ERDC Satellite Shoreline Mapper

Version 1.0

CoastSat algorithm developed at University of New South Wales (UNSW) by Vos et al. (2019)

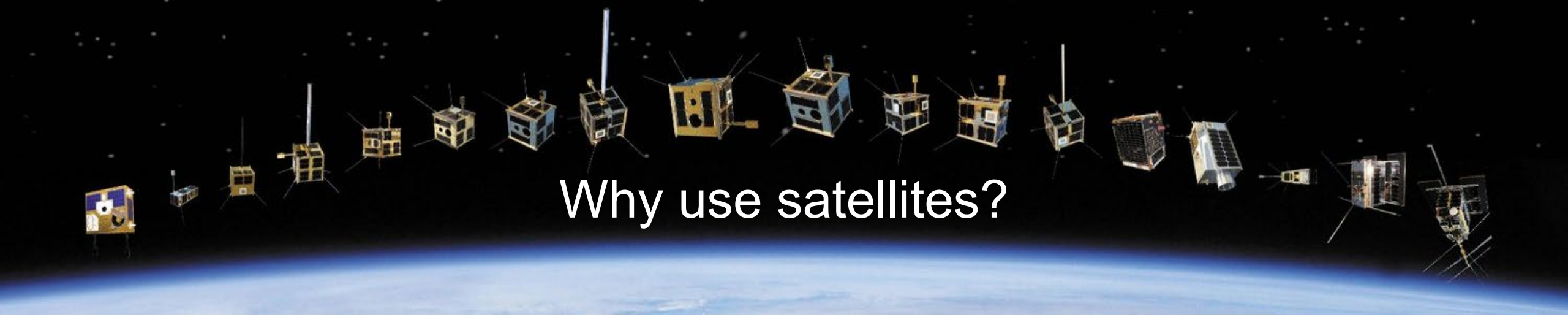
Why are shorelines important?

- Metric for beach condition and for coastal processes research
  - Shorelines change due to environmental and anthropogenic influences
  - Shoreline mapping may help determine areas of coastal vulnerability

- USACE tracks shoreline evolution at project sites
  - Equilibration after nourishment, berm construction, etc
  - Shorelines can be related to intended project design and longevity
  - Maintaining beach width important for recreation

