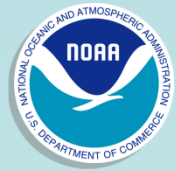


NWS Storm Surge Forecasting

AMS Students

Silver Spring, MD (July 20, 2011)

Arthur Taylor – MDL/NWS/NOAA



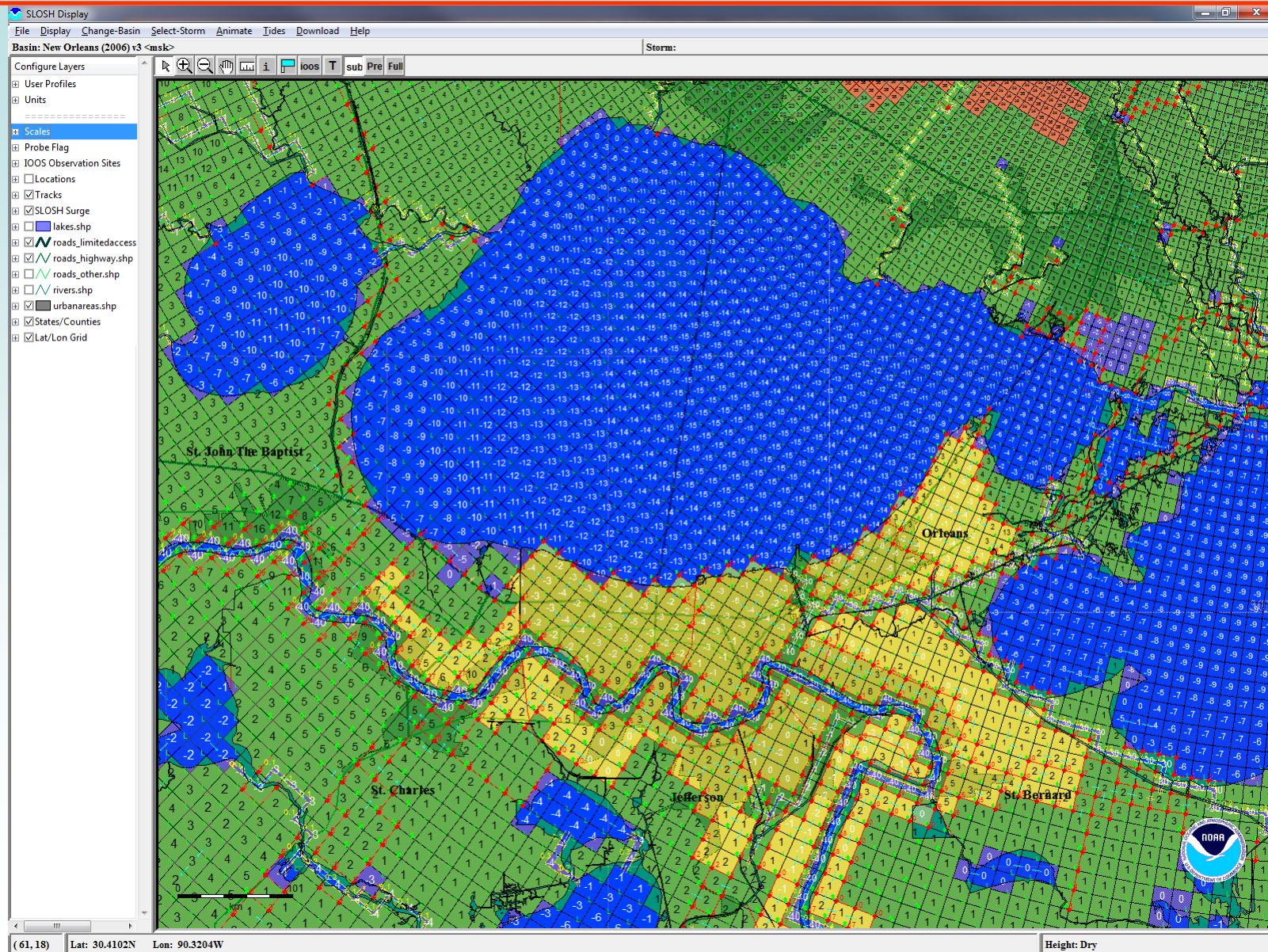
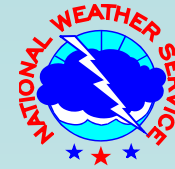
SLOSH

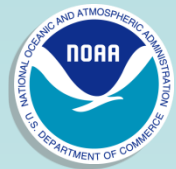


- Sea, Lake and Overland Surges from Hurricanes
 - Finite differencing model developed by the Meteorological Development Laboratory to predict storm surge heights from historical, hypothetical or predicted hurricanes
 - Overland flooding
 - Parametric wind model for forcing
 - Structured grid with finer 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



