Developing the ADCIRC Grid for the South Carolina Storm Surge Project

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URS

Summary

- ADCIRC Study Overview
- Topographic Data
- Bathymetric Data
- Grid Development Overview
- Challenges

ADCIRC Study Overview

- SCDNR - FEMA CTP Program
- Initiated in late 2007
- Study team includes:
  - FEMA
  - SCDNR
  - URS
  - AECOM
  - Project Steering Committee

Study Overview

ADCIRC results to be used for:

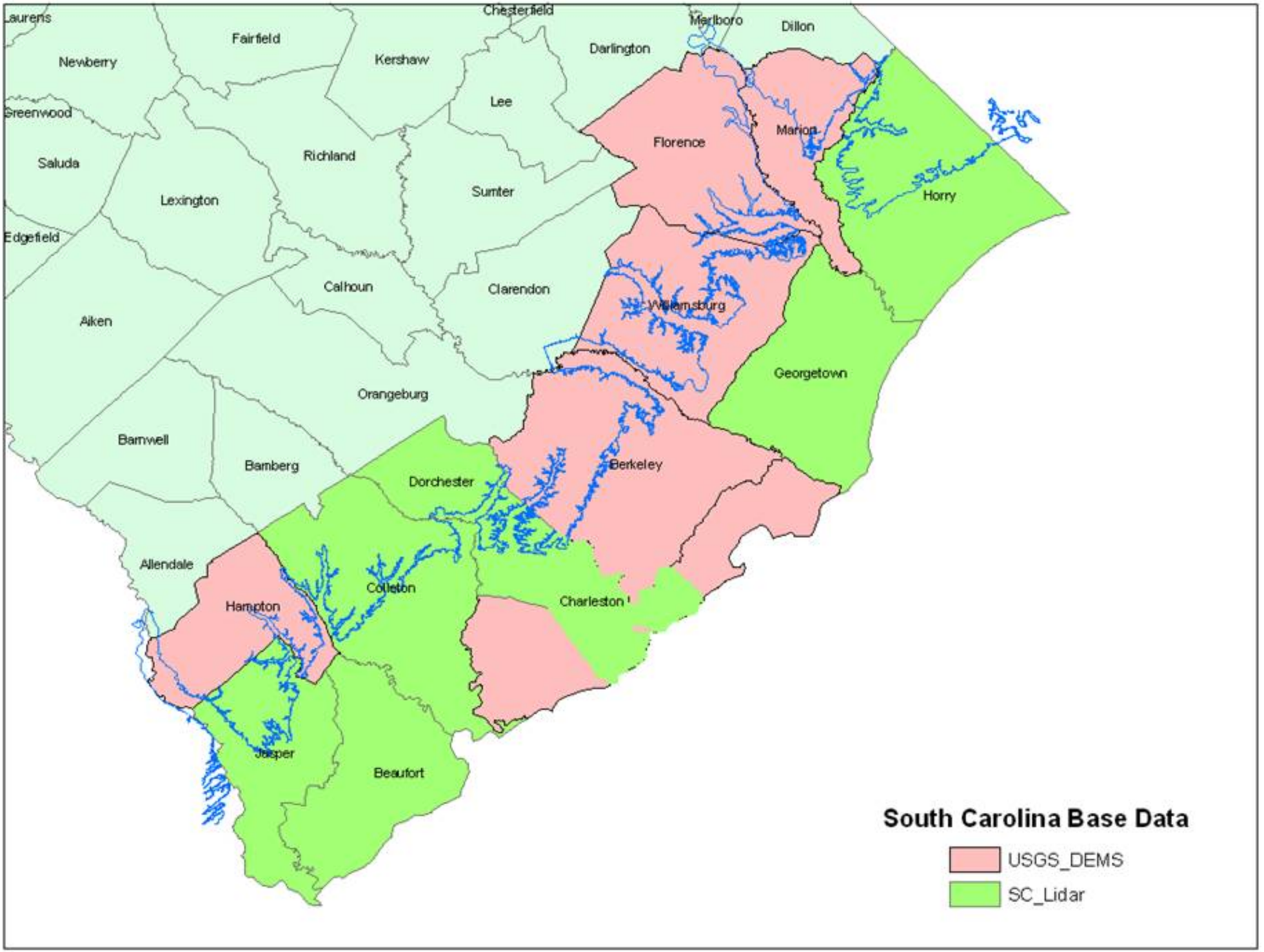
- Wave Height Analyses
- Flood Hazard Mapping
- Digital Flood Insurance Rate Map Production
- 6 Coastal Countywide Studies (187 miles)
- Updated Flood Hazard Mapping Due September 2010

Study Overview

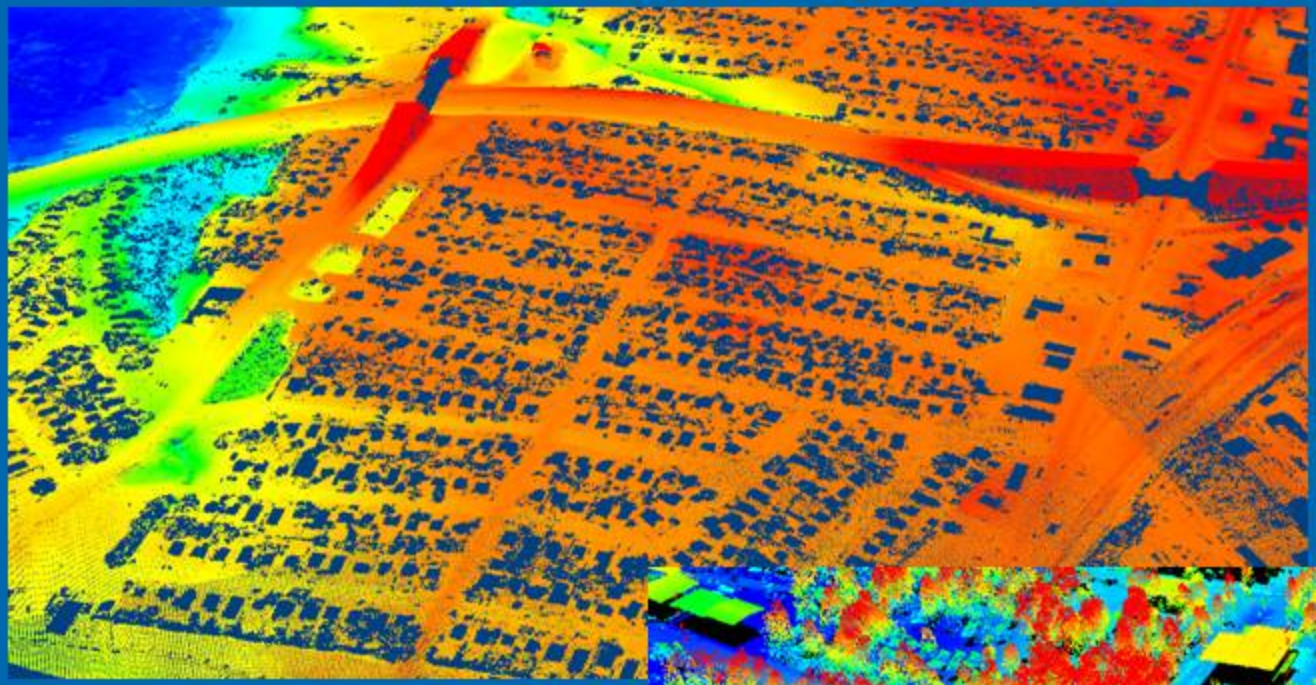
- ADCIRC Model Development
  - ADCIRC Grid – March 2009
  - Validation Runs – July 2009
  - Production Runs – March 2010

