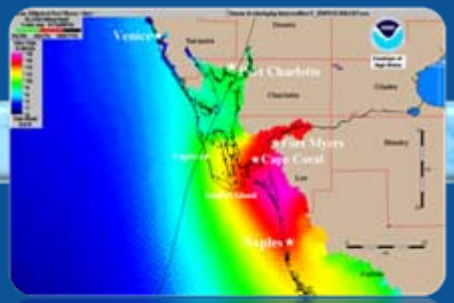
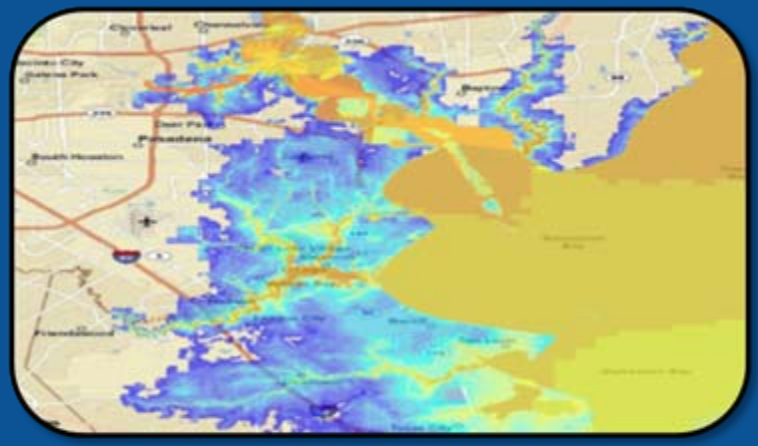




NOAA's Roadmap for Improving Storm Surge Products and Forecasts

Jesse C. Feyen

Storm Surge Roadmap Portfolio Manager

The Vision



Highly accurate, relevant, and timely information

CLEARLY COMMUNICATED

which results in reductions in loss of life and ensures communities are resilient

NOAA's Storm Surge Roadmap

- 10 year plan to improve modeling, products and services
- Provides a common direction across the agency and to partners

Bottom line: first comprehensive strategy to holistically address needs and establish a community response

The Bottom Line for NOAA

Customers Ask:

- Who will get flooded? How much?
- When will it arrive and leave?
- What will the impacts be?
- How often will it occur?
- How should I act?

NOAA's Goals:

- Accurately define storm water levels
  - Total Water Level (TWL) models with surge + tides + waves + rivers
  - Determine uncertainty
- Describe flooding as inundation above ground
  - In statements and maps
- Communicate actionable information
  - Intuitive and consistent products

Surge System Needs Modernization

- SLOSH uses coarse grids for predicting surge and omits tides, waves, river inflow
  - Used for tropical and extratropical surge predictions
  - Need community-based models that can accelerate transition of research to operations
- Forecast products limited to jargon-filled text statements
  - Text cannot adequately describe local surge levels or extent of flooding
  - People confused by vertical datums (e.g., surge above normal tide level)