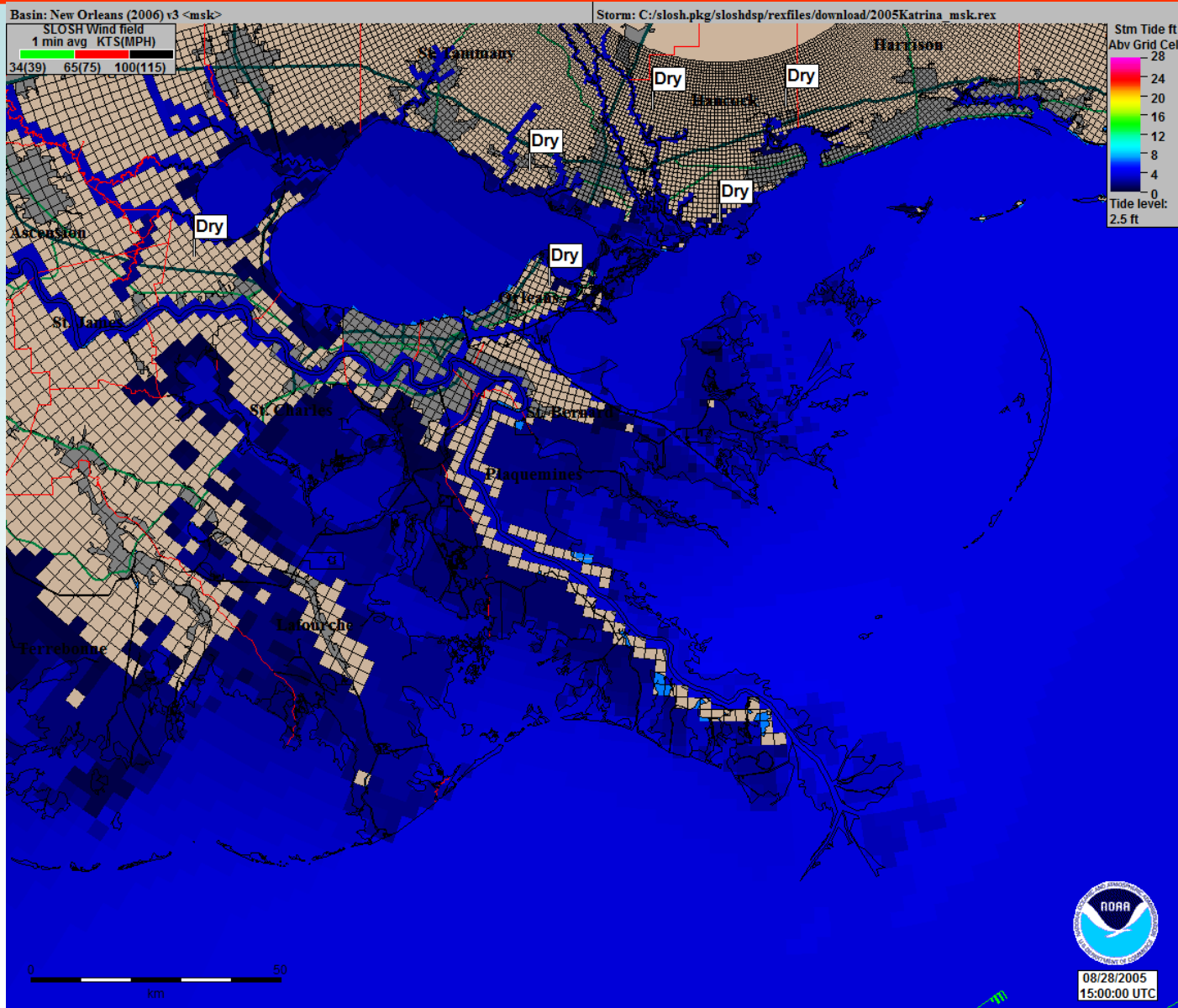
SLOSH Basin





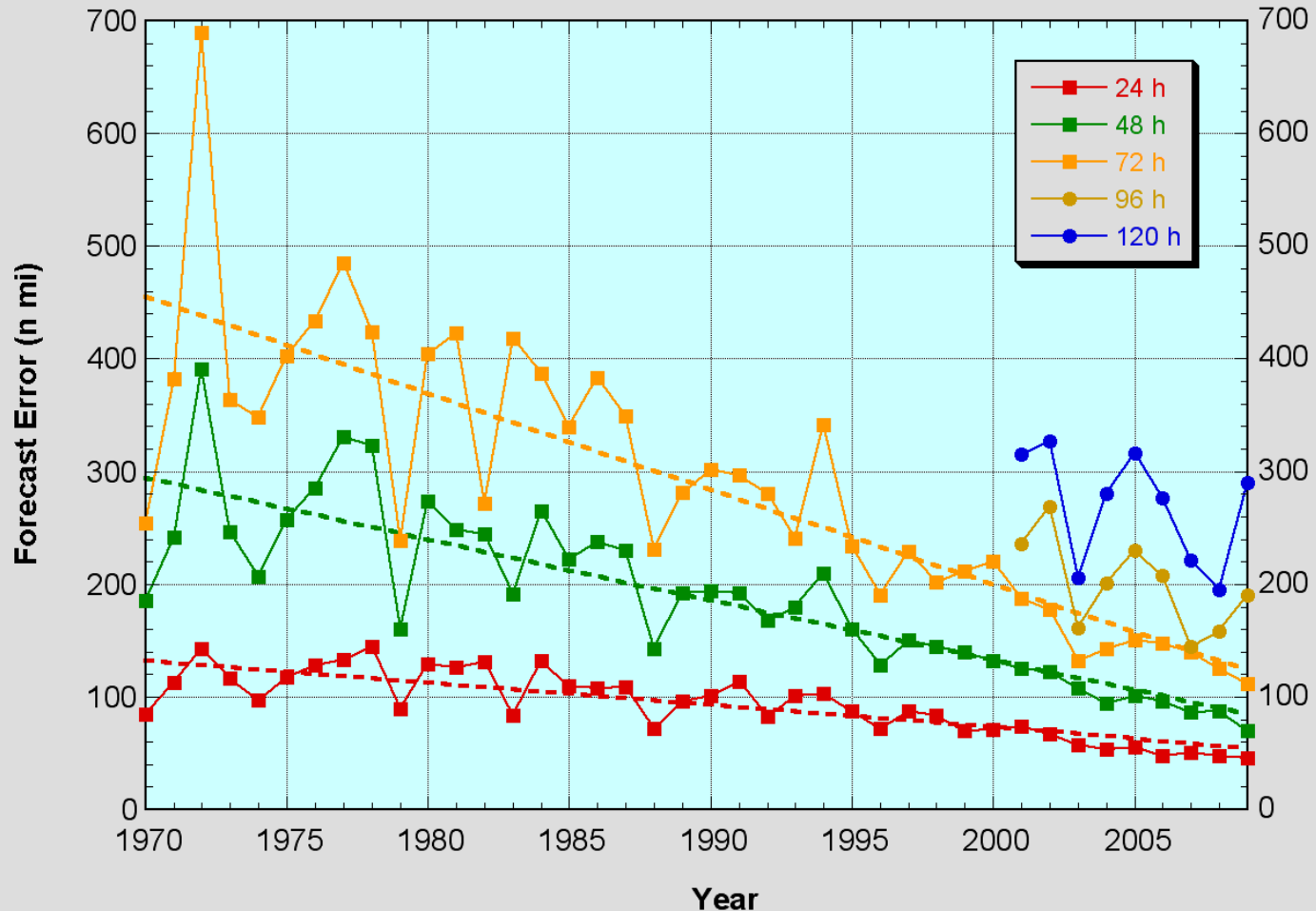
SLOSH Display Program

