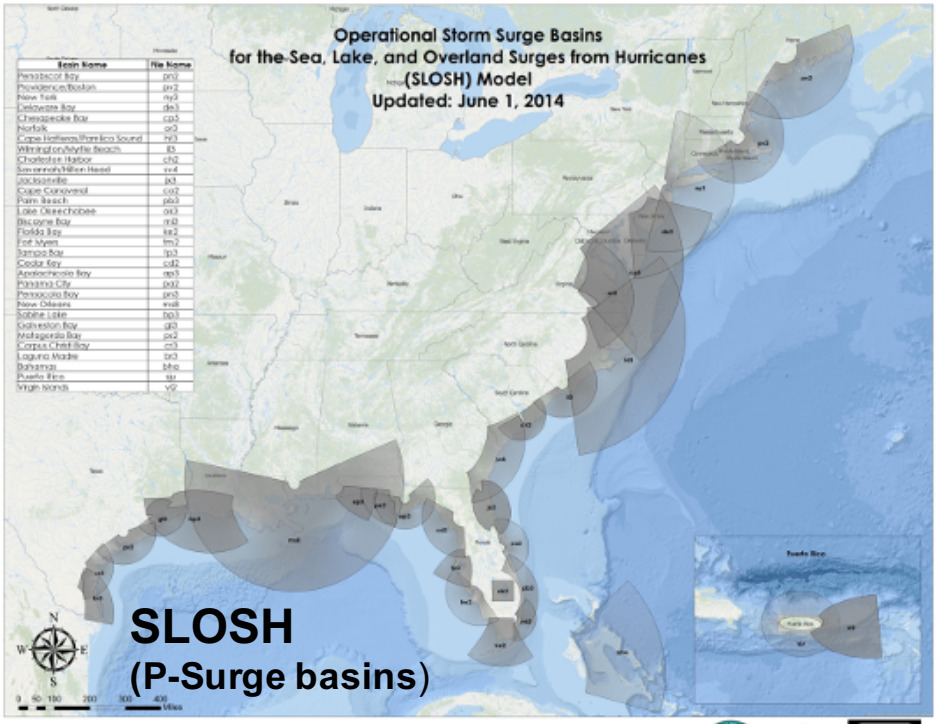
IOOS Coastal and Ocean Modeling Testbed for Puerto Rico and Virgin Islands:

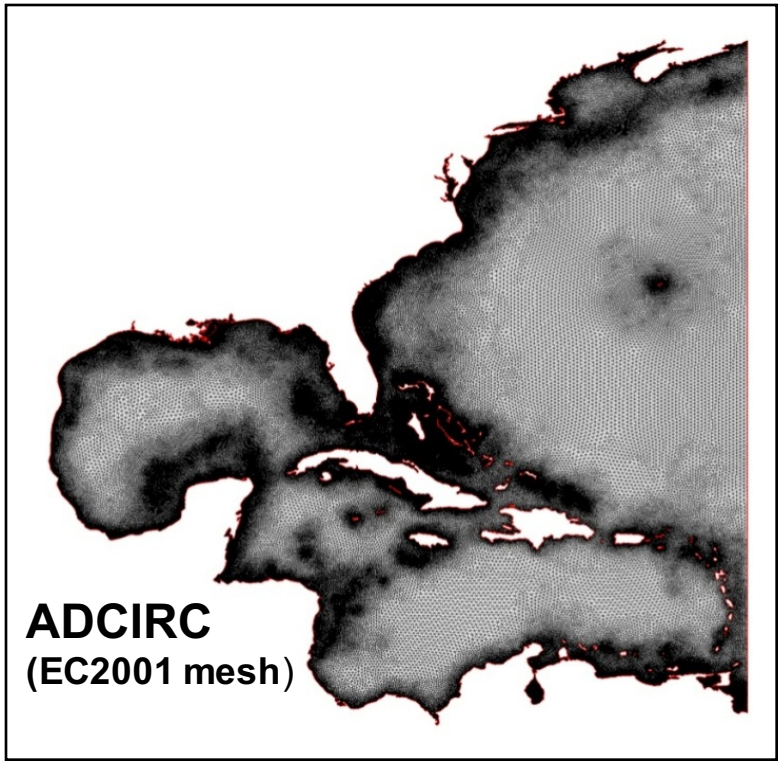
Field cases and Cyber-Infrastructure

André van der Westhuysen, Brian Mckenna, Kelly Knee, Joannes Westerink, Juan Gonzalez, Jane Smith, Jamie Rhome, Jesse Feyen, Cristina Forbes, Julio Morell, Aurelio Mercado, Reniel Calzada, Volker Roeber, Jay Veeramony, Hugh Cobb, Carlos Anselmi, Ernesto Rodriguez (and thanks to Luis Aponte)

Background

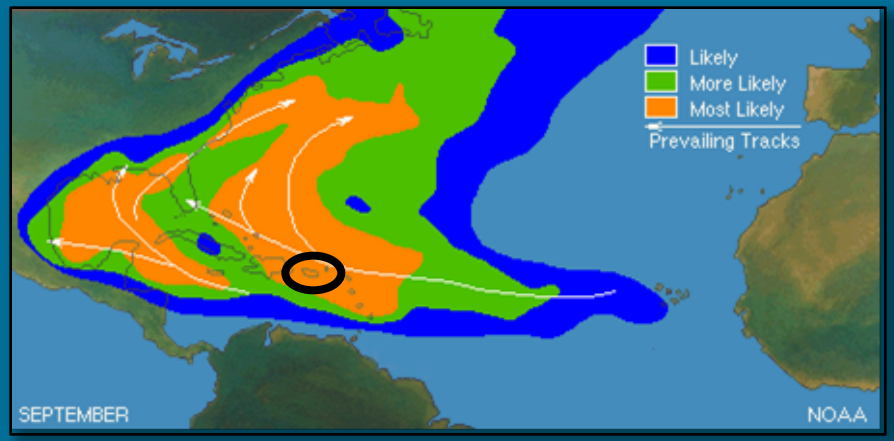
NOAA currently applies both the fast and efficient surge model **SLOSH** (probabilistic guidance) and state-of-the-art **ADCIRC** (deterministic guidance). However, neither of these modeling systems at NOAA has been configured with wave effects or specific focus on island environments.





Objective

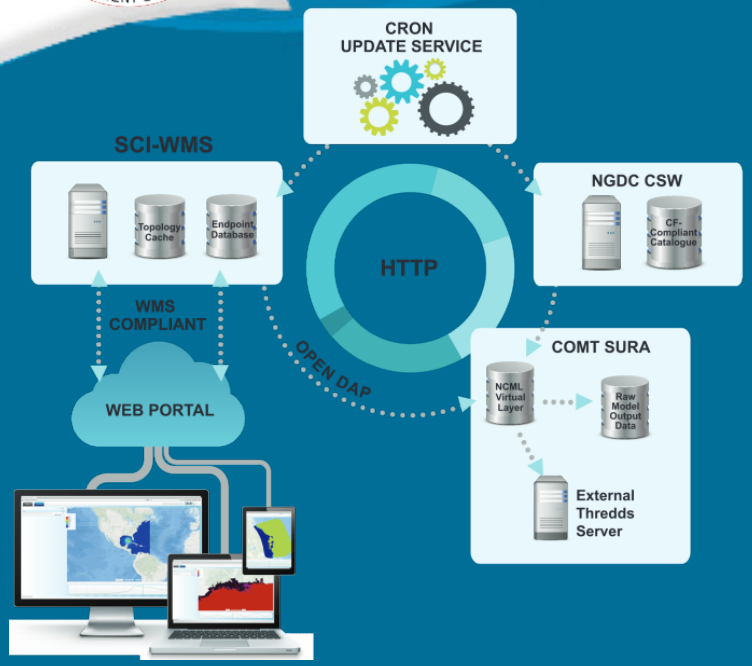
To extend the present **operational surge forecasting** capability from mild-sloped coastal areas such as the US East and Gulf of Mexico coasts to **steep-sloped areas** such as Caribbean and Pacific islands, and study the **contribution of waves**. Identify models or techniques to transition to NOAA's **National Hurricane Center** and **local WFOs**.



www.nhc.noaa.gov/climo

www.caricoos.org

COMT CyberInfrastructure (CI)

