Forecasting Coastal Storm Erosion: COAST-SEA as a decision support tool

2026 NJ Coastal & Climate Resilience Conference

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Coastal Engineering Research Group

March 9, 2026

Collaborators

Jon K Miller *Stevens*

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Guy Carpenter

Audrey Fanning *USACE*

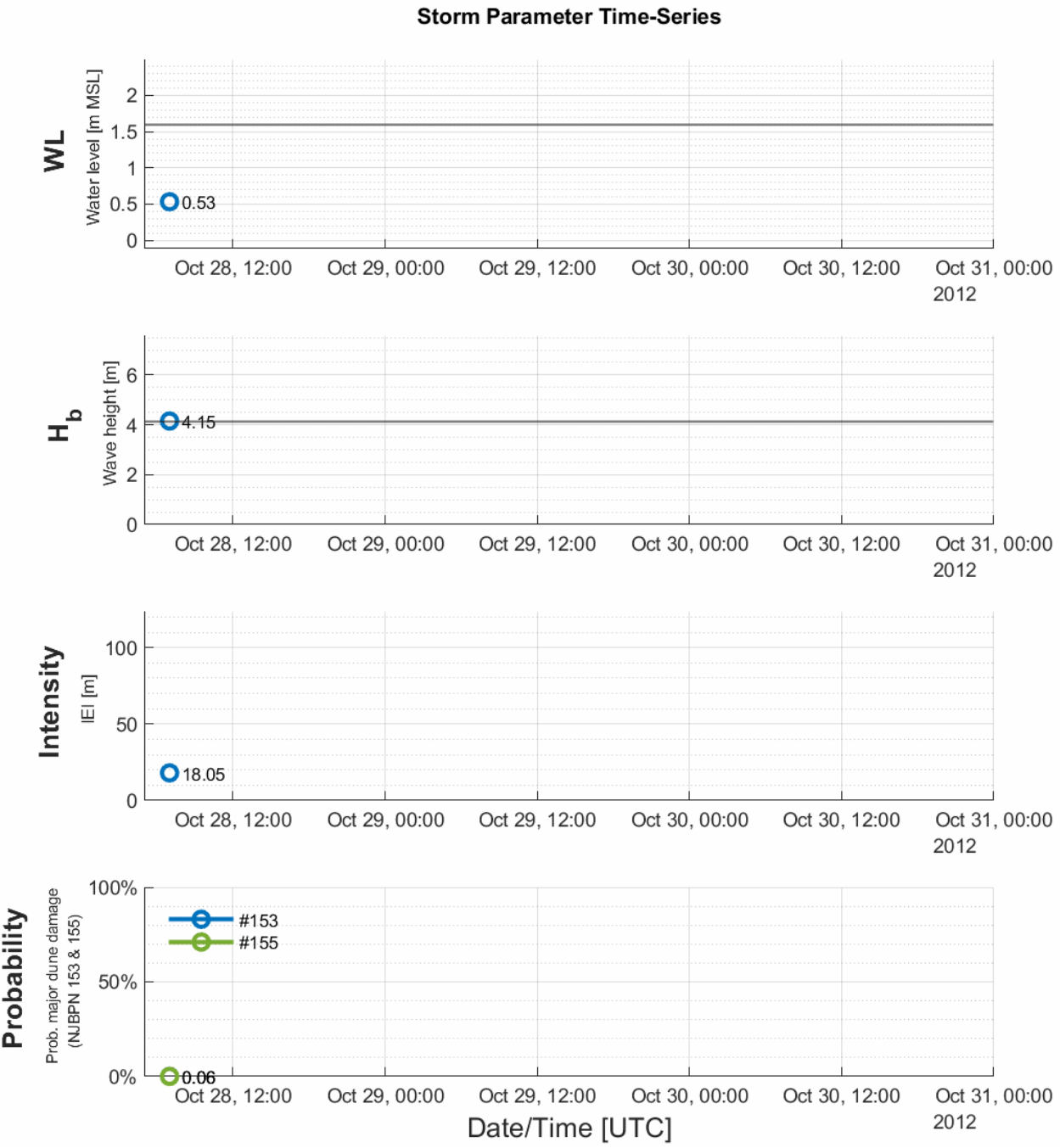
Ian J Day *Stevens*

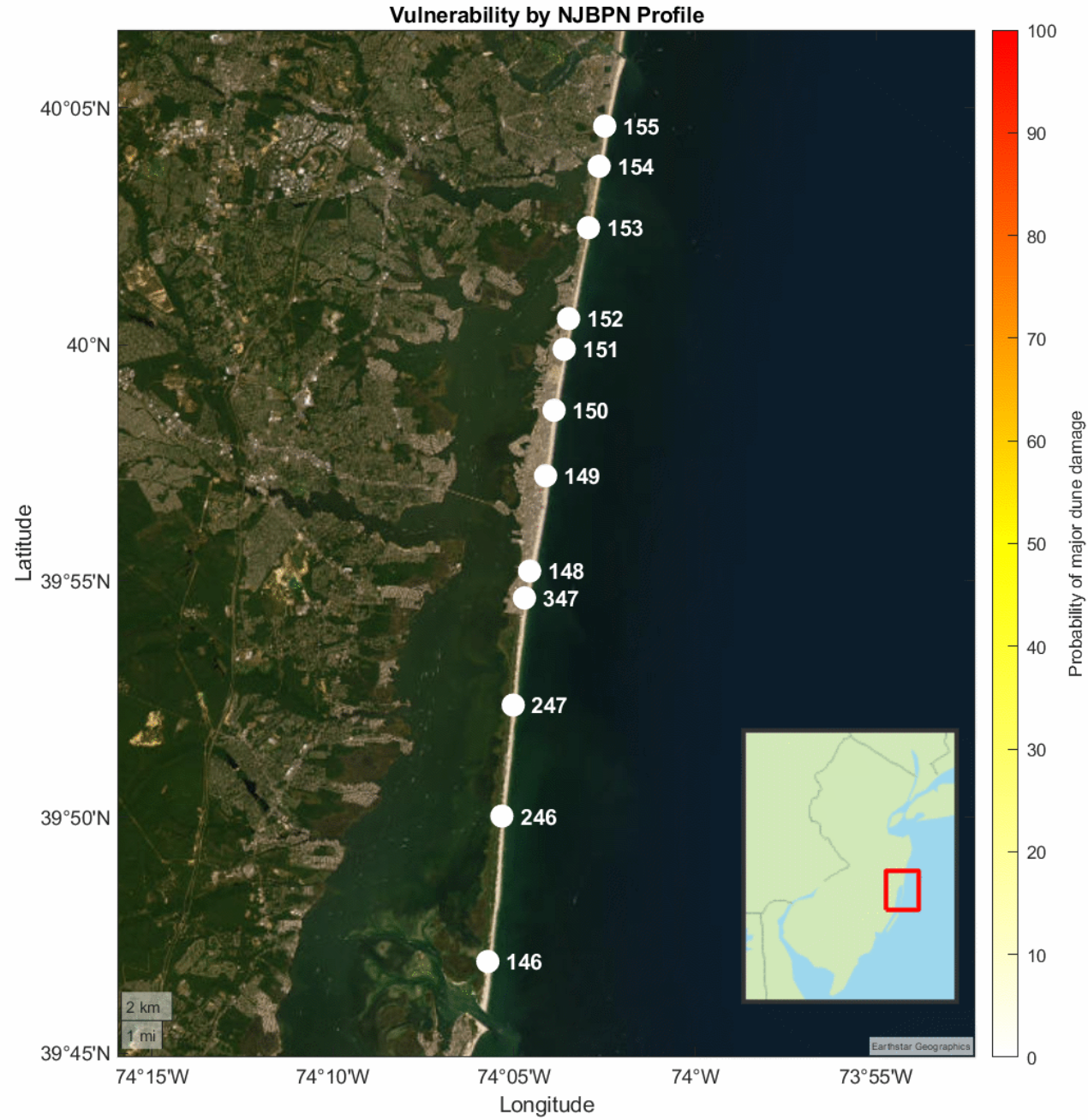
Pouya Farahani *Stevens*

Jillian McCarthy *Stevens*

Brenna Derby *Stevens*

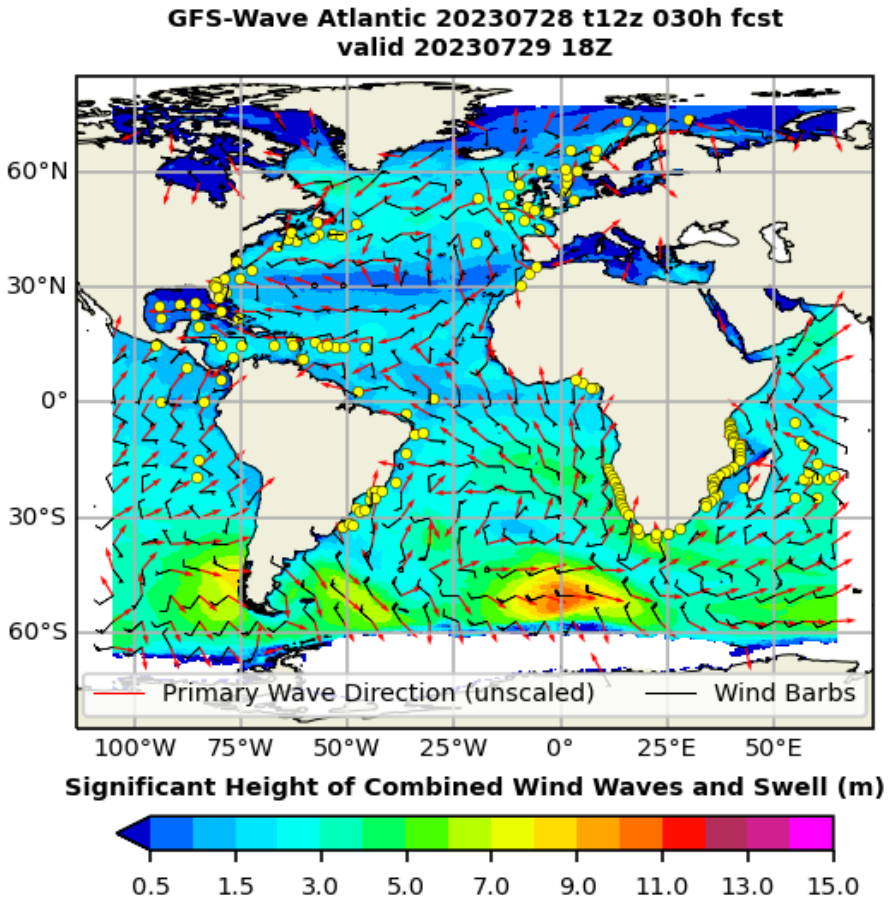
Hourly Storm Vulnerability
NJ Shoreline Segment 5



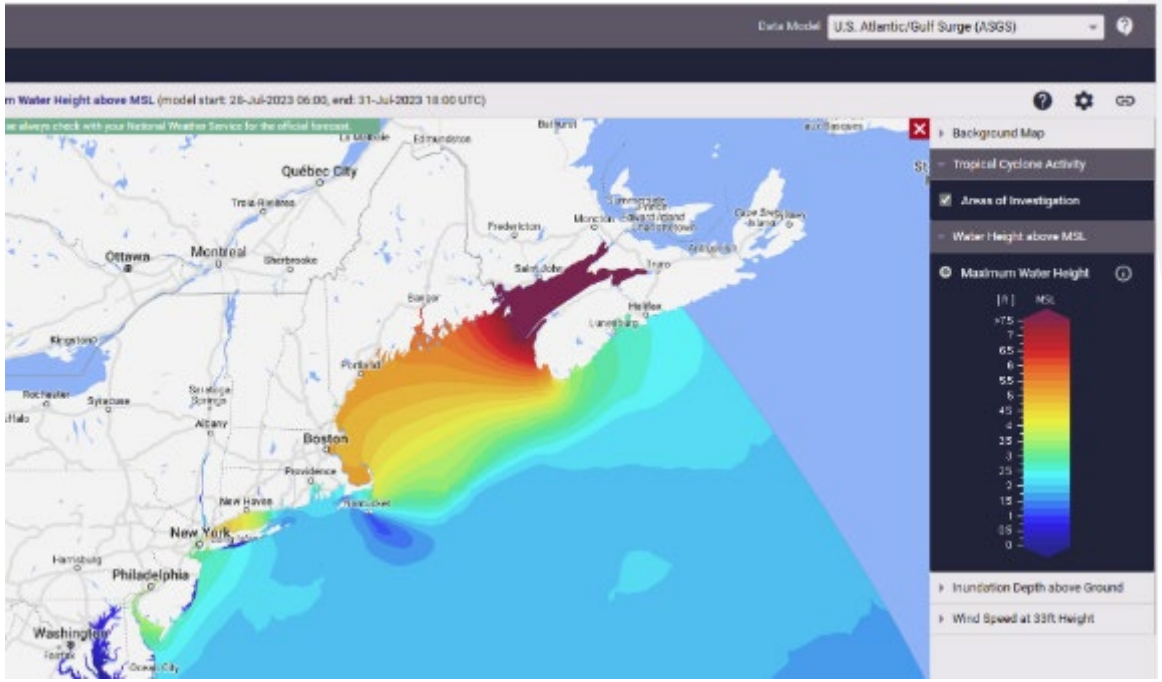


The Problem: Available forecasts focus on a specific metric (e.g., wind, water level) and are difficult to interpret

WaveWatch III (Wave height)



ADCIRC (Water Levels)



The Weather Channel on MSN · 12d

Live updates: Winter storm Hernando 'bombs out,' knocks out power to 600,000+ in Nort 10,000 flights canceled

Updates from throughout the day Monday as the historic storm made its mark: ...

Aol. · 13d

Winter Storm Hernando Strikes The East Coast With Snow, Strong Winds; Thousands Lose Power In New Jersey, Virginia

A powerful nor'easter is expected to intensify into a "bomb cyclone" into Monday, bringing blizzard conditions, heavy snow ...

yahoo! · 13d

Winter Storm Hernando Maps Tracker: Alerts, Radar, Snow Forecast And More

Winter Storm Hernando is making its way up the East Coast, bringing winter weather impacts to millions in cities li D.C., Philadelphia, New York City and Boston. On this page, you'll ...

yahoo! · 13d

Winter Storm Hernando Underway In Maryland

Winter Storm Hernando is well underway in Hagerstown, Maryland, where snow fell heavily on Sunday afternoon. Vehicles were ...

The Weather Channel on MSN · 13d

Winter storm Hernando strengthening, bringing 'potentially historic blizzard' to Northeast, New England

Blizzard conditions are ongoing for New York City and Boston. Expect winds gusting to at least 70 mph, major coastal flooding ...

Tracking Major Winter Storm Hernando: An Explosive Bomb Cyclone Targets Northeast

By Marko Korosec

Published: 22/02/2026

Global weather

As February slowly ends, the Polar Vortex disruption is triggering another **explosive bomb cyclone**, with a **Nor'Easter Winter Storm Hernando** unfolding off the U.S. East Coast on Monday. A rapidly deepening cyclone takes place as a powerful subtropical jet streak collides with a sharply **displaced lobe of Arctic air** divi

The cen as a

The Weather Channel® Follow

Deadly Bomb Cyclone Drops Record Snowfall On Northeast, Snarling Travel And Utilities

Sean Breslin

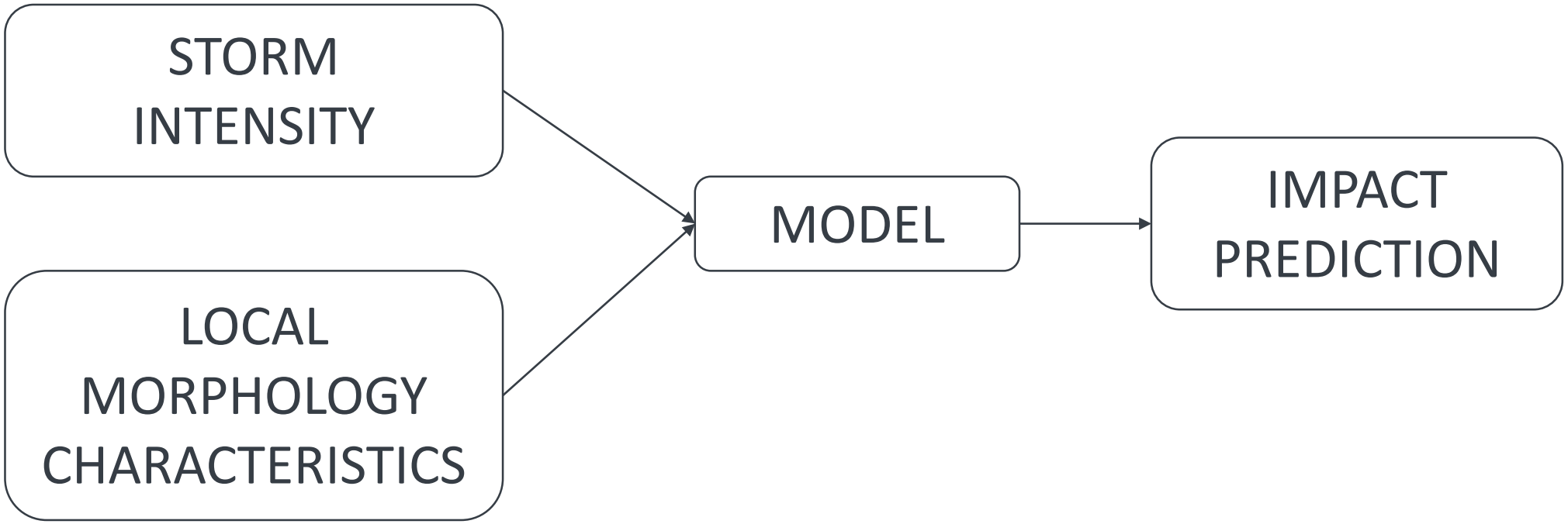
Tue, February 24, 2026 at 6:35 AM EST

20 min read

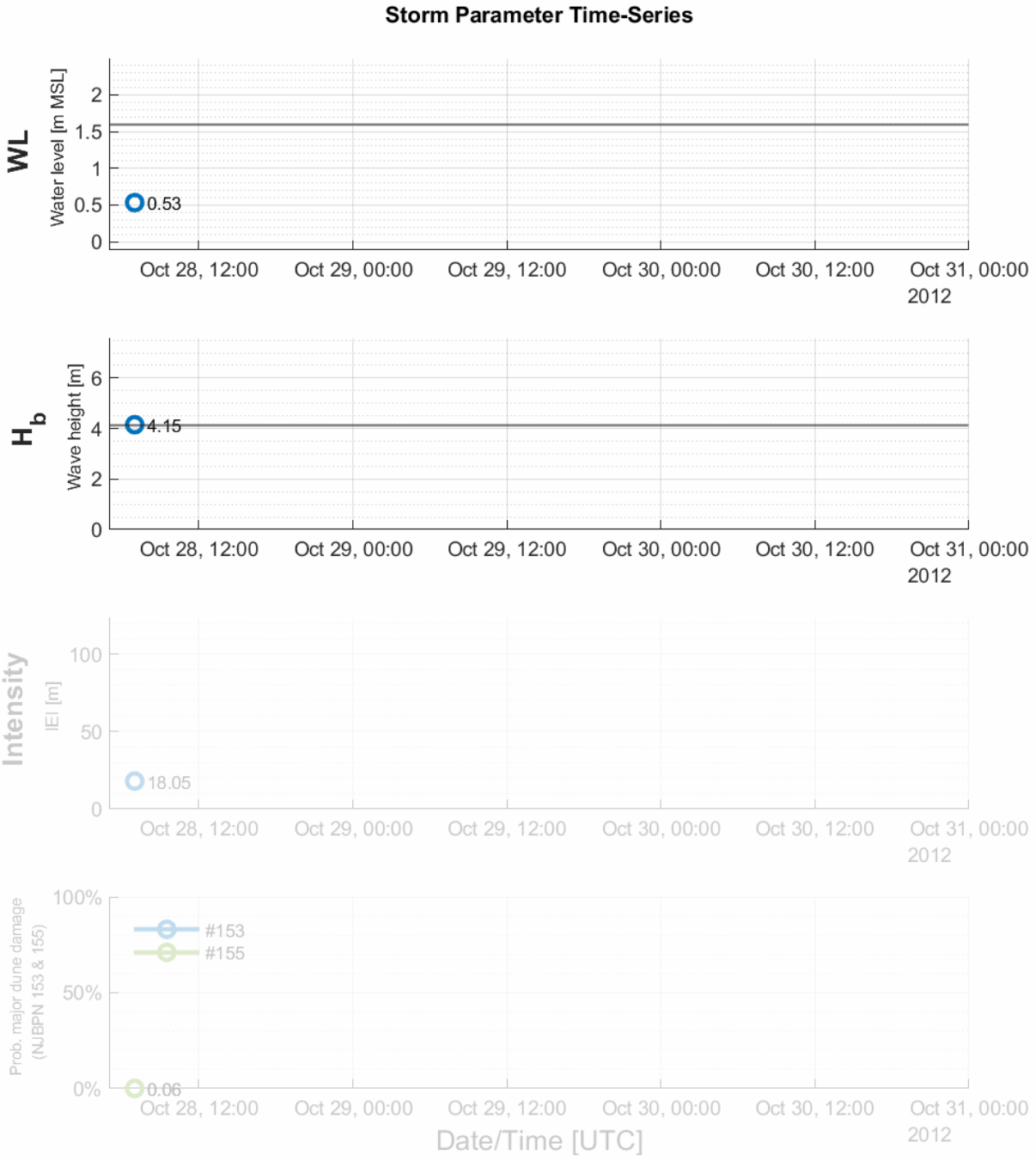
Add Yahoo on Google 15

Key takeaways

- Winter Storm Hernando has caused power outages, travel restrictions, and at least two deaths in the Northeast. See more


