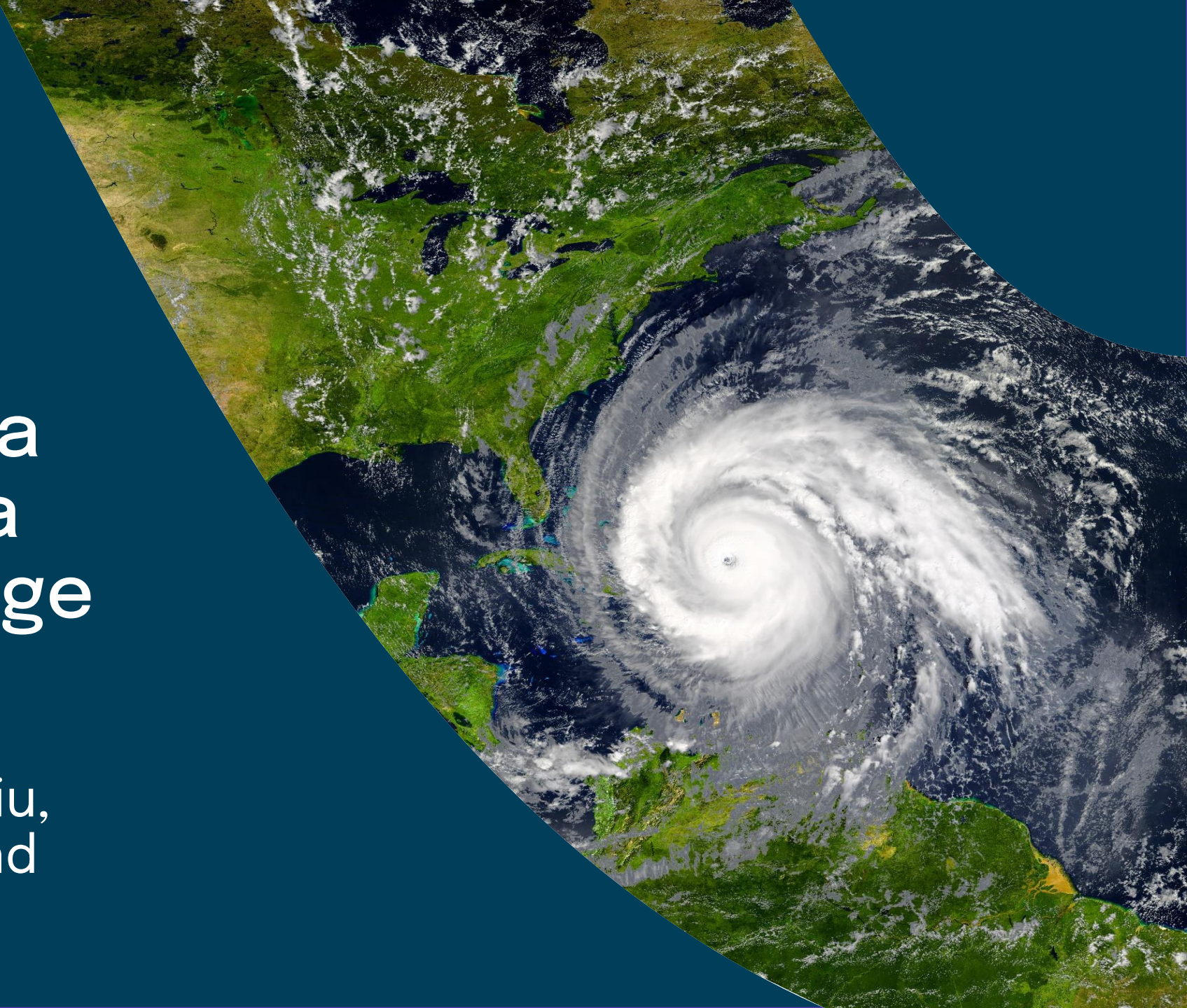




# Grand Bahama and Eleuthera hurricane surge pilot study

Stephen Grey, Ye Liu,  
Michael Turnbull and  
Jeffery Simmons



# Grand Bahama and Eleuthera hurricane surge pilot study

## Organisation

Pilot project for The Bahamas Department of Meteorology

- Funded by the Green Climate Fund through the Caribbean Community Climate Change Centre

Contractors:

- HR Wallingford Ltd (UK)
- SEV Consulting (The Bahamas)

