

## HISTORY OF CYCLONES ON THE CAPRICORN COAST

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### ABSTRACT

Tropical cyclones form on the monsoon trough, which in summer usually lies over the North Queensland Coast. Consequently the Capricorn Region is less affected by tropical cyclones than is North Queensland. Nevertheless tropical cyclones have in the past impacted on the Capricorn region and known details of these impacts are detailed in this study. Tropical cyclones threaten this area mostly in January, February and March, although some have occurred in April. There is a strong year-to-year variation in tropical cyclone numbers in the region, with nearly twice as many impacts occurring during La Niña conditions than during El Niño. Several case studies are presented of cyclone impacts with particular reference to coastal effects from waves and storm surge. In this regard the size as well as the intensity of different tropical cyclones are compared.

### INTRODUCTION

#### Tropical cyclones

Tropical cyclones are severe atmospheric disturbances, which in the Southwest Pacific Ocean, mostly occur between the latitudes of ten degrees and thirty degrees (Neumann 1993). They can develop within two latitude degrees of the equator, although this is very rare. These systems have a circular structure of rain, cloud and very high winds surrounding a calm clear centre with very low atmospheric pressure. Due to the rotation of the earth the vortex circulation is clockwise in the Southern Hemisphere. Typically, the size of the clockwise swirling circulation is between 80 km and 800 km. Average wind speeds (over 10 minutes) in excess of 140 km/hr (75 knots) are relatively common in the circular heavy rain bands close to and encircling the calm centre (eye).

The World Meteorological Organization definition of a tropical cyclone is: *A non-frontal cyclone of synoptic scale developing over tropical waters and having a definite organised wind circulation with average wind of gale force (34 knots or 63 km/h) or more surrounding the centre.*

Most tropical cyclones develop along the Inter-Tropical Convergence Zone (ITCZ) where the trade winds of both hemispheres meet. The ITCZ changes position with the seasons penetrating to about latitude 15 degrees North between July and October and to latitudes 10-15 degrees South between January and April. Over the Australian summer the trade winds from the Northern Hemisphere cross the equator and are deflected eastwards by the rotation of the earth forming the northwest monsoon. The convergence zone where this monsoon flow meets the southeasterly trades is referred to in Australia as the monsoon trough.

Tropical cyclones are accompanied by destructive winds and, very heavy rain which often produces disastrous flooding overland after landfall. Over the ocean the intense wind fields generate very large waves and strong ocean currents, which can result in coastal inundation at landfall. Very low atmospheric pressure near the centre of the cyclone also raises the level of the ocean although this effect is secondary when compared with the effect of the wind (Anthes 1982). The coastal inundation is known as storm surge and globally is the major cause of loss of life from tropical cyclones. The destructive force of tropical cyclones is usually expressed in terms of the strongest wind gusts, which can be expected. The maximum wind gust is related to the central pressure of the cyclone. The Bureau of Meteorology uses the five category system shown in Table 1 for classifying tropical cyclone intensity in Australia. Severe tropical cyclones are those of Category 3 and above.

Category	Maximum wind Gust Km/hr (knots)	Potential damage
1	<125 (68)	Minor
2	125(68) to 170(91)	Moderate
3	170(91) to 225(133)	Major
4	225(133) to 280(166)	Devastating
5	>280(166)	Extreme

Table 1...Australia tropical cyclone category scale.

## TROPICAL CYCLONE CLIMATOLOGY- ROCKHAMPTON REGION

The Tropical Cyclone Coastal Impacts Program (TCCIP) was launched in 1994 to help focus research attention and resources on the problem of increased hazard levels and vulnerability of our coastal communities from tropical cyclone impacts. Seed funding for specific research projects, was provided by the National Greenhouse Advisory Committee. This has since been augmented by funding from Queensland Emergency Services, The Australian International Decade for Natural Disaster Reduction Committee, Australian Research Council, US Office of Naval Research, the Insurance Industry as well as substantial commitments by Macquarie University, Bureau of Meteorology, James Cook University and Australian National University.

As part of the TCCIP, the Severe Weather Section of the Bureau of Meteorology in Brisbane has reviewed the record of tropical cyclones in eastern Australia. Part of this work included cataloguing tropical cyclone impacts over eastern Australia. Earlier work on tropical cyclone impacts was carried out by Holthouse (1971) who spent several months searching through the archives of the Bureau of Meteorology in Brisbane. This was a very useful work, however he concentrated on only twenty of the more notable events. Other lists of tropical cyclone activity over eastern Australia, such as Lourensz (1981) and an archived list of Australian tropical cyclones available on the web, consists of track data and estimated central pressure data only.

Details of tropical cyclone impacts in this study are taken from the work carried out by the Severe Weather Section, which were compiled from the following sources: -

- (I) Published and unpublished Bureau of Meteorology tropical cyclone seasonal summaries;
- (ii) Results of Rainfall Observations in Queensland, H.A. Hunt, Commonwealth Meteorologist (1914);
- (iii) Results of Rainfall Observations in Queensland, W.S.Watt, Commonwealth Meteorologist (1940);
- (iv) Australian Hurricanes and Related Storms (1925), S.S.Visher and D. Hodge, Bulletin No 16, Bureau of Meteorology;
- (v) Archived newspaper clippings held by the Bureau of Meteorology;
- (vi) Archives of the Brisbane Courier Mail held at the Queensland State Library;
- (vii) Archives of the Rockhampton Morning Bulletin at the Rockhampton Library;
- (viii) Archives of the Maryborough Chronicle.

Rockhampton is located near the Tropic of Capricorn and well south of the average position of the monsoon trough and therefore has less direct exposure to tropical cyclones than centres such as Townsville. However the Rockhampton region has been exposed to destructive winds, flooding, storm surge and phenomenal seas from tropical cyclones in the past.

### Tropical cyclone season

Overall 37 tropical cyclones are known to have caused an impact in the Rockhampton area between St. Lawrence and Gladstone (see details of all these impacts listed in the appendix). The monthly distribution of these 37 events were as follows:

January	February	March	April	Total
9	14	12	2	37

This list helps define the tropical cyclone season in Rockhampton, which is most active over January, February and March.

