Developing an Emulator for Morphodynamic Response of the Nourished Beaches During Future Storm Events Based on XBeach Predictions

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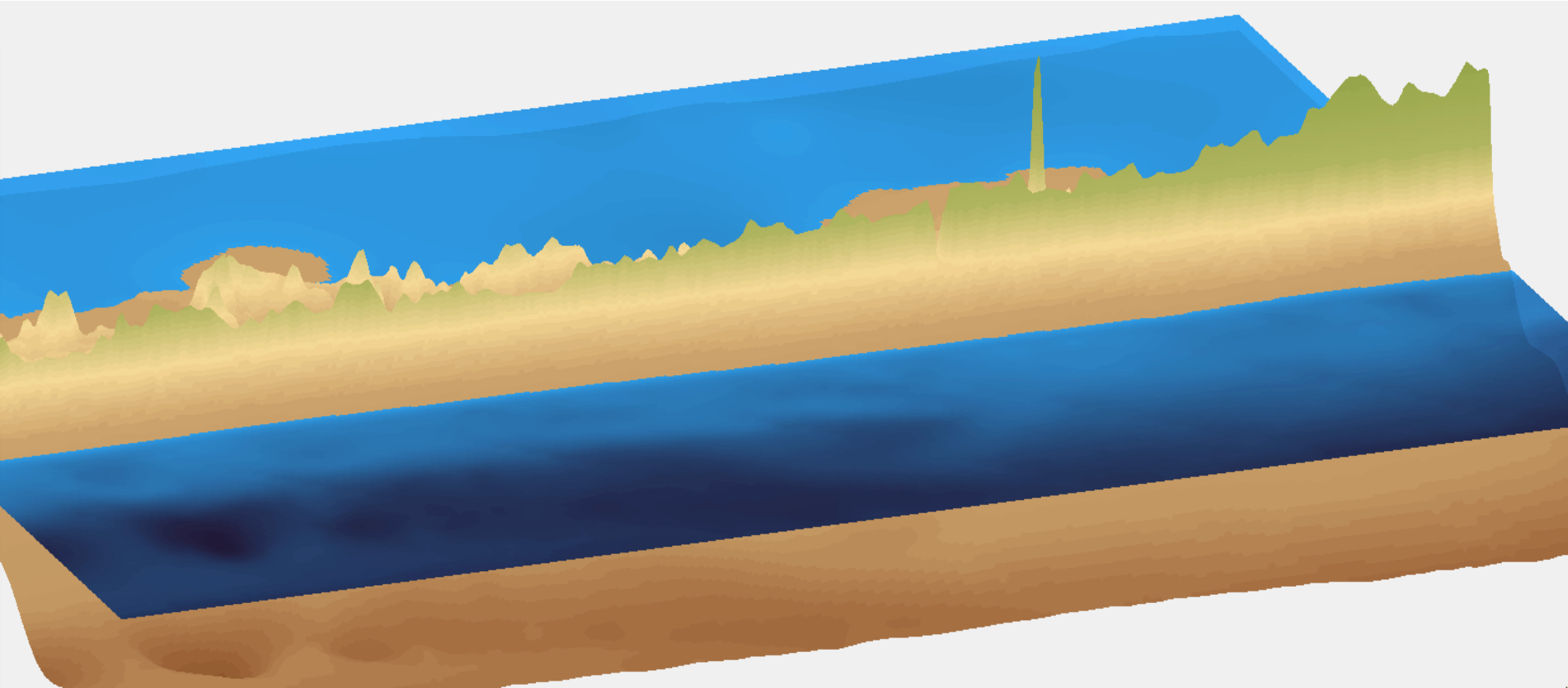
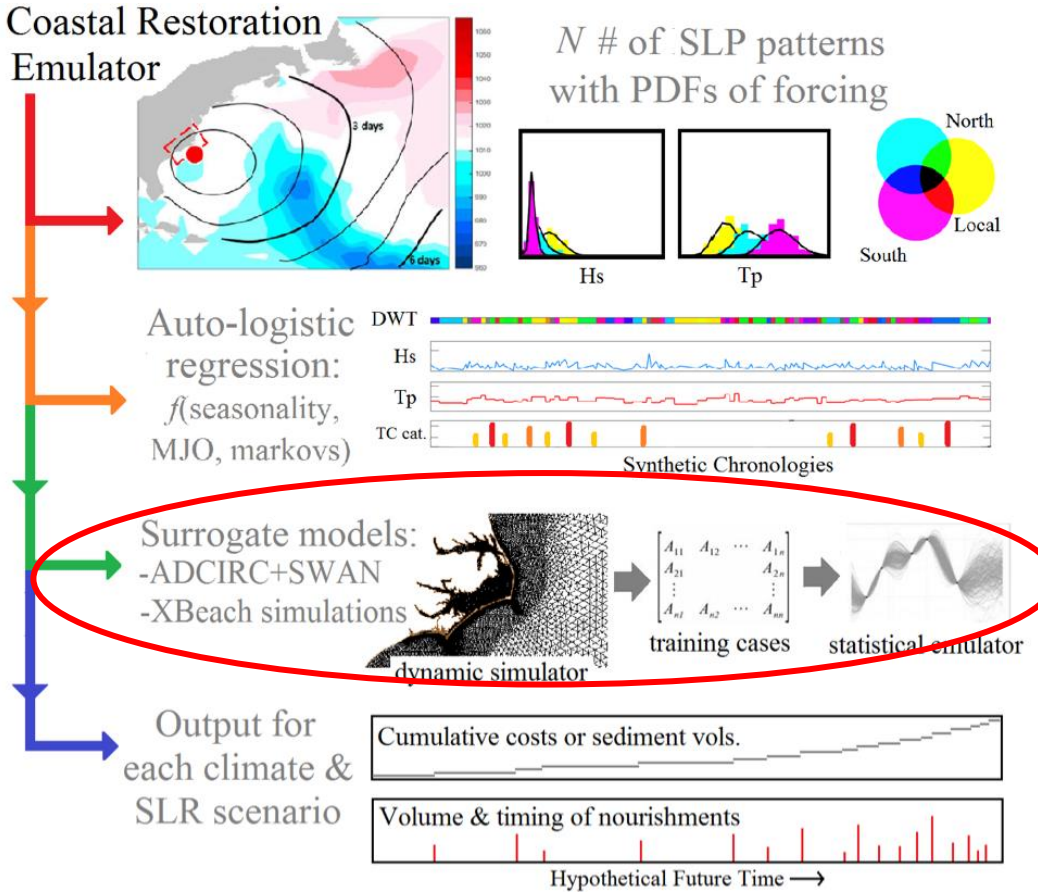
XBeach:



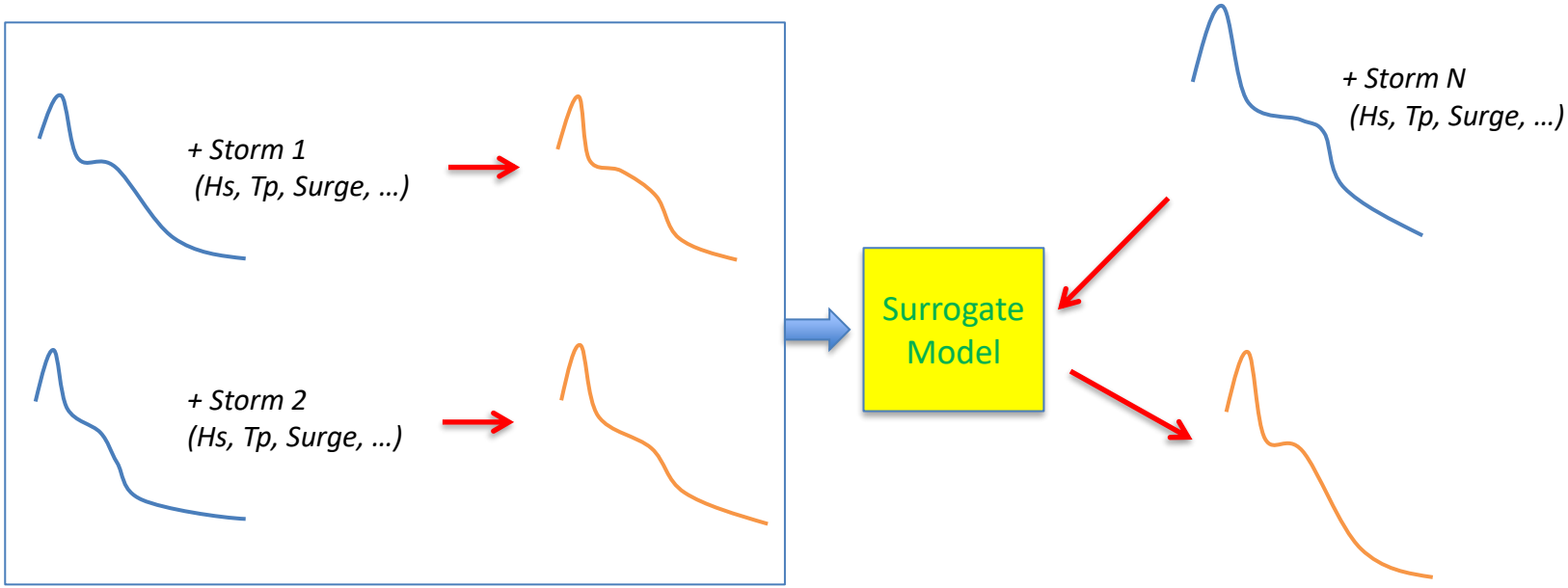
- The modeling tool is computationally expensive
- Not the best choice for predicting 1000s hypothetical scenarios

Therefore we combine statistic models with process-based model



Surrogate model:

Statistical model that learns how to predict like a process-based model using machine learning tools



Objectives:

- Develop a surrogate model to predict nourishment retreat during storms
- Compile 1000s of storm data into possible future scenarios
- Parameterize beach geometry and the nourishment
- Develop a library of XBeach simulations using synthetic storms

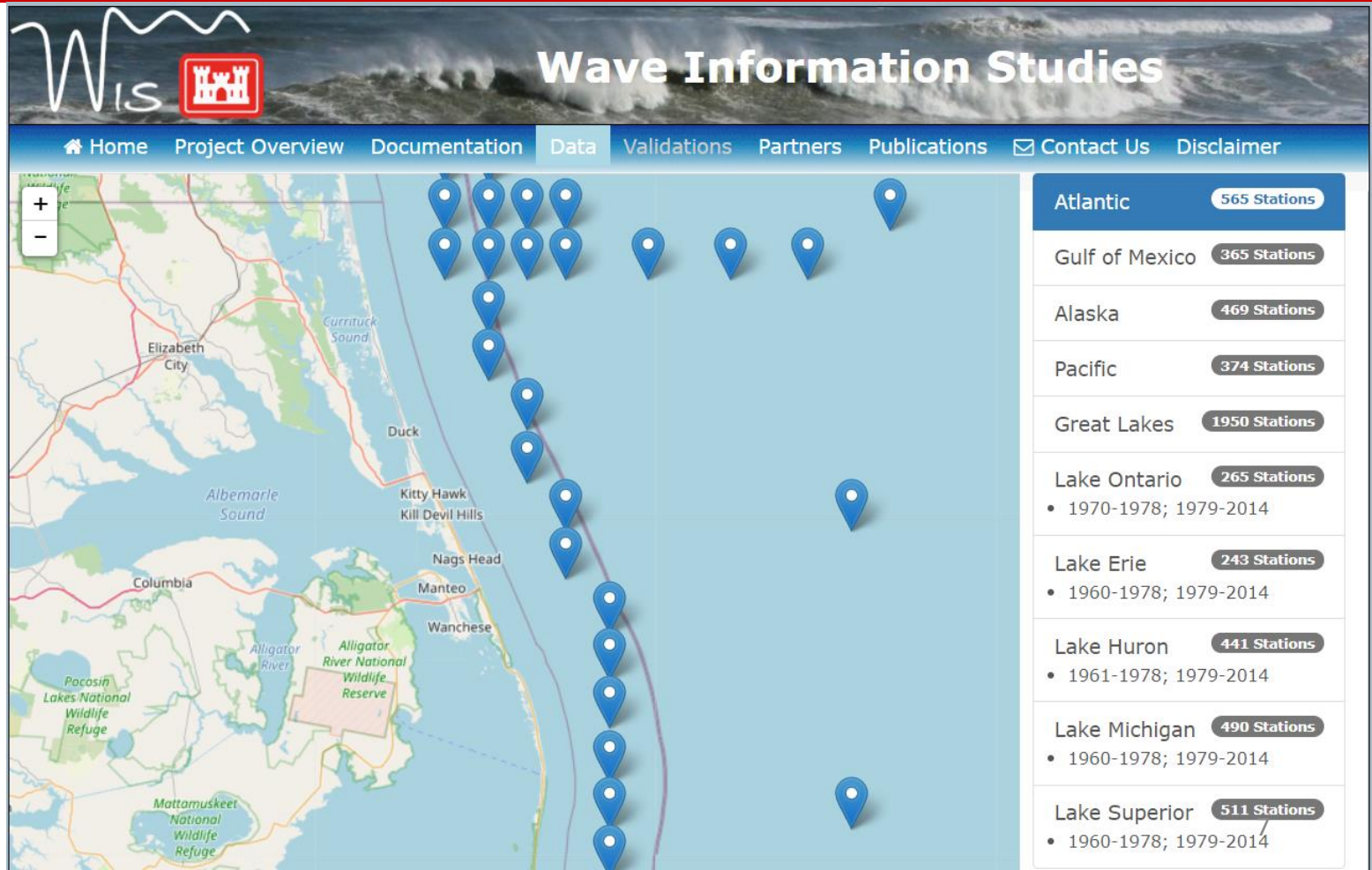
Not just a surrogate for storm parameters To beach/dune response parameters

But storm + initial beach/dune parameters To beach/dune response parameters

We assess if a library of synthetic storms and idealized nourishment profiles produces an emulator with the ability to simulate realistic nourishment response to storm sequences.

