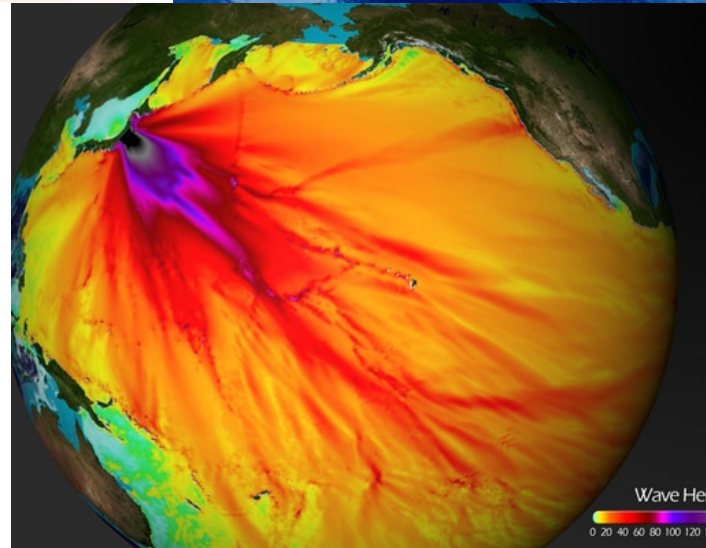
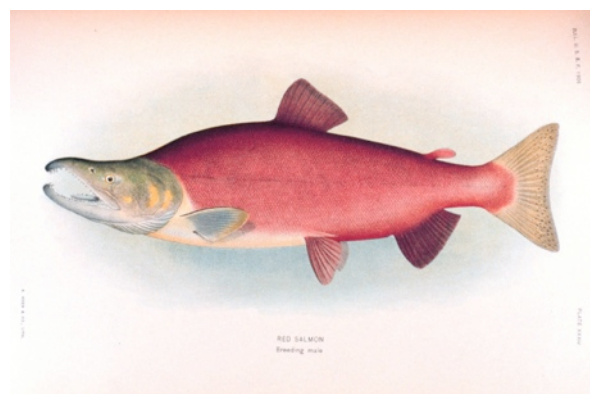


Identifying generation mechanisms in U.S. east coast non-seismic tsunami events



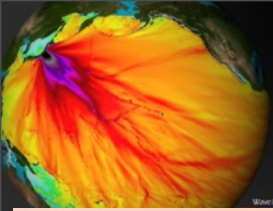
Christopher Moore
Vasily Titov
Diego Arcas
Utku Kanoğlu
Jose Manuel González-Vida



NOAA Center for Tsunami Research

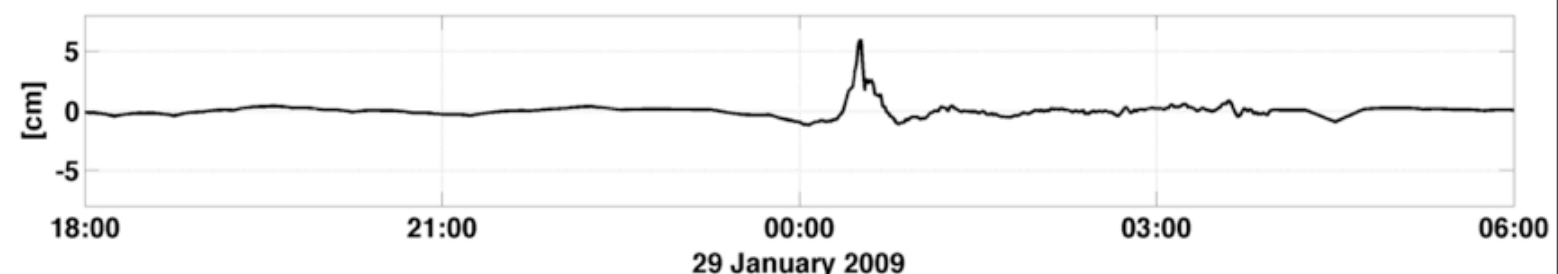
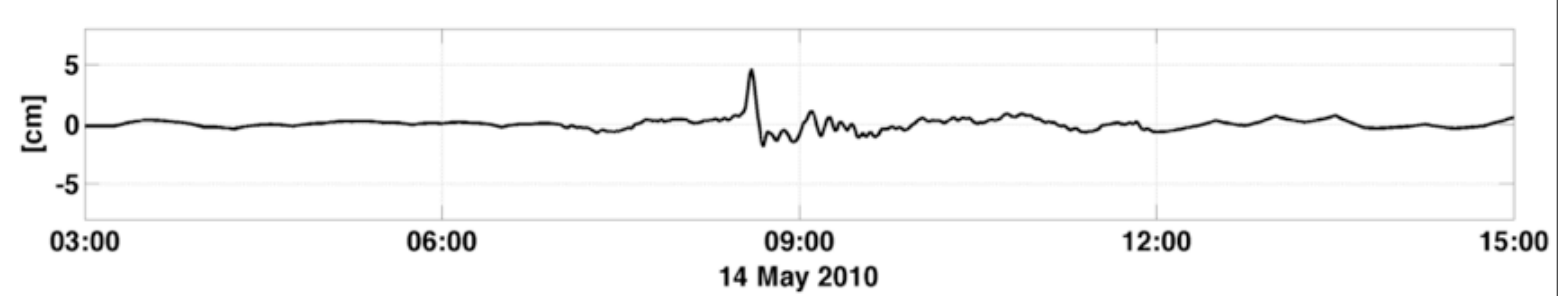
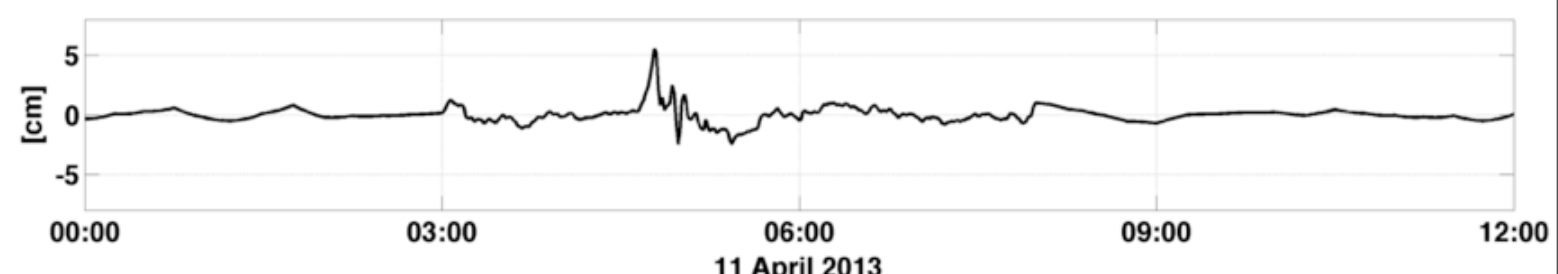
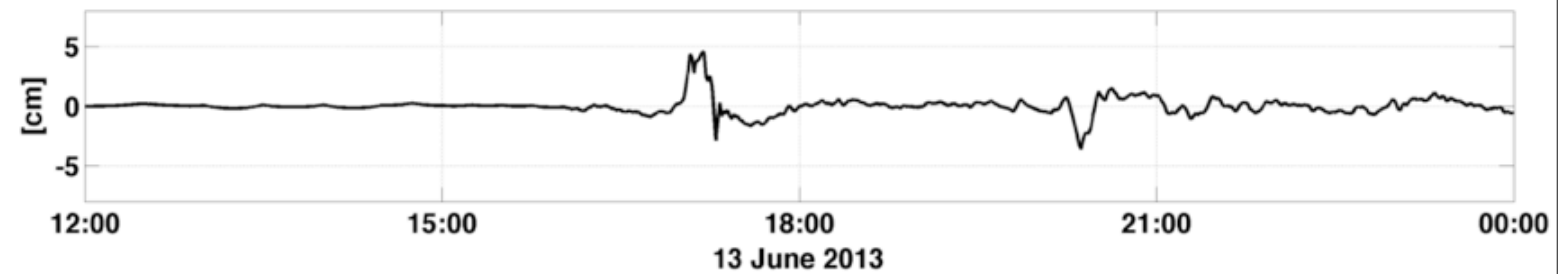
Pacific Marine Environmental Laboratory





DART 44402 triggers

DART 44402 - non-seismic triggers

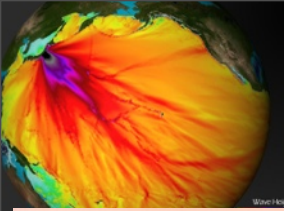


- 4 “false” triggers in 4 years
- deep-water amplitudes > 5cm
- no seismic signal
- not a spike

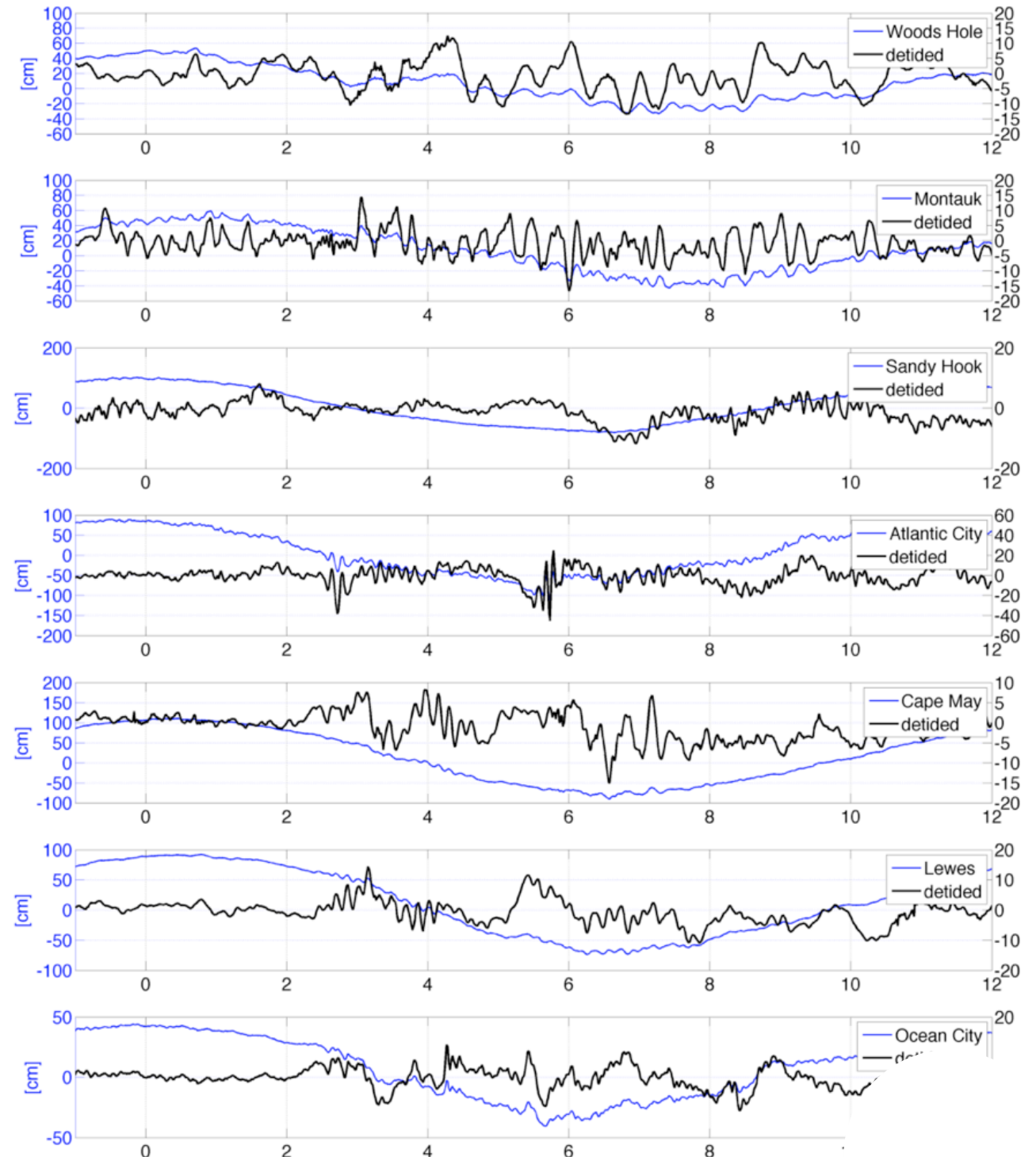
Tide gauges ...



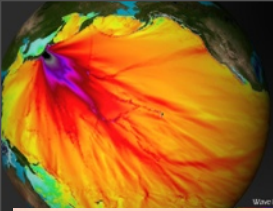
11 April 2013 event



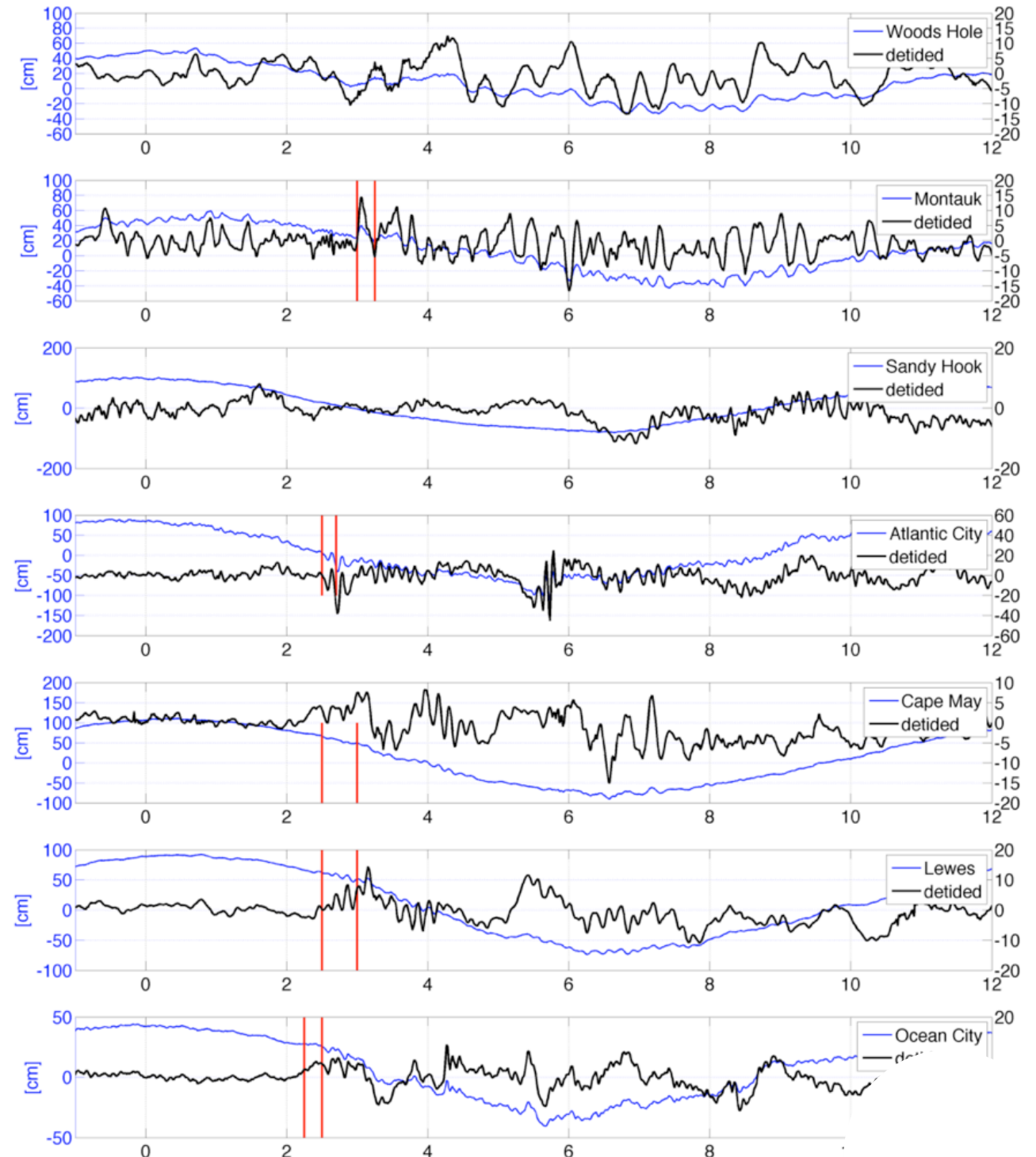
Many gauges show a clear wave arrival time (est. in red)



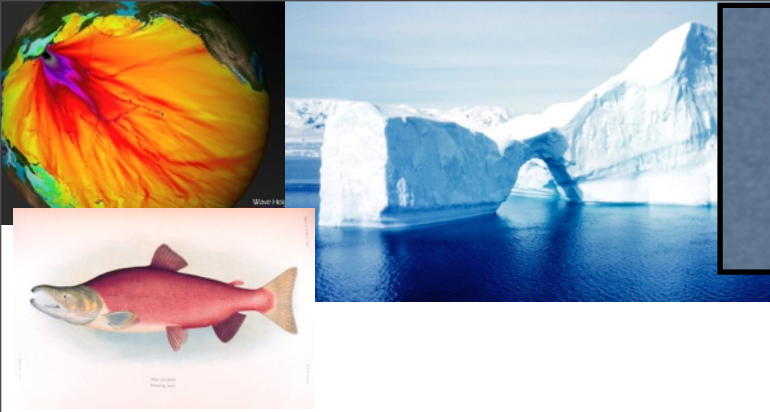
11 April 2013 event



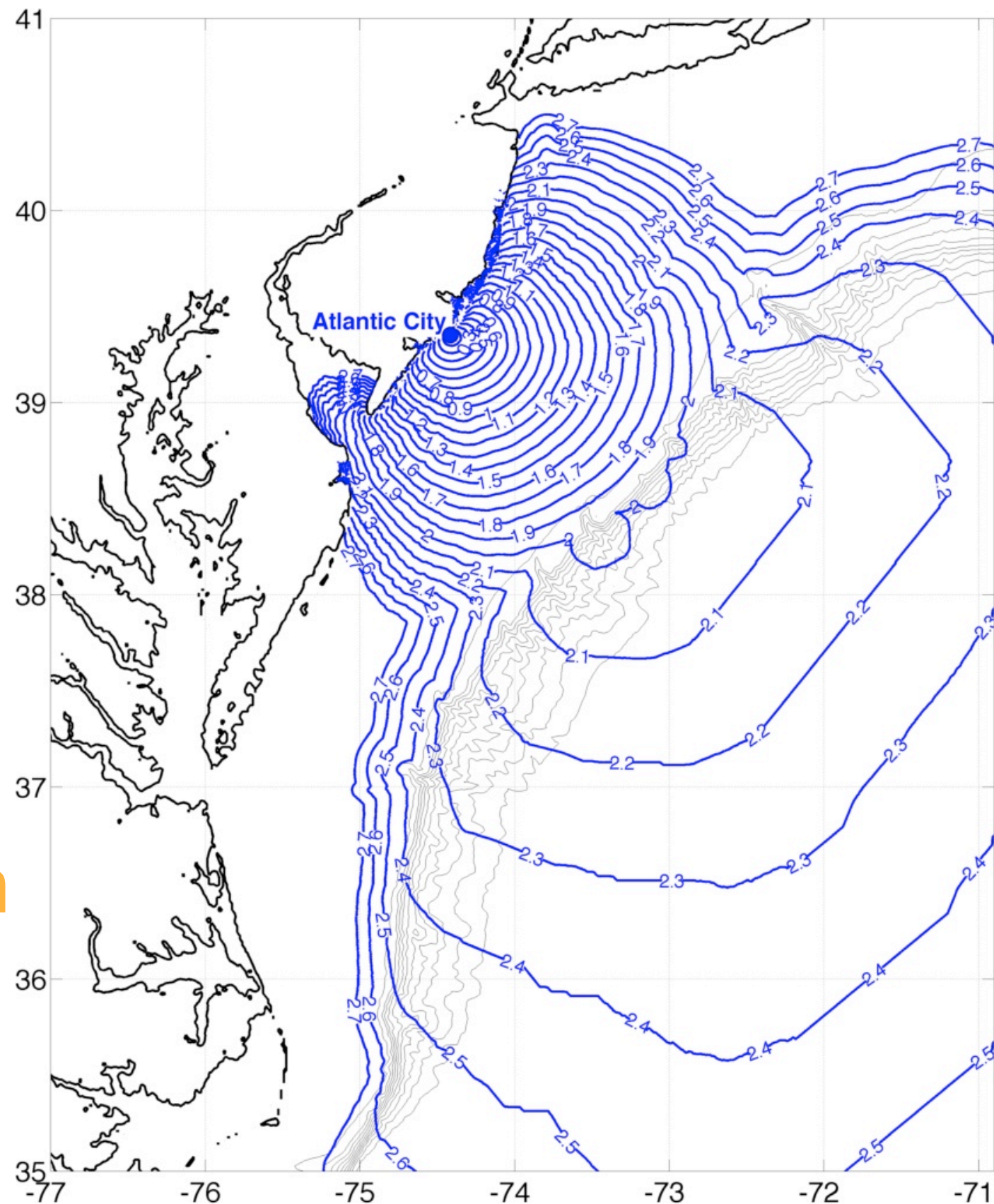
Many gauges show a clear wave arrival time (est. in red)