<http://slosh.nws.noaa.gov/sloshPub/>

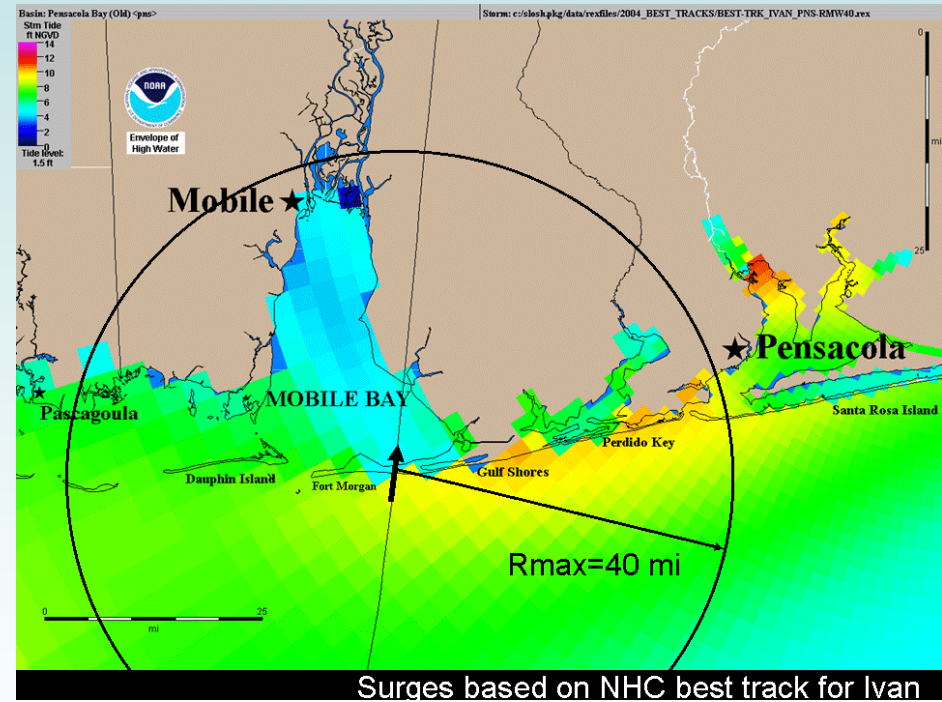
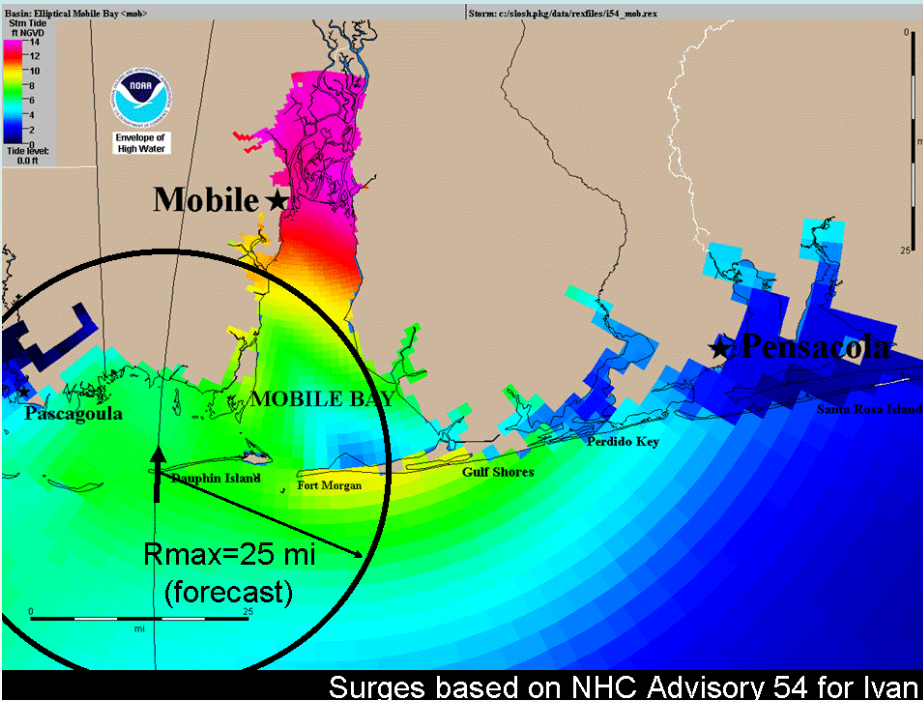


