

Tropical Cyclone Ului, March 2010

Summary

When Tropical Cyclone (TC) Ului made landfall in Queensland, it was just over one year since category 5 TC Hamish narrowly missed the Queensland coastline, and four years to the day since category 4 TC Larry commenced its path of devastation.

On 18 March 2010, at 10:00 Australian Eastern Standard Time (AEST), the first TC Advice for Queensland was issued by the Australian Bureau of Meteorology in Brisbane for category 3 TC Ului. Earlier as a 930 hPa category 5 TC with maximum sustained winds of 215 km/hr, it had left a path of destruction through the southern Solomon Islands. Table 1 lists the information provided through TC Advices as TC Ului developed and tracked across north Queensland.

A disaster situation was declared on 20 March 2010 for a number of coastal and adjacent local government areas from Townsville to Rockhampton prior to TC Ului crossing the coastline near Airlie Beach sometime between 01:00 AEST and 02:00 AEST on 21 March 2010. Figure 1 shows the path of TC Ului as it approached and crossed the Queensland coast. Figure 2 shows a meteorological view of the cyclone as it developed offshore.

TC Ului key features included:

- Minimum central pressure of 930 hPa (whilst in Solomon Island waters).
- Maximum sustained wind speed 215 km/h.
- Maximum wind gust 290 km/h.
- Minimum central pressure for Queensland of 955 hPa at 19:00 AEST on 20 March, when TC Ului was approximately 190 km NE of Mackay.
- Maximum storm surge of 2.45 metres recorded at Laguna Quays at 02:20 AEST on 21 March.
- Peak measured wave height of 9.4 metres recorded at Mackay wave site at 00:00 on 21 March.
- Highest wave ever recorded at Mackay. Previous highest was 8.45 metres at 00:00 AEST on 10 March 1997 during TC Justin.

TC Ului resulted in moderate erosion damage to beaches and some damage to local infrastructure. Photographs of some of the damage to the coast, boats and infrastructure are shown in Figure 3.

Officers from the Department of Environment and Resource Management's (DERM) Coastal Unit provided advice on potential storm surge magnitudes.

Wave recording

DERM operates a network of wave monitoring sites along the Queensland coastline using moored Waverider buoys manufactured by Datawell of The Netherlands. The closest operating wave sites to TC Ului were off Mackay and Hay Point.

Mackay wave monitoring site

This site recorded a peak wave height (Hmax) of 9.4 metres at 00:00 AEST on 21 March when TC Ului was estimated to be 93 km east of Bowen and 127 km north of Mackay (and approximately 1.5 hours before the cyclone crossed the coast). This was the highest wave ever recorded at the Mackay wave site since it commenced operation on 20 September 1975.

A time series plot of this event for the period 20–21 March is shown as Figure 4. From this plot it can be seen that waves at Mackay reached a peak about 1.5 hours before the cyclone crossed the coastline but wave heights quickly reduced after coast-crossing. Peak wave periods (Tp) were in excess of eight seconds as the cyclone approached the coast (indicating that there was a large fetch distance over which the cyclonic winds were blowing). This allowed the waves to build up as energy was being transferred from the cyclone to the waves.