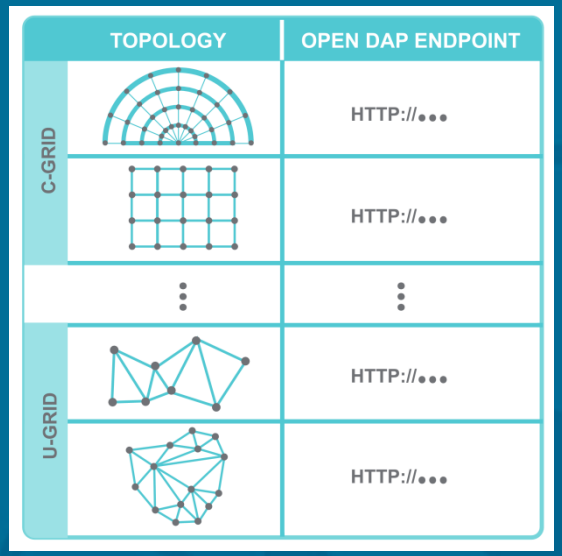


Motivation

- *Facilitate **collaboration** across various institutions and models*
- *Enable **exploration**, presentation and archive of research results*
- *Provide **community** access and tools to the COMT research*

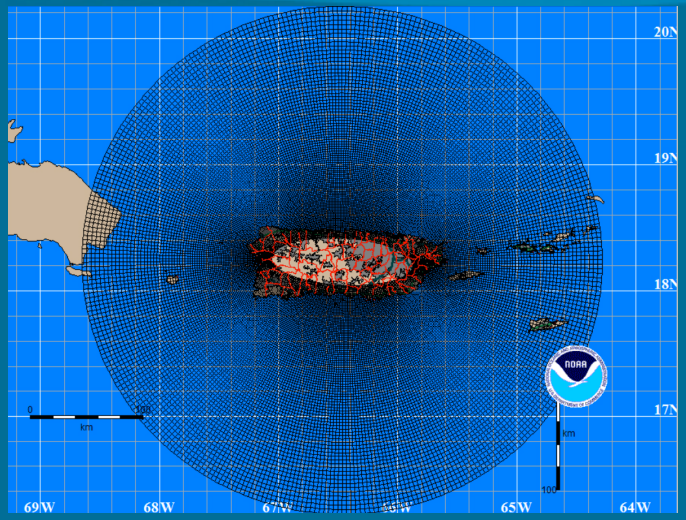
Implementation/Tools

- *Modelers upload data via FTP to central server*
- *CI works with modelers to make all data CF-compliant*
- *User interface enables exploration of catalog and graphics for all projects*
- *Direct data access available via TDS (OPeNDAP and HTTP)*
- *Visualization via Python-based SCI-WMS for graphic display of data*
- *Handles structured, staggered and unstructured grids*

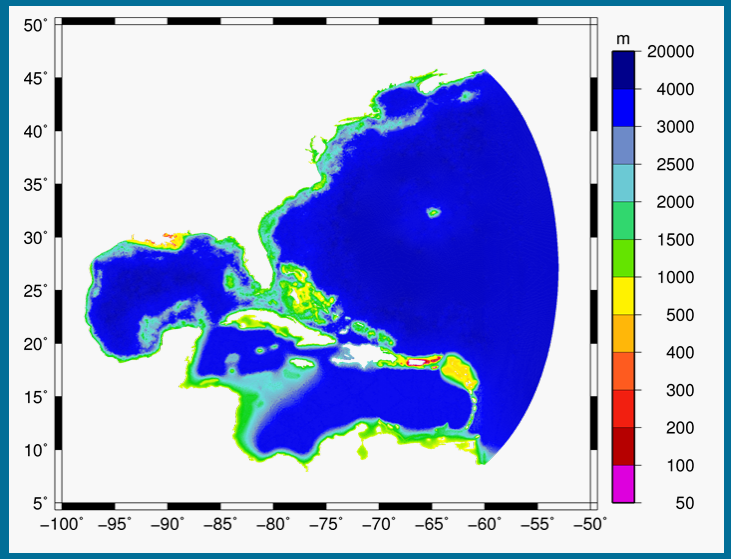


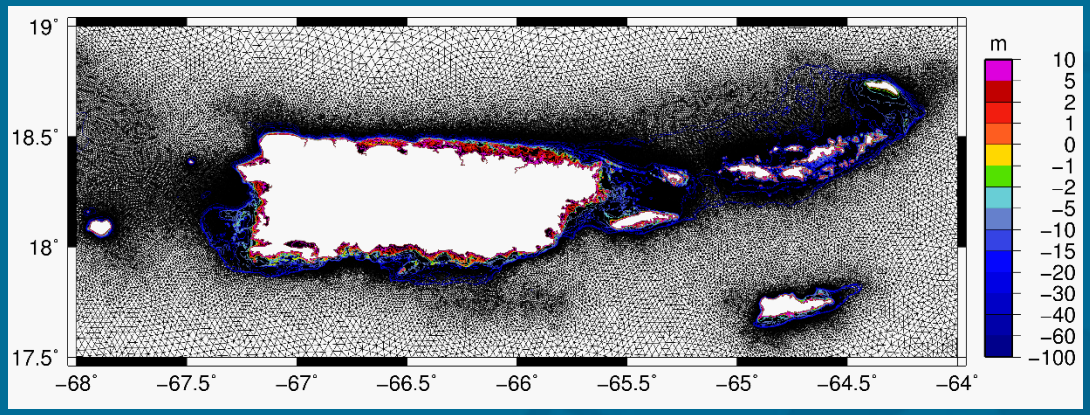
Puerto Rico/USVI: Model selection

- **UND:** ADCIRC+SWAN
- **NCEP/USACE:** ADCIRC+WW3
- **NHC:** SLOSH+SWAN
- **UPR:** BOSZ/FUNWAVE/XBeach



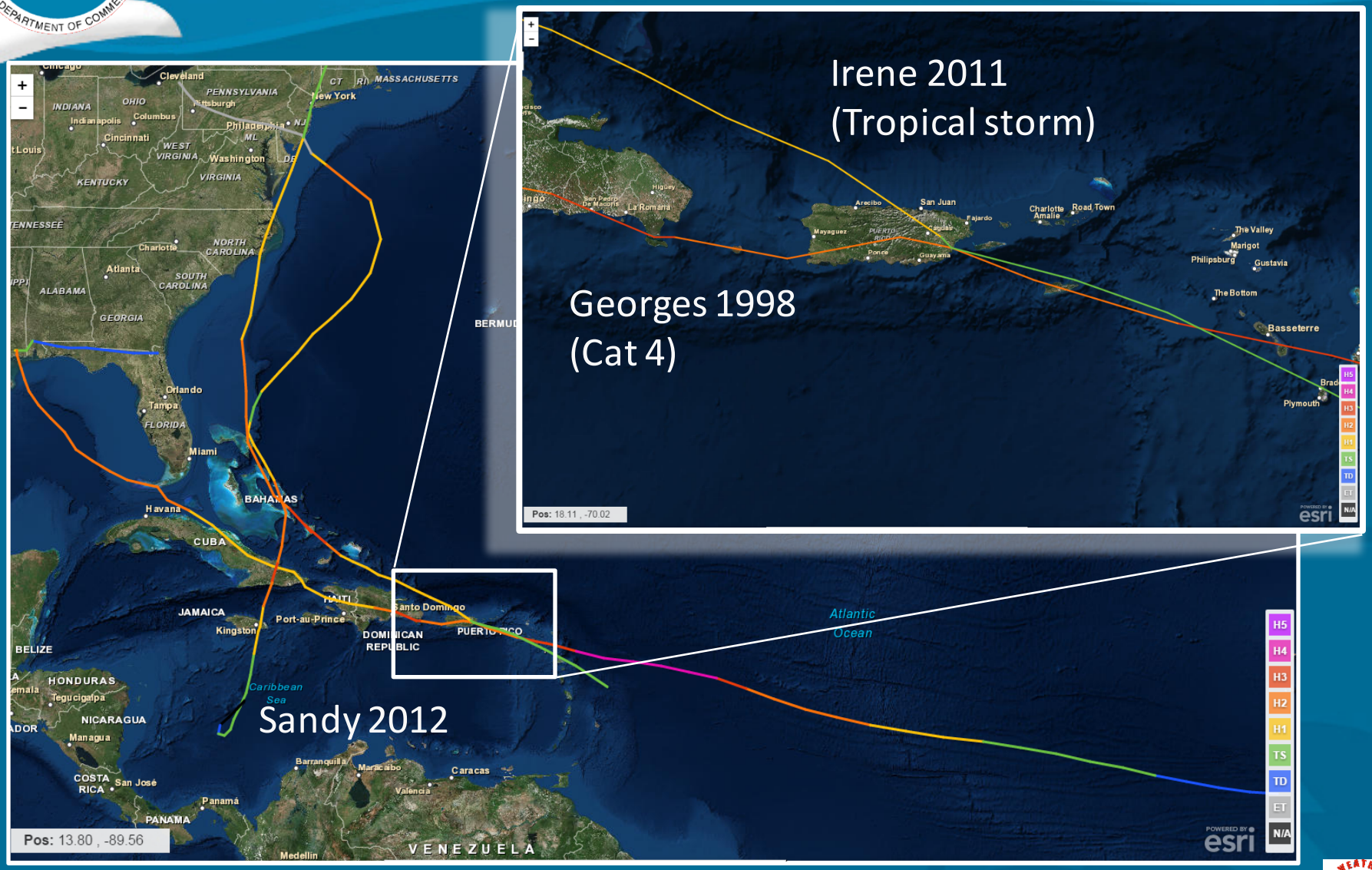
Curvilinear grid (min res: 90 m)



