

# The Australian tropical cyclone season 1985-86

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Fifteen tropical cyclones occurred in the Australian region during the 1985-86 season compared with the ten-year average of about thirteen. Five cyclones reached the severe category ( $120 \text{ km h}^{-1}$  or more). Widespread major damage and three fatalities were attributed to *Winifred*, one of only two cyclones to cross the Australian coast compared with the 21-year average of 4.8. A maximum gust of  $176 \text{ km h}^{-1}$  was recorded at the Joint Tropical Trials and Research Establishment at Cowley Beach in *Winifred's* direct path, while at South Johnstone a minimum pressure of 958 hPa was recorded during the passage of *Winifred*. Two cyclones commenced during May. This is only the second time two May cyclones have affected the Australian region since 1964.

## Introduction

The 1985-86 tropical cyclone season commenced in late November and continued through until late May. Fifteen tropical cyclones occurred during the season, five of which were classified as severe (10-minute mean wind speed of  $120 \text{ km h}^{-1}$  or more). The three most intense cyclones were *Victor* (930 hPa), *Nicholas* (945 hPa) and *Billy* (950 hPa). *Victor* and *Nicholas* remained over the Indian Ocean for their entire existence whereas *Billy* weakened below cyclone intensity before crossing the Western Australian coast near Geraldton.

There were two active cyclogenesis periods during the season. Five cyclones formed in the Australian region from 9 to 29 January (21 days) and another five cyclones from 18 February to 6 March (17 days). Nine cyclones have commenced in the Australian region after 30 April since 1964. The occurrence of *Billy* and *Namu* in May represents only the second time in 23 years that two May cyclones have occurred in the one season.

Two cyclones crossed the coast compared with the 21-year average of 4.8 found by Lourensz (1981). One of these (*Winifred*) was classified as severe on crossing the coast. Three other cyclones weakened significantly before reaching the coast while one depression crossed Cape York Peninsula before reaching cyclone intensity in the Coral Sea.

Significant damage was caused by the two cyclones which crossed the Australian coast (*Hector* and *Winifred*). Three deaths were attributed to *Winifred* while the cost of damage was placed at \$130-150 million. *Hector* weakened rapidly after landfall but subsequent heavy rain over the Kimberley region

caused \$2.5 million damage to the road systems. The flooding caused by *Hector* was estimated to be a one in 200 years event.

## Large-scale features

The early part of the 1985-86 tropical cyclone season was characterised by a significantly weaker than normal northwest monsoon over northern Australia and the Coral Sea.

The large-scale features which contributed to the weaker than normal monsoon from November to mid-January were anomalous low pressures over the Indian sub-continent and the region east of the Philippines and, in the southern hemisphere, anomalous high pressures over Papua New Guinea.

A near normal synoptic flow pattern returned in late January to early March. For the remainder of the season the northern hemisphere pattern was near normal, although the Siberian high pressure system was anomalously weak in April.

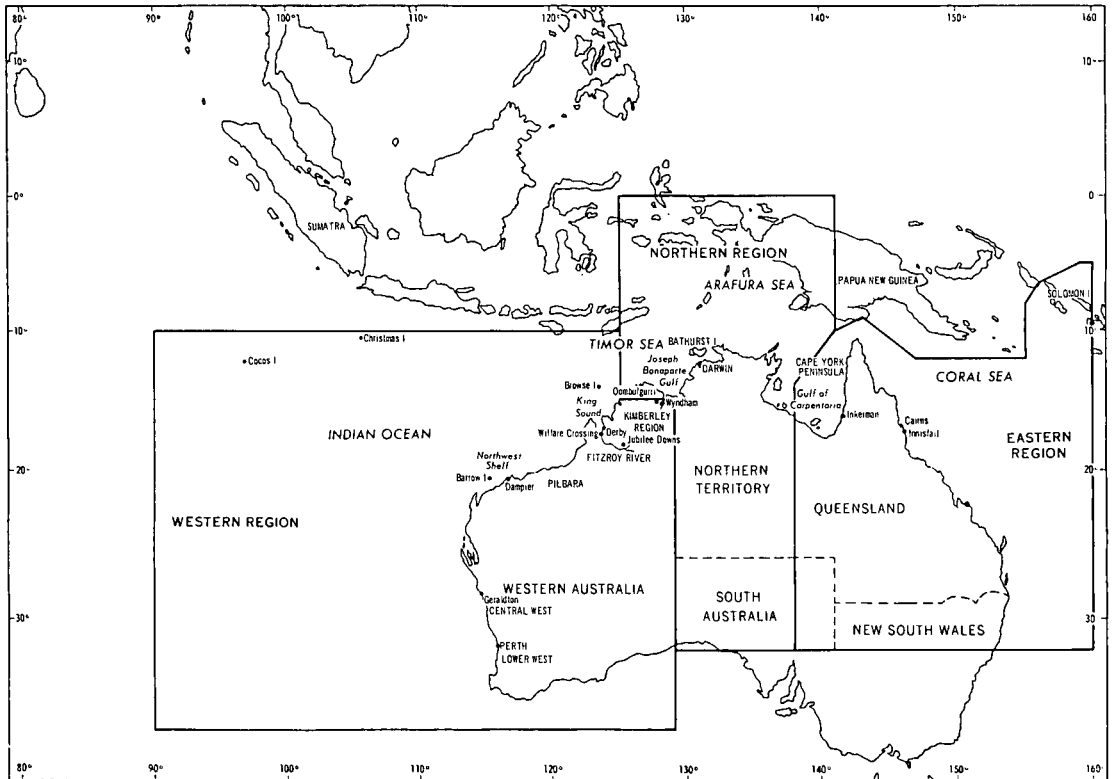
Due to a high pressure anomaly in the southern mid-latitudes, a stronger than normal southeast trade flow persisted over the Australian region during March although this weakened slightly over the Northern region in April.

The sea surface temperatures in the Australian region were one to two degrees Celsius above normal, throughout the season.

## Seasonal statistics

The area for which the Australian Bureau of Meteorology had international tropical cyclone warning responsibility during the 1985-86 season is shown in Fig. 1. The Western region's western boundary has been altered from  $80^\circ\text{E}$  to  $90^\circ\text{E}$ . Any

Fig. 1 Australian tropical cyclone warning and advisory area of responsibility.



reference in the text to cyclones outside this area is tentative only. Place names and localities mentioned in the report are also indicated in Fig. 1 (however, more detailed place names near *Winifred's* landfall are included in Fig. 7). A statistical summary of some aspects of the 1985-86 season is presented in Tables 1 and 2. The averages presented in Table 1 have been calculated using only data within the new Australian region of responsibility.

The average number of tropical cyclones in the various regions for the ten-year period ending 30 June 1986 was derived from Lourenz (1981), Kuuse (1985) and information held in the Darwin Regional office.

In the Australian region during the 1985-86 season there were fifteen tropical cyclones compared with the 10-year average of about thirteen.

A tropical cyclone day is defined as a day on which one or more tropical cyclones (10-minute mean winds of  $63 \text{ km h}^{-1}$  or more) existed in the Australian region for any part of the day commencing at 0000 UTC. In the Australian region there were 57 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.

## Tropical cyclones of the 1985-86 season

### 1. Tropical cyclone Nicholas, 26 November to 7 December 1985 (Fig. 2)

Tropical cyclone *Nicholas* formed from a low which developed within a broad band of monsoonal activity to the south of Sumatra, after initially being located near  $6.6^{\circ}\text{S}$ ,  $102.2^{\circ}\text{E}$  at 0000 UTC on 26 November 1985. The low moved south and then southwest before recurving onto an easterly track at 280600 UTC near  $9.3^{\circ}\text{S}$ ,  $100.9^{\circ}\text{E}$ . At this stage it had just reached cyclonic strength.

