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DARWIN TROPICAL DIAGNOSTIC STATEMENT

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DARWIN TROPICAL DIAGNOSTIC STATEMENT

June 2010

ISSUED BY NORTHERN TERRITORY CLIMATE SERVICE CENTRE

SUMMARY

Most oceanic and atmospheric indicators continued to be consistent with the prevailing neutral conditions across the equatorial Pacific during June. Since March 2010, positive SST anomalies have consistently decreased across the equatorial Pacific with warm SST anomalies now confined to the tropical western Pacific. Sub-surface temperatures have continued to cool and remain below average across most of the central and eastern Pacific Ocean. Positive anomalies have continued in the far west at around 140° east, with a core positive anomaly at around 100 meters deep in relation to a deepening of the mixed layer. The Southern Oscillation Index (SOI) remained above one standard deviation for a third month in a row. No tropical cyclone occurred in the RSMC analysis area during the month.

INDICES

Troup's Southern Oscillation Index (SOI) for June 2010	+1.8
5-month mean (centred upon April)	+0.4
Darwin mean MSL pressure for June 2010	1013.2 hPa
Pressure anomaly (1933 – 1992 mean)	0.7 hPa
Tahiti mean MSL pressure for June 2010	1014.6 hPa
Pressure anomaly (1933 – 1992 mean)	0.9 hPa

Time series of Troup's SOI:

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	+ 14	+ 21	+ 12	+ 4	- 4	+ 5	+ 2	+ 9	+ 14	+ 13	+ 17	+ 13
2009	+ 9	+ 15	0	+9	- 5	- 2	+ 2	- 5	+ 4	-15	-7	-7
2010	-10	-14	-11	+15	+10	+2						

The above table presents monthly values of the SOI from 2008 to date. Fig.1 shows the monthly SOI and its five-month running mean for the past ten years. After six consecutive months of negative SOI values, the monthly SOI soared to a positive value (+15) in April and stayed positive during May and June. The five month mean SOI rose from -2 in May to +0.4 in June. The change in the SOI value is consistent with a neutral phase, observed during the past few months.

TROPICAL CYCLONES (TC) [Fig. 2]

No tropical cyclones were analysed in the RSMC area during June although one short-lived tropical depression was observed 600km east of Manila in the Philippines. The comparative long-term means for tropical cyclone formation during June are 1.8 tropical storms (1.1 typhoons) for the north-western Pacific Ocean, 0.2 for the South Pacific and Indian Oceans combined and 0.6 for the northern Indian Ocean including the Bay of Bengal.

SEA SURFACE TEMPERATURE (SST) [Figs. 3a, 3b]

Sea surface temperatures over the central equatorial Pacific continued to cool during June, with cooler than average temperatures extending east of the date-line to the American continent. Warm temperature anomalies have now expanded over most of the western tropical Pacific, the Maritime Continent and the Philippine Sea. Warm SSTs to the north and east of Papua New Guinea have continued to expand, while sub surface temperatures have warmed by up to 2 degrees at around 140° east. Sub surface temperatures across the equatorial Pacific remained cooler than normal with some areas in the central Pacific up to 4° C below the norm. Over the Indian Ocean, warm SSTs have contracted towards the equatorial region and the Maritime Continent. Warmer than normal SSTs persisted in the Indian Ocean at around 30° south during June.

MEAN SEA LEVEL PRESSURE (MSLP) [Figs. 4a, 4b]

Weak negative MSLP anomalies persisted over the equatorial Indian Ocean and the Arabian Sea, with positive MSLP anomalies extending over most of the RSMC area. Strong positive anomalies extended across southern Australia and into the South Indian Ocean. Anomalies were also positive over the North Pacific around the dateline associated with a relative absence of a monsoon trough during June.

850hPa FLOW [Figs. 5a, 5b]

Low-level easterly winds over the eastern tropical RSMC area continued to strengthen during June. Easterly flow over the Equator was stronger than average over the equatorial Pacific, most notably north of Papua New Guinea as a response to a weakening of El Niño, and becoming more characteristic of a La Niña pattern. Stronger than normal easterly flow off the west coast of Western Australia was also observed in June in response to the positive MSLP anomalies over the area.

200hPa FLOW [Figs 6a, 6b]

The upper level flow remained close to the long-term average over most of the equatorial Pacific and Indian Oceans. The Northern Hemisphere sub-tropical jet was weaker than normal, giving rise to easterly anomalies of up to 20 ms^{-1}.

VELOCITY POTENTIAL [Figs 7a, 7b]

The axes of low level convergence and upper level divergence were well aligned across the Indian subcontinent and the Maritime Continent in June. This is indicative of an active monsoon over India and a relative absence of a monsoon trough over the northwest Pacific.

OUT-GOING LONG-WAVE RADIATION (OLR) [Figs 8a, 8b]
Negative OLR anomalies over the northern Indian Ocean were observed during June, while an active monsoon persisted in the region. On the other hand, the western tropical Pacific recorded strong positive OLR anomalies, where there was a relative lack of monsoonal activity in June. The enhanced low-level easterly winds, triggered mostly by the rapid transition from El Nino towards La Nina, generated significant broadscale convergence across the Indonesian Archipelago during June (resulting in strong negative OLR anomalies due to widespread convection) and significant rainfall across the region.

CROSS-EQUATORIAL INTERACTION [Fig. 9]
Strong northerly flow at 200 hPa in the Indian Ocean, underlain by strong southerlies near the surface, is indicative of an active southwest monsoon over the Asian subcontinent. This strong Hadley circulation can be seen to break down east of 130E, where we have seen a relative absence of monsoonal activity in the Southeast Asian region.

850 hPa WIND COMPONENTS AT DARWIN [Figs. 10a, 10b]
Low-level winds at Darwin remained south-easterly during the first few days of the month, which dropped overnight temperatures below 20° for the first time this year. Later in the month, the normal southerly component weakened, leading to a more easterly flow over Darwin due to a persistent ridge over eastern Australia. This gave rise to slightly warmer than average daytime and nighttime temperatures.

INTRA-SEASONAL VARIATIONS [Figs. 11, 12, 13]
June was marked by the active phase of the Madden-Julian Oscillation remaining near stationary in the northern Indian Ocean, while the inactive phase remained in the western North Pacific for most of the month. In turn, rainfall over southern Asia was much greater than normal during June (as can be seen from the OLR diagrams), with Southeast Asia (including Thailand through to the Philippines) recording well below average rainfall.

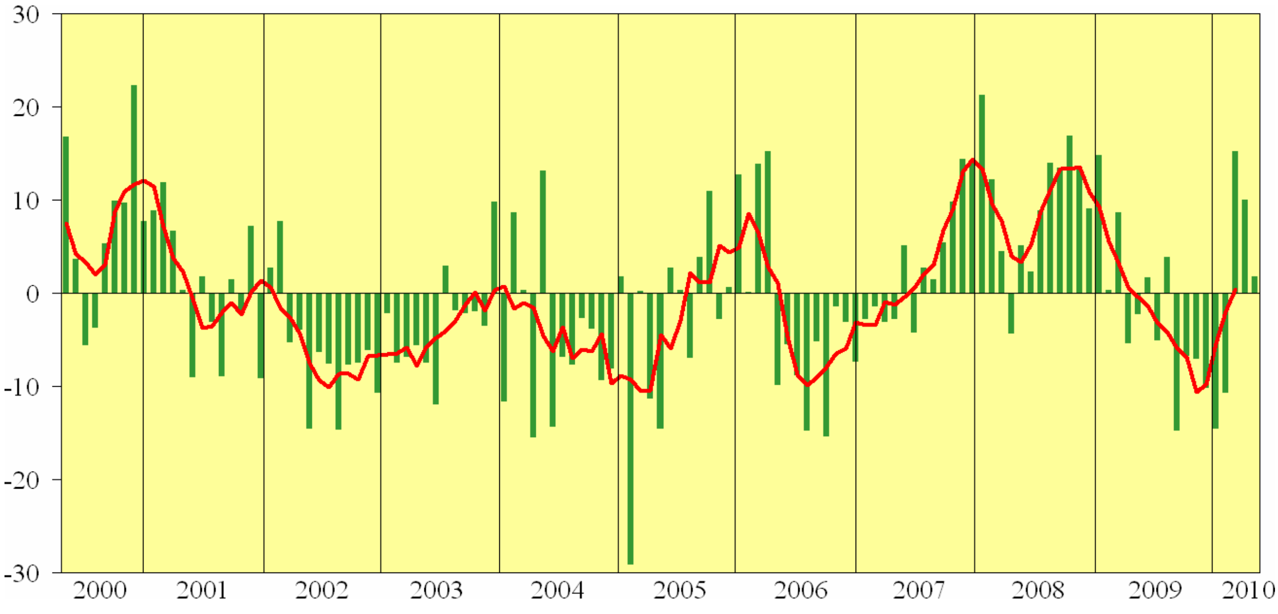

Fig. 1 SOUTHERN OSCILLATION INDEX 2000 – 2010
Monthly SOI (bars) and 5-month running mean SOI (Red line).