Forecast Uncertainty

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

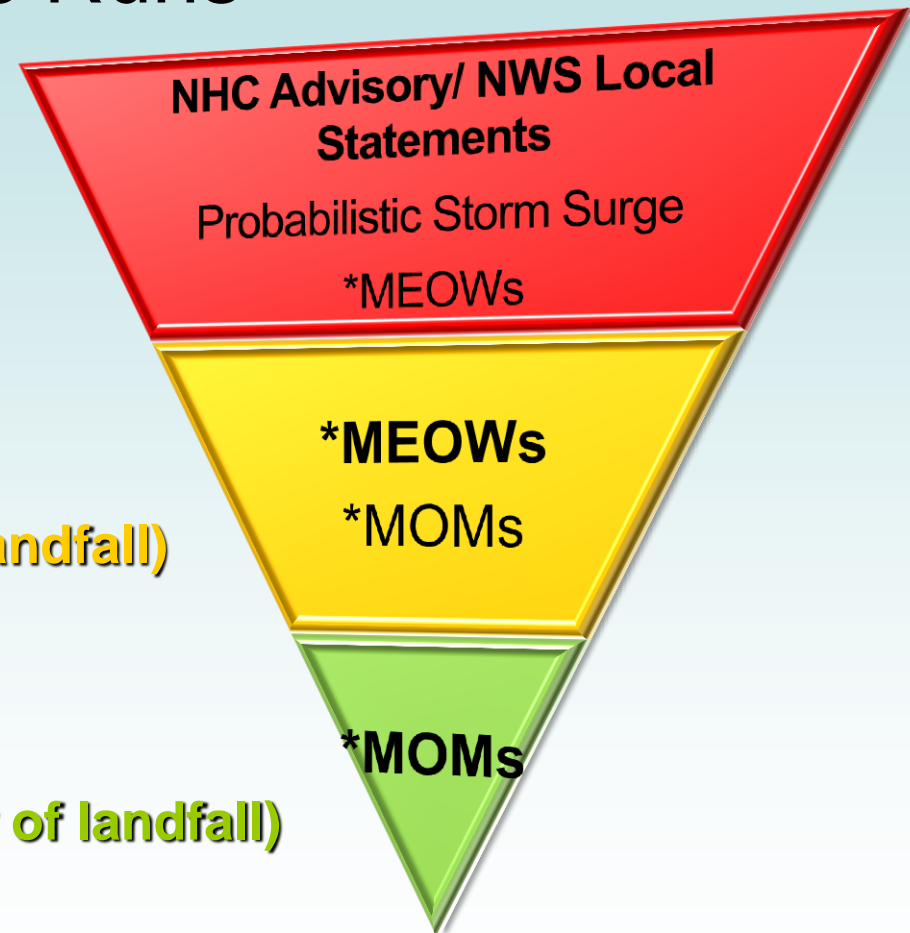


Hurricane Ivan: A case study



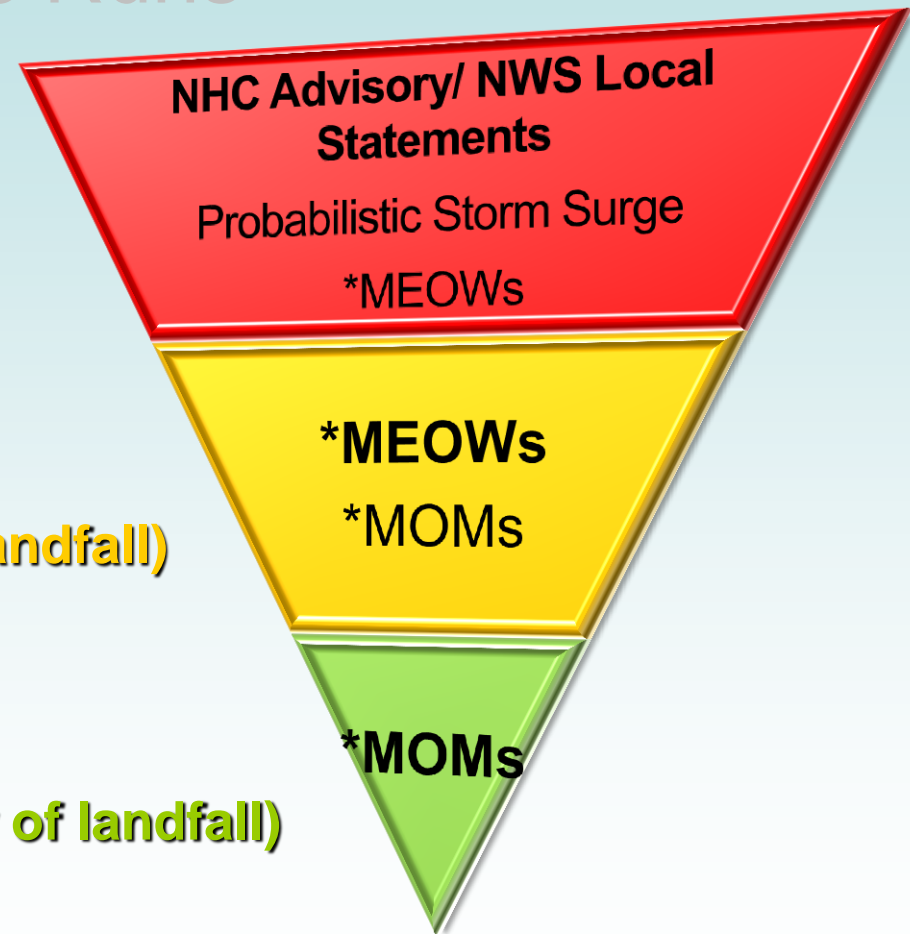
SLOSH Products

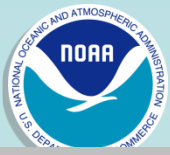
- Deterministic / Historic Runs
- P-Surge
 - Probabilistic Storm Surge
 - **Response (<48 hr of landfall)**
- MEOW
 - Maximum Envelope Of Water
 - **Readiness (48hr – 120 hr of landfall)**
- MOM
 - Maximum Of the MEOWs
 - **Planning / Mitigation (>120 hr of landfall)**