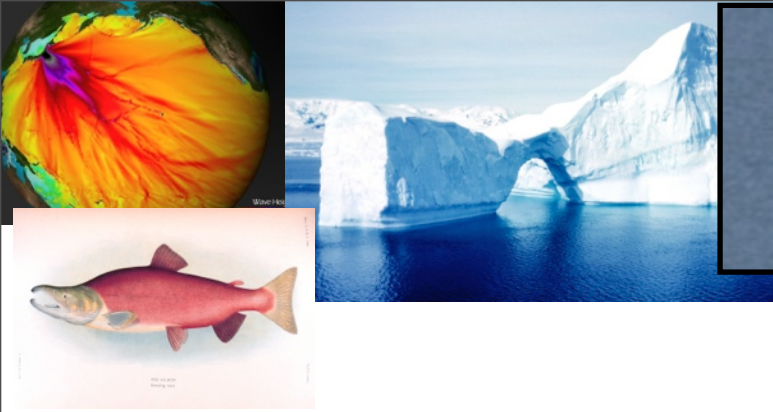
Identifying forcing region



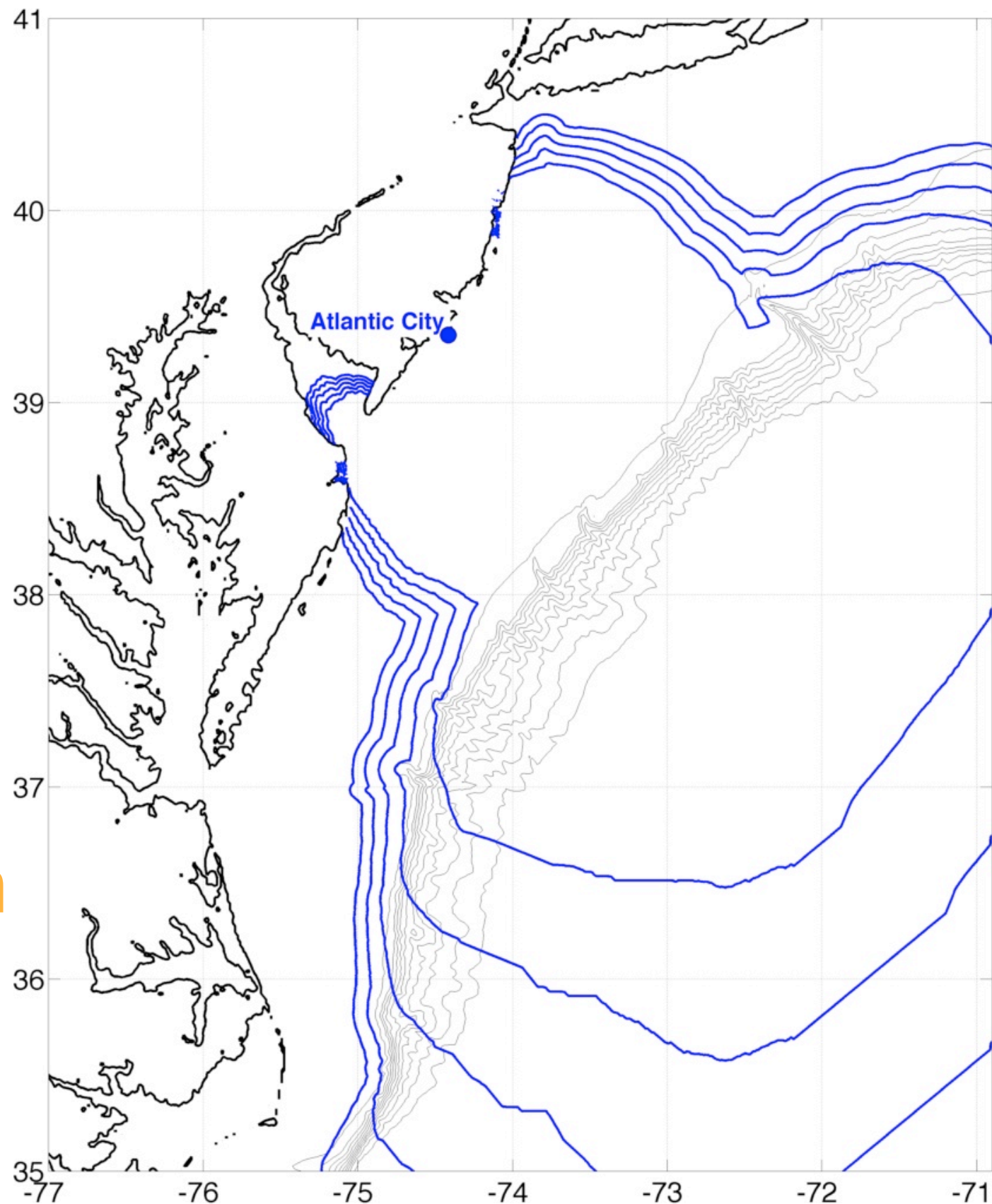
- Reverse isochrons calculated from each gauge and DART
- Contours of time from arrival time estimates
- Overlap shows possible forcing region



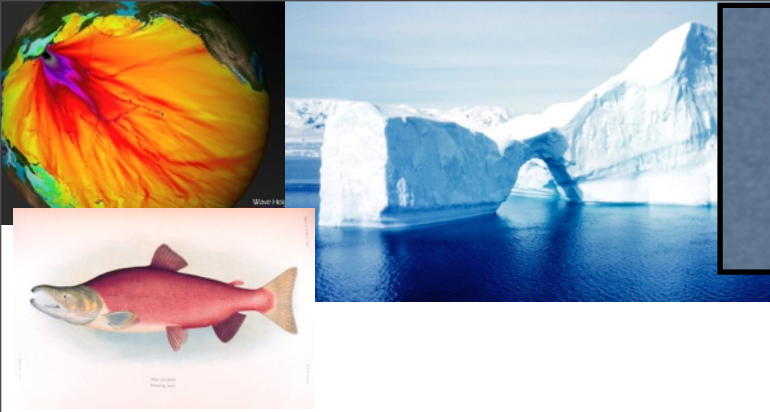
Identifying forcing region



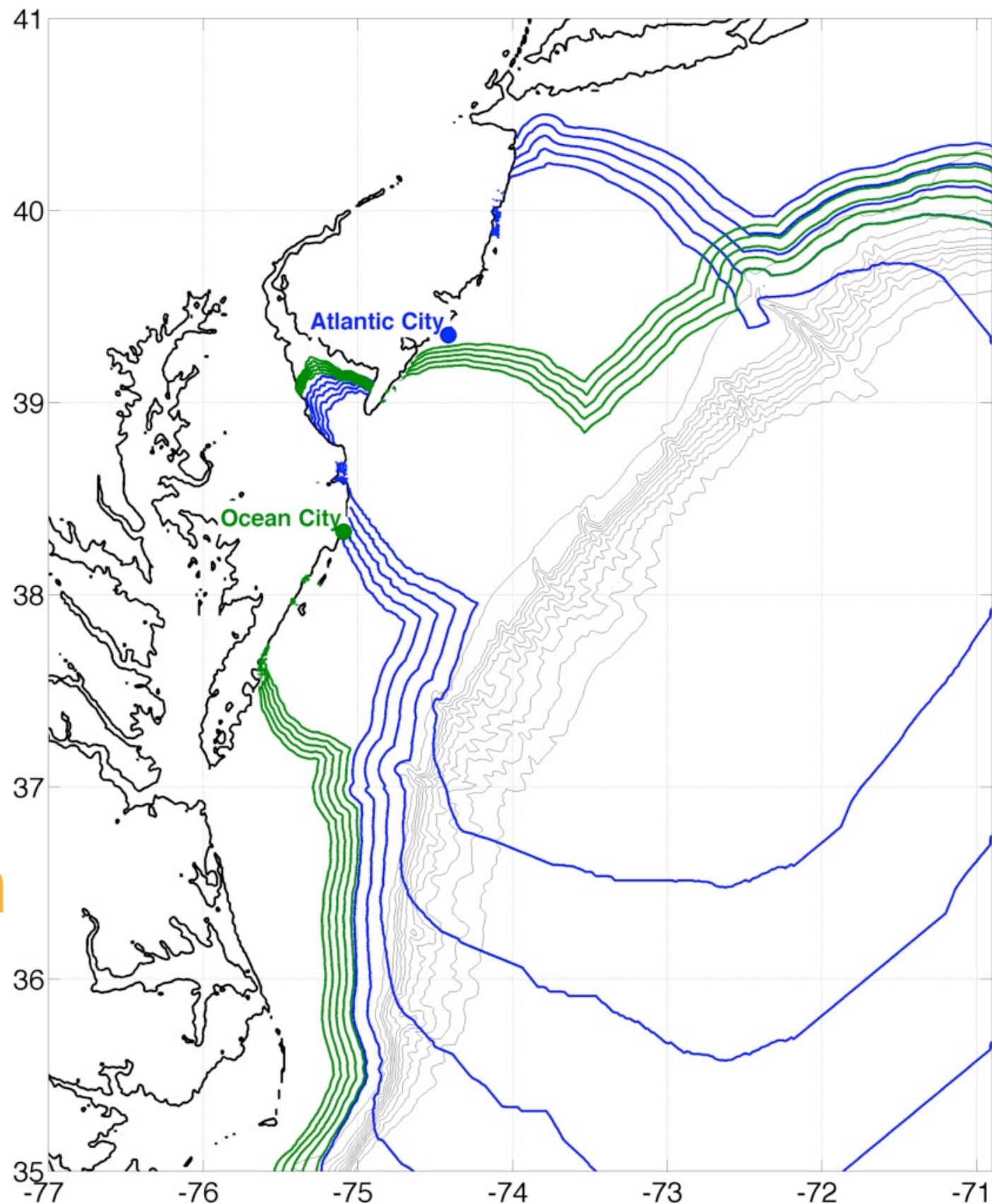
- Reverse isochrons calculated from each gauge and DART
- Contours of time from arrival time estimates
- Overlap shows possible forcing region



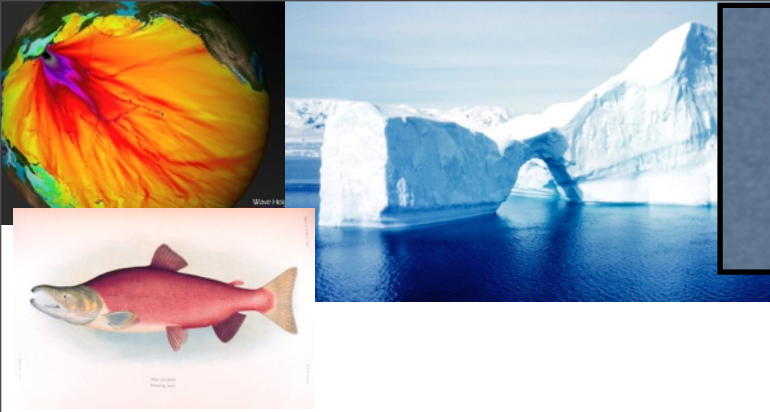
Identifying forcing region



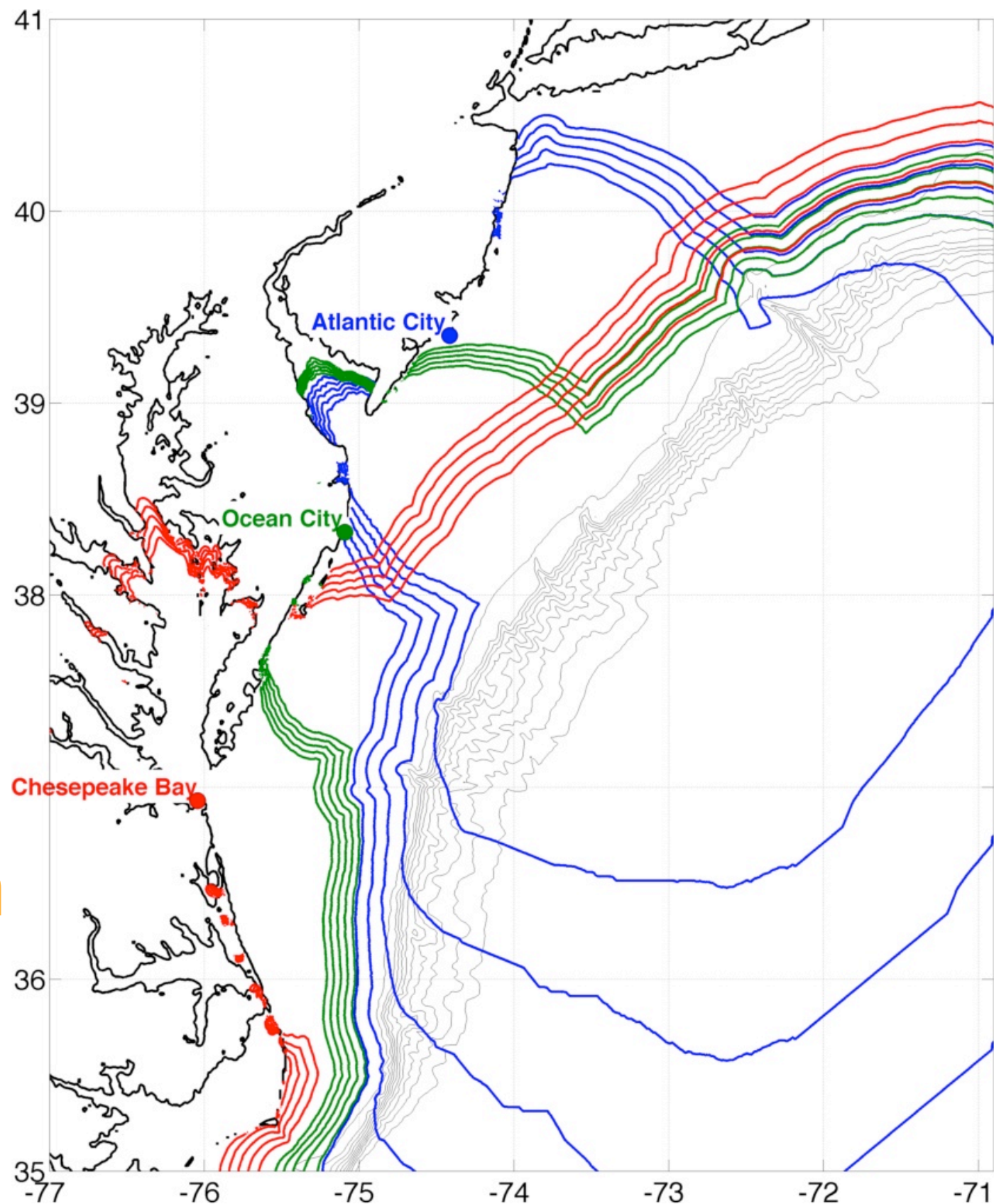
- Reverse isochrons calculated from each gauge and DART
- Contours of time from arrival time estimates
- Overlap shows possible forcing region



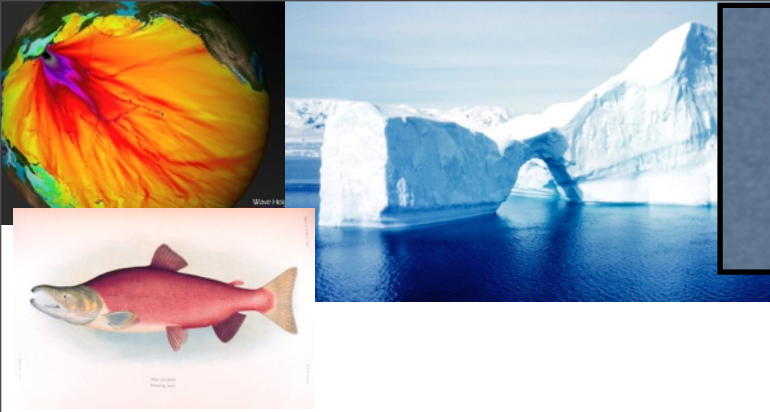
Identifying forcing region



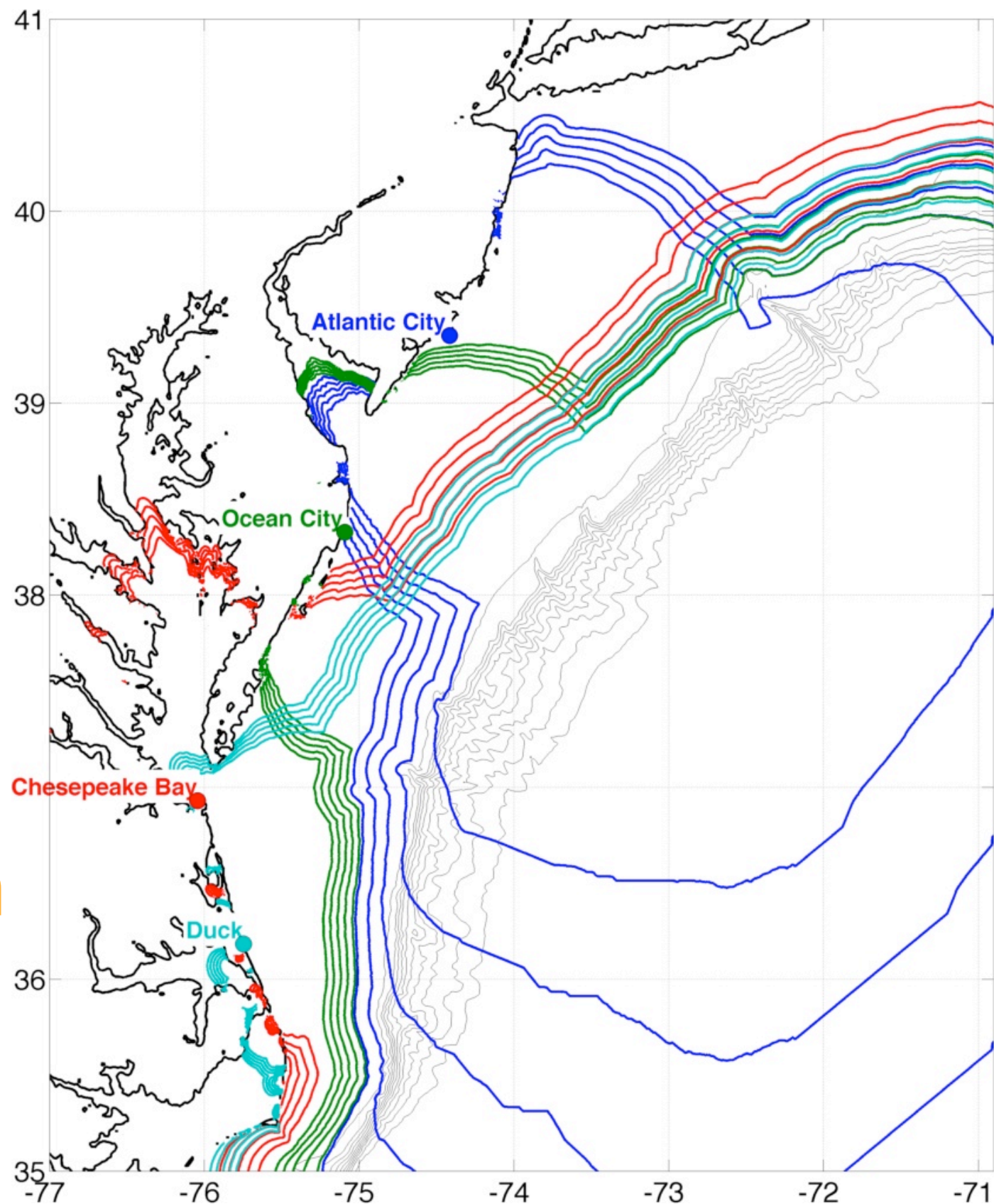
- Reverse isochrons calculated from each gauge and DART
- Contours of time from arrival time estimates
- Overlap shows possible forcing region



