level convergence was centred between the Philippines and Papua New Guinea with axes extending east and west into the southern hemisphere. The high level divergence maximum was centred west of Sumatra with the axis along about 2°S. This indicates that the upward branch of the mean Hadley cell migrated a little northward from it's position last month, which is against the expected trend for January. The Hadley circulation for January was weaker than normal, as evidenced by the weaker than normal cros-equatorial flow and GMS satellite imagery, which showed most convection was located west of 115°E.

A descending branch of the cell was centred over the Queensland coast. This subsidence was linked with suppressed rainfall and positive pressure anomalies over this region. The strongest subsidence region however was located in the mid northwest Pacific with a weaker branch over the Himalayas.

The divergent wind field suggests the upward branch of the Walker circulation remained on or near the equator east of New Guinea with a similar zonal circulation west of Sumatra.

WIND CROSS SECTIONS

Cross sections of zonal wind along 100°E, 130°E and 160°E are shown in Figs 15, 16 and 17 respectively; the equatorial cross section of meridional wind is given in Fig. 18.

The longitudinal cross sections indicate weak monsoonal westerlies were confined to north of 10°S during January. The northern hemisphere northeasterly trades were also generally weak; typically the strongest northeasterlies would be expected between 100°E and 130°E, however Fig. 17 indicates the strongest northeast winds were displaced well east near 160°E. At high levels the northern hemisphere sub tropical jet had moved slightly southward from it's December position.

The equatorial meridional wind cross section bears a striking resemblance to that of December. The broad area of low level northerly east of 100°E and the southerly return flow at 200hPa both increased in strength during January.

RAINFALL

Fig. 19 shows monthly rainfall quintiles for selected stations in December.

Rainfall was generally average or above average along the southeastern seaboard and southern coast of Australia. Elsewhere rainfall was less than average. Suppression of rainfall appeared to be related to the westward displacement from the long term mean of the Queensland ridge, combined with the anomalous northward displacement of the monsoon trough affecting northern Australia. The stronger than average high pressures over the Tasman Sea enhanced the onshore easterlies over the New South Wales coast produced above average rainfall in this region. Further to the south the sub-tropical ridge was displaced up to 4° north from it's long term mean position allowing, an increased onshore flow onto the south coast, (cf: westerly anomalies over this region in Fig. 7). This in turn resulted in above average rainfall over the southern coastal fringe.

Lack of data over the northern hemisphere prevents a detailed analysis of rainfall patterns over this region, but above average rainfall over China is consistent with the sea surface temperature anomaly pattern.

REFERENCES

Lourensz, R.S., 1981: Tropical cyclones in the Australian region July 1909 to June 1980: Meteorological summary, Bureau of Meteorology.

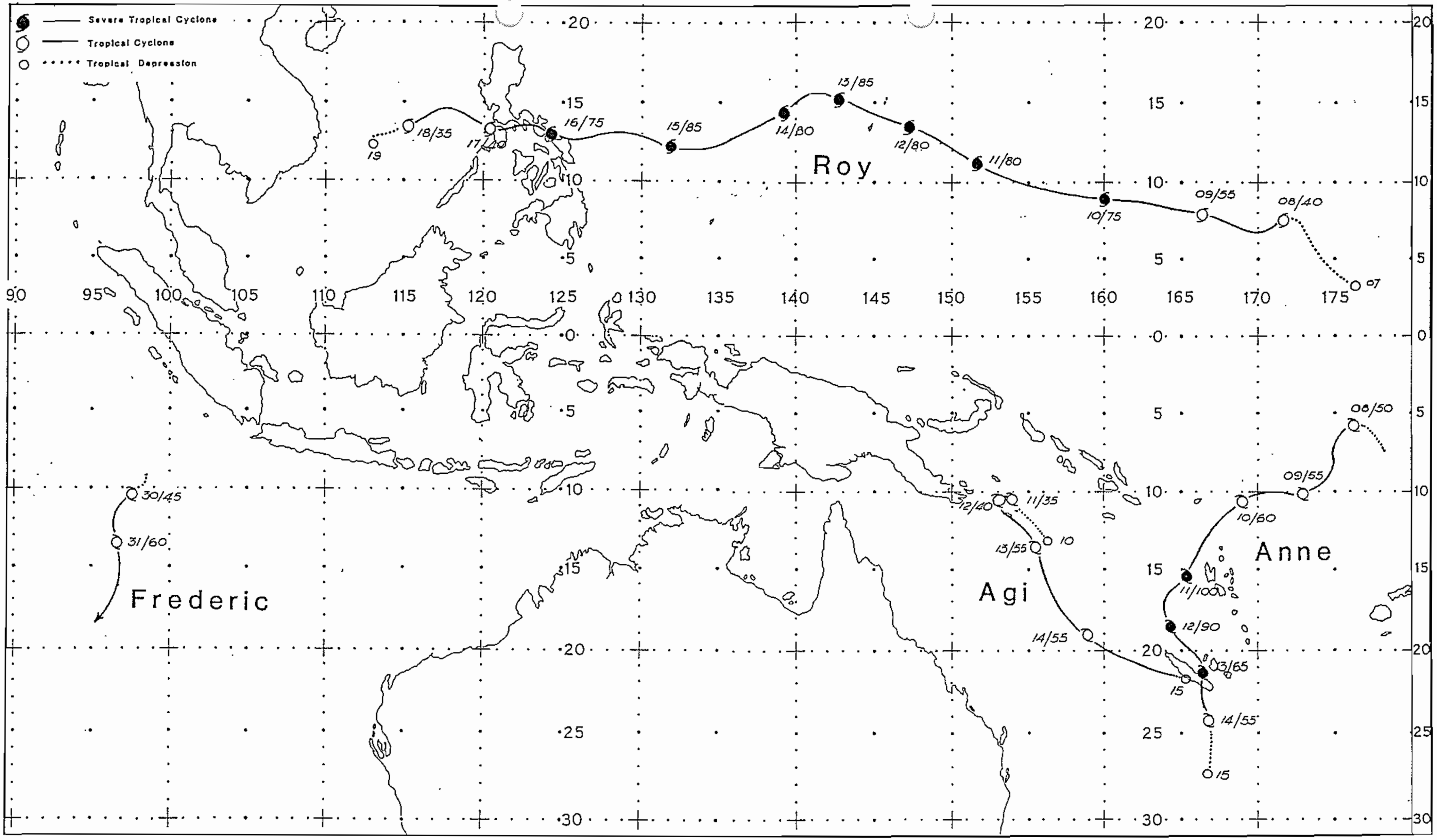


Fig. 1 UNOFFICIAL TRACKS OF CYCLONES ROY, ANNE, AGI AND FREDERIC (JANUARY 1988)
Date (DD) and maximum sustained wind (ff) in knots denoted by DD/ff.

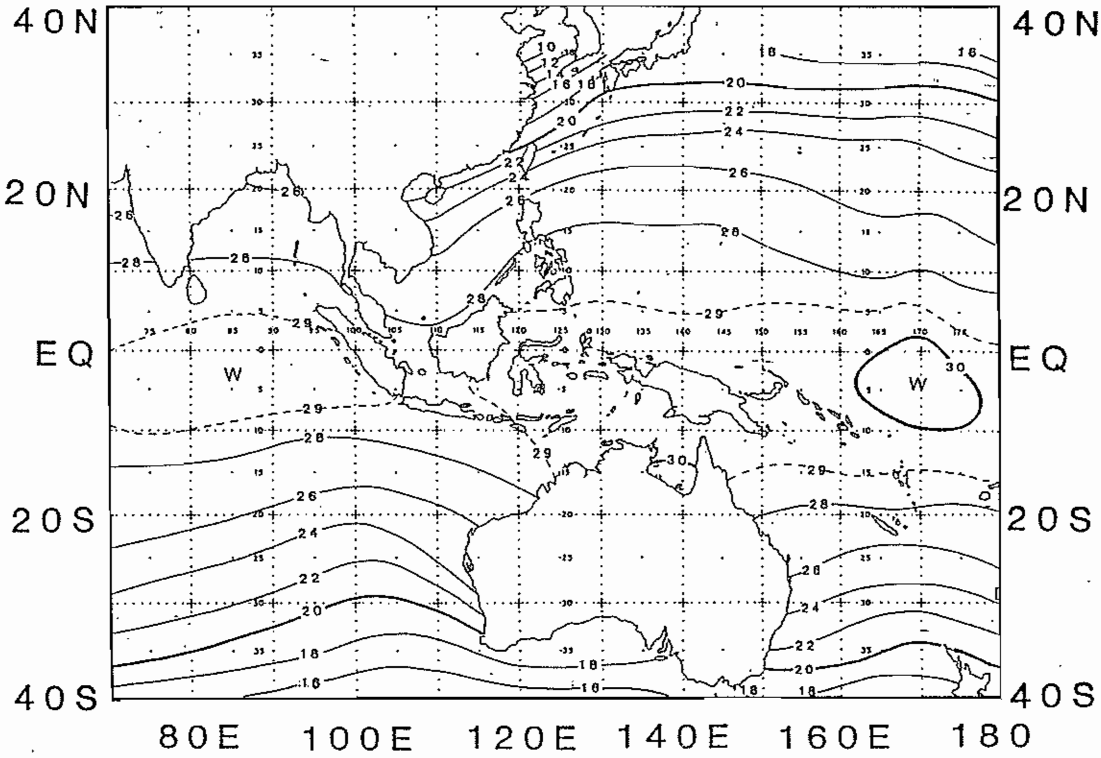


Fig. 2 MEAN SEA SURFACE TEMPERATURES, BASED ON DARWIN RMC ANALYSES AVERAGED OVER THE MIDDLE FOUR WEEKS OF JANUARY 1988
Isotherm interval 2° C.

