

# Hurricane Storm Surge Flood Modeling for the Lower Laguna Madre

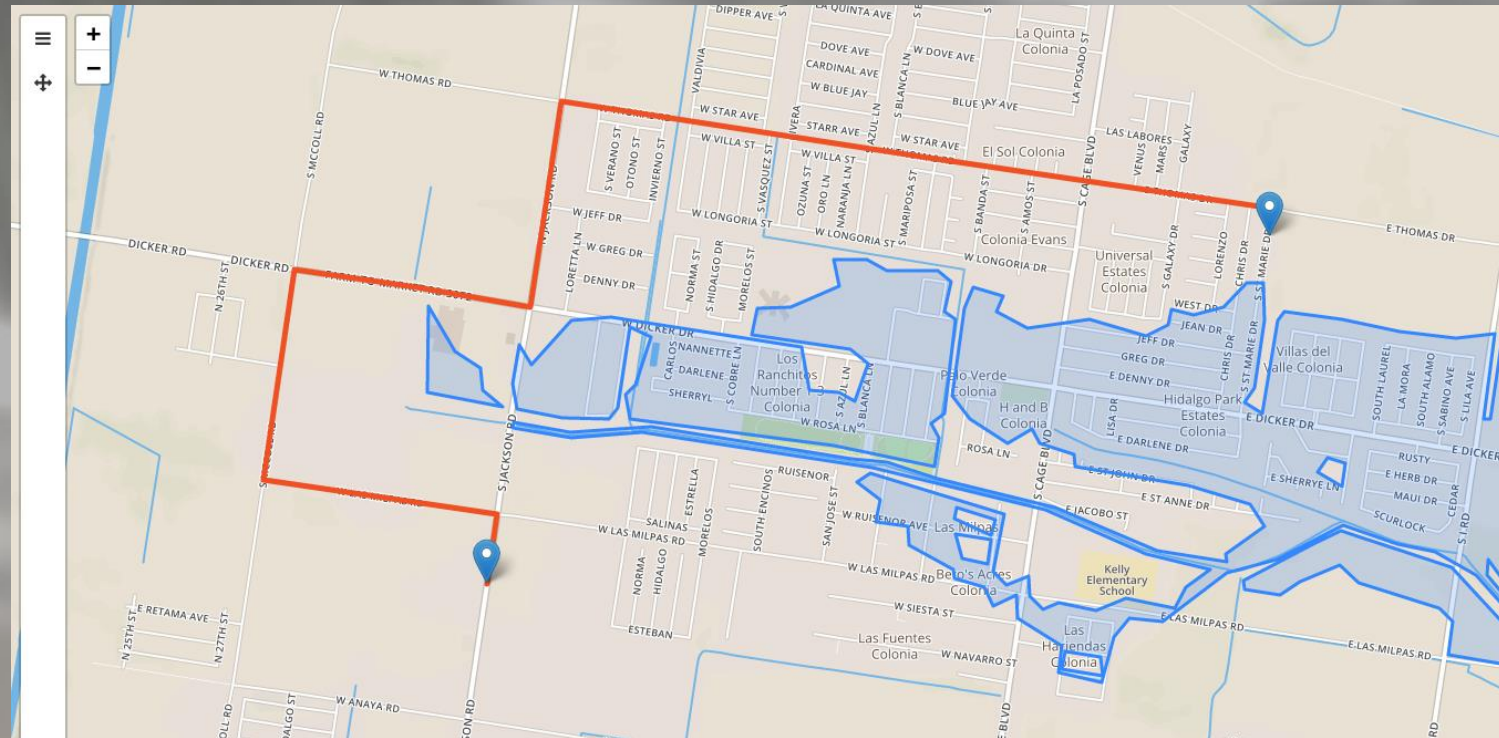
Cesar Davila, Dongchul Kim, and Jungseok Ho  
The University of Texas Rio Grande Valley

# Background

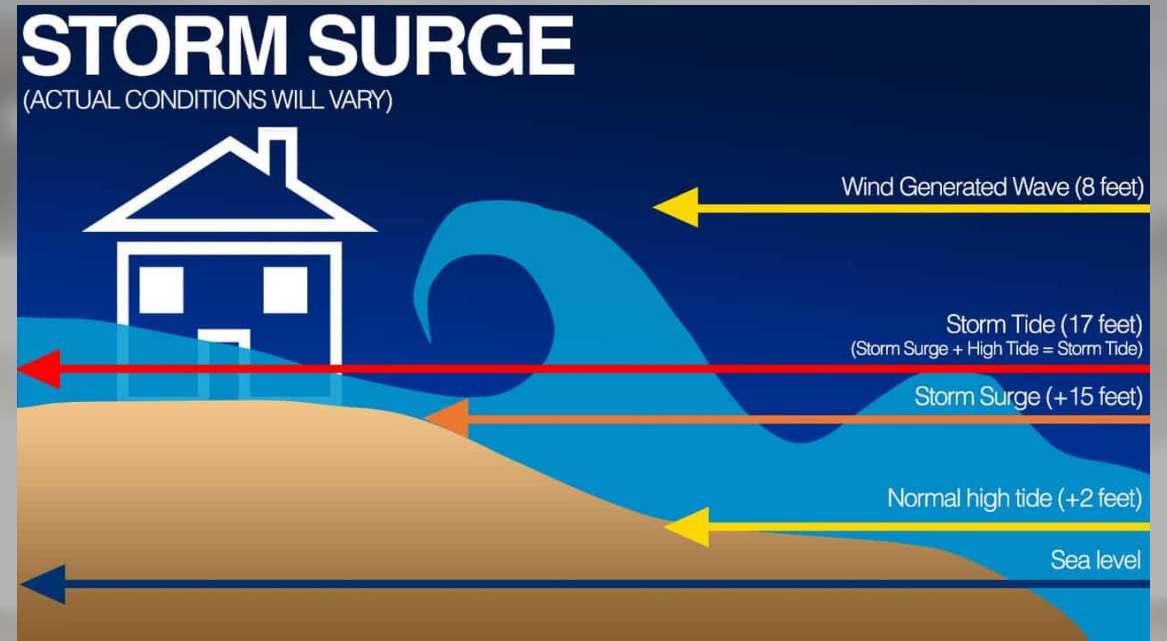
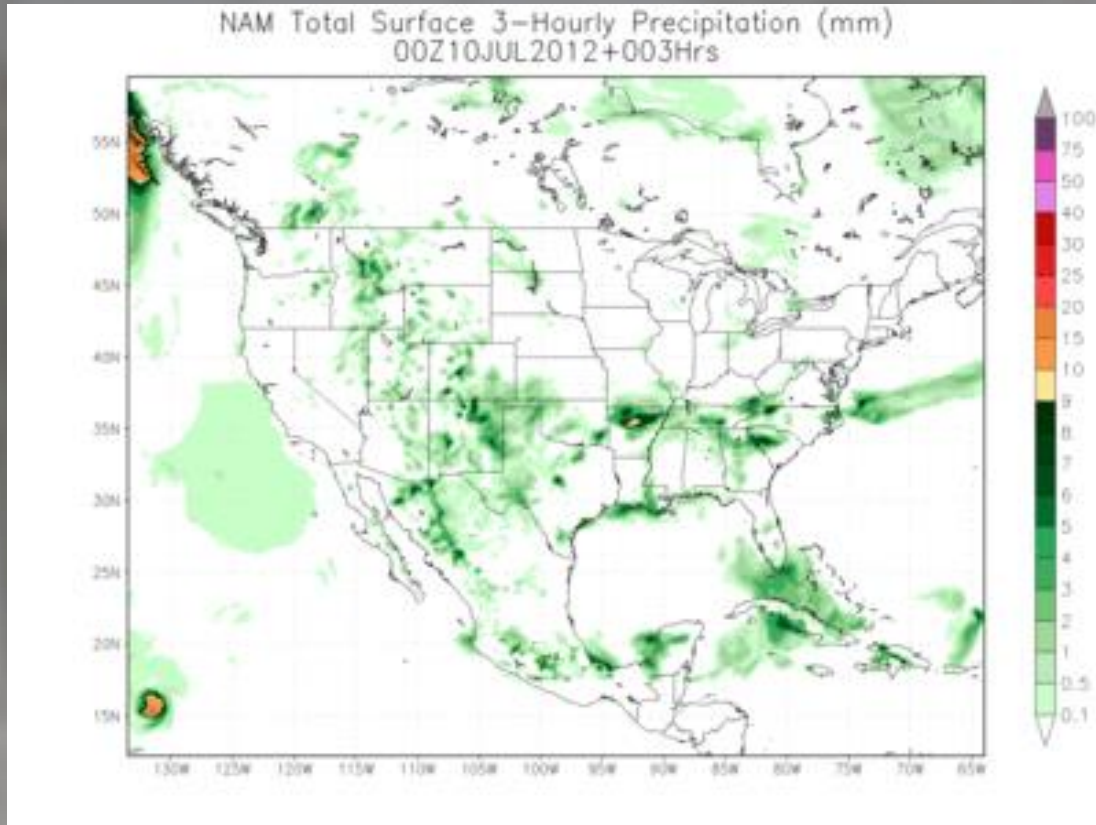
- B.S. in Computer Science from The University of Texas Rio Grande Valley
- For the past years, I've been working on projects related to storm surge modeling, GIS, automation, and machine learning
- Interdisciplinary study between the Department of Civil Engineering and the Department of Computer Science

# Objective of the study

- To build a system to produce forecasted flooding maps in RGV. The maps will be delivered to the public in an interactive web map and include a flood aware navigation system.

