Australian Government
Bureau of Meteorology

Tropical Cyclone *Anthony*

23 - 31 January 2011

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A. Summary

Tropical Cyclone Anthony was initially analysed as a tropical low in the northwest Coral Sea, northeast of Cairns on the 22nd January 2011. The low developed an easterly track away from the Queensland coast prior to forming into a tropical cyclone during the afternoon on the 23rd of January. *Anthony* moved into an area of increased wind shear and weakened to a tropical low early on the 24th of January. The low continued to move east-southeast across the Coral Sea until January 25th before turning back to the west-northwest.

Ex-TC Anthony re-intensified into a category 1 tropical cyclone for 12 hours on January 28th, weakening to a tropical low late in the day.

EX-TC Anthony began to adopt a southwesterly track on January 29th towards the central Queensland coast. It persisted with this movement and re-intensified into a category 1 cyclone by 10am 30th January, further intensifying into a marginal category 2 system before making landfall near Bowen just before 10pm on January 30th with mostly minor reported near the crossing location.

Anthony was the third tropical cyclone in the Queensland area of responsibility during the 2010/11 season.

B. Meteorological Description

Intensity analysis
On January 23rd an area of increased convection off the Queensland North Tropical Coast developed near a low level circulation. Convection became more organised overnight in a low wind shear environment and Dvorak estimates showed the system had developed into a tropical cyclone during the afternoon on January 23rd based on a curved band of 0.7 and MET values of T3.0. During this period a well defined circulation appeared on radar and microwave imagery suggesting that *Anthony* may have been a strong category 1 or even close to category 2 strength for a brief period late on the 23rd.

Anthony remained as a category 1 system overnight before moving into an area of increased wind shear and weakening to a tropical low during the morning on the 24th of January. The system remained as a tropical low for the next few days as it moved across the Coral Sea as a low level circulation centre with little or no associated convection.

Ex-TC Anthony reintensified into a category 1 system early on the 28th of January as a result of a brief change in movement to the east-northeast, thus reducing the effect of northwesterly wind shear located over the area. Dvorak estimates gave T3.0 with DT 3.0 based on a shear pattern with LLCC <0.75 degrees into a large area of convection. MET also agreed with this T3.0 value. Late on the 28th Anthony turned back to the west-northwest and became sheared, again weakening into a tropical low.

Ex-TC Anthony again re-intensified into a category 1 system by 10am January 30th as it continued a southwesterly track towards the Queensland coast. Dvorak estimates of T3.0 at 10am 30/1/11 were based on a DT 3.0 using a curved band of 0.9 with MET also agreeing. Late on the 30th, in a region of reduced wind shear, *Anthony* intensified into a marginal Category 2 system just before making landfall near Bowen at around 10pm. To support this observations from the exposed Hamiltion Island Automatic Weather Station (AWS) showed maximum gusts to 67 knots while Dvorak analysis gave DT 3.5 based on a CDO width of 1.5 degrees and MET in agreement. *Anthony* then rapidly weakened into a tropical low over land.

Motion

Anthony was initially analysed as a tropical low in the northwest Coral Sea, northeast of Cairns on January 22nd 2011. The low developed an east-southeast track away from the Queensland coast under the influence of an upper trough over the northern Coral Sea. This trough remained the main steering influence until January 25th, taking the system east of 160°E when a new lower atmospheric ridge began to build to the south of *Anthony* and move the system back to the west-northwest.

