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

Field cases and Cyber-Infrastructure

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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.
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
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

- Irene 2011 (Tropical storm)
- Georges 1998 (Cat 4)
- Sandy 2012
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

ADCIRC (wind only)

Run time = 55 min (540 proc)

SLOSH (wind only)

Run time = 35 min (1 proc)

ADCIRC+SWAN

Run time = 14.9 h (540 proc)

SLOSH+SWAN

Run time = 11.2 h (12 proc)
Case 1: Surge – SLOSH, impact of waves

H. George (1998), Asymmetrical vortex model

Charlotte Amalie, VI

San Juan, PR

Lime Tree Bay, VI

Magueyes, PR
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)

ADCIRC Tidal forcing only

ADCIRC Tide+Atm

ADCIRC Tidal forcing only

ADCIRC Tide+Atm
BOSZ phase-resolving model
Jan 14, 2013, 04:30 LST

Cross-reef wave transformation:
Outer vs. inner pressure sensors
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
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.