DARWIN TROPICAL DIAGNOSTIC STATEMENT

February 2003

ISSUED BY DARWIN RSMC

SUMMARY

Ocean and atmospheric indicators are suggesting that El Niño is moving into a decaying phase. The SOI fell to –7, though overall move towards zero is evident on the 5-month running mean; the general trend of cooling continued over the equatorial Pacific; and the Hadley cell near the dateline has moved closer to its climatological mean position. An active MJO pulse was associated with the establishment of the monsoon in the southern Indian Ocean at the start of the month. This spawned three tropical cyclones in the RSMC, and one to the west, within a 6-day period. During the month, monsoonal activity was experienced throughout the southern tropics of the RSMC, and was particularly persistent over northern Australia. This interacted with mid-latitude systems to produce widespread rain over most of Australia breaking drought conditions in many areas.

INDICES

Troup's Southern Oscillation Index (SOI) for February 2003	-7
5-month mean (centred upon December)	-7
Darwin mean MSL pressure for February 2003	1006.6 hPa
Pressure anomaly (1933 – 1992 mean)	+0.1 hPa
Tahiti mean MSL pressure for February 2003	1009.6 hPa
Pressure anomaly (1933 – 1992 mean)	-1.5 hPa

Time series of Troup's SOI:

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	+9	+12	+7	0	-9	+2	-3	-9	+1	-2	+7	-9
2002	+3	+8	-5	-4	-14	-6	-8	-15	-8	-7	-6	-11
2003	-2	-7										

The above table presents the monthly values of SOI from year 2001. Fig. 1 shows the monthly SOI and its five-month running mean for the past ten years.

The monthly SOI fell to –7, with the five-month running mean remaining steady for the past two months at –7, though overall a trend towards zero is evident. This trend, along with other factors discussed later, is indicating that the broad-scale Walker circulation is returning closer to its climatological mean.

TROPICAL CYCLONES [Figs 2]

Five tropical cyclones were analysed in the Darwin RSMC area during February, including the redevelopment of ex-Typhoon Beni to tropical cyclone intensity off the northeast Australian coast. The other four systems, Fiona, Hape, Isha and Graham, all developed in the southern Indian Ocean. Additionally, two other cyclones occurred just outside the Darwin RSMC area, Gerry to the west (formed 56°E, dissipated 67°E) and Dovi to the east (formed 163°W, dissipated 168°W). Comparative monthly average for February (the most active month in the southern hemisphere) is 6.6 cyclones (including depressions with maximum winds of ≥ 25 knots) in the south Indian and Pacific Oceans.

Unnamed tropical cyclone (Indian Ocean) *(continued from the January issue)*

As detailed in the January issue this system formed when a monsoon low moved over the sea off the northwest coast of Australia on the 21st January. After drifting slowly south along the west coast it crossed the coast on the 25th and dissipated over land soon after. The post analysis of the system indicated that it reached cyclone intensity prior to landfall. The track of this cyclone is shown in Fig 2(a) inset.

Typhoon Beni *(continued from the January issue)*

At the end of January an upper low developed just to the west of New Caledonia and Beni, moving beneath a 40 knot vertical wind shear, consequently weakened rapidly. On the 1st of February Beni had weakened to a tropical low with the middle-level circulation sheared to the southeast of the low-level centre. The low-level circulation started moving northwest across the Coral Sea. During the 3rd convection was seen to blow-up near the circulation, caused by warm air advection into the area, with gales recorded near the convection overnight. At this stage Beni was again named a tropical cyclone, maximum winds to 40 knots, before the convection and gales being displaced away from the centre resulted in the system being downgraded on the 4th. Resultant rains produced drought-breaking floods on the northeast Australian coast with the media reporting one death.

