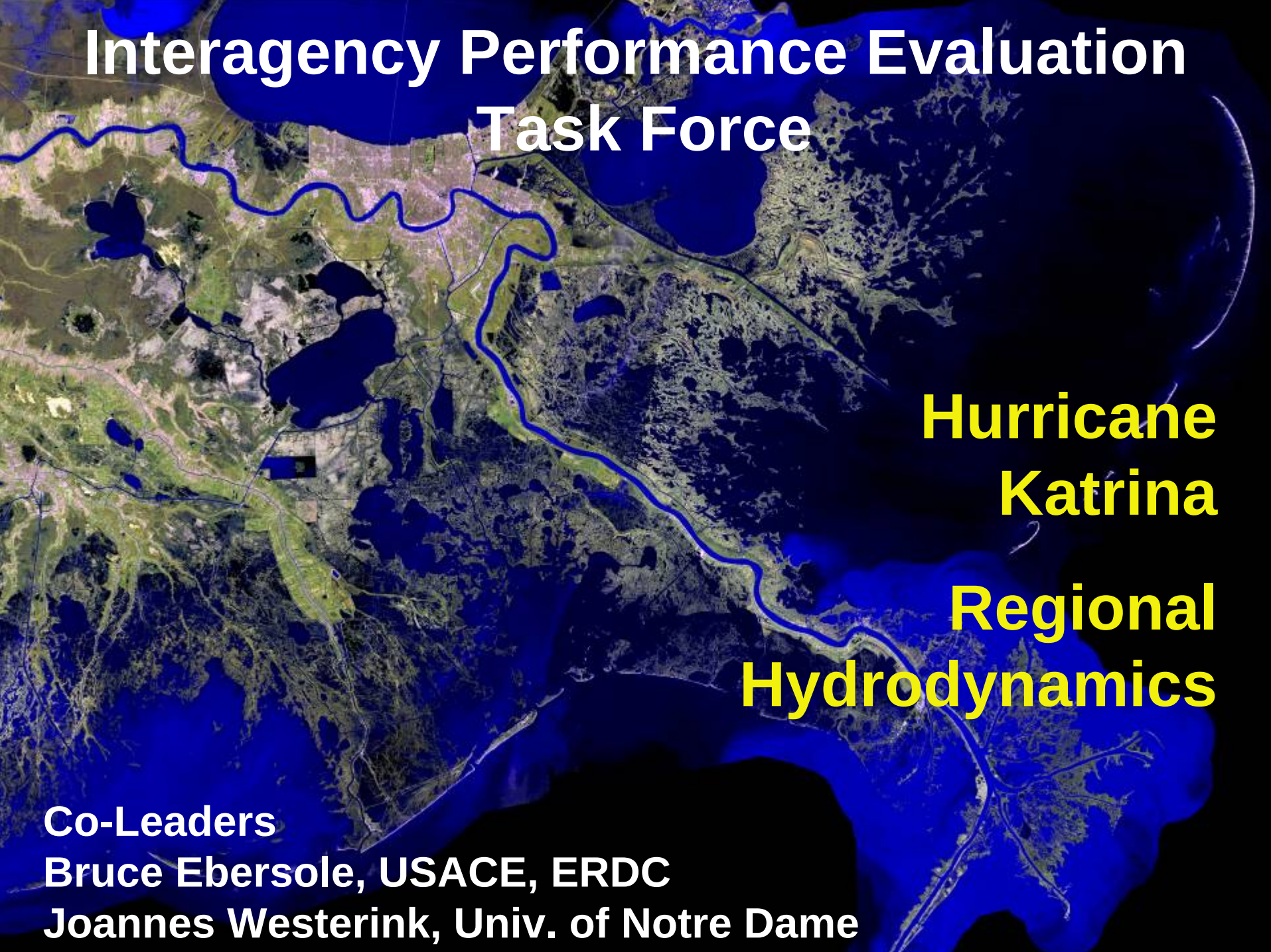
Interagency Performance Evaluation Task Force

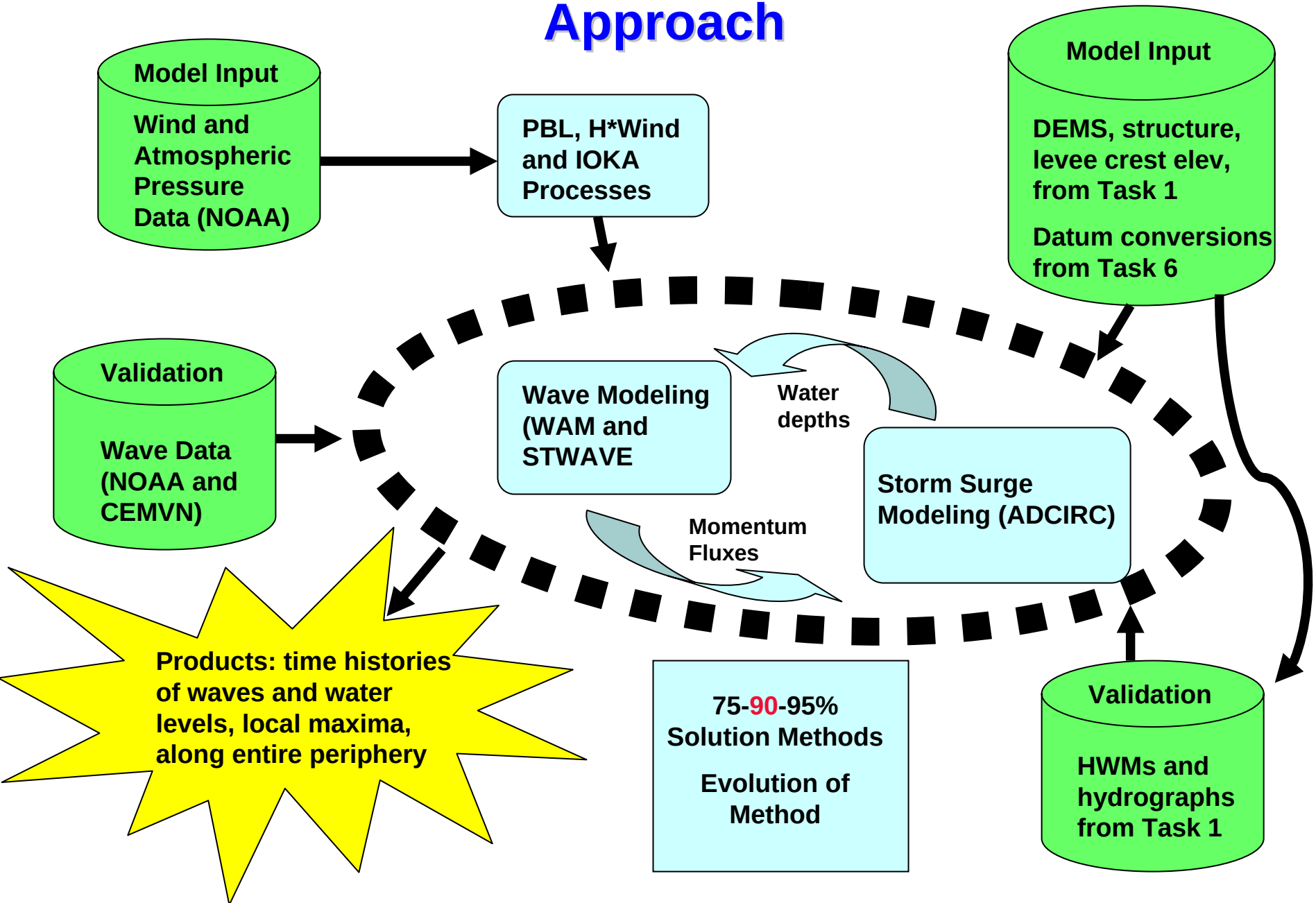


Hurricane Katrina

Regional Hydrodynamics

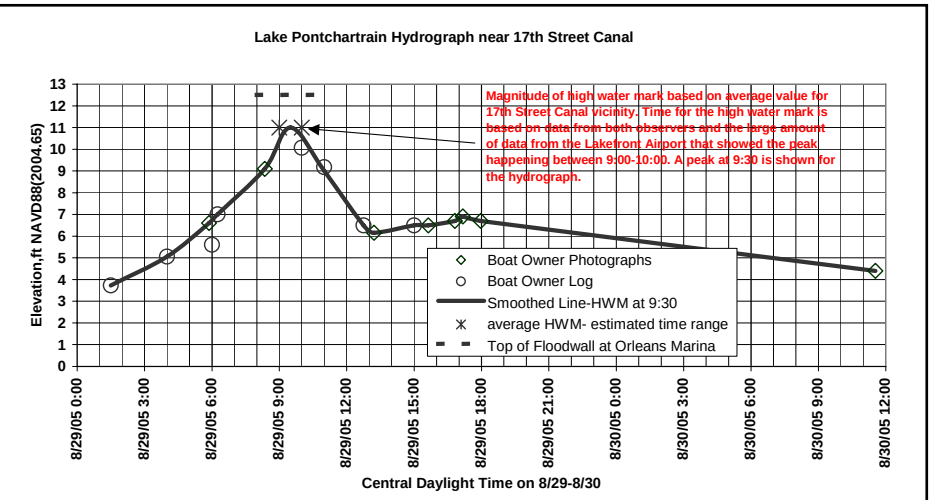
Co-Leaders
Bruce Ebersole, USACE, ERDC
Joannes Westerink, Univ. of Notre Dame

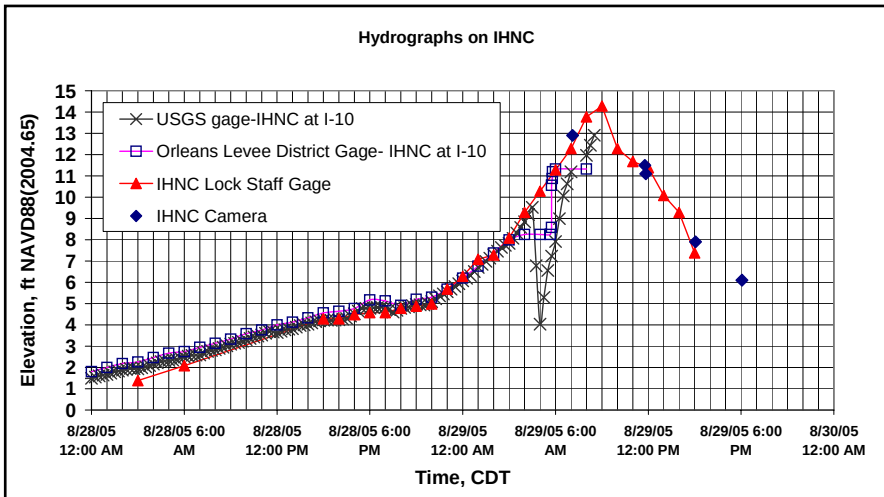
Regional Wave and Storm Surge Modeling Approach



High Water Mark and Hydrograph Analysis

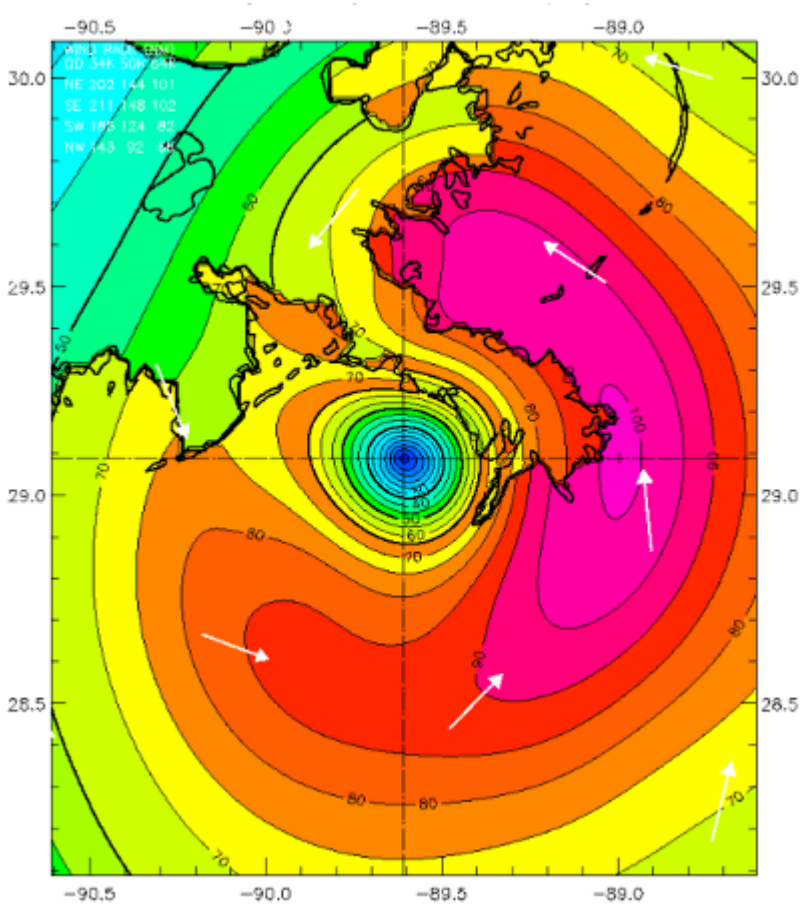
- 13 measured hydrographs considered in the region (only 1 captured peak in N.O. vicinity)
- 2 reconstructed hydrographs
- 15% of non-protected HWMs rated excellent

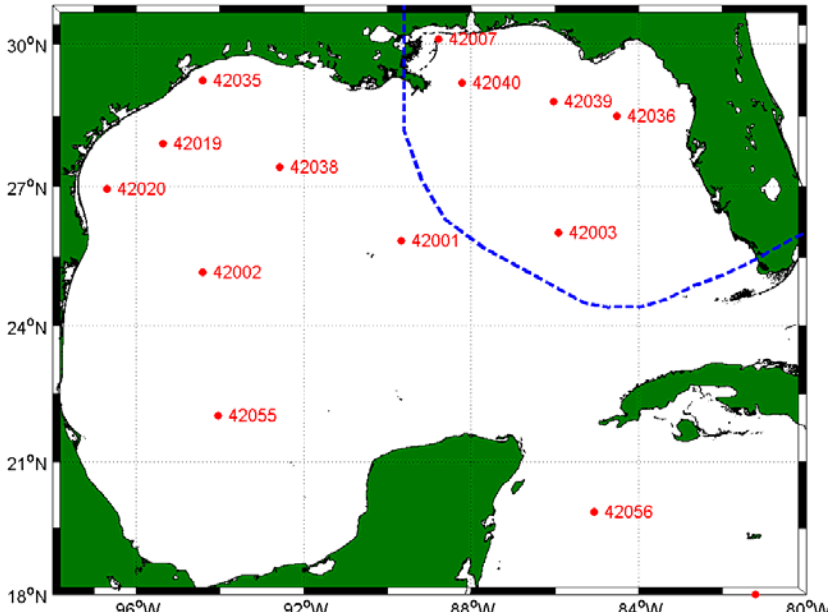


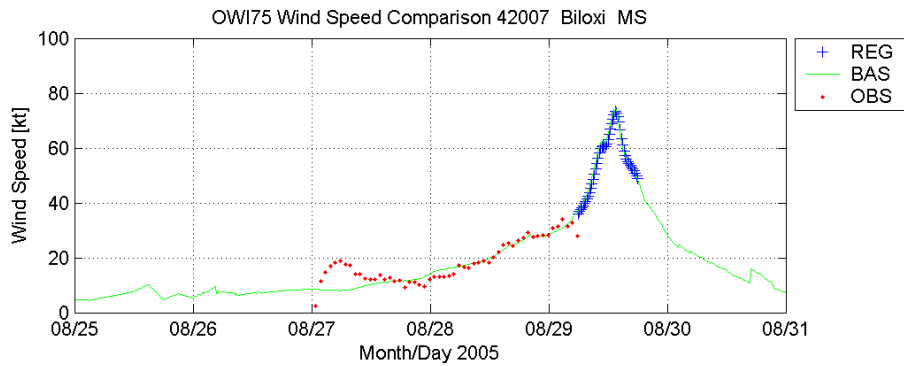


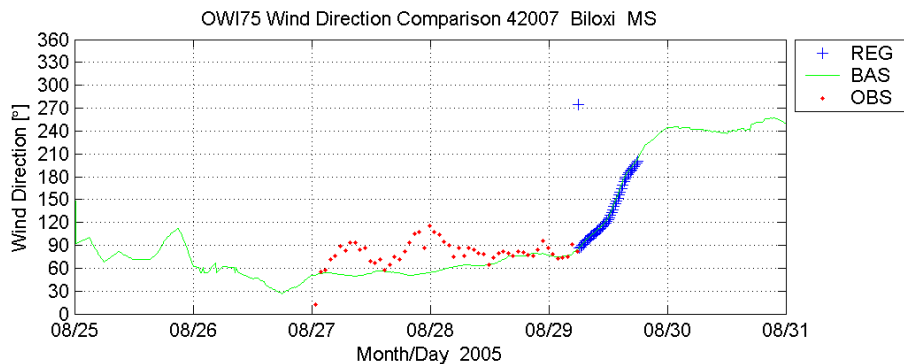
Wind and Atmospheric Pressure Fields

- Storm Surge - Planetary Boundary Layer (PBL) Model
- Waves – product from H*Wind/IOKA process
- Most anemometers close to storm failed near the peak

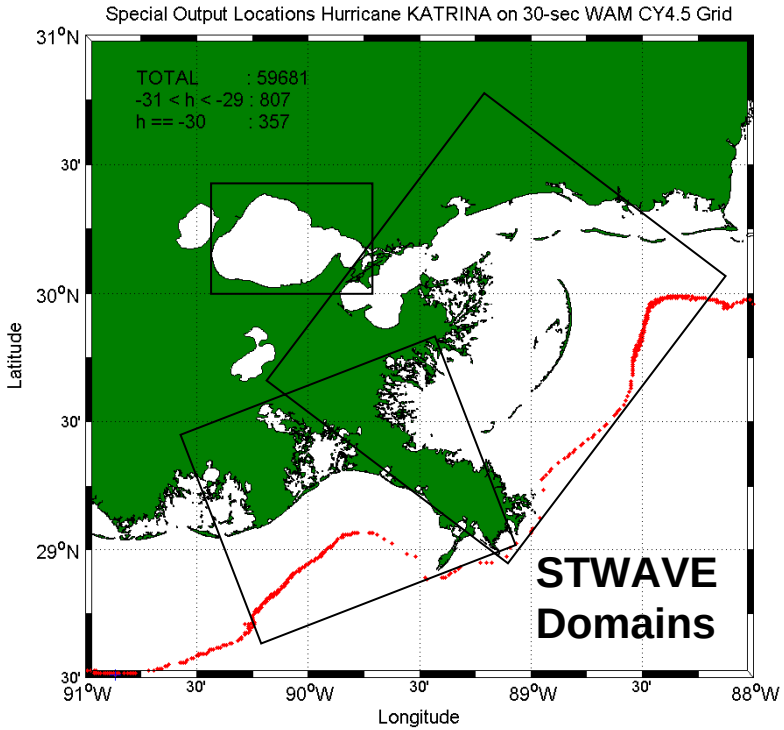




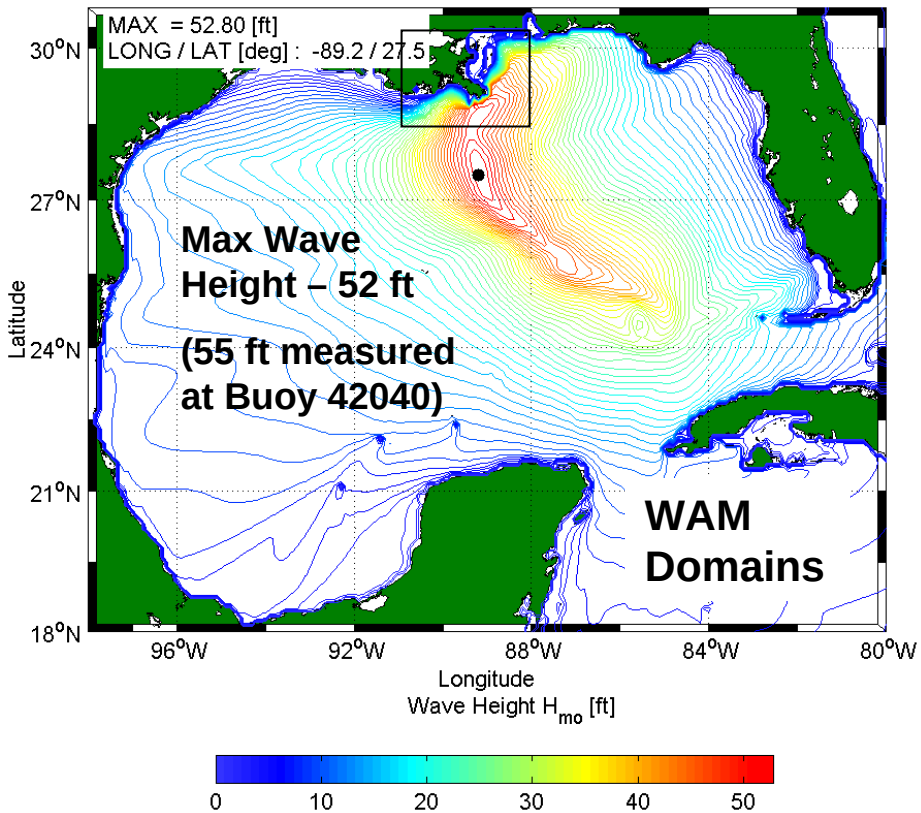




Nested Wave Modeling Approach (3 Nests)

