# Severe Tropical Cyclone Debbie

## Sea Surface Response

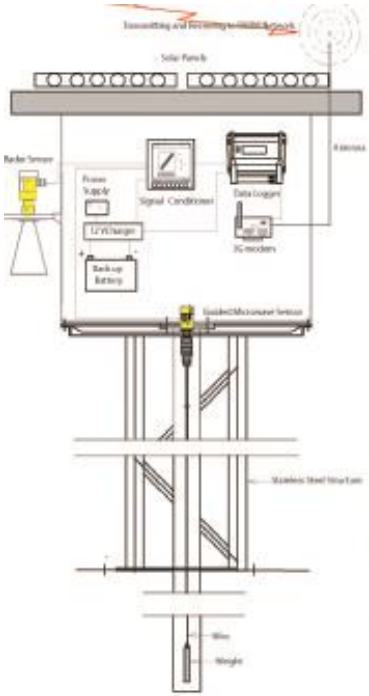
Daryl Metters

# The Coastal Impacts Unit

- Monitor sea level and ocean waves in real time along Queensland coast
- 36 storm tide gauges + 11 tide gauges
- 15 wave monitoring buoys
- The data are utilized for:
- Disaster Management
- and by numerous other groups including: scientists, coastal engineers, maritime safety and recreational users.

# Storm Tide Gauge

- Built to withstand Cat 5 TC
- Measure SL in real time
- With microwave sensors
  (1) stilling well
  (2) open to air
- Measures barometric pressure

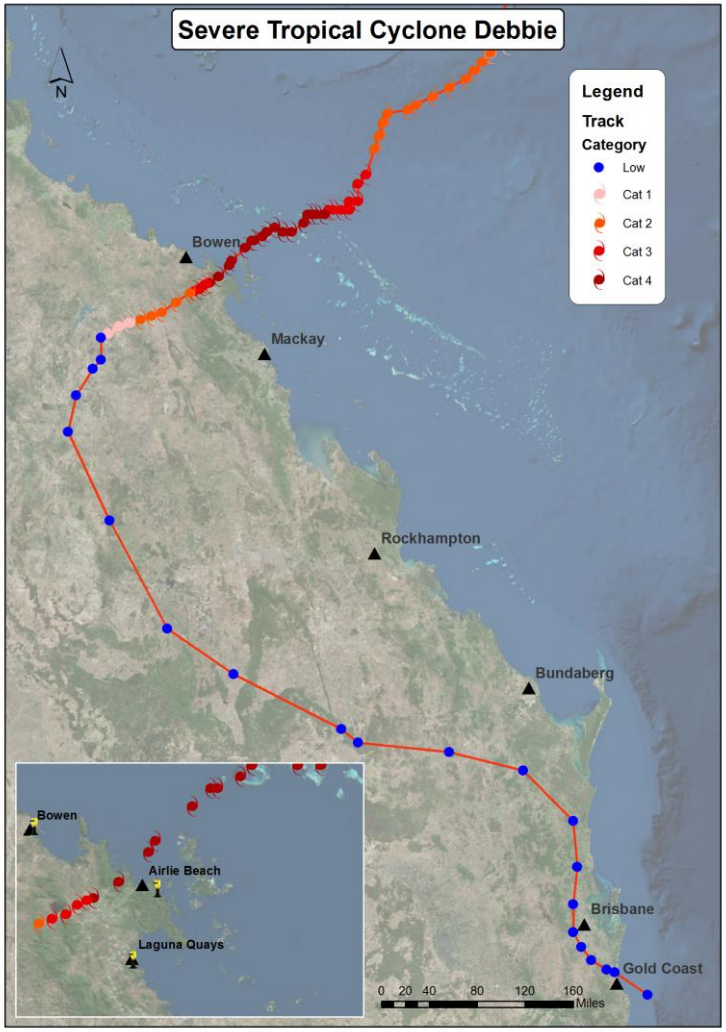


# Severe Tropical Cyclone Debbie

- Slow moving cyclone 7 – 9 km/h
- Maximum sustained wind = 195 km/h
- Maximum Gust = 260 km/h
- Minimum MSLP = 943 hPa (modelled)
- Landfall @ 12:40pm 28 March 2017 at Airlie Beach as a Category 4 Severe Tropical Cyclone

# Severe Tropical Cyclone Debbie

## Modelled (Estimated) Track

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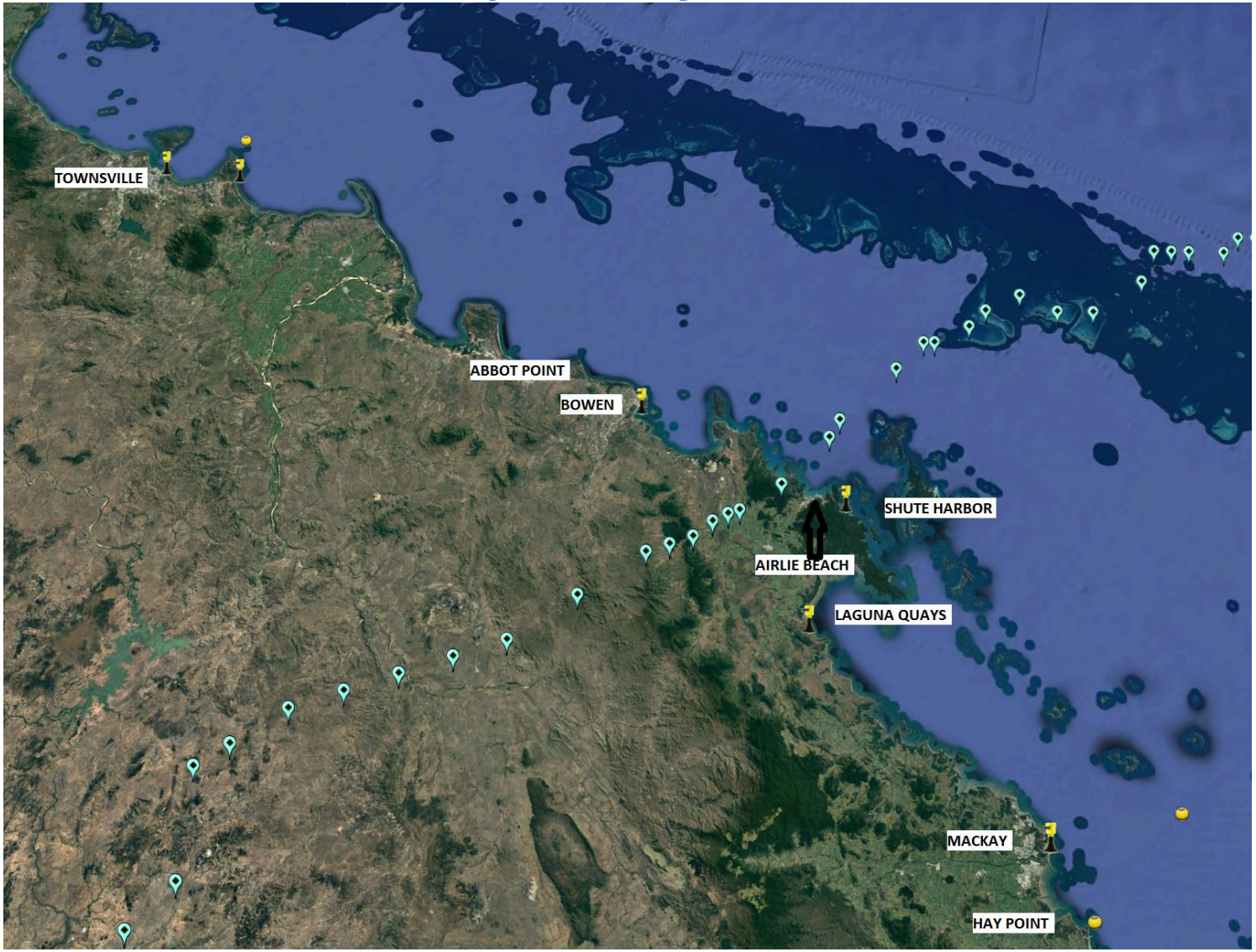
# Severe Tropical Cyclone Debbie



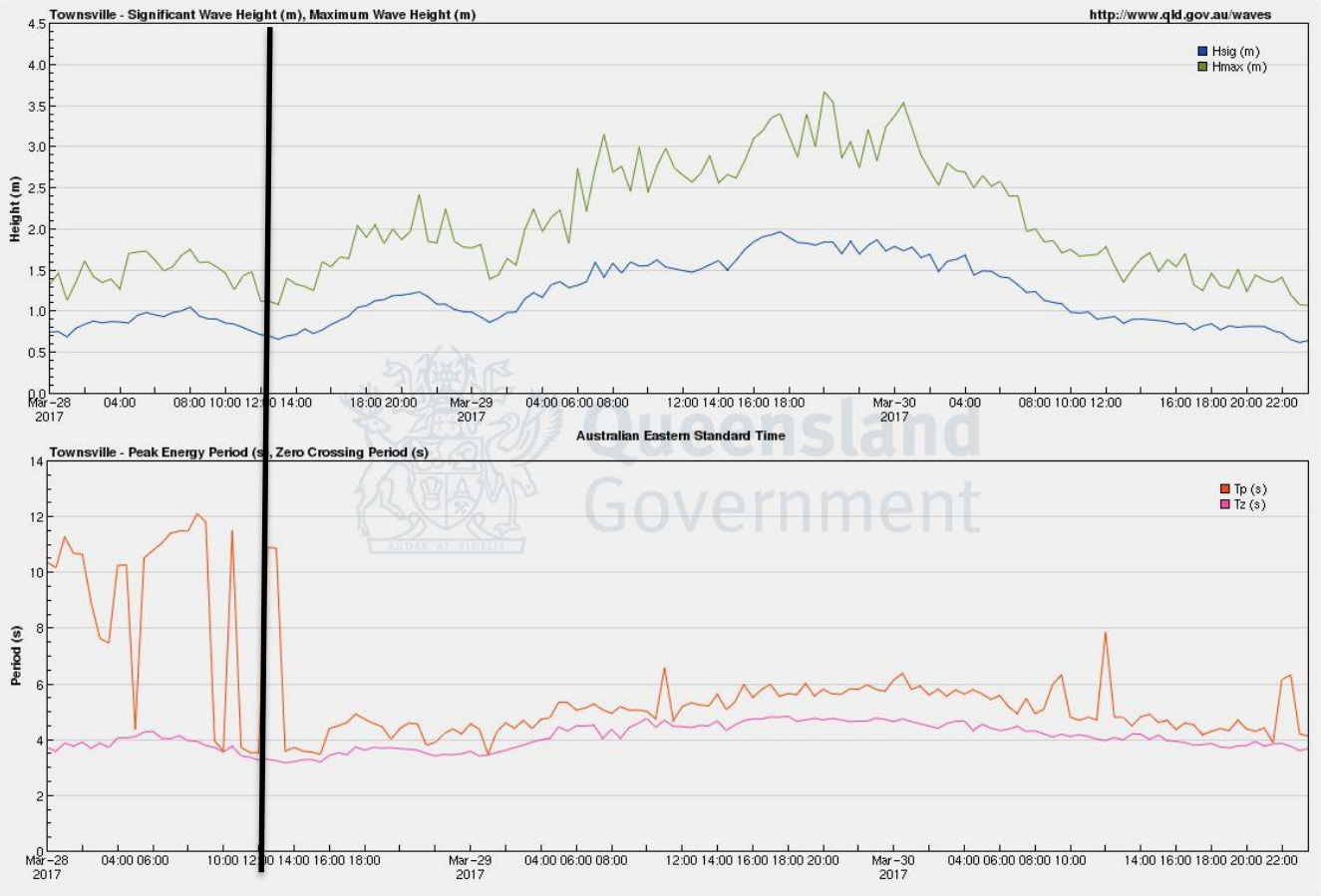
# Severe Tropical Cyclone Debbie

- Storm Surge dependant on several factors
  - Pressure gradient
    - > Inverse Barometer IB=-9.948(ΔP-1013.3)
  - Speed and direction of wind stress
    - > On-Shore south of central pressure max
    - > Off-shore north of central pressure max
  - Orientation of site to wind
  - Stage of the tide
  - Shape, depth and beach slope at location