After this recurvature and until peak intensity at  $9.9^{\circ}\text{S}$ ,  $113.9^{\circ}\text{E}$  (031200 UTC) the cyclone maintained a generally easterly track and a small but intensifying circulation. Although the cyclone passed through major shipping routes no reports of gales were received. One ship located the centre on radar at a

**Table 1. Summary of the 1985-86 tropical cyclone season in the Australian region.**

	Australian region	Western region	Northern region	Eastern region
Number of cyclones in the 1985-86 season	15	10	1	5
Average number of cyclones (10-year average 1976-77 to 1985-86)	13.4	8.0	2.2	4.6
Initial location of tropical depression	11*	4	3	4
Coastal crossing at cyclone intensity (sea to land)	2	0	1	1
Tropical cyclone days (one active)	57	41	1	15
Tropical cyclone days (two active)	3	1	0	0
Severe tropical cyclones	5	3	0	2

\* Four tropical depressions which formed outside the Australian region subsequently developed into tropical cyclones in the Australian region.

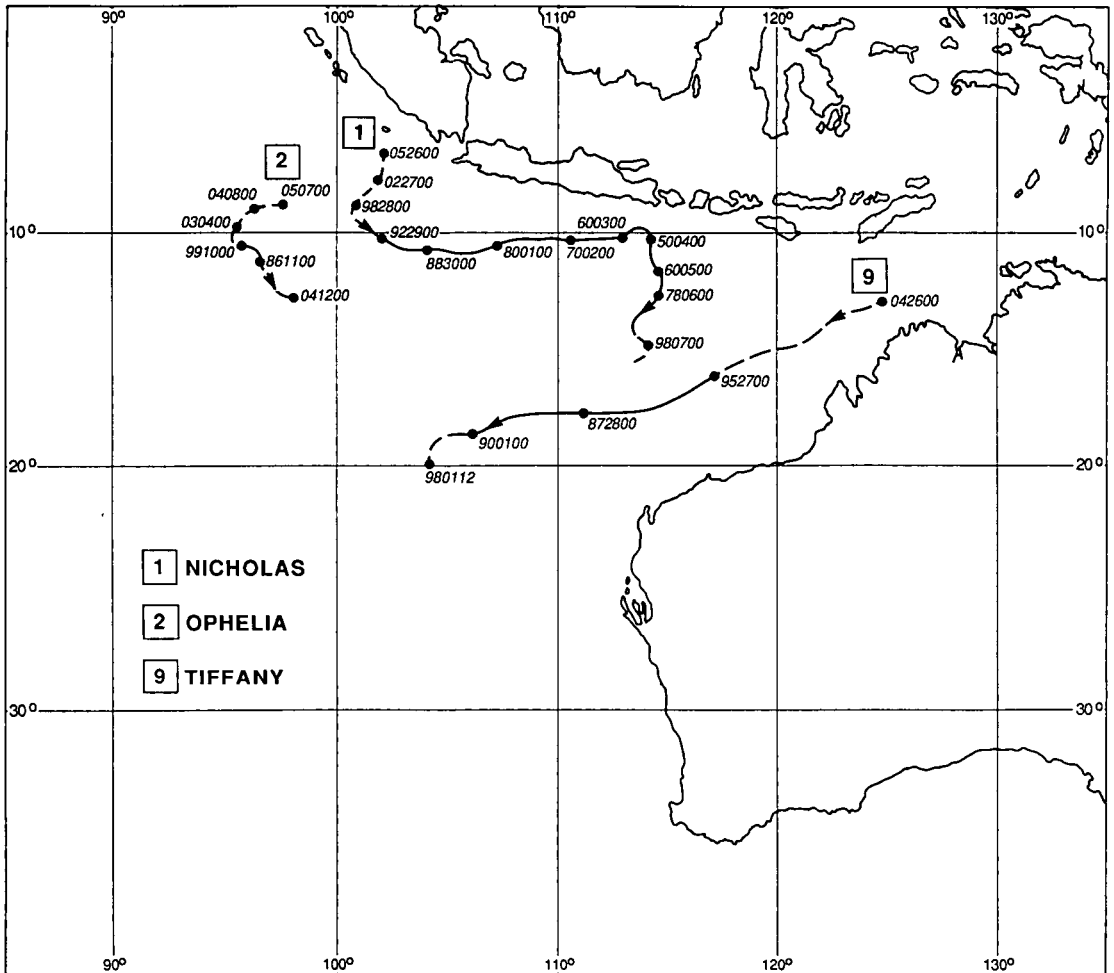
**Table 2. Tropical cyclones in the Australian region during the 1985-86 season.**

No.	Name and life span as a cyclone	Initial location of tropical depression	First reached tropical cyclone intensity	Estimated lowest central pressure (hPa)	Weakened below tropical cyclone intensity
1	<i>Nicholas</i> 26 Nov-7 Dec	6.6°S, 102.2°E 0000 UTC 26 Nov	9.3°S, 100.9°E 0600 UTC 28 Nov	945	14.1°S, 113.7°E 1200 UTC 6 Dec
2	<i>Ophelia</i> 7-12 Jan	8.6°S, 97.6°E 0000 UTC 7 Jan	10.3°S, 95.2°E 1800 UTC 9 Jan	986	12.4°S, 97.3°E 1200 UTC 11 Jan
3	<i>Pancho</i> 18-21 Jan	14.4°S, 107.7°E 0000 UTC 18 Jan	13.7°S, 109.5°E 1800 UTC 18 Jan	976	17.7°S, 111.7°E 1800 UTC 21 Jan
4	<i>Hector</i> 18-24 Jan	12.2°S, 130.0°E 0600 UTC 17 Jan	13.2°S, 128.8°E 0000 UTC 19 Jan	982	15.2°S, 127.8°E 0000 UTC 20 Jan
5	<i>Vernon</i> 21-24 Jan	16.5°S, 139.5°E 0000 UTC 21 Jan	17.8°S, 148.1°E 1200 UTC 23 Jan	990	21.9°S, 157.1°E 1200 UTC 24 Jan
6	<i>Winifred</i> 27 Jan-5 Feb	12.9°S, 144.9°E 0300 UTC 27 Jan	14.1°S, 146.5°E 1800 UTC 29 Jan	957	18.5°S, 145.0°E 1800 UTC 1 Feb
7	<i>Rhonda</i> 17-22 Feb	15.8°S, 116.2°E 0000 UTC 17 Feb	17.8°S, 114.8°E 0900 UTC 18 Feb	968	27.5°S, 113.0°E 0000 UTC 21 Feb
8	<i>Selwyn</i> 21-26 Feb	13.4°S, 114.3°E 0600 UTC 21 Feb	16.2°S, 113.8°E 1800 UTC 22 Feb	980	23.0°S, 106.2°E 1200 UTC 25 Feb
9	<i>Tiffany</i> 25 Feb-1 Mar	13.5°S, 125.5°E 1200 UTC 25 Feb	16.2°S, 117.2°E 0000 UTC 27 Feb	984	18.9°S, 104.0°E 0600 UTC 1 Mar
10	<i>Victor</i> 1-9 Mar	11.4°S, 127.3°E 1200 UTC 1 Mar	13.5°S, 123.9°E 1800 UTC 2 Mar	930	26.5°S, 109.3°E 1800 UTC 8 Mar
11	<i>Alfred</i> 2-7 Mar	14.4°S, 150.3°E 1500 UTC 2 Mar	16.5°S, 155.1°E 1800 UTC 6 Mar	990+	Moved into Nadi region about 1200 UTC 7 Mar
12	<i>Alison</i> 4-9 Apr	11.3°S, 105.2°E 1800 UTC 4 Apr	10.8°S, 100.7°E 0600 UTC 7 Apr	974*	Moved into Mauritius region about 1800 UTC 9 Apr
13	<i>Manu</i> 21-27 Apr	8.0°S, 156.0°E 0000 UTC 21 Apr	11.3°S, 153.7°E 0900 UTC 23 Apr	970	15.2°S, 146.0°E 0000 26 Apr
14	<i>Billy</i> 4-15 May	4.7°S, 89.3°E 0000 UTC 4 May	6.1°S, 92.2°E 1800 UTC 5 May	950	26.1°S, 106.7°E 0000 UTC 13 May
15	<i>Namu</i> 16-22 May	6.9°S, 163.7°E 1500 UTC 16 May	8.2°S, 163.5°E 1200 UTC 17 May	960	Moved into Nadi region about 0000 UTC 21 May