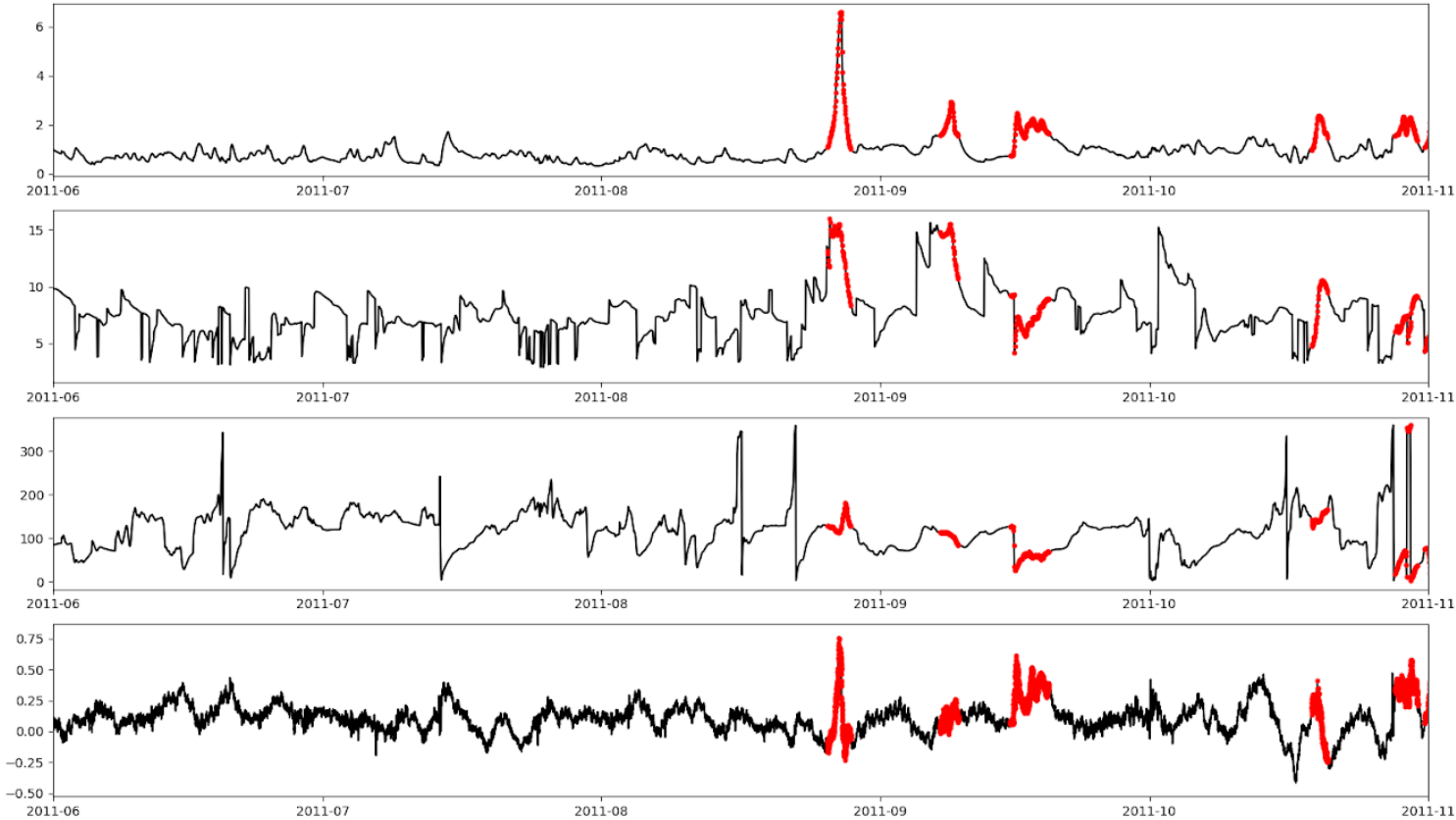
Inputs:

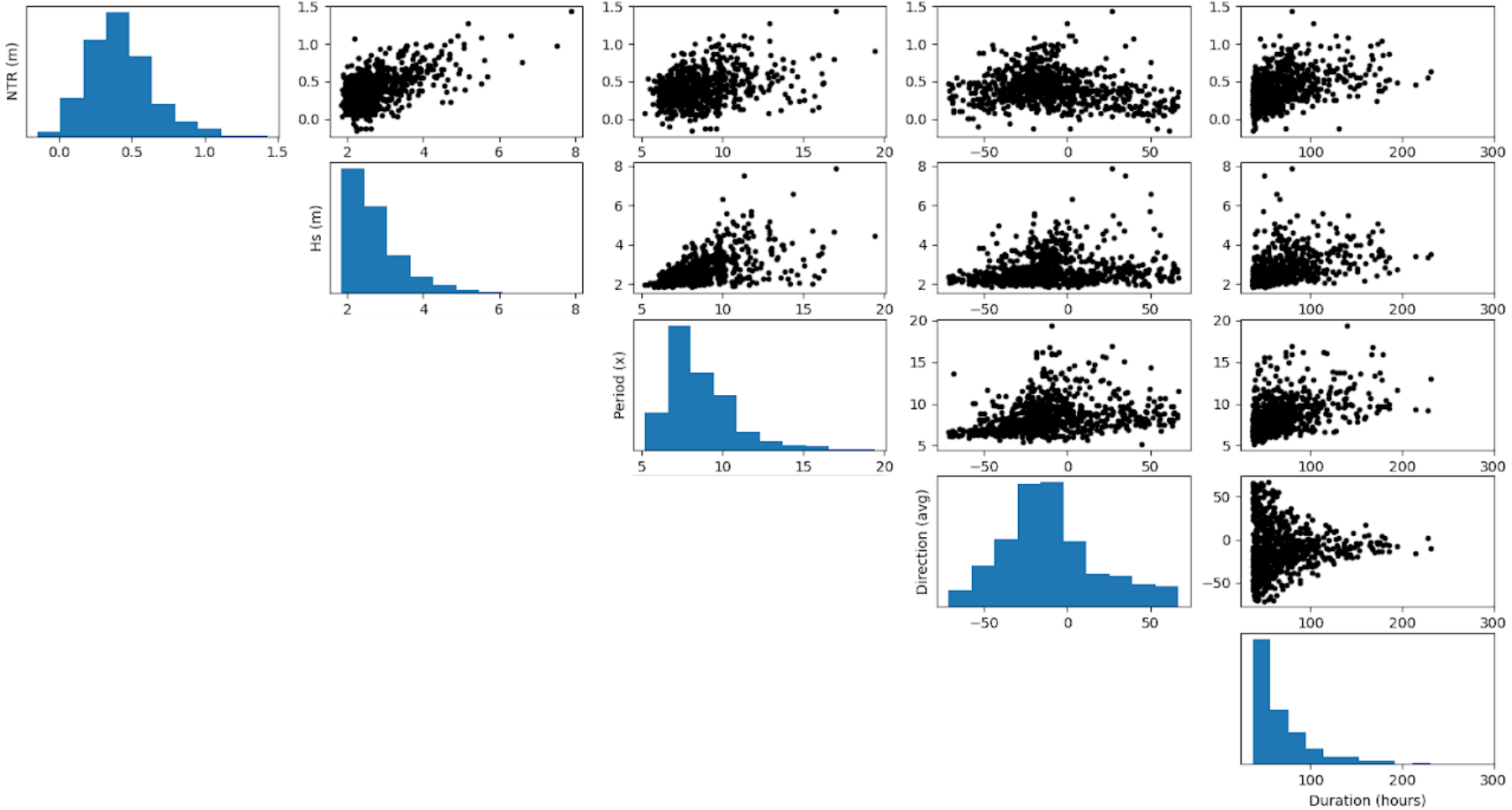
Storm data

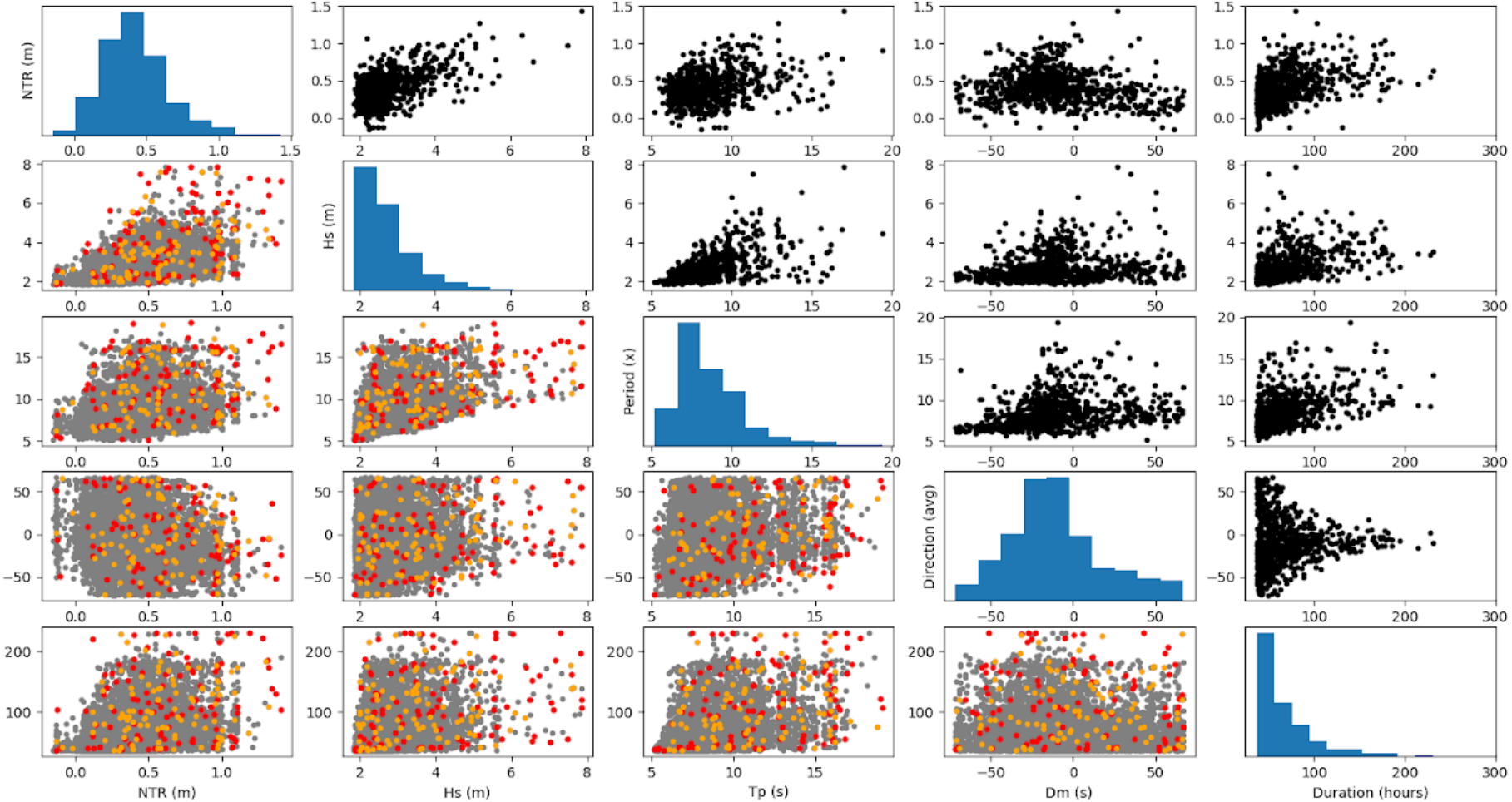


Inputs: Storm data

- Selecting storms
- Extracting parameters:
  - Hs
  - Tp
  - Theta
  - Surge
  - Duration

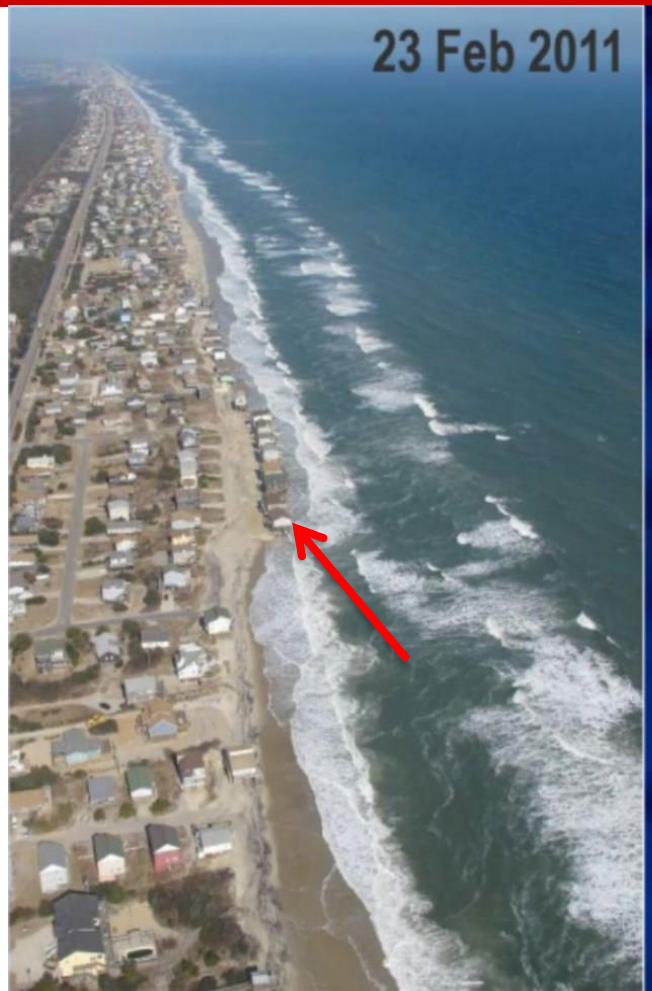


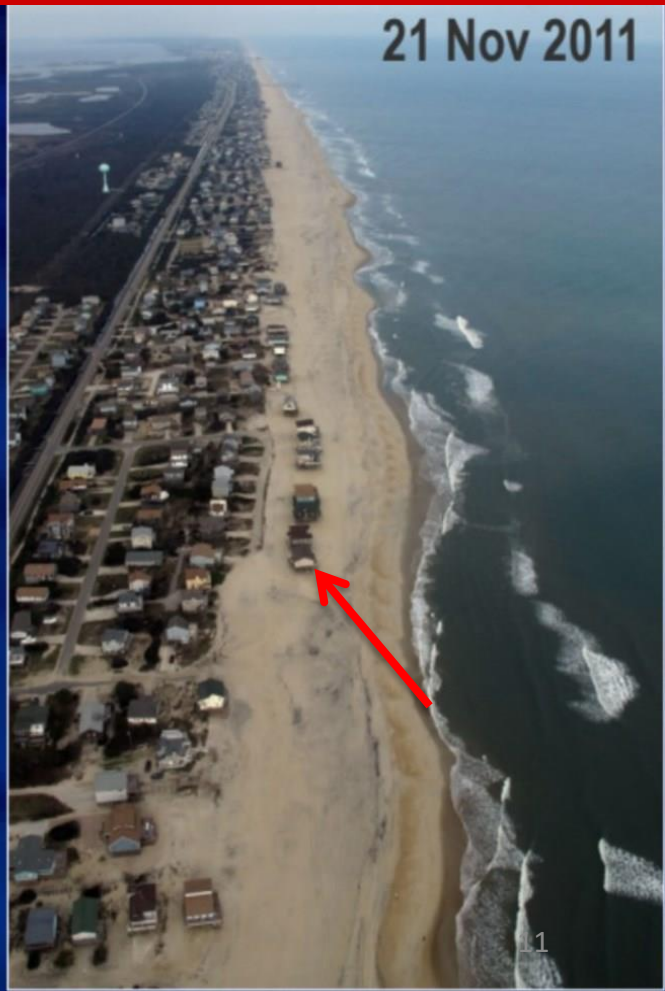

NTR (m)
Hs (m)
Period (x)
Direction (avg)
Duration (hours)


NTR (m)
Hs (m)
Period (x)
Direction (avg)
Duration (hours)
Tp (s)
Dm (s)