# Severe Tropical Cyclone Debbie

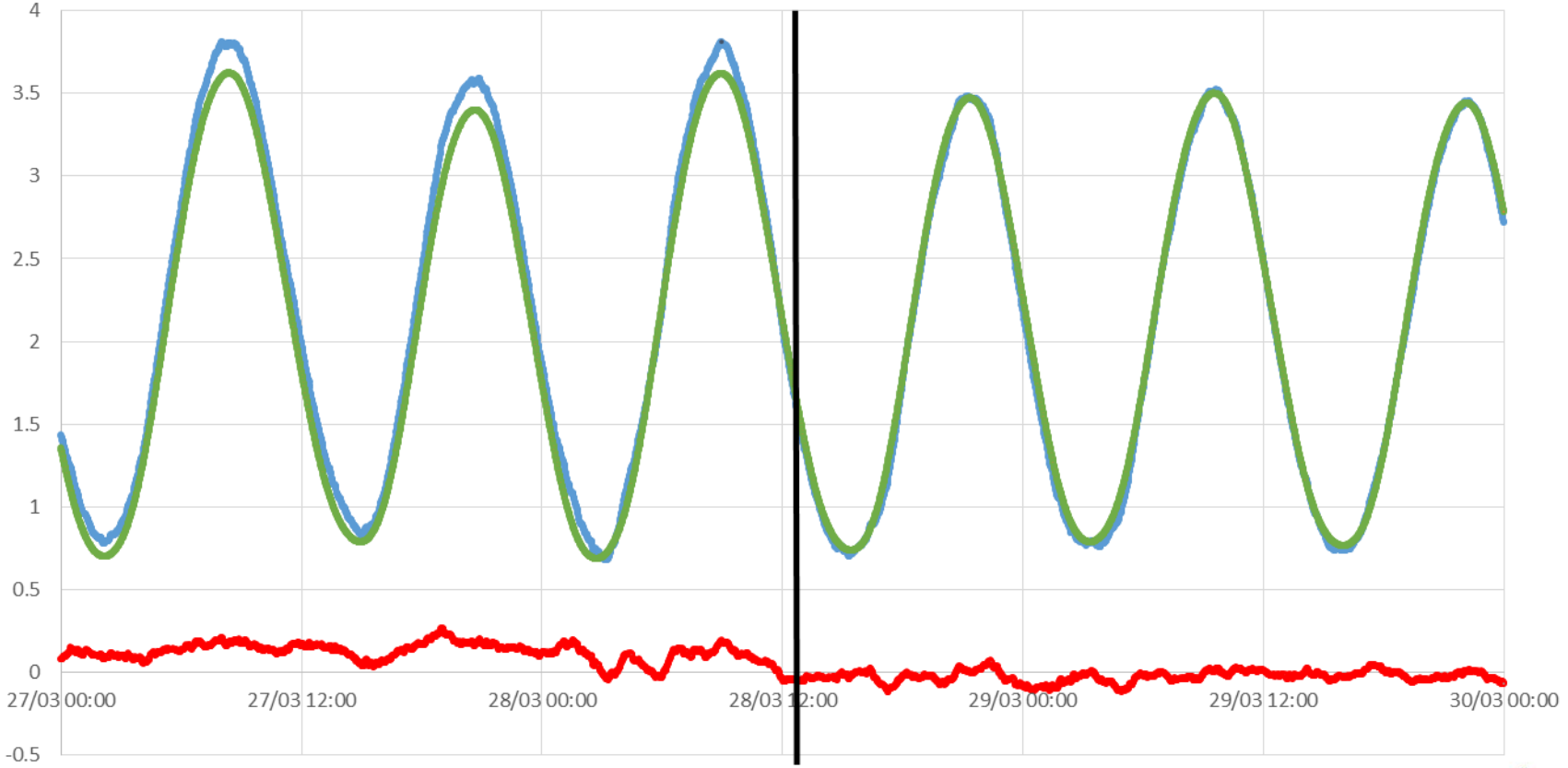
## Wave Height Townsville

## Max height: 3.7m, well after landfall



# Severe Tropical Cyclone Debbie

## Townsville Surge +0.2 to slightly negative

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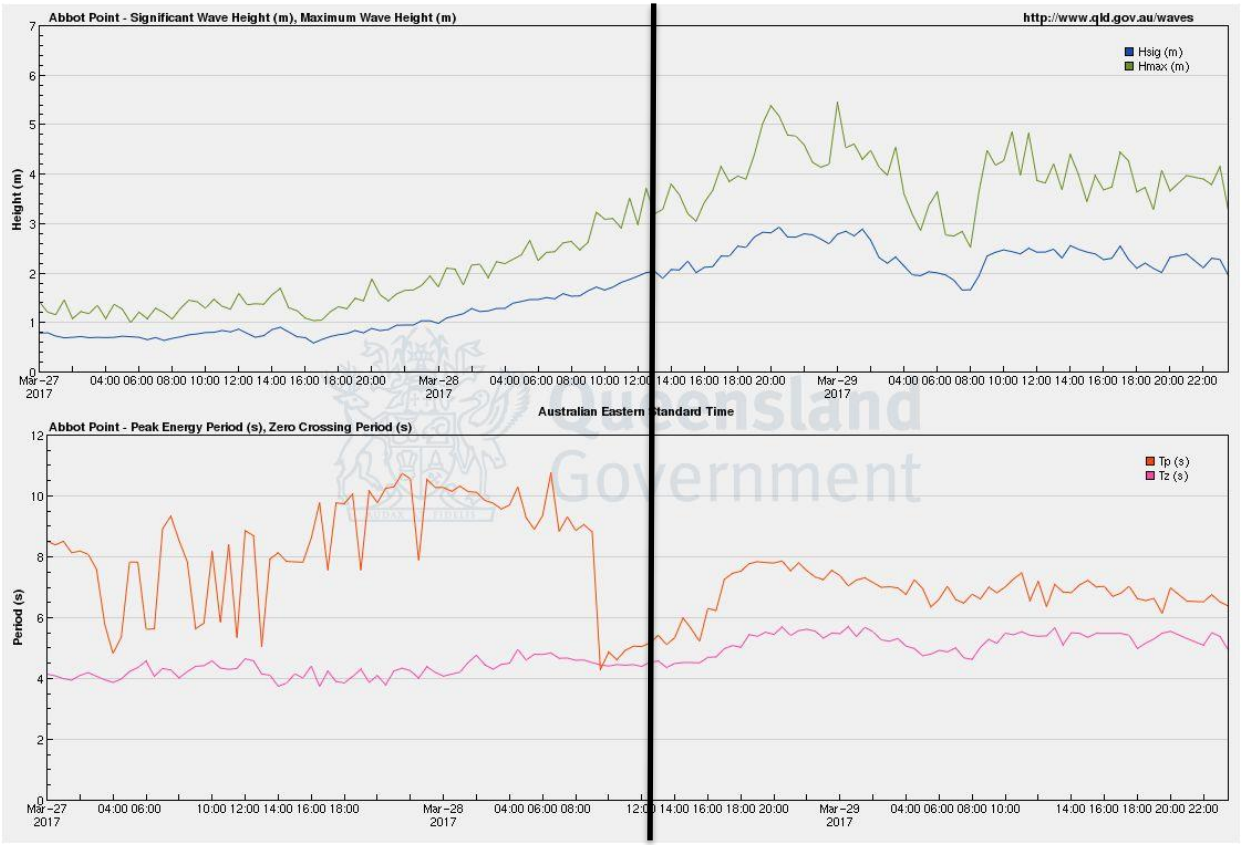
# Severe Tropical Cyclone Debbie