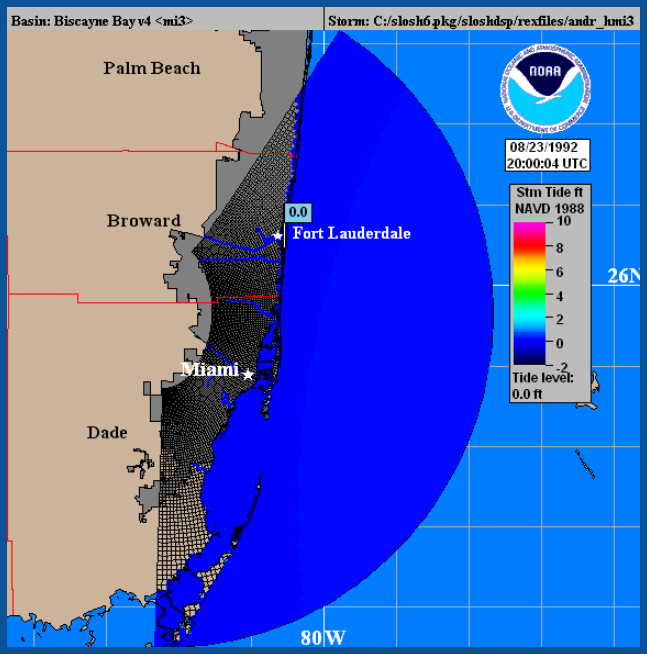
Surge Model Development Efforts

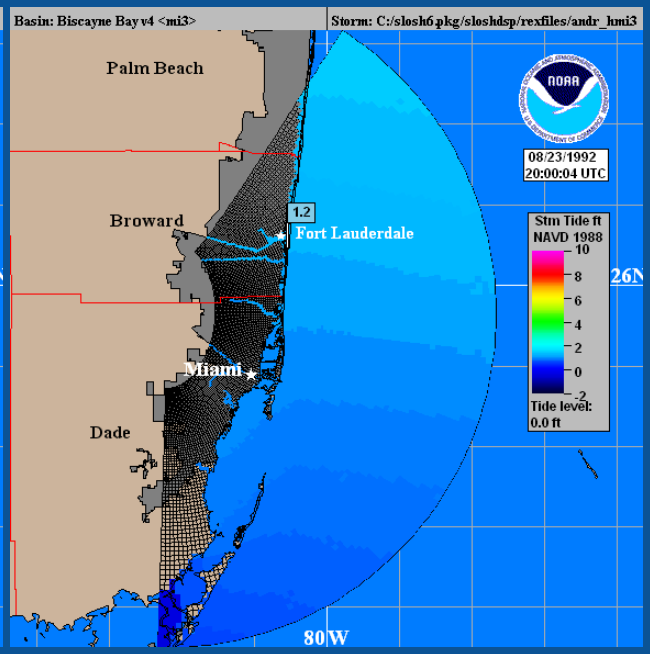
- Moving toward total water level modeling
  - Adding tides to SLOSH
  - Implementing extratropical surge+tide system
  - Coupling surge (ADCIRC) and wave (WAVEWATCH III®) models in the Nearshore Wave Prediction System
- Accelerating transition of research to operations
  - IOOS testbed for evaluating costs and benefits of transitioning community models to operations
  - Investigating ensemble approaches to use multiple surge models

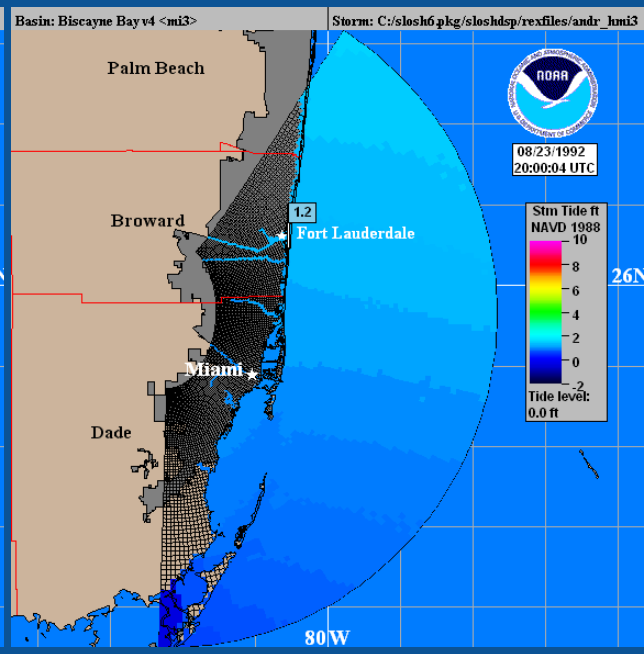
Adding tides to SLOSH

- SLOSH is the basis of multiple surge predictions
  - MOMs/MEOWs for evacuation planning, P-Surge and deterministic runs for hurricane surge forecasting, and ETSS for extratropical surge prediction
- Tidal harmonic constants drawn from high resolution ADCIRC models
  - Coastal resolution around 100 m (VDatum grids)
  - Updating East Coast and West Coast tidal databases (via collaboration with OU and USACE/CHL)
- Tidal time series superposed onto SLOSH predictions