**INTER-ANNUAL VARIATION OF TROPICAL CYCLONE IMPACTS**

Australia's rainfall is associated with year-to-year variations in sea surface temperatures in the tropical Pacific Ocean. Variations in ocean temperatures in the tropical Pacific are often associated with the El Niño/Southern Oscillation (ENSO), the most important coupled ocean-atmosphere phenomenon causing global climate variability on inter-annual time scales. A useful measure of ENSO activity is the Southern Oscillation Index (SOI), which is defined here as ten times the normalized difference in monthly pressure anomaly between Tahiti and Darwin. El Niño is usually associated with a large negative SOI, where tropical waters around Australia often have relatively cool temperatures and waters over the equatorial Eastern Pacific are anomalously warm. El Niño is often associated with drought in Australia (e.g. Nicholls 1992a, Allan 1991). La Niña is usually associated with a large positive SOI, where tropical waters around Australia have relatively warm temperatures while waters over the equatorial Eastern Pacific are anomalously cool. La Niña is associated with increased rainfall in Australia.

The relationship between the number of tropical cyclones in the Australian region and the SOI is well-known (e.g., Nicholls, 1984, 1985, 1992; Solow and Nicholls, 1990; Basher and Zheng, 1995). This relationship can be used to predict cyclone activity. Low values of the SOI, typically associated with an El Niño, during the Southern Hemisphere spring usually indicate that the ensuing cyclone season will have fewer than normal cyclones. During such years cyclone activity usually increases in the central South Pacific (Basher and Zheng, 1995).

SOI data are available for thirty-two of the thirty-seven tropical cyclones which impacted on Rockhampton and below we have examined these data to see if there is any relationship between the SOI and tropical cyclone impacts in the Rockhampton region. The SOI values are the three-monthly averages centred on the month of occurrence.

Range of SOI	Number of impacts
< - 10.0	3
-10.0 to - 5.0	5
- 4.9 to - 1.1	3
- 1.0 to + 1.0	2
+ 1.1 to + 4.9	4
+ 5.0 to +10.0	6
> +10.0	9

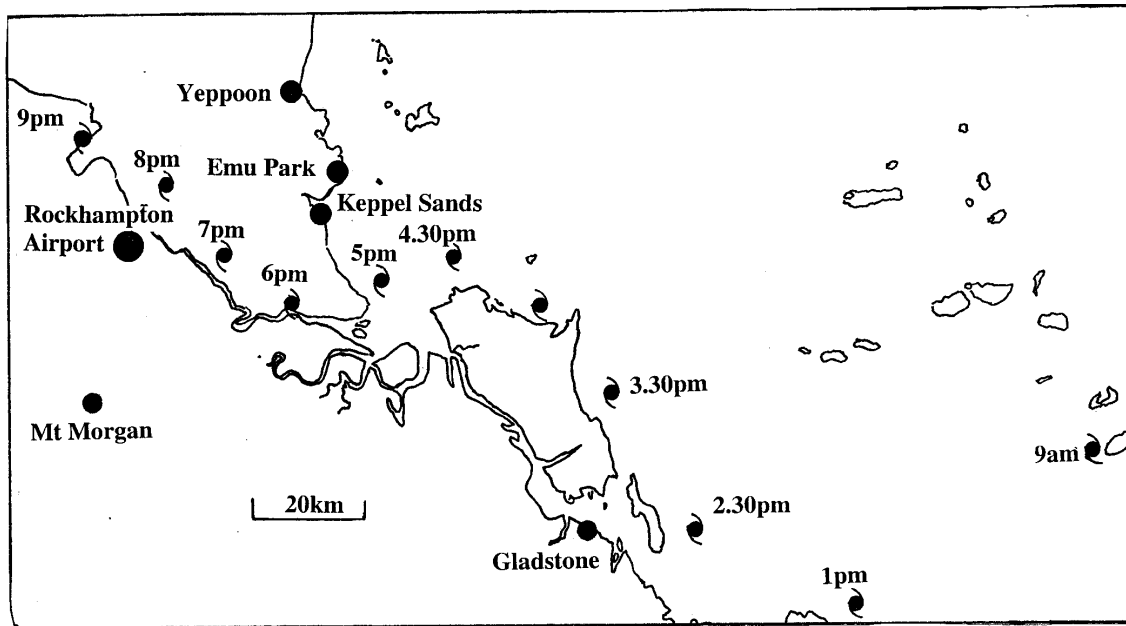
Table 2. Tropical cyclone impacts for different ranges of SOI.

From Table 2 these data show that almost twice as many impacts (15 against 8) occurred with La Niña type conditions (SOI  $\geq +5$ ) when compared with El Niño type conditions (SOI  $\leq -5$ ). There was a tendency for an impact to be associated with a positive SOI. Two events occurred when the SOI was near zero and 19 events when the SOI was clearly positive and 11 events when the SOI was negative.

**TROPICAL CYCLONE CHARACTERISTICS**

**Severe tropical cyclones**

Tropical cyclones are classified as severe if they reach at least the category 3 level of intensity. From Table 1 severe tropical cyclones are capable of inflicting major (category 3), devastating (category 4) or extreme (category 5) damage. A severe tropical cyclone, which probably fluctuated between category 4 and category 3 intensities, caused widespread damage over the region during March 1949. The track of the cyclone through the region has been constructed in Figure 1.



**Figure 1.** Track of the 1949 severe tropical cyclone From 9am 2 March 1949 to 9pm 2 March 1949.

The lowest barometer reading at Gladstone was 975.3hPa at 2.30pm 2 March 1949 when the wind there was changing from southwesterly to southerly and increasing to 65 knots (120 km/h). This indicated that the centre of the cyclone was passing to the east of Gladstone at this time.

The eye of the cyclone passed over Cape Capricorn (northeast point on Curtis Island) between 2pm and 4.25 pm 2 March 1949. The wind there was calm at 4.25pm and then rapidly increased to 65 knots (120 km/h) at 4.30pm. The worst of the wind damage occurred at Emu Park around 4pm when the wind was from the northwest. This indicated that the cyclone passed to the south of Emu Park.