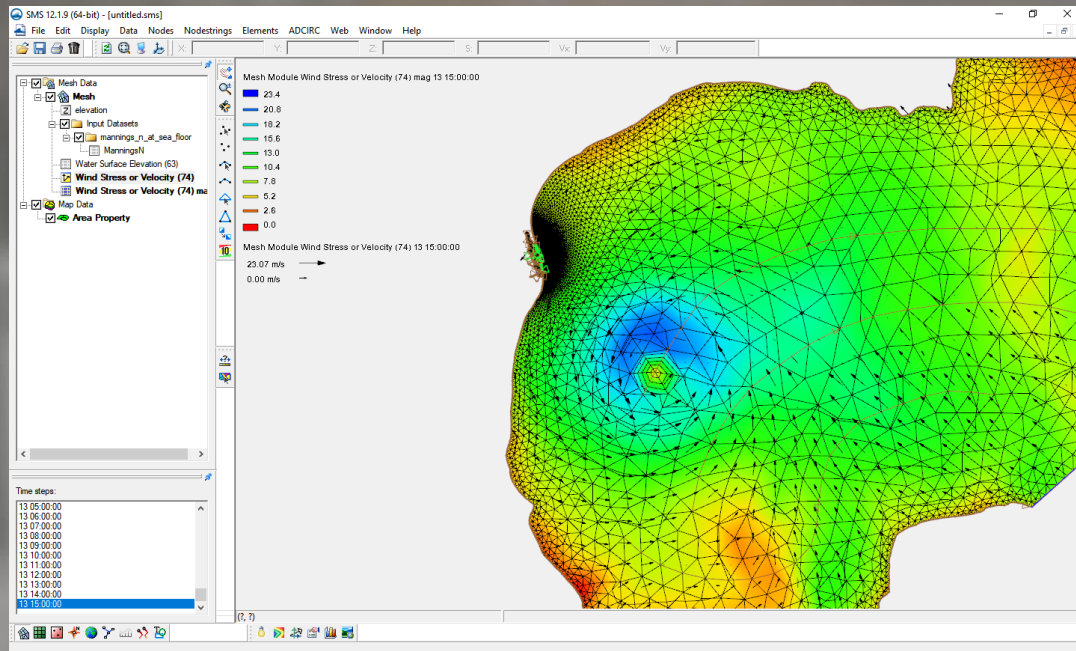


# How to forecast?

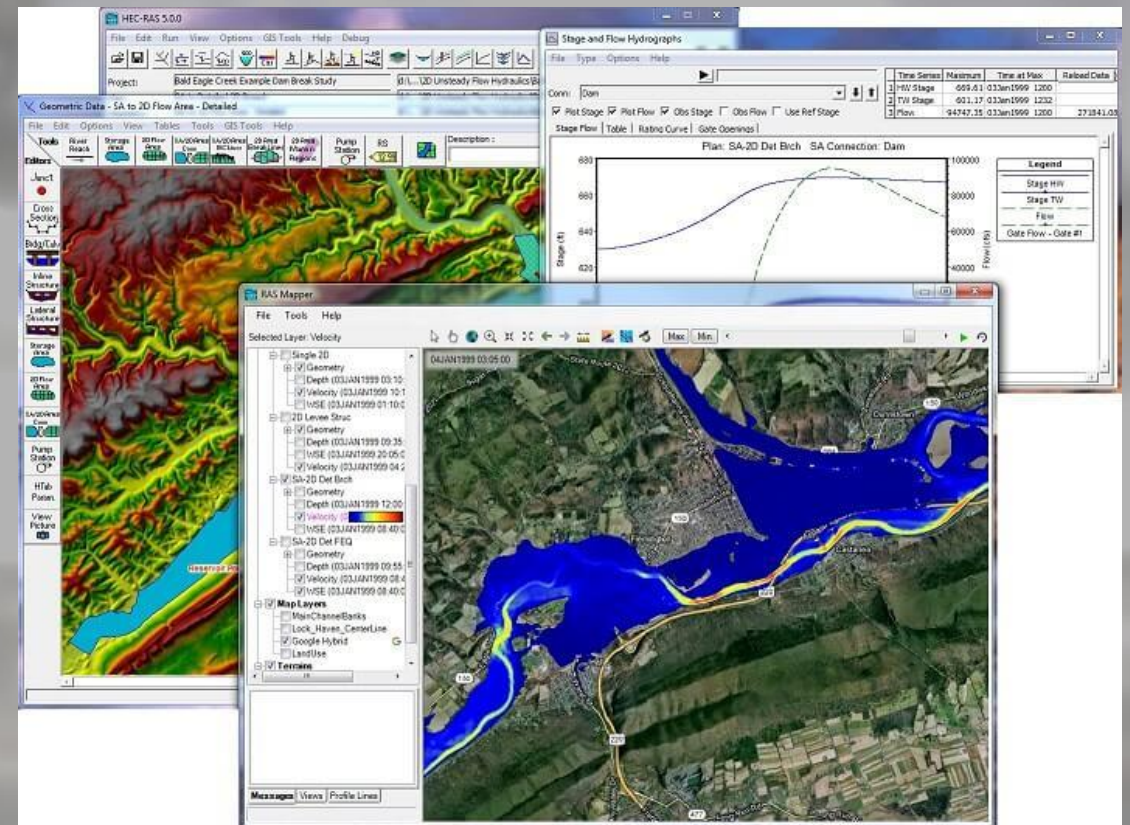


# Models involved

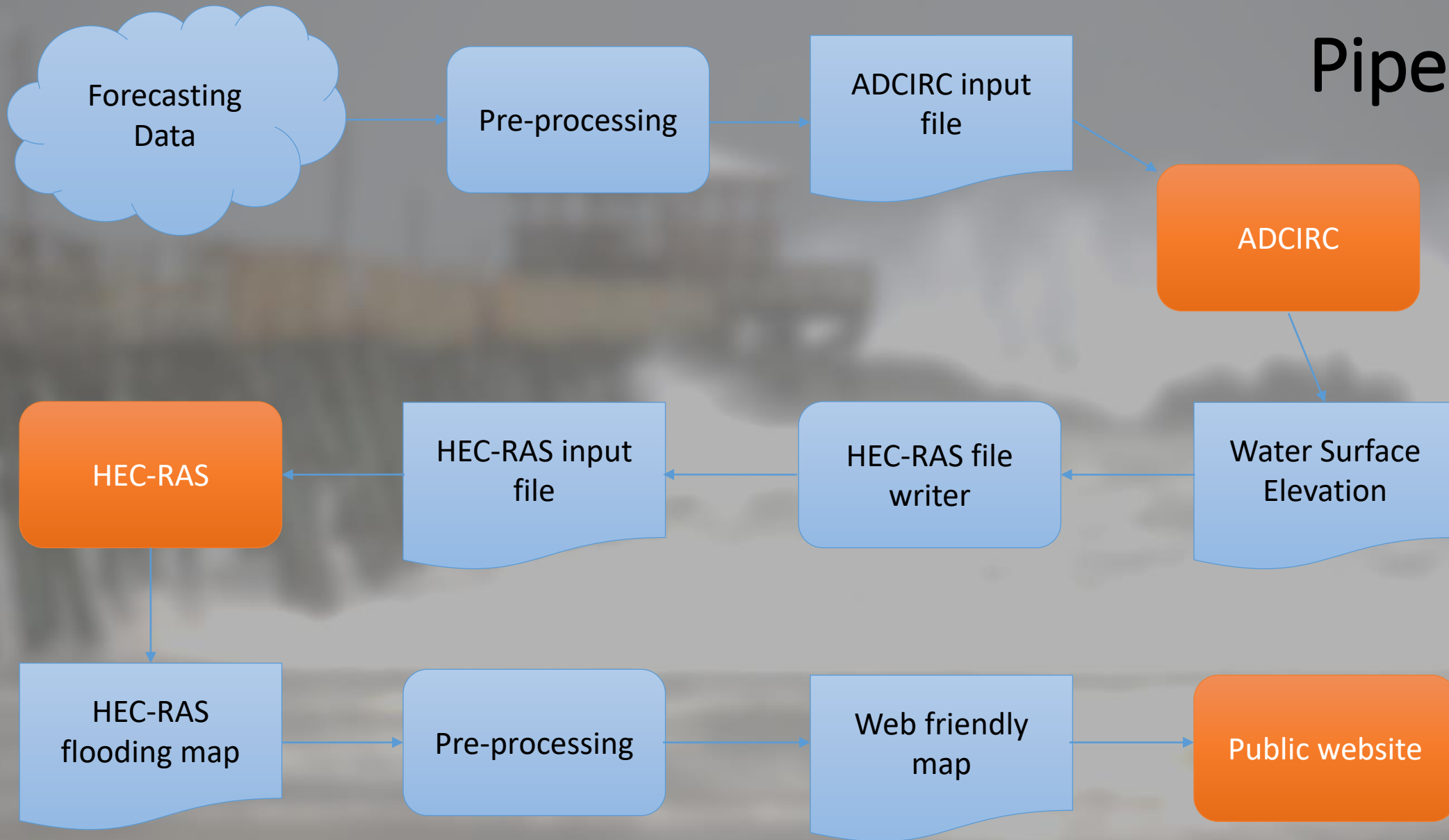
ADCIRC



HEC-RAS



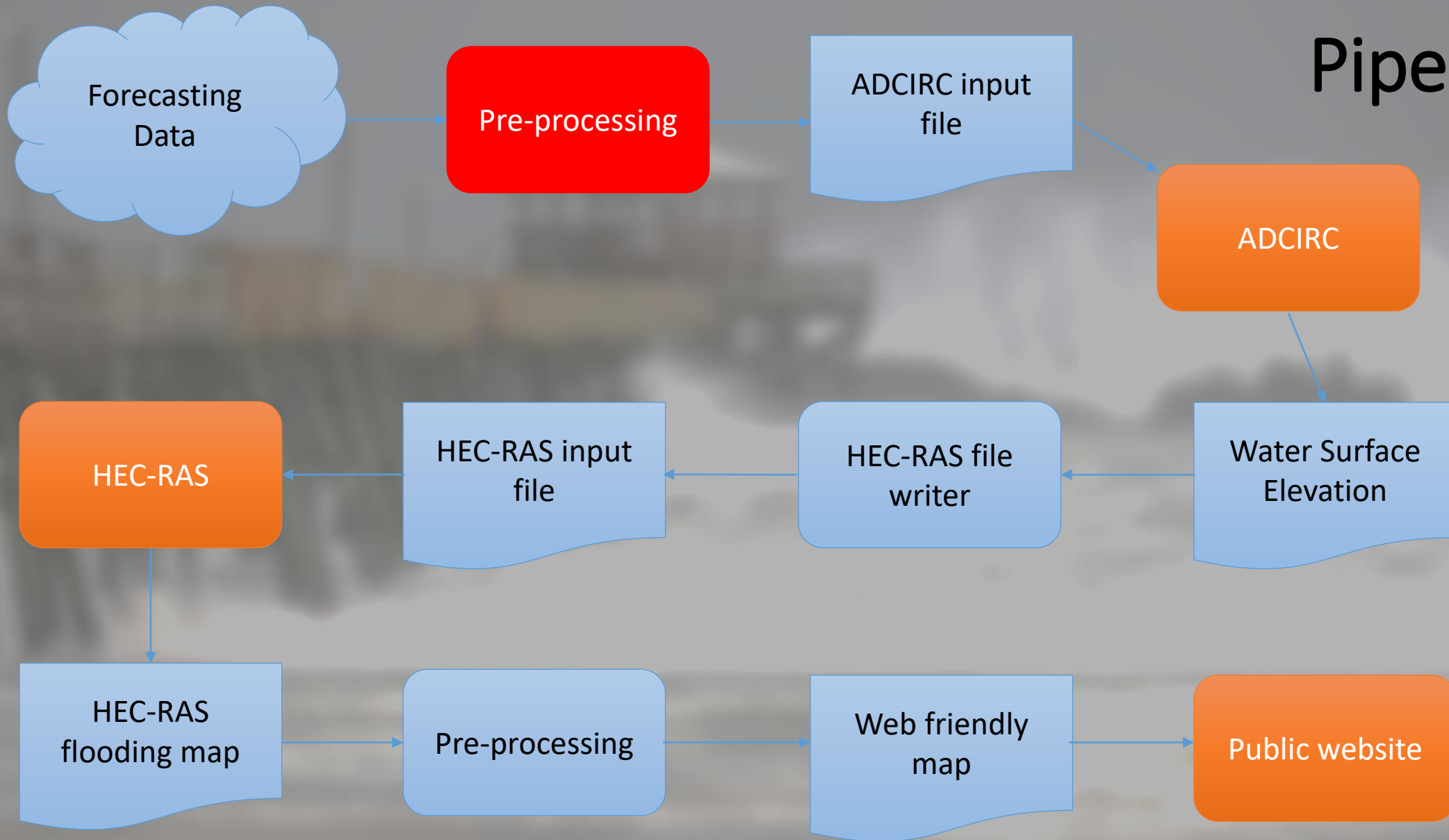
# Pipeline



# ADCIRC

- ADCIRC is the first model to be run in the system.
- It is responsible for estimating storm surge based on wind and pressure information as well as tides.
- ADCIRC requires forecasted gridded data on winds and pressure.

# Pipeline

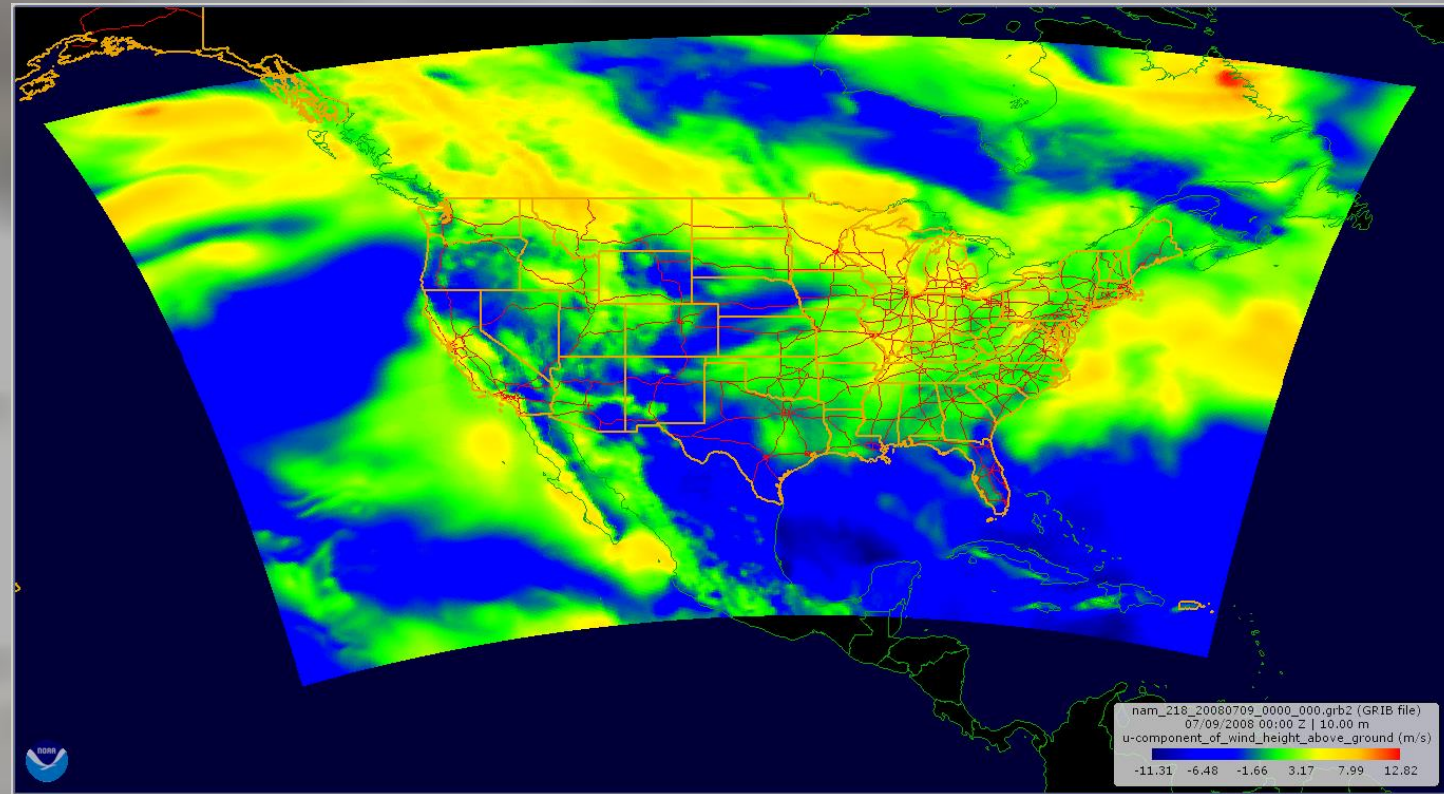


# Forecasting Data

- Many forecasting datasets are made available by NOAA.
