NC STATE UNIVERSITY

Mapping and Visualization of Coastal Flood Forecasts for Decision Support

JC Dietrich[1], N Tull[1]

[1]Dep't of Civil, Construction, and Environmental Engineering, NC State University

NCDS Data Fellows Showcase
Chapel Hill NC, 22 September 2016

About Me

North Carolina State University

- Civil, Construction, and Environmental Engineering
  - Assistant Professor: 08/2013 to present

CCEE Department, Mann Hall, NCSU

About Me

North Carolina State University

- Civil, Construction, and Environmental Engineering
  - Assistant Professor: 08/2013 to present

University of Texas at Austin

- Institute for Computational Engineering and Sciences
  - Research Associate: 09/2012 to 07/2013
  - Postdoctoral Researcher: 11/2010 to 08/2012

University of Notre Dame

- Civil Engineering and Geological Sciences
  - Graduate Researcher: 08/2005 to 10/2010

University of Oklahoma

- Civil Engineering and Environmental Science
  - Graduate Researcher: 06/2004 to 07/2005
  - Undergraduate Researcher: 06/1999 to 05/2004

About Me

North Carolina State University

- Civil, Construction, and Environmental Engineering
  - Assistant Professor: 08/2013 to present

University of Texas at Austin

- Institute for Computational Engineering and Sciences
  - Research Associate: 09/2012 to 07/2013
  - Postdoctoral Researcher: 11/2010 to 08/2012

University of Notre Dame

- Civil Engineering and Geological Sciences
  - Graduate Researcher: 08/2005 to 10/2010

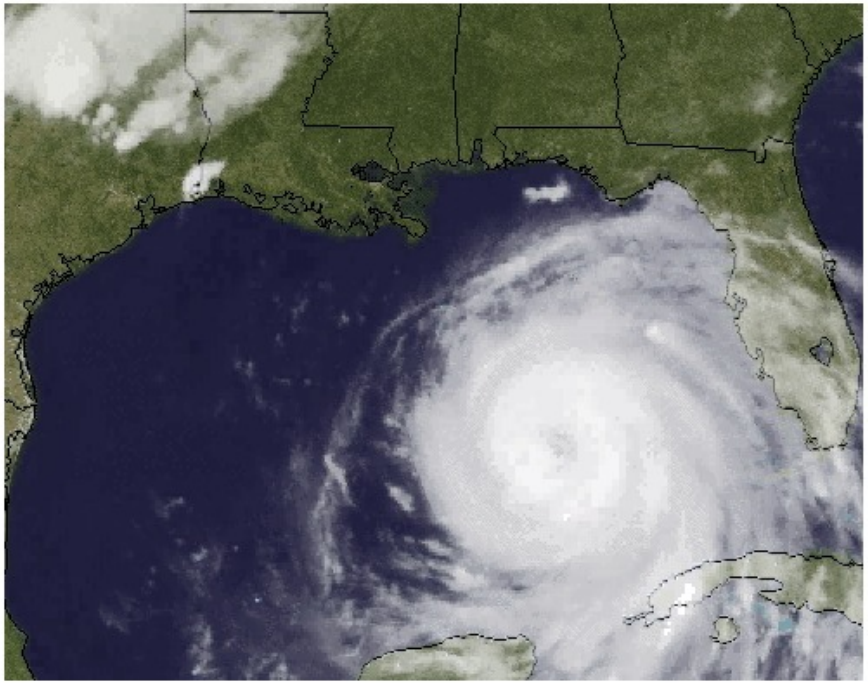
University of Oklahoma

- Civil Engineering and Environmental Science
  - Graduate Researcher: 06/2004 to 07/2005
  - Undergraduate Researcher: 06/1999 to 05/2004