\* In Western region

+ In Eastern region

Fig. 2 Tracks of cyclones 1, 2 and 9 of the 1985-86 season. Broken lines denote pre- and post-cyclone stage. Key to number groups along the track in code form PPYYGG — PP central pressure (tens and units of hectopascals); YY — dates; GG — time (UTC whole hours).



distance of 55 km and reported northwesterly winds of 56 km h<sup>-1</sup>. Dvorak analysis estimates of the winds at the centre were 160 km h<sup>-1</sup> at that time.

At peak intensity (central pressure 945 hPa) *Nicholas* again changed direction and began to move on a more southerly track and weaken. Whilst the early easterly movement had been the result of upper-level westerly winds associated with a ridge across the equatorial Indian Ocean, the slower southerly track was associated with the passage of an upper trough to the south with accompanying northeasterly and then northwesterly upper-level winds.

Decay of the cyclone was comparatively rapid, despite the fact that it remained over warm water. A strong surface high, moving eastward following the upper trough, injected dry air into the low-level environment so that by 061800 UTC at 14.7°S, 114.0°E the central pressure had risen to 998 hPa.

The track of the cyclone was entirely maritime and all intensities were derived from Dvorak analysis techniques.

**2. Tropical cyclone Ophelia, 7 to 12 January 1986 (Fig. 2)**

Tropical cyclone *Ophelia* was a weak cyclone that developed to the north of Cocos Island during a period of strong monsoonal activity across the southern equatorial Indian Ocean. Three other cyclones (*Delfinina* at 85°E, *Costa* at 60°E and an unnamed cyclone at 40°E) were active to the west of the area.

After forming at 8.6°S, 97.6°E (0000 UTC 7 January 1986) the low moved slowly southwest entering the Western region of responsibility at the time the low reached cyclonic strength. At 091800 UTC (10.3°S, 95.2°E) the system recurved and began moving generally southeast. The track appears to have

been influenced by the flow on the western side of an upper-level high.

*Ophelia* passed 30 km to the east of Cocos Island. Winds on the island exceeded gale force ( $63 \text{ km h}^{-1}$ ) for brief periods during 11 January however the strongest wind recorded was a gust of  $80 \text{ km h}^{-1}$  at 101550 UTC. At 110001 UTC a ship 110 km south-southwest from the storm reported winds of  $66 \text{ km h}^{-1}$ , however this wind may have resulted from the strong pressure gradients which developed between the cyclone and a high to the south. The lowest central pressure was estimated to be 986 hPa during the period 0000-0600 UTC 11 January.

As the cyclone moved southeast past Cocos Island it was affected by the shear between upper-level northwesterly and low-level southeasterly winds. Under this influence the cyclone decayed rapidly to a low with central pressure of 1004 hPa by 120000 UTC.

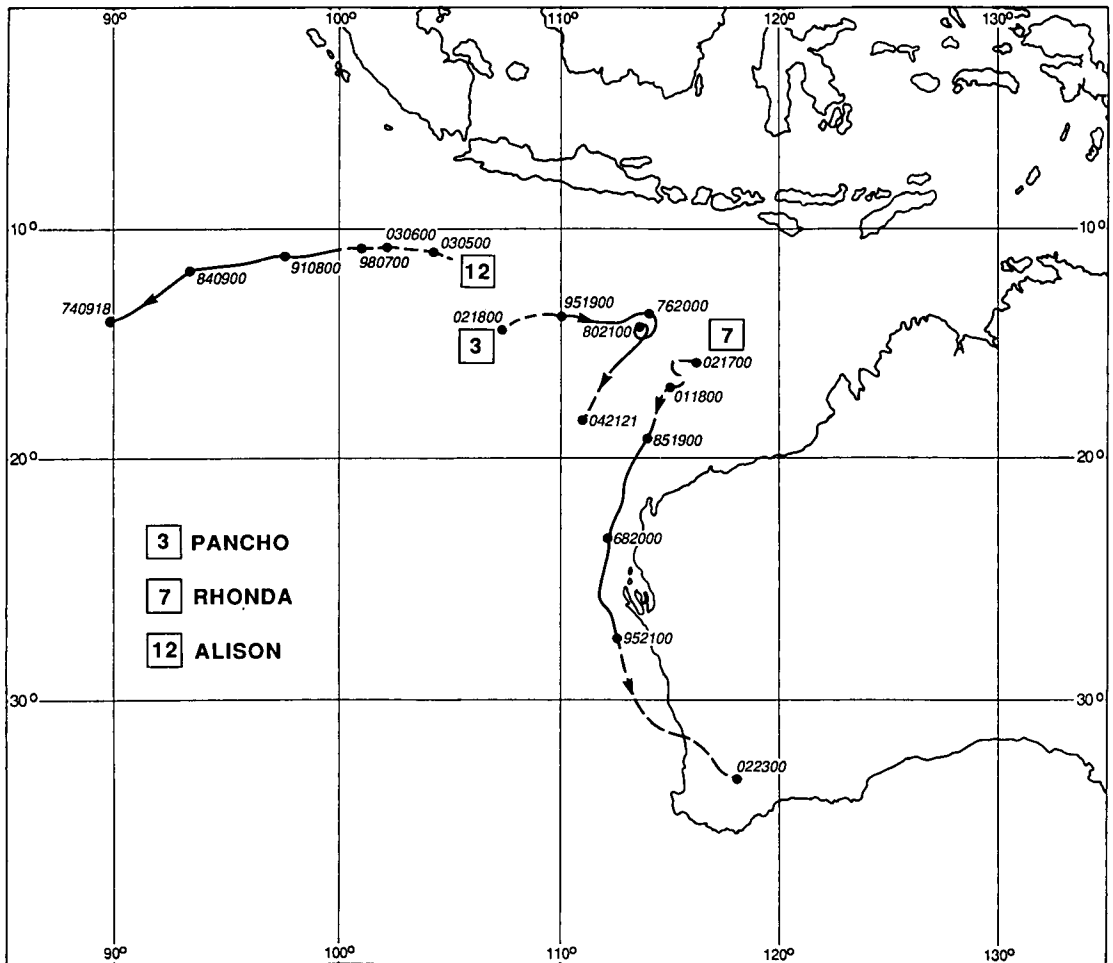
### 3. Tropical cyclone Pancho, 18 to 21 January 1986 (Fig. 3)

Tropical cyclone *Pancho* was the third cyclone to develop in the Western region in the 1985-86 season, and was active at the same time as cyclone *Hector* was moving southwest into the Kimberley region. *Pancho* remained over the ocean throughout its life cycle.

Initial development occurred approximately 500 km south-southeast of Christmas Island in an area of weak monsoonal activity. The developing low moved eastward from  $14.4^{\circ}\text{S}$ ,  $107.7^{\circ}\text{E}$  at 0000 UTC 18 January 1986 and reached cyclonic strength near  $13.7^{\circ}\text{S}$ ,  $109.5^{\circ}\text{E}$  at 181800 UTC. The basic eastward movement was continued against the influence of an extensive upper-level ridge to the south of the cyclone until 200000 UTC.