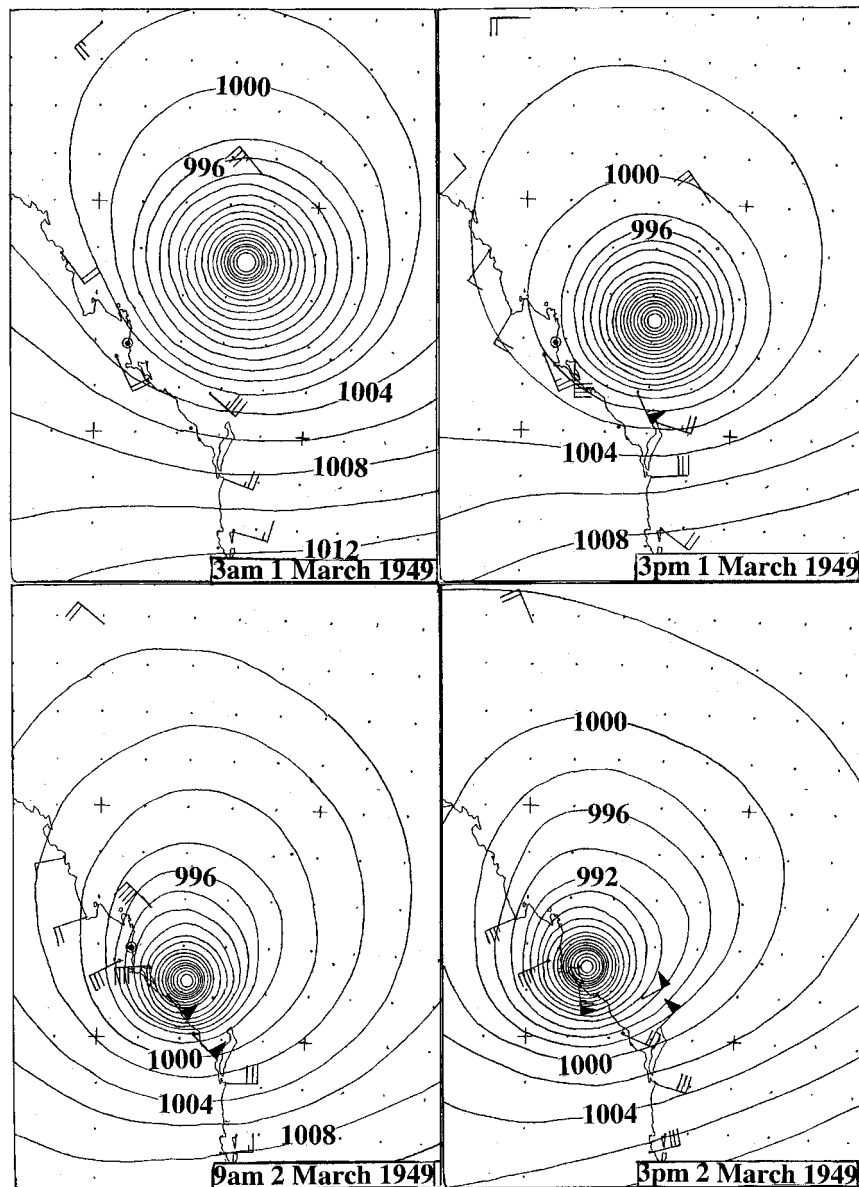
At 7pm 2 March 1949 the wind at Rockhampton was southwesterly at 50knots (93km/h) and the bar was 968.1hPa. This data implied that the cyclone then was near to and slightly south of east of Rockhampton. The lowest bar at Rockhampton was 965.1 hPa at 8pm when the wind was from the south-southeast at 52 knots (96km/h). Thirty minutes earlier the maximum wind gust of 87 knots was recorded at Rockhampton. We have calculated that the cyclone passed just to the north of Rockhampton shortly after 8pm 2 March 1949. The cyclone traveled more than 40km overland before passing to the north of Rockhampton when its central pressure was near 960hPa. Tropical cyclones rapidly weaken soon after landfall so that the central pressure of this cyclone as it approached Yeppoon was likely 950 hPa or less.

The mean sea level charts (Figure 2) show that the cyclone lay out to sea east of Yeppoon on 1 March 1949 when it would have been directing large waves towards the Capricorn Coast. The isobaric pattern indicated a cyclone of medium size. Seas badly damaged the beaches along the Capricorn Coast.

### Variation in size

The height of wind waves increases with increasing wind speed and the duration of this wind together with the fetch of the wind. The fetch is the distance over which the wind blows along a great circle path. The limited fetches associated with circular wind fields can at times limit the growth of waves generated by a tropical cyclone. Tropical cyclones, which are large in size are not restricted by small fetches and thus can generate very large waves.

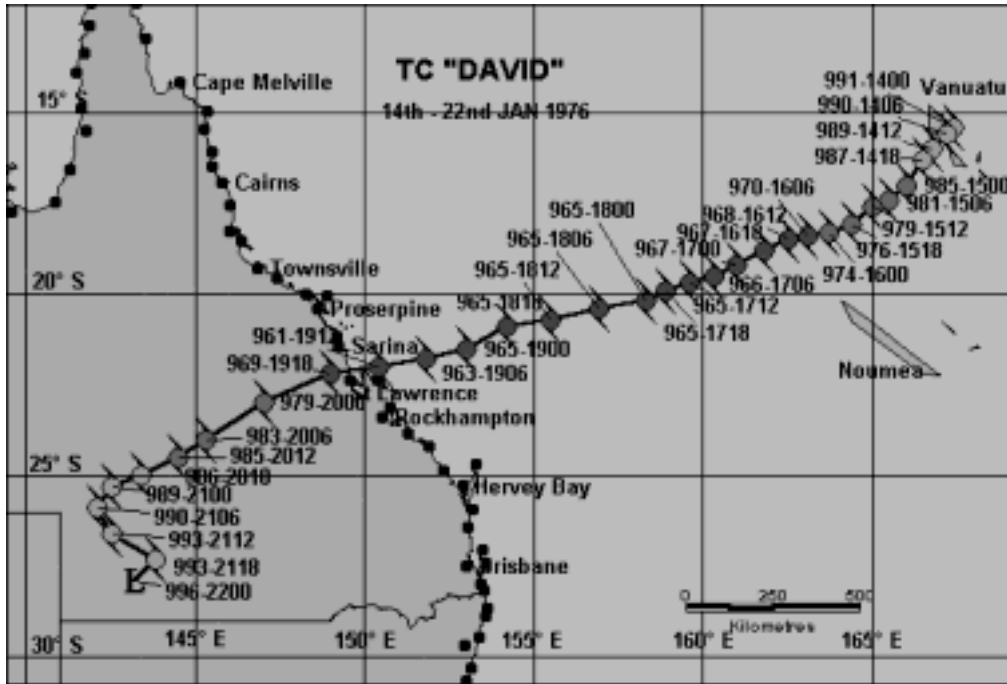
Tropical cyclone size, as distinct from intensity, is therefore a very important property of a tropical cyclone. For example tropical cyclone *David* in 1976 was a cyclone with a large circulation and had a major impact in the Yeppoon region even though it made landfall just to the north of St Lawrence.