## Wave Height Abbot Point

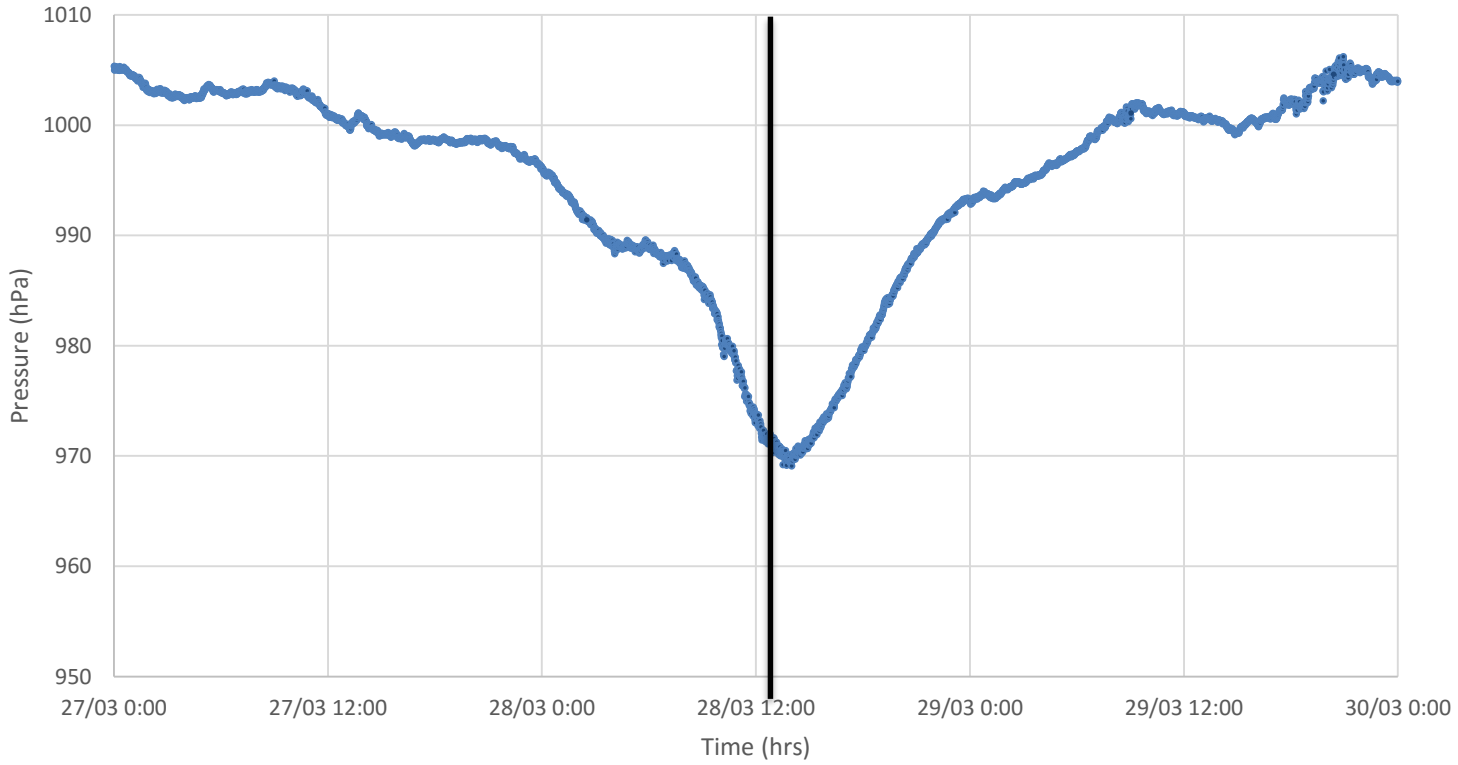
## Max wave height 5.85m



# Severe Tropical Cyclone Debbie

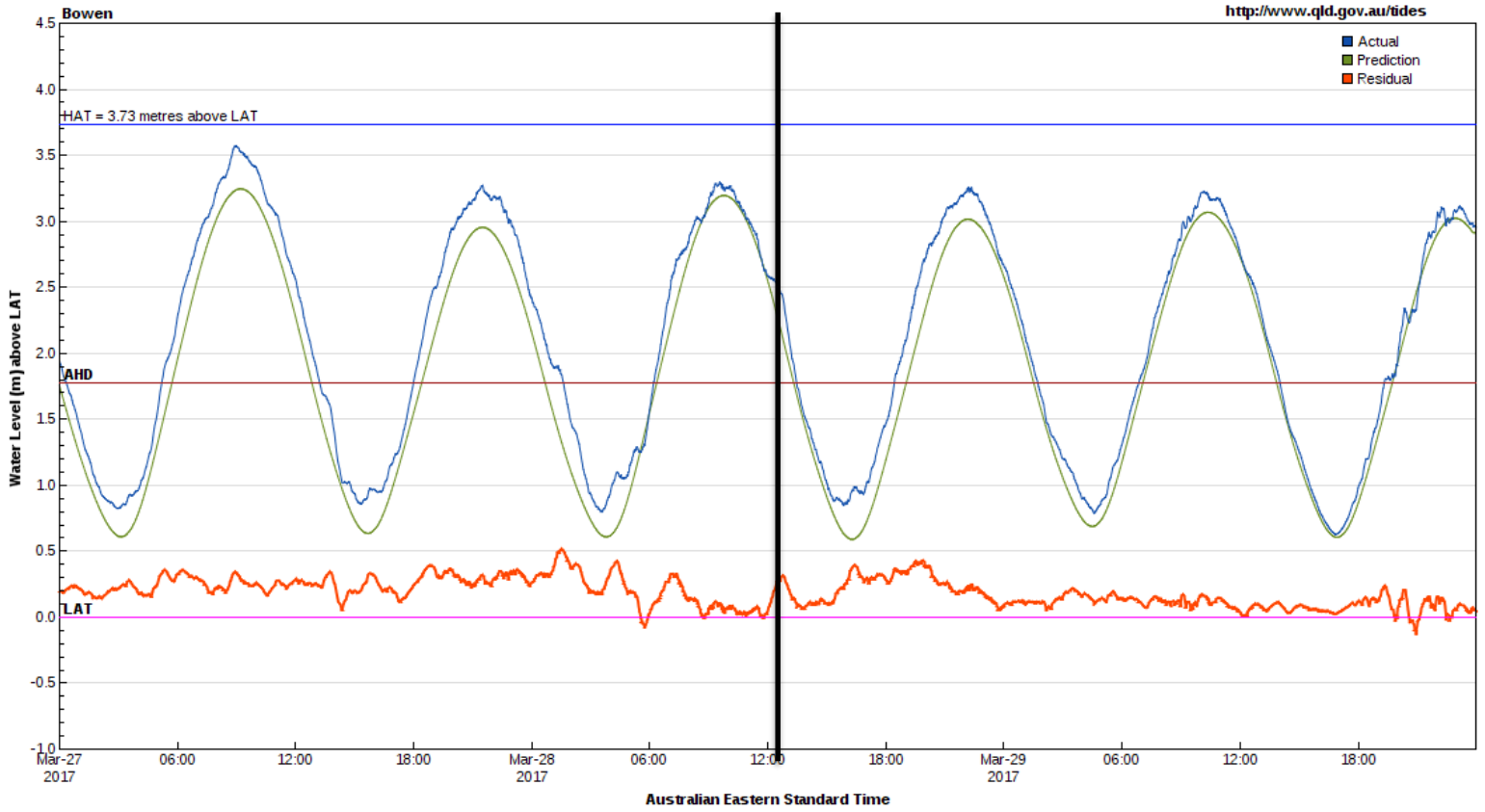
## Bowen north of cyclone eye

## Min pressure = 969 hPa, IB ~ 0.43m



# Severe Tropical Cyclone Debbie

## Bowen Surge: 0.52m

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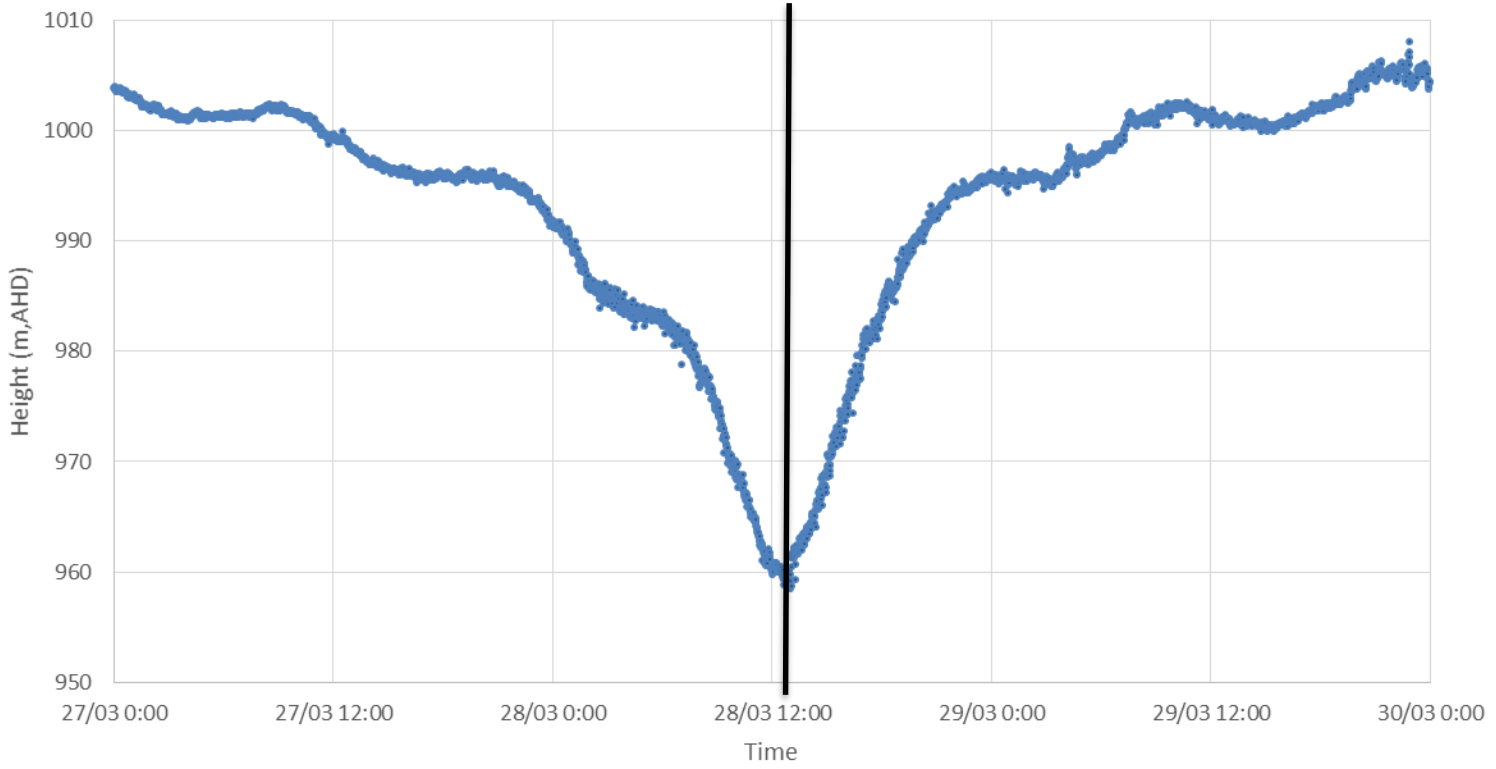
# Severe Tropical Cyclone Debbie

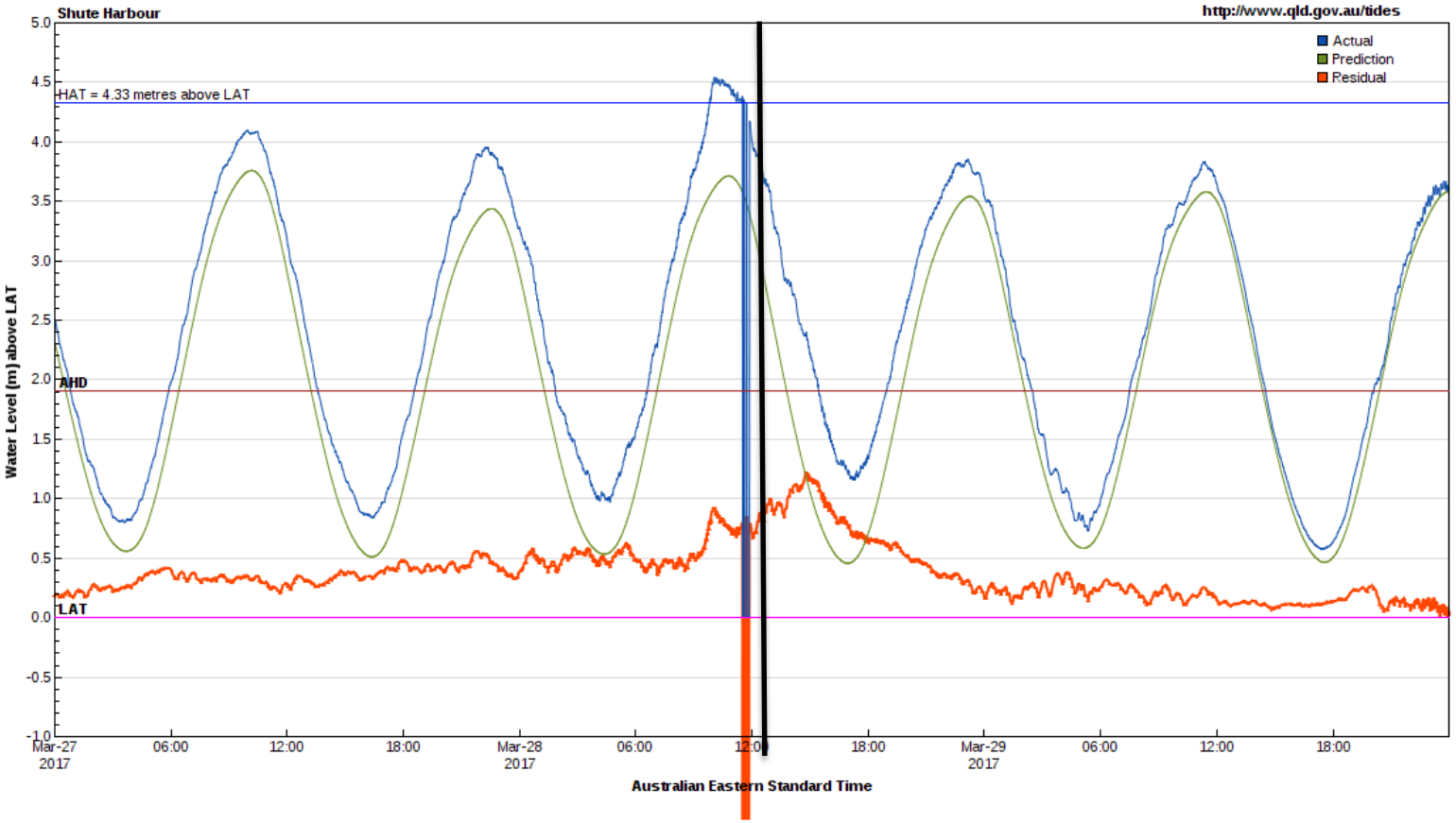
## Shute Harbor south of cyclone eye

## Min pressure = 957 hPa, IB ~ 0.56m



# Severe Tropical Cyclone Debbie

## Shute Harbour Surge: 1.23m

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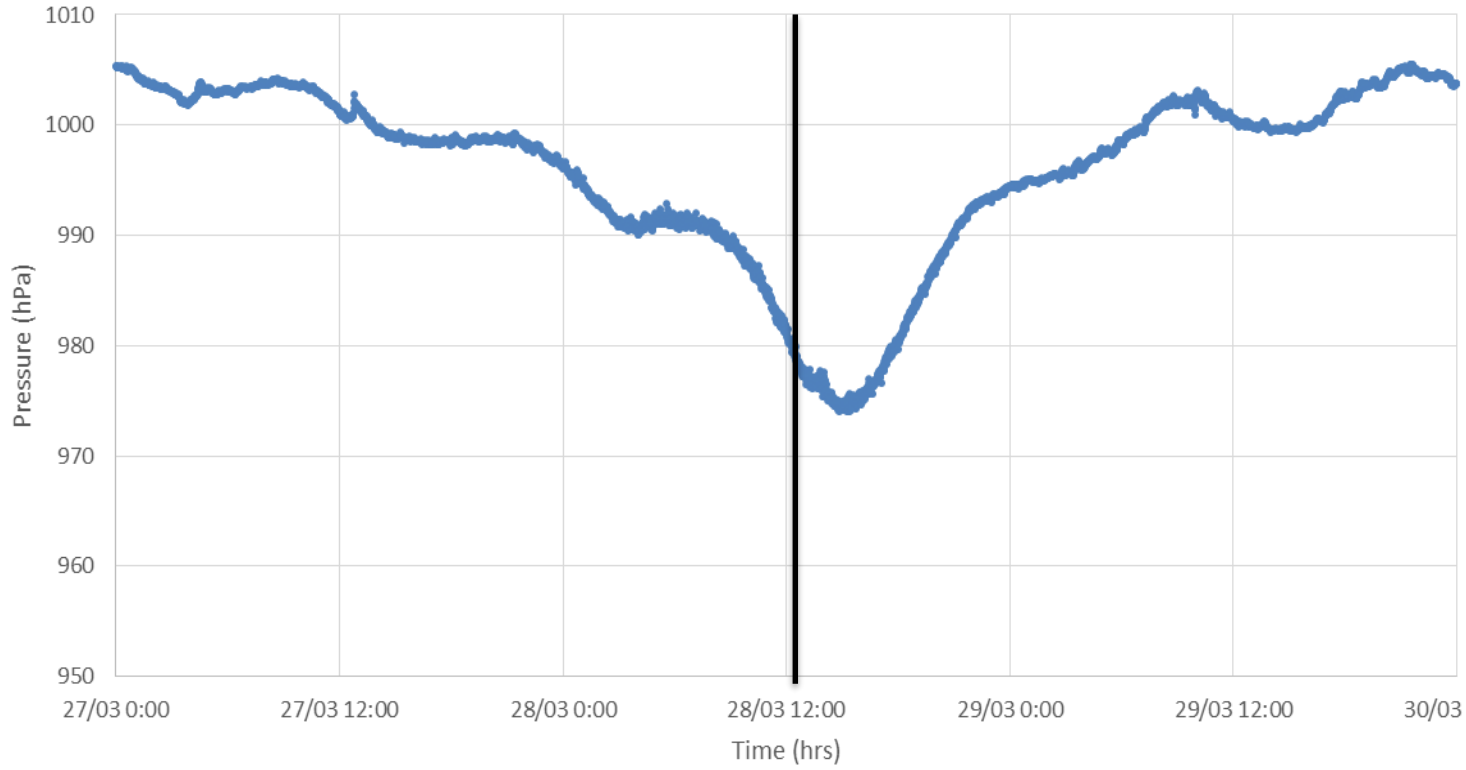
# Severe Tropical Cyclone Debbie

## Laguna Quays south of cyclone eye

## Min pressure = 974 hPa, IB ~ 0.39m

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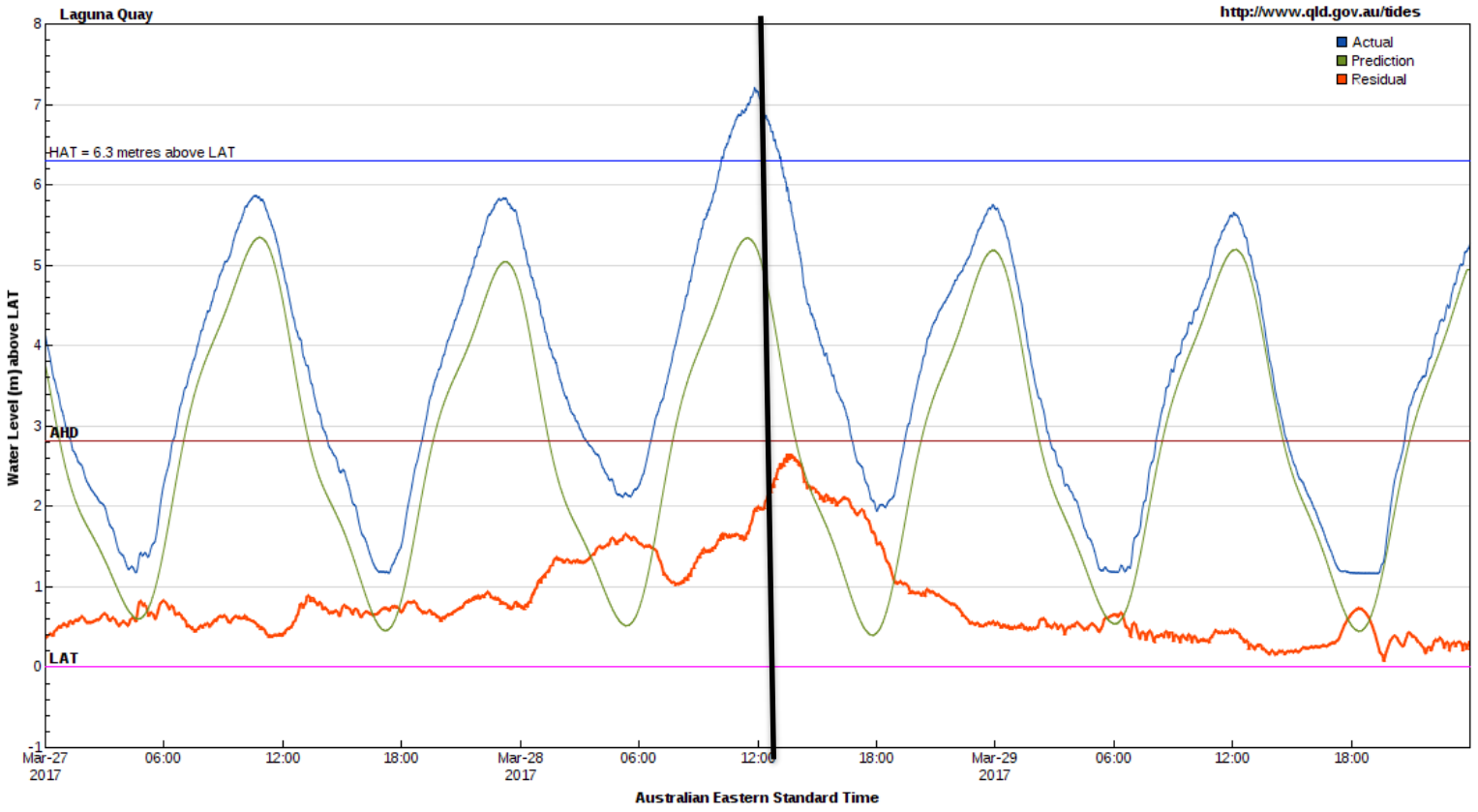
# Severe Tropical Cyclone Debbie

