

Analysis of Morphological Change at Ponte Vedra, FL caused by Hurricane Ian Using Drone Imagery and RTK GPS Surveys



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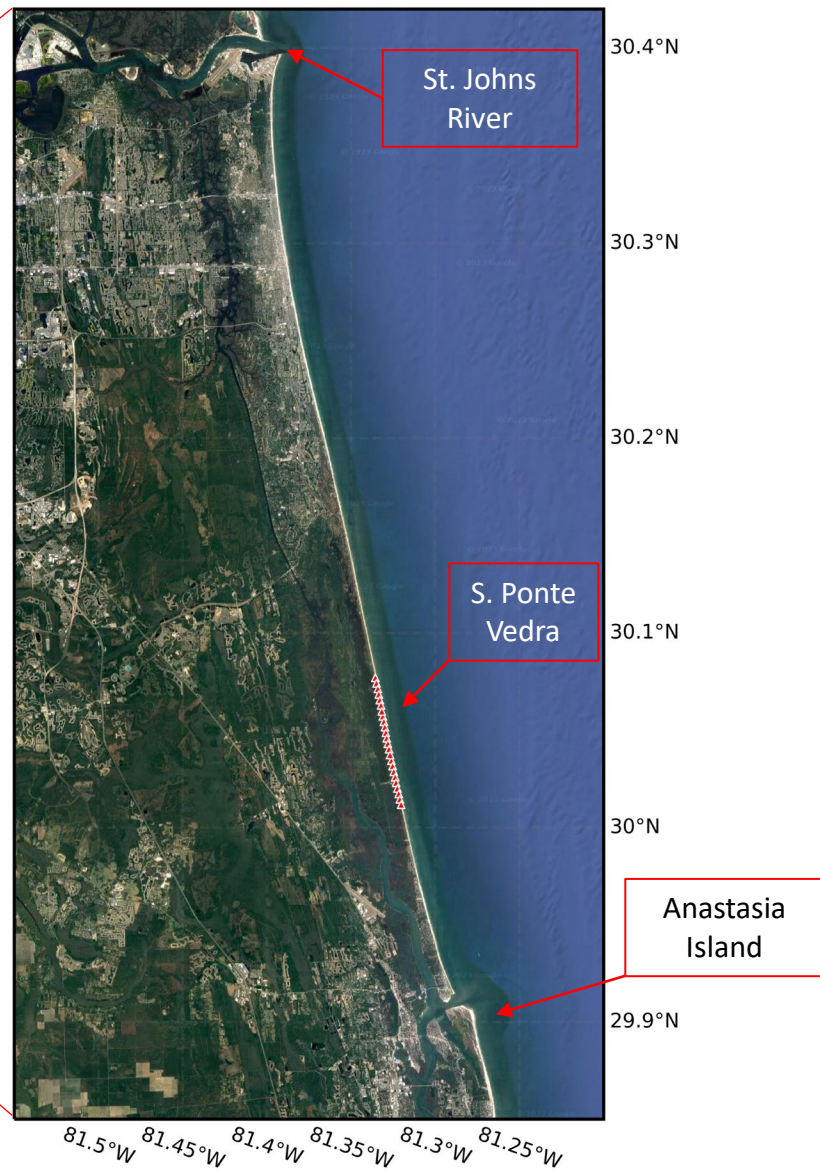
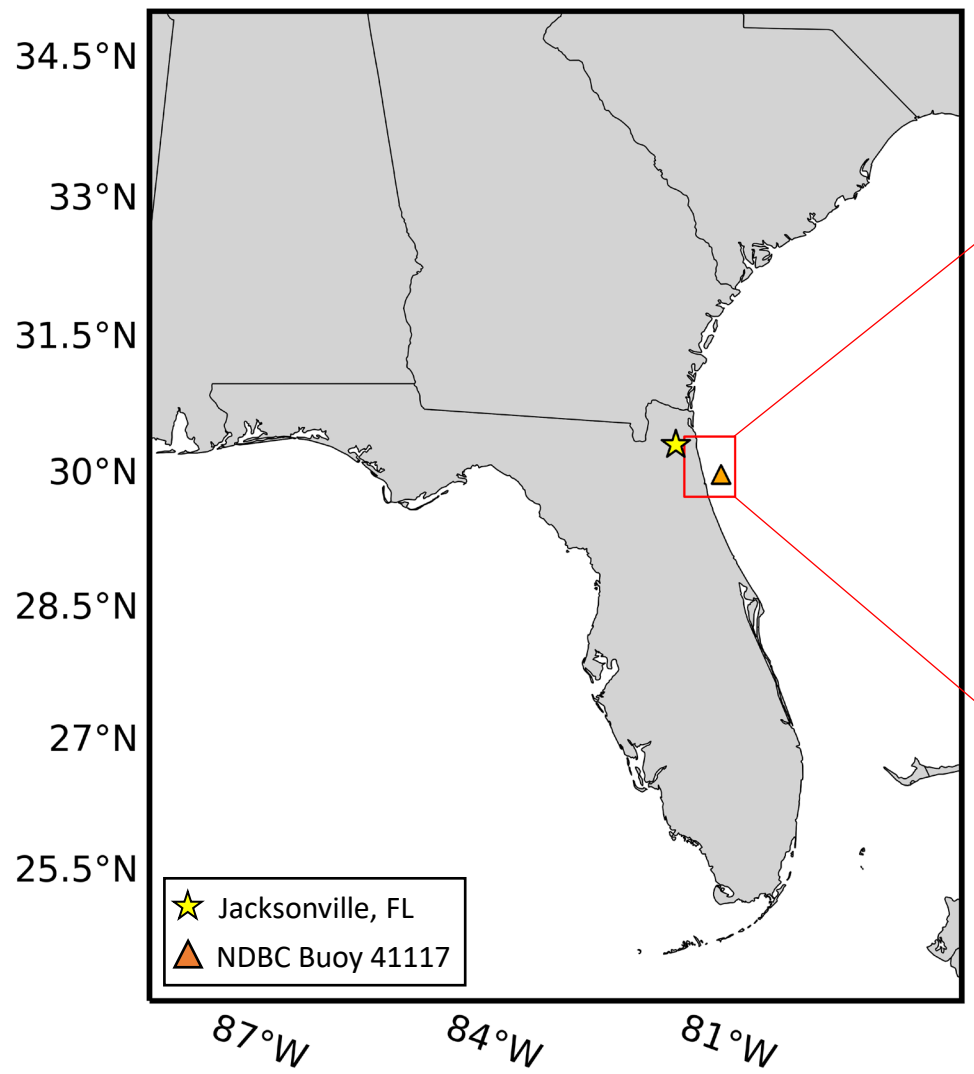
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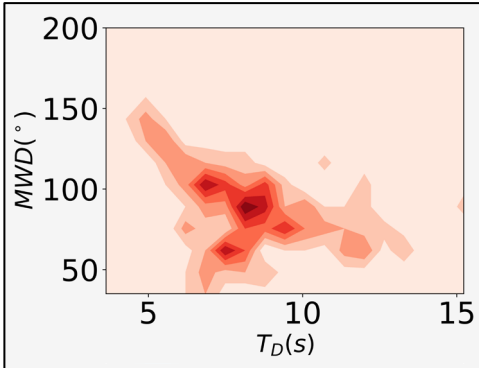
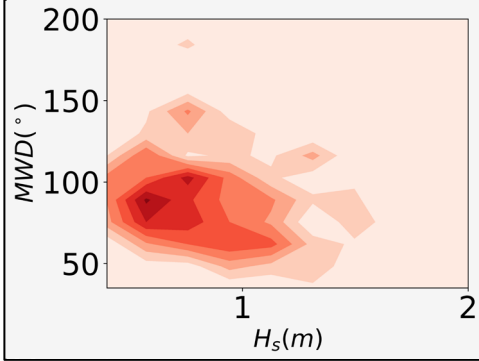
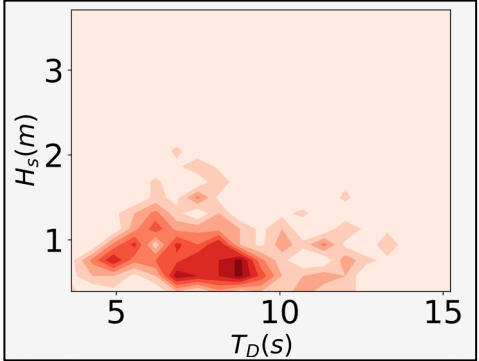
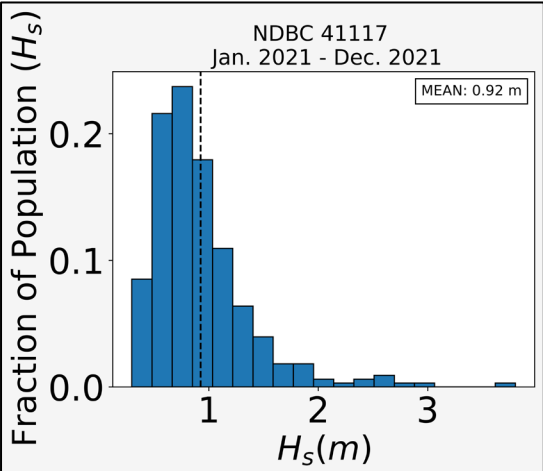
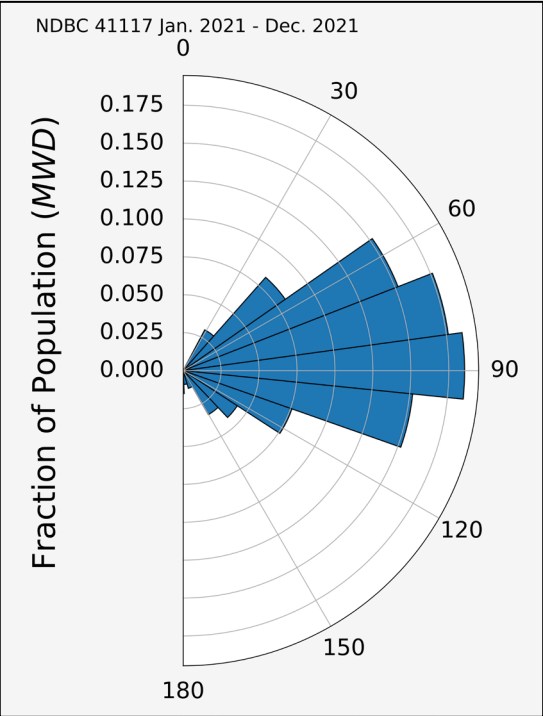
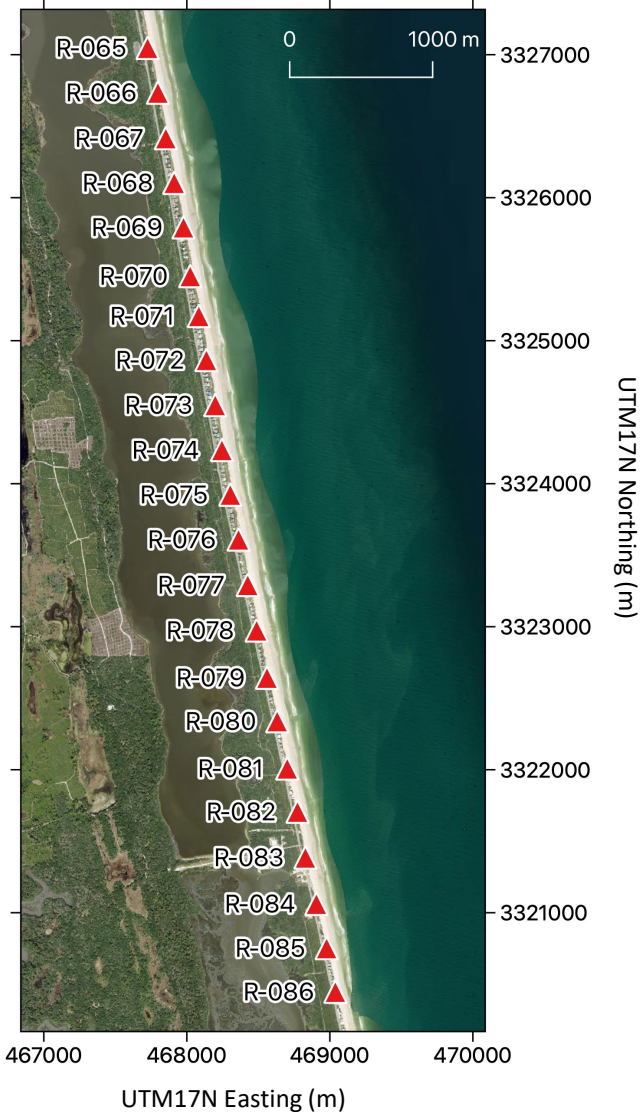