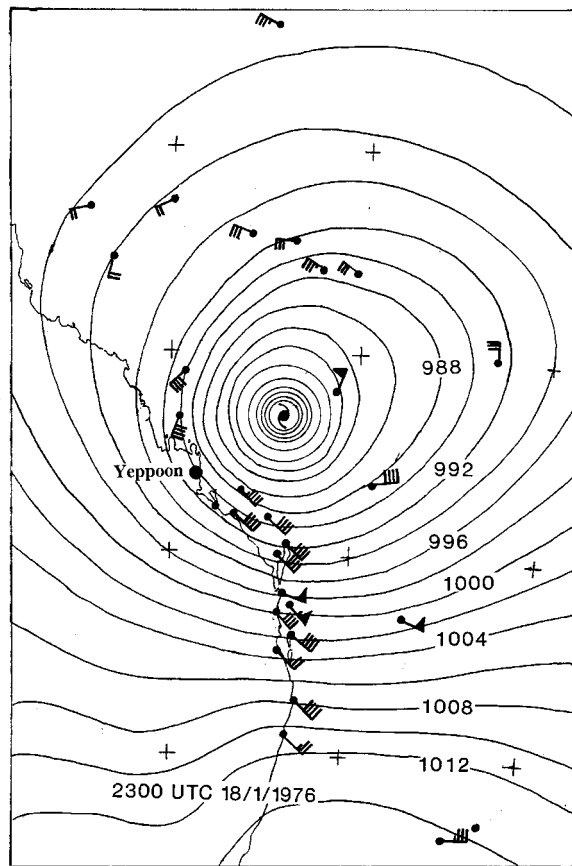
**Figure 2...**Mean Sea Level Pressure distribution (hPa) together with selected wind observations. Flag represents 50 knots (25 m/s) full barb represents 10 knots (5m/s) and half barb represents 5 knots (2.5m/s).

As *David* approached the coast (see track in Figure 3) it caused damage on Heron Island. On 17 and 18 January 1976 the Island was buffeted by southeast swells with some inundation. On 19 January 1976 large northeast swells brought sea levels approximately one metre above normal with 2 metre waves breaking on the beach (inside the fringing coral reef). One wall of the TV room was pushed in by waves - water from waves entered the lounge bar, Manager's residence, office, cinema, Boatman's residence and games room.

Figure 4 shows the mean sea level weather chart for 9 am Monday 19 January 1976. The wind plots in Figure 4 indicate that there was a huge area of gales associated with *David* extending from Papua New Guinea waters down to areas off the northern NSW coast.



**Figure 3.** Track of tropical cyclone *David*. Numerical group ppp-ddhh with each cyclone position where ppp denotes the central pressure (hPa) and dd is the date (UTC) and hh is the hour (UTC). UTC is Australian EST – 10 hours.



**Figure 4.** Tropical cyclone *David* at 9am 19 January 1976. Mean Sea Level Pressure distribution (hPa) together with selected wind observations. Flag represents 50 knots (25 m/s) full barb represents 10 knots (5m/s) and half barb represents 5 knots (2.5m/s).

*David* crossed the coast in a sparsely populated area to the north of St Lawrence however winds unroofed 30 buildings in Yeppoon and several in Mt Morgan. Wind gusts reached 95knots (176km/h) at Pine Islet and 84knots(156 km/h) at the Gladstone Meteorological Office. Large seas combined with high tides caused considerable damage to breakwaters, retaining walls and other structures especially at Rosslyn Bay Harbour (Yeppoon) where the Breakwater was destroyed along with yachts and trawlers. At the Yeppoon wave recording stations the significant wave and peak height reached 3.8 m and 8.7 m. The 3.8m significant wave height at Yeppoon were recorded from 1700 UTC 18/1/1976 to 1700 UTC 19/1/1976 (readings every 12 hours) while the peak reading of 8.7m was recorded at 0500 UTC 19/1/1976. Storm surges (tide level minus predicted level) were measure about the coast and these were 1.2m at Port Alma, 1.45m at Port Alma and 1.25m at Gladstone.

Other large cyclones, which are known to have caused extensive sea damage near Yeppoon, were the 1893 cyclone, the Mackay 1918 cyclone and the 1936 cyclone. Details of the impact of these storms can be found in the appendix.

**Small tropical cyclones**

In contrast tropical cyclone *Simon*, was a very intense small cyclone. The track is shown in Figure 5 and notice that *Simon* made landfall in the remote and sparsely populated area north of Yeppoon. Its small size can be seen in Figure 6. Though the peak winds near the centre would have been much stronger than *David*, the effect on Yeppoon was minimal with only tree damage even though it was much closer to Yeppoon than *David* was.

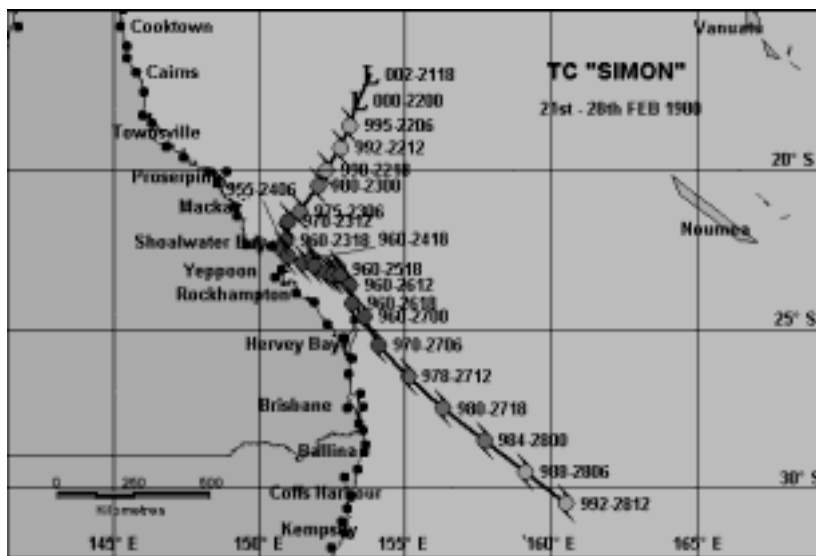


Figure 5. Track of tropical cyclone *Simon*.

