Observations of Storm Surges by Satellite Altimetry: Hurricane Igor off Newfoundland

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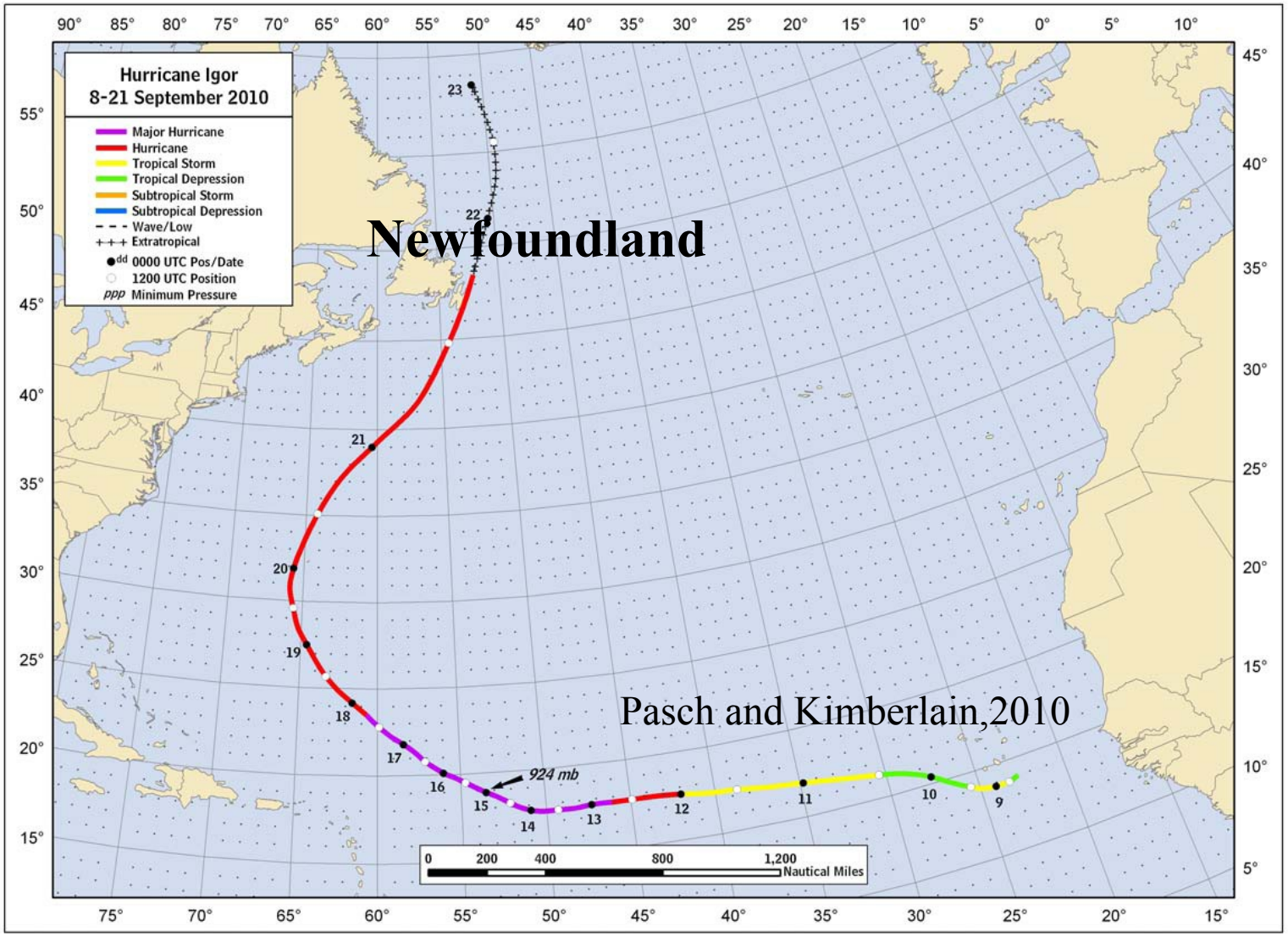
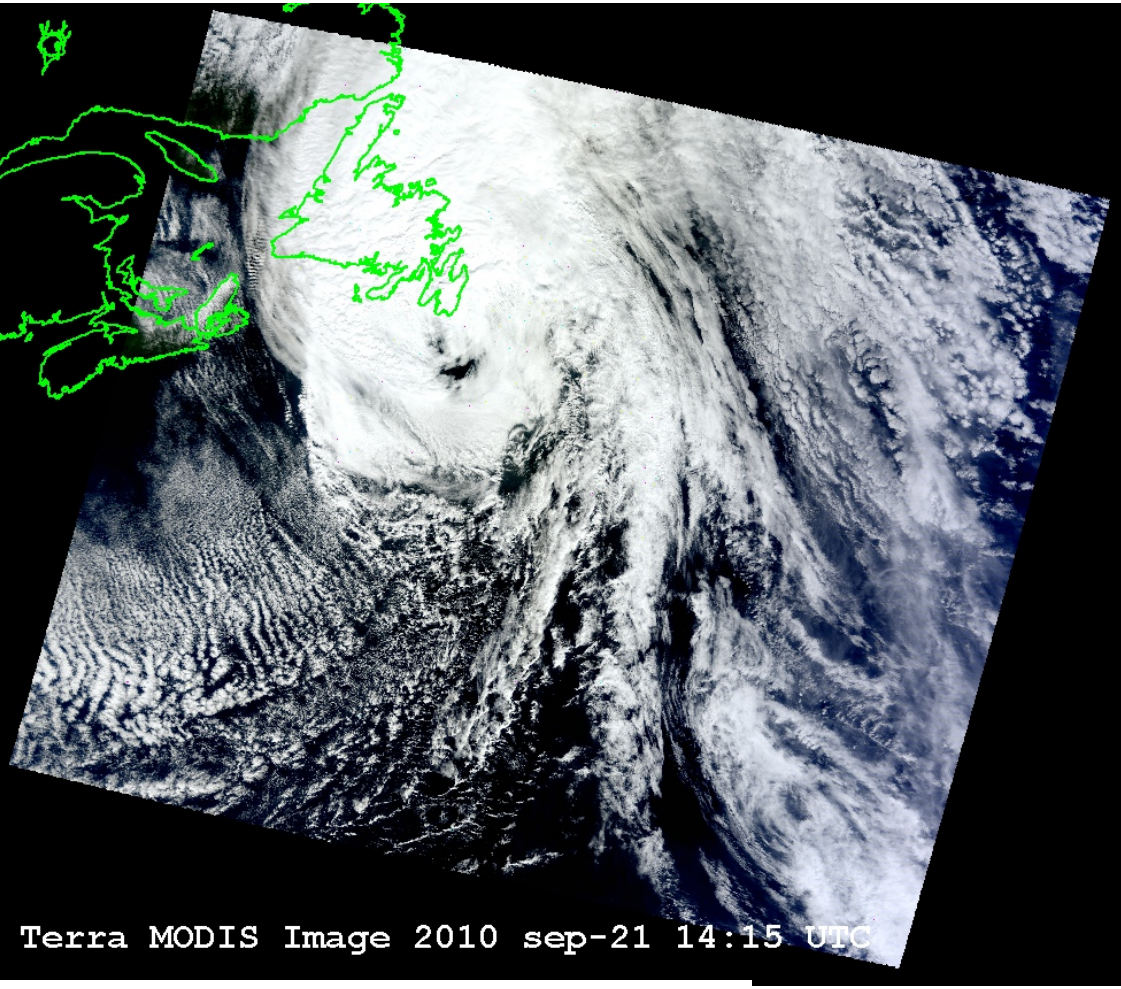
Supported by Canadian Space Agency GRIP Program