Nags Head, NC

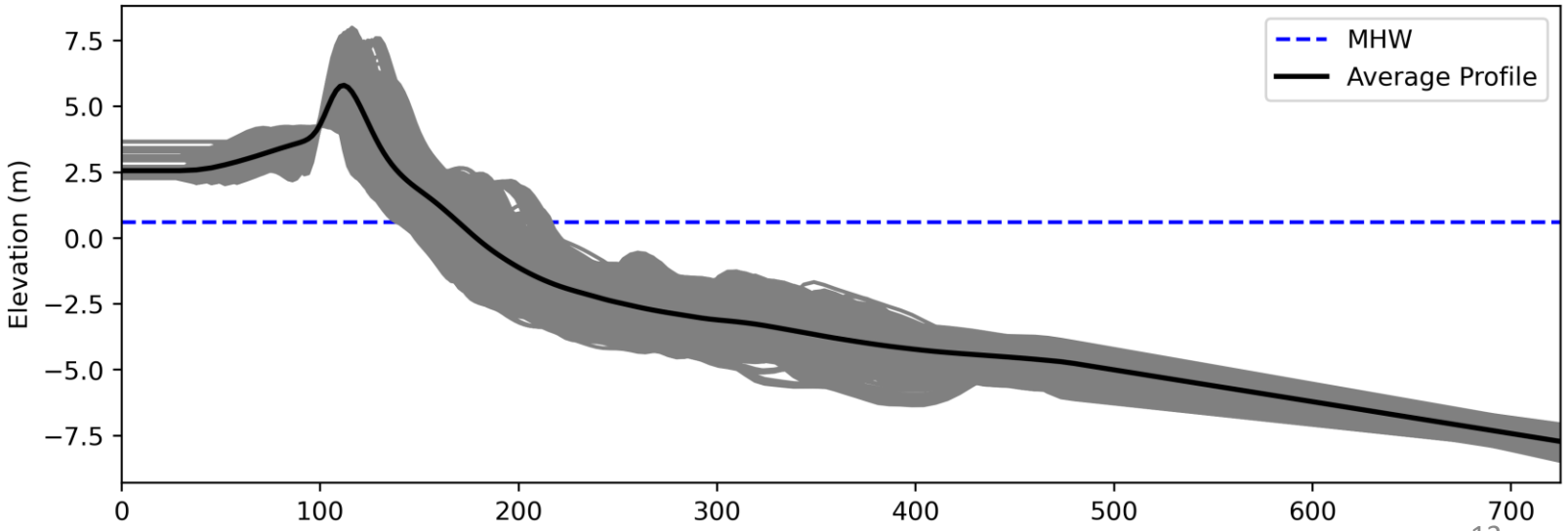
- Over 15 surveys between 2010 & 2019
- Beach nourishment in 2011 & 2019





Inputs: beach profile data

- Interpolated surveys into DEM
- Extracted the Beach profile for each survey

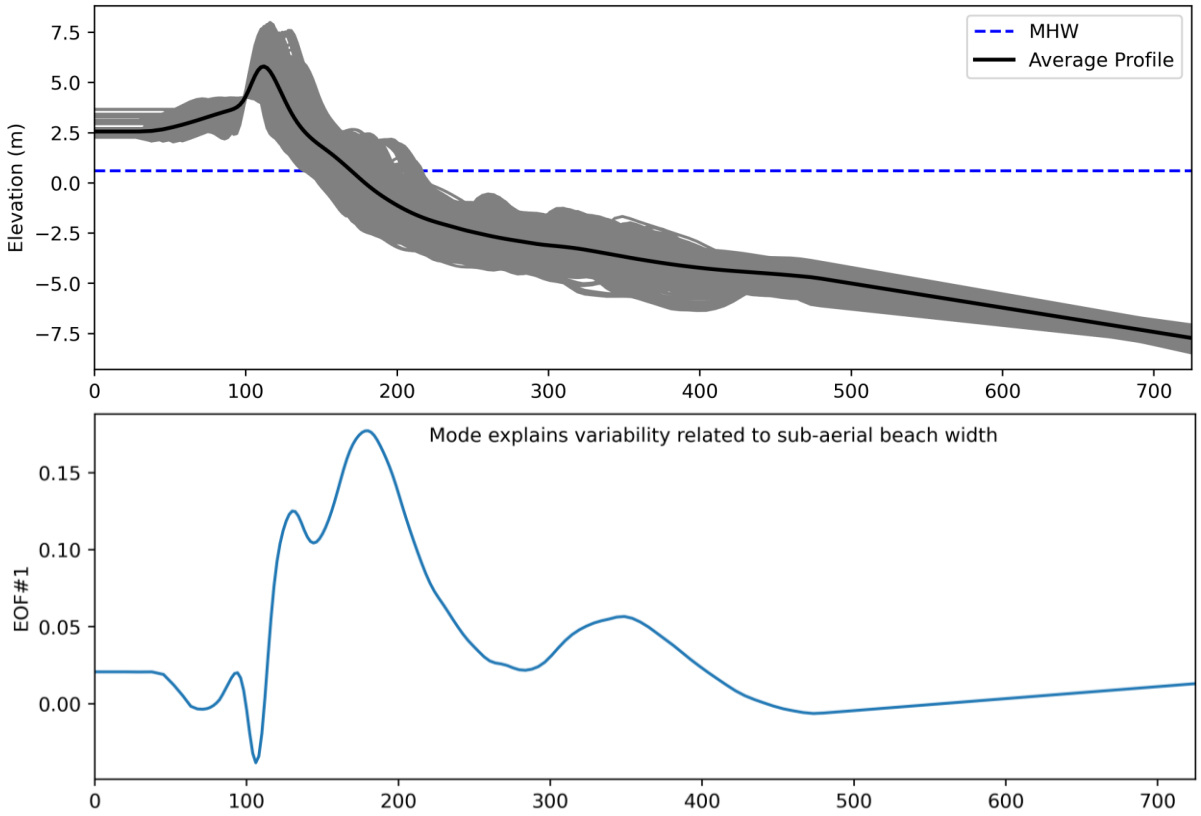


Inputs: beach profile data

We use PCA to reduce dimensions

Modes of variability :

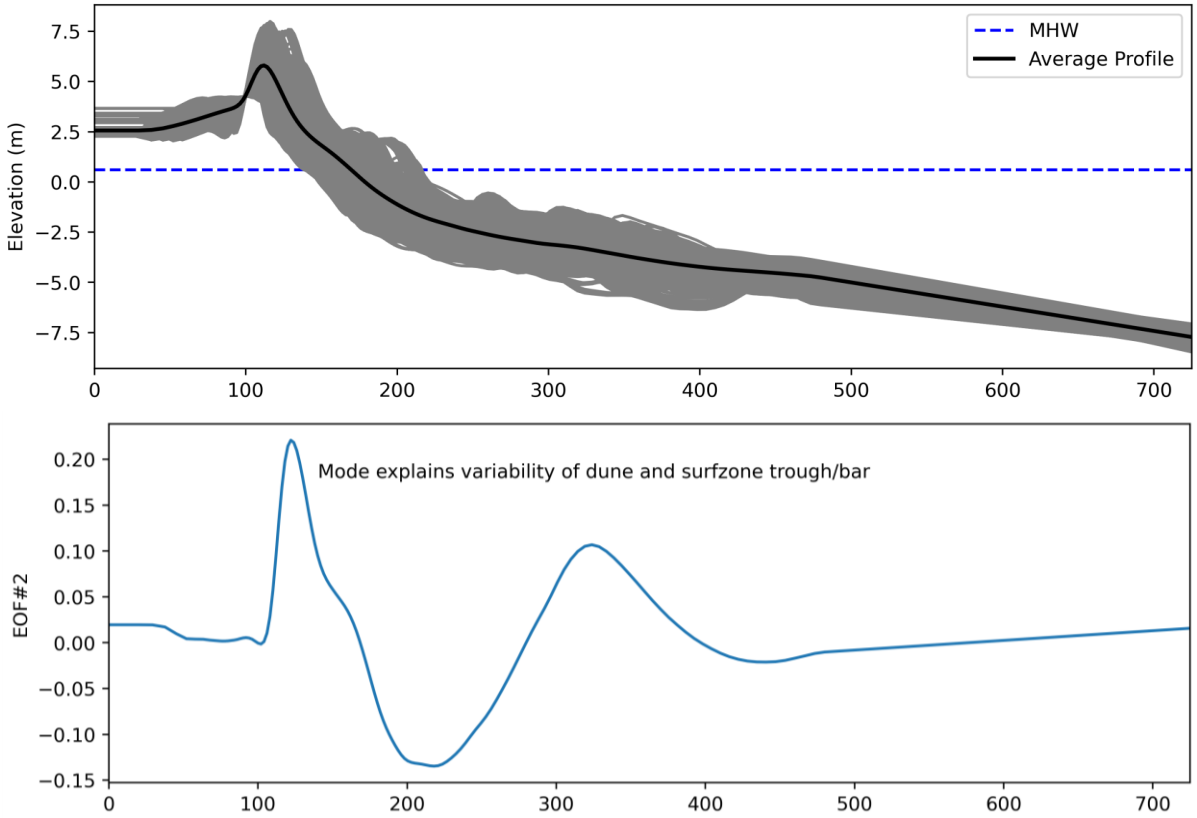
- Principal component #1
  - Dune
  - Beach

