The Australian tropical cyclone season 1984-85

J. Kuuse, Regional Office, Bureau of Meteorology, Perth, Western Australia
(Manuscript received August 1985)

Seventeen tropical cyclones occurred in the Australian region during the 1984-85 season compared with the ten-year average of about fourteen. Ten cyclones reached the severe category (120 km h⁻¹ or more). The three most intense tropical cyclones did not affect the mainland. Nine cyclones crossed the coast compared with the 21-year average of 4.8. Fortunately only two of these were classified as severe. The damage caused by the tropical cyclones was relatively minor and no fatalities or serious injuries were reported. Centre Island in the Gulf of Carpentaria recorded a sustained wind speed of 170 km h⁻¹ and a minimum pressure of 973 mb during the passage of cyclone Sandy. A feature of the season was the relatively large number of oceanic cyclones with long life-spans. In the Australian region there were nineteen days with two cyclones active and five days with three cyclones active.

Introduction
The 1984-85 tropical cyclone season commenced in early December and continued through until late April. Seventeen tropical cyclones occurred during the season of which ten were classified as severe (10-minute mean wind speed of 120 km h⁻¹ or more). The three most intense cyclones of the season were Kirsty (920 mb), Odette (930 mb), and Margot (942 mb). Cyclones Kirsty and Margot remained over the Indian Ocean throughout their existence. Odette, also an oceanic cyclone, reached maximum intensity over the Coral Sea before moving southeastward into the Nadi region and weakening. A notable feature of the oceanic tropical cyclones was their relatively long life-span (period at or above tropical cyclone intensity). The five Indian Ocean cyclones which did not reach land had an average life-span of 8.8 days. The most active period was from 11 February to 7 March 1985 (25 days) when seven tropical cyclones formed in the Australian region. On five days in February there were three cyclones active at the same time.

Centre Island meteorological station recorded a maximum sustained wind speed of 170 km h⁻¹ with a gust of 220 km h⁻¹ during the passage of Sandy just to the north of the island. The observed minimum pressure was 973 mb. Rowley Shoals automatic weather station recorded a sustained wind speed of 154 km h⁻¹ and a minimum pressure of 979 mb as Frank passed 10 to 20 km to the north of the station. A drifting buoy in the Indian Ocean recorded a pressure of 961.6 mb near the centre of Jacob.

It was an unusually active season for coastal crossings. Nine cyclones crossed the coast compared with the 21-year average of 4.8 found by Lourensz (1981). Fortunately only two of these (Lindsay and Sandy) were classified as severe just before crossing the coast. Four cyclones weakened significantly before reaching land. Emma weakened to below tropical cyclone intensity (10-minute mean wind speed of 63 km h⁻¹ or more) before crossing the coast and Tanya weakened within two hours of its coastal crossing. The unusually high speed of movement of some of the tropical cyclones resulted in forecasting problems. Emma reached a 24-hour average speed of 35 km h⁻¹ while moving southeast towards the northwest coast of Australia.

Overall the damage caused by the tropical cyclones was relatively minor and no fatalities or serious injuries were reported. During the passage of Sandy two trawlers were beached in the Pellew Islands and a fishing boat sank at Port Roper. Marine fauna and cattle perished in the storm surge produced by Sandy which at Centre Island was estimated to have been in the range 3.0 m to 3.5 m. Darwin suffered minor structural damage from cyclone Greiel with insurance claims mainly due to fallen trees and branches estimated at two million dollars. The clean-up of debris cost nearly half a million dollars. During cyclone Lindsay a 20-metre fishing boat was sunk at Broome damaging the jetty, but the town escaped with slight damage sustained mainly from fallen trees.
Large-scale features

The major large-scale synoptic feature of the 1984-85 tropical cyclone season was the weaker than normal northwest monsoon over northern Australia. However, the large-scale balance seems to have been compensated by unusually active monsoons over the Indian Ocean and the Coral Sea-Solomon Islands regions. The main northern hemisphere synoptic features which contributed to the weaker than normal monsoon from mid-December to mid-February were the anomalous low pressure area over India and the weaker than normal anticyclones over Asia. Contributing synoptic features in the Australian region were persistent anti-cyclogenesis in the Great Australian Bight and blocking high pressure systems near New Zealand. In the low and middle levels a dry southeast to southwest airflow tended to suppress convection over northern and eastern Australia. Near average synoptic flow patterns returned from the middle of February to the end of April. Sea-surface temperatures in the Australian region were near normal throughout the tropical cyclone season. Information on the large-scale synoptic features was obtained from the monthly Diagnostic Statement issued by Darwin Regional Meteorological Centre.

Large-scale control of tropical cyclone formation is indicated by the high incidence of tropical cyclone genesis in the same geographical region during certain periods. The most active periods seem to be linked to strong cross-equatorial flows and the strengthening of the low and middle-level easterlies to the south of the monsoon trough (shear line) as found by McBride and Keenan (1982). Persistence of conditions favourable for genesis during periods when steering flow produces moderate to rapid movement of cyclones often results in very short intervals between tropical cyclone genesis. The 1984-85 season provided many such events. It may be that once a tropical cyclone has formed it reinforces the initial circulation (i.e. positive feedback). This effect would be most significant around large tropical cyclones.

Seasonal statistics

The area for which the Australian Bureau of Meteorology had international tropical cyclone warning responsibility during the 1984-85 season is shown in Fig. 1. Any reference in the text to cyclones outside this area is tentative only. Place names and localities mentioned in this report are also indicated in Fig. 1. A statistical summary of some aspects of the 1984-85 tropical cyclone season is presented in Tables 1 and 2.

