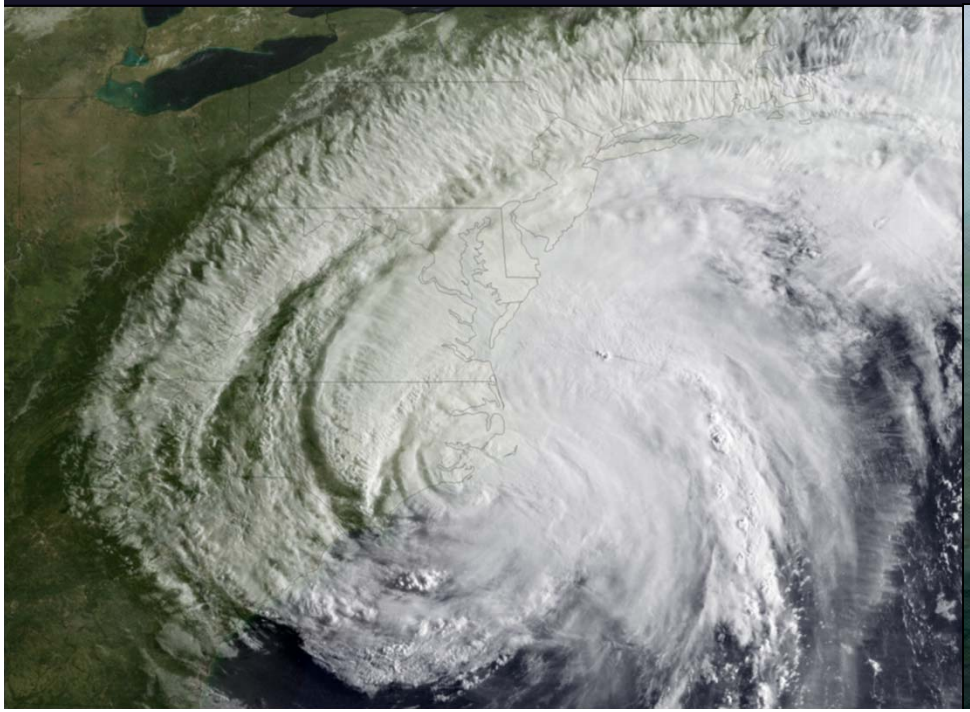
# CI-FLOW Project

## Coastal & Inland Flooding Observation & Warning

Kodi Monroe
University of Oklahoma,
Cooperative Institute for Mesoscale Meteorological Studies
National Severe Storms Laboratory



# Origin of the CI-FLOW Project

Initiated in response to Hurricanes Dennis & Floyd in Sep 1999

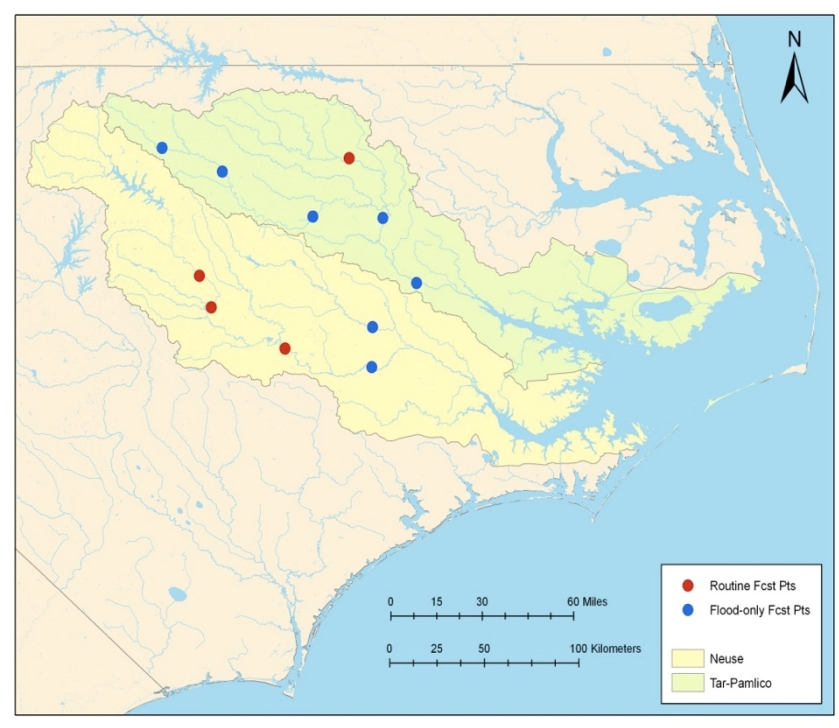
- 20-25 in of rain over 10 days
- River crests up to 24 ft above flood stage
- Storm surge as high as 10 ft

Impacts

- 52 lives lost in North Carolina
- Homes: 7,000 destroyed; 17,000 uninhabitable; 56,000 damaged
- 30,000 hogs, 700,000 turkeys, & 2.4 million chickens drowned
- Warnings that tap water may contain high levels of fecal coliform bacteria

# Increasing Hydrologic Forecasting Capabilities In Coastal Watersheds

**Current NWS Forecast Points**




**CI-FLOW Forecast Points**

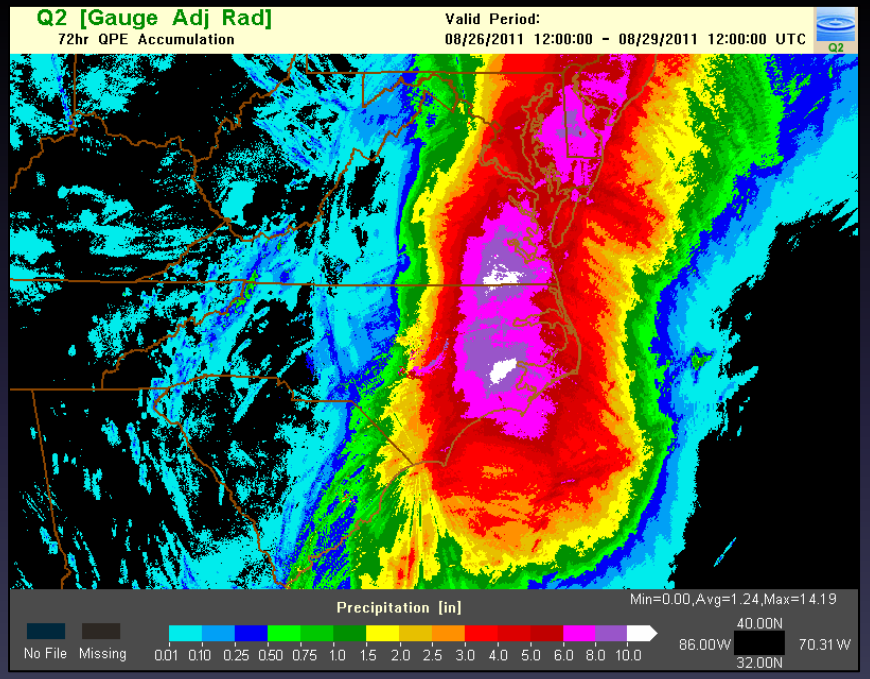
# CI-FLOW Precipitation

Past rainfall: NSSL's Next Generation QPE (Q2)

