

CASE STUDY: Tropical Cyclone *Justin*, March 1997

First Impact of *Justin*

Justin lay well out to sea but was a very large cyclone (see analyses below in Figure 1) and tides exceeded highest astronomical tide (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 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. In the Cairns Region inundation at three beachfront communities resulted in damage estimated at \$430,000. The islands around Hayman Island and the adjacent mainland suffered wind damage to trees and roofs and damage to retaining walls, marinas and yachts by the wild seas.

At sea the Large Tandem Thrust International Military exercise was badly disrupted with extensive damage to two landing craft. Troop ships were evacuated well out to the fringes of the Coral Sea away from *Justin* and many troops succumbed to sea sickness from the large waves. A Canadian couple were rescued from a 15 metre ferro concrete yacht by helicopter 1 hour 20 minutes out from Townsville. The rescuers reported waves at least 10 metres in height. In its passage through the eye of the cyclone, the vessel *Osco Star* sustained \$600,000 damage.

Willis Island recorded more than a metre of rain from *Justin* as it slowly past the station. The wind, huge seas and horizontal rain from the cyclone caused a great deal of moderate damage to the station and to its equipment. The prolonged nature of the wind, rain and seas contributed to the damage. The maximum wind gust recorded was 67 knots.

Papua New Guinea

Storm force monsoon westerly winds extended well to the north of *Justin* and a 12 year old boy and plantation operator working at Karkar Island off Madang were killed by falling trees. The crew of the 300 tonne *MV Pera* which overturned in heavy seas off the southern tip of New Ireland at 0930 UTC 9 March 1997 were lost.