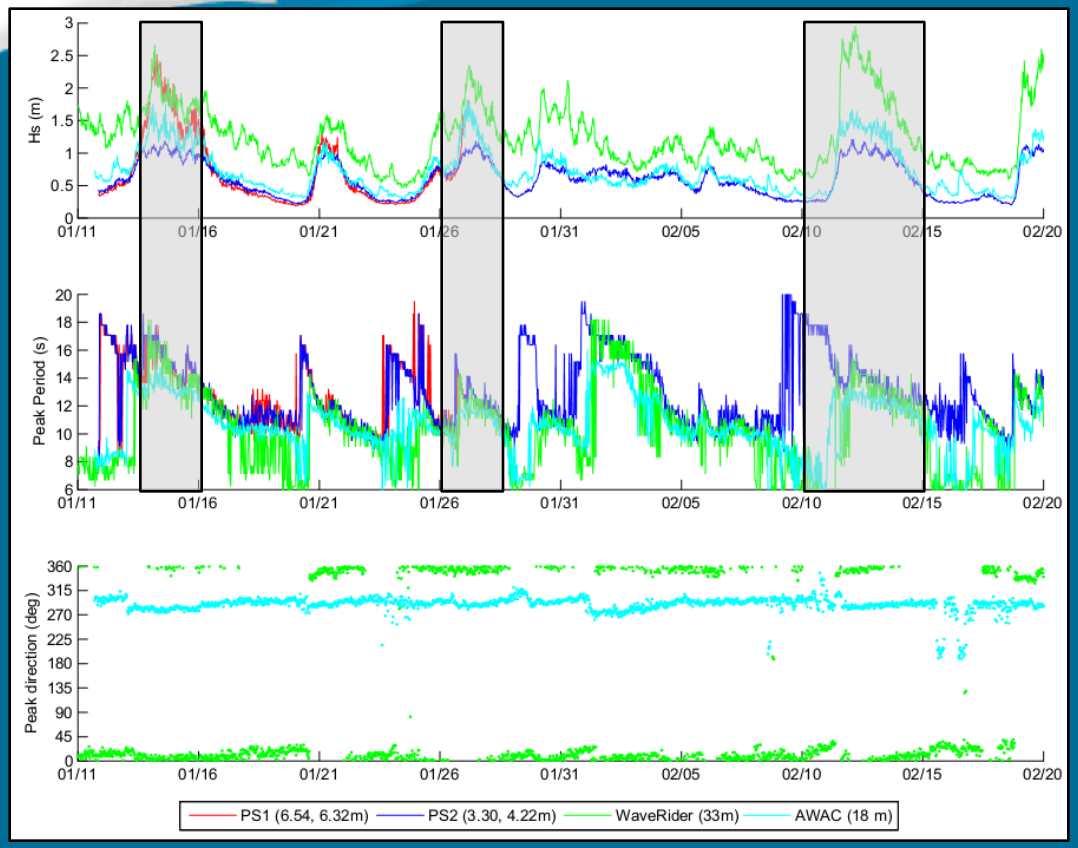


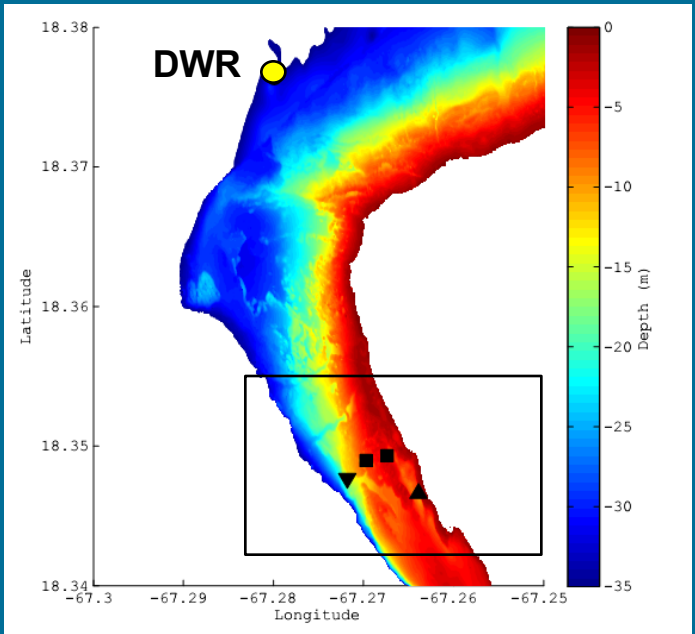
Unstructured, 2,733,258 nodes (min res: 50 m)

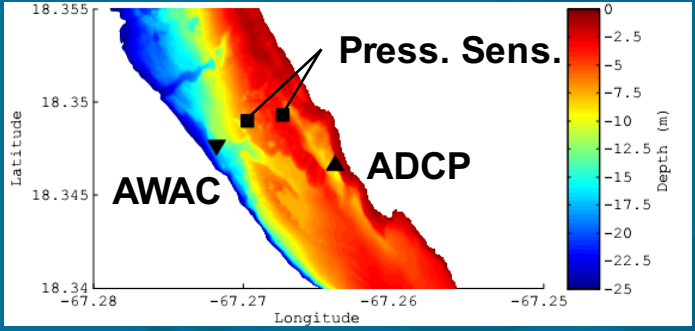
Regional hindcast cases



Cross-reef cases (Rincon, PR)