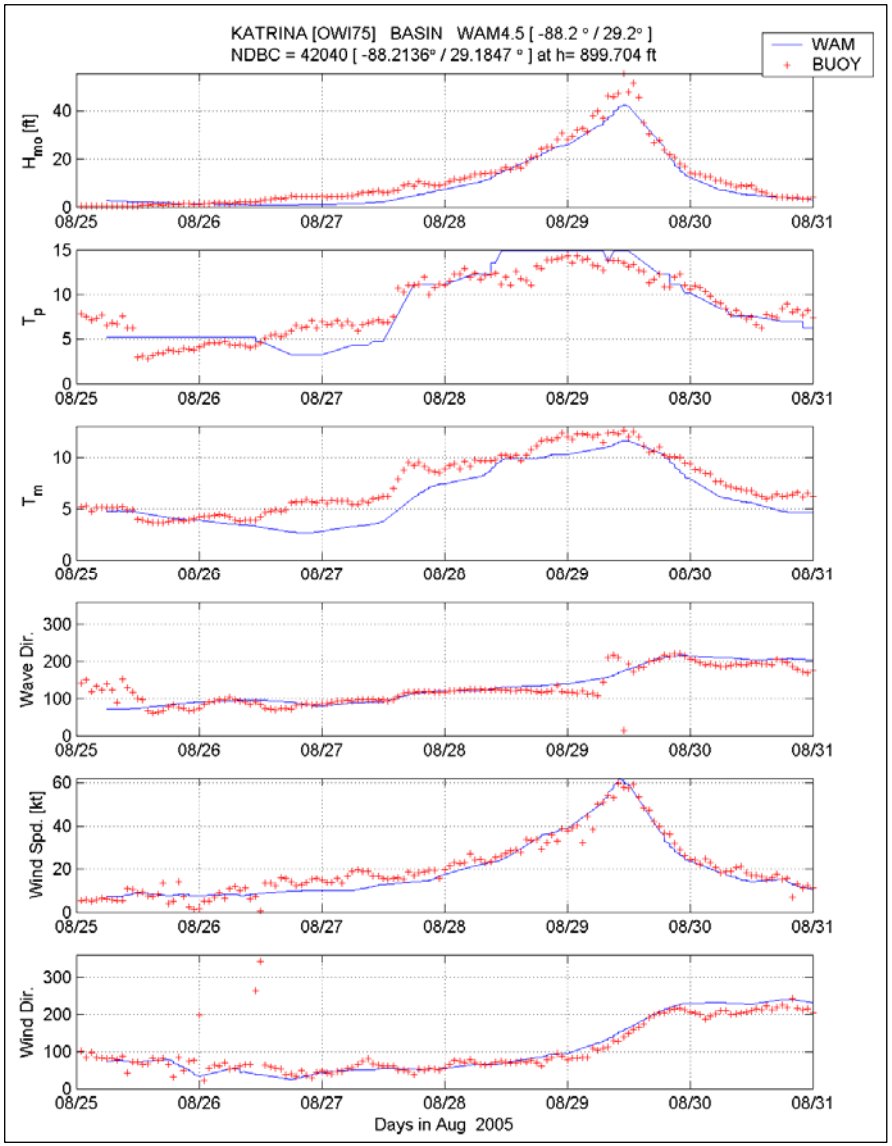


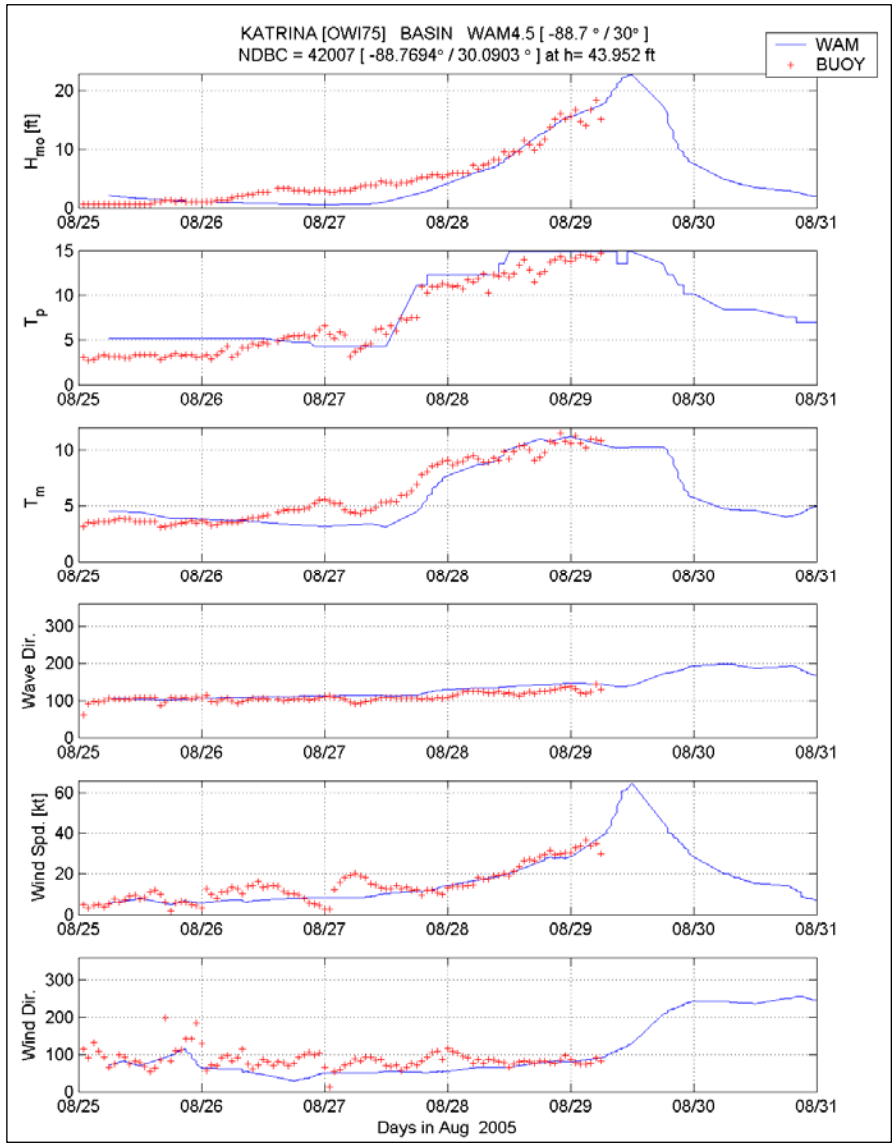
- Basin – Regional – Nearshore
- Wave-storm surge interaction handled at the nearshore level



- Maximize model-to-measurement comparisons
- STWAVE compared to SWAN
- Examine steady-state assumption in STWAVE
- WAM compared to WAVEWATCH III