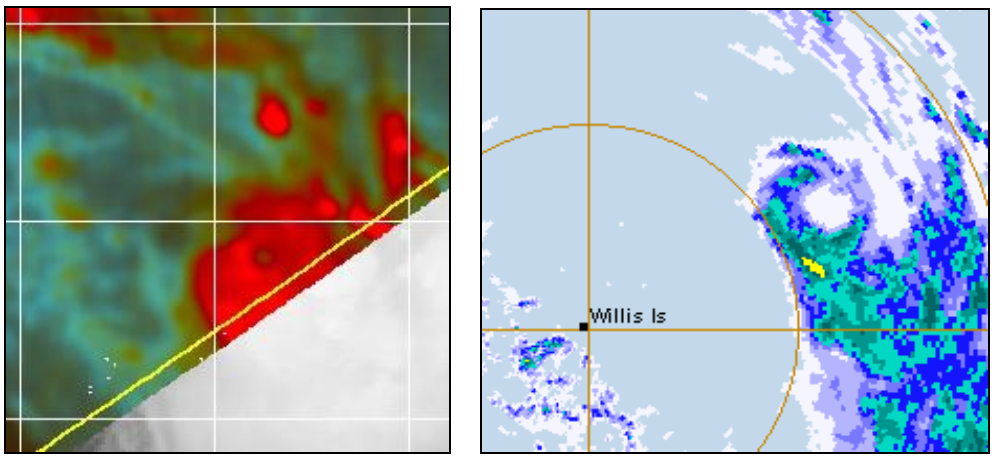
Ex-TC Anthony adopted an east-northeasterly track late on January 27th, most likely as a result of the Fujiwara Effect as a secondary circulation developed on its eastern side and rotated to its south. As this secondary circulation moved to the northwest of *Anthony*, early on January 28th, its movement rapidly returned to the west-northwest. During this period *Anthony* may have also been influenced by the Fujiwara Effect from *Severe Tropical Cyclone Wilma*, located east of New Caledonia and moving south towards New Zealand.

Ex-TC Anthony began to adopt a southwesterly track on January 29th towards the central Queensland coast as an upper high strengthened over central Australia and extended a ridge into the southern Coral Sea. This movement persisted into January 30th when the system made landfall on the Queensland east coast near Bowen.

Structure

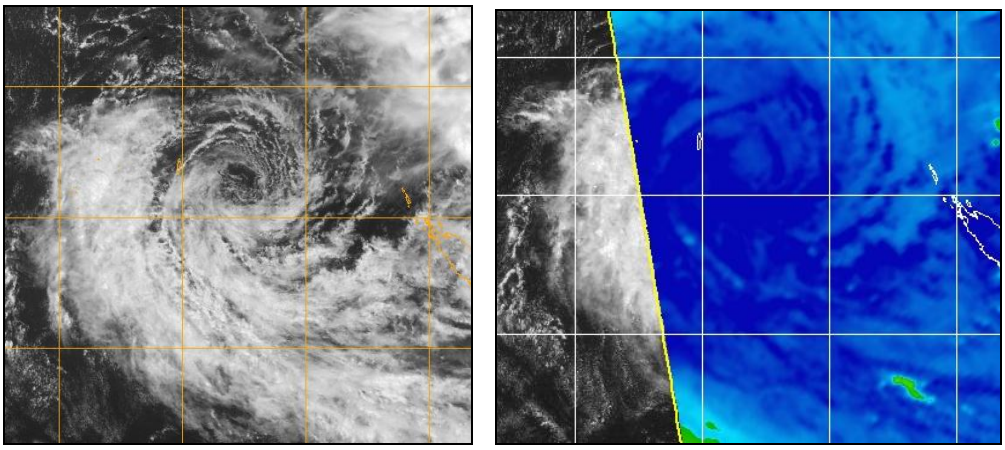
On January 22nd deep convection existed about the northern Coral Sea offshore from Cairns under the influence of weak shear. On the morning of January 23rd this convection became organised with Dvorak wind estimates showing the system at tropical cyclone strength. On the afternoon of the 23rd *Anthony* briefly showed signs of a partial eye wall forming on both microwave and radar imagery, suggesting it may have been a strong category 1 system, or even marginal category 2, at this time.