- Best practices of OHD's MPE & NSSL's NMQ
- Gauge-adjusted 1-hr accumulation

Future rainfall: HPC's QPF

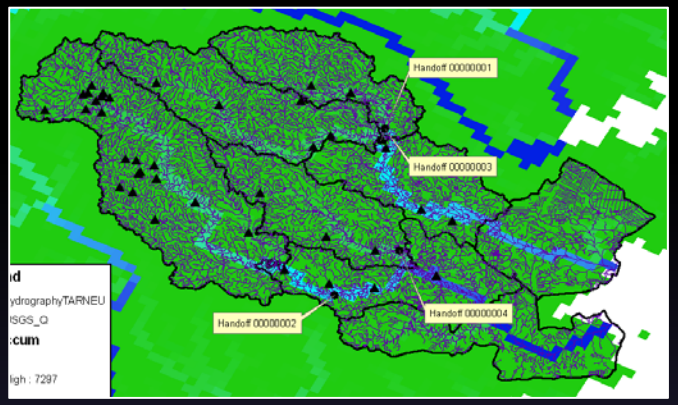
- 6-hour accumulation

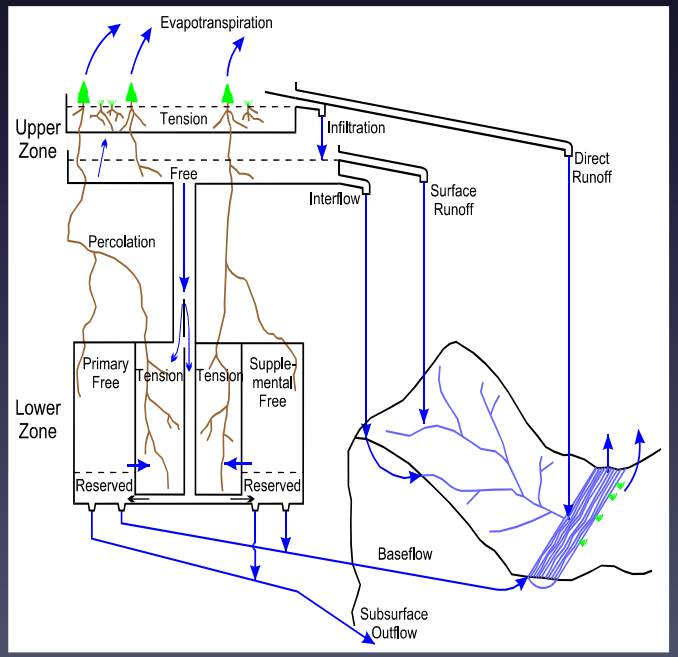



http://nmq.ou.edu

# CI-FLOW Hydrologic Modeling

- Tar-Pamlico & Neuse river basins
- NWS Hydrology Laboratory – Research Distributed Hydrologic Model (HL-RDHM)
- Hybrid conceptual-physical distributed watershed model:
  - Sacramento Soil Moisture Accounting model (SAC-SMA)
  - Kinematic Wave Model for routing



# CI-FLOW Hydrologic Model Ensemble

1. "Event-based" parameter set (Isabel) x 16 rainfall multipliers (0.8-1.2, uniformly distributed)
2. "Automatic" parameter set x 16 rainfall multipliers
3. Multiple basin scale parameter set x 16 rainfall multipliers
4. A-priori model (uncalibrated) x 5 rainfall multiplier x 16 channel routing perturbations = 80

Total Number of Members = 16x3 + 80 = 128

Runs every 6 hours

# CI-FLOW Storm Surge Model

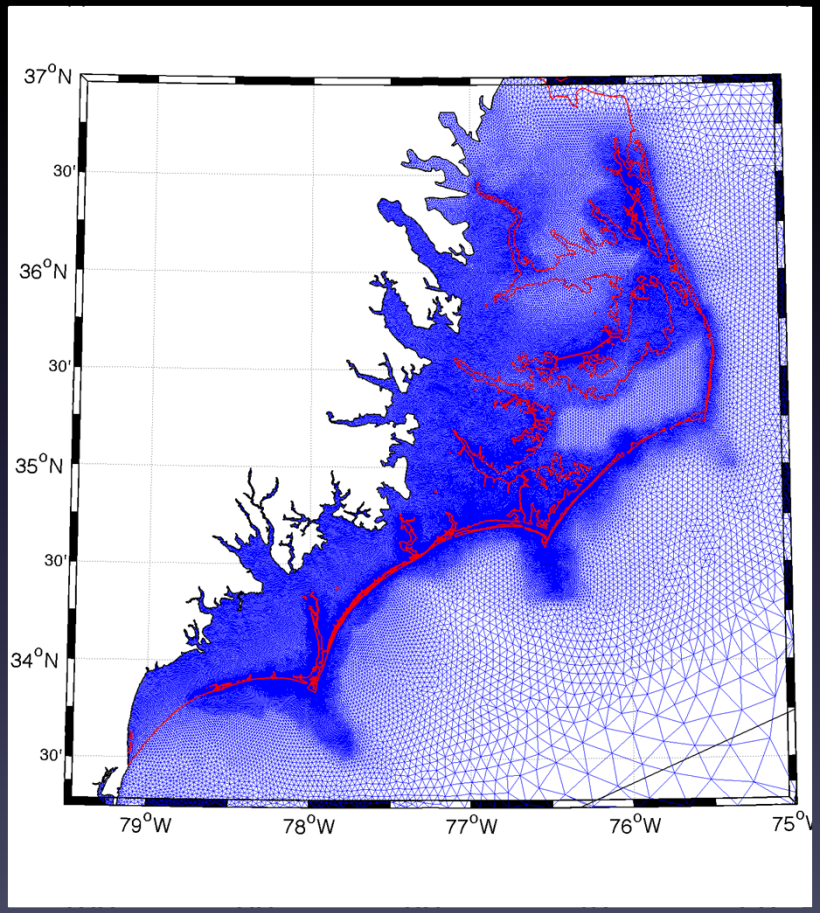
## ADvanced CIRCulation + Simulating WAves Nearshore

- Winds: Asymmetric Vortex Wind Model or NAM
  - Uses official track, forward speed, radius to maximum winds, central pressure & other information from NHC advisories
- 2-D ADCIRC
  - Tides
  - River input provided by HL-RDHM at 4 hand-off points
  - Wind waves
  - Wetting/drying of elements
- SWAN: Spectral wave model
  - Waves in all 360 degrees
  - Wave action balance equation with sources/sinks

# CI-FLOW Storm Surge Model

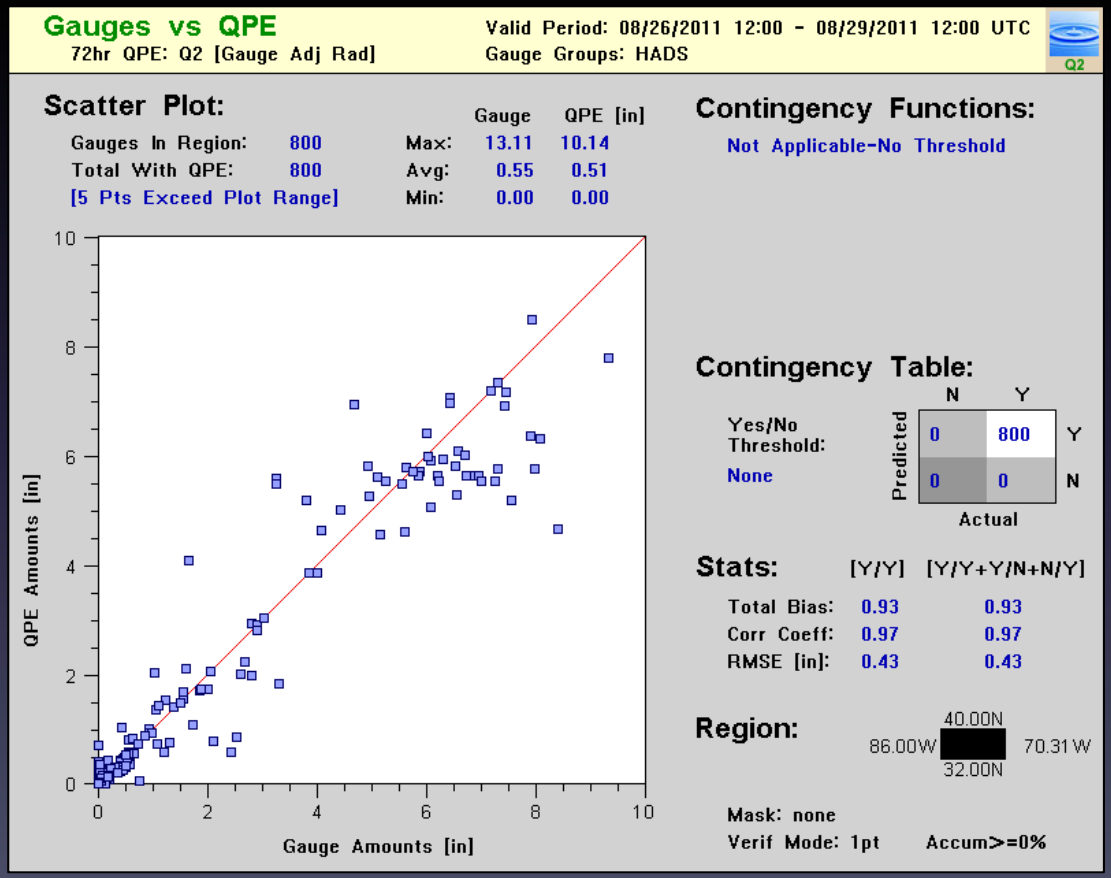
## ADvanced CIRCulation + Simulating WAves Nearshore

