

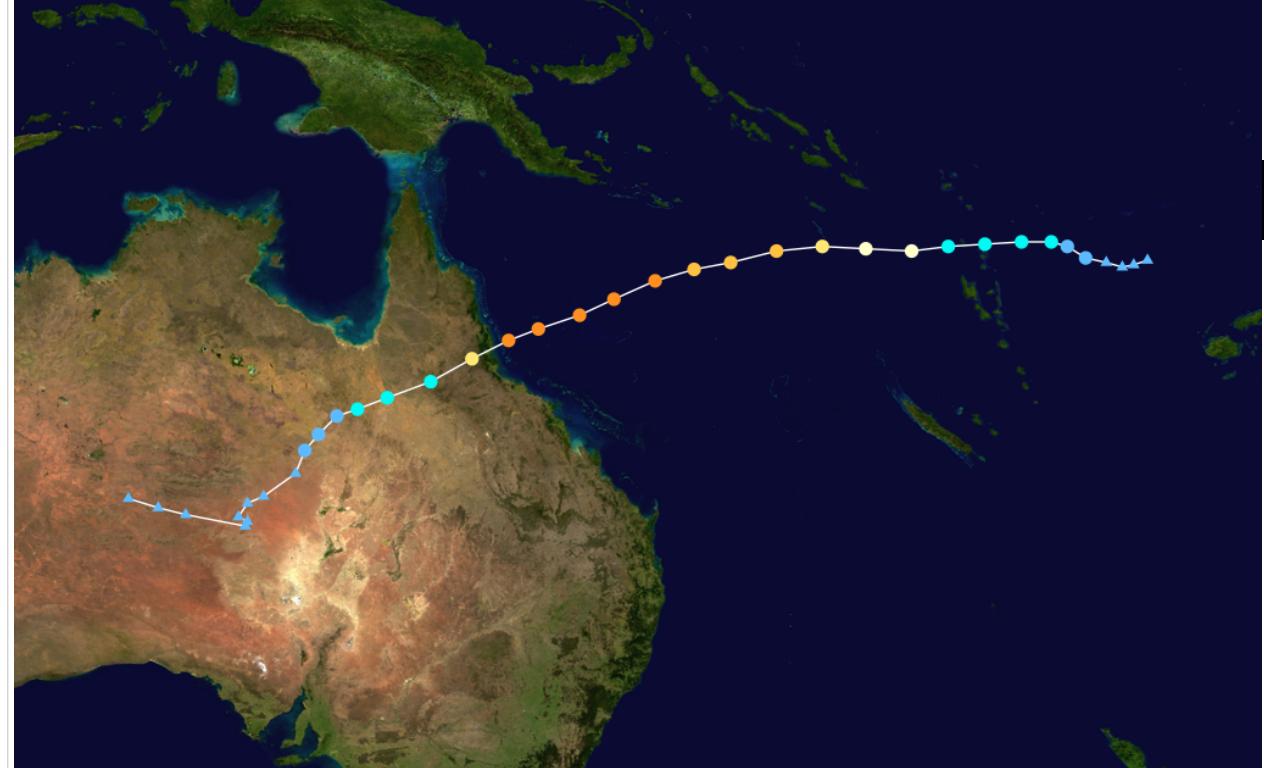


# Observed tropical cyclone Yasi from Jason-1 & Jason-2

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# Introduction



- Severe Tropical Cyclone Yasi in early February 2011 was the most intense cyclone that hit north Queensland, Australia since 1918.
- It began developing as a tropical low northwest of Fiji on 29 January and started propagating on a general westward track.
- Yasi maintained its west-southwest movement and rapidly intensified from a Category 2 to Category 5 when making landfall on the north Queensland coast near Mission Beach between midnight and 1am early on 3 February (14:00 UTC on 2 February).

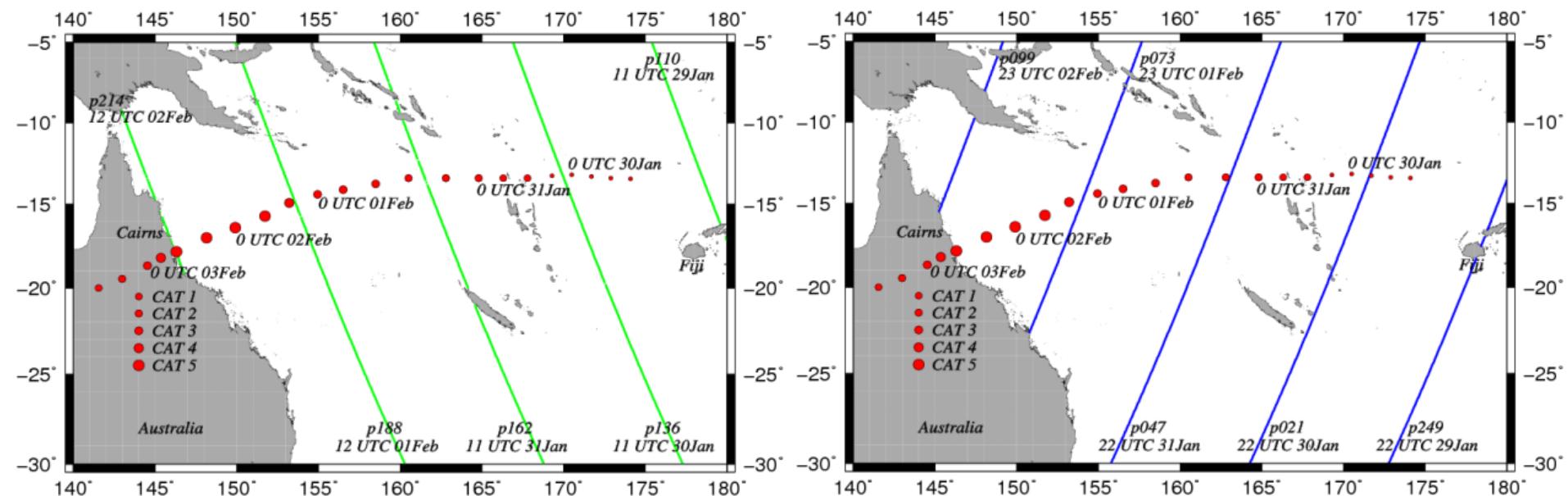
# Introduction (Cont.)

- Yasi has caused \$800 million in losses.