Fig. 1 Locality map, including the Western, Northern, and Eastern regions that comprise the Australian area of tropical cyclone forecasting responsibility.
### Table 1. Summary of the 1984-85 tropical cyclone season in the Australian region.

<table>
<thead>
<tr>
<th>Number of cyclones in the 1984-85 season</th>
<th>Australian region</th>
<th>Western region</th>
<th>Northern region</th>
<th>Eastern region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average number of cyclones (10-year average)</td>
<td>17</td>
<td>9</td>
<td>2</td>
<td>7†</td>
</tr>
<tr>
<td>1975-76 to 1984-85</td>
<td>13.9</td>
<td>8.3</td>
<td>2.4</td>
<td>4.9</td>
</tr>
<tr>
<td>Initial location of tropical depression</td>
<td>17</td>
<td>7</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Coastal crossing at cyclone intensity (sea to land)</td>
<td>9*</td>
<td>3</td>
<td>3*</td>
<td>3</td>
</tr>
<tr>
<td>Coastal crossing at cyclone intensity (land to sea)</td>
<td>3*</td>
<td>1</td>
<td>2*</td>
<td>0</td>
</tr>
<tr>
<td>Tropical cyclone days (one cyclone active)</td>
<td>94†</td>
<td>68</td>
<td>9</td>
<td>17†</td>
</tr>
<tr>
<td>Tropical cyclone days (two cyclones active)</td>
<td>19</td>
<td>14</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Tropical cyclone days (three cyclones active)</td>
<td>5</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Severe tropical cyclones</td>
<td>10</td>
<td>8</td>
<td>1</td>
<td>2†</td>
</tr>
</tbody>
</table>

* Includes Cobourg Peninsula crossing by Gretel.
† Includes tropical cyclone Sandy.

### Table 2. Tropical cyclones in the Australian region during the 1984-85 season.

<table>
<thead>
<tr>
<th>No.</th>
<th>Name and life span as a cyclone</th>
<th>Initial location of tropical depression</th>
<th>First reached Tropical cyclone intensity</th>
<th>Estimated lowest centred pressure (mb)</th>
<th>Weakened below tropical cyclone intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Emma 4-13 Dec</td>
<td>5.3°S, 101.0°E</td>
<td>8.5°S, 98.9°E</td>
<td>966</td>
<td>20.6°S, 116.1°E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0000 UTC* 4 Dec</td>
<td>1800 UTC 6 Dec</td>
<td>0900 UTC 12 Dec</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Frank 20-27 Dec</td>
<td>16.5°S, 128.2°E</td>
<td>17.3°S, 122.1°E</td>
<td>950</td>
<td>20.8°S, 118.7°E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0000 UTC 20 Dec</td>
<td>0900 UTC 22 Dec</td>
<td>0600 UTC 27 Dec</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Monica 25-29 Dec</td>
<td>14.4°S, 148.3°E</td>
<td>16.5°S, 152.0°E</td>
<td>982</td>
<td>Moved into Nadi region about</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2100 UTC 25 Dec</td>
<td>0300 UTC 27 Dec</td>
<td>1200 UTC 28 Dec</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Nigel 14-18 Jan</td>
<td>16.5°S, 150.3°E</td>
<td>16.0°S, 159.0°E</td>
<td>996†</td>
<td>Moved into Nadi region about</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1200 UTC 14 Jan</td>
<td>1800 UTC 16 Jan</td>
<td>2100 UTC 16 Jan</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Odette 16-20 Jan</td>
<td>14.6°S, 145.6°E</td>
<td>14.6°S, 148.8°E</td>
<td>930†</td>
<td>Moved into Nadi region about</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1200 UTC 16 Jan</td>
<td>0600 UTC 17 Jan</td>
<td>1300 UTC 19 Jan</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Gertie 26 Jan-3 Feb</td>
<td>16.2°S, 125.9°E</td>
<td>18.4°S, 119.0°E</td>
<td>973</td>
<td>25.2°S, 117.8°E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0000 UTC 26 Jan</td>
<td>1200 UTC 29 Jan</td>
<td>0000 UTC 1 Feb</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Hubert 10-19 Feb</td>
<td>14.2°S, 129.0°E</td>
<td>14.7°S, 123.5°E</td>
<td>950</td>
<td>19.2°S, 114.9°E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0000 UTC 10 Feb</td>
<td>0900 UTC 11 Feb</td>
<td>1200 UTC 18 Feb</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Isobel 11-22 Feb</td>
<td>7.5°S, 106.6°E</td>
<td>10.8°S, 102.4°E</td>
<td>960</td>
<td>26.0°S, 95.0°E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0600 UTC 11 Feb</td>
<td>0000 UTC 13 Feb</td>
<td>0600 UTC 21 Feb</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Jacob 15-27 Feb</td>
<td>9.0°S, 127.6°E</td>
<td>12.6°S, 123.3°E</td>
<td>950</td>
<td>36.6°S, 100.2°E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0000 UTC 15 Feb</td>
<td>1800 UTC 16 Feb</td>
<td>1800 UTC 26 Feb</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Pierre 17-24 Feb</td>
<td>11.8°S, 143.3°E</td>
<td>15.4°S, 146.7°E</td>
<td>986</td>
<td>22.7°S, 150.6°E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0600 UTC 18 Feb</td>
<td>0600 UTC 20 Feb</td>
<td>2100 UTC 21 Feb</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Rebecca 20-23 Feb</td>
<td>11.4°S, 135.3°E</td>
<td>11.8°S, 139.8°E</td>
<td>994</td>
<td>12.9°S, 141.7°E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0300 UTC 20 Feb</td>
<td>1800 UTC 21 Feb</td>
<td>0900 22 Feb</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Kirsty 1-19 Mar</td>
<td>11.5°S, 112.0°E</td>
<td>10.7°S, 95.3°E</td>
<td>920</td>
<td>29.5°S, 98.9°E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0000 UTC 1 Mar</td>
<td>0300 UTC 6 Mar</td>
<td>0000 UTC 16 Mar</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Lindsay 6-11 Mar</td>
<td>9.2°S, 117.6°E</td>
<td>10.2°S, 119.7°E</td>
<td>950</td>
<td>25.3°S, 27.5°E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0000 UTC 6 Mar</td>
<td>0600 UTC 7 Mar</td>
<td>0300 UTC 11 Mar</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Sandy 18-24 Mar</td>
<td>13.2°S, 135.4°E</td>
<td>13.4°S, 137.8°E</td>
<td>953</td>
<td>13.6°S, 135.0°E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0000 UTC 18 Mar</td>
<td>1200 UTC 20 Mar</td>
<td>1800 UTC 25 Mar</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Tanya 27 Mar-1 Apr</td>
<td>13.2°S, 151.5°E</td>
<td>13.4°S, 149.3°E</td>
<td>982</td>
<td>14.4°S, 143.6°E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0600 UTC 27 Mar</td>
<td>0600 UTC 29 Mar</td>
<td>0600 UTC 1 Apr</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Margot 10-25 Apr</td>
<td>6.7°S, 103.8°E</td>
<td>7.8°S, 102.6°E</td>
<td>942</td>
<td>17.9°S, 111.3°E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0300 UTC 10 Apr</td>
<td>2100 UTC 11 Apr</td>
<td>1800 UTC 20 Apr</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Gretel 9-14 Apr</td>
<td>9.0°S, 145.5°E</td>
<td>11.0°S, 133.0°E</td>
<td>984</td>
<td>14.0°S, 129.0°E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0000 UTC 9 Apr</td>
<td>0000 UTC 12 Apr</td>
<td>0600 UTC 14 Apr</td>
<td></td>
</tr>
</tbody>
</table>