STORM INTENSITY
LOCAL MORPHOLOGY CHARACTERISTICS
MODEL
IMPACT PREDICTION

Hourly Storm Vulnerability
NJ Shoreline Segment 5

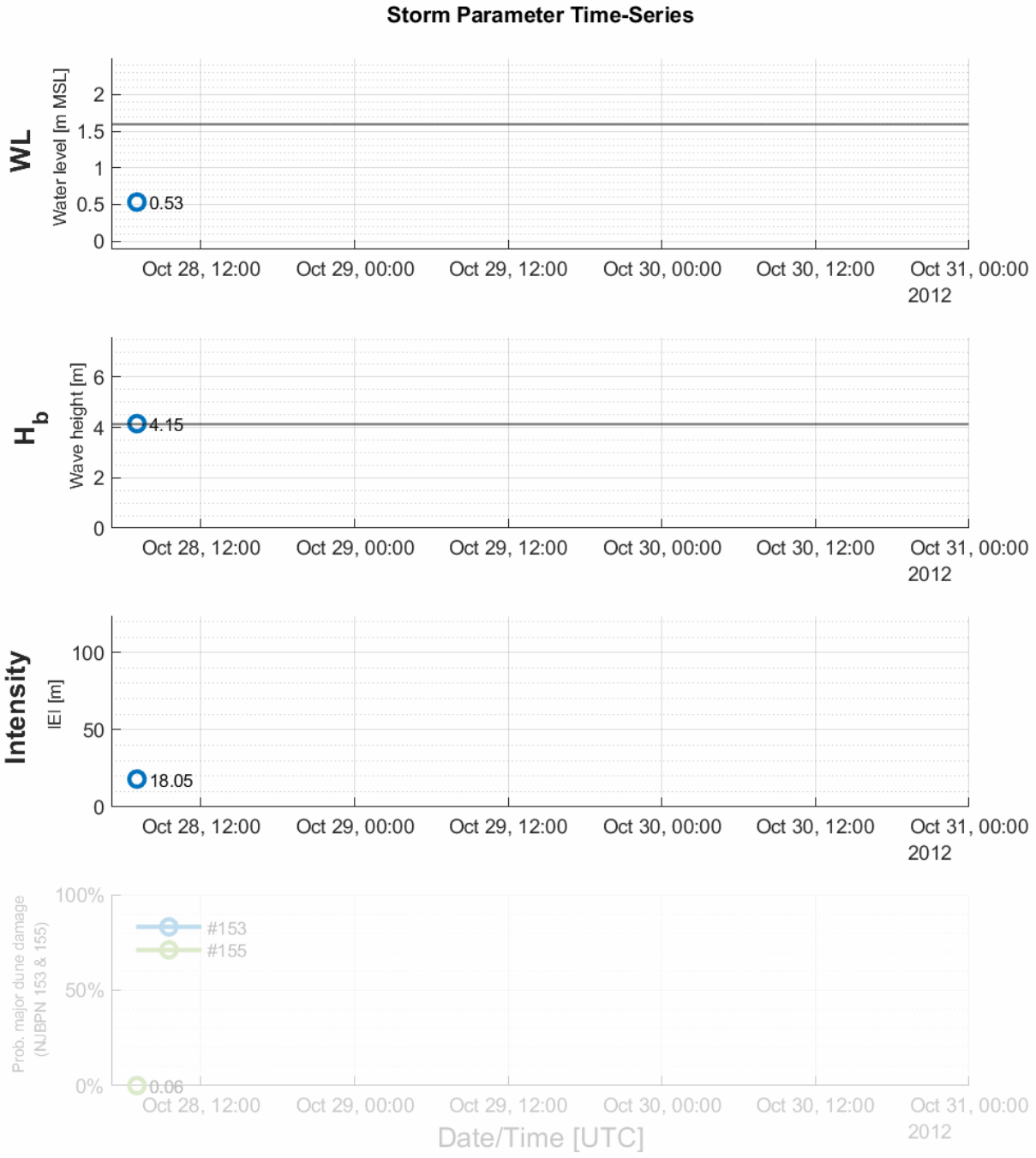


Instantaneous Erosion Intensity (IEI)

$$\mathrm{IEI}(t_i) = W_* \left[\frac{0.068 H_b(t_i) + S(t_i)}{B + 1.28 H_b(t_i)} \right]$$

Lemke and Miller (2020)

Hourly Storm Vulnerability
NJ Shoreline Segment 5



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Lemke and Miller (2020)

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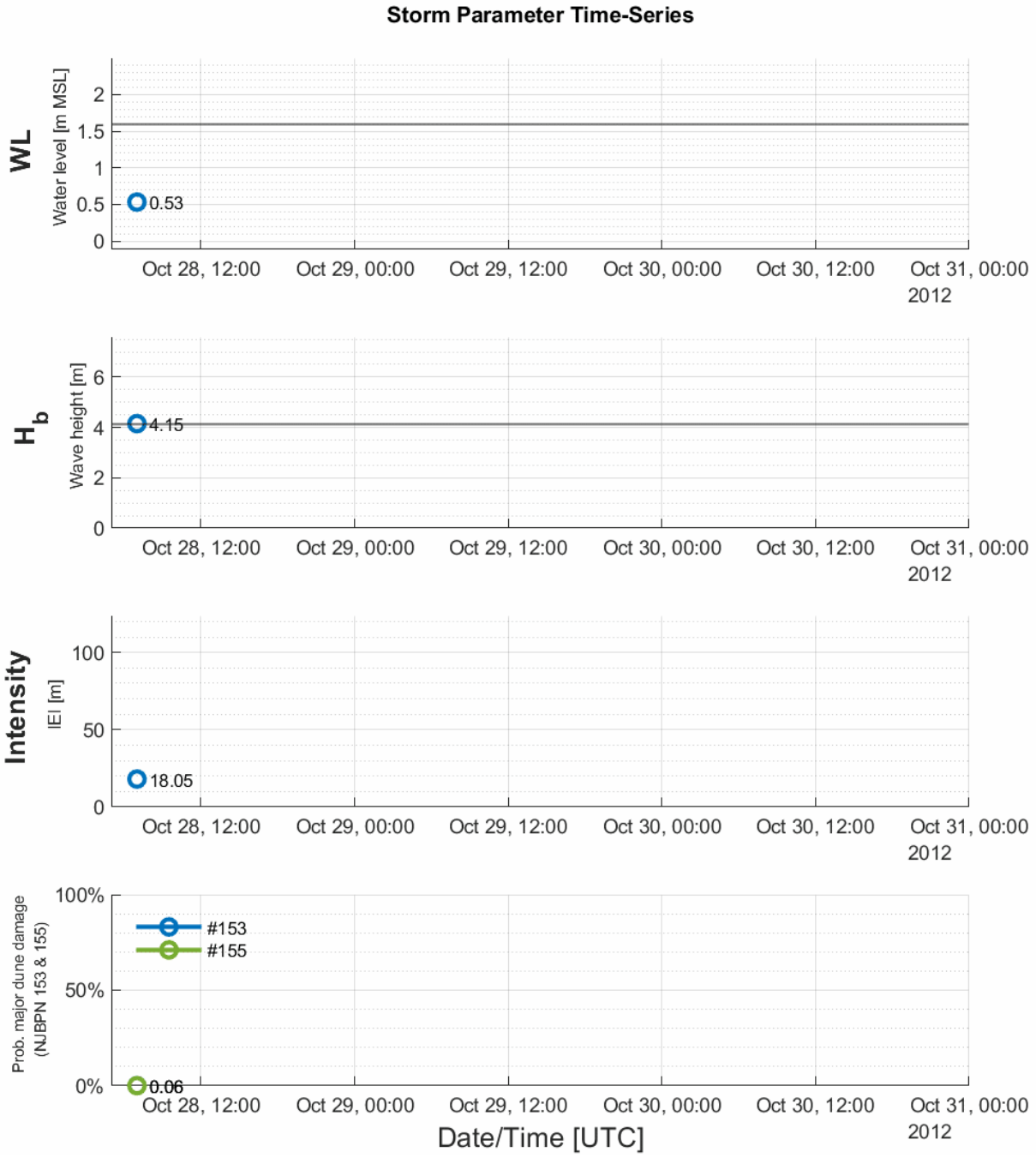

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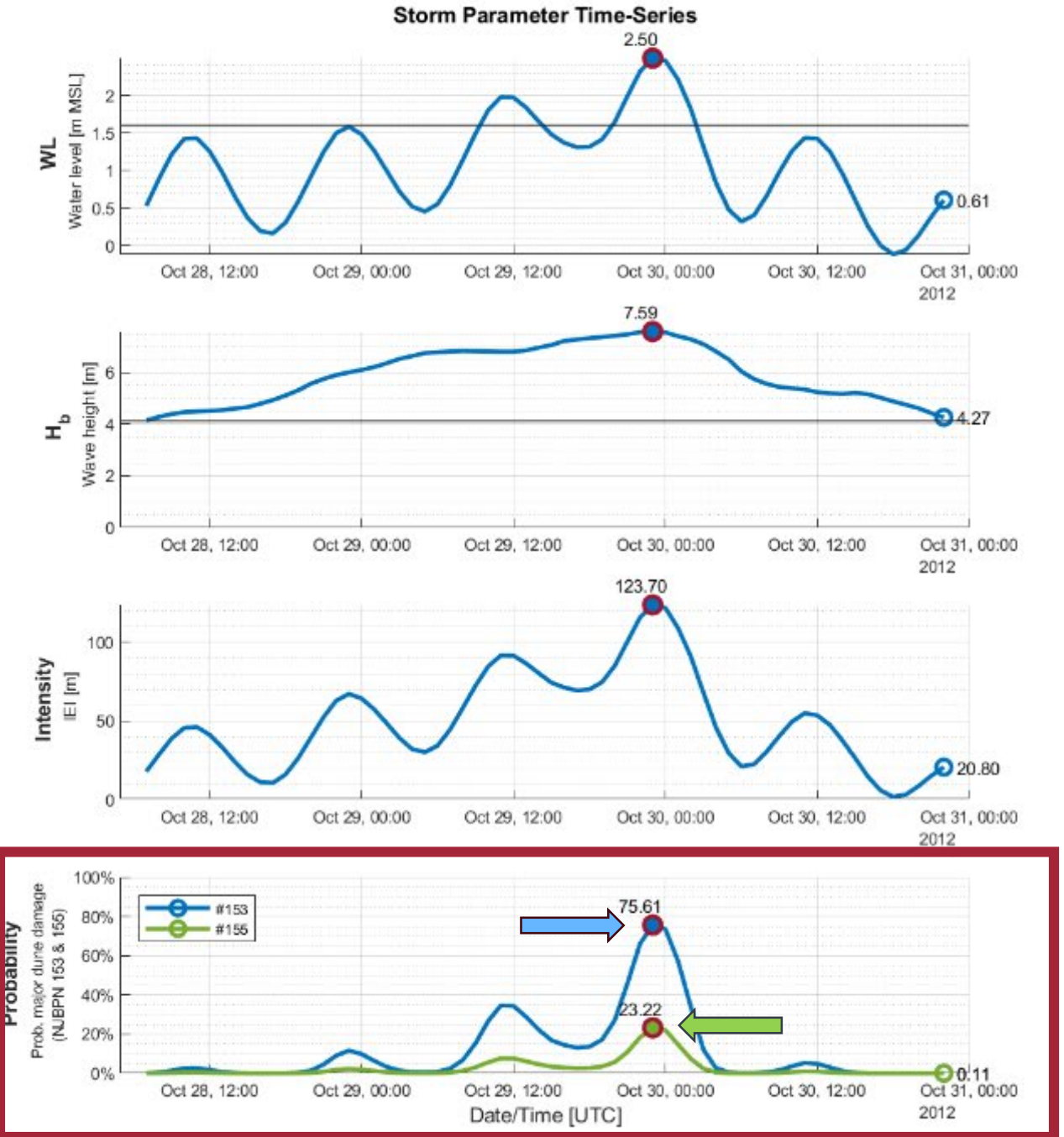
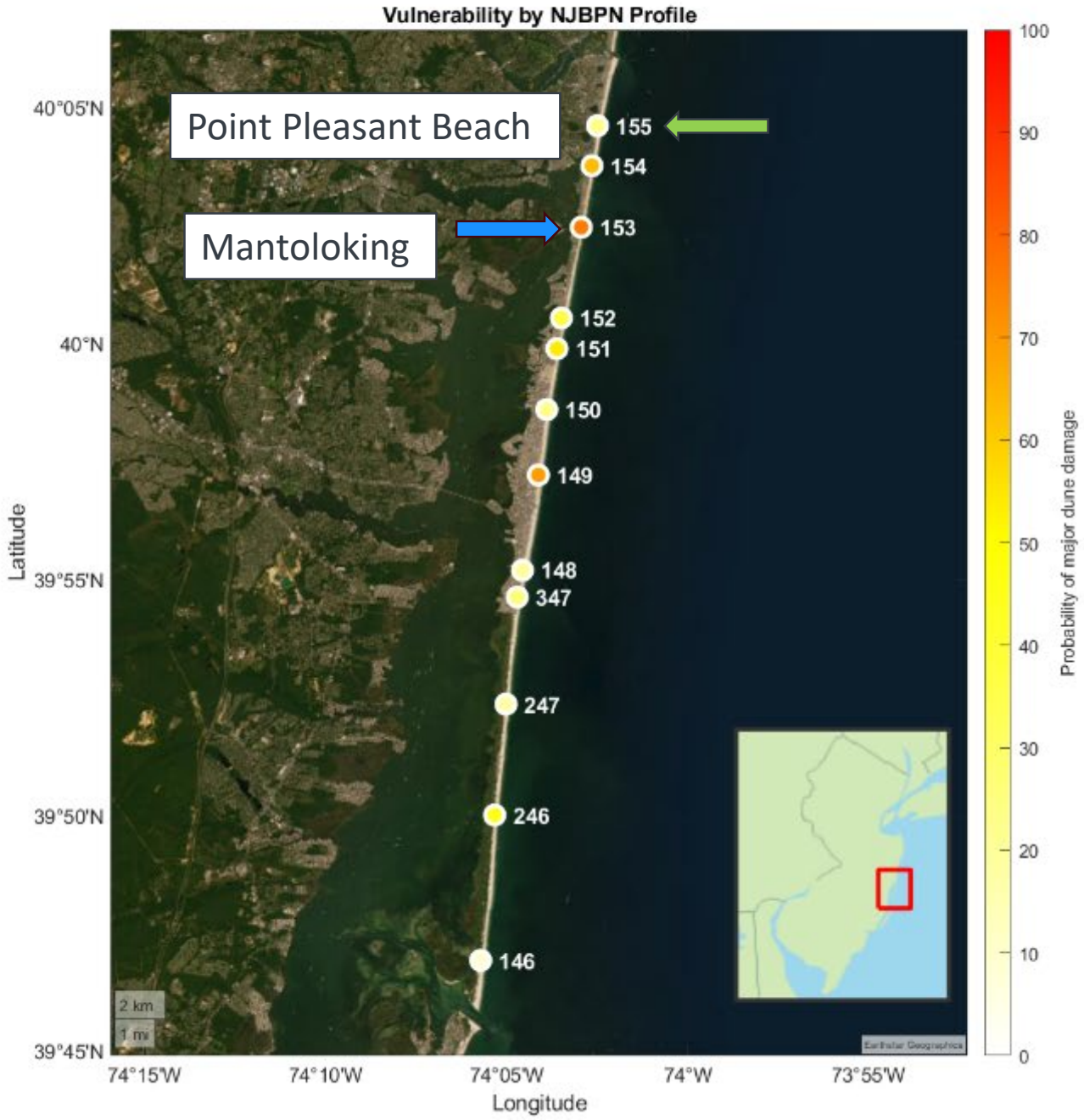
Engineering Demand Parameter (EDP)

$$EDP = \frac{PEI^4}{Dune\ Vol\ x\ Berm\ Width^{\,2}}$$

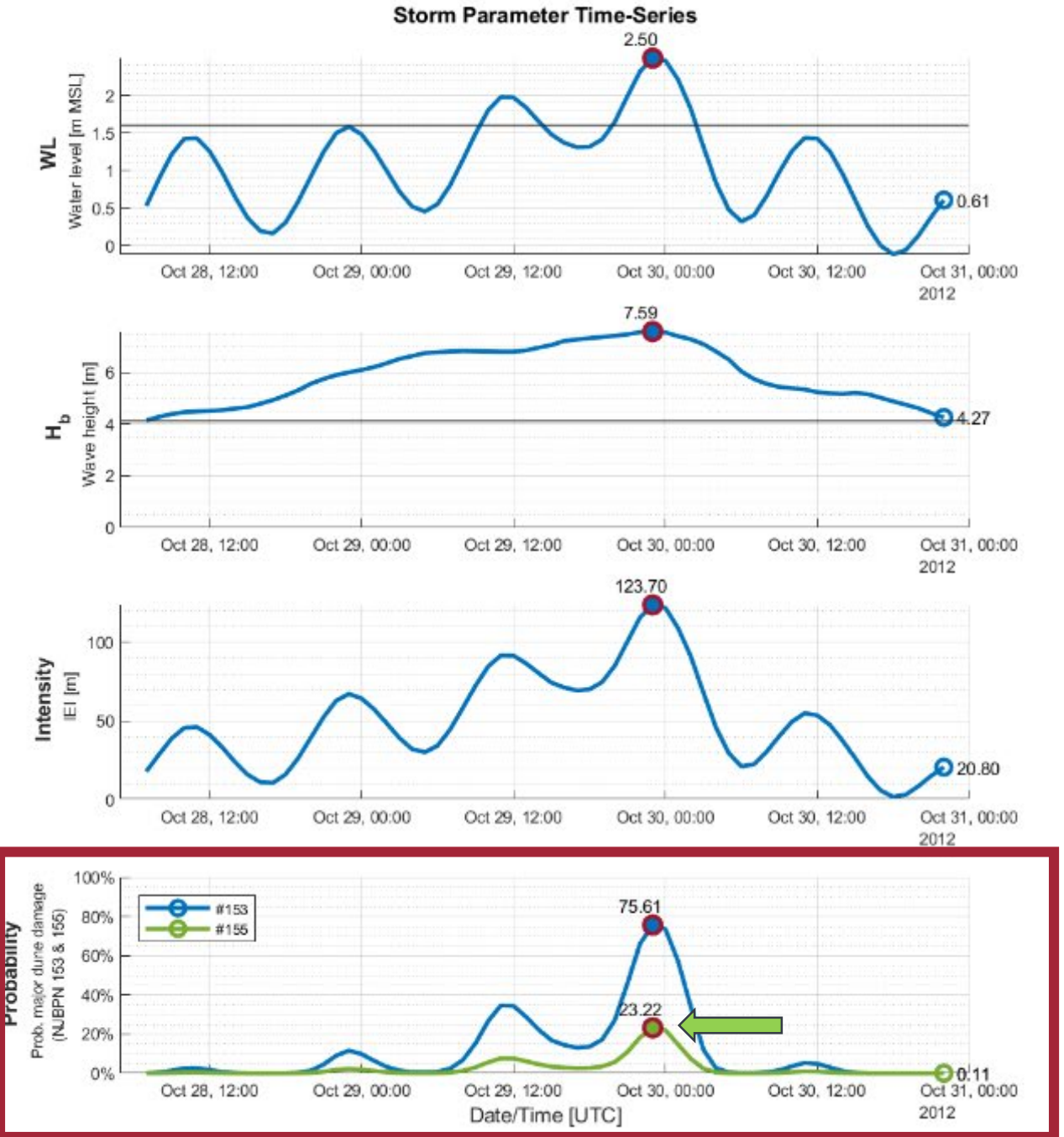
Janssen and Miller (2022)