# Introduction (Cont.)

- Previous studies (e.g., Scharroo 2005; Yong et al. 2011) have shown that altimeter data are capable of detecting cyclones.
- Both Jason-1 and Jason2 provided important sea level measurements along several ground tracks during the Yasi period, which can be used for monitoring of this extreme event.



Selected Jason-1 (left) and Jason-2 (right) altimeter tracks during the period of Yasi from 29 Jan to 3 Feb 2011. Red dots show the tracks and intensity of the Cyclone Yasi.

# Objectives

- To demonstrate that altimeter-derived wind speed, wave height, and sea level anomalies can be used to detect tropical cyclone Yasi.
- To analyse the altimeter measurements during the cyclone.

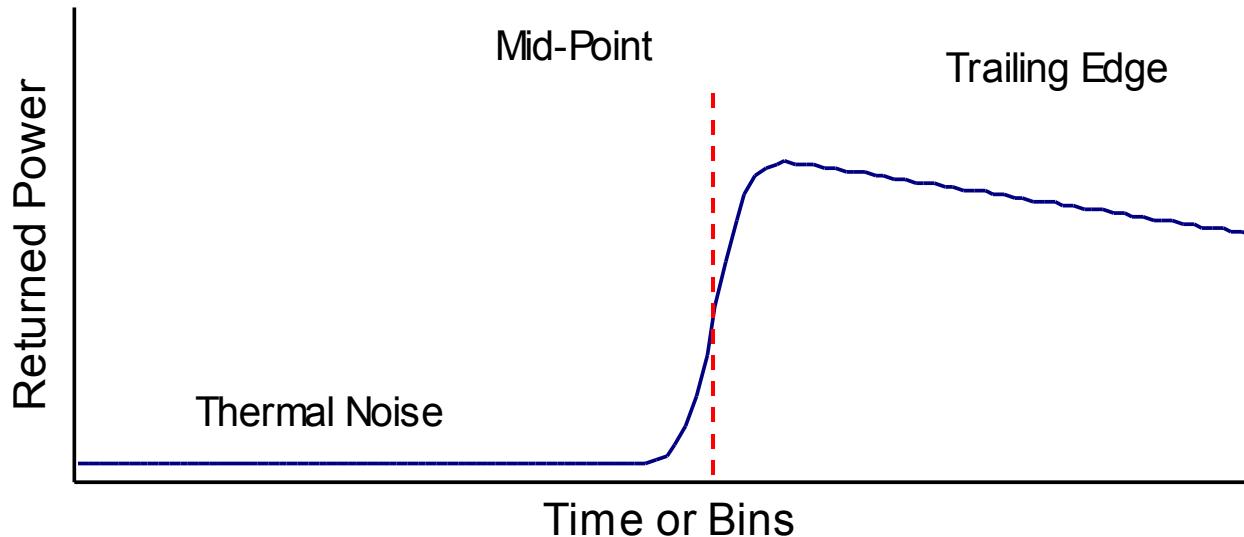
# Data

- Jason-1 altimeter Ku-band 20 Hz SGDR data from cycle 334
  - Three descending tracks: 162, 188 and 214.
- Jason-2 altimeter Ku-band 20 Hz SGDR data from cycle 095
  - Three ascending tracks: 047, 073 and 099.

# Altimeter-Derived Sea Level, Wave height and Wind Speed

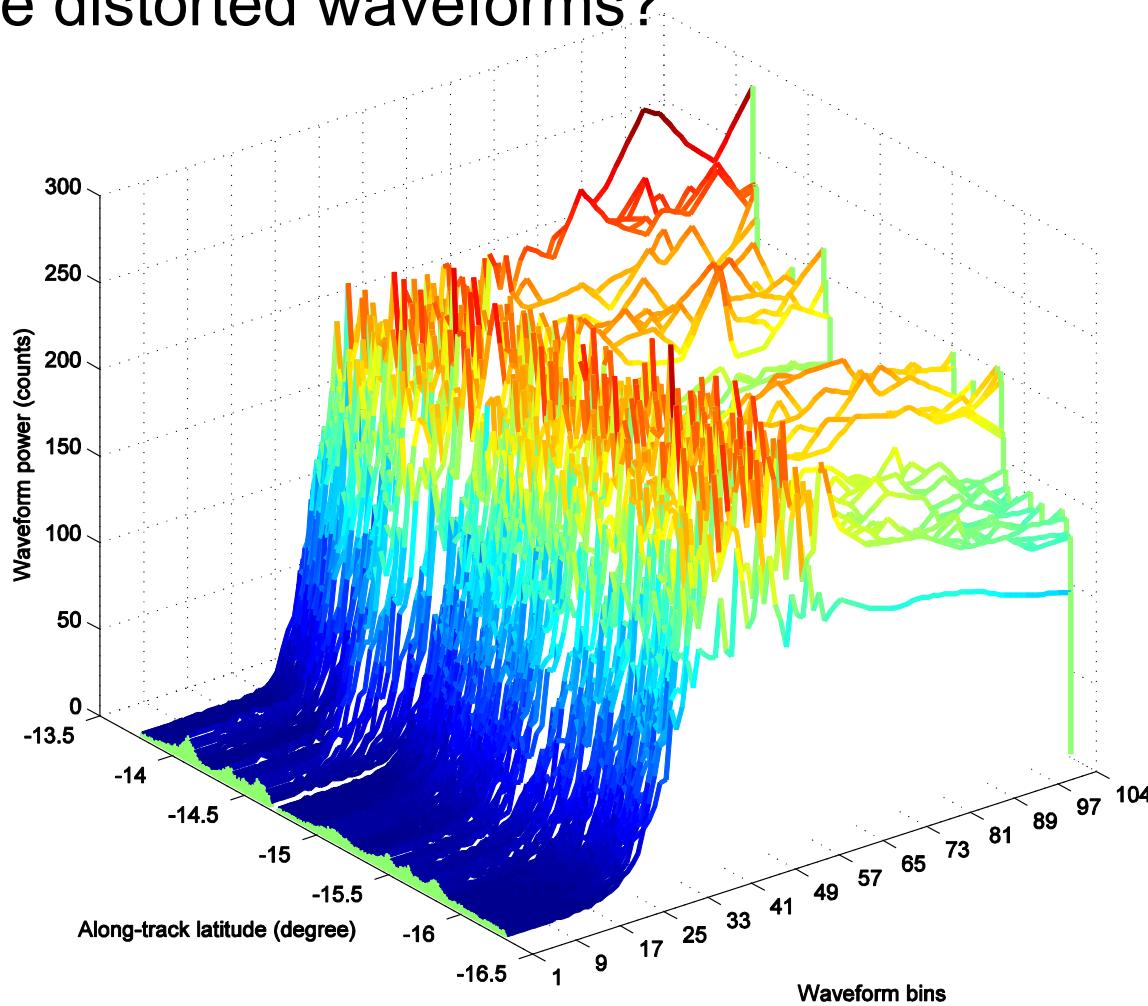
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- Sea level is inferred from the mid point on the leading edge of the waveform.
- Significant wave height is characterised by the slope of the leading edge of the waveform.
- Wind speed is estimated using the backscatter coefficient  $\sigma_0$  related to the slope of trailing edge of the waveform.