- Unstructured finite element grid
- High resolution for the Tar & Neuse Rivers, Outer Banks, & Pamlico Sound (down to 30 – 60 m)
- Dynamic coupling between ADCIRC & SWAN
  - Predictions of total water level, maximum inundation, wave height, wave period, & tides



# Hurricane Irene Performance

# Hurricane Irene – NMQ/Q2 radar+gauge storm total rainfall

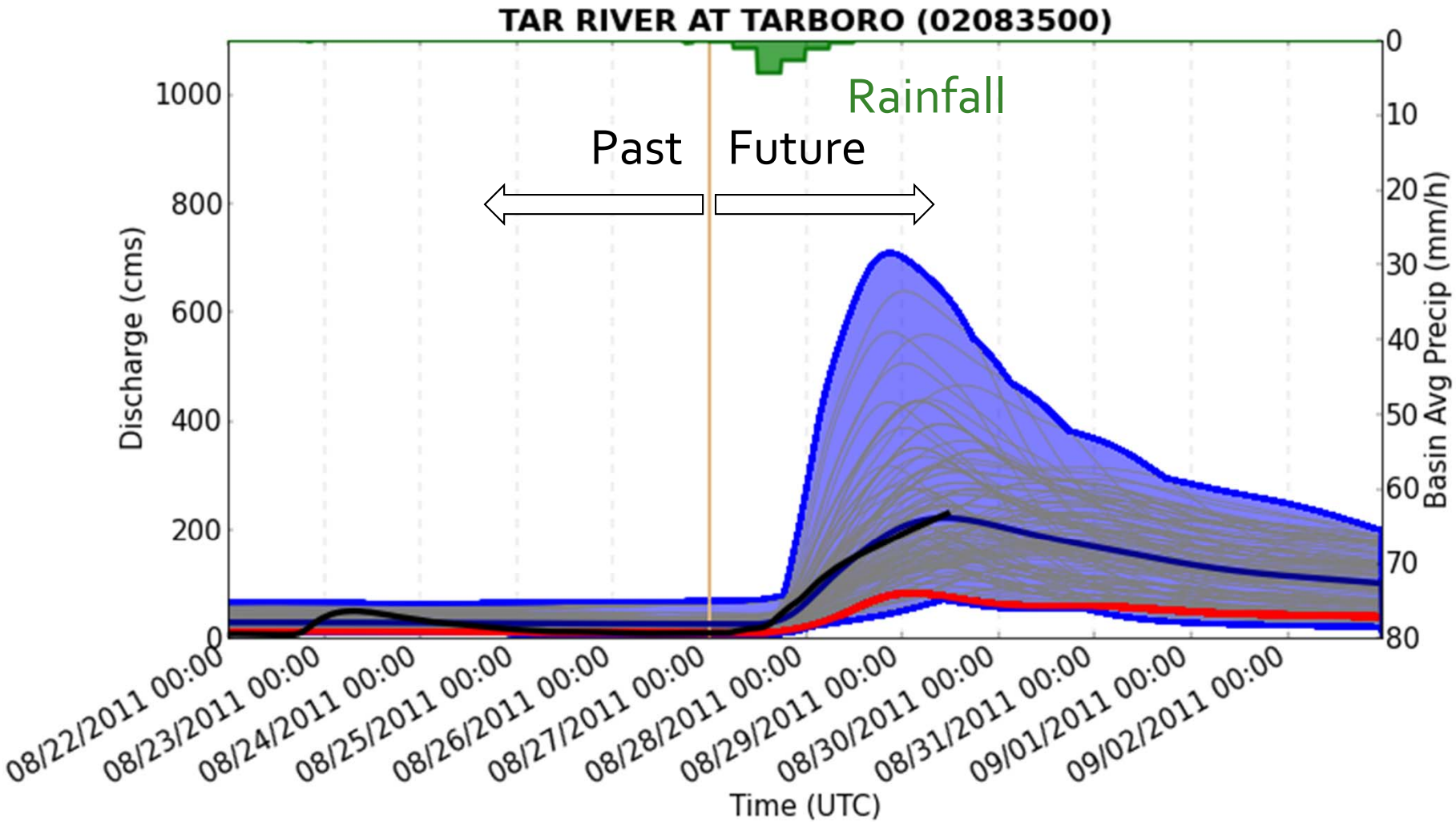


Black = Observed Streamflow

Blue = Ensemble Simulations (Max, Min, Mean)

Red = Best Member Simulation

Gray = Individual Simulations (members)



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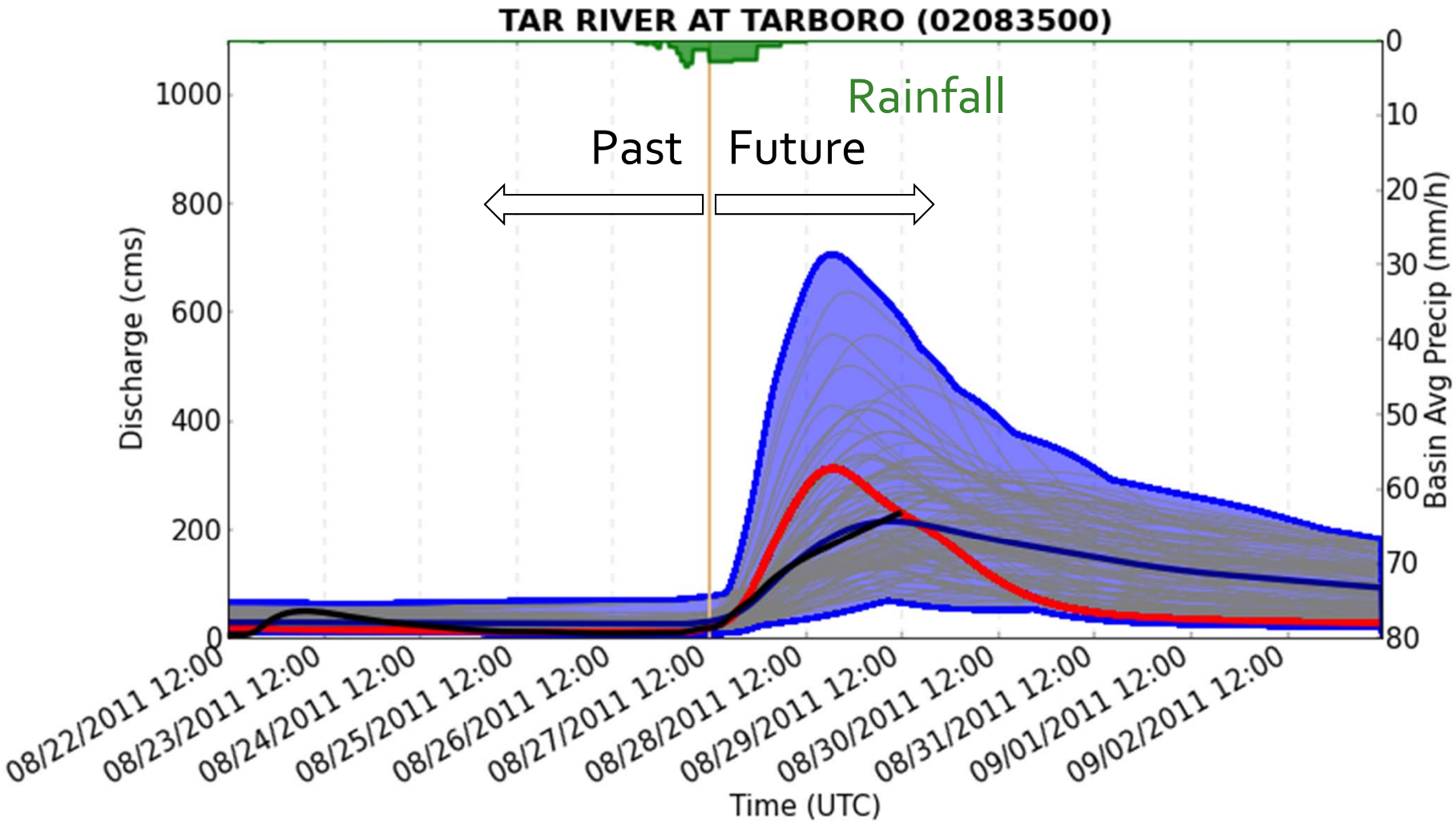