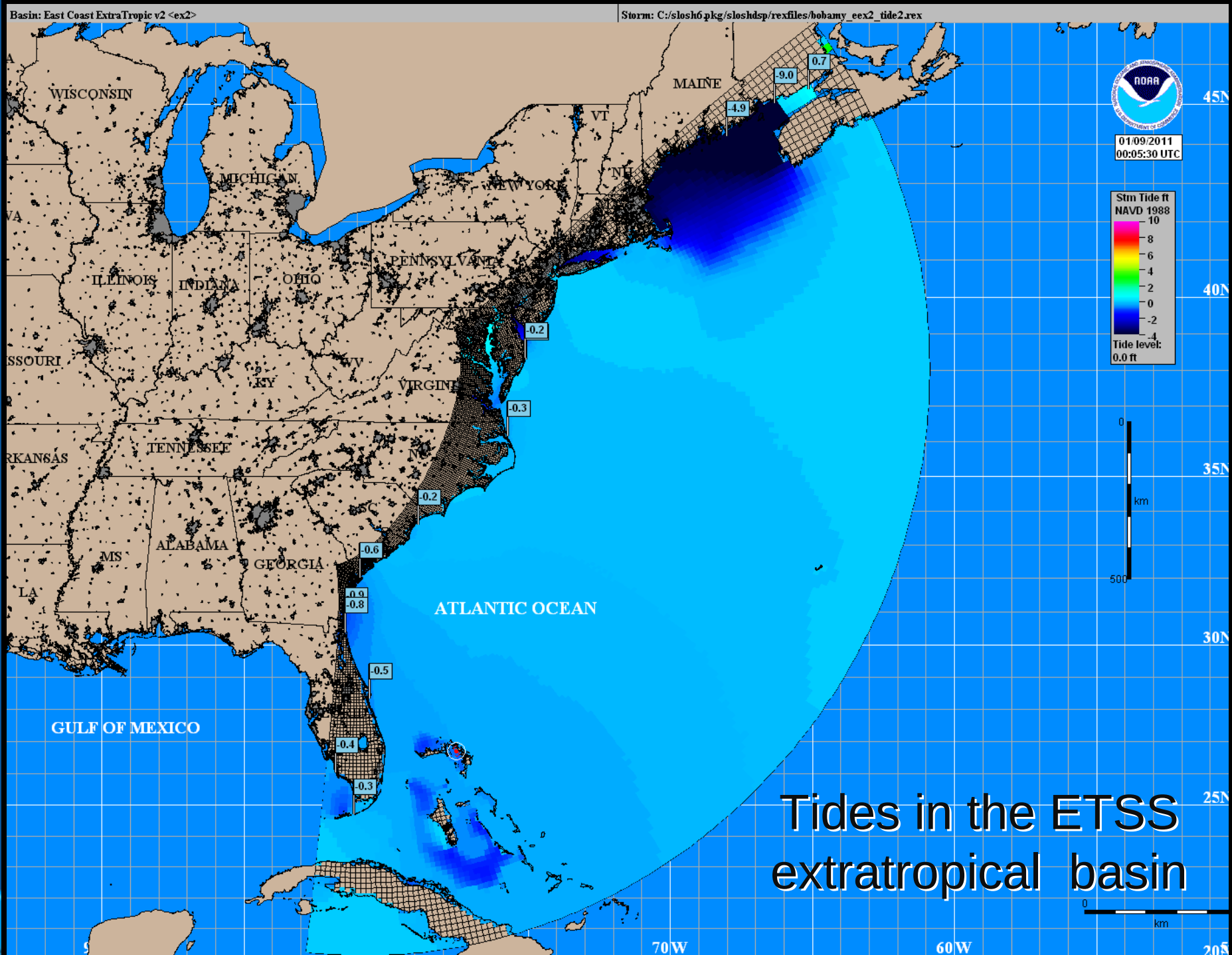
Tides in SLOSH Tropical Basins







Surge + Tides = SLOSH+Tides



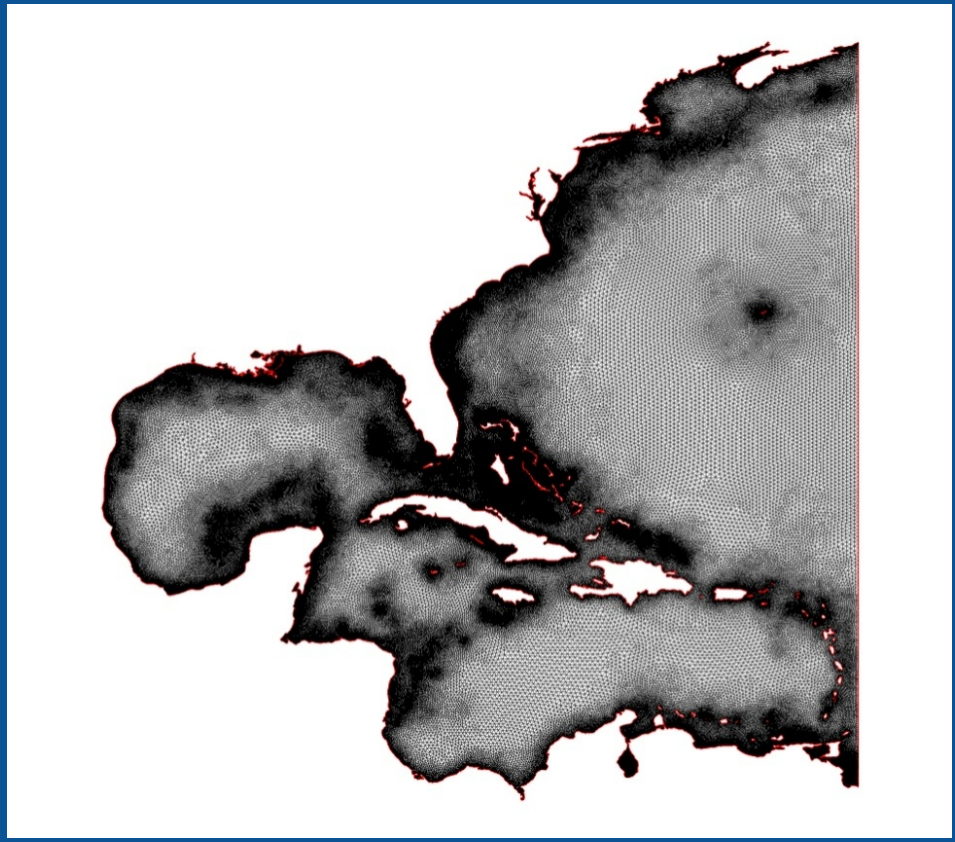
Tides in the ETSS extratropical basin

Atlantic Extratropical Surge and Tide Operational Forecast System (ESTOFS)