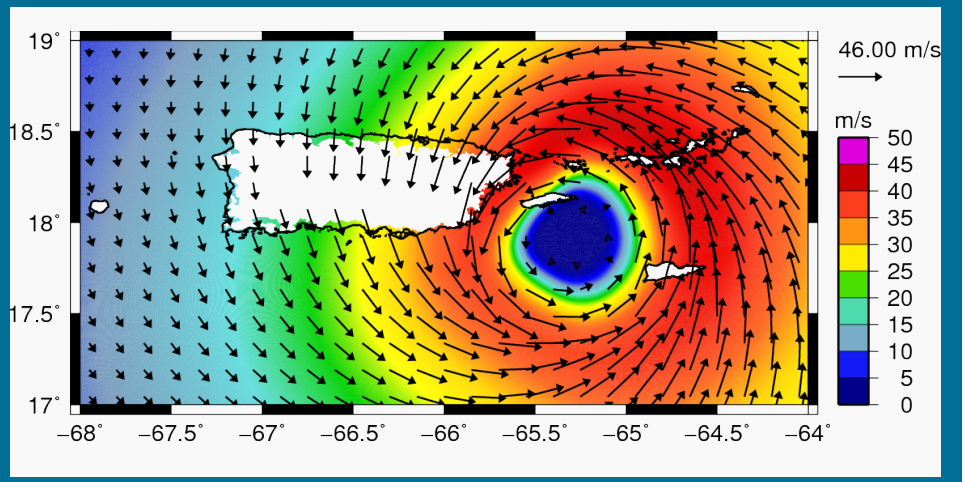


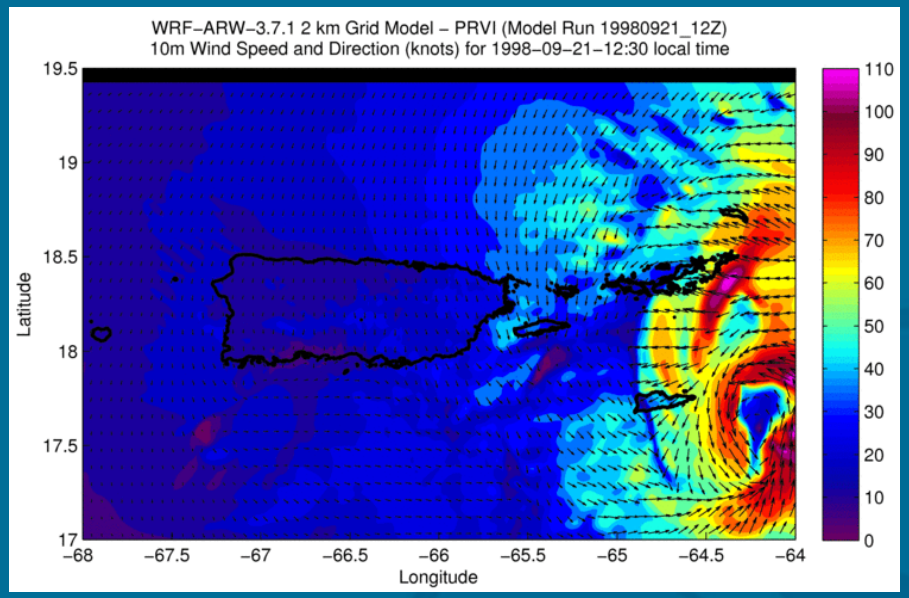


(1) Datawell Waverider (33 m, 2D wave spectrum)
(1) Nortek AWAC (18 m, 2D wave spectrum)
(2) Ocean Sensor Systems Pressure Sensor (6.54 m, 3.33 m)
(1) Teledyne Sentinel ADCP (10 m channel)

Input/Validation Data Collection

- **Atmospheric input** – Parametric vortex models, CFSR, WRF model simulations
- **Bathymetry** - 1/3-1 arc-sec NOAA Tsunami Inundation DEMs, NOAA benthic map classifications
- **Observations** - CO-OPS tidal data, NDBC buoys, CariCOOS stations (>2011), WeatherFlow winds