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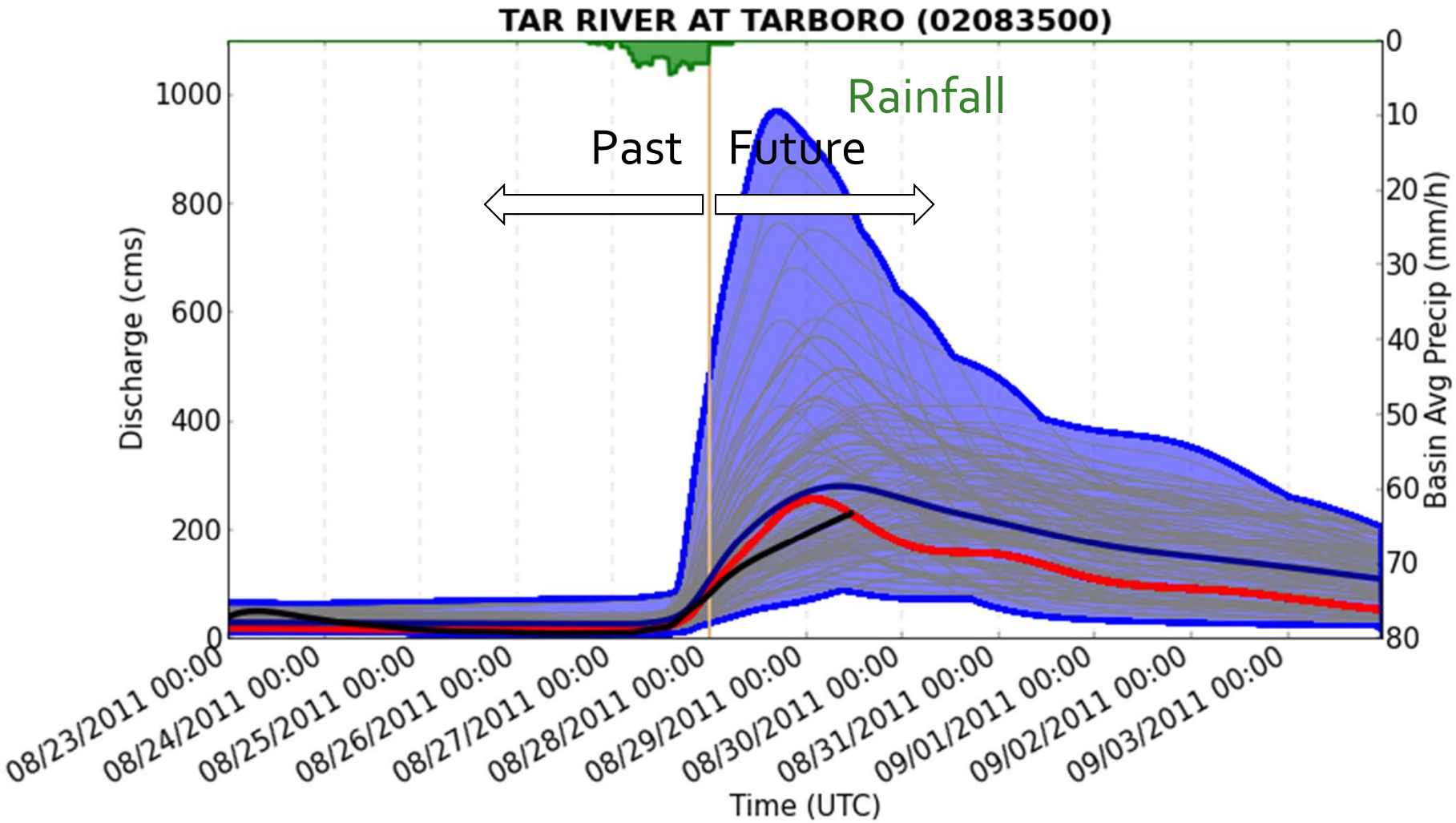