Grand Bahama and Eleuthera

- LiDAR survey data available

## Scope

Storm surge model

- Storm surge due to hurricanes
- Flooding
- Forecast

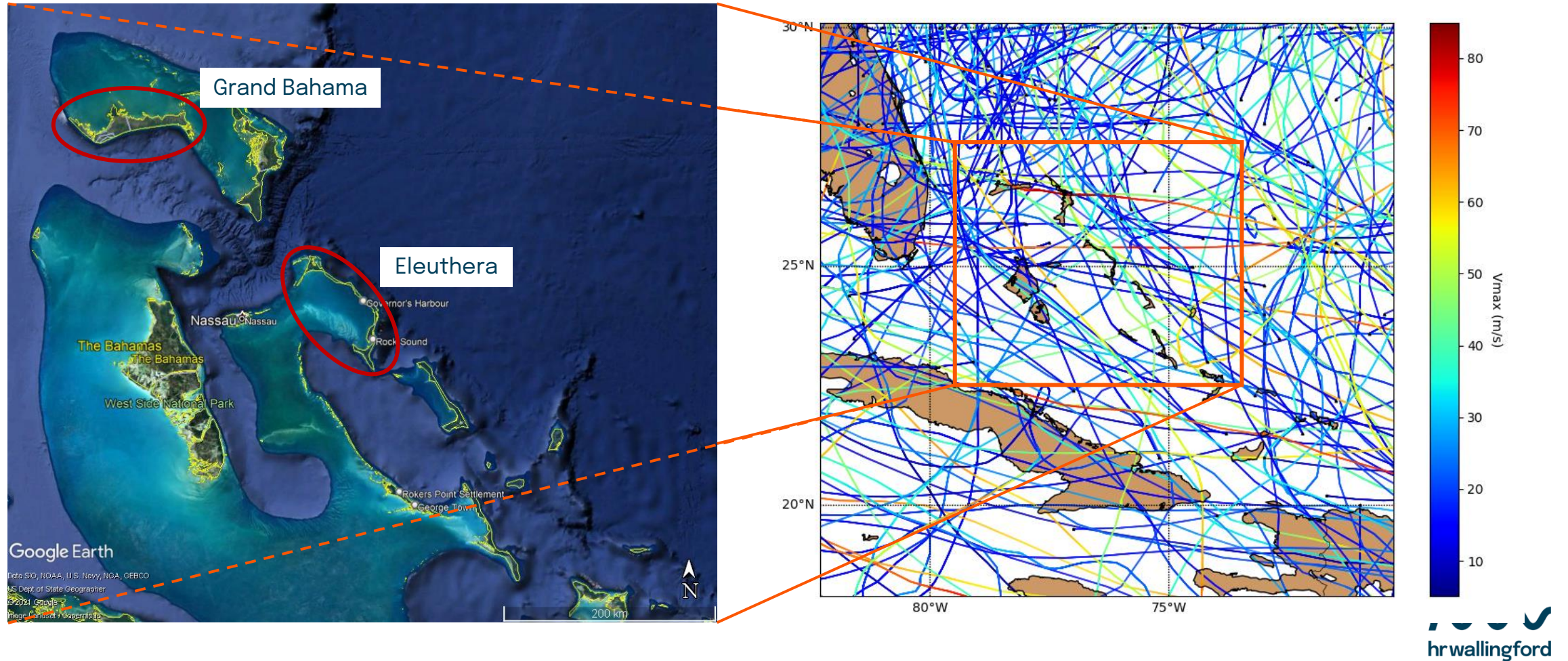
Storm surge atlas

- Reference tool for flooding risk
- Climate change scenarios

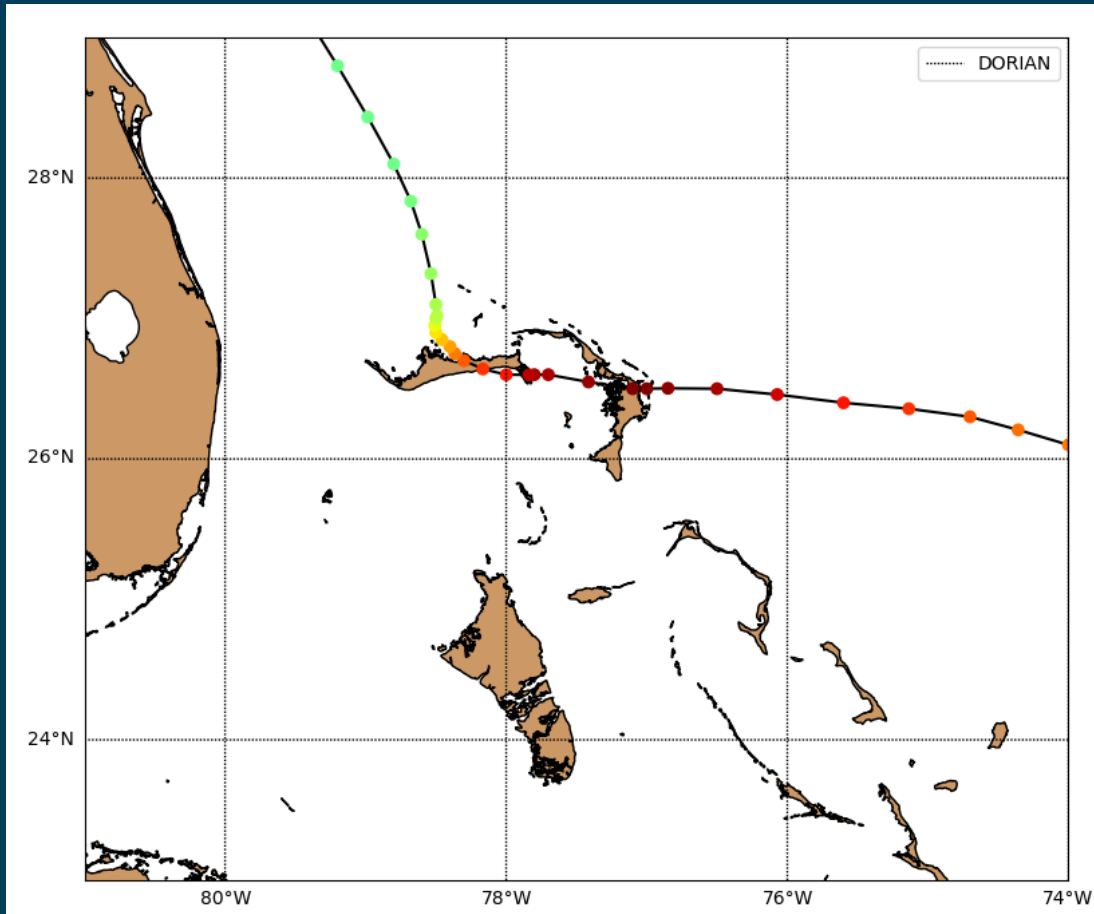
Digital platform

- Hosted and run by Bahamas Department of Meteorology