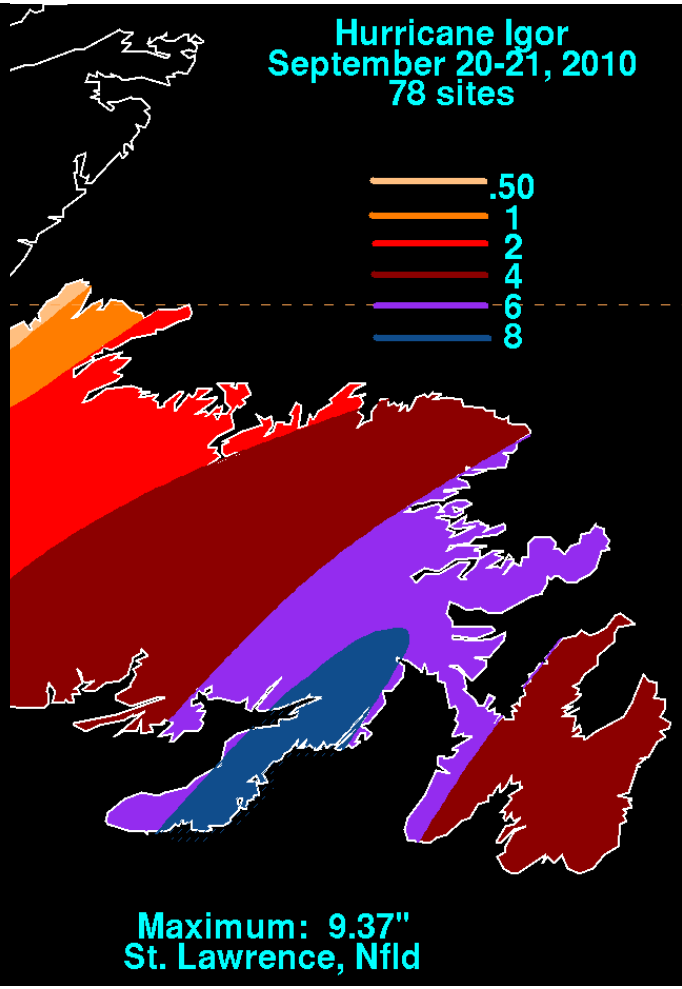
Hurricane Igor Track

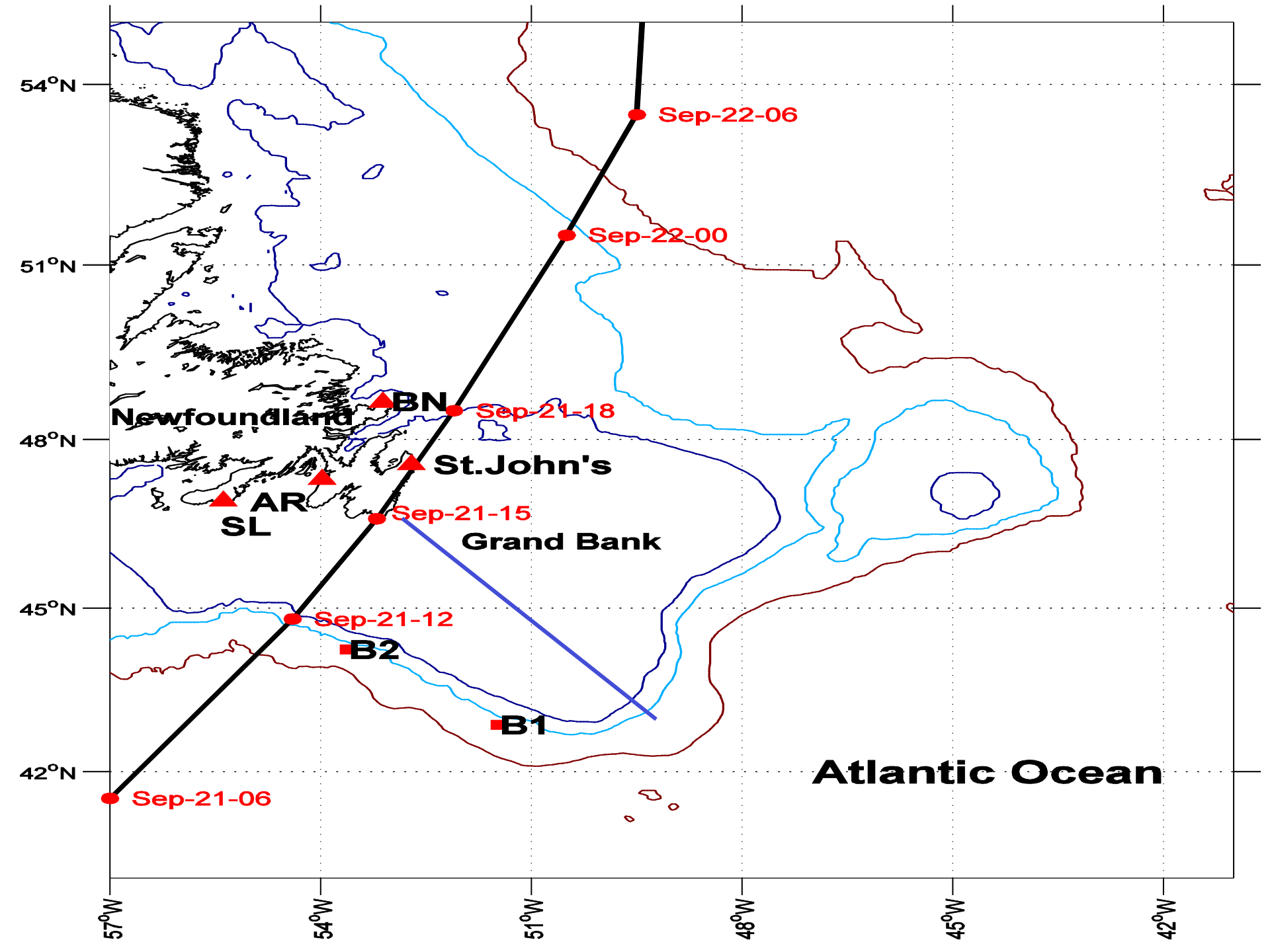


Hurricane Igor

Precipitation



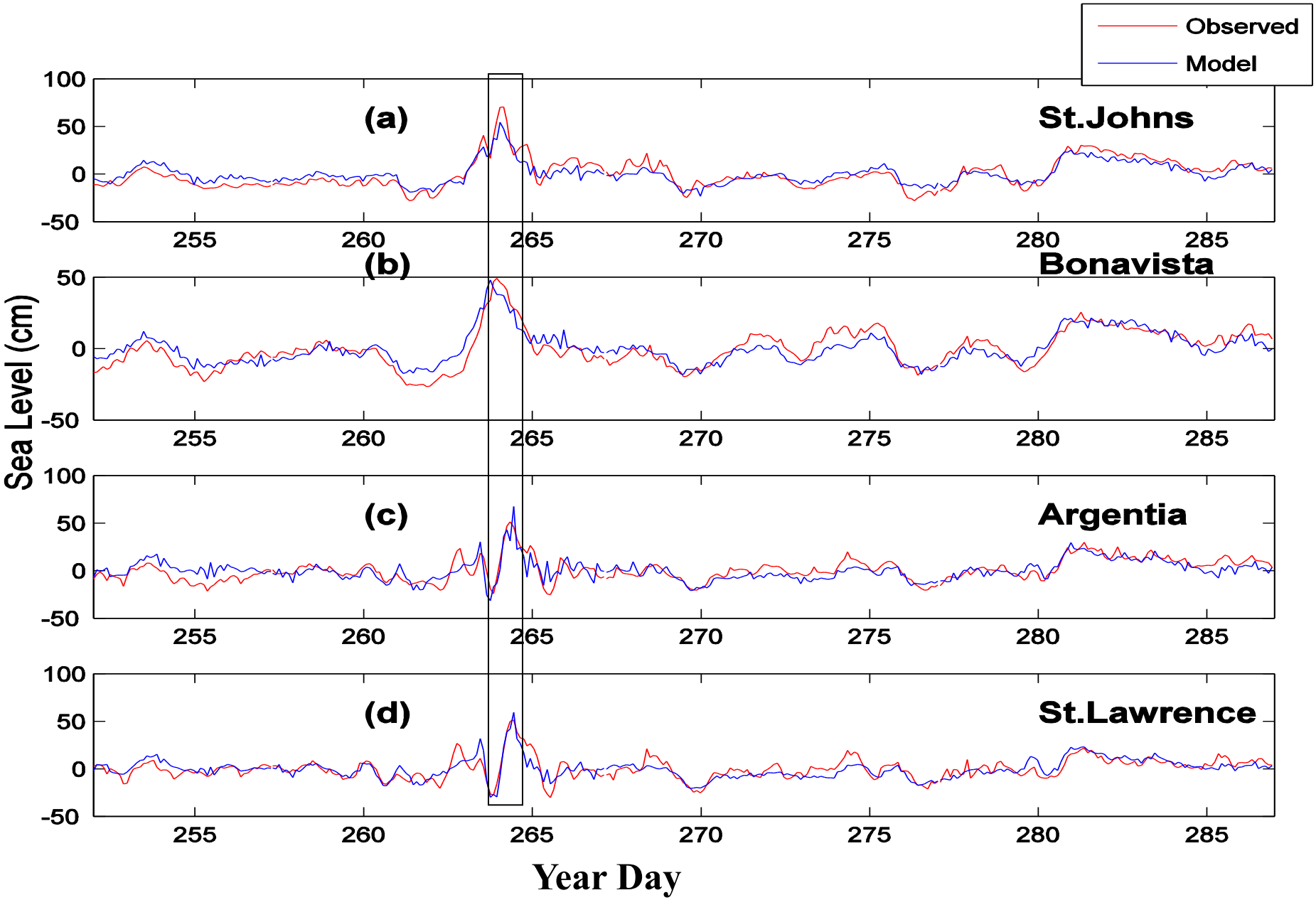



54°N
51°N
48°N
45°N
42°N
57°W
54°W
51°W
48°W
45°W
42°W
Sep-22-06
Sep-22-00
BN
Sep-21-18
Newfoundland
St.John's
AR
SL
Sep-21-15
Grand Bank
Sep-21-12
B2
B1
Atlantic Ocean
Sep-21-06