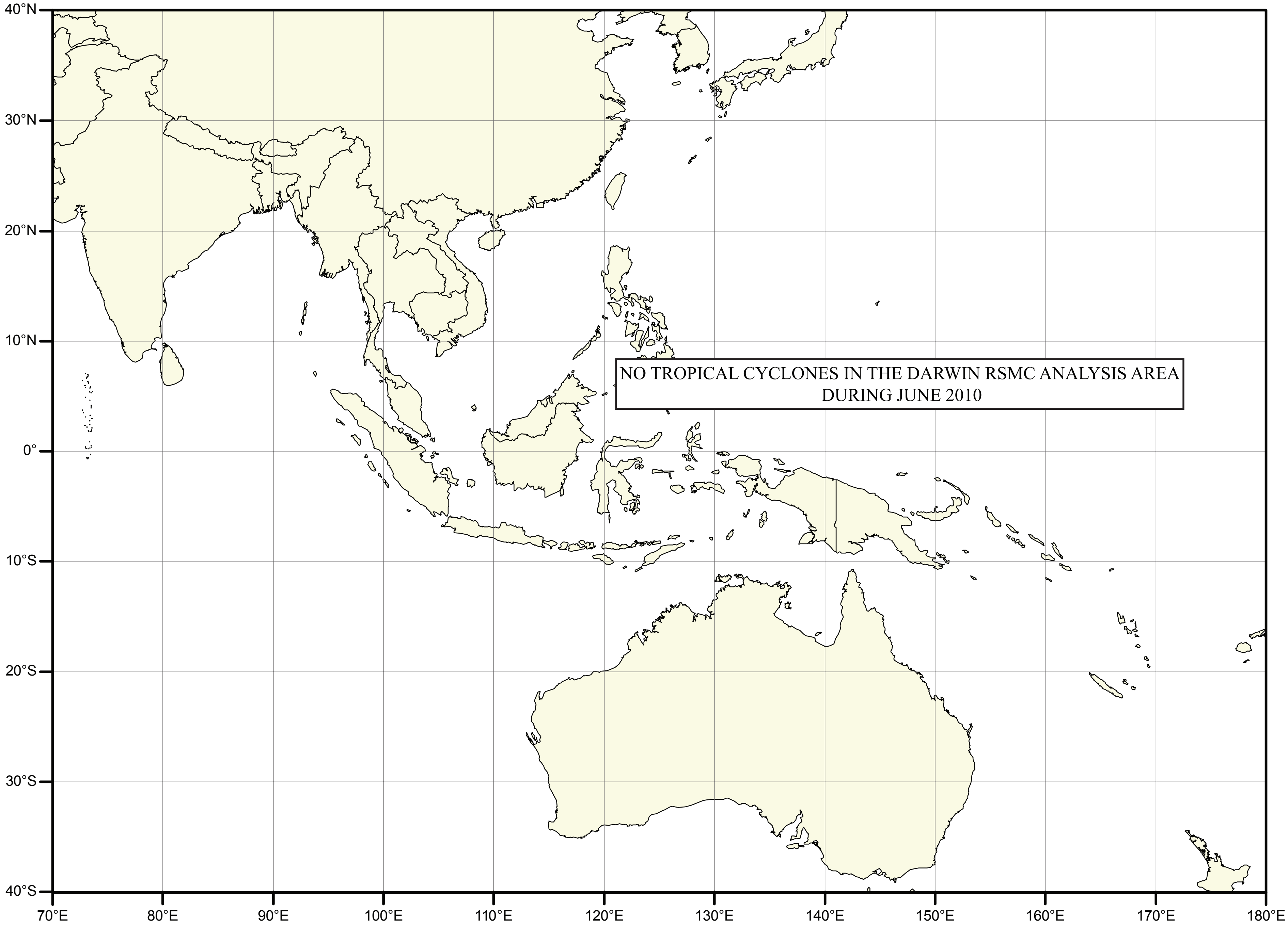

Fig. 2 OPERATIONAL TRACKS OF CYCLONES FOR JUNE 2010.

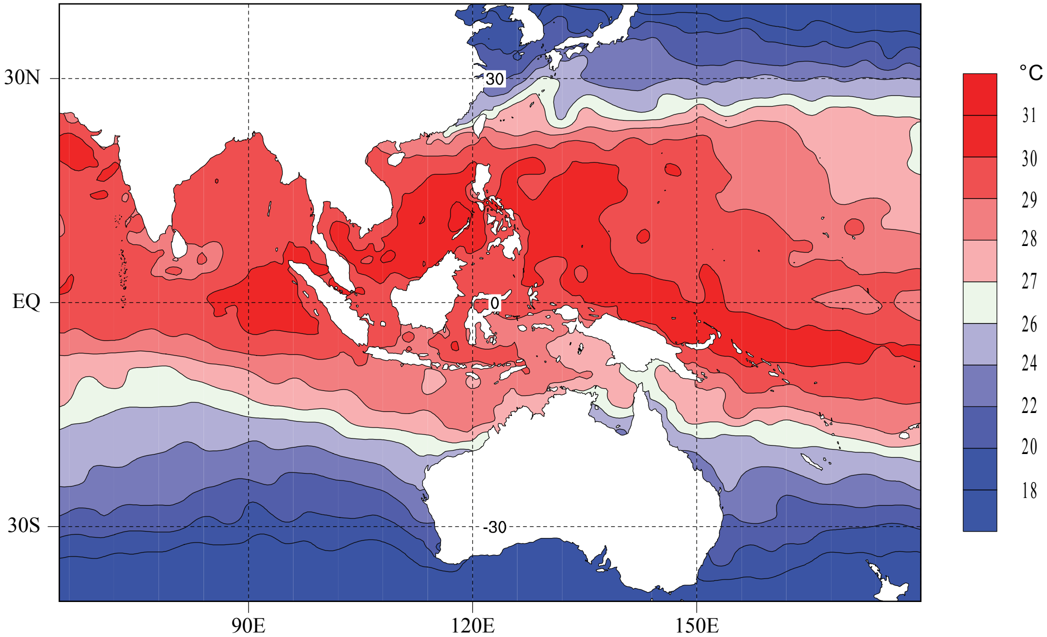

Fig.3(a) SEA SURFACE TEMPERATURE, June 2010.

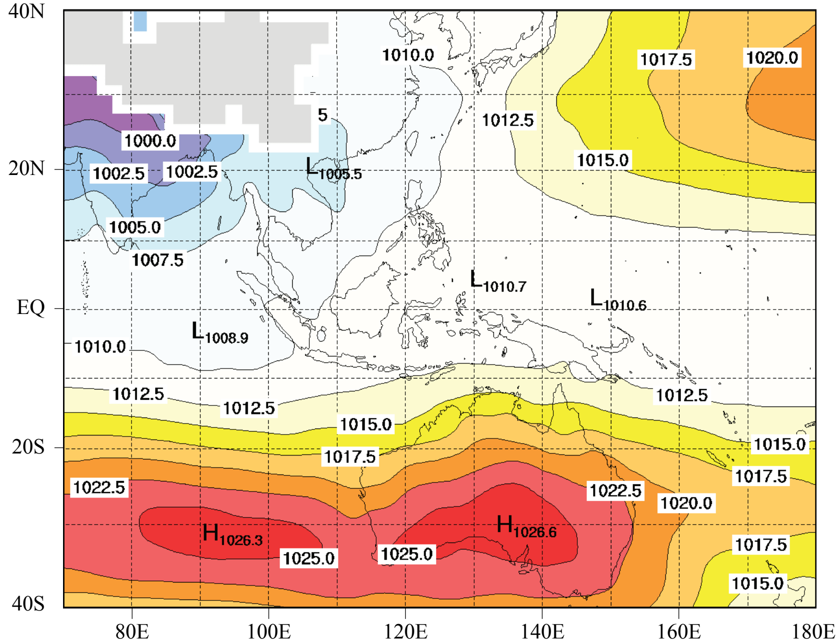

Fig.4(a) MEAN SEA LEVEL PRESSURE, June 2010.
Isobar interval 2.5 hPa

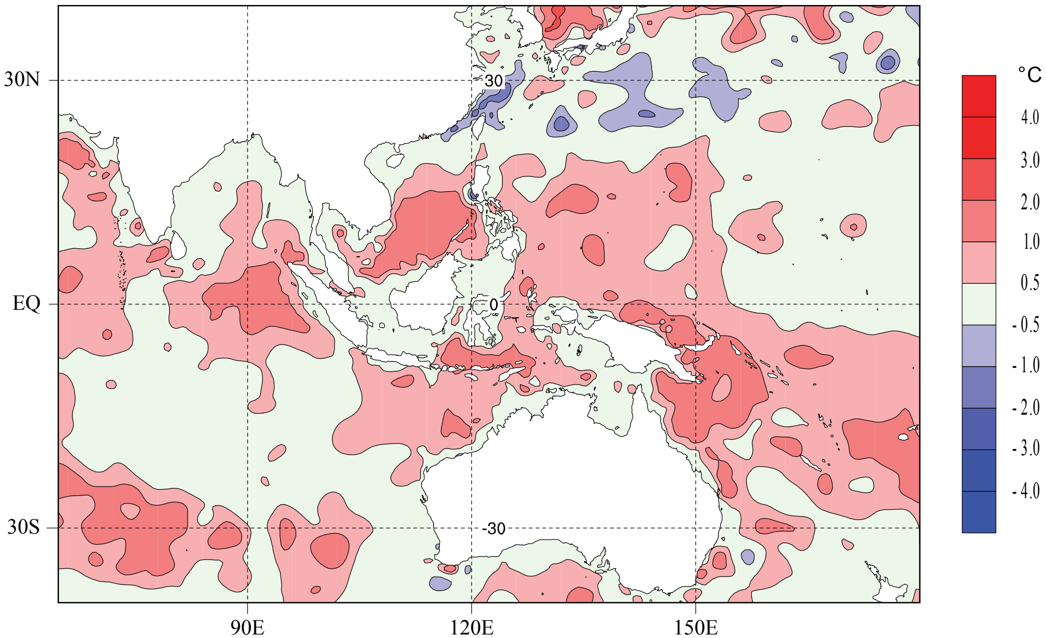

Fig.3(b) SEA SURFACE TEMPERATURE ANOMALY, June 2010.