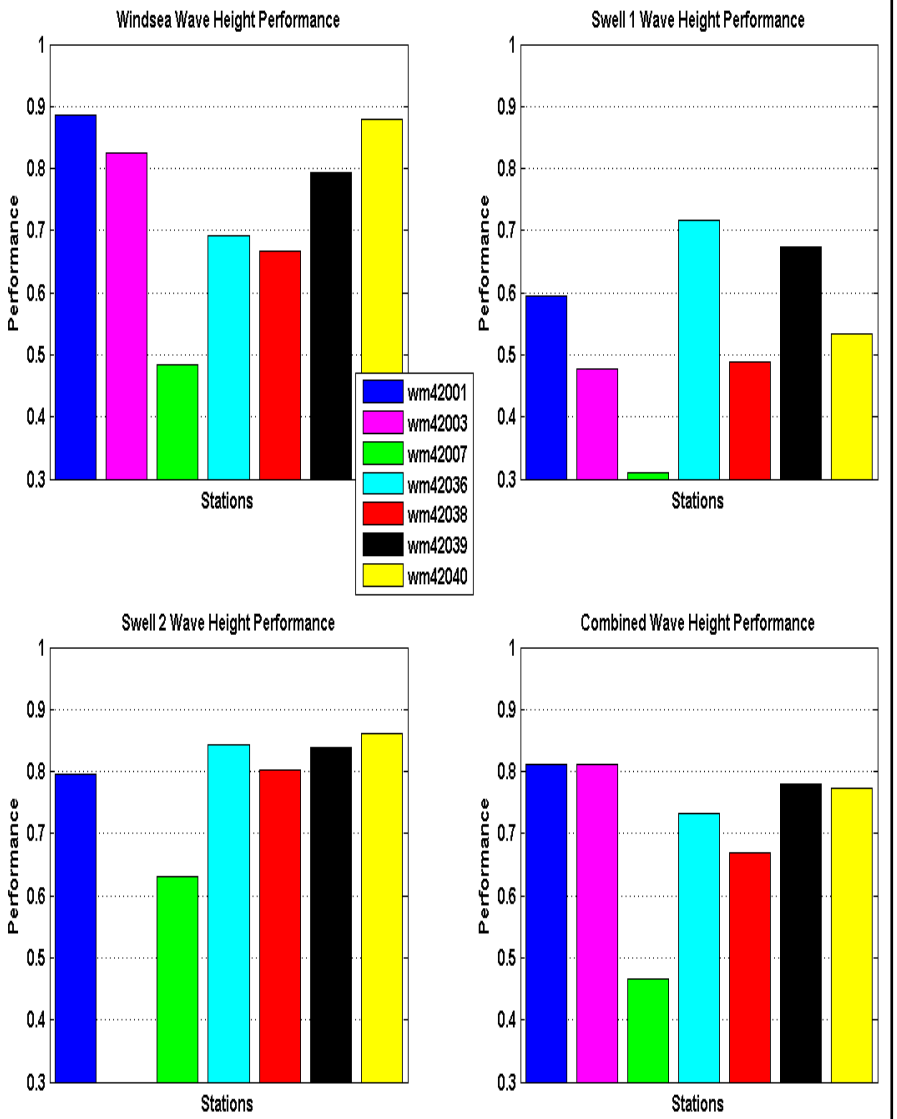
Comparisons: WAM and Measurements



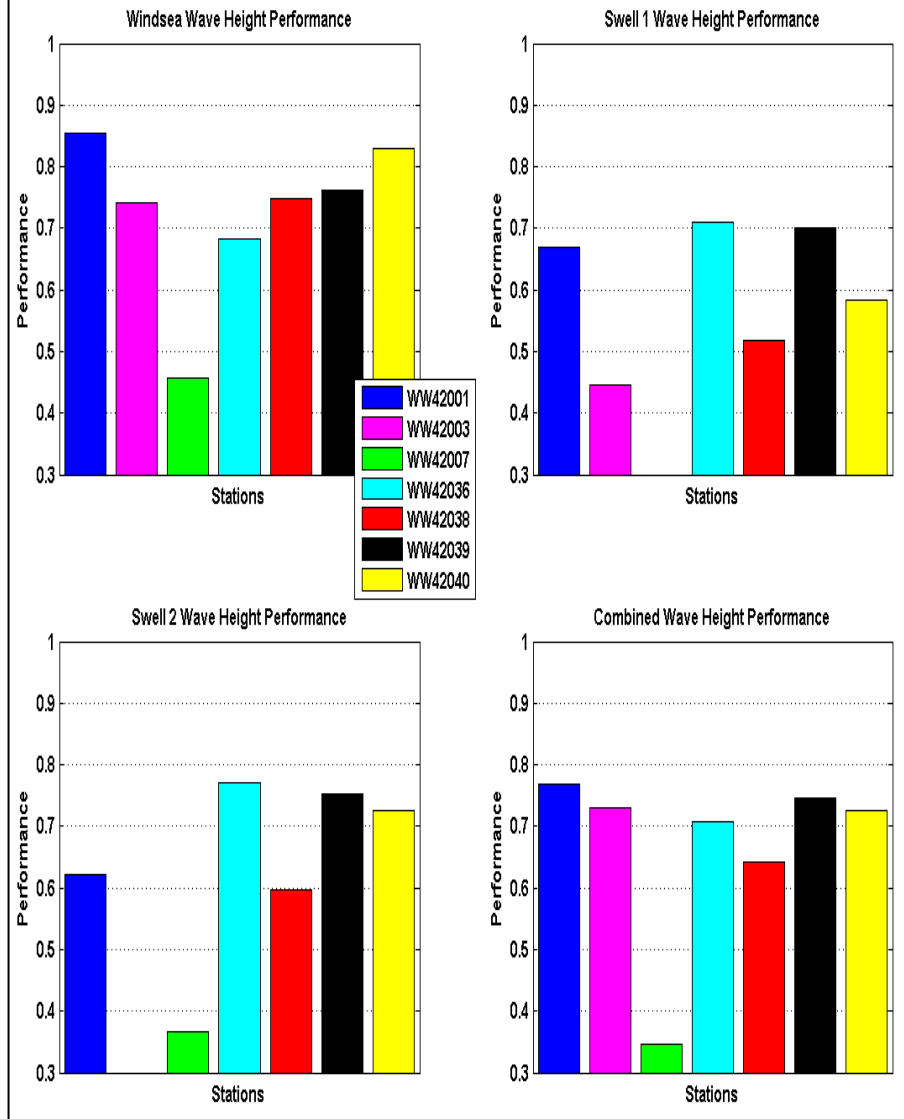


WAM-WAVEWATCH III Comparisons

WAM

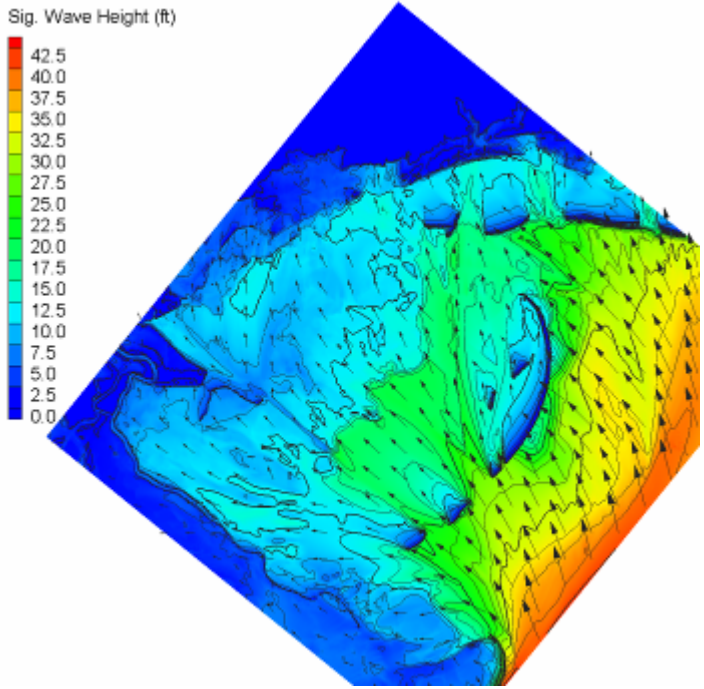


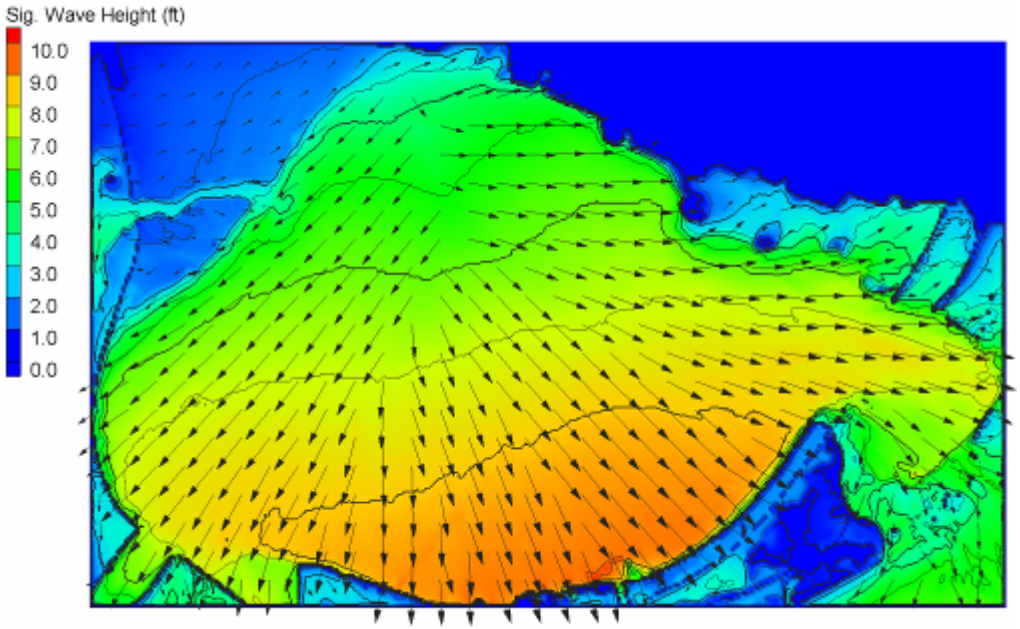
WAVEWATCH III

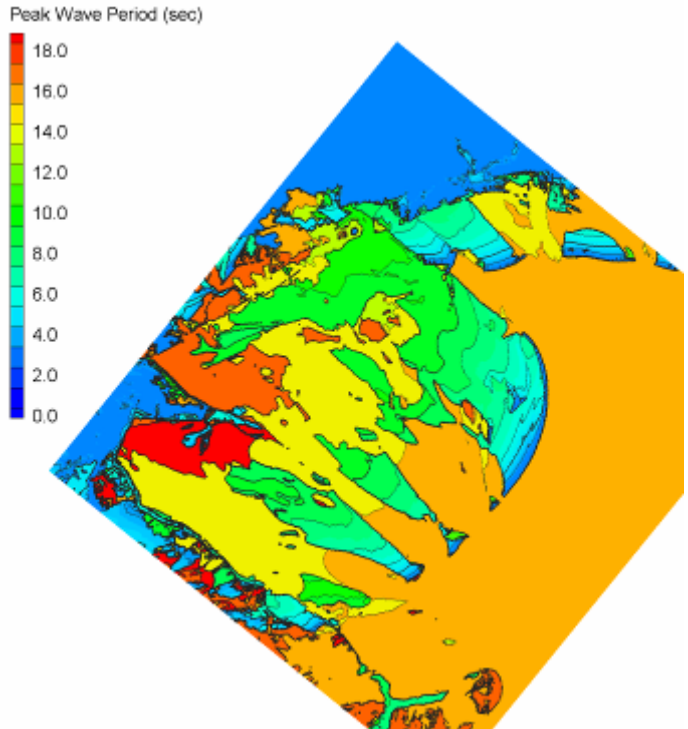


Maximum Nearshore Wave Conditions

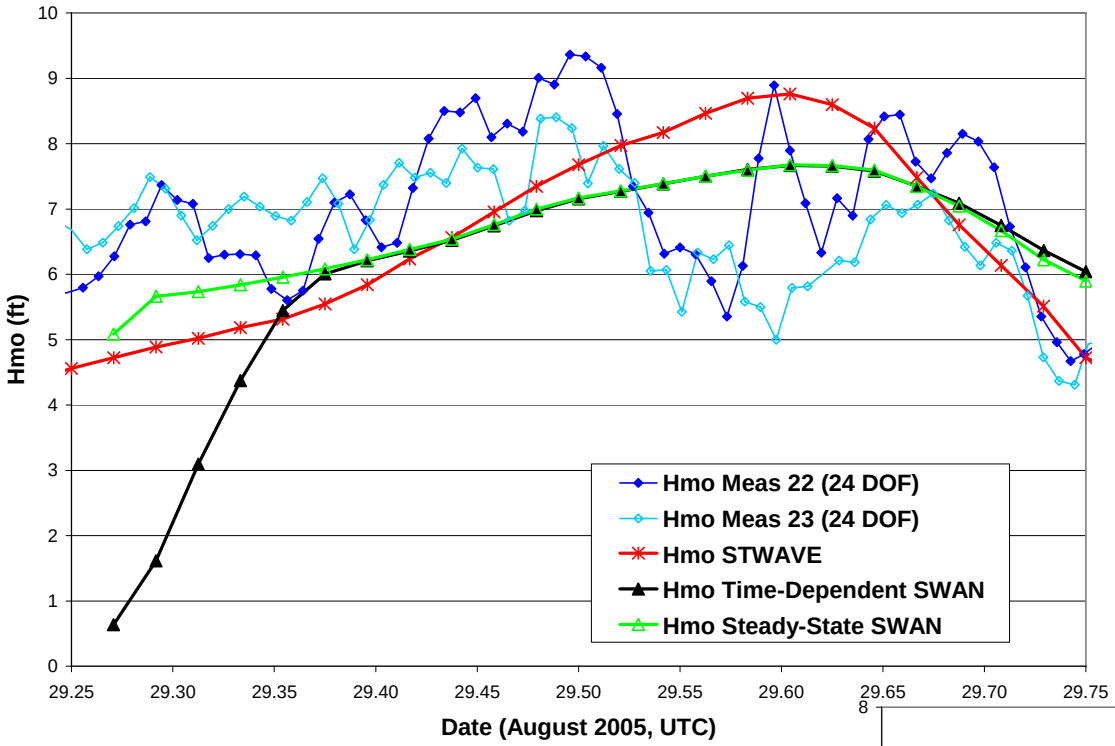
- Lake Pontchartrain – max significant wave heights of 9 ft, peak periods of 7 sec
- St. Bernard – wave heights of 5 ft; periods exceeding 15 sec
- Plaquemines (east-facing)– wave heights of 7-10 ft, periods 13-15 sec
- Levees exposed to long period wave energy



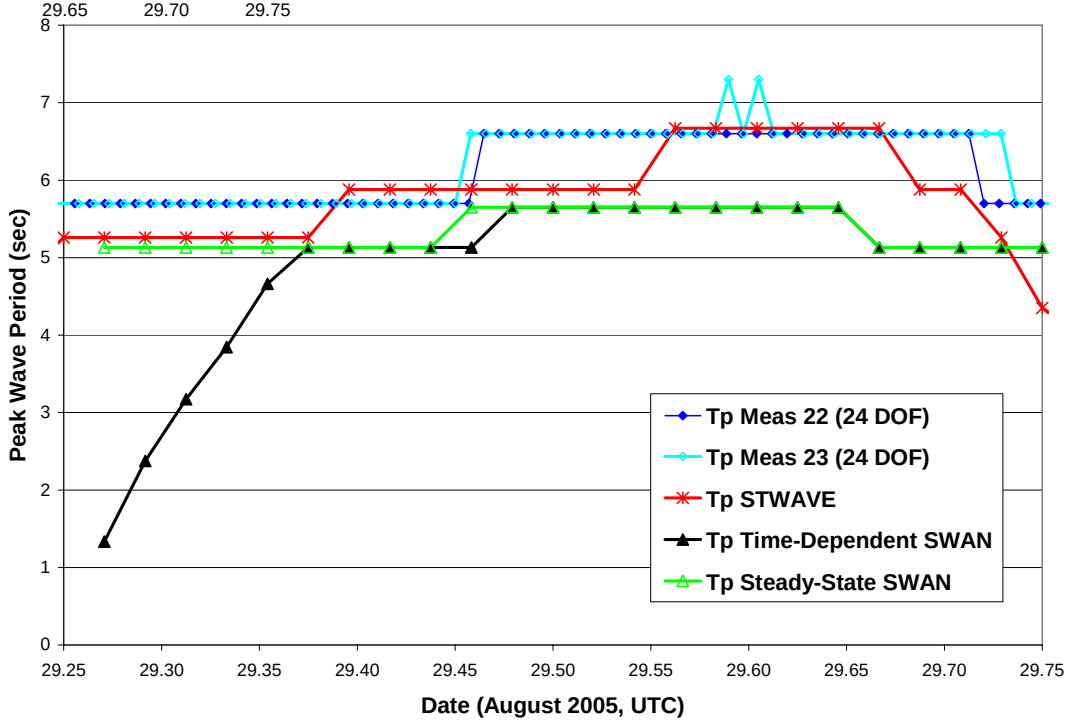




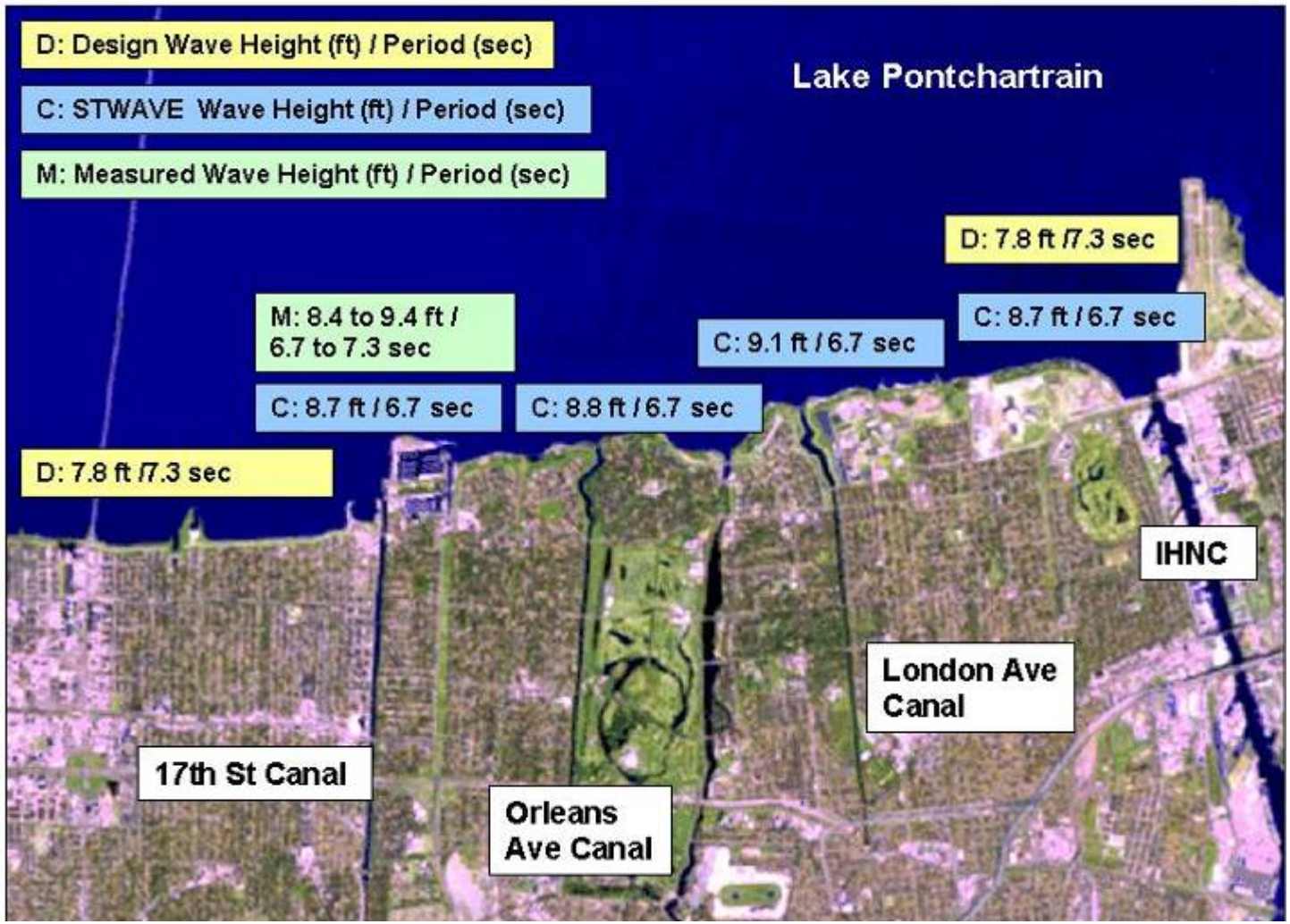
Comparisons: STWAVE-SWAN-Measurements



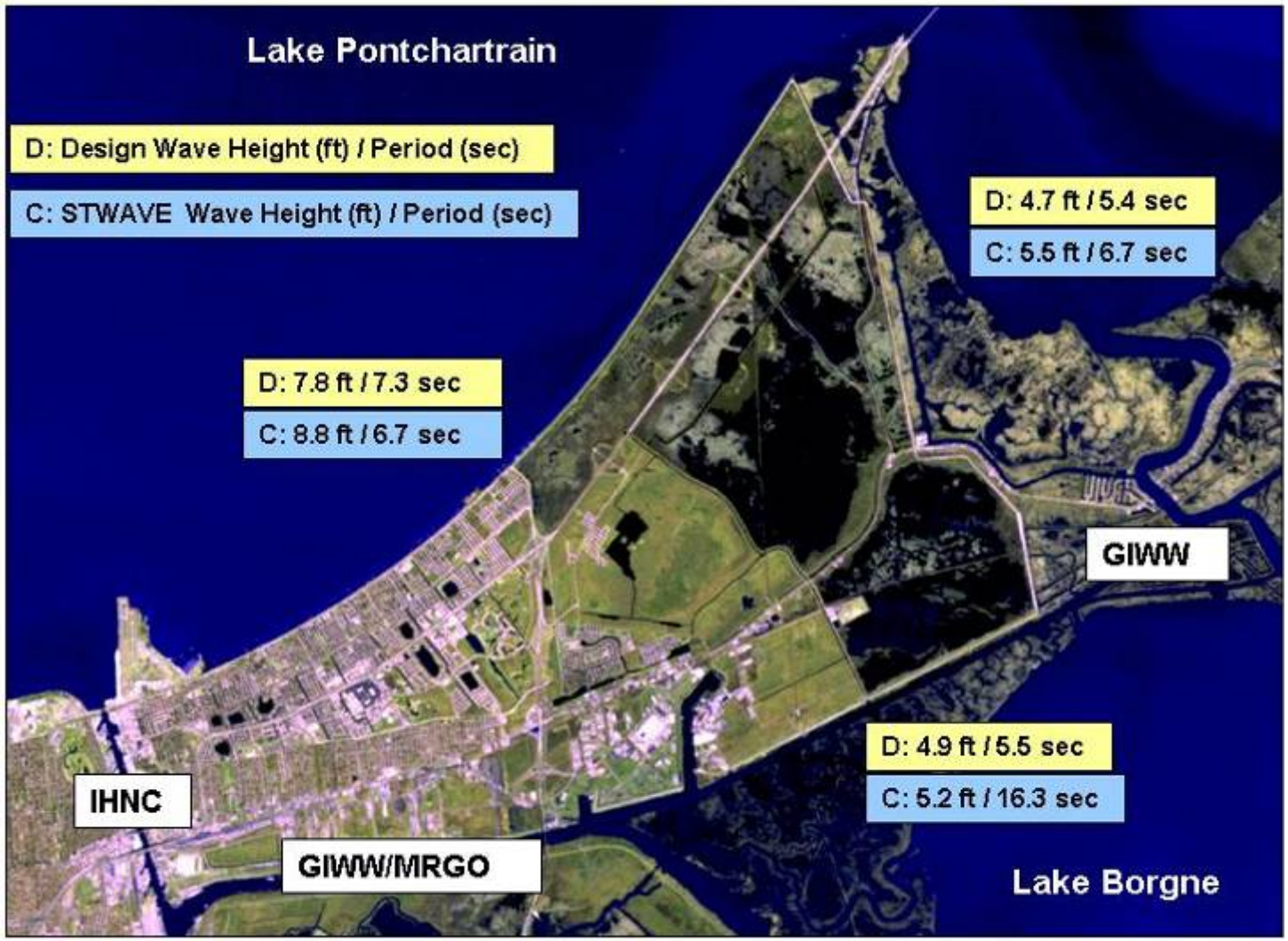
- Measurements just north of 17th Street Canal entrance (2 small buoys)
- Measured data during the peak are suspect
- Steady-state assumption of STWAVE valid



Peak Wave Conditions
(Comparison: Katrina and Design Values)



Peak Wave Conditions
(Comparison: Katrina and Design Values)



Peak Wave Conditions
(Comparison: Katrina and Design Values)

Peak Wave Conditions
(Comparison: Katrina and Design Values)

The Way Ahead - Waves

- Mississippi coast STWAVE domain
- ADCIRC-STWAVE coupling – depths and radiation stresses
- Update all wave modeling with 95% winds
- Consider spatially variable winds in all STWAVE domains
- Sensitivity tests (wind, barrier island, bottom roughness)
- Update model-to-measurement comparisons and Katrina/Design
- Prepare for data releases

Hurricane Katrina Hindcasts

- Domain/Grid Improvements
  - TF01 Add North Shore, Alabama and Mississippi
  - TF01x2 Add resolution for waves and critical regions
  - S14 Add resolution, features, apply Lidar
  - S14x2 S14 with additional resolution in North Shore of LP, for MS and AL and for wave radiation fields
- Define directional wind reduction coefficients across LA, MS and AL
- Define Manning n coefficients

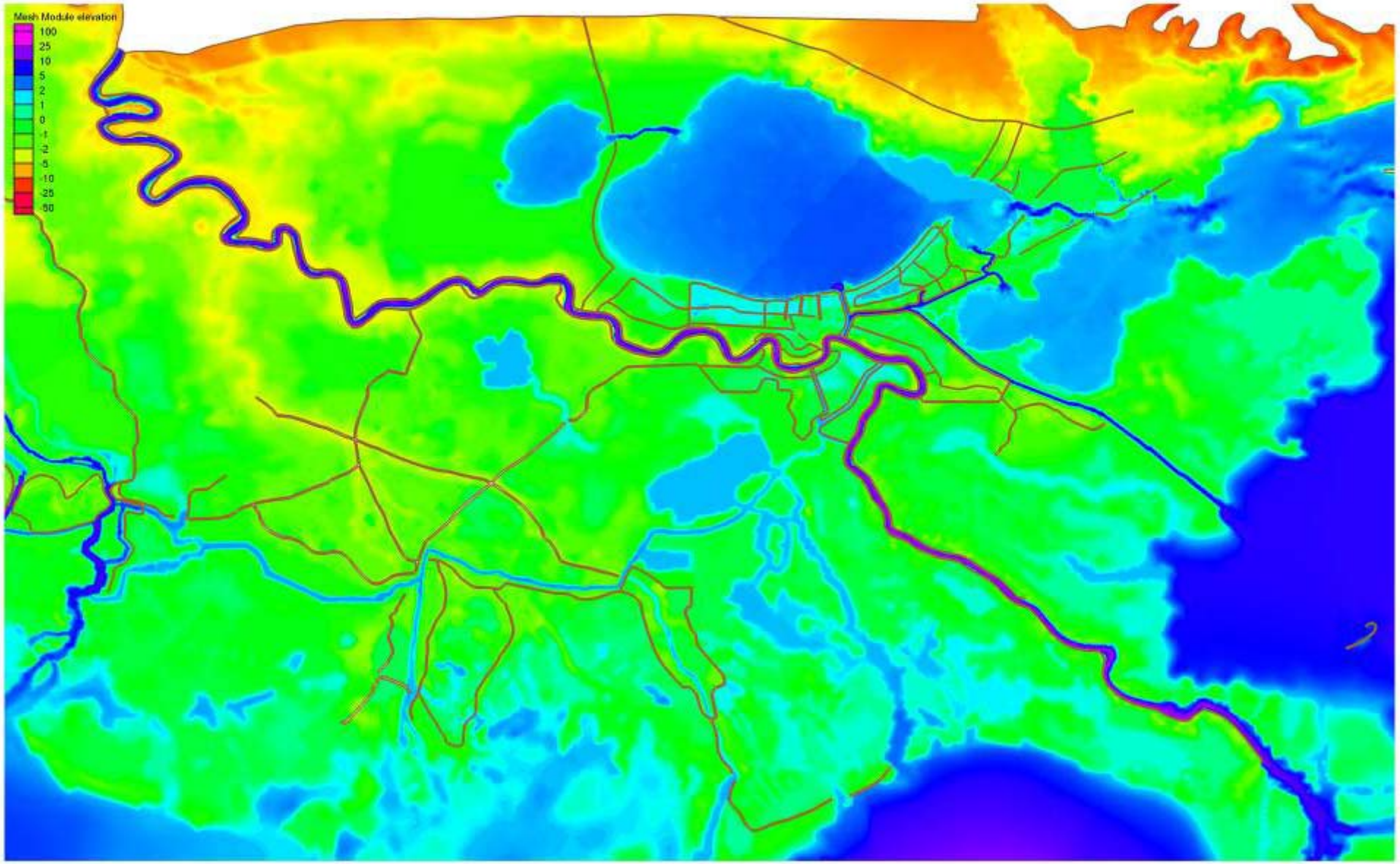
Hurricane Katrina Hindcasts

- Incorporation of tides
- Detailed synthesis of wind and pressure fields
  - PBL Analysis
  - H*Wind / OWI preliminary synthesis
  - H*Wind re-analysis / OWI synthesis
- Incorporation of wave radiation stress fields
  - WAM
  - ST-WAVE (up to 4 grids)