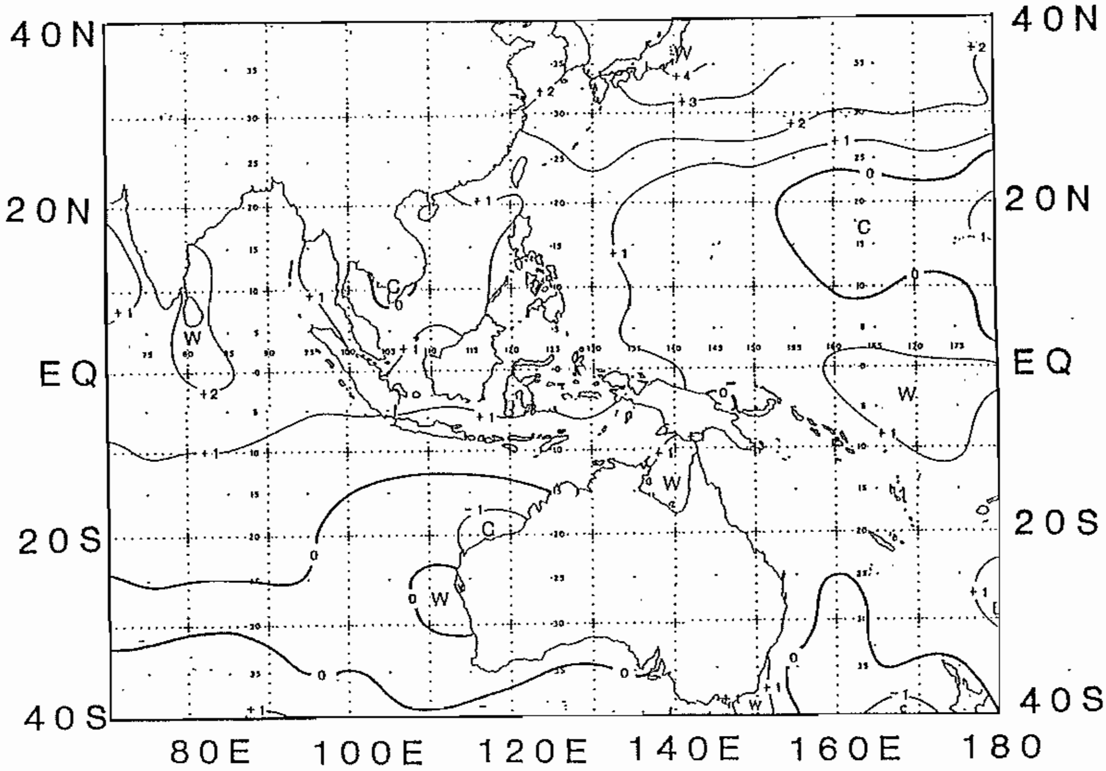


Fig. 3 SST ANOMALY CHART, BASED ON FIG. 2 AND THE CLIMATOLOGY OF REYNOLDS, NOAA REPORT NWS 31, 1983
Isotherm interval 1° C.

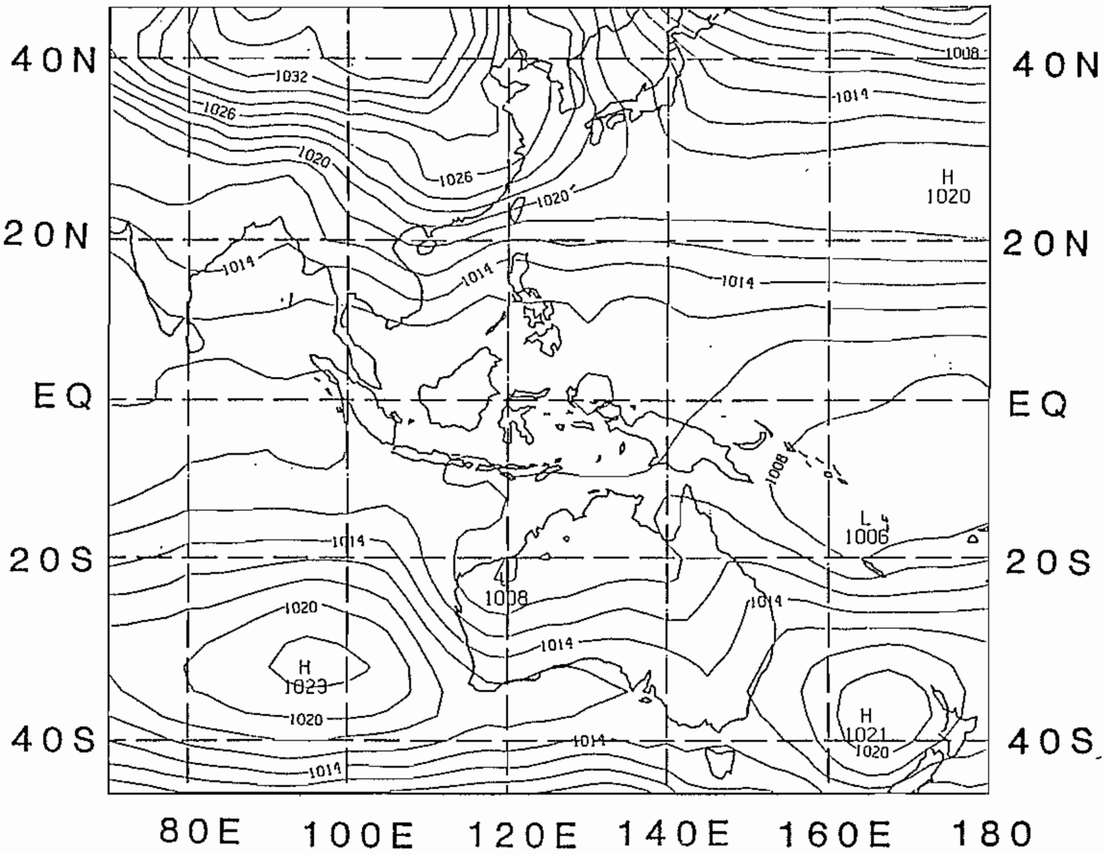


Fig. 4 MONTHLY MEAN MSL PRESSURE, JANUARY 1988
Isobar interval 2 hPa.