## Laguna Quays Surge: 2.66m

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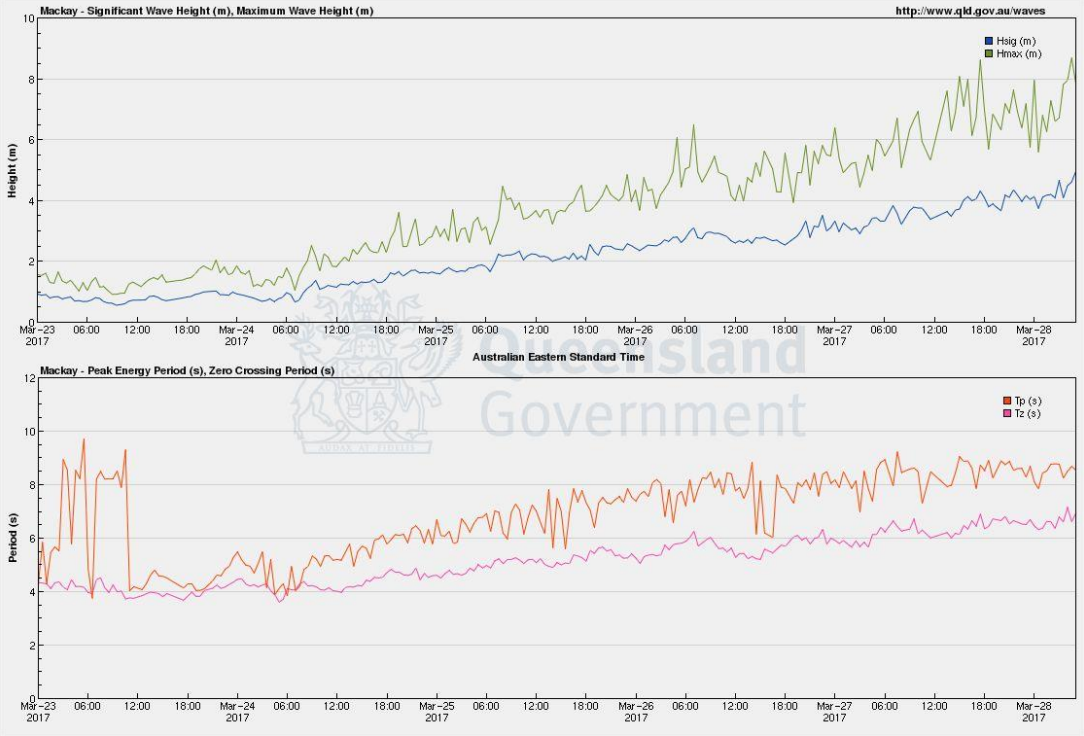
# Severe Tropical Cyclone Debbie

## Wave Height Mackay

## Max height: 8.67m

## Catastrophic failure just before landfall

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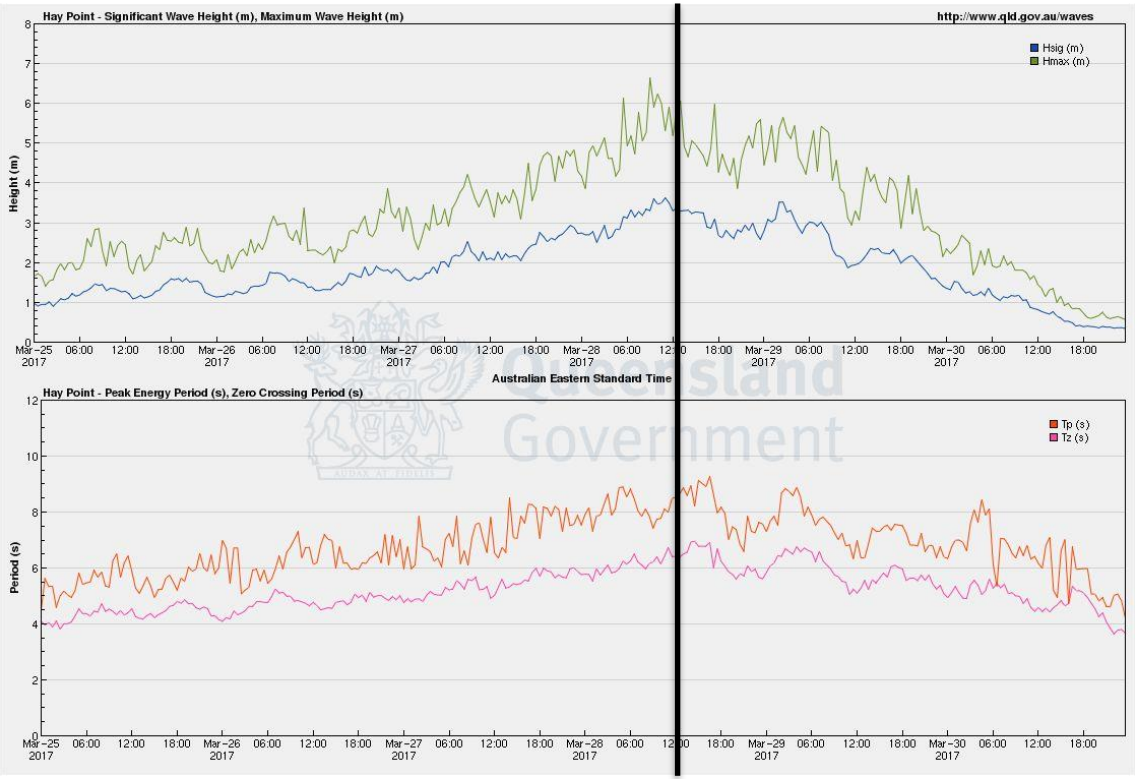
# Severe Tropical Cyclone Debbie

## Wave Height Hay Point

## Max Height: 6.63m at landfall

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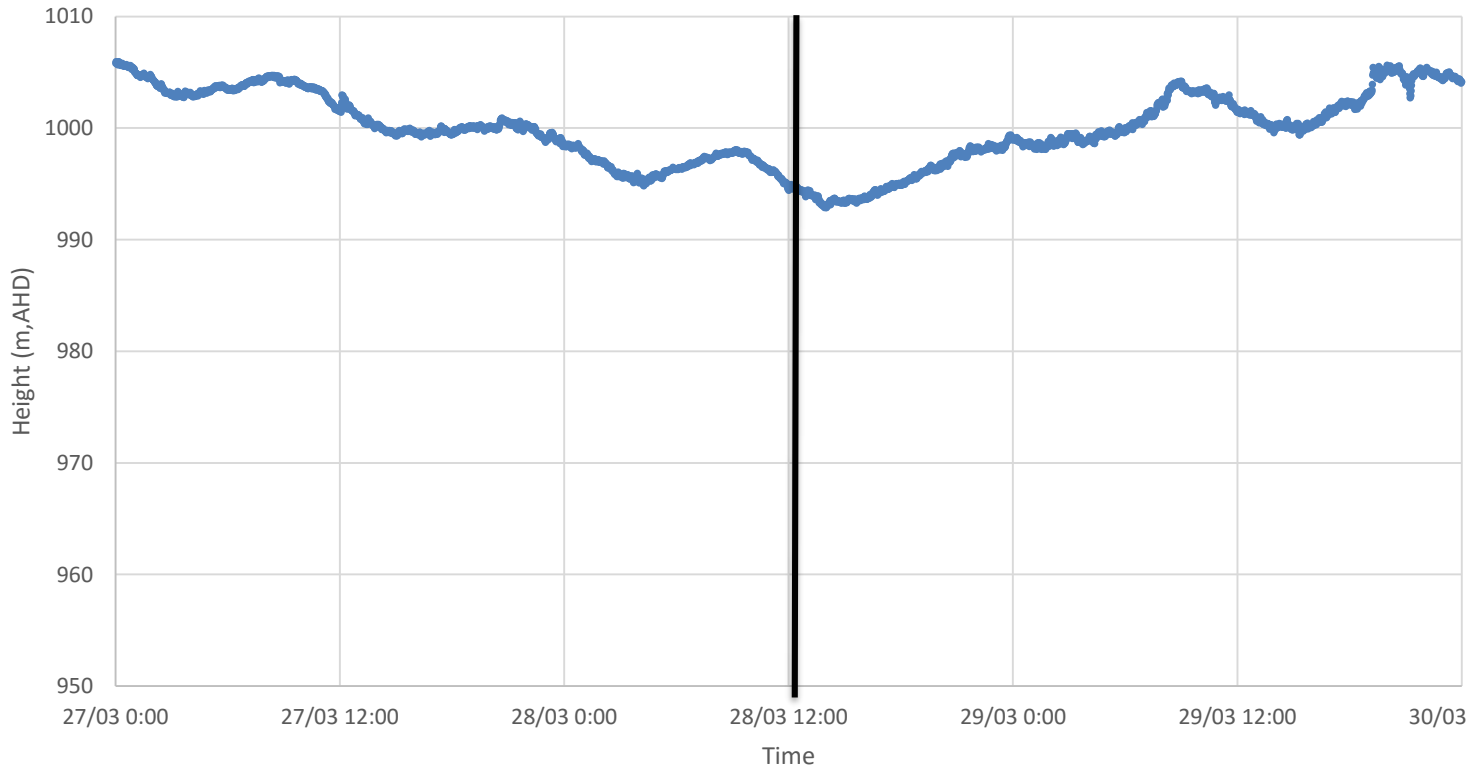
# Severe Tropical Cyclone Debbie