South Ponte Vedra Beach is a linear beach located in NE Florida to the south of the St. Johns River and to the north of Anastasia Island.



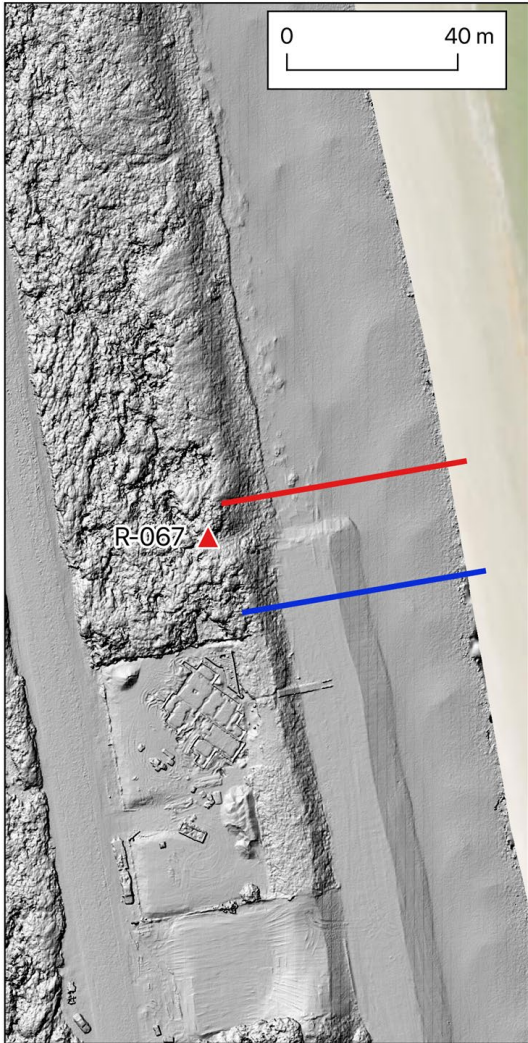


Waves at South Ponte Vedra Beach typically arrive from the northeast indicating a southern littoral drift.

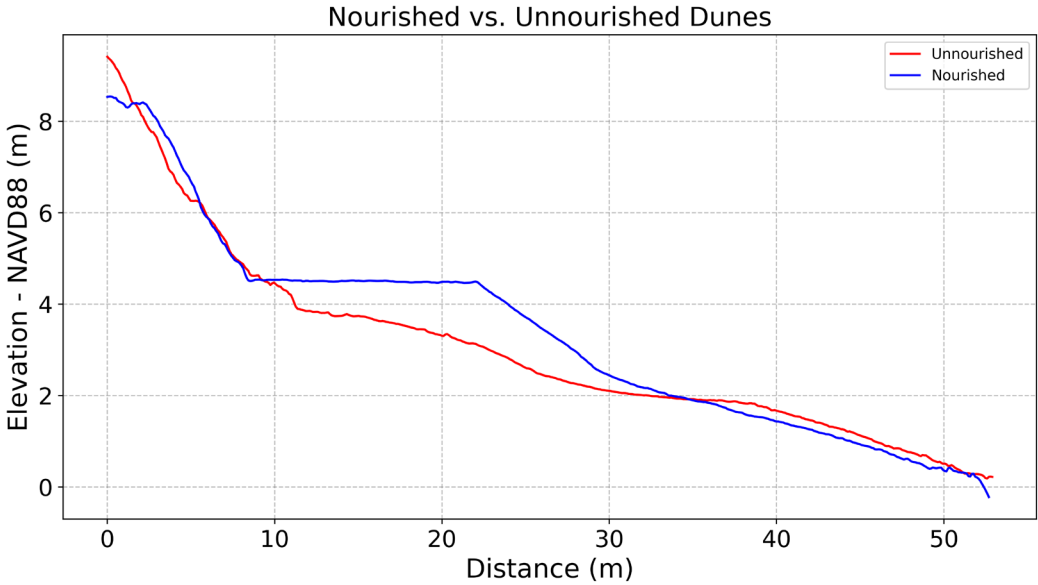




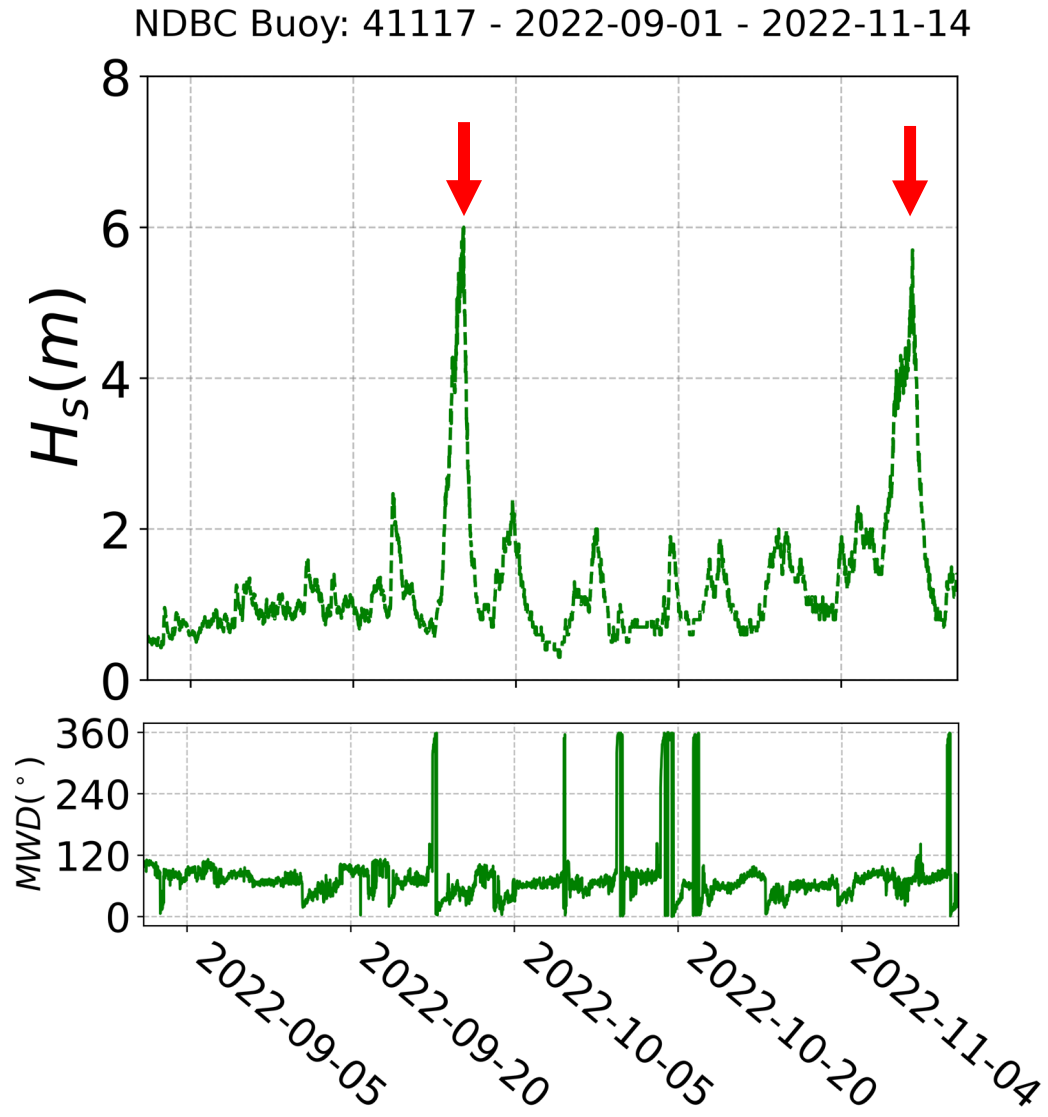
South Ponte Vedra Beach has undergone dune nourishments (restorations) to protect local infrastructure and residences.