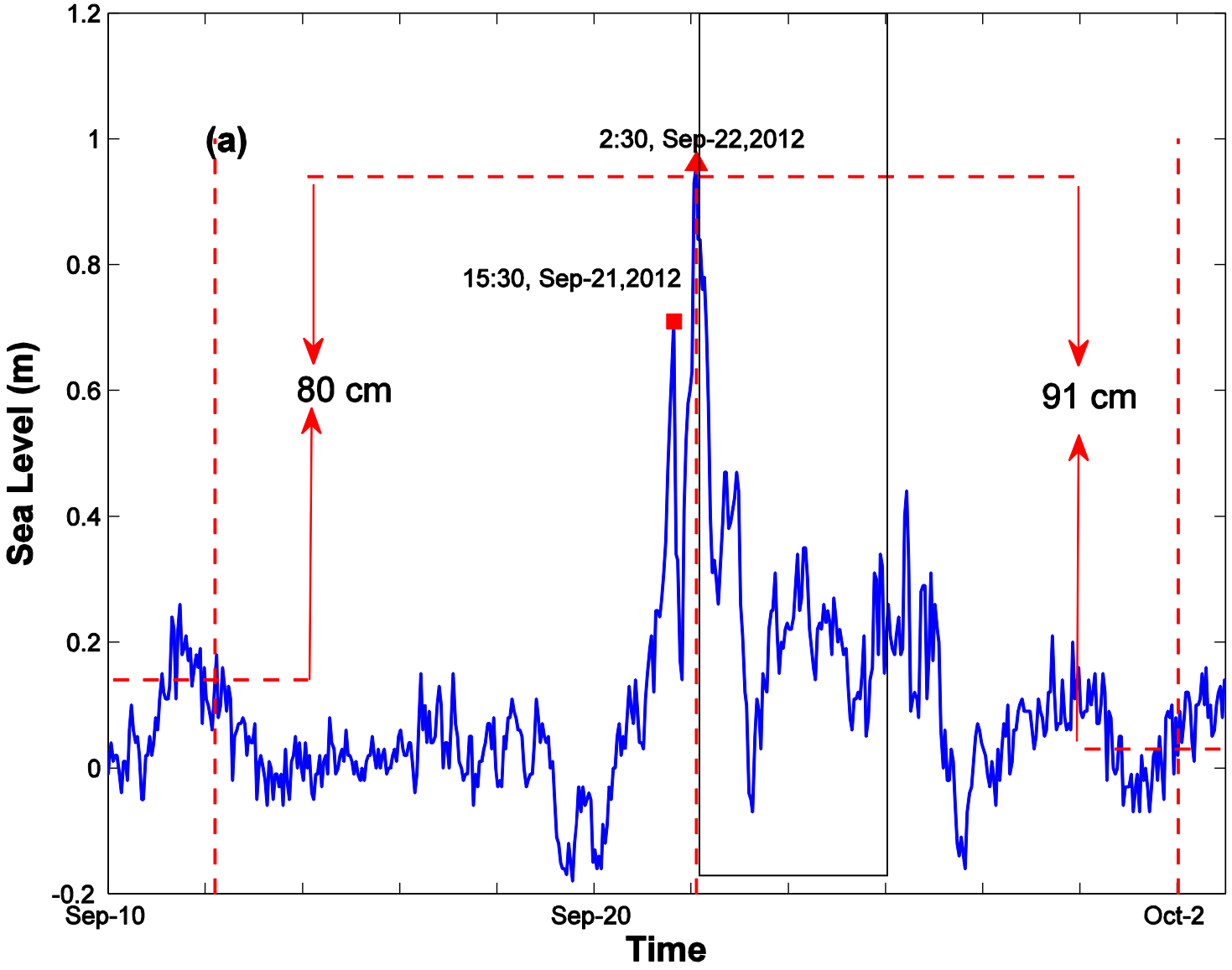
Objectives

- To investigate along- and cross-shelf features of the storm surge caused by Hurricane Igor
- To explore mechanism that generates the storm surge

Sea Level (Model vs Tide-Gauge)