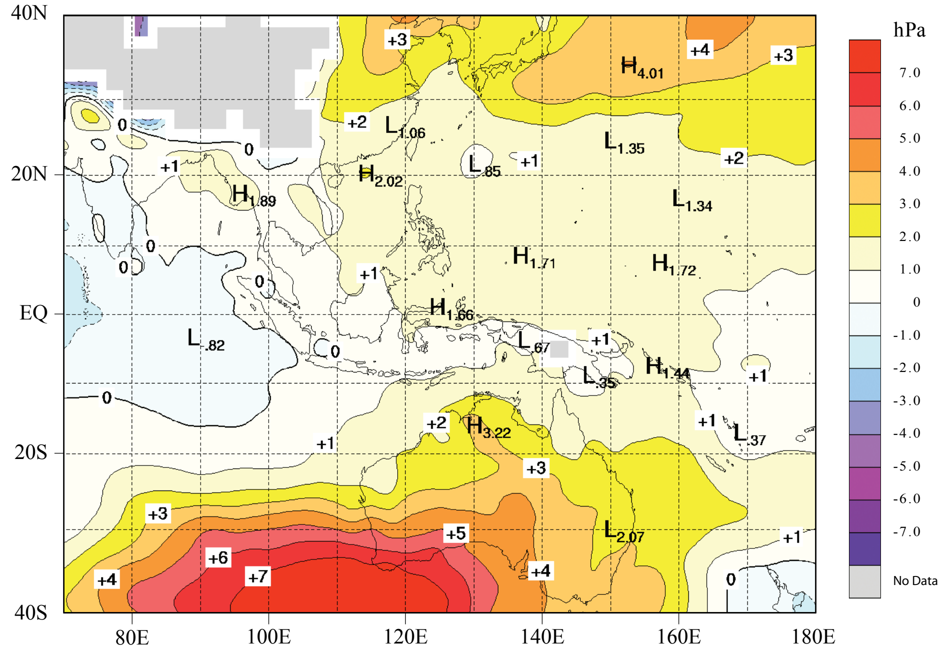

Fig.4(b) MEAN SEA LEVEL PRESSURE ANOMALY, June 2010.
Contour interval 1 hPa. Heavy line represents zero anomaly.

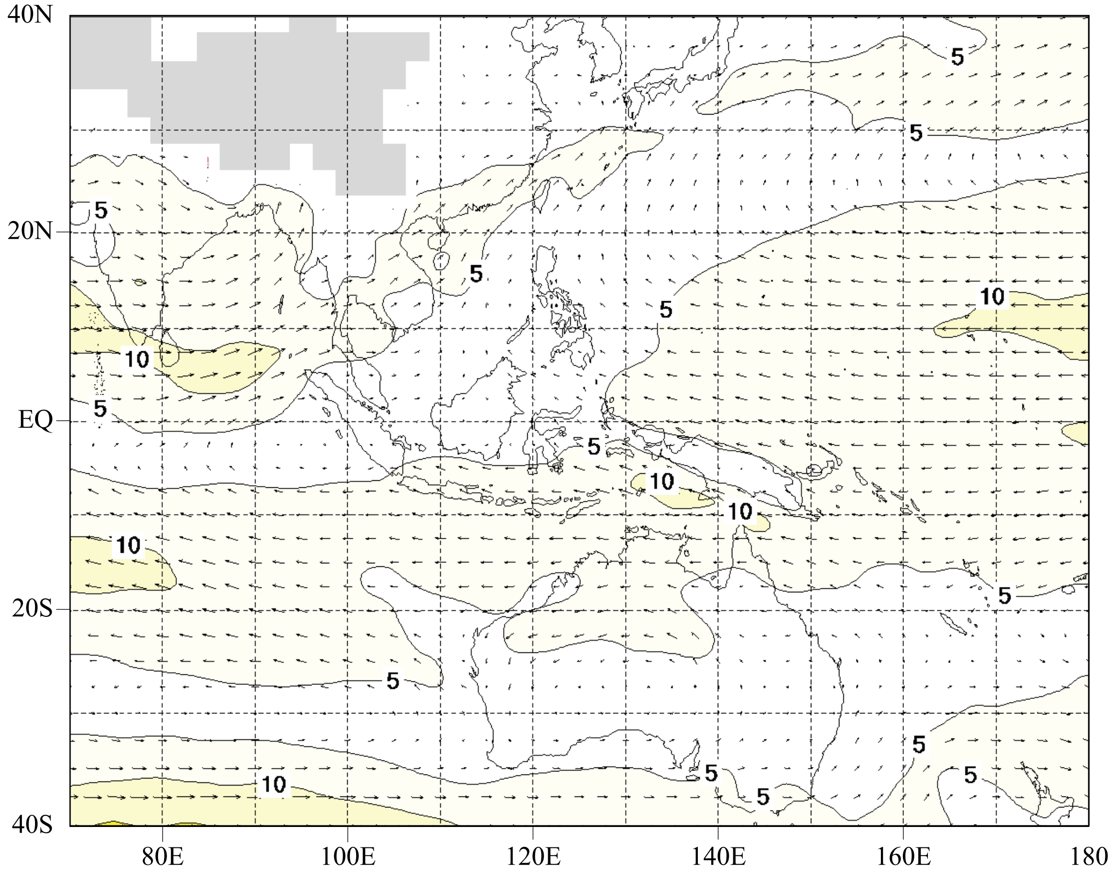

Fig.5(a) 850 hPa VECTOR WIND ANALYSIS, June 2010.
Arrow length indicates relative magnitude. Isotachs at 5ms^{-1} intervals are shaded.

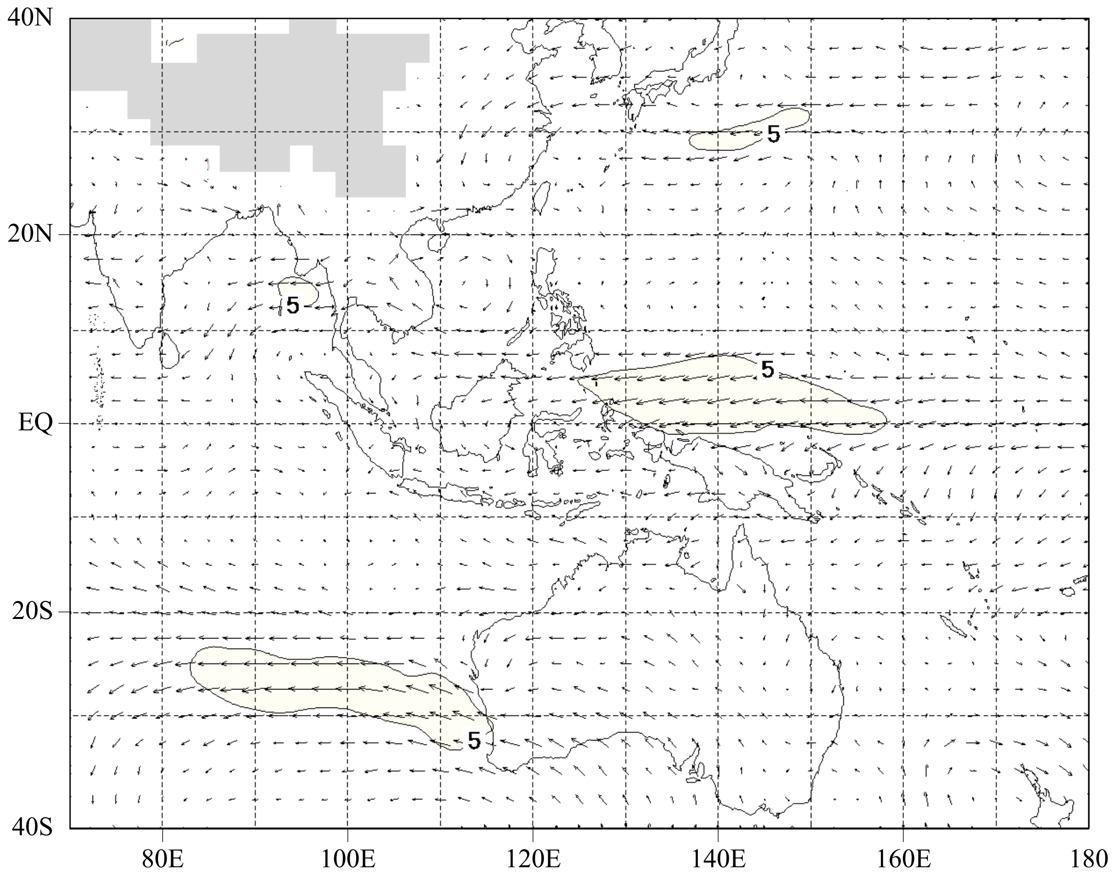

Fig.5(b) 850 hPa WIND ANOMALY, June 2010.
Arrow length indicates relative magnitude. Anomalies > 5 ms^{-1} are shaded.