# Distorted Waveforms

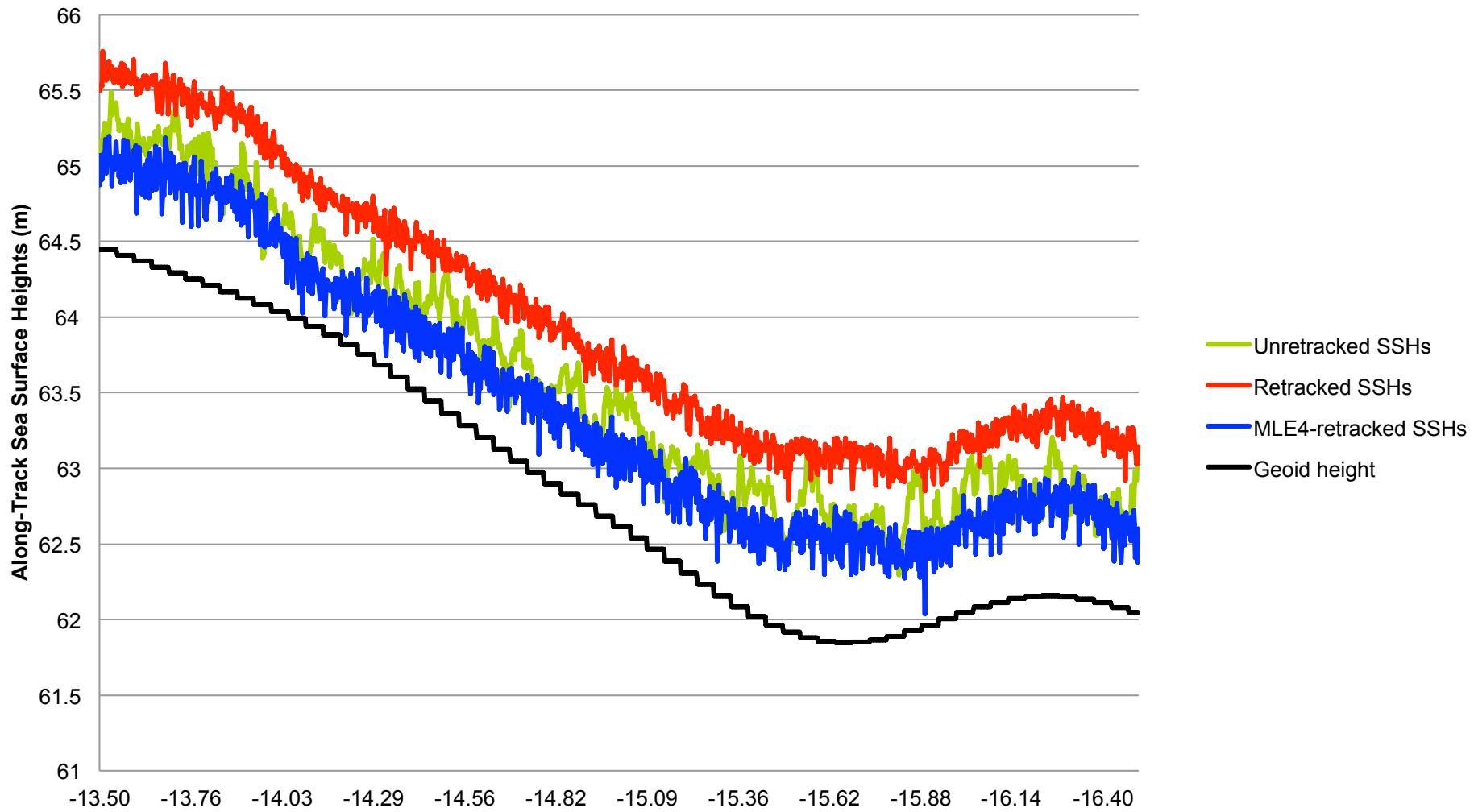
- Ku-band radar data can be affected by heavy rain associated with the storm.
- Q: how can altimeter parameters be accurately retrieved from these distorted waveforms?