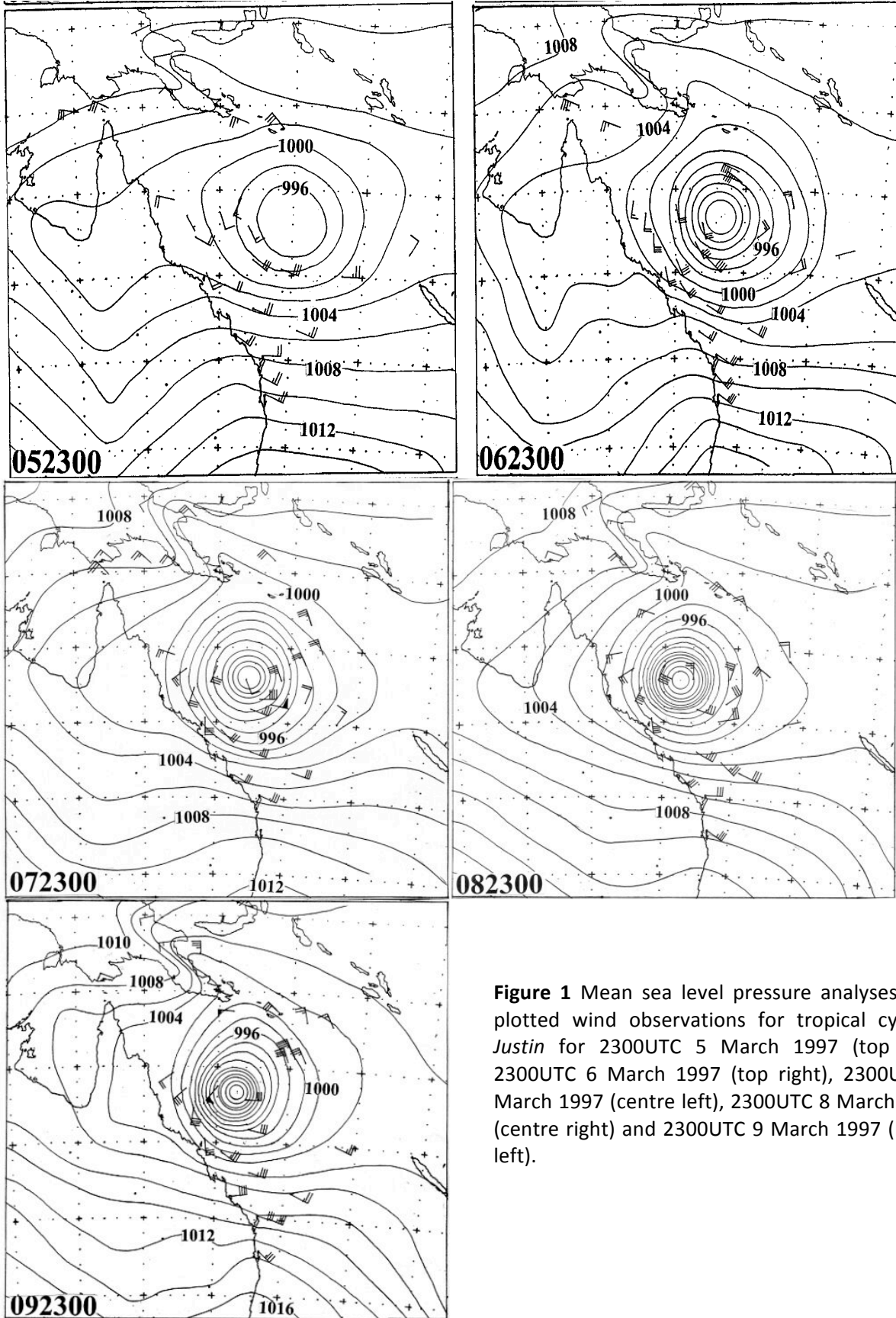


Figure 1 Mean sea level pressure analyses with plotted wind observations for tropical cyclone *Justin* for 2300UTC 5 March 1997 (top left), 2300UTC 6 March 1997 (top right), 2300UTC 7 March 1997 (centre left), 2300UTC 8 March 1997 (centre right) and 2300UTC 9 March 1997 (lower left).

Waves

Large waves are rarely observed along the tropical east coast waters of Queensland due to the protection by the Great Barrier Reef and the limited lengths of open water. During the 9 March 1997 and 10 March 1997 some very large wave heights were reported between Rockhampton and Townsville. The Beach Protection Authority of Queensland maintains a network of wave recording stations along the Queensland coast. The wave parameters recorded include:- Hsig- the average height of the highest one third waves in a record and Hmax- the highest individual wave in a record.

The peak readings of Hsig and Hmax from four of their stations are listed in Table 1. Additionally a ship at 2200 UTC 8 March 1997 was inside the Great Barrier Reef 130 km east southeast of Townsville and reported a 4.5 metre swell coming from the southeast.

Wave recording Station	Height and time of peak Hsig (metres)	Height and time of peak Hmax (metres)
Emu Park (60 km ENE of Rockhampton)	3.09 m at 1000 UTC 9 March 1997	6.85 m at 0130 UTC 9 March 1997
Hay Point (18 km SE of Mackay)	3.10 m at 0930 UTC 9 March 1997	6.76 m at 0000 UTC 10 March 1997
Mackay Offshore (38 km ENE of Mackay)	4.81 m at 1400 UTC 9 March 1997	8.45 m at 0100 UTC 9 March 1997
Lindeman Is (40km SSE of Hayman Is.)	3.85 m at 1400 UTC 8 March 1997	7.26 m at 0300 UTC 9 March 1997