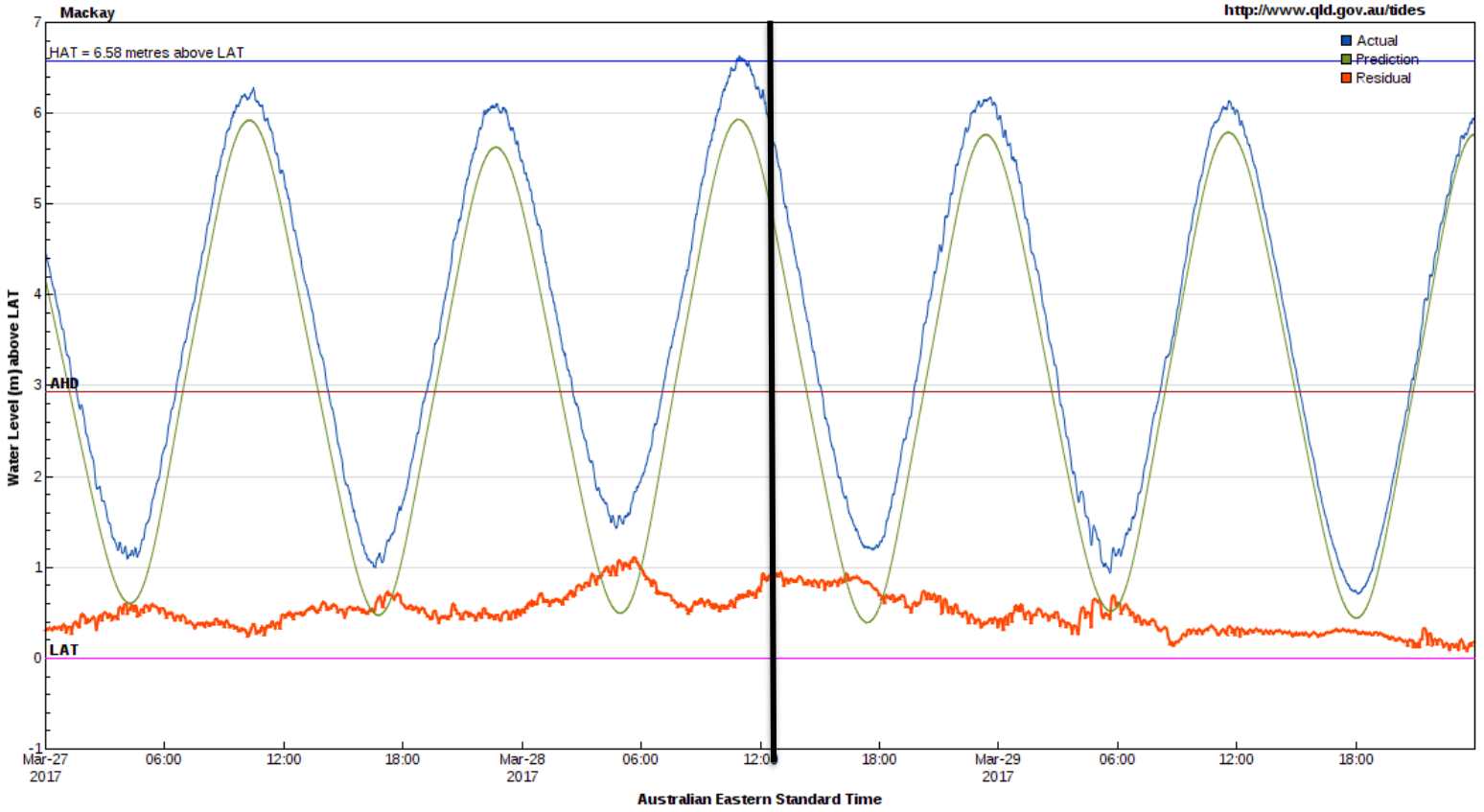
## Mackay south of cyclone eye

## min pressure = 992 hPa, IB ~ 0.21m



# Severe Tropical Cyclone Debbie

## Mackay Surge: 1.11m

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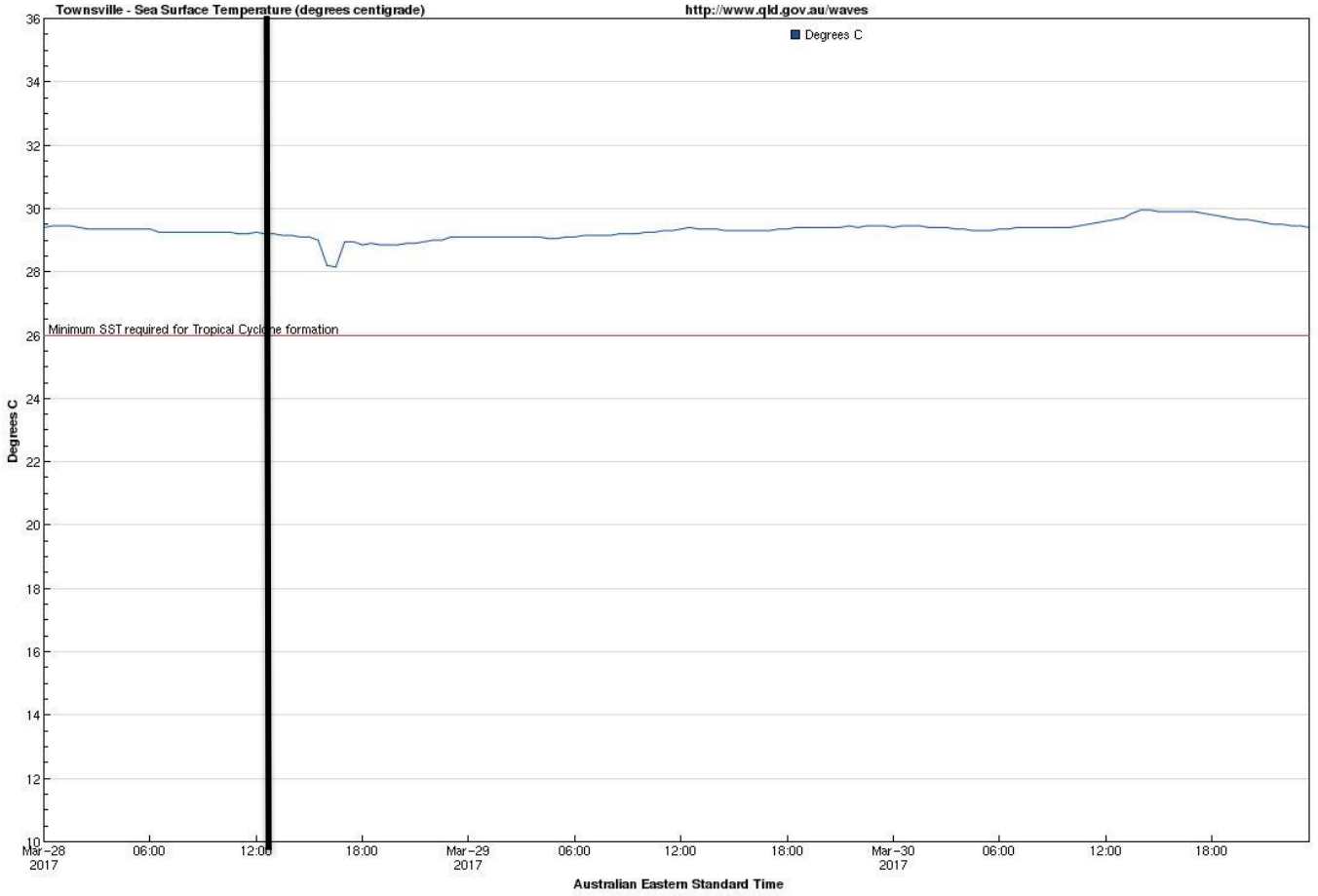
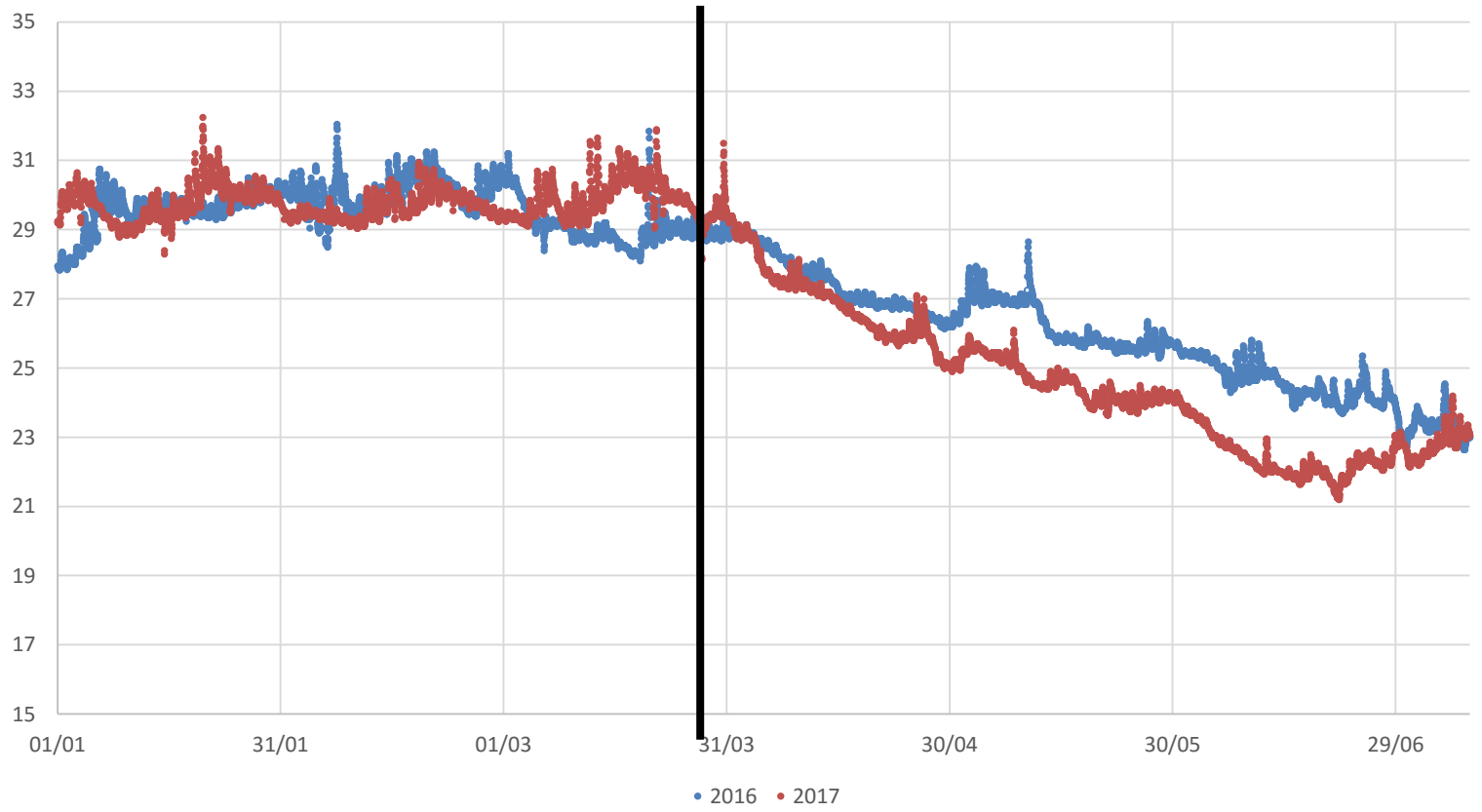
# Severe Tropical Cyclone Debbie