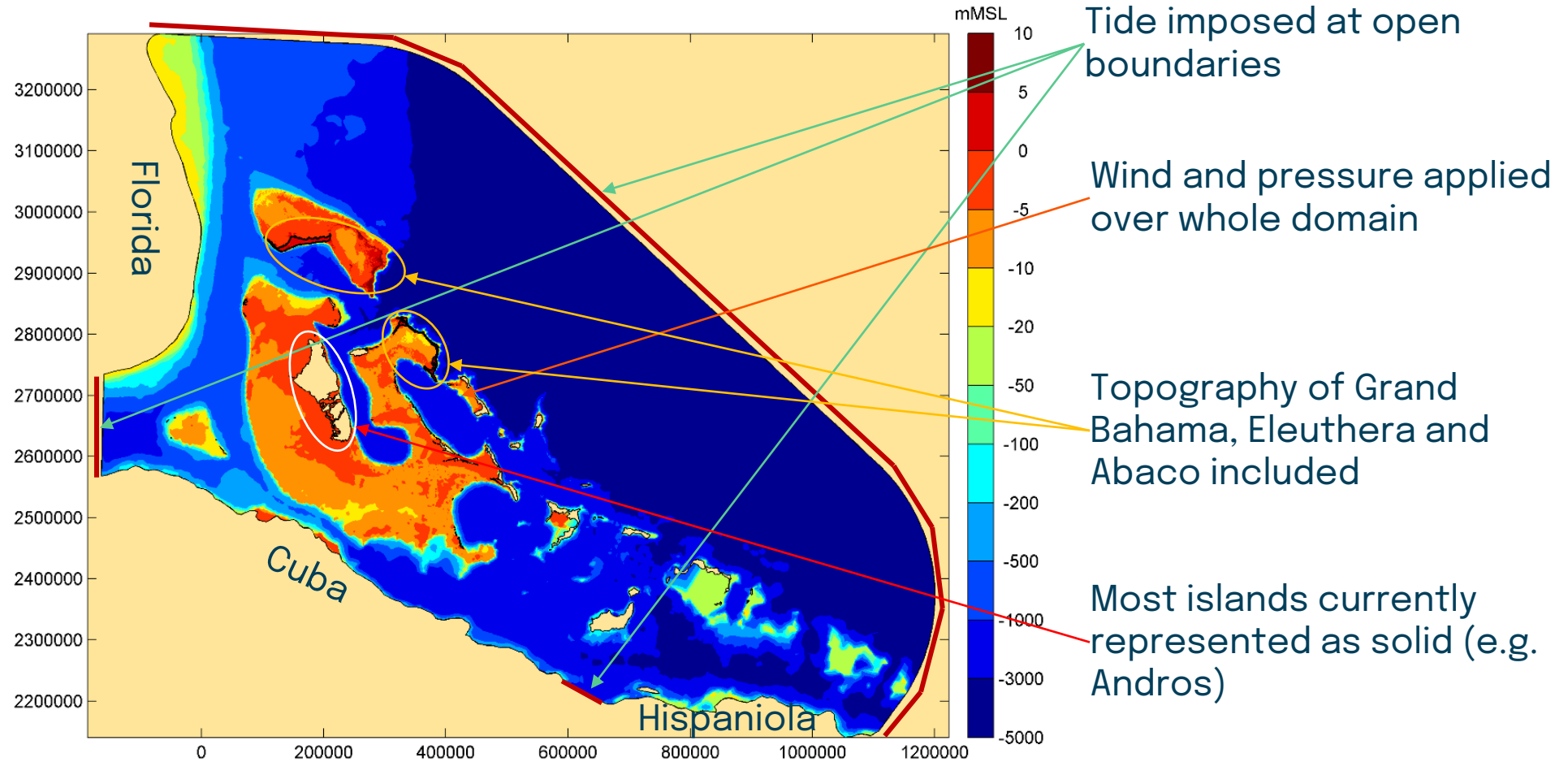
# The Bahamas Storm Surge Pilot Study



# Hurricane Dorian 2019



# Bahamas hurricane surge model – TELEMAC-2D



\\hrw-uk.local\projects\live\der6456S\3\_technical\bathy\Mesh\UTM18\Bahamas\_mesh2\_UTM18\_MSL.sel  
\\hrw-uk.local\projects\live\der6456S\3\_technical\bathy\Mesh\UTM18\WholeBathy.mws