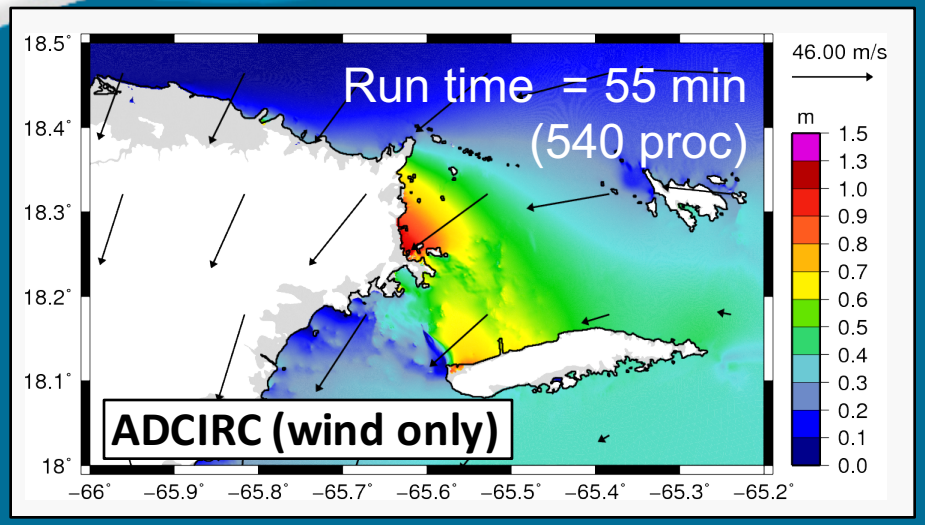


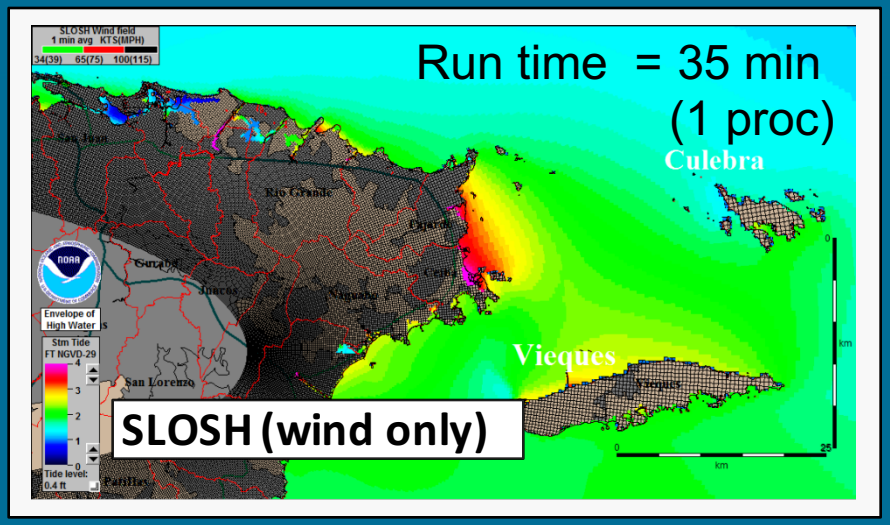


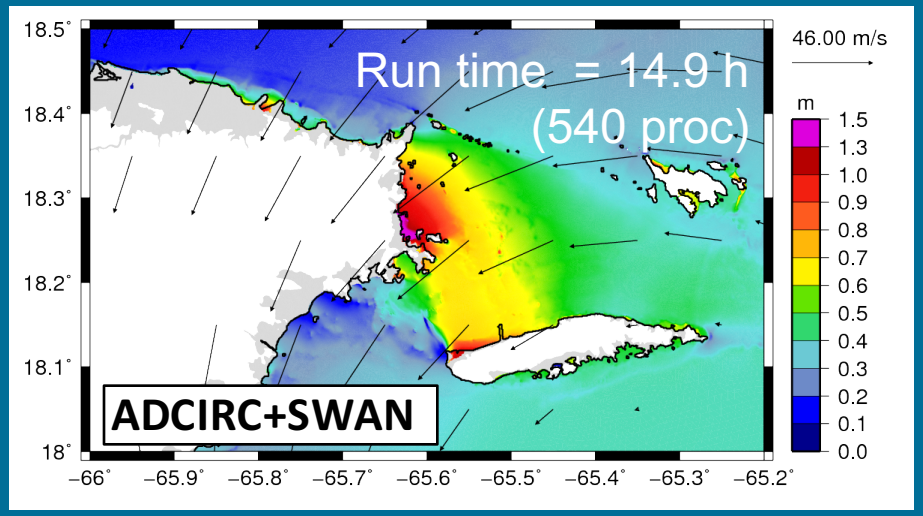
Credit: L. Aponte

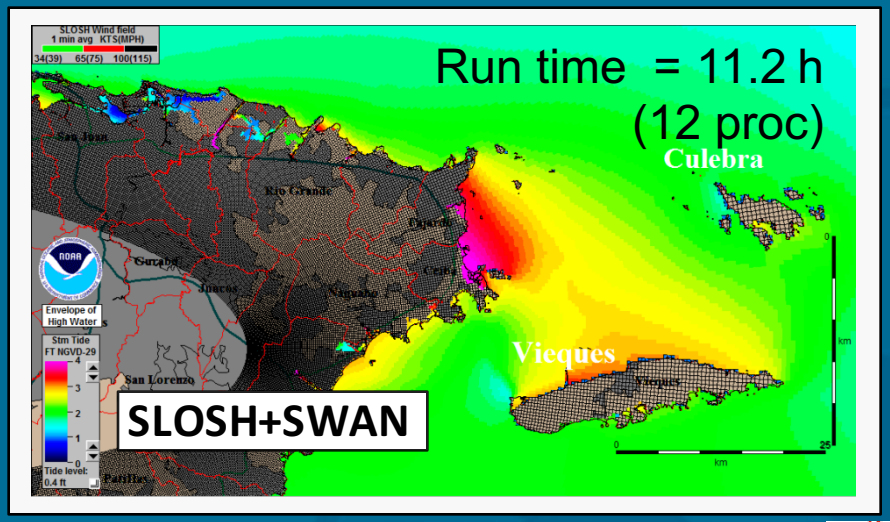
Case 1: ADCIRC vs. SLOSH

H. George (1998), Cat 4 – Asymmetrical vortex model



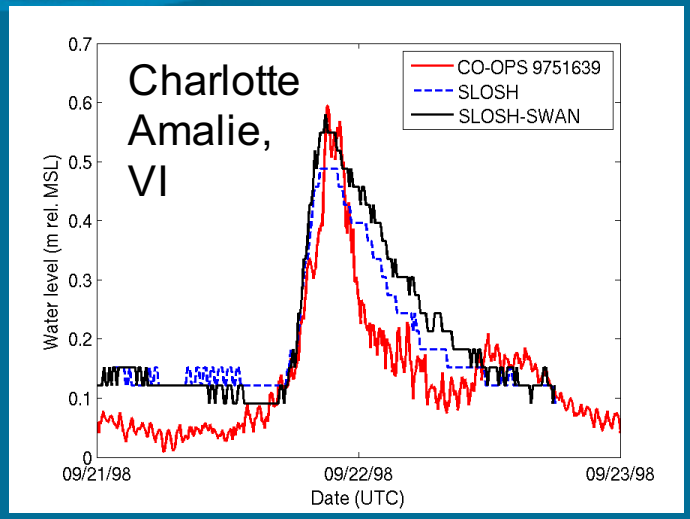


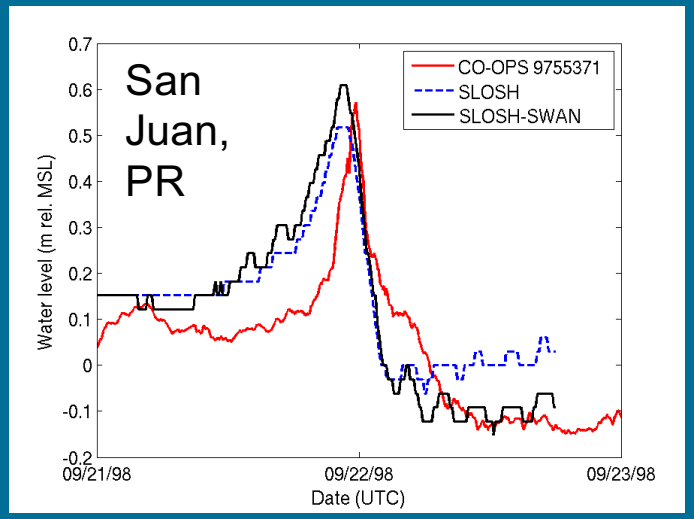


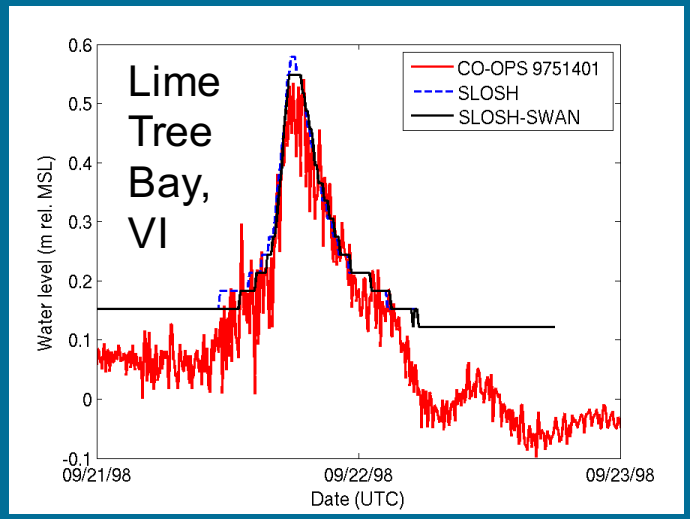


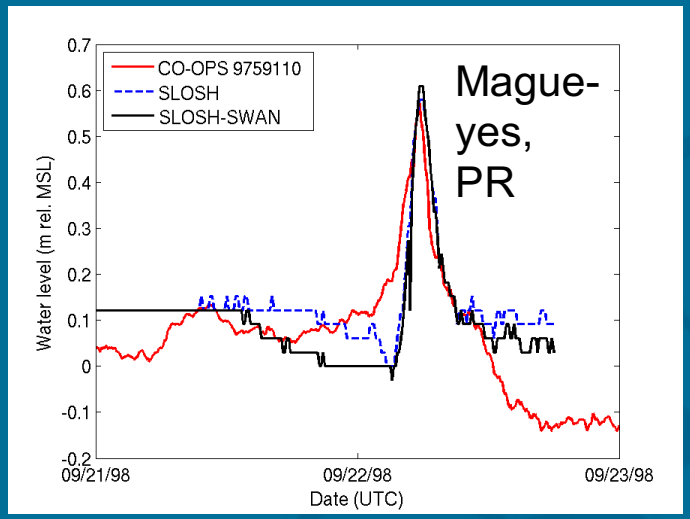
Case 1: Surge – SLOSH, impact of waves

H. George (1998), Asymmetrical vortex model