## Cool Wake, SST Townsville



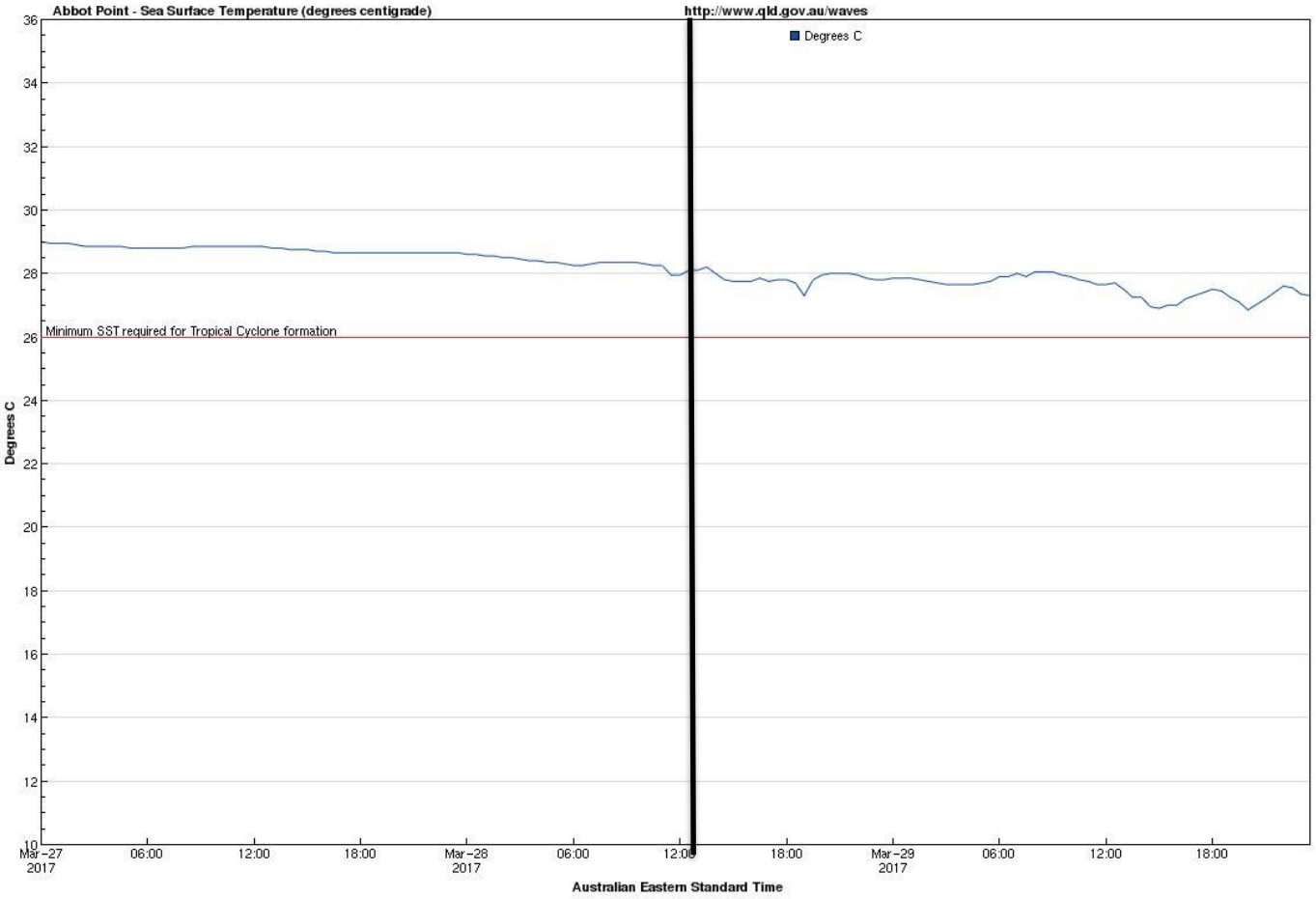
# Severe Tropical Cyclone Debbie

## SST Townsville 2016-17



# Severe Tropical Cyclone Debbie

## Cool Wake, SST Abbot Point



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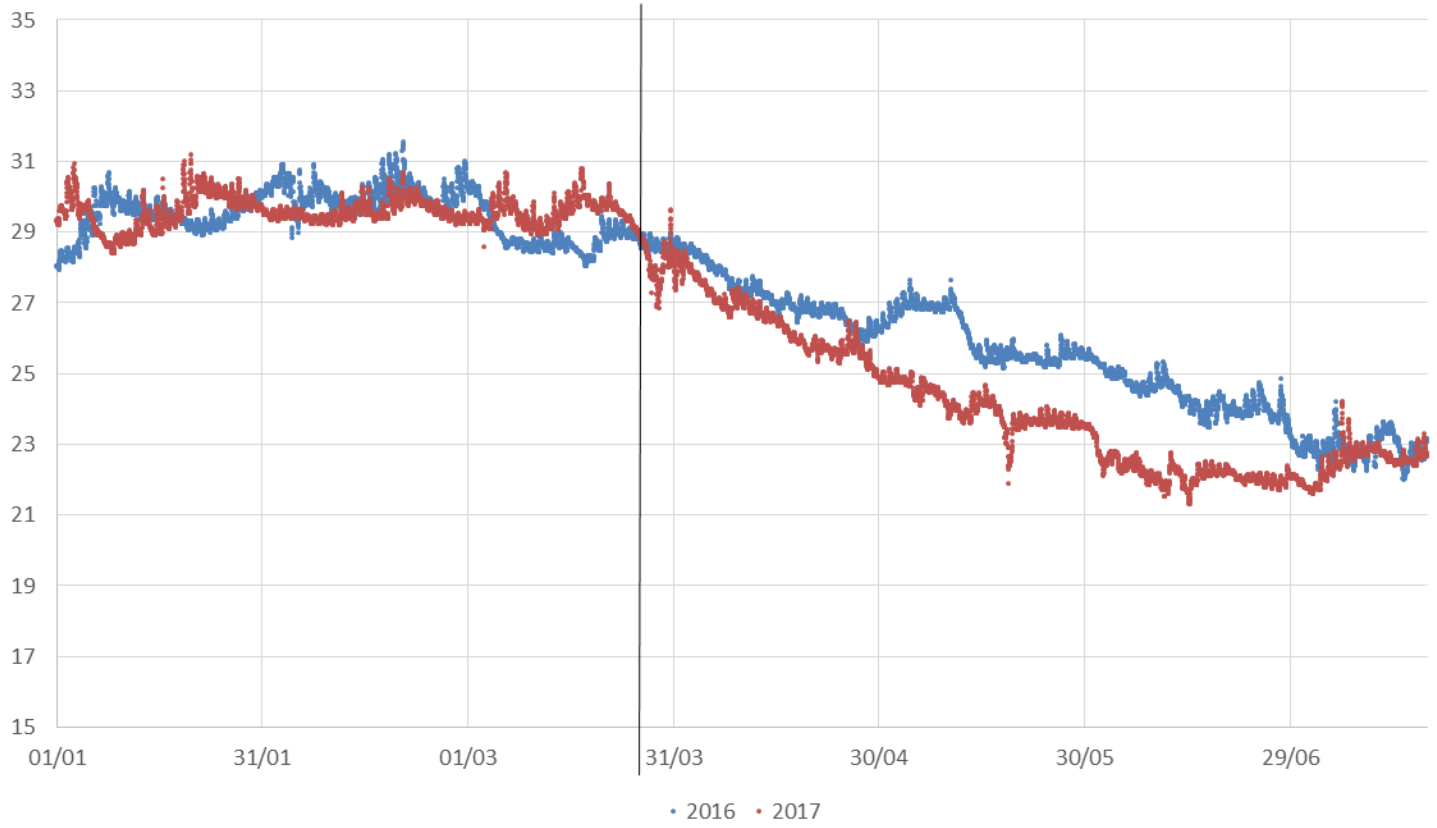
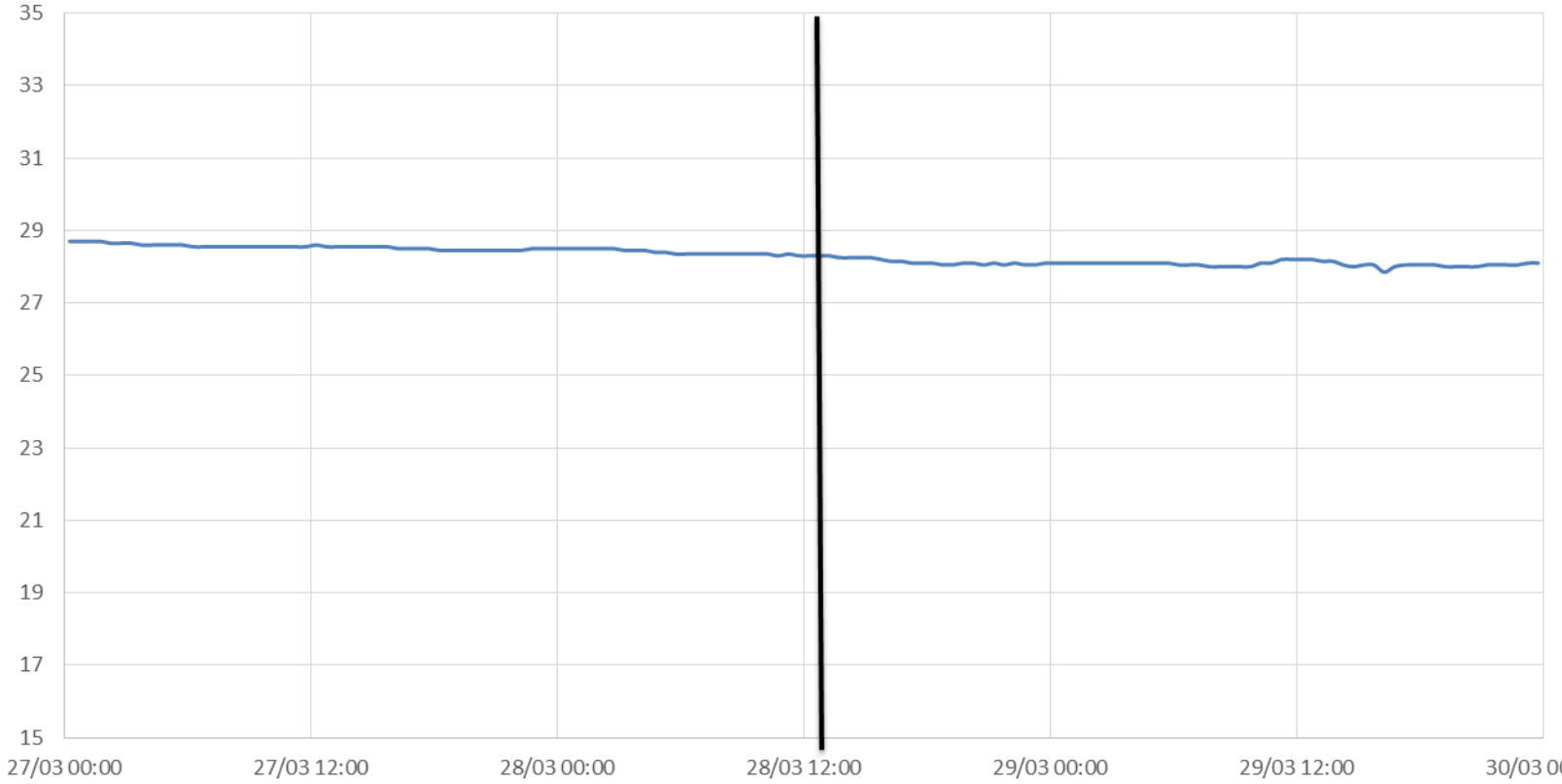