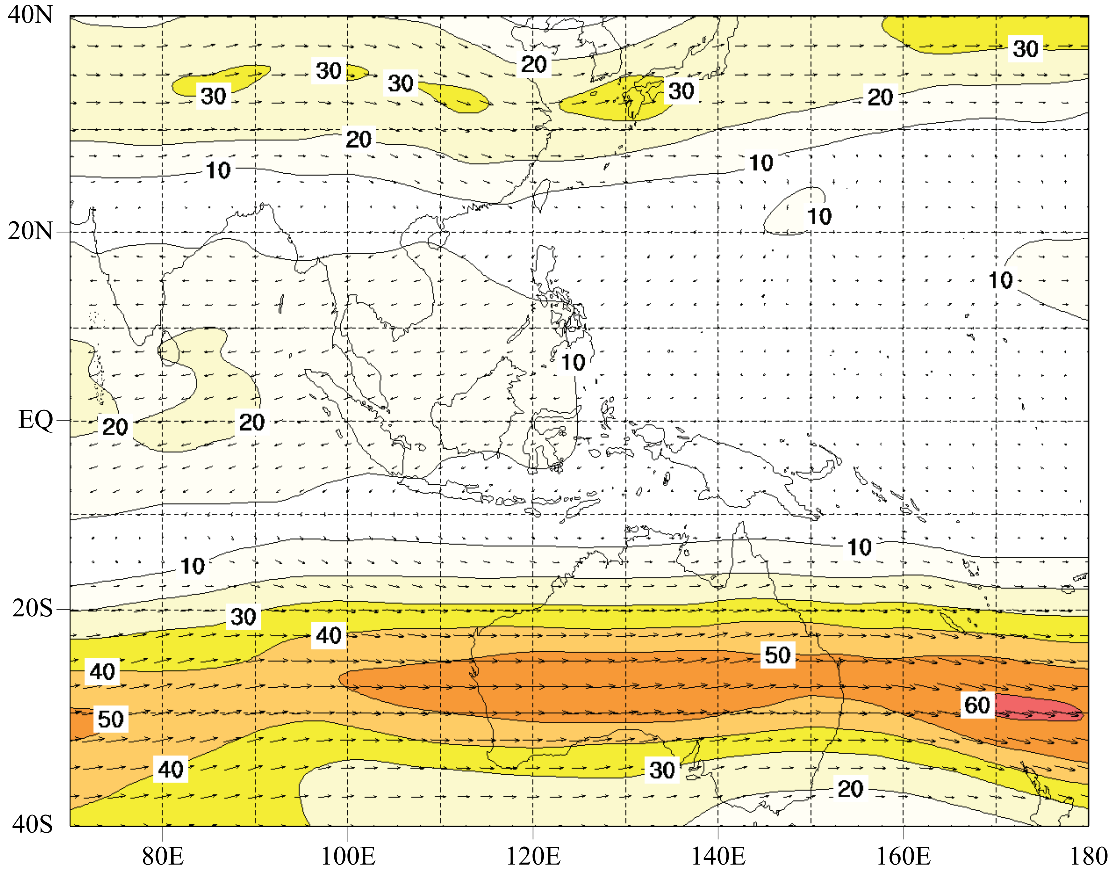

Fig.6(a) 200 hPa VECTOR WIND ANALYSIS, June 2010.
Arrow length indicates relative magnitude. Isotachs at 10ms-1 intervals are shaded.

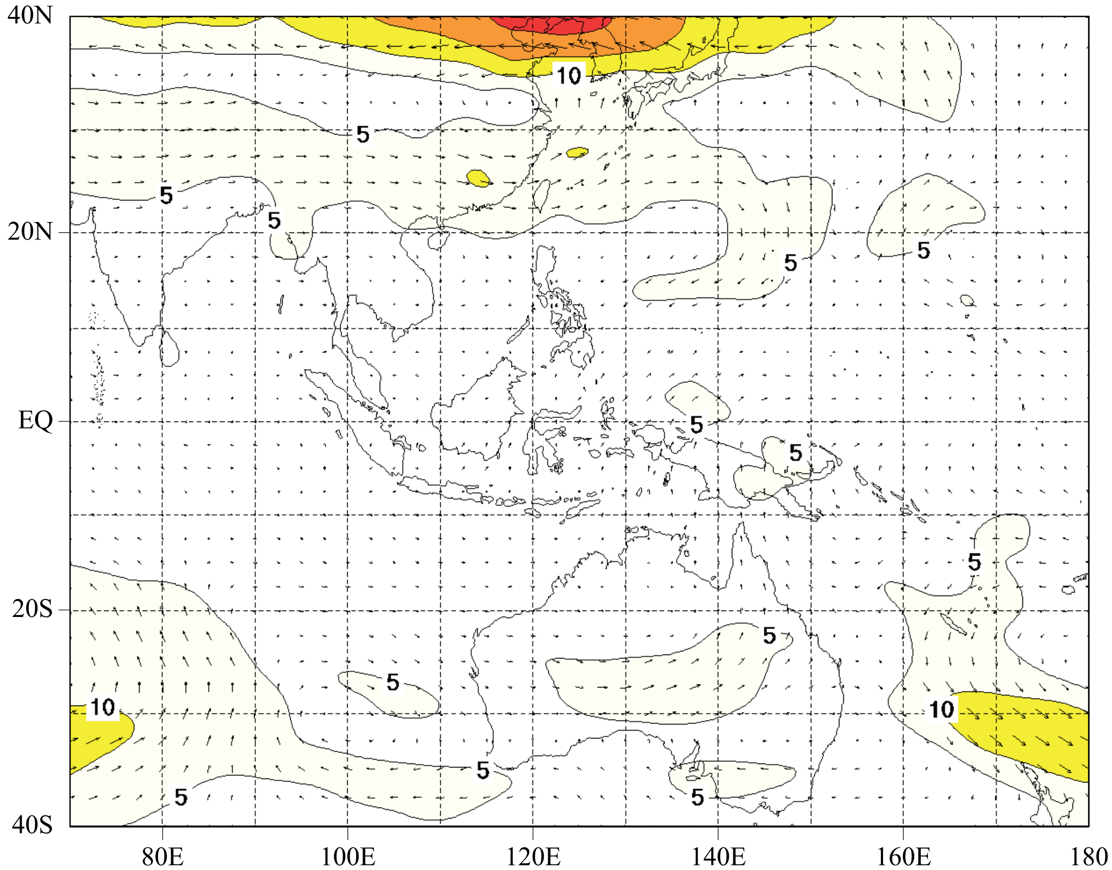

Fig.6(b) 200 hPa WIND ANOMALY, June 2010.
Arrow length indicates relative magnitude. Anomalies > 5 ms-1 are shaded.

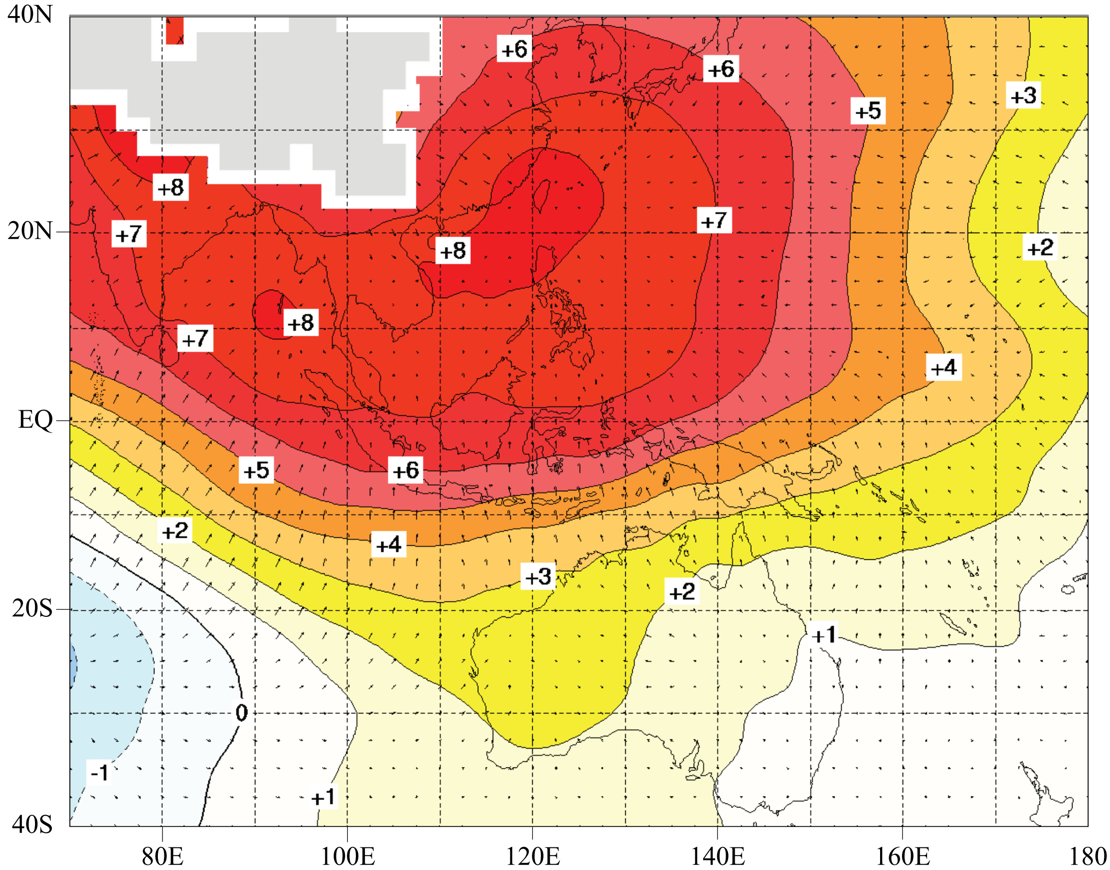

Fig.7(a) 850 hPa VELOCITY POTENTIAL (x $10^6 m^2 s^{-1}$) and DIVERGENT WIND, June 2010.