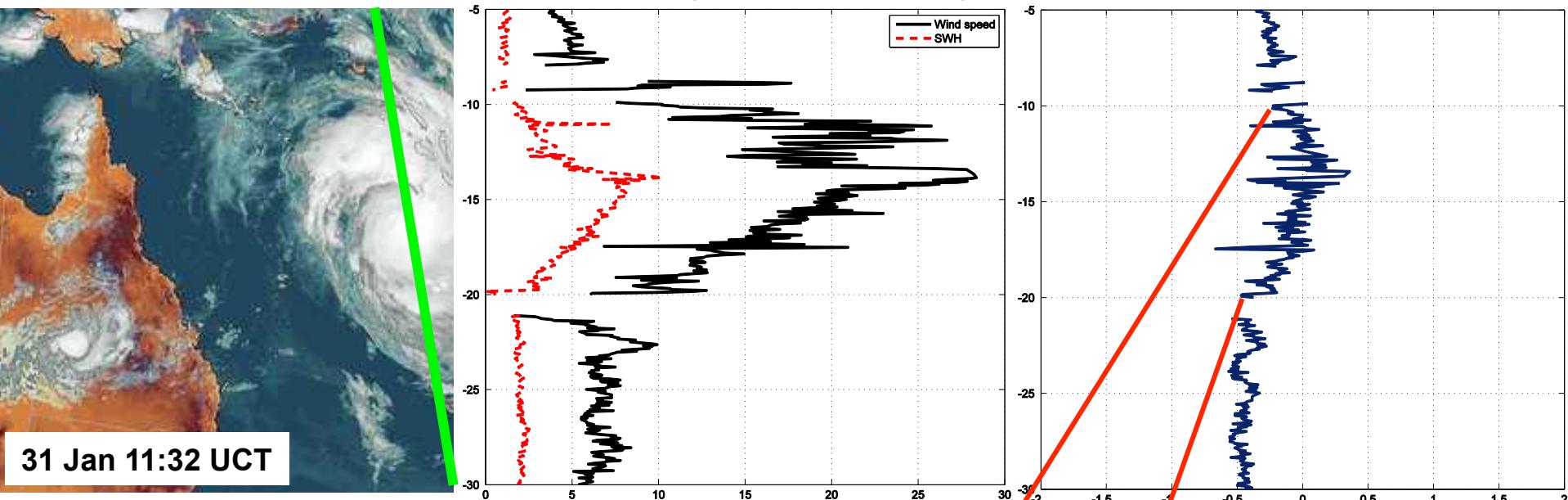
# Data Editing and Processing

- Along-track 20 Hz waveforms are retracked using combined fitting and threshold retrackers for improved sea level anomalies
- Wave heights and wind speeds are taken from SGDR but are carefully edited
- Corrections are applied
  - Modelled dry and wet tropospheric corrections are applied
  - Ionospheric correction from IGS Global Ionosphere Model (GIM) is applied
  - Inverse barometer correction is not applied
  - High frequency fluctuations of the sea surface topography are applied to Jason-2.
- Along-track profiles of wave height, wind speed and sea level anomalies during Yasi are created.

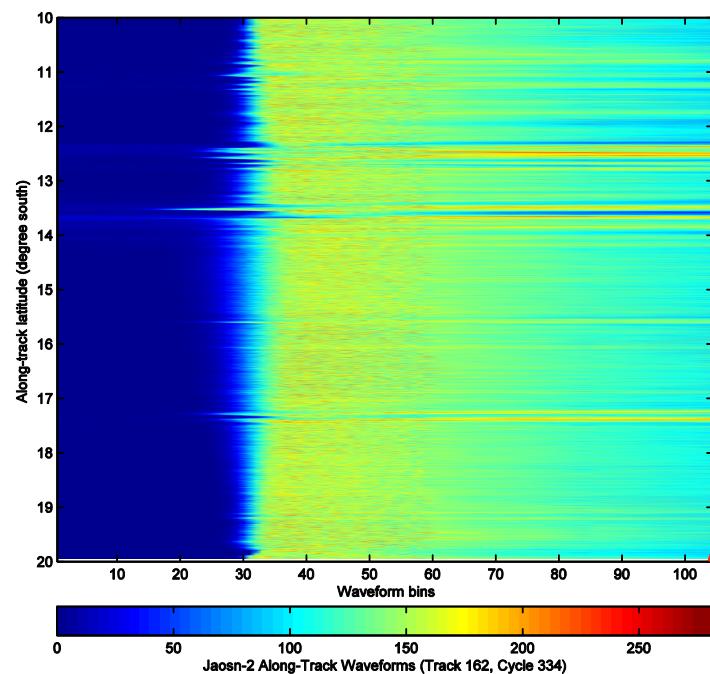
# Retracked Along-Track 20Hz Sea Surface Heights (SSHs)



J1 p162 11:28 – 11:33 UTC, CAT 3. Satellite image: [http://www.bom.gov.au/products/national\\_radar\\_sat.loop.shtml](http://www.bom.gov.au/products/national_radar_sat.loop.shtml)

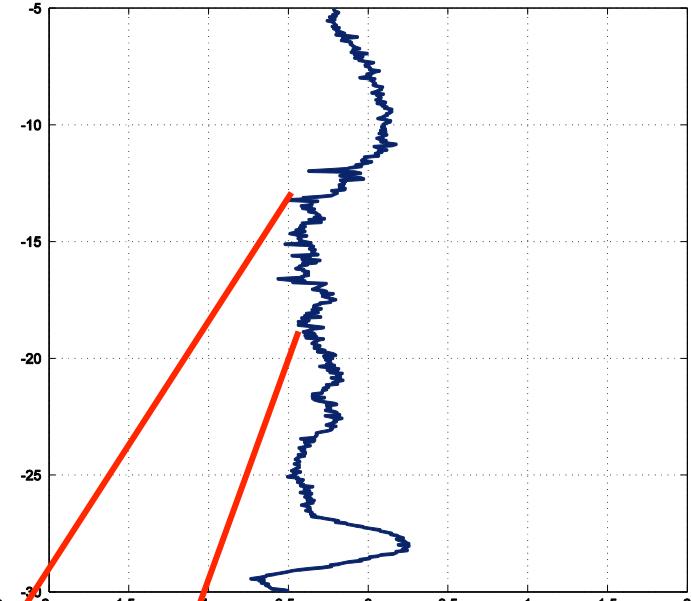
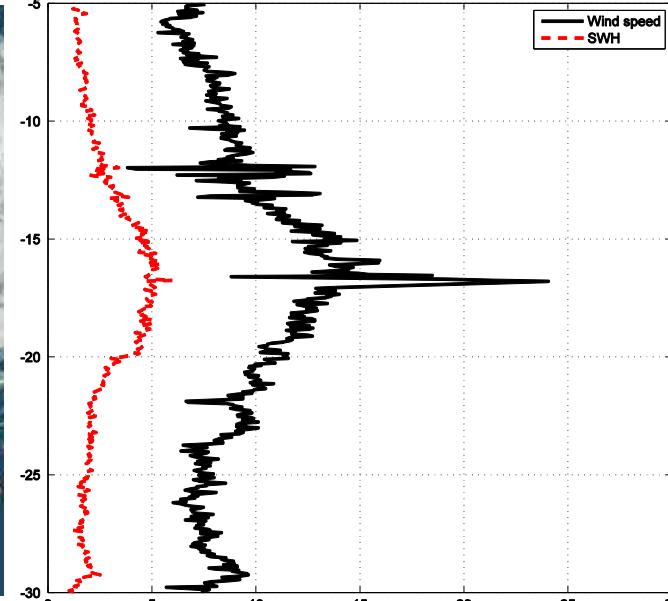
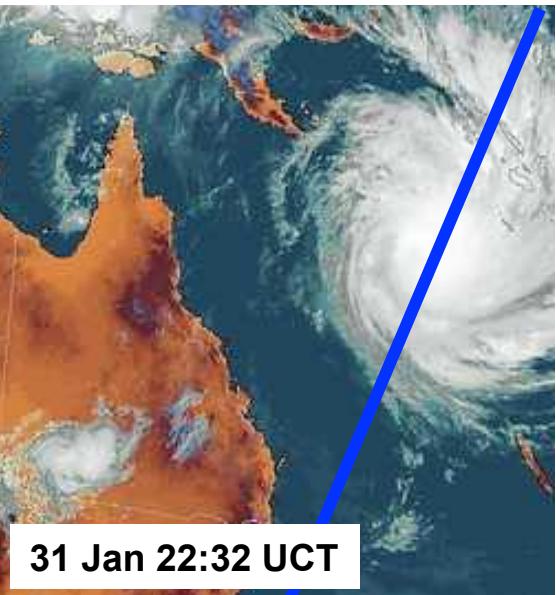


