Improving NOAA’s Capacity to Address Coastal Inundation Events

The Storm Surge Roadmap

Jesse C. Feyen
Storm Surge Roadmap Portfolio Manager
NOS/Office of Coast Survey /Development Laboratory
The Vision

Highly accurate, relevant, and timely information

*CLEARLY COMMUNICATED*

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

Modeling’s role is to provide information to those who assess and communicate risk...
Roadmap Guiding Principles

• Storm surge enterprise is a NOAA-wide program
  – Shared priorities, coordinated execution
• Need to efficiently maintain and upgrade systems
  – Leverage community-based approaches
  – Functionally align activities with expertise (don’t duplicate efforts or knowledge)
• Must be customer-driven
  – Customers’ requirements set what needs to be done; technical experts determine how
• Need to provide national capacity
  – Little value to one-offs
Operational Modeling Requirements

• Emergency managers and decision makers rely on official, authoritative NWS forecasts to support tough decisions during crisis events
  – Modelers should not duplicate or conflict with official forecasts! User confusion can lead to inaction or poor decision-making

• NWS forecasters rely heavily on operational model guidance within their system (AWIPS)
  – Accessing external data can be challenging and time consuming, particularly during an event
  – Confidence may be low
Advanced Weather Interactive Processing System (AWIPS)

169 separate AWIPS systems at 137 geographical locations

AWIPS Workstations and Servers

~900 Workstations (total)
~1200 Servers (total)

Service provided to 3066 US Counties
24 hrs/day, 365 days/yr.
Transitioning Improved Modeling to Operations

- NSW operational system heavily prioritizes robustness
  - 99.99% uptime using well-vetted, “hands-off” systems
  - Robust, standardized model skill assessments and testing before transition to operations
- Development “pipeline”
Considerations for IOOS RA Modeling

• RAs provide focus on advancing science and focusing on local issues (i.e., resolution)
• Consider federal modeling transition groups a primary customer
  – Understand operational requirements and consider those in planning
• Use of community-based models, standards and frameworks shortens transition to operations
  – Common data format and dissemination can speed use before operations
Model Improvements Prioritized by NOAA’s Storm Surge Roadmap

• Storm surge model predictions that are:
  – Ensembled and/or probabilistic
  – High resolution
  – Able to capture dynamics of large scale storms
  – Include all factors that contribute to total water level of flooding: surge, tides, waves, and river inflow
  – Community-based to leverage multi-agency investments (e.g., ADCIRC)
Concept of a Next Generation Storm Surge System

- Hurricane Modeling
  - Ensemble output (e.g., HWRF)
  - NHC Official Forecast Tracks

- Tidal Database

- Hydrologic Modeling
  - Precipitation
  - Inflow

- Storm Surge Modeling
  - Wind, Pressure
  - Water Level, Currents
  - Water Level
  - River Level

- Wave Modeling
  - Wave spectra
  - Wind, Pressure
  - Water Level, Currents

- Products
  - GIS-based
  - Inundation graphics
  - Hydrographs
  - Wave Conditions
  - Ensembles

Coastal hazards modeling
- Flexible grids that combine large regions with locally high resolution
- Combine effects of surge + tide + waves + rivers to assess flooding
Total Water Level: Adding Tides to SLOSH

- NOS’ ADCIRC tide predictions coupled to NWS’ surge model
- Operational requirement for probabilistic model $P_{\text{surge}}$ (hundreds of SLOSH tracks per forecast)
Improving Extratropical Surge Prediction

- Extratropical Surge+Tide Operational Forecast System (ESTOFS) operational in 2012
- Computes surge with tides for forecasting and for coupling to NCEP’s WAVEWATCHIII® and Nearshore Wave Pred. System
- NOS developed with ADCIRC
  - Coastal resolution \( \approx 3 \) km
  - 6-hr nowcast followed by 180-hr forecast
- Pacific in development
Providing Water Level Fields to Forecasters

EC2001 grid (NetCDF)  NDFD 2.5 km CONUS grid (GRIB2)
Nearshore Wave Prediction System (NWPS)

- Extension of operational wave modeling to the shore
- Run locally, on-demand, using SWAN or nearshore WWIII --> moving to unstructured grids
- Included in the AWIPS II baseline
- Addresses regionally-specific high impact issues in the nearshore (surf breaking, wave-current interaction, etc.)
- Driven by forecaster-developed wind grids
- Using ADCIRC grids and being coupled to ESTOFS
Experimental High Res Surge Ensemble

• ADCIRC Surge Guidance System
  – Automated system for ADCIRC + SWAN running on tjet as part of HFIP
  – Forced by NAM or NHC advisories
  – Utilizes community library of ADCIRC grids
  – Support from USACE and DHS; maintained by researchers at UNC-CH and partners

• Perturbs official NHC forecast
  – Official forecast track, wind speed increase, veer halfway/fully to edges of cone, slower forward speed, change in Rmax
Ensemble Forecast to Address Track Uncertainty

Official Track

20% More Intense

Left shift

Right Shift
IOOS Testbed: using Community-Based Models to Improve Operations

• Provides shared, systematic methodology for evaluating benefits of research models for transition to operations

• Coastal inundation subgroup
  – Tropical (Ike, Rita) and extratropical (Scituate, MA)
  – Evaluating community-based research models
  – Provided SLOSH coupled to SWAN wave model, experimental hi res ADCIRC surge guidance system
  – Proposed extension to Puerto Rico (island waves)
CI-FLOW: combining coastal and inland flood prediction

- NSSL leading collaborative effort to research coupled precip+hydrologic+hydraulic+coastal flood prediction
- Real-time predictions in Pamlico Sound; beginning second project in Louisiana
- Informs coupling strategies for operational modeling of rivers and coasts
- Collaborators include NOS, NWS, academia

http://www.nssl.noaa.gov/projects/ciflow/
CI-FLOW Precipitation
- Past Precip: Gauge-adjusted QPE from NSSL’s NMQ/Q2 (aka, MRMS), 1-hour accumulation
- Forecast Precip: QPF from HPC, 6-hour accumulation

CI-FLOW Hydrology
- NWS HL-RDHM (Hydro Lab – Res. Distributed Hydro Model)
- SACramento Soil Moisture Accounting (SAC-SMA)
- Kinematic Wave Model for routing
- 128 ensemble members

CI-FLOW Storm Surge, Waves, & Tides
- ADCIRC + unSWAN wave model
- River boundary conditions at 4 hand-off points
- Wind fields provided by NWS operational NAM or Asymmetric Vortex Wind Model (if hurricane)