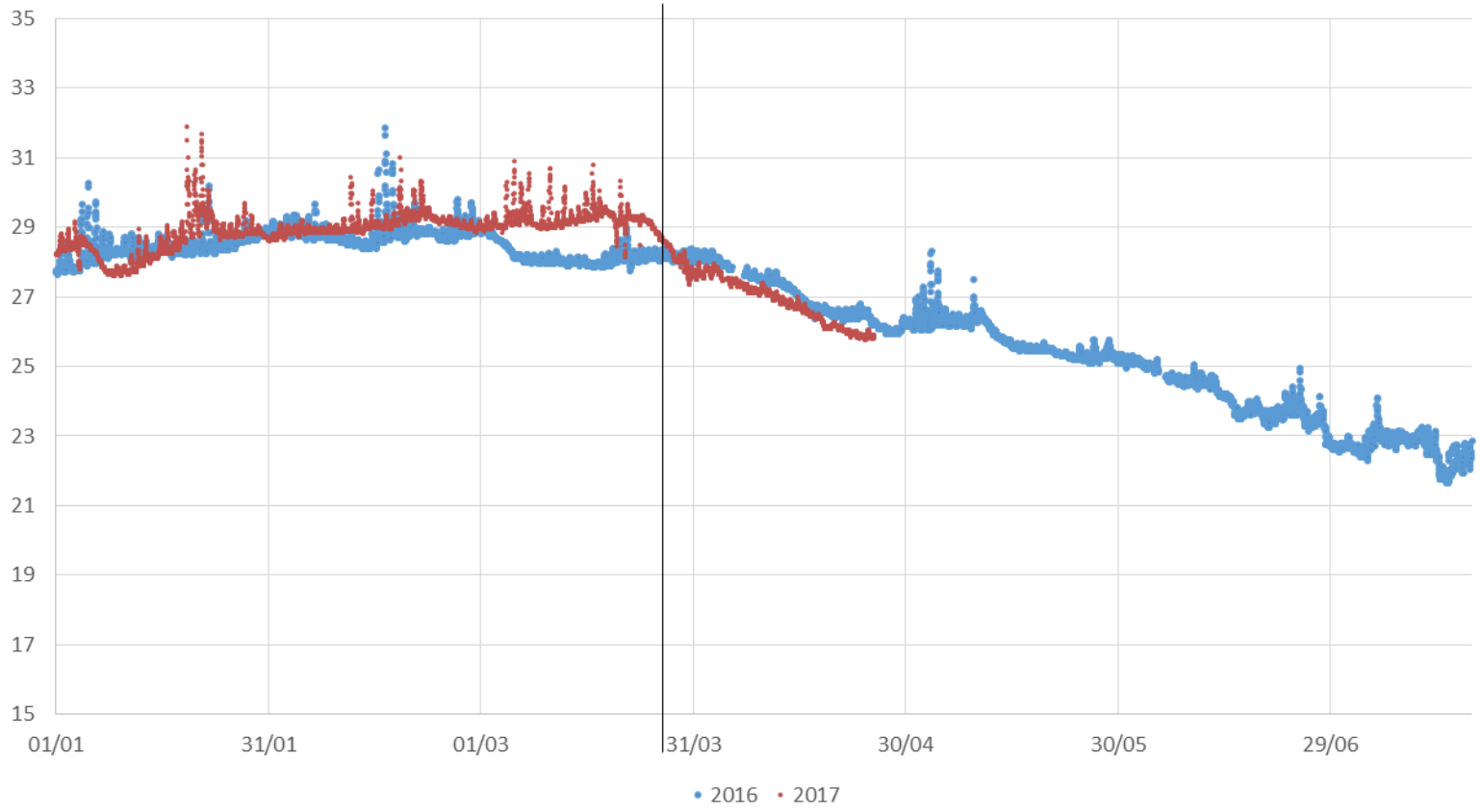
# Severe Tropical Cyclone Debbie

## Cool Wake, SST Mackay



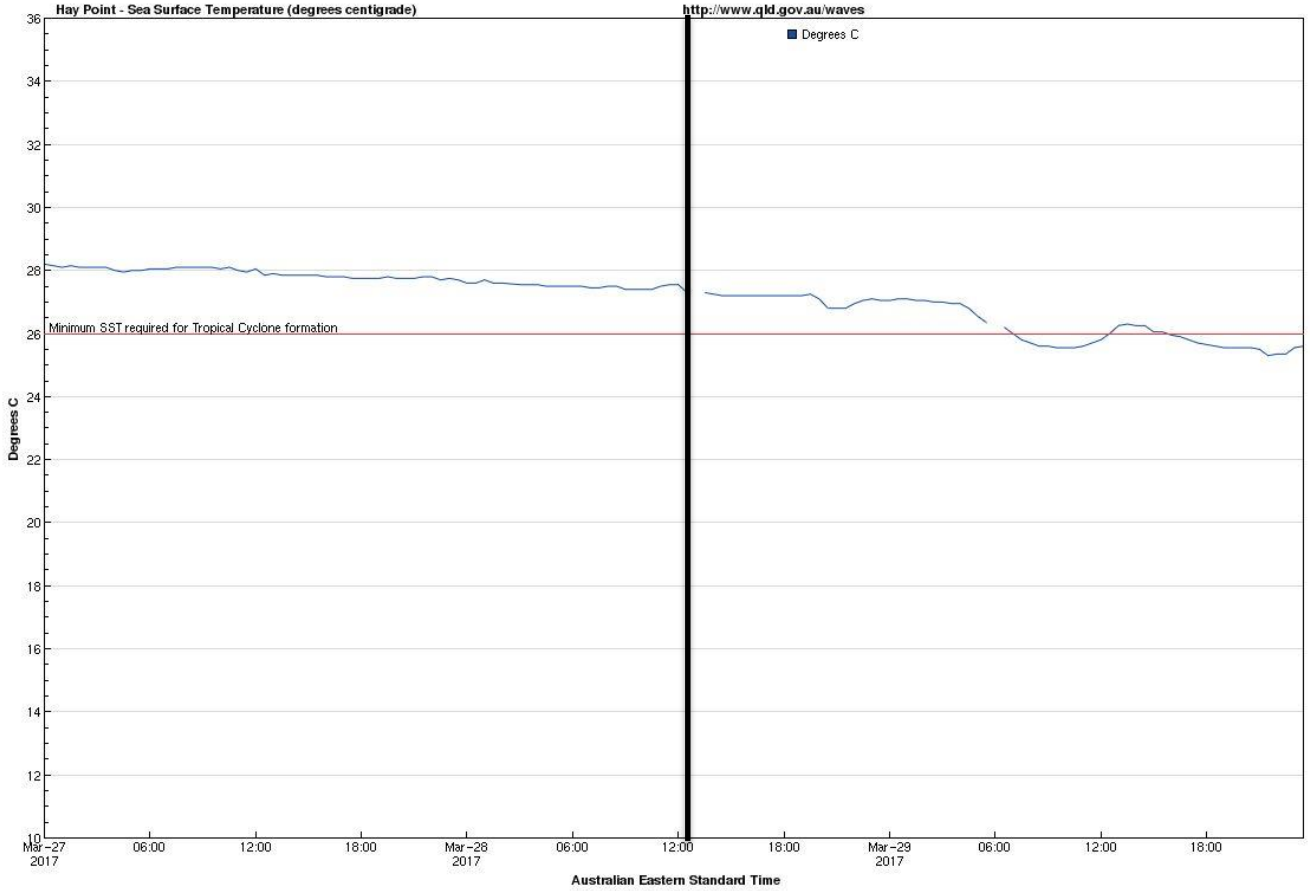
# Severe Tropical Cyclone Debbie

## SST Mackay 2016-17



# Severe Tropical Cyclone Debbie

## Cool Wake, SST Hay Point

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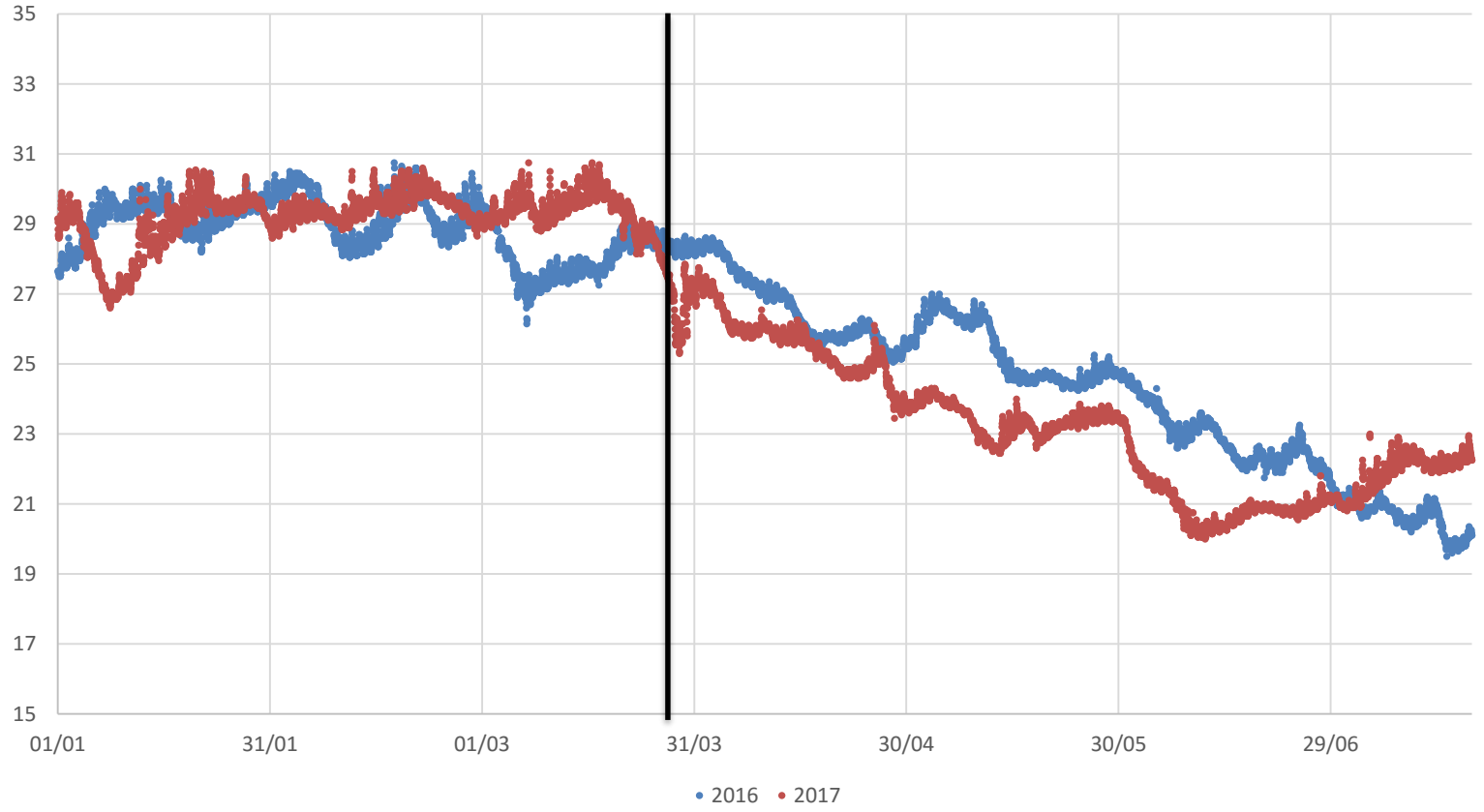
# Severe Tropical Cyclone Debbie

## SST Hay Point 2016-17



# Severe Tropical Cyclone Debbie

- **Learnings from this analysis**
- Surge height is mostly influenced by inverse barometer, site orientation and wind speed/direction. Site selection is important to capture largest surge.
- Need for denser network of storm tide gauges
- Moored wave buoys often miss the zone of maximum winds
- Need to capture wave data spatially across TC by other means

# Severe Tropical Cyclone Debbie

Future works:

- Lite tide gauges
- Clamp onto marker beacons
- Deploy 2-3 days prior to landfall

# Severe Tropical Cyclone Debbie

Future works:

- Lite tide gauges
- Investigating latest wave measuring tech including:
  - Drifting buoys alternative to BoB

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  - Microwave shore based sensors

# Severe Tropical Cyclone Debbie

Future works:

- Lite tide gauges
- Investigating latest wave measuring tech including:
  - Drifting buoys alternative to BoB
  - Wave glider, AIMS trial
  - Microwave shore based sensors
  - Scoping study into new wave measuring instrumentation

# Additional Information

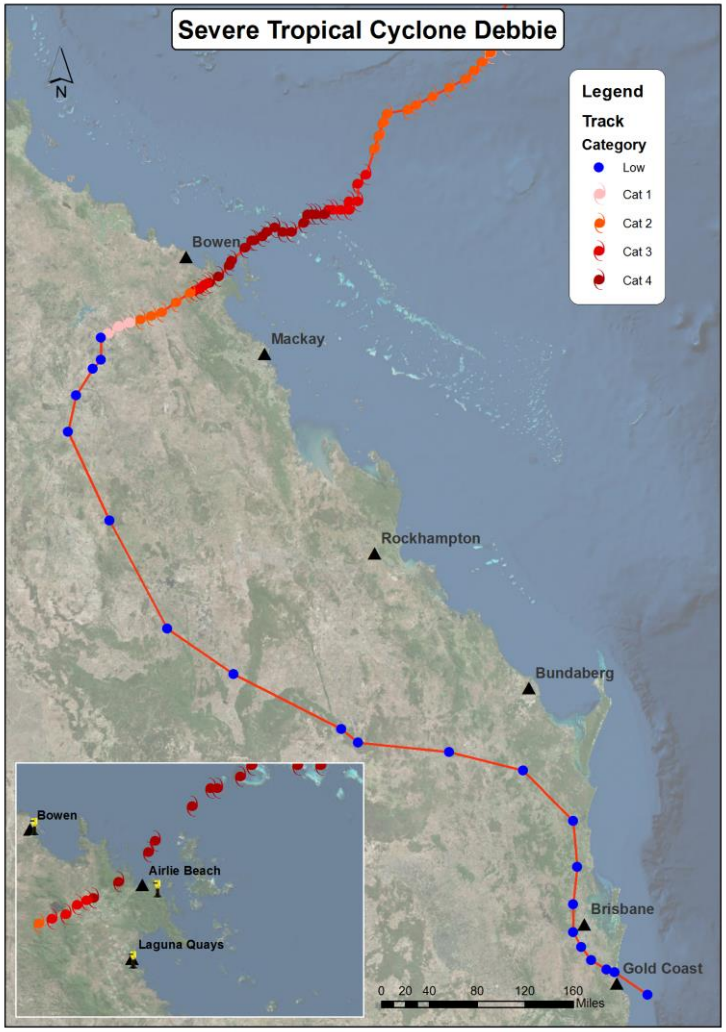
- General information on Tides and Surges
  - Pugh and Woodworth, Sea-Level Science 2013
- Queensland Government Website
  - Storm Tide Gauge Data:

    https://www.qld.gov.au/tides
  - Wave Buoy Data:

    https://www.qld.gov.au/waves

# Severe Tropical Cyclone Debbie

## Modelled (Estimated) Track

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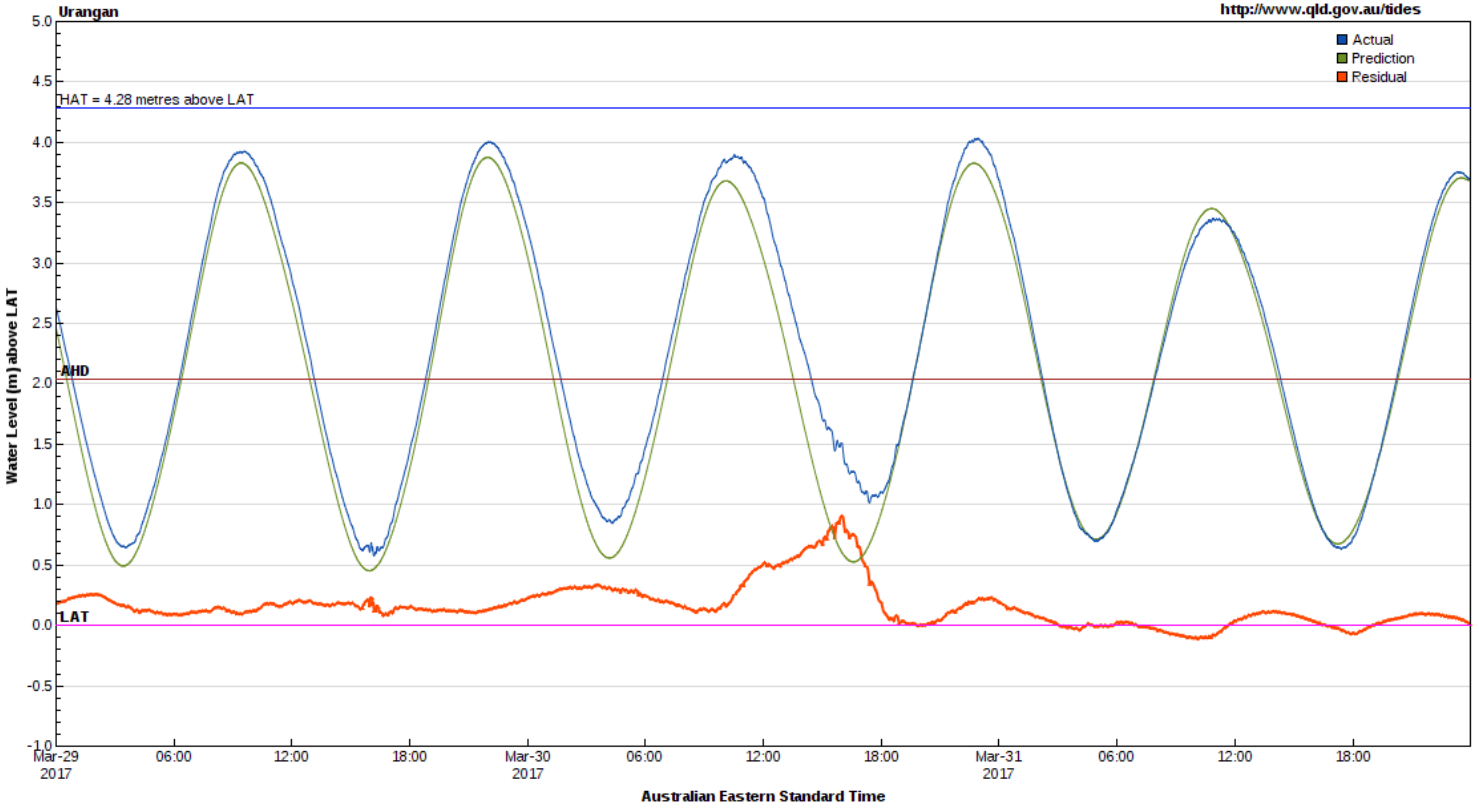
# Ex – STC Debbie

- Surge recorded along the South East Queensland Coast
- Gauge coverage is more dense
- Extreme wave conditions from Bundaberg to the QLD/NSW border