Waveforms are distorted/affected by the heavy rain accompanying with Yasi near the core of cyclone.



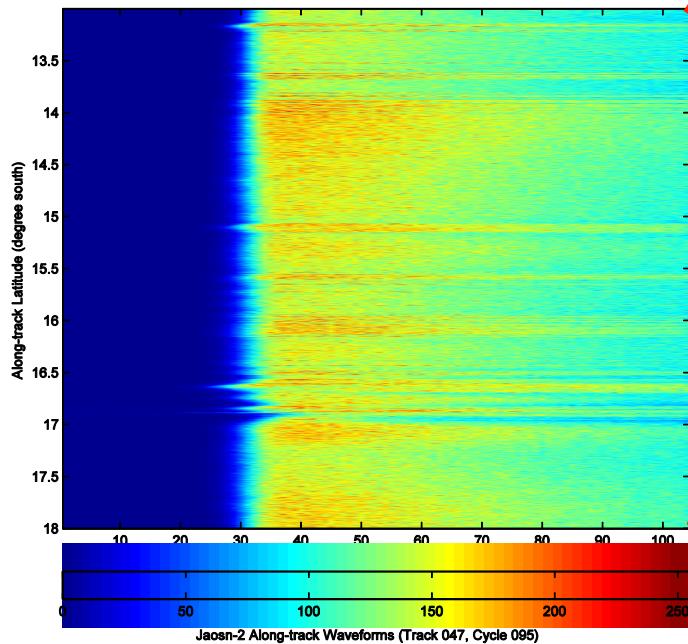
All profiles become nosier near the eye of cyclone due to rain effect on waveforms.

J2 p047 22:25 – 22:33 UTC, CAT 3



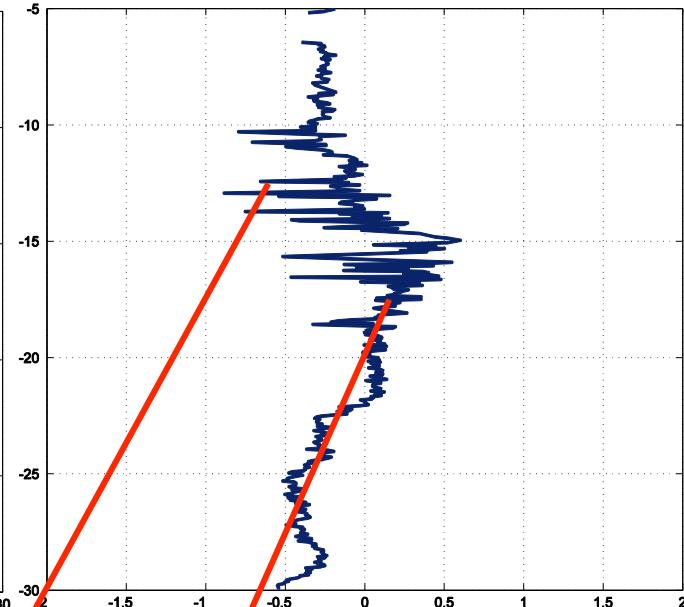
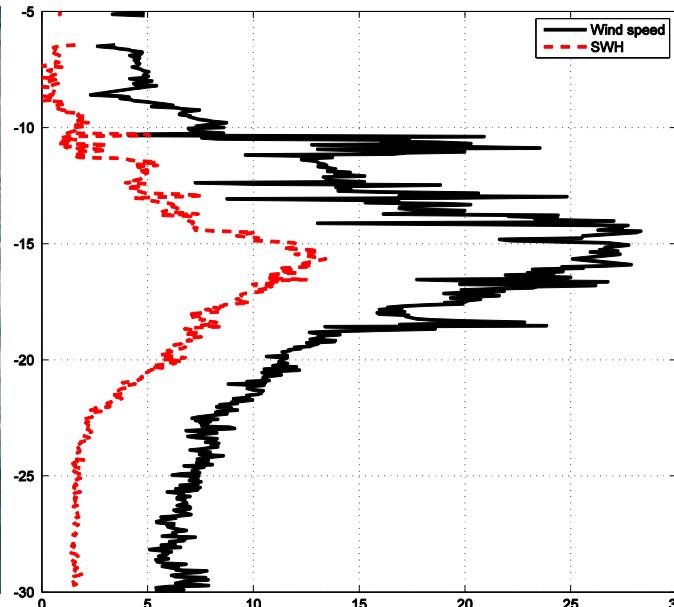
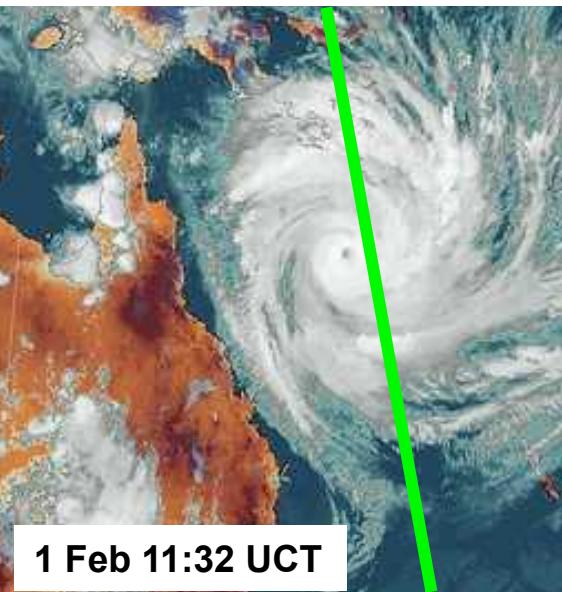
Both wave heights and wind speeds reach their max at the closest distance to the eye of cyclone.