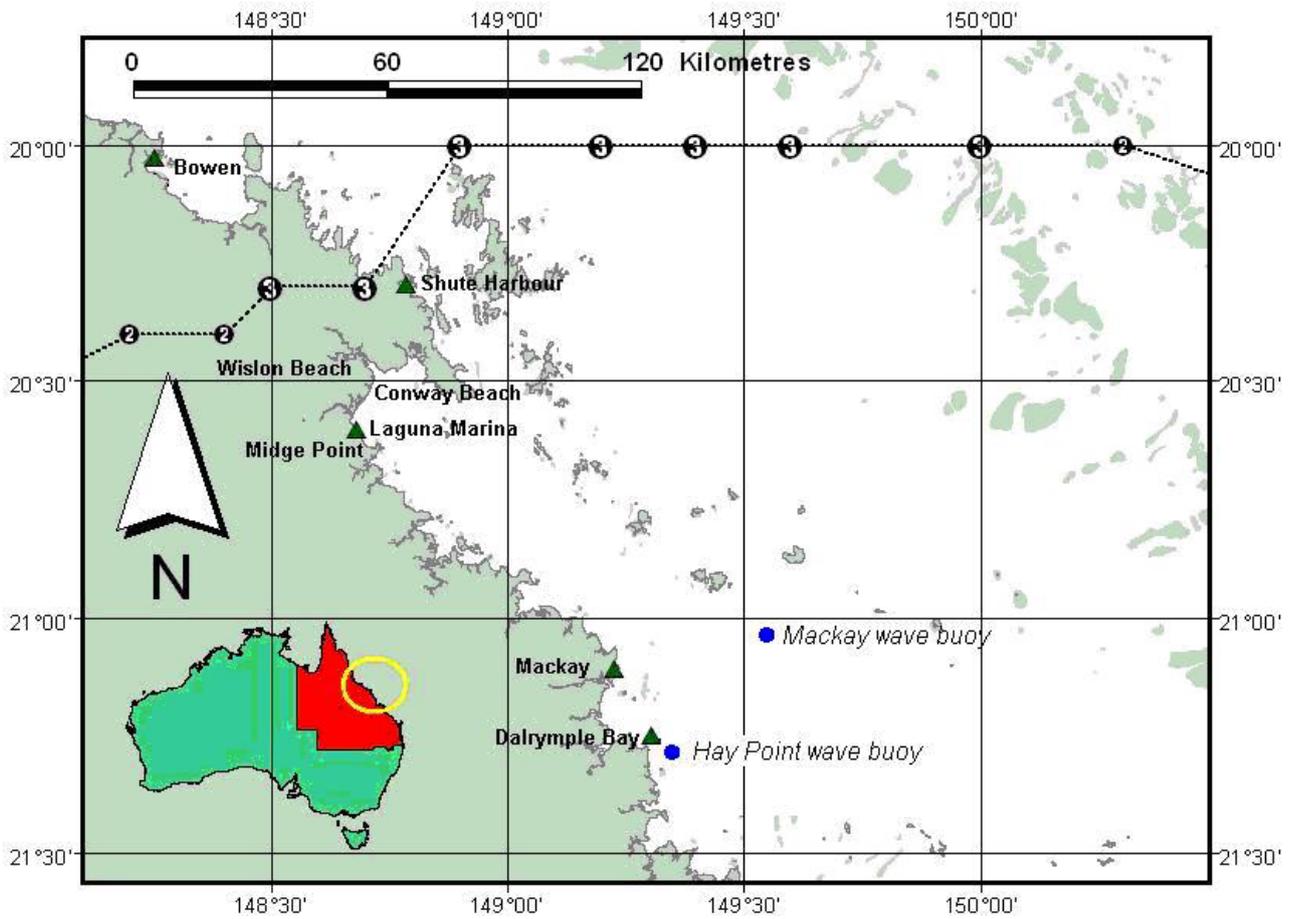


Figure 1 – Tropical Cyclone Ului track map for Queensland coastline

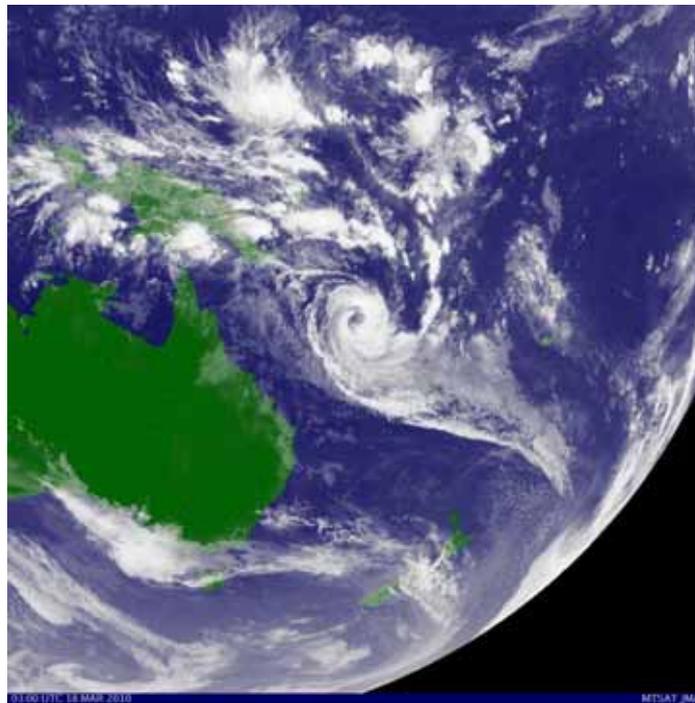


Figure 2 – Tropical Cyclone Ului, 18 March 2010

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Advice No.	Date (AEST)	Latitude (°South)	Longitude (°West)	CP (hPa)	Category
1	18/03/2010 10:00	15.00	157.80	960	3
2	18/03/2010 16:00	15.40	157.60	965	3
3	18/03/2010 22:00	15.70	157.70	970	3
4	19/03/2010 04:00	16.70	157.60	972	3
5	19/03/2010 10:00	16.70	156.90	980	2
6	19/03/2010 16:00	17.40	156.20	984	2
7	19/03/2010 19:00	17.80	155.80	983	2
8	19/03/2010 22:00	18.00	155.70	983	2
9	20/03/2010 01:00	18.20	155.50	980	2
10	20/03/2010 04:00	18.40	155.10	980	2
11	20/03/2010 07:00	19.40	154.10	978	2
12	20/03/2010 10:00	19.60	153.30	978	2
13	20/03/2010 13:00	19.70	152.30	978	2
14	20/03/2010 16:00	19.90	151.50	975	3
15	20/03/2010 19:00	20.10	150.60	955	3
16	20/03/2010 20:00	20.00	150.30	955	2
17	20/03/2010 21:00	20.00	150.00	964	3
18	20/03/2010 22:00	20.00	149.60	964	3
19	20/03/2010 23:00	20.00	149.40	965	3
20	21/03/2010 00:00	20.00	149.20	965	3
21	21/03/2010 01:00	20.00	148.90	965	3
22	21/03/2010 02:00	20.30	148.70	965	3
23	21/03/2010 03:00	20.30	148.50	968	3
24	21/03/2010 04:00	20.40	148.40	975	2
25	21/03/2010 05:00	20.40	148.20	979	2
26	21/03/2010 06:00	20.70	147.60	988	2
27	21/03/2010 07:00	20.60	147.30	992	1
28	21/03/2010 08:00	20.60	147.30	1001	0

Table 1 – Tropical Cyclone Advices for Queensland as issued by the Australian Bureau of Meteorology in Brisbane

Prior to coast-crossing, the recorded waves at the site were coming from slightly to the south of east (indicating that they were being driven by the strong wind field south of the advancing cyclone). Once the cyclone crossed the coast, the wave direction briefly swung to the north of east (now being driven by winds coming from the trailing edge of the cyclone) before swinging back to the south of east under the influence of the normal prevailing south easterly trade winds.