Figure 1 – 09:00Z TRMM-TMI 85-91GHz Color image and 06:20Z Willis Island radar image showing a partial eyewall on 23rd January. (Image courtesy of US NRL: http://www.nrlmry.navy.mil/)



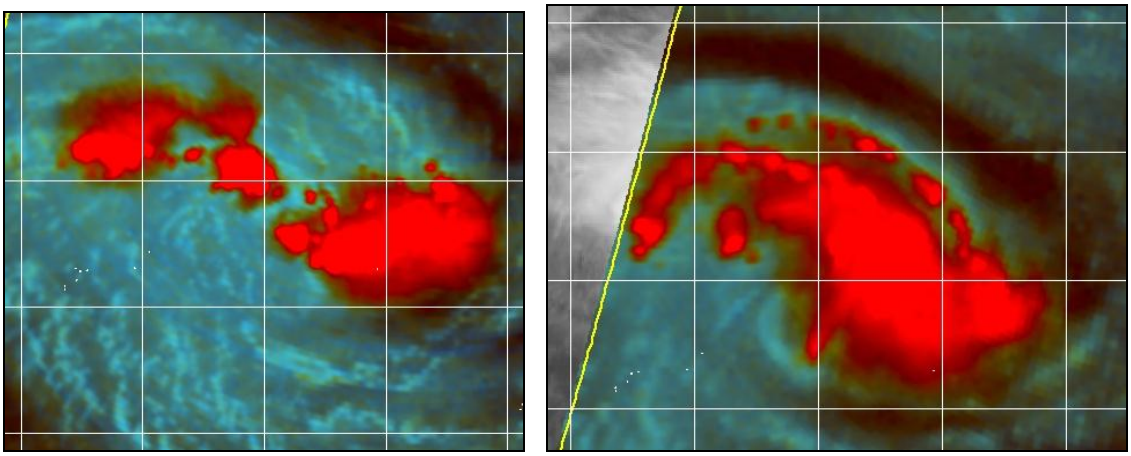
On January 24th the system became sheared and weakened to a tropical low, maintaining a shallow depth with only brief pulses of convection until late on January 27th. During this time the low level circulation remained relatively symmetrical and was unaffected by shear in the upper atmosphere.

Figure 2 - 01:32 UTC MTSAT visible and 02:41 UTC AMSRE 85-91 GHz microwave image of *Ex-TC Anthony* showing the low level circulation with little convection. (Image courtesy of US NRL: http://www.nrlmry.navy.mil/)



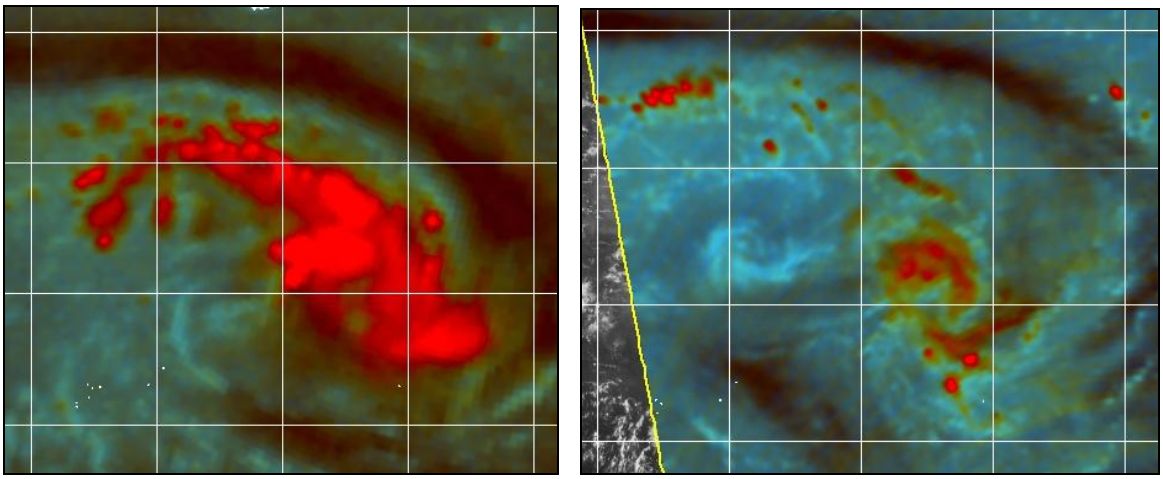
Late on January 27th *Ex-TC Anthony* turned to the east-northeast, thus experiencing a reduced effect from northwesterly wind shear in the upper atmosphere. This movement was most likely a result of the Fujiwhara effect from a secondary circulation which developed to the east of *Anthony*. With the reduced influence from wind sheer, convection increased significantly overnight and the system reached tropical cyclone intensity at 4am January 28th.