They change symmetrically with respect to the eye.

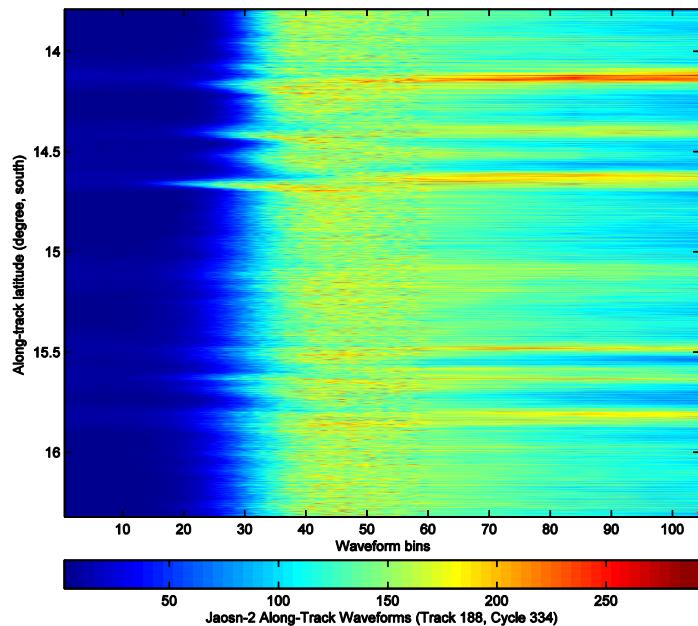


It is noted that there are no land and islands nearby.

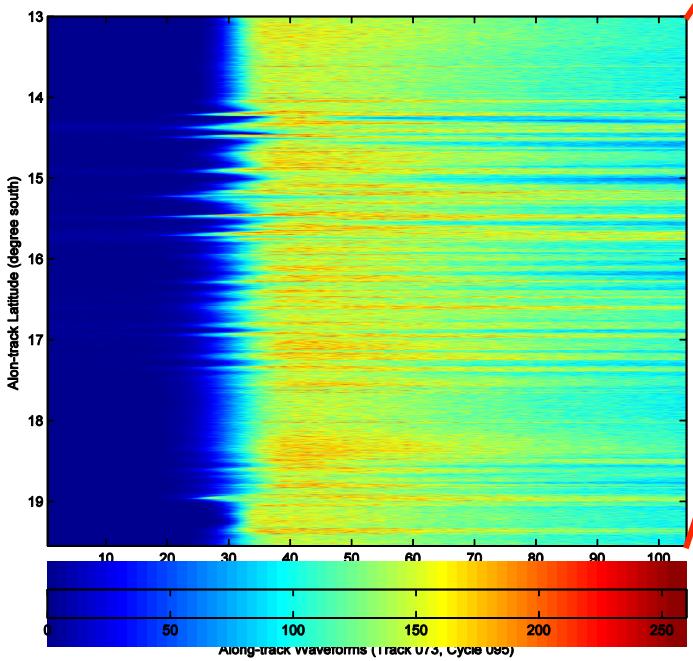
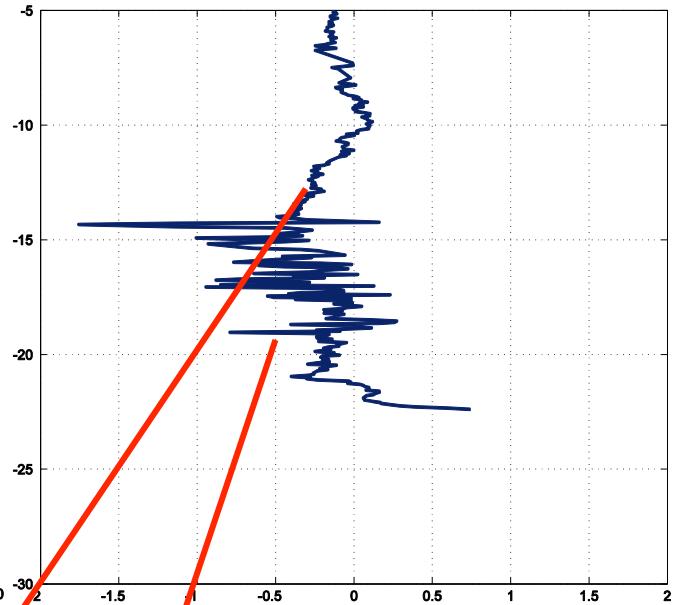
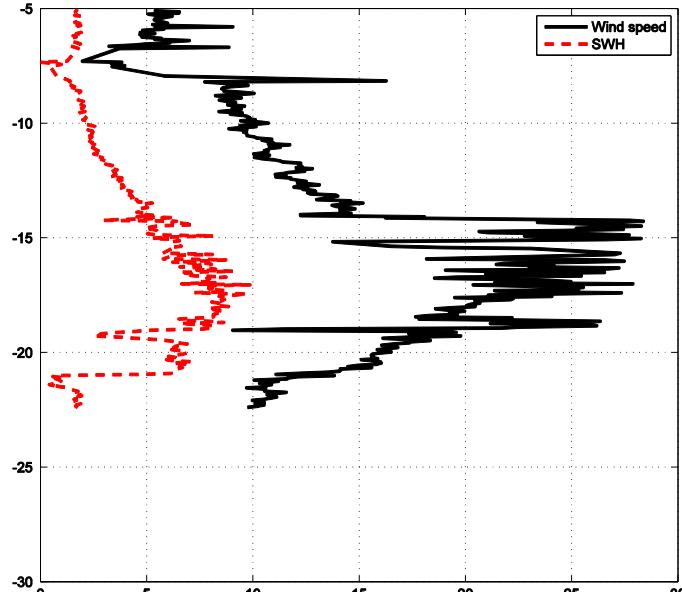
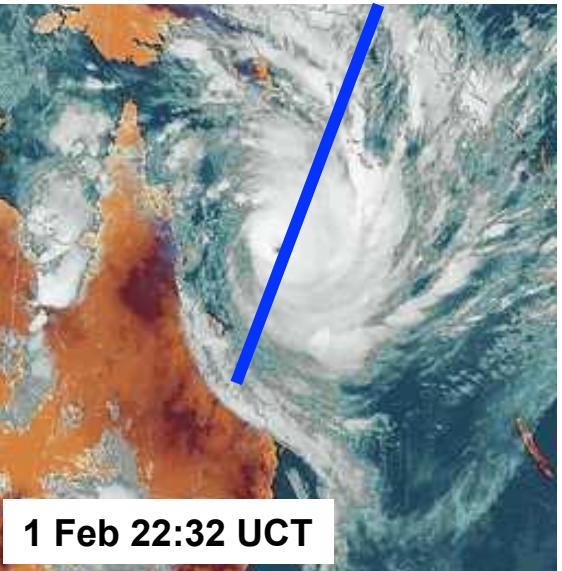
J1 p188 11:50 – 11:55 UTC, CAT 5