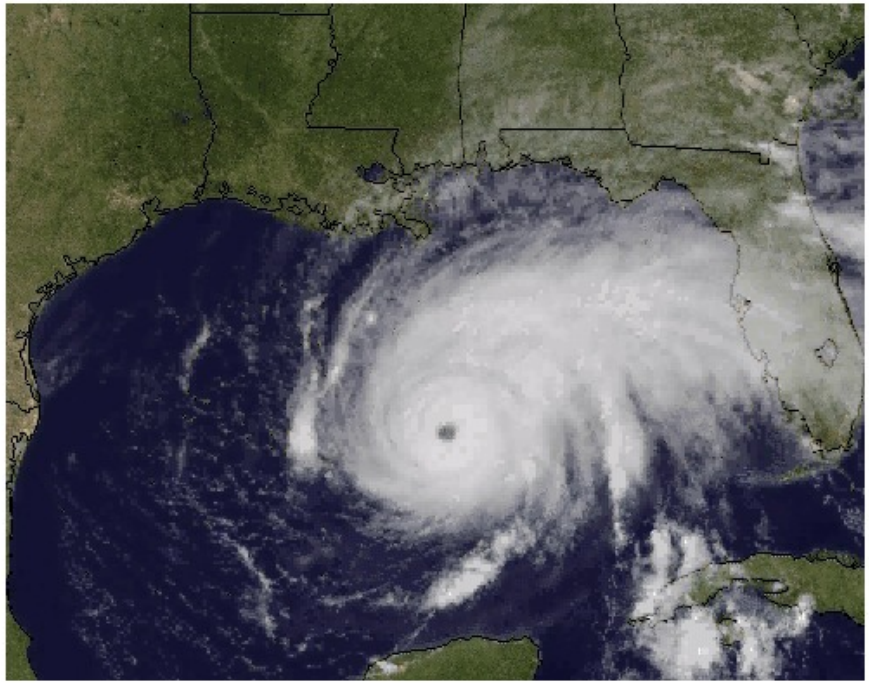
Hurricane Season 2005

Impacts on Southern Louisiana

Katrina: 08/28 - 08/29

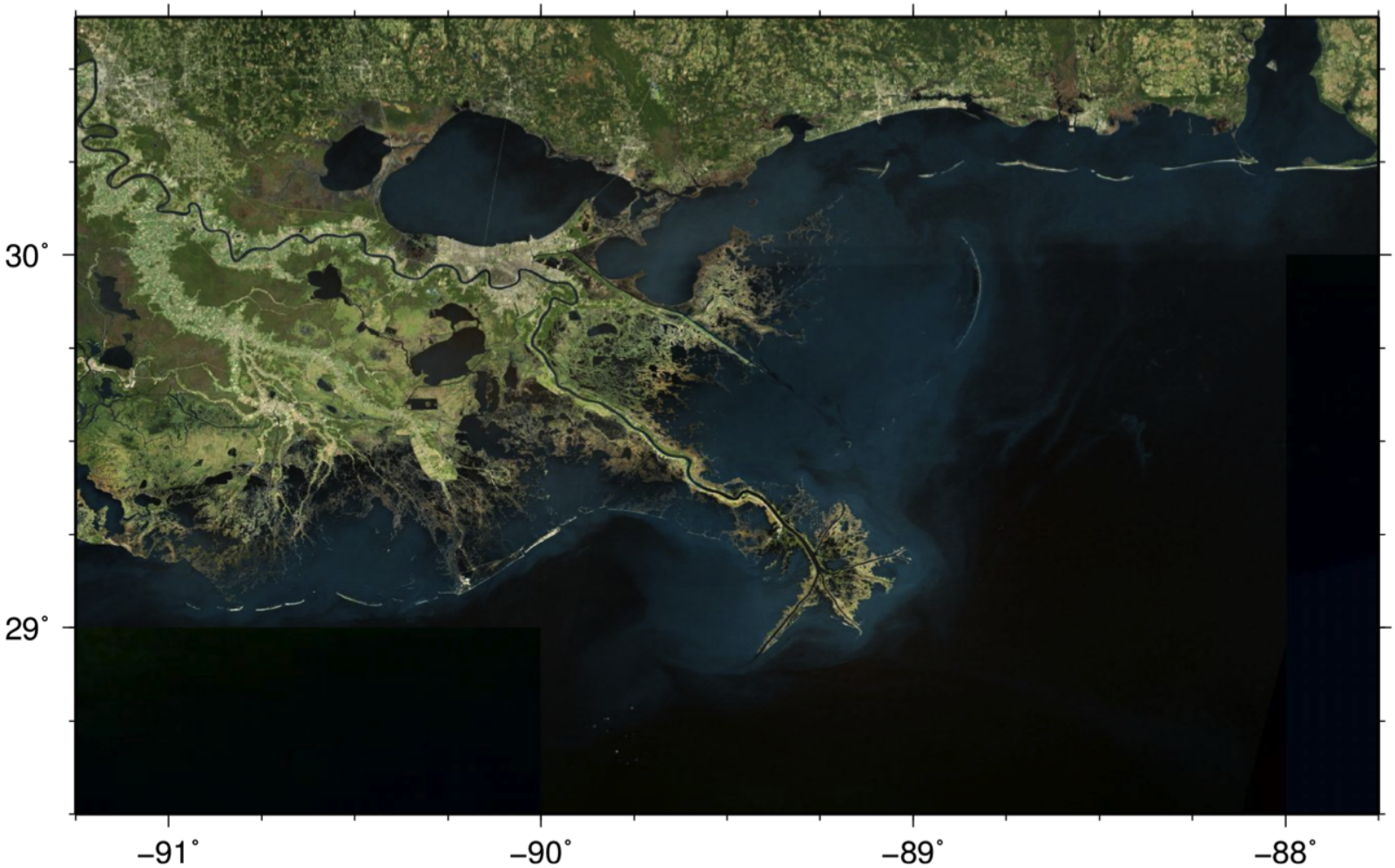


Rita: 09/22 - 09/24



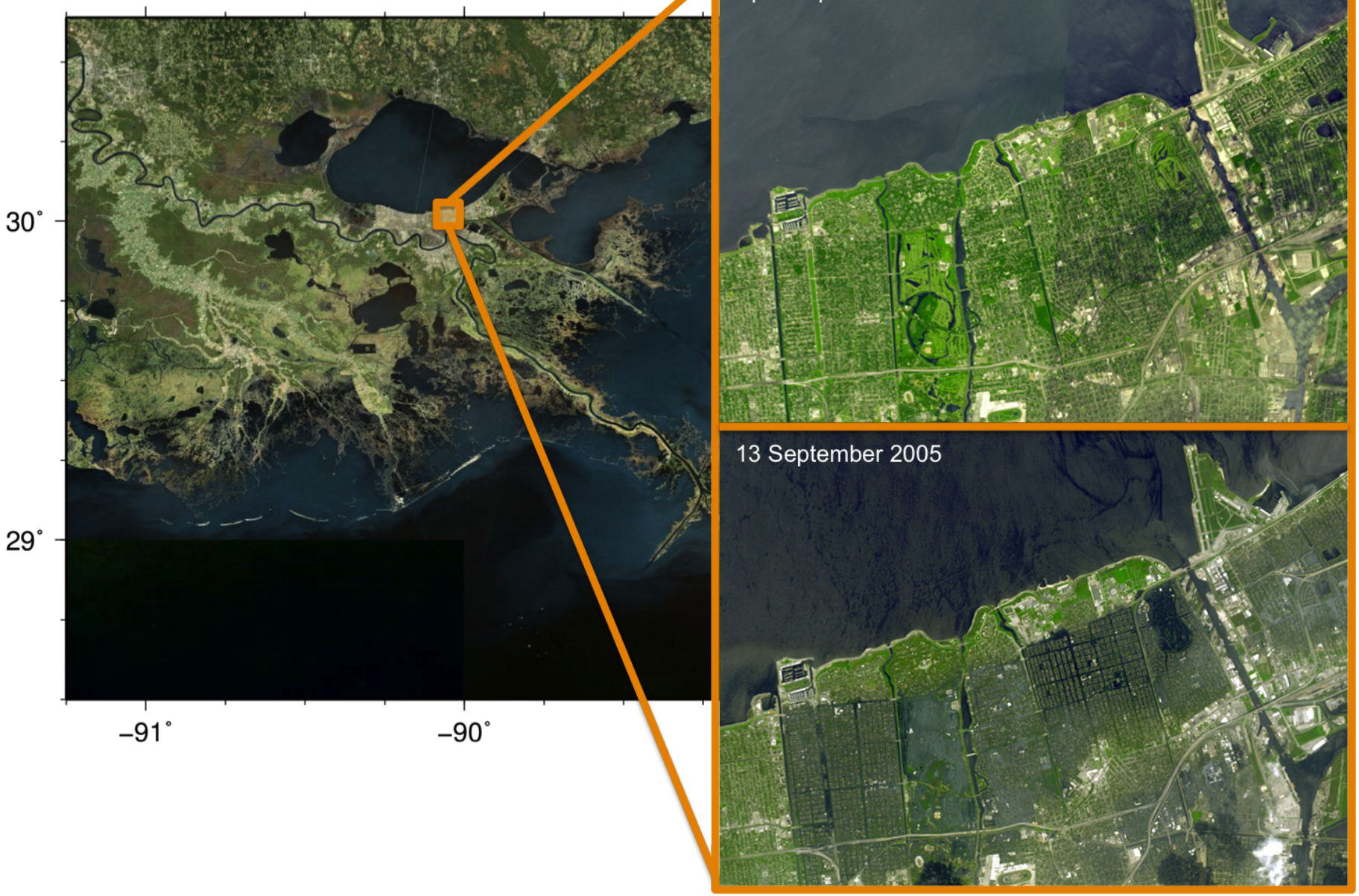
Hurricane Season 2005

Flooding of New Orleans



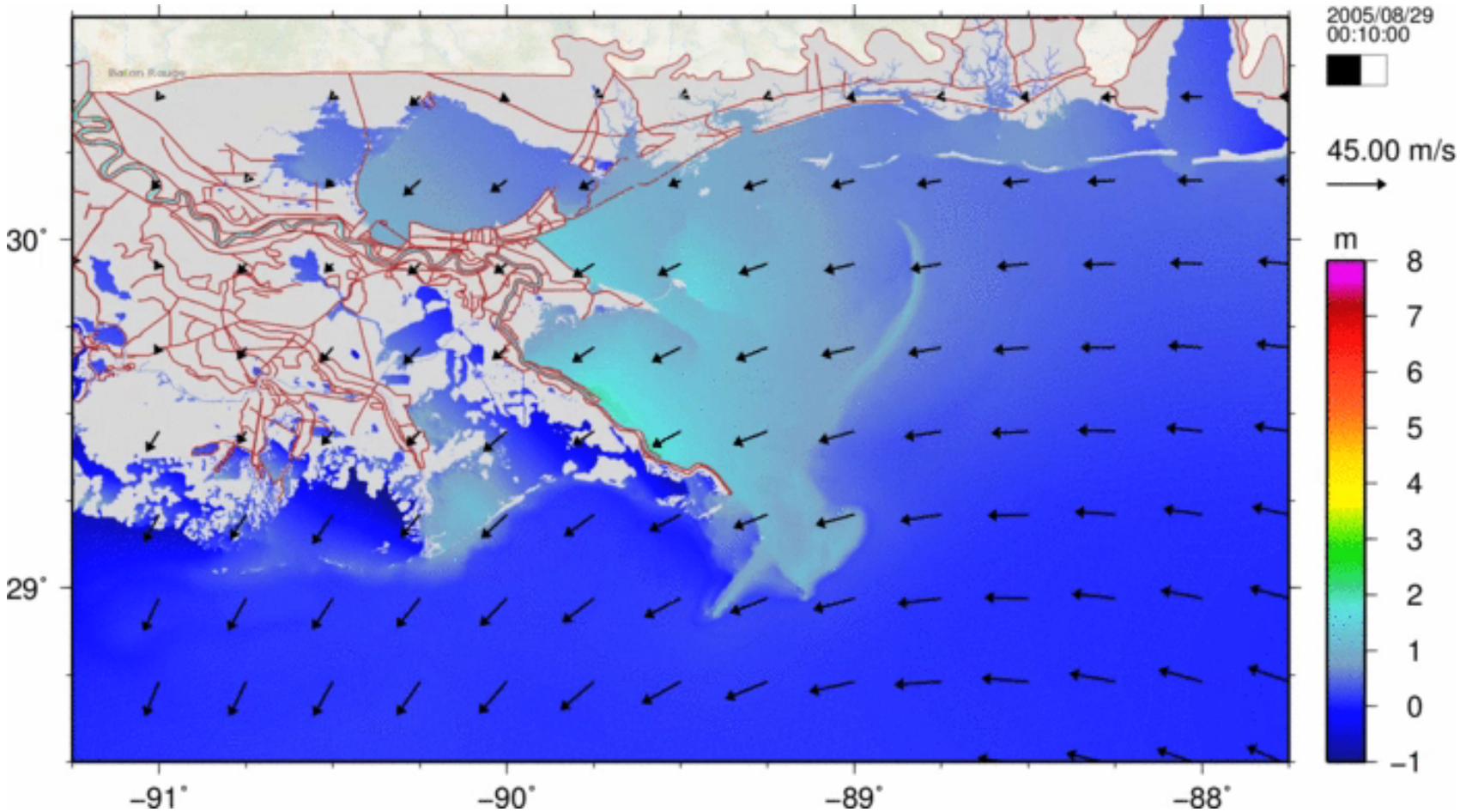
Hurricane Season 2005

Flooding of New Orleans



Hurricane Season 2005