- NOAA provides gridded forecasting data over the United States and the world.
- Options were narrowed down to one dataset based on features.

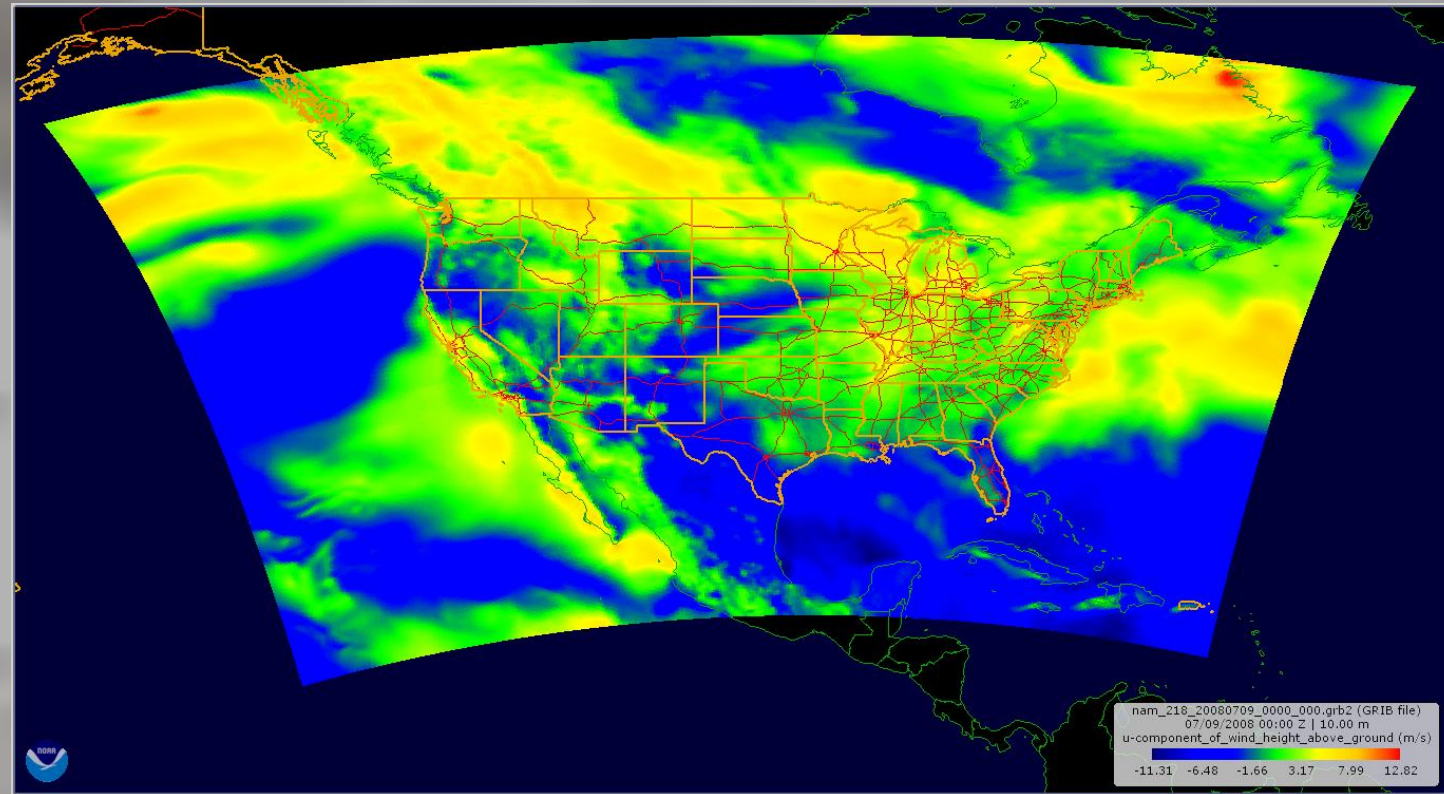
# North American Mesoscale Forecasting System (NAM) contd.

- ADCIRC requires a regularly spaced grid that covers the modeled area and the time simulated.
- NAM is distributed in 'grib' format, a World Meteorological Organization (WMO) standard for weather data. It is a binary file that contains grids for different levels in the atmosphere over its domain space.