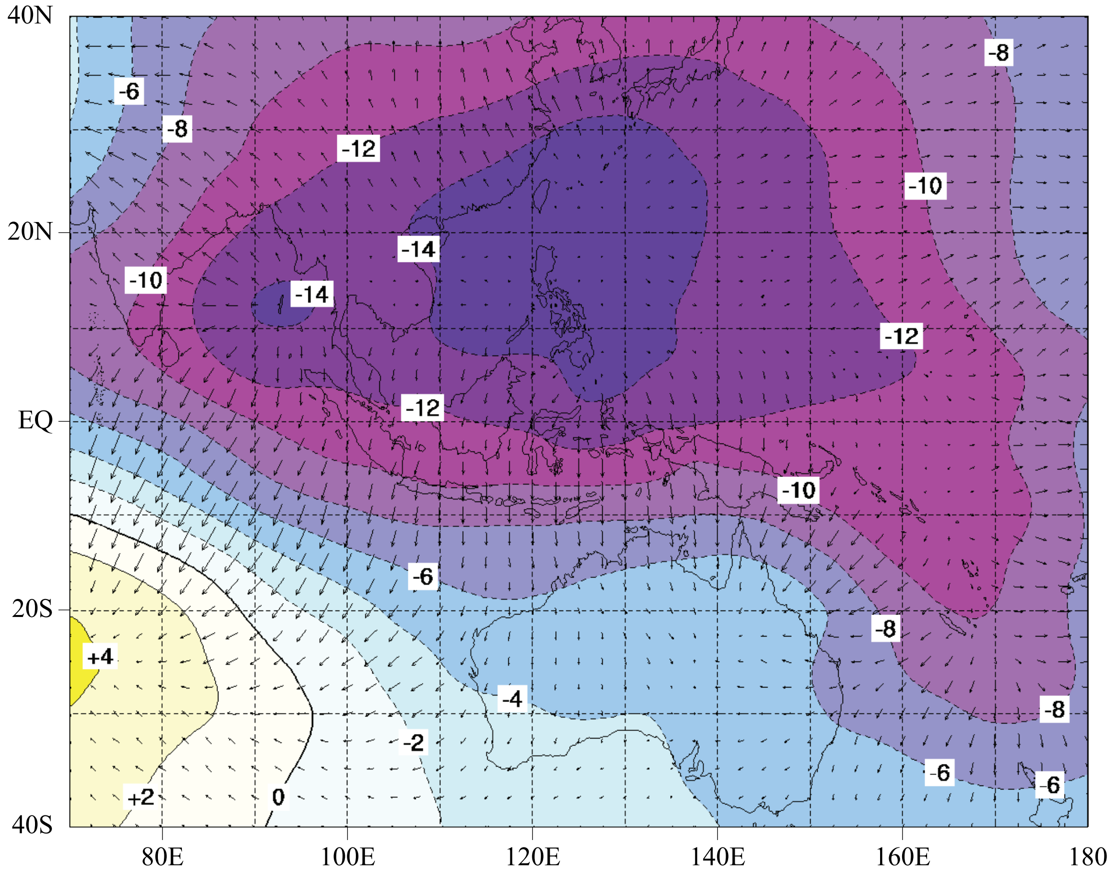

Fig.7(b) 200 hPa VELOCITY POTENTIAL (x $10^6 m^2 s^{-1}$) and DIVERGENT WIND, June 2010.

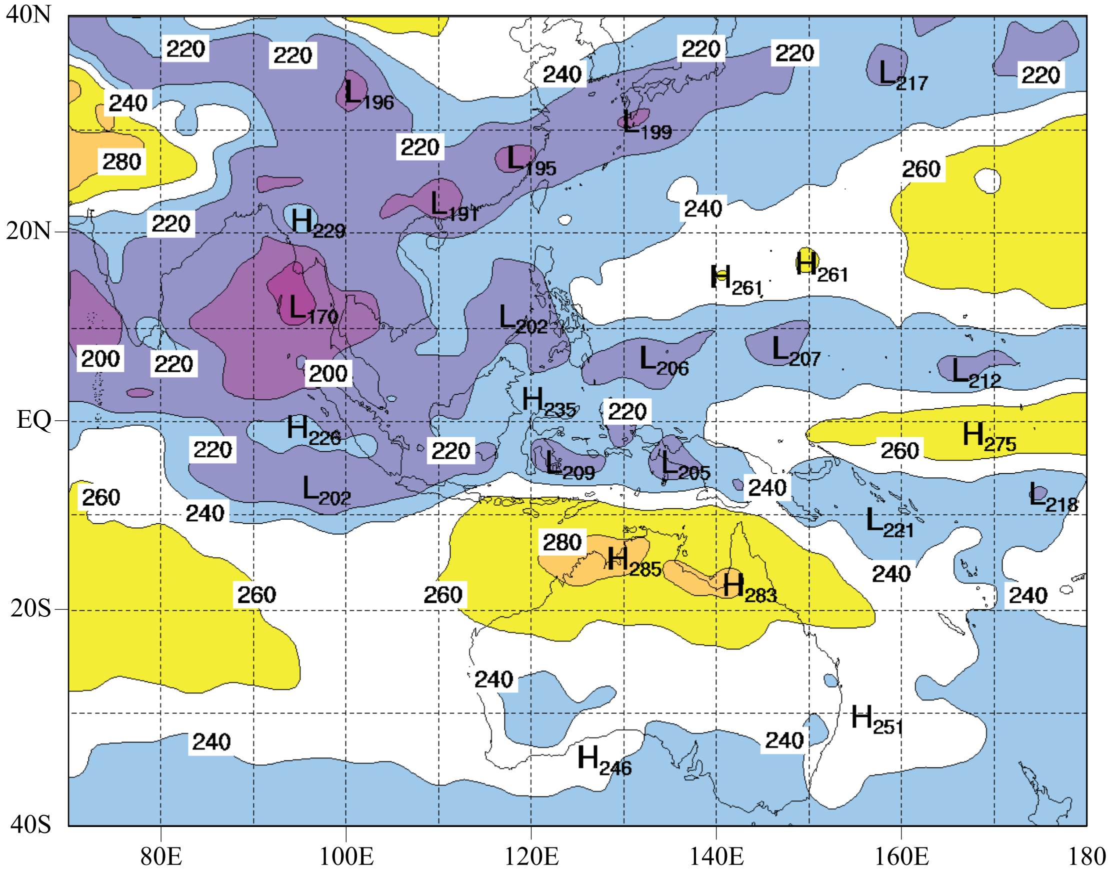

Fig.8(a) OUTGOING LONG WAVE RADIATION, June 2010.
Contour interval 20 watt m^{-2}.

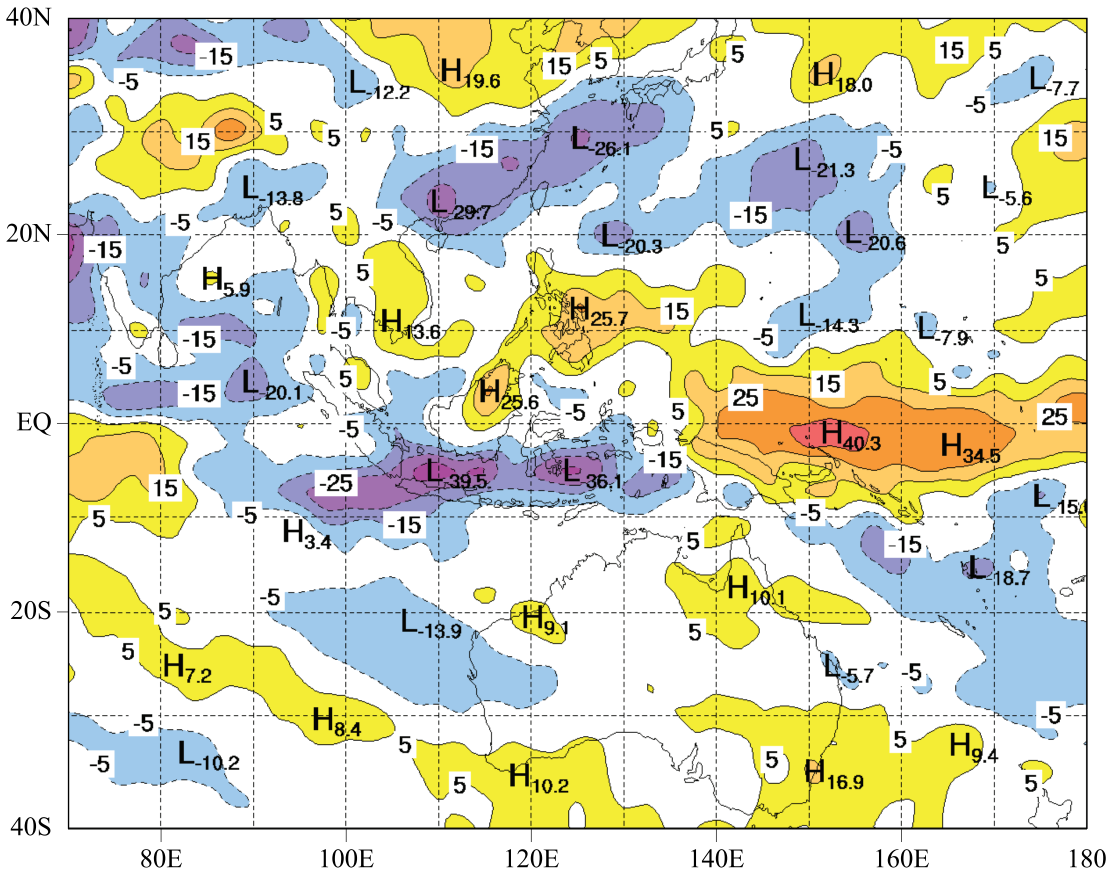

Fig.8(b) OUTGOING LONG WAVE RADIATION ANOMALY, June 2010.
Contour interval 10 watt m^{-2}.