By 200000 UTC the cyclone had moved to  $13.7^{\circ}\text{S}$ ,  $114.2^{\circ}\text{E}$  where steering mechanisms were weak, and during the next 30 hours *Pancho* performed a 480

Fig. 3 Tracks of cyclones 3, 7 and 12 of the 1985-86 season. Symbols as per Fig. 2.



degree clockwise loop. Subsequently the movement of the cyclone seems to have been influenced by the upper-level northerly flow. During the 12 hours after the completion of the loop, cool stable maritime air was entrained into the cyclone. This produced a rapid decay so that by 211800 UTC winds were estimated to have fallen below gale force.

A lowest central pressure of 976 hPa was reached briefly at 200000 UTC near 13.7°S, 114.2°E, however the strongest wind reported was 74 km h<sup>-1</sup> from a ship 120 km northwest of the centre at 201800 UTC.

**4. Tropical cyclone Hector, 17 to 24 January 1986 (Fig. 4)**

*Hector* formed from a low which had been embedded in the monsoon trough for several days.

During 17 January 1986 the north to northwest monsoon flow north of the monsoon trough rapidly strengthened, while to the south there were southeast trade winds of 37 to 46 km h<sup>-1</sup>.

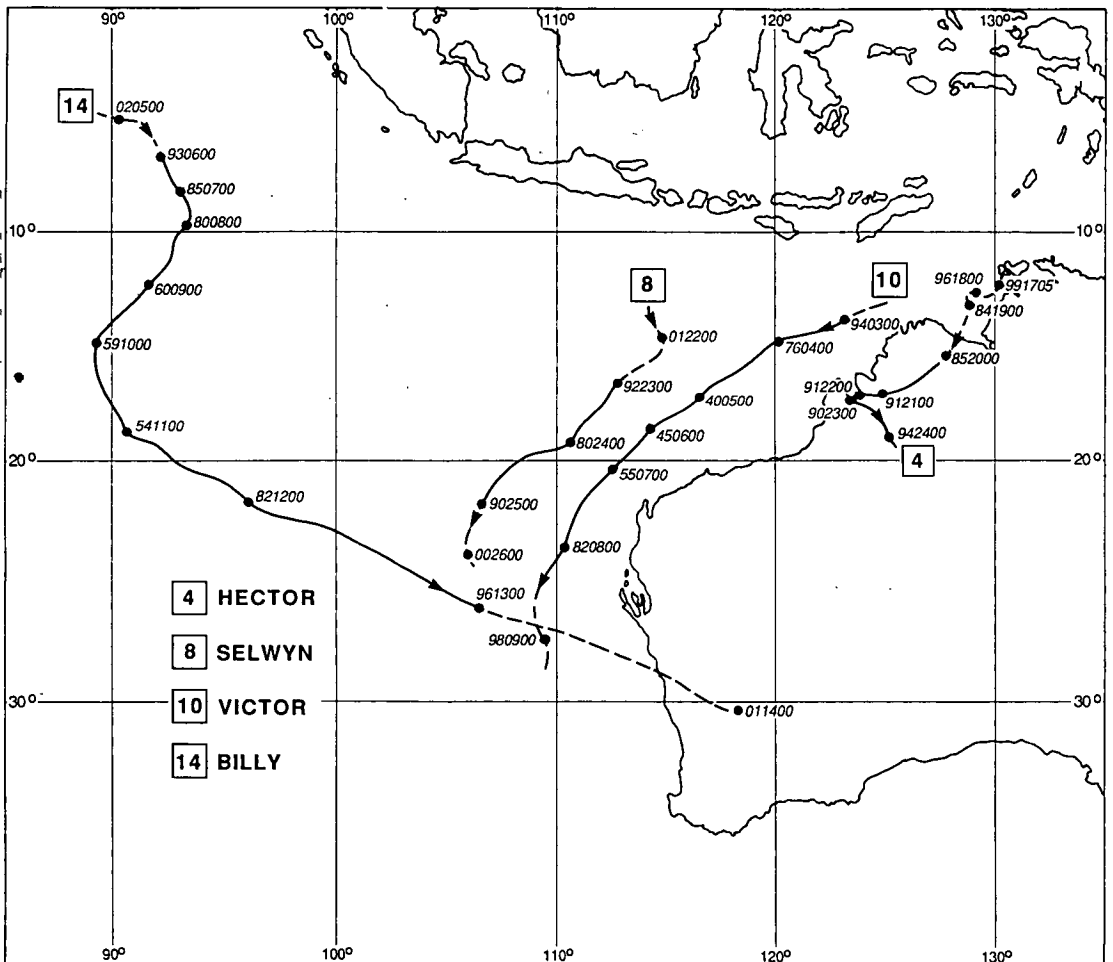
In this period of increased cyclonic vorticity a small recognisable depression formed just south of Bathurst Island at 170500 UTC.

It maintained characteristics of a cold-cored monsoon depression throughout its lifetime.

The depression moved steadily southwest before slowing, recurving to the south-southeast and deepening on 18 January 1986. The depression was named at 0000 UTC 19 January. During 19 January 1986 tropical cyclone *Hector* slowly accelerated to the south-southwest. A lowest central pressure of 982 hPa was achieved by 190500 UTC at 13.4°S, 128.9°E with an estimated wind speed of 74 km h<sup>-1</sup>. A ship 40 km from the centre of the system at 181200 UTC recorded winds in the range 55 to 74 km h<sup>-1</sup>. No direction was given.

Tropical cyclone *Hector* made landfall 50 km north of Wyndham. Wyndham recorded an easterly wind of 69 km h<sup>-1</sup> at 192200 UTC when *Hector* was 50 km to the northwest.

Fig. 4 Tracks of cyclones 4, 8, 10 and 14 of the 1985-86 season. Symbols as per Fig. 2.



During 20 January 1986 the monsoon depression moved steadily southwest across the Kimberley region causing heavy rainfall over the headwaters of the Fitzroy River. Gale force winds were reported in areas where the system interacted with the northwest monsoon winds. After 210300 UTC the depression's track became westerly and it passed north of Derby before moving northwest up King Sound. At 221800 UTC (16.9°S, 123.3°E) the system recurved suddenly and moved southeast back down King Sound.

The depression passed over Derby at 230700 UTC with a central pressure of 992 hPa but without gales being recorded. After continuing to move to the southeast, the depression was absorbed into a broad quasi-stationary low pressure system stretching from the southern Kimberley region into the Pilbara region.

The system was notable for the heavy rain that was deposited over the Kimberley region resulting in flooding of the Fitzroy River and the closure of the Great Northern Highway at the new Willare Crossing south of Derby. Repair costs to the crossing and associated works were estimated to be \$2.19 million. Flooding also occurred in the inland Kimberley region causing closure of the main highways. Repair costs to inland roads were a further \$260000.

Flooding also necessitated the evacuation of 200 people from the Oombulgurri community northwest of Wyndham.

The period of heaviest rainfall extended from 19 to 24 January. Figure 5 shows cumulative isohyets for this period over the Kimberley region. The highest cumulative recording for the five-day period 9am 19 January to 9am 24 January was 471 mm at Jubilee Downs Station. Main roads Department engineers have calculated that the flooding caused by the depression was a once in 200 years event with a flow rate from the Fitzroy Basin of 17500 cubic metres per second at the peak of the flood.

### 5. Tropical cyclone Vernon, 21 to 24 January 1986 (Fig. 6)

*Vernon* was the first tropical cyclone to affect the Eastern region in the 1985-86 season. A cloud mass was evident in the southern Gulf of Carpentaria for several days prior to the formation of the tropical low that was to become *Vernon*.