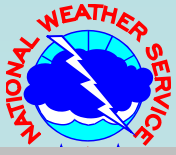
SLOSH Products

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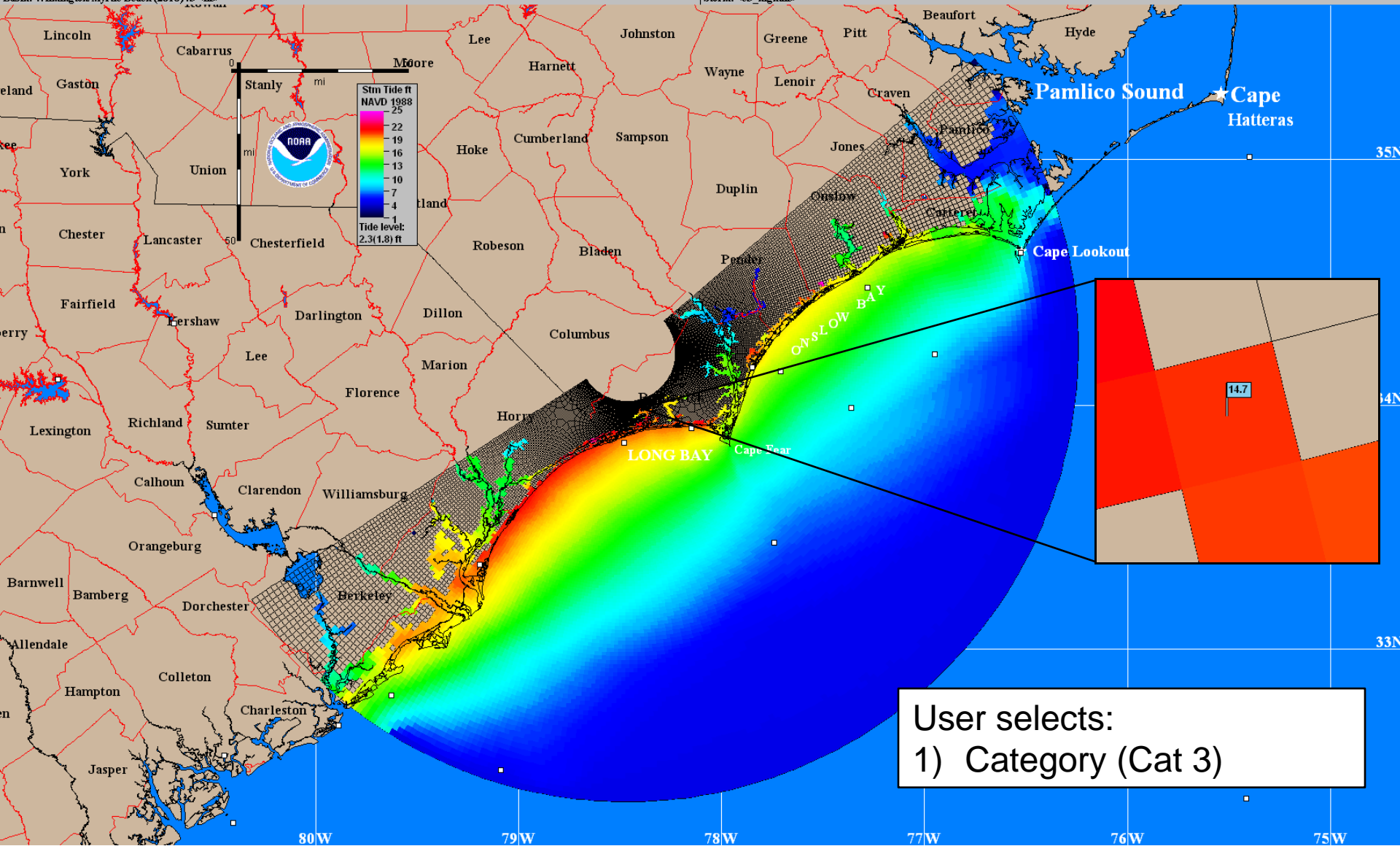


MOM: Maximum Of MEOWs



Basin: Wilmington/Myrtle Beach (2010) v3 <i3>

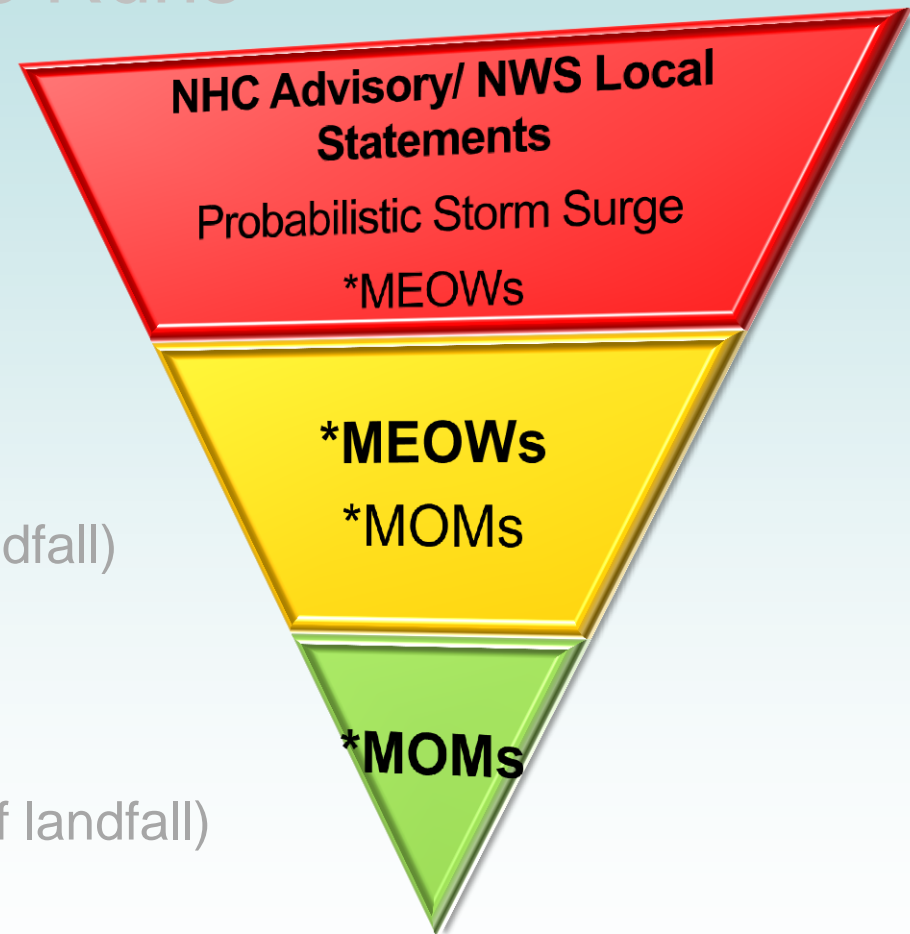
Storm: <c3_high.i3>

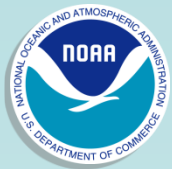


User selects:
1) Category (Cat 3)