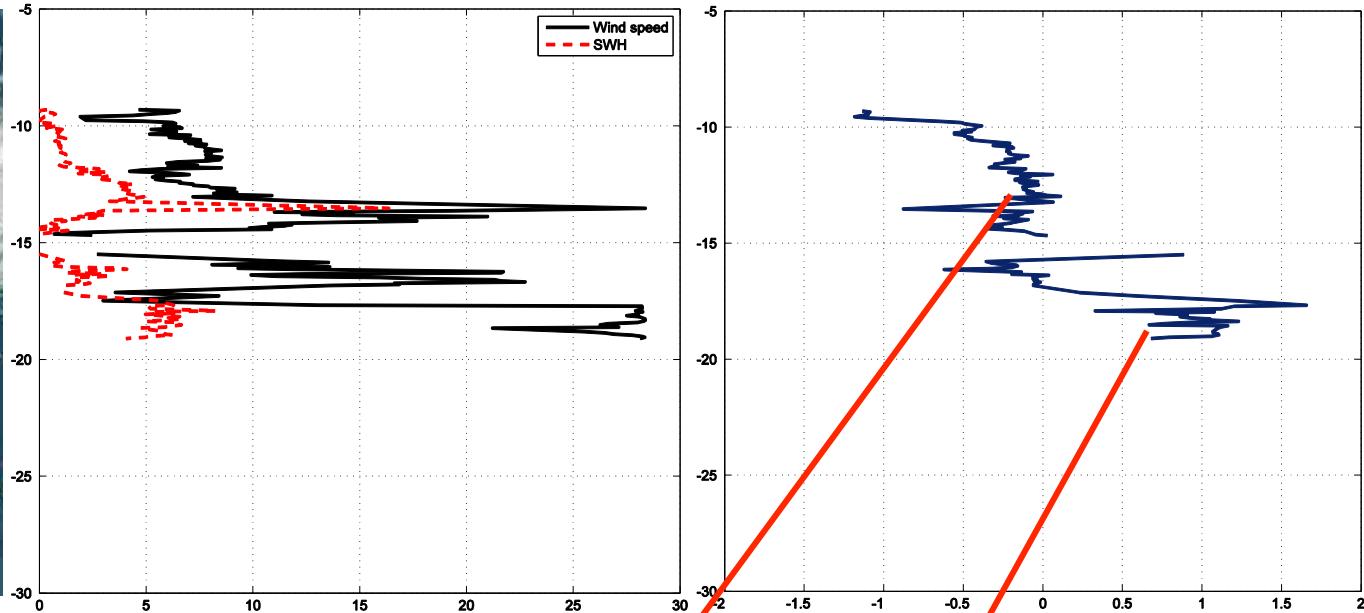
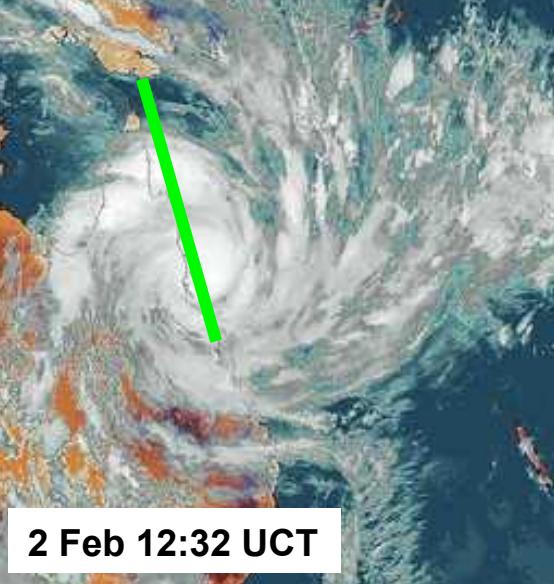
The peak values of wave height ( $\sim 14$  m) and wind speed ( $\sim 29$  m/s) are observed around 11:50 UTC on 1 Feb, when Yasi increases its intensity to storm category 5.