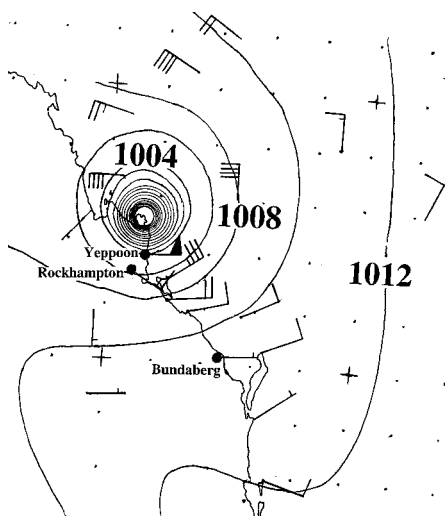


Figure 6. As in Figure 2 except for Tropical cyclone *Simon* at 9am 24 February 1980.

*Simon* was rapidly intensifying and moving towards the coast when it recurved seawards over Port Clinton. The Glen at Shoalwater Bay reported trees of all sizes blown down while at Stockyard Point 40 % of all trees were blown down. It passed slowly to the north of Heron Is, which experienced wind gusts to 93 knots (172 km/h) and a great deal of damage. Neap tides saved the Island from swell damage. There was severe beach erosion on Great Keppel Island.

## SUMMARY

Since 1863, 37 tropical cyclones have come close enough to the Capricorn Region to cause an impact. That is on average an impact from a tropical cyclone occurs about once in every four years in this region. Large cyclones can cause considerable damage to coastal areas even though the centres of these cyclones are well removed from the region.

Severe tropical cyclones have struck the area in the past and even Rockhampton, which is inland from the coast, suffered widespread destruction in 1949. The Capricorn region has undergone rapid development since then with a greatly increased population. Undoubtedly in the future the region will be hit another severe tropical cyclone similar to the 1949 event and this will present disaster managers with a serious challenge to limit the loss of life.

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## **APPENDIX**

### **TROPICAL CYCLONE IMPACTS IN THE ROCKHAMPTON AREA**

On the following pages are summarised all cyclones since 1863 affected the region of the Capricorn Coast.

The date of the cyclone refers to the day of landfall or the day of the major impact if it is not a cyclone making landfall from the Coral Sea.

The first number after the date is the SOI for that month followed by the three month running mean of the SOI centred on that month. This data is only available since 1876.

This is followed by information on the equatorial eastern Pacific sea surface temperatures where: -

W means a warm episode i.e. SST were above normal;

C means a cool episode and

Av means average SST

Cyclone	Impact
Middle to late Feb 1863	A tropical cyclone (TC) brought damaging winds and seas to region between Rockhampton and Hervey Bay. Houses unroofed in several centres with many trees blown down. Ketch driven onto rocks near Rockhampton. Severe erosion along shores of Hervey Bay with 10 metres lost to sea along a 32 km stretch of the coast. Twenty acres of forest were also lost to the sea.
17-19 Mar 1864	Gales with wind damage and flooding affected southeast Qld. Gales reached the Capricorn region with <b>trees down at Gladstone</b> . The barque <i>Panama</i> , 414 tons, was wrecked on the 18th on Breaksea Spit near Sandy Cape with 10 people on board. At 4 am on 19th wind shifted from ESE to NW with increased violence. The ship was then driven onto the beach and broke in two. One of the crew drowned and ten were lost and never seen again.
22 Jan 1874	A furious gale along the northern coast destroyed much property. At St Lawrence <b>a new wharf disappeared, the Post Office and miles of telegraph lines were blown down and several stores were wholly or partially destroyed</b> . Trees for miles around were uprooted. The schooner <i>Countess of Belmore</i> was badly damaged. <b>At Keppel Bay some of the houses were partially unroofed and the jetty was washed away. Although it was neap tides the sea rose 3 feet higher than ever before</b> . The ketch <i>Hibernia</i> was driven ashore on Northwest Island (all safe). The <i>James Patterson</i> grounded on Masthead Island (all rescued). The S.S. <i>Lord Ashley</i> was caught in it and was almost wrecked.
25 Feb 1874	The ship <i>Southern Belle</i> encountered a furious gale off Frazer=s Bay and narrowly escaped shipwreck. She was eventually towed into Keppel Bay on 5 March. The schooner <i>Chance</i> returned to Maryborough on 26 <sup>th</sup> Feb disabled. It was 200 nm on its way to Noumea when it encountered a gale, which lasted for 2 weeks. The schooner <i>Io</i> struck SE gales on the 21 <sup>st</sup> at Refuge Bay and NE gales off Gladstone on the 24 <sup>th</sup> / 25 <sup>th</sup> .
24 Feb 1875	Steamer <i>Gothenberg</i> wrecked off Cape Upstart (near Ayr) in TC 102 lives lost. <b>On the 23rd NE gales struck Rockhampton with 8 inches (203mm) of rain registered</b> . Gales and flood rains also affected southeast Queensland.
17 Feb 1888 -2.2(-5.6) C	TC recurved just east of Mackay. <i>Geelong</i> ran aground and 2 were drowned. <i>Youyang</i> was dismantled. Several Mackay houses were completely demolished. <b>Wharves were awash at Rockhampton on the 20<sup>th</sup></b> . Flooding occurred at Pialba with water three feet over the road at Stockyard Creek and rising and trees blown down in all directions. Enormous Breakers were raging outside of Fraser Island
24 Mar 1890 14.3(10.4) C	TC crossed the coast near Cardwell 24 <sup>th</sup> and recurved over Fraser Island 28 <sup>th</sup> bringing disastrous floods over much of Queensland and northern NSW. Widespread damage with 11 deaths at South Barnard Island, Cardwell, Dungeness, Halifax, Ingham, Townsville, around the Burdekin, Ayr and Mackay. <b>Emu Park: Wednesday 26<sup>th</sup> 15 inches (381mm) of rain fell in 12 hours and man was killed by lightning at 6.30 am Wed. The Schooner <i>Matha Reid</i> was dismantled and the captain knocked senseless and thought to have died.</b> Darling Downs: 2 policemen missing in floods near Dalby and at Roma 100 people were evacuated from floods. Beaudesert: man drowned in creek 28 <sup>th</sup> . Stanthorpe: Numerous buildings washed away, man drowned and a large number of stock lost.
1 Feb 1893 7.7(5.9) C	TC crossed the coast near Yeppoon. At Yeppoon some iron was lifted off roofs, trees were uprooted and outhouses were overturned. Similar damage occurred at Rockhampton and Emu Park where one house was unroofed. The worst wind damage was observed along the railway to the north where numerous large trees were uprooted. Yeppoon recorded 509mm of rain in 24 hours and 586mm (gauge overflowed) at Woodlands in 24 hours. Large seas scoured large holes in the beach at Yeppoon rendering the access to the beach un-trafficable. The ladies bathing shed was washed away.