Figure 3 - 15:00 UTC AMSRE 85-91 GHz Color and,19:52 UTC TC_SSMIS 85-91 GHz Color microwave imagery showing a significant increase in convection over an almost 5 hour period. A secondary low level circulation can be seen to the southwest of the convection.
(Image courtesy of US NRL: http://www.nrlmry.navy.mil/)



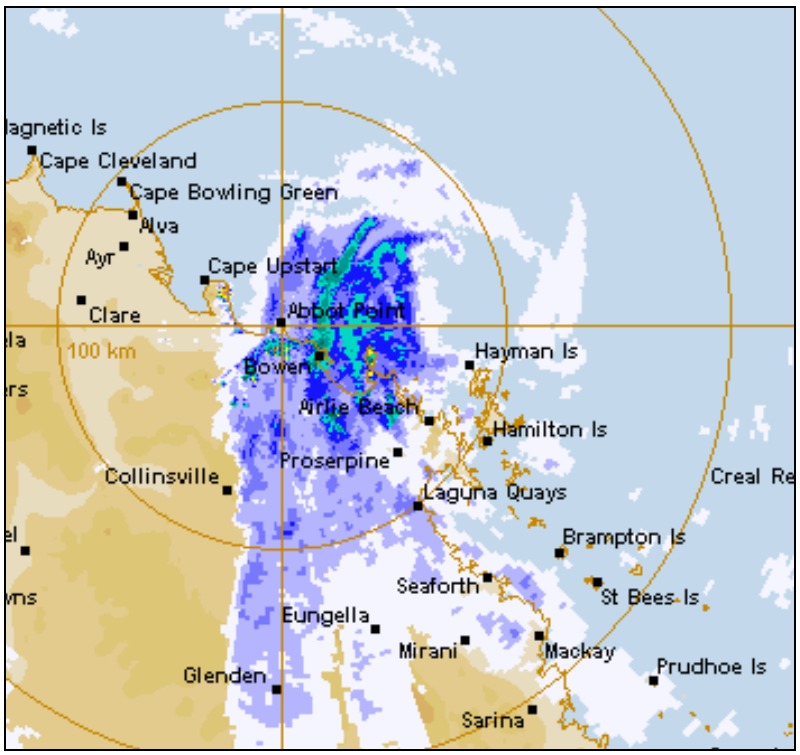
Early on January 28th *Anthony* took a west-northwest track, most likely as a result of the secondary circulation moving to its north. As a result, the system became increasingly susceptible to northwest wind shear and weakened to a tropical low at night.

Figure 4 - 21:30 UTC TC_SSMIS 85-91 GHz Color and 03:13 UTC AMSRE 85-91 GHz Color microwave imagery showing a secondary circulation moving from the southwest of the convection to the northwest over time. Convection has also been significantly hindered through this period.
(Image courtesy of US NRL: http://www.nrlmry.navy.mil/)



Ex-TC Anthony remained as a sheared tropical low until late on January 29th when convection began to increase as a result of weakening upper atmospheric wind shear. As the system moved to the southwest, convection became organised and reached tropical cyclone intensity at 10am January 30th. In the 12 hours to 10pm January 30th the system continued to intensify, developing deep convection and contracting in size. Wind gust observations of up to 67 knots and a partial eyewall evident on the Bowen radar suggest *Anthony* was a marginal category 2 system at landfall.

Figure 5 - 09:20 UTC Bowen radar image showing a partial eyewall prior to landfall.



C. Impact

Impacts were considered relatively minor with the coastal crossing of *Anthony*. 11,415 homes were reported to have lost power in Bowen, Airlie Beach, Mackay Collinsville and Sarina.

Around Bowen, the Whitsundays and as far south as Mackay there were numerous reports of damage to vegetation, and only minor damage to buildings. A boat sunk outside Bowen marina and 6 boats broke their moorings at Airlie Beach marina. Townsville and Mackay were pre-emptively declared disaster areas to aid recovery response and the ports at Townsville, Mackay, Hay Point and Abbott Point were closed.