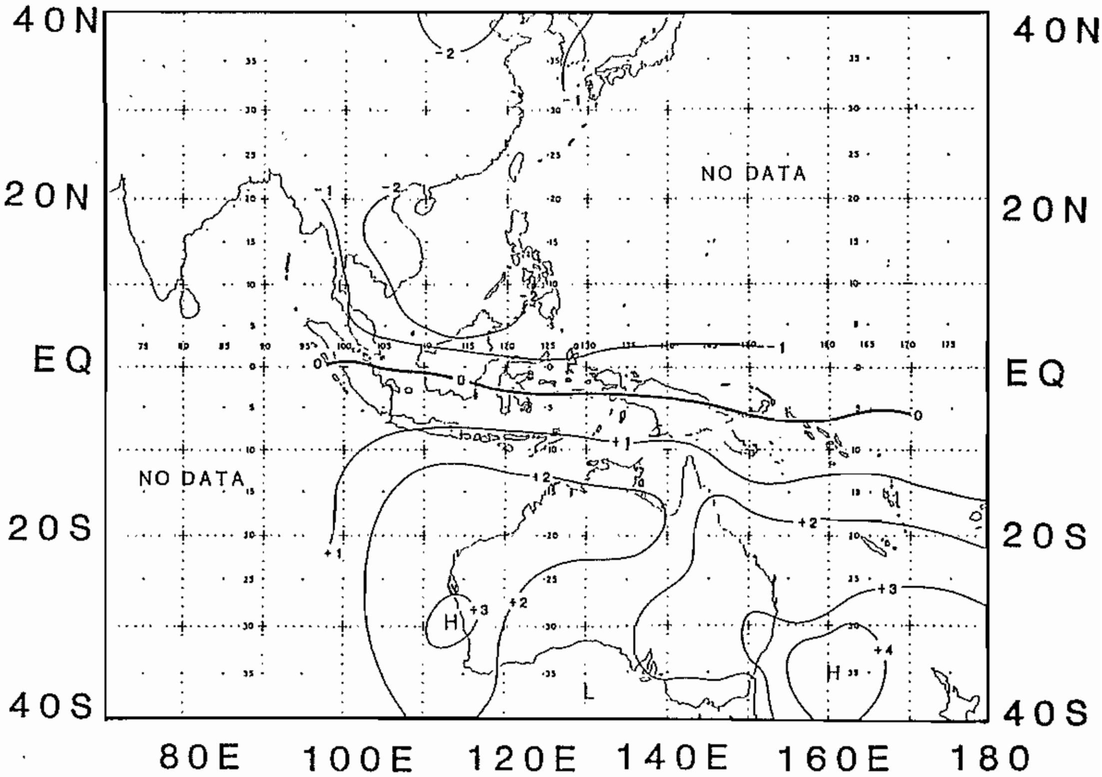


Fig. 5 MSL PRESSURE ANOMALY BASED ON CLIMAT MESSAGES
(AND MELBOURNE WMC DATA SOUTH OF 10^{o}S)
Contour interval 1 hPa.

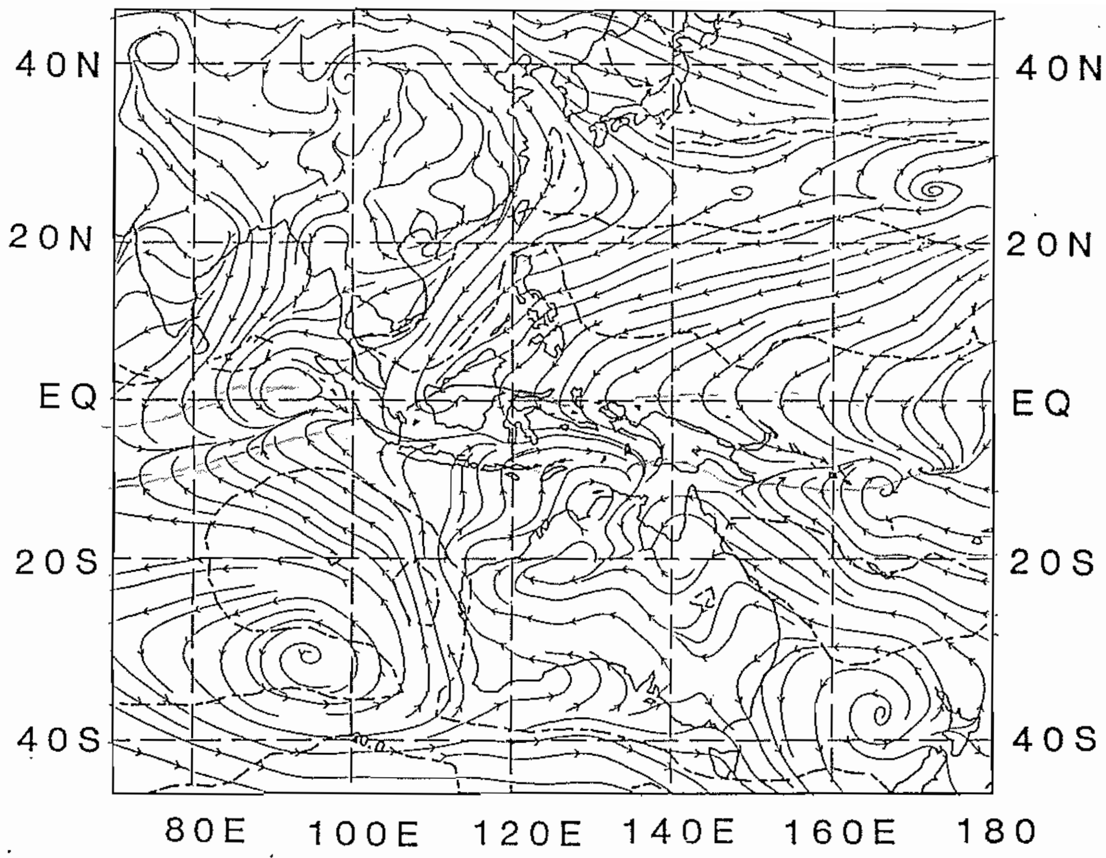


Fig. 6 950 hPa STREAMLINE ANALYSIS, JANUARY 1988
Isotachs (dashed line) at 10 knot intervals.