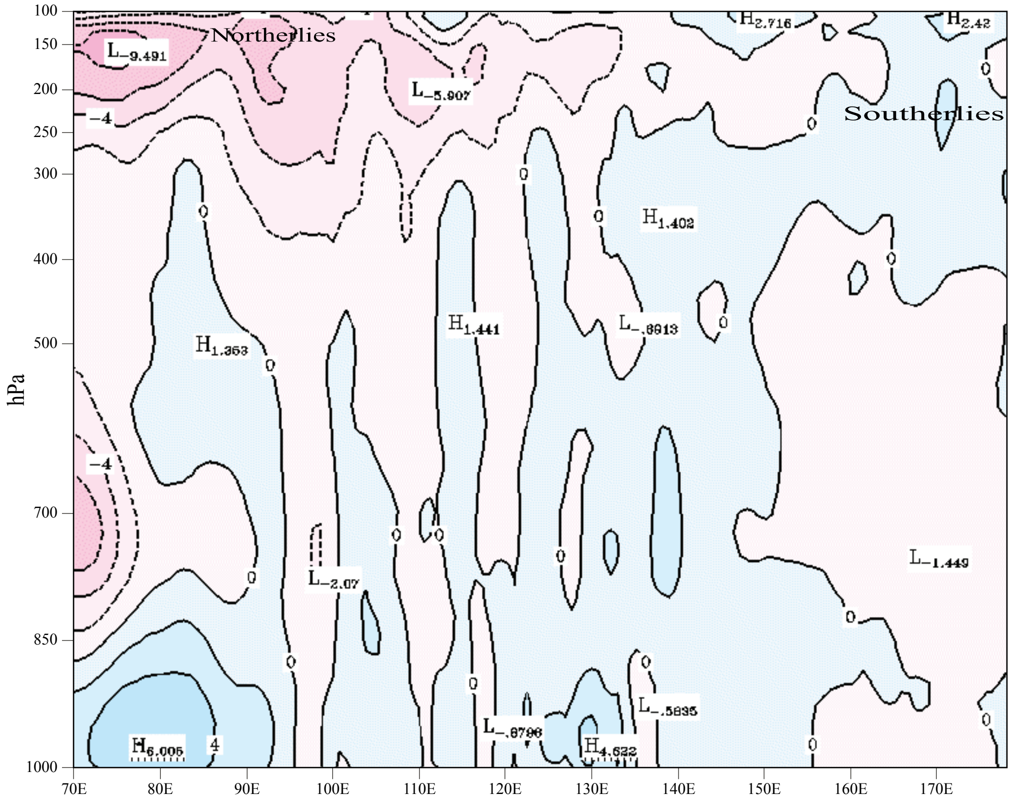

Fig.9 EQUATORIAL CROSS SECTION OF MERIDIONAL WIND, June 2010.
Isotachs at $2ms^{-1}$ intervals.

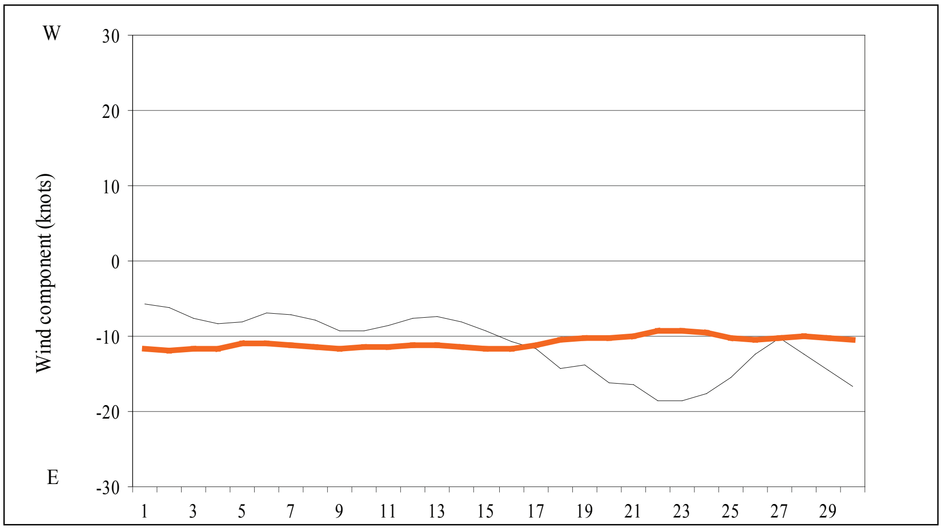

Fig.10(a) DARWIN 850 hPa MEAN ZONAL WIND, June 2010.
Black line represents 3-day running mean. Orange line represents the mean seasonal wind.

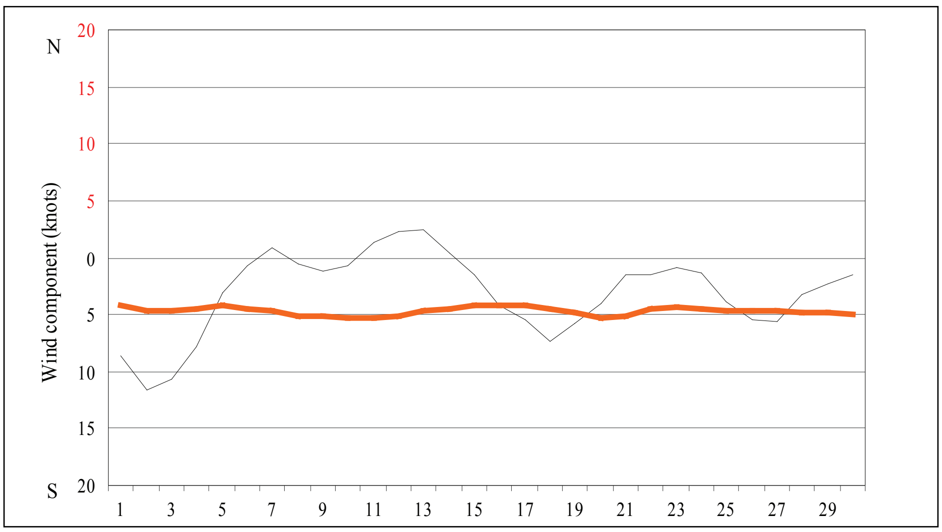

Fig.10(b) DARWIN 850 hPa MEAN MERIDIONAL WIND, June 2010.
Black line represents 3-day running mean. Orange line represents the mean seasonal wind.

Time/longitude cross section, southern series.
5 day running mean, averaged over 15°S to 5°S

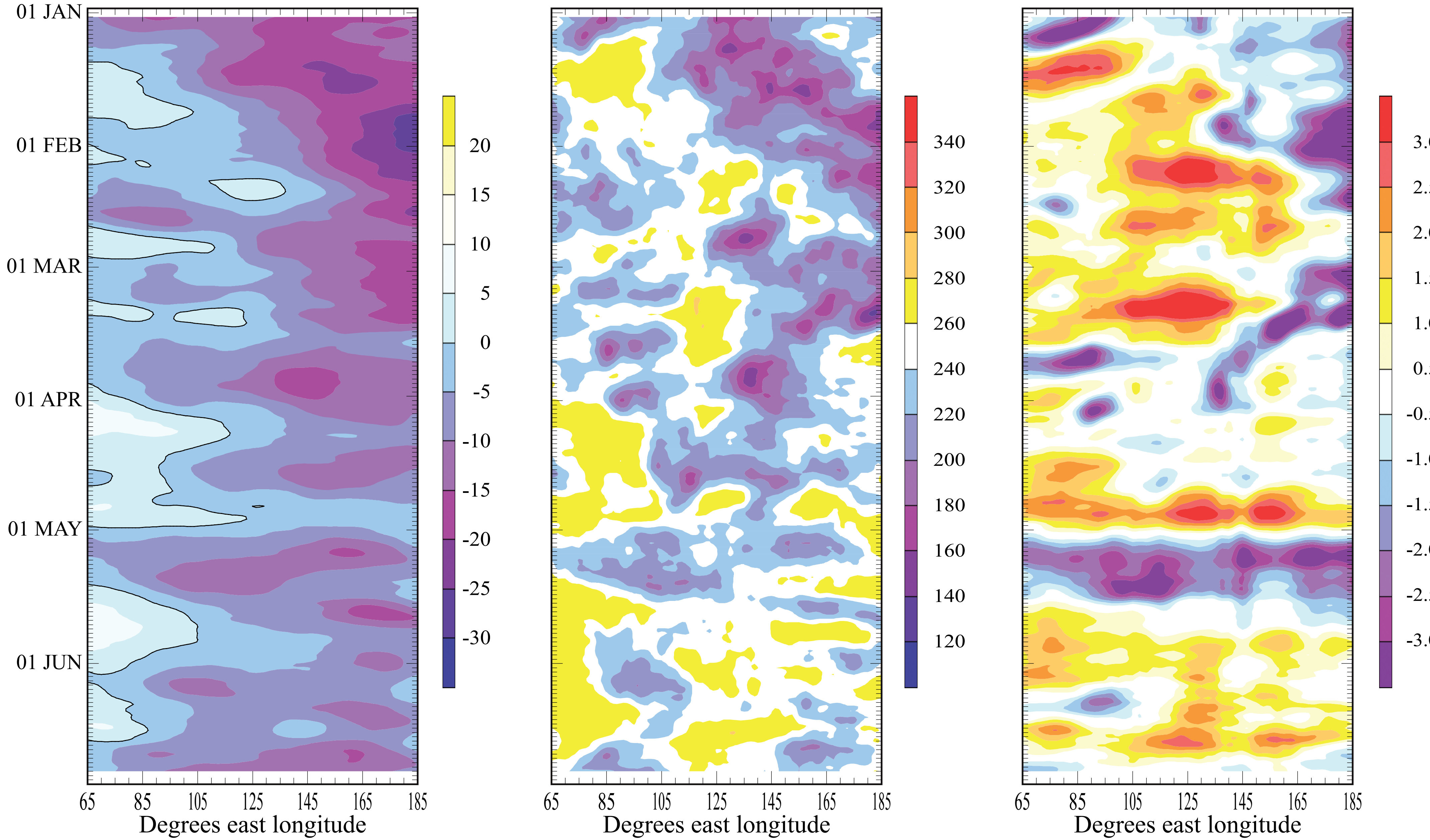

Fig. 11(a) 200hPa velocity potential based on GASP ($10^6 m^2 s^{-1}$)

Fig.11(b) Outgoing long wave radiation (watt m^{-2})

Fig. 11(c) Mean sea-level pressure anomaly (hPa)

Time/longitude cross section, equatorial series.
5 day running mean, averaged over 5°S to 5°N

