NOAA’s Storm Surge Roadmap: Transition Research to NWS Operations

RITT Forum
21 July 2010

Jesse Feyen,
Roadmap Portfolio Manager
Outline

• Why a NOAA Roadmap for Storm Surge?

• Vision and Goals

• Purpose and Structure of the Roadmap

• Phase 1 Plan

• Transitioning to NWS operations
  – A new extratropical storm surge model, ESTOFS
The Imperative

- **Increasing Risks**
  - Increasing coastal populations and sea level rise require more deliberate planning

- **Increasing Demand**
  - Decision makers require fine-scale local information that communicates risk clearly

- **Improving Science & Technology**
  - Surge modeling, the social science of decision making, information technology

- **NOAA Must Collaborate**
  - Partner to organize and lead state of the art research and development while making best use of resources
Purpose of the Roadmap

• Shows us our starting point and where we want to arrive

• Effective approach to long-range planning; shows a path to the future

• Effective for communicating and engaging across the agency, and with our partners

• **Bottom line**: first-ever comprehensive effort to holistically address rapidly expanding problem and establish a community approach
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 respond?

NOAA needs to:
- Improve determination of storm water levels
  - Total Water Level (TWL) can be much more than surge (tides, waves, rivers, prestorm setup)
  - Model and product accuracy needs to reflect uncertainties
- Describe flooding as inundation above ground
  - Statements, maps
- Communicate actionable information
  - Intuitive and consistent
Goals of the Roadmap

• **Total Water Level**: Produce water level analyses, forecasts, observations, and products that include:
  – *pre-storm forerunner, surge, tides, waves, fresh water inflow, speed, impact*

• **Inundation**: Provide information about the water depth over the land (inundation) to street level resolution

• **Communication Actionable Information**: Deliver information that people act on
  – *understandable, consistent information available in multiple formats*
  – *uncertainty, supports risk assessments, provides impact information, includes scenarios*
Roadmap Structure

Executive Steering Team
Office Directors from NOS, NWS
(D. Berchoff, M. Davidson, Z. Willis)

Program/Portfolio Manager
NOAA PM for Storm Surge

Storm Surge Action and Planning Team
NWS: Regions, OCWWS, OHD, NCEP/EMC, NHC, OST/MDL
NOS: OCS, CSC, CO-OPS, IOOS
OAR: Sea Grant, NSSL
3 Phase Approach

Phase I (FY9-11)
Consensus building and quick wins to improve our products today; lay groundwork for longer term

Phase II (FY12-14)
Research and develop new approaches; evaluate for transition to operations

Phase III (FY15-FY19)
Implementation of new products and services within operations

Continual Refinement
Moving Ahead: Roadmap
Progress To Date

- Projects are scheduled for Phase 1, which has AA-level approval from NWS, NOS and OAR
  - 5 short-term quick win improvements in 2010, 8 in 2011
    - Improve determination of water level in existing products
    - Reducing confusion about relationship to flooding above ground
  - Strategic long term projects to develop complete inundation information communicated in actionable ways
    - Building framework for community-based next generation modeling system (e.g., ADCIRC) that includes surge, tides, waves, river inputs
    - Improving products to better communicate threat
    - Capturing user preferences on products
- Synchronizing efforts of the enterprise and conveying strategy internally and externally
## Improving Determination of Water Levels: Phase 1 Quick Wins

- **Moving towards more complete picture of Total Water Level**

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<th>Project</th>
<th>FY10 Q1</th>
<th>FY10 Q2</th>
<th>FY10 Q3</th>
<th>FY10 Q4</th>
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**Legend:**
- **R & D** Research and Development
- **DT & E** Developmental Testing and Evaluation
- **ET & E** Experimental (Pre-operational) Testing and Evaluation
- **O & M** Operations and Maintenance

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*Hurricane Season*
## Improving Determination of Water Levels: Phase 1 Long Term Strategies

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Describing Flooding as Inundation Above Ground: Phase 1 Plan

- Users confused by datums and don’t understand flood risk at their location; developing maps and products to describe local flooding above ground level

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**Hurricane Season**

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Communicating Actionable Information: Phase 1 Plan

• Users misinterpret statements and graphics; can’t readily plan with risk in mind

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What’s Possible in Phase 2 and Phase 3?

- High resolution inundation mapping
- High resolution model of Pensacola Bay Inlet
- Impact Visualization and Assessment

Combine best available technology from the community into a robust, sustainable operational system
Transition Roadmap Projects to NWS Operations

• It appears collaboration between the Roadmap and the RITT would be beneficial for NWS projects
• Roadmap provides an overarching strategy that endorses projects with coordinated approach
• Will grown in importance as we progress through Phase 2
• Could start today with ESTOFS…
ESTOFS

- ADCIRC-based Extratropical Surge+Tide Operational Forecast System (ESTOFS) modeling system for Western North Atlantic
- Driven by both atmospheric and tidal forcing
- Delivers real-time water levels and depth-averaged currents as fields and at key point locations
- Designed for coupling with EMC’s WaveWatch III for coastal surge+tide+wave predictions
- Provides boundary conditions for coastal models
ESTOFS Approach

- Implement widely-used and tested community-based model ADCIRC
- Unstructured grid model is suitable to simultaneously resolve and predict the important processes in the deep, intermediate, and shallow domain
- Model will be implemented within NCO by collaboration with NCEP/EMC, NOS/CO-OPS, NCEP/OPC, and NHC/TAFB
Use of ADCIRC

- Finite element (FE) coastal ocean model
  - Unstructured grids are fundamentally advantageous for modeling circulation in coastal ocean
  - Local resolution to resolve important physical scales along with large domains to allow for simplified boundary conditions
- Widely used in depth-integrated form to predict water level (tides, surge)
- Under continued development and use at academic institutions, in federal agencies, (e.g., USACE, Navy, FEMA) and private sector
- High performance code uses up 16,000+ cores
- http://adcirc.org/
ESTOFS Set-Up

- **Forcing**
  - Tidal boundary conditions from global model (e.g. OSU TOPEX/Poseidon TPXO)
  - Meteorological forcing from GFS (10 m winds and sea level pressure every 30 mins)

- **Run Cycle**
  - 4X per day on GFS cycle in conjunction with WWIII
  - 9 hr hindcast followed by 180 hr forecast

- **Output**
  - Fields stored 3 hourly and stations hourly
  - Interpolate FE grid fields to 5km regular grid for transfer to NDFD coastal grids in GRIB2
ESTOFS Progress to Date

• Hindcast of 2009 completed, including Nor’Ilda
• Running on NCEP HPC and evaluating real-time operational framework
• Aim to have in parallel testing this year
• Working with NCEP to deliver output to OPC
BACKUP
Vision for NOAA’s Storm Surge Enterprise

- **Highly accurate**, relevant and timely storm induced coastal inundation information, **clearly communicated**, which results in significant reductions in loss of life and ensures all coastal communities are **optimally resistant and resilient** to inundation impacts
  - Drive community planning to reduce risk to life and property
  - Train and educate population to respond to threats appropriately
  - Infuse state of the art science and technology to refine risk assessment and reduce unnecessary evacuations
  - Communicate street level impacts that result in appropriate personal and community response before, during and after the events
Decision-makers need information on multiple time scales for:

- Coastal land-use (months – years before event)
- Emergency management planning (months before event),
- Evacuations (3-5-7? days before event),
- Real time response (36 hours before event through duration)
- Post-storm recovery (hours to days post landfall)