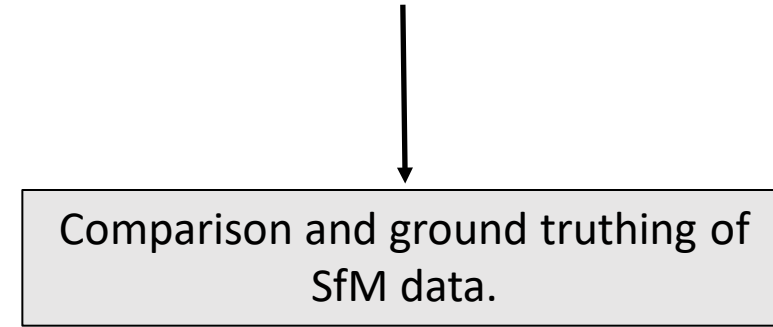
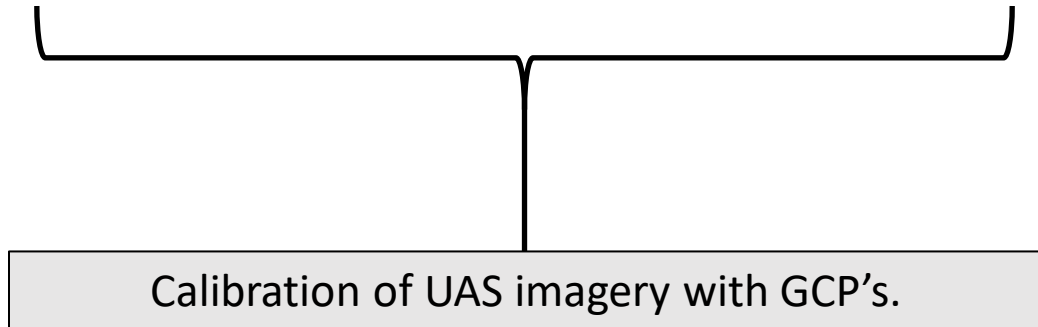
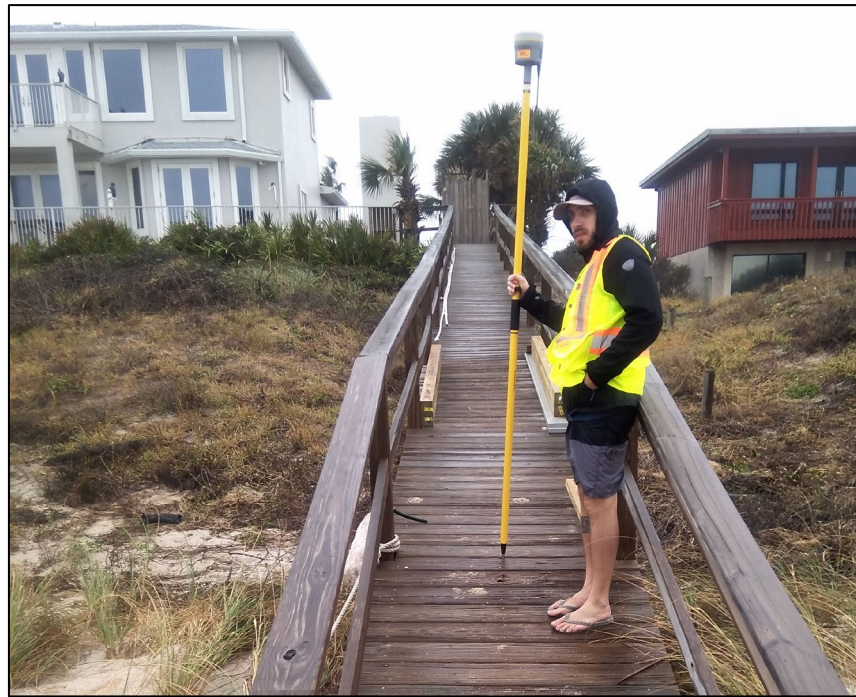
- Nourishments in 2021 and 2022 added ~500,000 cubic yards of sediment over 18 km alongshore.
- The South Ponte Vedra Beach Study area was part of this nourishment with dune nourishment occurring between coastal



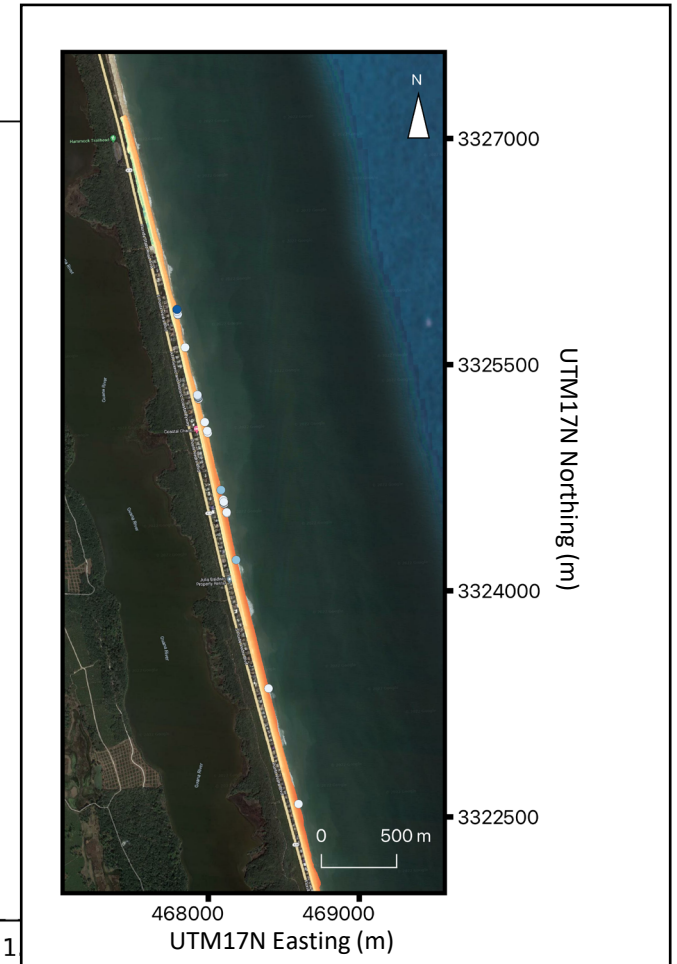
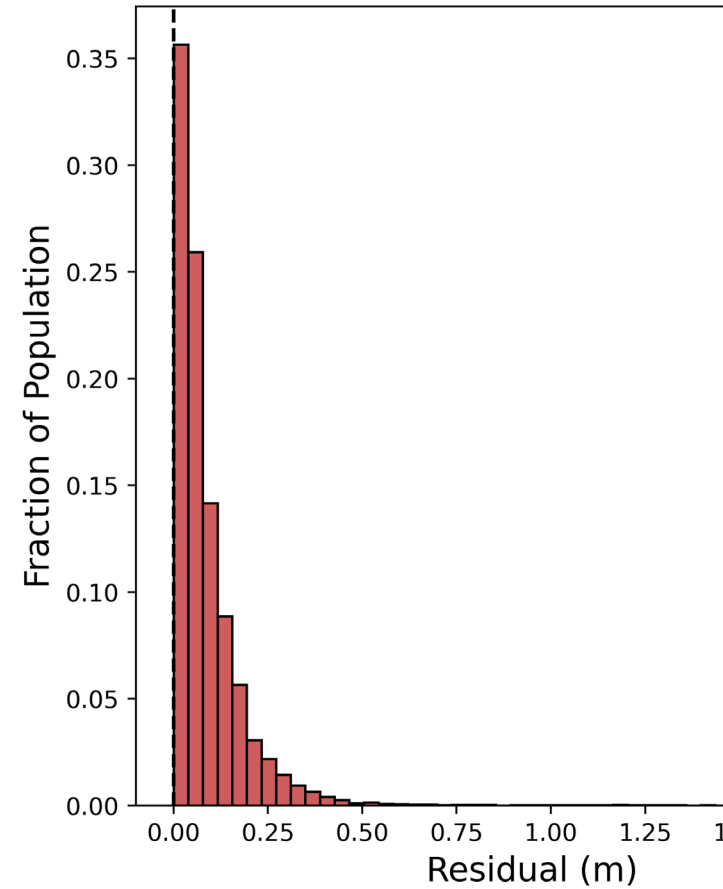
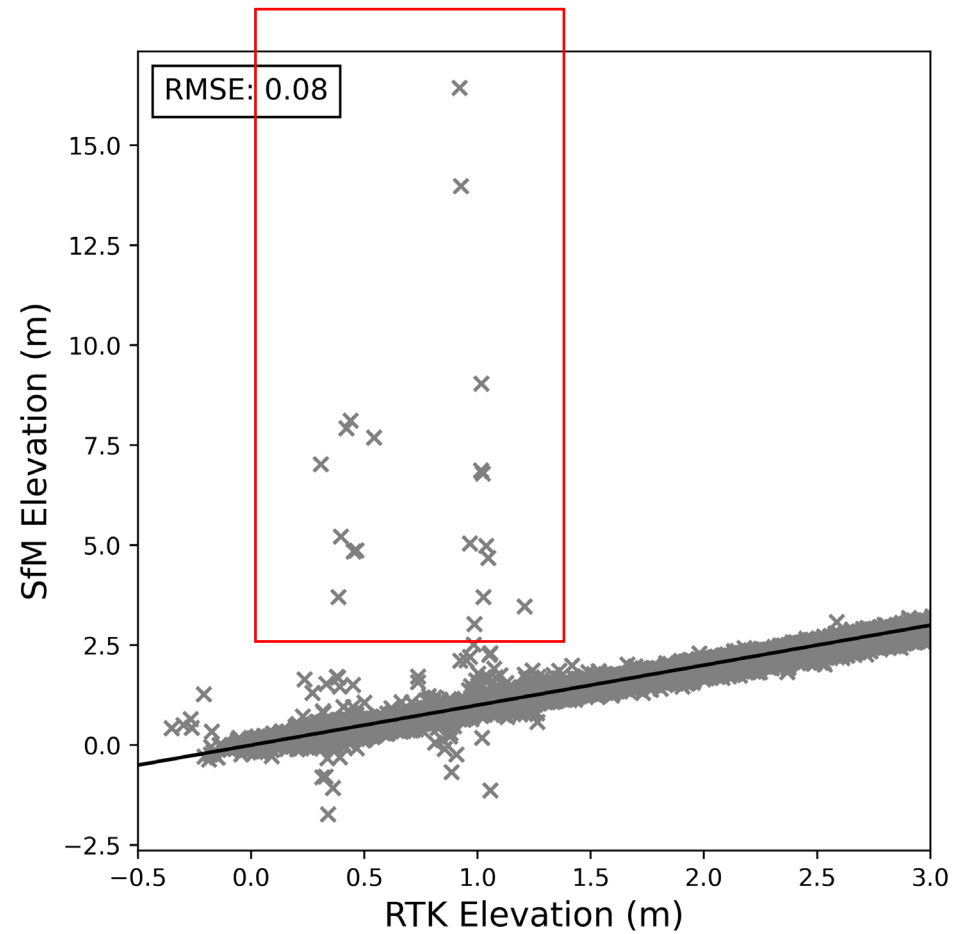
Recent storms have driven significant morphologic change at South Ponte Vedra Beach necessitating accurate monitoring of beach and dune morphology.