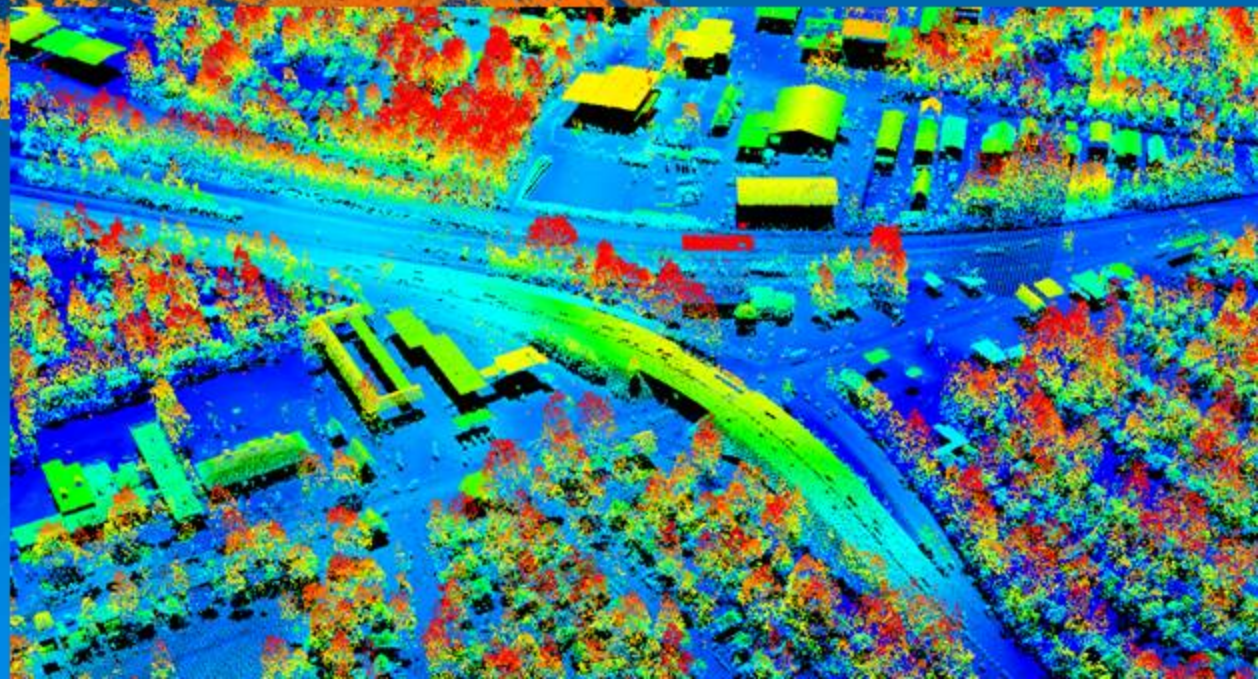
Topographic Data

- LIDAR
  - Counties
    - Beaufort, Charleston (western part), Colleton, Dorchester, Georgetown, Horry, Jasper
    - Flown in 2002 through 2007
  - Resolution
    - Input : ~3m x 3m gridded data
    - Output: 5m x 5m gridded data
- USGS
  - Counties
    - Berkley, Charleston (eastern part), Florence, Hampton, Marion, Williamsburg
  - Resolution
    - Input: 30m x 30m gridded data
    - Output: 30m x 30m gridded data

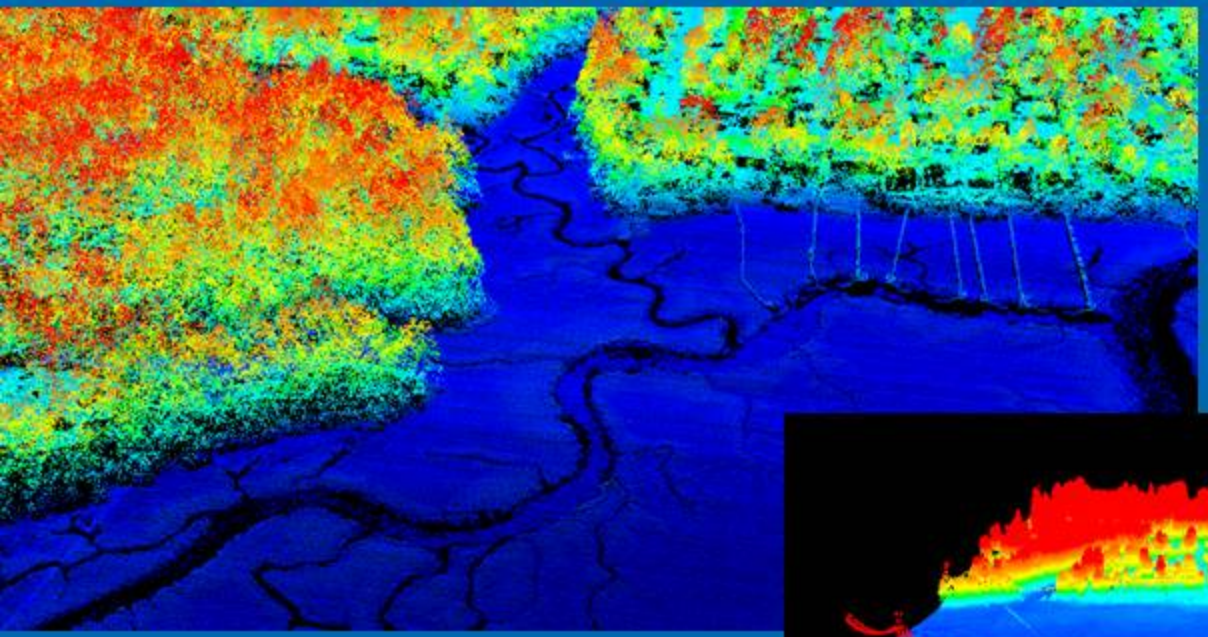

Laurens
Newberry
Fairfield
Chesterfield
Kershaw
Darlington
Marlboro
Dillon
Greenwood
Saluda
Lexington
Richland
Lee
Sumter
Florence
Marion
Horry
Edgefield
Aiken
Calhoun
Clarendon
Williamsburg
Georgetown
Orangeburg
Barnwell
Bamberg
Dorchester
Berkeley
Allendale
Colleton
Hampton
Charleston
Jasper
Beaufort
South Carolina Base Data
USGS_DEMS
SC_Lidar

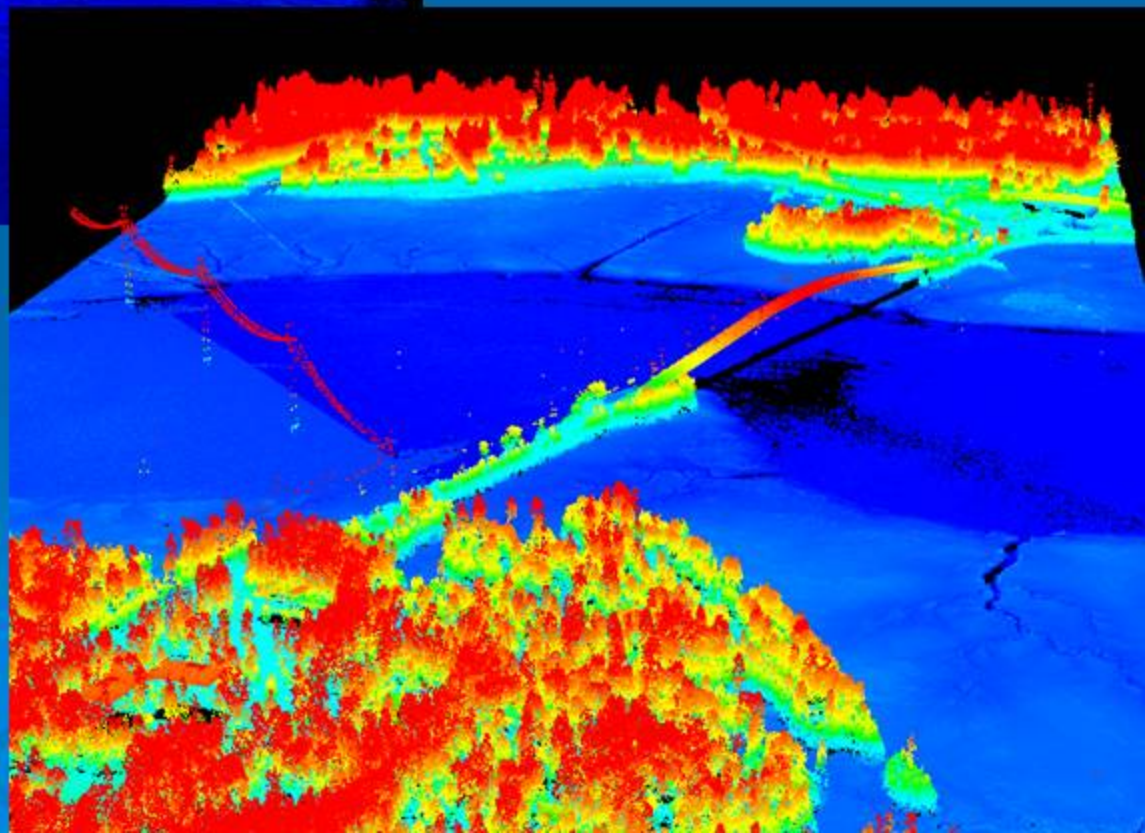
Sample LIDAR Data





Sample LIDAR Data





Bathymetric Data

SOURCES:

1. USACE Survey Data (point data)
2. NOAA - CSC Estuarine Bathy (DEM)
3. NOAA - NOS Survey Data (point data)
4. NOAA - NOS Electronic Nautical Chart Soundings (point data)
5. Other ADCIRC Grids (Hilton Head Grid → EastCoast 1995)

DATUM SHIFT:

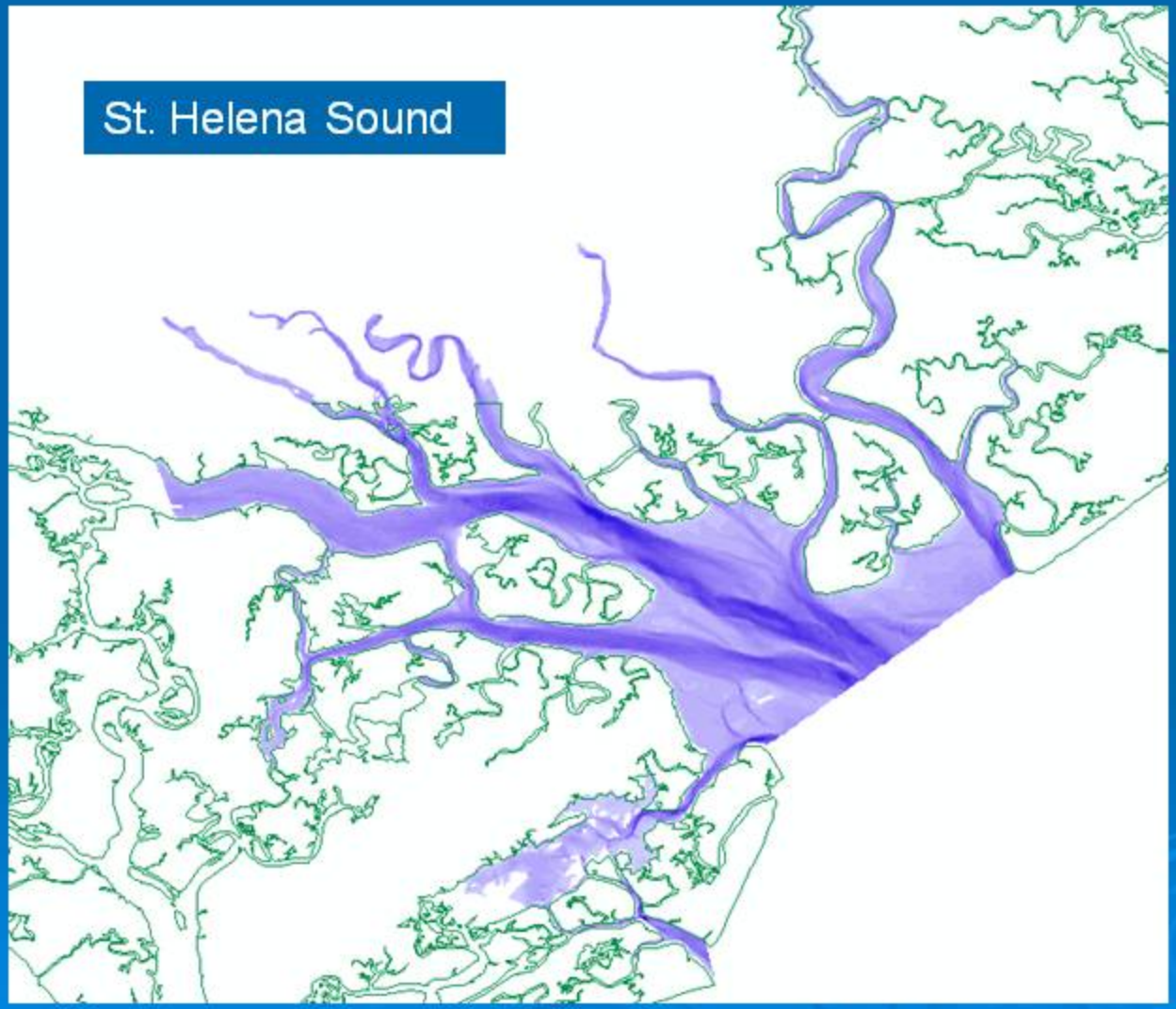
- MLW to NAVD88 = 0.97 meters
- MLLW to NAVD88 = 1.02 meters

USACE Survey Data

- Intercoastal Waterway & Charleston Harbor Surveys
- Mean Lower Low Water (MLLW) from 2007 & 2008