- Purpose
  - Provide coastal water levels for coupling to WAVEWATCH III® (WW3) to drive Nearshore Wave Prediction System
  - Compute surge with tides, astronomical tides, and subtidal water levels (surge only) for forecaster use
- Provides improvements in surge predictions
  - Incorporates the astronomical tides, lacking in ETSS
- Enables future development
  - River inflows
  - Improved resolution of bays, inlets, and barrier islands

ESTOFS-Atlantic

- Applies ADCIRC model
- East Coast 2001 tidal database grid (EC2001)
- 254,565 nodes
- Coastal resolution ≈ 3 km
- Tidal forcing at 60° W
  - TPXO 6.2



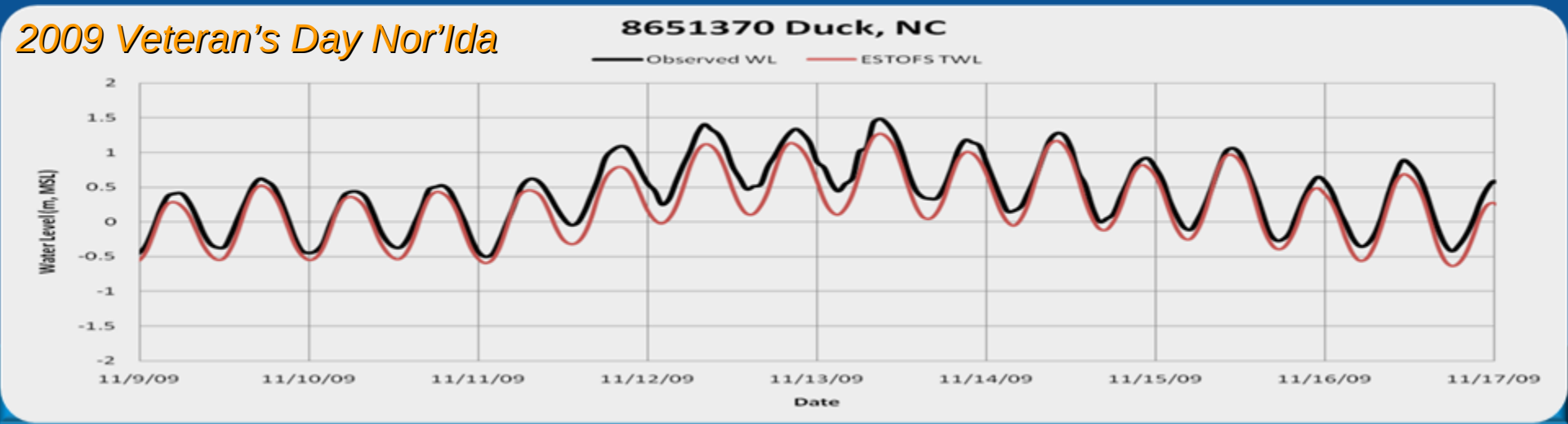
Operational Set-up

- Mirrors WW3 set-up to support coupling
- Run cycle: 4 times per day
  - 00z, 06z, 12z, and 18z
- Total 7.75 day simulations
  - 6-hr nowcast followed by 180-hr forecast
- Surface forcing from GFS
  - 10 m winds and sea level pressure every 3 hours
- Running experimentally in real-time now; fully operational April 2012