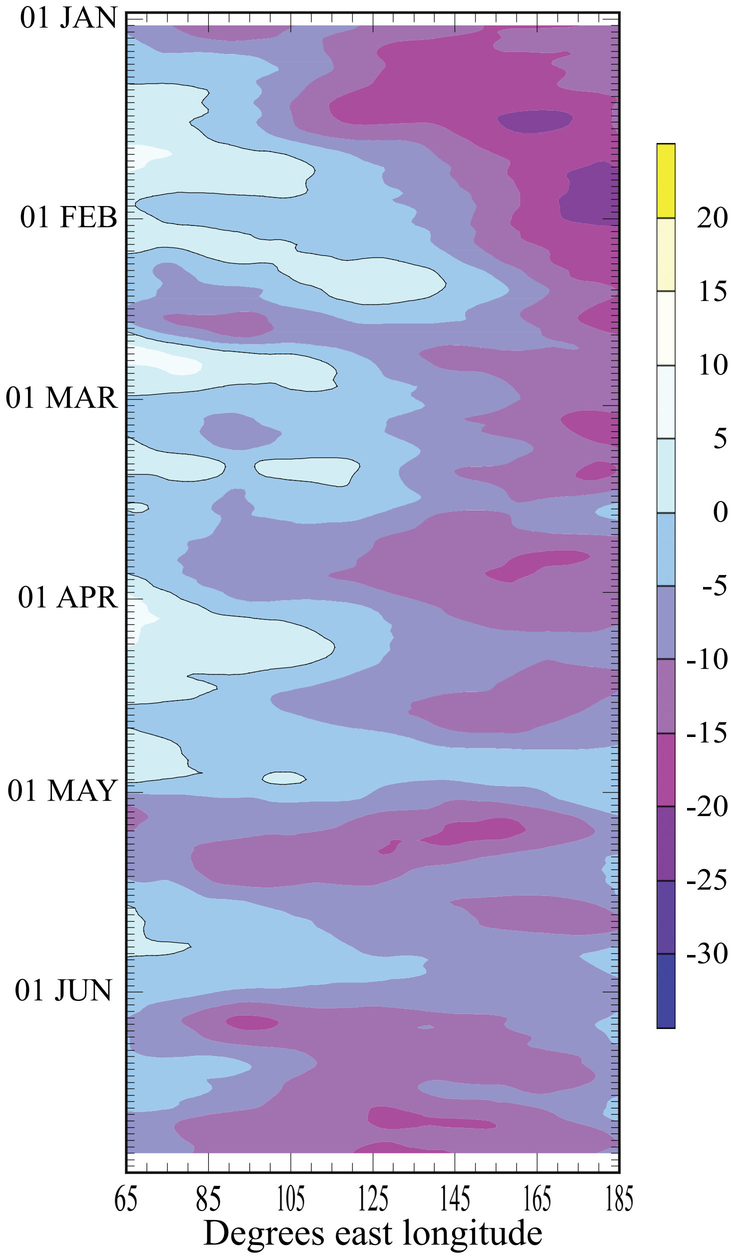

Fig. 12(a) 200hPa velocity potential based on GASP ($10^6 m^2 s^{-1}$)

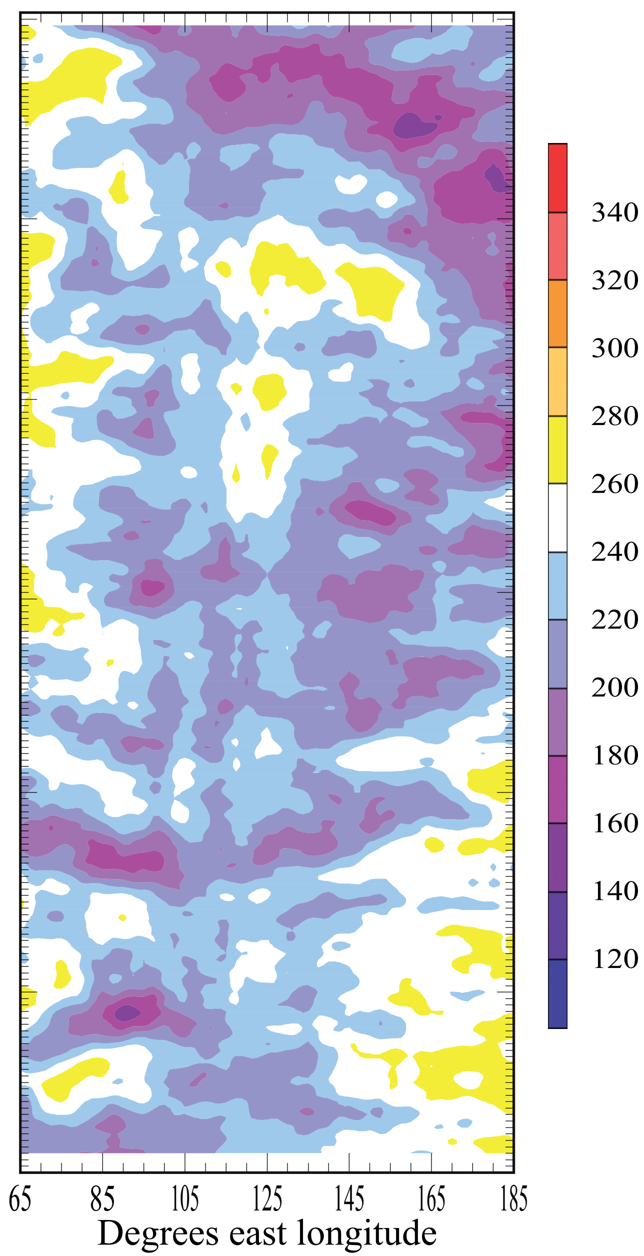

Fig.12(b) Outgoing long wave radiation (watt m^{-2})

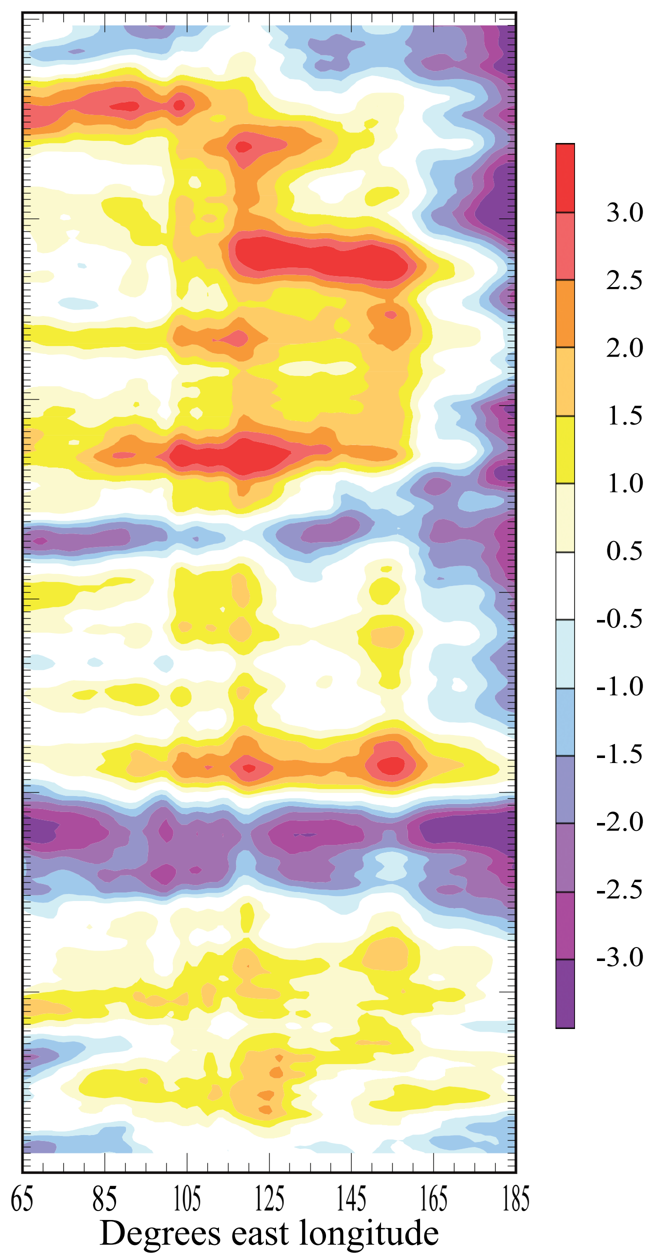

Fig. 12(c) Mean sea-level pressure anomaly (hPa)

Time/longitude cross section, northern series.
5 day running mean, averaged over 5°N to 15°N

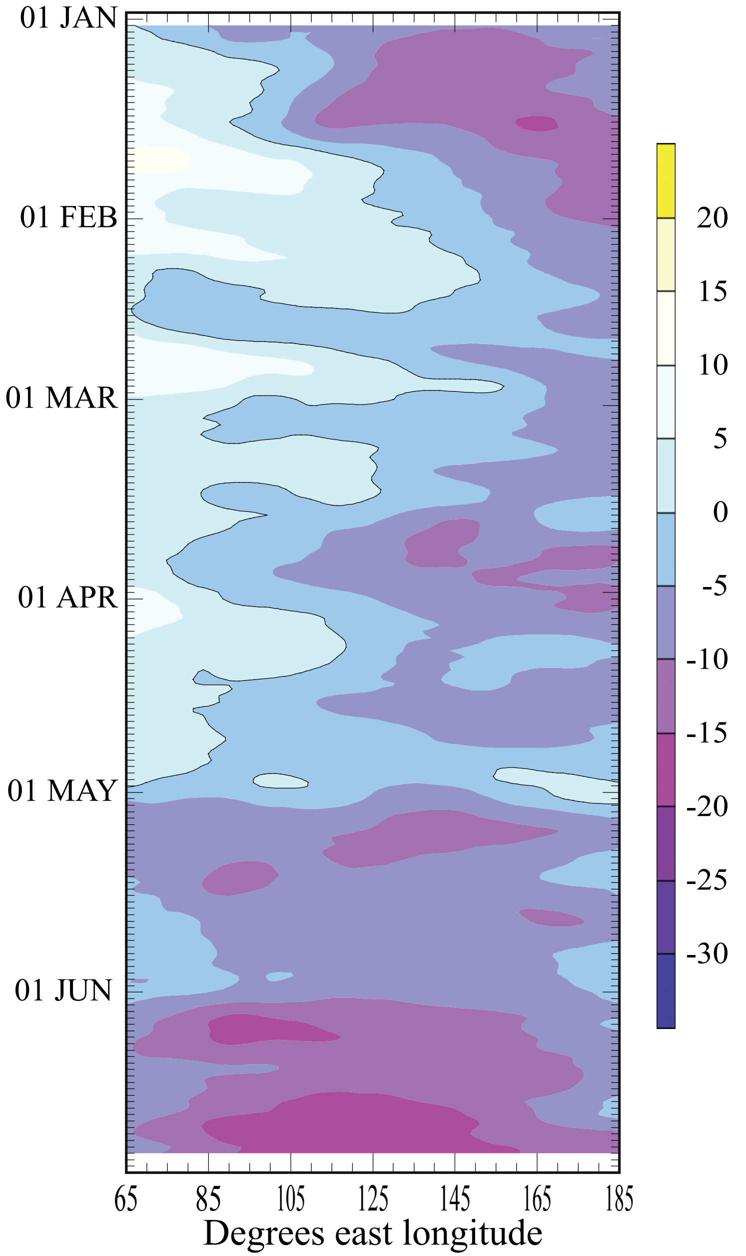

Fig. 13(a) 200hPa velocity potential based on GASP ($10^6 m^2 s^{-1}$)