*Co-ordinated Universal Time (UTC) = GMT.
† In Eastern Region.
The average number of tropical cyclones in the various regions for the ten-year period ending 30 June 1985 was derived from Lourensz (1981), Thom (1984) and unpublished records held by Perth Tropical Cyclone Warning Centre. In the Australian region there were seventeen tropical cyclones compared with the 10-year average of about fourteen. The regional distribution of cyclones was close to normal. Five of the nine cyclones in the Western region were oceanic with long life-spans. This accounts for the unusually large number of tropical cyclone days (68) in the region. A tropical cyclone day is defined as a day on which one or more tropical lows of at least tropical cyclone intensity (10-minute mean winds of 63 km h⁻¹ or more) existed in the Australian region for any part of the day commencing at 0000 UTC. In the Australian region there were 94 tropical cyclone days.

Estimates of central pressure and maximum wind speed have been based on the Dvorak (1984) technique with some slight variations by the regions to take into account local conditions. It is likely that current estimates of tropical cyclone intensity may need to be revised when sufficient local data become available to adjust the empirical relationships embodied in the Dvorak technique.

Table 2 lists the tropical depressions that later developed into tropical cyclones. The initial location may not necessarily be associated with the first appearance of a particular disturbance but is taken as that point from which a closed circulation deepened into a tropical cyclone in uninterrupted development. \textit{Kirsty} was the seventh tropical cyclone in the Australian region to have an estimated central pressure of 920 mb or less since 1960.

**Tropical cyclones of the 1984-85 season**

1. Tropical cyclone Emma, 4 to 13 December 1984 (Fig. 2)

The initial development of cyclone \textit{Emma} was in the intertropical convergence zone (ITCZ) off the southwest coast of Sumatra during 3 December 1984. The low at first moved to the southwest and then recurved to the southeast on 5 December. A southeasterly track was then maintained until after the system crossed the coast. Cyclonic strength was reached by 061800 UTC and a gradual deepening continued until a minimum pressure of 966 mb was reached at 102100 UTC. The estimated maximum wind speed was 125 km h⁻¹. Following recurvature the cyclone was under the influence of northwesterly winds at all levels. During 11 December the winds above 500 mb increased significantly and the cyclone underwent marked acceleration. The increased shear resulted in rapid weakening. Entrainment of cool, relatively dry subtropical air from the southwest may have contributed to the rapid weakening. A mean translational speed of 35 km h⁻¹ was maintained over the 24 hours ending 120300 UTC. No ship observations were available near the cyclone on 10 and 11 Decem-

![Fig. 2 Tracks of tropical cyclones 1 and 13 of the 1984-85 season. Broken lines denote pre and post-cyclone stage; full lines denote tropical cyclone stage. Key to number groups along the track in code form PPYYGG — PP central pressure (tens and units of millibars); YY — date; GG — time (UTC whole hours).](image-url)
ber. Maximum wind speed reported was 55 km h⁻¹ on 12 December.