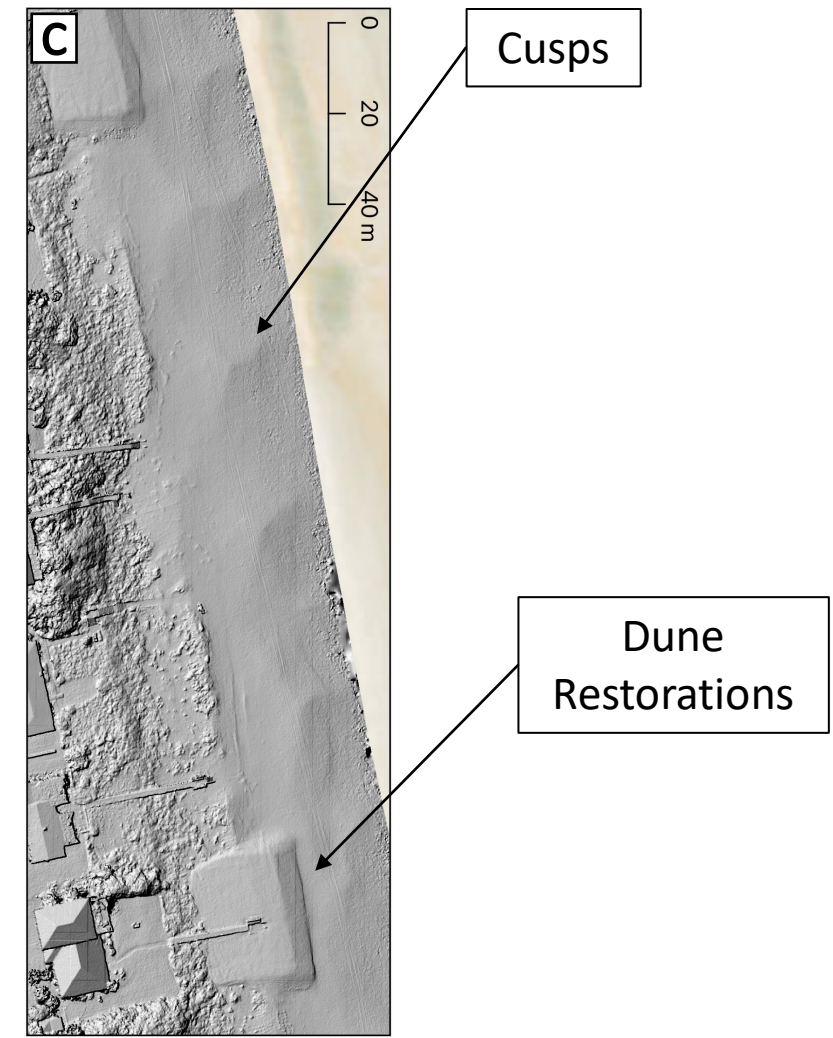
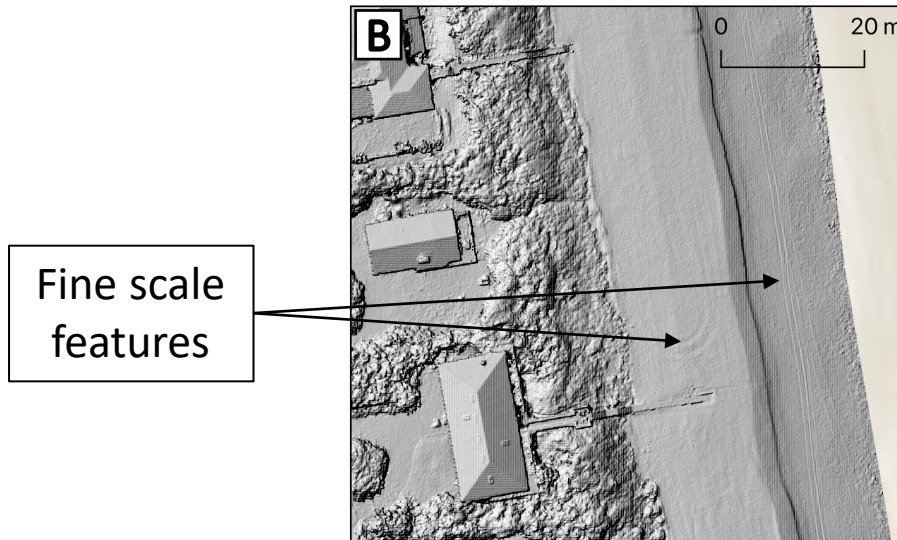
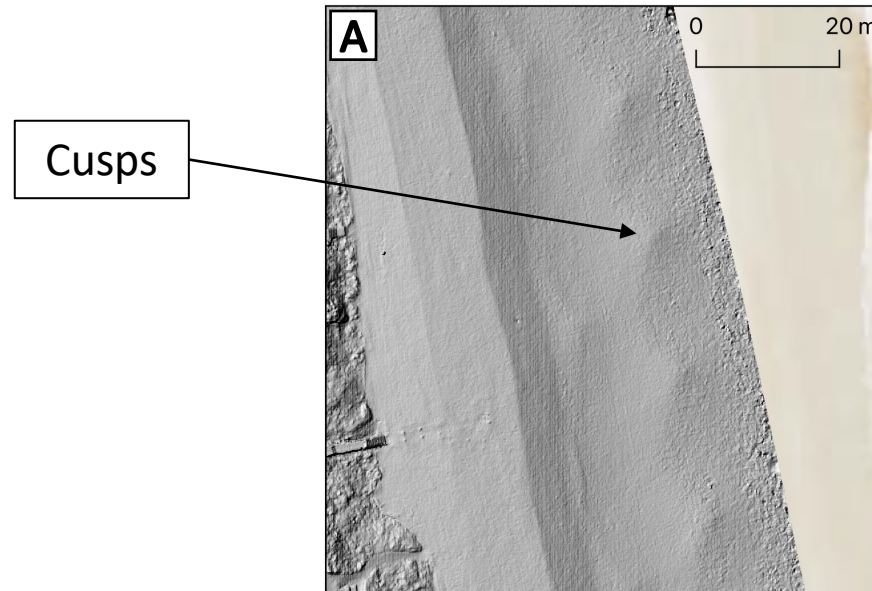
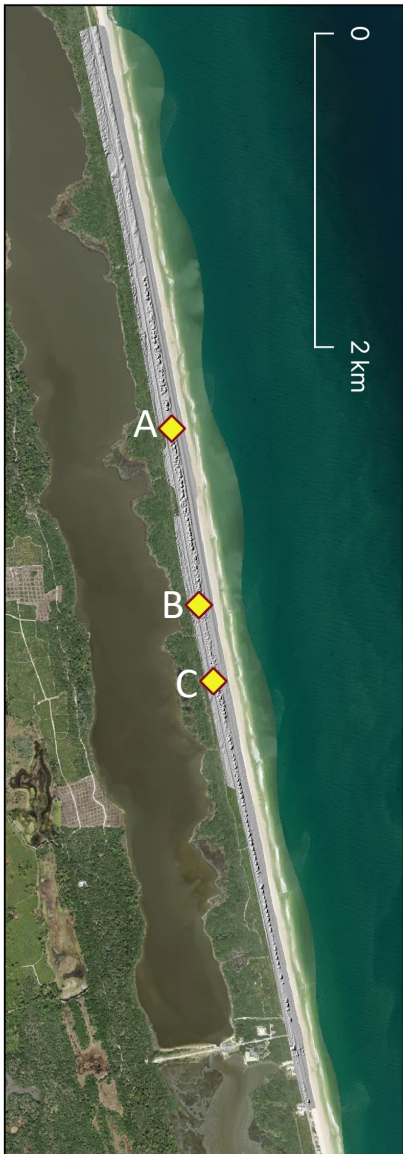
Drone imagery and SfM coupled with RTK surveys provide a reliable method of surveying storm damage and the recovery processes of beaches and dunes.