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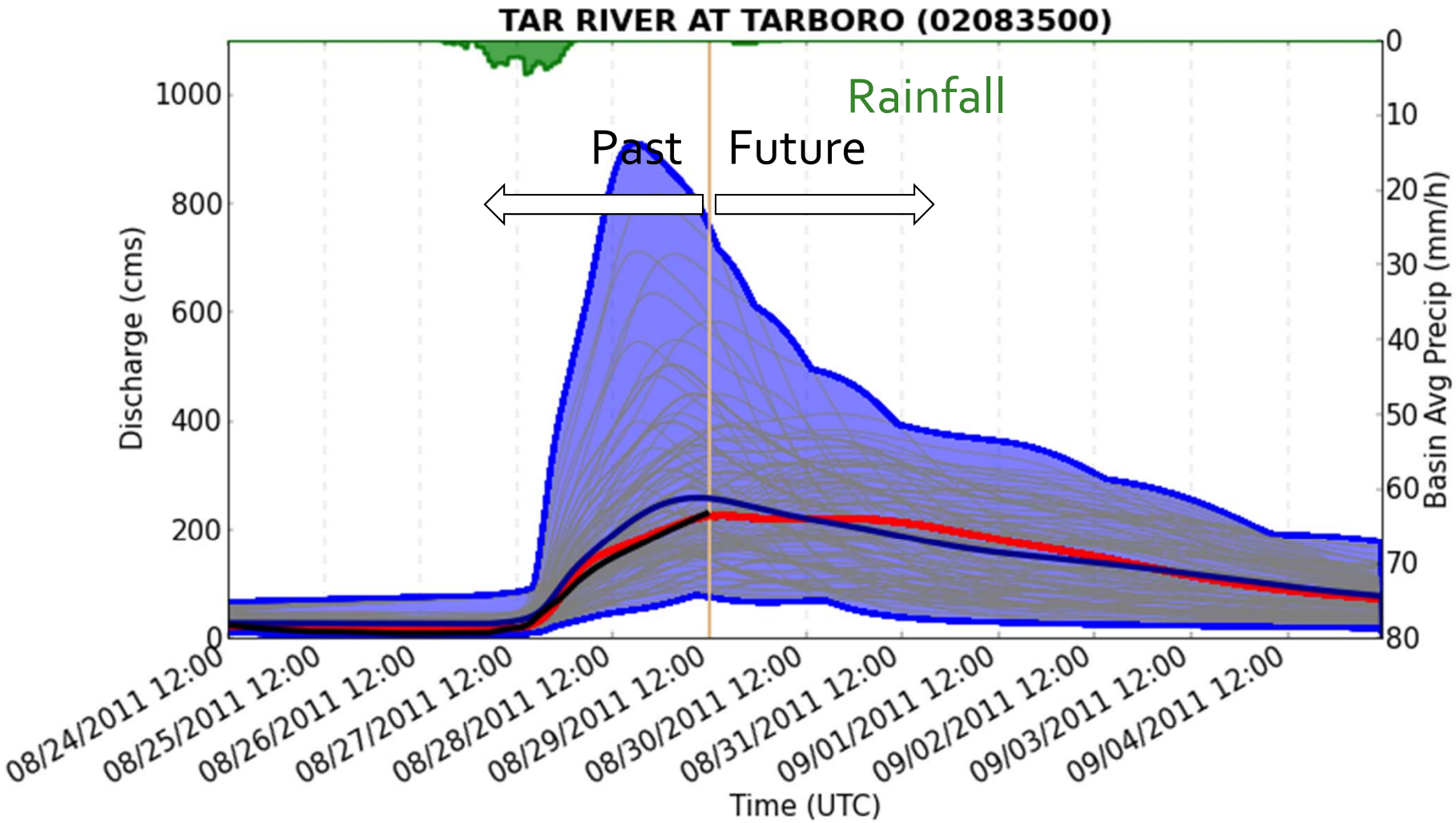
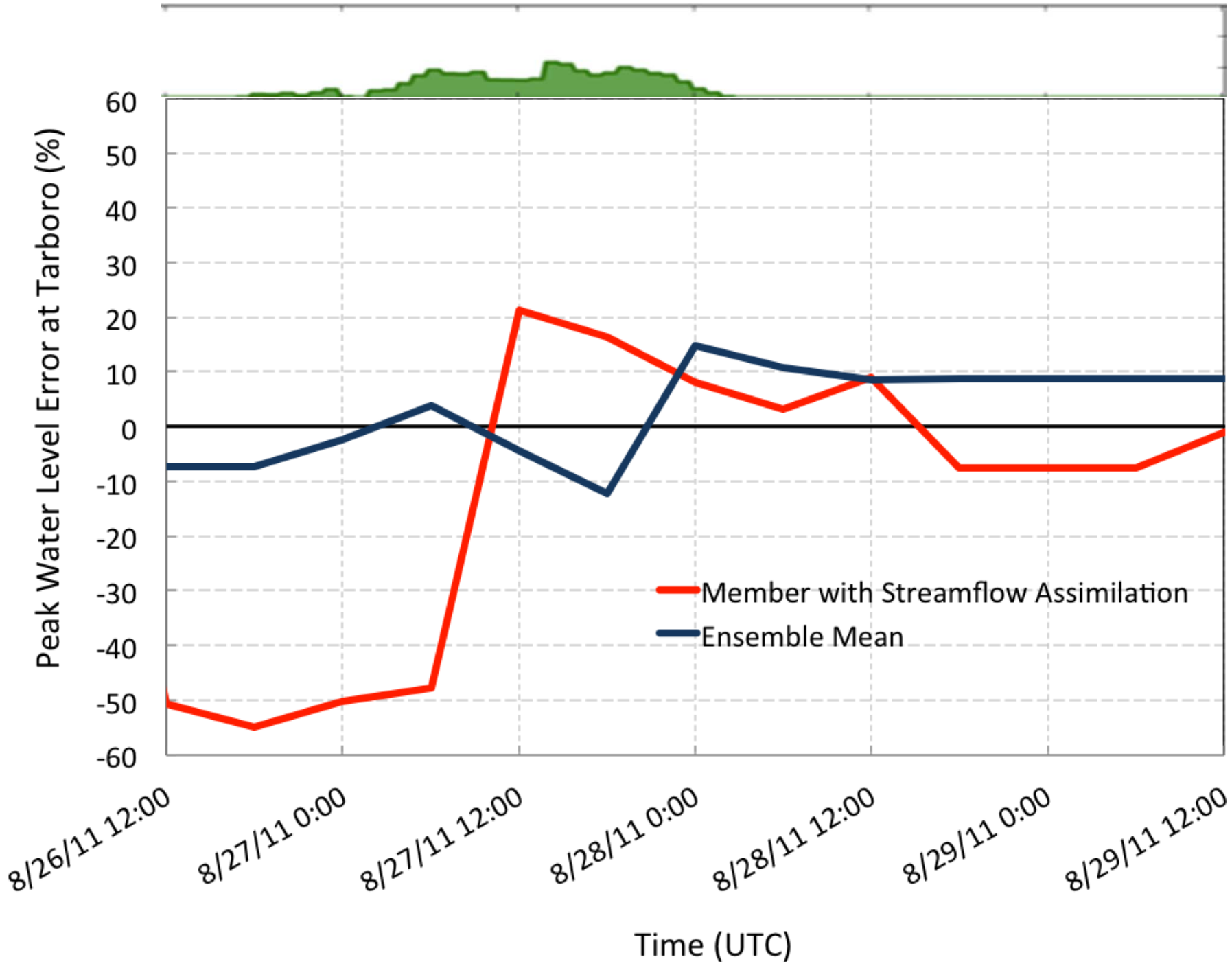
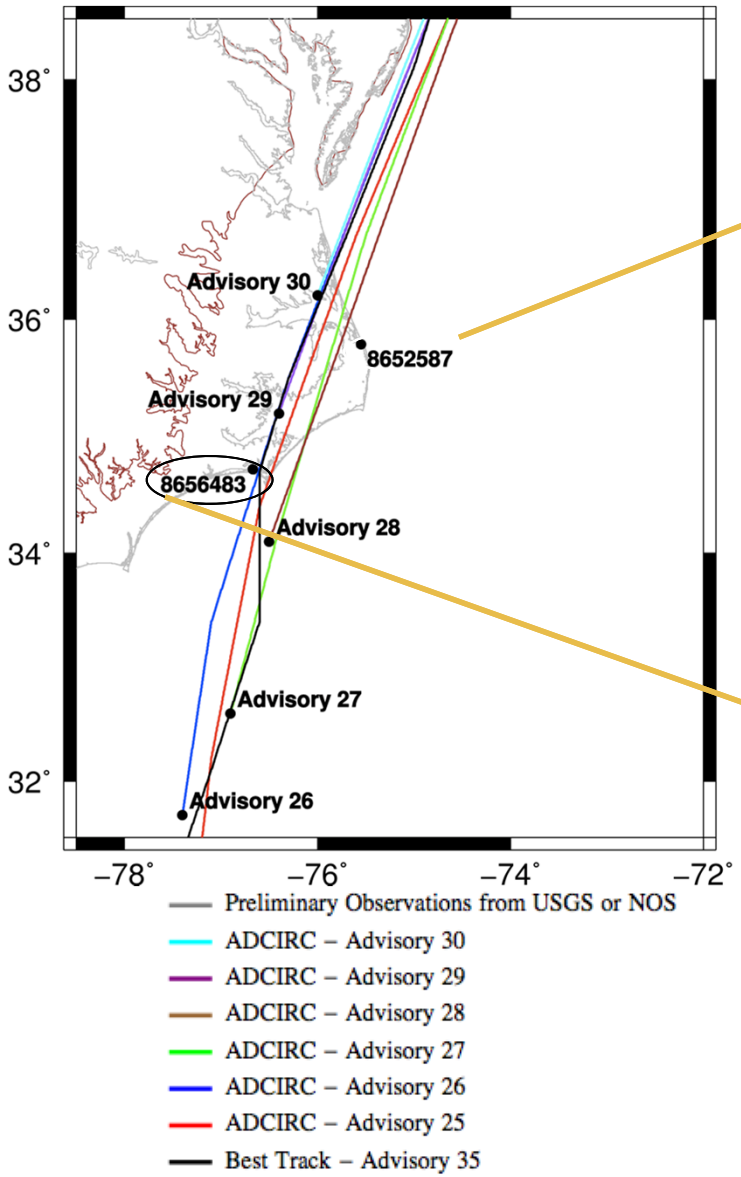
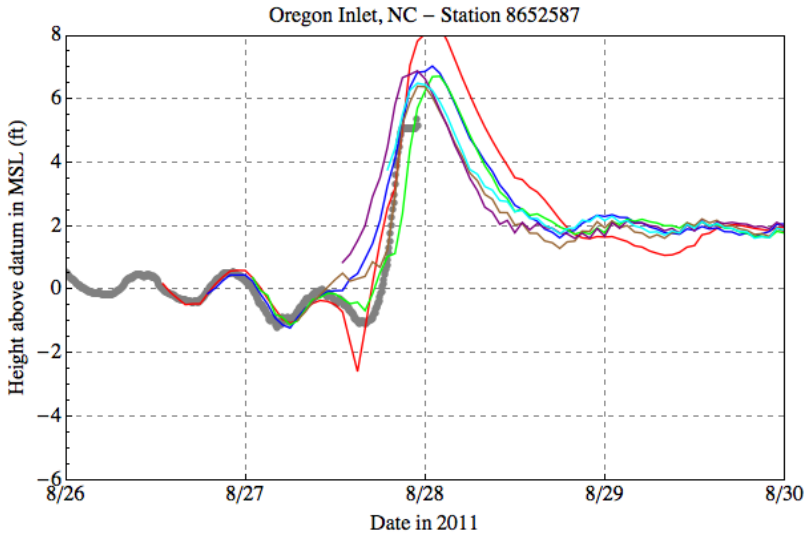
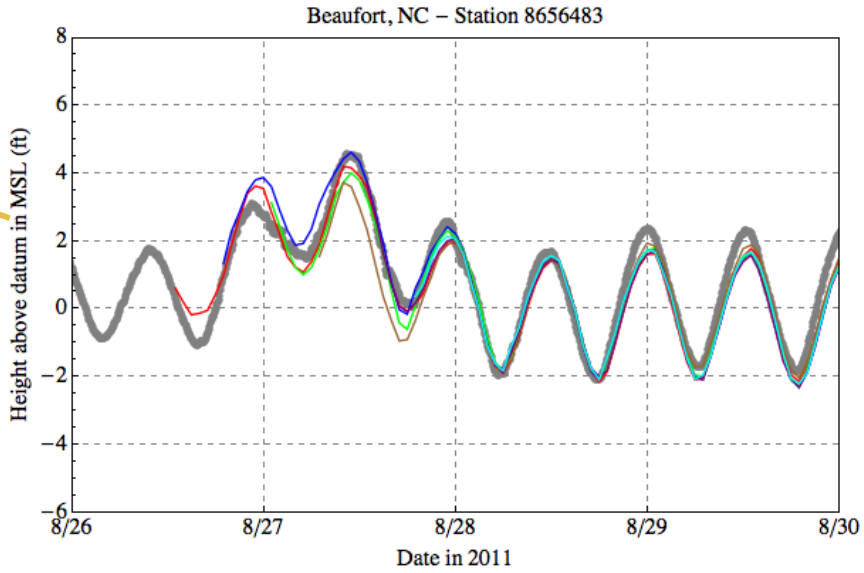
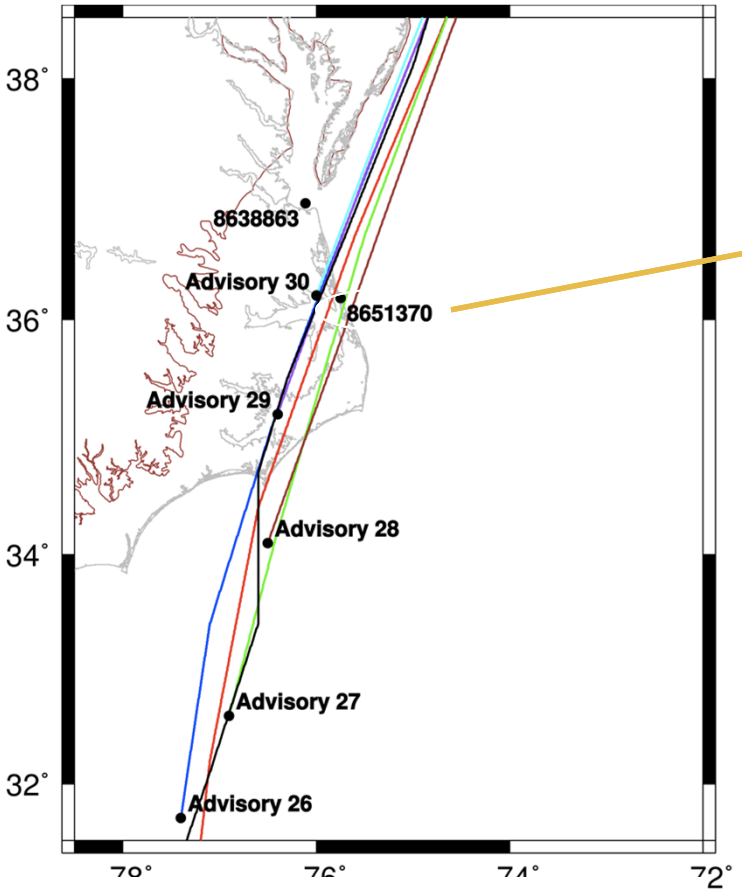



