

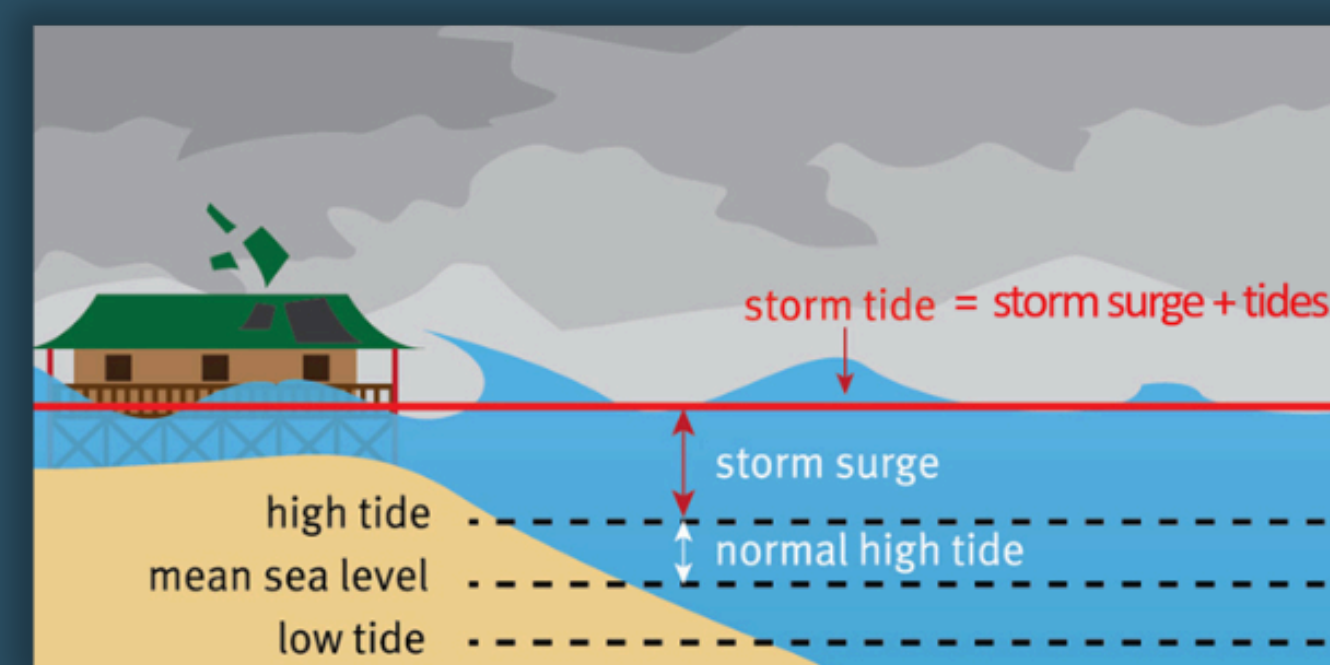
# Identifying the Extreme Scenario of Storm Tides from Tropical Cyclones in Coastal Communities

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## Introduction & Motivation

### Background

- Storm surge, an increase in water levels above tides, is the leading cause of damage by hurricanes and other coastal storms (0.5m to 3m).
- “Extreme Storm Tides” are those that cause water levels exceed 3m caused by major hurricanes.
- Extreme storm tides are:
  - Difficult to predict
  - Require lots of data
  - Computationally expensive
- Impacts from extreme storm tides are devastating.



#### Transportation Blockage

- Flooded Roads
- Flooded Rail
- Collapsed/ Damaged Bridges

#### Structural Failure

- Homes
- Hospitals
- Levees
- Lift Stations

#### Critical Infrastructure

- Military Installations
- Dams
- Hospitals

#### Critical Utility Failure

- Downed Electricity
- Water/Wastewater Plants



## Research Questions

- What **storm parameters/combinations** influence extreme storm tides?
- What is the **worst possible storm tide** at a specific coastal location?
- How will **future climate conditions** affect the worst possible storm tide at a specific coastal location?

## Objective:

To Build a Framework to Identify The Extreme Storm Scenario (“The Worst-Possible Storm”)