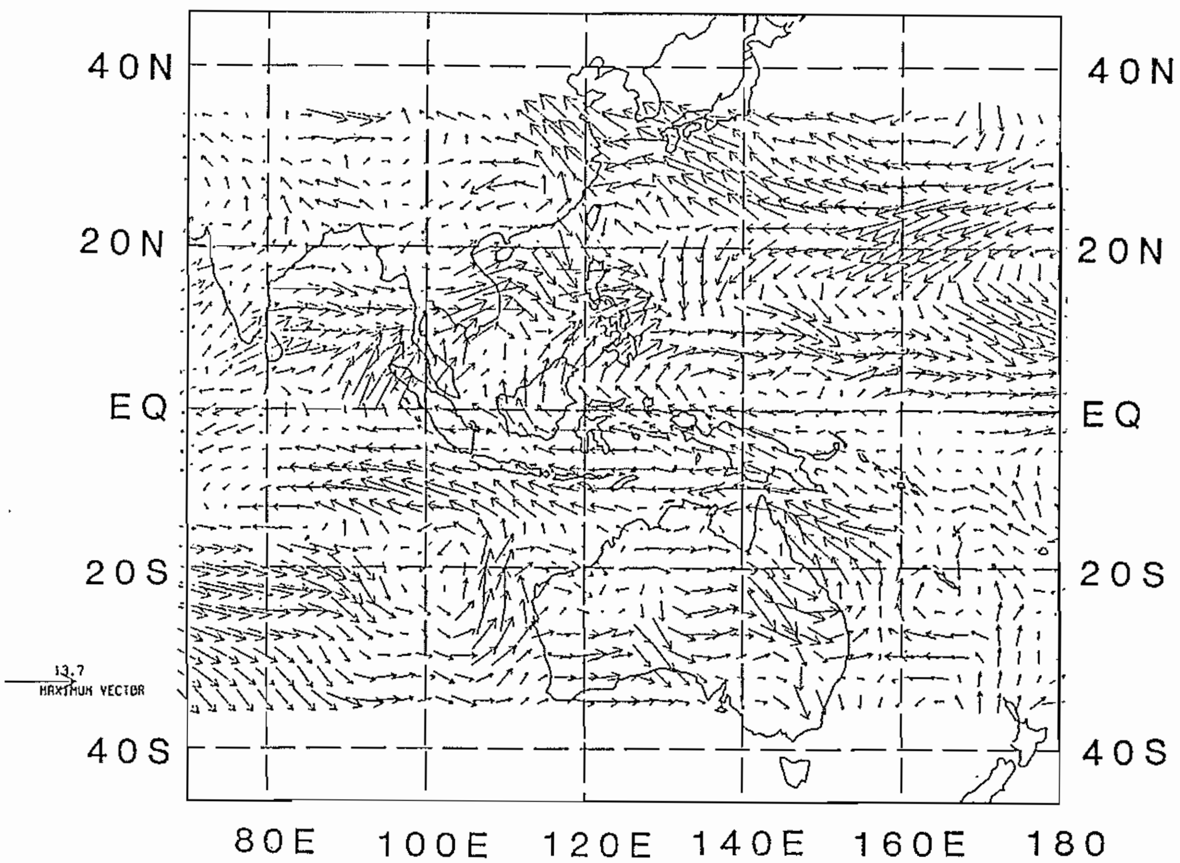
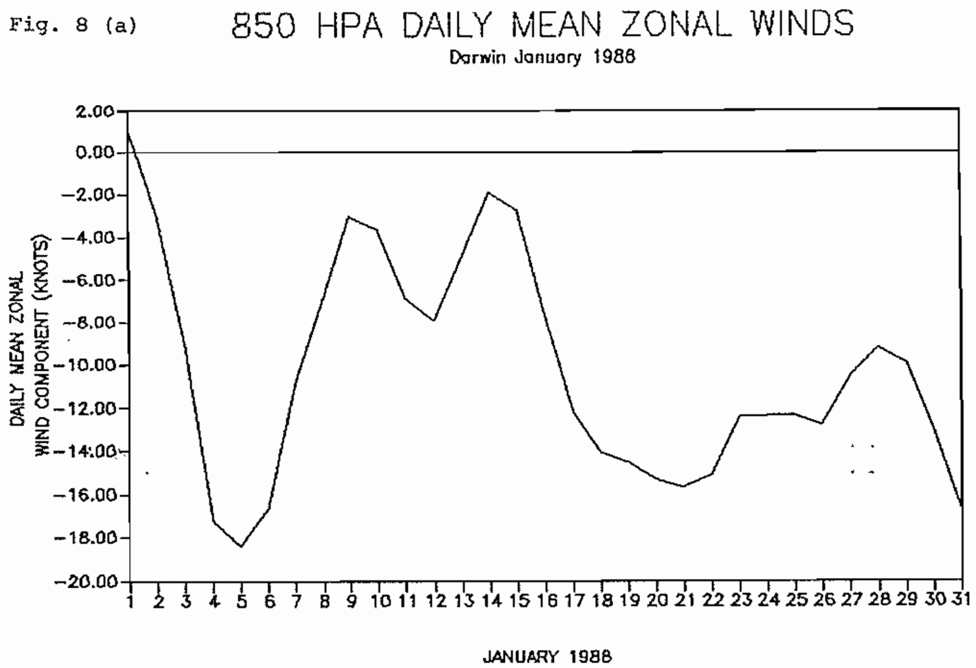
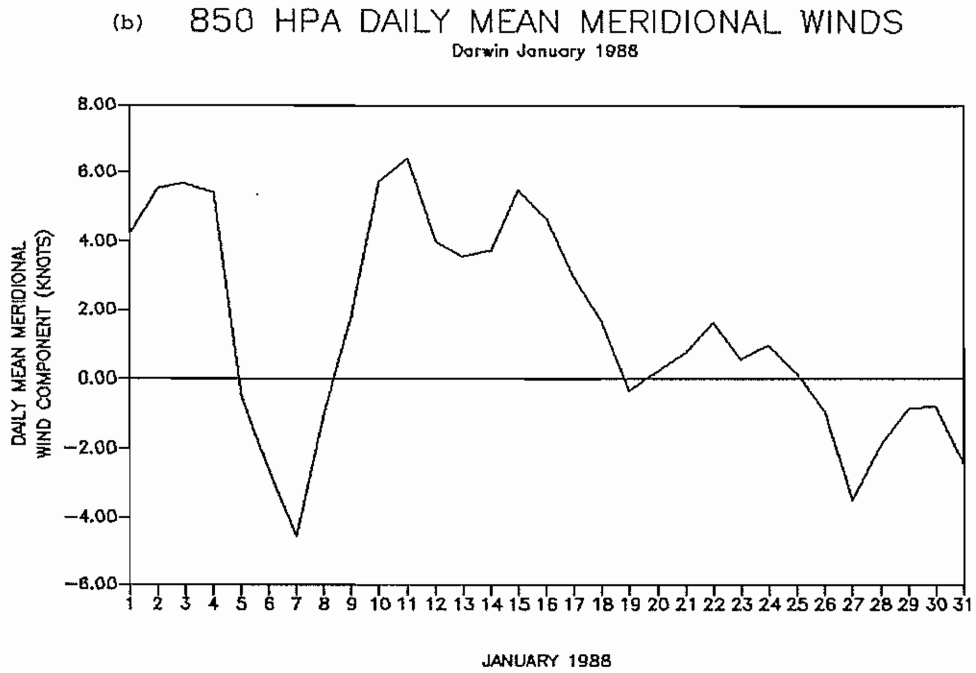


Fig. 7 950 hPa VECTOR WIND ANOMALY BASED ON FIG. 6
(Arrow length indicates magnitude).

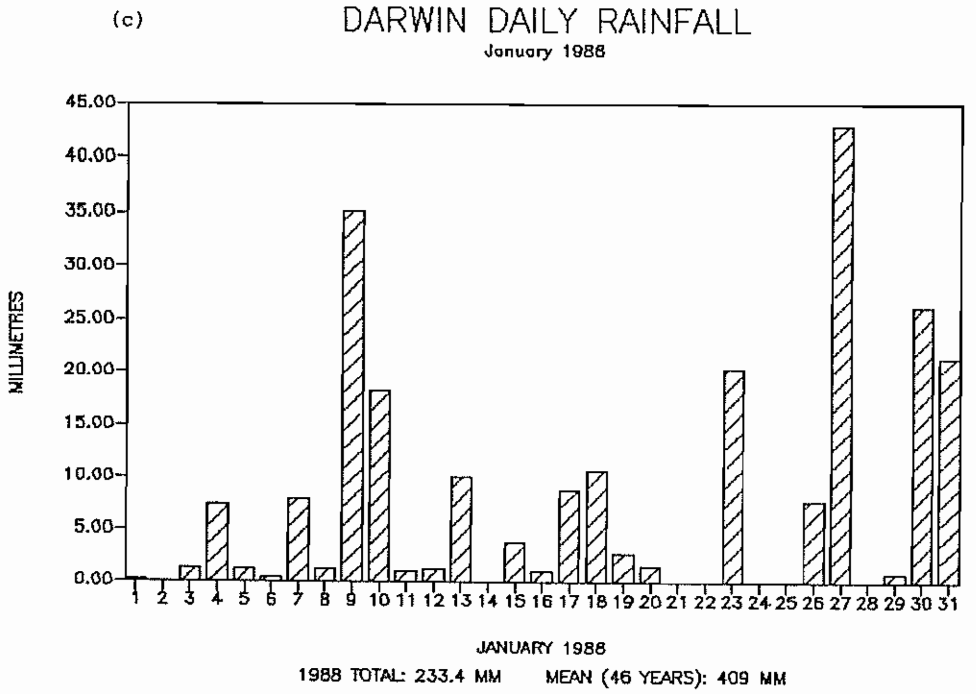
Fig. 8 (a)


850 HPA DAILY MEAN ZONAL WINDS
Darwin January 1988
DAILY MEAN ZONAL WIND COMPONENT (KNOTS)
2.00
0.00
-2.00
-4.00
-6.00
-8.00
-10.00
-12.00
-14.00
-16.00
-18.00
-20.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
JANUARY 1988

(b)


850 HPA DAILY MEAN MERIDIONAL WINDS
Darwin January 1988
DAILY MEAN MERIDIONAL WIND COMPONENT (KNOTS)
8.00
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
JANUARY 1988

(c)


DARWIN DAILY RAINFALL
January 1988
MILLIMETRES
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
JANUARY 1988
1988 TOTAL: 233.4 MM MEAN (46 YEARS): 409 MM