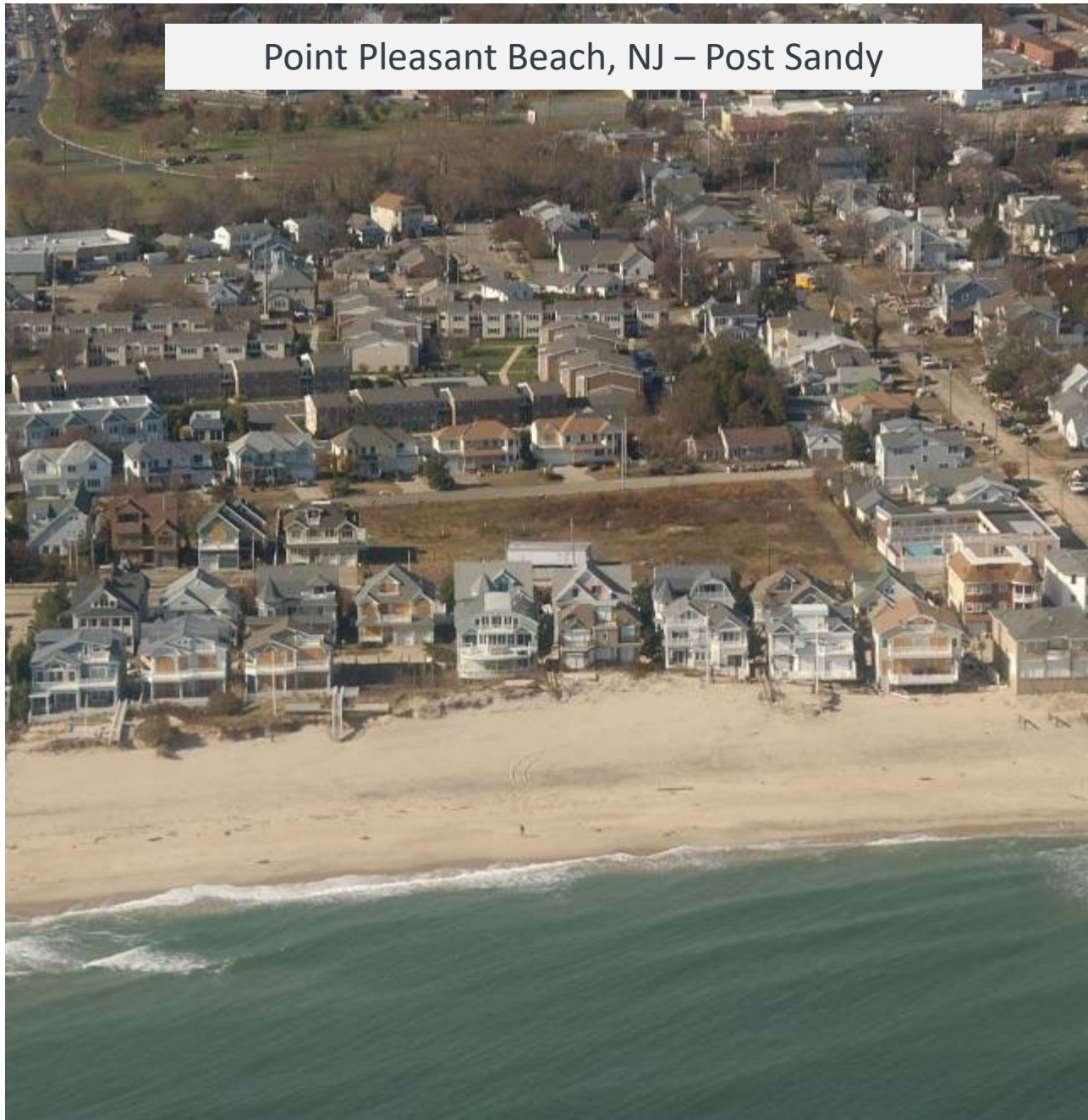
Hourly Storm Vulnerability
NJ Shoreline Segment 5



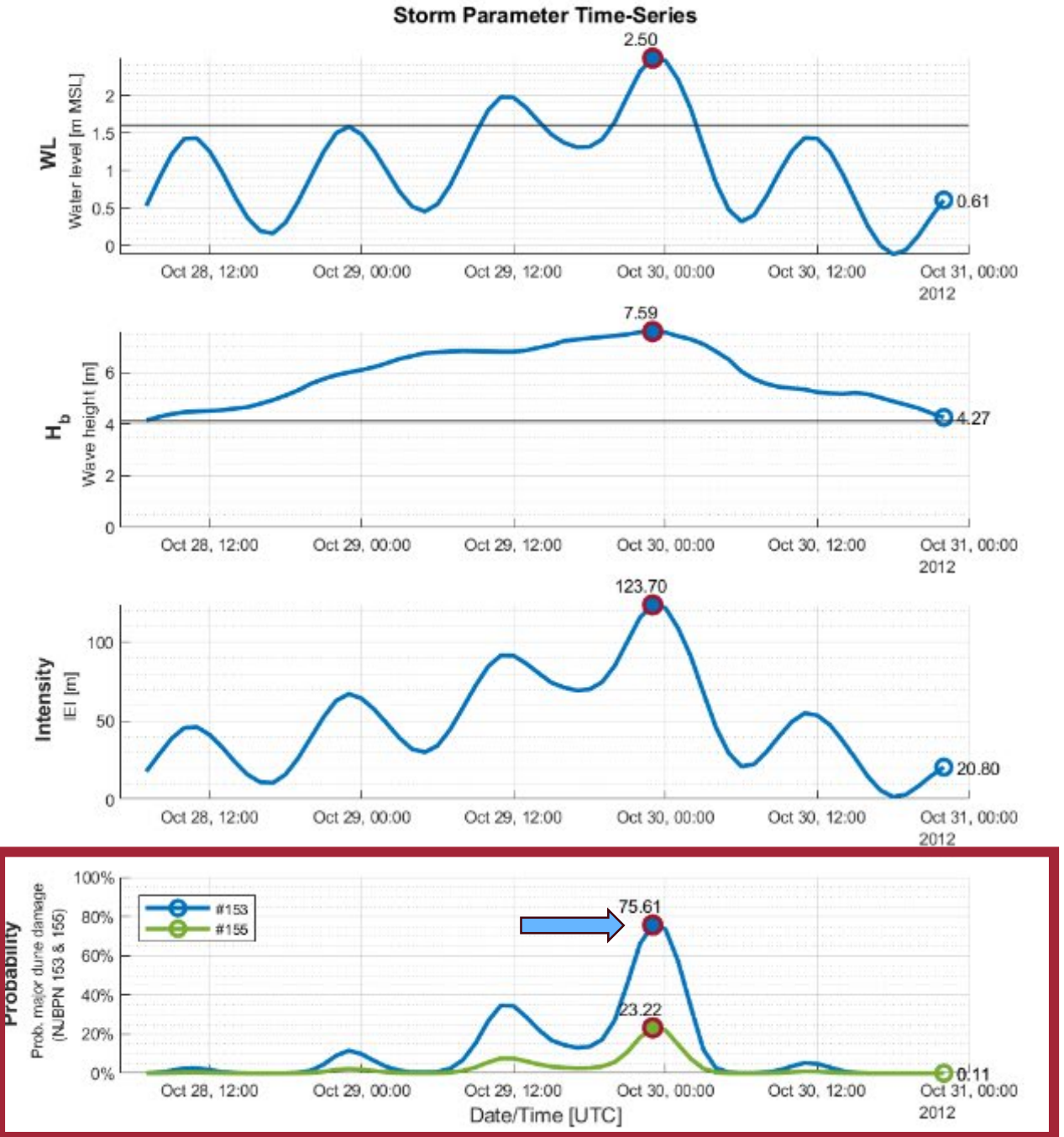


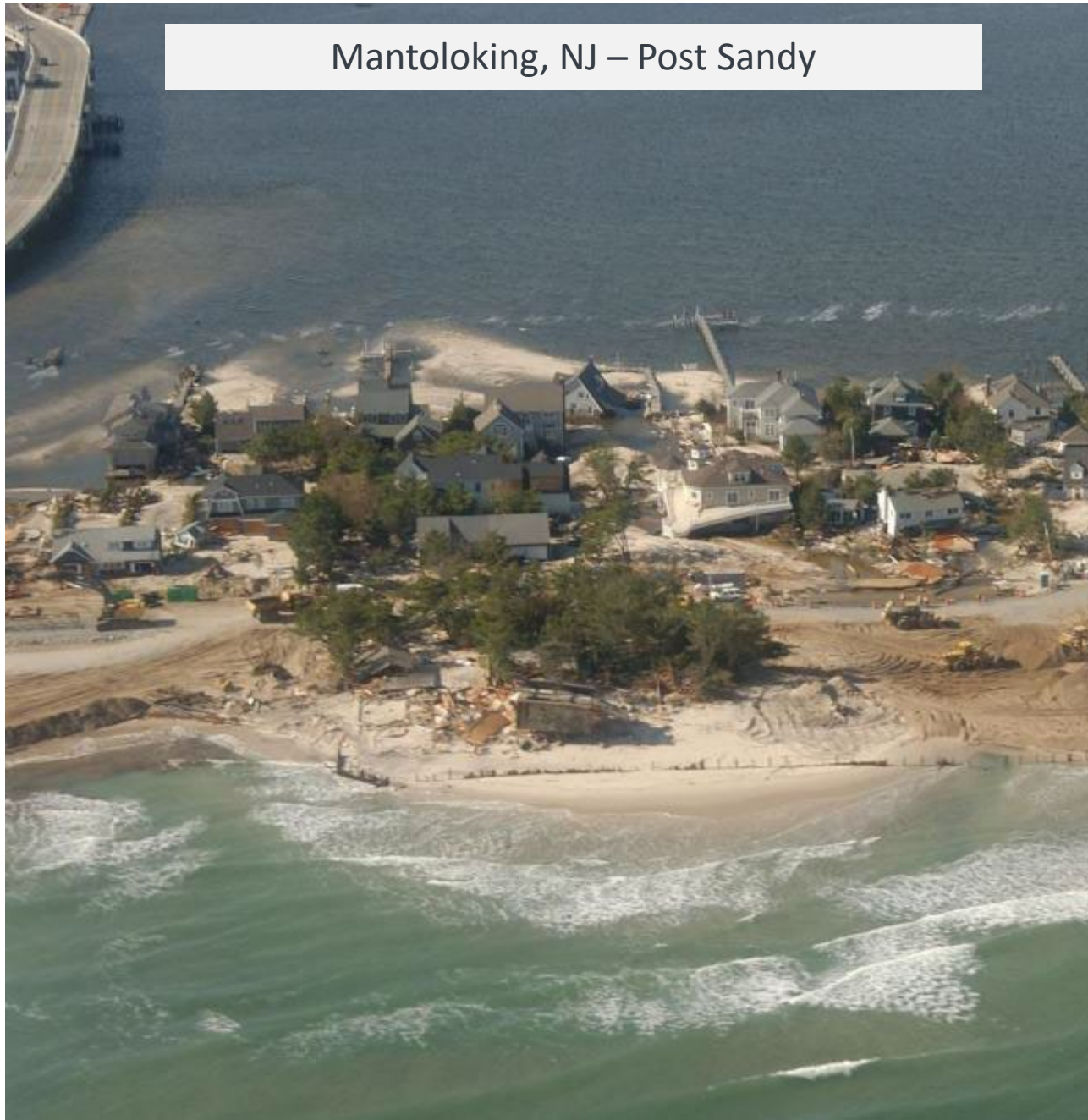
Hourly Storm Vulnerability
NJ Shoreline Segment 5





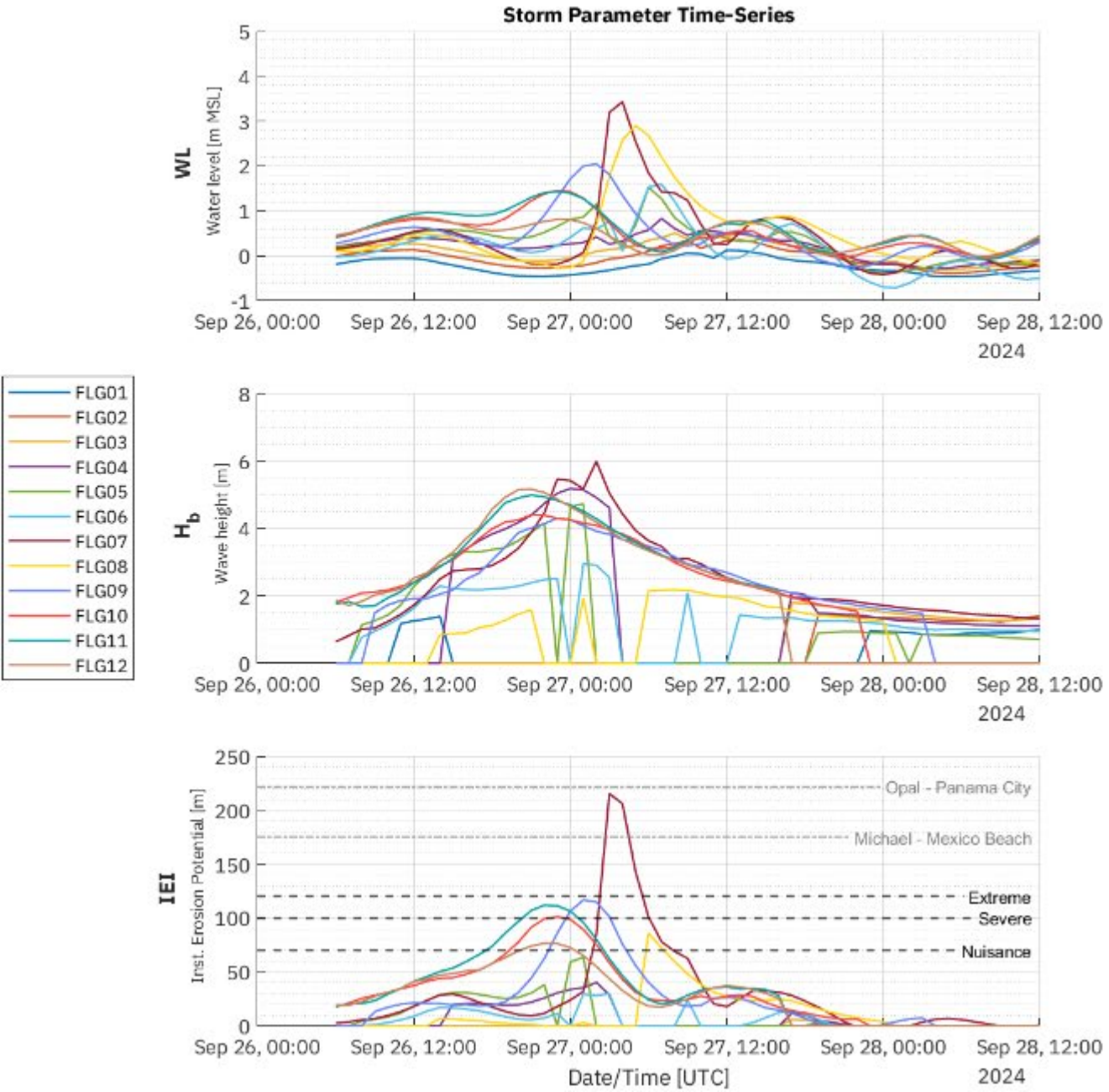
Hourly Storm Vulnerability
NJ Shoreline Segment 5