When *Emma* crossed the coast at 121000 UTC near 20.8°S, 116.2°E the centre was below cyclonic strength and no gales were recorded. After crossing the coast the low moved on a more easterly track and became absorbed in a broad low pressure centre located across central Australia.

### 2. Tropical cyclone Frank, 20 to 28 December 1984 (Fig. 5)

The primary low from which tropical cyclone *Frank* formed originated near the WA/NT border on 20 December 1984 and drifted westward across the Kimberley region. The low reached cyclonic strength over land near the coast, 50 km to the north of Broome at 220900 UTC. A photograph of the radar display of cyclone *Frank* from Broome Meteorological Office at this time is shown in Fig. 3. The cyclone is extraordinarily small with an eye diameter of 9 km and an outer eye-wall convection diameter of about 30 km. Even after development over water *Frank* remained a small tropical cyclone with a convective canopy about 200 to 350 km in diameter. Inflow from the equatorial region was weak and decreased with maturity.

The system continued westward and deepened until a minimum central pressure of 950 mb was achieved at 240900 UTC, about 18 hours before it began to recurve. Colour displays of NOAA 7 high resolution imagery of tropical cyclone *Frank* at 240812 UTC are shown in Fig. 4. The 1 km resolution of the advanced very high resolution radiometer (AVHRR/2) instrument clearly defines the very small eye which is about 15 km in diameter. Other notable features of the cyclone are its small size (about 200 km in diameter) and its near isolation from the large-scale environment.

Following recurvature the cyclone maintained a southeasterly track and crossed the coast at the mouth of the Turner River 20 km west of Port Hedland. Central pressure on landfall was 990 mb. Maximum wind recorded on the mainland was a gust of 102 km h⁻¹ at Port Hedland at 270235 UTC as the cyclone was crossing the coast. Maximum wind recorded was 154 km h⁻¹ (240830 UTC) at Rowley Shoals automatic weather station as the cyclone passed 10 to 20 km to the north of the island. Minimum pressure of 979 mb was measured at 240530 UTC when the wind speed was 102 km h⁻¹. No injuries were reported as a result of the cyclone but minor damage occurred at Port Hedland.

Over most of the period from 22 to 27 December *Frank* was tracked by Broome and Port Hedland radars. The movement of the cyclone was governed initially by an upper-level high located over the West Kimberley region. Recurvature and the subsequent southeasterly track were due to increasing upper-level northwesterly winds associated with a trough amplifying to the southwest of the tropical cyclone.

### 3. Tropical cyclone Monica, 25 to 29 December 1984 (Fig. 6)

Tropical cyclone *Monica* was the first cyclone to affect the Eastern Australian region in the 1984-85 season. *Monica* formed about 0300 UTC on 27 December 1984 near 16.5°S, 152.0°E from a tropical low which had been embedded in the ITCZ for about 36 hours. The central pressure at this time was 990 mb. *Monica* took an overall southeasterly track, starting at 14.4°S, 148.3°E at 252100 UTC. It slowly deepened to reach maximum intensity at about 271800 UTC with a central pressure of 982 mb. The cyclone was then at 17.4°S, 153.7°E with estimated maximum winds of 85 km h⁻¹. Subsequently the southeasterly track continued, but the cyclone began to weaken. *Monica* moved into the Nadi area at 281200 UTC near 21.5°S, 160.0°E with a central pressure of 988 mb. *Monica* lost its cyclonic intensity about 36 hours later when it was near 29°S, 163°E. The maximum reported wind was 74 km h⁻¹ at 280300 UTC from a ship at 21.3°S, 154.2°E. No reports of damage were received.

### 4. Tropical cyclone Nigel, 14 to 18 January 1985 (Fig. 7)

Tropical cyclone *Nigel* formed from a low which had been embedded in the ITCZ for several days. The low started life as an ill-defined circulation near Cape York Peninsula and drifted slowly eastwards.

A recognisable circulation formed about 1200 UTC on 14 January 1985 at 16.5°S, 150.3°E with a central pressure of 1005 mb. This low continued to move eastwards and deepen slowly until cyclone intensity was reached at about 161800 UTC with a central pressure of 996 mb at 16.0°S, 159.0°E. Three hours later *Nigel* moved into the Nadi area with winds just above gale force. The cyclone continued
Fig. 4 High resolution NOAA-7 infrared imagery of tropical cyclone Frank at 0812 UTC 24 December 1984. The AVHRR/2 instrument on the satellite gives a resolution of about 1 km near the centre of the image. The very small eye of about 15 km in diameter is clearly visible. The cyclone is near maximum intensity with an estimated central pressure of 950 mb. At 0830 UTC Rowley Shoals automatic weather station measured a wind speed of 154 km h⁻¹ and a pressure of 983 mb. Unenhanced infrared image (top) from channel 2 (0.7-1.1 μm). False colour display of cloud-top temperatures (bottom) derived from channels 4 and 5 (10.3-10.8 μm, 11.5-12.5 μm). (Data received at the Western Australian Institute of Technology. Photographs by courtesy of Dr A. J. Prata, CSIRO, Perth.)
Fig. 5 Tracks of tropical cyclones 2, 8, and 9 of the 1984-85 season. Symbols as per Fig. 2.

Fig. 6 Tracks of tropical cyclones 3 and 5 of the 1984-85 season. Symbols as per Fig. 2.
to develop for about two more days giving estimated maximum winds of 140 km h\(^{-1}\). *Nigel* did not cause any damage in the Australian region, however it seriously affected Fiji causing some deaths and considerable damage.