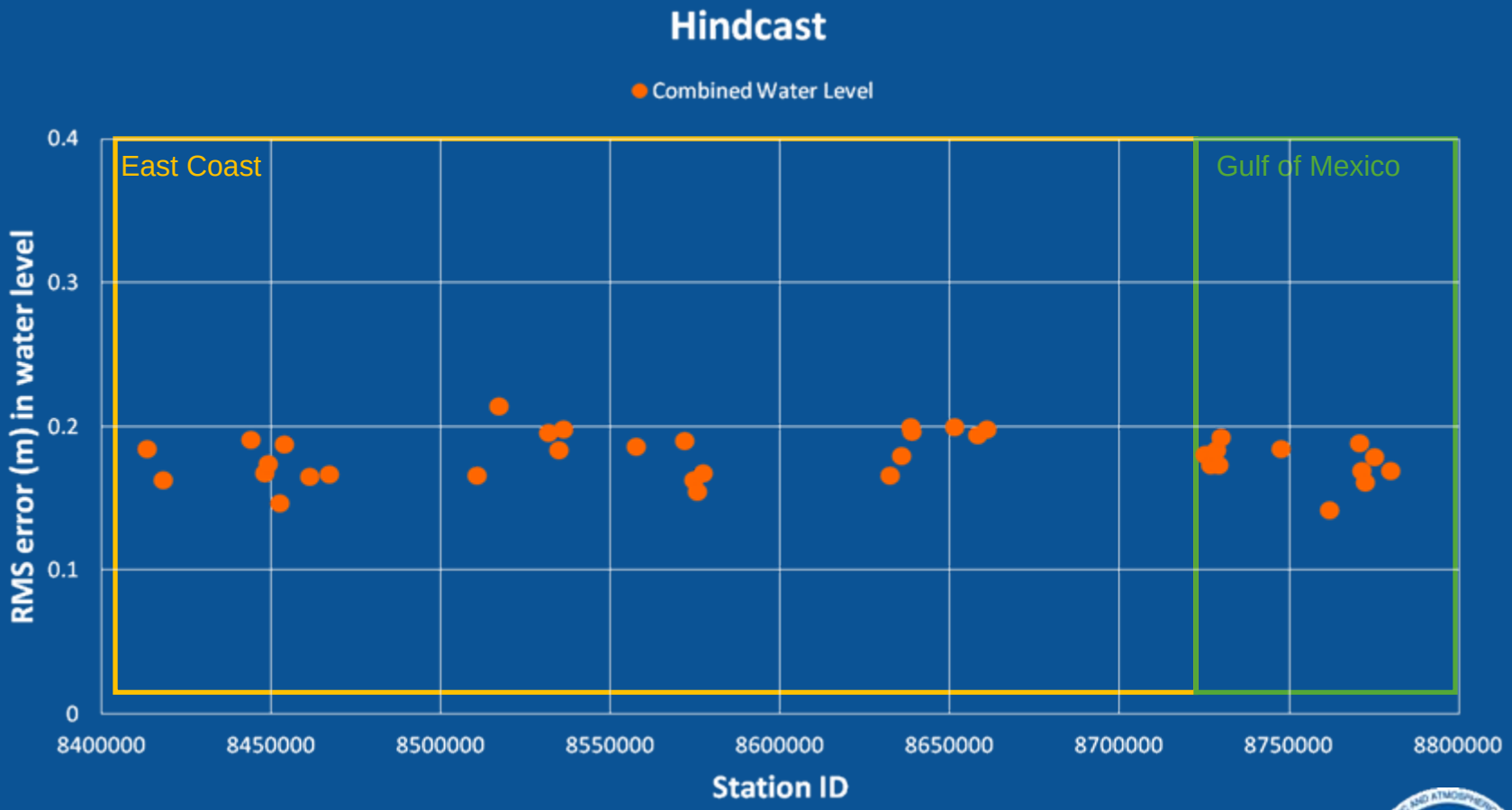
ESTOFS Output

- Deliver three types of water level
  - Combined Water Level (CWL): Surge + tides
  - Harmonic Tidal Prediction (HTP): Astronomical tides
  - Subtidal Water Level (SWL): SWL = CWL – HTP
- Provide both field and point output
  - 6 minute water level at points, hourly water level for fields
- Output in native (NetCDF) and 2.5 km NDFD (GRIB2)
  - http://nomad1.ncep.noaa.gov/pub/raid2/estofs/

2009 Veteran's Day Nor'Ida



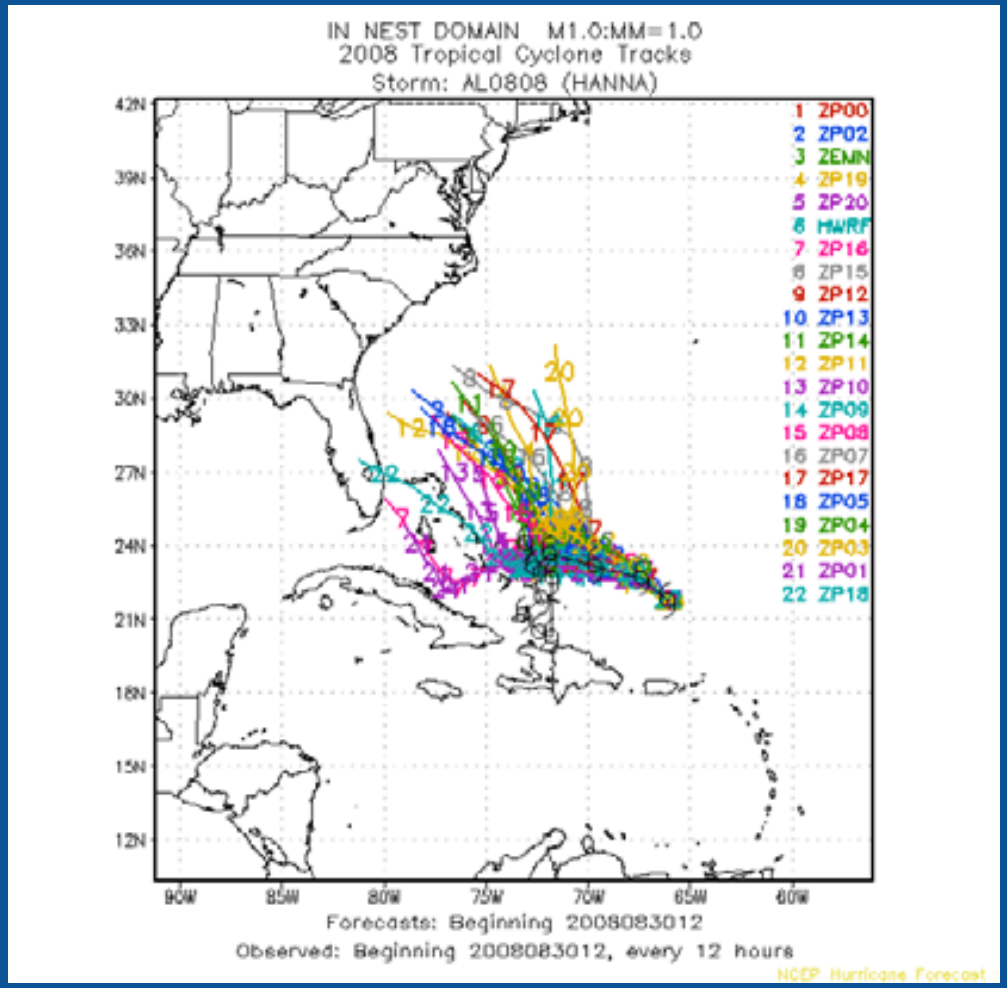
Hindcast Skill Assessment
(Combined Water Level)