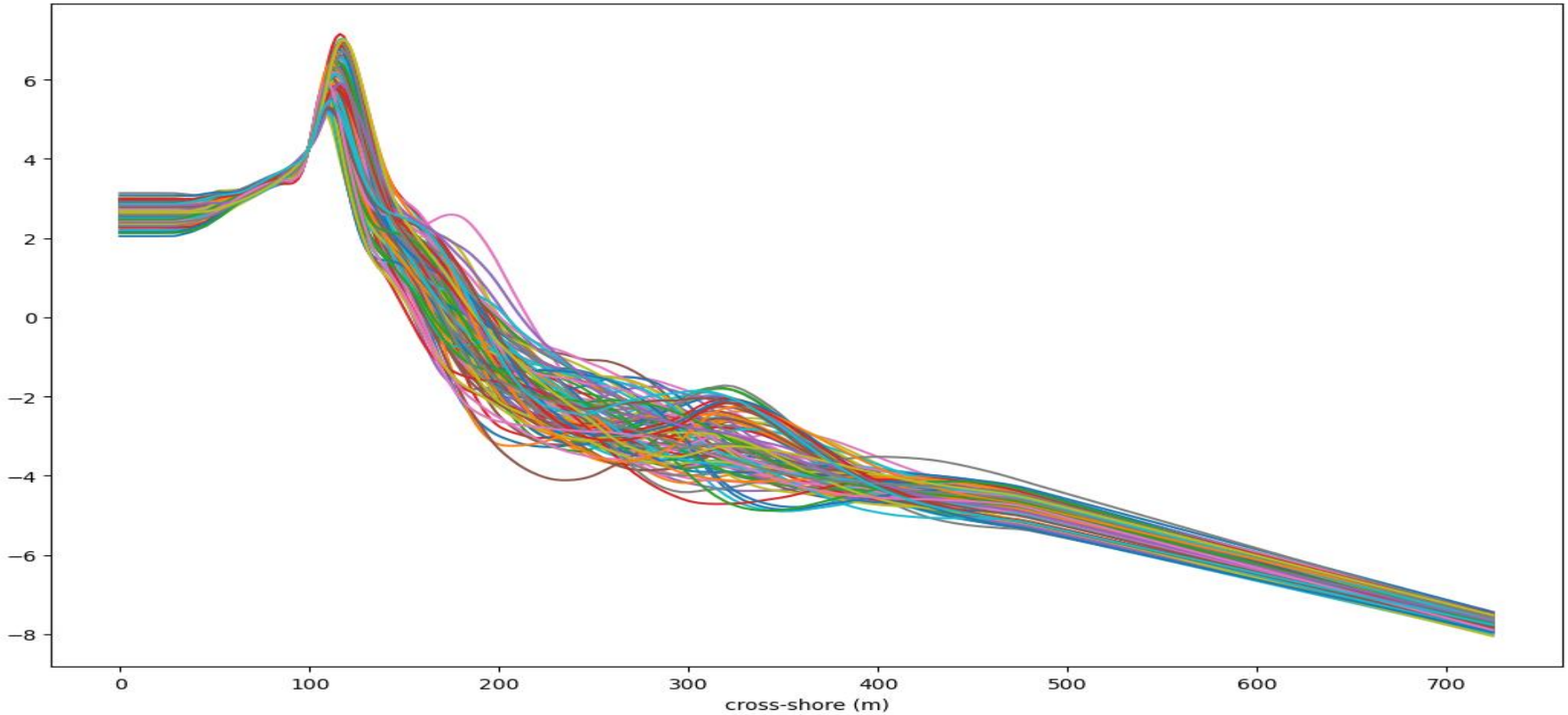


Inputs: beach profile data

Modes of variability :