The previous highest Hmax recorded at Mackay was 8.5 metres at 00:00 AEST on 10 March 1997 during TC Justin. The Mackay wave monitoring site also recorded its highest significant wave height (Hsig) of 5.7 metres at 22:30 AEST on 20 March 2010. The previous highest Hsig recorded at this site was 4.8 metres at 00:00 AEST on 10 March 1997 during TC Justin.



Figure 3 – Some of the damage caused by Tropical Cyclone Ului

Hay Point wave monitoring site

This site recorded a Hmax of 6.2 metres at 00:00 AEST on 21 March 2010. It also recorded a peak Hmax of 6.3 metres at 04:30 AEST on 21 March. This was the second highest wave ever recorded at the Hay Point wave site since it commenced operation on 3 February 1993.

A time series plot of this event for the period 20–21 March is shown as Figure 5. From this plot it can be seen that waves at Hay Point reached a peak about 1.5 hours before the cyclone crossed the coastline and stayed elevated for about four hours after the cyclone crossed the coast. Like the Mackay site, peak wave periods (T_p) were in excess of eight seconds and, prior to coast-crossing, the recorded waves at the site were coming from slightly to the north of east (indicating that there may have been some shoaling and refraction of the waves as they moved into the shallower water at this site. Once the cyclone crossed the coast, the wave directions tended to remain more to the north of east than at the Mackay site.

The highest wave ever recorded at the Hay Point wave site was 6.8 metres at 20:00 AEST on 9 March 1997, during TC Justin. The Hay Point wave site did, however record its highest Hsig of 4.0 metres at 01:30 AEST on 21 March 2010. The previous highest Hsig recorded at this site was 3.1 metres at 20:00 AEST on 9 March 1997, during TC Justin.