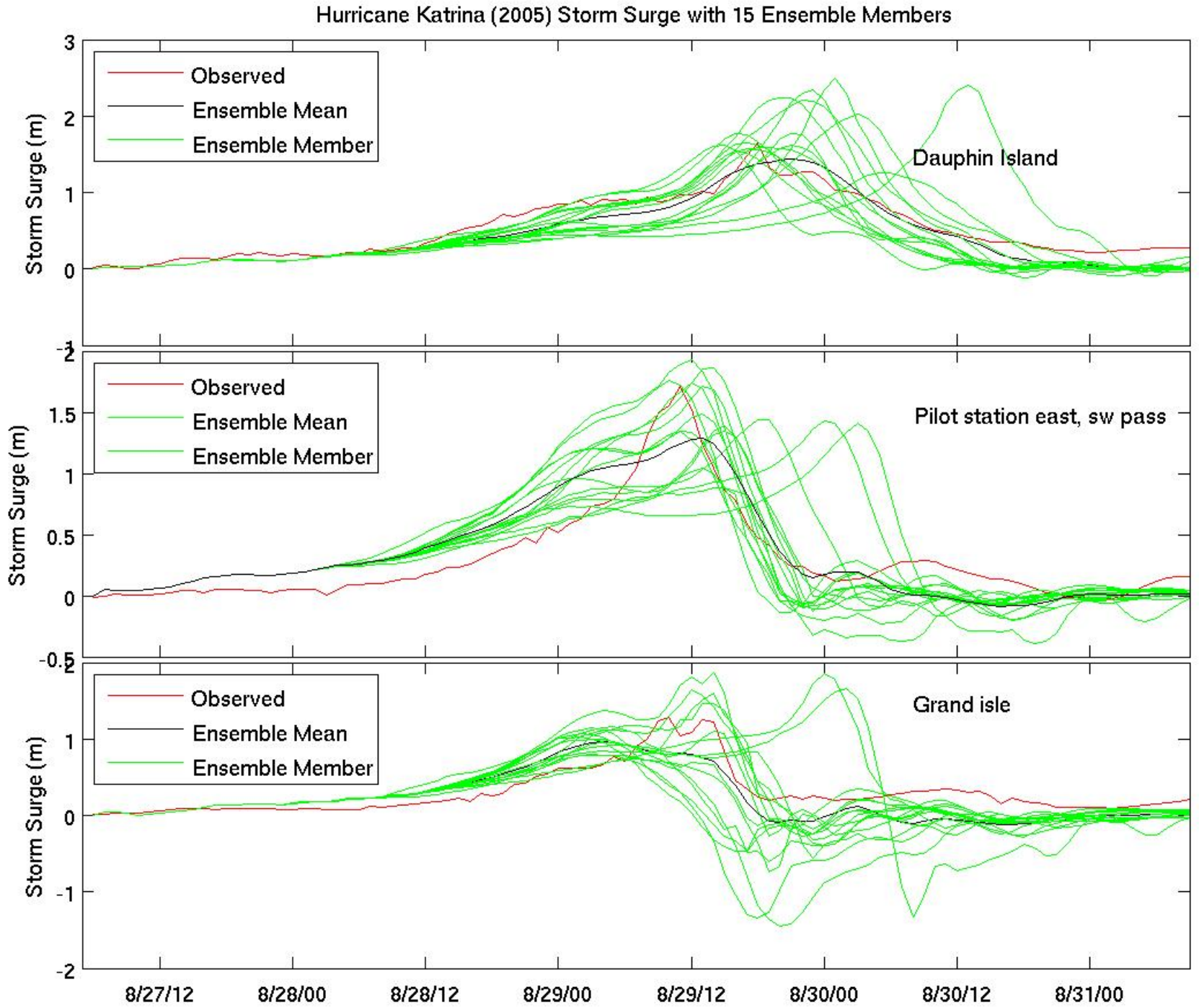
Ensemble Modeling Methodology

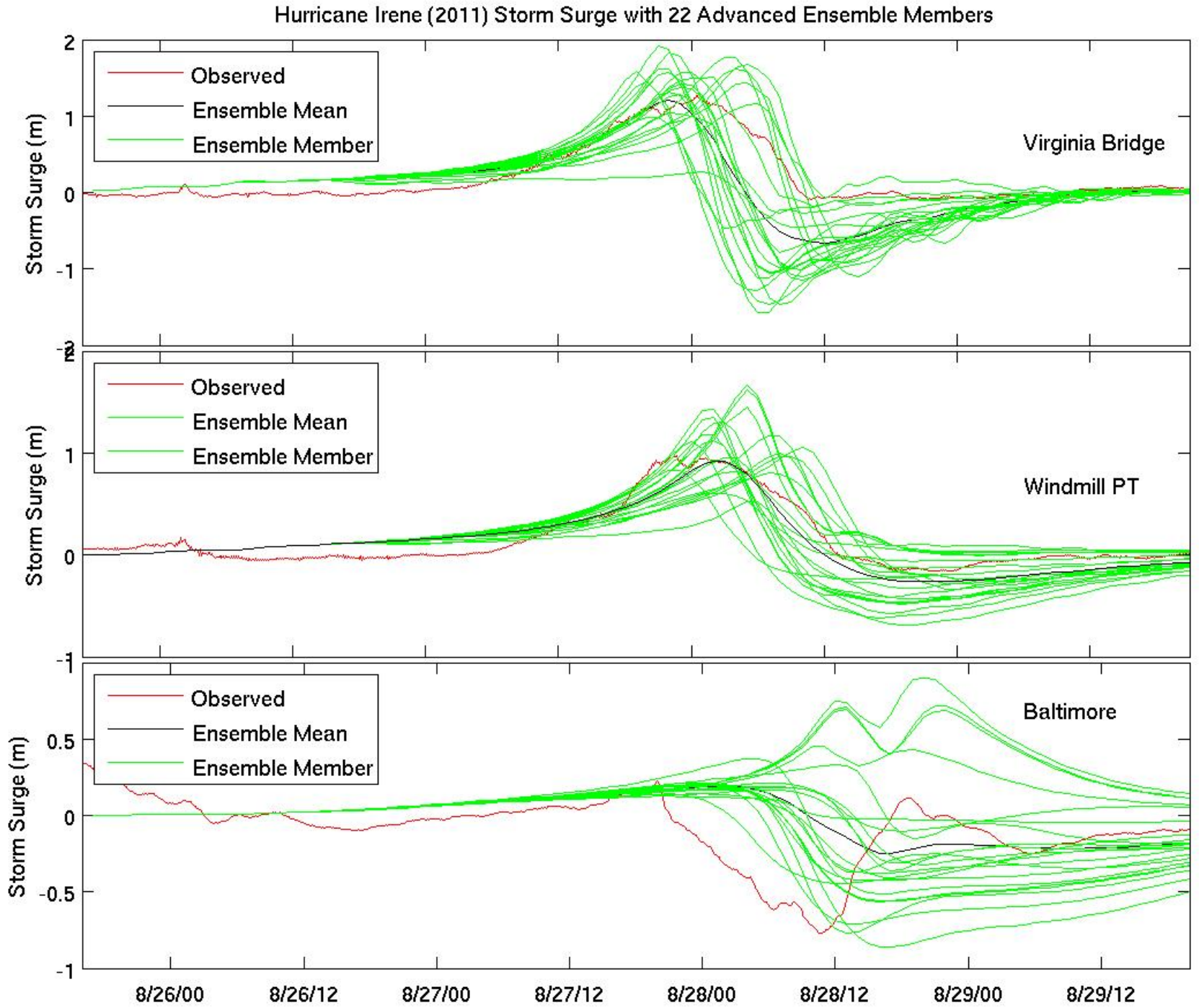
- Ensemble approach requires:
  - Multiple simulations (including both multiple forcing of one model and multiple surge models)
  - Statistical assessment of the ensemble members (e.g., max, min, mean, spread)
- Operational hurricane models generate an ensemble of possible forecast tracks
  - Official forecast and dynamical models, including an HWRF ensemble
- Adopting P-Surge code to generate ensemble methodology, and then add other surge models