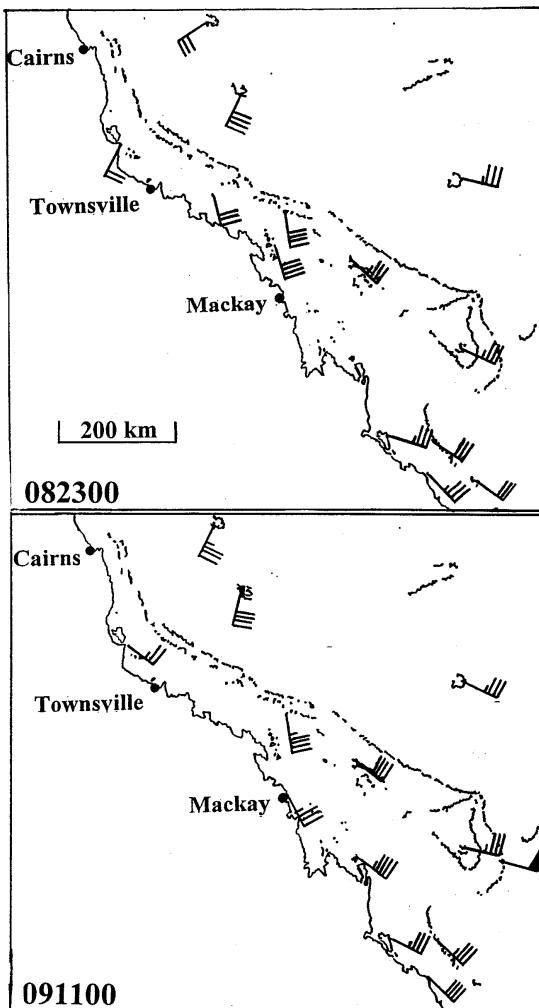


Table 1 Peak readings of Hsig and Hmax from four wave recording stations (Data supplied by The Beach Protection Authority, Queensland Department of Environment).

Figure 2 The Mackay wave station (inside the Great Barrier Reef) 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.

To explain these large waves, Figure 2 shows the wind fields along the tropical coast at 2300 UTC 8 March 1997 and 1100 UTC 9 March 1997. The Great Barrier Reef is also shown. There is a large opening (Capricorn Channel) in the southeastern end of the reef through which wave energy can pass. The wind observations show a large area of gales of relatively constant direction extending from around Hayman Island to the Capricorn Channel, a distance of some 500 km. Gales blowing over a body of deep open deep water 500 km long for 18 hours can generate waves up to 6 metres in height. The wind field was similar to that in at 1100 UTC 8 March 1997 and at 2300 UTC 9 March 1997 so that constant gales were blowing over the one body of water for more than 36 hours. The wind direction was orientated along the longest

fetch of water inside the reef. This explains the occurrence of these waves which would even be considered large in the open ocean.

North of the Whitsunday Island Group the coastline changes orientation such that the large southeasterly swell remained offshore moving parallel to the coast. This resulted in lower height readings at coastal wave recording stations. Significant wave heights reached only 1.5 metres at Abbot Point (near Bowen) and 1.4 metres at Townsville during this period.

Tides

Despite being well out to sea, the large size of *Justin* obviously contributed to very high tides along the Queensland tropical coast. Below is a listing of the storm surges associated with these large tides and in Figure 3 the outer circulation of *Justin* is shown around the time of these large storm surge readings.

Burnett Heads 0.37m surge 0510UTC 10 March 1997
 South Trees 0.50m surge 0520UTC 10 March 1997
 Port Alma 0.68m surge 0210UTC 9 March 1997
 Hay Point 0.81m surge 0520UTC 10 March 1997
 Mackay 0.78m surge 0520UTC 10 March 1997
 Shute Harbour 0.73m surge 0030UTC 10 March 1997
 Bowen 0.66m surge 0520UTC 10 March 1997
 Cape Ferguson 0.59m surge 0250UTC 10 March 1997
 Townsville 0.53m surge 0000UTC 10 March 1997
 Lucinda 0.57m surge 2140UTC 9 March 1997
 Cardwell 0.54m surge 2040UTC 10 March 1997
 Mourilyan 0.53m surge 0240UTC 10 March and 2230UTC 11 March 1997
 Mossman 0.53m surge 2020UTC 10 March 1997
 Cooktown 0.59M surge 0230UTC 11 March 1997.