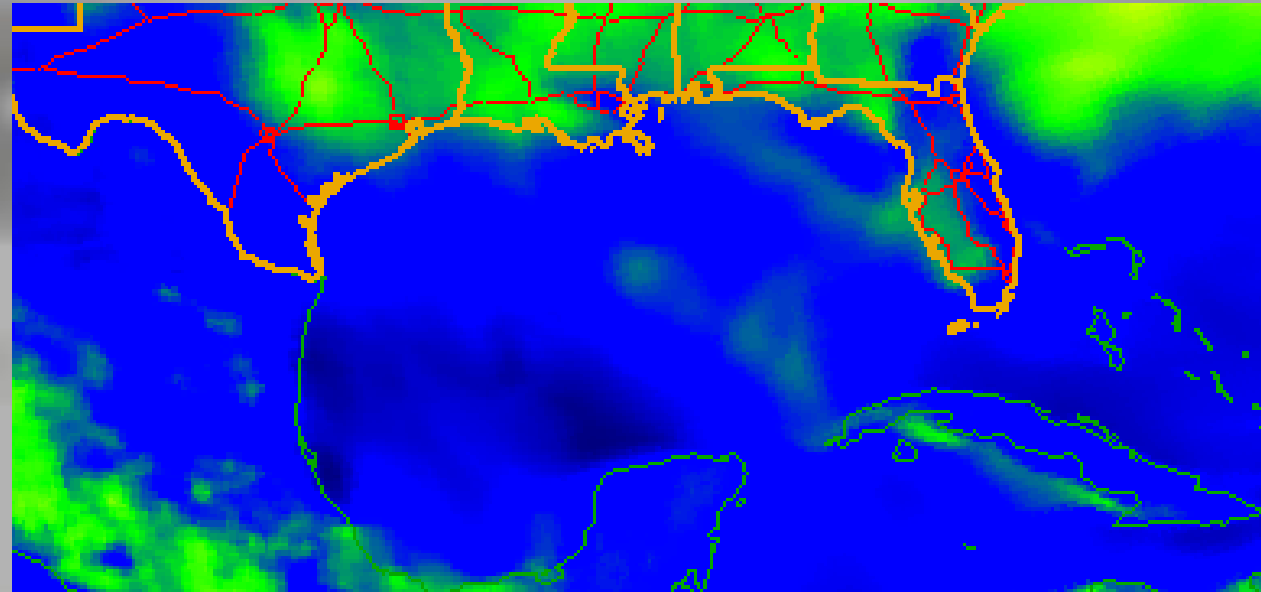
# North American Mesoscale Forecasting System (NAM) contd.

- A Python script was developed to process this data. It uses NOAA's C library for interacting with 'grib' files.
- The script will select the necessary data. U and V components of winds at surface level and pressure at surface level for every hour.
- This data is extracted and needs to be processed before it can be used by ADCIRC model.



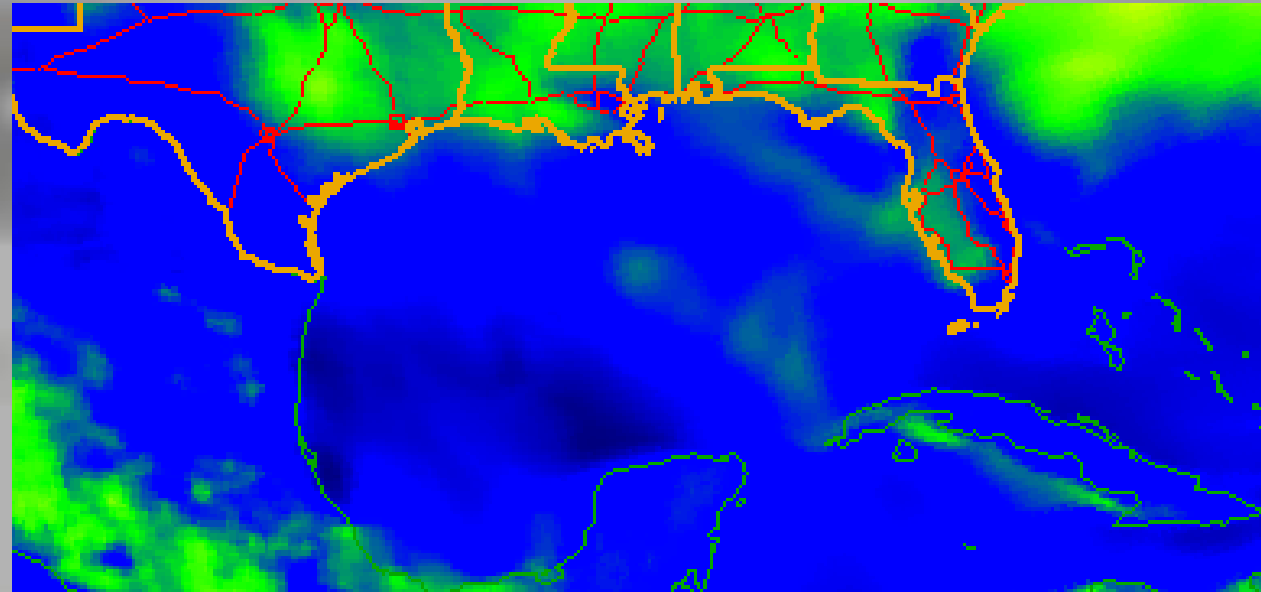
# North American Mesoscale Forecasting System (NAM) contd.

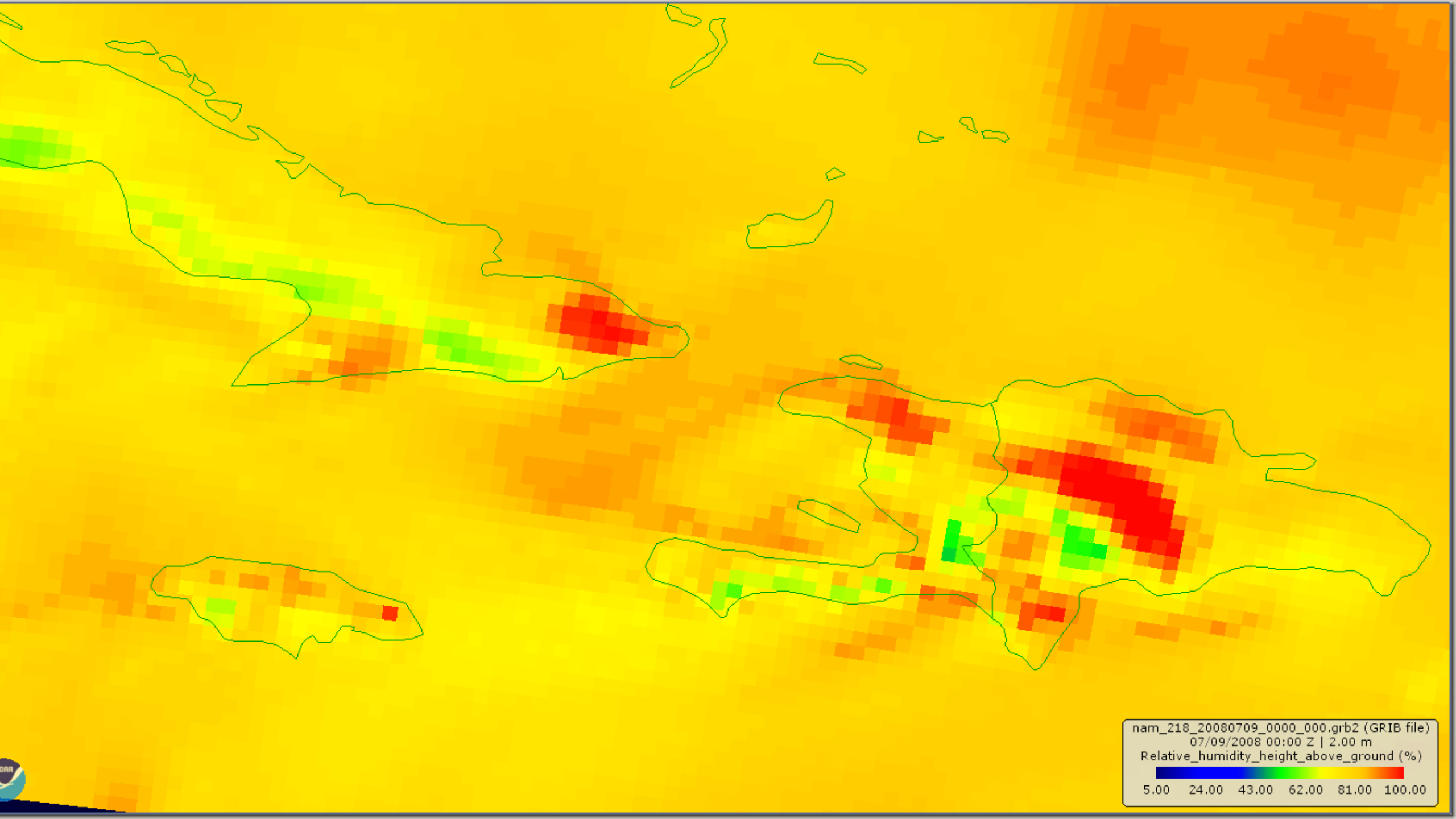
- After the data is selected, it is trimmed to only cover the gulf of Mexico.
- The data needs to be converted into a specific format that ADCIRC uses.