5. Tropical cyclone *Odette*, 16 to 20 January 1985 (Fig. 6)
Tropical cyclone *Odette* was the second of two tropical cyclones to form within a week from lows which had their origins in the northwest corner of the Coral Sea. The low which became *Odette* was first recognised at 1200 UTC on 16 January 1985 at 14.6°S, 145.6°E. *Odette* began about 2 degrees north of *Nigel* but took an east-southeast track and developed much more rapidly. It gained cyclonic intensity at about 170600 UTC (within 12 hours of *Nigel*) when at 14.6°S, 148.8°E with a central pressure of 998 mb. The cyclone reached its maximum intensity about two days later with estimated maximum winds of 170 km h\(^{-1}\) and a central pressure of 930 mb when at 16.3°S, 158.5°E. The system moved into the Nadi area at about the same point as *Nigel* had almost three days earlier, that is to say at 16.3°S, 160.0°E at about 191300 UTC.

*Odette* continued to weaken and take on a more southeasterly track, later turning east once more before passing over the southern islands of the Vanuatu Group about 1800 UTC on 20 January. The highest reported wind speed was 65 km h\(^{-1}\) from a ship positioned at 14.7°S, 149.8°E at 171000 UTC. *Odette* did not cause any damage in the Australian region although it was a severe tropical cyclone after 180300 UTC.

6. Tropical cyclone *Gertie*, 26 January to 3 February 1985 (Fig. 8)
The low pressure system from which tropical cyclone *Gertie* developed formed near 16.2°S, 126.0°E in the Kimberley region on 26 January 1985. The low moved west-southwest and passed out to sea to the north of Broome at 280900 UTC. While moving in a generally westerly direction the low had deepened to cyclonic strength by 291200 UTC at 18.4°S, 119.0°E.

Initial steering was governed by low to mid-level easterlies and the mid and upper circulation was well developed when the system moved out to sea. On 30 January the cyclone moved into a region of strengthening northwesterlies and within a nine-hour period the cyclone had changed from a westerly to southerly track.

Minimum pressure of 973 mb was reached at 302100 UTC, five hours prior to the cyclone crossing the coast at Cape Lambert (20.6°S, 117.2°E). A maximum wind gust of 140 km h\(^{-1}\) was recorded at Cape Lambert at 310300 UTC. Although the wind damage in the four towns in the immediate area was minimal, flood damage to the roads was estimated at $100 000.

---

Fig. 7 Tracks of tropical cyclones 4, 10, 11, and 15 of the 1984-85 season. Symbols as per Fig. 2.
**Fig. 8** Track of tropical cyclones 6, 7, and 12 of the 1984-85 season. Symbols as per Fig. 2.

*Gertie* moved rapidly south and maintained cyclonic intensity until it was 500 km inland at 0000 UTC 1 February. During the subsequent 48 hours the system moved east and was eventually absorbed into an inland trough.

7. **Tropical cyclone Hubert, 10 to 19 February 1985 (Fig. 8)**

The pre-cyclonic low that developed into cyclone *Hubert* formed rapidly in the Joseph Bonaparte Gulf on 10 February 1985. The low moved steadily westward, crossing onto the extreme north of the Kimberley area for some 18 hours as it intensified. Moving out into the Indian Ocean at 110900 UTC, the low reached tropical cyclone intensity.

In the main the track of the cyclone was westward under the influence of easterlies at all levels associated with intense anticyclones to the south, although minor perturbations were caused by the interaction with *Isobel* between 14 and 16 February. Figure 9 shows GMS-3 visual imagery of the interacting cyclones at 150300 UTC. The exposed centre of *Isobel* is located about 790 km to the north-northwest of *Hubert* and is being steered eastward by the larger circulation of *Hubert*. This interaction partly disrupted the airflow around *Hubert* and contributed significantly to the weakening of the cyclone.

The lowest central pressure of 950 mb was achieved by 132100 UTC at 17.2°S, 113.3°E. Estimated wind speed at the time was 150 km h⁻¹ although the strongest wind actually recorded was only 83 km h⁻¹. This was reported by a ship 110 km from the centre of the cyclone at 161200 UTC.

By 1800 UTC the cyclone had moved to 18.7°S, 86.8°E and was weakening steadily. At this stage the track became more southwesterly as the cyclone began to be influenced by an extratropical low to the west. Cyclonic strength was lost by 181200 UTC and the post-cyclonic low had merged with the extratropical low by 190600 UTC at 20.5°S, 82.0°E.

8. **Tropical cyclone Isobel, 11 to 22 February 1985 (Fig. 5)**

*Isobel* formed immediately south of Sumatra and to the west-northwest of the active tropical cyclone *Hubert*. Development was comparatively fast, 36 hours passing from the formation of the initial low to cyclonic strength by 130000 UTC at 10.8°S, 102.4°E. After an initial southeasterly track, *Isobel* moved onto a southwesterly track and deepened.

At 140600 UTC when the cyclone was at 13.4°S, 100.4°E, *Isobel* began to weaken slightly as interaction with *Hubert* increased. Steered by the stronger circulation of *Hubert* which overcame the large-scale environmental flow, the direction of movement of *Isobel* changed from southwest to northeast during
the twelve hours from 140300 UTC. The shear between the low and high levels increased and the centre became exposed to the southeast of the convective cloud mass. Figure 9 shows GMS-3 visual imagery of the interacting cyclones at 150300 UTC. *Isobel* began to intensify again from this point as the shear decreased and as the centre started to capture the low-level equatorial inflow into *Hubert*. Once the two cyclones had moved sufficiently far apart to no longer be influenced by each other, *Isobel* moved onto a consistent southwesterly path.

