NWS Storm Surge Forecasting

AMS Students
Silver Spring, MD (July 20, 2011)

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SLOSH

- Sea, Lake and Overland Surges from Hurricanes
  - Finite differencing model developed by the Meteorological Development Laboratory to predict storm surge heights from historical, hypothetical or predicted hurricanes
  - Overland flooding
  - Parametric wind model for forcing
  - Structured grid with finer resolution overland, and coarser offshore
  - Models sub-grid features with flows through barriers and cuts
- Does not include
  - Tides, waves, river flow
    - Tides can be conservatively estimated by initializing the grid at high tide
SLOSH Basin
Forecast Uncertainty

NHC Official Annual Average Track Errors
Atlantic Basin Tropical Storms and Hurricanes

Year

Forecast Error (n mi)
0 100 200 300 400 500 600 700

Legend:
- 24 h
- 48 h
- 72 h
- 96 h
- 120 h
Hurricane Ivan: A case study
SLOSH Products

- Deterministic / Historic Runs
  - 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)
SLOSH Products

- Deterministic / Historic Runs
- P-Surge
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Maximum Envelope Of Water

User selects:
1) Category (Cat 3)
2) Landfall direction (wnw)
3) Forward speed (15 mph)
4) Initial tide (High)
MOM: Maximum Of MEOWs

User selects:
1) Category (Cat 3)
SLOSH Products

- Deterministic / Historic Runs
  - P-Surge
    - Probabilistic Storm Surge
    - Response (<48 hr of landfall)
  - MEOOW – Maximum Envelope Of Water
    - Readiness (48hr – 120 hr of landfall)
  - MOM
    - Maximum Of the MEOOWs
    - Planning / Mitigation (>120 hr of landfall)
Katrina Advisory 23

Hurricane Tracker
- Hurricane
- Tropical Storm
- Tropical Depression

08/28/2005 15Z

KATRINA Adv #23
Aug 28 2005 15z
172 mph 907 mb

Lat: 27°25'57"N  Lon: 94°38'36"W
P-surge - Vary Cross Track
P-Surge – Vary Other Variables

- Size: Small (30%), Medium (40%), Large (30%)
- Forward Speed: Fast (30%), Medium (40%), Slow (30%)
- Intensity: Strong (30%), Medium (40%), Weak (30%)
P-surge Error Distributions

• Error distributions are computed for cross track, along track and intensity by:
  – Assuming a normal distribution
  – Using a 5-year “mean absolute error” and getting the standard deviation (sigma) from:

![Diagram showing error distribution with mean absolute error occurring at 0.6745 sigma.](image)
Probability of >= 5 feet of Surge

Experimental Tropical Cyclone Storm Surge Probabilities
Chance of Storm Surge >= 5 feet at Individual Locations
Hurricane Katrina (2005) Advisory 23
Valid from 11 AM EDT Sun Aug 28 to 04 PM EDT Wed Aug 31
Surge Height Exceeded by 10% of Ensemble Members

Experimental Tropical Cyclone Storm Surge Exceedence
Heights Which Have a 10% Chance of Being Exceeded
Hurricane Katrina (2005) Advisory 23
Valid from 11 AM EDT Sun Aug 28 to 04 PM EDT Wed Aug 31
Probabilistic product shows considerable surge threat to Pensacola area.
Extra-Tropical Storm Surge

- **Extra-Tropical Storm Surge (ETSS)**
  - Finite differencing model developed by the Meteorological Development Laboratory
  - Modified SLOSH to predict storm surge heights from extra-tropical storms
  - Global Forecast System for wind forcing
  - Structured grid with finer resolution overland, and coarser offshore

- **Does not include**
  - Tides, waves, river flow
  - Overland storm surge
Extratropical Storm Surge Website

Combine the ETSS output with:

- Observations from NOS / CO-OPs
- Tides computed from constituents provided by NOS/CO-Ops
- Uses a 5 day running average error to improve total water level forecast
- Provides guidance on flooding (when total water level exceeds the HAT)

NOS/OPC also has ETSS model output

- Animations of maps of ETSS output with GFS pressure fields
Review:
NWS’s Storm Surge Products

• Tropical
  1. [potential Warning]
  2. NHC / WFO forecast
  3. Deterministic guidance
  4. Real-time ensemble guidance (P-surge)
  5. Climatological ensemble guidance (MEOW/MOM)

• Extratropical
  1. Coastal Flood Warning/Advisory
  2. WFO forecast
  3. Deterministic guidance (ETSS)
  4. [potential Real-time ensemble guidance]
  5. [potential Climatological ensemble guidance]