Katrina (2005) on 29 August

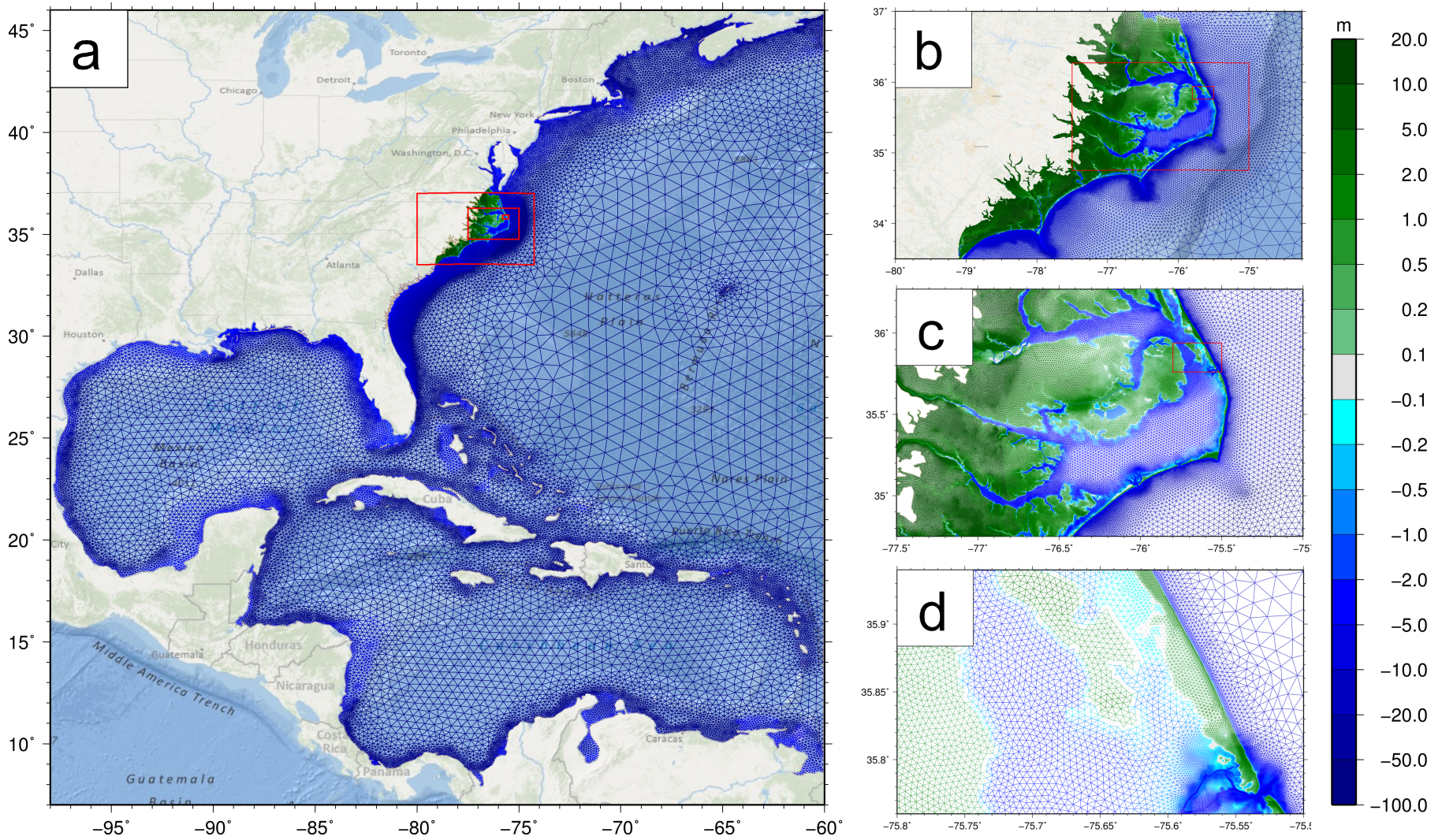


S Bunya, JC Dietrich, *et al.* (2010). A High-Resolution Coupled Riverine Flow, Tide, Wind, Wind Wave and Storm Surge Model for Southern Louisiana and Mississippi: Part I – Model Development and Validation. *Monthly Weather Review*, 138(2), 345-377.

JC Dietrich, *et al.* (2010). A High-Resolution Coupled Riverine Flow, Tide, Wind, Wind