Peak Water Level Error at Tarboro (%)
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
8/26/11 12:00
8/27/11 0:00
8/27/11 12:00
8/28/11 0:00
8/28/11 12:00
8/29/11 0:00
8/29/11 12:00
Time (UTC)
Member with Streamflow Assimilation
Ensemble Mean

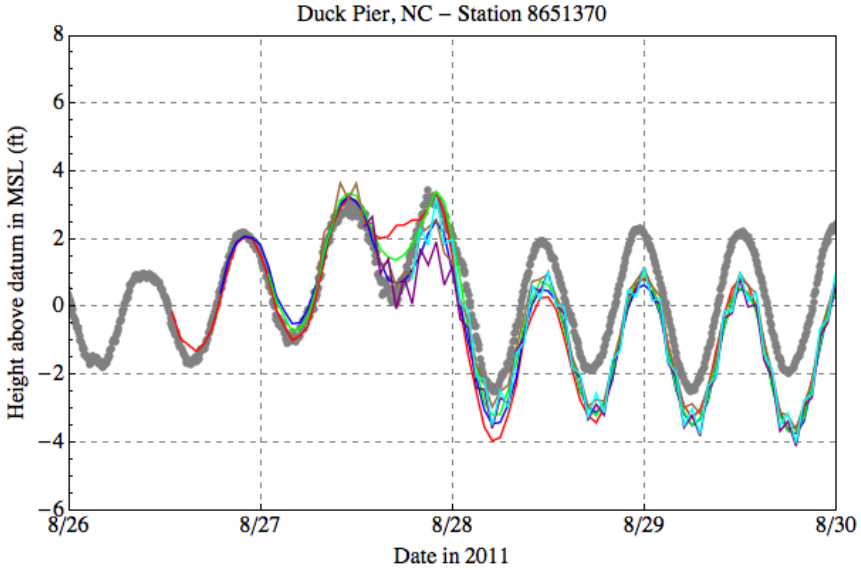

38˚
36˚
34˚
32˚
−78˚
−76˚
−74˚
−72˚
Advisory 30
8652587
Advisory 29
8656483
Advisory 28
Advisory 27
Advisory 26
Preliminary Observations from USGS or NOS
ADCIRC – Advisory 30
ADCIRC – Advisory 29
ADCIRC – Advisory 28
ADCIRC – Advisory 27
ADCIRC – Advisory 26
ADCIRC – Advisory 25
Best Track – Advisory 35

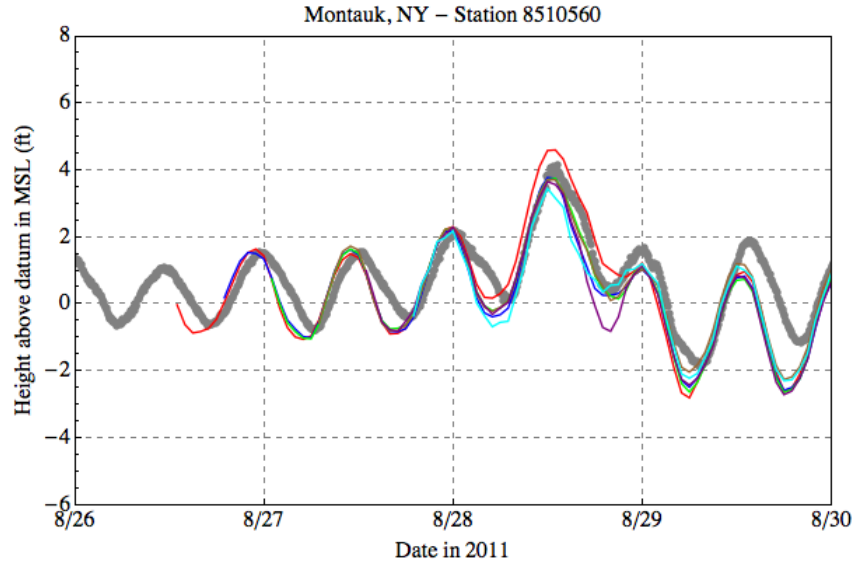

Oregon Inlet, NC – Station 8652587
Height above datum in MSL (ft)
8
6
4
2
0
−2
−4
−6
8/26
8/27
8/28
8/29
8/30
Date in 2011