Peak surge at much the same time between Burnett Heads and Mackay

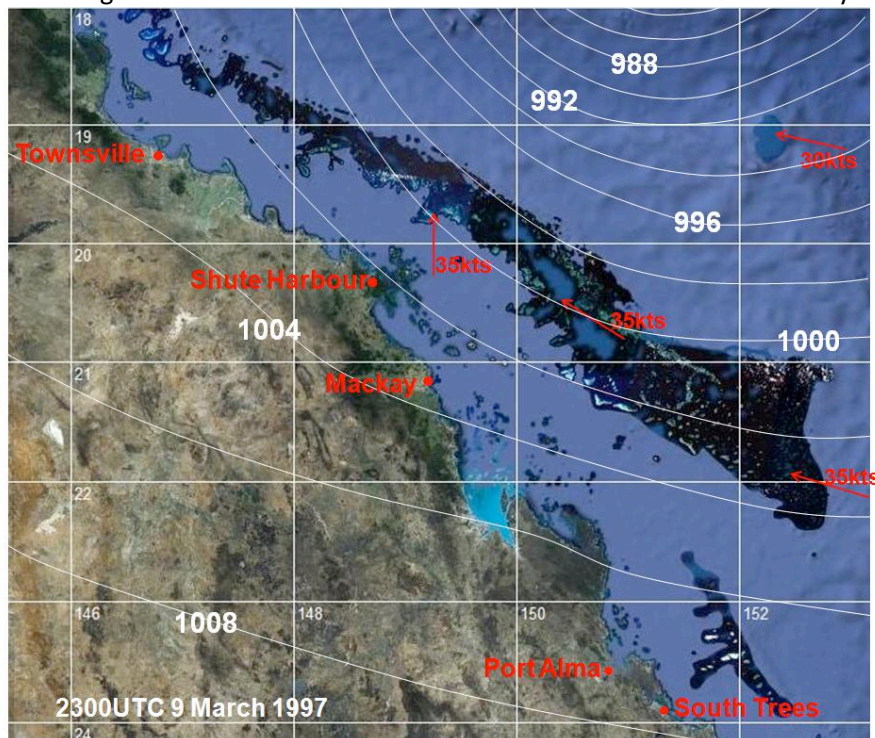


Figure 3 Outer circulation of Justin showing isobars, average wind observations and the Great Barrier Reef at 2300UTC 9 March 1997 (9am 10 March AEST).

As a demonstration of Justin's asymmetric wind field, the vessel *Oscro Star* sailed northward through the eye of the cyclone. The highest average wind speeds it reported from the southern side were 50 knots (32 hours before Justin reached peak intensity for this phase). Later it reported 80 knots northwesterly winds (at peak intensity) when it was under the deepest convection 180 to 190 km northeast of the centre of Justin. This vessel had no anemometer and reported wind speeds of 45 to 50 knots as it passed near an AWS reporting 10 minute average wind speeds of 35 to 40 knots. This error of 10 knots may have been greater for larger wind speeds. The analyses over the period are shown in Figure 4 below.

From 0000 UTC 8 March 1997 to 0000 UTC 9 March 1997 the central pressure of *Justin* deepened slowly from 980 hPa to 974 hPa and the pressure gradient increased around the centre while all the deep convection (coldest cloud tops) remained on the northern (monsoon) side of the cyclone. By 1200 UTC 9 March 1997 the central pressure was still 975 hPa though there is evidence that it continued to intensify. The pressure gradient between the 982 and 990 isobars can be clearly seen to have increased and the region between these two isobars (180 to 190 km from the centre of the cyclone) marked the maximum wind zone at 1200 UTC 9 March 1997. The *Oscro Star* (marked by the arrow in was experiencing its highest wind speeds around 1200 UTC 9 March 1997.