# North American Mesoscale Forecasting System (NAM) contd.

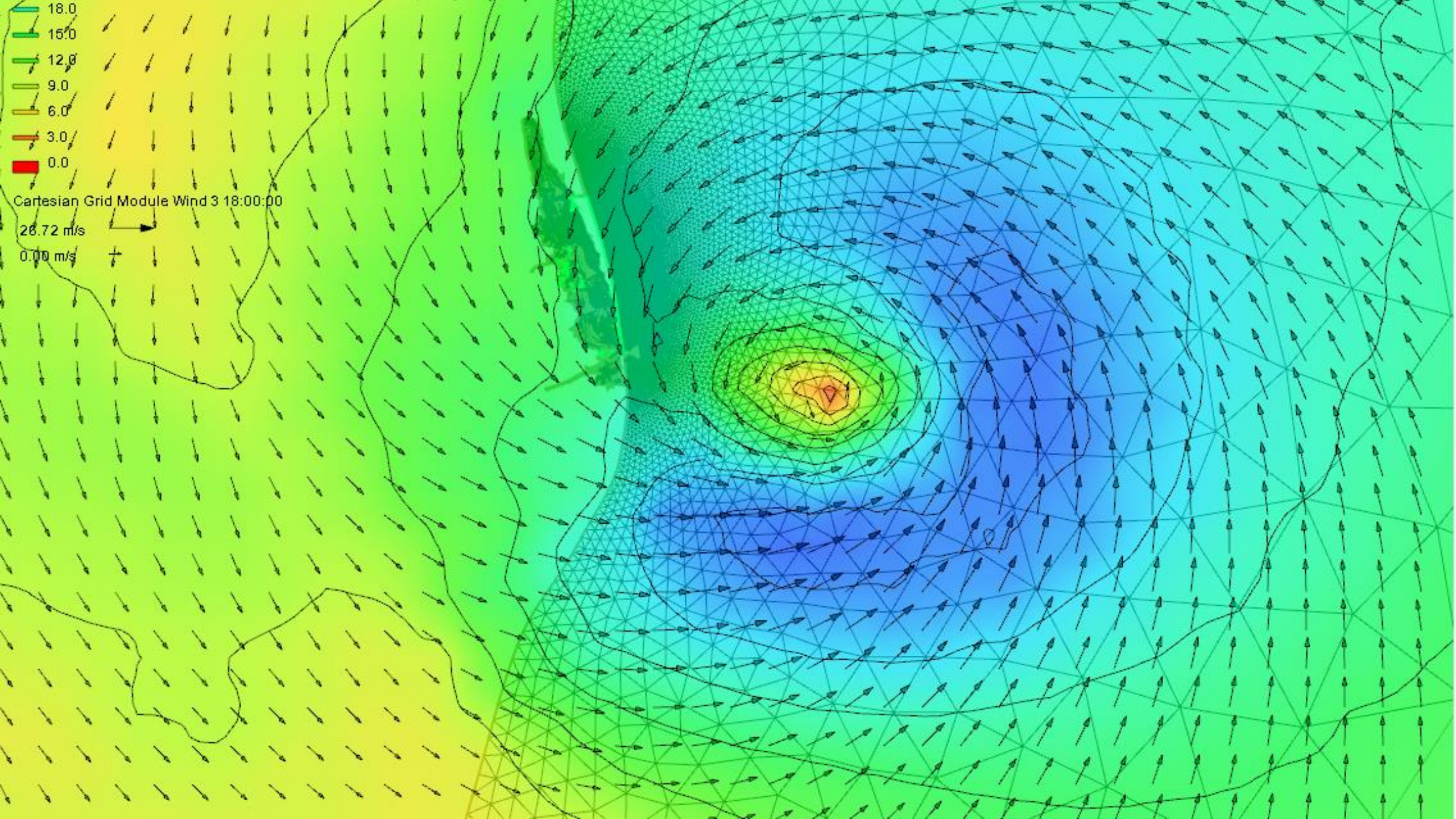
- The data needs to be converted into a specific format that ADCIRC uses.
- Examples and documentation are close to nonexistent.
- First test runs were unstable because NAM data was not regularly spaced.

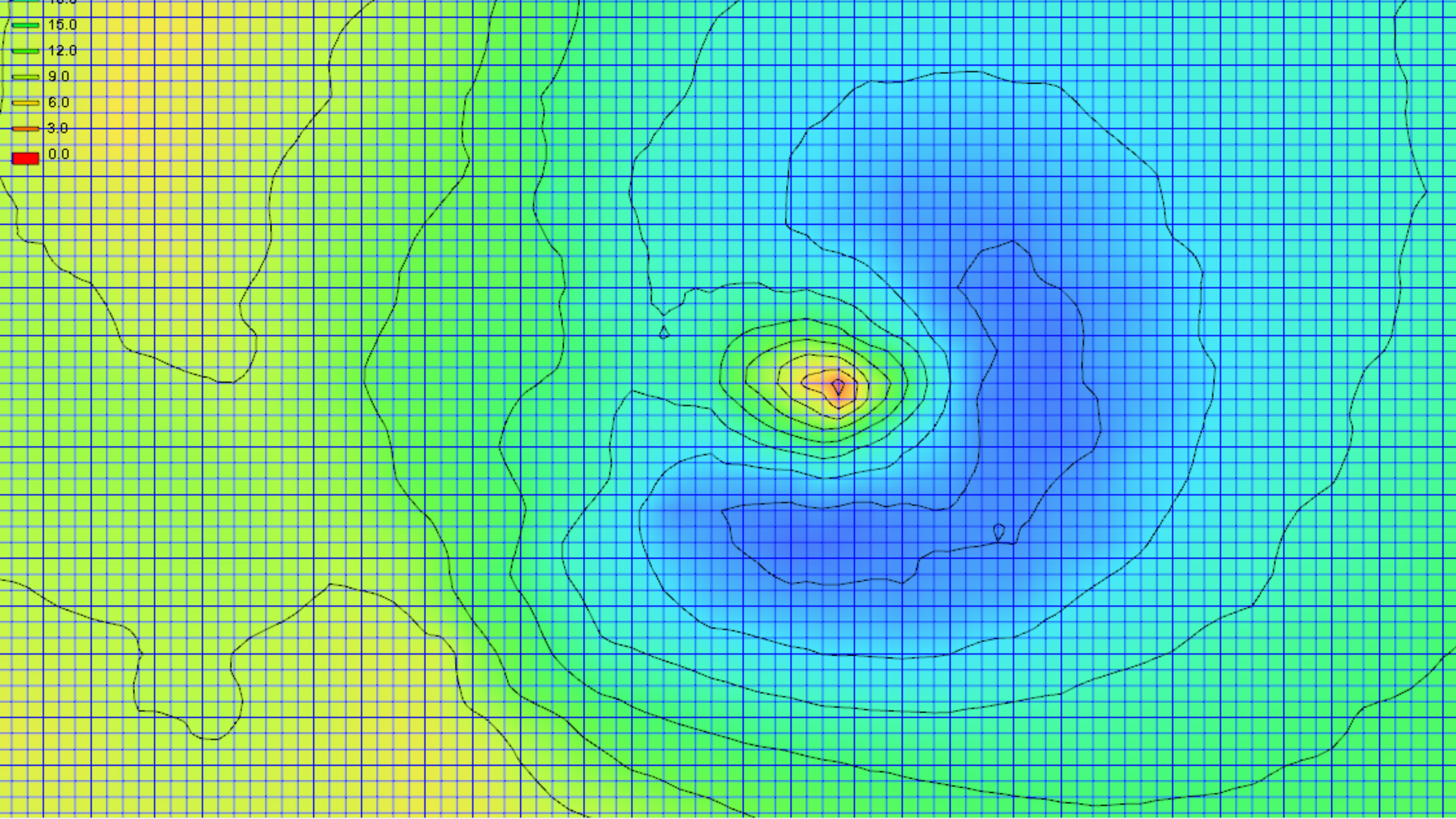




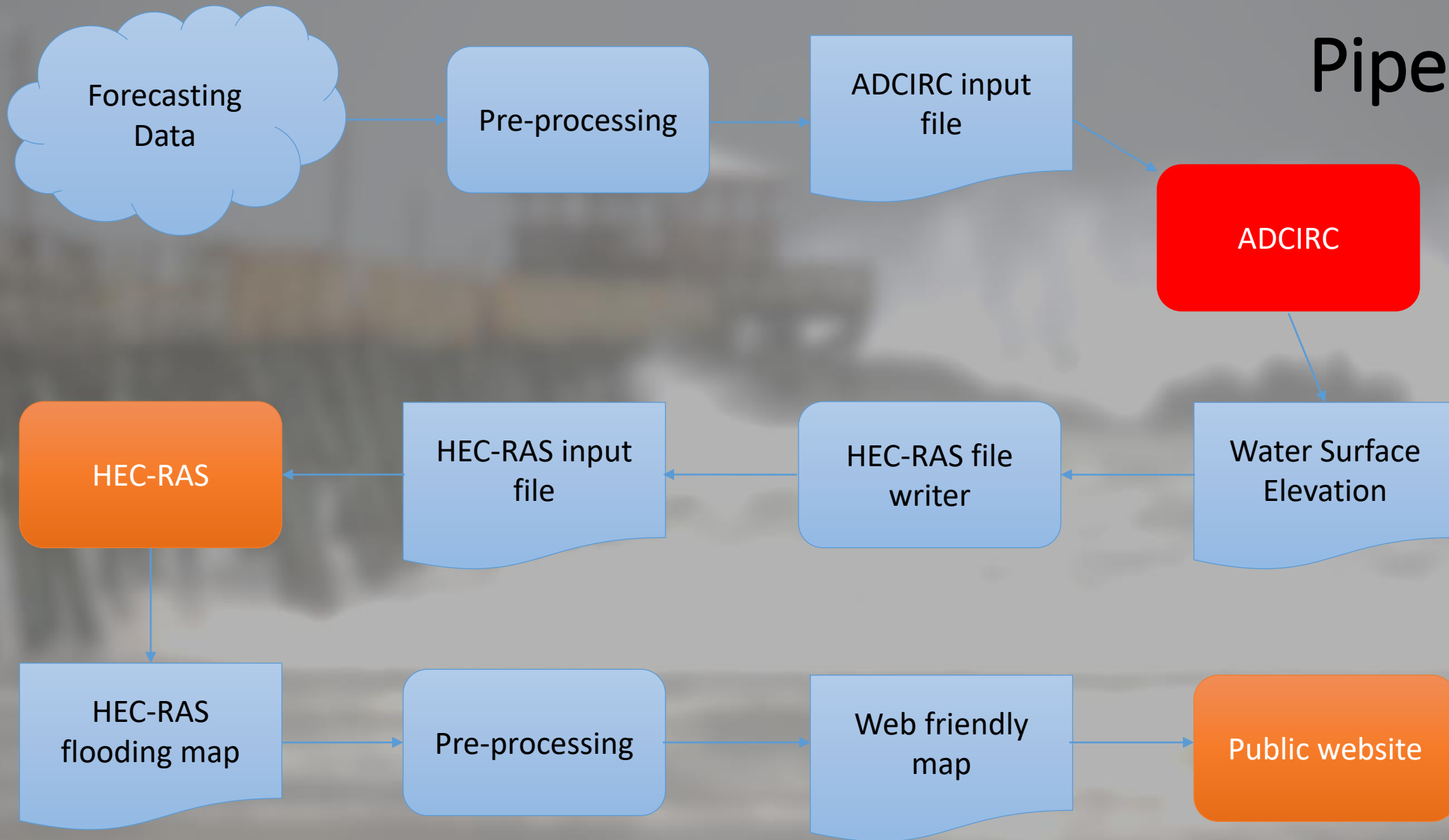
nam\_218\_20080709\_0000\_000.grb2 (GRIB file)  
07/09/2008 00:00 Z | 2.00 m  
Relative\_humidity\_height\_above\_ground (%)

5.00	24.00	43.00	62.00	81.00	100.00
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# Pipeline