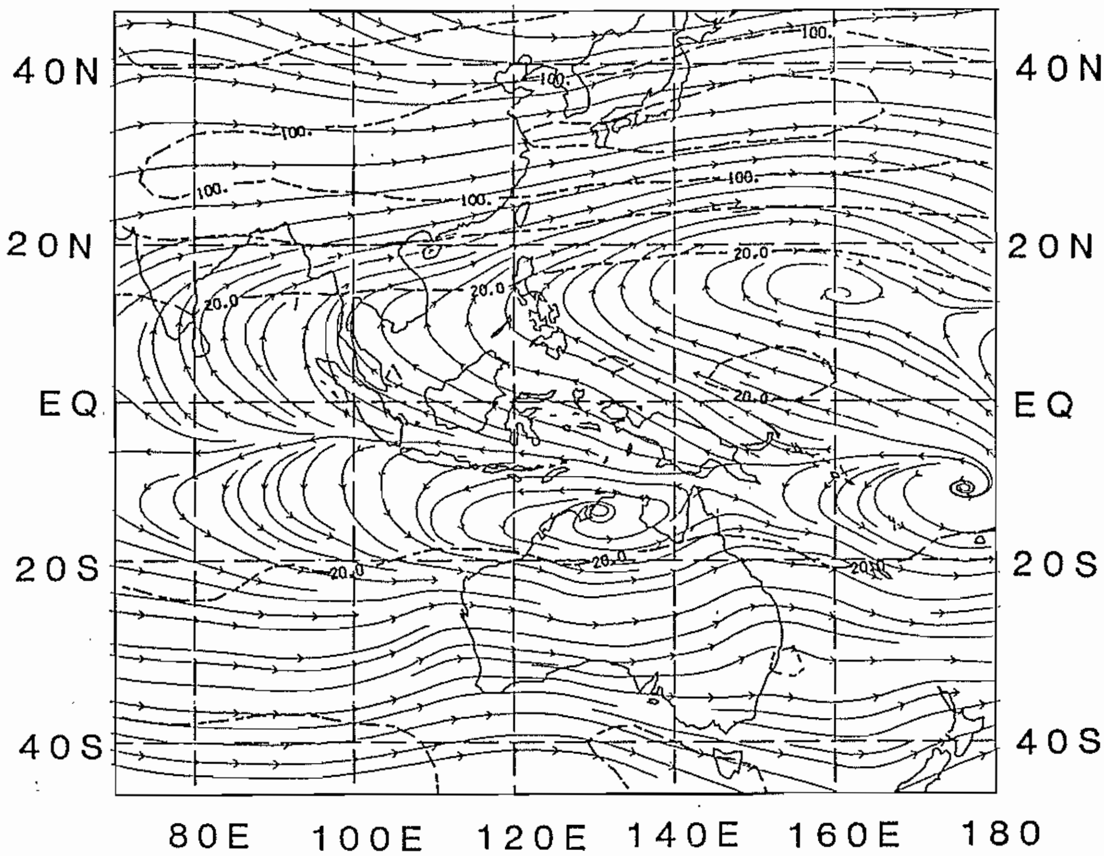


Fig. 9 200 hPa STREAMLINE ANALYSIS, JANUARY 1988
Isotachs (dashed line) at 40 knot intervals.

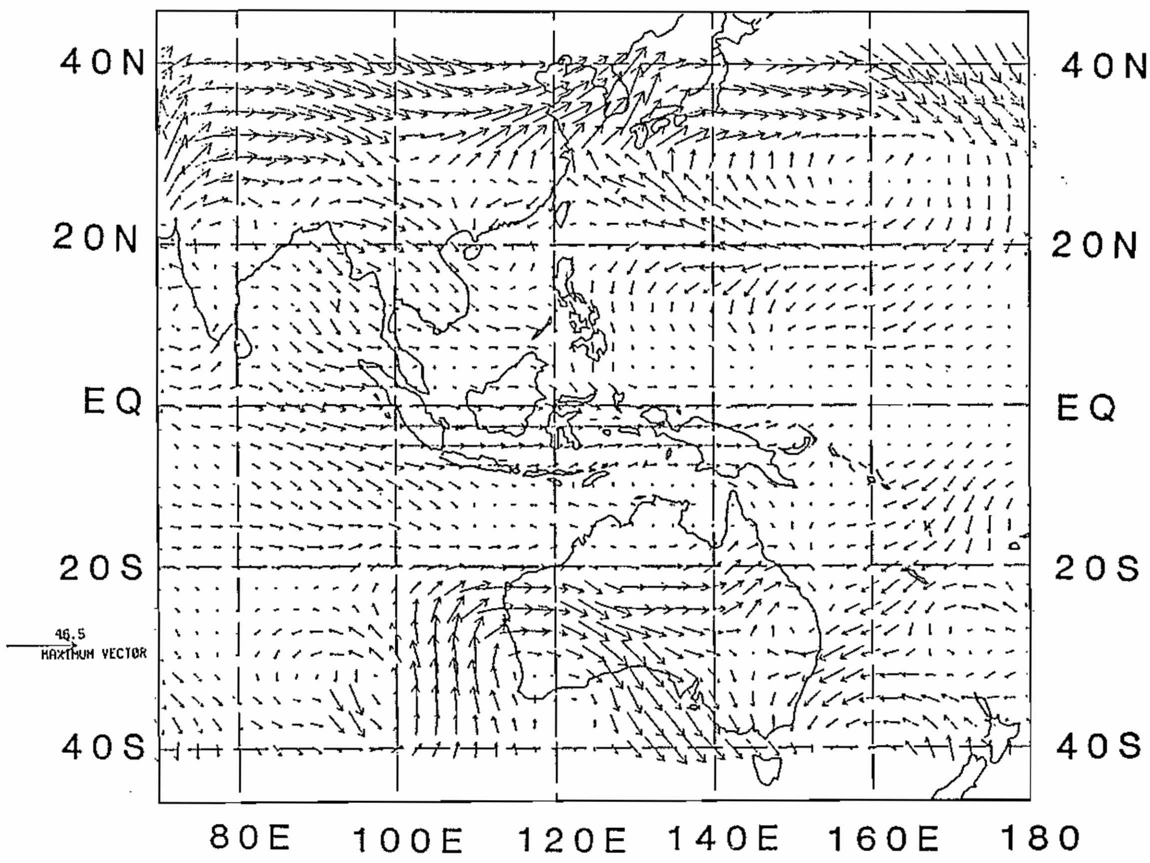


Fig. 10 200 hPa VECTOR WIND ANOMALY BASED ON FIG. 8
(Arrow length indicates magnitude).

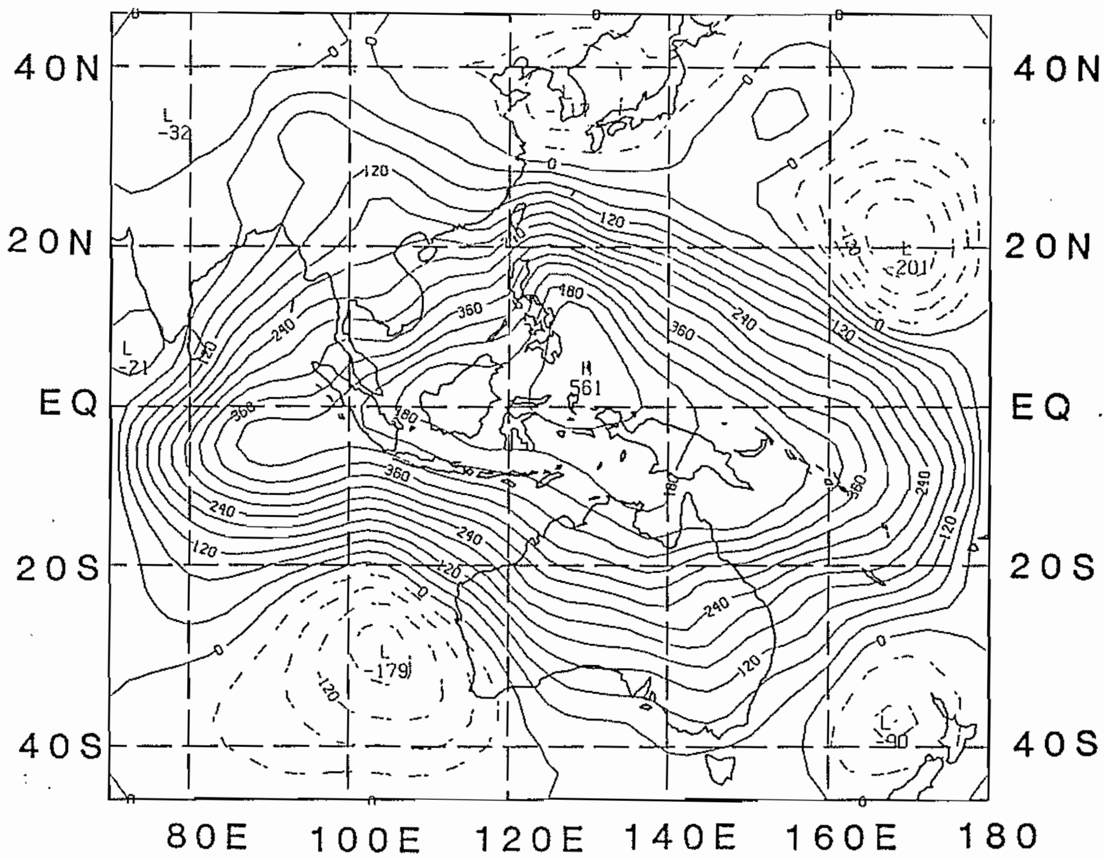


Fig. 11 950 hPa VELOCITY POTENTIAL, JANUARY 1988
Contour interval 40 x 10^{5} m^{2} s^{-1}