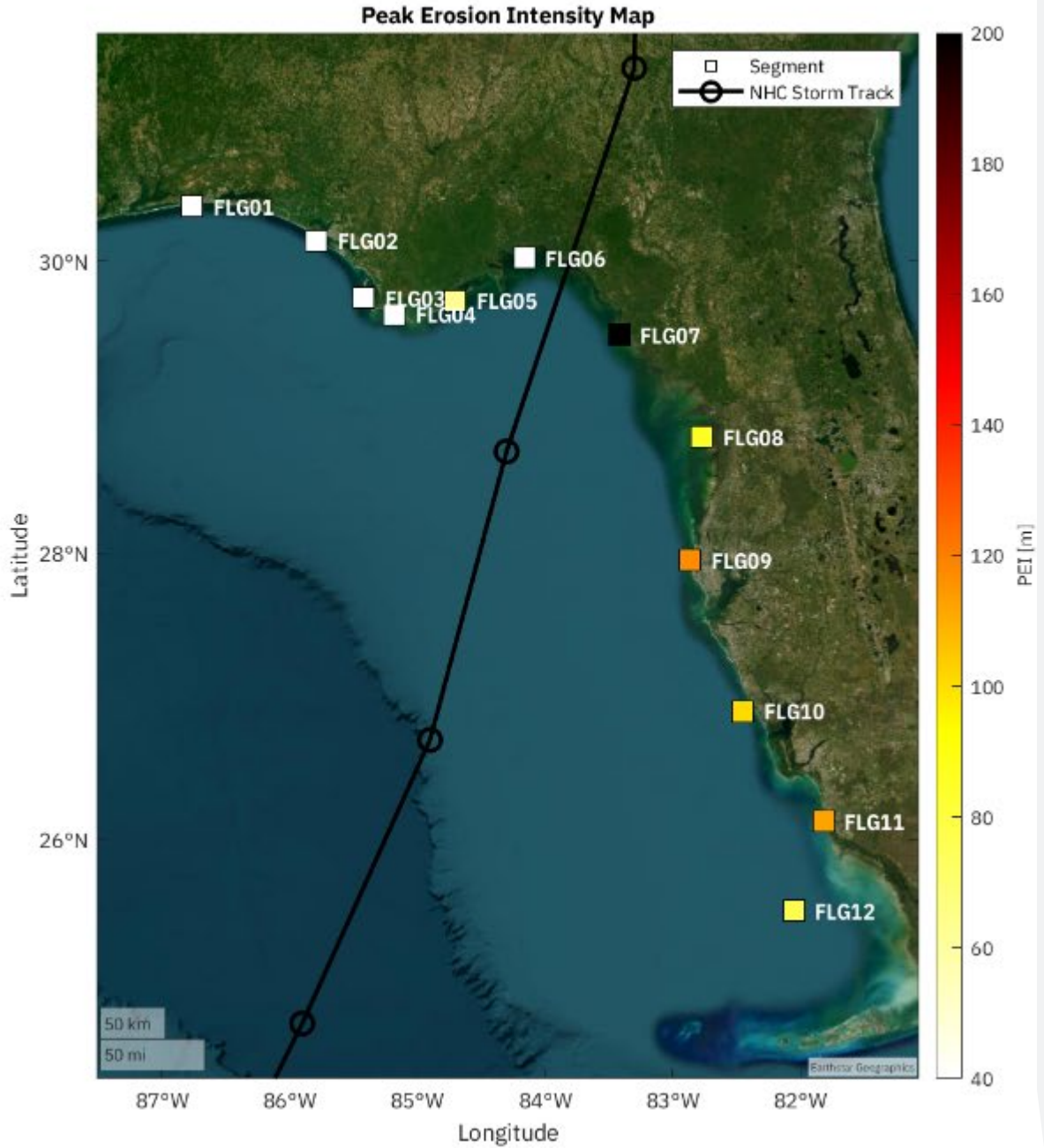




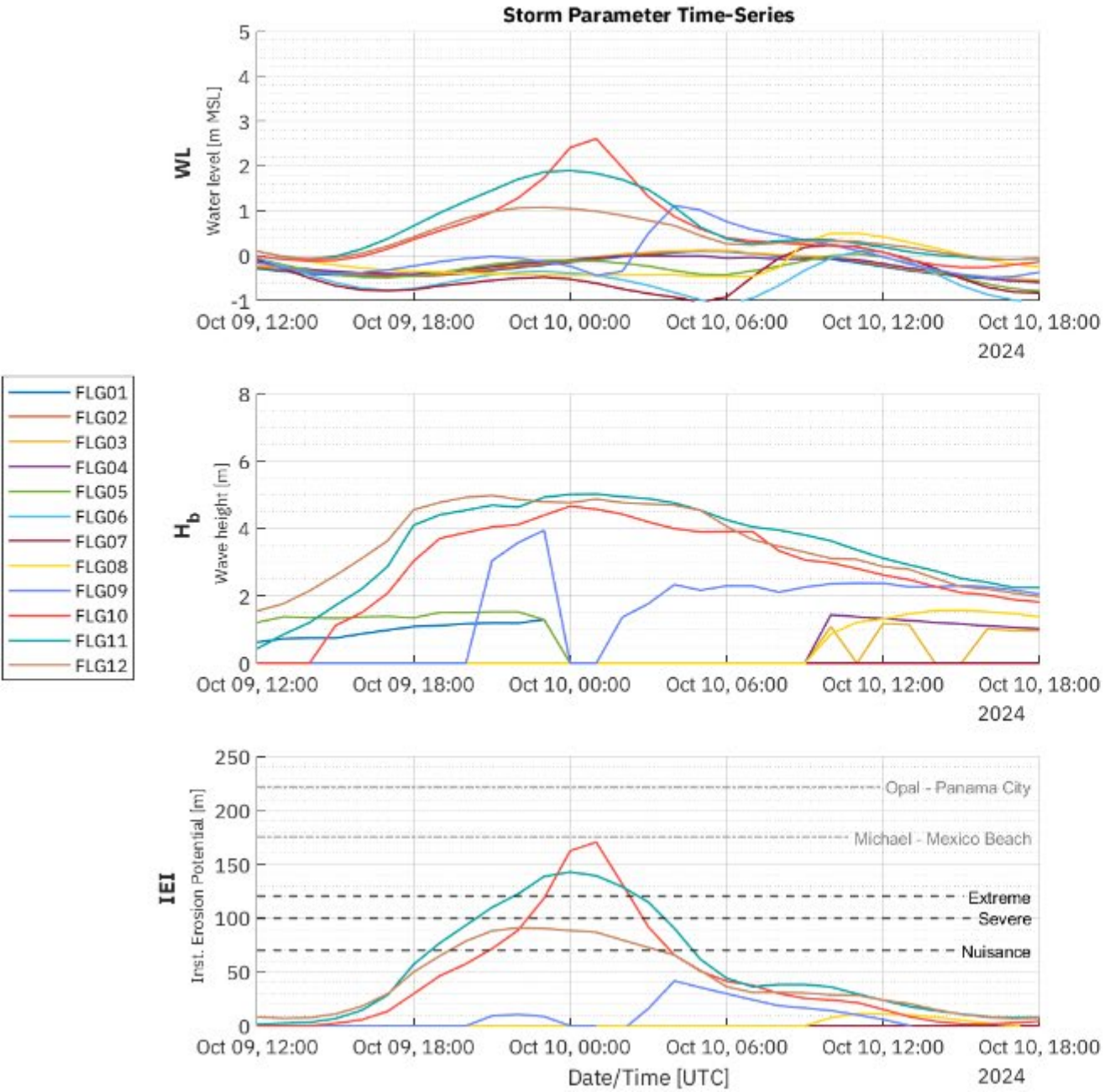
Hurricane Helene & Milton

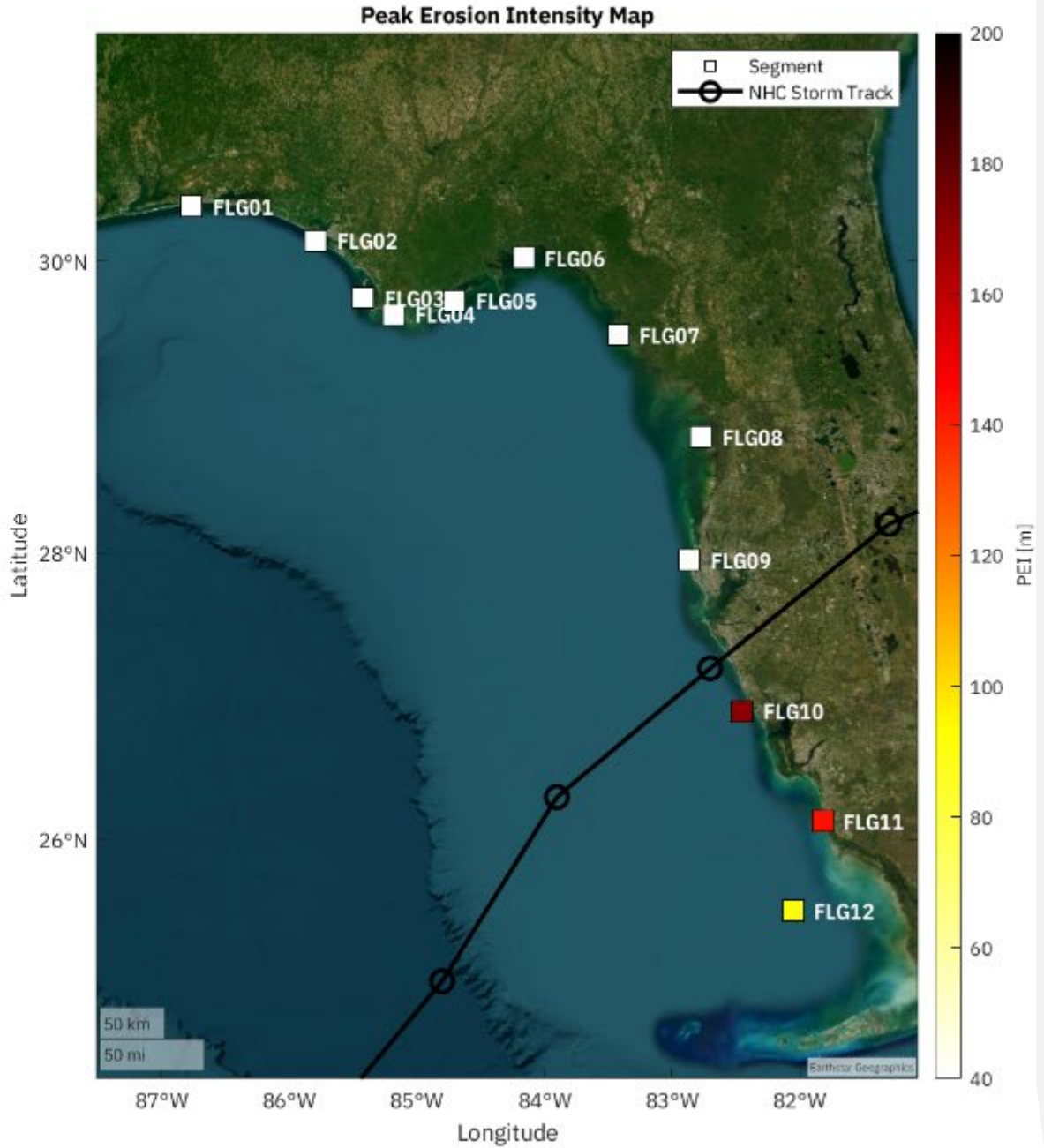
Hourly Storm Intensity
Hurricane Helene Gulf Coast





Hourly Storm Intensity
Hurricane Milton Gulf Coast

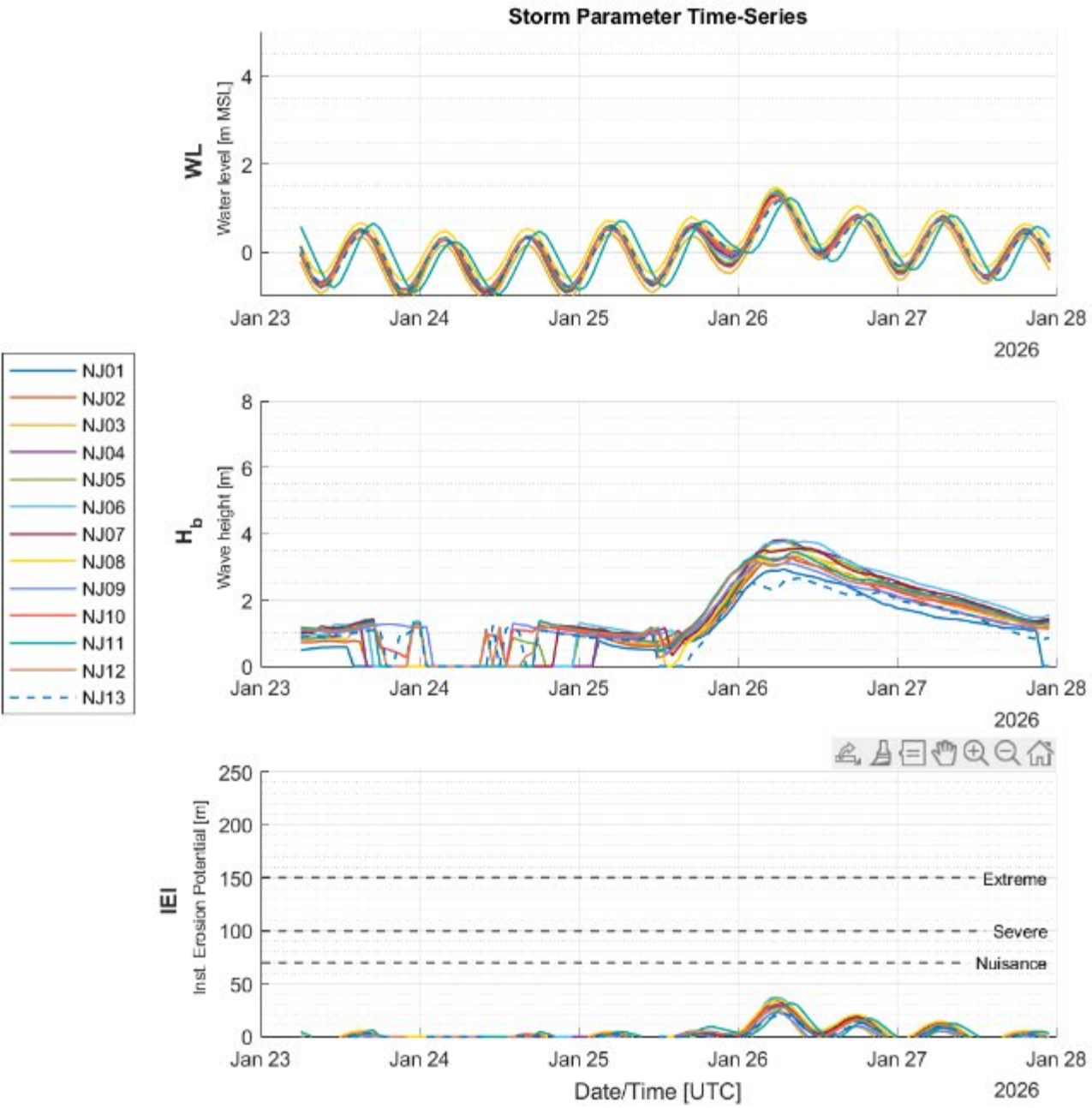


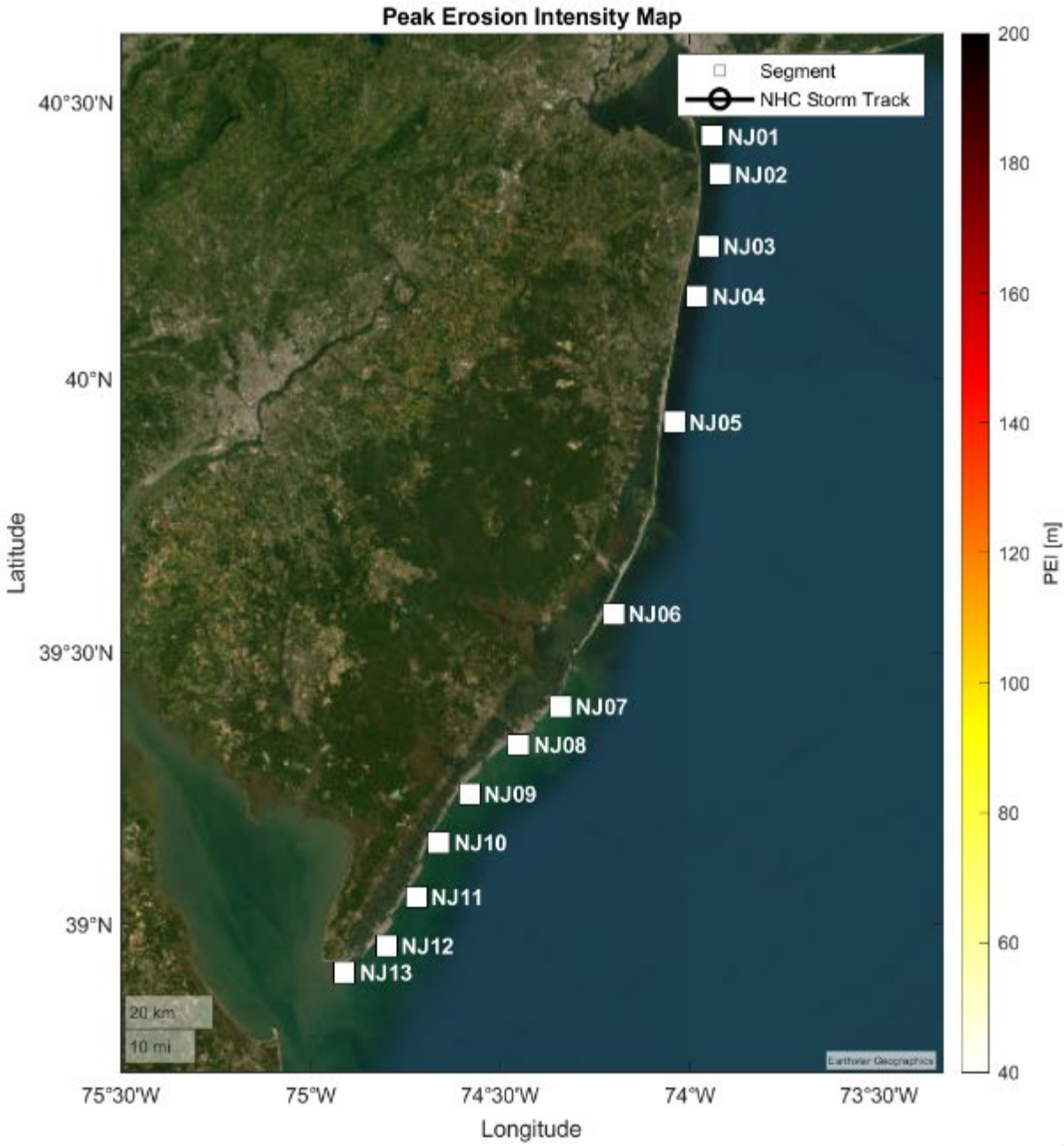


Winter Storm Fern (2026)