Wave and Storm Surge Model for Southern Louisiana and Mississippi: Part II – Synoptic Description and Analysis of Hurricanes Katrina and Rita. *Monthly Weather Review*, 138(2), 378-404.

Real-Time Forecasting

High-Resolution Model for North Carolina Coast



Real-Time Forecasting

ADCIRC Surge Guidance System (ASGS)

Our models can be employed in real-time via the ASGS

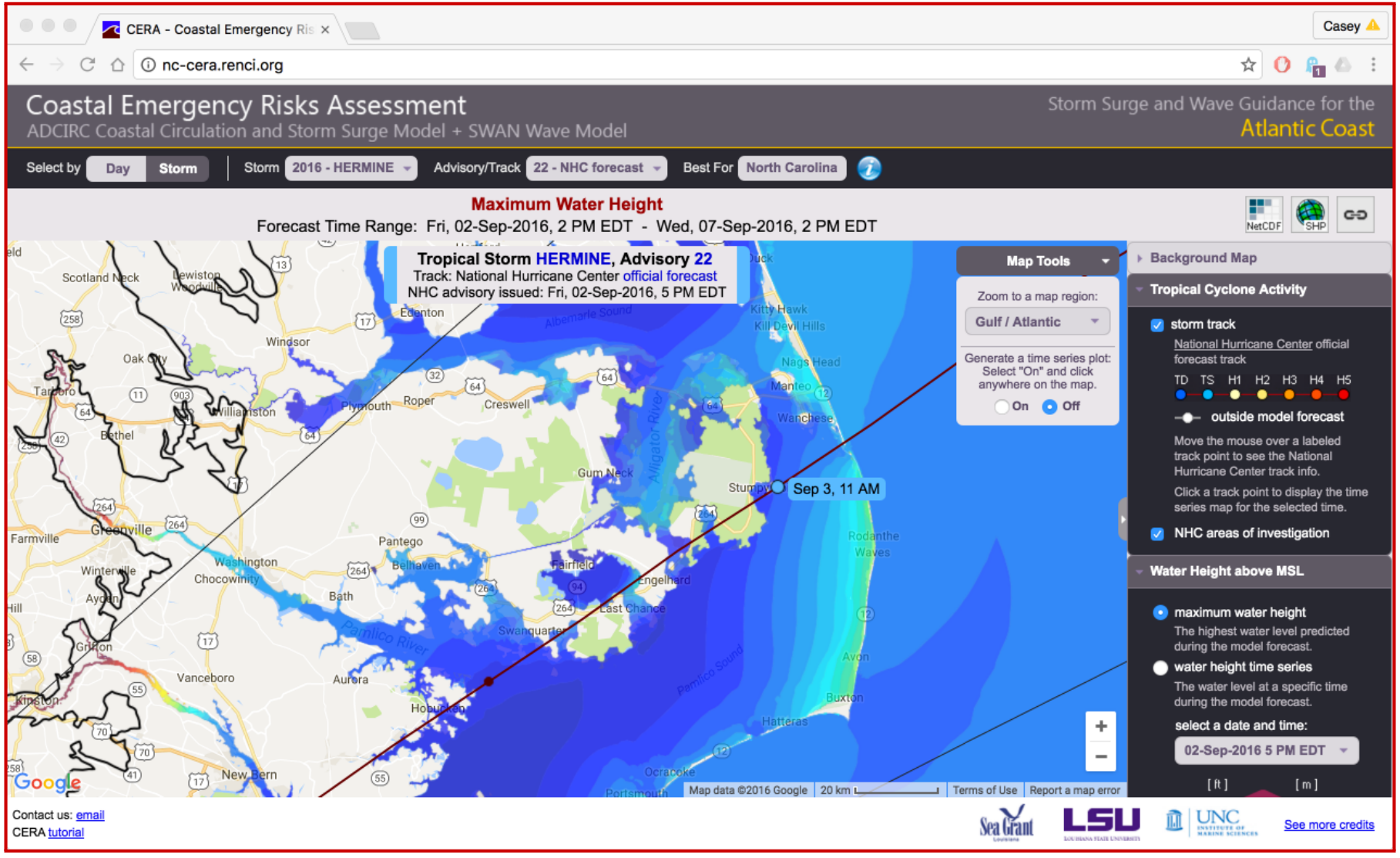
- Everything happens automatically
- Models are initialized, run and processed by Perl scripts
  - Detect when a new advisory is issued by the NHC
  - Configure the model input files for a 5-day forecast simulation
  - Submit and monitor jobs in an HPC environment
  - Post-process and archive the model results
- This process is repeated for every NHC advisory
  - Up to 4 times per day