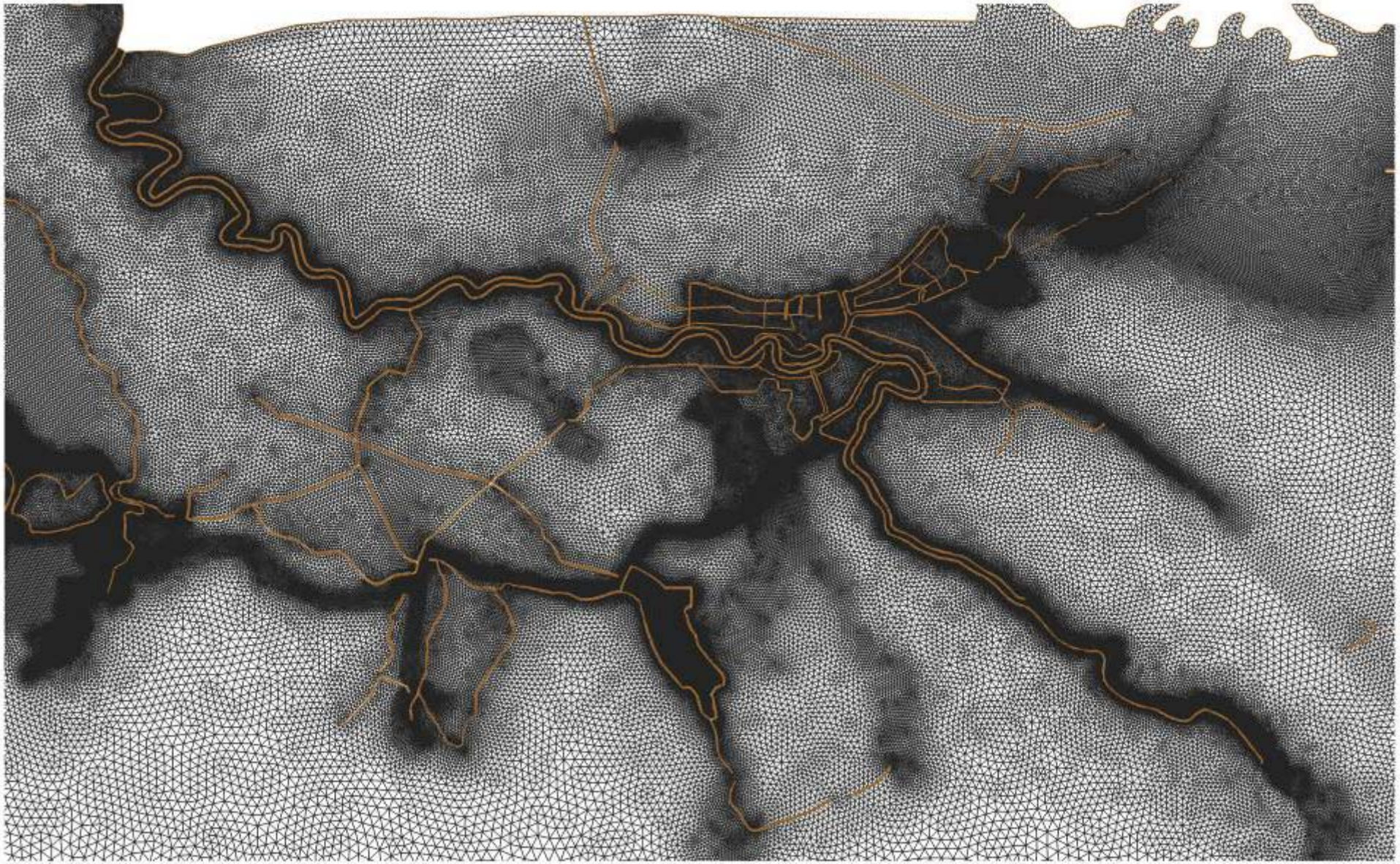
Hurricane Katrina Hindcasts

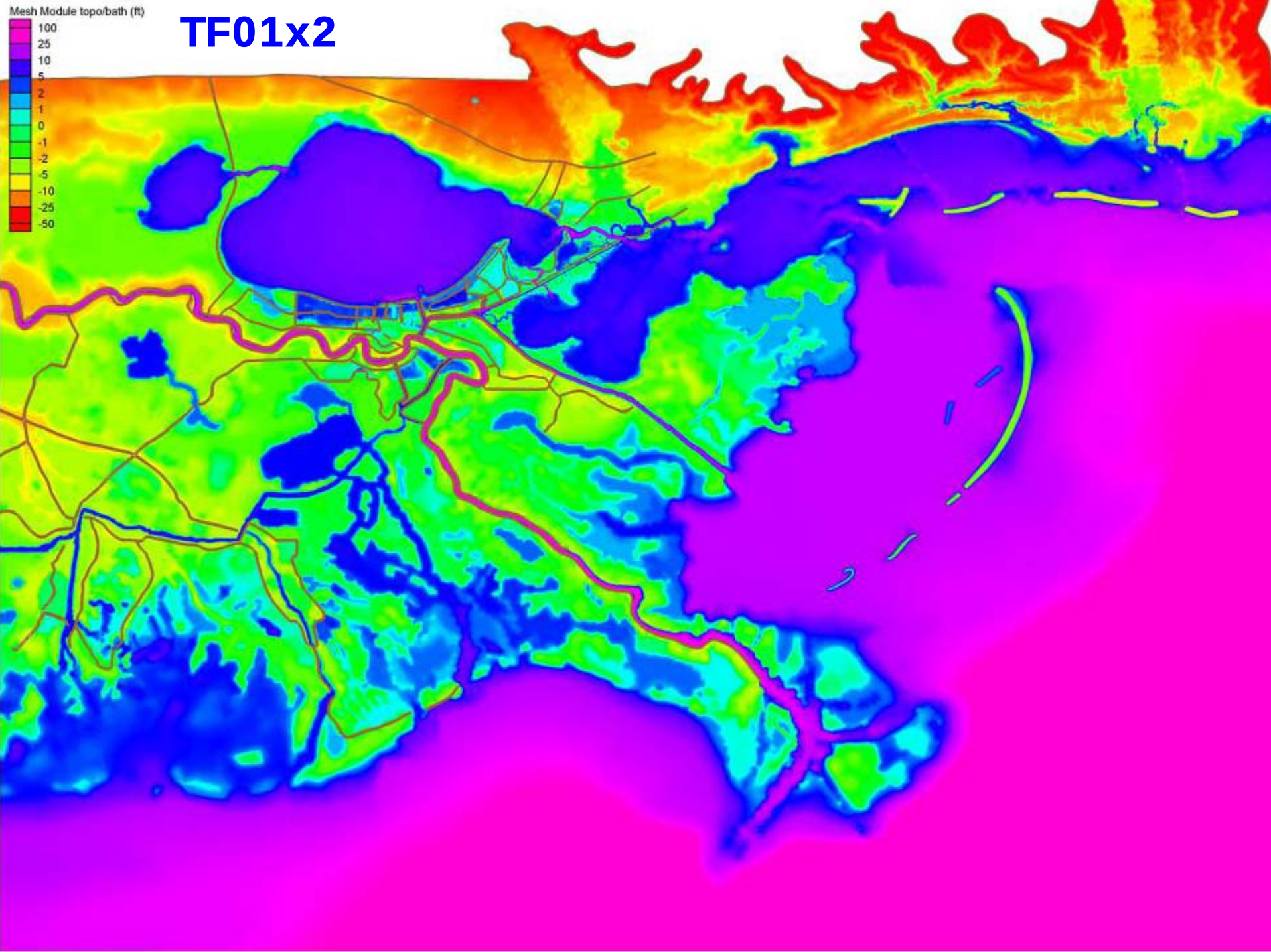
- QA/QC of the physical system in the model (bathymetry, topography, levee elevations, hydraulic features)
- Adjustment of MLLW, NGVD29 and NAVD88 to Geoid for simulations
- Incorporation of high density Lidar topo data
- Incorporation of updated levee heights
- Output converted to NAVD 88 2004 to match HWM's and hydrographs

TF01



TF01




Mesh Module topo/bath (ft)
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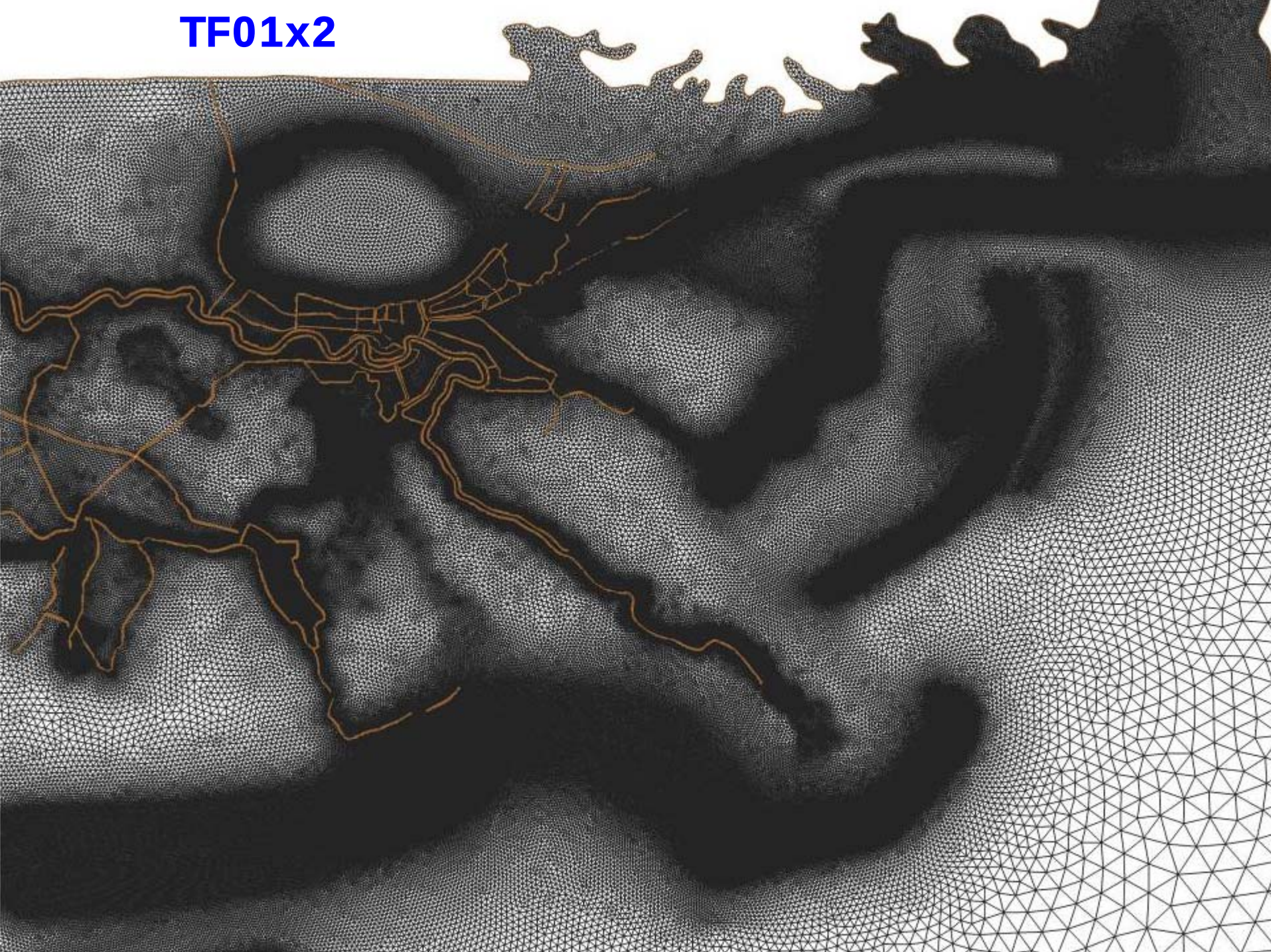
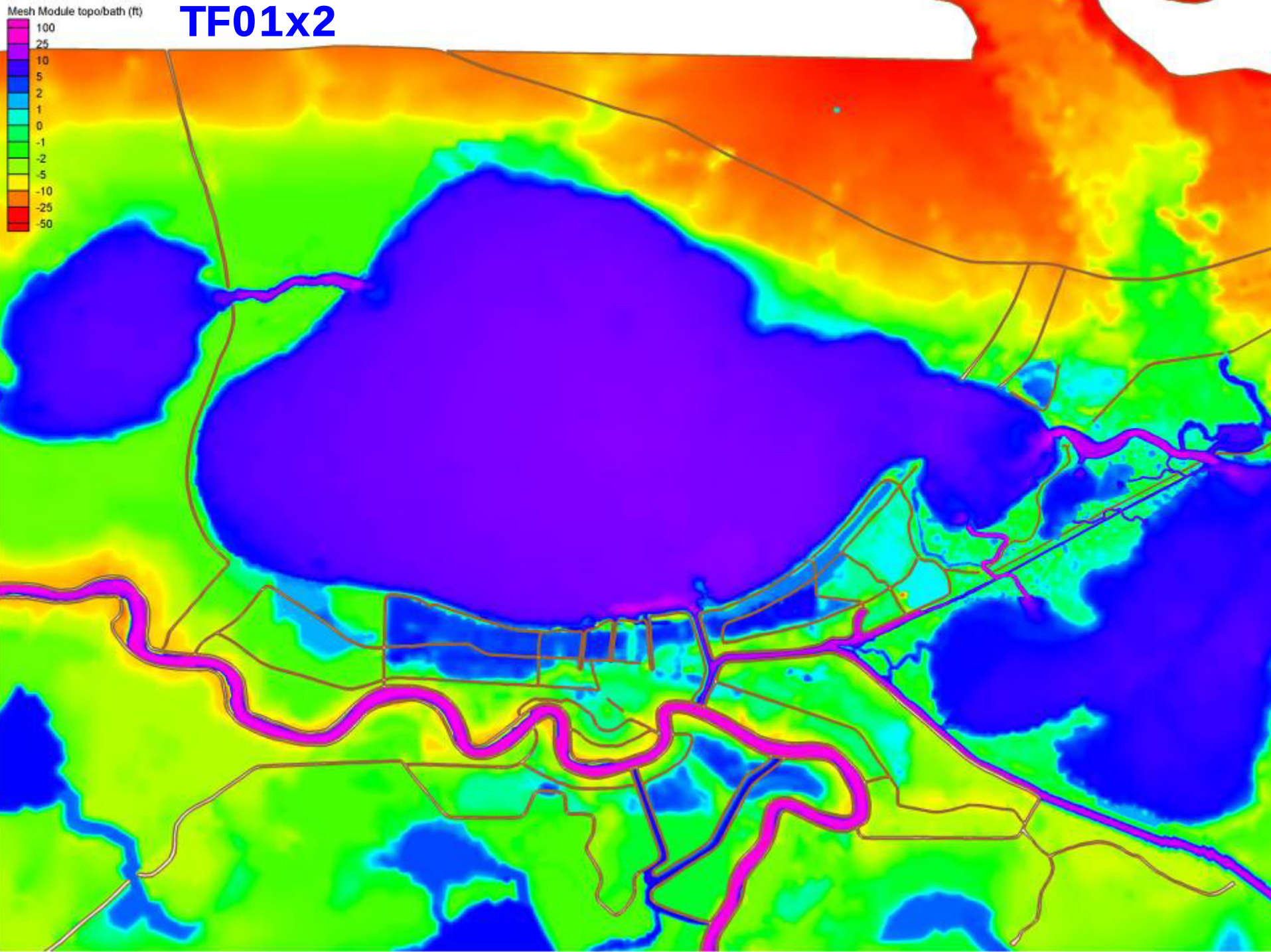
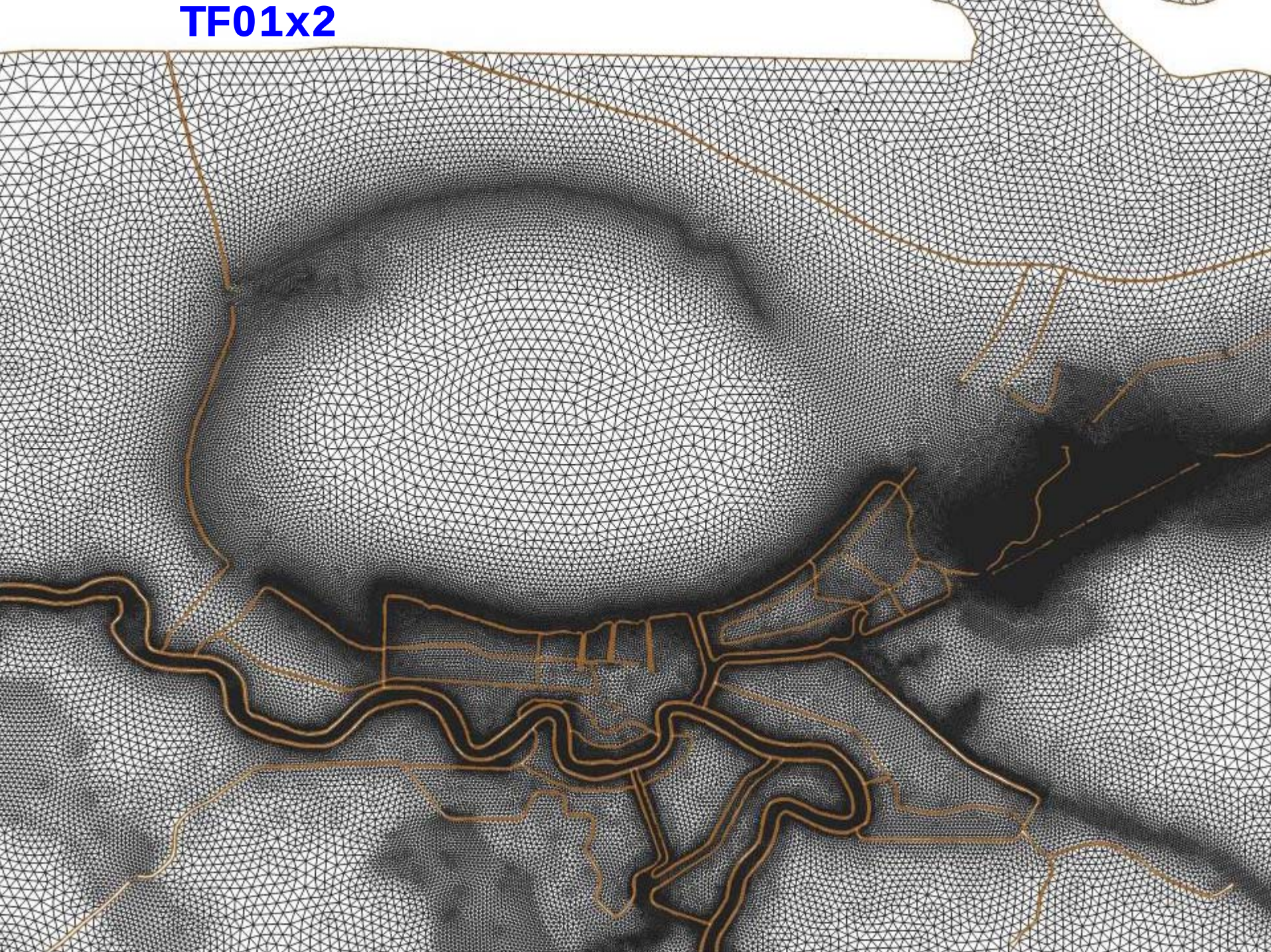
25
10
5
2
1
0
-1
-2
-5
-10
-25
-50
TF01x2