After its formation at 0000 UTC 21 January, the low was initially slow-moving but gradually accelerated during the whole of its life. Its motion was initially towards the east, gradually changing to southeast. The system slowly deepened until it crossed the coast near Inkerman at 1600 UTC 21 January. During the

Fig. 5 Five-day cumulative isohyets (mm) for the Kimberley region from 9am 19 January to 9am 24 January 1986.

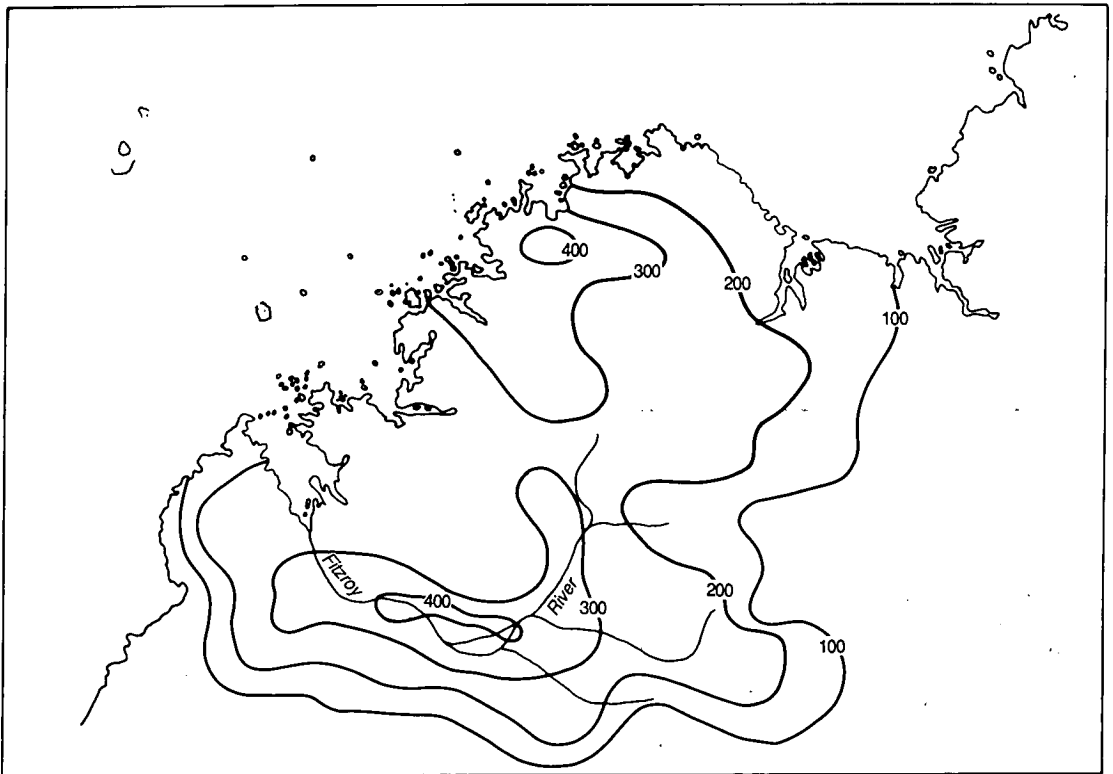
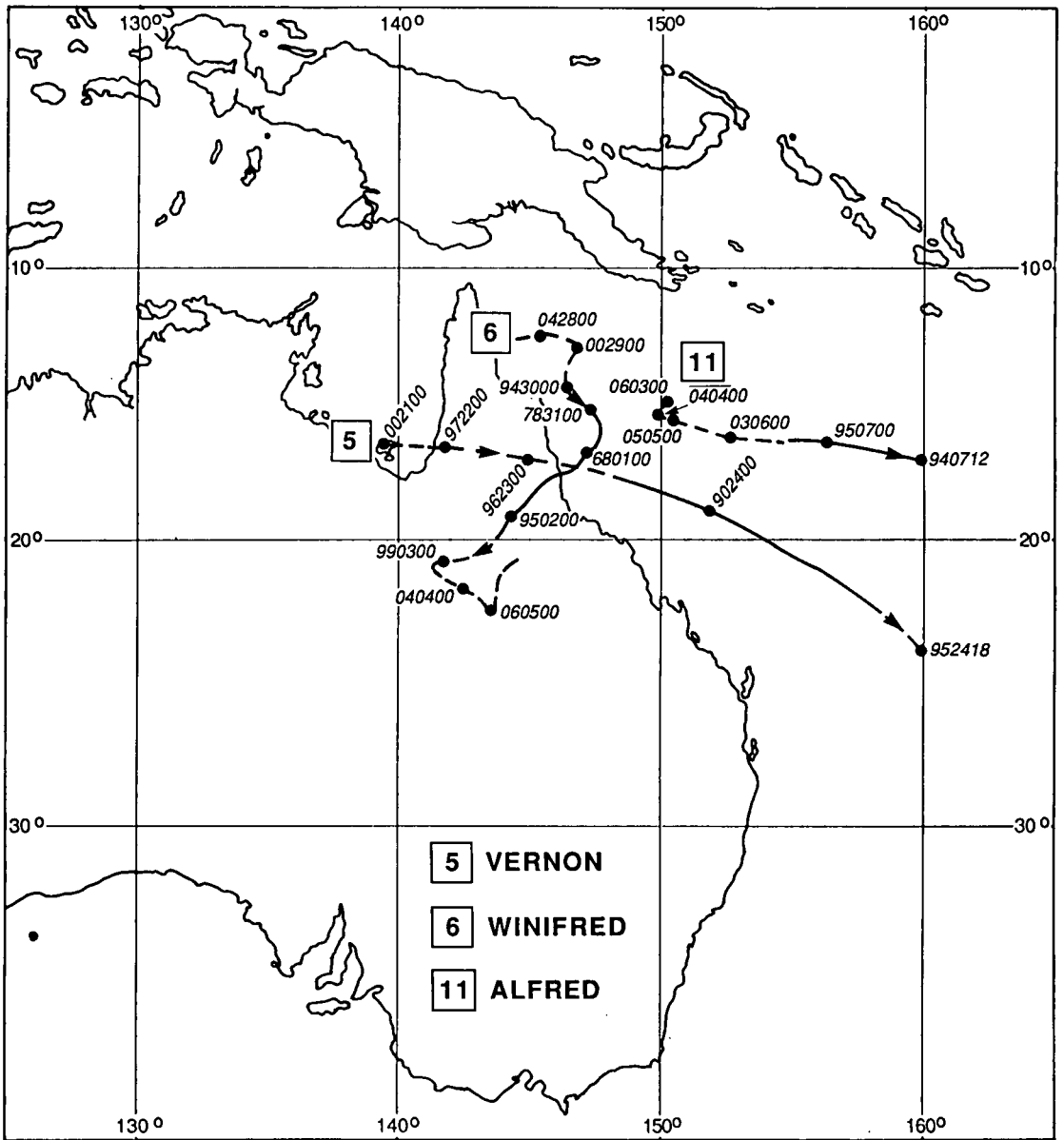


Fig. 6 Tracks of cyclones 5, 6 and 11 of the 1985-86 season. Symbols as per Fig. 2.



crossing of Cape York Peninsula development was minimal. At 0400 UTC 23 January the low crossed the coast between Cairns and Innisfail. Once over the ocean intensification commenced and cyclonic intensity was reached at 231200 UTC near 17.8°S, 148.1°E with a central pressure of 995 hPa.