	<p>The Bar dropped to <b>969 hPa</b> when the TC passed over the <i>Buninyong</i> near the Northumberland Group. Large seas wrecked 225-ton steamer <i>Dickey</i> on Dickey Beach Caloundra. Crohamhurst (on Stanley R) recorded 907 mm of rain in 24 hrs to 9am 3 Feb. Following this rain; the worst known floods affected the southeast Queensland with more than 25 deaths.</p>
<p>28 Jan 1910 5.6(8.5) C</p>	<p>TC crossed the coast to the north of Cairns on the 27<sup>th</sup>, then recurved west of Cairns before passing back out to sea on the 30<sup>th</sup>. Wind and sea damage at Cairns and Cooktown with the <i>Bombala</i> run aground. At 9am on the 30<sup>th</sup> the bar at Mackay was 990.9 hPa with strong SW winds. At 9pm a whole gale from ESE was blowing at Sandy Cape. <b>There were washouts and railway line flooding in the Rockhampton area.</b></p>
<p>21 Jan 1918 14.6(17.9) C</p>	<p>A TC crossed the coast just north of Mackay with a disastrous storm surge, flooding and widespread wind damage. The lowest pressure of <b>932.6 hPa</b> was recorded near Mackay at 7.30 am 21<sup>st</sup>. In Mackay the death tally was 20 on the 31<sup>st</sup> January 1918 and it is now thought that a total loss of thirty people lost their lives in the cyclone and the subsequent floods in Central Queensland. <b>The cyclone was very large in size and destructive winds extended down to Rockhampton with the worst damage occurring after the winds shifted from SE to NE. Several houses were unroofed in North Rockhampton and along Lakes Creek Road. Trees were uprooted including large jacaranda trees. Many houses had verandas blown off and lost portion of their roofs. Two men were drowned at Rockhampton. At Yeppoon, a man drowned, trees were uprooted, three buildings were badly damaged or unroofed and several houses were lifted off their blocks. At Emu Park many houses were badly damaged and the fishing fleet suffered severely. At Mt Morgan roofing iron was lifted off buildings and at Clermont thousands of trees were uprooted along all the surrounding roads and buildings lost roofing iron. Widespread flooding occurred in Central Queensland including a record flood at Rockhampton with widespread property damage.</b></p>
<p>5 April 1921 -7.1(1.3) C</p>	<p>This tropical cyclone passed close to the vessel <i>Camira</i>, which was hove to near North Reef <b>(120km east of Yeppoon). The vessel was in cyclonic conditions for 16 hours and 500 rams were swept overboard. Large seas would have affected Yeppoon but we have no record of the impact.</b> The cyclone then passed east of Bustard Heads where a bar reading of 979 hPa was obtained. It went on to cause a great deal of damage in Bundaberg and is one of the worst cyclones to strike that centre. It then passed between Maryborough and Hervey Bay. Bathing houses were washed away at Pialba and 2 men were badly injured by a storm surge.</p>
<p>21 Apr 1928 11.9(7.7) C</p>	<p>TC recurved near Mackay and over Broudsound. Floods with extensive damage affected the Callide, Dawson and Dee Valleys. Houses washed away and 9 people drowned. Extensive flooding south to border with extensive crop losses and thousands of cattle lost. Low parts of Brisbane were flooded with one drowning.</p>
<p>22-23 Feb 1929 18.0(13.0) C</p>	<p>TC moved towards the coast and recurved away east of Bowen. <b>31.33 inches (795mm) of rain fell in 65 hours at Rockhampton. Fitzroy River peaked at Rockhampton pm Sat 23<sup>rd</sup> (reached just over 25 feet (7.6m)) and two men drowned in the Rockhampton area. Bridges and crops were badly damaged around Rockhampton.</b></p>
<p>28- 29 Feb 1929 18.0(13.0) C</p>	<p>Cyclone recurved towards southeast and redeveloped off the Central Coast. Bar down to 986.1hPa at Double Island Point 8pm 28<sup>th</sup>. Huge seas off the south coast. Heavy easterly swell was reported at Sandy Cape on 27<sup>th</sup> which would have affected the Capricorn Coast region as well. Widespread severe sea damage Gold Coast and northern NSW.</p>
<p>1-8 Feb 1931 -14.9(-0.8)W</p>	<p>TC entered Coral Sea near Cooktown and moved down to Hervey Bay. <b>Passed southwards over North Reef (120 km east of Yeppoon) with a central pressure of 982 hPa.</b></p>
<p>22 Mar 1936 1.8(8.0) C</p>	<p>A tropical cyclone with a very large area of gales recurved seawards of Fraser Island. There was extensive sea and storm surge damage on the Gold Coast and in Moreton Bay. <b>At Yeppoon waves came over the sea wall and entered a beach Cafe.</b></p>