TF01x2

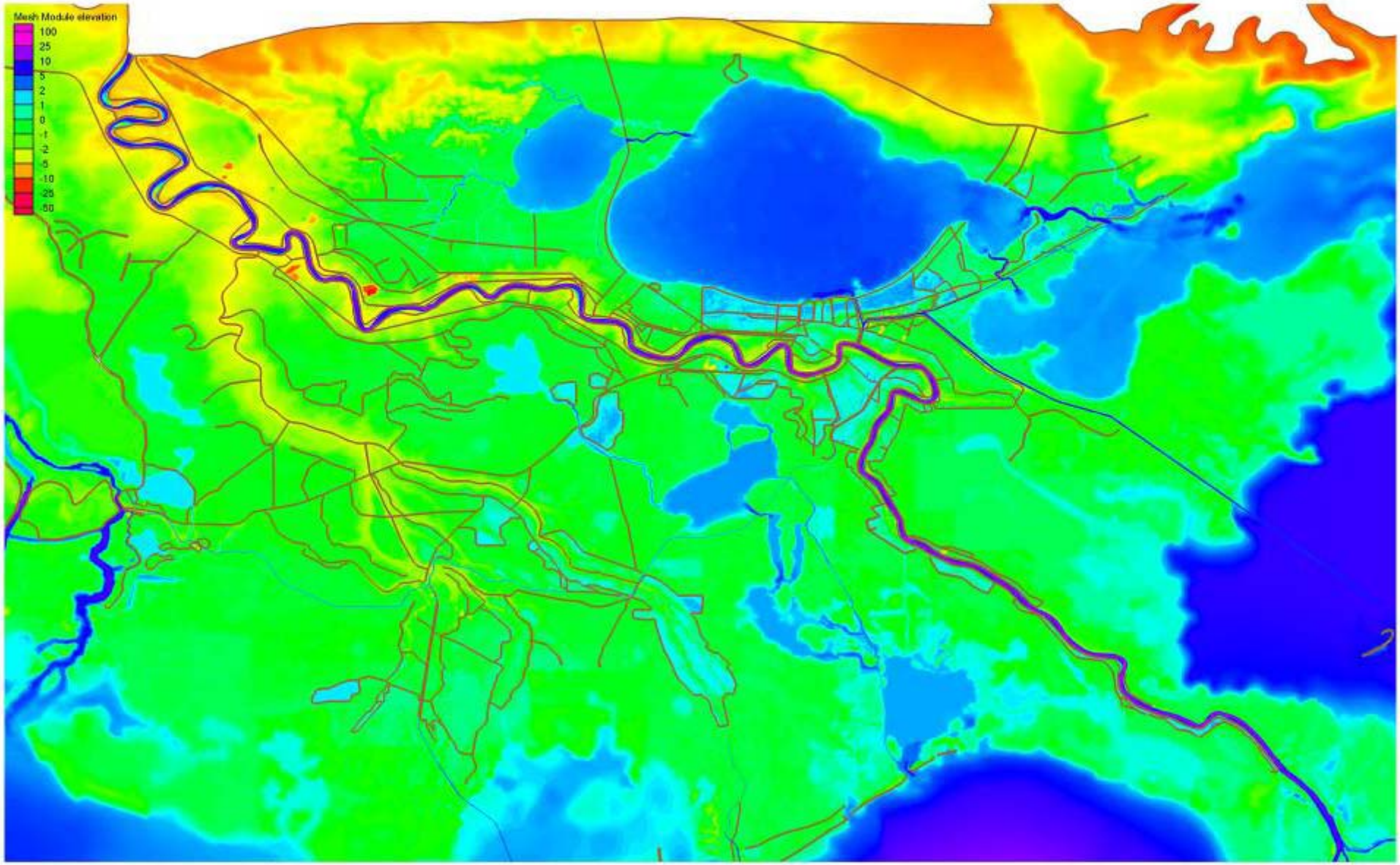



Mesh Module topo/bath (ft)
100
25
10
5
2
1
0
-1
-2
-5
-10
-25
-50
TF01x2

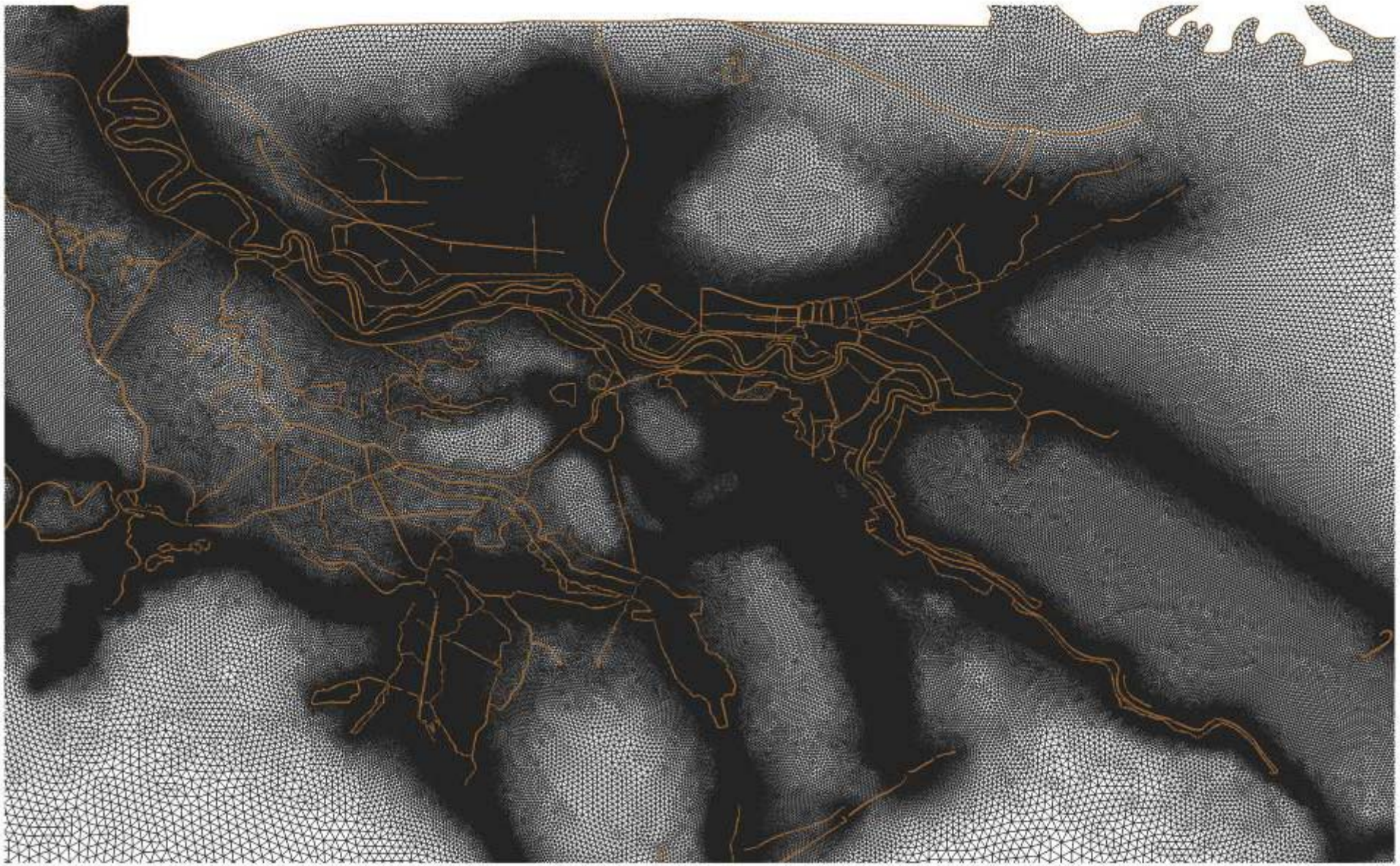
TF01x2



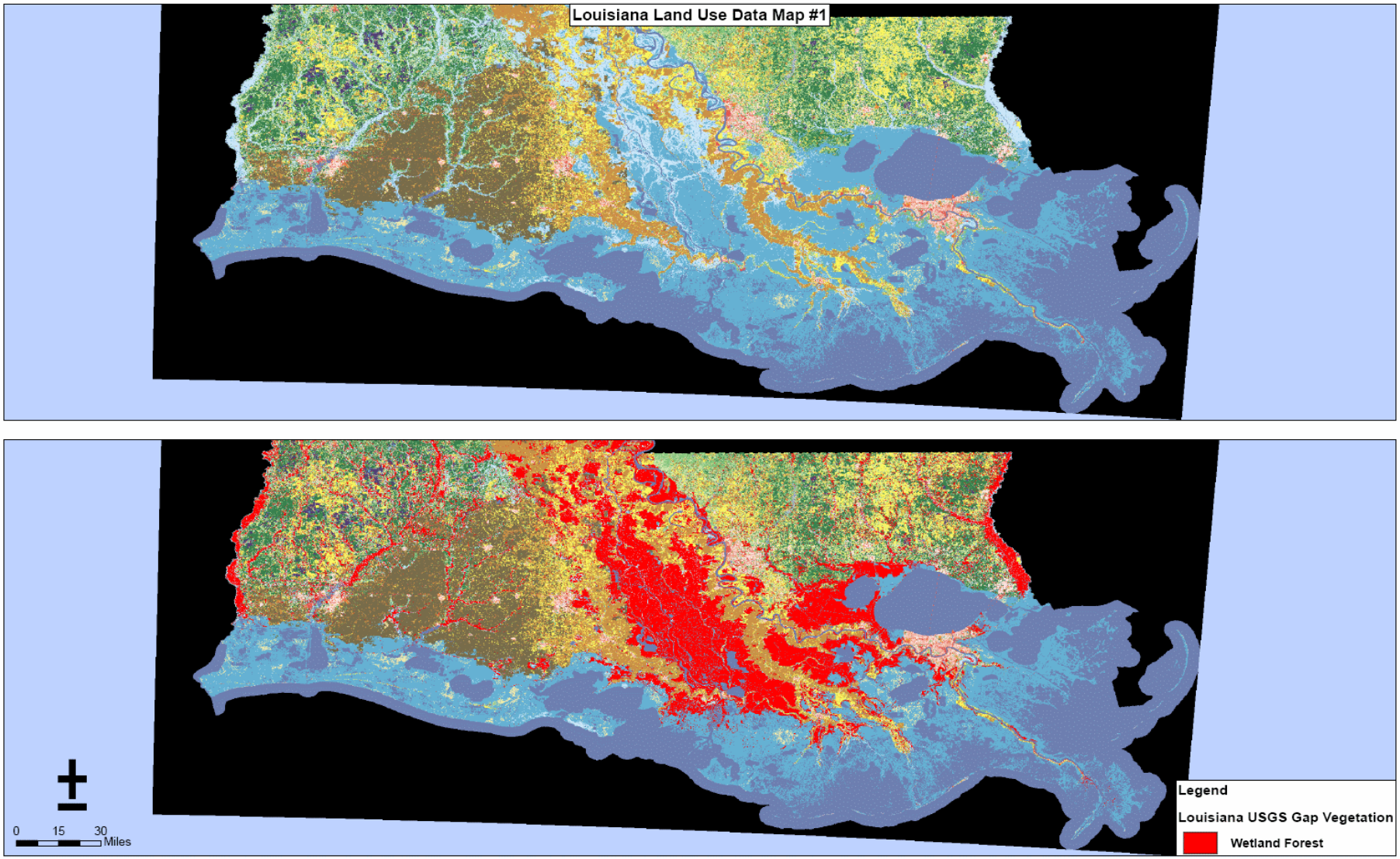
S14



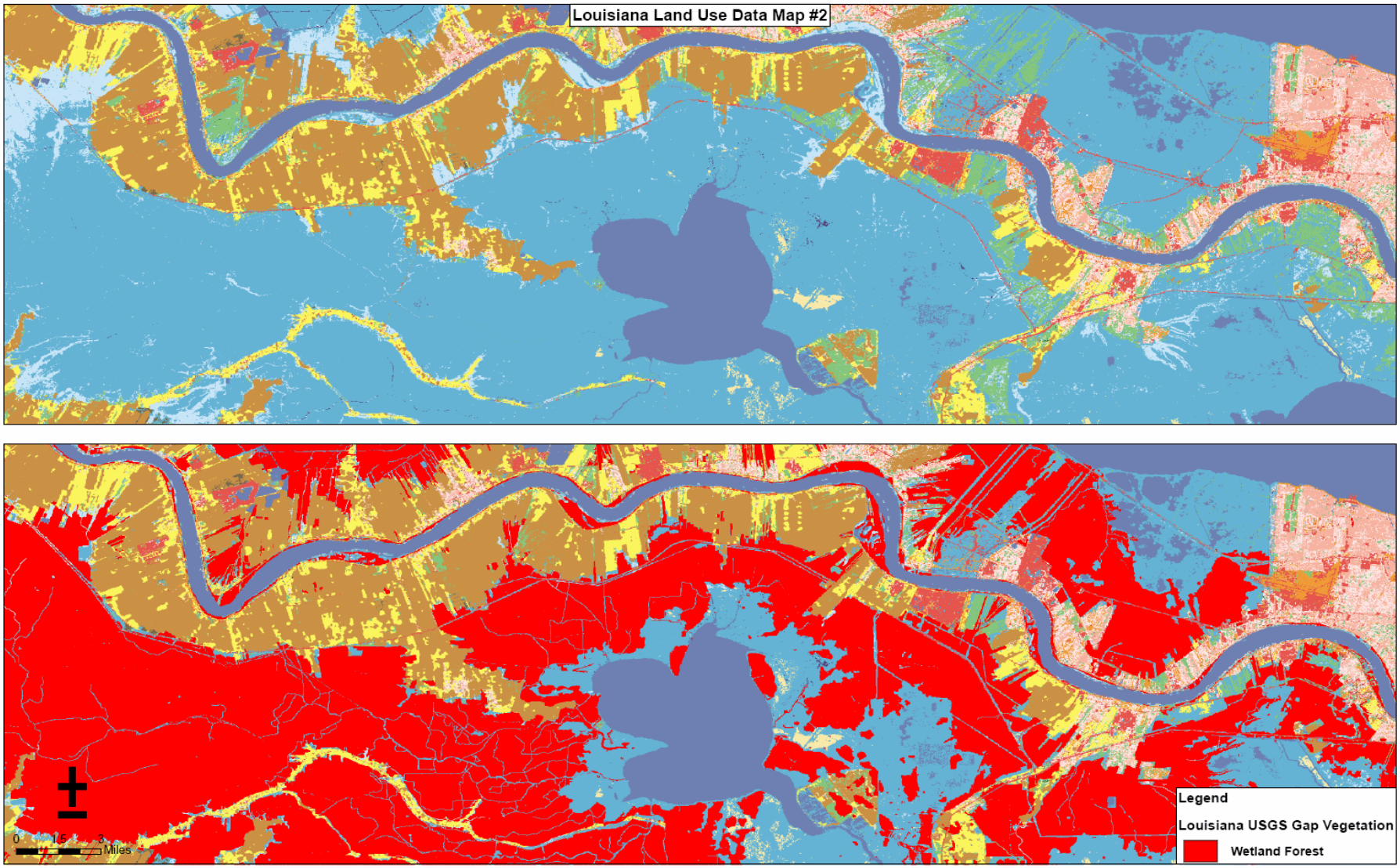
S14

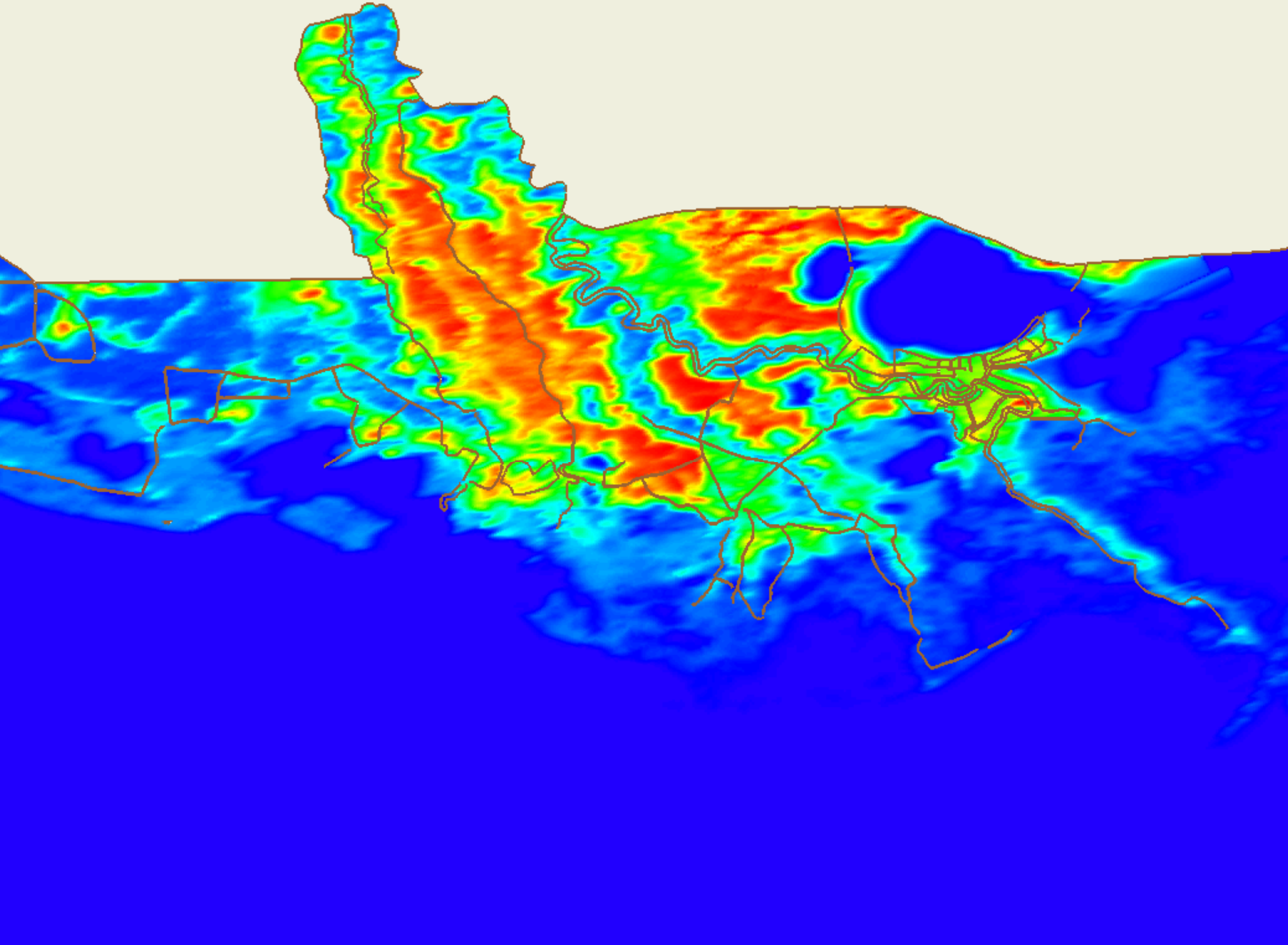


Land Use Factors



Land Use Factors

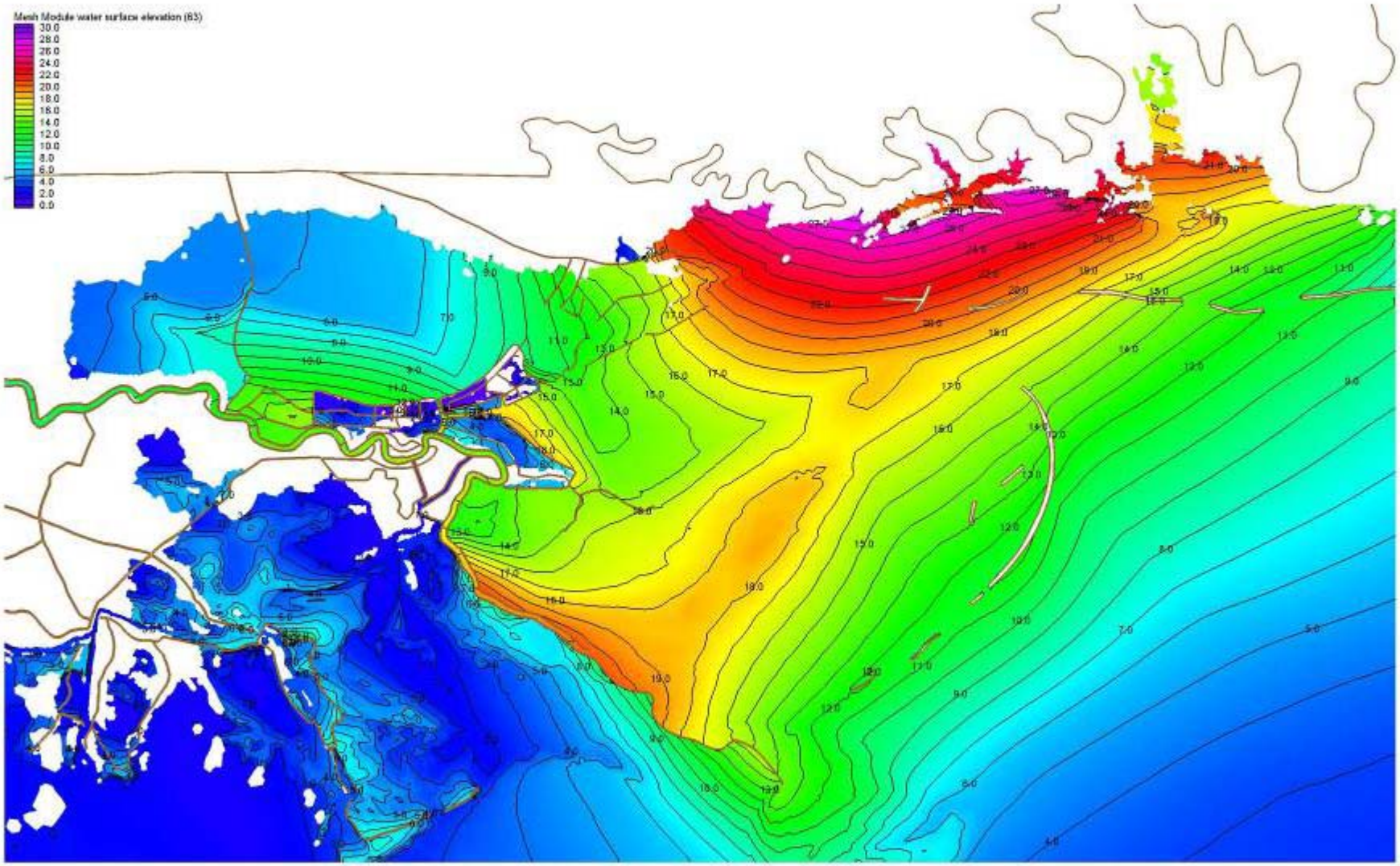




Hurricane Katrina Hindcasts

- Base Case
  - TF01 grid
  - PBL Wind field using final track info
  - River flows
  - No tides
- Run information
  - 377,815 computational points, solved every 1 second for 6 days.