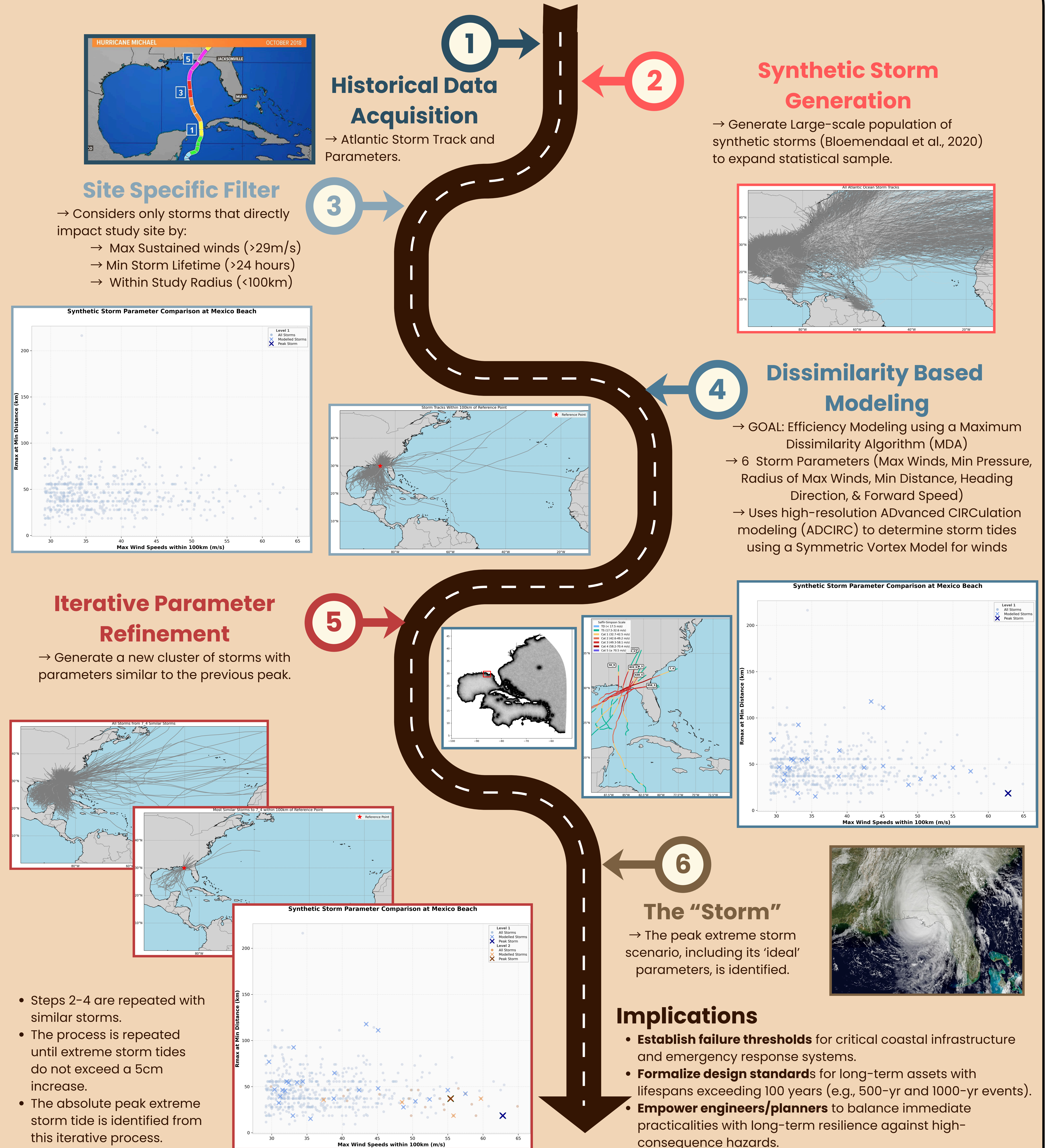
## Preliminary Results

- 46 Years of historical storms obtained (1980–2025).
- Storms generated from 1000-yr, 5000-yr, and 10000-yr simulations
  - +50k synthetic storms generated
  - 9302 synthetic storms in 10000-yr simulation
- 256 storms filtered for Mexico Beach
- MDA identifies the most dissimilar storms from the sample set.
- 15 Pairwise Combinations between storm parameters show early trends for strong storms.
- 2 Storms identified as more extreme than Michael (2018).
  - Synthetic storms provide just enough data for a Symmetric Vortex Model.

Number	Pairwise Combination
1	$V_{max}$ vs. $R_{max}$
2	$V_{max}$ vs. $P_{min}$
3	$V_{max}$ vs. $d_{min}$
4	$V_{max}$ vs. $\phi$
5	$V_{max}$ vs. $V_f$
6	$R_{max}$ vs. $P_{min}$
7	$R_{max}$ vs. $d_{min}$
8	$R_{max}$ vs. $\phi$
9	$R_{max}$ vs. $V_f$
10	$P_{min}$ vs. $d_{min}$
11	$P_{min}$ vs. $\phi$
12	$P_{min}$ vs. $V_f$
13	$d_{min}$ vs. $\phi$
14	$d_{min}$ vs. $V_f$
15	$\phi$ vs. $V_f$

Storm ID	Peak Storm Tides (m)
Michael**	3.24**
234_5	0.08
316_6	2.84
482_2	0.11
490_2	3.18
<b>50_9</b>	<b>3.46</b>
638_4	2.43
<b>7_4</b>	<b>3.32</b>
833_0	0.1
858_3	0.05

## Methodology: The Integrated Framework



## Future Work

- Calibrate storm selection to increase spatial and temporal similarity.
- Synthesize near-site characteristics with full-lifecycle storm behavior.
- Integrate future climate projections into the existing framework.
- Deploy the finalized model to a suite of coastal test cases.
- Use statistical modeling to:
  - Analyze storm parameters and combinations.
  - Quantify the return periods of synthetic storms.
  - Isolate the absolute “extreme storm” scenario.