27-29 Jan 1939 17.0(12.8) C	Low moved offshore between Rockhampton and Mackay and became slow moving TC. Shipping delayed by gales and high seas. Flooding with stock losses and towns isolated in Dawson Valley.
8 Feb 1942 -3.6(-7.5) End W	<b>TC crossed the coast north of Rockhampton. Trees uprooted, fences blown down and iron ripped off roofs. Main grandstand at the Show-grounds was unroofed. The city was blacked out from downed power lines.</b>
16 18 Feb 1942 -3.6(-7.5) End W	TC crossed coast near Cardwell and moved back out to sea north of Mackay on the 18 <sup>th</sup> . Extensive damage and loss of life occurred from flooding in the Burnett River and Dawson and Callide Valleys. In the Dawson Valley and Callide head waters the towns of Rannes and Wowan were evacuated with much loss. The death toll was 6 (maybe7) - 2(maybe 3) in Bundaberg, 1 Monto, 1 Mundubbera and, <b>1 Boyne Island</b> and 1 in Chinchilla.
31 Jan 1943 9.4(11.2) C	<b>TC crossed coast near Rockhampton. Flooding along the coast between Mackay and Maryborough.</b>
10 Feb 1947 - 4.1(0.9) C	TC crossed the coast at Broadsound. Floods in most east coast rivers. Some loss of life occurred as well as much damage to infrastructure.
2/3 Mar 1949 5.6(2.9) C	TC came close to Gladstone at 2pm on the 2 <sup>nd</sup> and then crossed the coast south of Emu Park and passed close and to the north of Rockhampton. There was <b>widespread damage in 15 towns. Two men died, one in Rockhampton and the other in Gladstone as they were blown from the roofs of their homes while making repairs. Another man was killed in Rockhampton after being struck by a falling branch. A child was killed in Bundaberg by a falling gum tree. A dairy farmer was drowned in the Biloela district and another man was drowned near Thangool.</b> The lowest barometer reading in Rockhampton (not in the eye) was <b>965.1 hPa</b> and the maximum wind gust on the airport anemometer was <b>87 knots just after 7pm on the 2<sup>nd</sup></b> . A survey by the Mayor in Rockhampton showed that over 1000 houses were damaged, <b>500 severely</b> . Most of the 1500 homes in Gladstone were damaged and many buildings were extensively damaged. At Yeppoon northwesterly winds were estimated at 87 knots and 100 buildings were noticeably damaged, 30 to 40 were badly damaged and 4 were demolished. In Yeppoon 25 inches (635mm) of rain was recorded in 24h, which flooded business premises. In Emu Park the damage was worse than Yeppoon where whole buildings collapsed and almost all houses lost all or parts of their roofs. Several houses were moved off their blocks. One house lost its roof with half the roofing iron blown 450 metres away and the rest blown into the sea. The worst wind was around the period between 3 and 4pm. The Yeppoon to Emu Park scenic road was devastated with trees littering the whole highway. The beaches were badly eroded with Kemp Beach suffering badly where most of the trees were damaged. 47 cattle carcasses were washed up onto the beaches. Heavy seas closed the ports of Rockhampton, Gladstone, Bundaberg and Maryborough while a lightship was grounded on Breaksea Spit. There were severe floods in Central Qld and <b>3 drovers were drowned.</b>
11 Mar 1950 17.6(17.3) C	TC crossed the coast at Carmilla (S of Mackay) with severe structural damage. At Carmilla one girl was killed and 4 others injured. Trees a metre in diameter were uprooted. 400 people live in the area and only 8 buildings left standing. The Hall and 3 houses were completely wrecked. 15 business houses and the school residence were uninhabitable. Every other house in town was unroofed. 20 farmhouses within 16 km of Carmilla were battered with windmills destroyed. Rail and farm buildings damaged between Kalarka and West Hill. <b>Easterly Gales were reported at Rockhampton on 11 March 1950 and 60-knot southerlies at Cape Capricorn (Curtis Island) on 10 March 1950.</b>
7 Mar 1955 2.9(5.1) C	TC crossed coast just south of Mackay with eye passing over Sarina and bar down to 963 hPa. Lugger <i>Barrier Princess</i> lost with 8 hands. Widespread structural damage and heavy flood rains. Bar down to 957 hPa on vessel Cape Hawke just off Mackay at 2pm 7 <sup>th</sup> with SW wind Force 12 and over. <b>50 to 80 knot winds affected the coast between Cape Capricorn and Mackay and several buildings were unroofed at Yeppoon. Major floods Flinders Burdekin and Fitzroy Rivers.</b>
<i>Connie</i> 16 Feb 1959	TC crossed the coast at Guthalungra where pressure in the eye was recorded at 948 hPa. Severe wind damage occurred at Ayr Home Hill and Bowen. A man was killed at Ayr when a shop fell on him. The anemometer at Bowen recorded wind gusts up to 100 knots over a

<p>-14.0(-4.8) W</p>	<p>2-hour period with forty homes totally destroyed, 190 badly damaged and 300 partly wrecked. Wind also caused considerable damage at Proserpine with 50 houses and the Hospital badly damaged.</p> <p><b>There was even damage at Rockhampton as the cyclone moved south.</b> Floods extended down to NE NSW.</p> <p>On the 18th Brisbane had wind gusts to 48 knots with minor damage and power lines down. Fallen power lines in NSW killed a man.</p>
<p><i>Dinah</i> 28/30 Jan 1967 14.6(7.8) Start C</p>	<p><i>Dinah</i> caused <b>severe damage at Heron Island initially from inundation from large NE swells and a day later from winds.</b> It recurved and passed over Sandy Cape, which recorded a central pressure of 944.8 hPa and high water 10 metres above normal. Although well off the coast <b>many trees were blown down from Rockhampton</b> to Grafton. Houses were unroofed at Bundaberg Maryborough and along the Sunshine and Gold Coasts. Banana and cane crops were wiped out on the Tweed Coast and a severe wind gust overturned a car at Evans Head. <b>Huge seas and storm surge caused severe erosion at Emu Park, Yeppoon,</b> and in the Maryborough Bundaberg area. Storm surges affected the Sunshine Coast, Gold Coast and Moreton Bay. Storm surge also on the Tweed River isolating Fingal. A section of the esplanade collapsed at Surfers Paradise.</p>
<p><i>Fiona</i> 20 22 Feb 1971 15.7(12.5) C</p>	<p><i>Fiona</i> tracked from the Gulf and entered the Coral Sea near Rockhampton. Flooding in the Burdekin and Fitzroy Basins varied from minor to major with severe damage to infrastructure. Motorists were cut off for days. Paw Paw crops were lost near Gladstone by wind and rain effects. A 0.6 m to 0.9 m storm surge was observed at Gladstone and Bundaberg respectively.</p>
<p><i>Emily</i> 2 Apr 1972 -5.5(-6.1) W</p>	<p><i>Emily</i> crossed the coast just to the SE of Gladstone while rapidly weakening. Wind damage was confined to trees and sheds. The cyclone had been very severe and generated huge seas. <b>It claimed the lives of 8 seamen in three separate incidents</b> off the southern and central Queensland coasts. Flooding occurred with Kingaroy being isolated for a time and Breakfast Creek flooded some houses in Brisbane. <b>Trees were blown down at Yeppoon and large waves were lifted up on the seaward side of the breakwater on Rosslyn Bay Harbour.</b></p>
<p><i>David</i> 19 Jan 1976 11.8(14.7) C</p>	<p><i>David</i> crossed to the north of St Lawrence. It passed over Gannet Cay AWS where a central pressure of 970 hPa was recorded. It was intensifying right up to the time of landfall. A feature was its huge size with gales extending from PNG waters down to Lord Howe Is. <b>It generated huge swells and these combined with large tides caused extensive damage to Heron Island as it passed to the north. It crossed the coast in a sparsely populated area however winds unroofed 30 buildings in Yeppoon and several in Mt Morgan. Wind gusts reached 95 knots at Pine Islet and 84 knots at the Gladstone Met Office. Large seas combined with high tides caused considerable damage to breakwaters, retaining walls and other structures especially at Rosslyn Bay Harbour (Yeppoon) where the Breakwater was destroyed along with yachts and trawlers.</b> Storm tides flooded houses and shops at Urangan, Noosa and Kirra. Storm surge at Beachmere on Moreton Bay cut all roads into the town. The Port of Brisbane was closed. At wave recording stations the significant wave (peak) height reached 5.8 m (8.9 m) at Double Island Pt and <b>3.8 m (8.7 m) at Yeppoon.</b></p> <p>The 3.8m significant wave height at Yeppoon were recorded from 1700 UTC 18/1/1976 to 1700 UTC 19/1/1976 (readings every 12 hours) while the peak reading of 8.7m was recorded at 0500 UTC 19/1/1976.</p> <p>Storm surges (tide level minus predicted level) were measure about the coast and these were 1.2m at Port Alma, 1.45m at Port Alma and 1.25m at Gladstone.</p>
<p><i>Dawn</i> 5/6 Mar 1976 13.2(9.3) End C</p>	<p><i>Dawn</i> developed on the N Qld coast and moved down the coast crossing Fraser Island. Two homes were unroofed in N Mackay and trees were uprooted on Heron Is. Rainfalls up to 230 mm between Proserpine and Bundaberg caused flash flooding.</p>
<p><i>Simon</i> 24 Feb 1980</p>	<p><i>Simon</i> was rapidly intensifying and moving towards the coast when it recurved seawards over <b>Port Clinton with a radar eye diameter of 35 km. In this remote area it caused extensive damage to vegetation. It passed slowly to the north of Heron Is which</b></p>