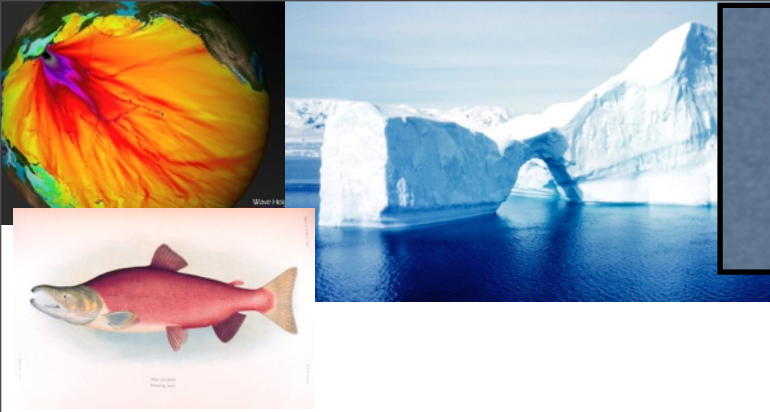
Identifying forcing region



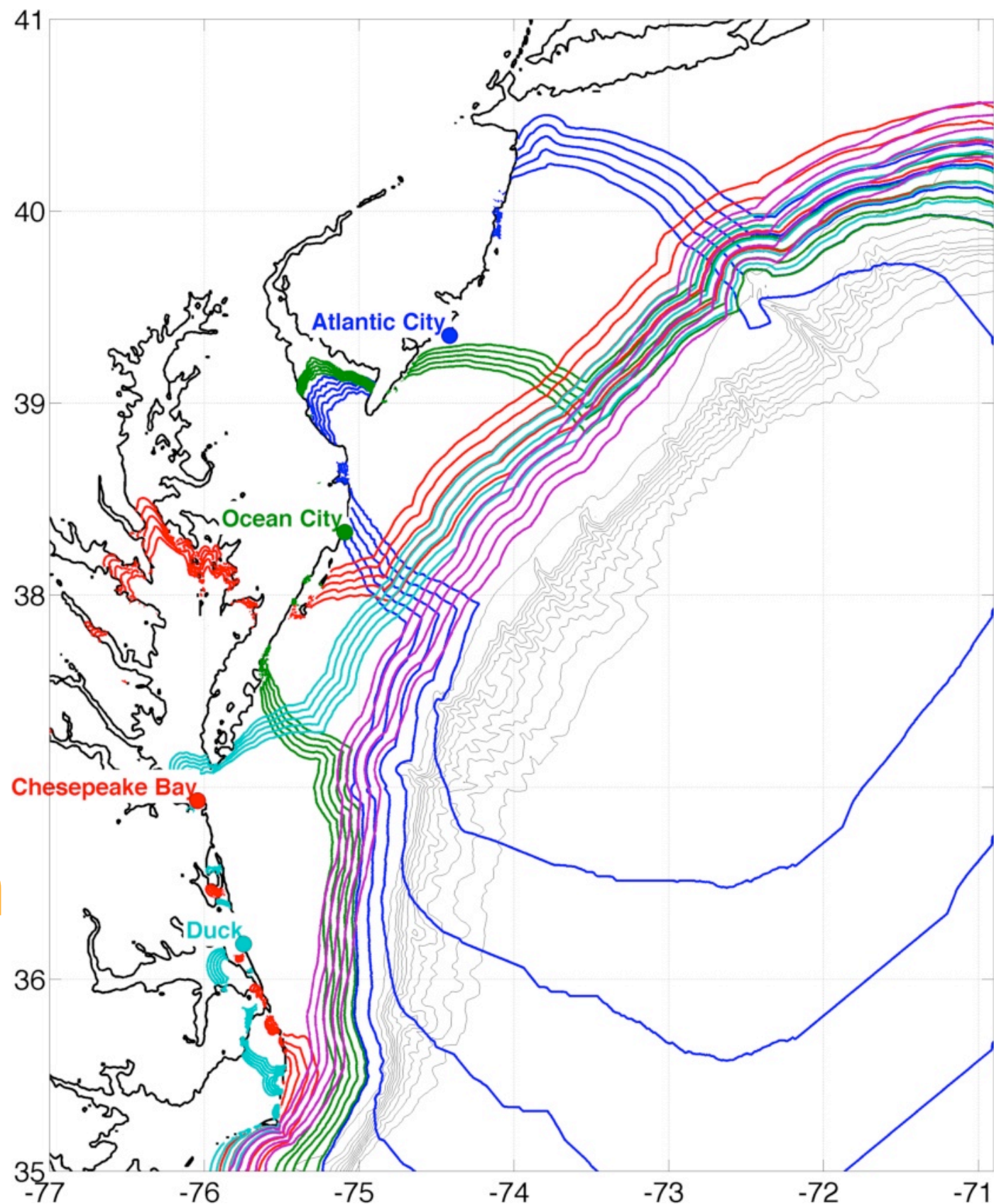
- Reverse isochrons calculated from each gauge and DART
- Contours of time from arrival time estimates
- Overlap shows possible forcing region



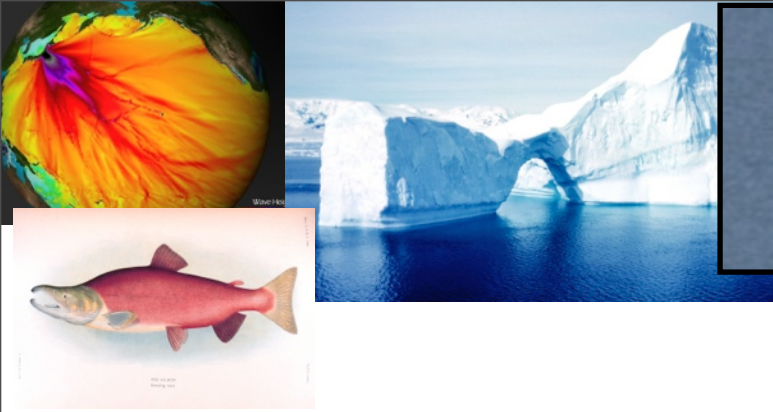
Identifying forcing region



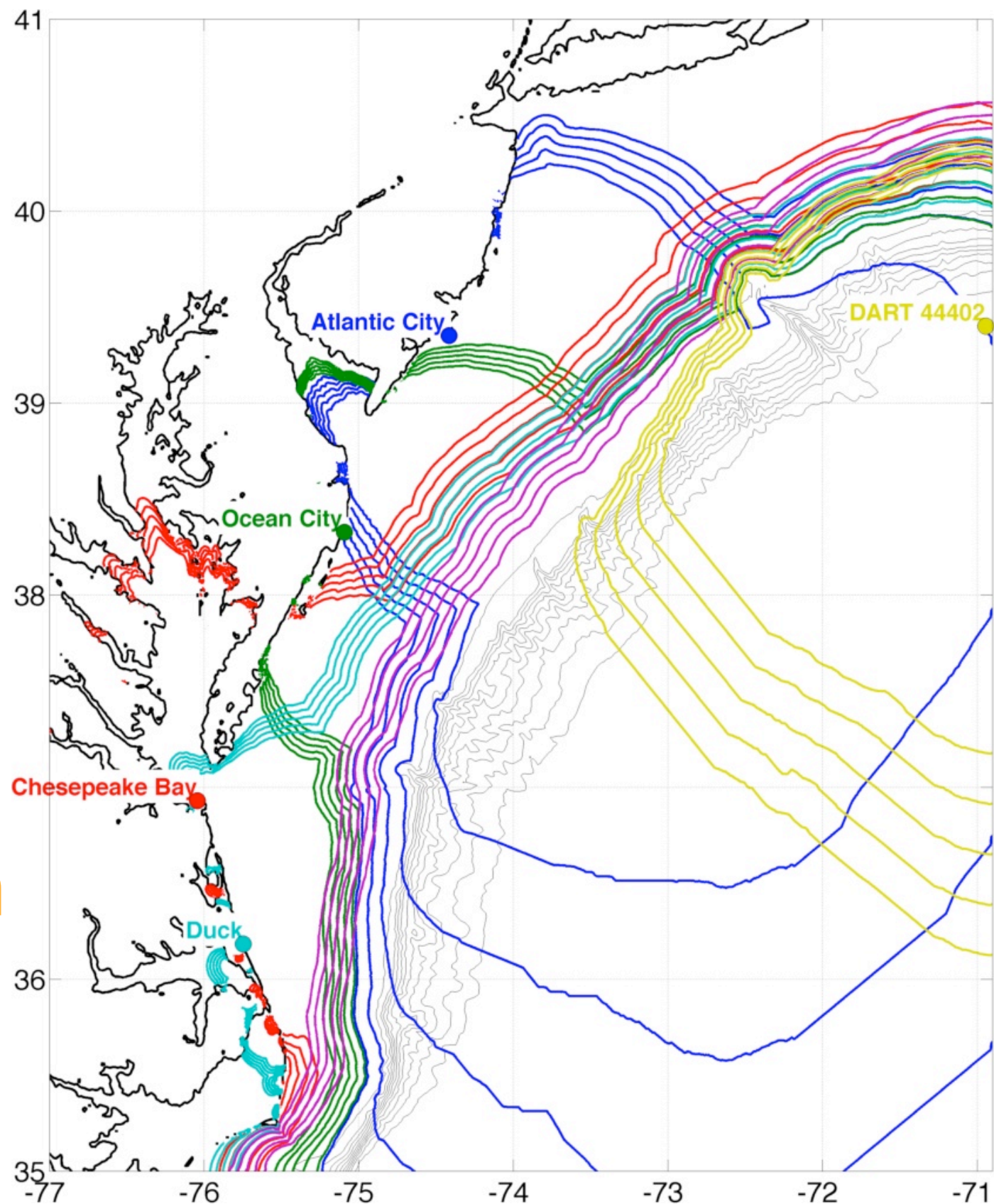
- Reverse isochrons calculated from each gauge and DART
- Contours of time from arrival time estimates
- Overlap shows possible forcing region



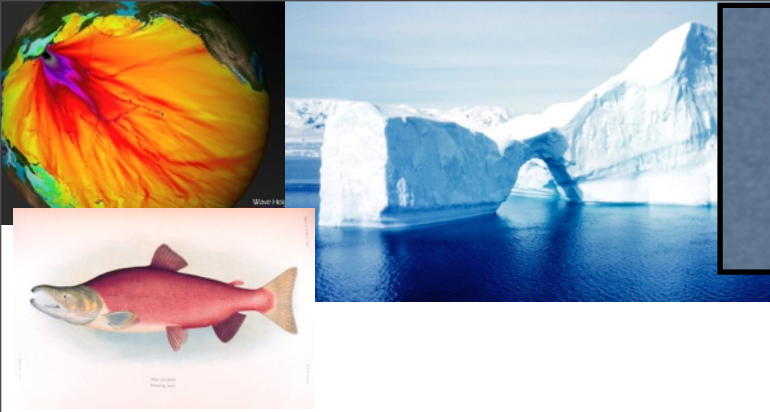
Identifying forcing region



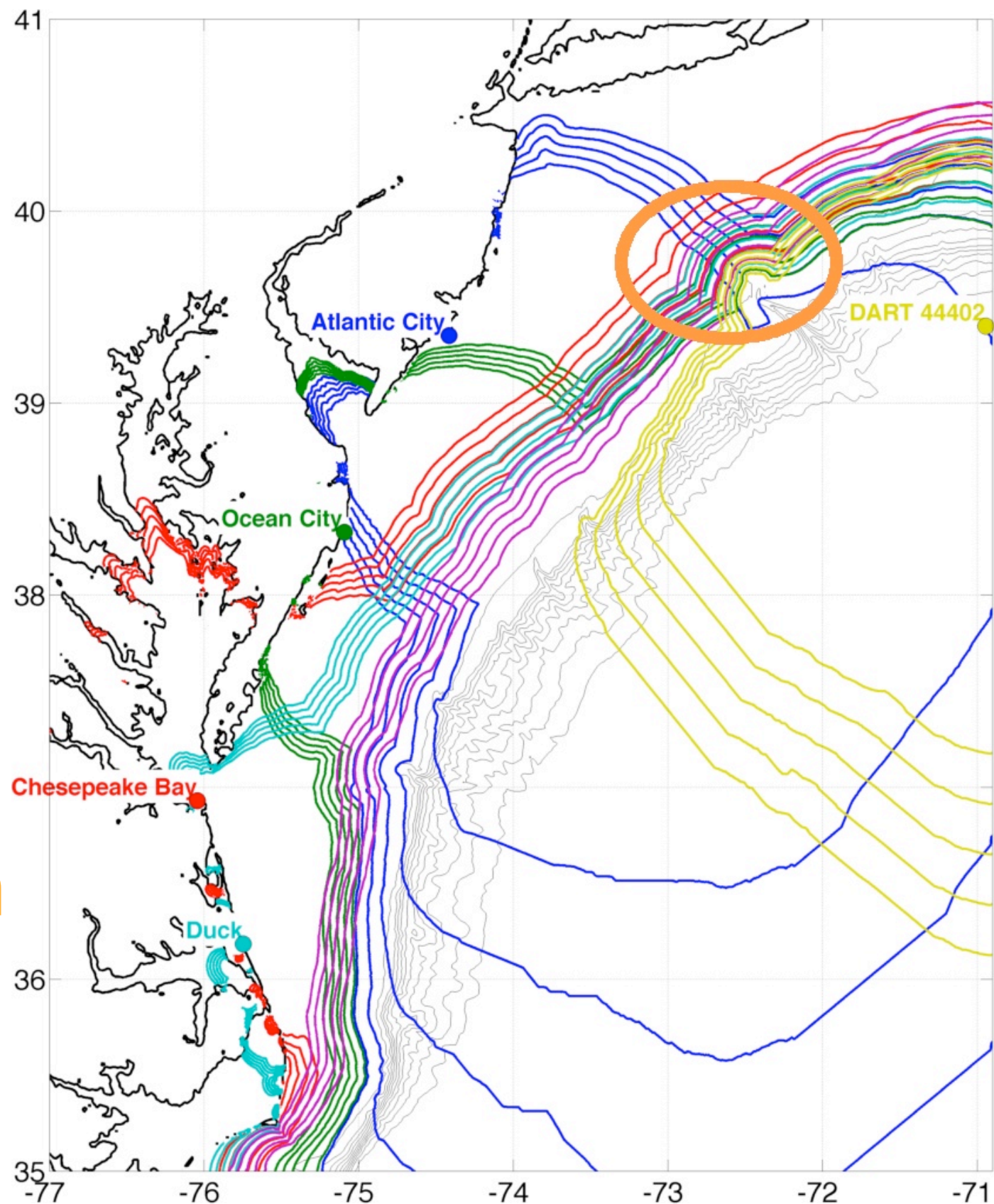
- Reverse isochrons calculated from each gauge and DART
- Contours of time from arrival time estimates
- Overlap shows possible forcing region



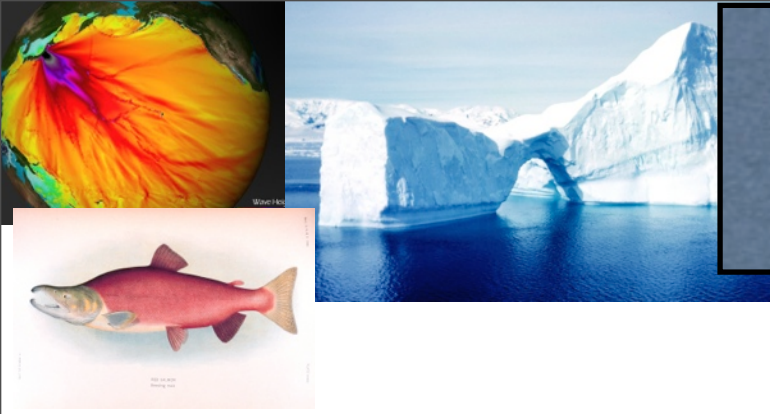
Identifying forcing region



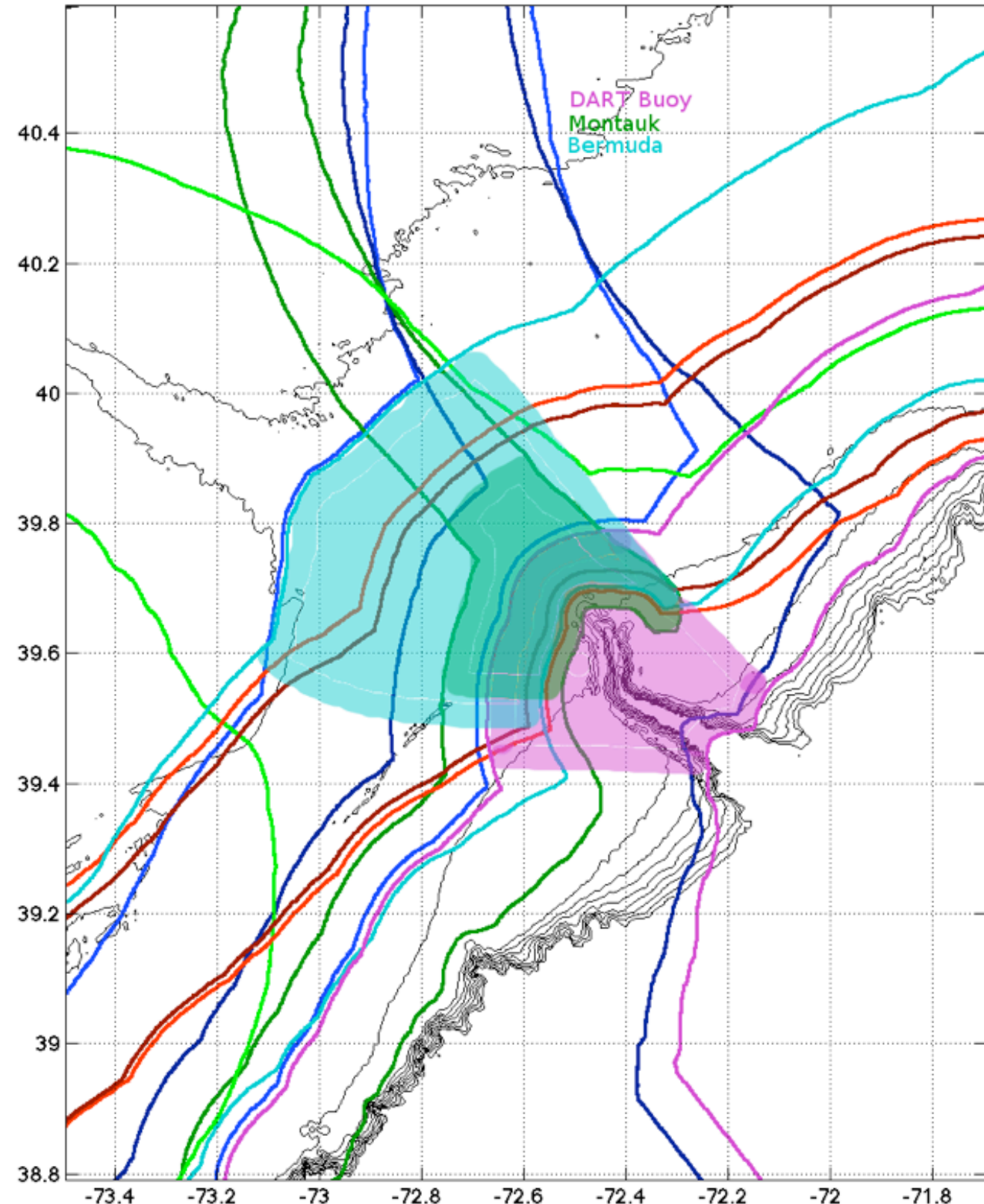
- Reverse isochrons calculated from each gauge and DART
- Contours of time from arrival time estimates
- Overlap shows possible forcing region