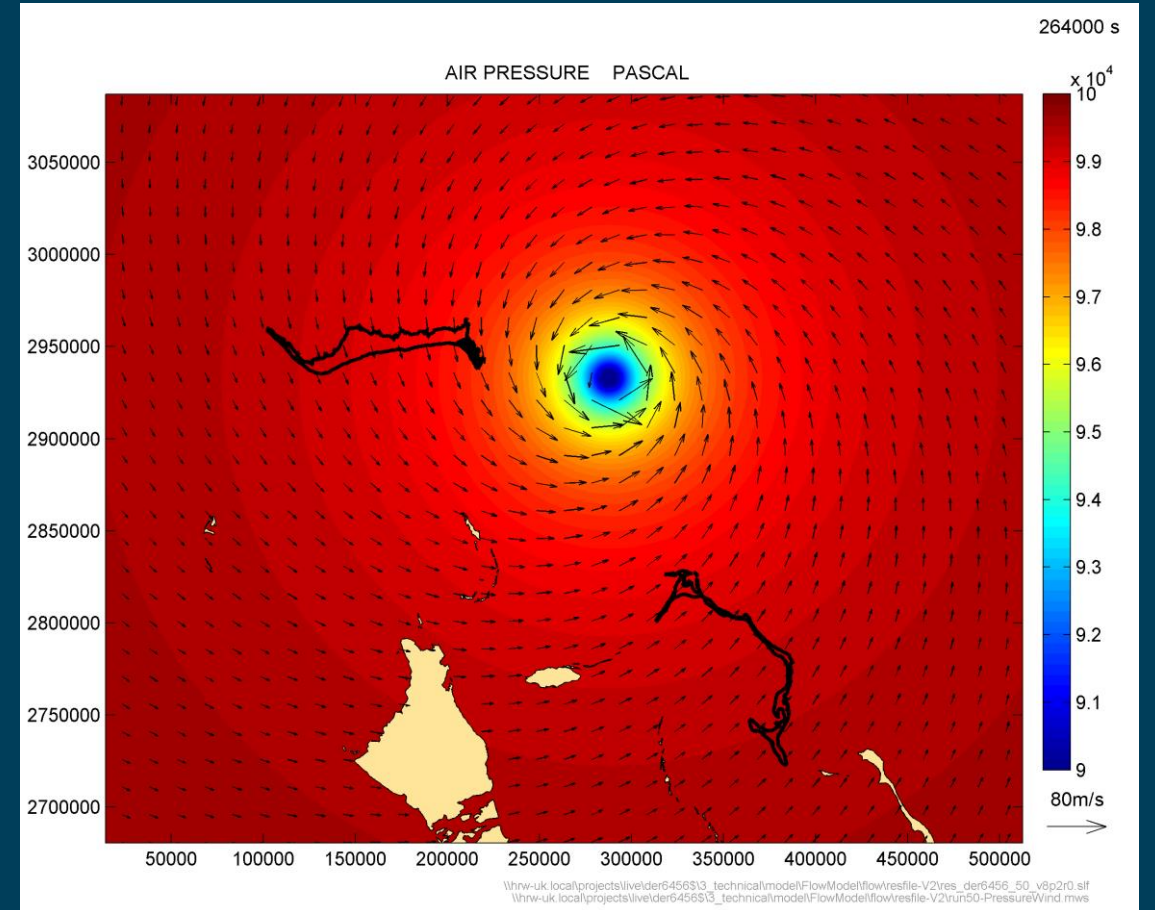
# Model inputs

## Tide

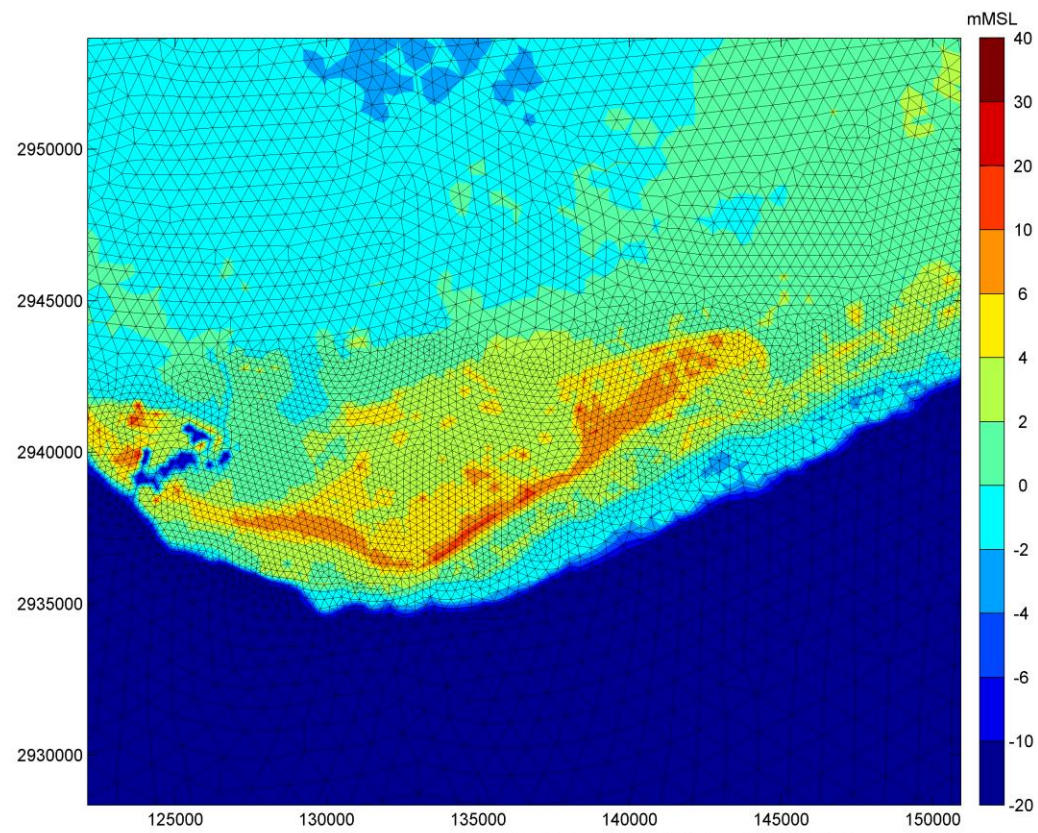
- Imposed around the open boundaries

## Atmospheric pressure and wind

- Time-varying 2D fields created from the hurricane track
- Domain-wide

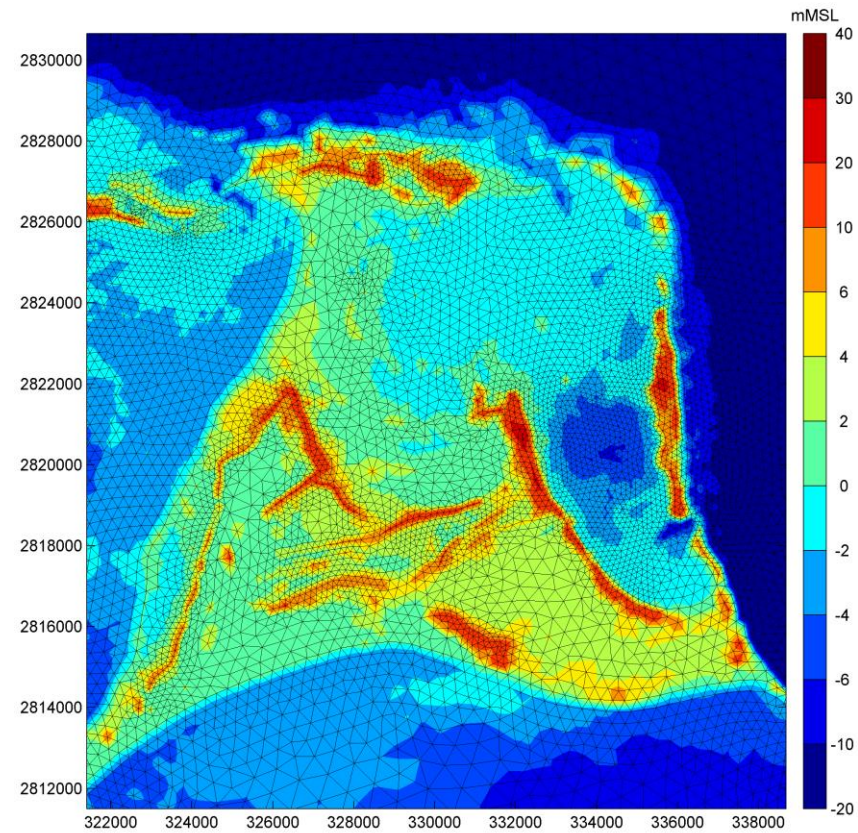