<p>1.1(-1.4) W</p>	<p><b>experienced wind gusts to 93 knots and a great deal of damage. Neap tides saved the Island from swell damage.</b> Huge swells were observed but their energy was dissipated on the exposed fringing reef. There was severe beach erosion at Great Keppel Island. A yacht ran up onto Lady Elliot Island and a rescue helicopter turned over but there were no casualties. As the cyclone passed to the east of Fraser Island a ship near Indian Head reported wind gusts greater than 100 knots. Sandy Cape Lighthouse reported winds gusting to 92 knots. Houses lost roofing iron at Hervey Bay where there was flooding. The Burnett Heads wave recording station recorded significant (peak) wave heights of 4.5m (8.9m)</p>
<p><i>Elinor</i> 3 4 Mar 1983 -28.0(-26.0) W</p>	<p><i>Elinor</i> crossed the coast near Carmila. 2 yachts were wrecked near the coast. A one-metre storm surge was reported at Collins Is (Broadsound). Wind blew down 0.75 diameter trees, power lines and caused minor house damage along the Central Coast and Islands. <b>Heavy rain fell in the Yeppoon area.</b></p>
<p><i>Ivor</i> 19 Mar 1990 -8.5(-8.8) End W</p>	<p><i>Ivor</i> crossed the coast near Princess Charlotte Bay as it was weakening. There was some structural damage to sheds and light damage to the main buildings in Coen. The cyclone retained its identity as a monsoonal low and moved through the eastern Gulf and back down the east coast with heavy rain south of its centre. <b>As it moved down the Central Coast unofficial 24 hr fall of 1000mm were reported near Yeppoon and this caused flash flooding and extensive damage in the Yeppoon area.</b></p>
<p><i>Fran</i> 16 Mar 1992 -24.2(-17.5) W</p>	<p><i>Fran</i> crossed the coast neat the Town of 1770. The maximum anemometer wind gust recorded was <b>76 knots on Great Keppel Island (just off the coast from Yeppoon).</b> In Bundaberg 40 houses were unroofed, one was blown off its stumps and at Bargara the caravan Park was evacuated. Heavy damage to fruit and vegetable crops occurred in the Bundaberg district. At Burnett Heads the marina and 3 yachts were damaged and there was extensive damage to pontoons and yachts forced against a rock wall. Powerlines, trees, and roofs were damaged at Gympie. There was roof damage along the Sunshine Coast when <i>Fran</i> crossed Fraser Island on its way back out to sea. A storm surge inundated 20 business premises, 100 houses and 50 caravans at St Hervey Bay. <b>Heavy swells caused damage on Heron Island</b> and severe erosion on the Gold and Sunshine Coasts.</p>
<p><i>Rewa</i> 20 Jan 1994 -1.6 (0.2) C</p>	<p><i>Rewa</i> came within 100 km of the coast as it was recurving away from Australia. <b>Two men were rescued from a fishing trawler near Yeppoon by an army Blackhawk helicopter.</b></p>
<p><i>Barry</i> 9 Jan 1996 8.4(1.3) Weak C</p>	<p><i>Barry</i> tracked from the Gulf through Central Qld. A surface trough extended from the centre to the east coast and was, associated with wind gusts to 70 knots as it moved down the coast from Sarina to Hervey Bay. This resulted in pockets of structural and tree damage along this part of the coast along with tides of up to a metre above normal.</p>
<p><i>Justin 1</i> 9 Mar 1997 -8.5(-4.0) Start W</p>	<p><i>Justin</i> lay well out to sea but was a very large cyclone and tides exceeded HAT at most centres between Bundaberg and Cooktown. The highest overall tide gauge recordings in relation to HAT were 0.4 m above HAT at Shute Harbour and 0.5 metres above HAT at Mackay. The Mackay wave station recorded significant (peak) heights to 4.8m (8.45m). Wind observations showed a large area of gales of relatively constant direction over open waters extending from around Hayman Island to the Capricorn Channel, a distance of some 500 km for more than 36 hours. The large waves and high tides resulted in severe beach erosion and inundation along coast and offshore Islands between Townsville and Bundaberg. <b>The Emu Park wave recording station registered a peak wave height of 6.76metres at 0000 UTC 10 March 1997 when the significant wave height was 2.89metres The peak significant wave height of 3.06 metres was recorded at 0930 UTC 9 March 1997. Port Alma tide gauge reported a peak storm surge of 0.68metres at 0210 UTC 9 March 1997.</b></p>