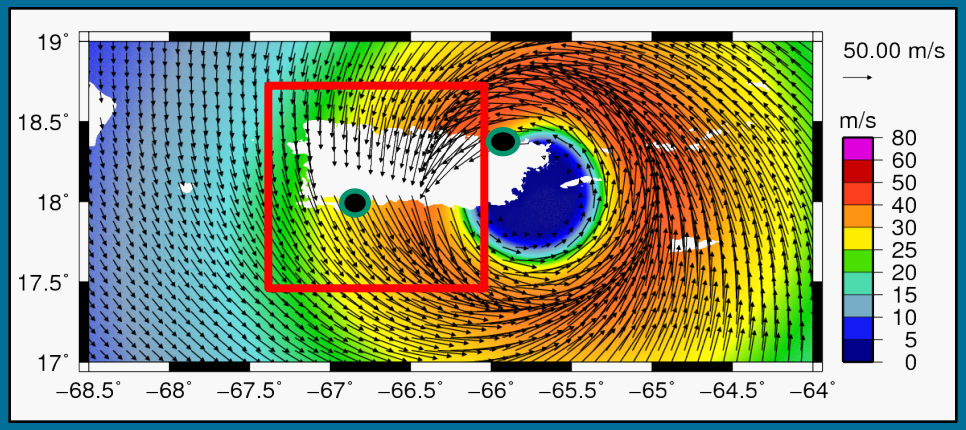


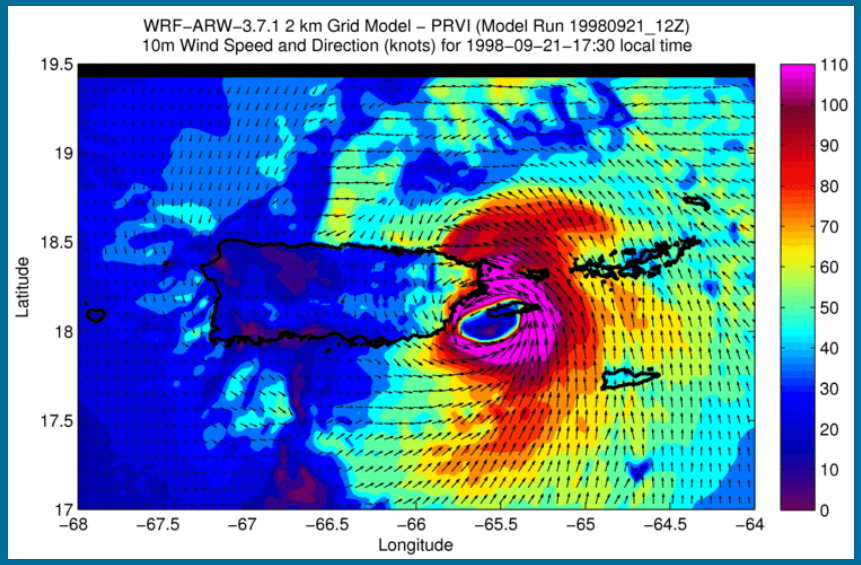


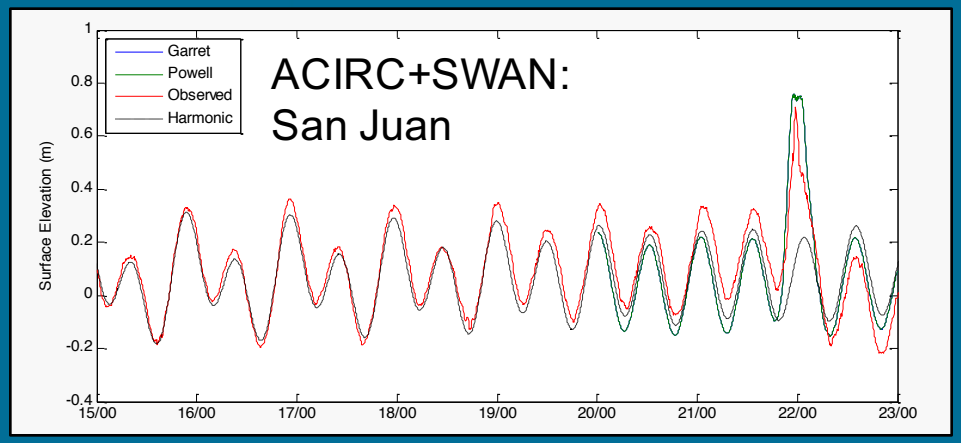
Case 1: Sensitivity to wind forcing

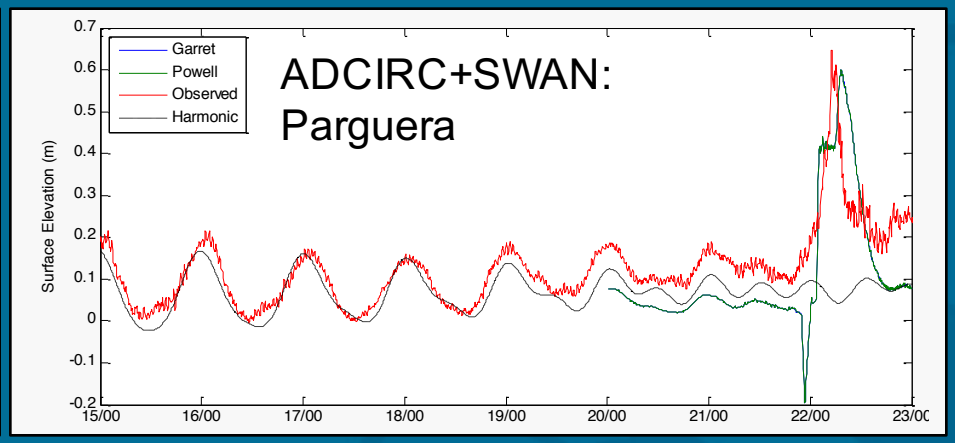
H. Georges: Category 4 at landfall

Wind speed overestimation by parametric model causes exaggerated set-down at Parguera





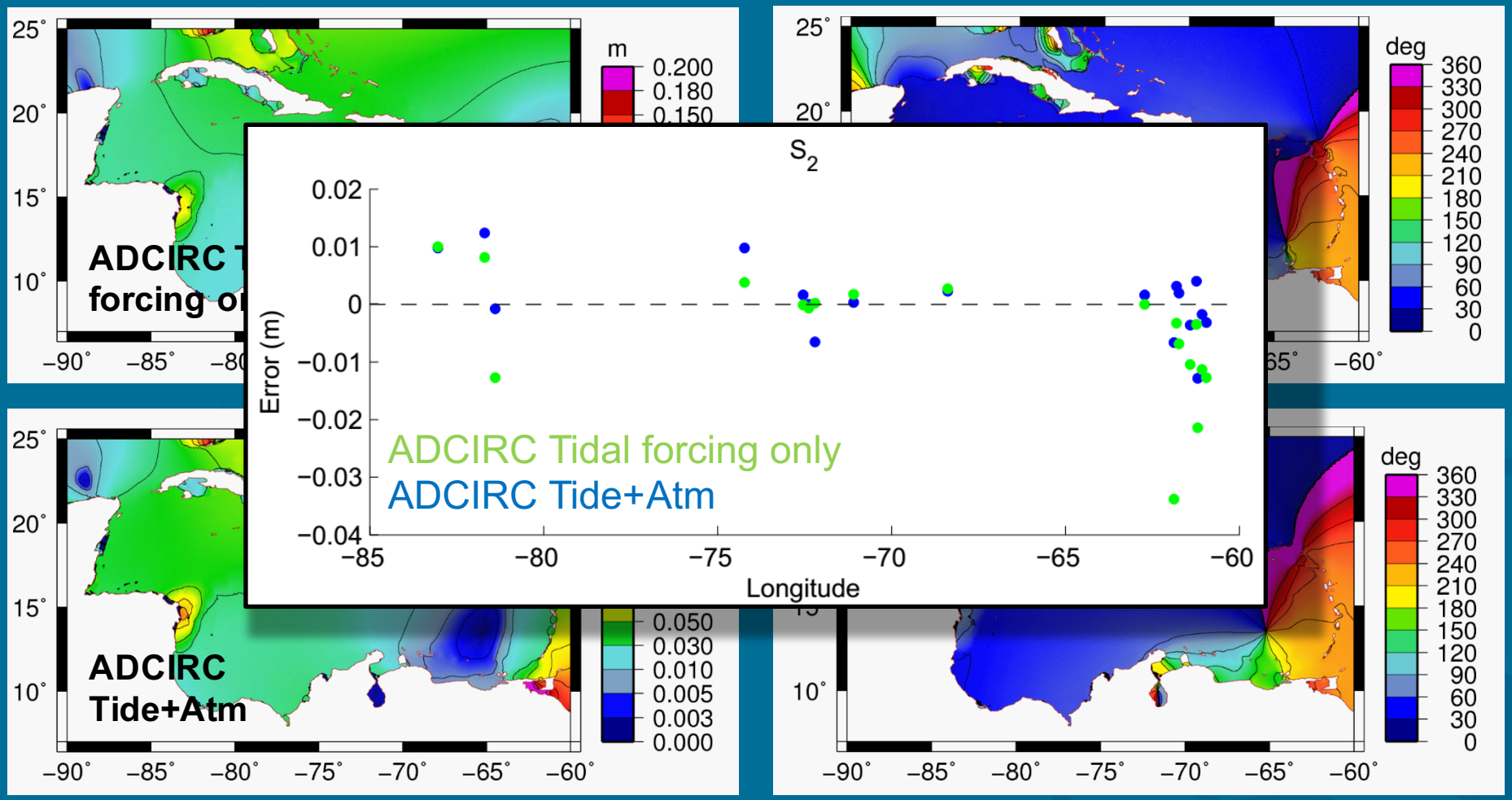




Tides and atmospheric effects

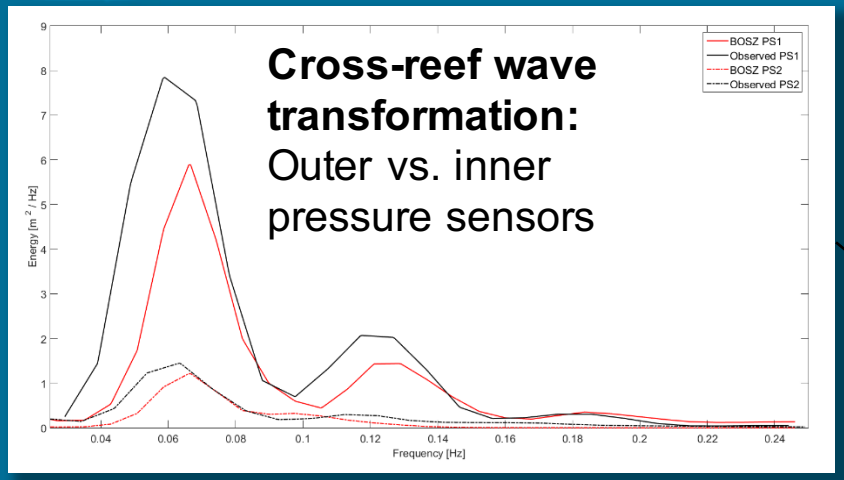
S_2 Constituent (Amplitude)

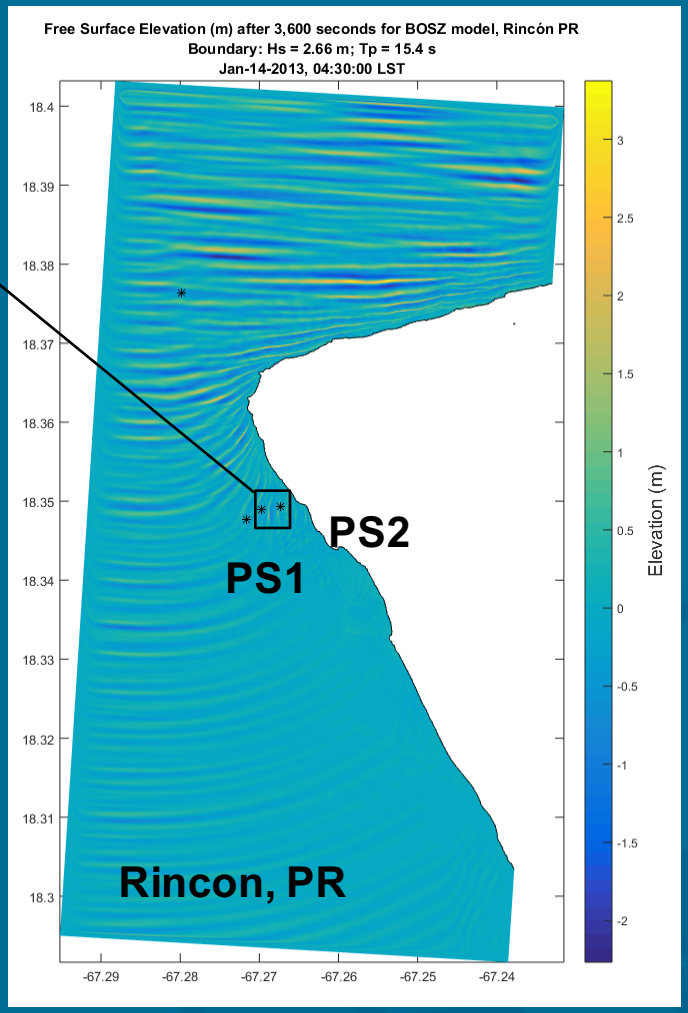
S_2 Constituent (Phase)