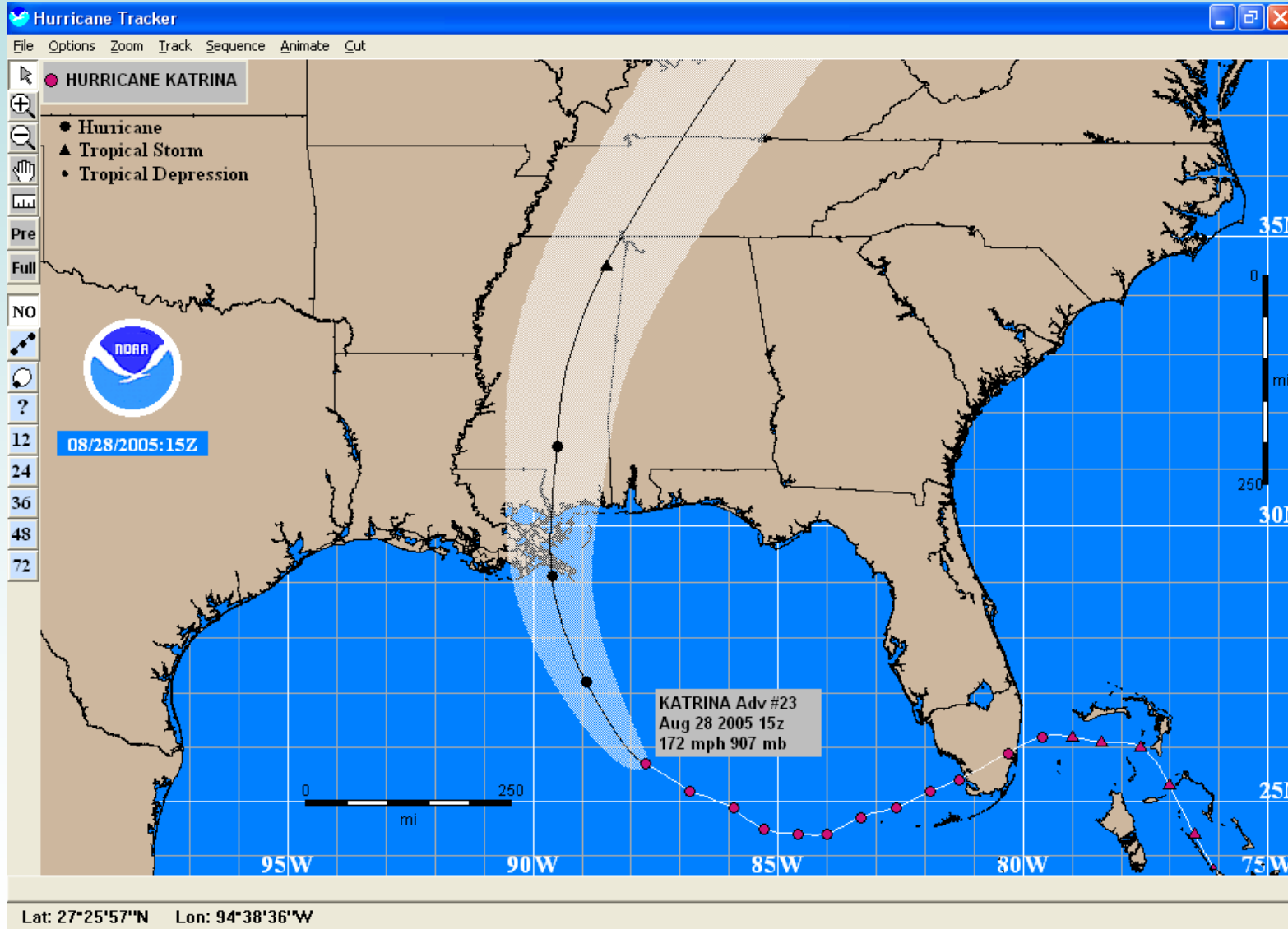
SLOSH Products

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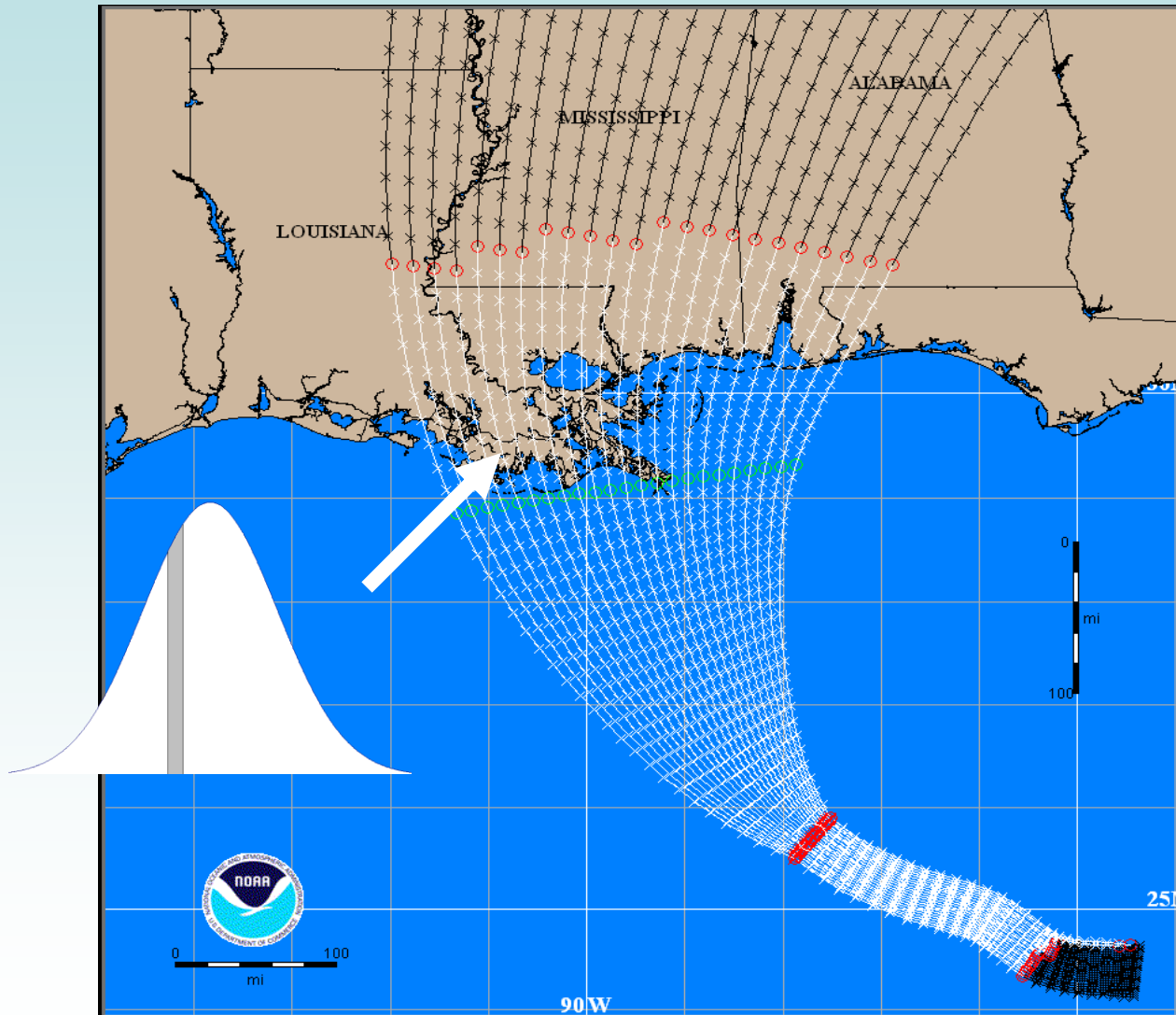