# Unstructured mesh



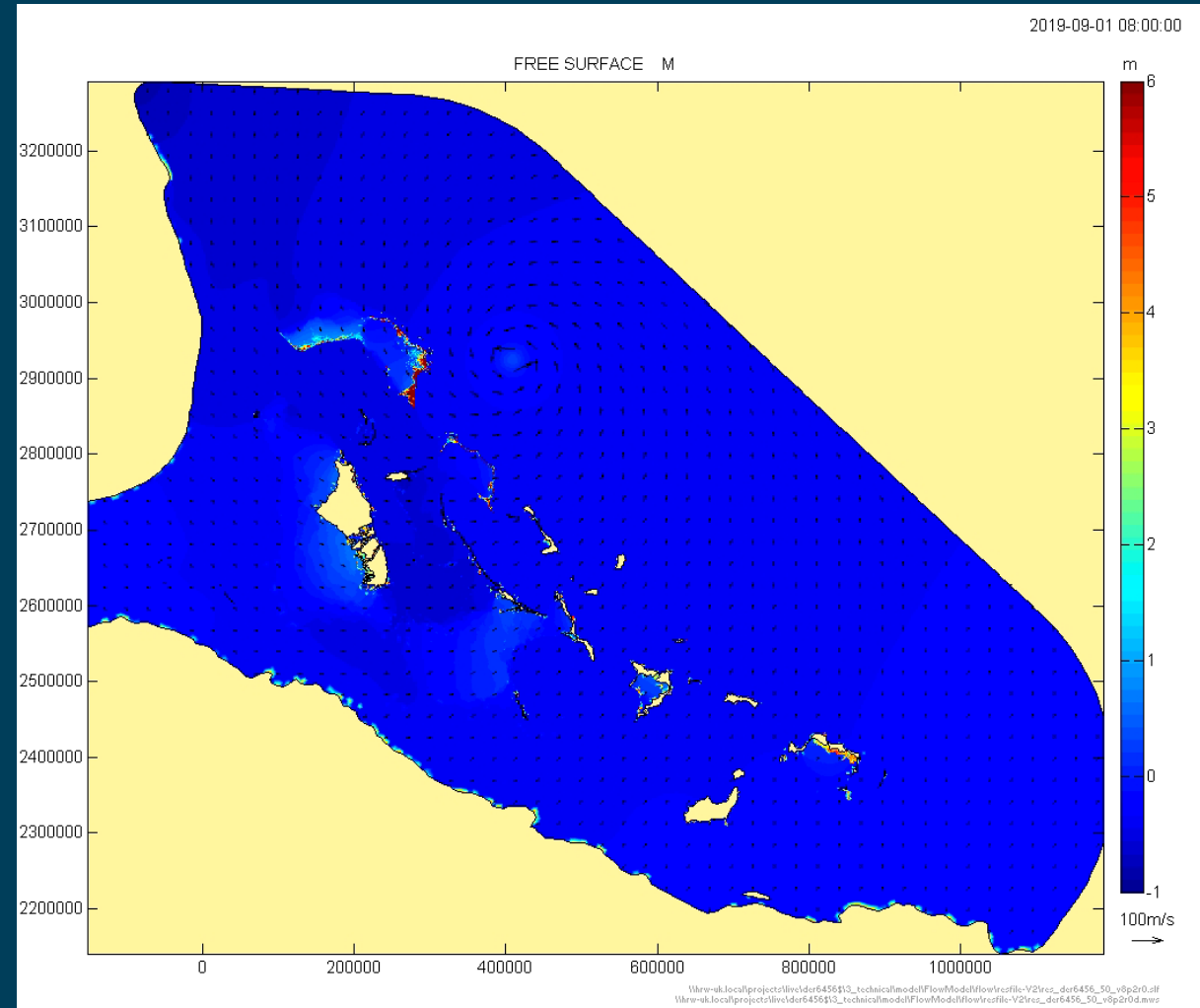
\\hvw-uk.local\projects\live\der64565\3\_technical\bathy\Mesh\UTM18\Bahamas\_mesh2\_UTM18\_MSL.sel  
\\hvw-uk.local\projects\live\der64565\3\_technical\bathy\Mesh\UTM18\Grand5BahamaMesh.mws

Variable resolution – 150 m to 10 km



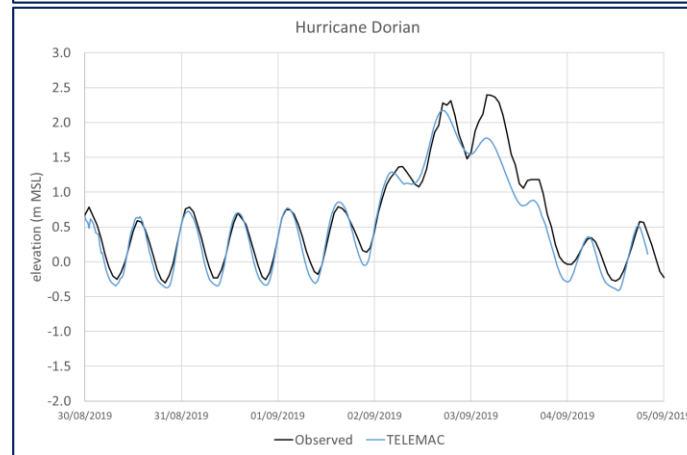