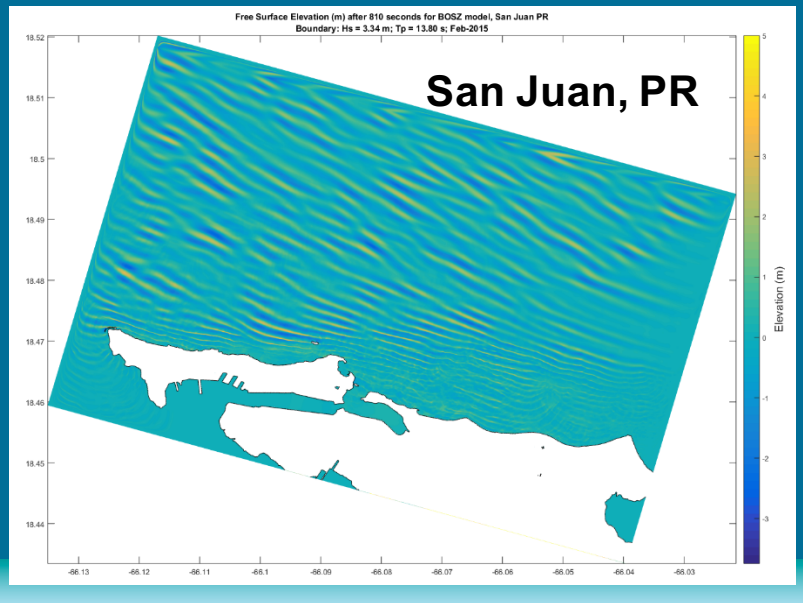


BOSZ phase-resolving model

Jan 14, 2013, 04:30 LST

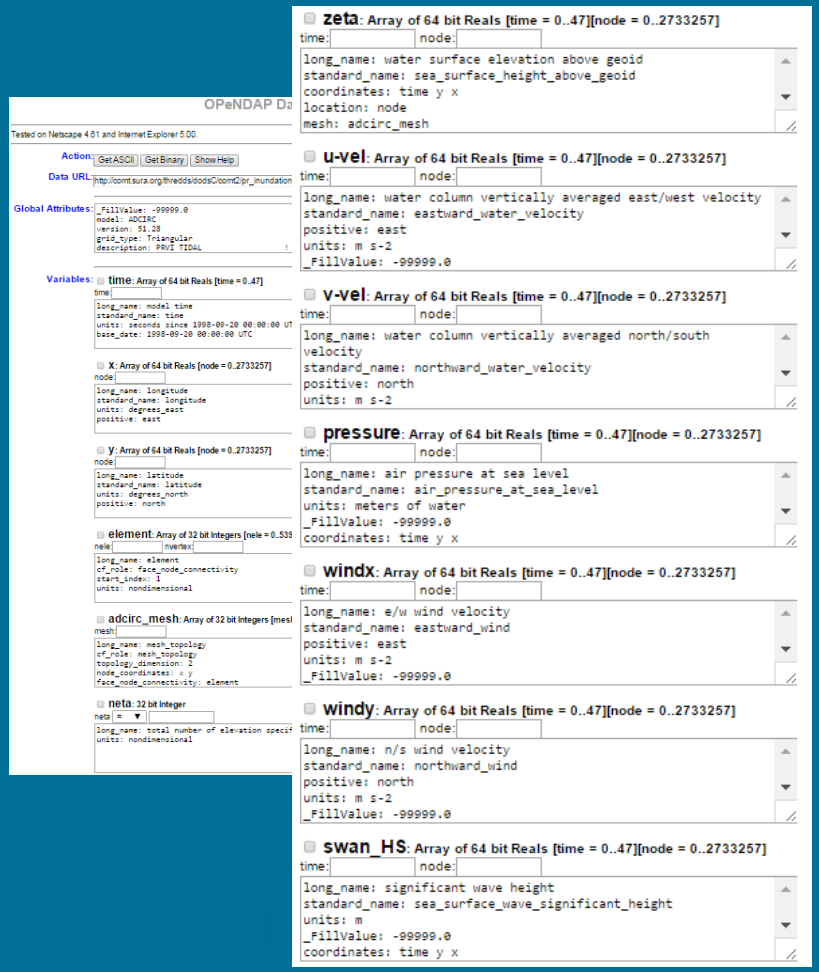




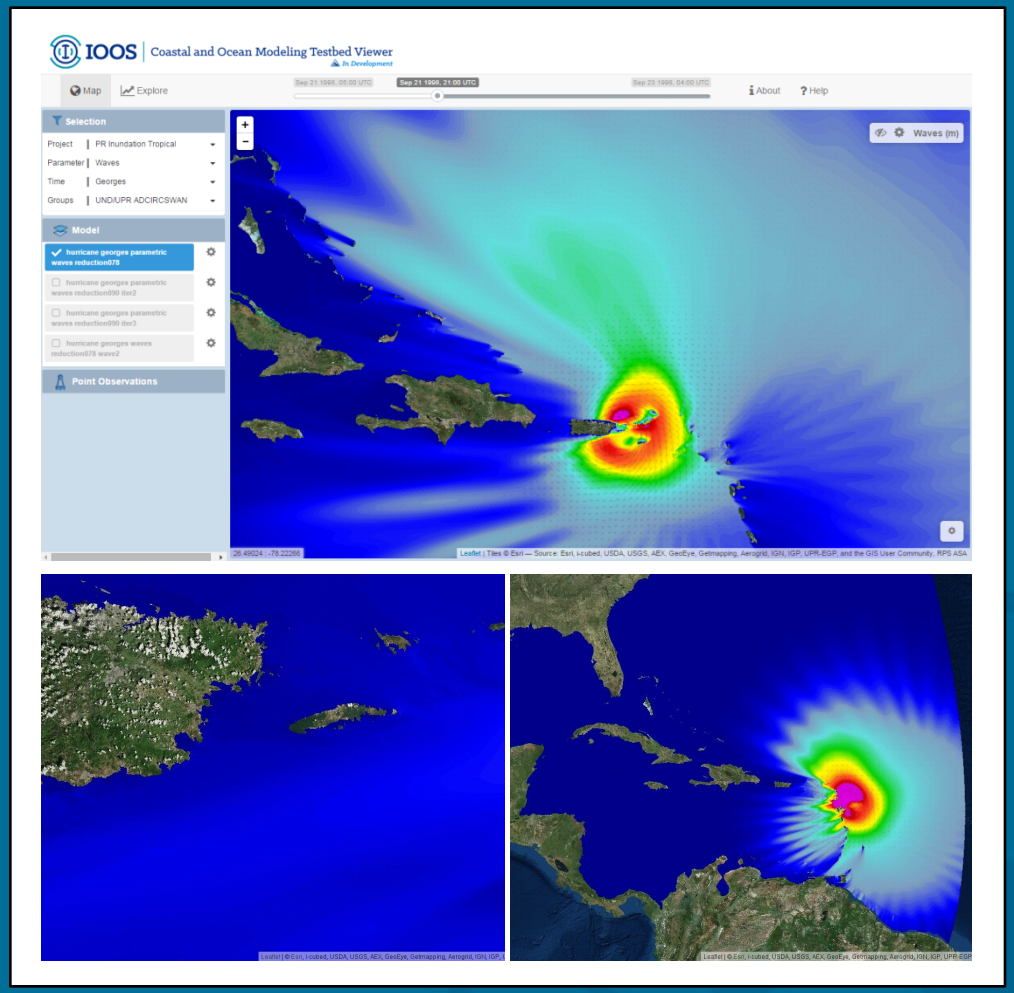


COMT CyberInfrastructure (CI)

Data Access (eg. OPeNDAP)