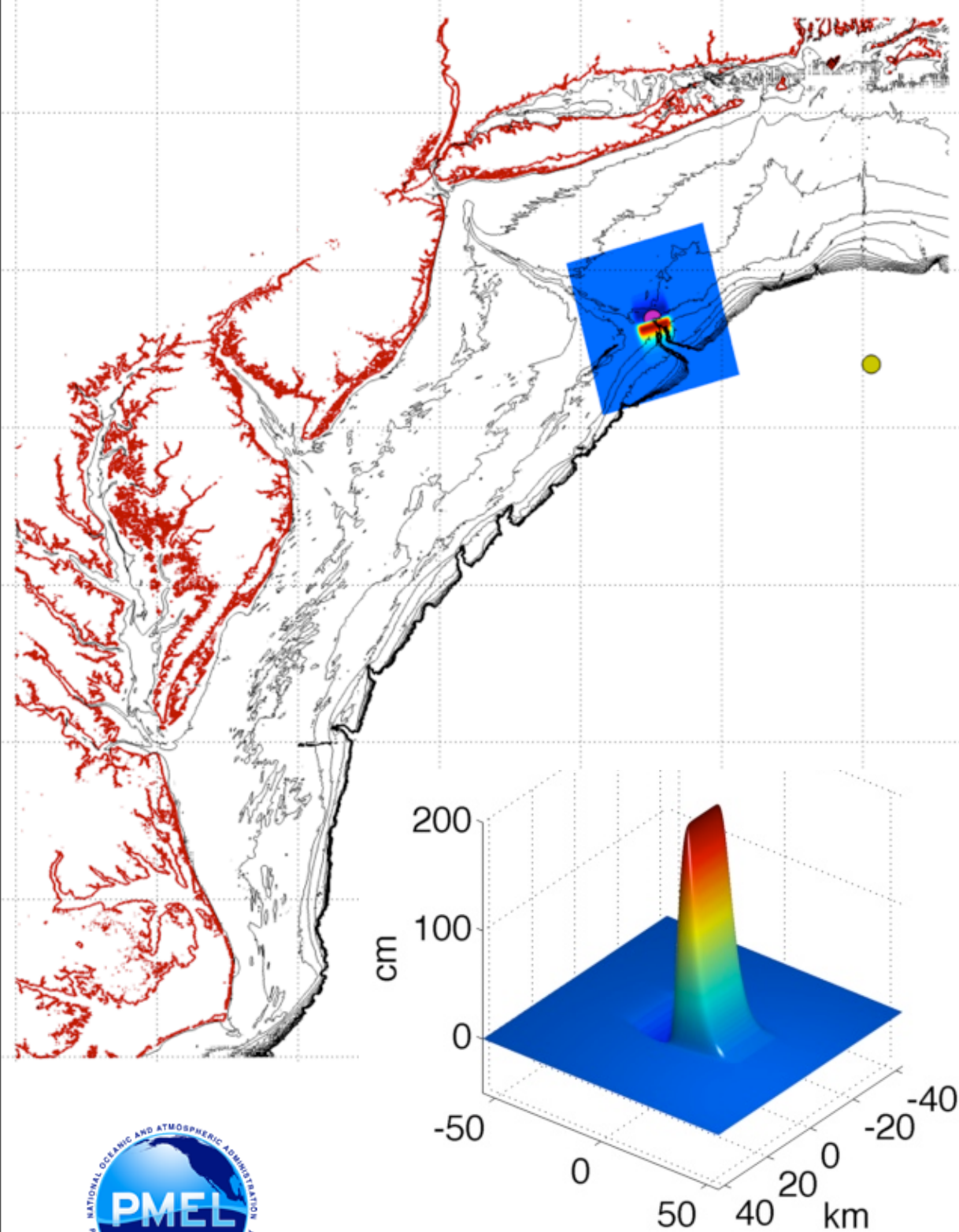
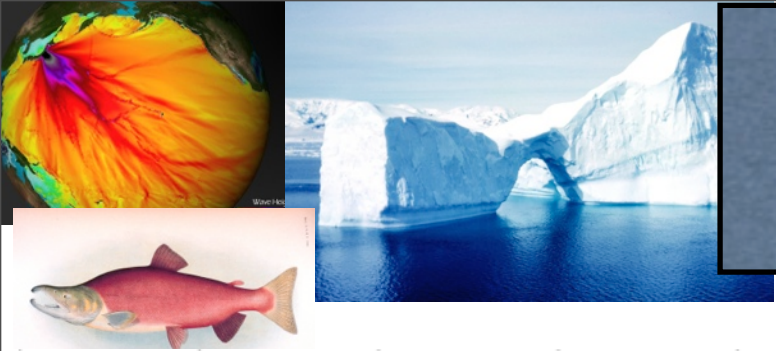
Identifying forcing region



- Start and end times shaded for major gauges
- All gauges overlap at head of Hudson Canyon



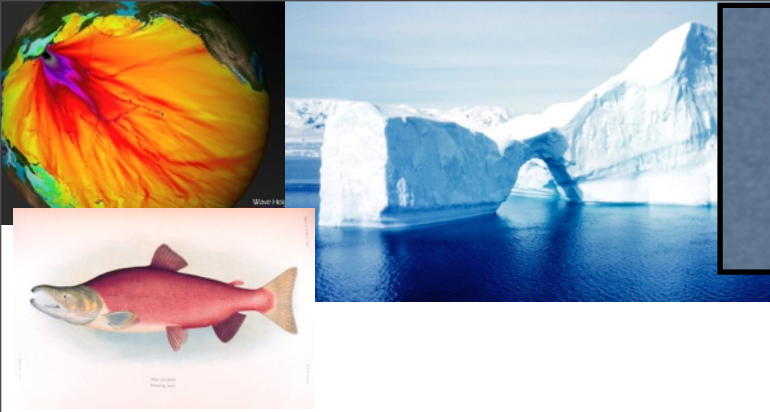
Preliminary model runs



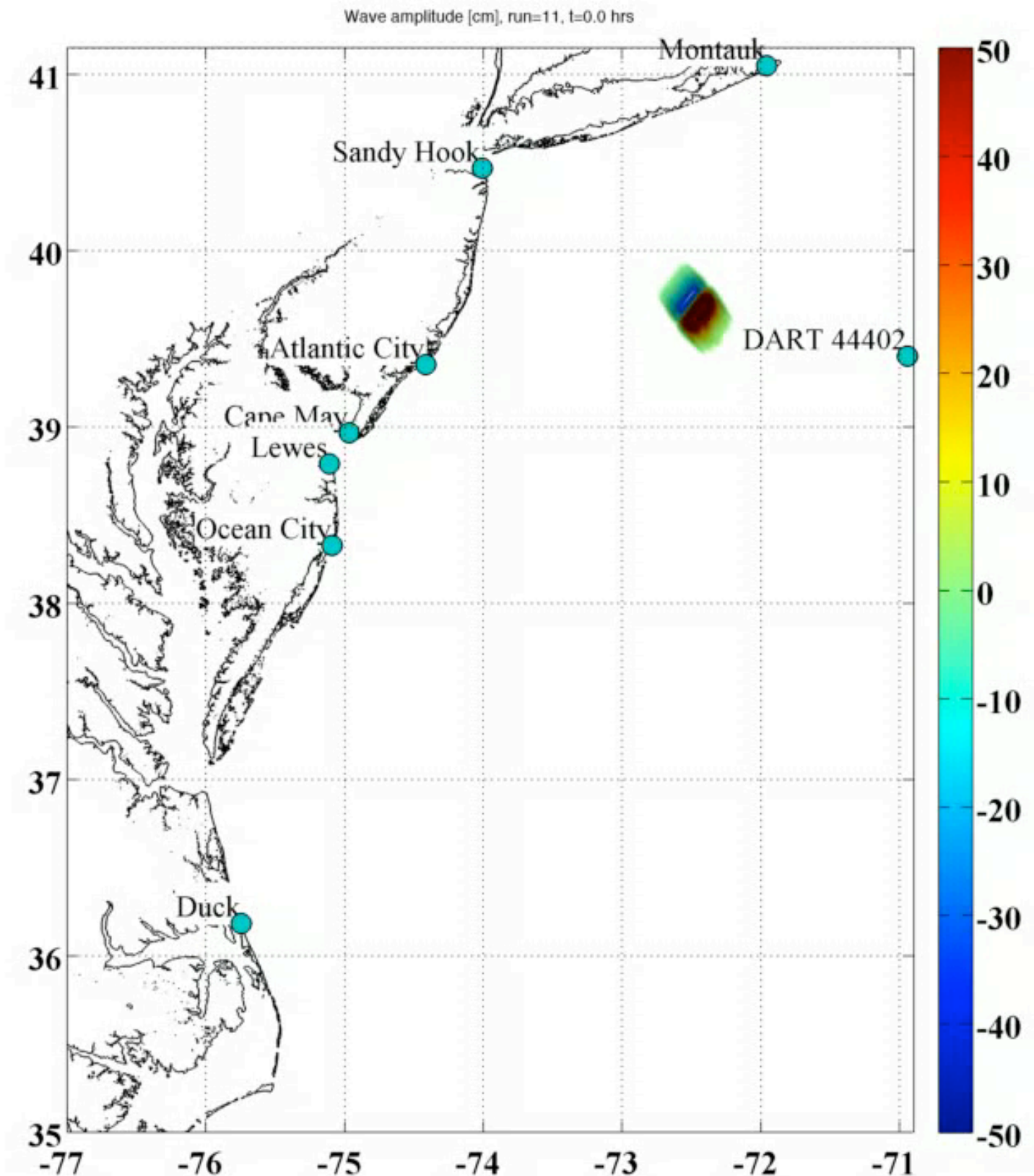
- A short landslide study at the forcing region
- Parameters varied:
 - locations (Hudson Canyon)
 - orientations
 - wavelengths = 10-30 km
 - widths = 5-20 km
 - max amps = 20-300 cm



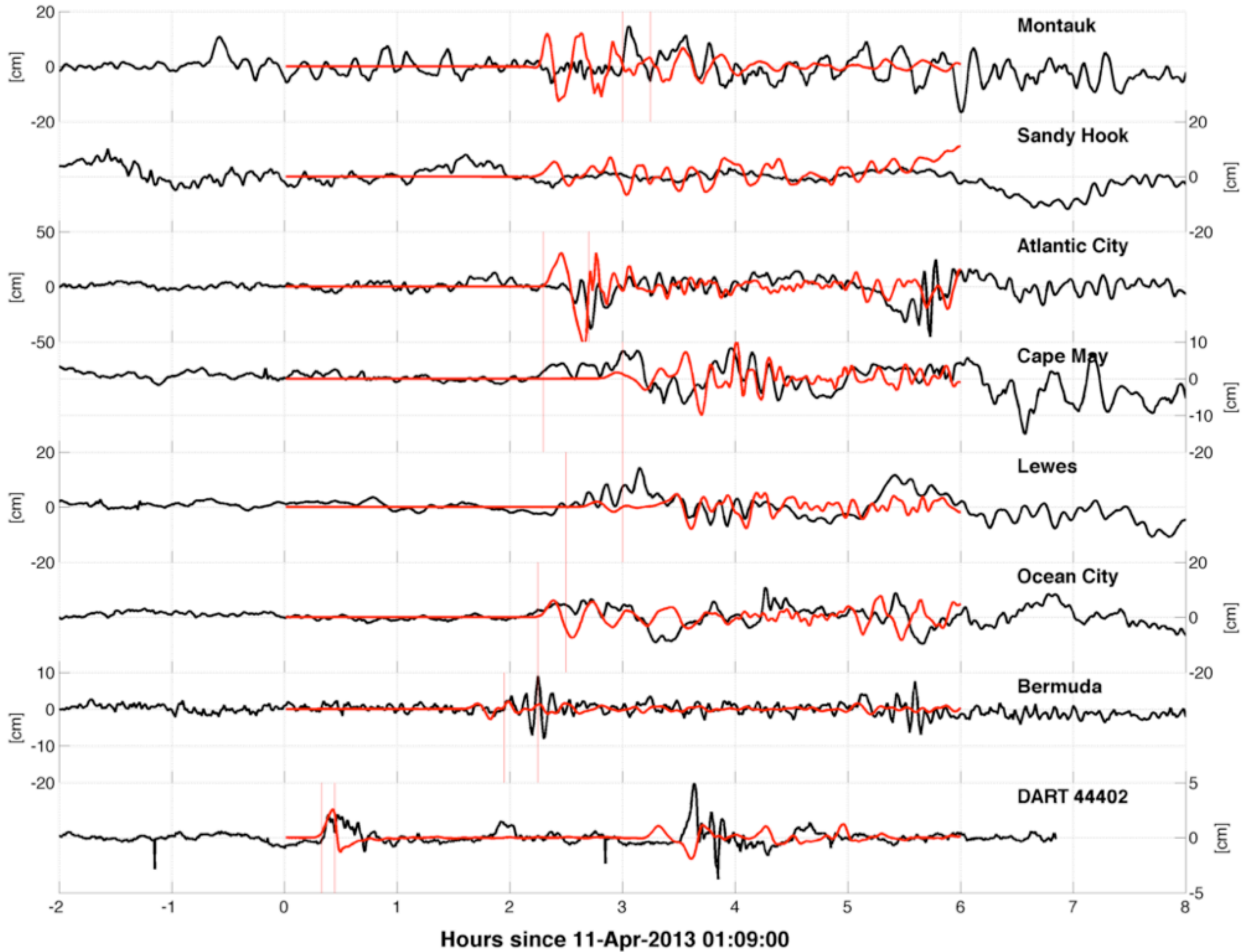
Preliminary model runs



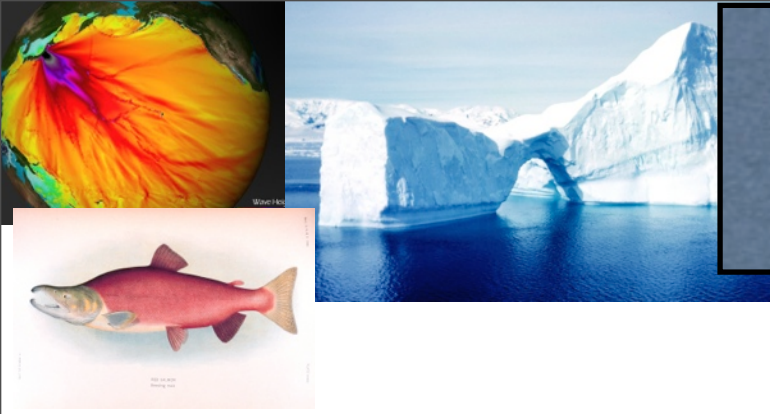
- First wave at DART arrives directly
- Second wave at DART is reflection off Long Island
- Wave arrival times approximate gauge data
- Reflects from shelf edge
- Very sensitive to direction



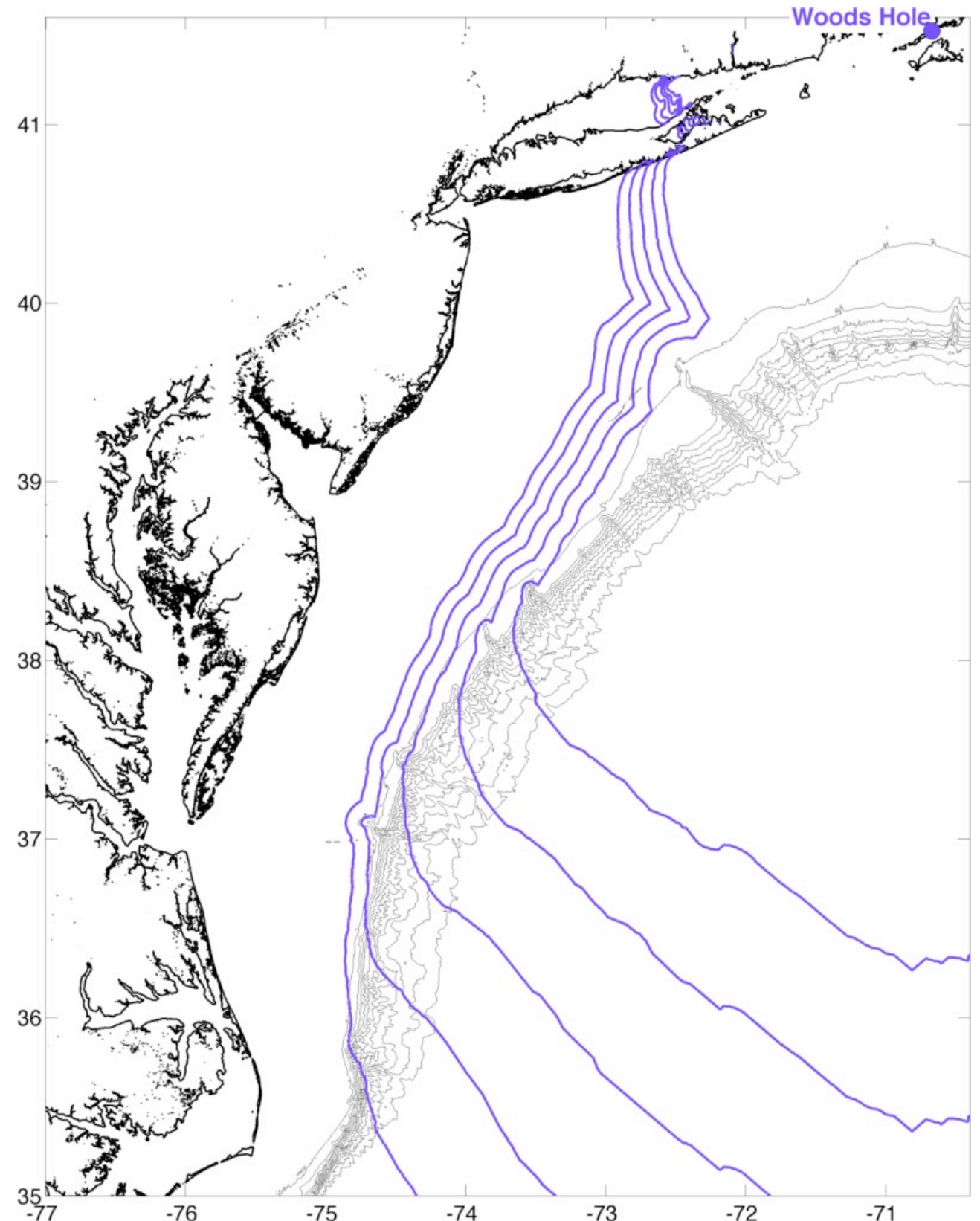
Run=13, $\lambda = 10.00$ [km], len=20.00 [km], maxamp=150.00 [cm], aspect=0.2500