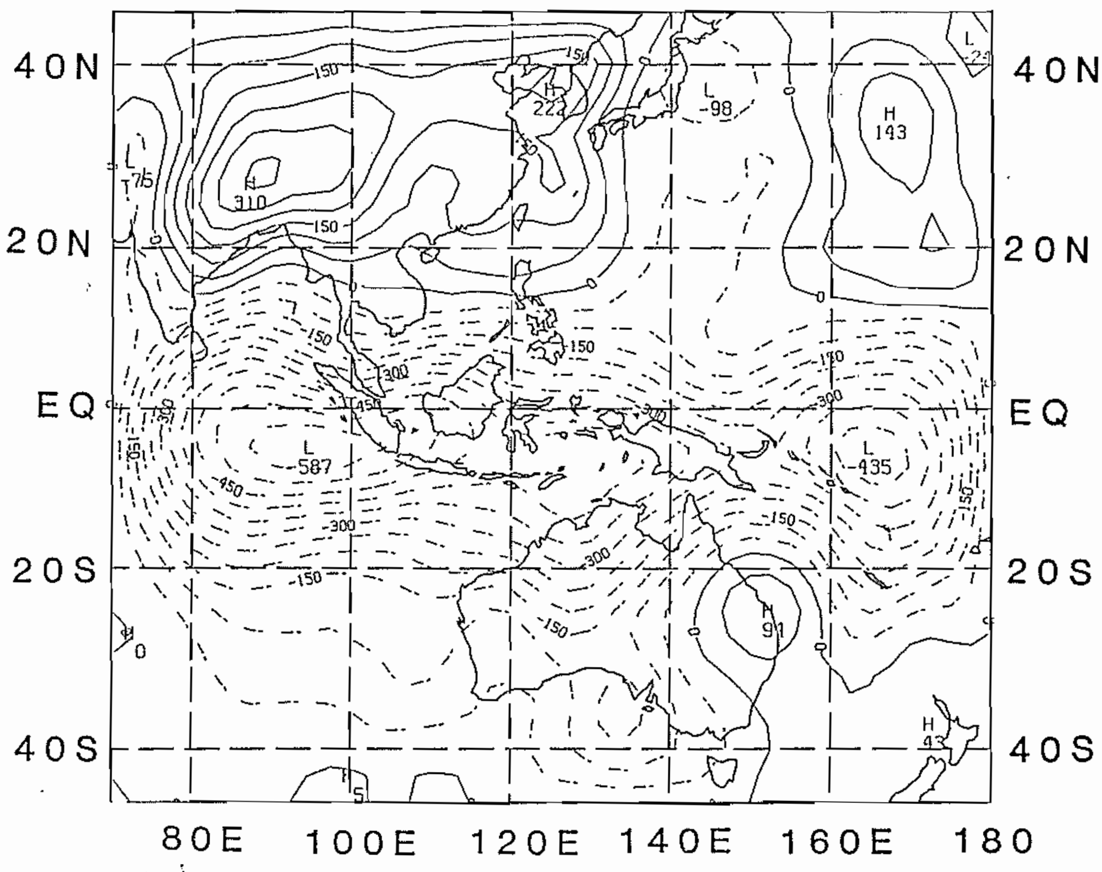


Fig. 12 200 hPa VELOCITY POTENTIAL, JANUARY 1988
Contour interval 5 x 10^{5} m^{2} s^{-1}

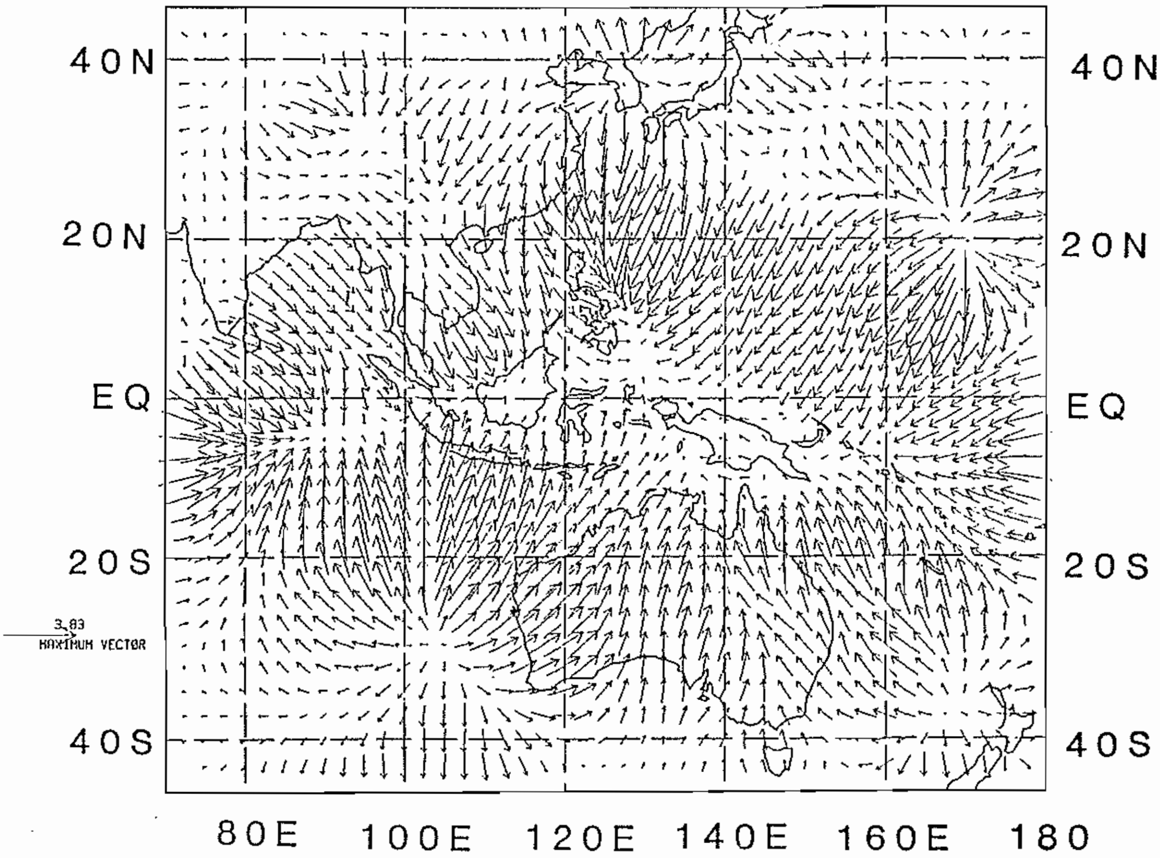


Fig. 13 950 hPa DIVERGENT WIND, JANUARY 1988
(Arrow length indicates magnitude).

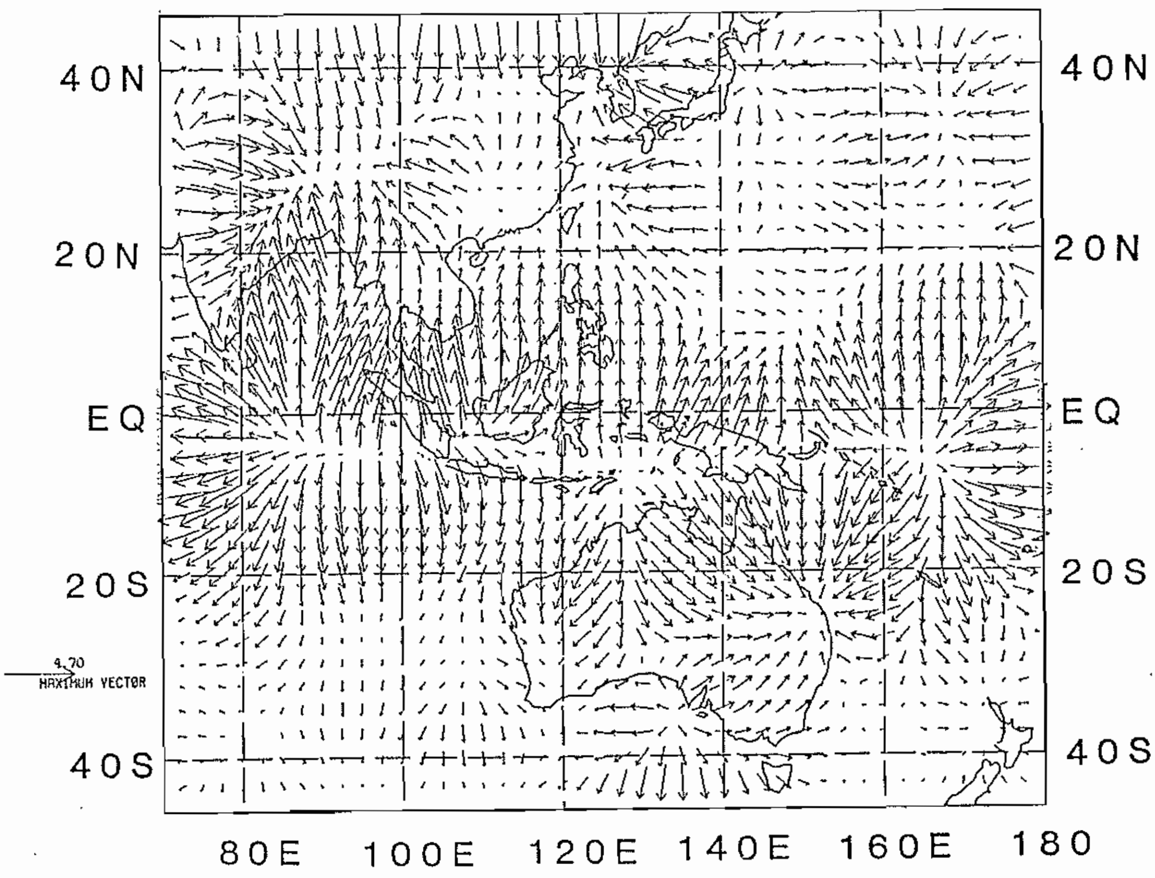


Fig. 14 200 hPa DIVERGENT WIND, JANUARY 1988
(Arrow length indicates magnitude).