The minimum pressure reached was an estimated 960 mb at 15.6°S, 105.0°E (170000 UTC). As cyclones *Hubert*, *Isobel*, and *Jacob* were all active in the eastern Indian Ocean at the same time, the area became data sparse. No exceptionally strong winds were recorded; however a maximum of 135 km h⁻¹ was estimated.

As *Isobel* moved further south over cooler waters weakening occurred and the system degenerated to a depression at 26.0°S, 95.0°E by 210600 UTC. Decay after this was rapid as an extratropical depres-

Fig. 9 GMS-3 visual imagery of the interacting tropical cyclones *Hubert* (963 mb) and *Isobel* (982 mb) at 0300 UTC 15 February 1985. The exposed centre of *Isobel* (12.6°S, 102.3°E) is located about 790 km to the north-northwest of *Hubert* (19.4°S, 104.5°E) and is being steered eastward by the larger circulation of *Hubert*. The image is slightly enhanced so that the brightest cloud tops appear black.

ion moving in from the west caused a shearing northwesterly flow across *Isobel*. By 220001 UTC the system had dissipated at 31.5°S, 94.2°E.

9. Tropical cyclone *Jacob*, 15 to 27 February 1985 (Fig. 5)

Early on 15 February 1985, satellite and synoptic data indicated a weak low off the eastern tip of Timor. A day later the convective activity became more vigorous and extended over most of the Timor Sea. The low moved steadily in a west-southwesterly direction along the monsoon trough and slowly intensified to reach tropical cyclone intensity by 161800 UTC. *Jacob* became the fifth tropical cyclone active in a monsoon trough which stretched from the northwest coast of Australia to the east coast of Africa. The tropical cyclones outside the Australian region were *Feliska* near 12°S, 47°E and *Gerimena* near 16.5°S, 56.0°E.

After attaining tropical cyclone intensity the rate of development of *Jacob* changed from slow to normal according to the Dvorak satellite analysis scheme. Peak intensity of 950 mb was estimated to have been reached at about 200600 UTC. An unusual feature of the time variation of intensity of *Jacob* was the long duration of near peak intensity. Estimated central pressure was below 960 mb from 190600 UTC to 240001 UTC (4.75 days). During this period the surface circulation extended 800 km from the centre and gales were reported up to about 550 km from the centre. The highest wind speed reported was 93 km h⁻¹ from a ship located 190 km from the centre at 210600 UTC. At 232300 UTC a buoy about 25 km south of the centre recorded a pressure of 961.6 mb and at 250136 UTC a buoy about 110 km to the northeast of the centre reported a pressure of 988.7 mb.

Entrainment of cool and relatively drier air from the south intermittently suppressed convection over the southern quadrants of the storm from 22 to 26 February. GMS-3 visual imagery at 220300 UTC shown at Fig. 10 depicts clearly one such event. The inflow of cool air from the south, highlighted by the south to north orientated low stratocumulus cloud band near 20°S, 101°E, has suppressed convection in the southwest quadrant of *Jacob*. During this period *Jacob* closely (to within about 100 km) paralleled the track of *Isobel* four to five days earlier. The mixing and cooling of the ocean surface in this area by *Isobel* very likely had a weakening effect on *Jacob*.

From 24 to 26 February *Jacob* decayed more rapidly over the cooler waters but maintained a banding structure with convection near the centre, until early on 26 February when the high-level circulation was sheared by upper-level northwesterlies. Over nine days from 171200 to 261200 UTC, while above cyclonic intensity, *Jacob* travelled about 4800 km at an average speed of 20 km h⁻¹.
10. Tropical cyclone Pierre, 17 to 24 February 1985 (Fig. 7)

The low that was to become tropical cyclone Pierre was first recognised as an ill-defined circulation over the tip of Cape York Peninsula on 17 February 1985. A definable circulation formed on the ITCZ at about 180600 UTC near 11.8°S, 143.3°E with a central pressure of 1002 mb. The low moved slowly to the east-southeast at first, gradually turning south-southeast until its track was almost parallel to the coast. It gradually deepened until cyclonic intensity was reached about two days later, by which time the centre was about 160 km east of Cooktown. The central pressure was then 995 mb.

Tropical cyclone Pierre accelerated gradually to reach a speed of about 25 km h⁻¹ during the morning of 21 February. Maximum intensity was reached about 210600 UTC when the central pressure was 986 mb. Decay was fairly rapid, cyclonic intensity being lost in about fifteen hours. This occurred two hours after landfall in Shoalwater Bay. The resulting low went out to sea again near Yeppoon after about three hours over land and took on an almost easterly track until it passed into Nadi’s area at 23.8°S, 160.0°E on the afternoon of 24 February.

The maximum reported wind speed was 102 km h⁻¹ reported from Hayman Island at 210600 UTC. Damage was minimal with only minor temporary flooding occurring.