  - On a Cray XT3 using 256 processors computation takes 74.9 wall clock minutes

TF01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26.0
24.0
22.0
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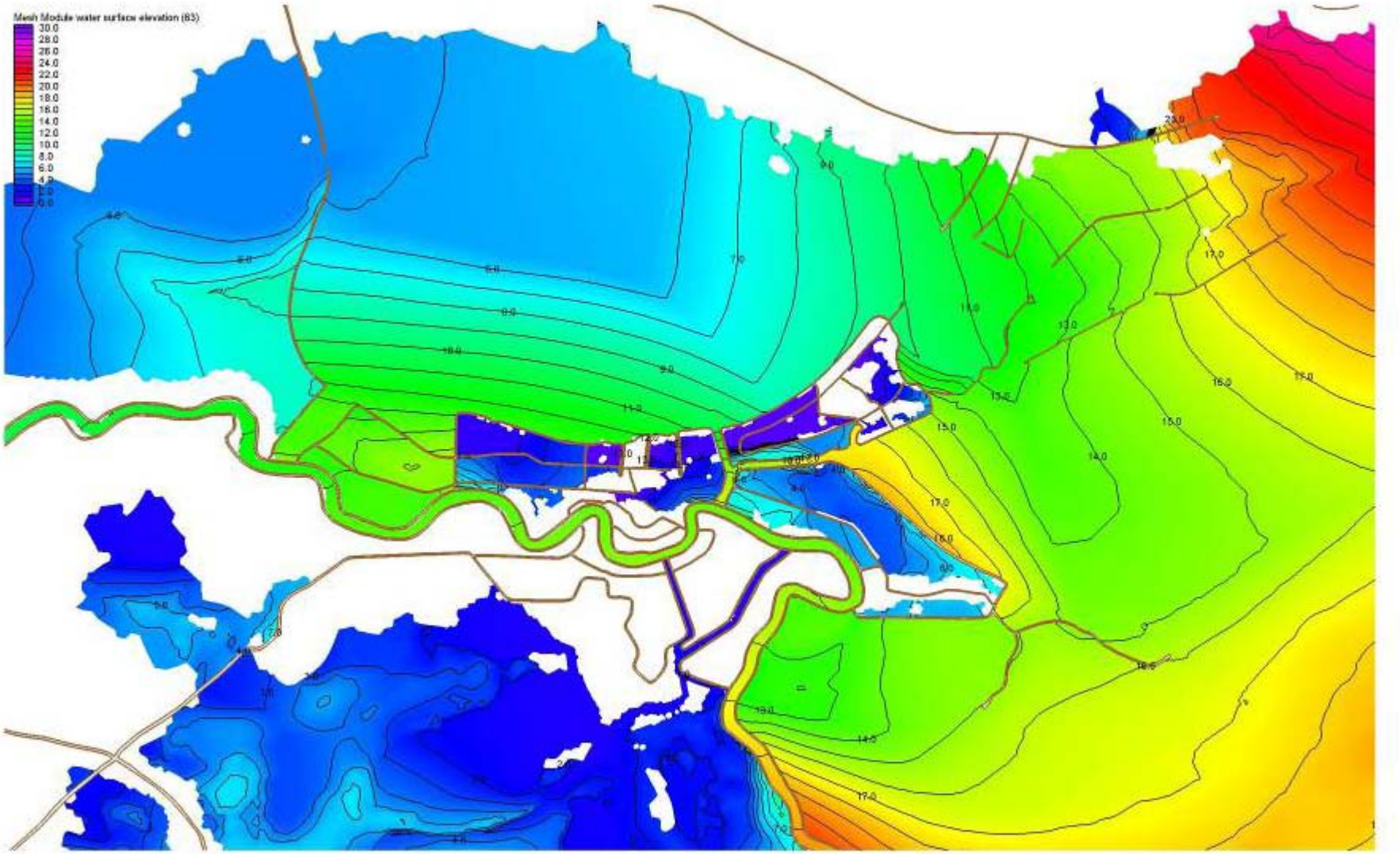
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0

TF01


Mesh Module water surface elevation (83)
30.0
28.0
26.0
24.0
22.0
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14.0
12.0
10.0
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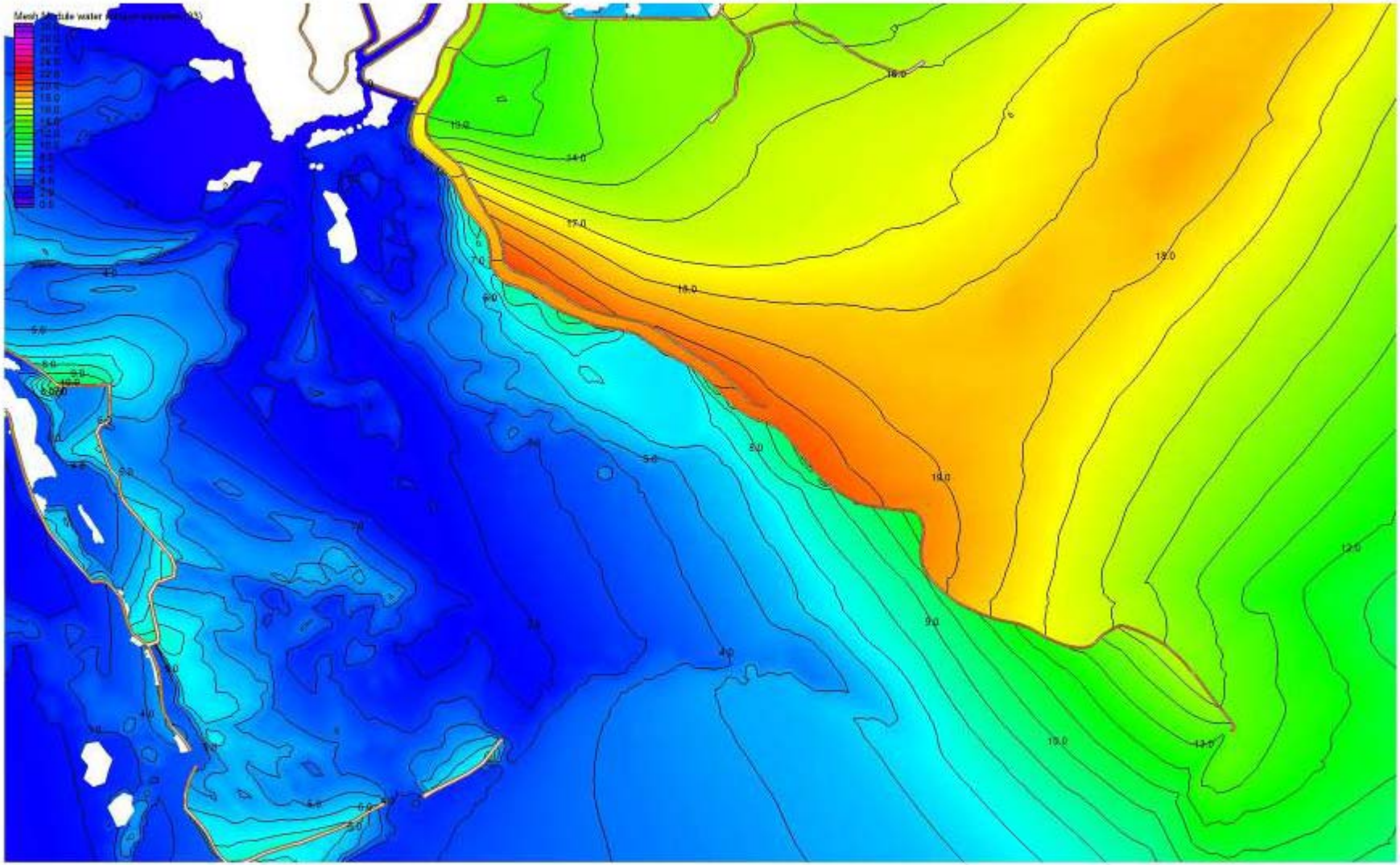
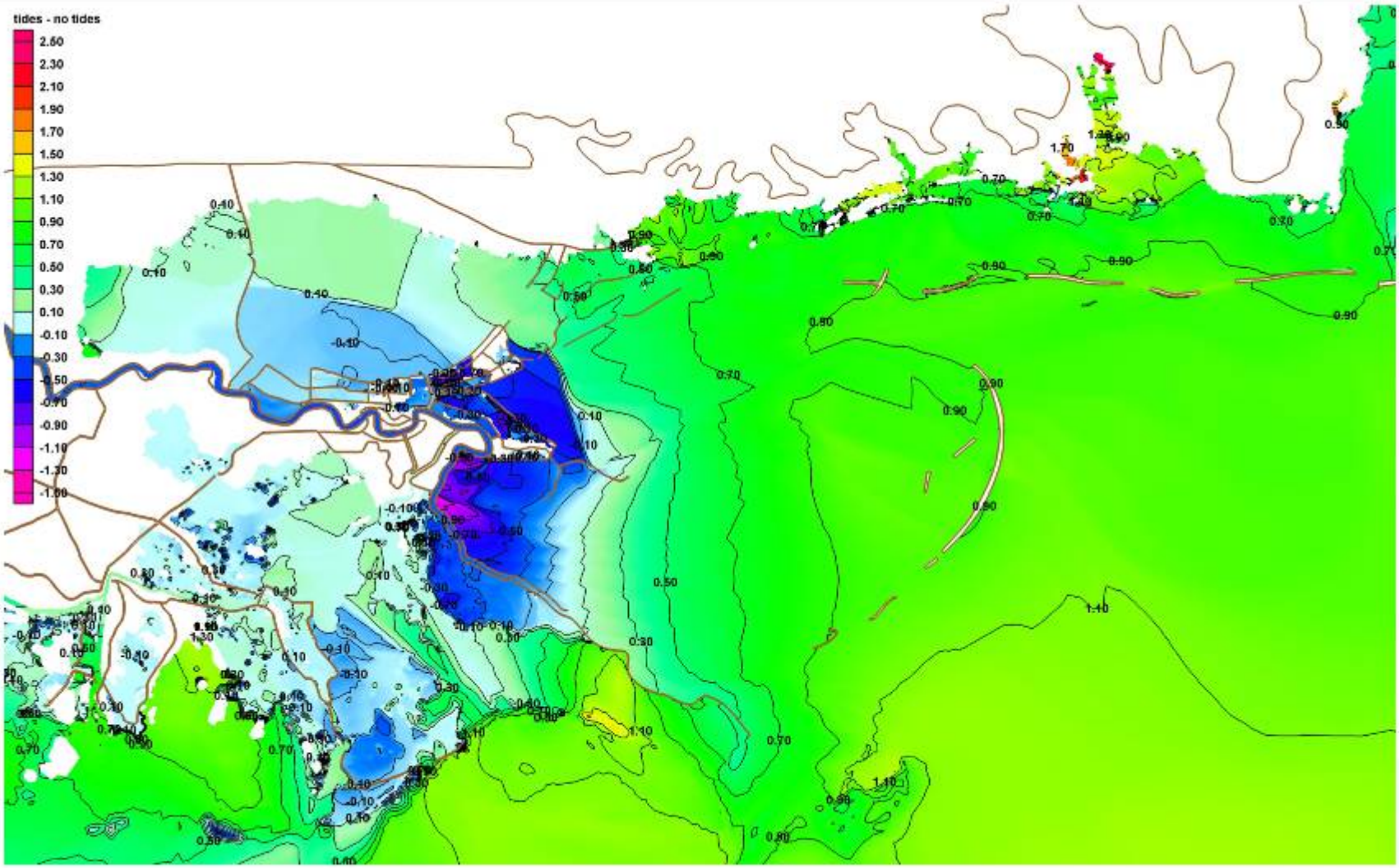
6.0
4.0
2.0
0.0