Maximum intensity was reached at 0000 UTC on 24

January with a central pressure of 990 hPa at 19.0°S, 152.0°E. Cyclonic intensity was lost 13 to 14 hours later and the resulting low was no longer evident by 242100 UTC.

The highest reported wind was 87 km h<sup>-1</sup> (0000 UTC 24 January) from a ship at 15.3°S, 144.4°E.



### 6. Tropical cyclone Winifred, 27 January to 5 February 1986 (Fig. 6)

*Winifred* developed from a tropical low first identified on the afternoon of 27 January, about 450 km north of Cairns. Figure 7 shows the combined track of the tropical low and cyclone *Winifred*. Landfall occurred at about 0900 UTC 1 February at 17.6°S, 146.1°E with a central pressure of 957 hPa. The system then moved inland and rapidly lost cyclonic intensity. The resulting depression was still evident until 6 February moving first southwest then southeast and finally northeast.

At or shortly before landfall *Winifred* was estimated to be at its most intense. Gales extended over 160 km from Cairns to Cardwell. Estimated winds between 130 and 150 km h<sup>-1</sup> were reported by the observer at Innisfail. However, the Joint Tropical Trials and Research Establishment at Cowley Beach over which the eye passed provided instrumental data suggesting a maximum mean wind of 126 km h<sup>-1</sup>. From this it is estimated that gusts to 176 km h<sup>-1</sup> occurred. The barograph at South Johnstone, also in or close to the eye during the coastal crossing, recorded a minimum pressure of 958 hPa.

Cairns radar tracked a complete eye from 0300 UTC 1 February. The mean diameter was then 51 km, decreasing to 49 km as the leading edge of the eye reached the coast, and still further to 41 km as the eye crossed the coast. The tide gauge at Clump Point recorded a storm surge of 1.6 metres. Wave run-up on beaches was about 2 metres above the astronomical tide.

Significant 24-hour rainfalls during the period were Topaz 304 mm, Ravenshoe 373 mm, Tully 212 mm, Innisfail 221 mm and Babinda 251 mm.

There were three deaths attributed to tropical cyclone *Winifred*. One during the storm, one as a result of associated flooding and a third from severe injuries sustained during the event.

The best estimate of damage cost is between \$130 and \$150 million, most of this being crop losses to the value of about \$90 million.

*Winifred* produced the most disastrous effects on the Queensland coast of any tropical cyclone since *Althea* in 1971. A detailed report on cyclone *Winifred* has been produced (Bureau of Meteorology 1986).

### 7. Tropical cyclone Rhonda, 17 to 22 February 1986 (Fig. 3)

Tropical cyclone *Rhonda* formed in an area of moderate monsoonal activity approximately 550 km north of Dampier. The developing low pressure system moved west, southeast and then southwest before settling on a sustained south-southwesterly track.

After the initial low formation near 15.8°S, 116.2°E (0000 UTC on 17 February) cyclonic strength was reached near 17.8°S, 114.8°E (180900 UTC). The lowest pressure of 968 hPa was analysed at 200000 UTC near 23.3°S, 112.5°E.

The track of *Rhonda* followed the coast of Western

Australia at a distance of between 90 and 200 km offshore. Steering was maintained by a middle and upper-level high pressure system centred over inland Australia. As the cyclone steered around the western side of the high the direction of movement changed from south-southwesterly to south-southeasterly, until the system was forced across the coast near Perth by increasing northwesterly winds ahead of an approaching southern depression.

The cyclone had weakened to a low near 27.5°S, 113.0°E by 210000 UTC, however it caused heavy rain over the southern parts of the Central West Coastal district and in the Lower West Coastal districts. Twenty-four hour falls of up to 101 mm were recorded with 88 mm falling in the Perth metropolitan area. Flooding occurred on suburban arterial roads and over 100 traffic accidents were attributed to the wet conditions.

The strongest sustained wind reported was 63 km h<sup>-1</sup> at Barrow Island at 190400 UTC when the cyclone was 200 km to the northwest of the island. Sustained gale force winds did not reach the coast and no damage was reported.

### 8. Tropical cyclone Selwyn, 21 to 26 February 1986 (Fig. 4)

Tropical cyclone *Selwyn* developed in the Indian Ocean, some 825 km north of Barrow Island at 13.4°S, 114.3°E within an extensive low pressure area that extended from Christmas Island to Darwin and southwest to Perth. The southern extent of the low pressure area contained the decaying remains of cyclone *Rhonda*.

The developing low moved south-southeast during 21 February 1986 and after 0300 UTC on 22 February commenced a sustained southwesterly track.

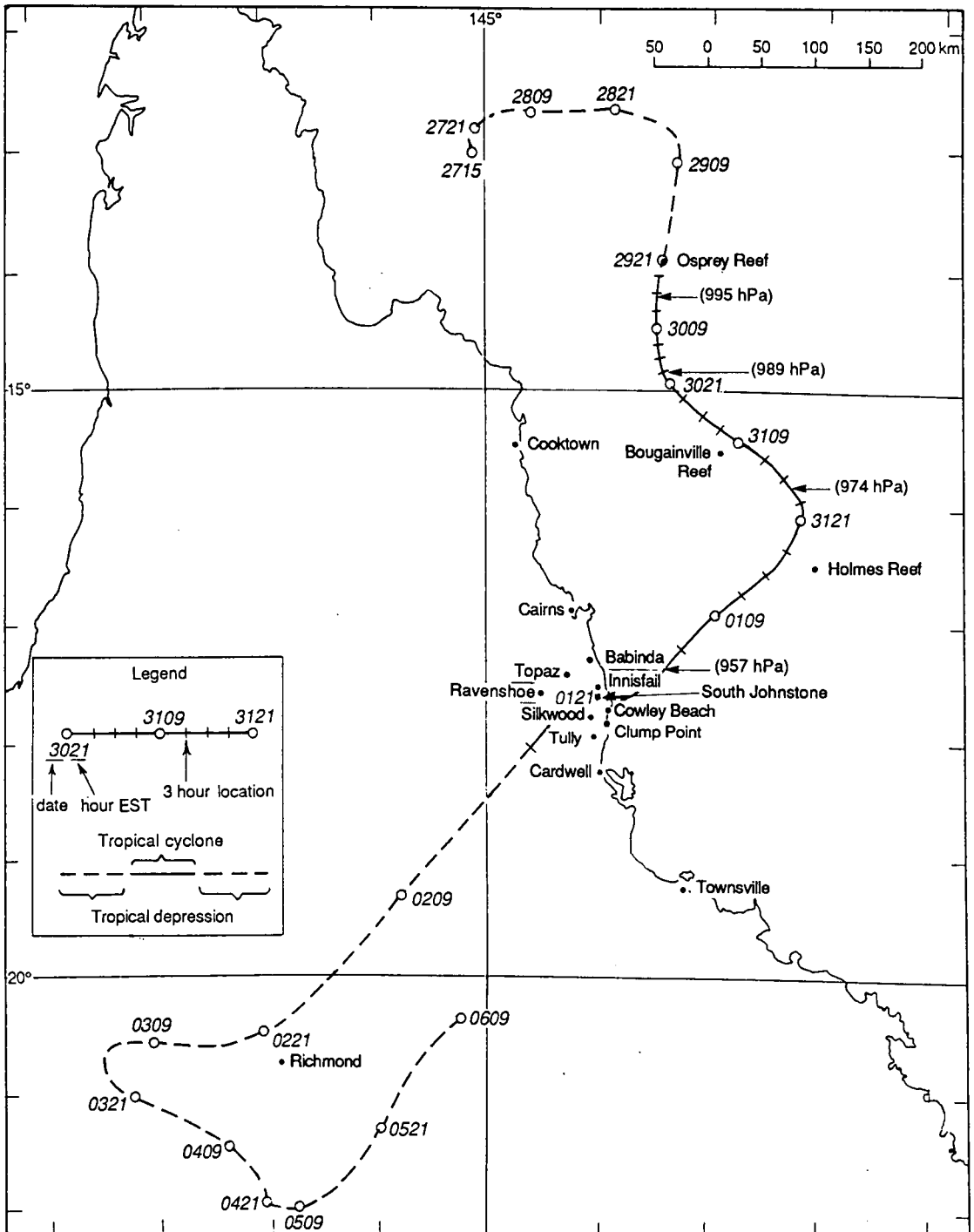
The lowest central pressure of 980 hPa was attained at 231800 UTC near 18.9°S, 110.9°E and was maintained until 240900 UTC at 20.3°S, 108.3°E. Further intensification was inhibited by shearing associated with increasing upper-level northwesterly winds and underlying low-level easterly winds from a ridge lying across the eastern Indian Ocean and southern Western Australia. By 250600 UTC the central pressure had risen to 995 hPa at 22.5°S, 106.5°E and the system took on a more southerly track before losing identity near 24.2°S, 106.3°E by 260600 UTC.