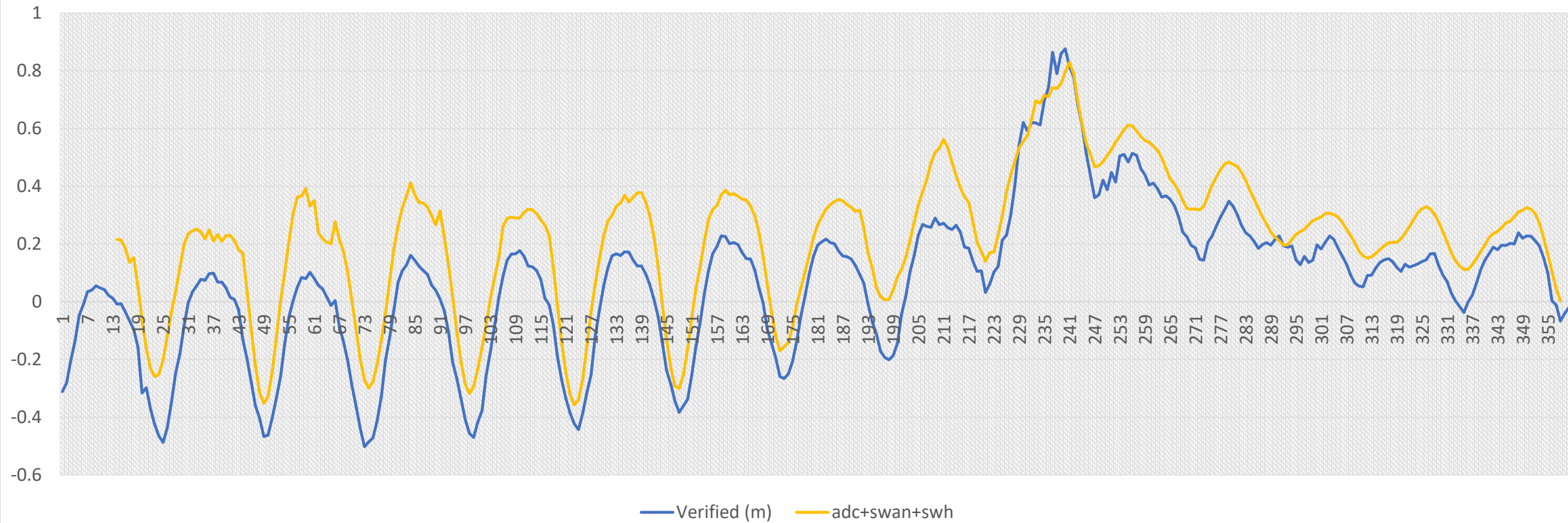
# ADCIRC

- ADCIRC can be installed in a Linux system
- It uses MPI to be executed in HPC solutions or several cores.
- ADCIRC is a command-line application that can be automated with Python tools.

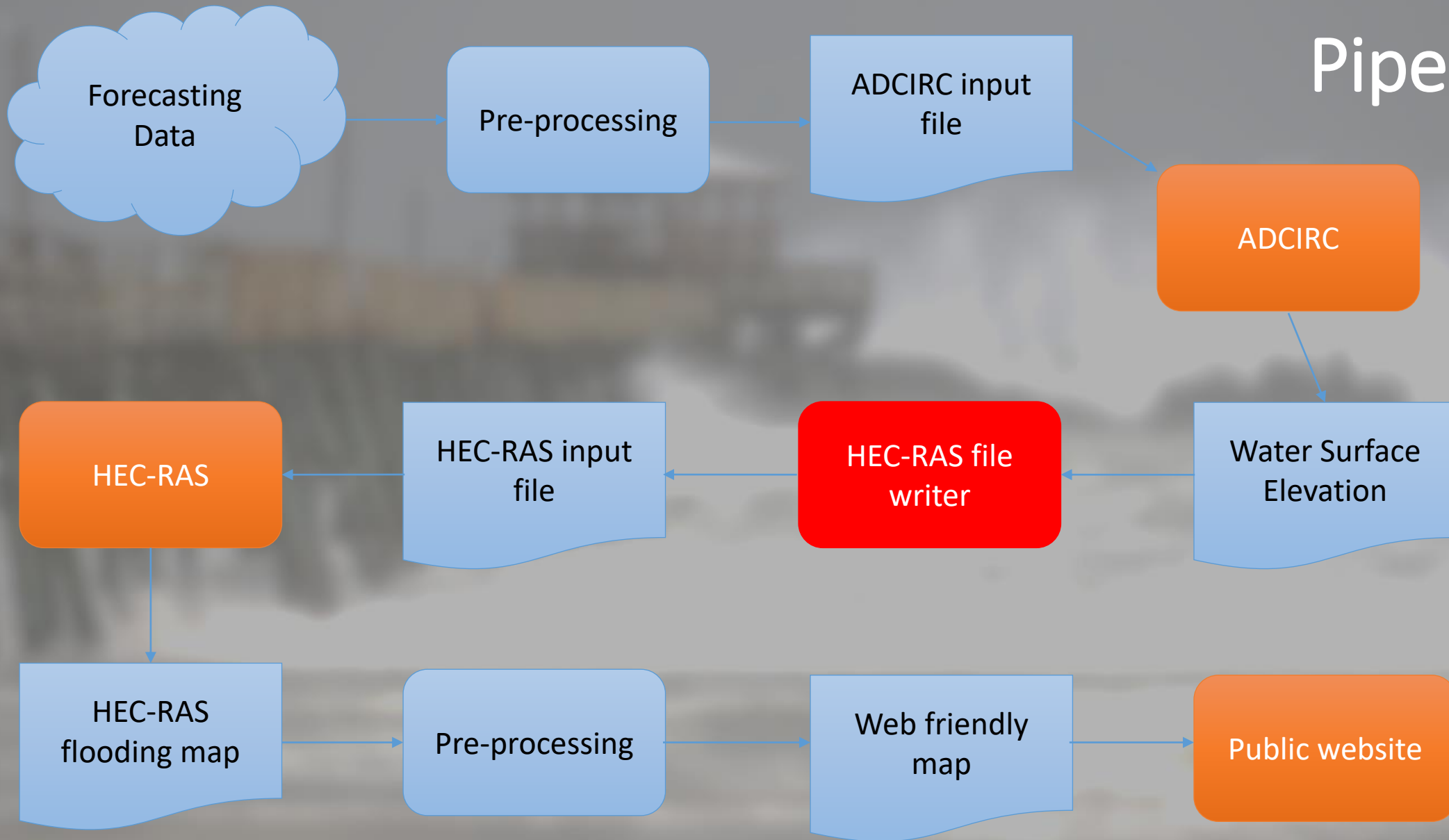
- After an ADCIRC simulation is complete. The script checks the return value of the MPI call to see if the simulation was run to completion.
- Another function is called to extract the water surface elevations.