- DEMs gridded at 30 meters, MLW datum

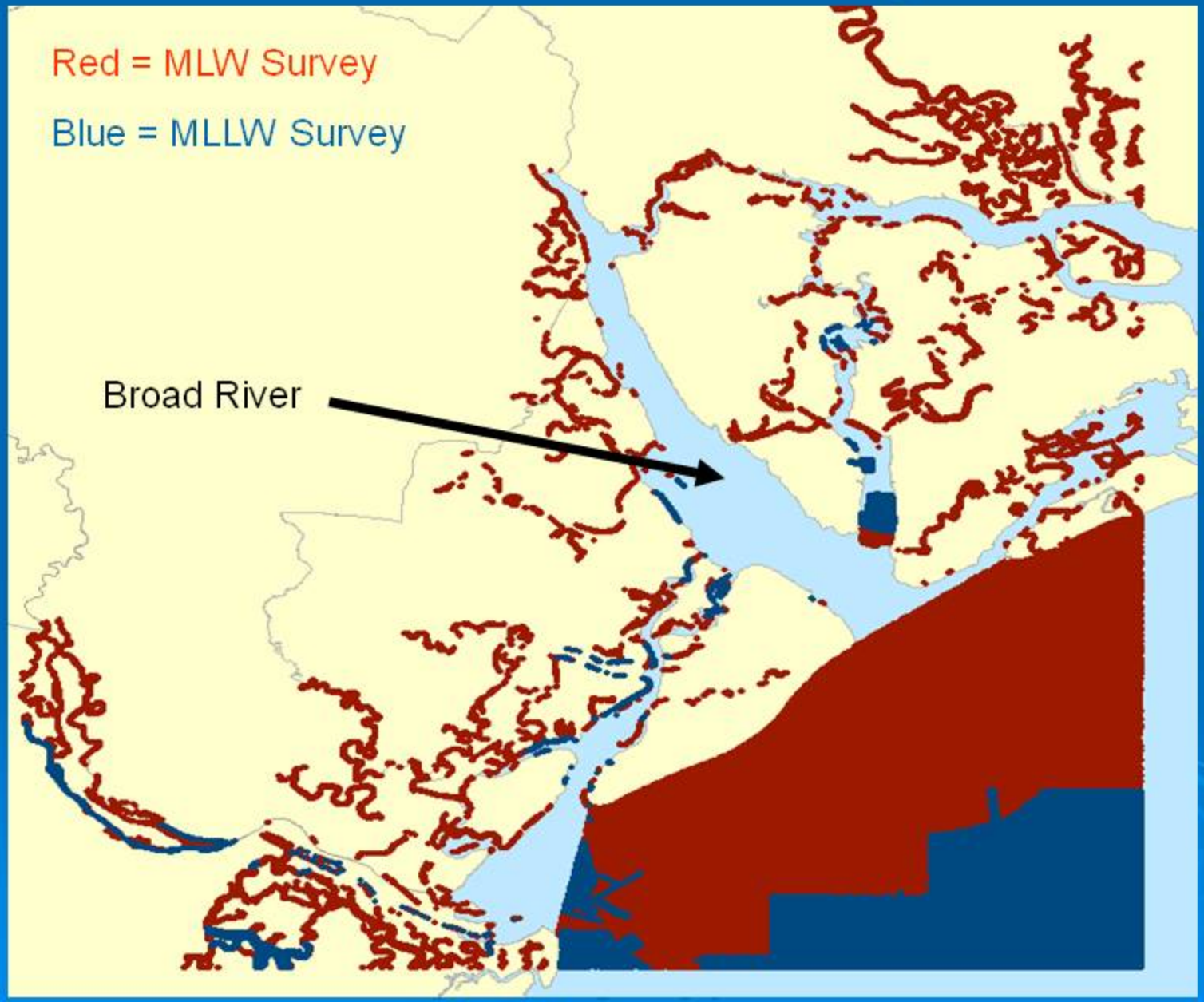
NOAA's ESTUARINE BATHYMETRY



NOAA – NOS Survey Data

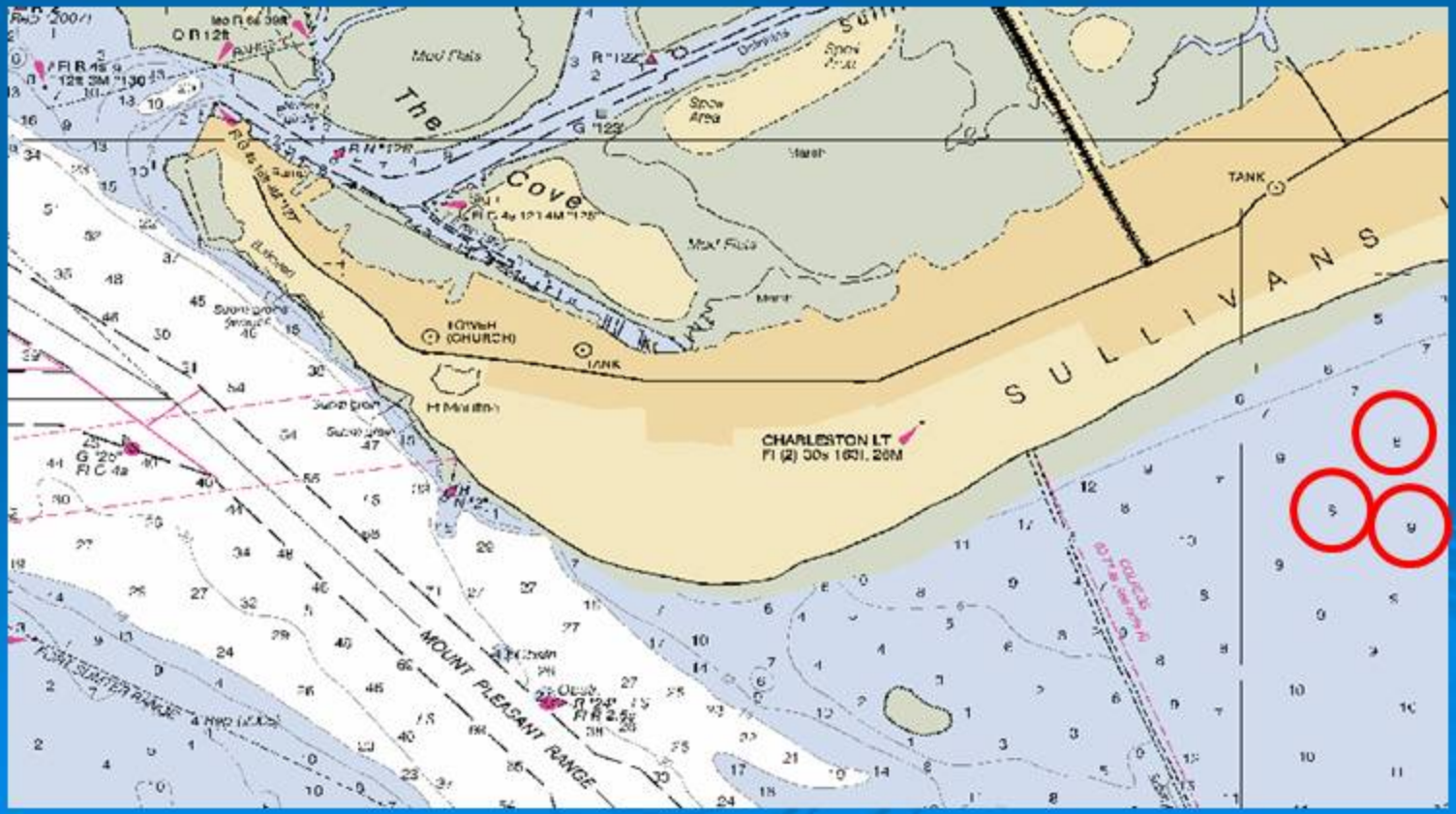
- Bathy Surveys from as far back as 1876
- Referenced to:
  - Local Low Water (LLW)
    - 14 surveys from 1876 to 1953 (eliminated)
  - Mean Low Water (MLW)
    - 239 surveys from 1886 to 1980
  - Mean Lower Low Water (MLLW)
    - 79 surveys from 1980 to 2005

NOAA – NOS Survey Data

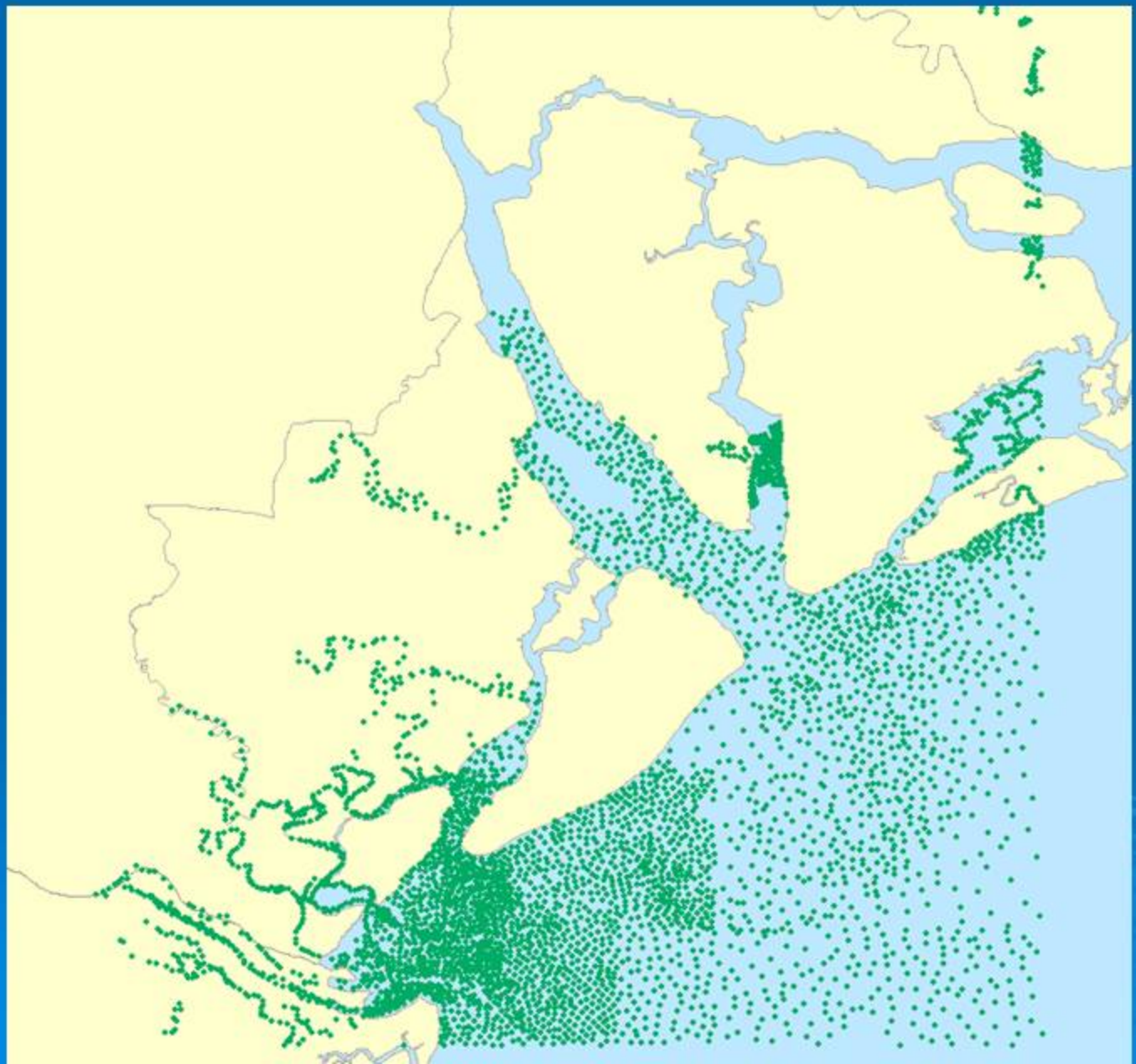


NOAA - NOS Electronic Nautical Chart Soundings

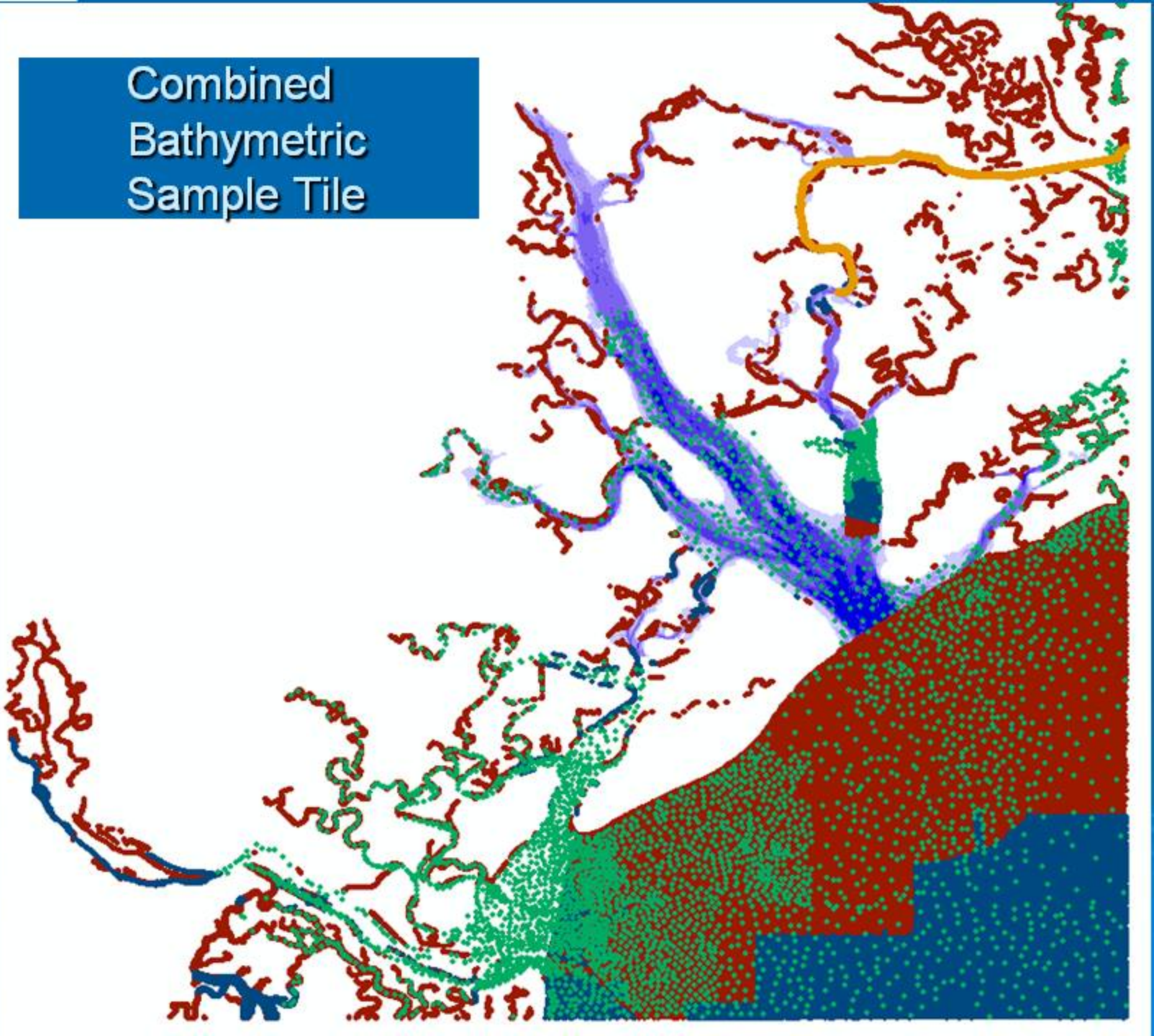
- Sounding data as shown on Nautical Charts
- Mean Lower Low Water (MLLW)