Storm tide monitoring

DERM operates a network of storm tide gauges along the Queensland coastline. The closest operating storm tide gauges to the path of TC Ului are shown in Figure 1. The peak storm surge recorded at each of these sites is listed in Table 2.

Time series plots from the storm tide gauges at Laguna Quays and Mackay (the two sites recording the largest storm surges during this event) are shown as Figures 6 and 7. These plots show the actual tide recorded during the event; the predicted tide that should have occurred under normal meteorological conditions; and the observed surge (which is the difference between the actual and predicted values). They also show that the peak of the storm surge at these sites was close to high tide.

Fortunately at Mackay, the predicted high tide at the time was relatively low (neap tide), so the actual recorded tide was still more than a metre below Highest Astronomical Tide (HAT). At Laguna Quays, even though neap tides also prevailed there, the magnitude of the storm surge was still sufficient to cause the actual tide to exceed HAT by 0.4 metres.

Figure 8 shows a plot of the recorded surges for each of the storm tide gauges in the area affected by the cyclone. It can be seen that the peak storm surge occurred along a stretch of open coast about 40 km south of the coast-crossing track of the cyclone. Larger surges occurred at sites to the south of TC Ului's path (due to the fact that the strongest winds predominately occur to the south of cyclones approaching the Queensland coast from the east).

Storm tide gauge	Date (AEST)	Recorded peak storm surge (metres)
Rosslyn Bay	21/03/2010 04:10	0.47
Dalrymple Bay	21/03/2010 03:20	1.04
Mackay	21/03/2010 03:20	1.17
Laguna Quays	21/03/2010 02:20	2.45
Shute Harbour	21/03/2010 01:20	0.82
Bowen	21/03/2010 04:40	0.60
Cape Ferguson	21/03/2010 07:40	0.31