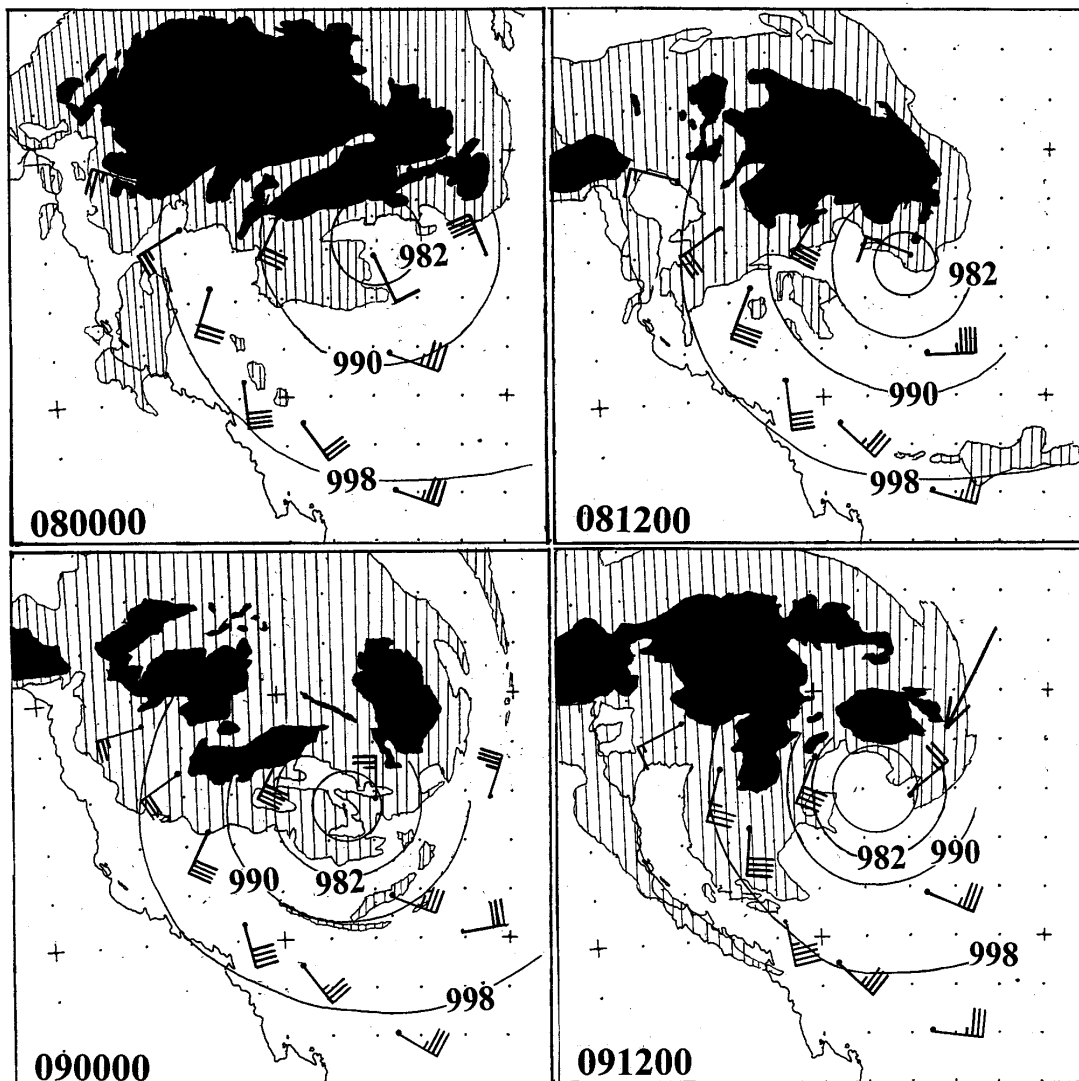


Figure 4 Mean sea level pressure analyses with plotted wind observations for tropical cyclone *Justin* for 0000UTC 8 March 1997 (top left), 1200UTC 8 March 1997 (top right), 0000UTC 9 March 1997 (lower left) and 1200UTC 9 March 1997 (lower right). In the lower right frame the Vessel *Oscro Star* (marked by arrow) reported NW/ 80 knots (probably 10 minute mean winds of 65knots from earlier reports when near AWS). Hatched areas-cloud tops $< -32^{\circ}\text{C}$ Black areas-cloud tops $< -63^{\circ}\text{C}$

Second Impact of *Justin*

This was the period when Justin intensified to the severe (category 3) stage near PNG. The mean sea level analyses are shown below in Figure 5. Eleven people were killed when entire villages were flattened in Milne Bay and other maritime provinces in the far southeast of the country. It is feared that 30 lives were lost from the effects of Justin in PNG.