J2 p073 22:49 - 22:55 UTC, CAT 5

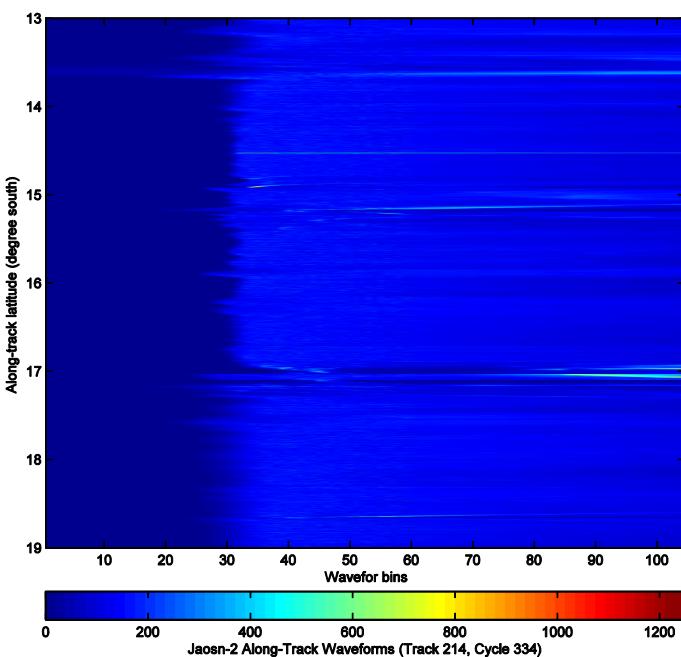


## J1 p214 12:12 – 12:15 UTC, CAT 5

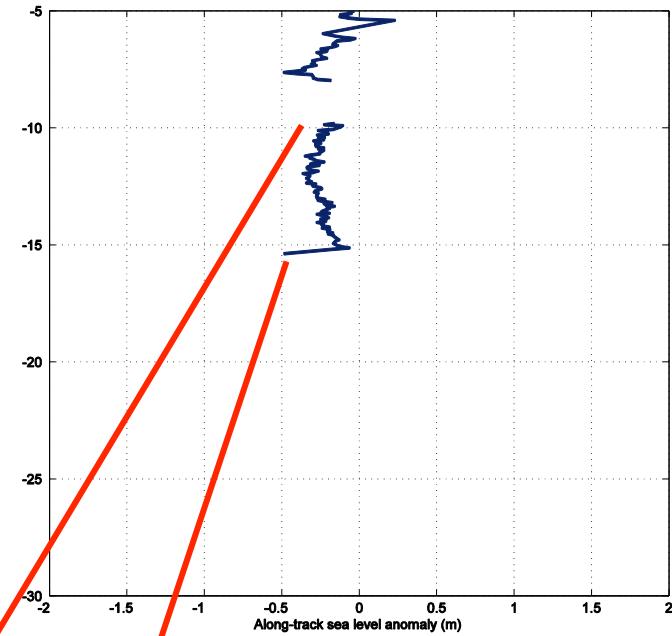
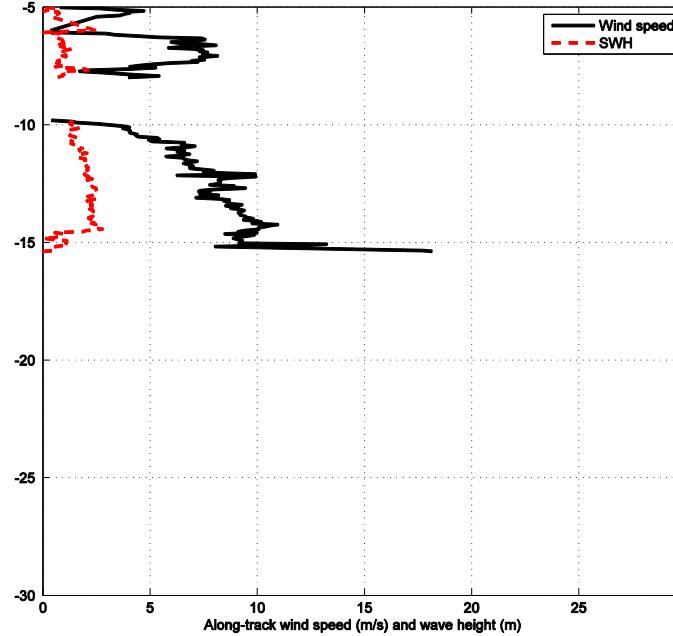
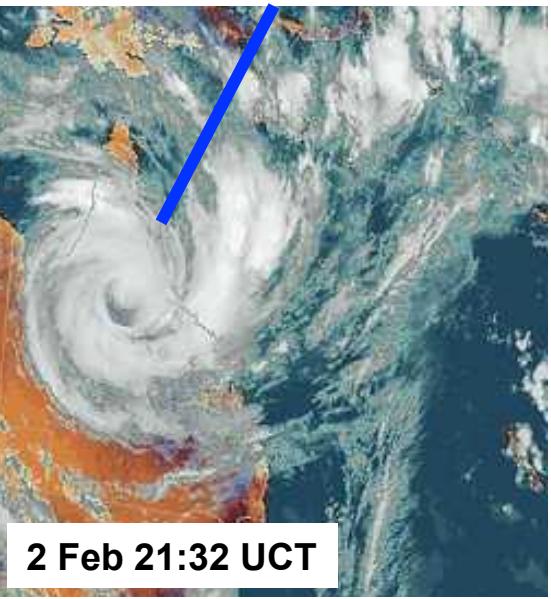


The large values of wave height and wind speed are observed again.

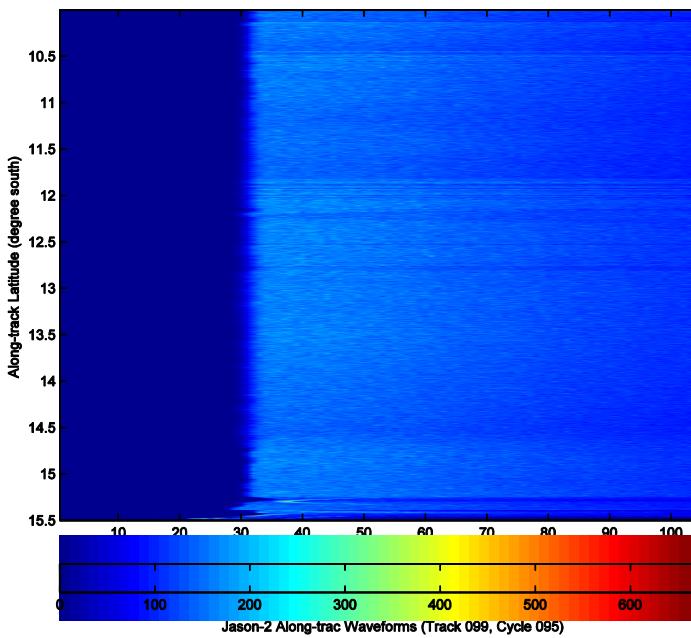
Both land and rain contamination appeared on waveforms for jason-1 track 214 .



J2 p099 23:13 - 23:16 UTC, CAT 4



Waveforms appear  
not to be affected  
when the track is  
away from the  
centre of cyclone.



# Conclusions

- The along-track profiles of altimeter-derived wave height, wind speed and sea level passing through Yasi show that their intensification increase with the growth of the cyclone approaching the north Queensland coast
- The Ku-band waveforms are obviously distorted near the core (or eye) of Yasi by heavier rain and rougher sea surface associated with the cyclone.
- Because the wind speed and wave height are estimated depending on the slopes of waveform leading and trailing edges, it is also important to further investigate how the waveform distortion affects both quantities.



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# Thanks and Questions

A presentation to the 5<sup>rd</sup> Coastal Altimetry Workshop, 16-18 Oct 2011  
San Diego, USA