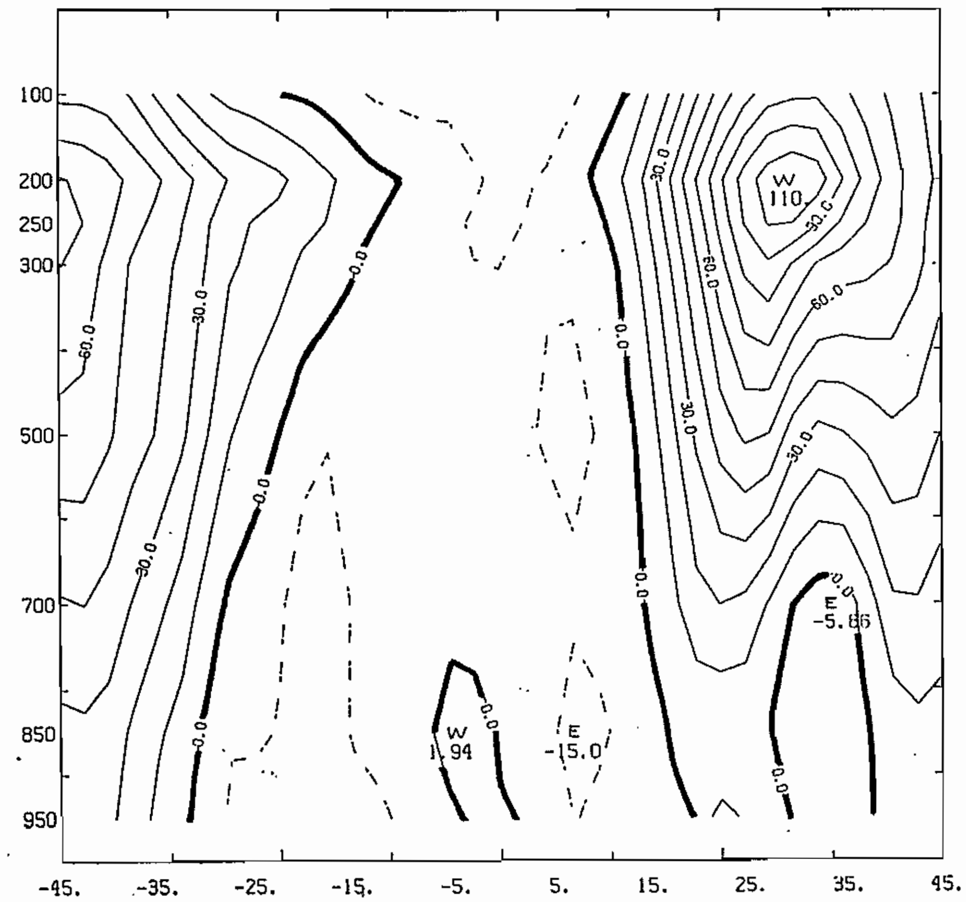


Fig. 15 CROSS-SECTION OF ZONAL WIND ALONG 100°E, JANUARY 1988
Isotach interval 10 knots.

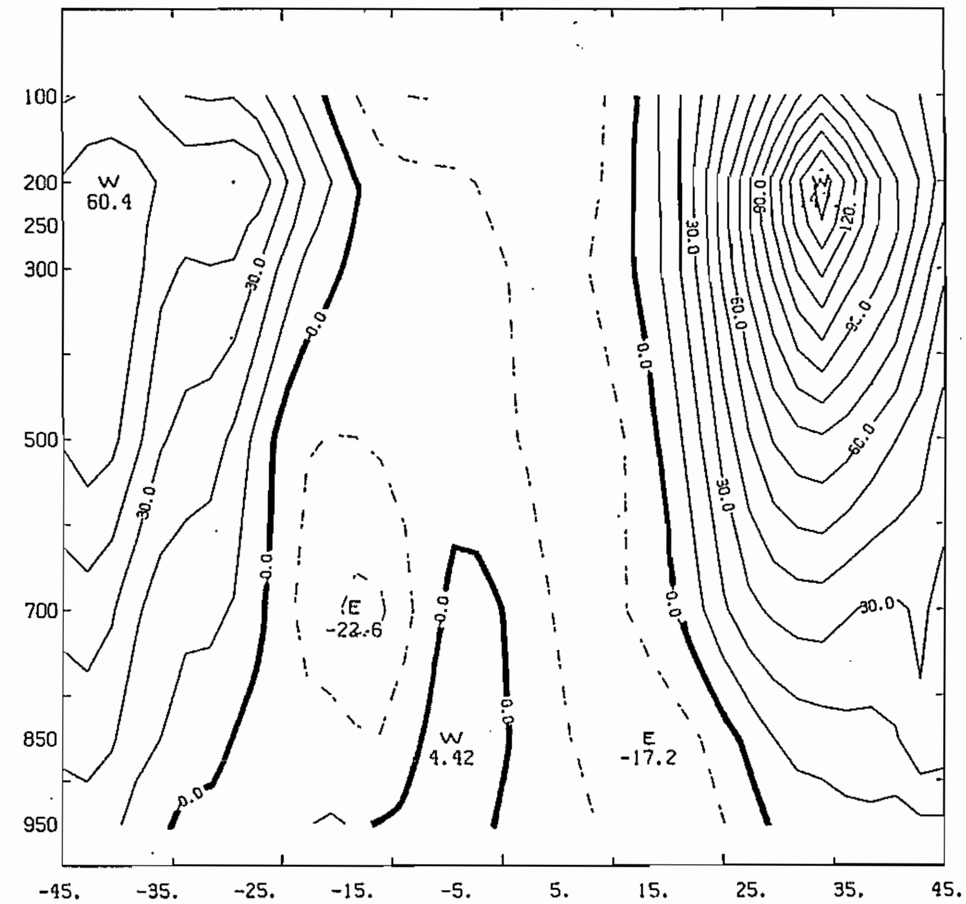


Fig. 16 CROSS-SECTION OF ZONAL WIND ALONG 130°E, JANUARY 1988
Isotach interval 10 knots.