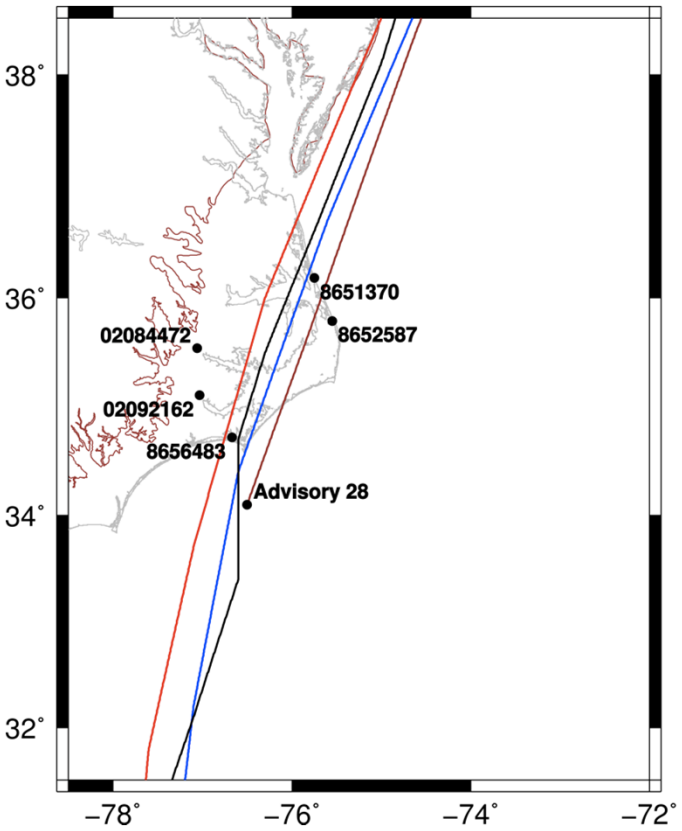

Beaufort, NC – Station 8656483
Height above datum in MSL (ft)
8
6
4
2
0
−2
−4
−6
8/26
8/27
8/28
8/29
8/30
Date in 2011




Preliminary Observations from USGS or NOS
ADCIRC – Advisory 30
ADCIRC – Advisory 29
ADCIRC – Advisory 28
ADCIRC – Advisory 27
ADCIRC – Advisory 26
ADCIRC – Advisory 25
Best Track – Advisory 35



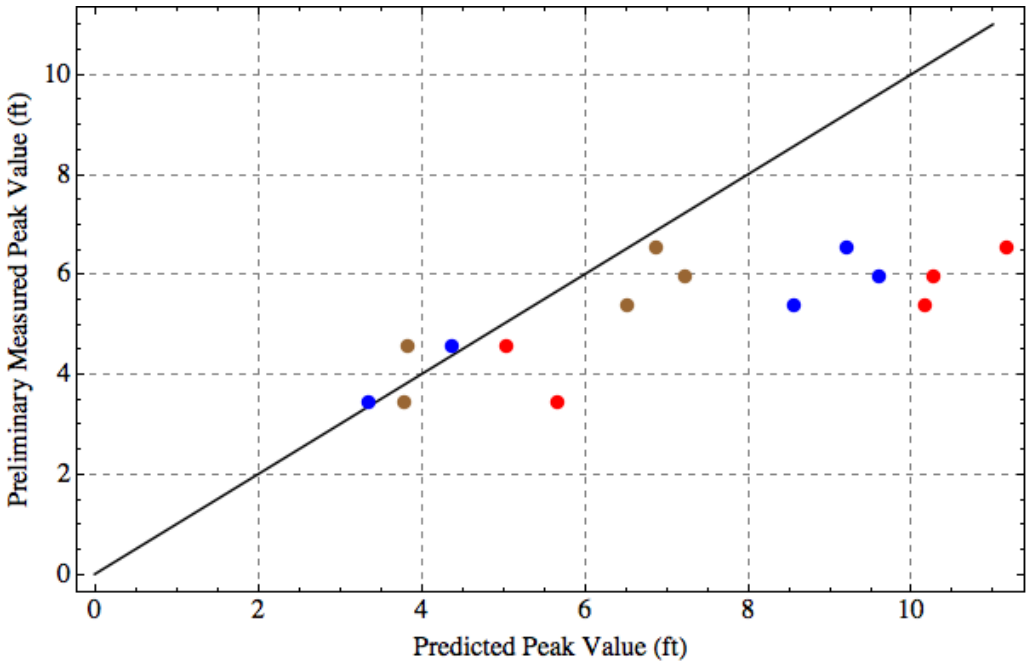



ADCIRC – Advisory 28

ADCIRC – Advisory 25

ADCIRC – Advisory 23

Best Track – Advisory 35



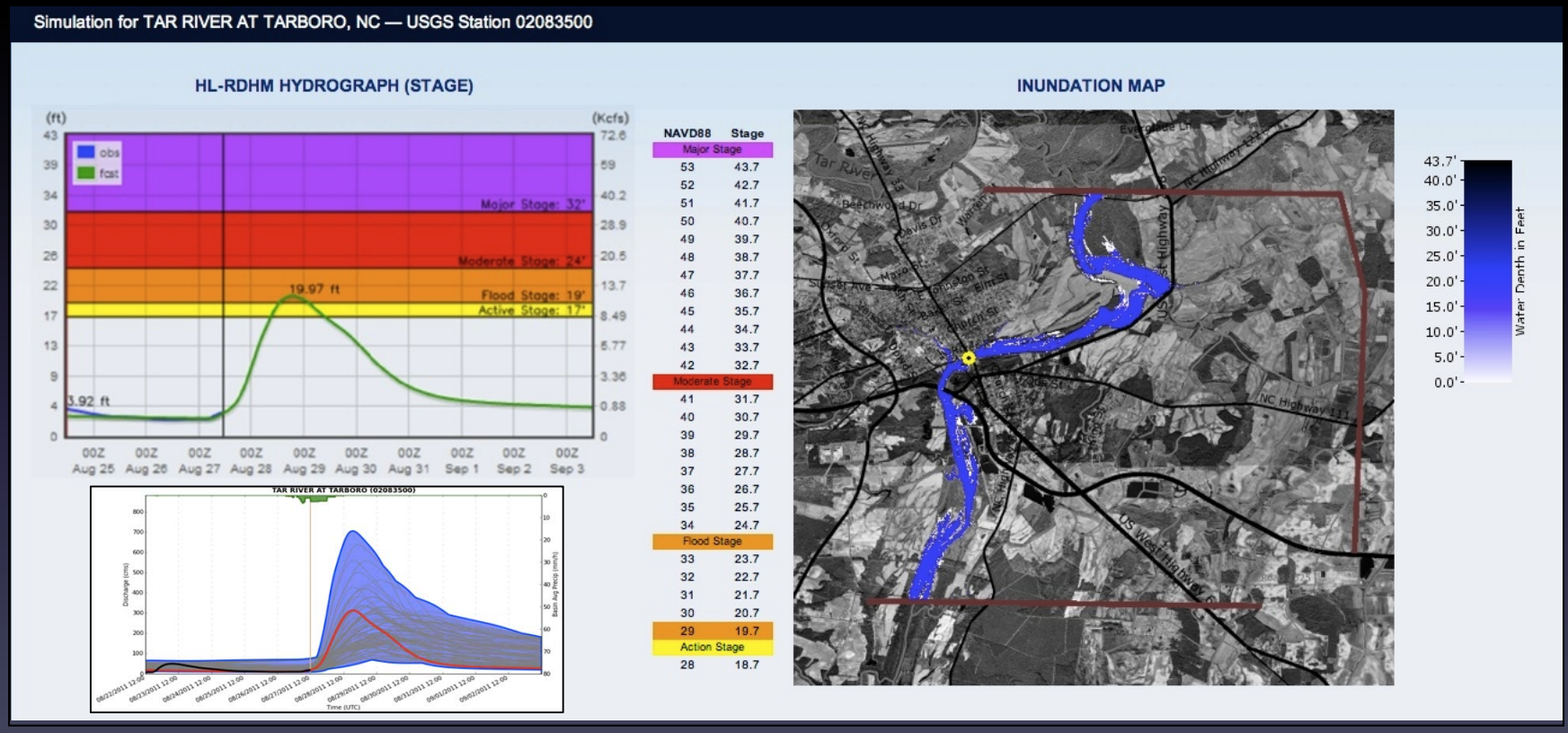
# Hurricane Irene Summary

- QPE
  - Able to wait for the gauge-adjusted QPE
- HL-RDHM
  - Dependent on accuracy of the QPF
- ADCIRC
  - Dependent on accuracy of forecast track
  - Currently does not account for rainfall-runoff over ADCIRC domain