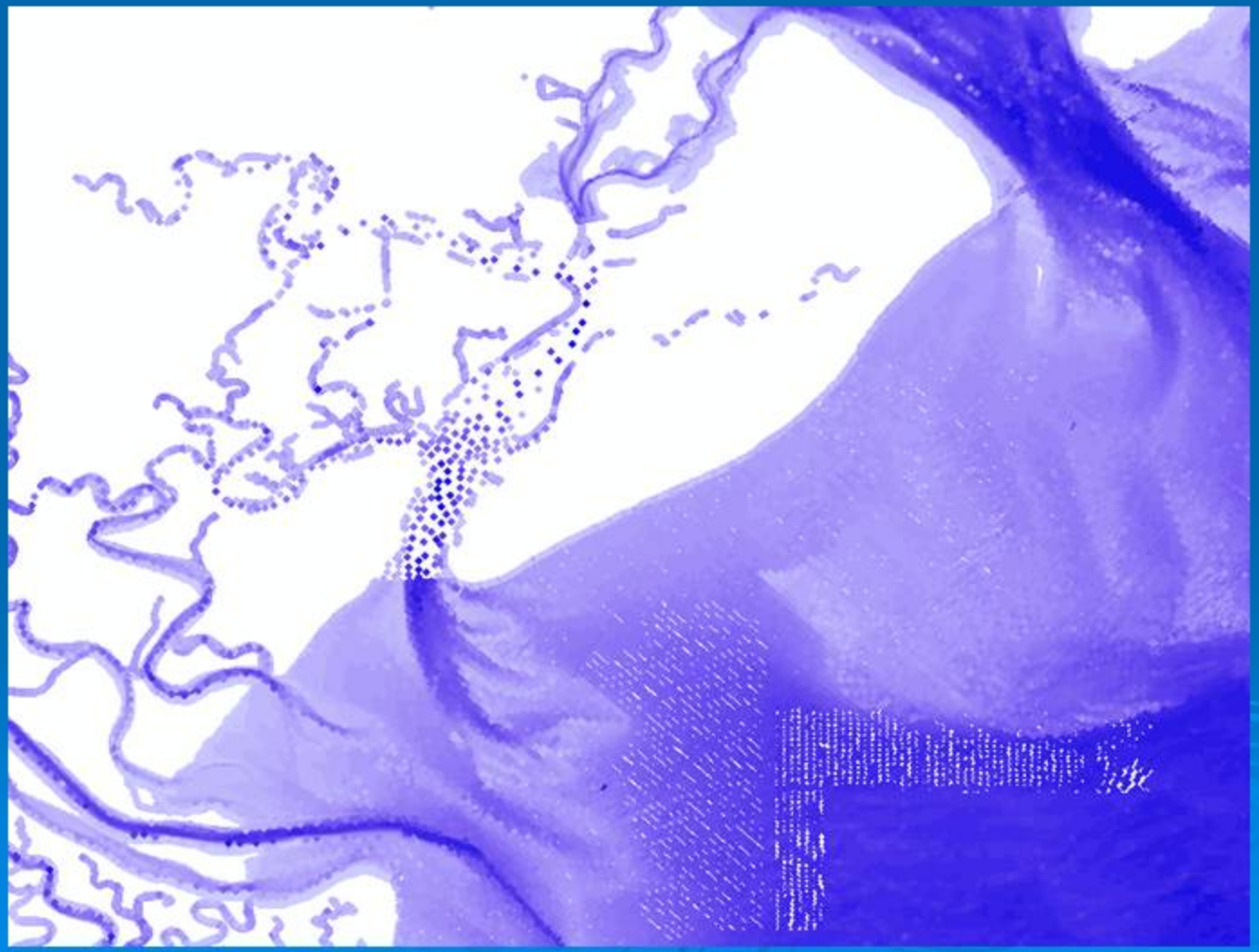
NOAA - NOS ENC Soundings



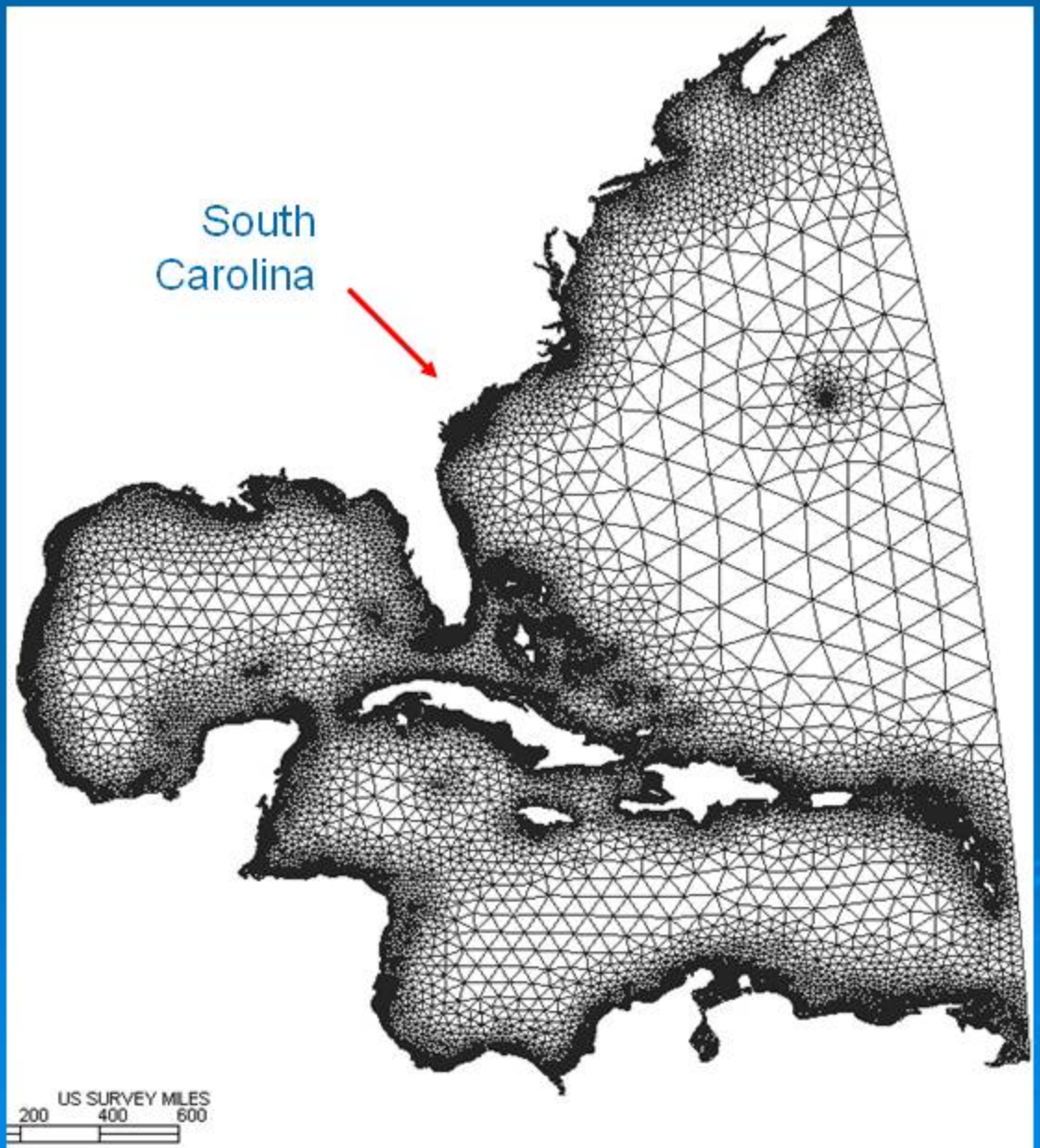
Combined Bathymetric Sample Tile



Bathymetric Data



Grid Development Overview



Grid Overview

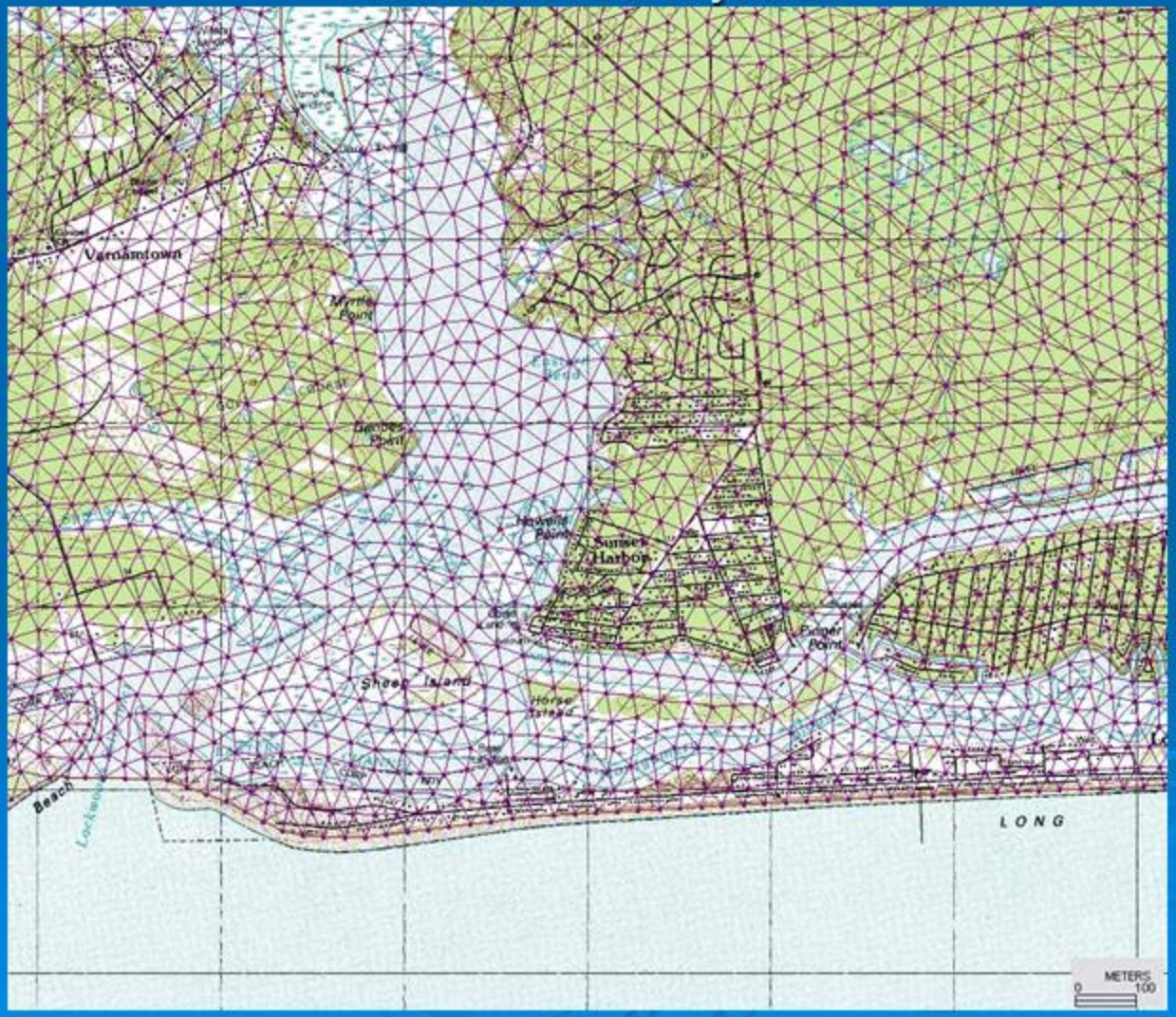
South Carolina Resolution

Little River Inlet

Minimum Resolution approx. 100m

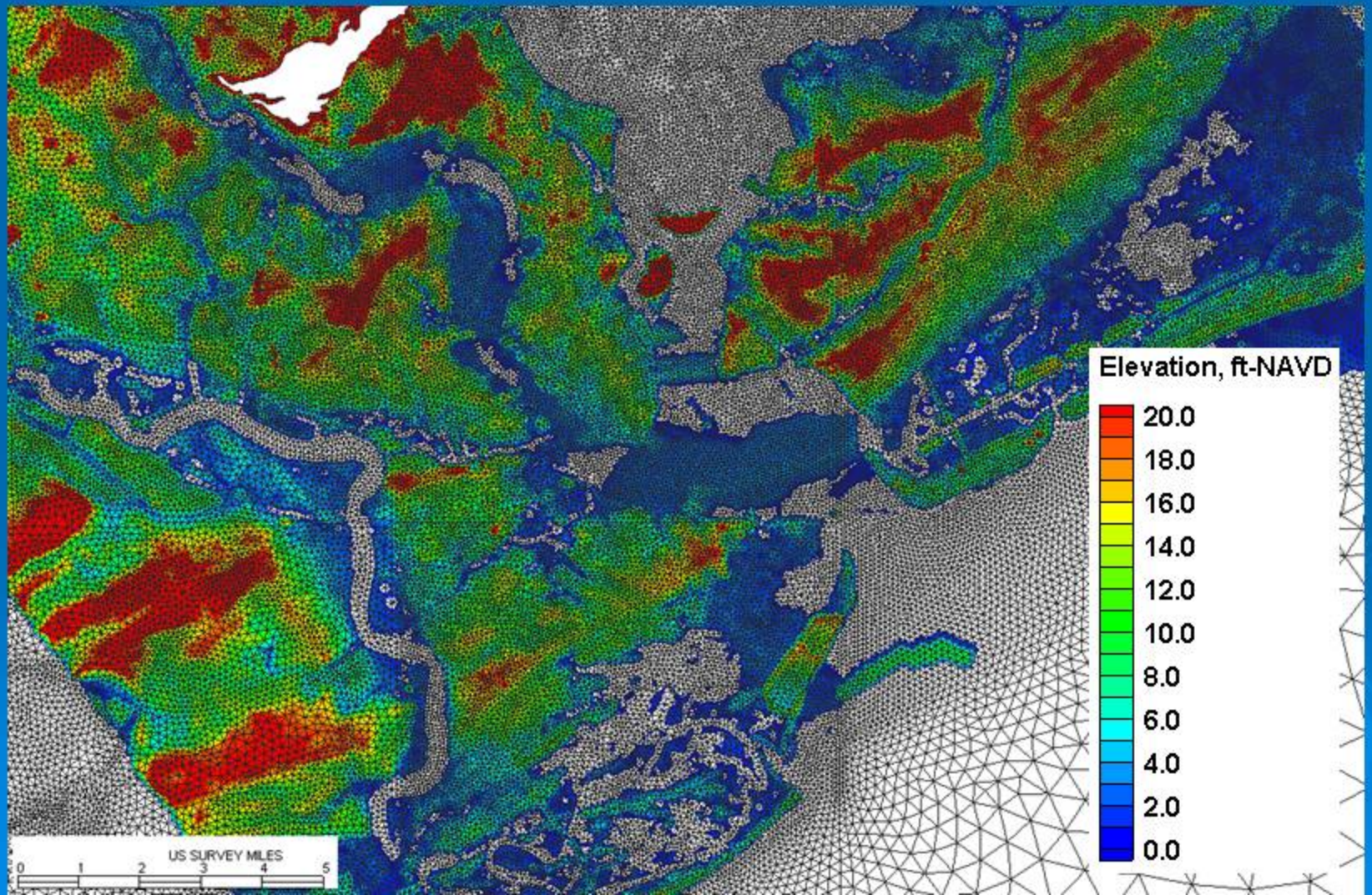
South Carolina Resolution

Lockwoods Folly Inlet

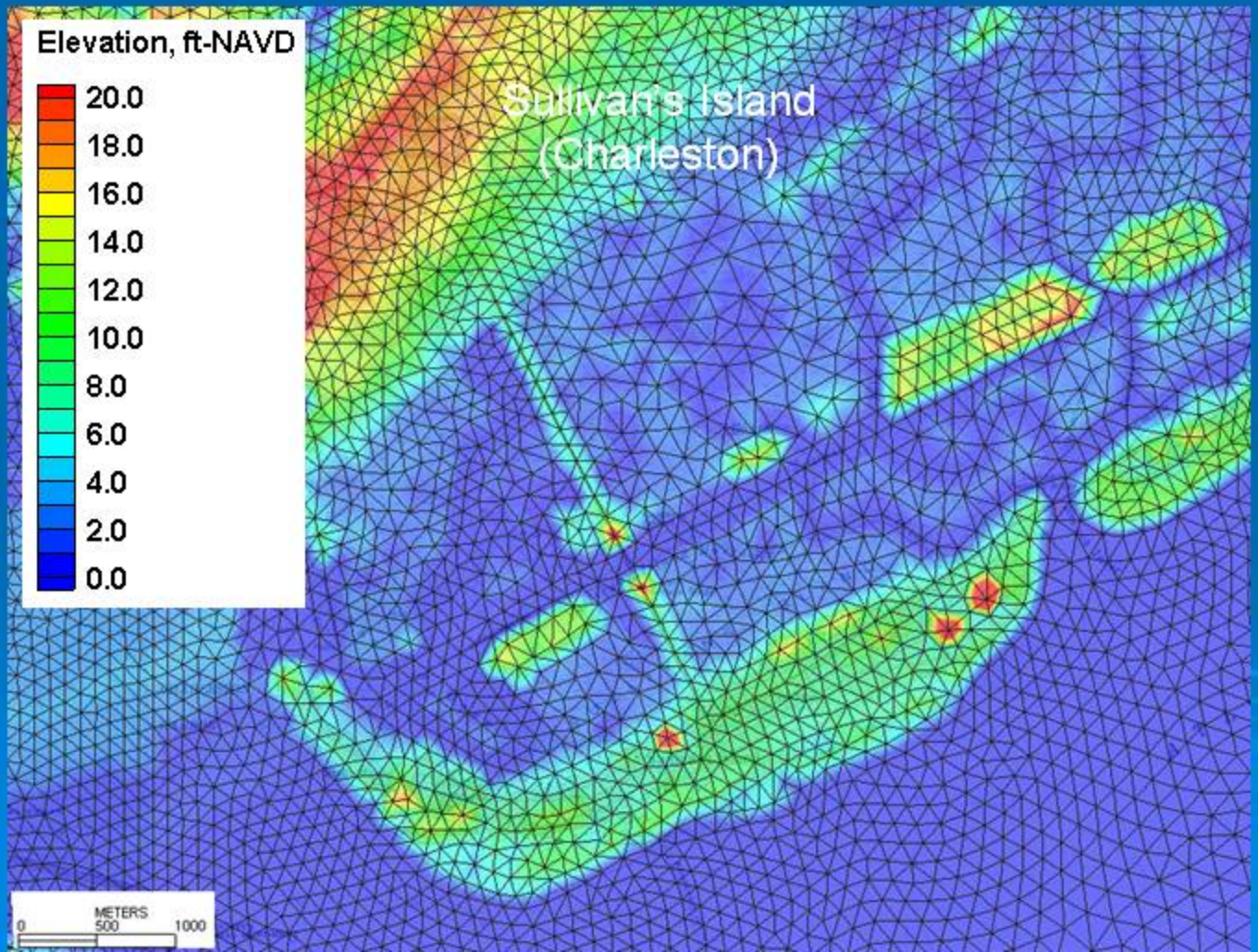


Minimum Resolution approx. 100m

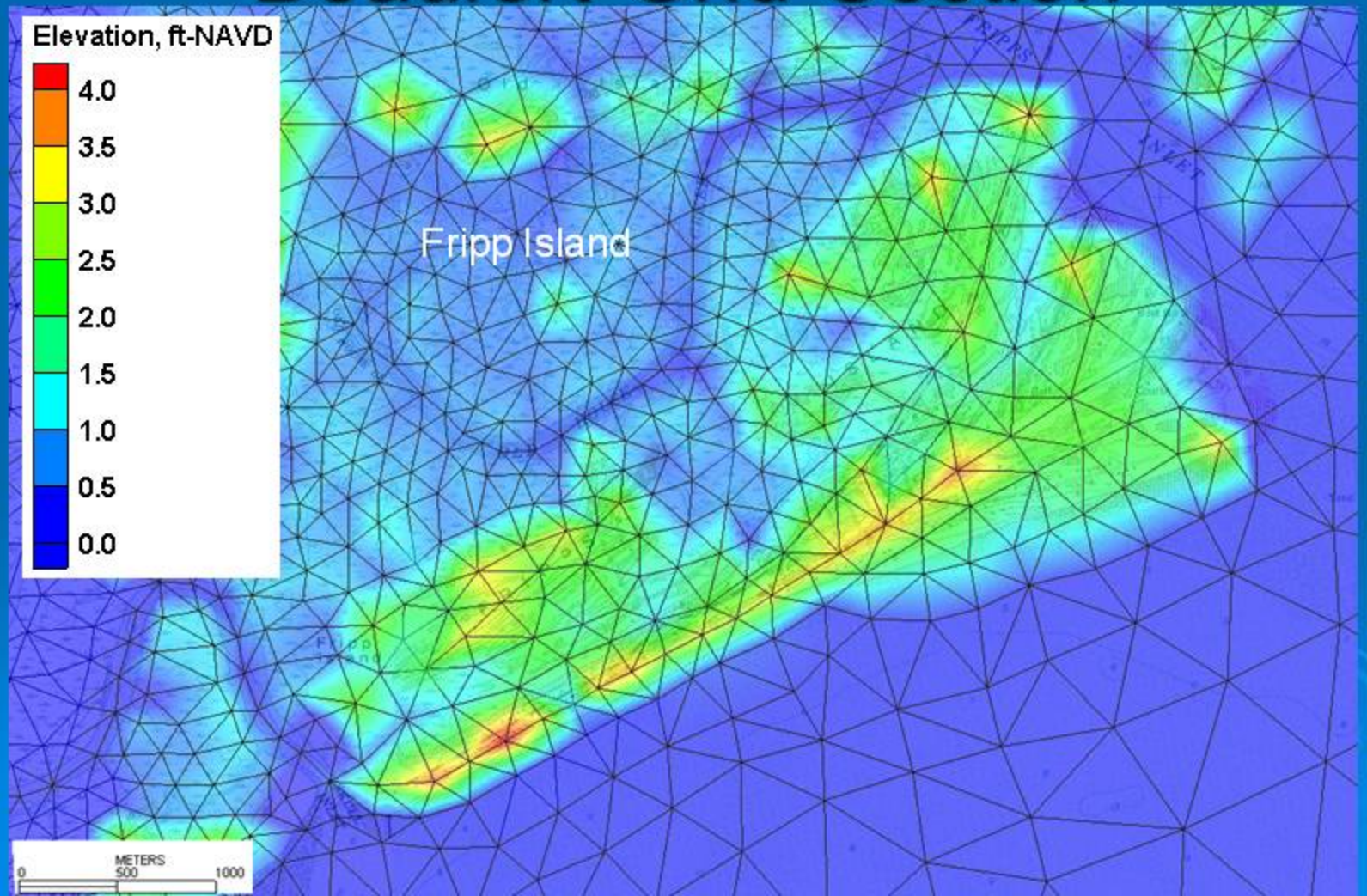
Charleston Grid Section



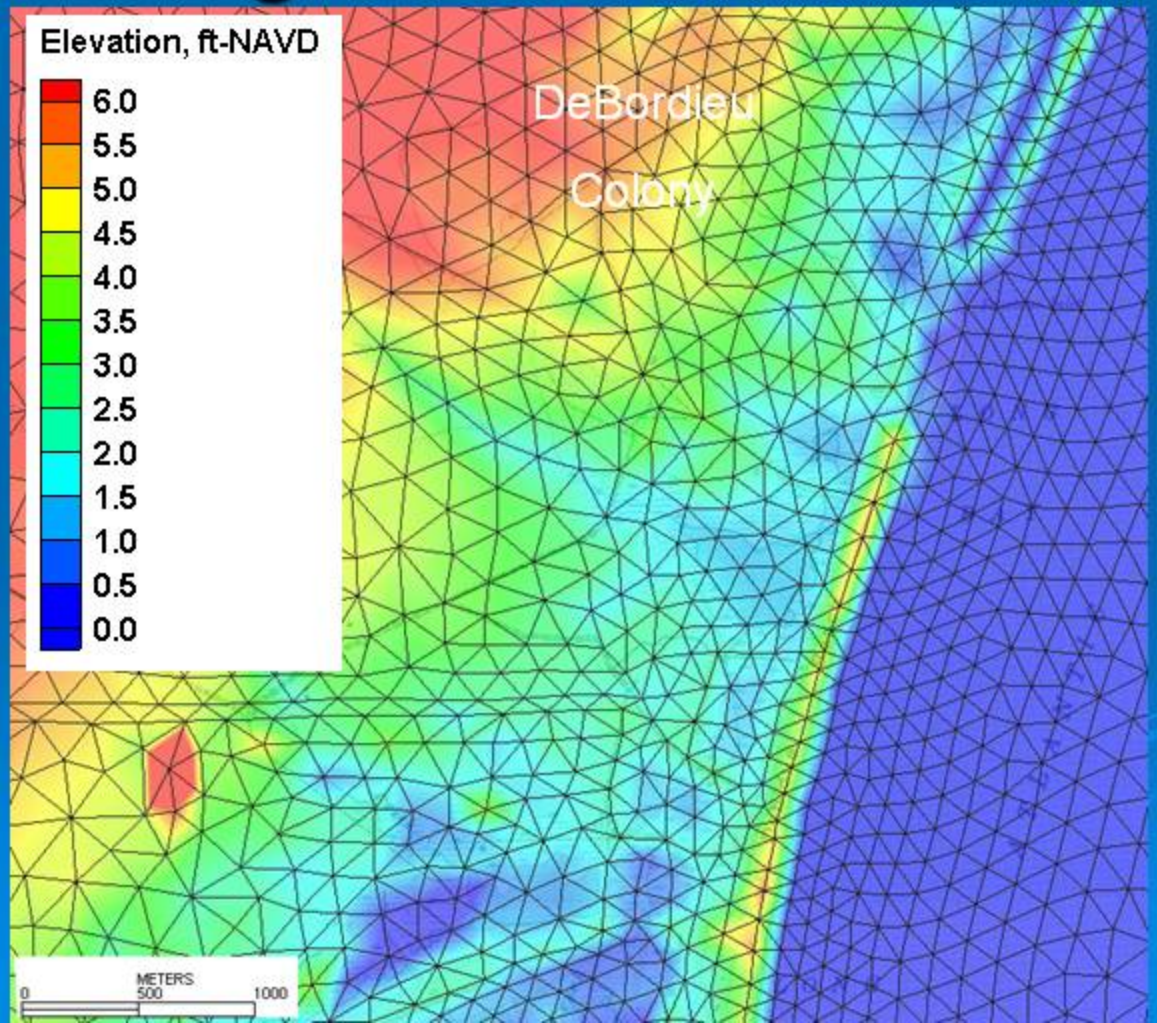
Close View of Charleston Grid Section



Fripp Island View of Beaufort Grid Section



Close View of Georgetown Grid Section



Grid Development Overview

- Completed:
  - Constructed base ADCIRC grid from topo maps (~450k nodes with minimum 100 m grid node spacing)
  - Field Recon trip
  - Developed interpolation programs: topo complete for Beaufort, Charleston, Georgetown
  - Compared grid topo with LIDAR data and field notes

Grid Development Overview

- In Process:
  - Merge LIDAR and sparse bathy data
  - Add bathy data to grid
  - Verifying NC-SC overlap