How to communicate the model results?

- Forecasts of wind speeds, wave heights and periods, surge levels, etc.
- About 2.5 GB of data per simulation
- Need to convert into geo-referenced, visual formats for end users

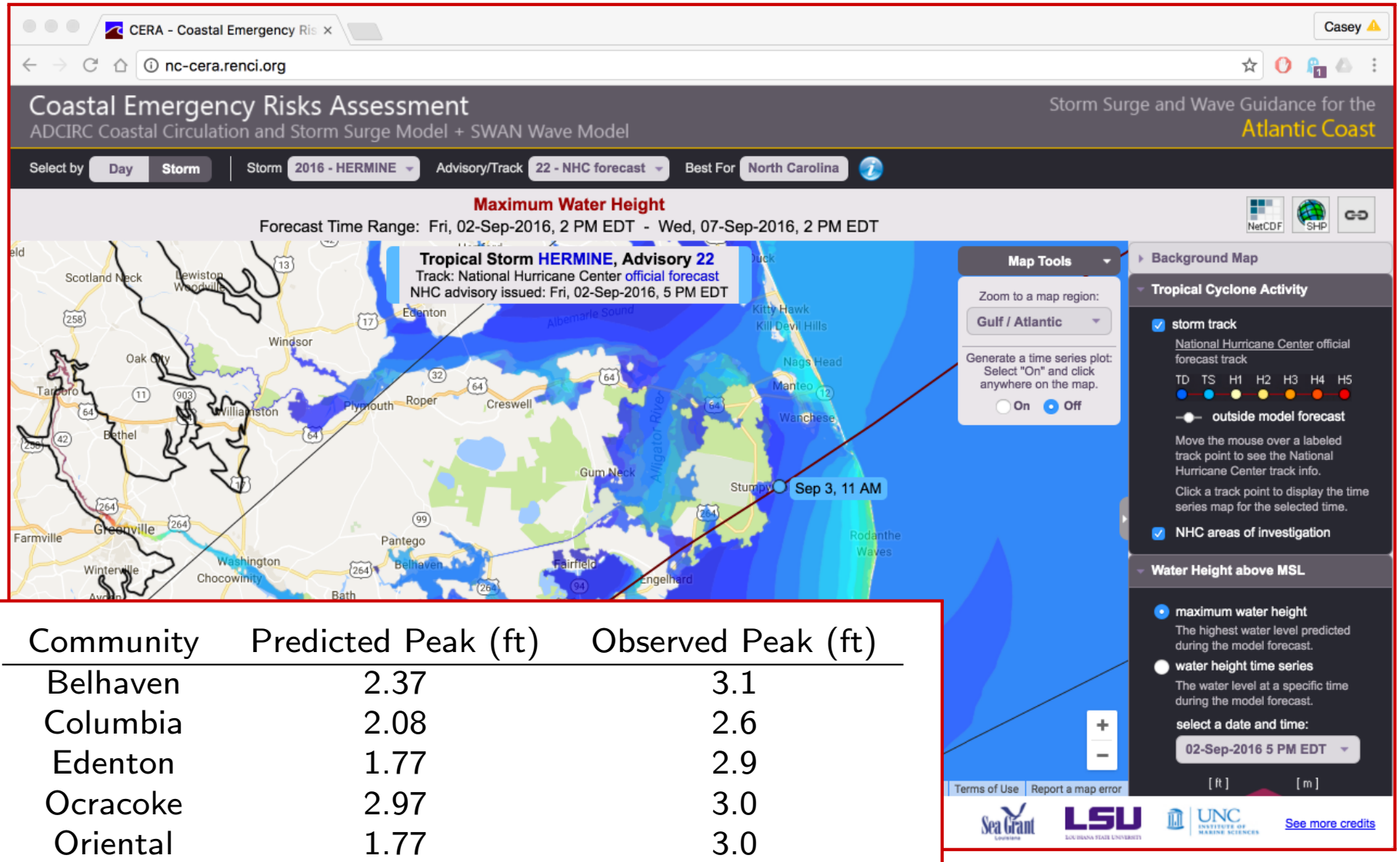
Real-Time Forecasting

Coastal Emergency Risks Assessment (CERA): `nc-cera.renci.org`



Real-Time Forecasting

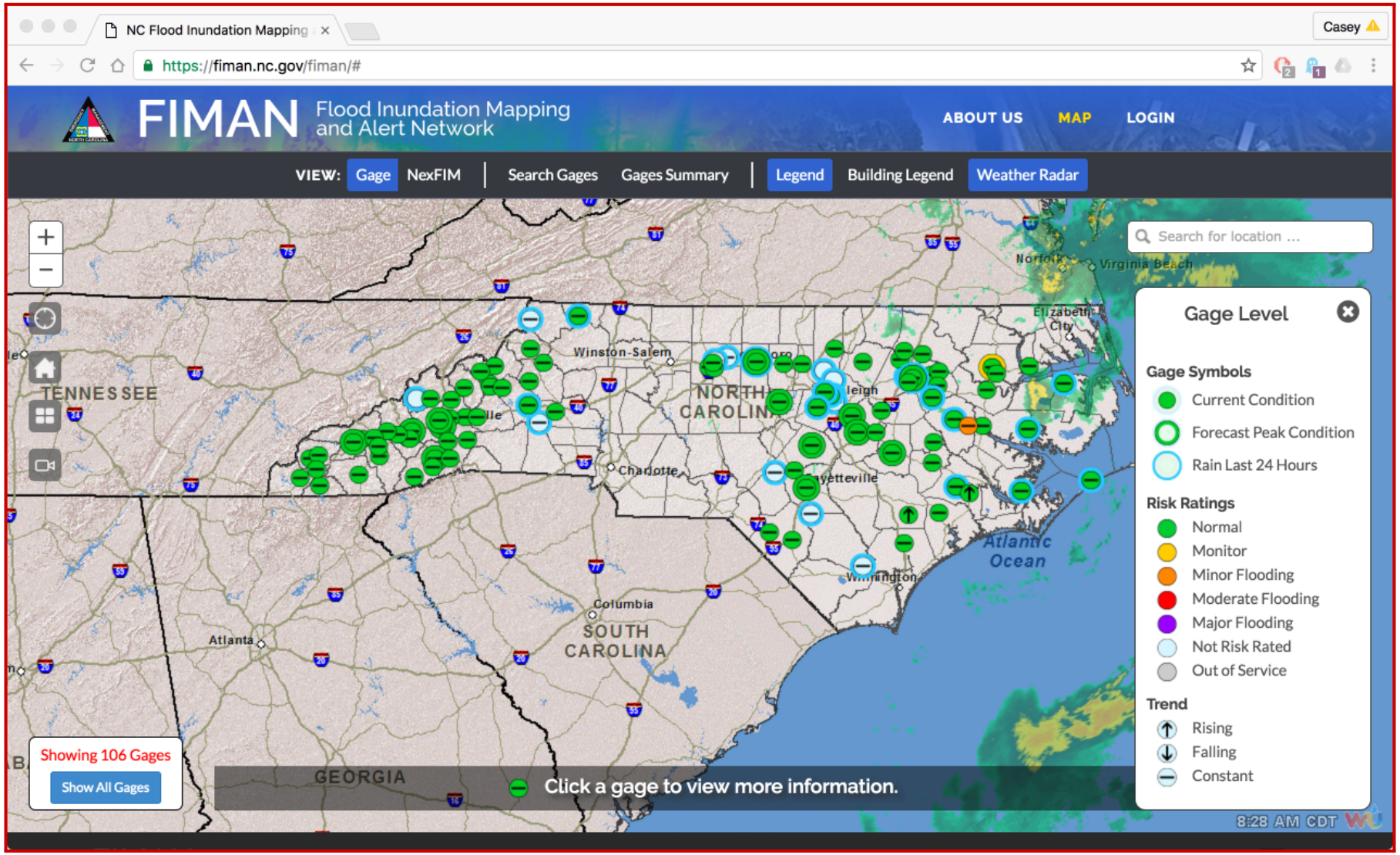
Coastal Emergency Risks Assessment (CERA): `nc-cera.renci.org`



Community	Predicted Peak (ft)	Observed Peak (ft)
Belhaven	2.37	3.1
Columbia	2.08	2.6
Edenton	1.77	2.9
Ocracoke	2.97	3.0
Oriental	1.77	3.0