- Principal component #2
  - Dune
  - Surf zone
  - Offshore bar

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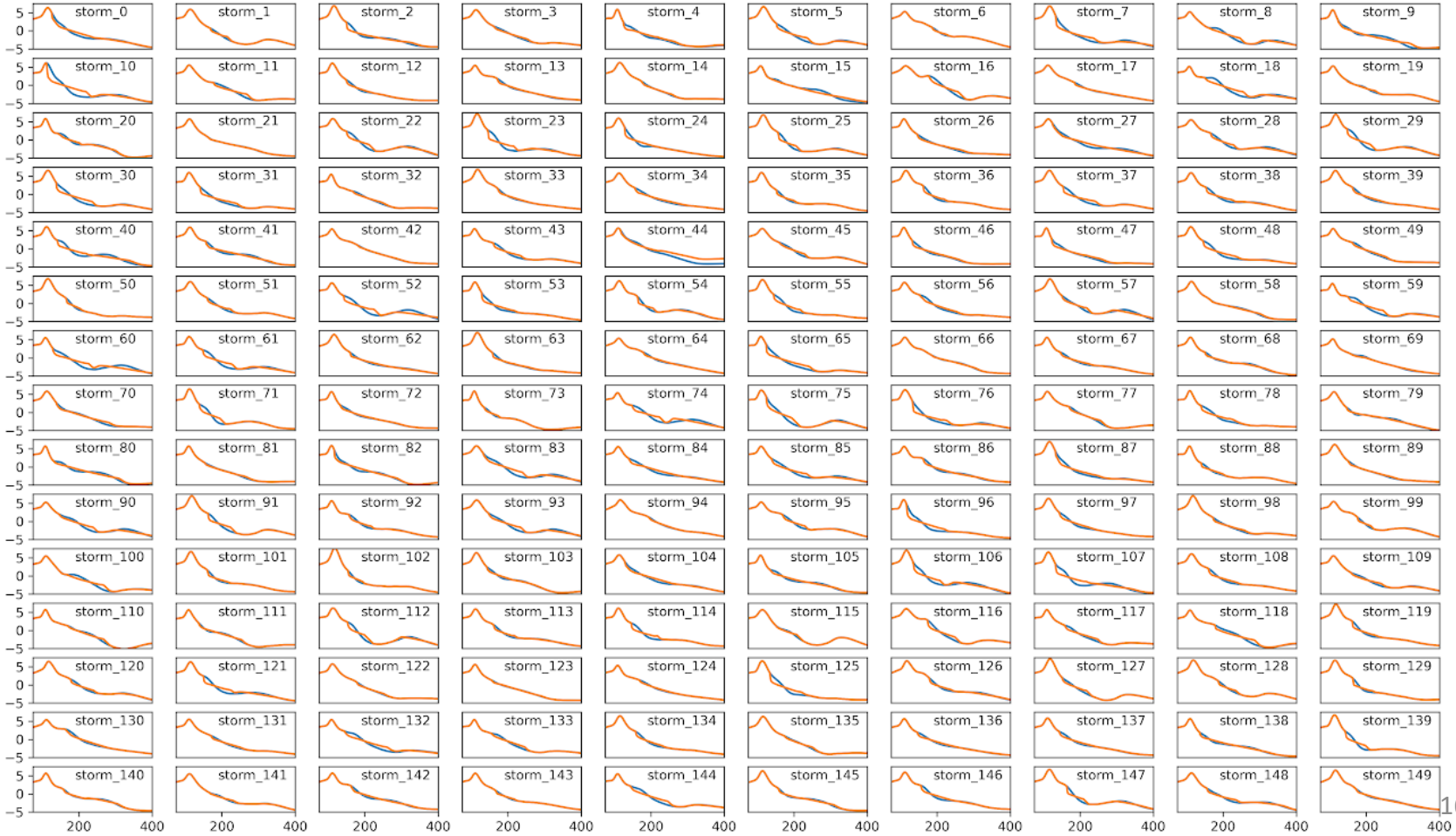
cross-shore (m)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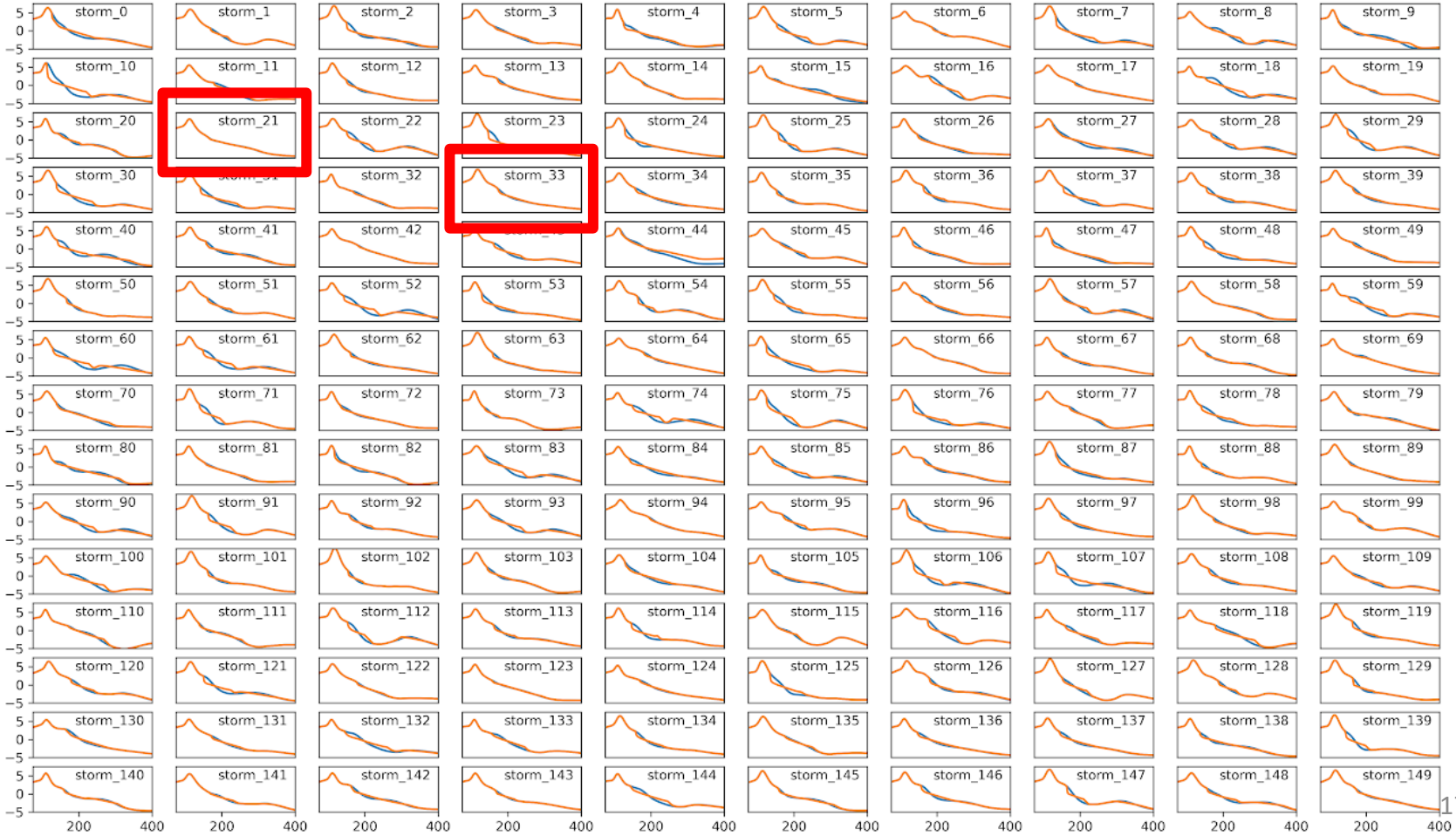
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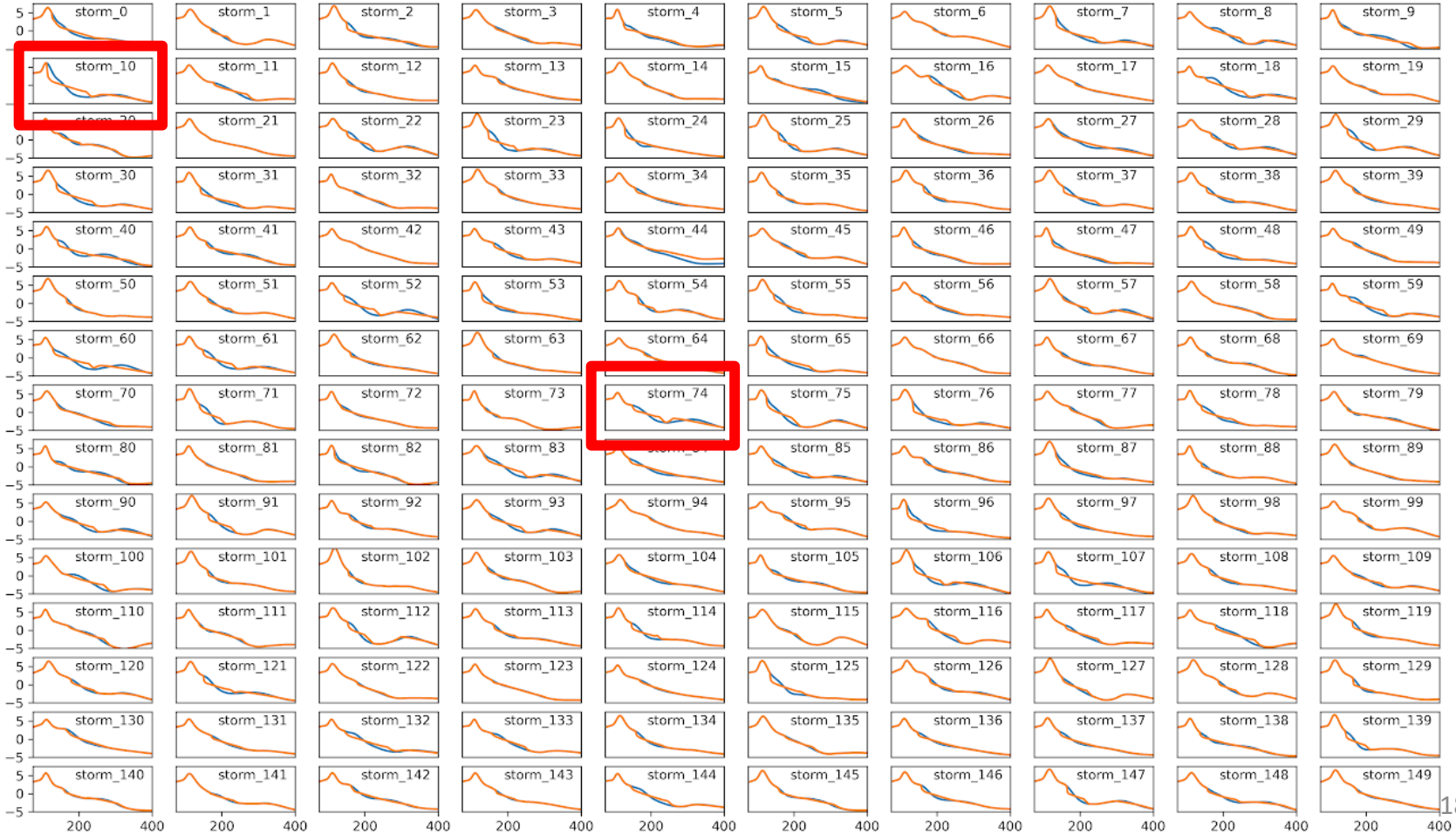
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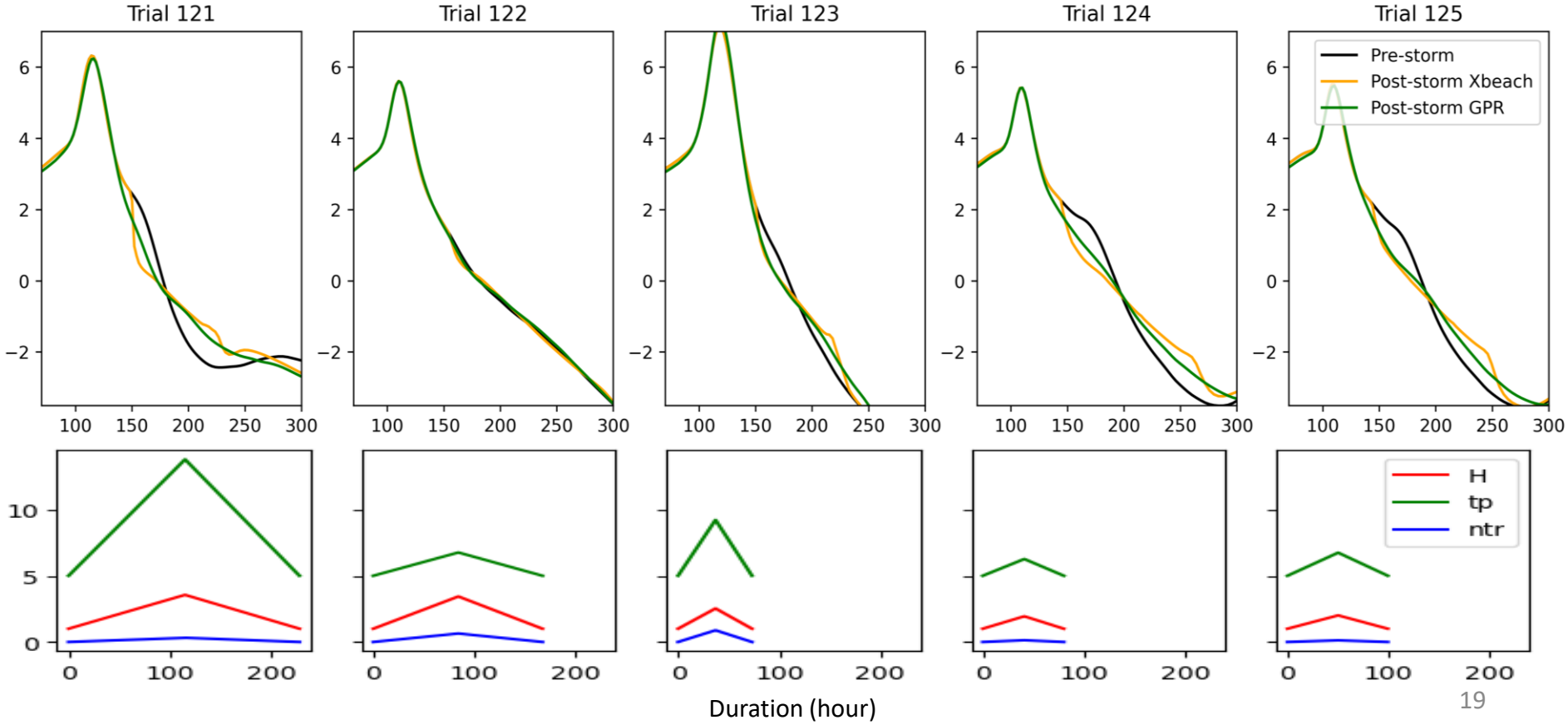
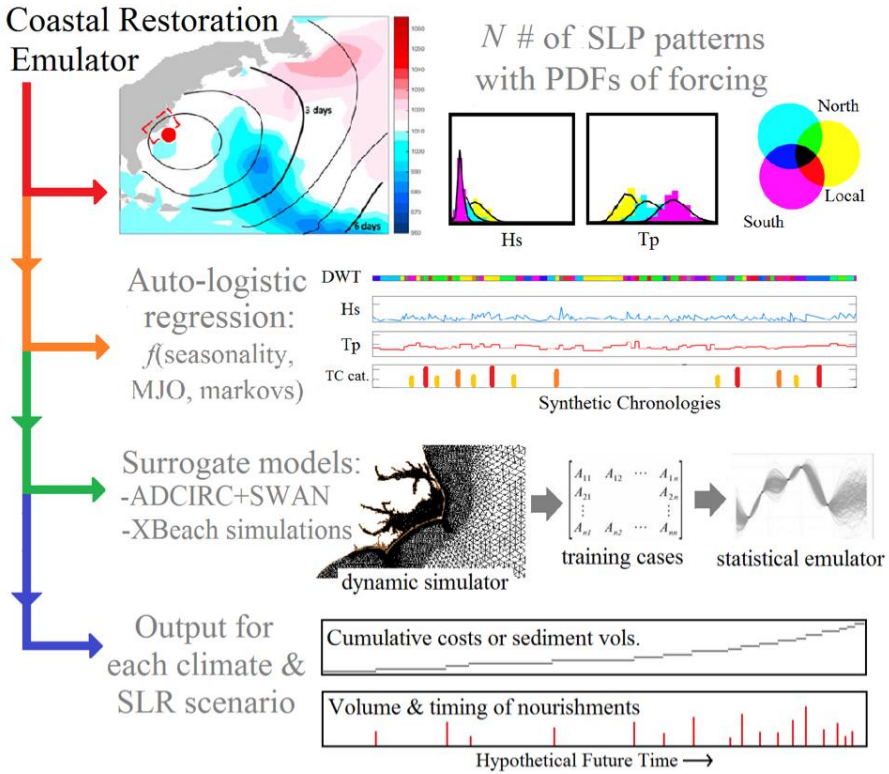
- Surrogate model predictions and comparison to XBeach



Conclusion

- The preliminary surrogate model results are encouraging
- We use the surrogate model to predict the erosion on the nourished beach during a sequence of hypothetical storms
- This can help to predict the frequency of required replenishment or amount of sediment needed for renourishment

- This is an ongoing work
- Need to expand the number of storms and profiles
- Need to add other parts of the emulator