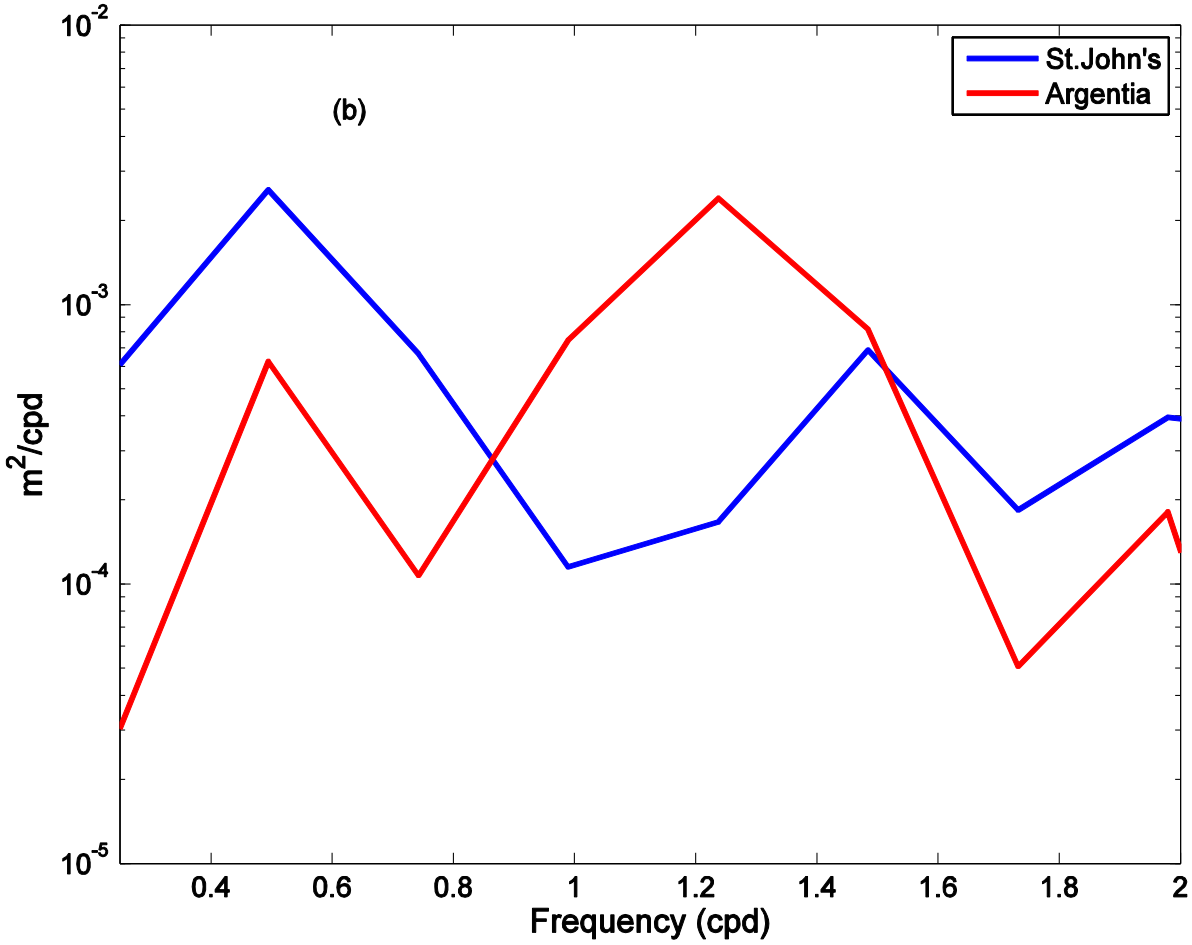


Tide-gauge Sea Level at St. John's

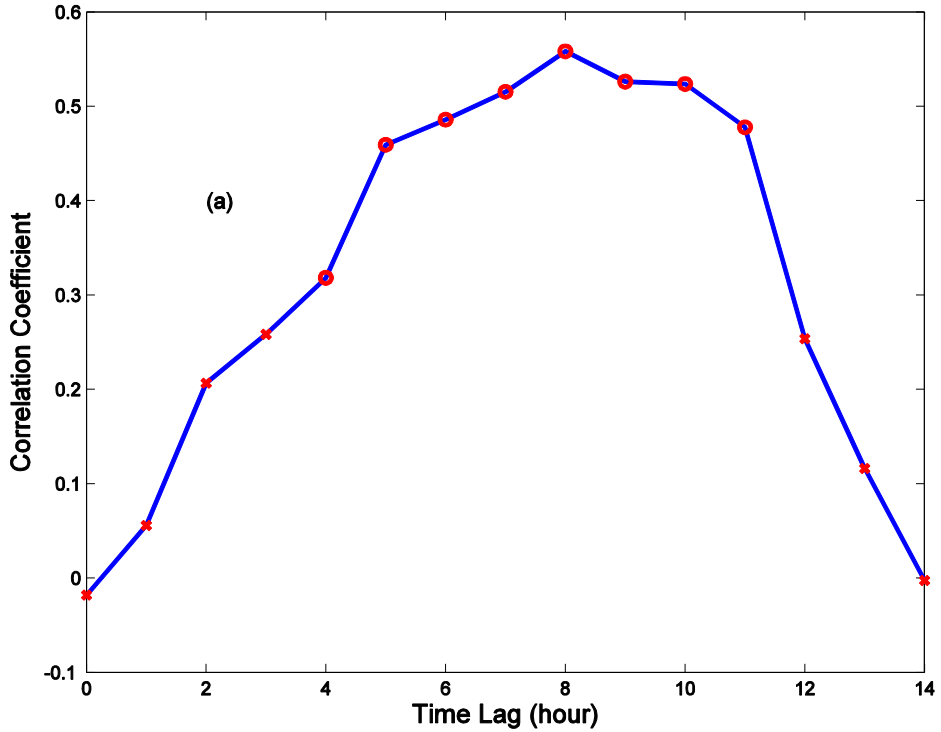


Dominant Frequency

Spectral analysis: a dominant sub-tidal oscillation at a period of 48 hours, i.e., 0.5 cpd at St. John's and 1.2 cpd at Argentia.