Hourly Storm Intensity

Winter Storm Fern - Jan 25 0600z

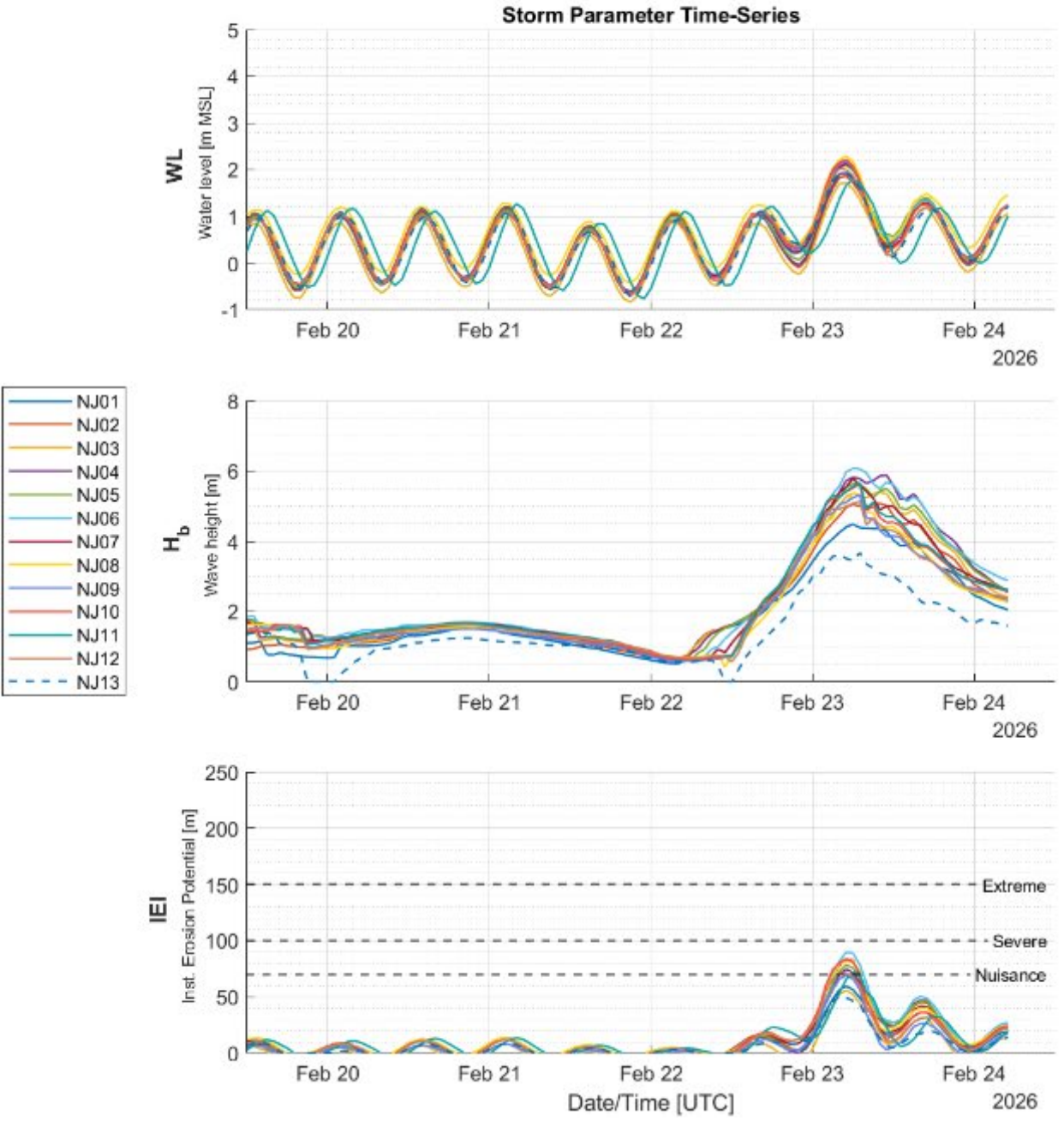


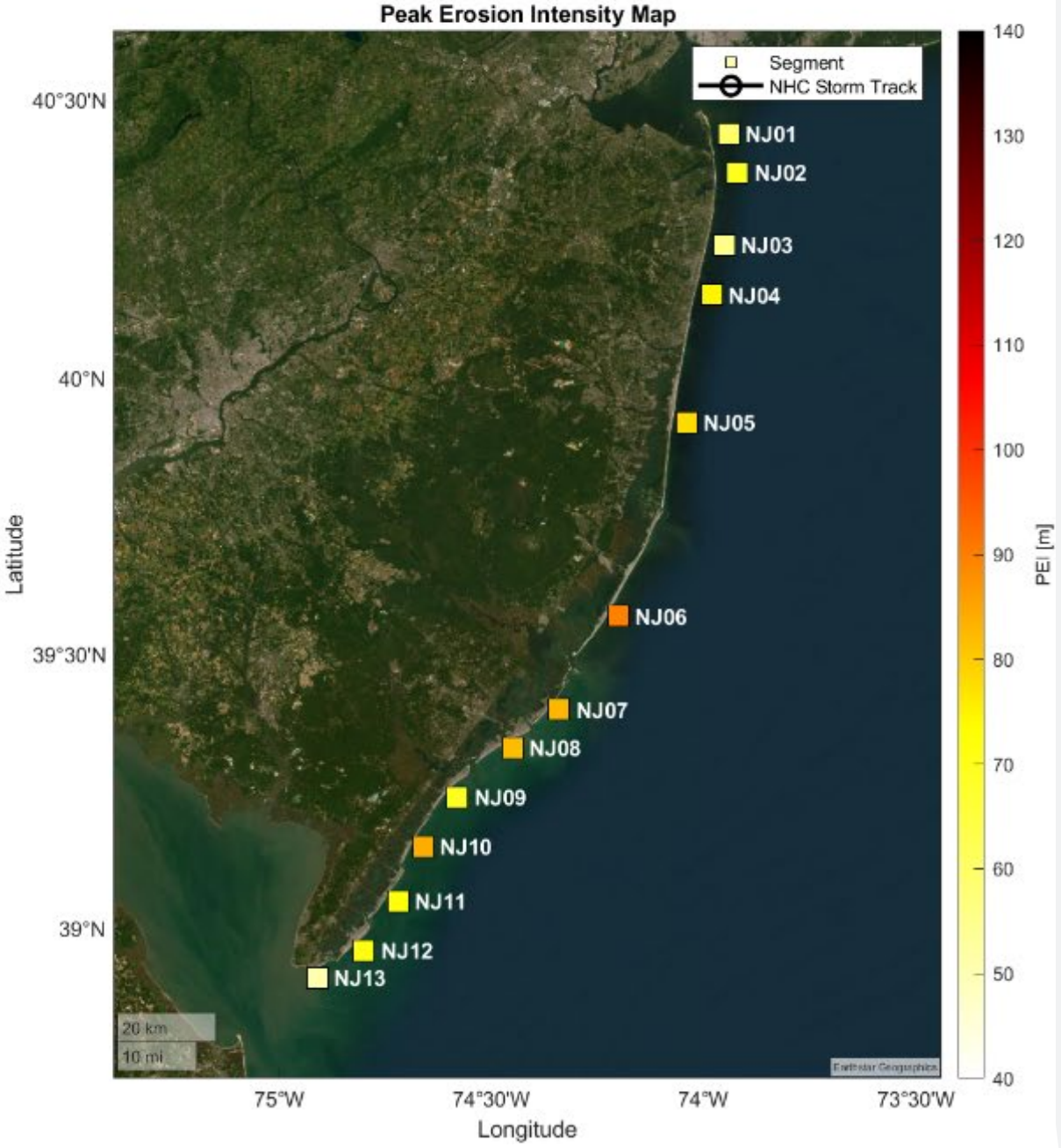


Winter Storm Hernando

Hourly Storm Intensity

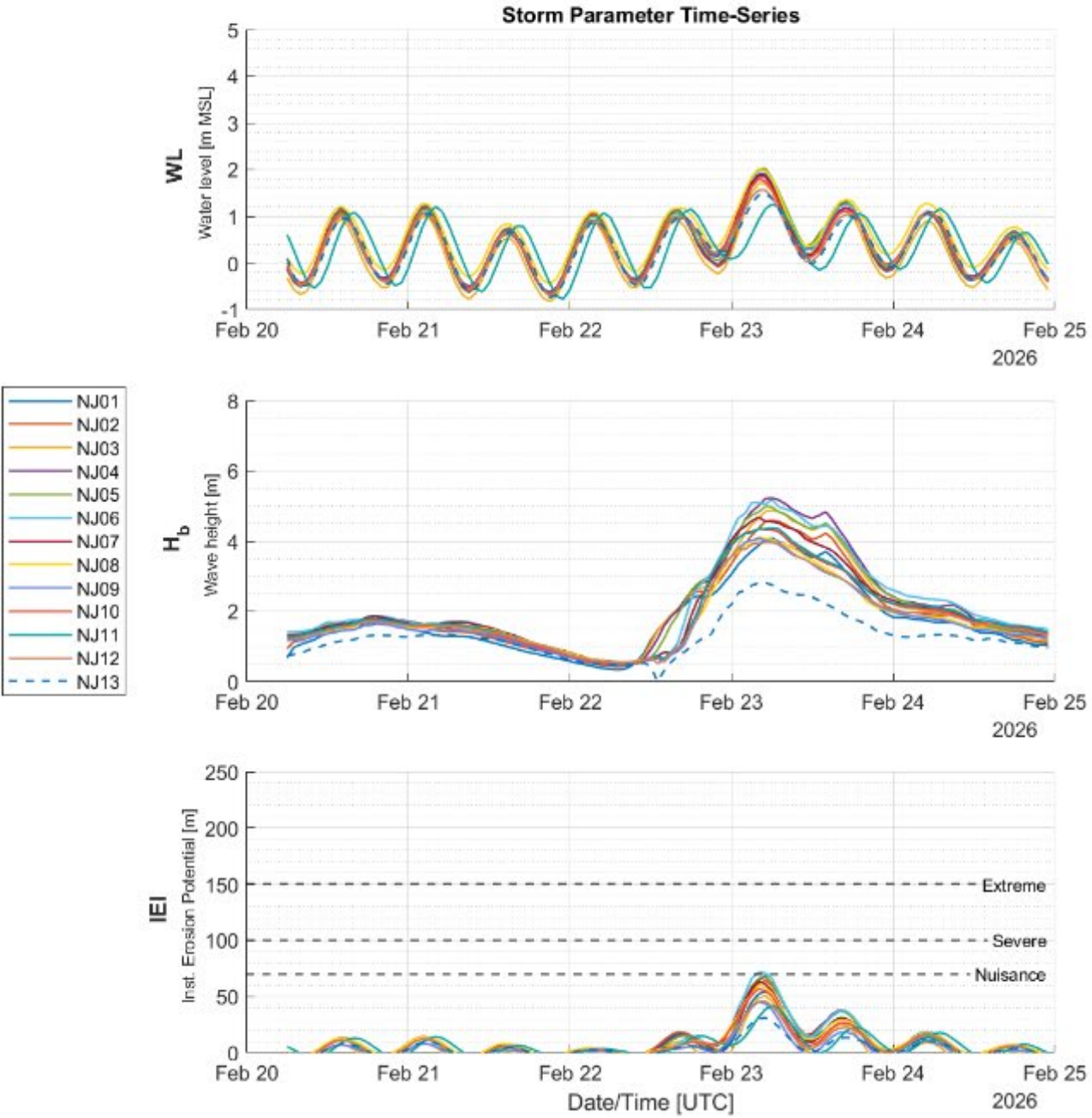
Winter TBD - Forecast Run: Feb 19 1800z

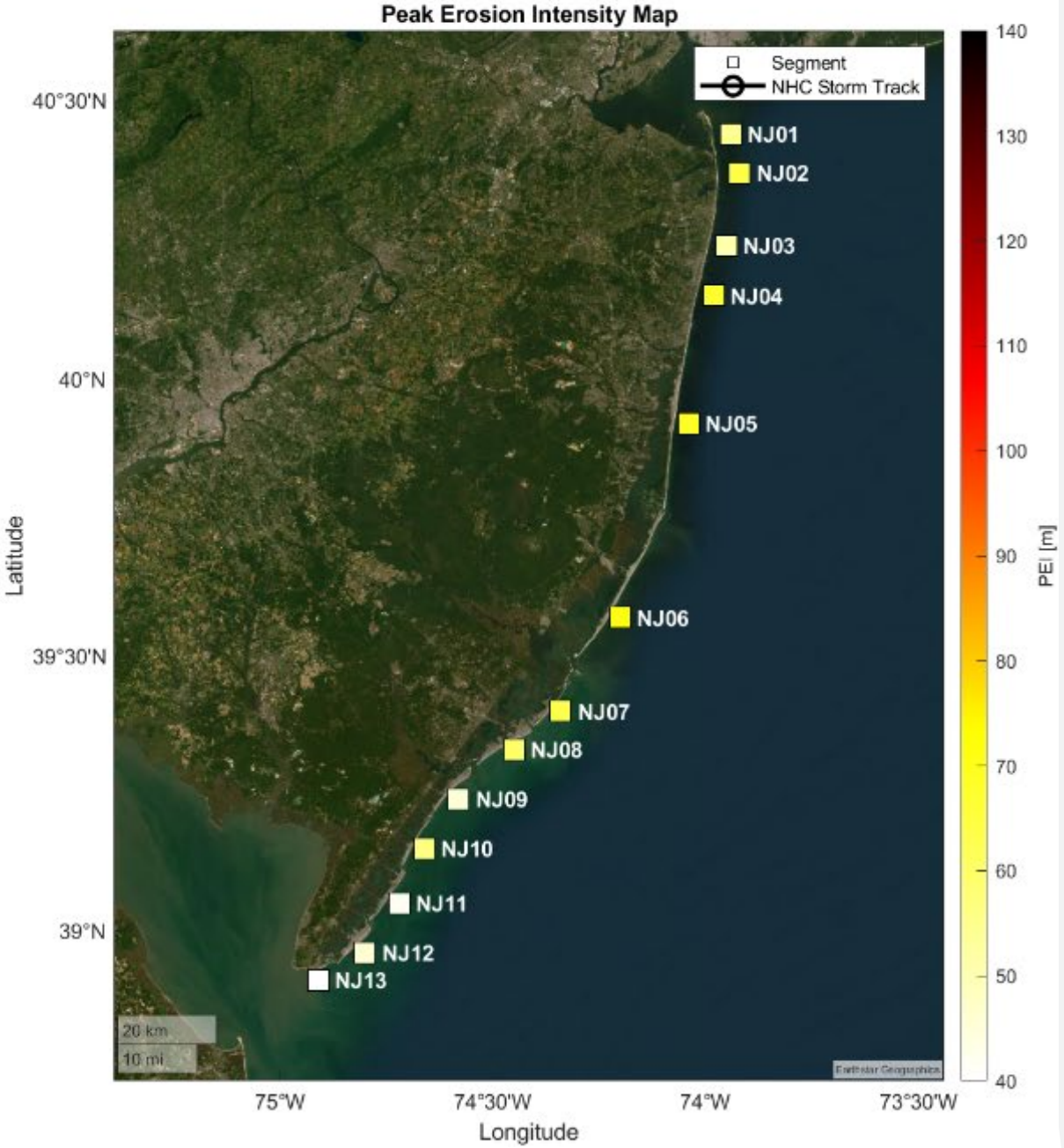




Hourly Storm Intensity

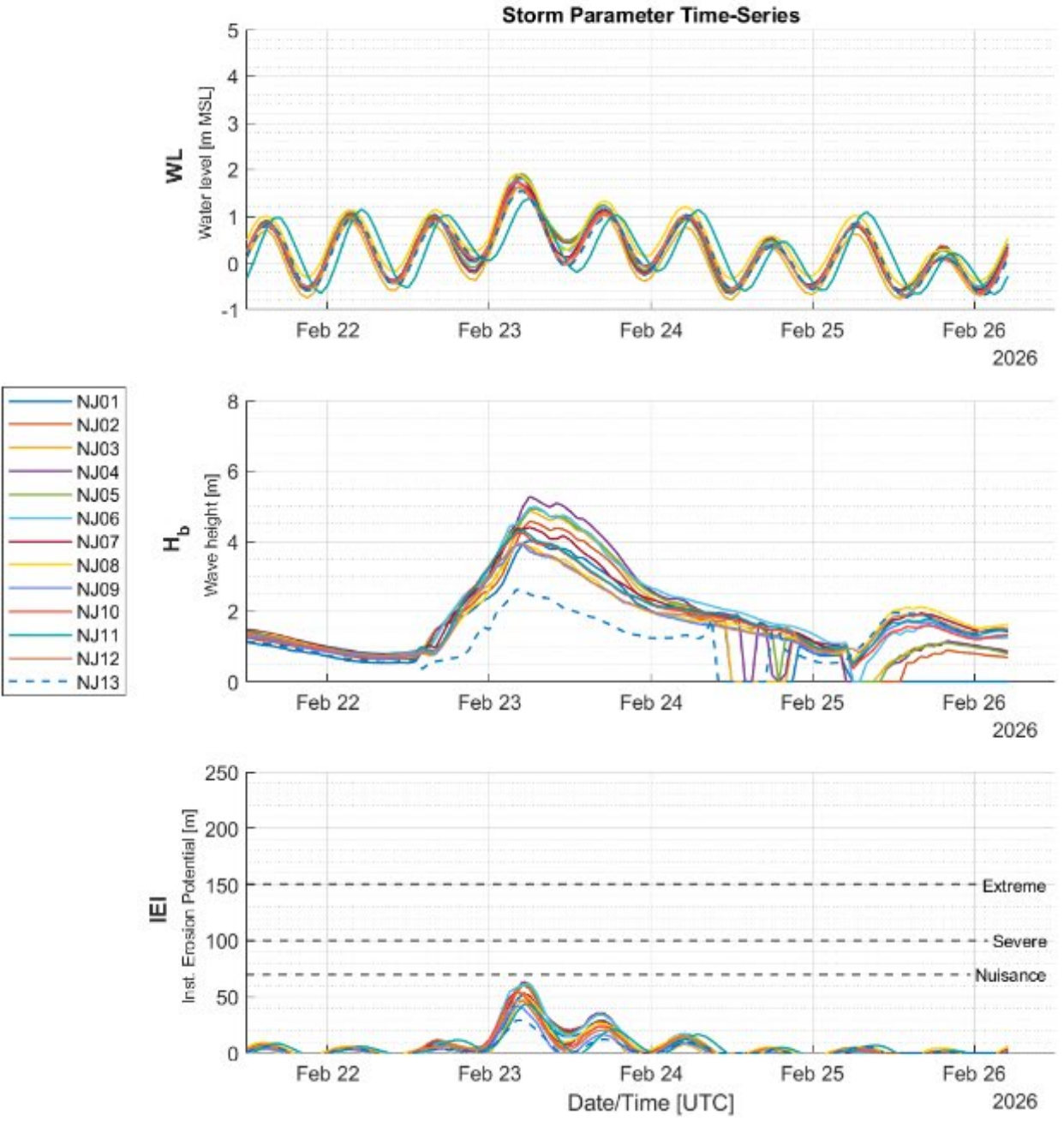
Winter TBD - Advisory 2: Feb 20 0600z

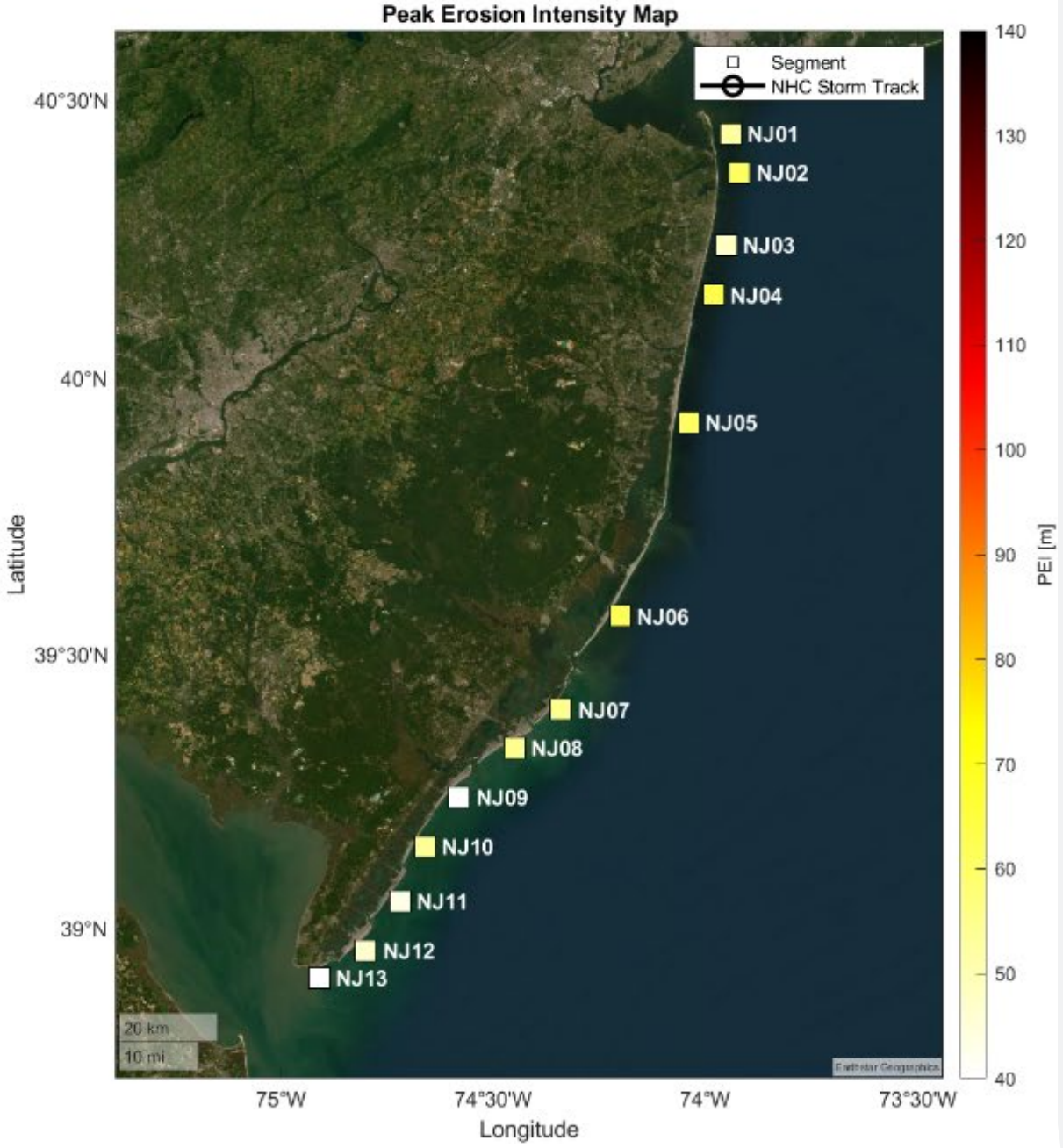




Hourly Storm Intensity

Winter Hernando - Advisory 6: Feb 21 1200z





Winter Storm Hernando


COAST-SEA FORECASTS
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Coastal storm erosion forecasts for NJ using:
Storm Erosion Index
doi.org/10.1016/j.co...
and Dune Fragility Curves
doi.org/10.3390/jmse...
Hindcast model evaluation
doi.org/10.34237/100...
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Tropical Storm Erin (2025)