Table 2. Peak recorded storm surges during cyclone Ului

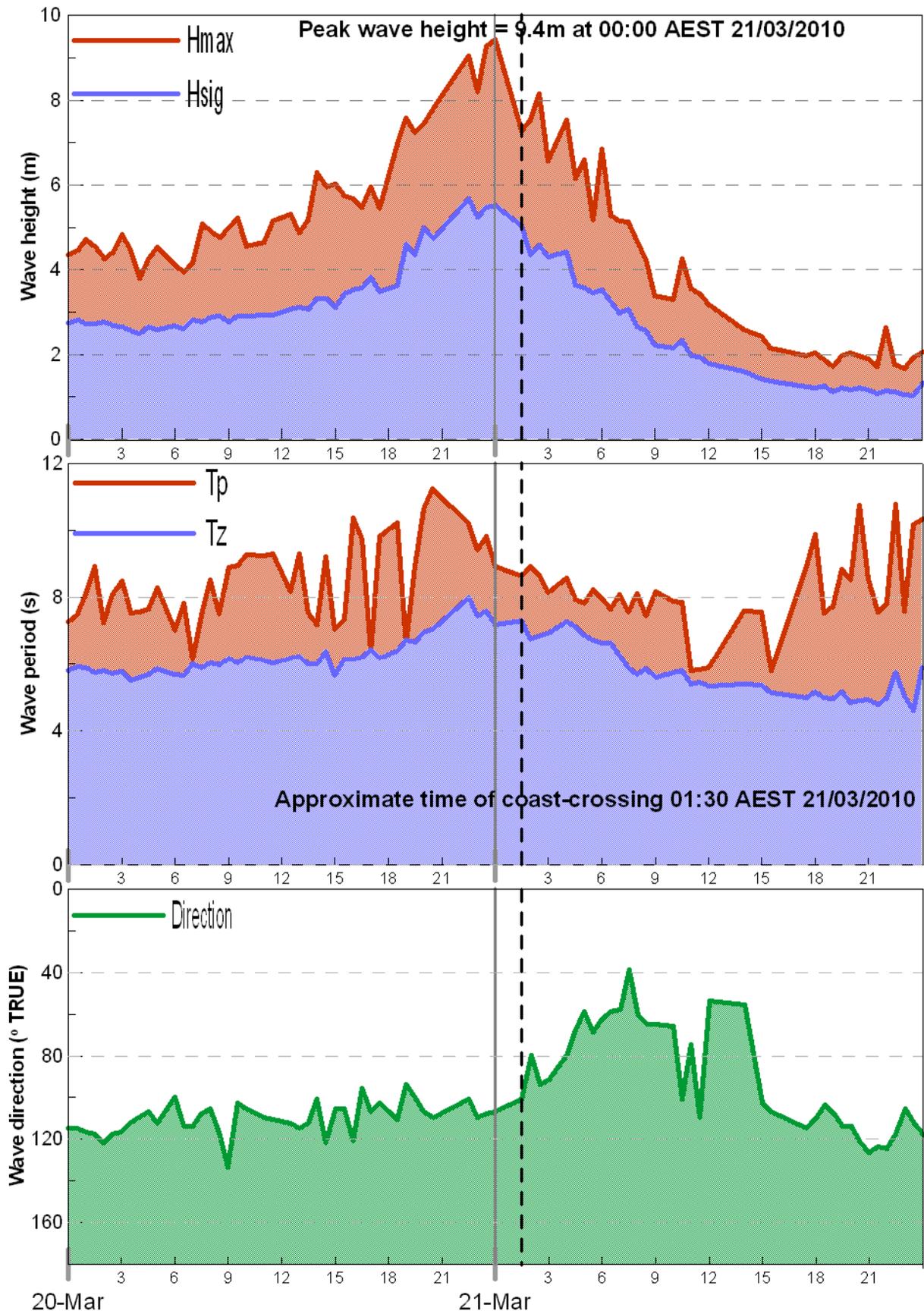


Figure 4 – Time series plots of wave height, period, and direction recorded at Mackay