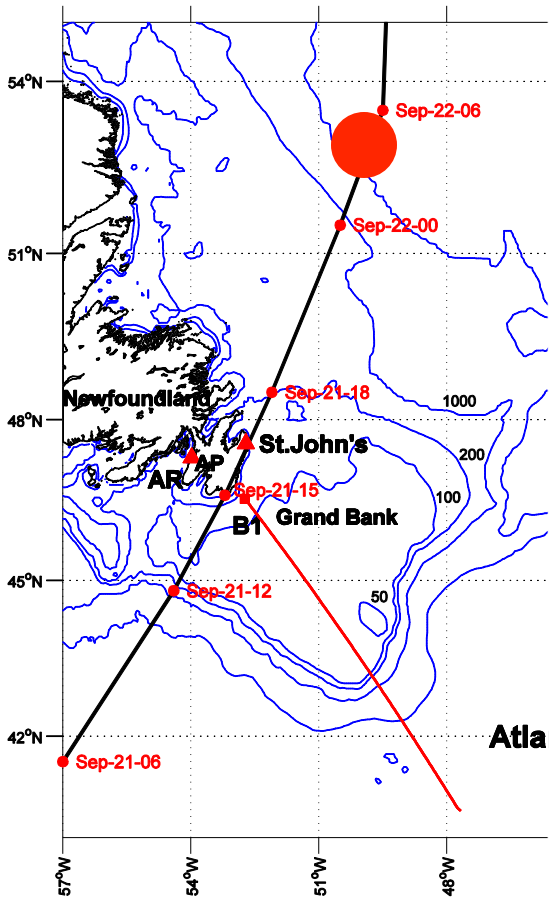


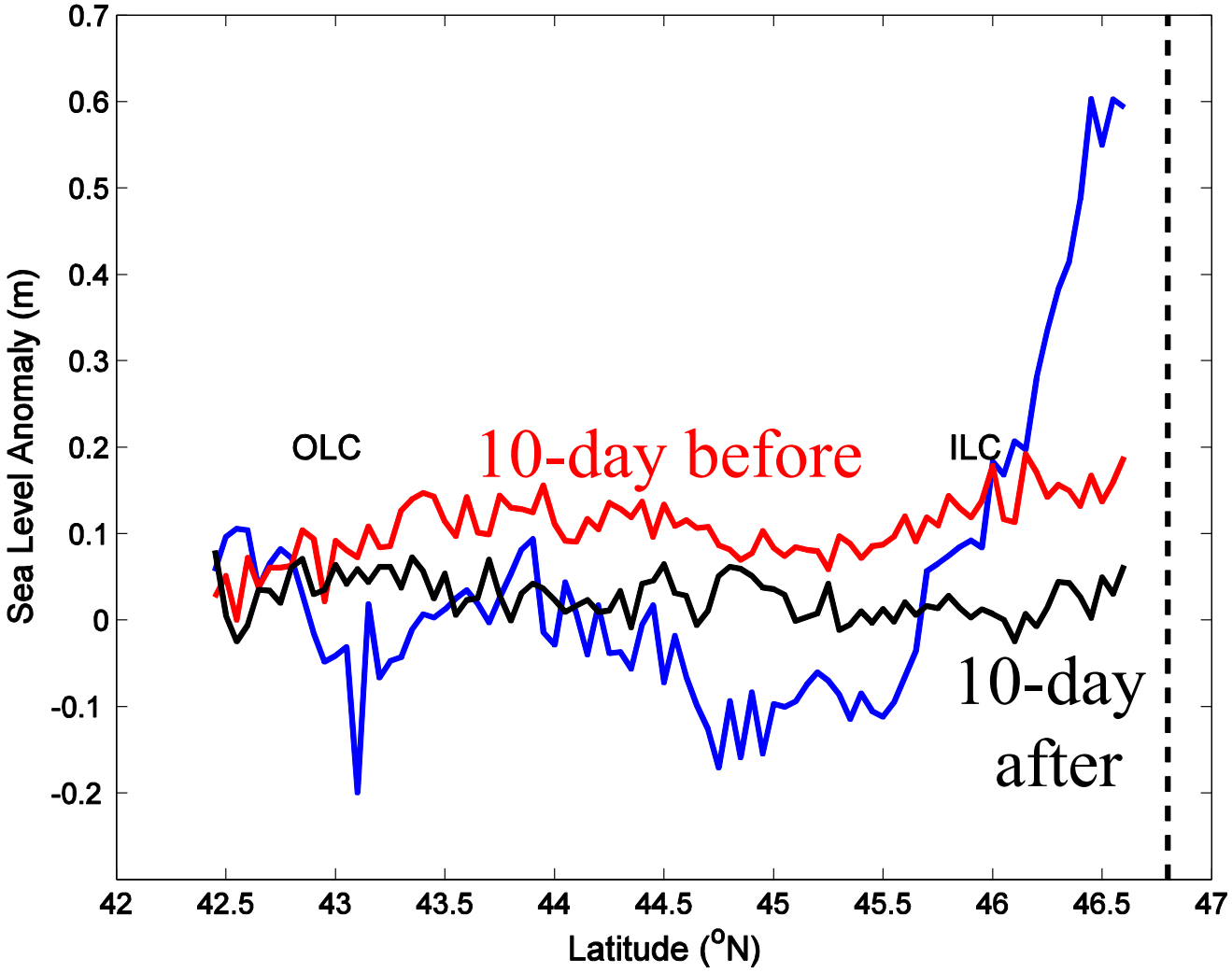
Time Lag (Argentia relative to St. John's)



Lagged correlation is used to determine the propagation time between stations. Then the propagation speed is estimated. The average phase speed is 11-13 m/s, much smaller than the average gravity wave speed of over 30 m/s in this region.