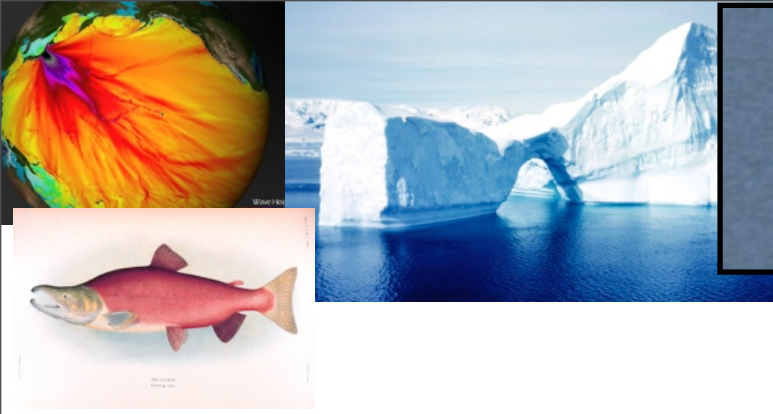
2nd event: 13 June 2013



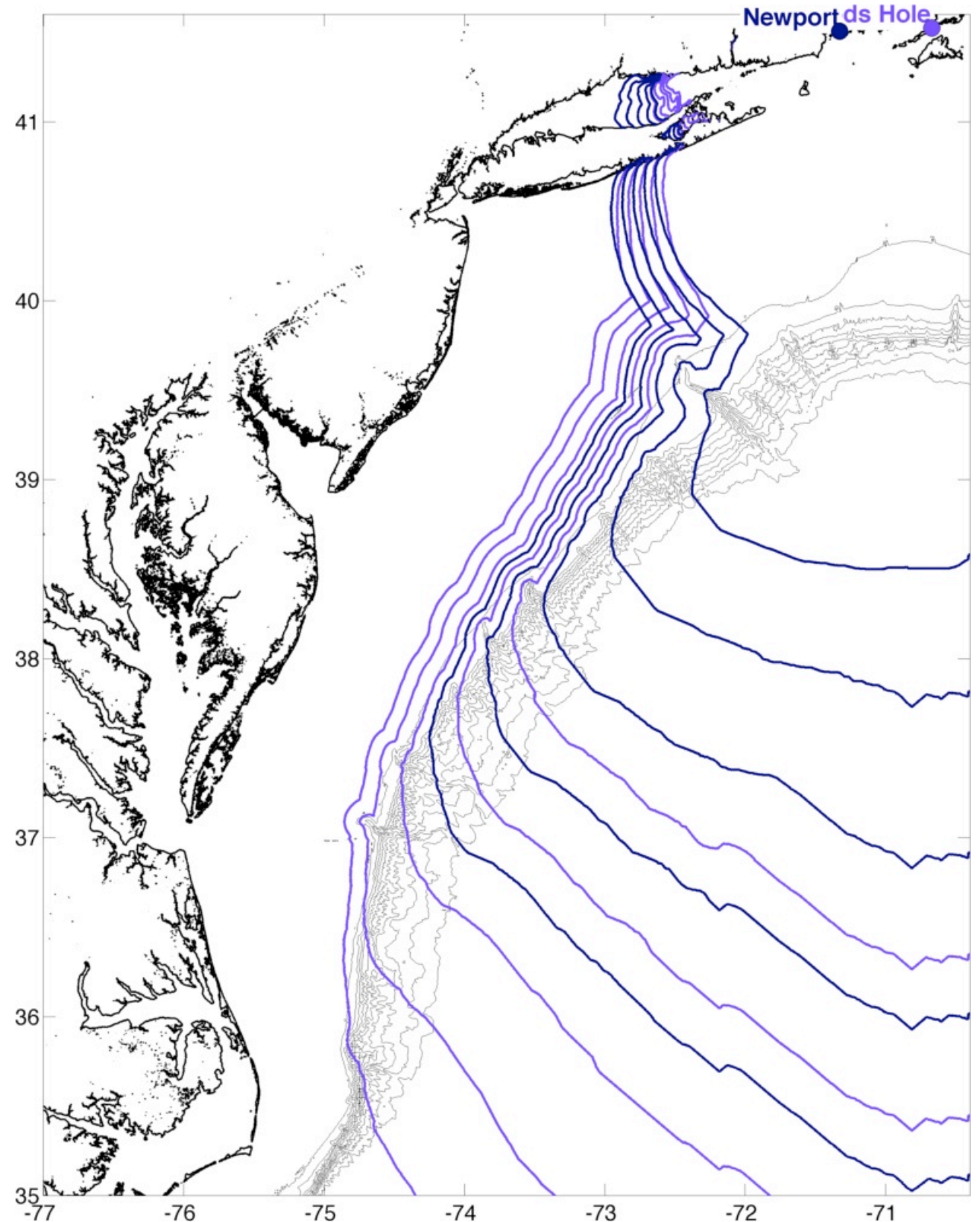
- Stronger event
- Reverse isochrons show a similar forcing region
- Waves seen in gauges as far away as Bermuda and Puerto Rico



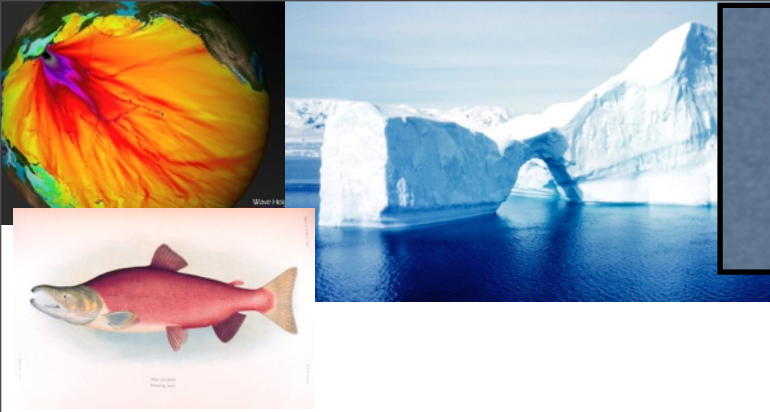
2nd event: 13 June 2013



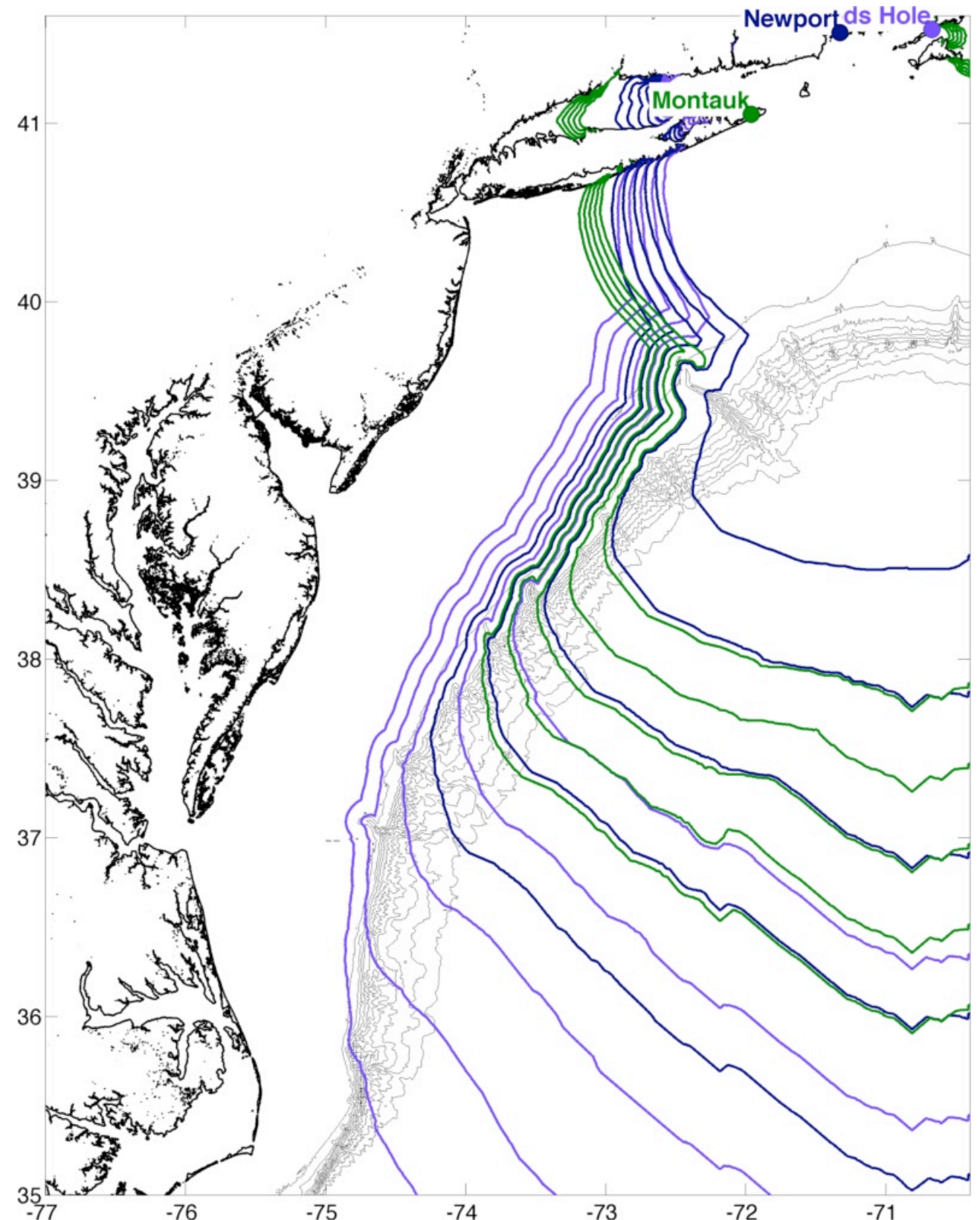
- Stronger event
- Reverse isochrons show a similar forcing region
- Waves seen in gauges as far away as Bermuda and Puerto Rico



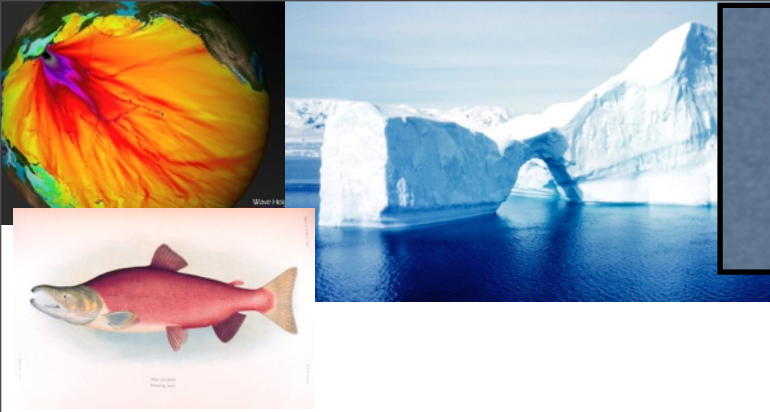
2nd event: 13 June 2013



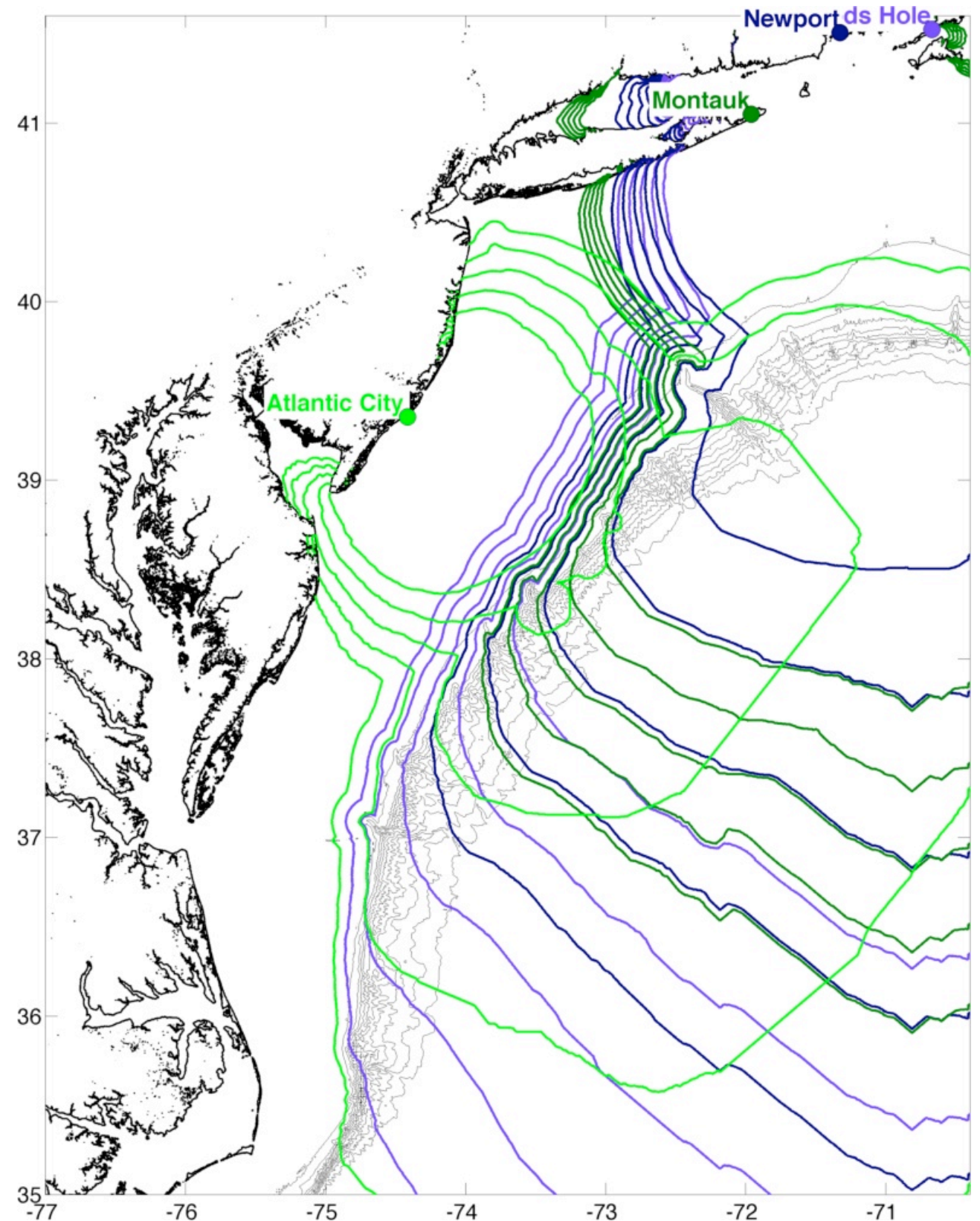
- Stronger event
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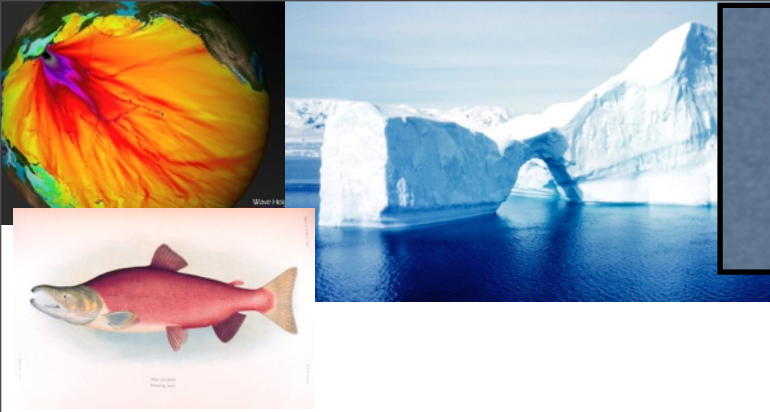
2nd event: 13 June 2013



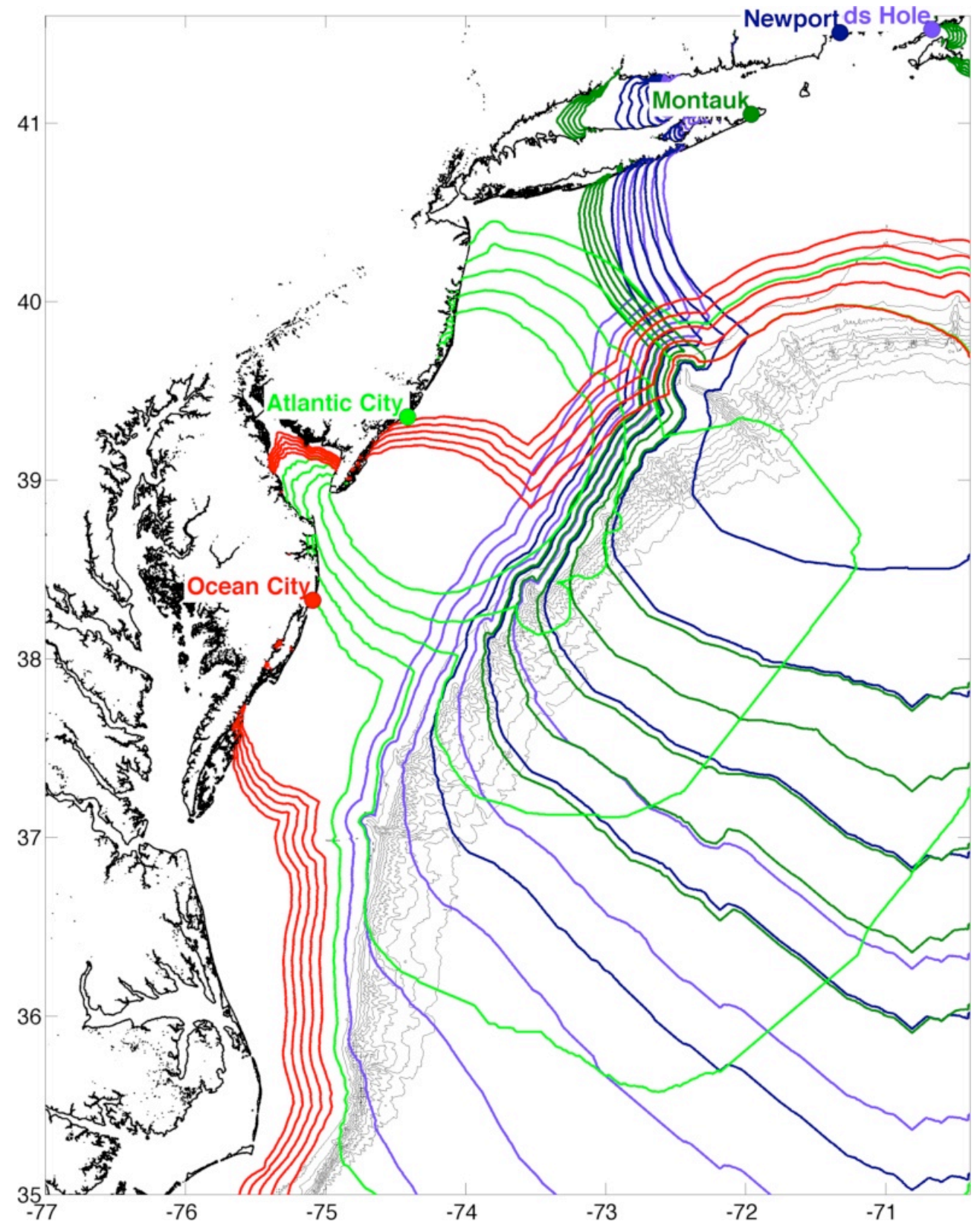
- Stronger event
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- Waves seen in gauges as far away as Bermuda and Puerto Rico