  - Perform volume adjustments (areas flagged in grid)

Challenges – ADCIRC Model

- State-of-the-Art Model
- ADCIRC Grid Data Sources
- Seamless Topo/Bathy
- Other challenges

Challenges – ADCIRC Model

- State-of-the-Art models are complex, but can provide increased accuracy through:
  - Large domains
  - Complex grids
  - Detailed parameterization
  - Sub-grid features (e.g. levees)
- Therefore, the data resources should match complexity

Challenges – ADCIRC Grid

Topography

- Need to find and combine sources from various federal and local agencies (USGS, States, Communities)

Issues:

- No data
- Multiple data sources

Challenges – ADCIRC Grid

- Bathymetry
  - Need to find and combine sources from various federal and local agencies (NOAA, USACE, State Authorities)
- Issues:
  - No data
  - Multiple data sources

Challenges – Seamless Topo/Bathy

Seamless Bathy/Topo

- Need to adjust bathymetric datums (MLW, MSL, etc.) to orthometric datum (NAVD88) to create a seamless data set

Issues:

- Conversion process
- Zero contour?

Challenges – Seamless Topo/Bathy

Datum Conversion of Bathy Data to NAVD88

- NOAA CSC recommends:
  - VDatum
  - Harmonic Constant Datum (HCD) Method