Severe Tropical Cyclone Fiona

At the start of the month a weak tropical low moved off the northwestern coast of Australia, into the Indian Ocean. With a middle-level ridge to the south, this system continued moving westward along 10°S as a semi-organised cluster of convection. On the 4th it was influenced by the eastward propagating MJO pulse, at which stage convection was enhanced and the system intensified reaching TC strength late on the 5th. Over the next few days Fiona tracked west-southwest with the STR to the south, in a region of good upper divergence and weak vertical wind shear. Maximum intensity of 105 knots was reached on the 8th and 9th, before encountering an area of cooler and drier air wrapping into the system from the south on the 10th. On the 11th and 12th the system moved through the STR into an environment of increasing vertical wind shear, dissipating on the 13th.

Severe Tropical Cyclone Hape

Severe Tropical Cyclone Hape formed in the Indian Ocean, west of the RSMC area, and was named on the 11th. Tracking eastwards it reach it's maximum intensity of 70 knots prior to crossing into the RSMC area on the 13th. On the 14th the system started to interact with TC Gerry to the west and move southeast into an increasing vertical wind shear environment, this exposed the low-level centre and weakened the system.

Tropical Cyclone Isha

Isha was a very weak and short-lived system that formed in the monsoon trough extending between Hape and Fiona on the 10th. Developing under favourable upper divergence and weak vertical shear, it reached TC intensity and was named on the 13th for a brief period before encountering the same increasing vertical wind shear environment as Fiona and Hape, weakening the system on the 14th.

Tropical Cyclone Graham

Like the unnamed system in January off the western Australian coast (described earlier), Tropical Cyclone Graham formed from a monsoon low moving offshore into the Indian Ocean and drifting southwest along the coast for three days. A northward movement of the STR over the low and a strengthening low-level monsoon flow contributed to further development on the 26th. Graham reached TC intensity on the 27th, peaking at 45 knots, as it slowly crossed the coast and dissipating on the 1st March.

SEA SURFACE TEMPERATURE [Figs. 3, 4]

The SST pattern over the tropical oceans has changed a little since January. The general trend of cooling continued over the equatorial Pacific, though there are still areas of greater than 1°C anomalies near the dateline. Overall, the SST pattern in the equatorial Pacific is consistent with an El Niño event entering a decaying phase. Positive SST anomalies in the tropical Indian Ocean have shown a steady increase over the past three months in both temperature and areal extent. The warm waters off the northwest Australian coast have continued, though with an areal reduction in the last two months.

MSL PRESSURE [Figs. 5, 6]

The mean sea level pressure over the tropical areas is close to the climatological norm with only small anomalies; this contrasts to the January pattern that had some strong positive anomalies, particularly about the western Coral Sea. During February an active monsoon trough became established in the southern Indian Ocean and across northwest Australia. The SPCZ remained further east than normal in the early part of the month, as shown by the positive anomaly over the Coral Sea; this anomaly however has weakened significantly since January. Pressures through Southeast Asia and the northwestern Pacific remained higher than normal, particularly over Burma where a strong positive anomaly has developed in the last month.

850 hPa FLOW [Figs. 7, 8]

The southern Indian Ocean pattern sees the monsoon trough established near its normal position for February with a stronger than normal northwesterly flow into the trough indicative of its vigorous activity during the month. Strong cross-equatorial flow through the South China Sea and into the Indian Ocean contributed to the anomalous anti-cyclonic flow over Burma associated with the positive pressure anomaly discussed above. Over the Coral Sea the monsoon trough is located further north than usual resulting in easterly anomalies east of 170^{o}E, this in conjunction with the weaker than normal anticyclonic flow over eastern Australia contributed to the dry conditions over the region for most of the month. This pattern started to break down in the last week of February as the monsoon trough started to develop over northeastern Australia. A band of westerly wind anomalies, which were evident for the past two months over the southern equatorial Pacific, has disappeared this month due to an increased cross-equatorial flow.