# Distribution of Information

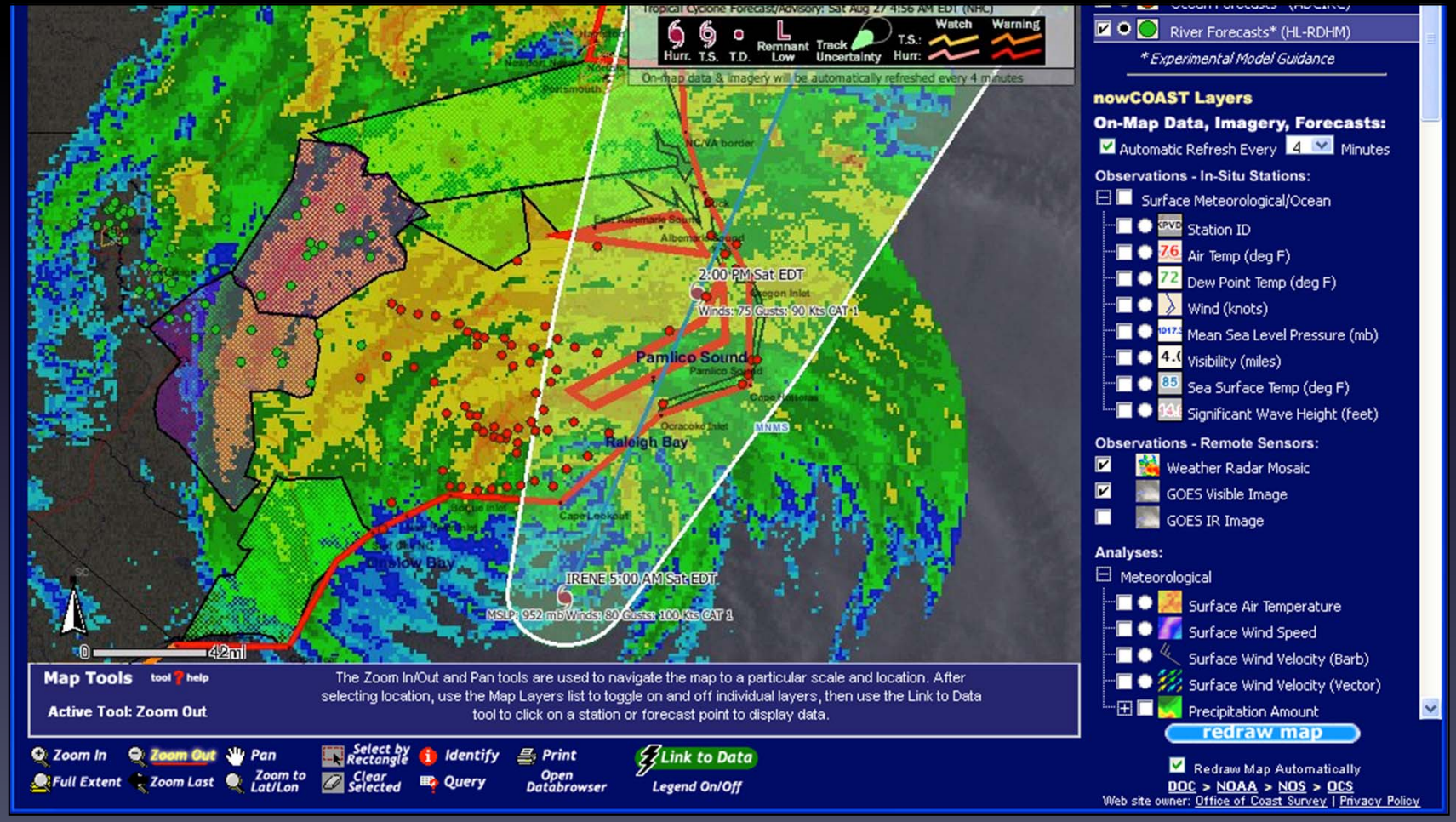
https://secure.nssl.noaa.gov/projects/ciflow/

NOAA LDAP login



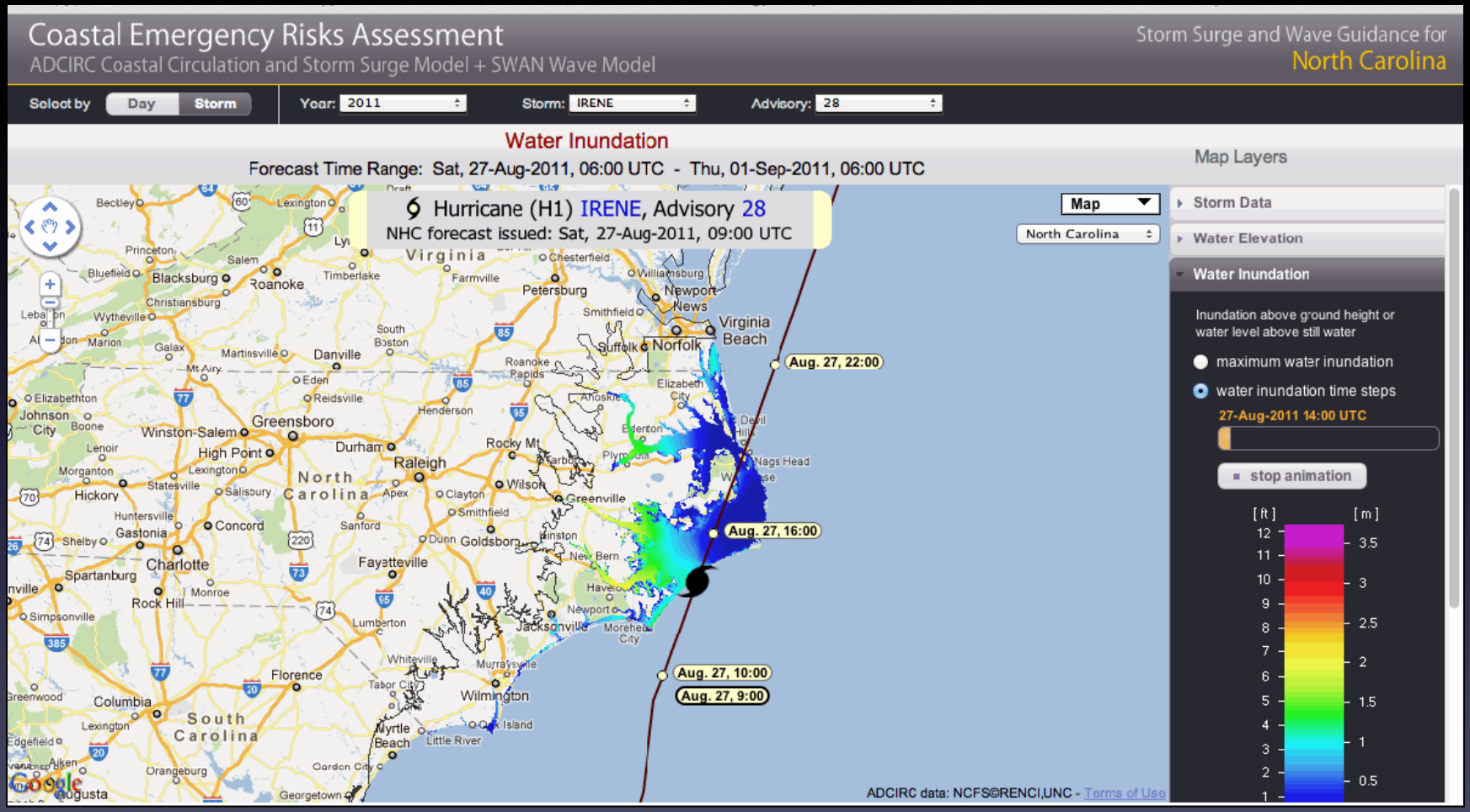
# Distribution of Information

http://nowcoast.noaa.gov/ciflow/



# Coastal Emergency Risks Assessment

http://nc-cera.renci.org/cgi-cera_nc/cera_nc.cgi



# Future CI-FLOW Work

- Verification of any future storms
- 2012
  - More thorough Irene assessment
  - New ADCIRC wetting/drying routine to fix problems in rivers
  - Work with SERFC to force HEC-RAS on the Tar with ADCIRC

# Future CI-FLOW Work

- 2013
  - Rudimentary hydrology component added to ADCIRC to account for rainfall-runoff processes
  - Pending DHS proposal to transition coupled system to additional location
- Work with NOAA Storm Surge Roadmap and RFCs to evaluate components for transition
  - Run 3-5 track/strength perturbations at coarser resolution
  - Run river ensemble within CHPS