D. Observations

Wind.
Dvorak satellite estimates give *tropical cyclone Anthony* an estimated maximum wind gust strength of 70 knots or 130 km/h.

Three automatic weather stations (AWS) recorded gale force winds as *Anthony* approached the Queensland coast on January 30th.

Hamilton Island AWS recorded a maximum 10 minute wind speed of 54 knots at 7:55pm and maximum wind gust of 67 knots at 6:01pm. Marion Reef AWS recorded a 10 minute mean wind of 36 knots at 8:00am while Creal Reef AWS recorded a 10 minute mean wind of 43 knots at 5:20pm.

Hardy Reef, part of the Australian Institude of Marine Science (AIMS) network recorded a 10 minute mean wind of 130kmh (70 knots) at 7:30pm and a minimum pressure of 993.9hPa at 7:10pm January 30th. This data should be considered with caution.

Rainfall/Flooding

Rainfall totals of up to 200mm were recorded on January 31st in the area between Bowen and Mackay. There were no reports of serious flash flooding in the region and only isolated major flooding was observed in the upper reaches of the Pioneer River and in Denison Creek in the Fitzroy River Basin.

Storm surge

No significant storm surge anomalies were recorded for tropical cyclone *Anthony*, and no tide heights exceeded Highest Astronomical Tide (HAT).

E. Forecast Performance

Ocean gale warnings were issued from 5pm January 22nd and coastal gale warnings from 6pm January 22nd as favourable environmental conditions existed over the northwest Coral Sea. Forecast Track Maps were issued from 8:58am January 23rd. Twenty Tropical Cyclone Advices were issued. Tropical Cyclone Watches from 4:56pm January 28th including coastal towns between Innisfail and St Lawrence and inland west of Charters Towers, and Warnings from 7:58pm January 29th including towns between Cardwell and Sarina and inland to Charters Towers. All Advices were cancelled by 12:56am January 31st as the system weakened over land.

Table 1. Best track summary for *Anthony,* 23-31 January 2011.
Refer to the Australian Tropical Cyclone database for complete listing of parameters.

Year	Month	Day	Hour (UTC)	Position Latitude S	Position Longitude E	Position Accuracy nm	Max wind 10min knots	Max gust knots	Central Pressure hPa	Rad. of Gales nm	Rad. of storm force winds	Radius Max. Wind (RMW)
2011	1	23	00	15.3	148.9	50	30	45	997			
2011	1	23	06	15.7	151.0	12	40	55	990	60		10
2011	1	23	12	16.4	153.2	30	45	65	990	60		18
2011	1	23	18	16.9	155.2	50	35	50	993	60		25
2011	1	24	00	17.4	156.3	30	30	45	998			
2011	1	24	06	18.8	158.5	30	25	45	1002			
2011	1	24	12	18.5	159.8	40	25	45	1002			
2011	1	24	18	19.2	160.6	30	25	45	1000			
2011	1	25	00	19.5	160.8	20	25	45	998			
2011	1	25	06	19.6	160.6	20	20	45	1000			
2011	1	25	12	19.5	159.9	30	25	45	1001			
2011	1	25	18	19.1	159.7	40	30	45	997			
2011	1	26	00	19.1	159.5	30	30	45	996			
2011	1	26	06	18.9	158.5	30	30	45	1000			
2011	1	26	12	18.6	157.6	40	30	45	1002			
2011	1	26	18	18.4	156.6	50	30	45	1003			
2011	1	27	00	17.9	155.6	20	30	45	1000			
2011	1	27	06	17.6	155.1	20	25	45	1002			
2011	1	27	12	16.5	154.4	50	30	45	999			
2011	1	27	18	15.9	155.9	50	35	50	992	80		25
2011	1	28	00	16.0	155.5	30	35	50	993	80		25
2011	1	28	06	16.0	155.2	30	35	50	995	80		20
2011	1	28	12	15.5	154.9	30	30	45	1001			
2011	1	28	18	15.4	154.6	60	25	45	1000			
2011	1	29	00	15.3	154.3	40	25	45	999			
2011	1	29	06	15.6	153.7	30	30	45	999			
2011	1	29	12	15.8	153.4	30	30	45	998			
2011	1	29	18	17.2	152.2	30	30	45	1001			
2011	1	30	00	18.3	151	40	35	50	999	70		30
2011	1	30	06	19.3	149.5	15	45	65	990	90		25
2011	1	30	12	19.9	148.2	15	50	70	989	50	20	25
2011	1	30	18	21.4	146.6	40	25	45	1004			

Table 2. Verification statistics: Track and Intensity.