11. Tropical cyclone Rebecca, 20 to 23 February 1985 (Fig. 7)

There was a cloud mass north of Arnhem Land for several days before the surface circulation which was to become tropical cyclone Rebecca was identified. The low formed near 11.4°S, 135.3°E at 0300 UTC on 20 February 1985 with a central pressure of 1000 mb. This low drifted north-eastwards for about 12 hours before gradually altering course to the southeast during the following 12 hours. Intensification was spasmodic with cyclonic intensity being reached about 211800 UTC when the centre was at 11.8°S, 139.8°E. The southeasterly track continued with little further development until landfall at about 220900 UTC near 12.9°S, 141.7°E on the west coast of Cape York Peninsula.

As a weak cyclone Rebecca lost its cyclonic intensity almost immediately. The resulting low continued to the centre of Cape York Peninsula as a rain influence for about 30 hours before decaying about 300 km west of Cairns. The estimated maximum wind speed was 70 km h⁻¹. There was only minimal damage and no significant winds were reported.

12. Tropical cyclone Kirsty, 1 to 19 March 1985 (Fig. 8)

Kirsty, the most intense tropical cyclone of the season, began forming on 1 March 1985 in a monsoonal trough lying east-west to the south of Java. The pre-cyclonic low drifted westward and deepened very slowly. During 5 March, when the system was just northwest of Cocos Island, rapid intensification took place and cyclonic status was reached by 060300 UTC.

Under the influence of an upper-level anticyclone located over Cocos, Kirsty moved southwest and deepened rapidly after 080000 UTC. The lowest pressure, estimated at 920 mb, was reached at 090600 UTC at 14.7°S, 85.4°E. Figure 11 shows enhanced GMS-3 infrared imagery of Kirsty at this time. This intensity was maintained until 100000 UTC when the system began to weaken and recurve. Maintaining a southeasterly track Kirsty weakened over cooler water and lost cyclonic strength by 160600 UTC. The remnant low became embedded in a basically westerly stream and eventually dissipated off Cape Naturaliste at 190000 UTC.

While the strongest wind recorded was 93 km h⁻¹ at 071800 UTC, 110 km from the centre, winds are estimated to have reached 200 km h⁻¹ close to the centre during 9 March. Over the full life cycle the system travelled about 6900 km, however as the track was over the sea and distant from land, no damage is known to have occurred.
Fig. 11 Enhanced GMS-3 infrared imagery of tropical cyclone Kirsty at 0600 UTC 9 March 1985 when the cyclone was centred at 14.7°S, 85.4°E. Dvorak T number intensity estimate was between 6.0 and 6.5 (almost large eye) giving a central pressure estimate of 920 mb.

13. Tropical cyclone Lindsay, 6 to 11 March 1985 (Fig. 2)

Lindsay was the only cyclone to cause any significant damage in the Western region during the season. After forming to the south of Sumbawa Island in the Indonesian Archipelago on 6 March 1985, the pre-cyclonic low moved south and then east. By 070600 UTC the system had become a cyclone and began moving onto a southwesterly track.

While still deepening, Lindsay recurved at 11.7°S, 117.3°E and began a sustained southeasterly track that took it across the coast and continental Australia. Minimum pressure of 950 mb was reached at 090600 UTC when at 16.2°S, 120.8°E. Maximum winds were estimated at 150 km h⁻¹. The lowest pressure was reached twelve hours before landfall which occurred on the southern side of Roebuck Bay, 35 km southeast of Broome.

The strongest wind recorded (74 km h⁻¹) was at Broome at 091600 UTC when the cyclone was at its closest to the town. Damage to the town was superficial, being confined to uprooted trees and slight structural damage mainly from falling trees. A 20-metre ferro concrete fishing boat broke its moorings and sank under the Broome jetty. Severe vegetation damage was reported to the south of Broome near the point of landfall.

Lindsay retained a small tight cyclonic core until 110300 UTC as it moved rapidly across the continent. While just below cyclonic intensity the low passed 75 km to the southwest of Giles Meteorological Office at 110600 UTC where a gust of 80 km h⁻¹ was recorded. The remnant low moved steadily southeast until it was absorbed into westerly moving systems near Ceduna on the Great Australian Bight.

14. Tropical cyclone Sandy, 18 to 24 March 1985 (Fig. 12)

Sandy was the most intense cyclone in the Northern region and the second most intense cyclone in the Eastern region for the 1984-85 season. In a remarkable coincidence Sandy, on 21 March 1985, was positioned just 70 km away from where cyclone Kathy had been located exactly one year earlier.

Sandy formed from a cyclonic circulation embedded in the monsoon trough over northeast Arnhem Land. This circulation drifted over the tropical waters. After reaching tropical cyclone intensity at about 201200 UTC, Sandy remained almost stationary for 36 hours intensifying in the process. The cyclone moved into the Eastern region for about 55 hours during 21, 22 and 23 March. Although Sandy was classed as a severe tropical cyclone, satellite imagery showed that unlike Kathy, Sandy had a ragged eye and hence was not as intense. When Sandy finally began to move the cyclone tracked south-southwest towards the coast and then west-northwest along the coast. Sandy passed just north of the Sir Edward Pellew Group of islands at about 240000 UTC where the Centre Island meteorological station recorded a minimum pressure of 973 mb, a maximum wind speed of 170 km h⁻¹ and a maximum gust of 220 km h⁻¹. Two tawlers, the Hayman and the Sea Fever (Fig. 13) were beached by their crews after experiencing gusts well over 200 km h⁻¹ and swells as measured by their depth sounders of 12m. Storm surges measured by a Bureau survey team were 3 to 3.5 m at Centre Island and coastal surveillance flights reported a pilot whale 1 km inland. Flooding was extensive along the southern gulf coast with 860 mm of rain recorded at Centre Island in four days.