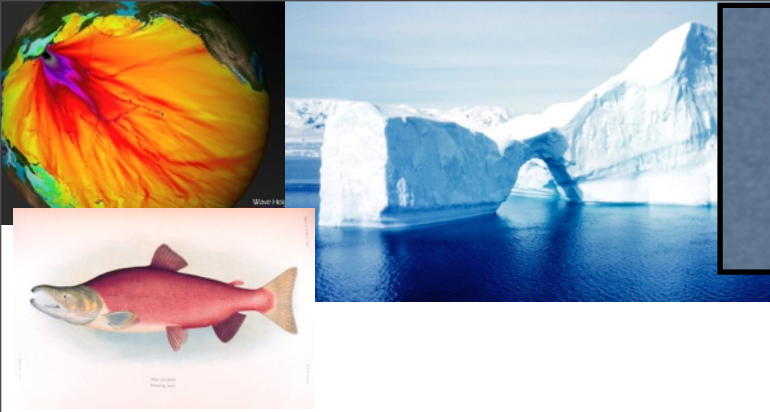
2nd event: 13 June 2013



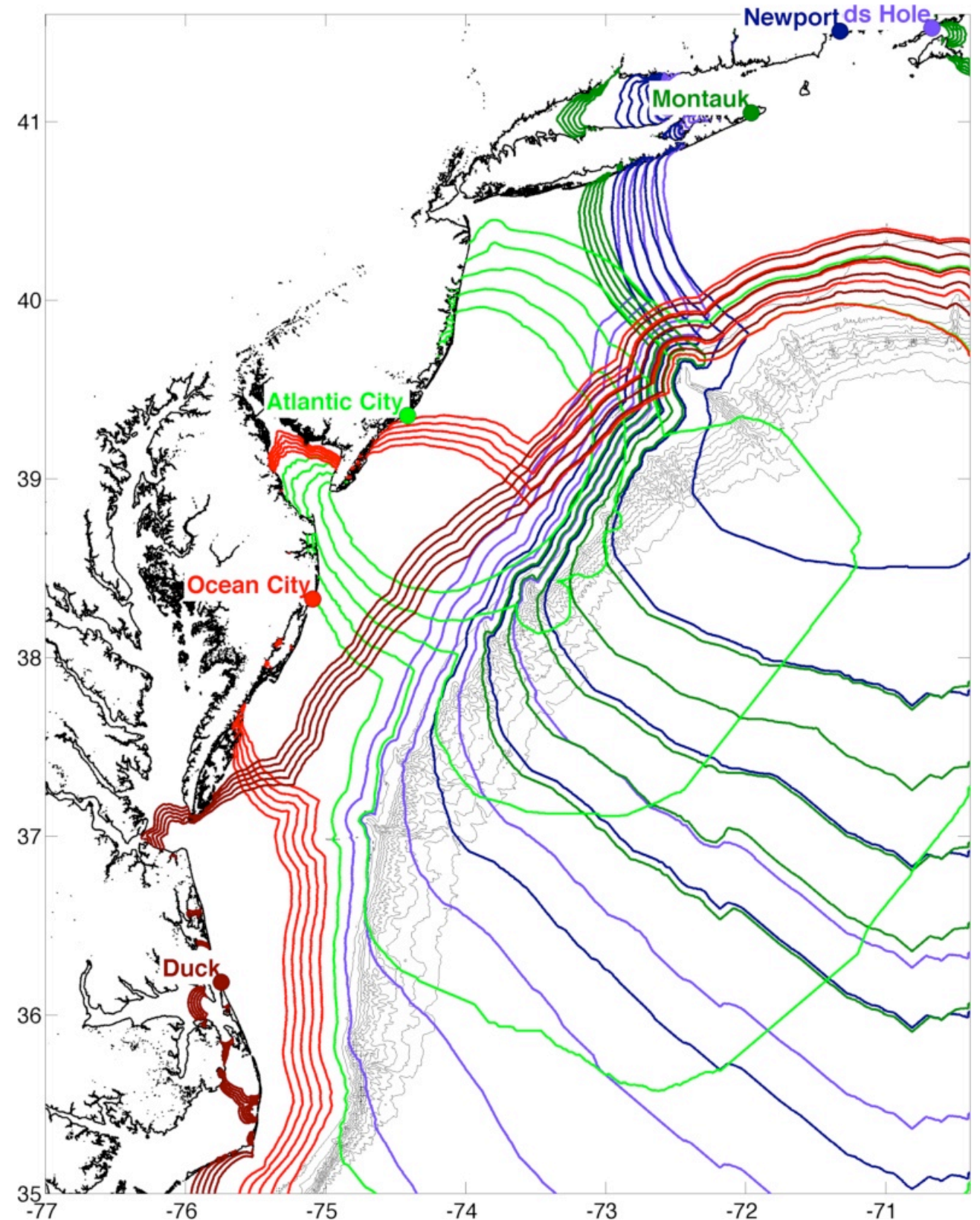
- Stronger event
- Reverse isochrons show a similar forcing region
- Waves seen in gauges as far away as Bermuda and Puerto Rico



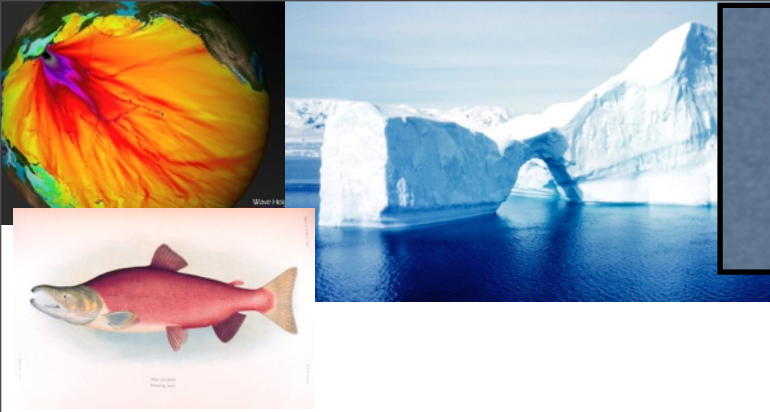
2nd event: 13 June 2013



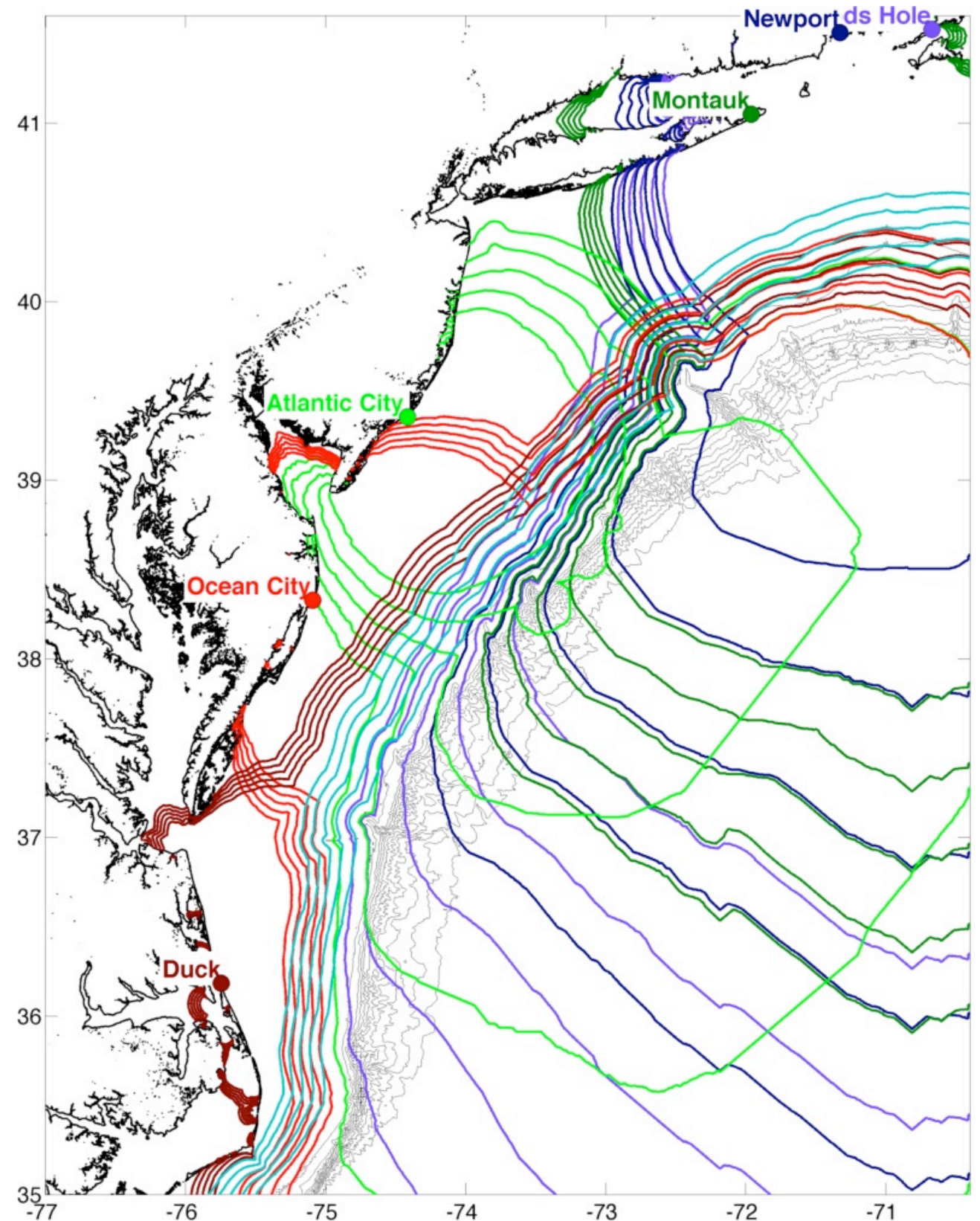
- Stronger event
- Reverse isochrons show a similar forcing region
- Waves seen in gauges as far away as Bermuda and Puerto Rico



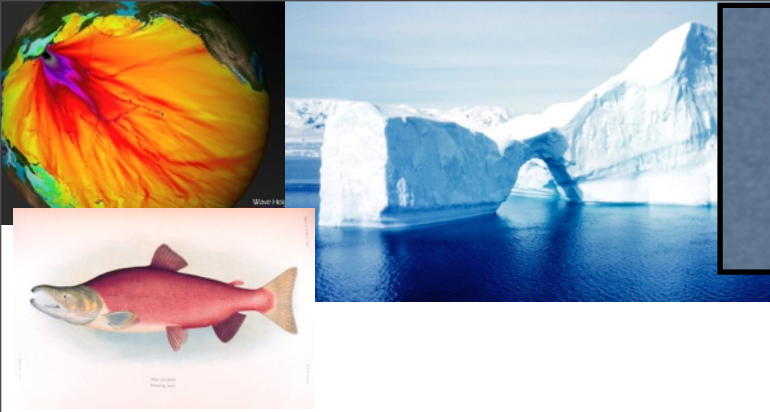
2nd event: 13 June 2013



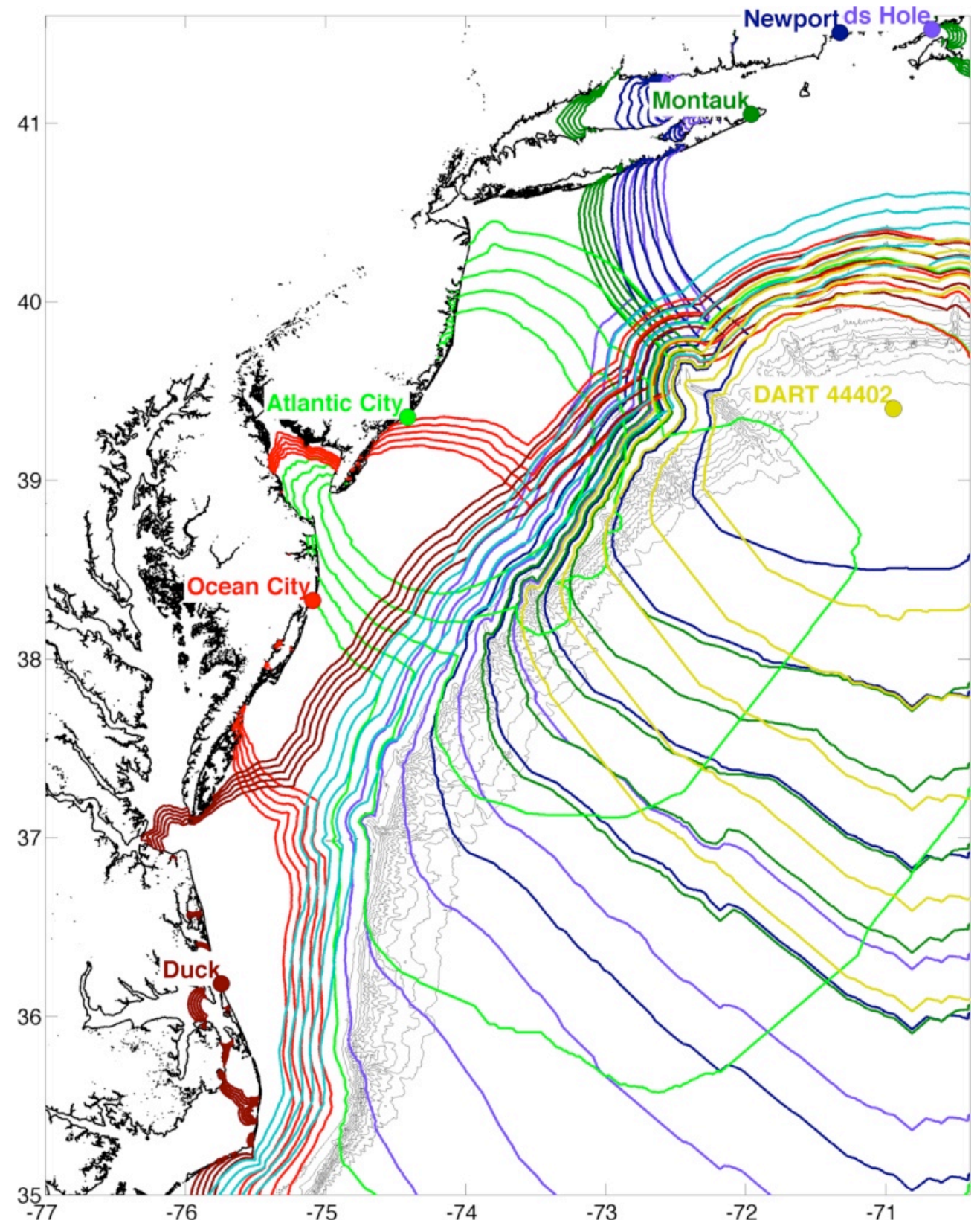
- Stronger event
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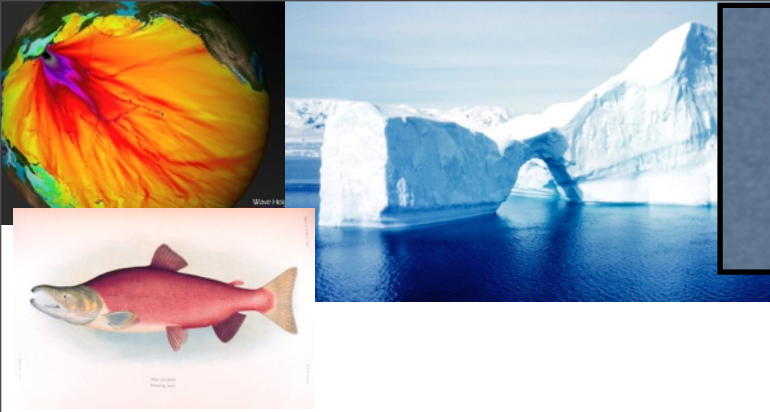
2nd event: 13 June 2013



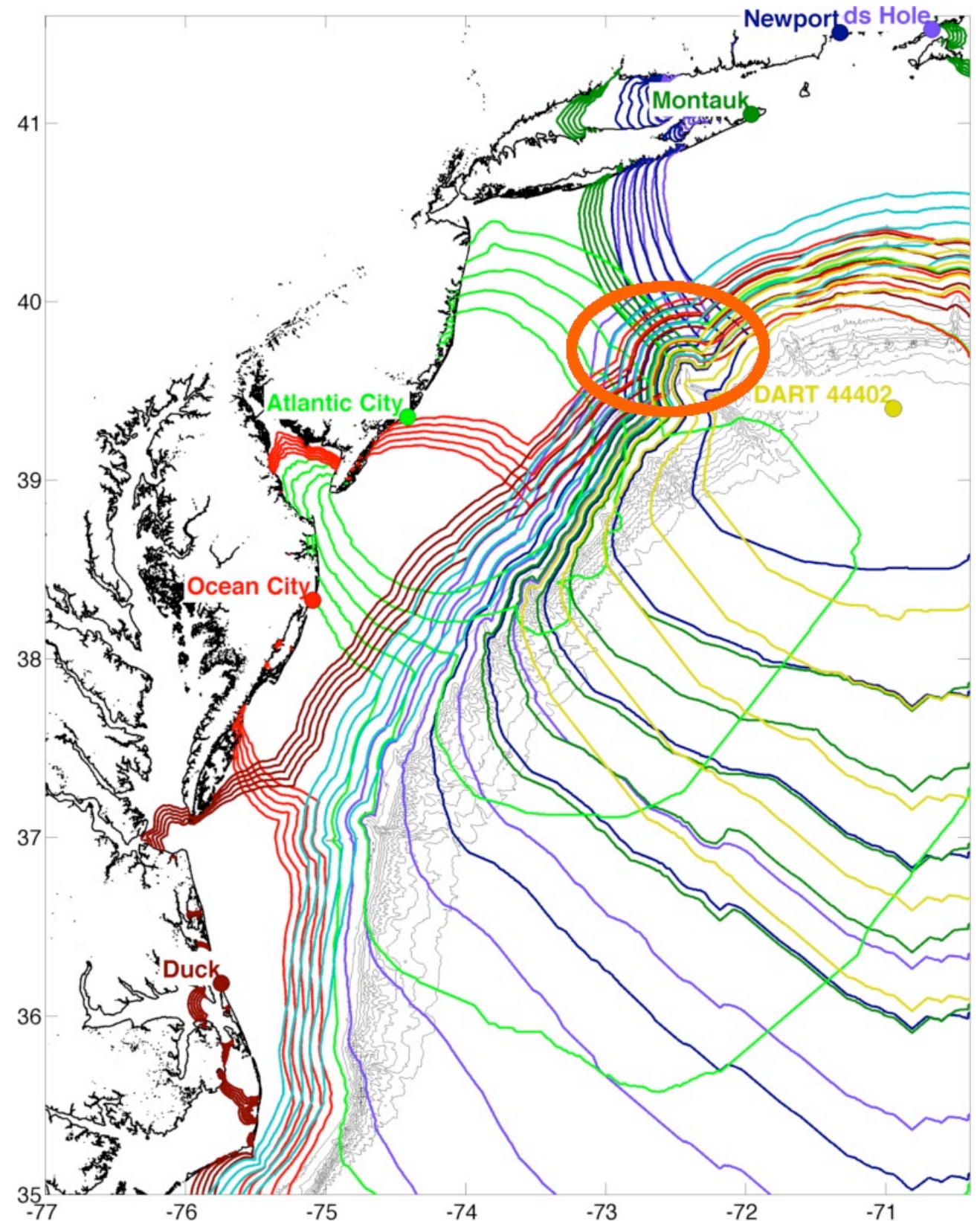
- Stronger event
- Reverse isochrons show a similar forcing region
- Waves seen in gauges as far away as Bermuda and Puerto Rico