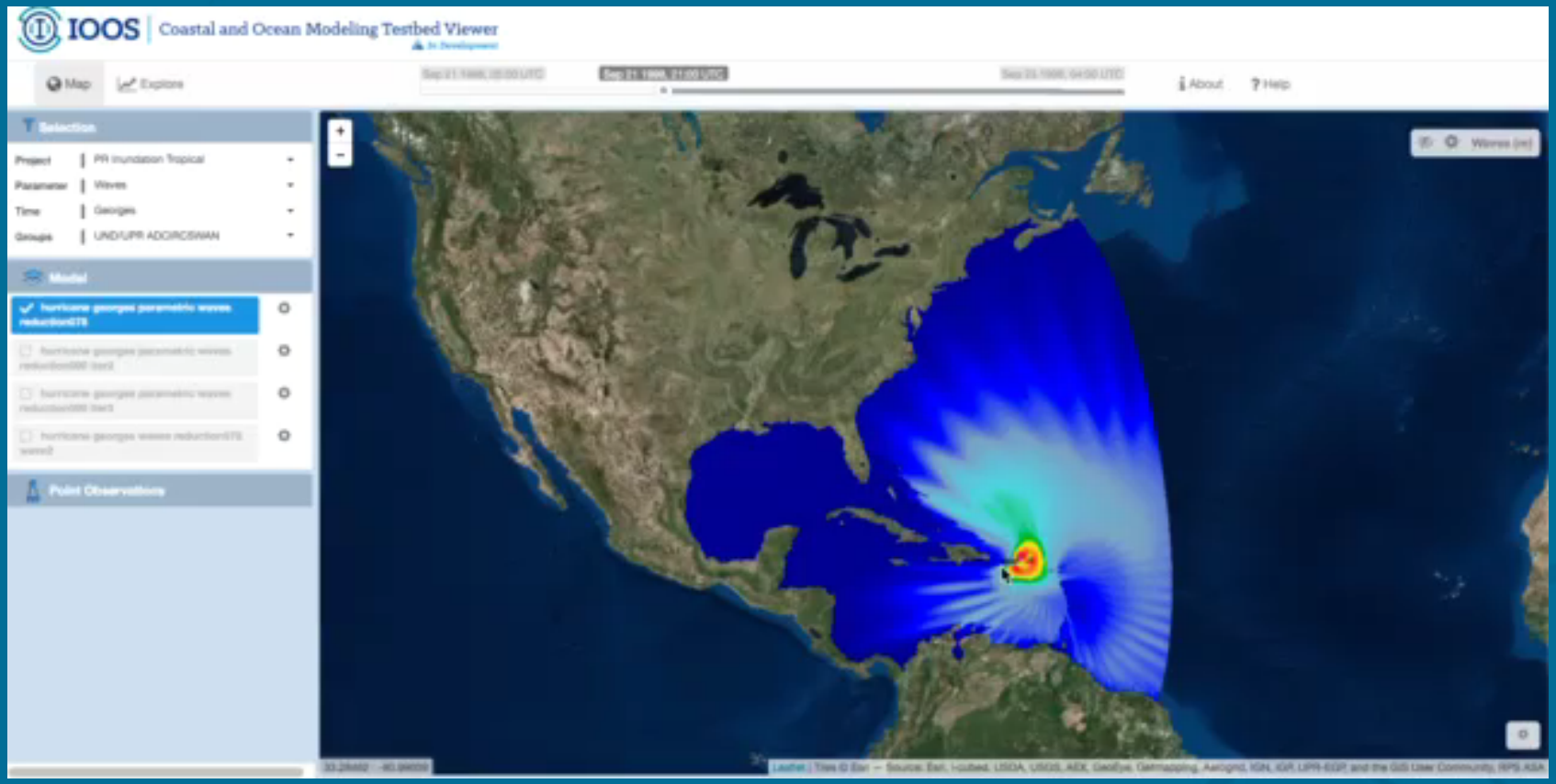


Presentation/User Interface



CI Web-based map view

Rapid exploration of model output from large scale to local

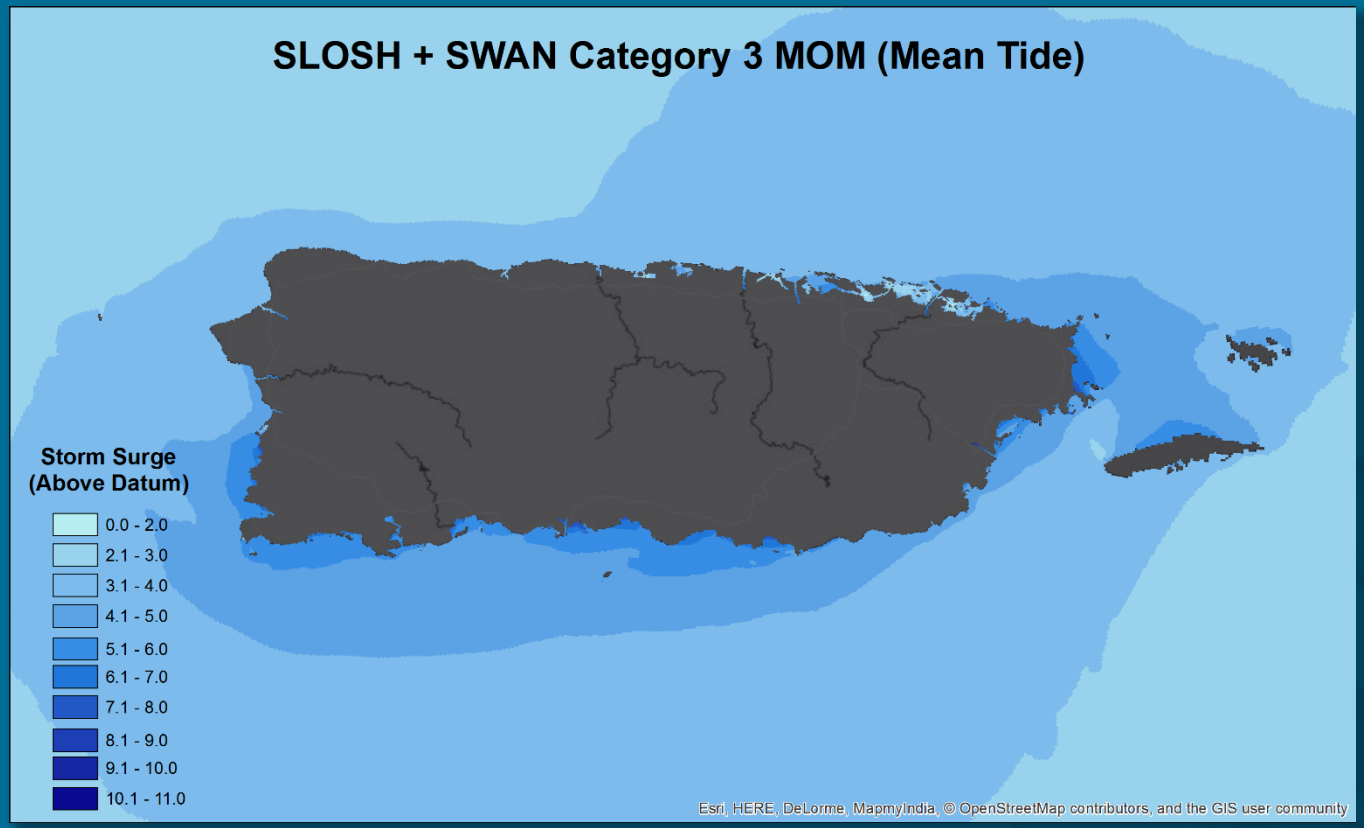


Inter-comparison of models regardless of grid or domain

- *Time series comparison across models available for any point within domain via OGC WMS GetFeatureInfo requests*

Transition to Operations

First-ever Maximum of Maximums (MOM) surge hazard database produced for Puerto Rico, using coupled SLOSH+SWAN. To be used for evacuation planning and response.



Conclusions

1. Island environments such as Puerto Rico have highly-detailed coastline features, best resolved with unstructured meshes.
2. Including wave effects has a clear impact on total surge levels, but magnitude is location-dependent.
3. The 3rd-gen wave model is a computationally-expensive component of the forecast system. For real-time operational application more efficient parameterized methods are being pursued.
4. The CI model repository and web-based map view enables rapid exploration and comparison of model output from large scale to local.
5. R2O: First-ever Maximum of Maximums (MOM) surge hazard database produced for Puerto Rico, using coupled SLOSH+SWAN. To be used for evacuation planning and response.