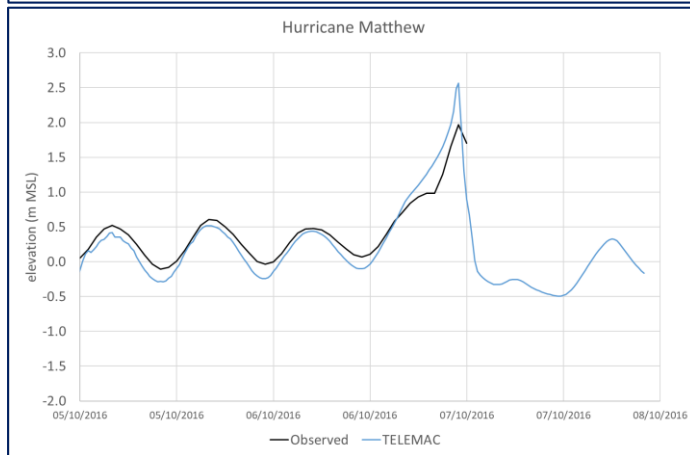
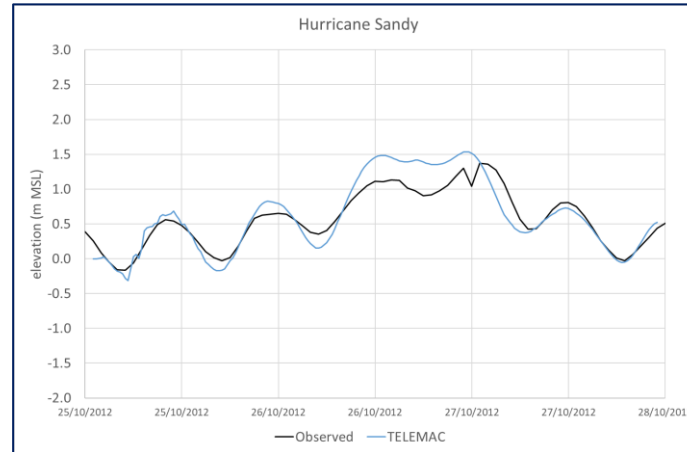
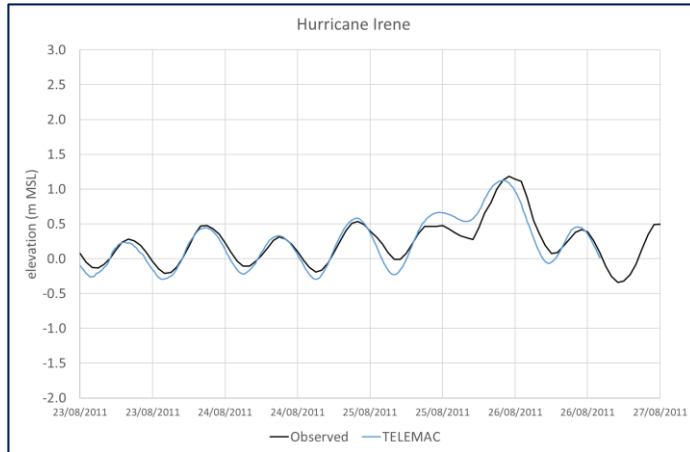
\\hvw-uk.local\projects\live\der64565\3\_technical\bathy\Mesh\UTM18\Bahamas\_mesh2\_UTM18\_MSL.sel  
\\hvw-uk.local\projects\live\der64565\3\_technical\bathy\Mesh\UTM18\EleutheraMesh.mws