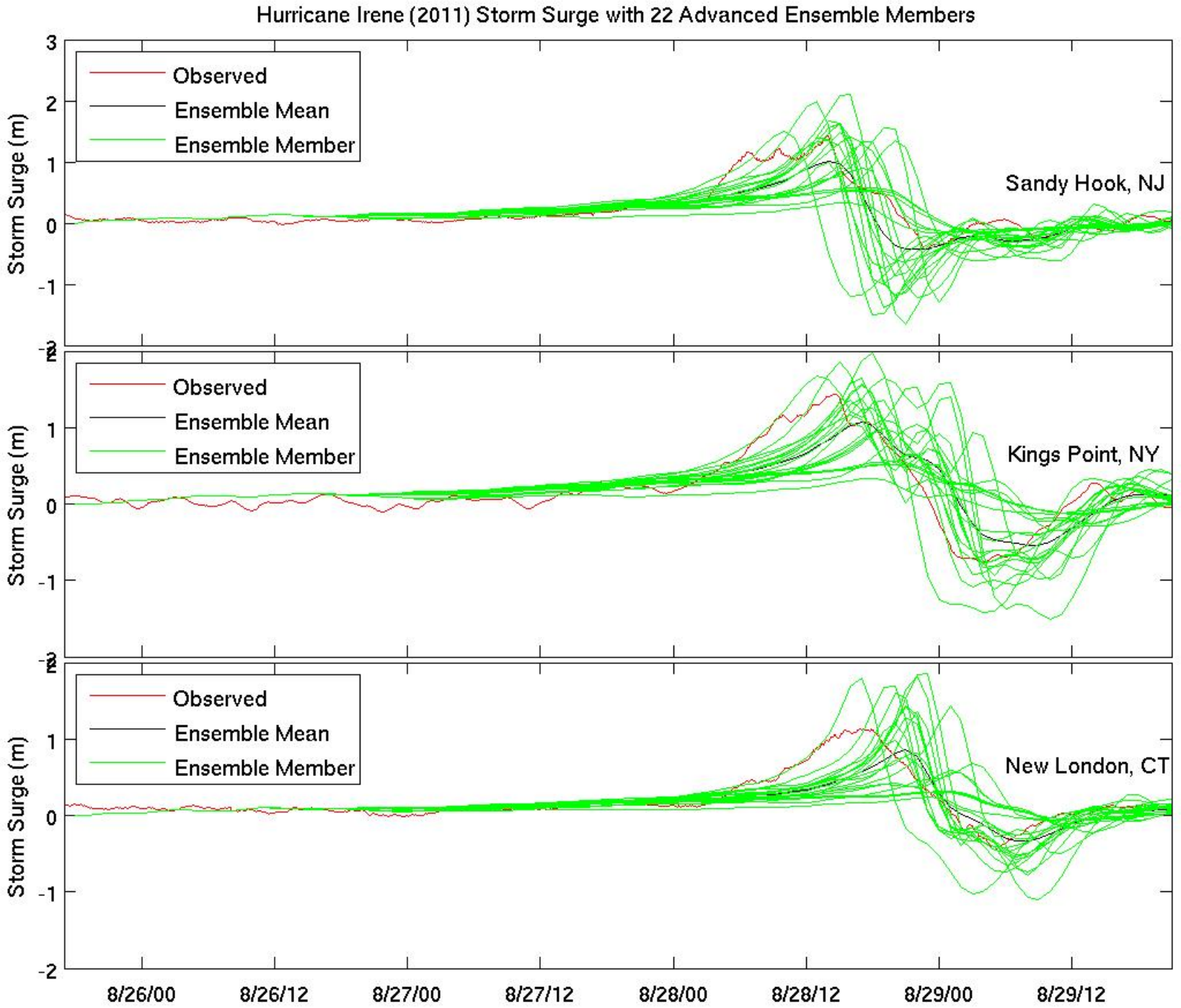
Example of HWRF Ensemble Forcing



Tracks are available from forecasters and numerous weather prediction models


Hurricane Katrina (2005) Storm Surge with 15 Ensemble Members
Observed
Ensemble Mean
Ensemble Member
Storm Surge (m)
Dauphin Island
Pilot station east, sw pass
Grand isle
8/27/12
8/28/00
8/28/12
8/29/00
8/29/12
8/30/00
8/30/12
8/31/00


Hurricane Irene (2011) Storm Surge with 22 Advanced Ensemble Members
Observed
Ensemble Mean
Ensemble Member
Storm Surge (m)
Virginia Bridge
Windmill PT
Baltimore
8/26/00
8/26/12
8/27/00
8/27/12
8/28/00
8/28/12
8/29/00
8/29/12


Hurricane Irene (2011) Storm Surge with 22 Advanced Ensemble Members
Observed
Ensemble Mean
Ensemble Member
Storm Surge (m)
Sandy Hook, NJ
Kings Point, NY
New London, CT
3
2
1
0
-1
-2
8/26/00
8/26/12
8/27/00
8/27/12
8/28/00
8/28/12
8/29/00
8/29/12

Improving Communication of Surge

- Employing social science techniques to assess user's needs and design new products
- Results show a significant portion of the surge vulnerable population does not understand:
  - what storm surge is, their vulnerability, what the forecast information means, and the potential impacts
  - people desire more info but unsure of how
- Now evaluating new product prototypes
  - Inundation graphics
  - Storm surge watch/warning

Acknowledgements

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