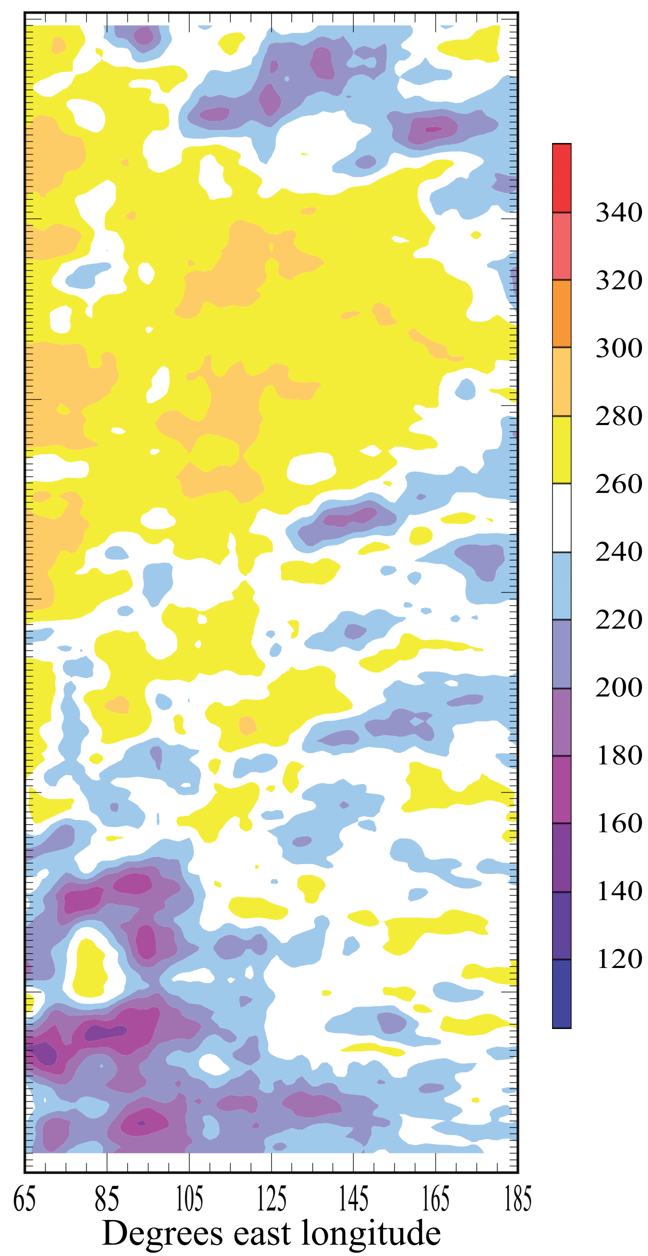

Fig.13(b) Outgoing long wave radiation (watt m^{-2})

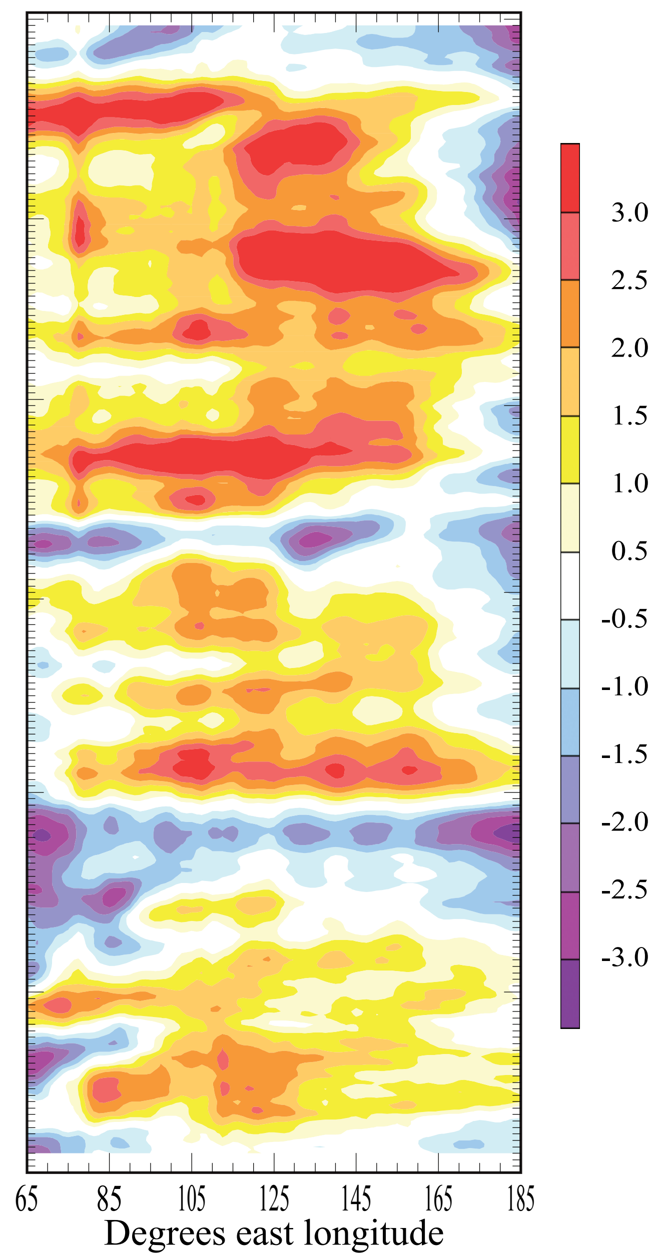

Fig. 13(c) Mean sea-level pressure anomaly (hPa)

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 40ºN-40ºS, 70ºE-180º. 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 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 $\geq 17\ ms^{-1}$ (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 $\geq 32\ m\ s^{-1}$ (63 Kn).

(iii) Tropical cyclone climatology for the northwest Pacific and the south Indian and Pacific Oceans is based on *2008 Annual Tropical Cyclone Report*, by Cooper, G.A. and R.J. Falvey, (2009), US Naval Pacific Meteorology and Oceanography Center/ Joint Typhoon Warning Center, Pearl Harbour, Hawaii, USA, (available at https://metoc.npmoc.navy.mil/jtwc/atcr/2008atcr/2008atcr.pdf). North Indian Ocean records are taken from WMO *Technical Document No. 430, Tropical Cyclone Report No.TCP-28* (Mandal, 1991).

(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, 1ºC resolution). The 1ºx 1º 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.
Equatorial cross section of meridional wind field was derived from the Bureau of Meteorology's operational Tropical region Extended Limited Area Prediction System (TXLAPS_PT375n) model. (Refer- *Analysis and Prediction Operations Bulletin No 59*. Bur. Met., Australia.) A full web version available at: http://www.bom.gov.au/nmoc/bulletins/nmc_bulletin.shtml).

(vi) The mean seasonal cycles for the Darwin 850 hPa wind components were constructed by averaging daily values over 57 years (1950 to 2006).

(vii) OLR time longitude plots and maps derived from the US National Oceanic and Atmospheric Administration.

4. **Some commonly-used acronyms**:

CS	- Cyclonic storm	SCS	- South China Sea
ISO	- Intra-seasonal oscillation	SOI	- Southern Oscillation Index
JMA	- Japan Meteorological Agency	SPCZ	- South Pacific convergence zone
JTWC	- Joint Typhoon Warning Center, Pearl Harbour	SST	- Sea Surface Temperature
MJO	- Madden-Julian Oscillation	STC	- Severe tropical cyclone
MSLP	- Mean Sea Level Pressure	STR	- Subtropical ridge
MT	- Monsoon trough	TC	- Tropical cyclone (see note 3(ii))
NET	- Near-equatorial trough	TD	- Tropical depression
OLR	- Out-going long-wave radiation	TXLAPS	- Tropical region Extended Limited Area Prediction Scheme
PAGASA	- Philippine Atmospheric, Geophysical and Astronomical Services	TS	- Tropical storm (generally used for TC in northern Hemisphere sector)
PNG	- Papua New Guinea	TUTT	- tropical upper tropospheric trough
RSMC	- Darwin Regional Specialised Meteorological Centre (see note 1)	VSCS	- Very severe cyclonic storm

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

Annual subs.	Postage	Subs (incl postage)
95.50 (86.80 ex GST)	12.00 (Australia)	107.50
	16.44 (Asia/Pacific)	103.24
	24.36 (Rest of the world)	111.16

6. **For further details contact**:

The Regional Director,
Bureau of Meteorology,
PO Box 40050, Casuarina,
Northern Territory 0811 AUSTRALIA
Telephone: (International: 61) (08) 8920 3813
Fax: (International: 61) (08) 8920 3832
E-mail: climate.nt@bom.gov.au