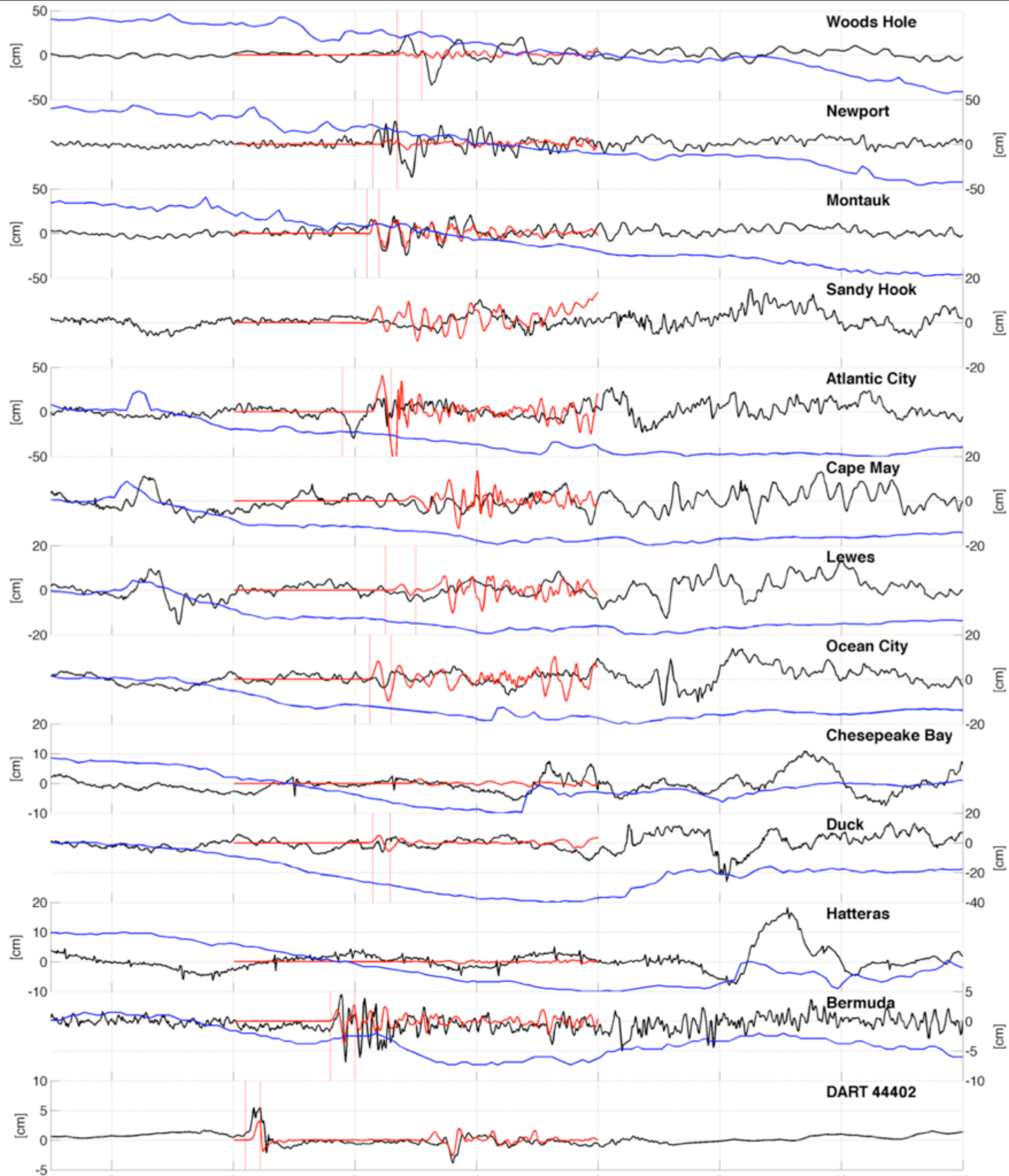


2nd event: 13 June 2013



- Stronger event
- Reverse isochrons show a similar forcing region
- Waves seen in gauges as far away as Bermuda and Puerto Rico

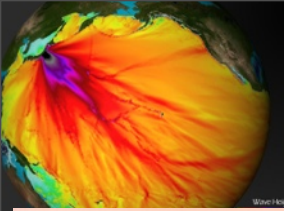




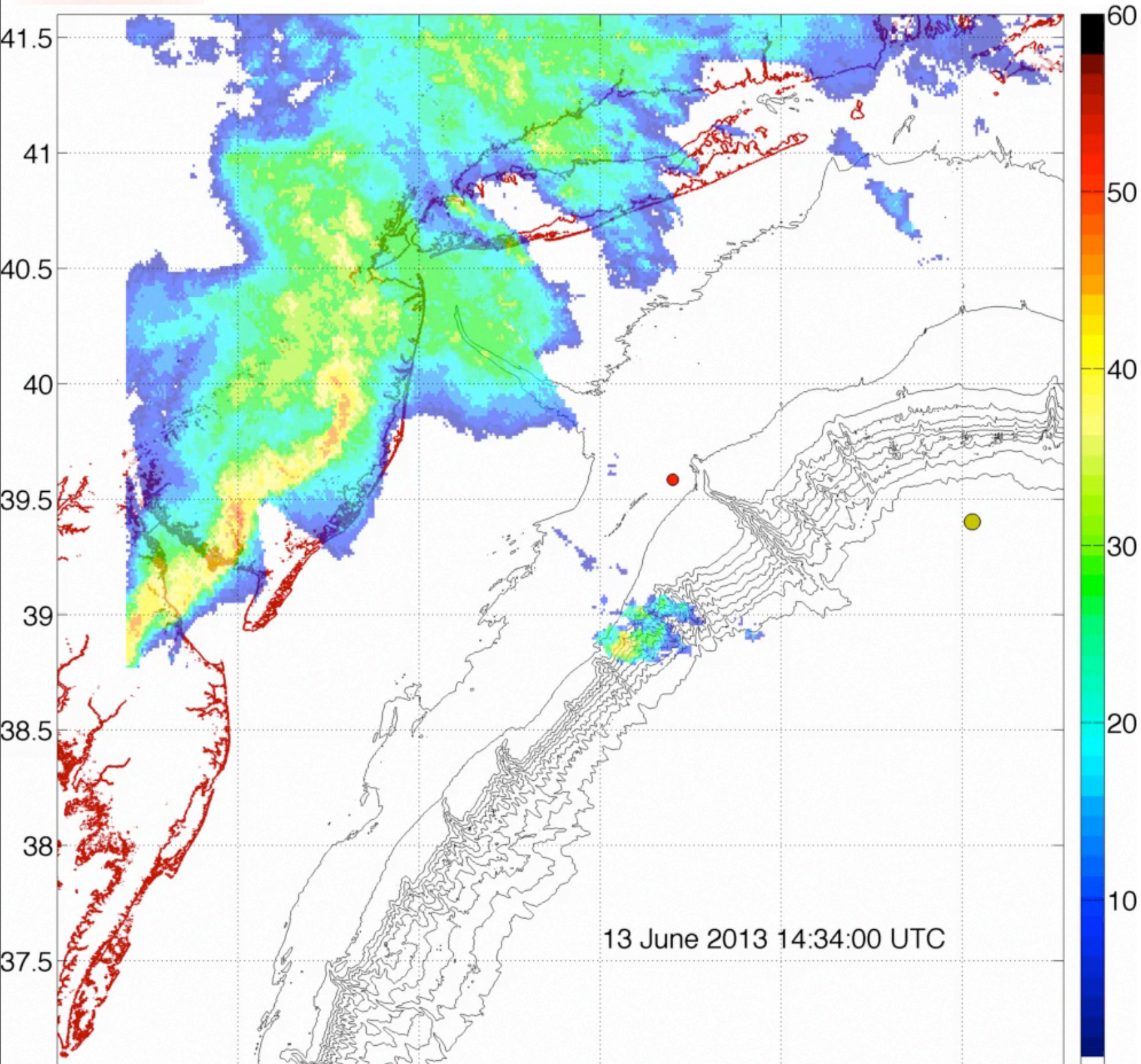
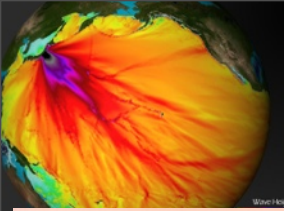
Black = Gauge
 Red = Model
 Blue = Atmos. press

Initial runs chosen
 from landslide sources
 run for 11 April event

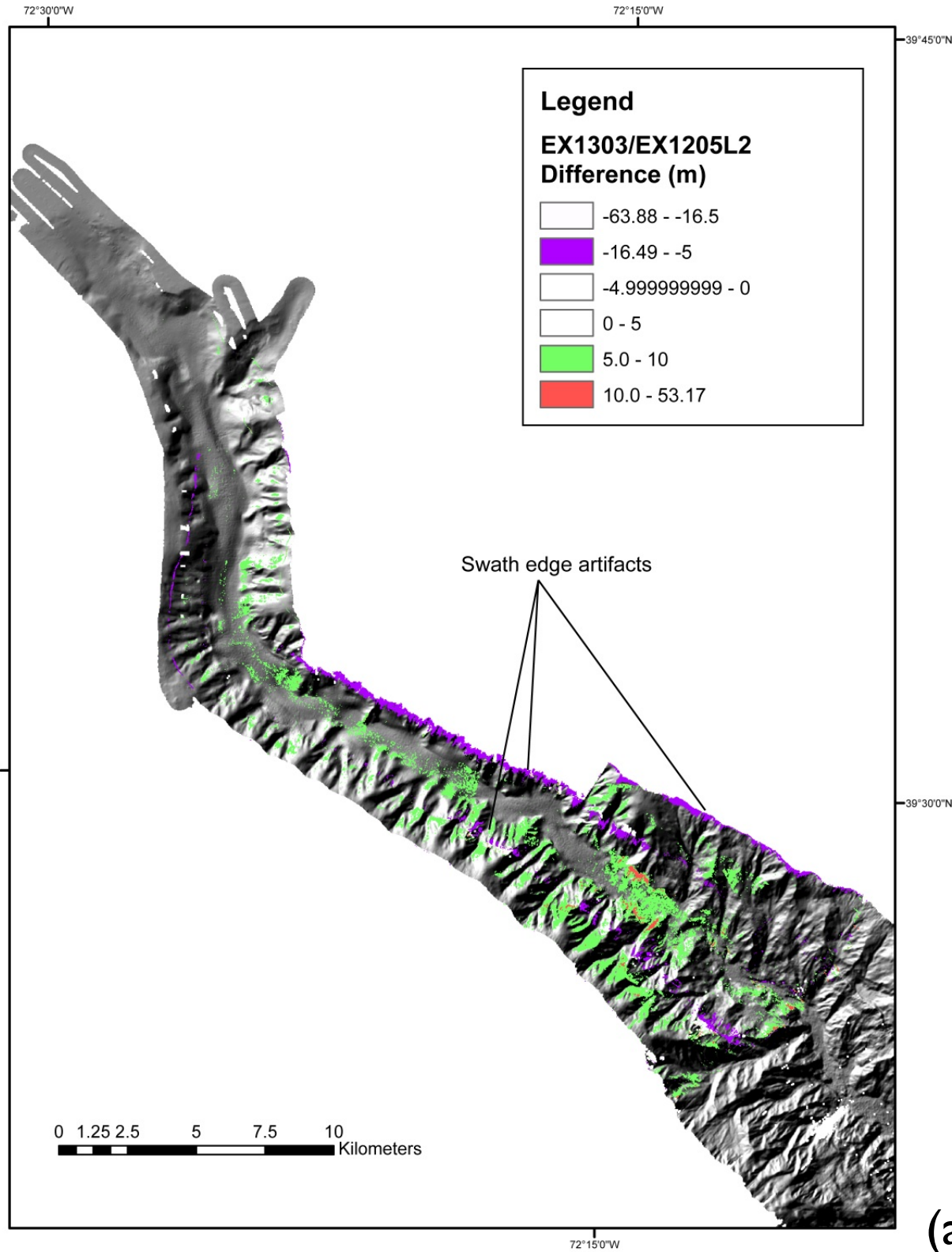
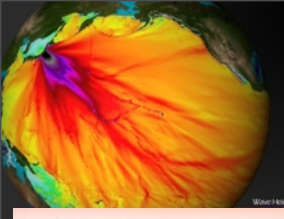
High Wind Event



High Wind Event



Hydrographic Survey

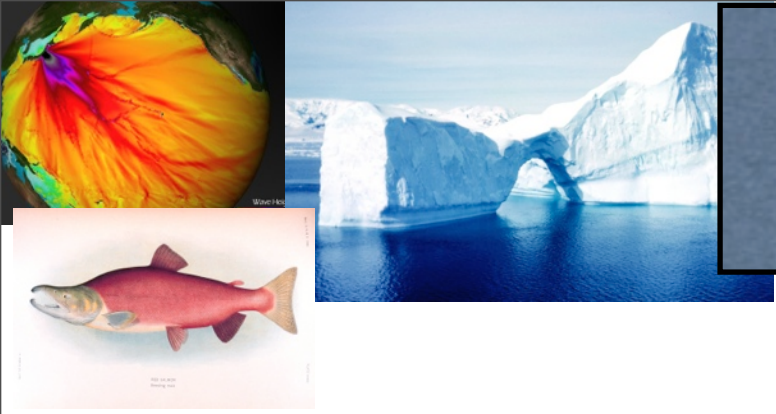


- Okeanos Explorer survey
- Differences show very small debris field (green)
- No evidence of *large* slide
- Provided high-resolution bathymetry for model

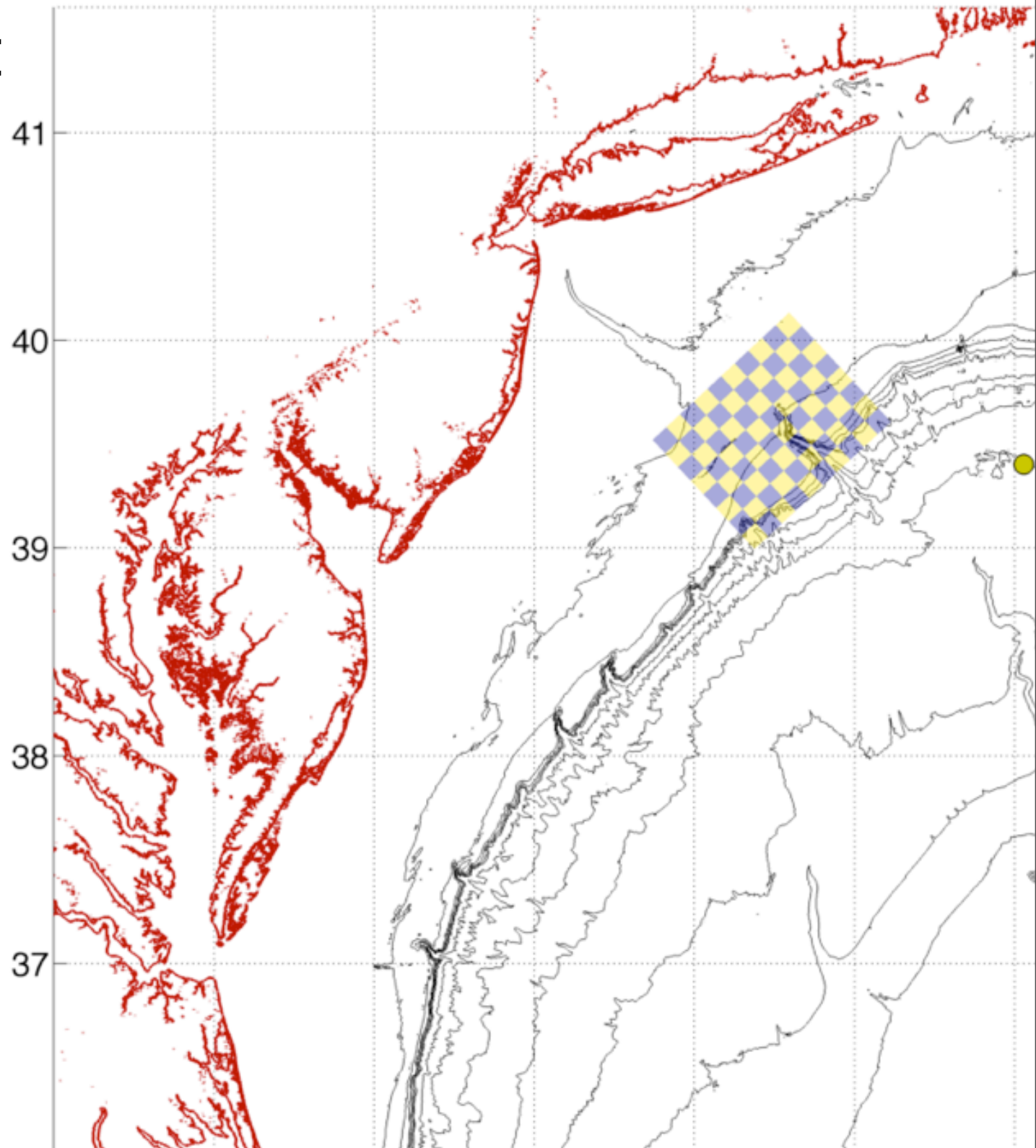
(analysis courtesy of Jason Chaytor, USGS)