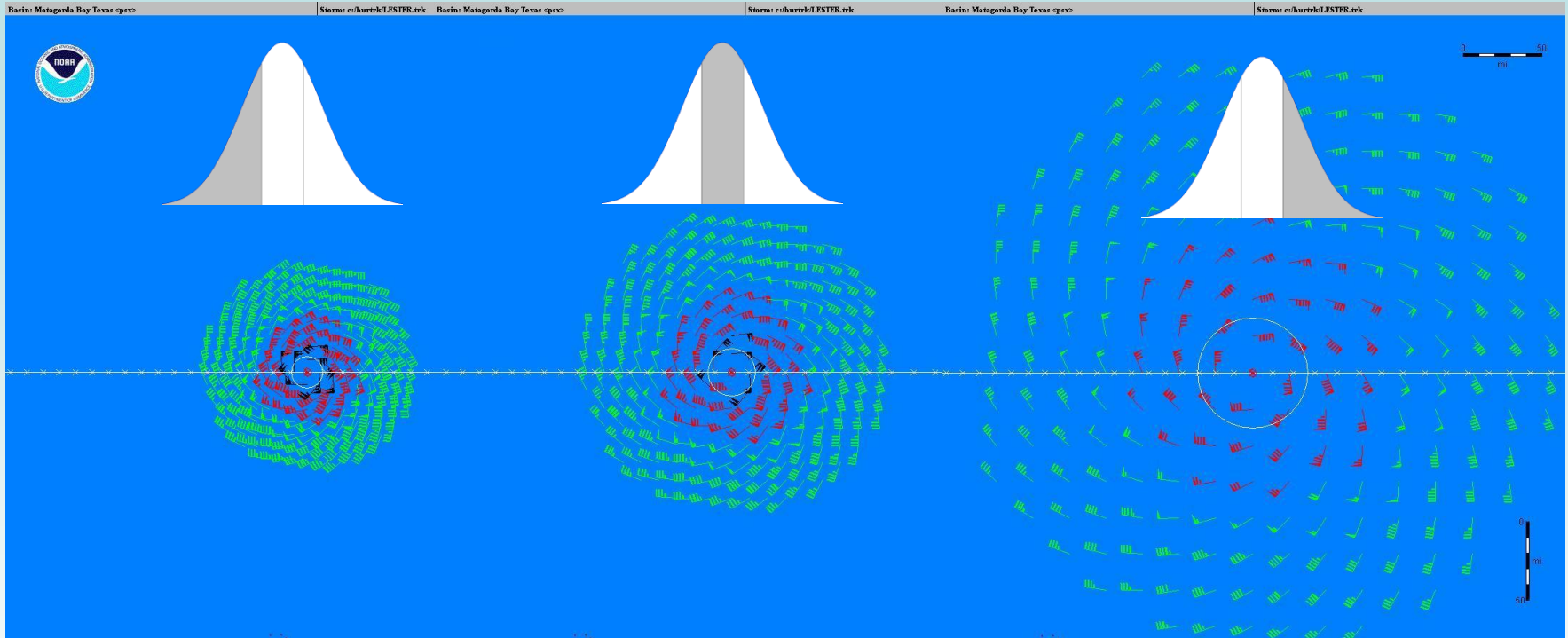
Katrina Advisory 23



P-surge - Vary Cross Track



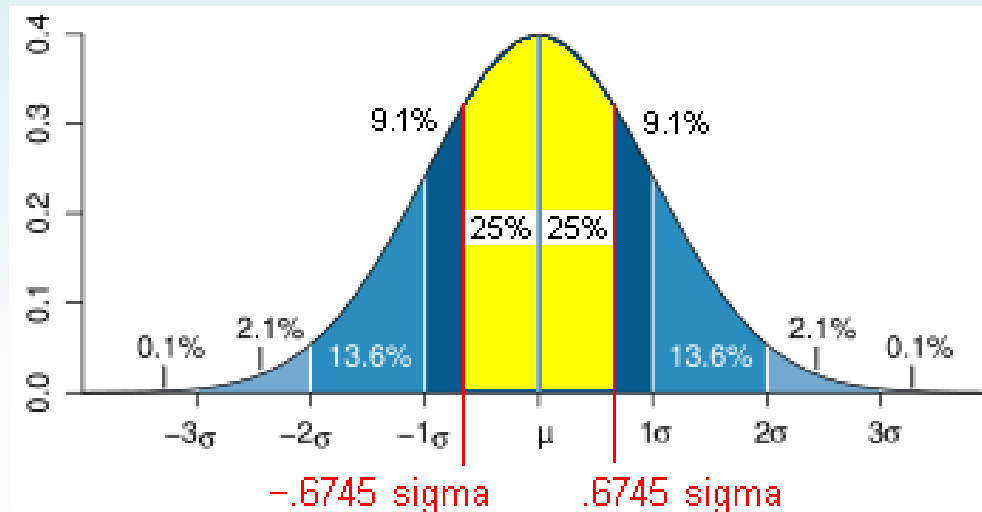
P-Surge – Vary Other Variables



- 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

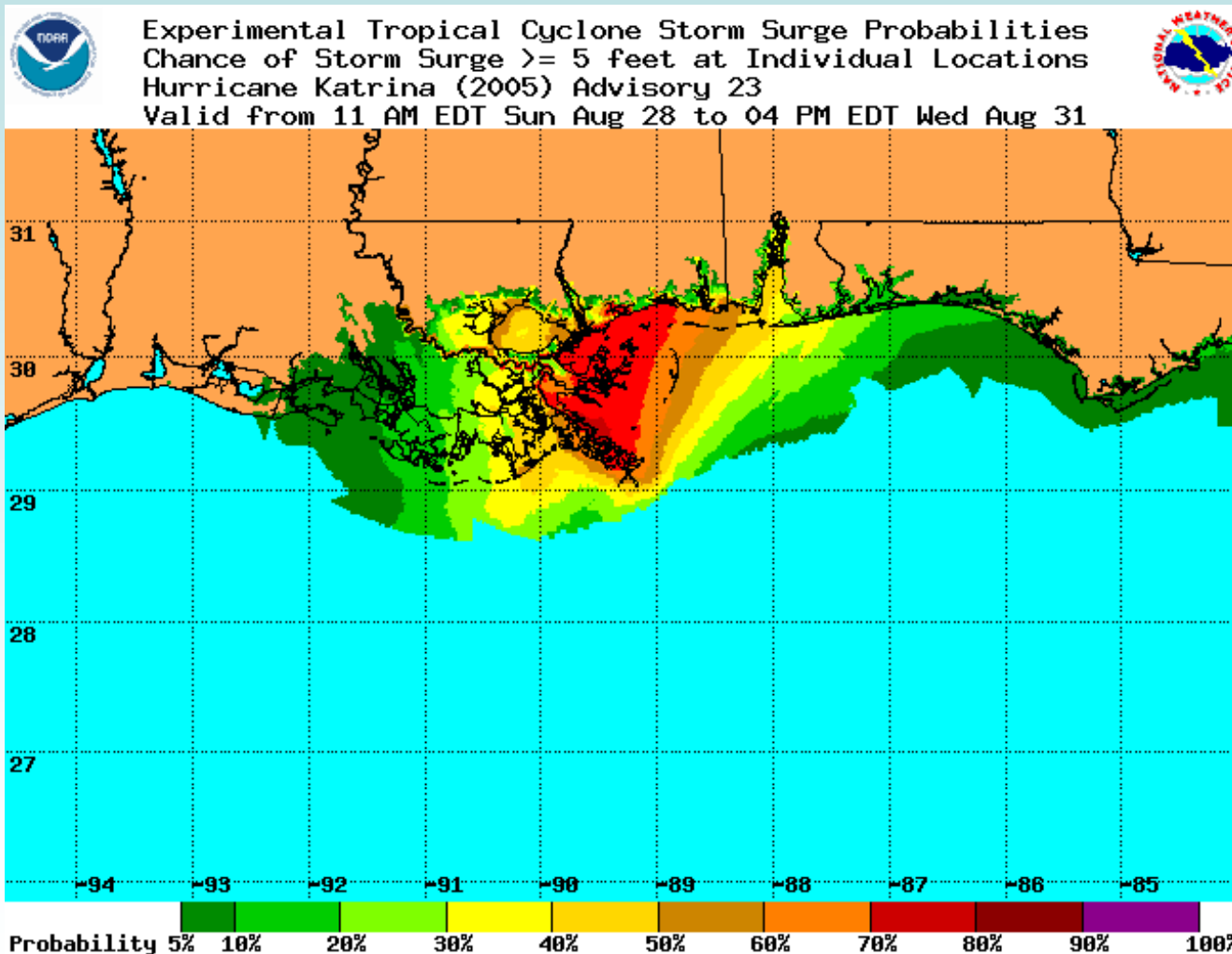
- Error distributions are computed for cross track, along track and intensity by:
 - Assuming a normal distribution
 - Using a 5-year “mean absolute error” and getting the standard deviation (sigma) from:



Mean absolute error occurs at $.6745\sigma$

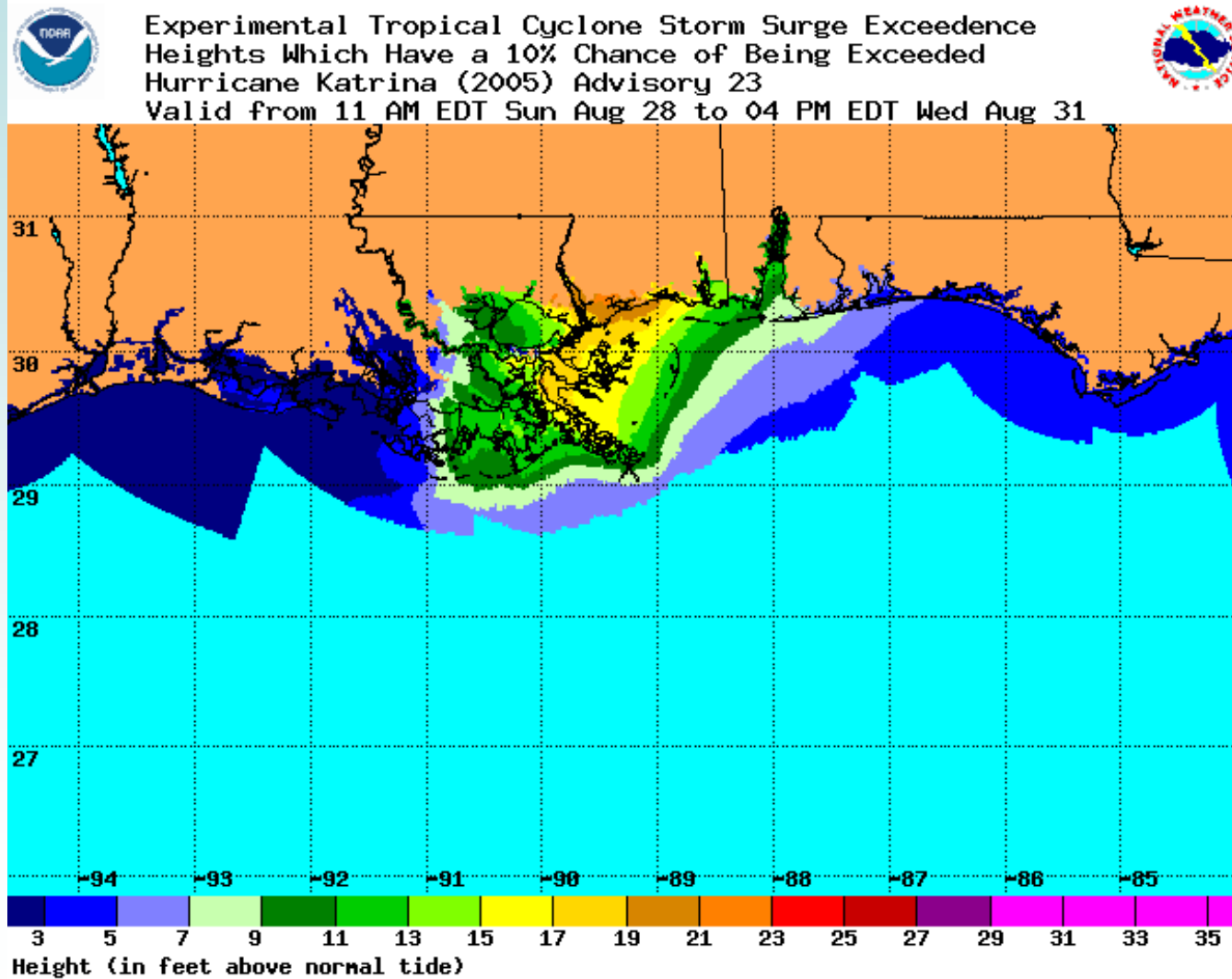


Probability of ≥ 5 feet of Surge





Surge Height Exceeded by 10% of Ensemble Members

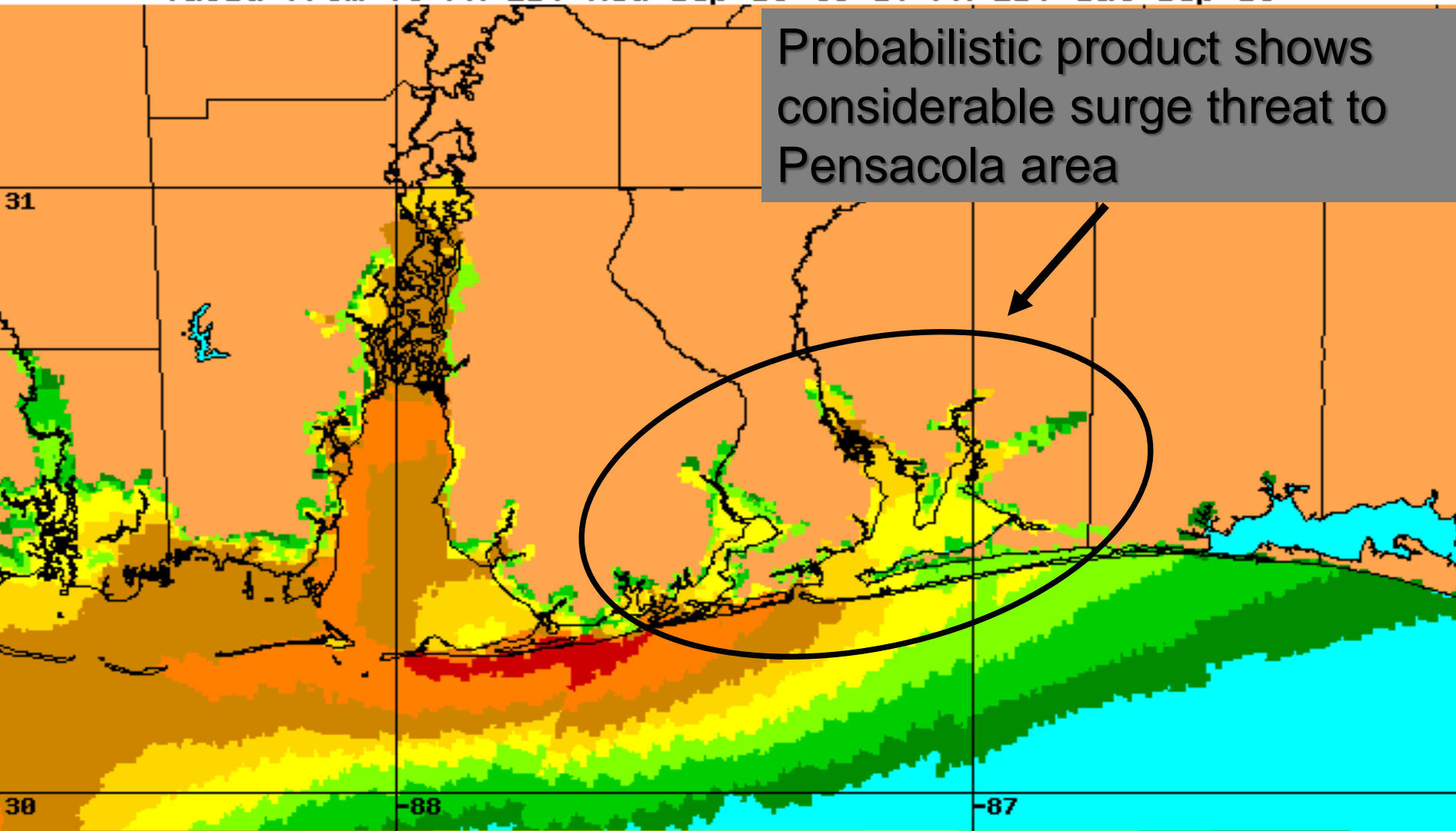




Experimental Tropical Cyclone Storm Surge Probabilities

Chance of Storm Surge \geq 8 feet at Individual Locations
Hurricane Ivan (2004) Advisory 54
Valid from 05 PM EDT Wed Sep 15 to 10 PM EDT Sat Sep 18

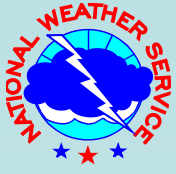
Probabilistic product shows considerable surge threat to Pensacola area



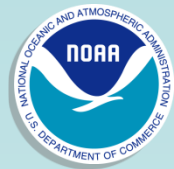
Probability



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



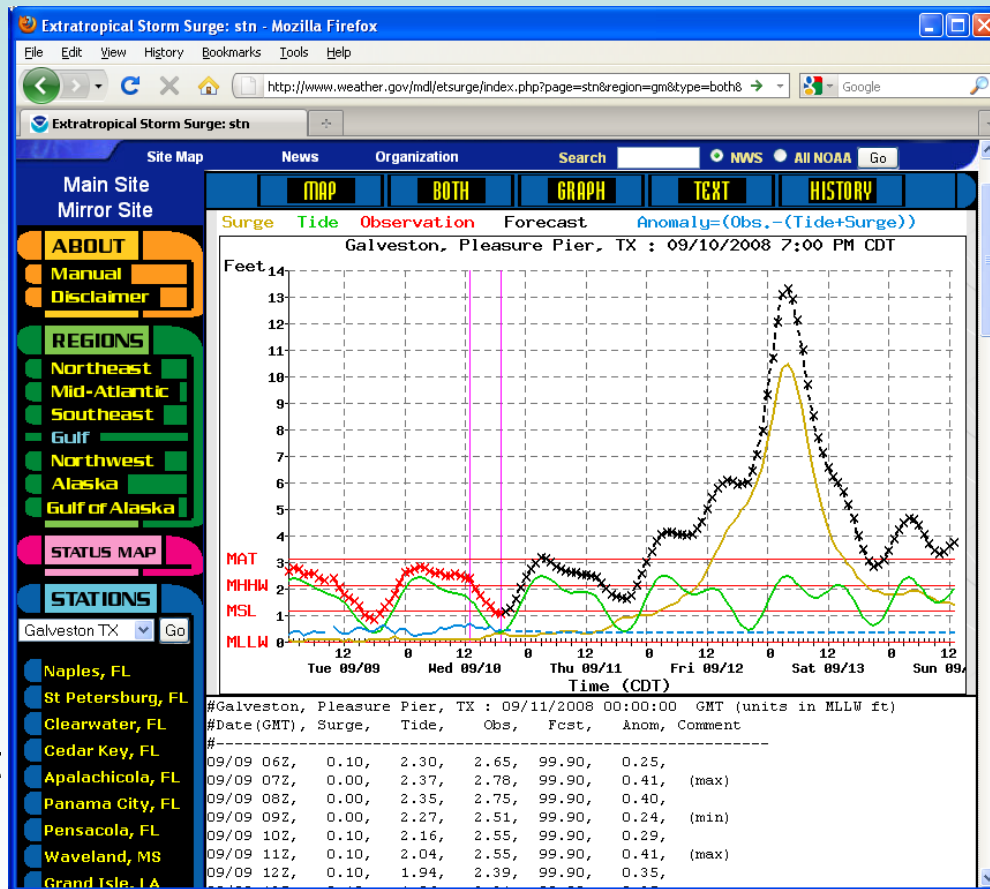
Combine the ETSS output with:

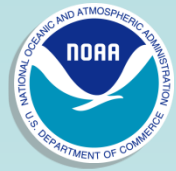
- Observations from NOS / CO-OPs
- Tides computed from constituents provided by NOS/CO-Ops
- Uses a 5 day running average error to improve total water level forecast
- Provides guidance on flooding (when total water level exceeds the HAT)

NOS/OPC also has ETSS model output

- http://www.opc.ncep.noaa.gov/et_surge/et_surge_info.shtml
- Animations of maps of ETSS output with GFS pressure fields

<http://www.weather.gov/mdl/etsurge>





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]