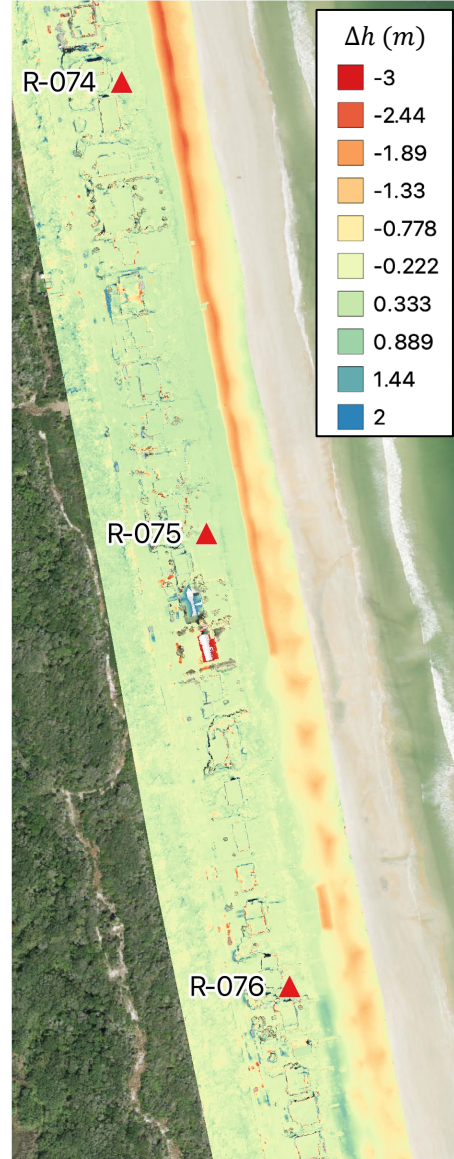
SfM provides elevations consistent with RTK surveys with error being largely confined to regions of wave activity.



SfM allows for kilometer-scale coastal surveys while retaining decimeter-scale accuracy.

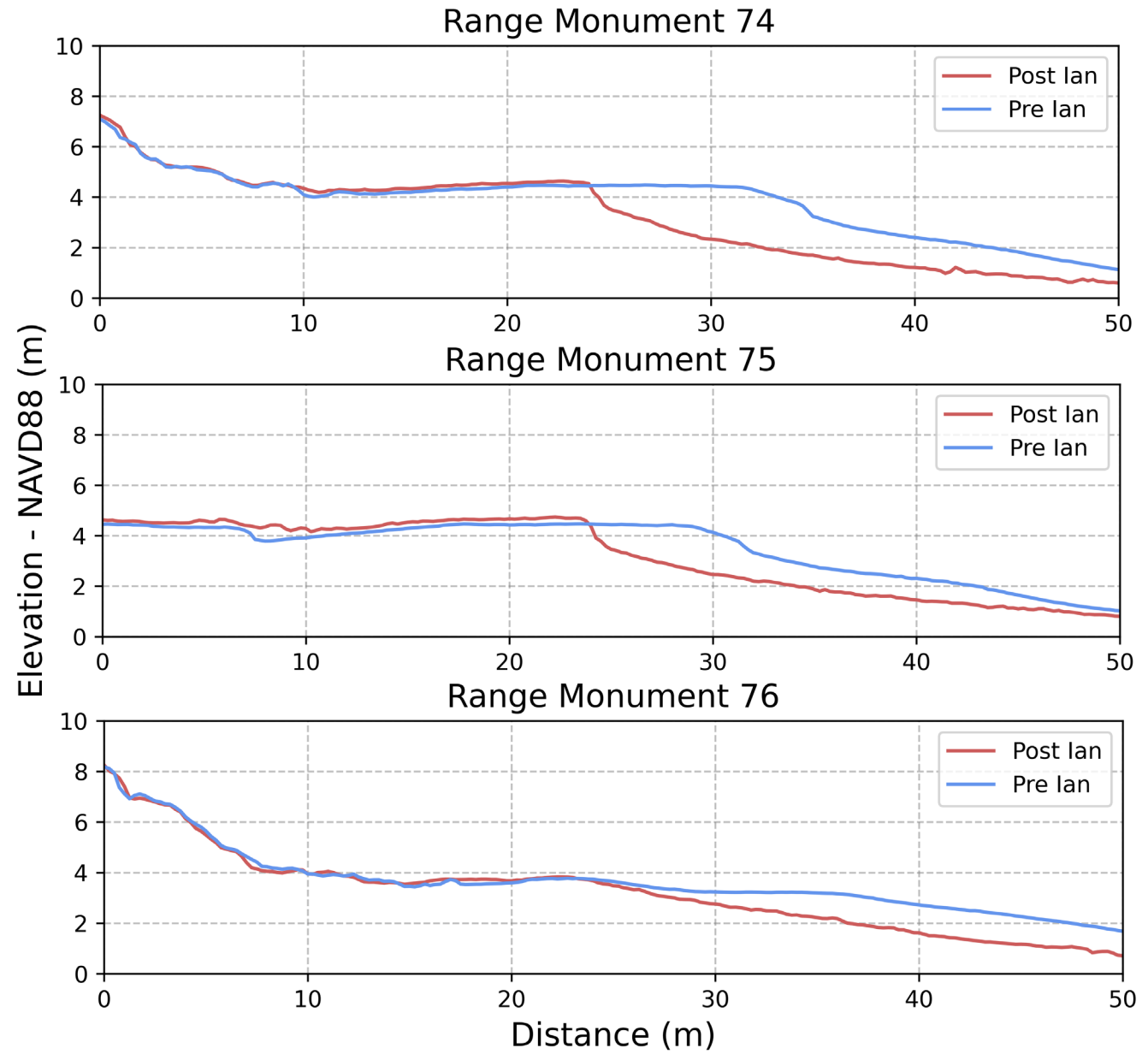
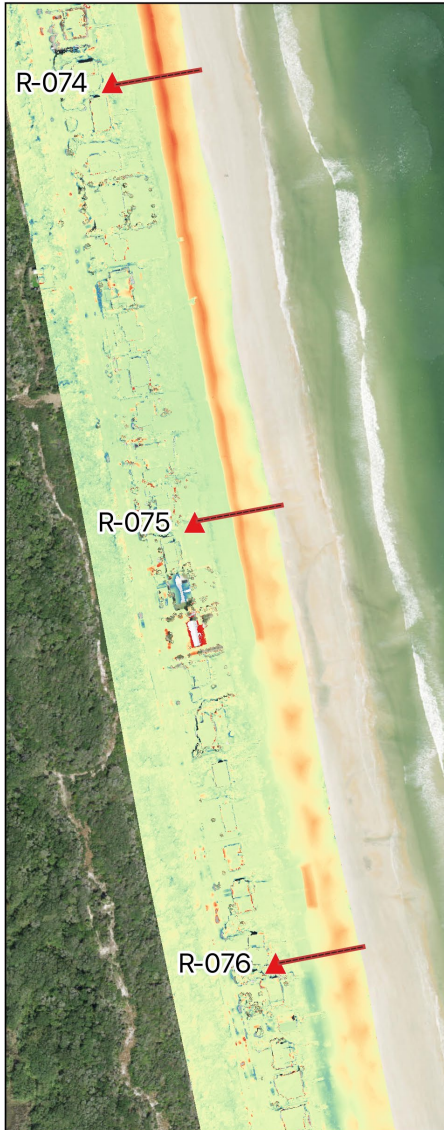


Hurricane Ian caused significant morphologic change – removing sediment from restored dunes and beach cusps.