850 hPa WIND COMPONENTS at DARWIN [Figs. 9(a), (b)]

Darwin was in a monsoon break phase for the first 13 days of the month with moderate easterlies and the return of active continental storms. The monsoon returned on the 14th with strong northwesterly winds that continued into March. Persistent monsoonal rain occurred in the second half of the month, peaking on the 20th with 101.6mm. Monthly rainfall for February was the second highest on record with a total of 727.2mm at Darwin; decile 10 rainfalls were observed along most of the north coast east of Darwin.

CROSS-EQUATORIAL INTERACTION [Fig. 10]

The main Hadley cells during the month were situated between 70 - 80^{o}E, 100 – 110^{o}E and 120 - 130^{o}E, being the foci of the active monsoonal cross equatorial flow. These cells were twice as strong as their respective climatology, which is also indicated in the 850 and 200 hPa wind anomalies (figs 8 and 12 respectively). Another Hadley cell near the dateline is consistent with its climatological location and strength, an indication that conditions are moving away from the El Niño conditions of the past year.

UPPER LEVEL FLOW [Figs 11, 12]

The subtropical ridges in both the hemispheres remained stronger than climatology. Over the Coral Sea the southern hemisphere STR continued north of its climatological position as has been observed for the past few months. With the Hadley cell near the dateline moving back into the eastern hemisphere, the easterlies anomalies, which have been a persist feature of the El Niño event, have been replaced by westerlies in the southern hemisphere this month. About the southern Indian Ocean and northern Australia the STR lies near its climatological position producing a strong cross-equatorial flow associated with the active monsoon.

VELOCITY POTENTIAL [Figs 13, 14]

With the active monsoonal trough in its climatological position over the southern Indian Ocean and northern Australia, the 850 and 200 hPa velocity potential diagrams both show patterns approaching the climatological means in this area. Strong up-motion is evident west

of 100°E, consistent with multiple cyclone formation in this area. The region of strong up-motion on the eastern boundary has weakened since January. With the axis of upper level divergence slightly southward of its mean location, the main area of upper divergence was located over northern Australia where active monsoon conditions occurred for a large part of the month.

INTRA-SEASONAL VARIATIONS [Figs. 15, 16, 17]

Southern (Fig 15) and equatorial (Fig 16) time series' show an area of enhanced convection evident at the western parts of the region during the last week of January; this propagated quickly to the east during the first week of the February and was a key trigger to the formation of STC Fiona on the 6th. Fiona's westward movement interrupted the MJO OLR signal, which did not redevelop until it reached northern Australia with the monsoon onset at Darwin. The MJO signal is confused in the southern band for the remainder of the month, but is apparent again in the equatorial band continuing its westward movement at the end of the month. The periodicity of the MJO has remained stable for the past few months at about 35-40 days.

RAINFALL [Figs 18, 19]

Gridded Australian rainfall maps provided by the Bureau of Meteorology's National Climate Centre are at Fig. 18. OLR maps, courtesy of the Bureau of Meteorology Research Centre, are shown in Fig. 19 (see Explanatory Notes for details).

Averaged across the Australia, February 2003 was wettest month since February 2002. In a major change to the previously dominant dry weather pattern, decile 8 or higher totals were widespread across Australia with the notable exception of the far south where totals were largely in the driest 10% of records. Monsoonal activity over the northwest of Australia gradually extended southward into central Australia producing heavy or torrential falls. Interaction with mid-latitude frontal systems resulted in moist tropical air being advected over the south This is consistent with studies relating heavy rainfalls events with the decaying El Niño phase over eastern Australia. Over southwest Indonesia the active monsoon also broke drought conditions, however drought conditions are still being experienced about many parts of tropical Southeast Asia.

The OLR anomaly map (Fig. 19(b)) clearly indicates the active convection associated with the monsoon over the southern Indian Ocean and Australia. A strongly suppressed area is shown over the northern Coral Sea, though this was becoming active in the last week of the month. Persistent El Niño-related enhanced convection over tropical Pacific east of 170°E was predominately a feature early in the month. Convection over the northern hemisphere was generally below mean values.