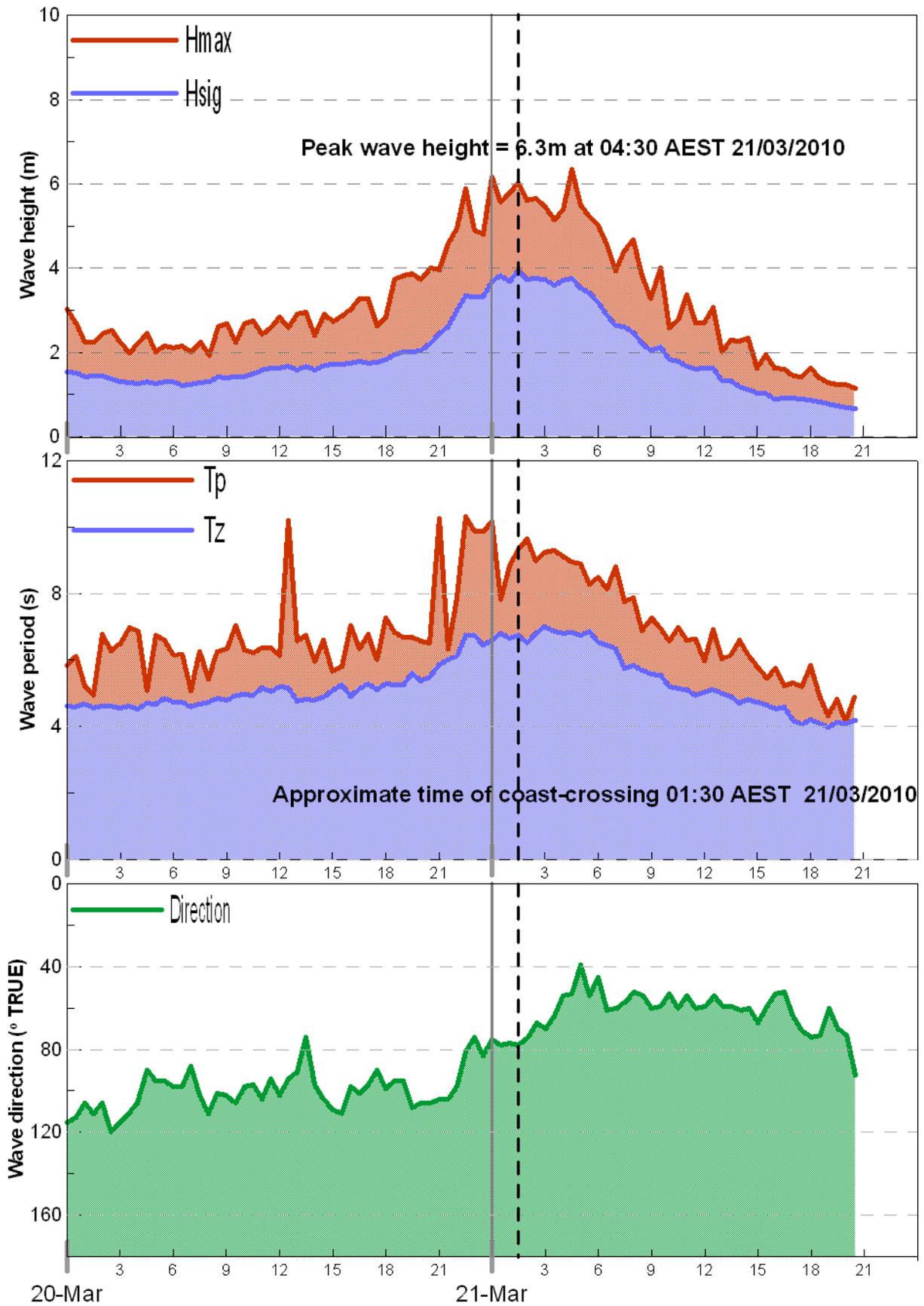


Figure 5 – Time series plots of wave height, period, and direction recorded at Hay Point