  - Constant Conversion
  - No Conversion

Challenges – Seamless Topo/Bathy

- VDatum application does not exist for SC
- HCD method requires hydrodynamic model
  - Costly
  - Schedule impacts
- No conversion alternative
  - Bathymetric data is not adjusted from the MLLW or the MLW datum to NAVD88
  - Approx 1 meter difference in SC

Challenges – Seamless Topo/Bathy

Interpolation of Bathymetric data

- Convert the bathymetric data from the original datum (either MLLW or MLW) to NAVD88

➢ NWLON stations used

- National Water Level Observation Network
- Network of 175 long-term, continuously operating water level stations
- Accurate and most reliable stations
- Three SC NWLON stations plus one station in northern GA and one station in southern NC

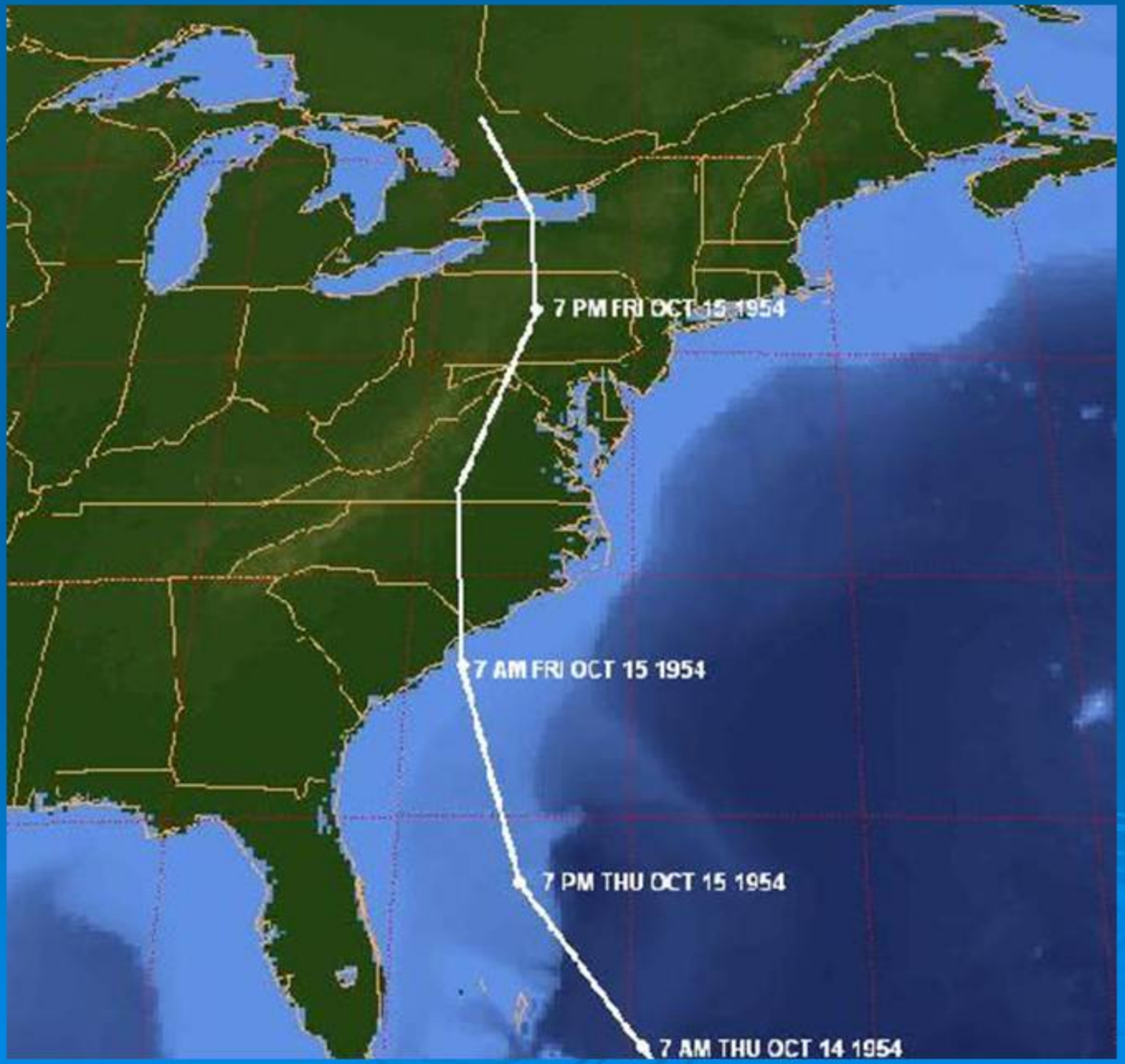
Challenges – Matching the NC Study

- Challenge to keep abreast of NC Storm Surge Study
- Overlap with NC Grid
  - Different resolution
  - Sensitivity tests in overlap area
  - SC team will splice NC data with SC data
    - No adjustment of SC grid resolution

Challenges – Historical Validation Data

- Validation of 3 storms
  - Hazel 1954
  - Hugo 1989
  - Ophelia 2005

Hazel 1954 – storm track



Hugo 1989 – storm track

- Trying to track down:
  - USACE HWMs
  - USGS HWMs

Ophelia 2005

Challenges – Historical Validation Data

There is never enough field data!

Issues:

- How do you validate a model run if the tide gauge or wave buoy is destroyed by the storm
- Which high water marks are accurate?
- To what extent should “old” data be included for validation purposes?

Challenges – Storm Events for Statistical Analysis

Historical storm data is used to create artificial storms for the model runs

Issues:

- Not enough historical storms
- How far back should data be included? Before 1945? Before 1960?

Challenges – Field Reconnaissance for Hydraulic Features

Need field recon for important local hydraulic features of bridges, elevated roads, culverts, and channels

Issues:

- What are the significant modeling parameters?
- How sensitive are the model results to parameter changes?
- What to do about limited data?

Challenges – Summary

- There is never enough data
- The partners need to decide how to deal with this reality in order to run state-of-the-art models.

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Questions?