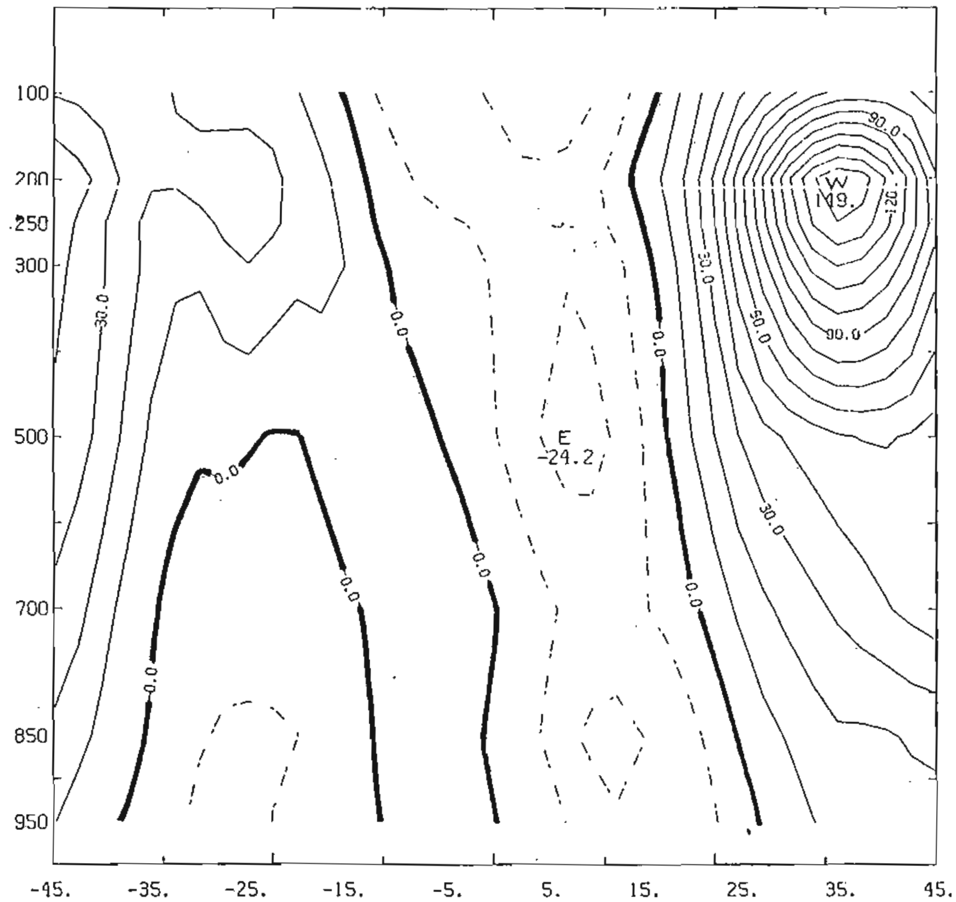


Fig. 17 CROSS-SECTION OF ZONAL WIND ALONG 160° E, JANUARY 1988
Isotach interval 10 knots.

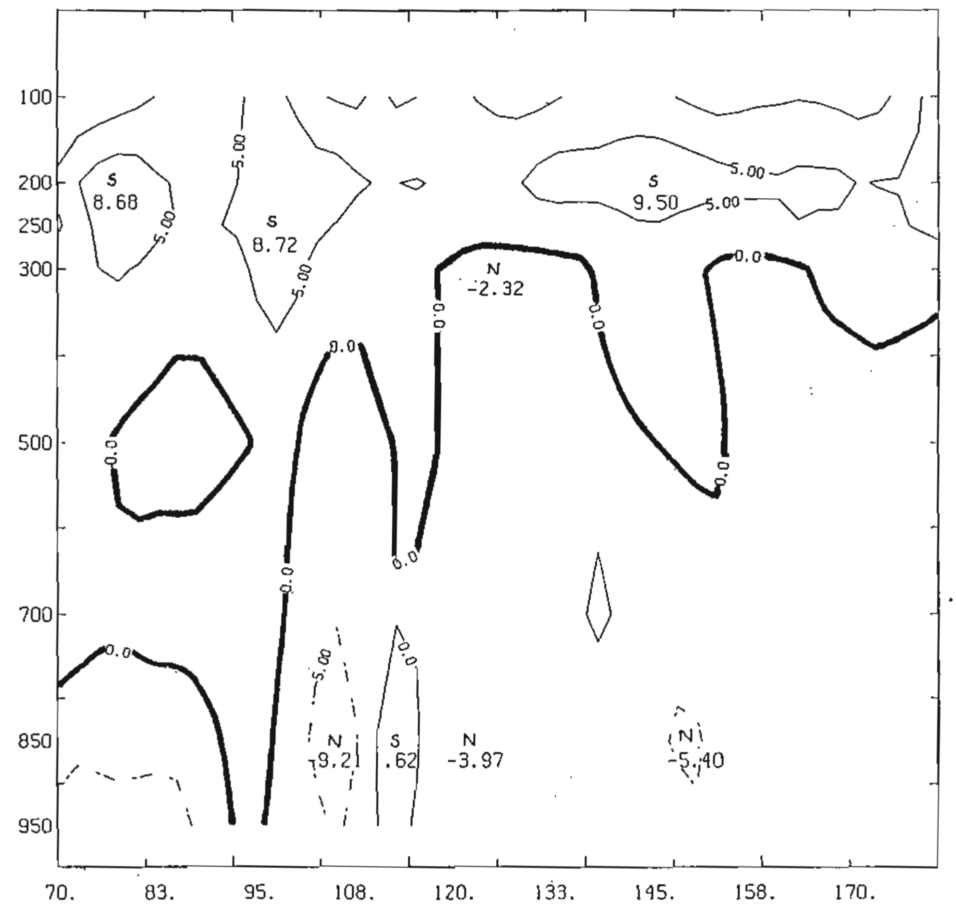


Fig. 18 EQUATORIAL CROSS-SECTION OF MERIDIONAL WIND
BETWEEN 70°E AND 180°E, JANUARY 1988. 5 knot isotachs.

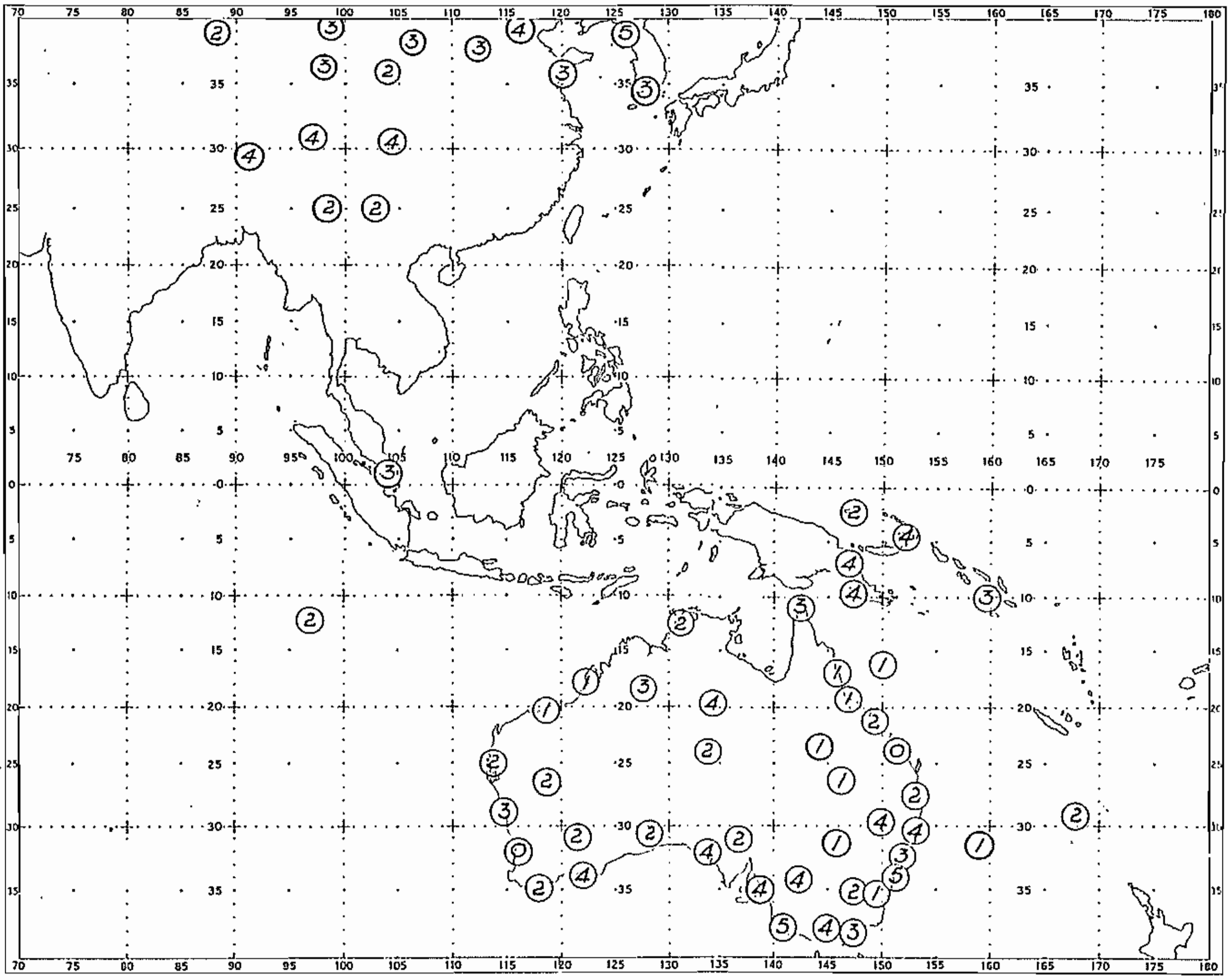


Fig. 19 MONTHLY MEAN RAINFALL QUINTILES from selected climat stations
JANUARY 1988

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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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