# Ex – STC Debbie

## Urangan Boat Harbour

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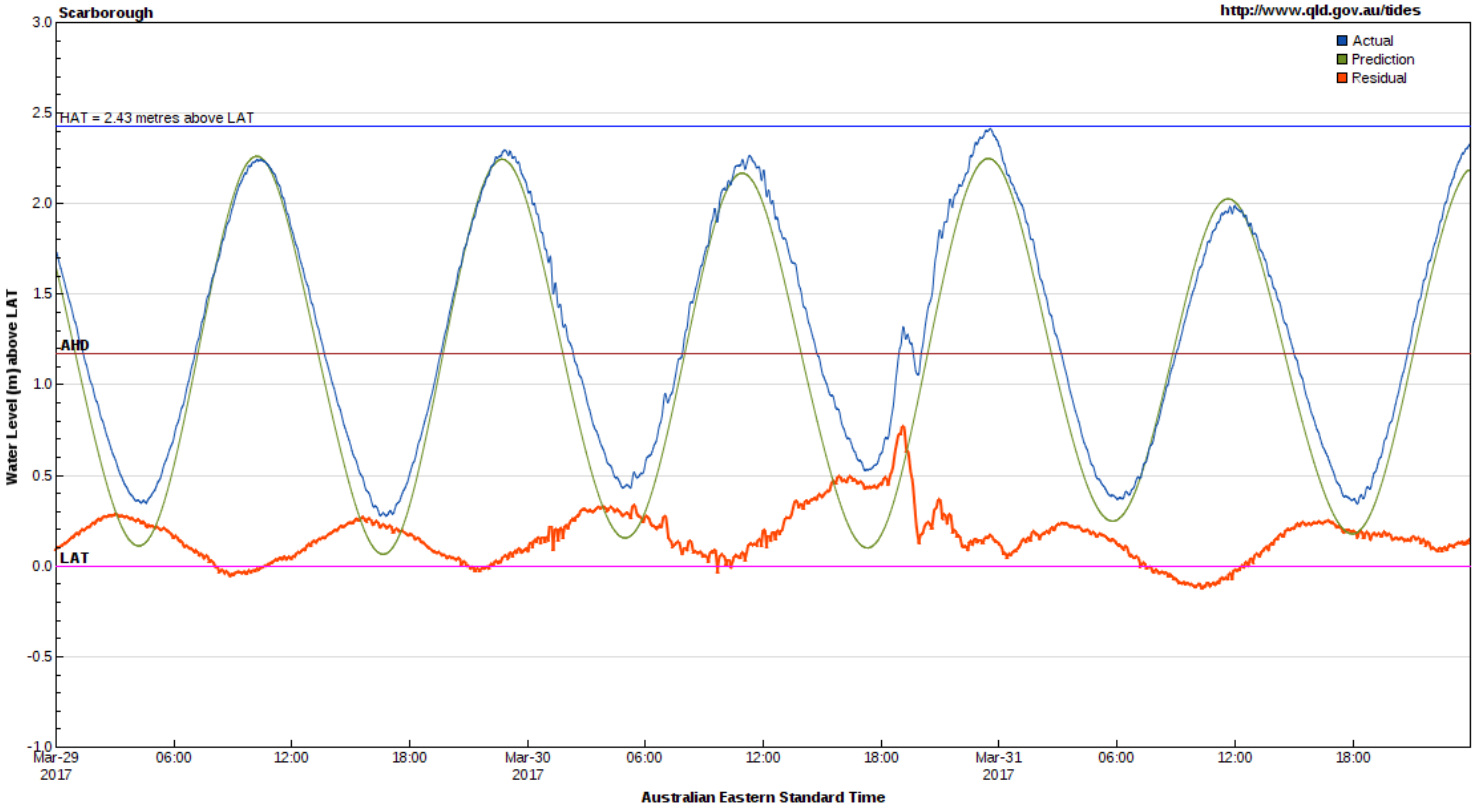
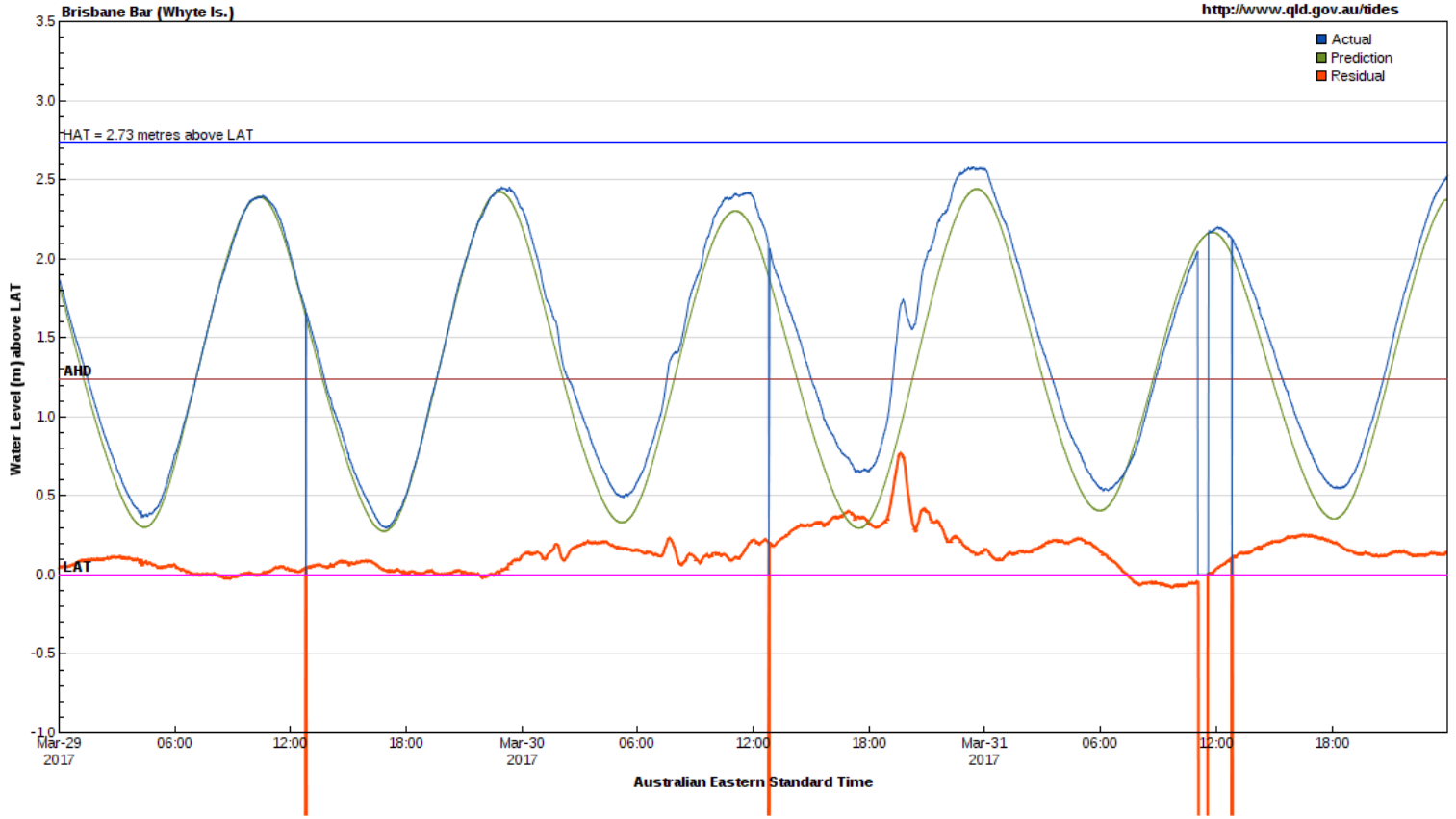
# Ex – STC Debbie

## Moreton Bay > Scarborough Boat Harbour



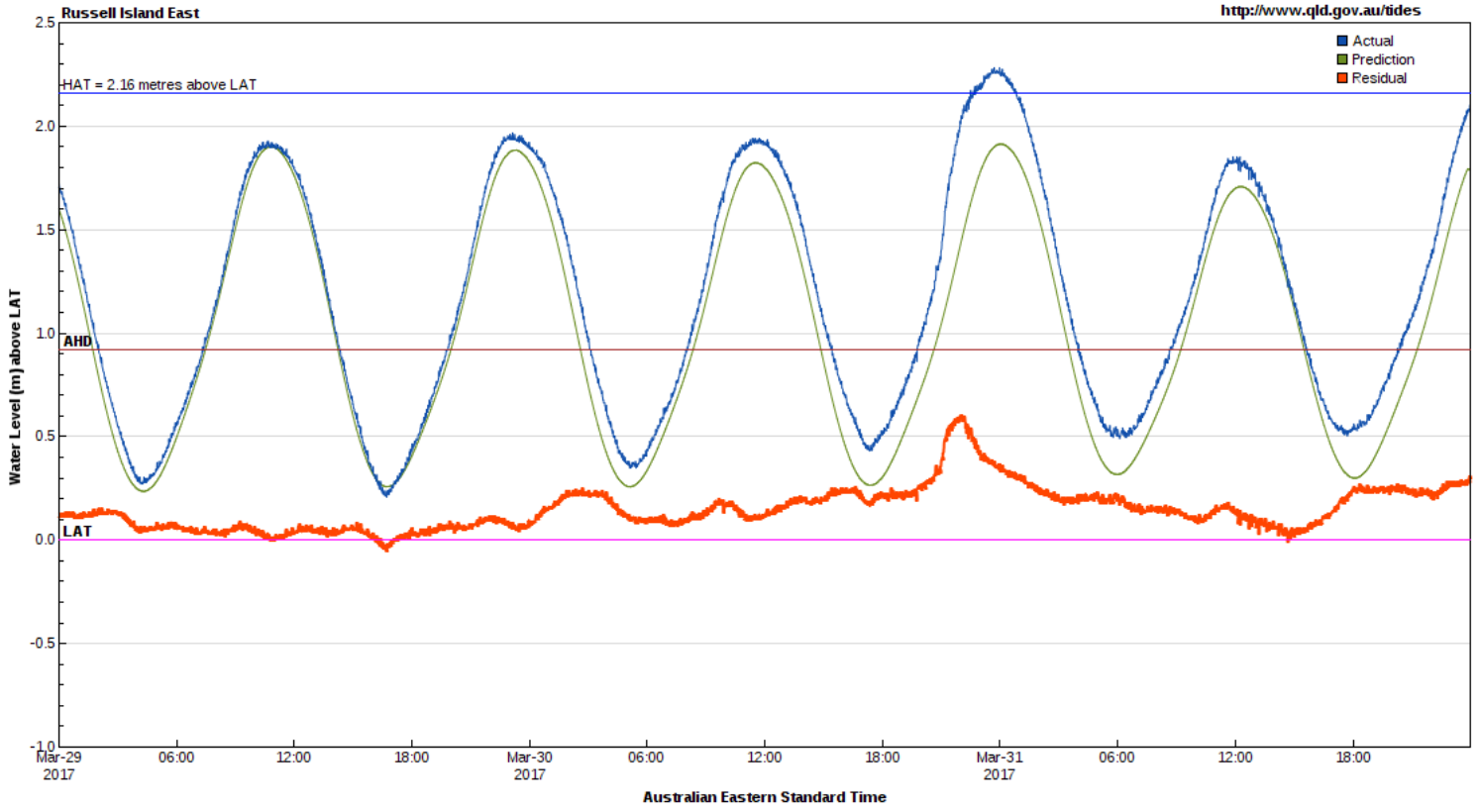
# Ex – STC Debbie

## Moreton Bay > Brisbane Bar



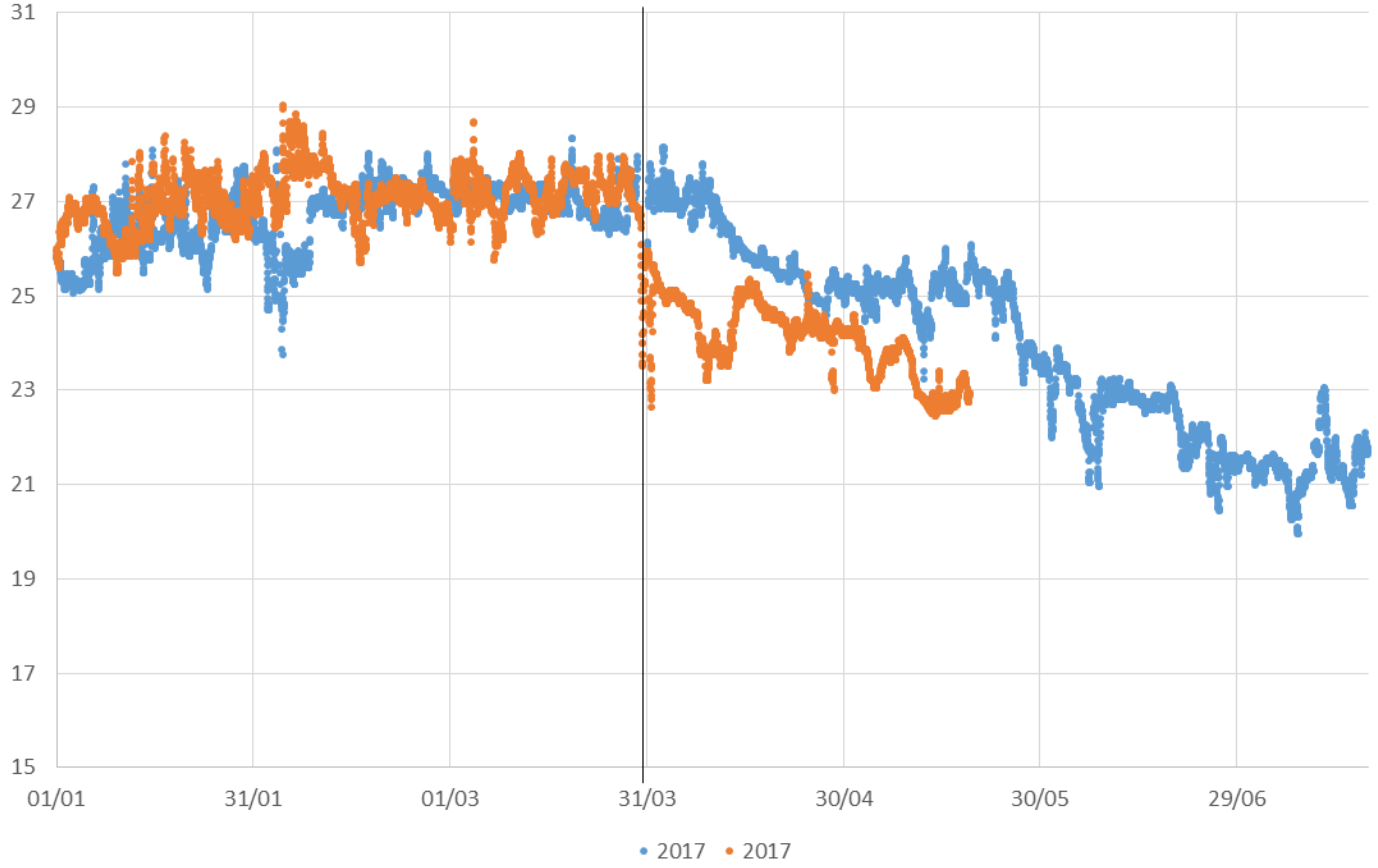
# Ex – STC Debbie

## Moreton Bay > Russell Island East



# Ex – STC Debbie

## Brisbane SST 2016-17



# Severe Tropical Cyclone Debbie

- Summary
  - Changing atmospheric pressure + extreme wind stress >> results in storm surge and inundation
  - Extreme wind stress over time generates large swell and seas
  - Sea surface temperature response to severe wind stress results in cool wake