# ADCIRC

Hurricane Alex 2010

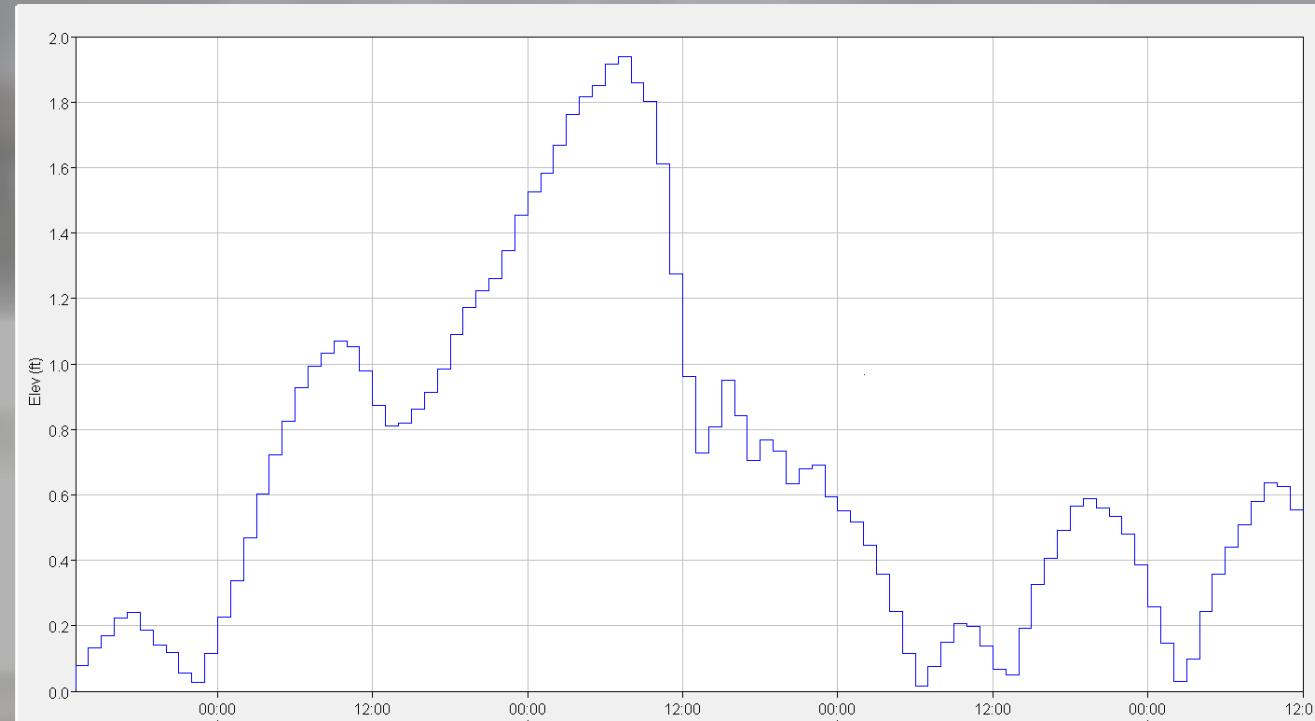


# Pipeline

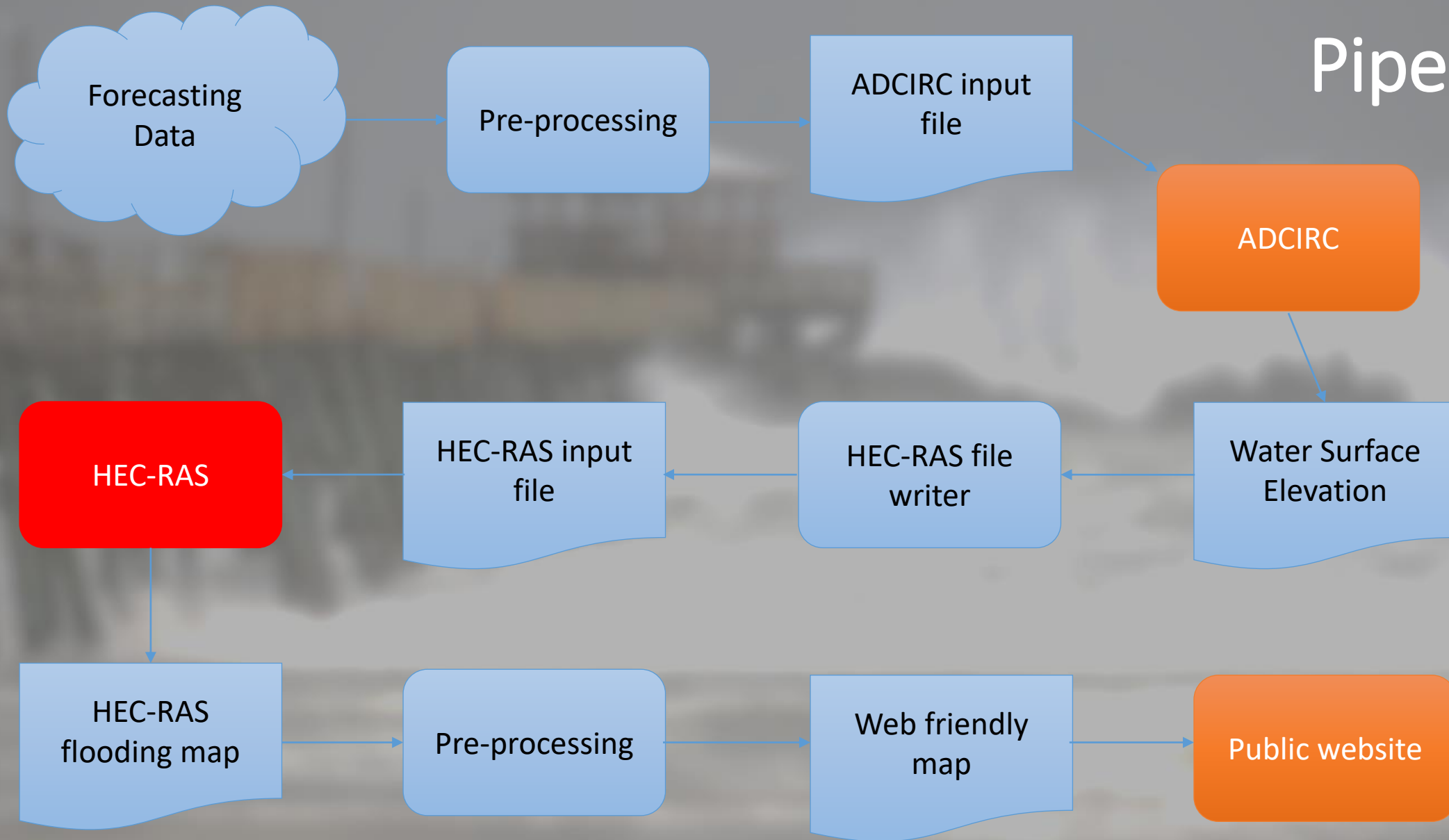


# HEC-RAS File Writer

- HEC-RAS is the second model involved in the system. It is developed by the US Army Corps of Engineers.
- It uses a special database file to read its input parameters called Data Storage System or DSS.
- There is a library project called 'pydsstools' that offers some functionality for CRUD operations in DSS files with Python.