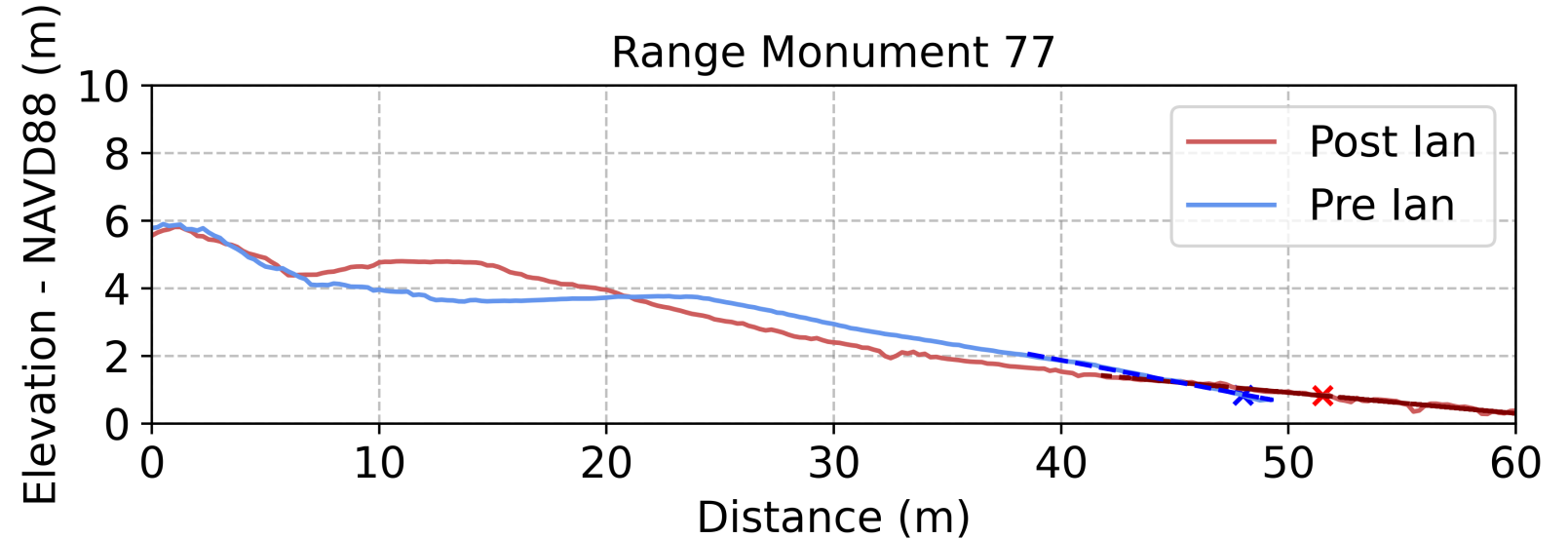
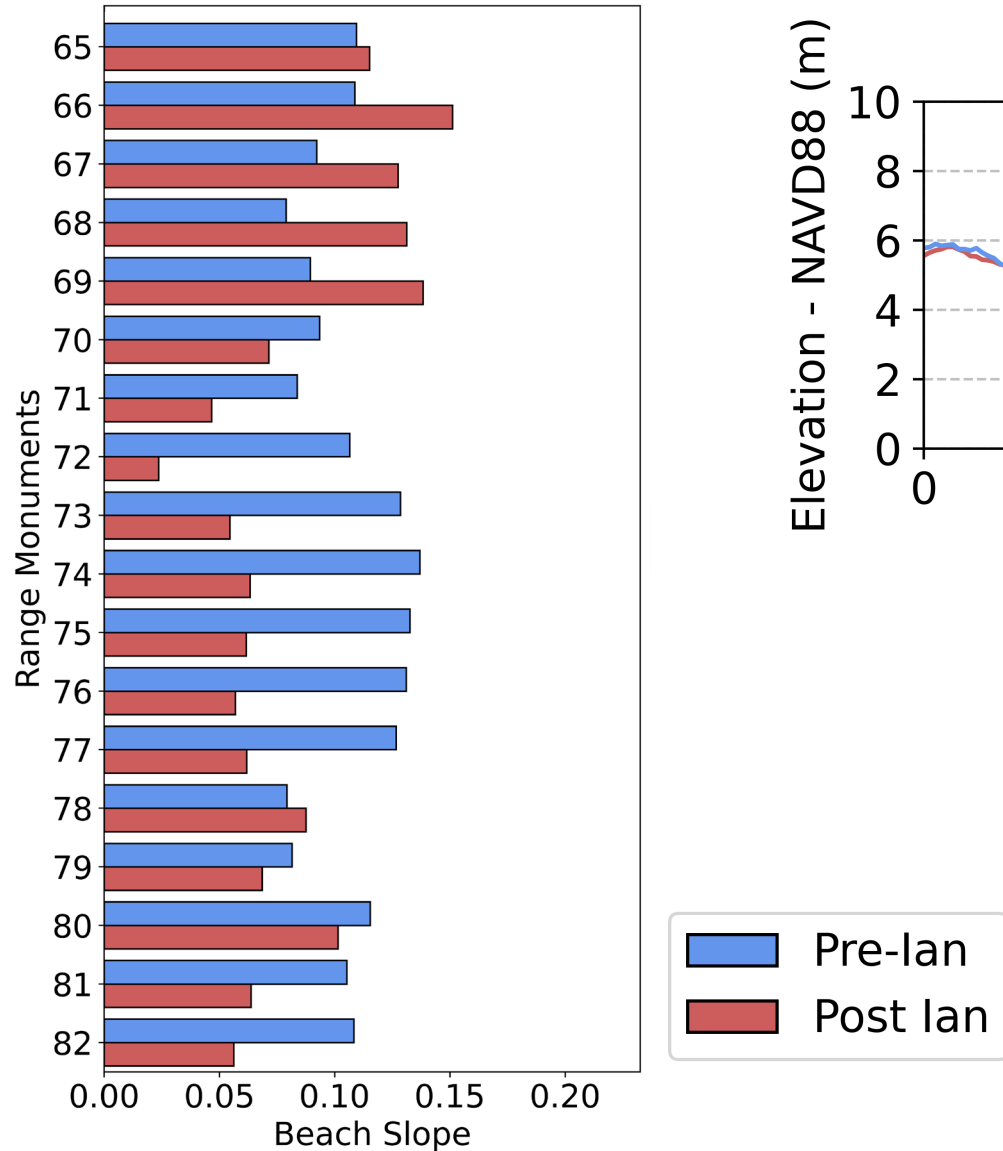


- Near Ranger Markers 74 and 75, significant alteration of restored dunes is observed following Hurricane Ian.
- Most of this alteration is focused on the restored dune segment of the beach.
- Between Range Markers 75 and 76, continuous restoration was not conducted.
- Morphological change appears centered on cusped features.

Transects show significant sediment loss following Hurricane Ian, and retreat of the restored dunes.

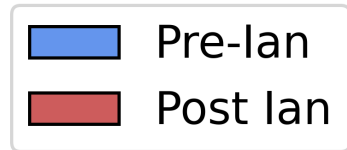
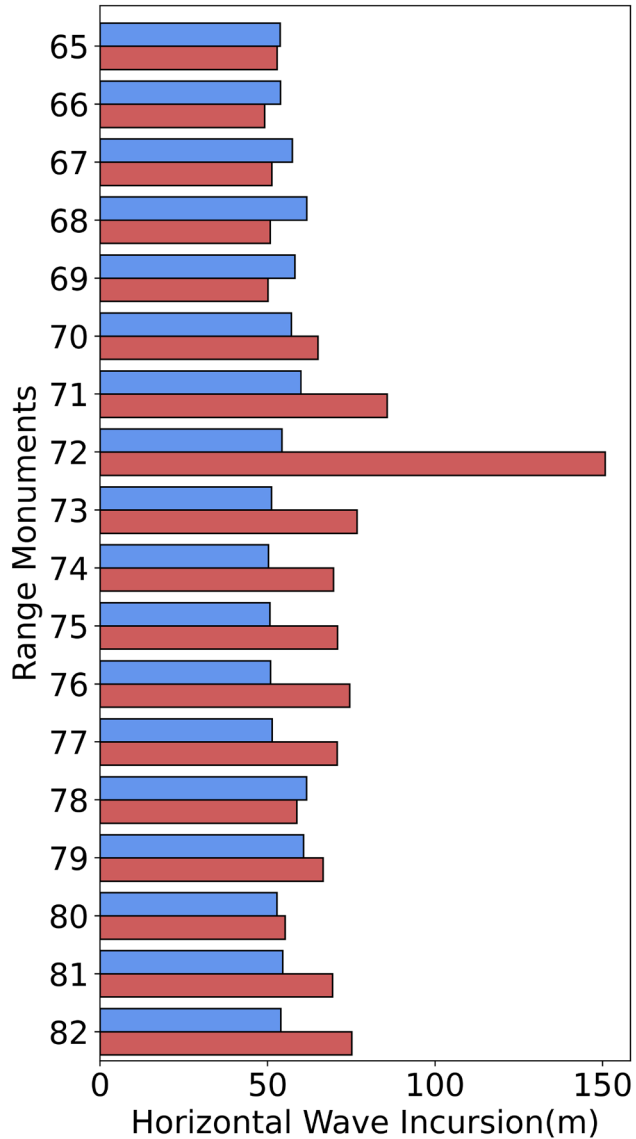


Following Hurricane Ian, mean beach elevation and foreshore slope decreased.



- Ordinary least squares regressions were performed on transects to determine slope.
 - We use the shoreline surrounding the MHW elevation to determine slope.
- After Hurricane Ian, the mean beach foreshore slope flattened by ~ 0.03 .

Empirical relationships from Stockdon et al., (2006) indicate horizontal wave incursion increased as a result of morphological change from Hurricane Ian.