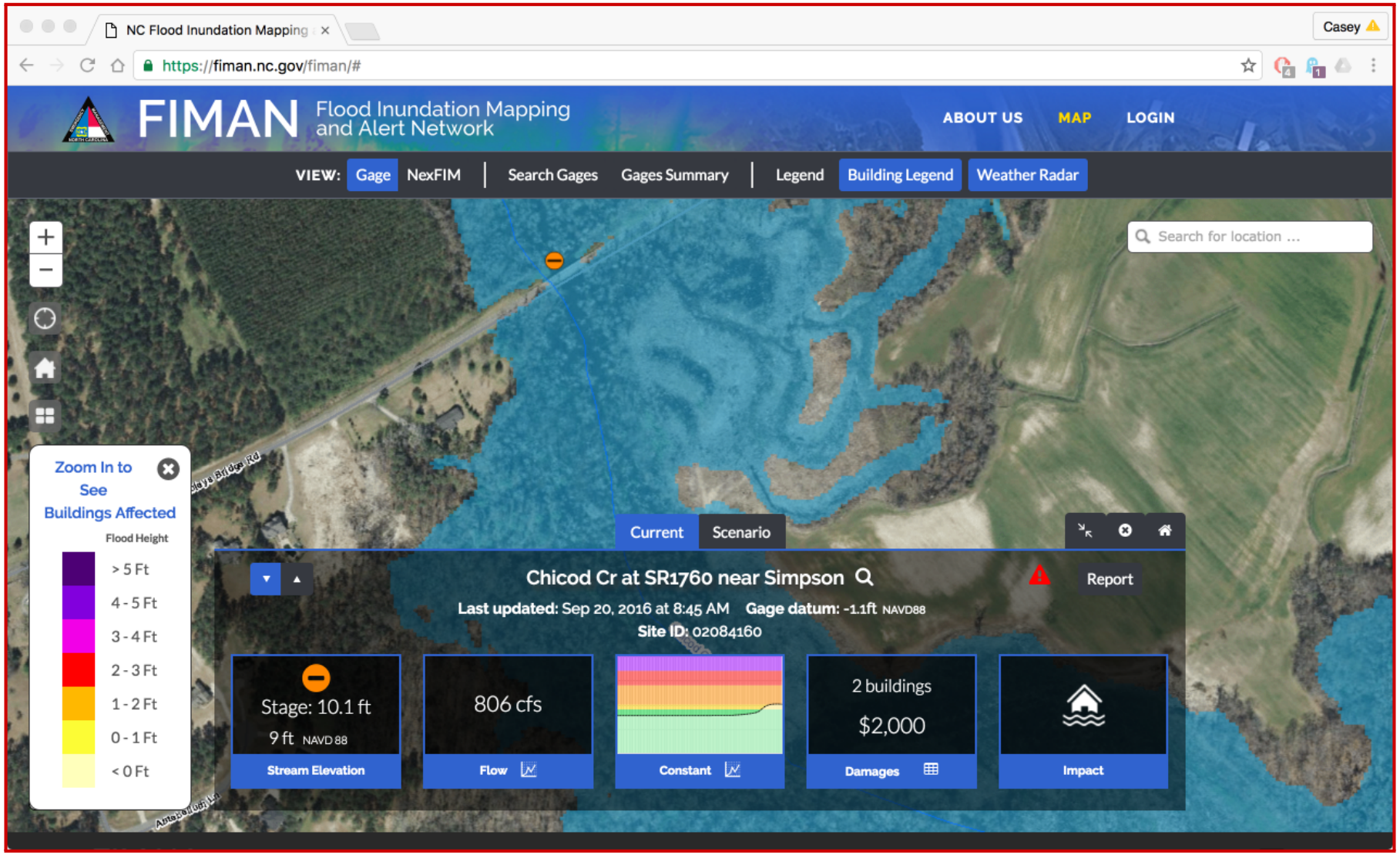
Real-Time Forecasting

Flood Inundation Mapping and Alert Network (FIMAN): `fiman.nc.gov`



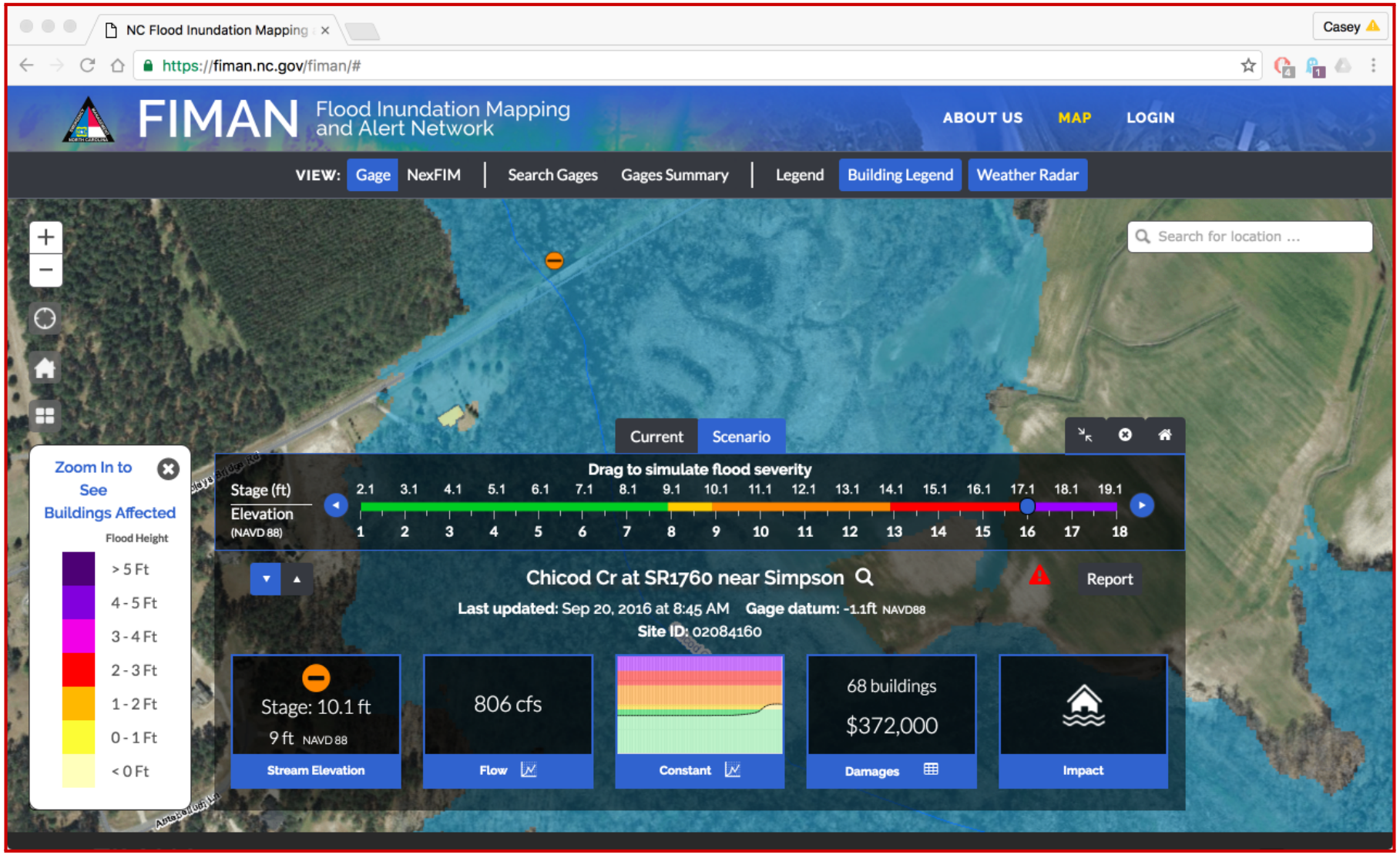
Real-Time Forecasting

Flood Inundation Mapping and Alert Network (FIMAN): `fiman.nc.gov`



Real-Time Forecasting

Flood Inundation Mapping and Alert Network (FIMAN): `fiman.nc.gov`



Data Fellows Project

Requirements for NCEM and FIMAN

Goal:

- Enable data-driven decision-making for coastal communities during storm events

Objectives:

- Downscaling the model forecast data to the resolution of geospatial datasets used for decision support
- Assessing the implications of this downscaling on forecast accuracy
- Connecting these technologies with the NCEM

Data Fellows Project

Leveraging Support from NC Sea Grant

Some partners prefer guidance in other formats:

- Polygon-based formats:
  - Shapefiles and ancillary files for GIS
  - KML files for Google Earth
- These files can be overlaid with information from other sources

We developed Python-based scripts to convert model output

- Based on older scripts from BO Blanton, RA Luettich Jr
- Expanded to consider time series information, KML formats

Now sharing guidance in developmental formats with partners at NWS offices, state and local emergency management teams