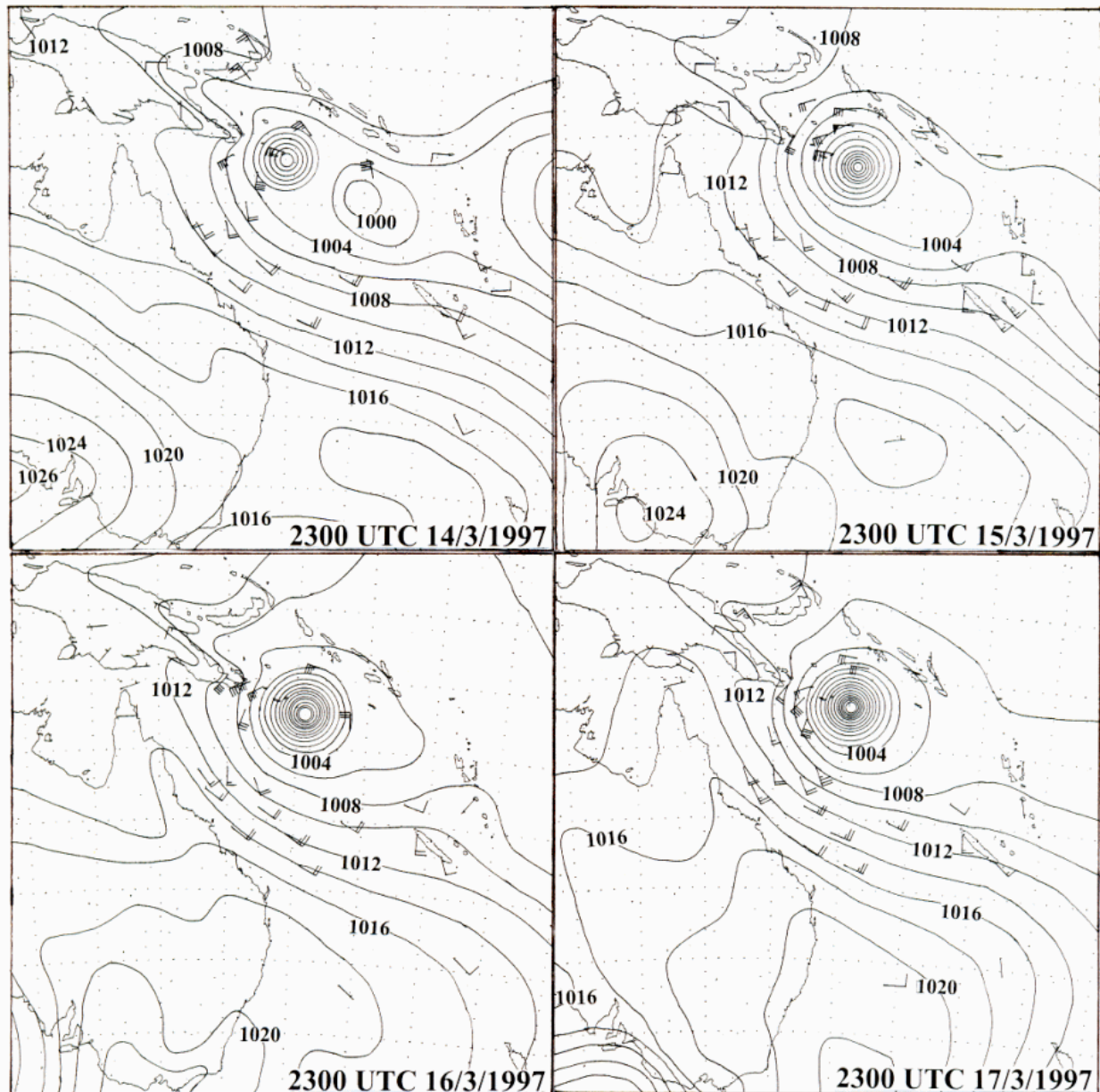


Figure 5 Mean sea level pressure analyses with plotted wind observations for tropical cyclone *Justin* for 2300UTC 14 March 1997 (top left), 2300UTC 15 March 1997 (top right), 2300UTC 16 March 1997 (lower left) and 2300UTC 17 March 1997 (lower right).

This was also the period when the wreckage of the yacht *Queen Charlotte* was found 275 nautical miles southwest of Honiara, the capital of the Solomon Islands (see location of *Queen Charlotte* and track of *Justin* below in Figure 6). Note the lengthy period that *Justin* was in the vicinity of the yacht. A massive air and sea search failed to find the two Australians and three New Zealanders aboard the vessel. Heavy rain with landslides also caused a great deal of damage in the Solomon Islands.