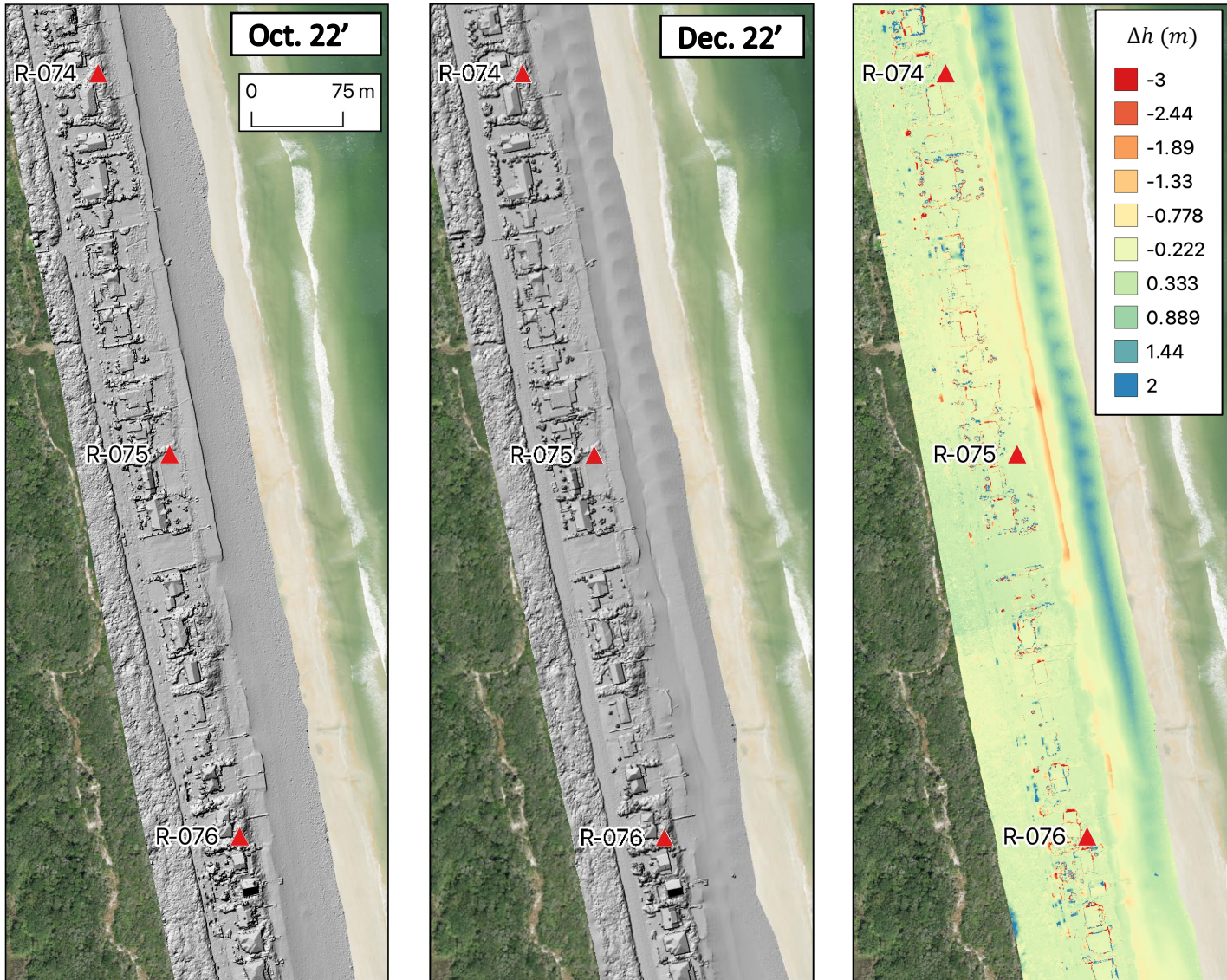


$$R_2 = 1.1 \left[0.35\beta_f(H_oL_o)^{\frac{1}{2}} + \frac{[H_oL_o(0.563\beta_f^2 + 0.004)]^{\frac{1}{2}}}{2} \right]$$

$$HWI = \left[\frac{R_2}{\beta_f} \right]$$

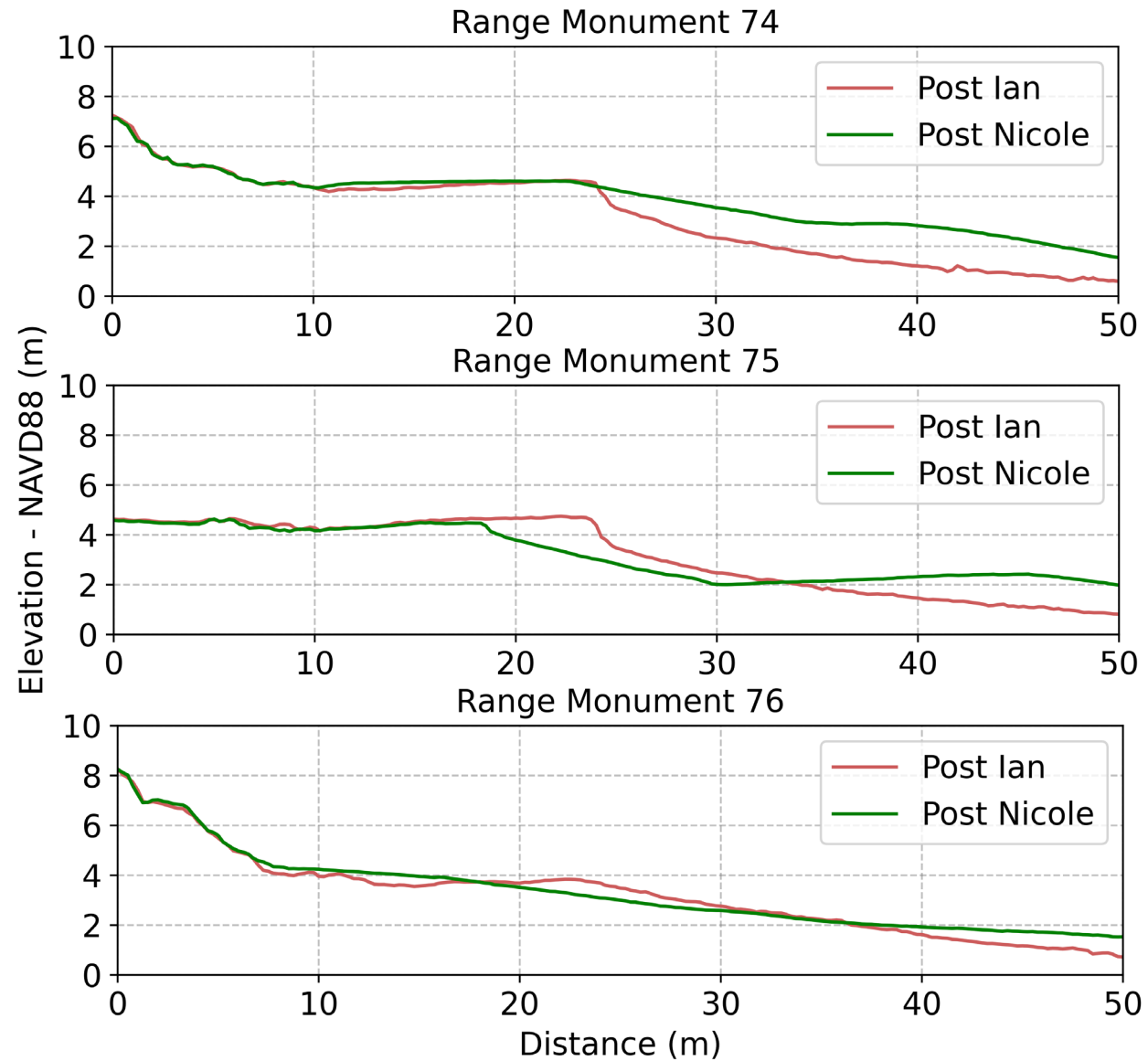
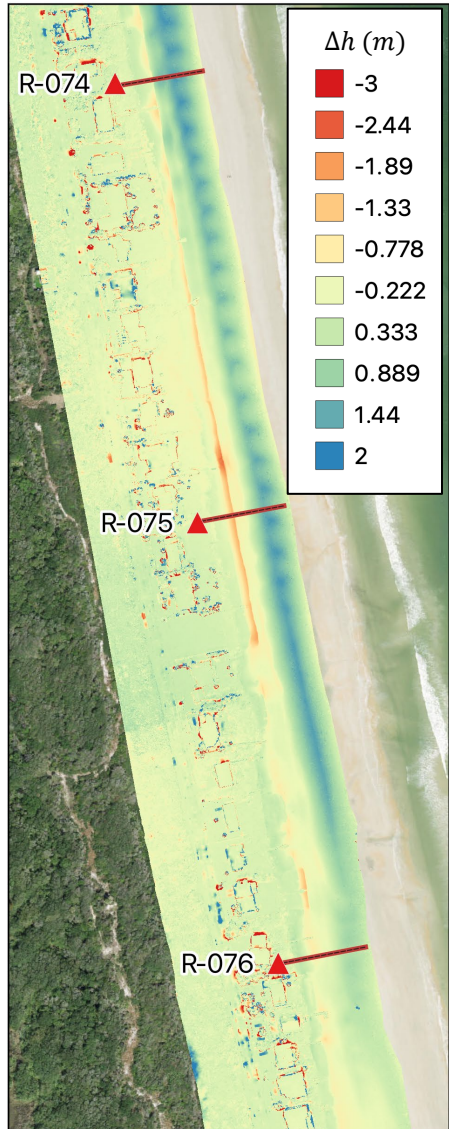
- Empirical relationships can be used to assess potential wave runup and incursion.
- As a result of foreshore flattening, wave runup decreases and horizontal incursion increases.
- Beaches should be more readily subjected to inundation during future storms or high water levels.

Hurricane Nicole did not remove sediment from restored dunes but resulted in aggradation on the foreshore leading to cusp formation.