The track of the system was entirely maritime and no reports of winds in excess of gale force were received.

### 9. Tropical cyclone Tiffany, 25 February to 1 March 1986 (Fig. 2)

The low pressure system from which cyclone *Tiffany* developed formed just east of 125°E and drifted rapidly westward into the Western Australian area of responsibility. At 0600 UTC 26 February 1986 the 1004 hPa low was at 13.8°S, 122.5°E and moving west-southwest under the influence of an upper-level high located over the inland Pilbara region. The

Fig. 7 Detailed track of cyclone *Winifred*.



steering influence of this high was maintained throughout the life of the cyclone.

At 16.2°S, 117.2°E the system reached cyclonic strength (0000 UTC 27 February) however, further development was inhibited by the continued rapid movement resulting from easterly winds at all levels. By 1600 UTC 27 February the cyclone began to slow down and deepen and at 281800 UTC *Tiffany* reached its lowest central pressure of 984 hPa near 18.2°S, 107.7°E. At this time the cyclone was coming under the influence of increasing northwesterly winds in the southwestern quadrant of the upper-level high. Low-level easterly winds persisted from an extensive low-level southern ridge. Subjected to strong shearing the system began to decay rapidly, and by 0600 UTC 1 March winds had moderated below gale force near 18.9°S, 104.4°E.

The life of this system was spent entirely over the ocean. Surface information was scant, and no winds exceeding gale force were recorded.

#### 10. Tropical cyclone Victor, 1 to 9 March 1986 (Fig. 4)

Tropical cyclone *Victor* was the most severe cyclone of the season. Its central pressure fell to 930 hPa and was maintained for three hours commencing 0600 UTC 5 March 1986. The cyclone did not cross the coast, but followed a track parallel to it at a distance from 240 to 450 km offshore. Gales were experienced briefly at Barrow Island at 0700 UTC 6 March, however, no damage was reported in coastal areas.

The developing low drifted westward from the Northern region and reached cyclonic strength near 13.5°S, 123.9°E at 021800 UTC. The cyclone adopted a basically southwesterly track and deepened steadily. Steering was maintained by an upper-level high located over the Pilbara area.

*Victor* followed a southwesterly or south-southwesterly track during the whole of the period from 050000–081200 UTC despite upper-level winds across the region which were mostly northwesterly. The structure of the cyclone began to show signs of decay after 0000 UTC 7 March and by 1200 UTC 8 March the upper-level cloud had been completely sheared from the low-level circulation. The decaying cyclone followed a south-southeasterly track still parallel to the coast and by 090000 UTC at 27.6°S, 109.7°E the central pressure had risen to 998 hPa.

Wind strengths at the centre were estimated to be 180 km h<sup>-1</sup>, gusting to 255 km h<sup>-1</sup> when the cyclone was at its peak intensity, however, the strongest reported wind was 74 km h<sup>-1</sup> at Browse Island at 030900 UTC when the cyclone was 100 km to the west-southwest of the island. A further report of the same wind strength was received from a ship 180 km southwest of the cyclone's centre at 0600 UTC 8 March.

Whilst no significant damage was caused by cyclone *Victor* the passage down the coast resulted in all major towns being placed on various stages of alert and industrial activities being curtailed to varying degrees. Two hundred and fifty personnel were evacuated from

oil and gas platforms and drilling rigs in the Northwest Shelf area and oil wells on Barrow Island were shut down.

**11. Tropical cyclone Alfred, 2 to 8 March 1986 (Fig. 6)**  
The low which was to become tropical cyclone *Alfred* was first identified at about 0000 UTC 2 March 1986 530 km northeast of Cairns.

This low moved very slowly south-southwest for 18 hours and then stagnated for a further 30 hours. During this time no significant development occurred. At about 1500 UTC 4 March the system began moving to the east-southeast very slowly. The system gradually accelerated and at about 0300 UTC 6 March began to develop. At this time the track became east. By 061800 UTC cyclonic intensity had been reached. *Alfred* was now at 16.5°S, 155.1°E with a central pressure of 995 hPa.

Nine hours later the track again became east-southeast. Development continued until the cyclone left the Eastern region at 071200 UTC near 17.2°S, 160.0°E with a central pressure of 994 hPa. *Alfred* caused no damage.

The highest reported wind was 83 km h<sup>-1</sup> at 0600 UTC 5 March estimated by a ship 330 km from the centre.

#### 12. Tropical cyclone Alison, 4 to 9 April 1986 (Fig. 3)

*Alison* was a westerly moving tropical cyclone in the Indian Ocean and was still developing when it moved into the Mauritius area of responsibility and was renamed *Krisostoma*.

A weak surface low was initially located near 11.3°S, 105.2°E at 1800 UTC 4 April. Intensification and westward movement were both slow in the early stages of development. By 0600 UTC 7 April gale force winds were inferred from Dvorak analysis of satellite imagery, however, no surface reports were available within the area.

The cyclone passed 80 km to the north of Cocos Island and at 1200 UTC 8 April gale force winds gusting to 89 km h<sup>-1</sup> were reported from the island. Winds on the southern flank of the system were enhanced by a high pressure system to the south. At 0000 UTC 9 April, when the cyclone with a central pressure of 984 hPa was at 11.9°S, 93.5°E, a ship northwest of the centre reported southerly winds of 74 km h<sup>-1</sup>.