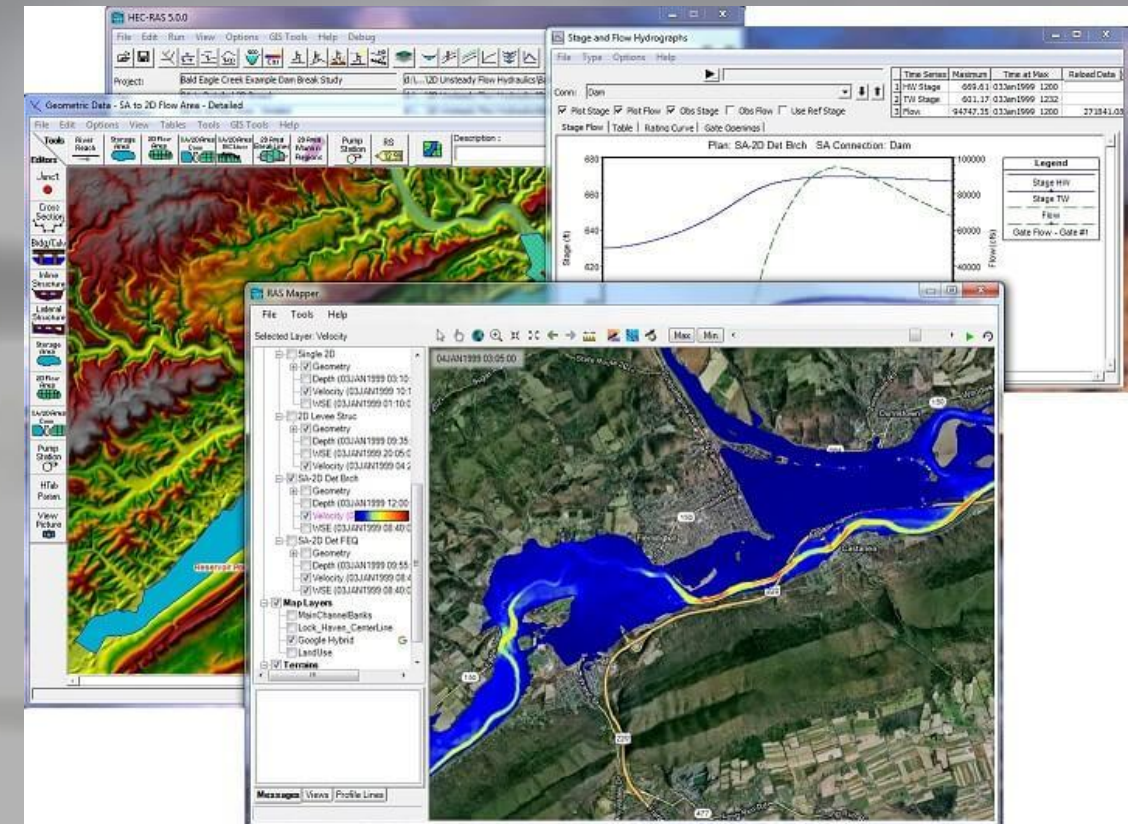


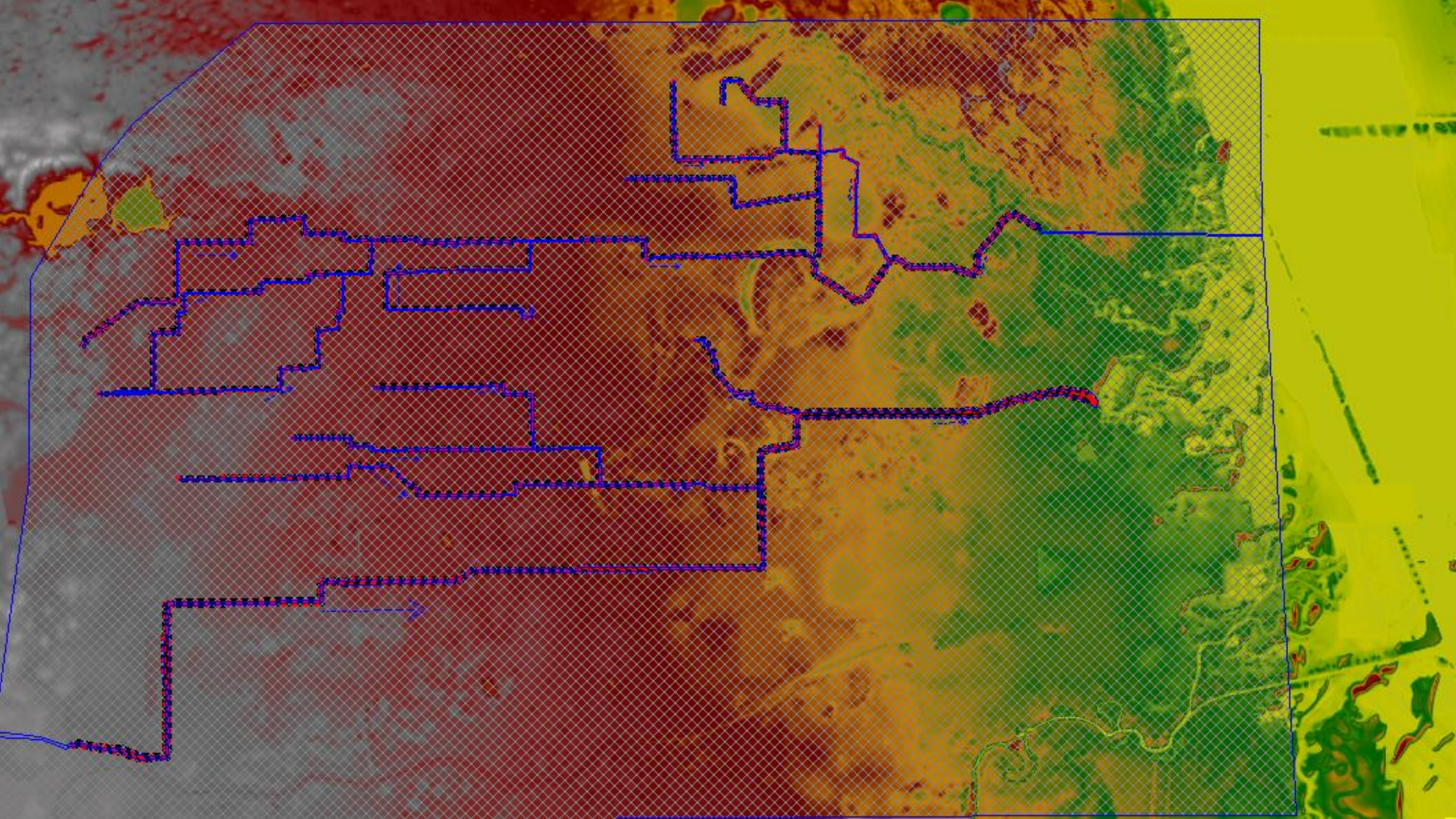
# Pipeline



# HEC-RAS

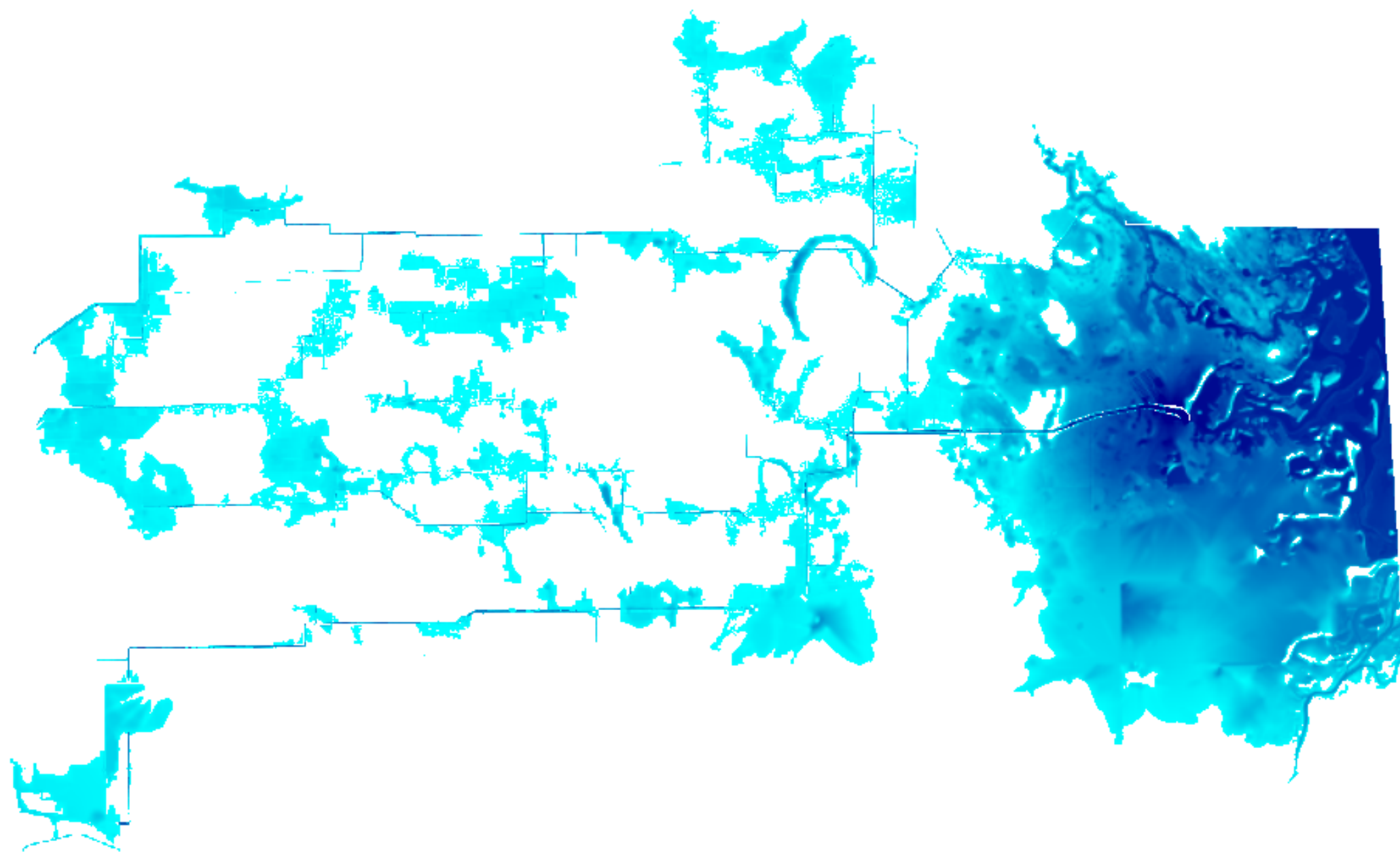
- River Analysis System (RAS). Is the second and last model to be used in the system. It will compute the final flooding map.

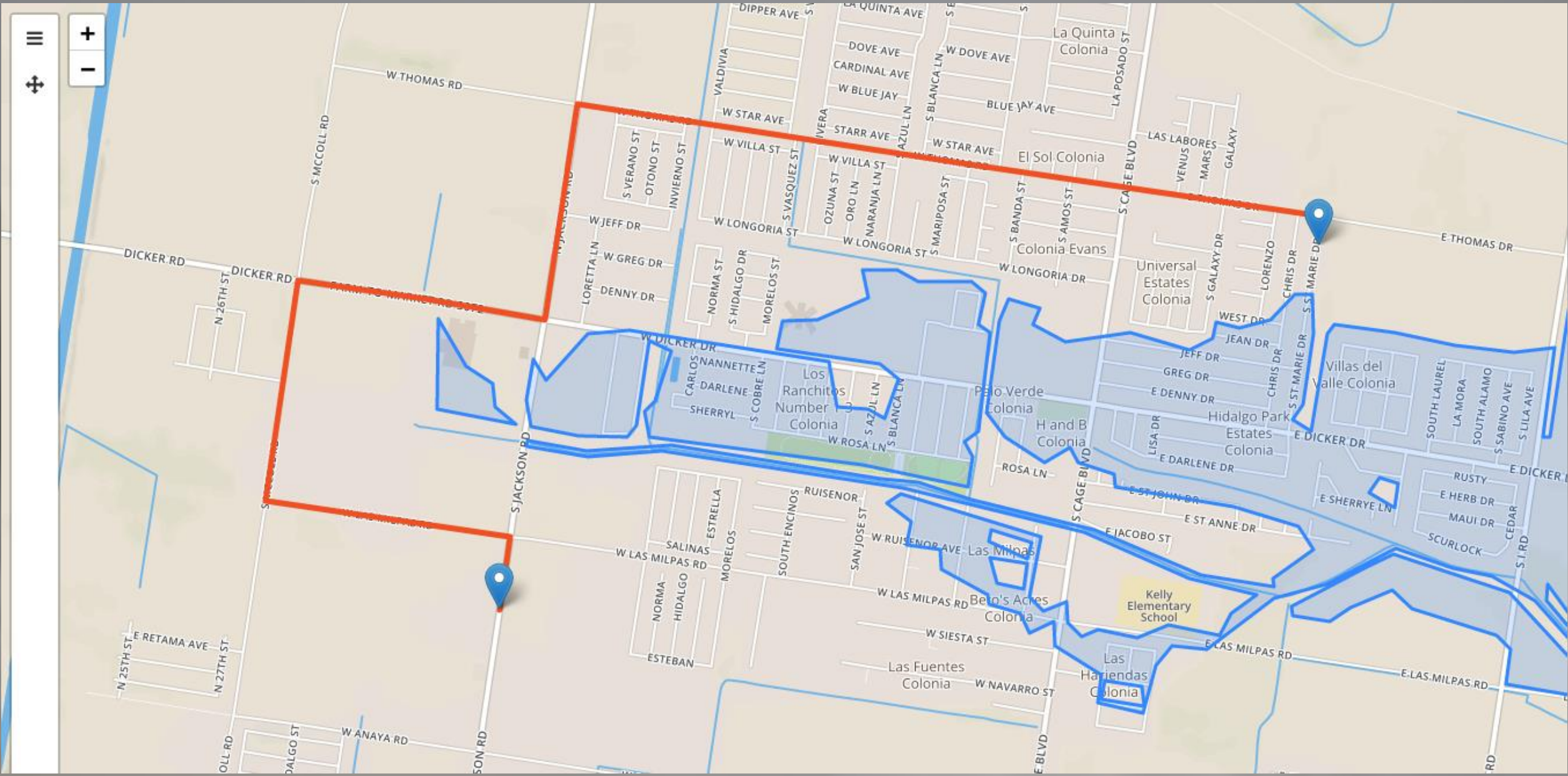




# HEC-RAS

- Automation of this system is done with the help of a Python script.
- This script communicates with HEC-RAS through a Component Object Model (COM) interface originally intended to be used with Visual Basic.
- RAS provides the final flood map to be uploaded to the website





# Artificial Intelligence for Storm Surge

- It is possible to use A.I. to predict storm surge
- Based on same input as ADCIRC
- ADCIRC requires great amounts of computational power
- Deep learning based Artificial Intelligence algorithm can help to substantially lower computational times and resources needed

# Artificial Intelligence for Storm Surge

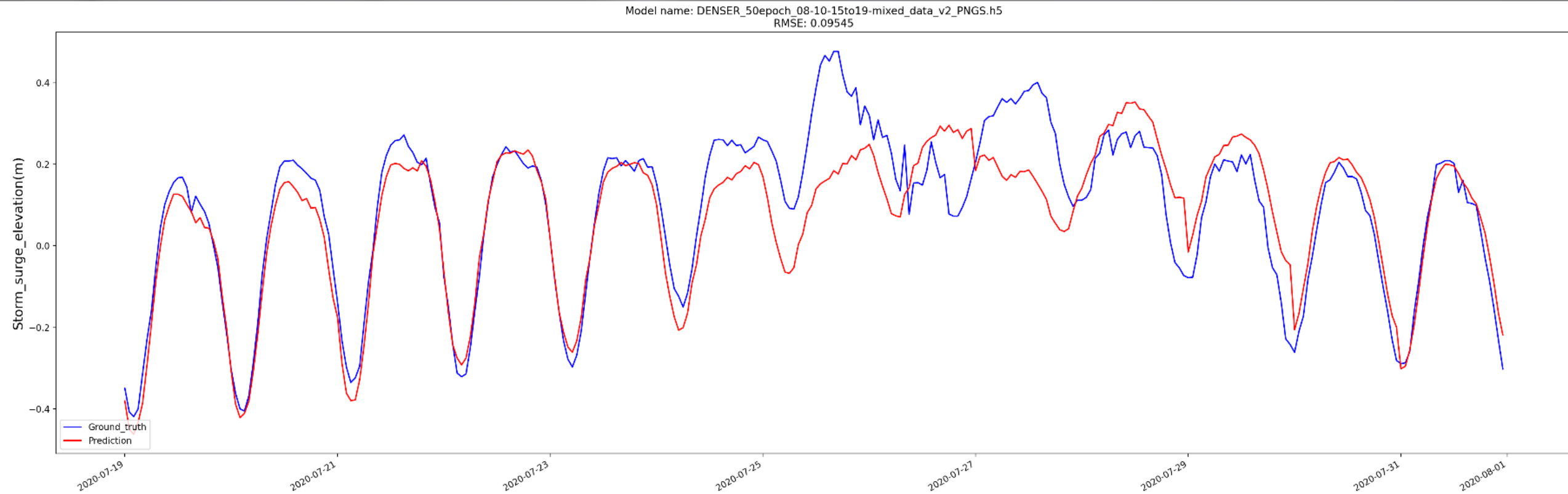
- A surrogate model is being developed for the Lower Laguna Madre and South Padre Island area using ADCIRC and forecasted gridded weather variables
- A.I. model will replicate storm surge results by ADCIRC

# Data

- NAM dataset is being used
- Data range from 2005 to 2020
- Historical buoy station data
- ADCIRC model simulation results



# Results



- Hurricane Hanna (2020)