# Hurricane Dorian simulation

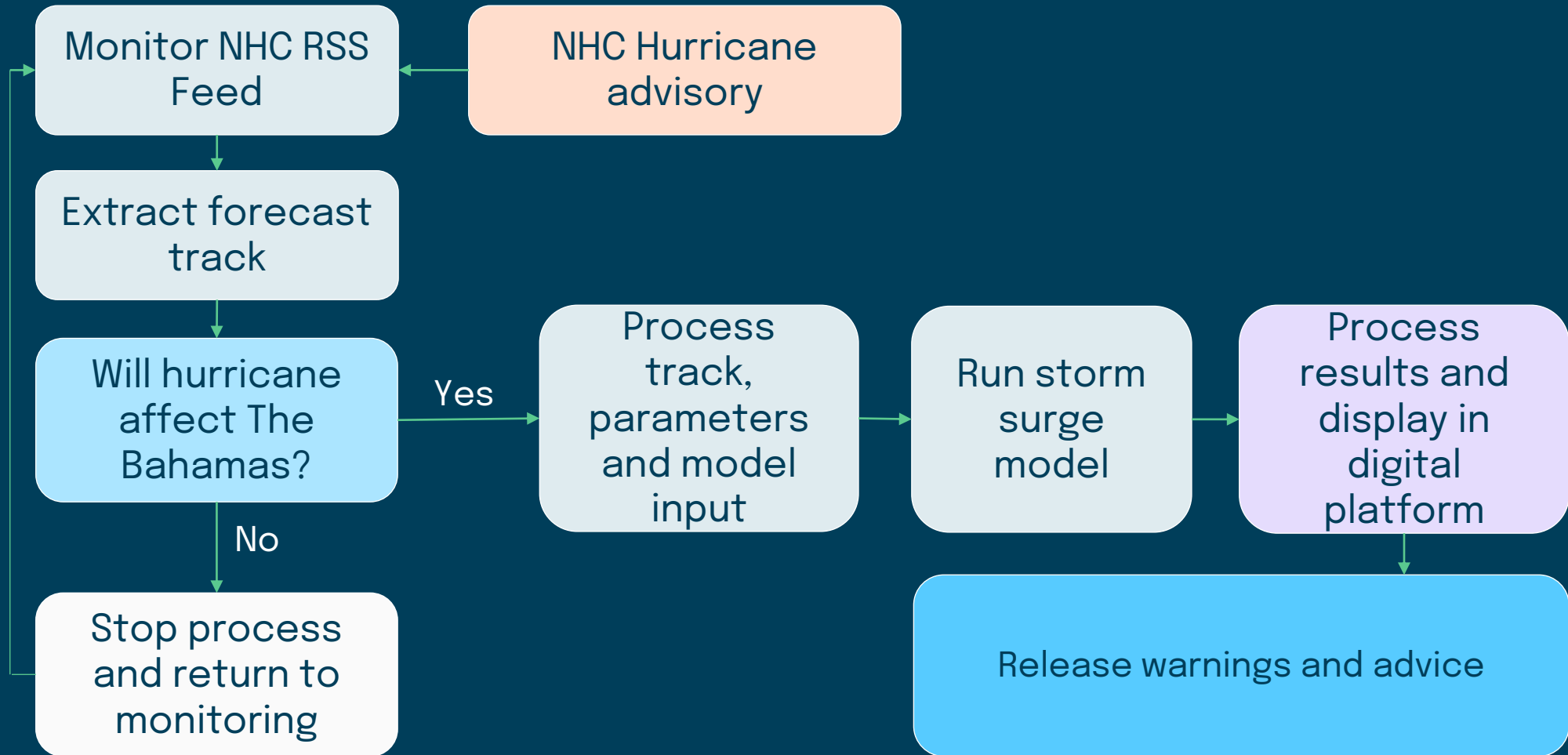




# Validation - Tide gauge at West End, Grand Bahama



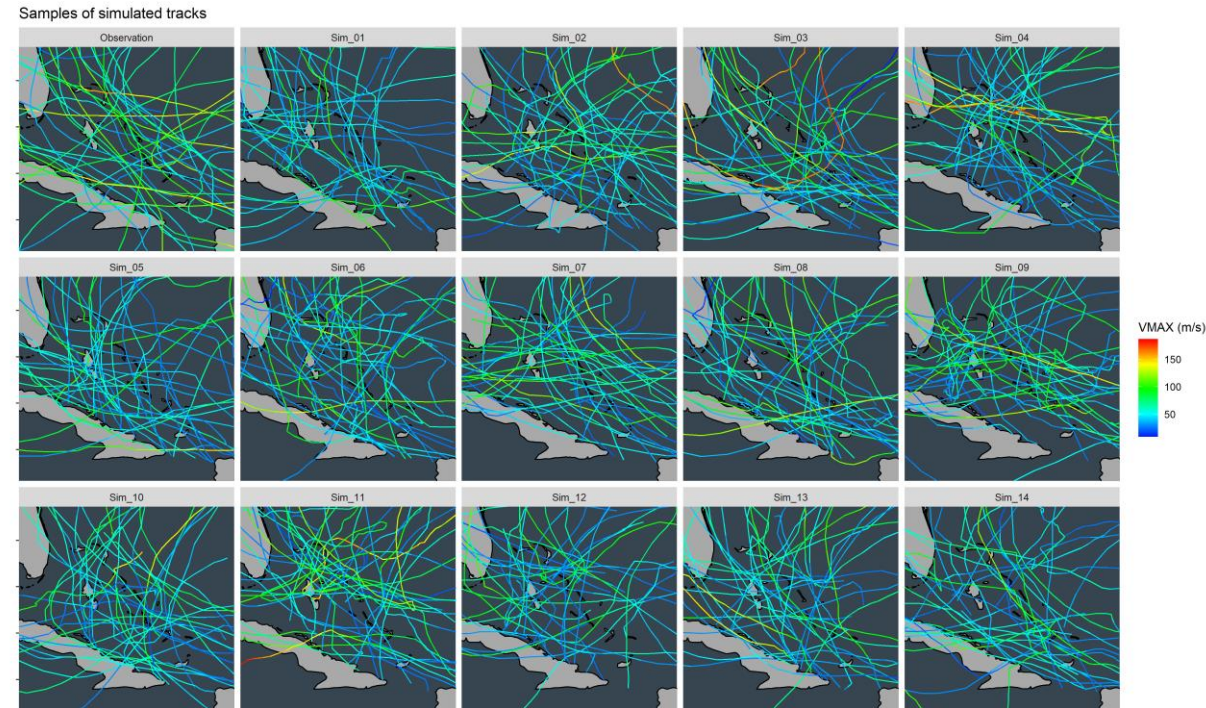
# Storm surge forecast process



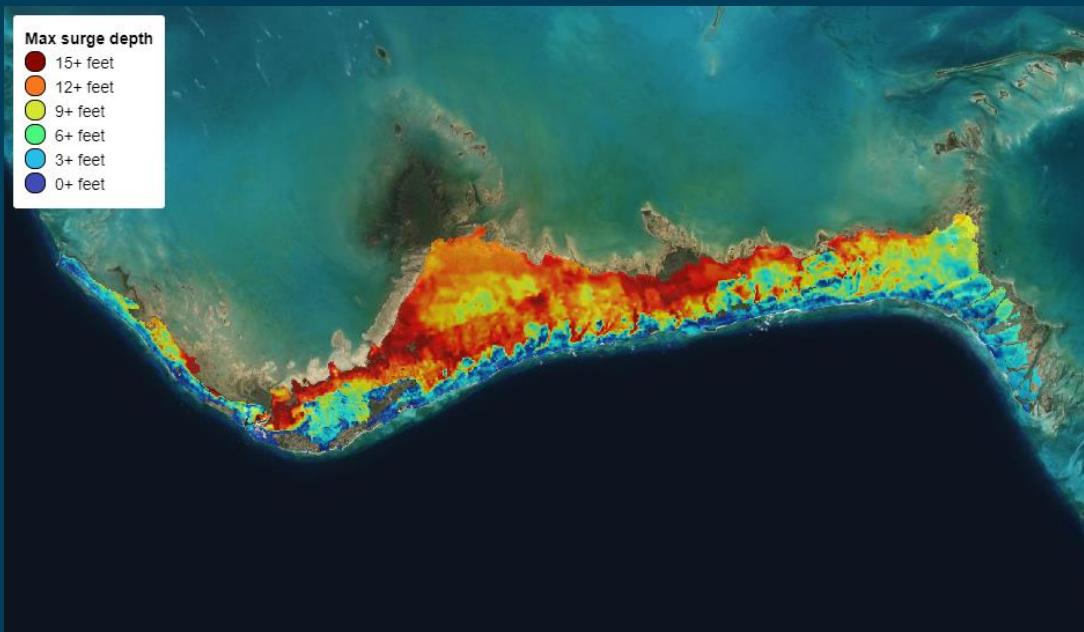
# Storm surge atlas

## Probabilistic method

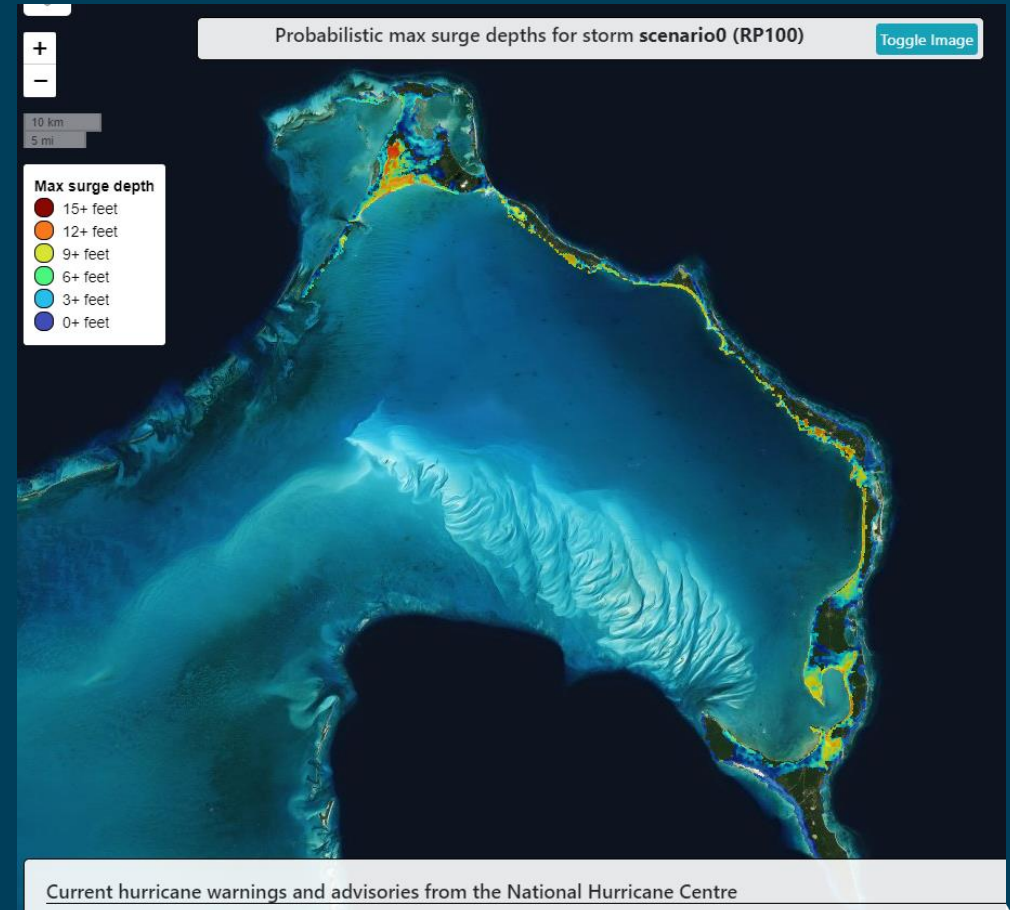
- Need to increase sample size for accurate flood risk assessment
- Stochastic track generation based on Grey and Liu (2019)
- Statistical analysis of historical hurricane tracks
- Generate 10,000 years of tracks with same statistical properties
- Model most severe synthetic cyclones affecting islands of interest



# Extreme flood depths



1:100 year return period flood

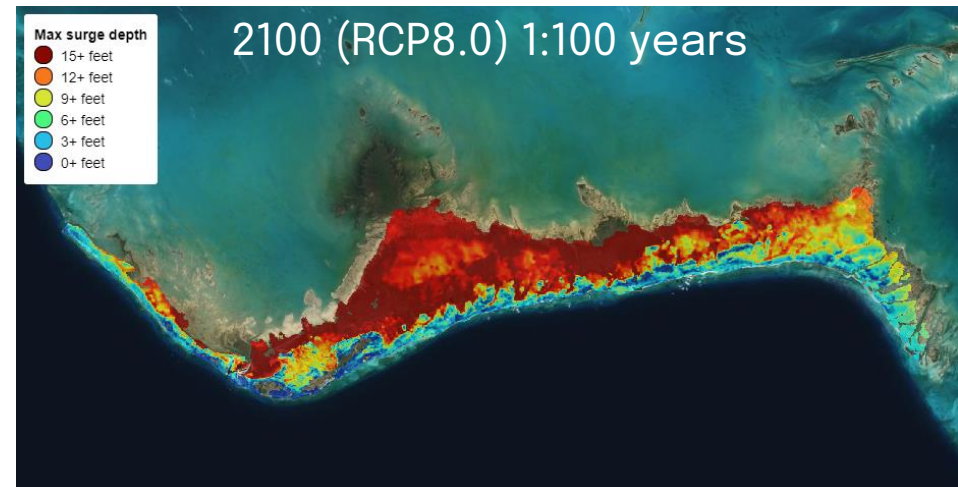
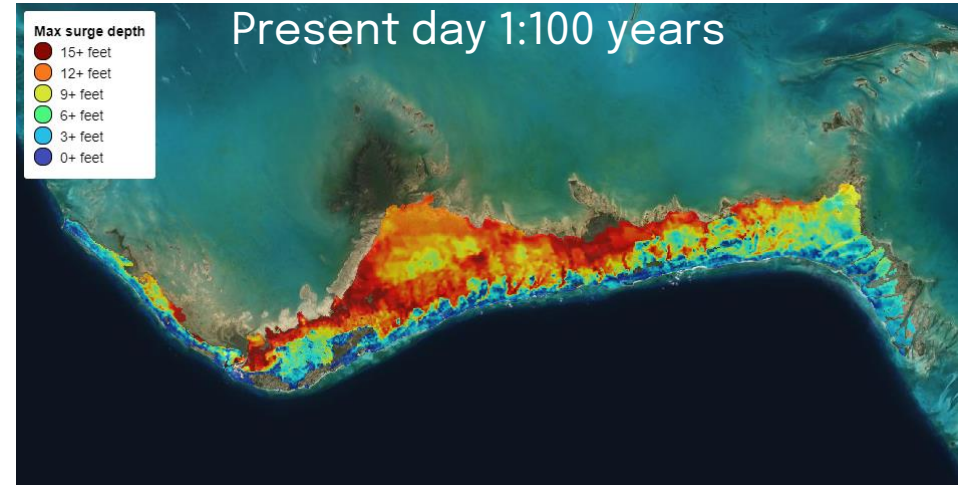


# Climate change scenarios

## Four scenarios:

- Present day
- 2055:
  - MSL increased by +0.3m
  - 5% increase in wind speed
- 2100 (RCP4.5):
  - MSL increased by +0.55m
  - 10% increase in wind speed
- 2100 (RCP8.0):
  - MSL increased by +0.84m
  - 10% increase in wind speed

IPCC 2019 (Oppenheimer 2019)



# Summary

## Storm surge model

- TELEMAC-2D model of The Bahamas
- Based on topographic surveys of Grand Bahama and Eleuthera
- Publicly available bathymetry
- Validated for four hurricanes
- Deterministic forecast based on NHC hurricane warning bulletins
- Installed and operated by Bahamas Department of Meteorology

## Storm surge atlas

- The likelihood of locations being affected by flooding
- Preparation for emergencies
- Planning regulations
- Selecting sites for development to minimise exposure to flooding
- Designing infrastructure to withstand flooding

# Further work

## **Improvements to the existing model:**

- Bathymetric surveys over shallows close to islands
- Network of tide gauges benchmarked to land datum
  - Further validation of model

## **Extend the model and atlas to include all of The Bahamas**

- The model has been set up so that other islands can be included later
- Require LiDAR, bathymetric surveys & tide gauges
- Run synthetic hurricanes specific to the other islands

## **Probabilistic forecast involving ensemble modelling**