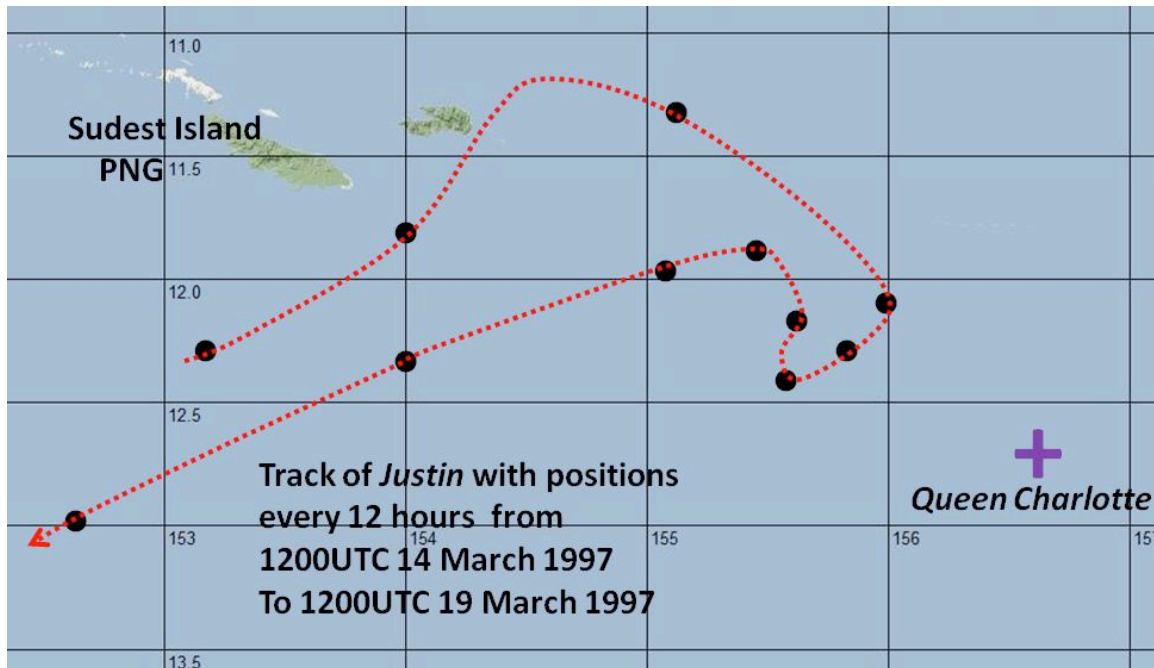


Figure 6 Track of tropical cyclone *Justin* and wreckage site of the yacht *Queen Charlotte*.

Third Impact of *Justin*

Justin crossed the coast near Cairns while rapidly intensifying and with a radar eye diameter of about 25 km. The maximum winds reported were from Green Island AWS with average winds to 55 knots and gusts to 69 knots (see Table 2). The lowest pressure there was 994.6 hPa in the eye. Two people were killed as *Justin* passed over the area. A lady was killed by a landslide at Paluma near Townsville. A boy was electrocuted by a fallen power line at Innisfail 70 km south southeast of Cairns. The total horticultural and sugar cane damage bill is expected to reach \$150,000,000 (1997 dollars). Damage to roads and bridges etc are expected to exceed \$20,000,000 (1997 dollars). Cairns Harbour wall was badly damaged and 50 berths in the marina were destroyed. There was widespread tree damage which brought down power lines and caused massive blackouts. Large landslides covered roads leading up into the Atherton Tablelands. In the Tablelands fifteen homes were damaged by trees smashing through roofs. There was also wind damage in the Townsville area. Thirteen flooded homes were evacuated in Dimbulah. Major flooding occurred in the Johnstone, Tully and Herbert Rivers. Ten houses were inundated at Innisfail. Four houses were inundated at Cardwell. At Deeragun in Townsville 60cm of water covered the suburb and several houses were evacuated. At Giru the town was covered by 25 cm of water.

Date/time UTC	Wind direction and 10 min winds (knots)	Wind gust (knots)	MSL pressure (hPa)	Remarks
211830	140052	69	998.7	Maximum wind gust
212000	130055	67	997.5	Maximum 10 min. winds
212130	110045	54	998.4	
212300	120041	48	997.1	
220014	050024	31	994.6	Lowest pressure
220130	360054	63	997.6	Under eastern eye wall

Table 2 Green Island AWS observations.