7-24-2015

Communicating Coastal Flood Risk & Impacts

Jeff Orrock
National Weather Service

Follow this and additional works at: https://digitalcommons.odu.edu/hraforum_09

Part of the Climate Commons, Communication Commons, and the Meteorology Commons

Repository Citation
https://digitalcommons.odu.edu/hraforum_09/4

This Presentation is brought to you for free and open access by the Hampton Roads Sea Level Rise/Flooding Adaptation Forum at ODU Digital Commons. It has been accepted for inclusion in July 24, 2015: Communicating Frequent Flooding by an authorized administrator of ODU Digital Commons. For more information, please contact digitalcommons@odu.edu.
Communicating Coastal Flood Risk & Impacts
The Vision

Highly accurate, relevant, and timely information CLEARLY COMMUNICATED

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

Roadmap Goals:
1. Accurately predict and assess storm water levels
   – Total Water Level (TWL) models with surge + tides + waves + rivers
   – Account for uncertainty (ensembles, probabilities)
2. Intuitively describe inundation as flooding above ground level
   – In statements and maps
3. Communicate actionable information
   – Based on social science
What is Storm Surge?

STORM SURGE is an abnormal rise of water generated by a storm, over and above the predicted astronomical tide.

STORM TIDE is the water level rise during a storm due to the combination of storm surge and the astronomical tide.
Sea, Lake & Overland Surges from Hurricanes (SLOSH)

- SLOSH is a numerical model developed by the NWS to estimate storm surge heights resulting from historical, hypothetical, or predicted hurricanes taking into account atmospheric pressure, size, forward speed, and track data.
- SLOSH model physics are applied to a specific locale's shoreline, incorporating the unique bay and river configurations, water depths, bridges, roads, levees and other physical features.
SLOSH Inundation

- Subtract Land (per grid cell)
Total Water Level: Adding Tides to SLOSH

- NOS’ model tide predictions coupled to NWS’ surge model
- *Operational requirement for probabilistic P-Surge predictions for Potential Storm Surge Flooding map*

NWS Surge  +  NOS Tides  =  SLOSH+Tides
• P-Surge
  – Probabilistic Storm Surge
  – **Response (<48 hr of landfall)**

• MEOW
  – Maximum Envelope Of Water
  – **Readiness (48hr – 120 hr of landfall)**

• MOM
  – Maximum Of the MEOWs
  – **Planning / Mitigation (>120 hr of landfall)**
Create more forecasts, first varying across the track

- Distribution based on known historical errors with NHC’s forecasts
- Chose to have forecasts spaced Rmax apart at the 48hr forecast point
More forecasts created by varying size (pictured left) as well as intensity and forward speed for all possible tracks, 3 variations for each.

Results in 270 total possible forecasts, run within multiple basins; p-surge completes its run in approx. 30min
Probability of Surge >= 5 feet
Surge Height Exceeded by 10% of Ensemble Members

Tropical Cyclone Storm Surge Exceedance
Heights Which Have a 10% Chance of Being Exceeded
Hurricane Irene (2011) Advisory 30
Valid from 05 PM EDT Sat Aug 27 to 10 PM EDT Tue Aug 30

Height (in feet above normal tide)
Rationale for PHISH

P-surge gives results above datum, which can be confusing for some users.

How to move p-surge to above ground level?

- Subtract land from p-surge products
  - Could work for exceedance product
  - Unable to subtract land from a probability
- Subtract land before combing into probabilities
  - Expert users may still need above datum product, so cannot replace p-surge
- Create a new product (PHISH)
PHISH Example (Probability)

P-surge (above datum)  
Probabilistic product

PHISH (above ground level)  
Probabilistic product
PHISH Example (Probability)

P-surge (above datum)
Probabilistic product

PHISH (above ground level)
Probabilistic product
Hurricane Arthur Example
Communicating Actionable Information