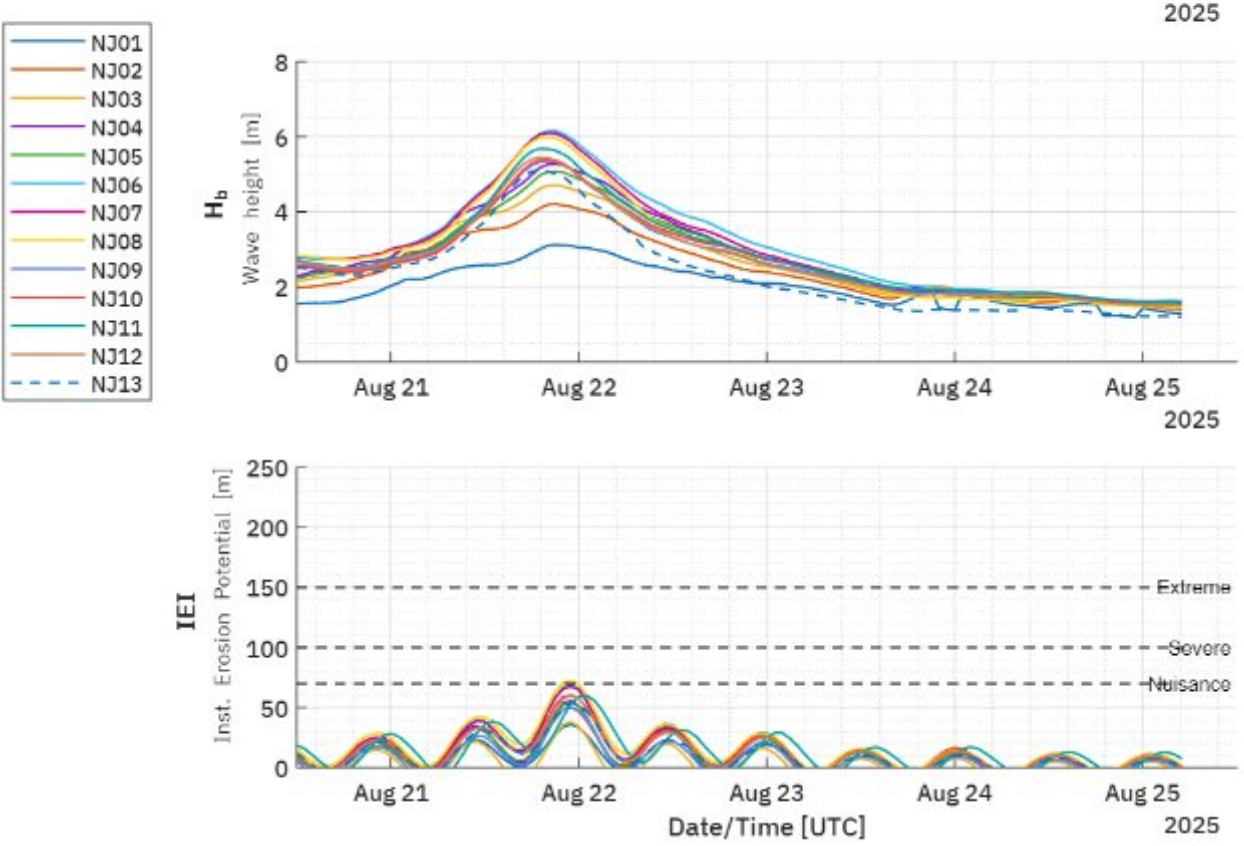
Hourly Storm Intensity

Hurricane Erin NJ

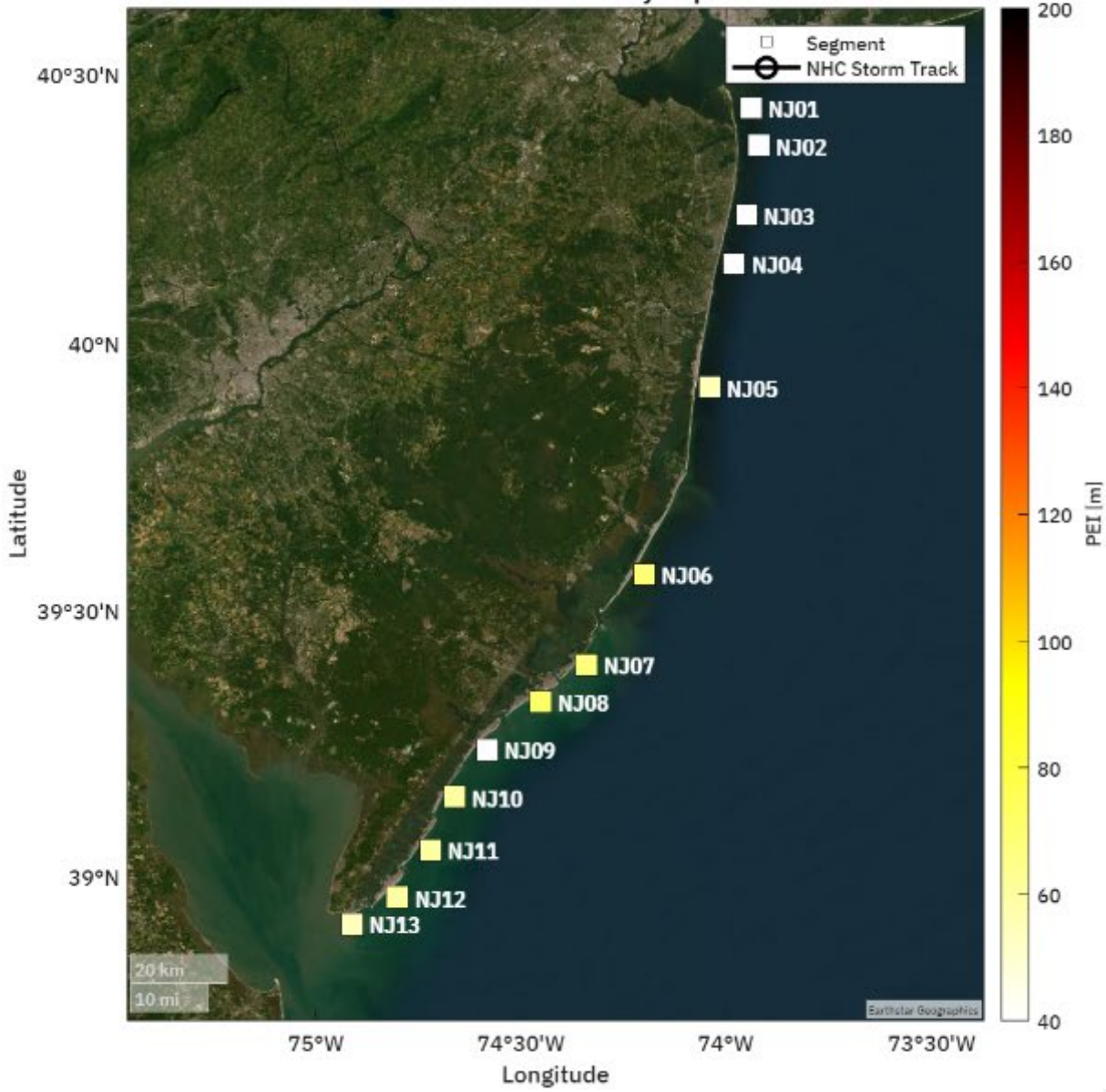
WV: WW3 WL: SFAS

T: 20250820t18z Statewide

Storm Parameter Time-Series



Peak Erosion Intensity Map



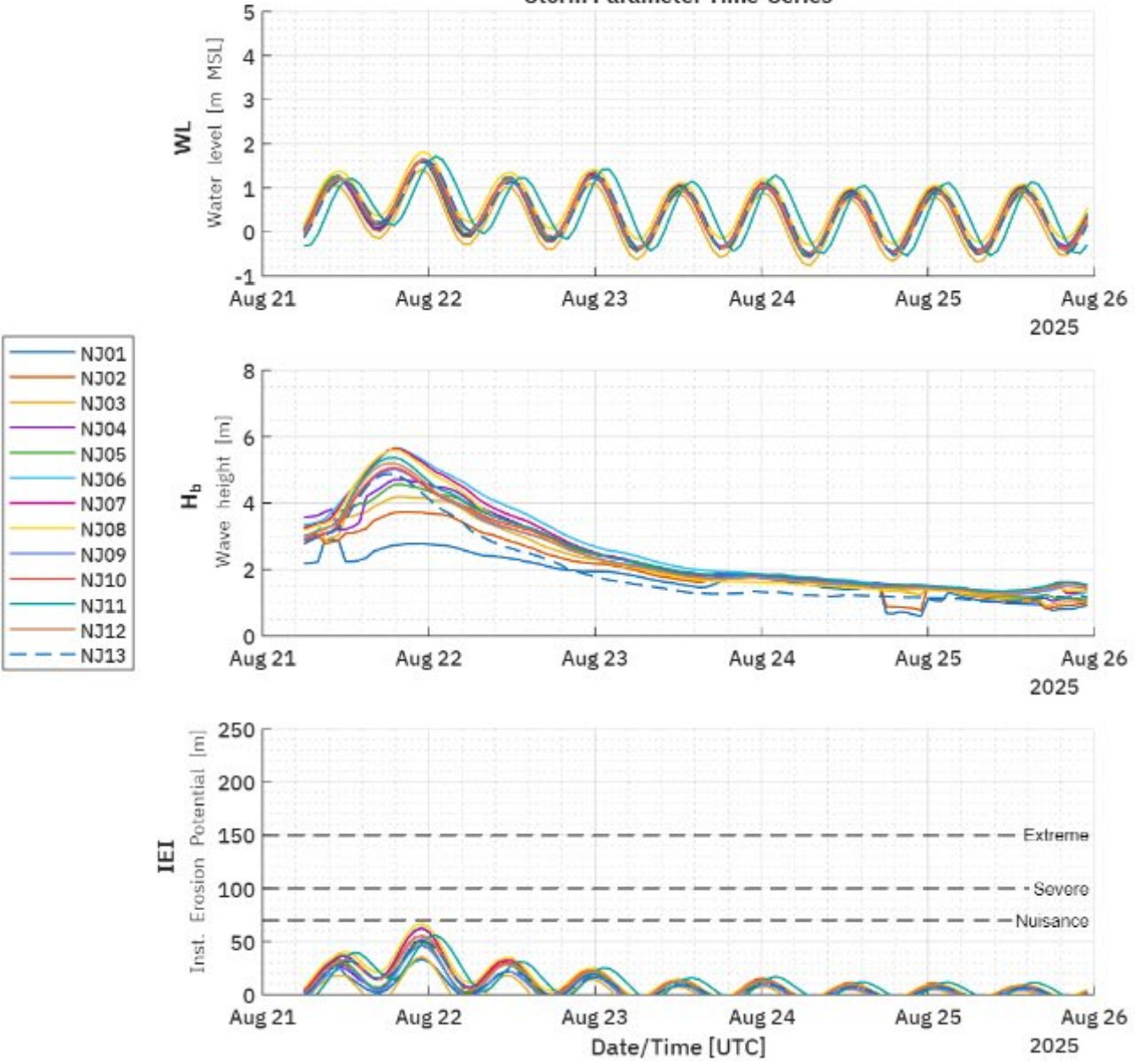
Hourly Storm Intensity

Hurricane Erin NJ

WV: WW3 WL: SFAS

T: 20250821t12z Statewide

Storm Parameter Time-Series



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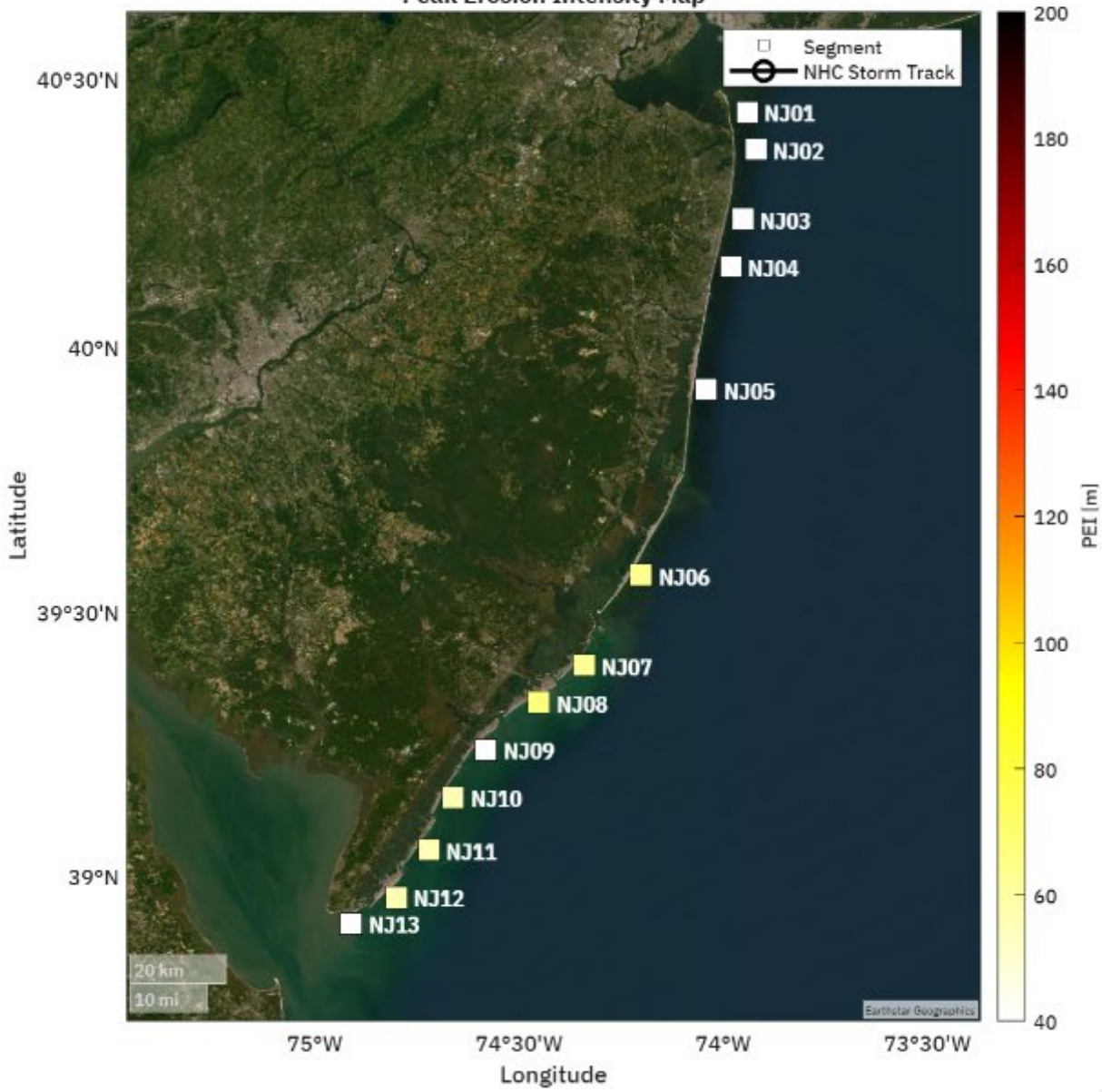
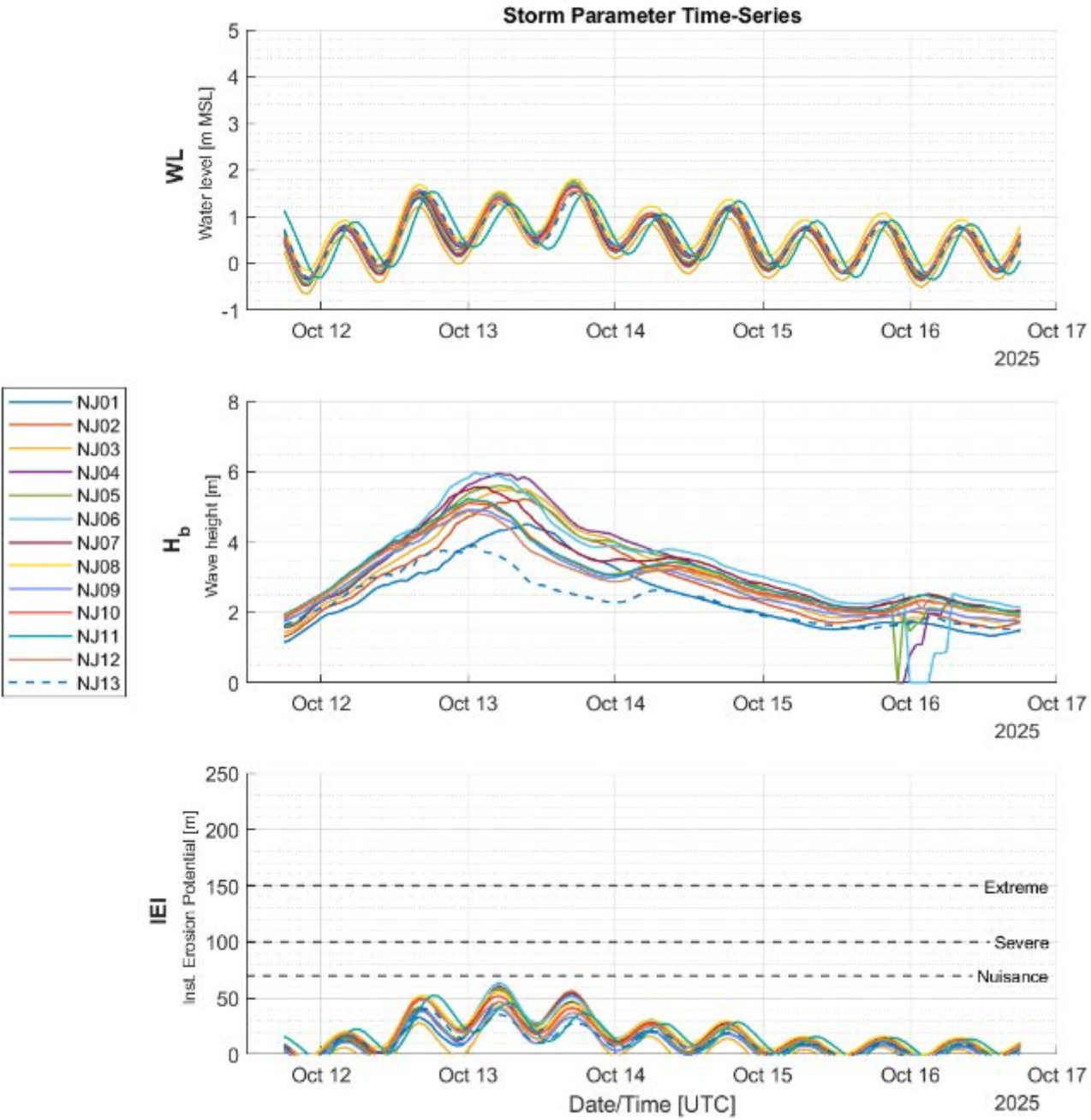
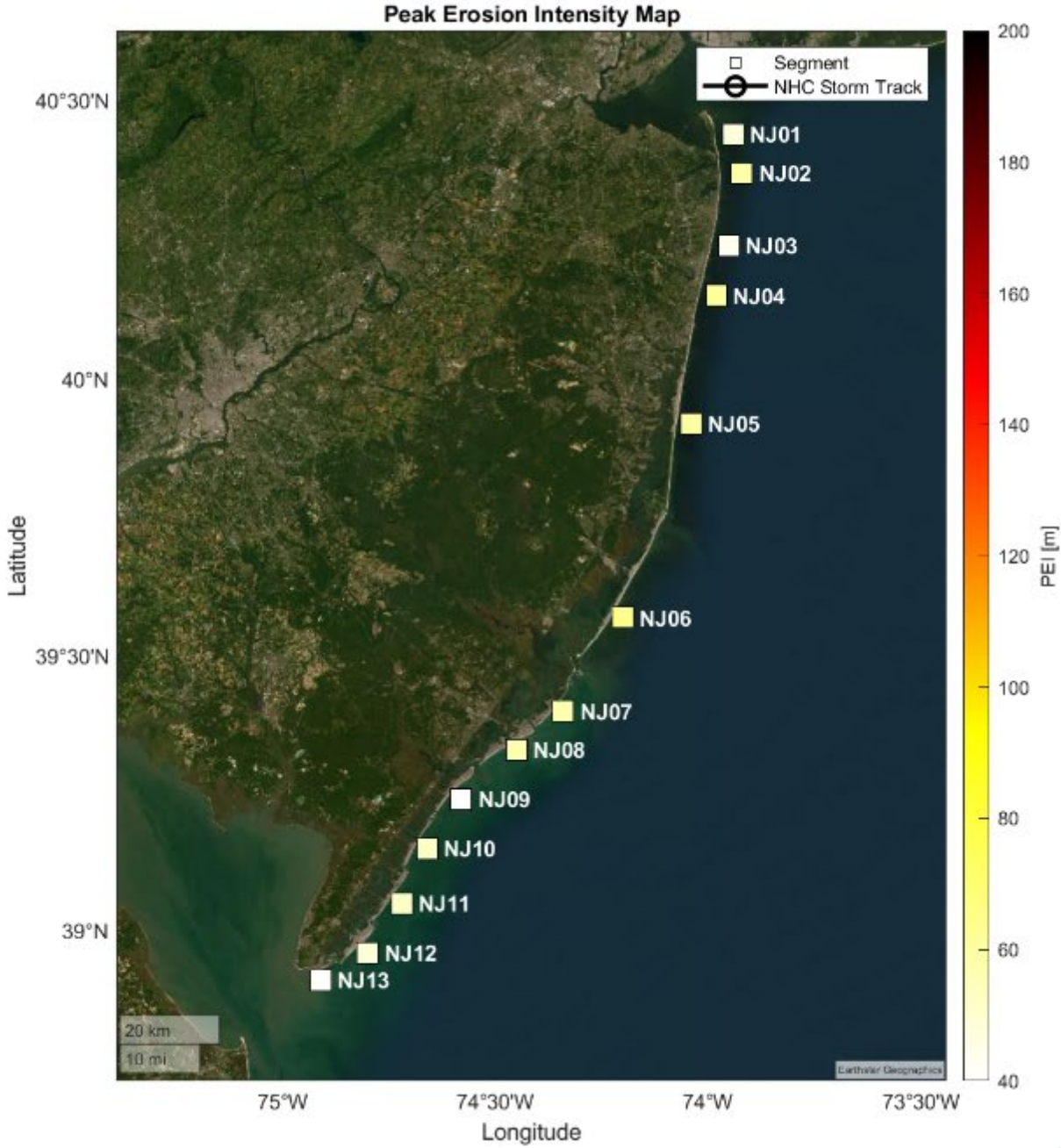