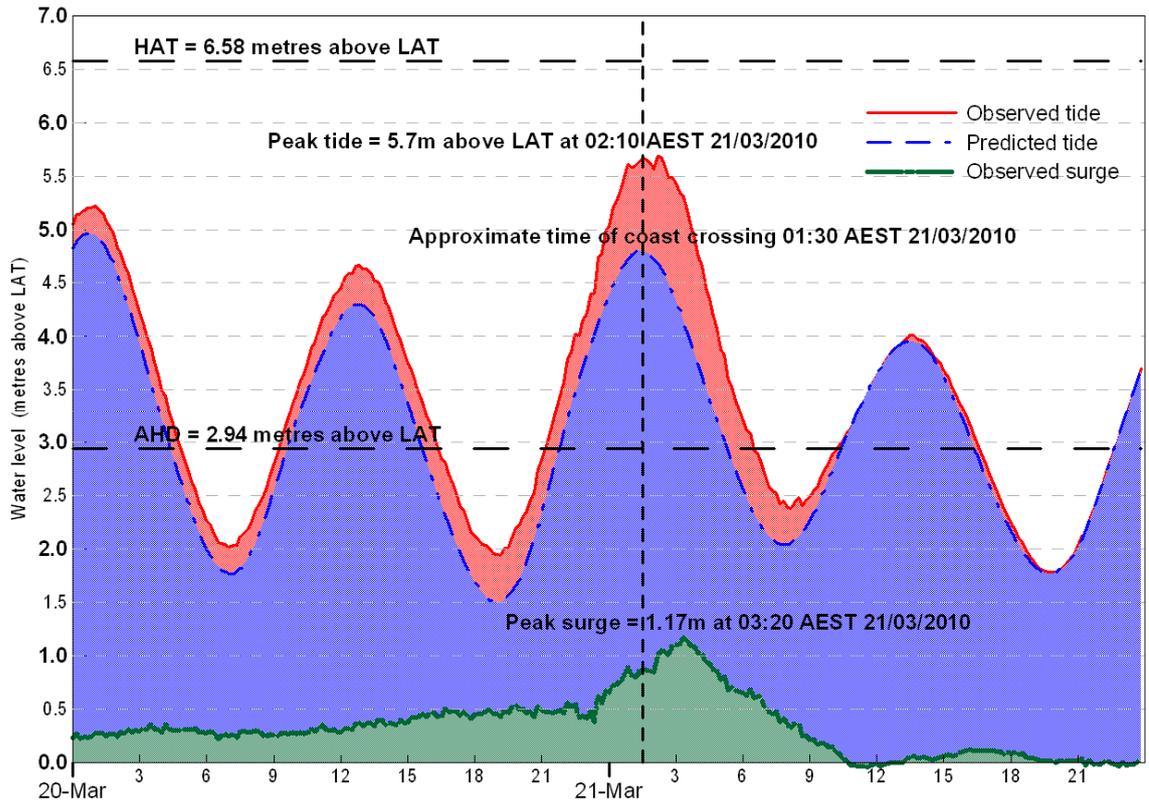


Figure 6. Plot of tides from Mackay storm tide gauge 20-21 March 2010

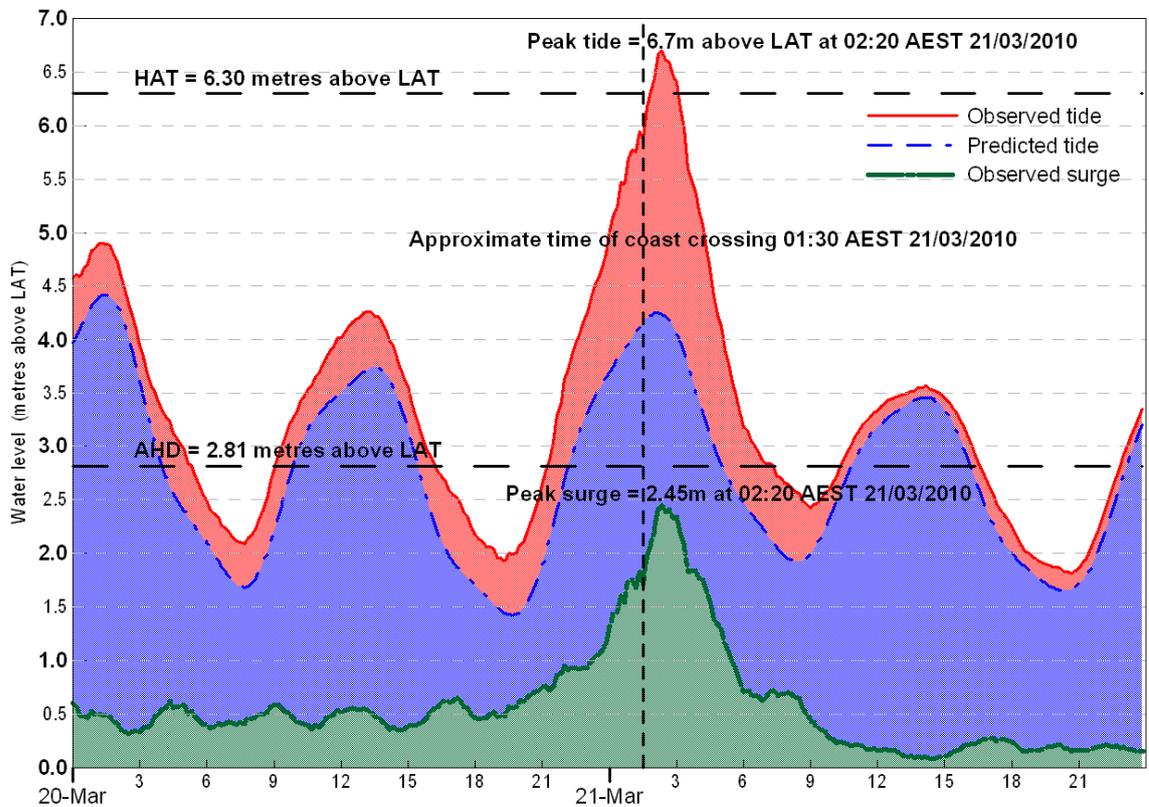


Figure 7. Plot of tides from Laguna Marina storm tide gauge 20-21 March 2010

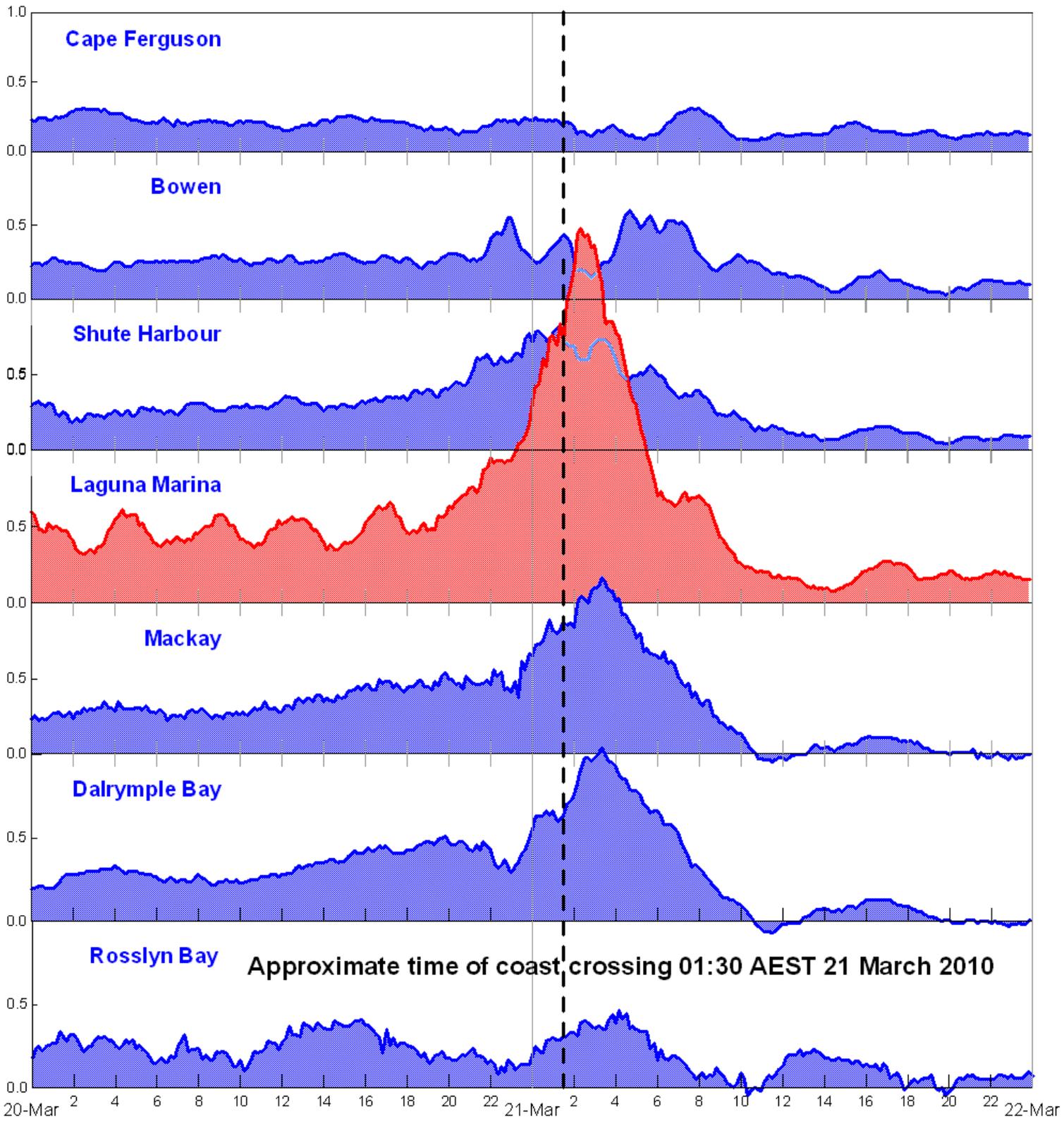


Figure 8 – Time series plots from selected sites, showing sea-surface fluctuations that differ from the normal predicted tides

Glossary

- Hsig** The significant wave height (in metres), defined as the average of the highest one third of the zero up-crossing wave heights in a 26.6-minute wave record. This wave height closely approximates the value a person would observe by eye.
- Significant wave heights are the values reported by the Bureau of Meteorology in their forecasts.
- Hmax** The maximum zero up-crossing wave height (in metres) in a 26.6-minute record.
- Tz** The average of the zero up-crossing wave periods (in seconds) in a wave record.
- Tp** Wave period at the peak spectral energy (in seconds). This is an indication of the wave period of those waves that are producing the most energy in a wave record. Depending on the value of Tp, waves could either be caused by local wind fields (sea) or have come from distant storms and have moved away from their source of generation (swell).
- Direction** The direction that peak wave period (Tp) waves are coming from (in ° True North). In other words, where the waves with the most energy in a wave record are coming from.

Web Sites

www.derm.qld.gov.au/waves

www.derm.qld.gov.au/tides

Wave Monitoring Publications

http://www.derm.qld.gov.au/environmental_management/coast_and_oceans/waves_and_storm_tides/wave_monitoring/wave_monitoring_publications/index.html

Storm Tide Monitoring Publications

http://www.derm.qld.gov.au/environmental_management/coast_and_oceans/waves_and_storm_tides/storm_tide_monitoring/storm_tide_monitoring_publications.html

July 2010

For general enquiries contact the
Queensland Government call centre 13 13 04
or visit www.derm.qld.gov.au