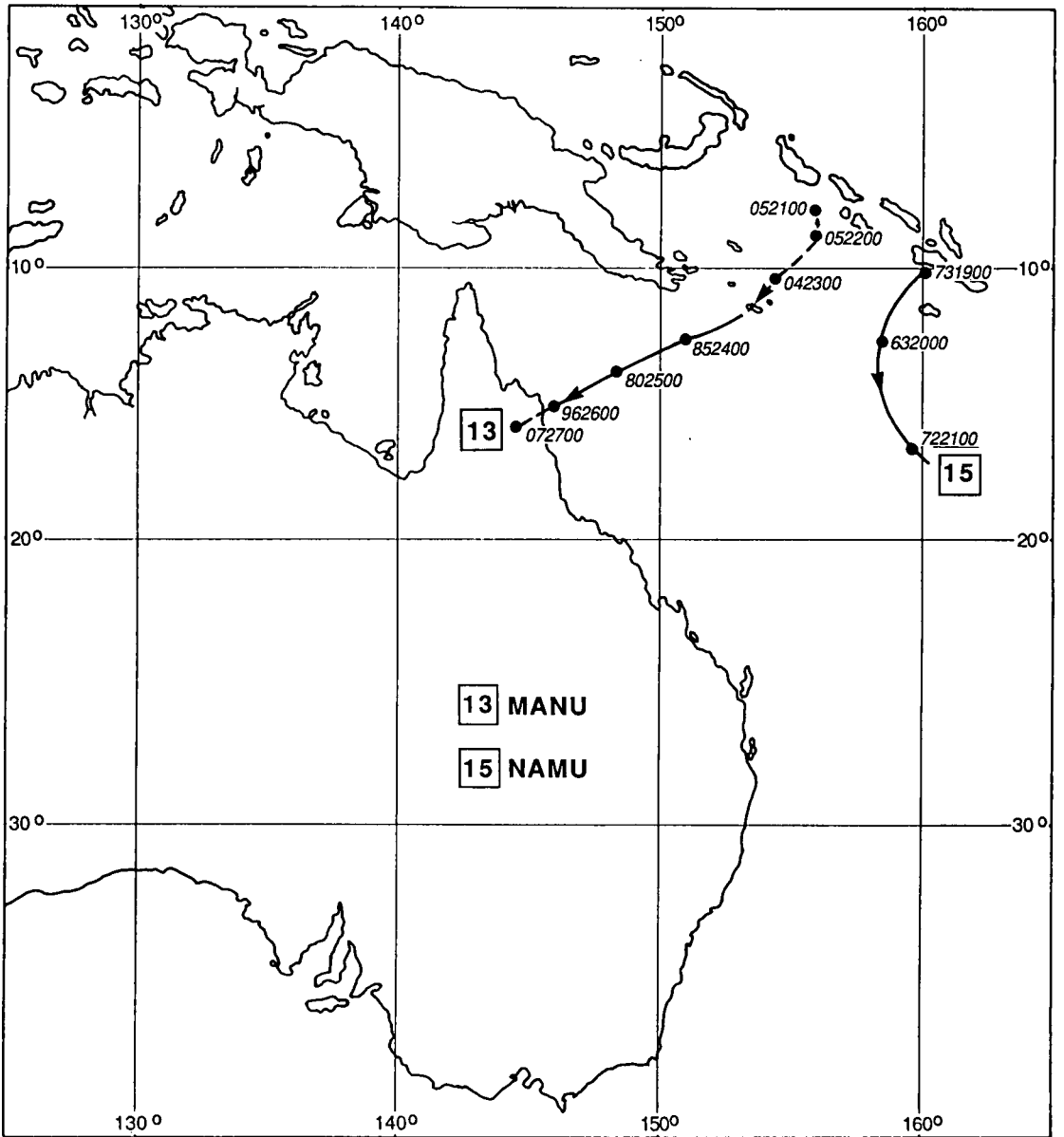
The cyclone continued to deepen and after 0300 UTC 9 April (12.3°S, 923.8°E) began to move on a more southwesterly track. By 1800 UTC 9 April *Alison* was at 14.1°S, 89.8°E, within the Mauritius area of responsibility, with a central pressure of 974 hPa.

#### 13. Tropical cyclone Manu, 21 to 27 April 1986 (Fig. 8)

The low which became tropical cyclone *Manu* was first identified just to the west of the Solomon Islands. At 0000 UTC 21 April it was near 8.0°S, 156.0°E.

The system moved first south and then southwest entering the Papua New Guinea area at 10.0°S, 155.0°E on 221800 UTC. No significant development had taken place by this time. Six hours later development began and by 0900 UTC 23 April

Fig. 8 Tracks of cyclones 13 and 15 of the 1985-86 season. Symbols as per Fig. 2.



cyclonic intensity was reached. Tropical cyclone *Manu* was then near 11.3°S, 153.7°E with a central pressure of 997 hPa.

*Manu* continued to track southwest and deepen, passing back into the Eastern region at 231500 UTC near 12.0°S, 153.9°E. The peak intensity was reached 18 hours later near 13.3°S, 149.7°E at a central pressure of 970 hPa. The system continued in the

same direction whilst filling and lost its cyclonic status at 260300 UTC near 15.2°S, 145.8°E. The resulting low moved inland and ceased to exist 24 hours later.

*Manu* caused extensive crop damage in Papua New Guinea but no damage in the Australian Eastern region. The maximum reported wind speed was 74 km h<sup>-1</sup> from Fitzroy Island lighthouse at 250000 UTC.

**14. Tropical cyclone Billy, 4 to 15 May 1986 (Fig. 4)**

Tropical cyclone *Billy* was the last cyclone in the Western region of the 1985-86 season and occurred outside the normally accepted cyclone period. Within the Western region over the past 10 seasons three cyclones have commenced after 30 April and a further two have commenced in late April and lasted into May.

*Billy* developed to the southwest of Sumatra in a weak monsoonal trough lying east-west along approximately 5°S on 4 May 1986. The developing low moved southeast and winds reached gale force at 051800 UTC near 6.1°S, 92.2°E. The cyclone continued southeast towards Cocos Island, however, at 9.3°S, 93.6°E (071200 UTC) it moved onto a south-westerly track and at 091200 UTC entered the Mauritius area of responsibility and was renamed *Lila*.

The cyclone remained within the Mauritius area until 010800 UTC at which time it again assumed a southeasterly track and re-entered the Western region at 17.8°S, 90.0°E. The name *Billy* was reapplied. At this stage the cyclone had reached its maximum intensity with a central pressure of 950 hPa and an estimated maximum wind speed of 174 km h<sup>-1</sup>. The major steering influence was an upper-level high pressure system located just south of the equator at approximately 100°E.

After re-entering the Western region *Billy* began to accelerate under the influence of strengthening northwest to westerly winds. At the same time weakening began as a result of the strong vertical shear and the entrainment of cool air from the maritime layer. By 130000 UTC (26.1°S, 106.6°E) the central pressure of the cyclone had risen to 996 hPa, however, the residual low persisted for a considerable period. In the three days after 120001 UTC it travelled over 1100 km per day.

The remnant low crossed the West Australian coast at Geraldton with a central pressure of 1000 hPa. Rains from the system extended across the bulk of the southwest land division with 24-hour falls of up to 70 mm. The low passed out of the Western region at 31.5°S, 129.0°E at about 150100 UTC. The total distance travelled by the system in all stages up to 129°E was approximately 6000 km.

The strongest wind recorded was 93 km h<sup>-1</sup> by a ship 160 km southwest of the centre of *Billy* when it was at 13.7°S, 90.3°E. No damage was reported. Rains in the southwest of Western Australia from the decaying low opened the new agricultural season.

**15. Tropical cyclone Namu, 16 to 22 May 1986 (Fig. 8)**

*Namu* was the last cyclone to affect the Australian region for the season. It was the first May cyclone to occur in the Eastern region since 1982.

*Namu* had its genesis in a cloud mass to the northeast of the Solomon Islands. At 161500 UTC a tropical depression was identified at 7.0°S, 164.0°E. Within 24 hours (171200 UTC) cyclone *Namu* developed at 8.2°S, 163.5°E with a central pressure of 995 hPa.

*Namu* tracked steadily southwest and strengthened during the 18-19 May. At 181800 UTC (9.7°S, 160.8°E) *Namu* had estimated winds of 93 km h<sup>-1</sup> and a central pressure of 976 hPa. *Namu* (12.0°S, 158.9°E) reached peak intensity 18 hours later with estimated winds of 130 km h<sup>-1</sup> and central pressure of 960 hPa. The cyclone recurved through south to east by 21 May when it moved into the Nadi (Fiji) area of responsibility.

*Namu's* slow passage over the Solomon Islands brought prolonged heavy rain and mud slides. These mud slides caused major damage and were the major contributing factor in the death of over 100 people. More than a thousand people were injured and 90000 were left homeless. Only minor damage was caused by high winds.

**Acknowledgment**

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