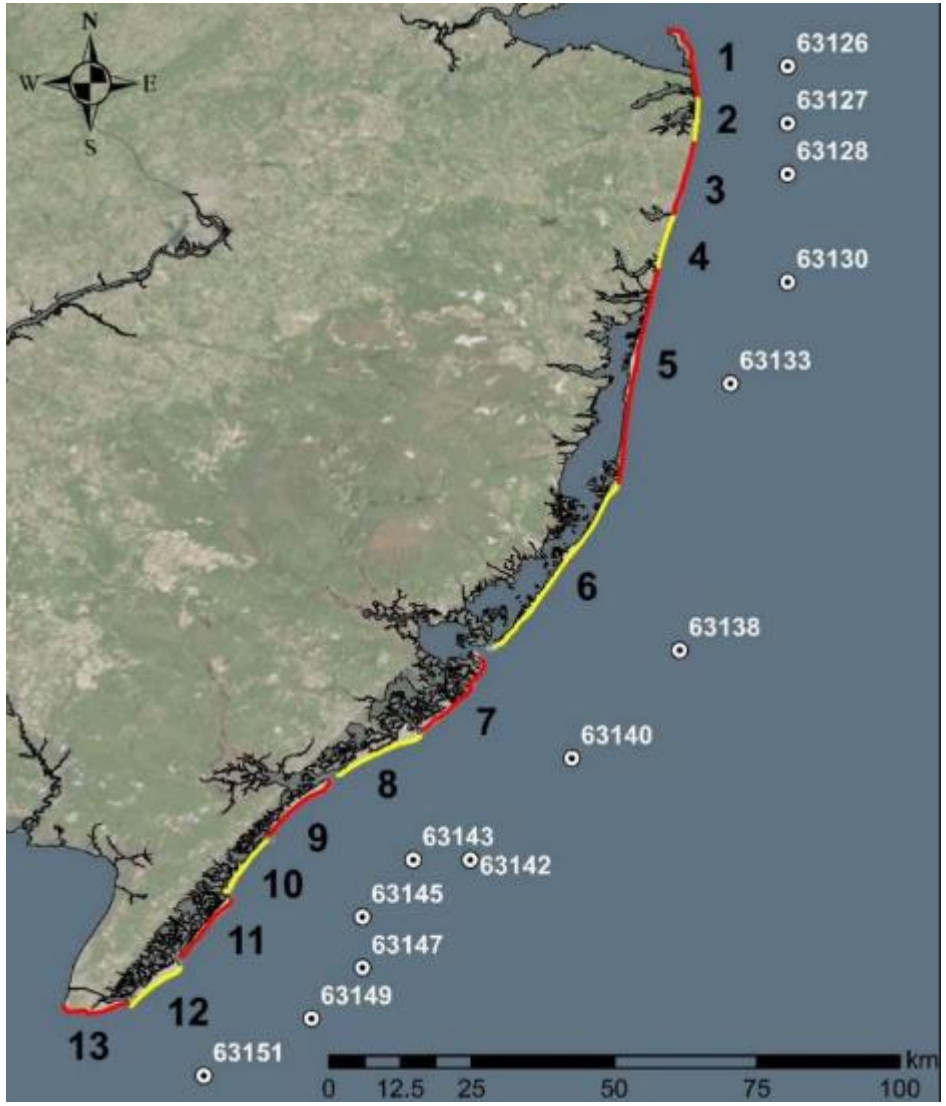
October 2025 Noreaster

Hourly Storm Intensity
Oct 2025 Noreaster - Oct 12 0800z





New Jersey SEI Climatology (Lemke and Miller, 2020)



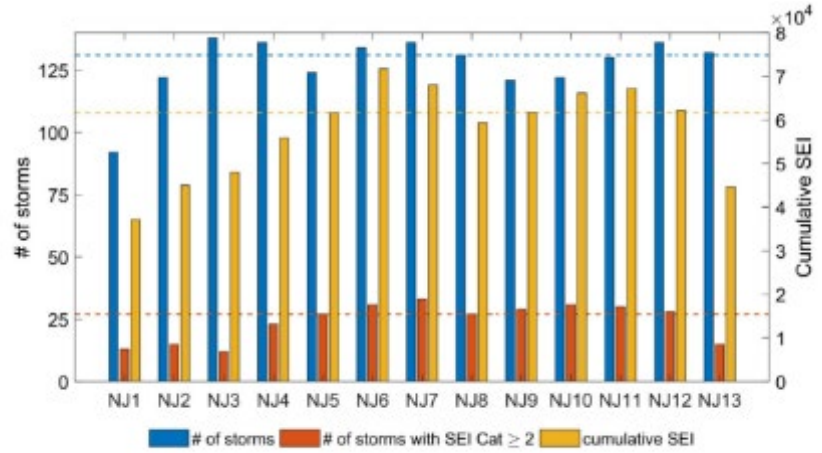
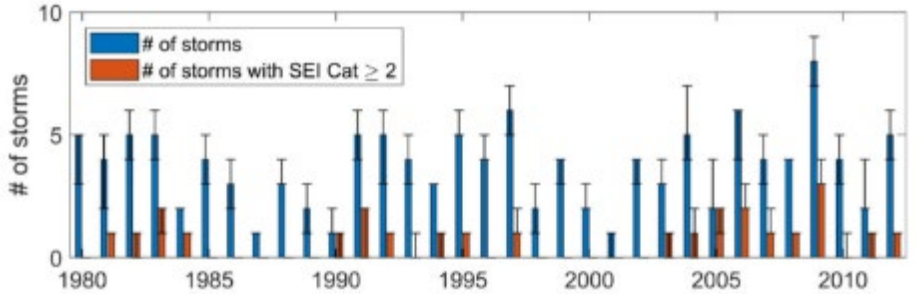
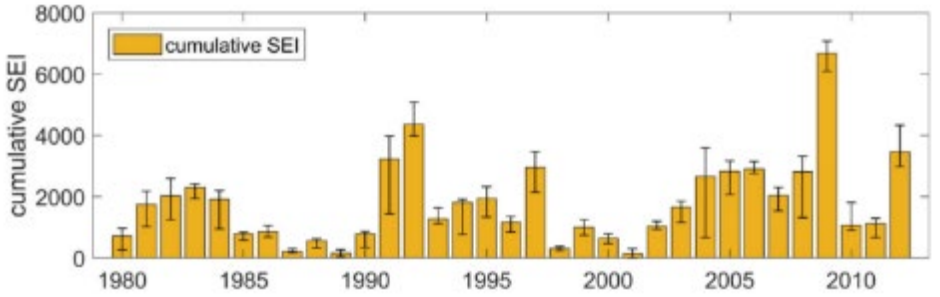


Fig. 7. Totals for three parameters, summed over the 34-year record, with median values presented as horizontal dotted lines.





Storm Erosion Index

Miller and Livermont (2008), Lemke and Miller (2020)

Instantaneous Erosion Intensity (IEI)

$$\mathrm{IEI}(t_i) = W_* \left[\frac{0.068 H_b(t_i) + S(t_i)}{B + 1.28 H_b(t_i)} \right]$$

Instantaneous erosion potential

Storm Erosion Index (SEI)

$$SEI = \sum_{t_d} \mathrm{IEI}(t_i)$$

Cumulative erosion potential

Peak Erosion Intensity (PEI)

$$PEI = \max(\{IEI(t_i)\}, , : i = 1 \ldots t_d)$$

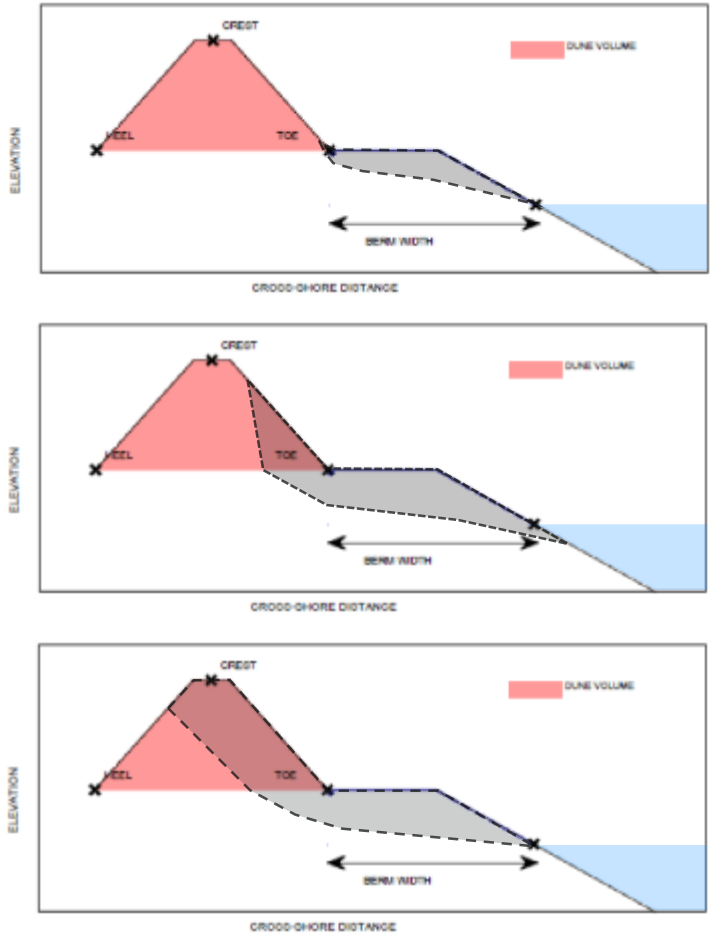
Peak erosion potential

(Janssen et al. 2019; Lemke and Miller 2021).

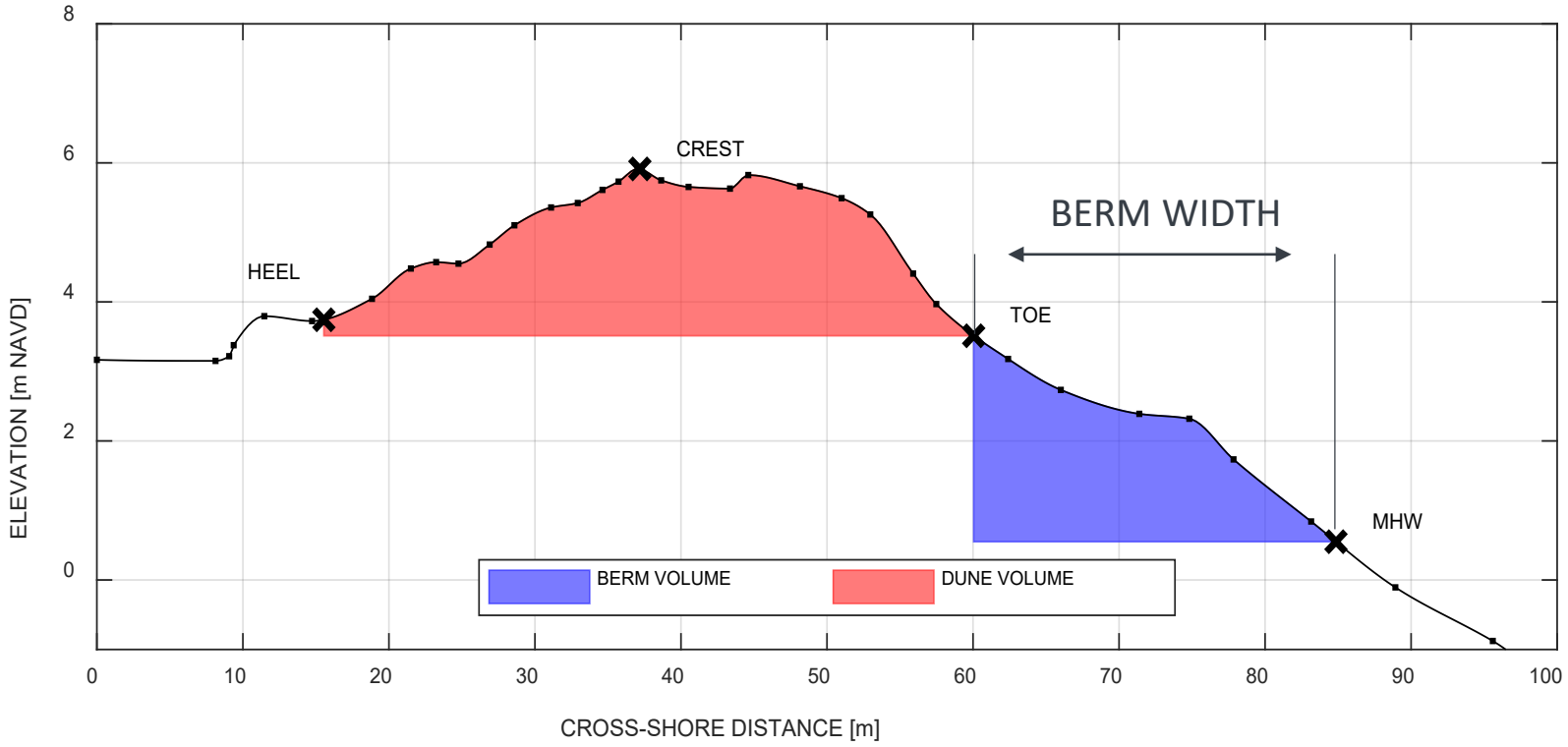
Dune Erosion damage classifications

Lemke and Miller (2021)

Class	Volume loss (% of pre-storm dune volume)	Interpretation
Minor	< 5%	No measurable impacts
Moderate	5% to 40%	Visually apparent erosion/scarping
Major	> 40%	Overwash likely; *Onset of damages upland*



$$EDP = \frac{PEI^4}{Dune\ Vol\ x\ Berm\ Width^{\ 2}}$$

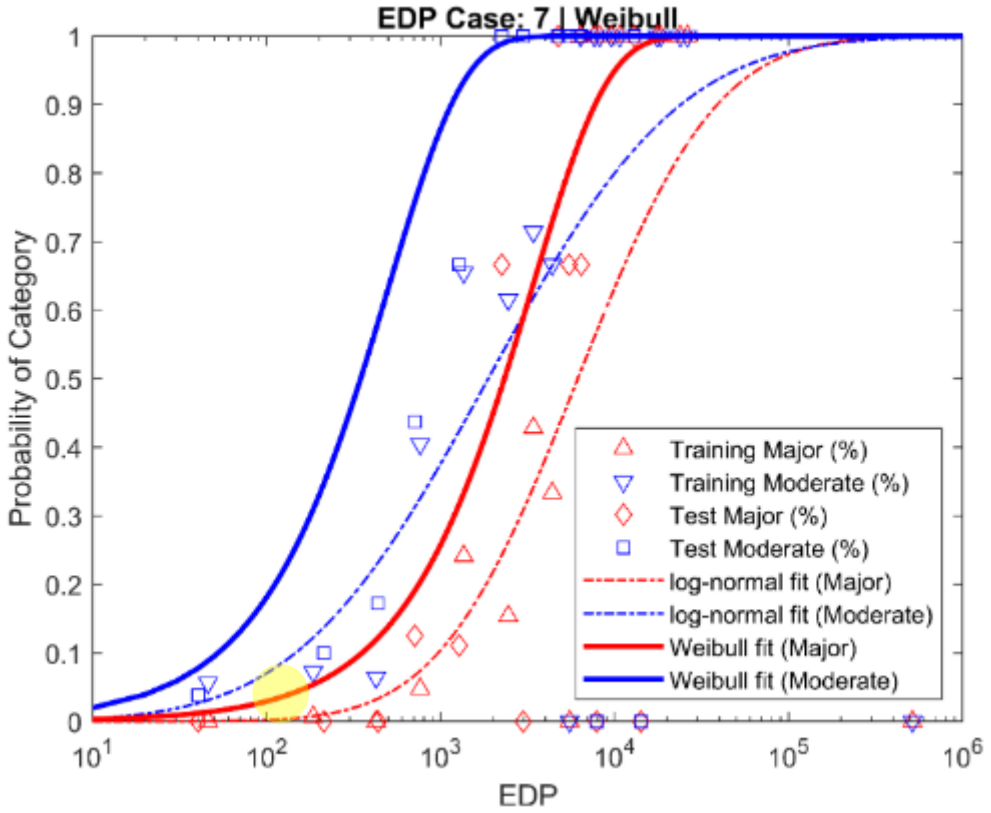


The EDP Fragility Curve

$$P\left(C \middle| \frac{IM}{R_f} = EDP\right) = 1 - exp\left(\frac{-EDP}{\lambda}\right)^{\kappa}$$