TC storm surge warning - experimental in 2015

Potential Storm Surge Flood Map
ET Modeling Strategy

• Storm Surge Roadmap is coordinating development of multi-model ensembles of total water level guidance, leveraging extensive federal investments
  – SLOSH (ETSS)
    • Uses simplified physics and efficient numerical scheme to run extremely quickly, enabling a large number of ensemble runs
    • Operational for TC and ET across US coasts
    • Developing tide and wave coupling, nesting
  – ADCIRC (ESTOFS)
    • Uses advanced physics and a complex numerical scheme to provide high fidelity predictions but are costly to compute, minimizing ensemble members
    • Extensive set of grids developed for federal projects
    • Operational for ET Atlantic
    • Couples to tide, wave, and hydraulic models
Extra Tropical Storm Surge Model Development

• Extra Tropical Storm Surge (ETSS) model with overland and tide capabilities
  – Introduce tide versions of SLOSH
  – Nest with SLOSH's finer (< 500 m) overland tropical grids

• Probabilistic Extra-Tropical Storm Surge (PETSS)
  – Forcing via the 21 GFS ensemble members (scalable to include other ensemble model's members)
Improving Extratropical Surge Prediction

- Extratropical Surge + Tide Operational Forecast System (ESTOFS) for Atlantic and Pacific
- Uses ADCIRC to model surge and tide with coastal resolution of 1 to 3 km
- 180 hour forecast produced 4 times per day on WCOSS operational high performance computer
ESTOFS Overview

• Purpose
  – Provide an operational set of forecast guidance for extratropical storm surge that includes tides
  – Supports coupling to wave models
    • Provide surge+tide boundary conditions for NWS’s Nearshore Wave Prediction System (NWPS)
    • Mimics WAVEWATCHIII® (WW3) set-up for future coupling
  – Leverages community-based model ADCIRC
ESTOFS Output

• Delivers three types of water level
  – Combined Water Level (CWL): Surge + tides
  – Harmonic Tidal Prediction (HTP): Astronomical tides
  – Subtidal Water Level (SWL): SWL = CWL − HTP = “surge”

• Generates output on ADCIRC unstructured grid
Sandy Supplemental ESTOFS Upgrade

- Funding to develop ADCIRC TC ensemble implementation
- Extend ESTOFS Atlantic overland and add ensemble members
  - An ensemble of 5 to 10 members will predict overland flooding along East and Gulf coasts at 200-500 m resolution
  - Potential ensemble members: GFS, GEFS, NAM, NDFD, ECMWF
  - Operational in FY16
Combining different models into an ensemble

- **SLOSH (Sea, Lakes, and Overland Surge from Hurricanes) model**
  - Uses simplified physics and an efficient scheme to run extremely quickly

- **ADCIRC (ADvanced CIRCulation) model**
  - Uses advanced physics and a complex high resolution scheme but more costly
NWS Wakefield Total Water Level Pilot
Total water level = Storm surge + Tides + Freshwater
Total Water Predictions

- Provides hydrographs and enhanced warnings
- Integrated into AHPS with all river flood data
- Working to develop a one stop shop interface.

http://www.erh.noaa.gov/akq/brief/tides.php
Plan to add the following as they come online in cooperation with the USGS and NOS;

Working with NOS to develop a prototype interface focused on Norfolk expanding beyond AHPS expanding impact statements and visualizations.
Comparable to a forecast of 7.5 ft MLLW – Major Flooding (Hurricane Irene)
Proposed Viewer Including:
- Inundation mapping by location
- Links to forecasts / impact elevations
- Flood visualizations
- Photos of past events
Breaking waves also contribute to the total water level through wave runup/setup.
The Dangers of Using Single Track Deterministic Guidance

• Users will go “weather shopping” with other model guidance. Users need to be aware of what they’re looking at.

• Can be visually appealing, while suggesting a degree of accuracy and precision that cannot be justified.

• Most storm surge models perform quite well and comparable only if meteorological conditions are perfectly correct.

• Deterministic/Single Track runs are subject to a host of potential errors, including…
  – Direction – where/angle storm will approach coast
  – Forward speed – when storm will approach coast
  – Intensity and size of wind field
Deterministic Surge Forecast
Original Forecast Track
Deterministic Surge Forecast
Track Shifted Slightly West
Deterministic Surge Forecast

Track Shifted Slightly East
Questions & Comments

jeff.orrock@noaa.gov