Sandy continued to move west-northwest until it reached landfall at Port Roper. Tawlers sheltering in the Roper River suffered damage and reported the passage of an eye in which calm winds were experienced for about one hour. The cyclone weakened to a depression by 251800 UTC but could be identified for a long period as it moved westward into the Indian Ocean.
Fig. 12 Tracks of tropical cyclones 14 and 17 of the 1984-85 season. Symbols as per Fig. 2.

Fig. 13 Trawlers beached on North Island due to tropical cyclone Sandy. Photograph taken three weeks later.
15. Tropical cyclone Tanya, 27 March to 1 April 1985 (Fig. 7)

The seventh and last tropical cyclone to affect the Eastern region in the 1984-85 season was *Tanya*. The cyclone developed from a low which formed on the ITCZ about 700 km southeast of Port Moresby during 27 March 1985. This low drifted firstly north-westwards and then west-southwestwards until cyclonic intensity was reached at 290600 UTC at 13.4°S, 149.3°E. The central pressure of *Tanya* was then 995 mb. The west-southwesterly track continued for a further twelve hours before the cyclone took on a westerly track while continuing to deepen. Maximum intensity was reached at 301800 UTC when *Tanya* had a central pressure of 982 mb and an estimated maximum wind speed of 100 km h⁻¹.

The near westerly track was maintained for another twelve hours during which time the system decayed marginally. The track then became south-westerly and this was maintained until landfall at about 0400 UTC on 1 April in Princess Charlotte Bay. Cyclonic intensity was lost within an hour or two. The resulting low continued southwestwards to the centre of Cape York Peninsula before losing its identity.

Tropical cyclone *Tanya* caused only limited damage to vegetation and no structural damage was reported. The maximum reported wind speed was 93 km h⁻¹ at 0600 UTC 30 March from a ship.

16. Tropical cyclone Margot, 10 to 25 April 1985 (Fig. 14)

Tropical cyclone *Margot* began forming to the southwest of Sunda Strait during 10 April 1985. While deepening the system moved in a generally south-westerly direction, and became a cyclone at 7.8°S, 102.6°E by 112100 UTC. After continuing southwest until 130600 UTC, *Margot* recurved at 9.8°S, 98.7°E and then maintained a steady southeasterly track until 16 April. During the period 17 to 24 April the system followed an erratic figure-eight path, weakening at the same time. Fluctuations in the central pressure occurred during the final days of the cyclone but by 210000 UTC, at 18.0°S, 111.0°E, the central pressure had risen to 997 mb and by 24 April the remnant low had been absorbed into a broad low pressure system covering the northeast Indian Ocean.

The path of *Margot* was governed by upper-level northwesterly winds until the influence of an intense high pressure system to the south of Western Australia was felt. Low-level easterly winds from this high caused shearing to take place and steered the low-level system to the west. During 19 April slight re-intensification took place, and the cyclone began

---

Fig. 14 Track of tropical cyclone 16 of the 1984-85 season. Symbols as per Fig. 2.
to again move in an easterly direction. This easterly movement again brought the cyclone into the influence of the dry low-level easterlies and increased the shear. *Margot* weakened rapidly and began to move in a westerly direction from 20 April.

Estimated minimum pressure of 942 mb was reached at about 141800 UTC when the cyclone was located at 13.9°S, 103.1°E. The maximum wind speed was estimated to be 165 km h⁻¹, while the strongest wind confirmed during the storm was 110 km h⁻¹ recorded by a ship 30 km from the centre at 140000 UTC.

17. Tropical cyclone *Gretel*, 9 to 14 April 1985
(Fig. 12)

*Gretel* formed from a tropical depression first analysed just west of Port Moresby in the Gulf of Papua. Embedded in a strong easterly steering stream, *Gretel* moved at speeds of up to 30 km h⁻¹ through the Torres Strait and over the southern Arafura Sea. Poor organisation in the cloudbands made tracking the depression and estimating its intensity difficult. *Gretel* was named at 0600 UTC 12 April 1985 following ship reports of mean gale force winds. After tracking westward over the Cobourg Peninsula, *Gretel* turned more southerly and passed just northwest of Darwin. At Darwin Airport mean wind speeds of 84 km h⁻¹ and gusts to 117 km h⁻¹ were recorded, with a lowest pressure of 984 mb. The anemograph record at Darwin Airport shows a 10-minute lull in the wind speed, however calm conditions were never observed. This measurement correlated well with minimum pressure readings, giving a good estimate of the time *Gretel* passed Darwin at 122120 UTC. *Gretel* then continued to track southwest until it reached the Port Keats area where strong upper-level shearing divorced the convection from the low-level centre and *Gretel* weakened at around 1400600 UTC.

Significant rainfall over the whole western Top End of the Northern Territory and along the north coast was recorded, with some minor flooding and road damage. Since *Gretel* was a weak cyclone, no significant storm surges were recorded. No casualties were reported, however tree damage around Darwin was widespread. Approximately 700 insurance claims totalling two million dollars were received as a result of *Gretel* passing close to Darwin. Most claims resulted from water damage, falling trees and minor structural damage. Estimated clean-up cost was $500 000.

**Acknowledgment**

This report was prepared from material supplied by the staff of the Tropical Cyclone Warning Centres in Brisbane, Darwin, and Perth.

**References**