TF01



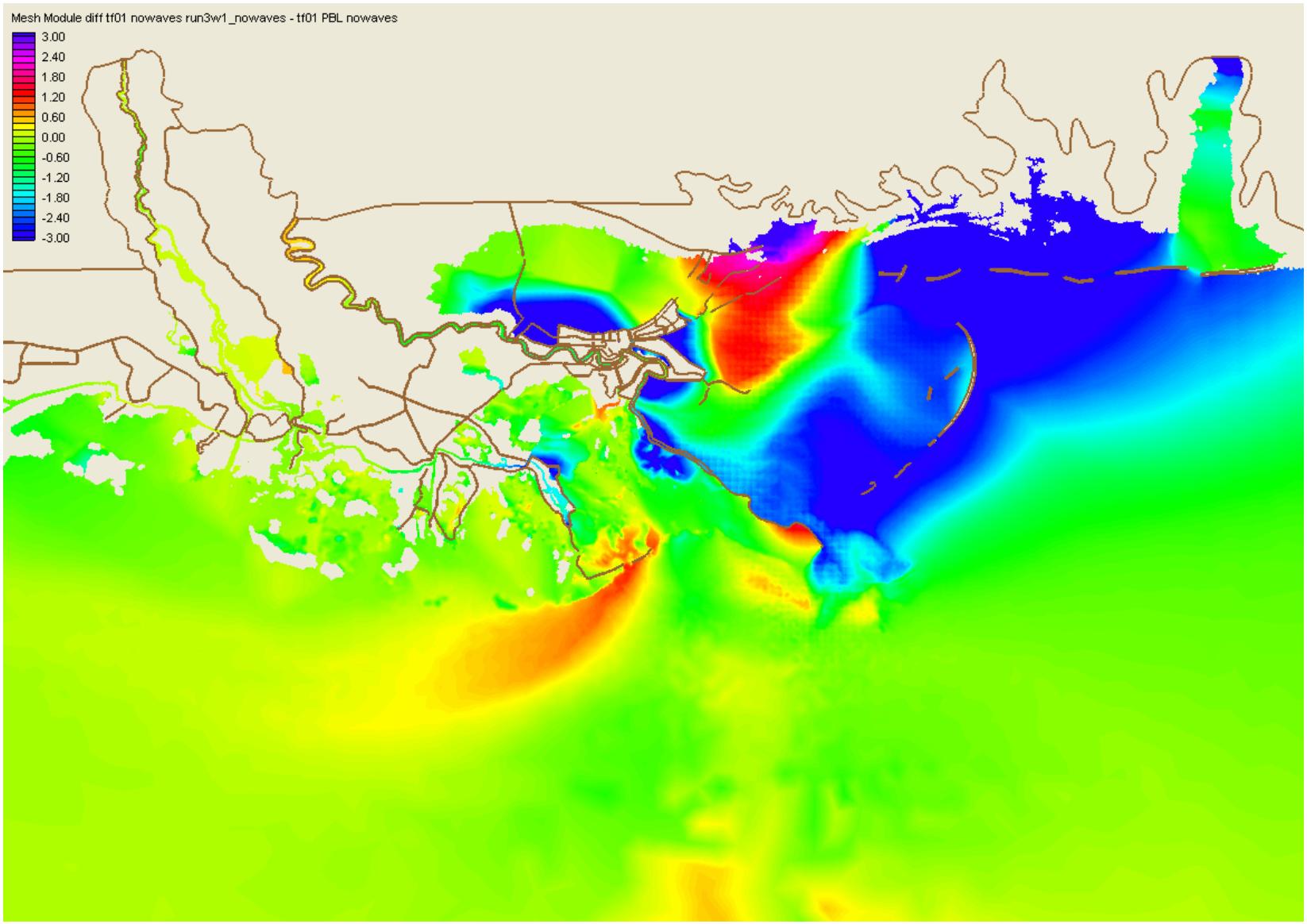
TF01 no tides – with tides

Effect of tides



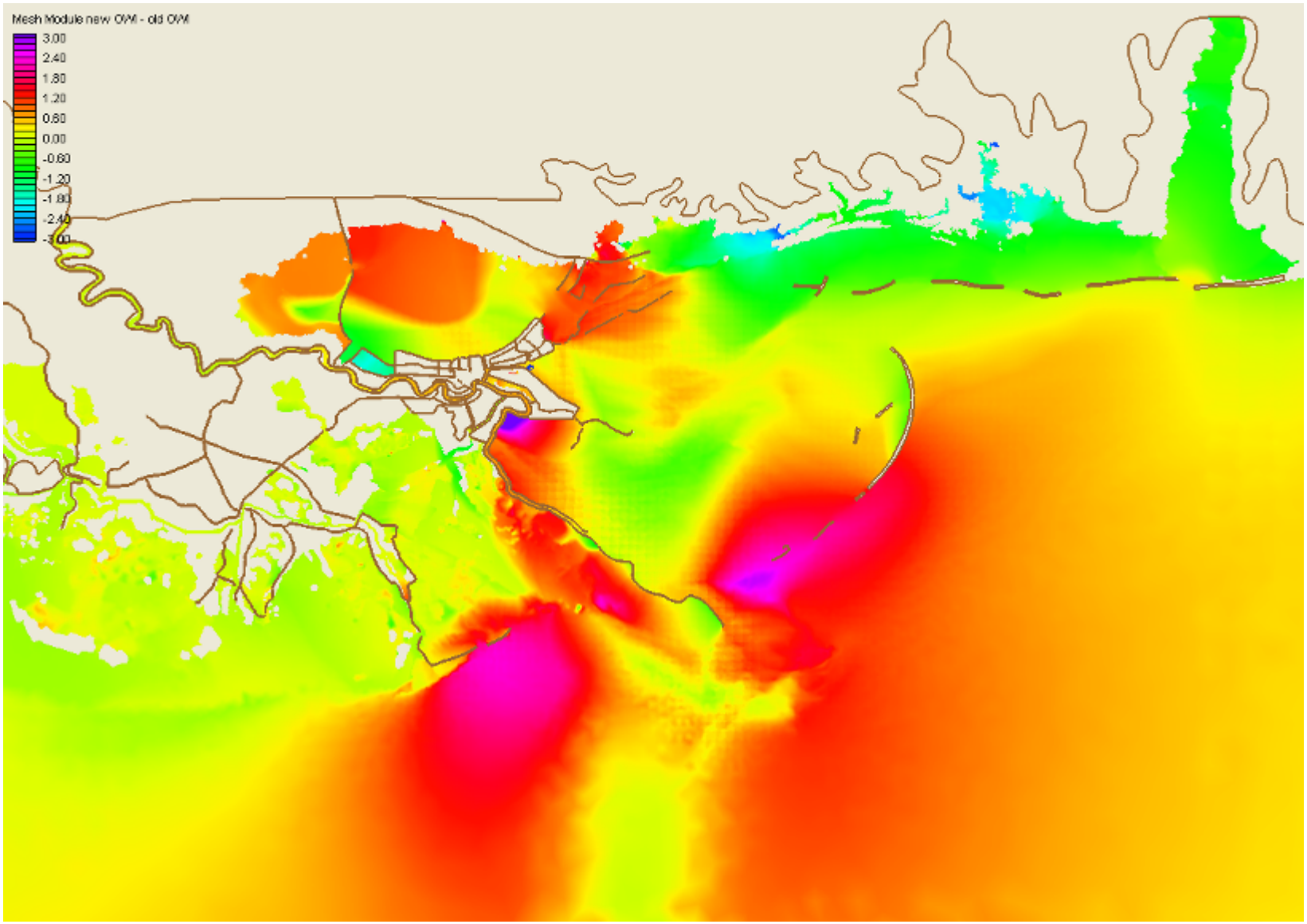
TF01 Prelim OWI winds – TF01 PBL winds (no waves)

Effect of wind models



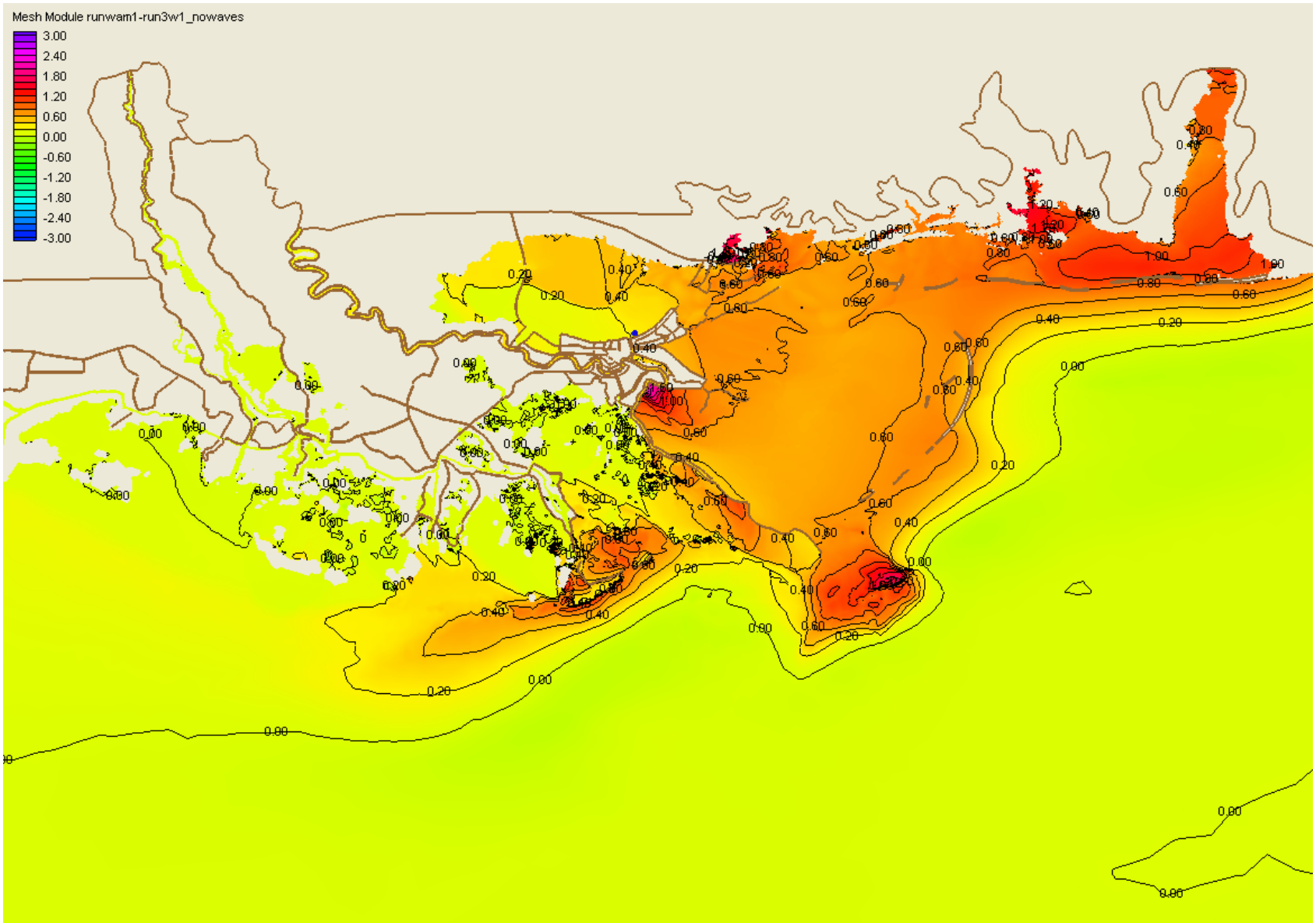
TF01, final OWI – TF01, prelim. OWI (no waves)

Effect of revision of OWI winds



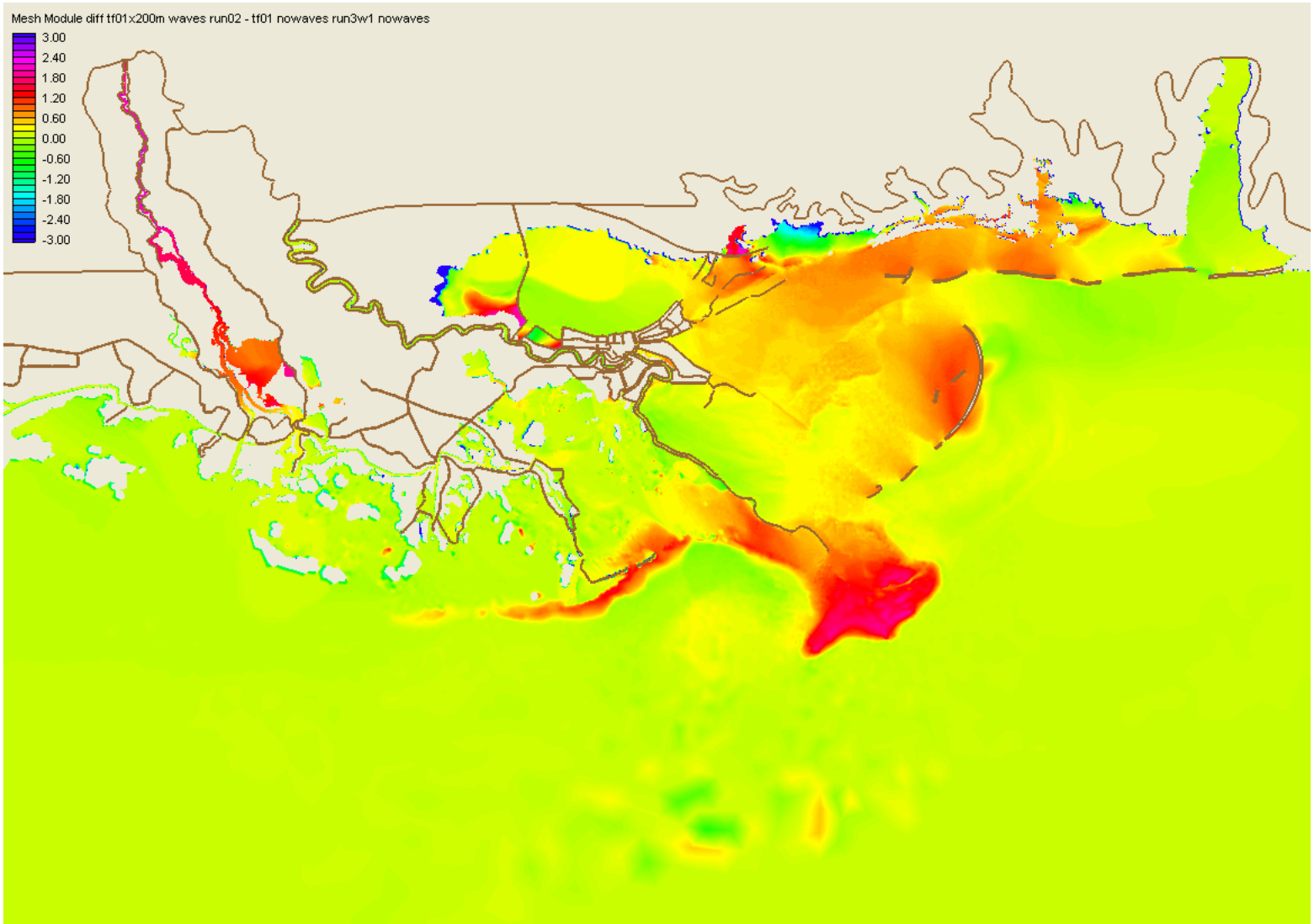
TF01, OWI, WAM waves – TF01, OWI, no waves