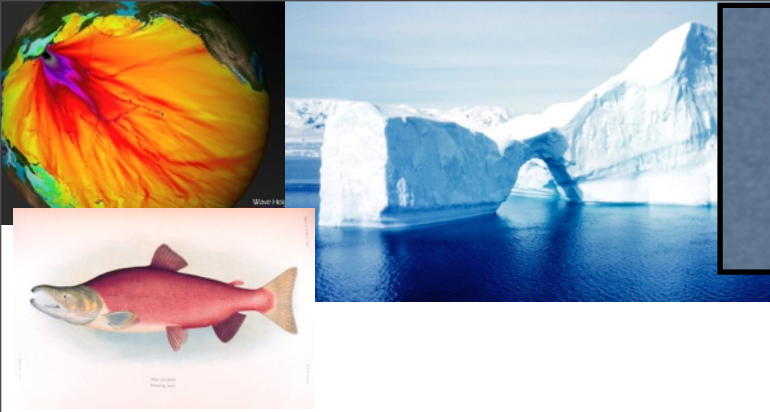
Invert against DART



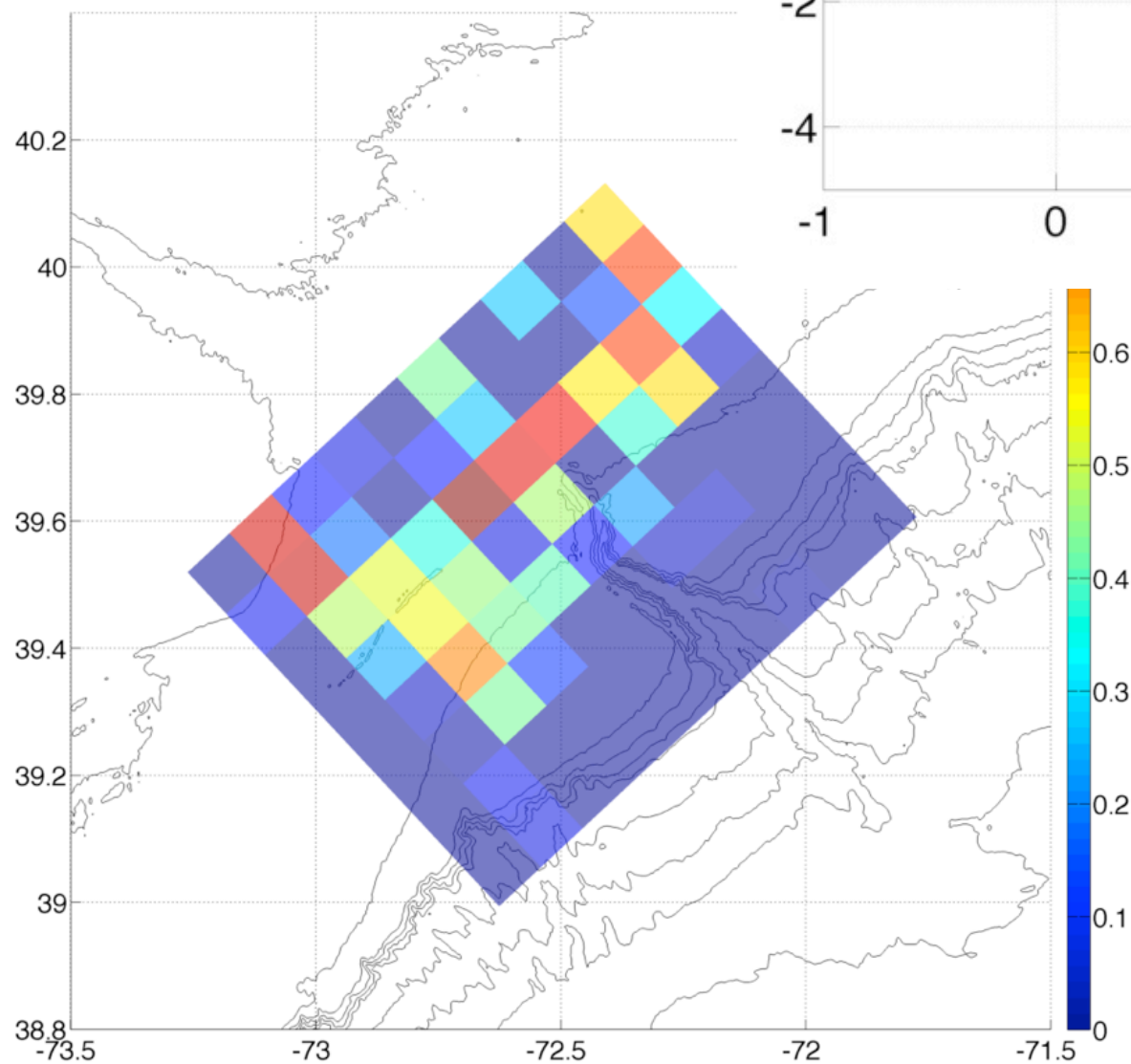
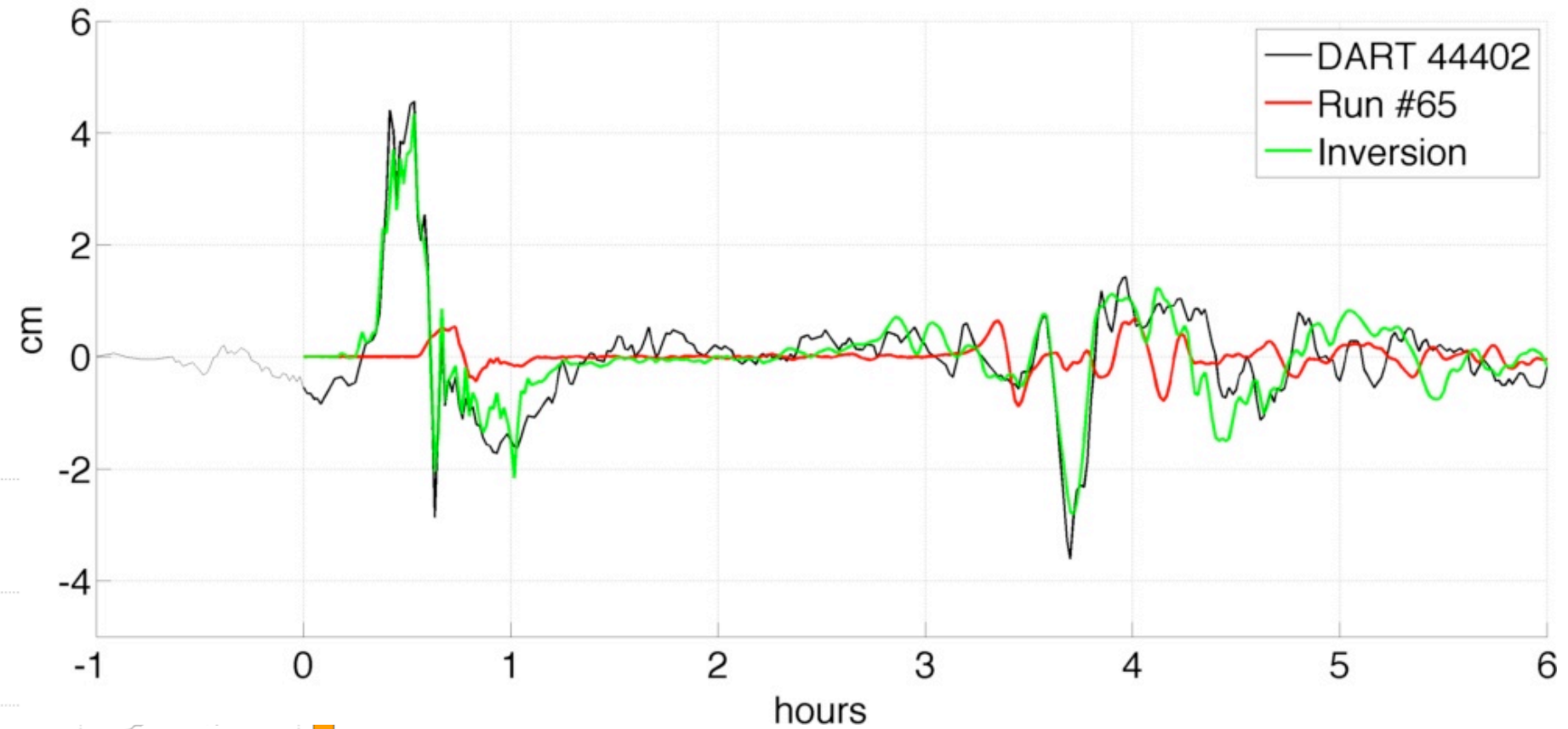
- Find an initial condition that fits offshore data
- Compare result to onshore gauges
- Use sources drawn from landslide study:
 - 10 km x 10 km by 1 m
 - 80 sources covering shelf near Hudson Canyon head



Inversion result



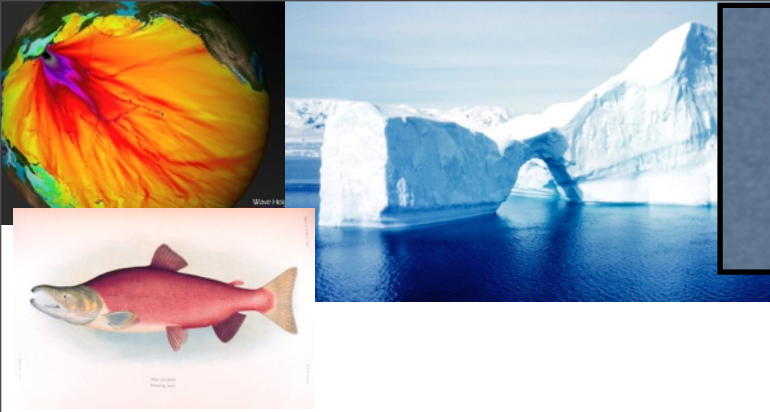
Inversion: 1, $r=0.88$



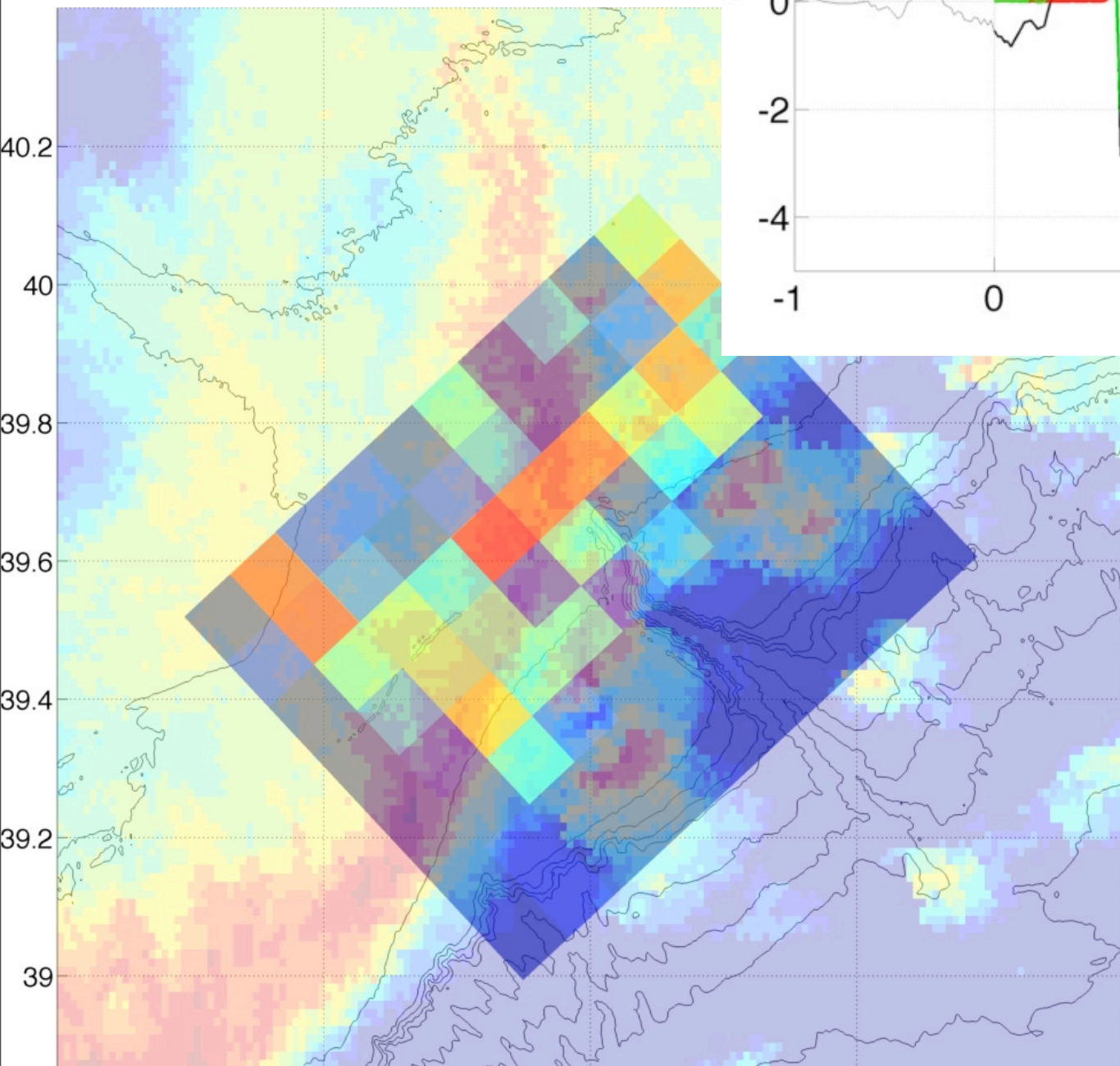
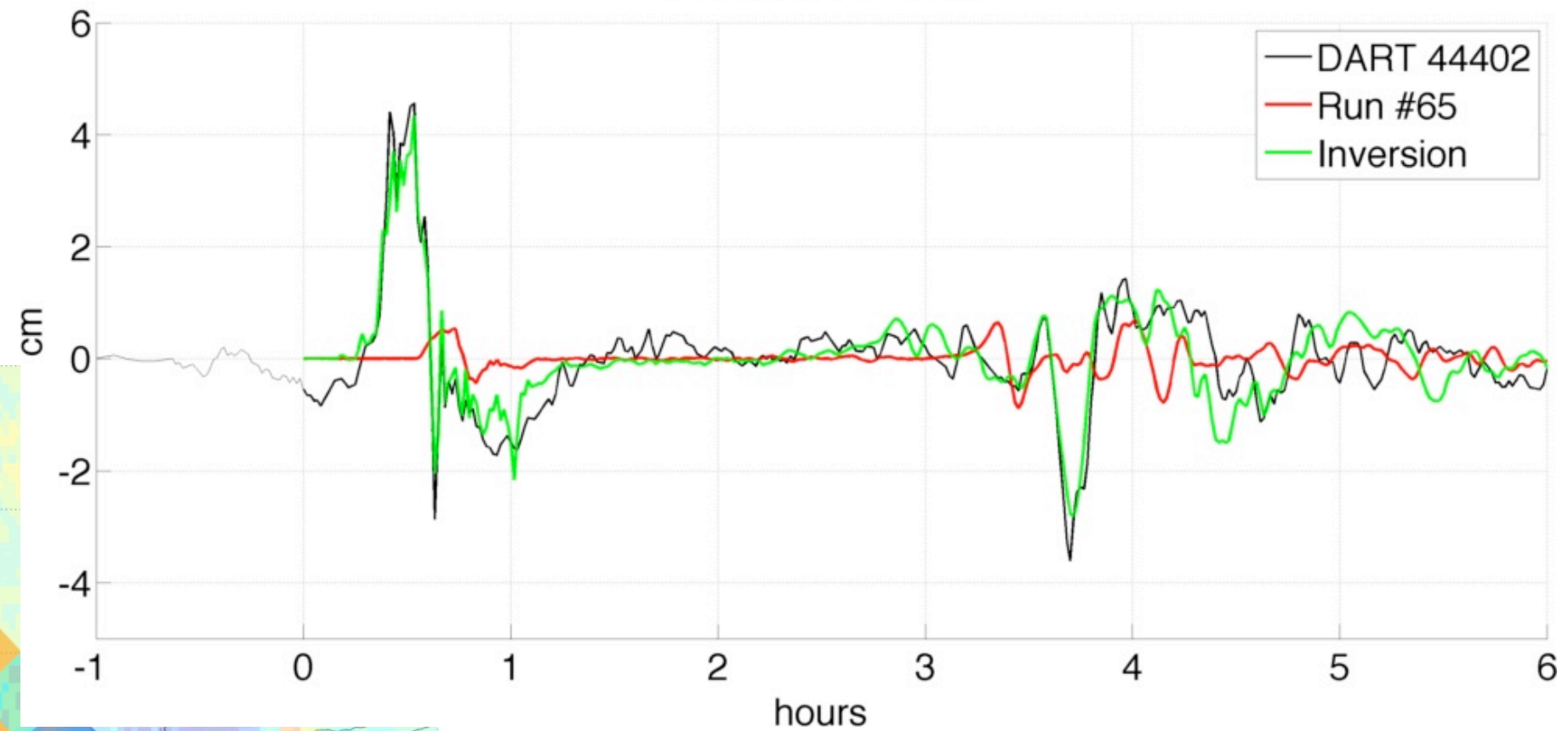
- Fits main peak and reflection ($r=0.88$)
- Selects sources outside canyon
- Compare to tide gauges



Inversion result



Inversion: 1, $r=0.88$

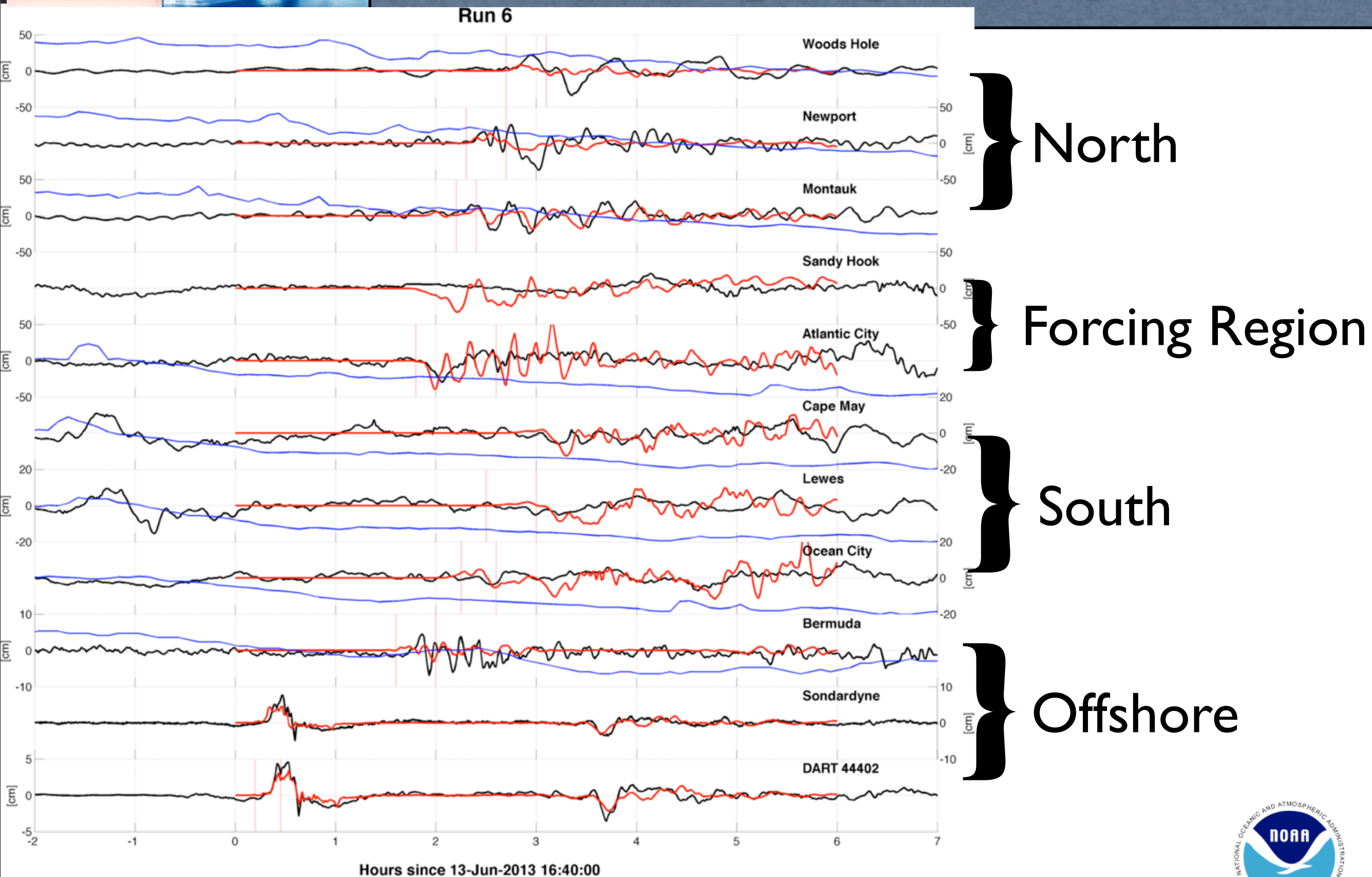


- Fits main peak and reflection ($r=0.88$)
- Selects sources outside canyon
- Compare to tide gauges

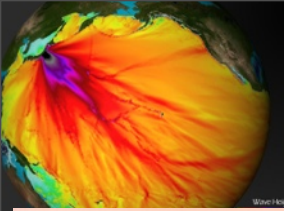




Results: gauge comparison



Conclusions



- Probably a meteotsunami
- Free wave leaves forcing region at shelf edge
- Perhaps a triggered landslide
- Next step: comparison with time-dependant pressure field forcing