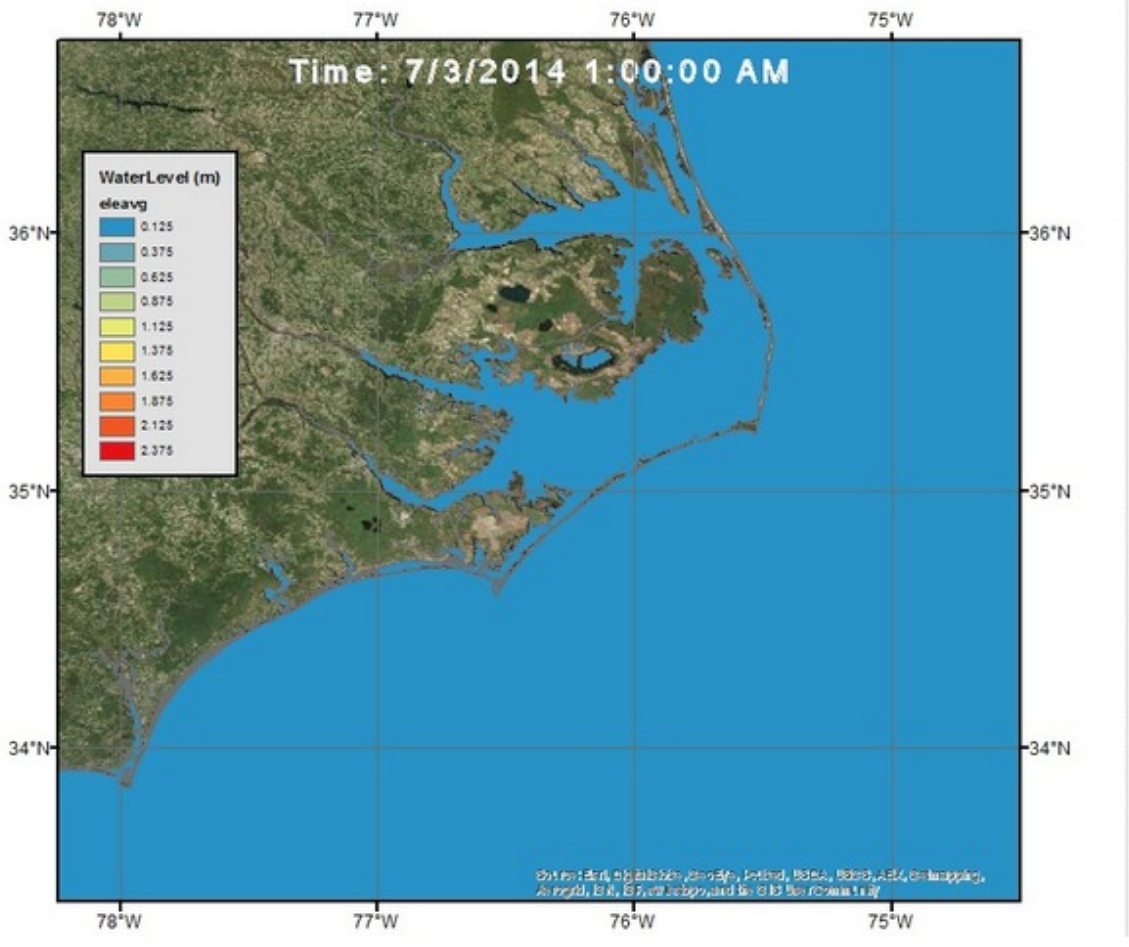
- **Guidance products are generated and archived automatically**

Data Fellows Project

Introducing *Kalpana* for Visualization of Waves and Flooding

Our Python-based script is called *Kalpana*:

- Shared as open-source code: `github.com/ccht-ncsu/Kalpana`
- Example of water levels during Arthur (2014):

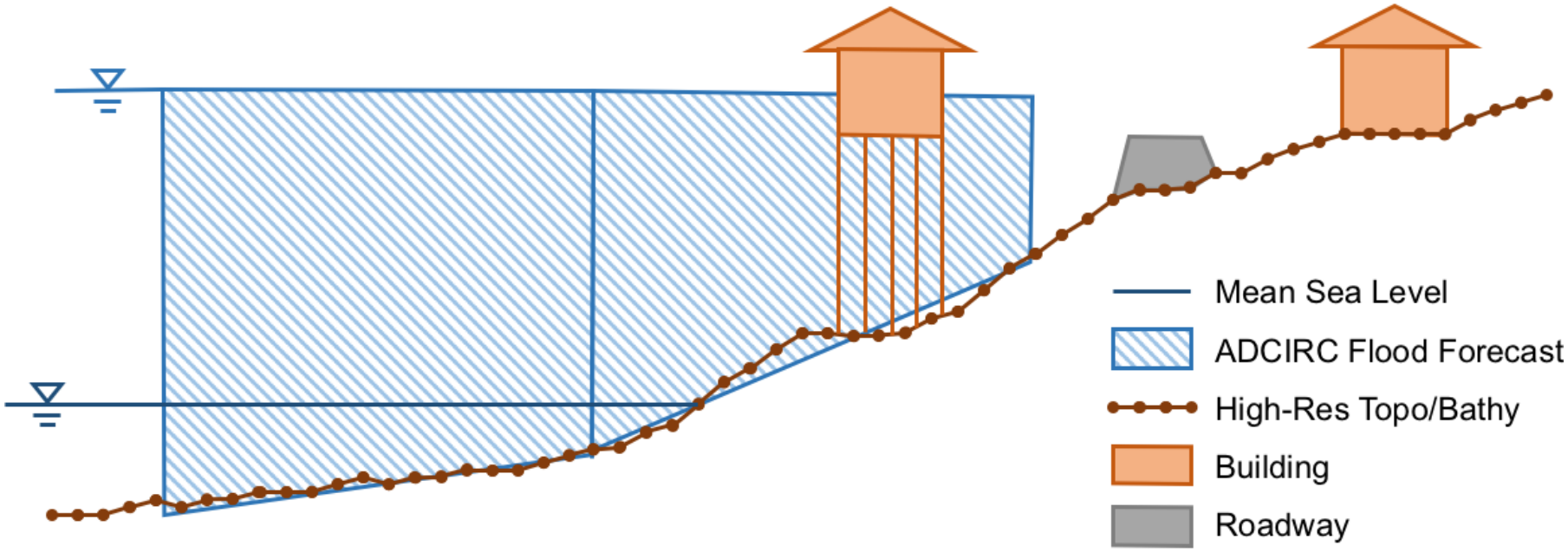


Data Fellows Project

Downscaling Forecast Results for Decision Support

How do we connect from model resolution (100-200m) to smaller scales?

- Can we account for hydraulic controls like raised roadways?
- Can we represent the local storm physics?
- Can we be faithful to the model?



Summary and Future Work

Requirements for NCEM and FIMAN

Flooding forecast data will be connected for use by emergency managers

- Existing forecasting effects for hurricane waves and surge
- Leverage the visualization tools developed in another project
- Connect to emergency managers at NCEM

Expected deliverables and milestones:

- Initial connection to NCEM happening now
  - Use existing forecast data and visualization technologies
  - Successes during Hermine
- Downscaling and extrapolation technologies by Mar 2017
- Assessment and implementation by 2017 hurricane season