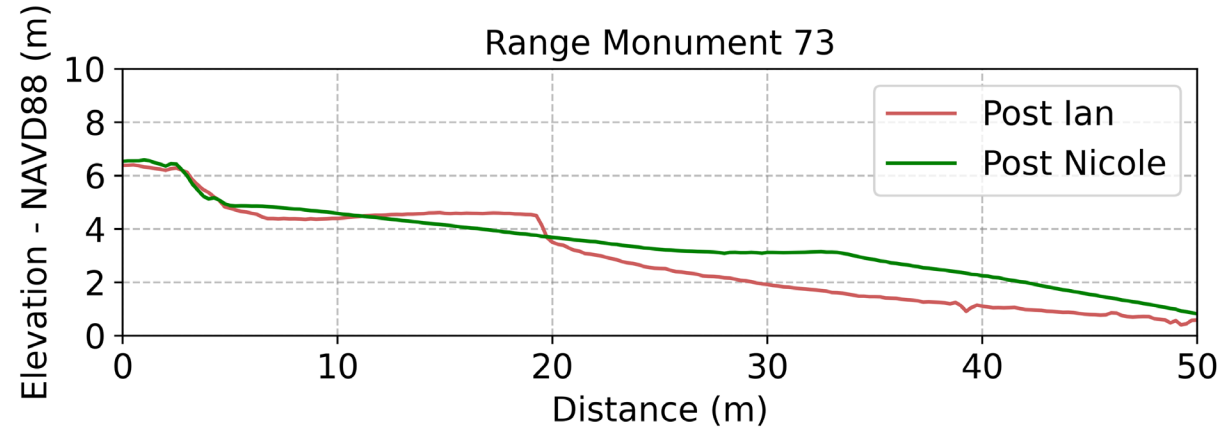
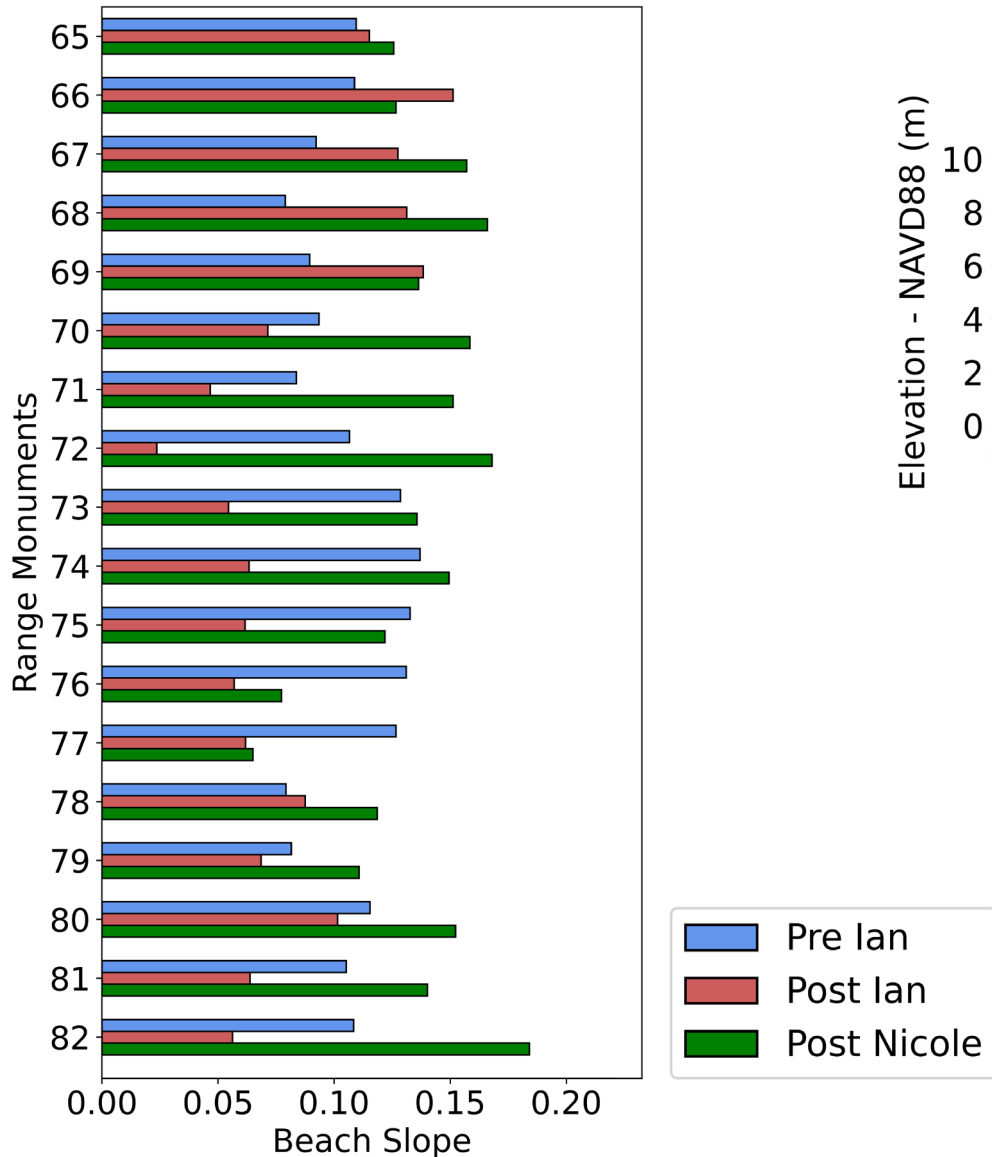


- Beaches did not erode during Hurricane Nicole, but instead accreted sediment on the foreshore.
- Only minor dune retreat and sediment removal occurred following Hurricane Nicole.
- This is a significantly different morphologic response when compared to Hurricane Ian.

Surveys following Hurricane Nicole indicate that dune crests were eroded, and that aggradation was prevalent on the foreshore.

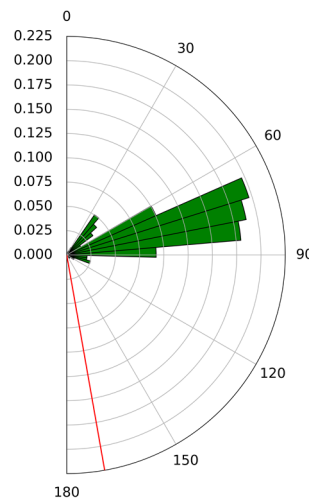
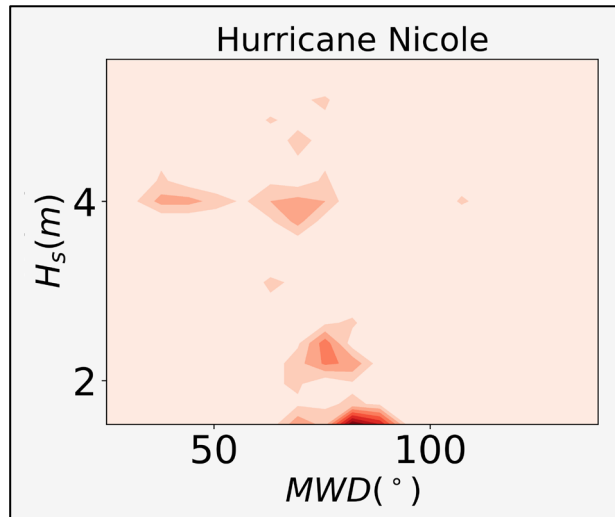
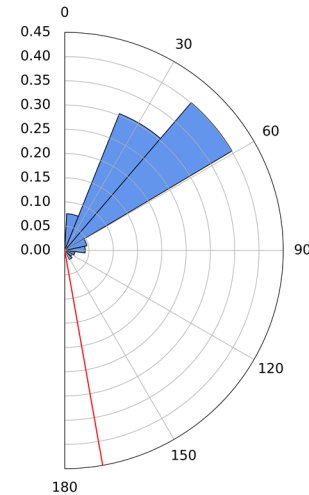
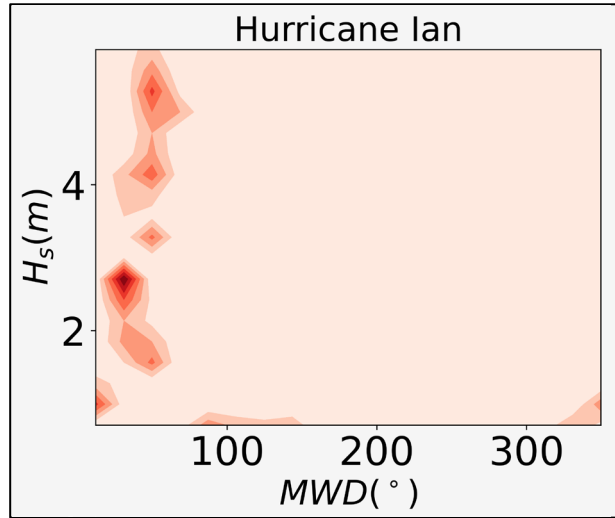


Foreshore aggradation following Hurricane Nicole, led to foreshore beach steepening exceeding beach steepness from prior to Hurricane Ian.



- Seaward migration of nourished dune sediment, resulted in a steepening of the beach.
- This is a significant deviation from morphological change following Hurricane Ian.

Morphologic responses may have resulted from differences in wave directions associated with Hurricane Ian and Nicole



- Wave directions from the five days surrounding Hurricanes Ian and Nicole, show significant differences.
- Wave directions associated with Hurricane Ian, are from the N-NE.
- Wave directions associated with Hurricane Nicole, are from the NE.

Questions?