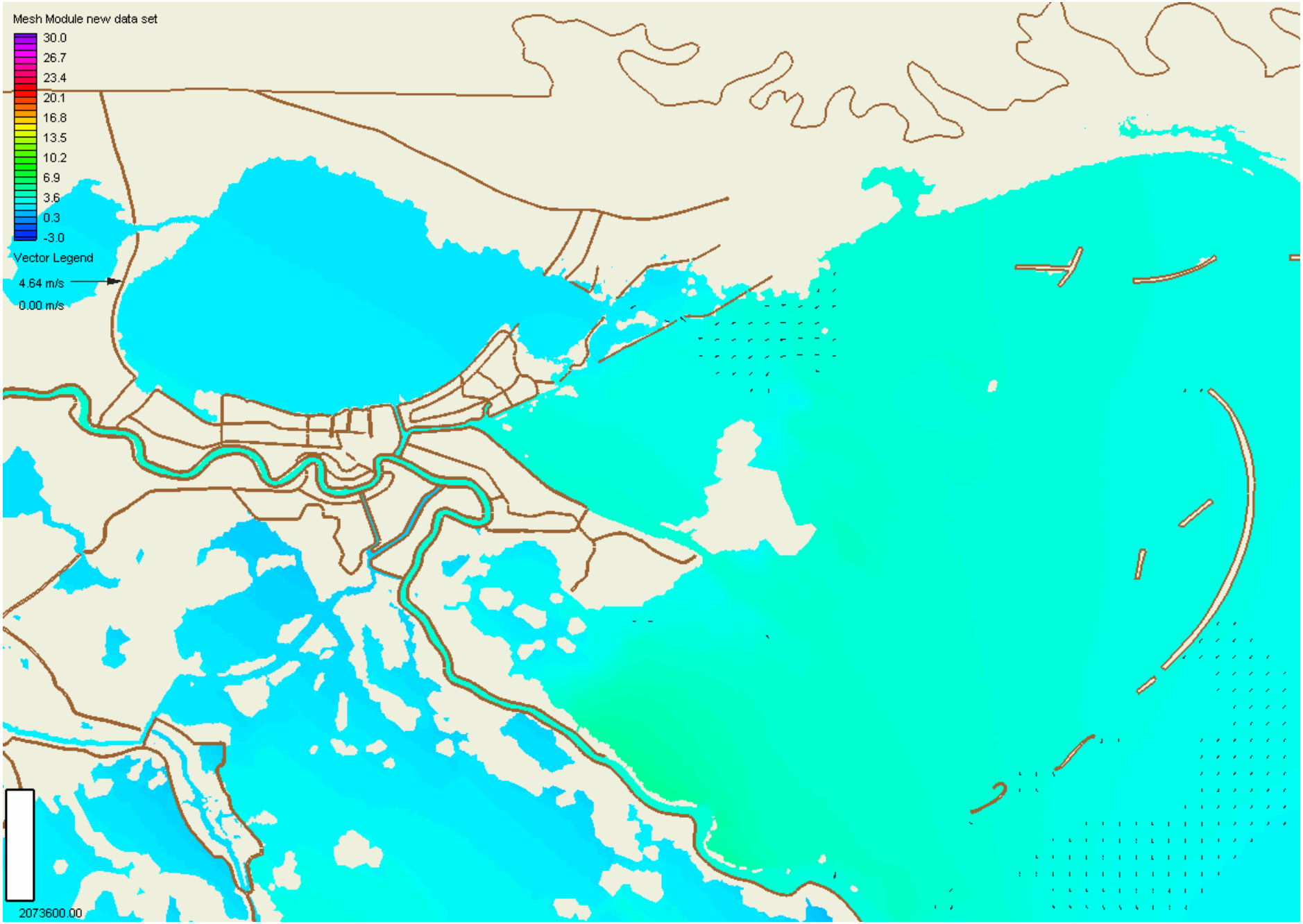
Effect of WAM



TF01x1 OWI winds + 200m-waves – TF01 OWI winds no waves

Effect of ST-WAVE waves + refined grid




Mesh Module new data set
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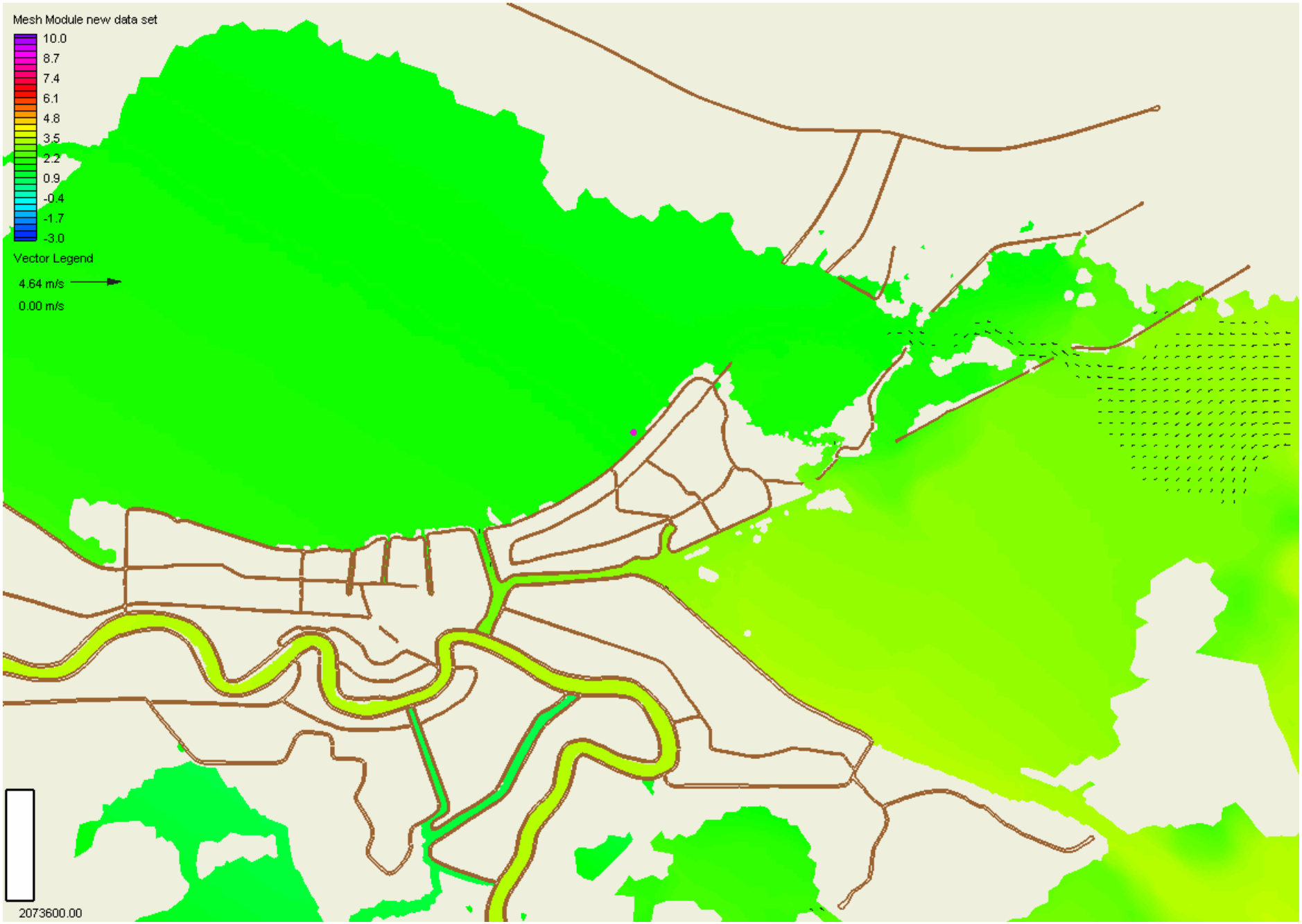
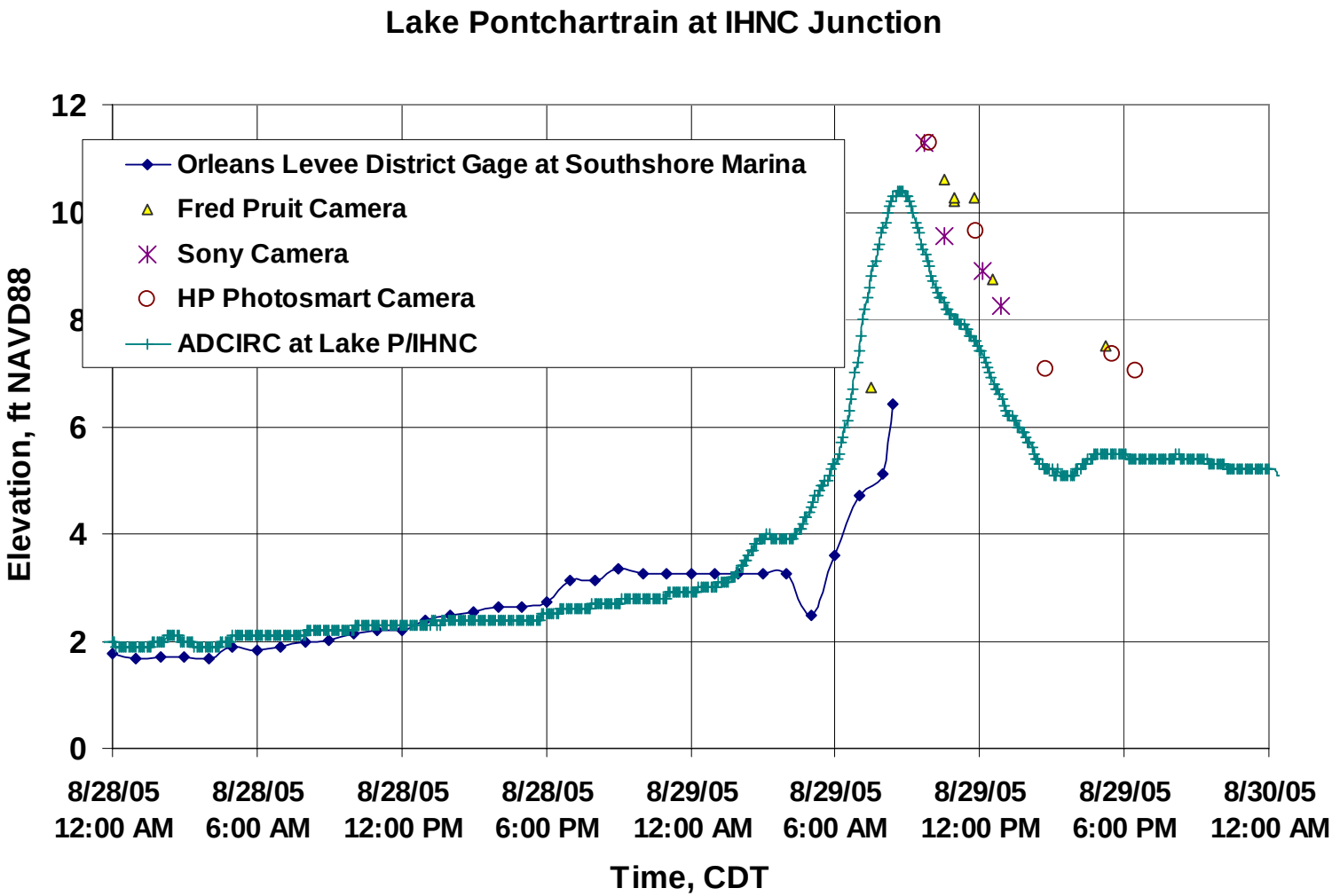
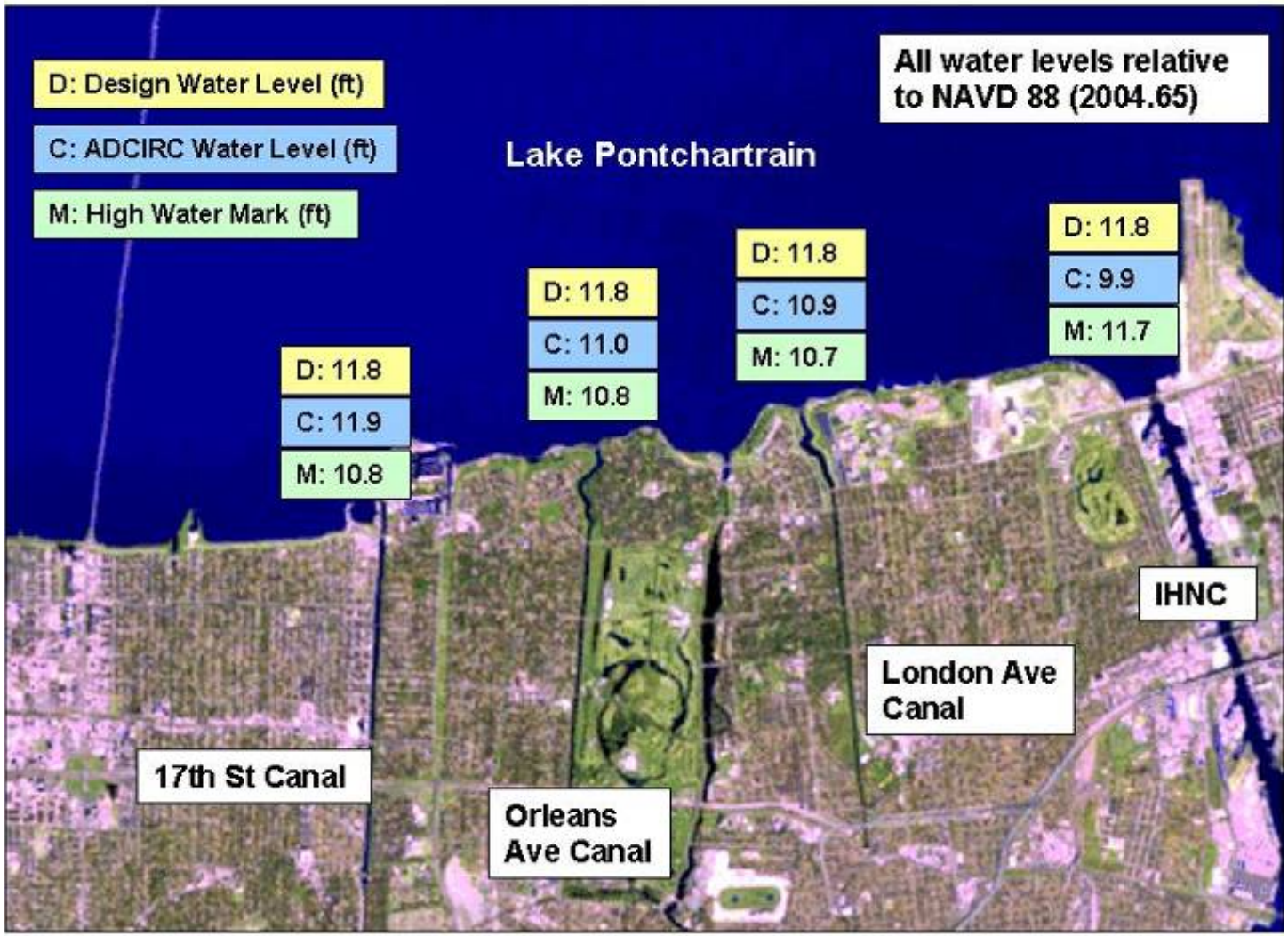
23.4
20.1
16.8
13.5
10.2
6.9
3.6
0.3
-3.0
Vector Legend
4.64 m/s
0.00 m/s
2073600.00


Mesh Module new data set
10.0
8.7
7.4
6.1
4.8
3.5
2.2
0.9
-0.4
-1.7
-3.0
Vector Legend
4.64 m/s
0.00 m/s
2073600.00

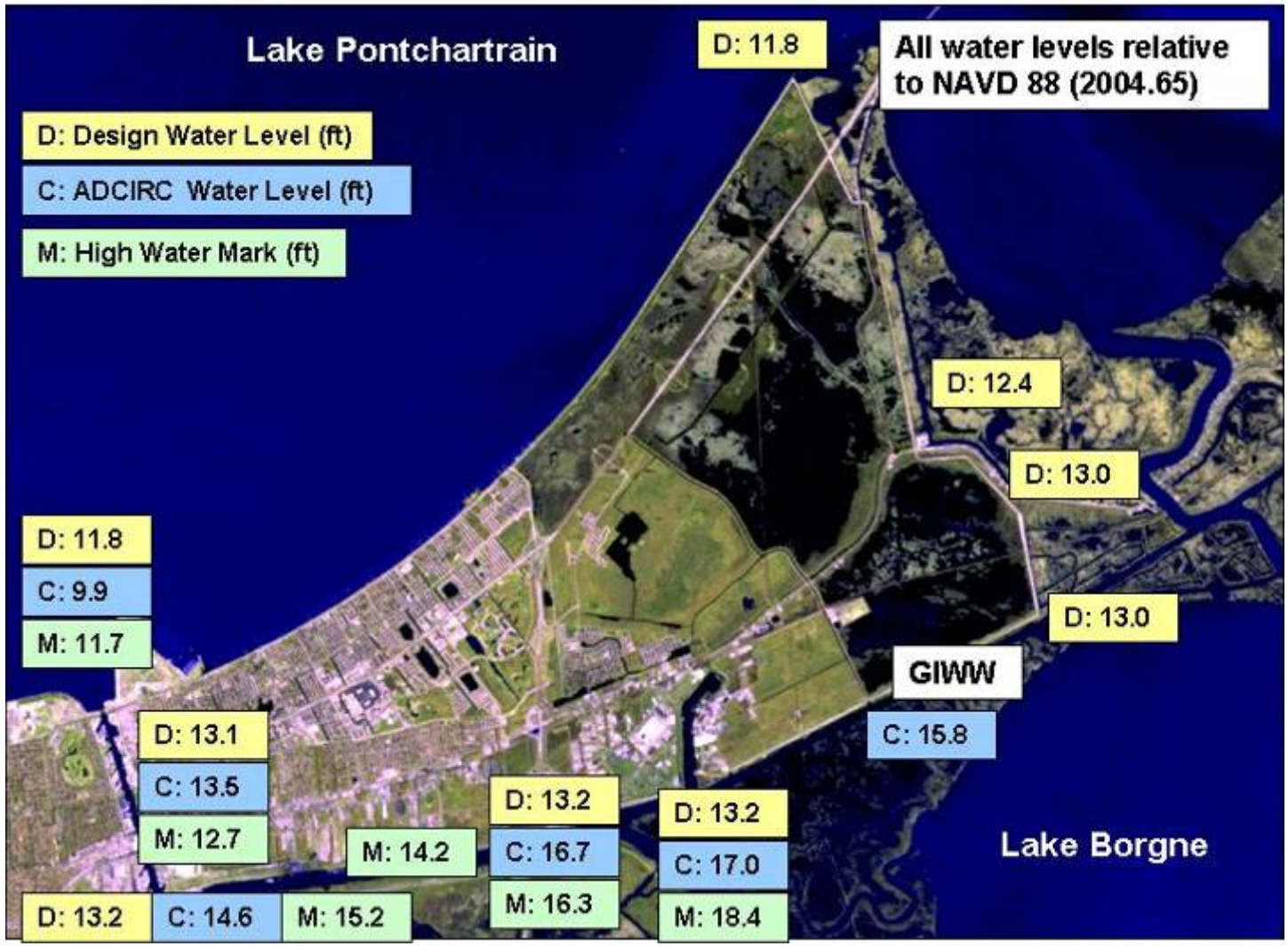
Preliminary Comparison to Hydrographs



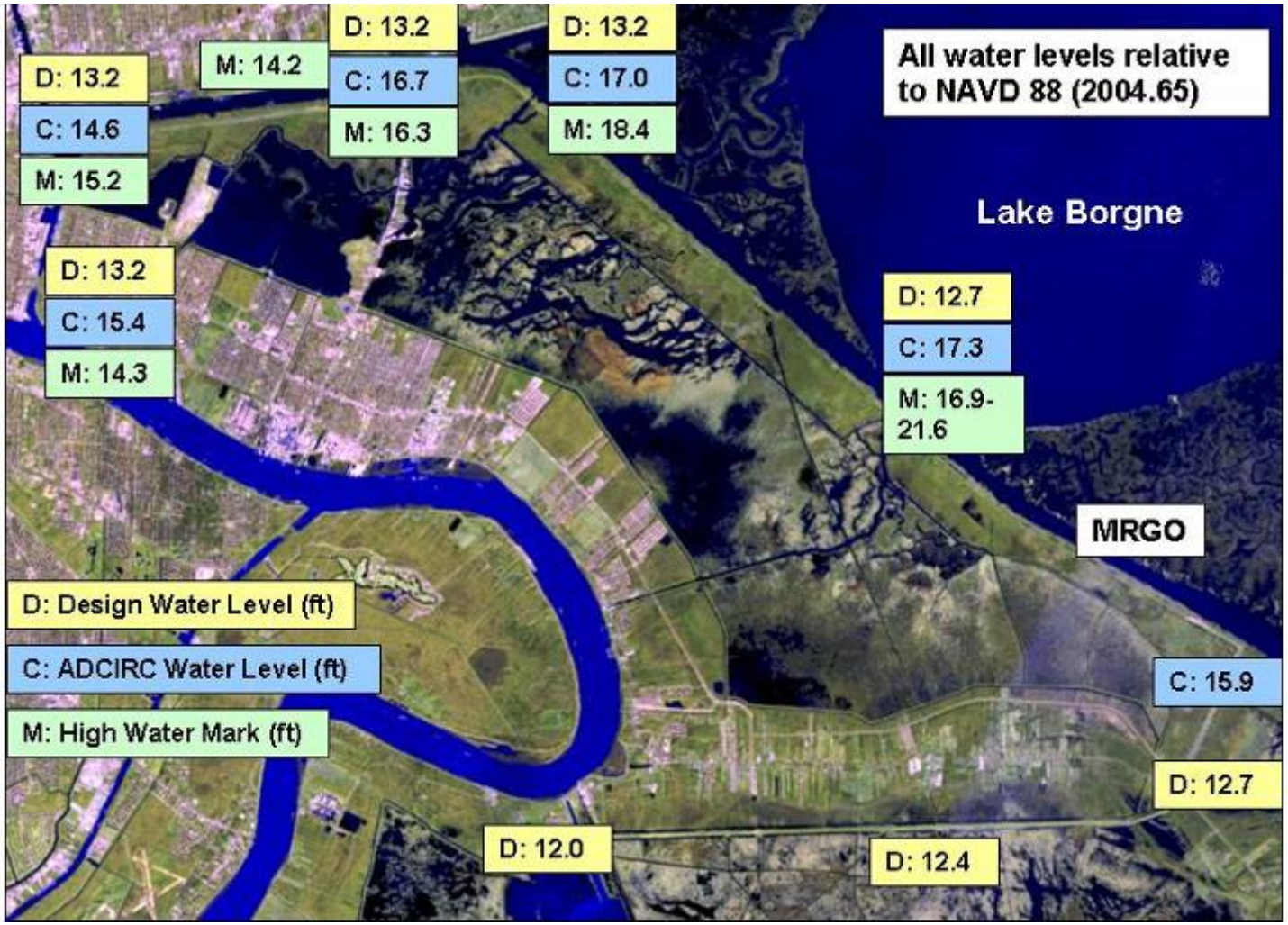
Peak Water Level Conditions (Comparison: Katrina and Design Values)



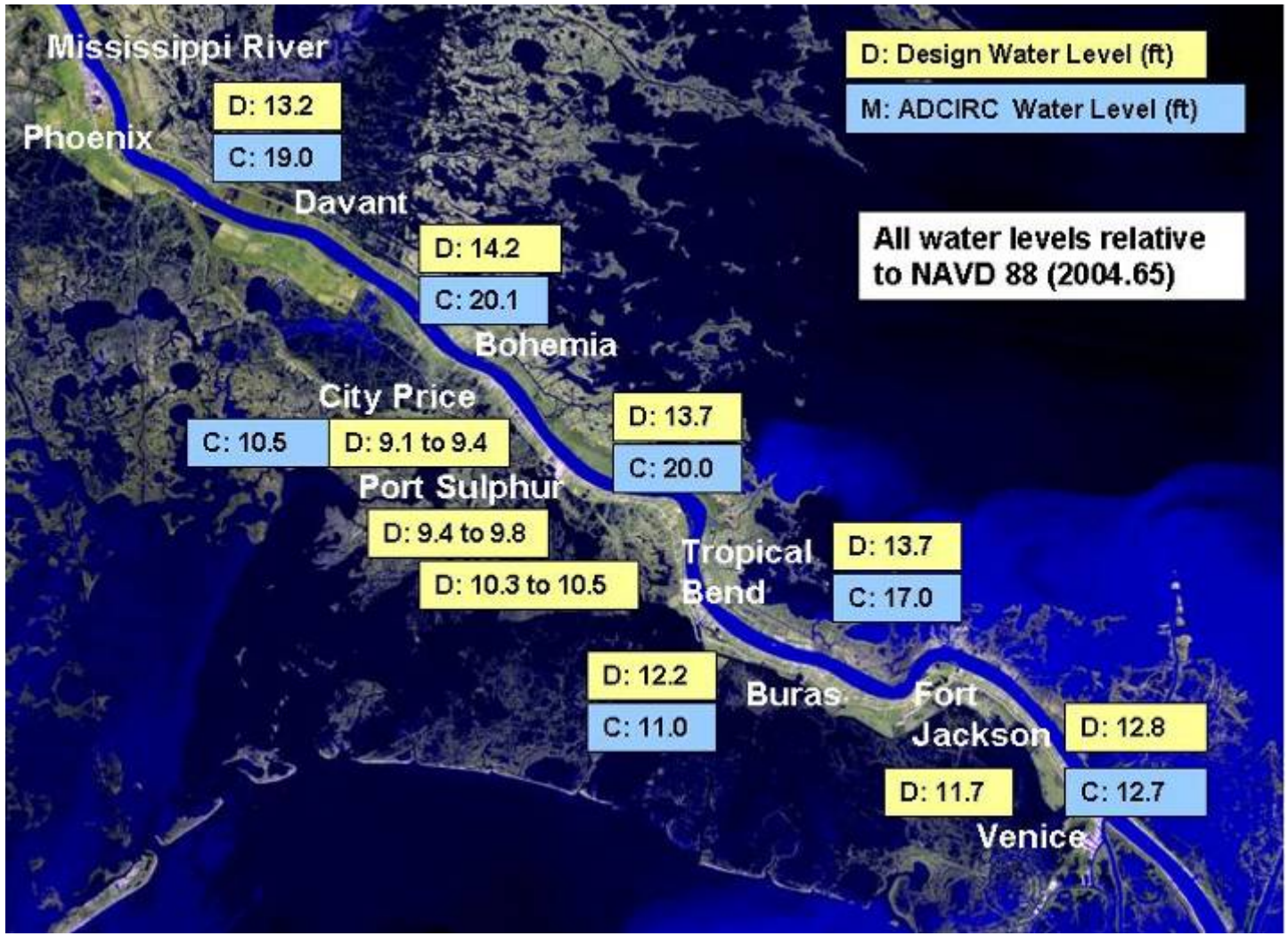
Peak Water Level Conditions (Comparison: Katrina and Design Values)



Peak Water Level Conditions (Comparison: Katrina and Design Values)



Peak Water Level Conditions (Comparison: Katrina and Design Values)



The Way Ahead

- Mesh resolution is key
  - Refine entrances, canals, waterways, and lakes
  - Add more levees and roads
- Improve bathymetry and topography (Lidar)
- Couple to wave models (ST-WAVE 4 grids)
  - Wave radiation stress
  - Modify bottom stress