Jason-2 Sea Level Profiles





Cross-shelf Scale and Surge Magnitude

Fitting Range (°N)	Length Scale (km)	Coastal Surge (cm)
45. 2 to 46.6	102	93
45. 15 to 46.6	97	95
45. 1 to 46.6	93	96
45. 05 to 46.6	91	97
45. 0 to 46.6	89	98
44. 95 to 46.6	89	97
44. 9 to 46.6	86	99
44. 85 to 46.6	87	98
44. 8 to 46.6	85	99
44. 75 to 46.6	86	99
44. 7 to 46.6	84	99
Mean ± SD	90 ± 6 (km)	97 ± 2 (cm)

Altimetry vs Tide gauge

Cross-shelf length scale:

- Tide gauge: C/f = 100-120 km
- Altimetry: 90 $\pm$ 6 km

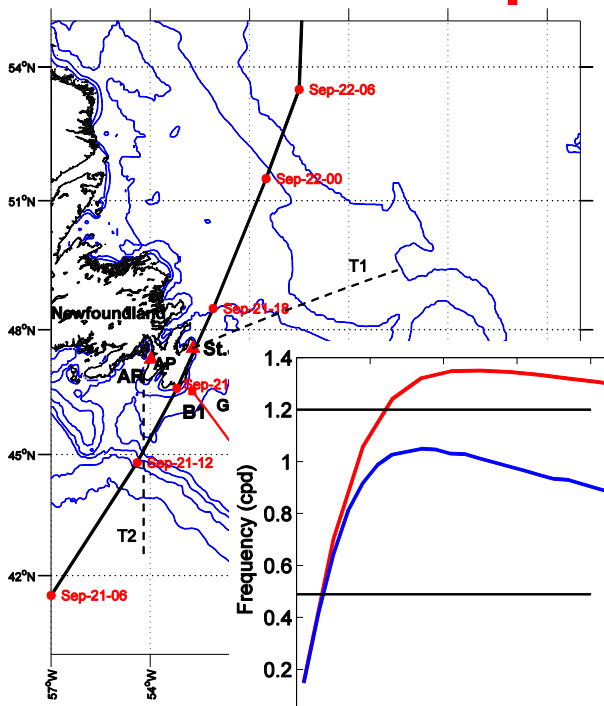
Surge magnitude at the coast

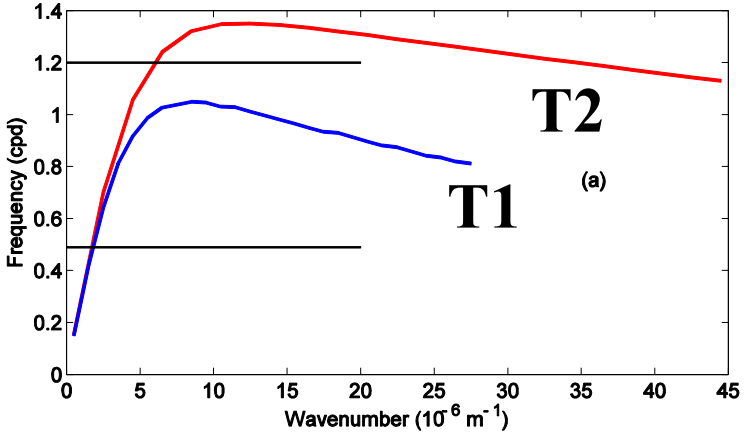
- Tide gauge: 96 cm
- Altimetry: 97 $\pm$ 2 cm

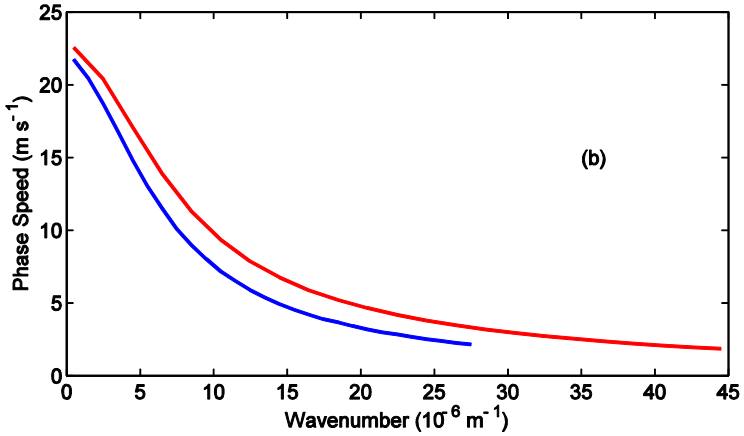
Continental Shelf Wave

- Not a barotropic Kelvin wave but
- A first-mode continental shelf wave
- Sea level has one node
- The phase speed is close to the shelf wave theory

Dispersion Relationship







Two cross-shelf transects are selected. The shelf wave theory is applied.

- The phase speed at 0.5 cpd is 19 m/s at the St. John's transect.
- The phase speed at 1.2 cpd is 13 m/s at the Argentia transect.

Conclusions

- Hurricane Igor caused a storm surge of 1 m at St. John's. The surge is associated with the first-mode continental shelf wave, propagating at an average speed of 11-13 m/s with a cross-shelf scale of ~100 km.
- Satellite altimetry is useful for observing and understanding the storm surge, complementing coastal tide gauges.