Parameter	**0 hr**	**6 hr**	**12 hr**	**18 hr**	**24 hr**	**36 hr**	**48 hr**	**72 hr**
Count	31	32	31	31	31	30	28	24
Distance (km)	38	57	80	96	117	164	209	282
Mean wind (knots)	5	6	7	9	11	14	13	14

Figure 7. Track of Tropical Cyclone *Anthony*, 23-31 January, 2011.
Times in EST (subtract 10 hours to convert to UTC).

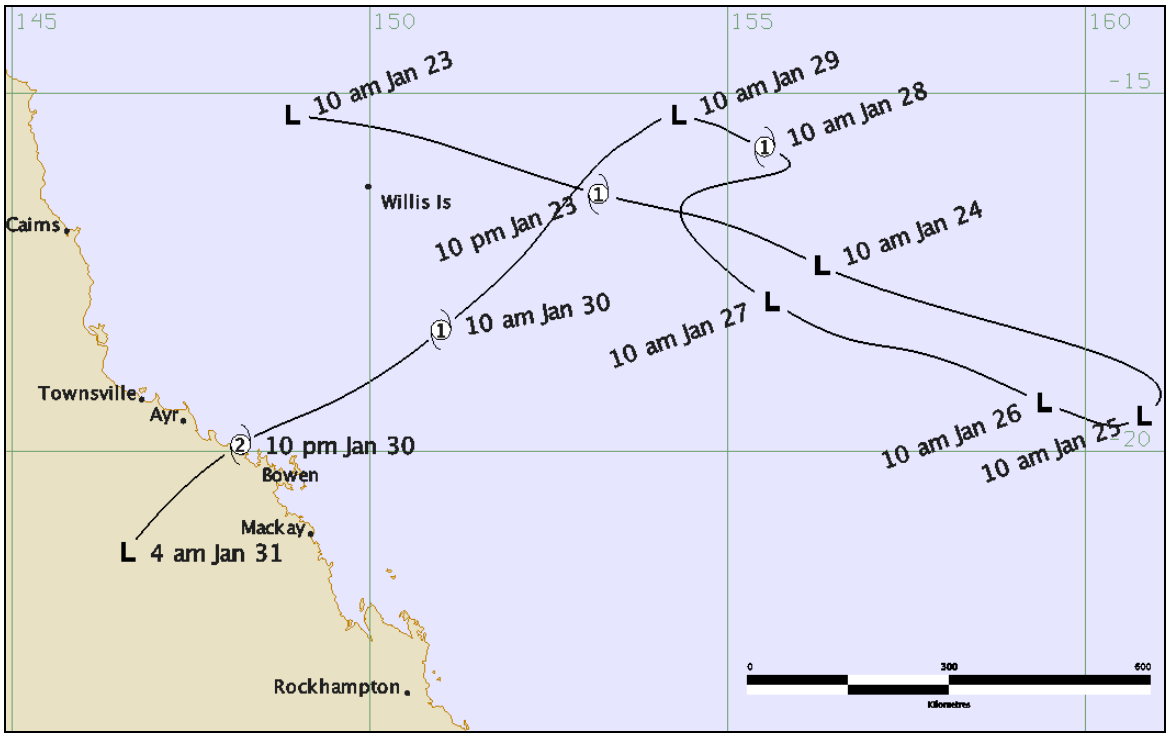


Figure 8 - Track of Tropical Cyclone *Anthony* near landfall including gale force wind (light pink) and storm force wind (dark pink) zones.
Times in EST (subtract 10 hours to convert to UTC).