- IM = Storm Intensity Measure
- R_f = Beach Resilience (e.g., beach width)

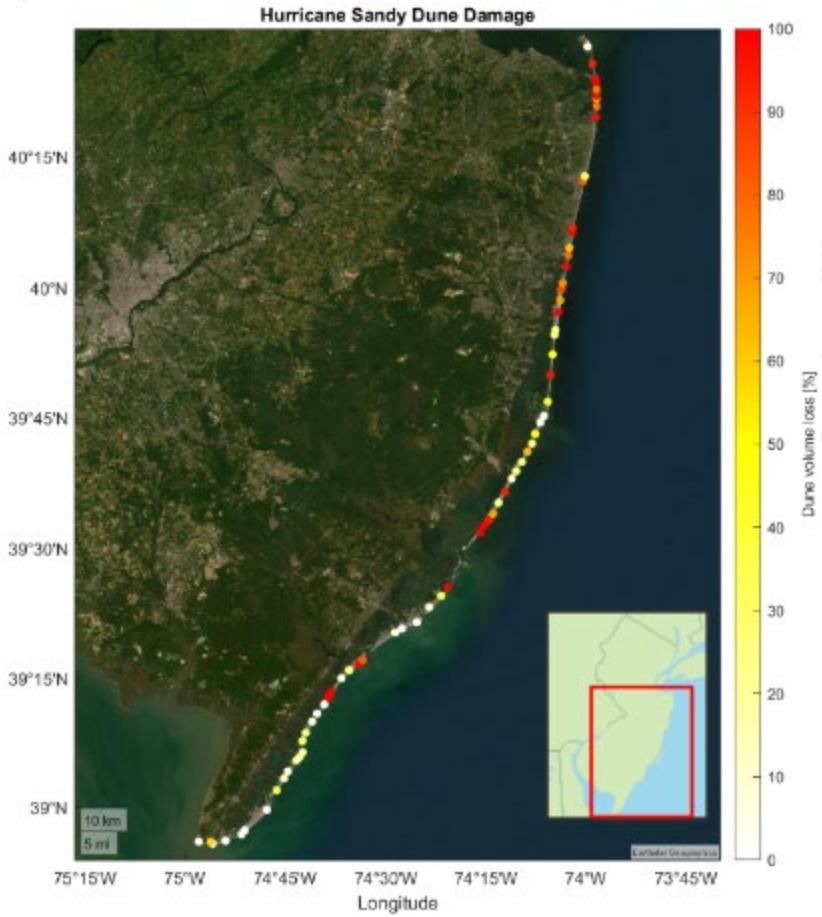
- Fit Coefficients:
  - κ (1.14 | 1.32)
  - λ (570 | 4428)



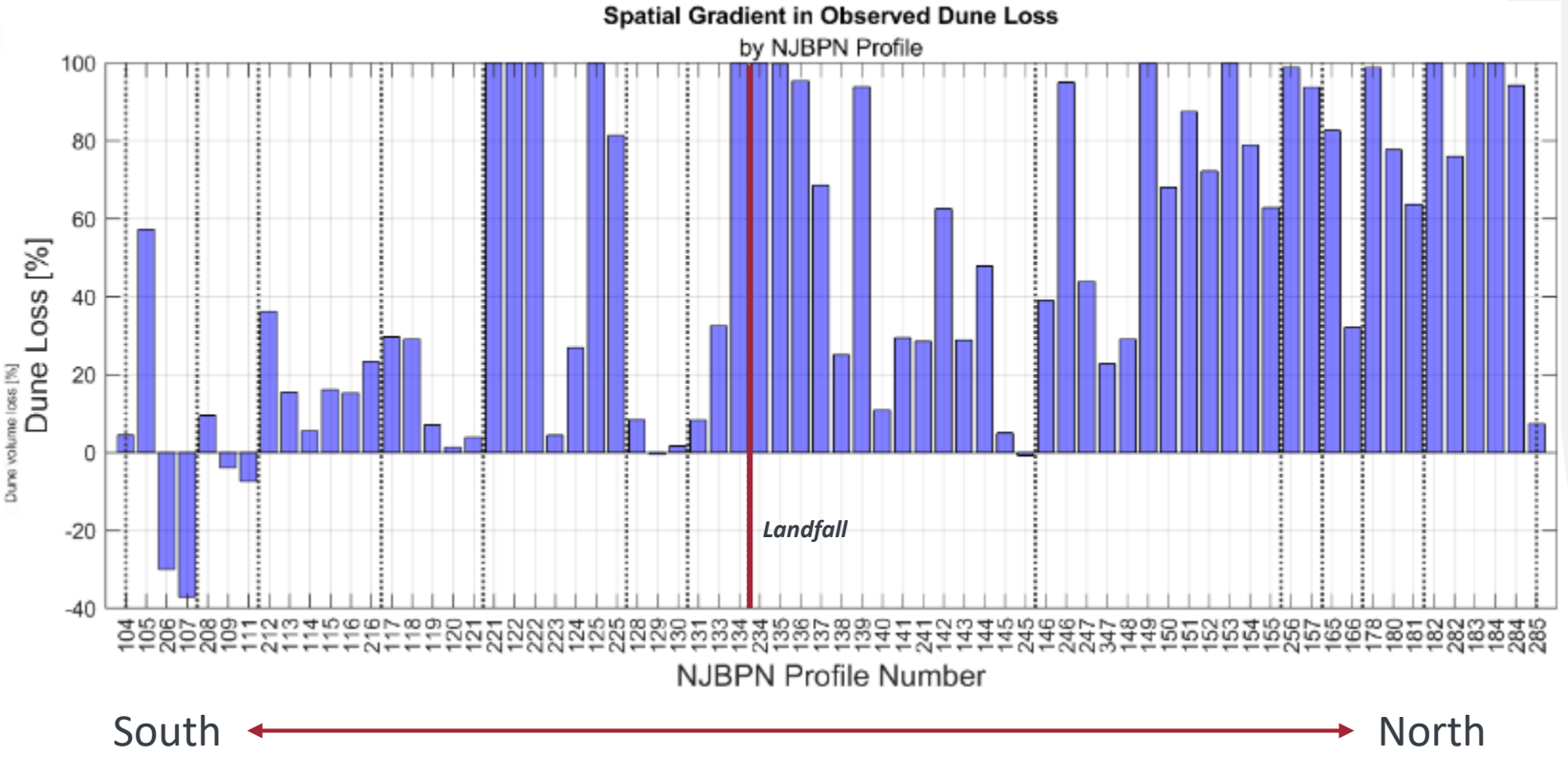
Janssen and Miller (2022), *The Engineering Demand Parameter and Applications to Forecasting Dune Impacts*

Observed Impacts of Hurricane Sandy

Spatial Variation



Measured Dune Losses based on NJBPN



NJBPN

Stockton University Coastal Research Center

Well-documented impacts and drivers

Storm Intensity spatial gradient

Correlations between beach state and damage

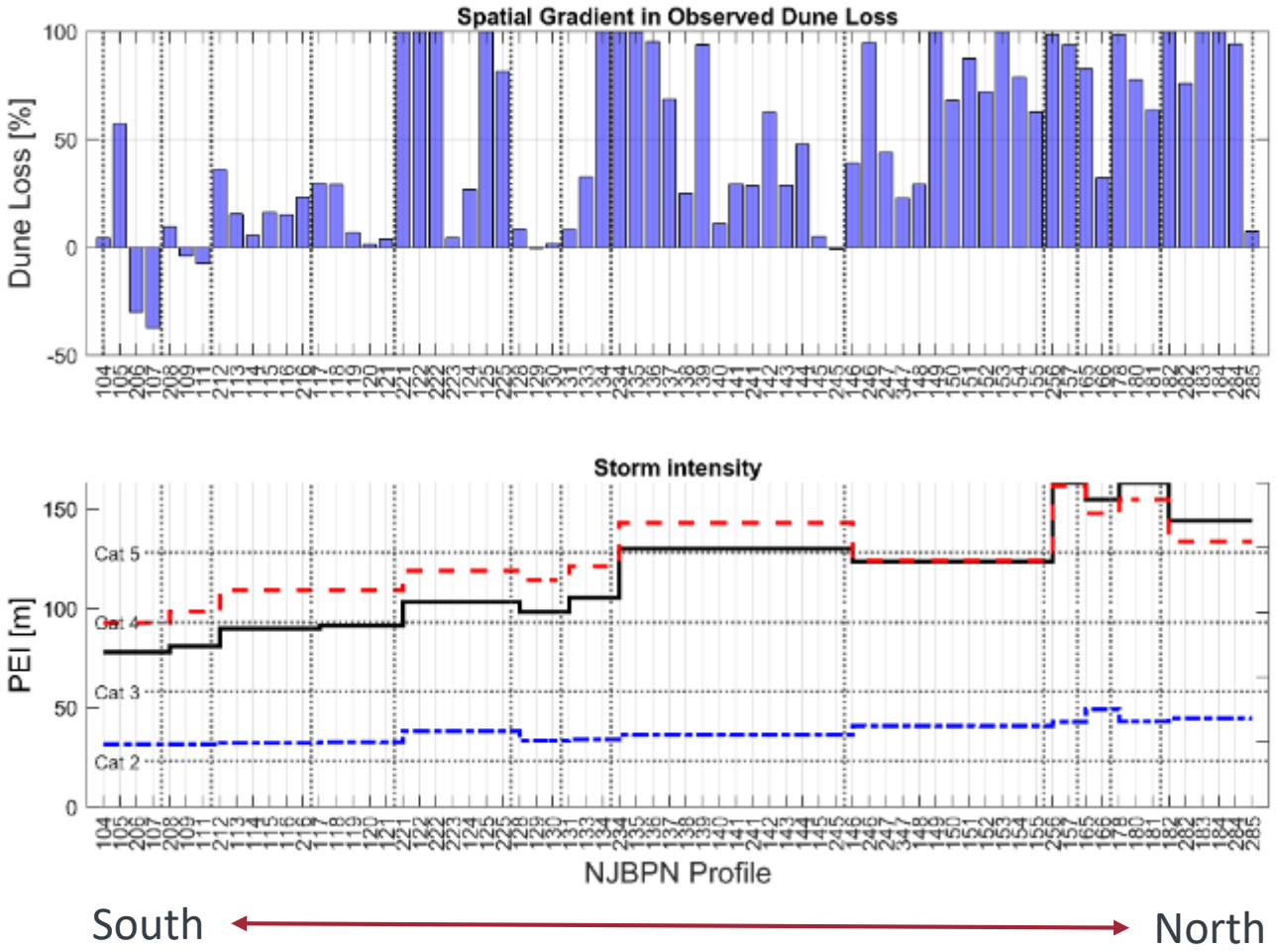
- Barone, D.A., McKenna, K.K., Farrell, S.C., 2014. Hurricane Sandy: Beach-dune performance at New Jersey Beach Profile Network sites 82.

- Overbeck, J.R., Long, J.W., Stockdon, H.F., 2017. Testing model parameters for wave-induced dune erosion using observations from Hurricane Sandy. Geophysical Research Letters 44, 937–945.

- Walling, K., T.O. Herrington and J.K. Miller, 2016. Hurricane Sandy damage comparison: Oceanfront houses protected by a beach and dune system with vs. without a rock seawall, Shore & Beach, 84(3), 35-41.

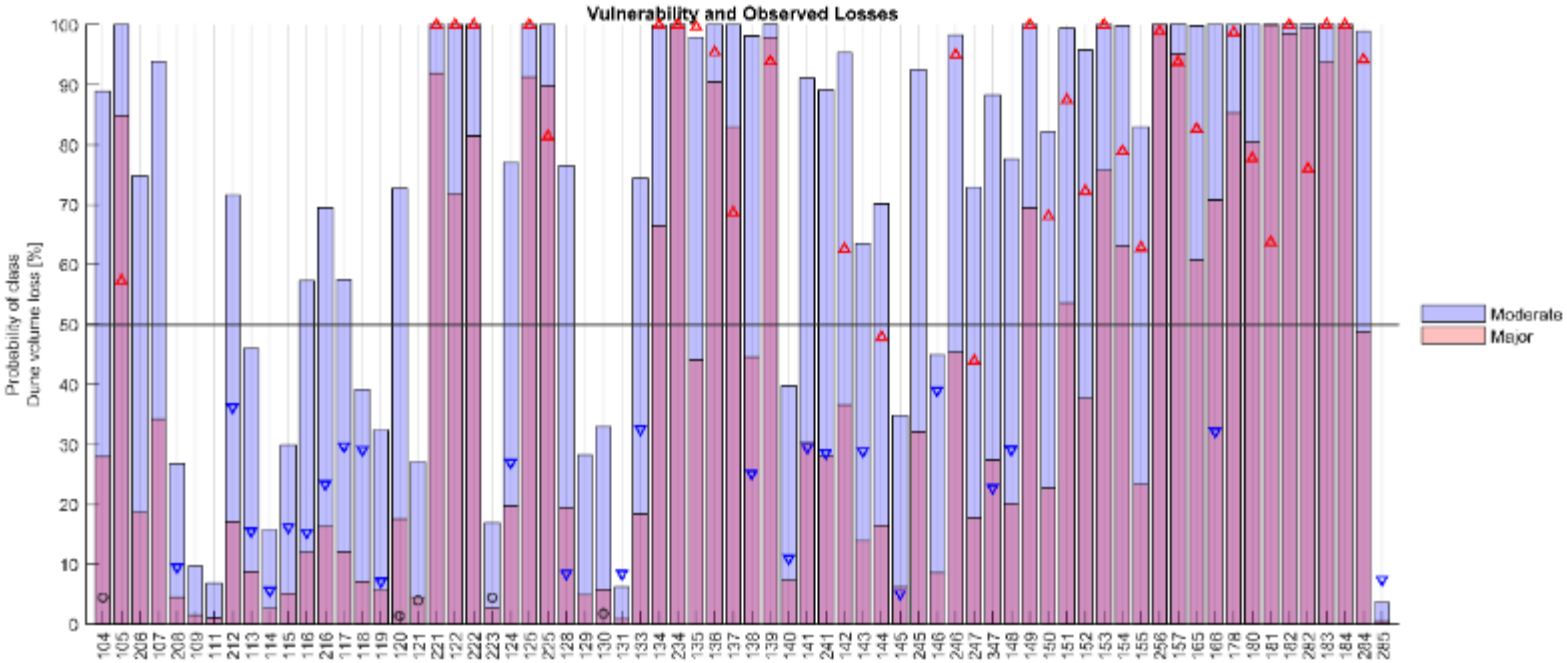
Influence of Storm Intensity

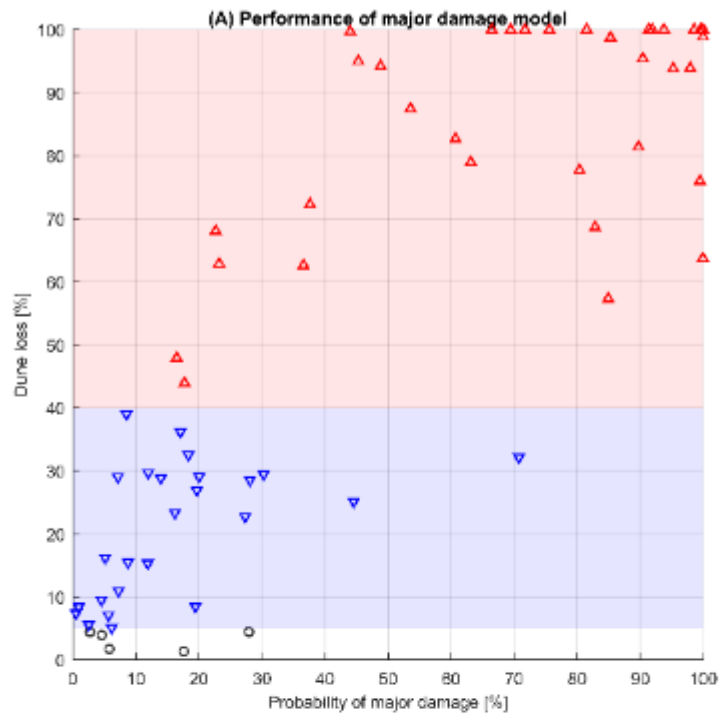
Spatial Variation

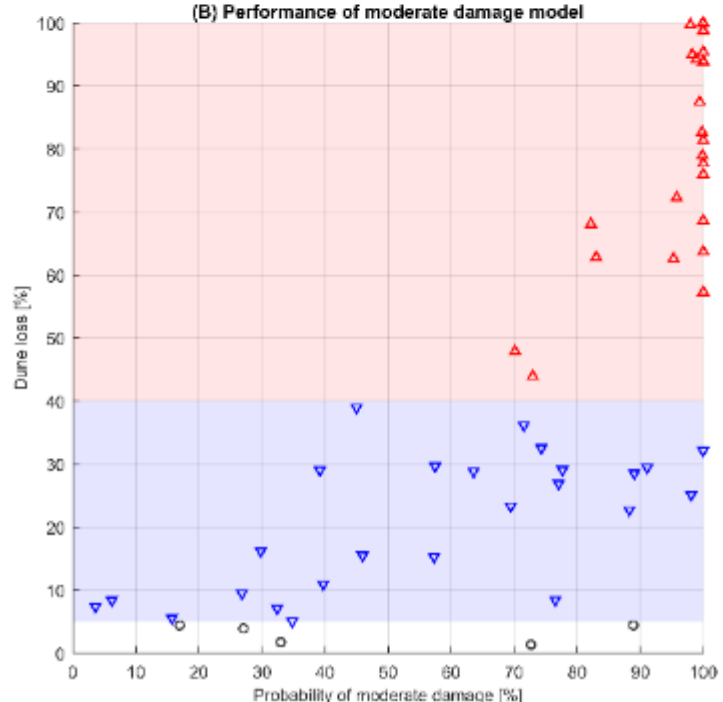


Storm intensity gradient explains much of the variation in observed impacts, but not all of it.

Lemke and Miller, 2020


Vulnerability and Observed Losses
Probability of class
Dune volume loss [%]
Moderate
Major


(A) Performance of major damage model
Dune loss [%]
Probability of major damage [%]


(B) Performance of moderate damage model
Dune loss [%]
Probability of moderate damage [%]