- Shorelines can be used to assess storm impacts and recovery

- Shorelines can be used to determine decadal trends for coastal evolution



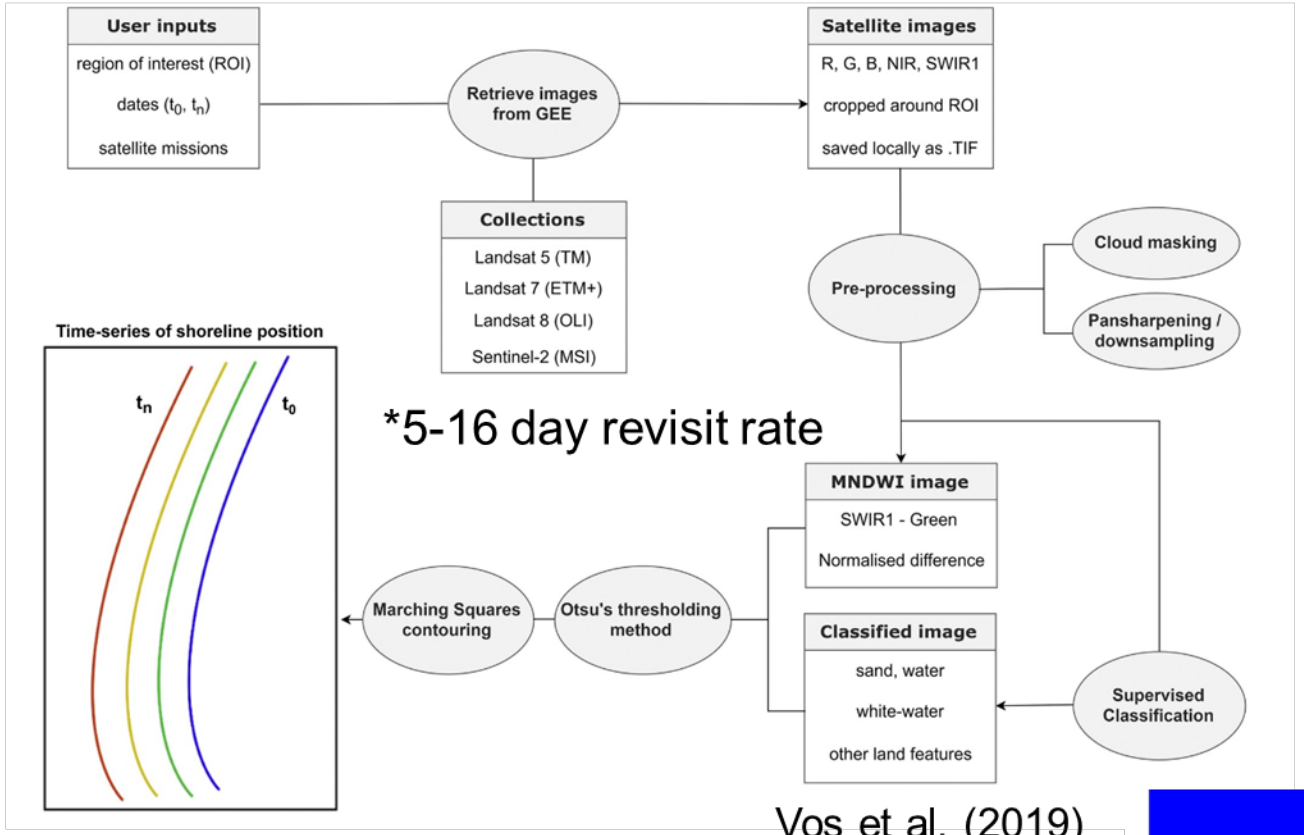
Why use satellites?

Existing coastal survey methods are often time-consuming, expensive and potentially hazardous

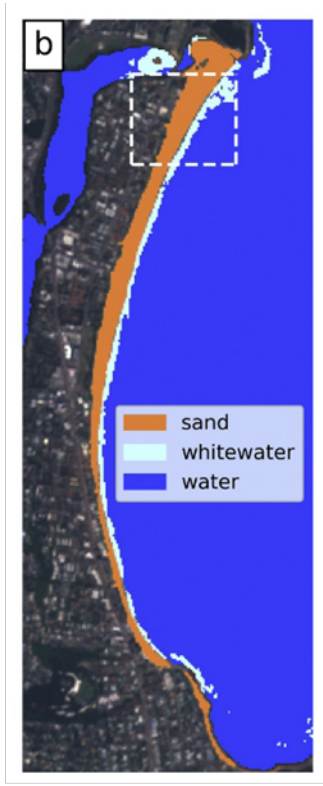
- to conserve limited operational resources (e.g., personnel and vessels), USACE Districts are often forced to narrow areas of interest or monitoring frequency, decreasing the likelihood of making data-driven management decisions

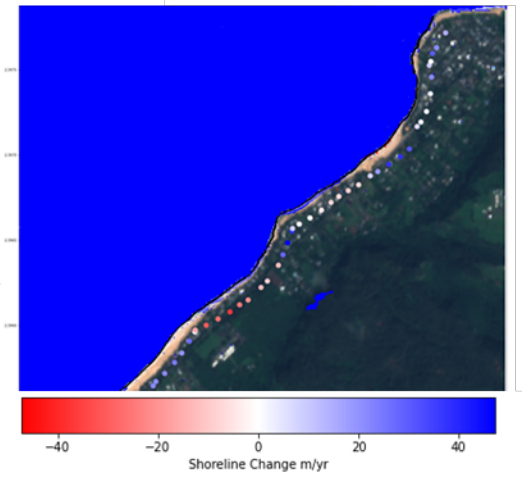
How Does CoastSat Work?

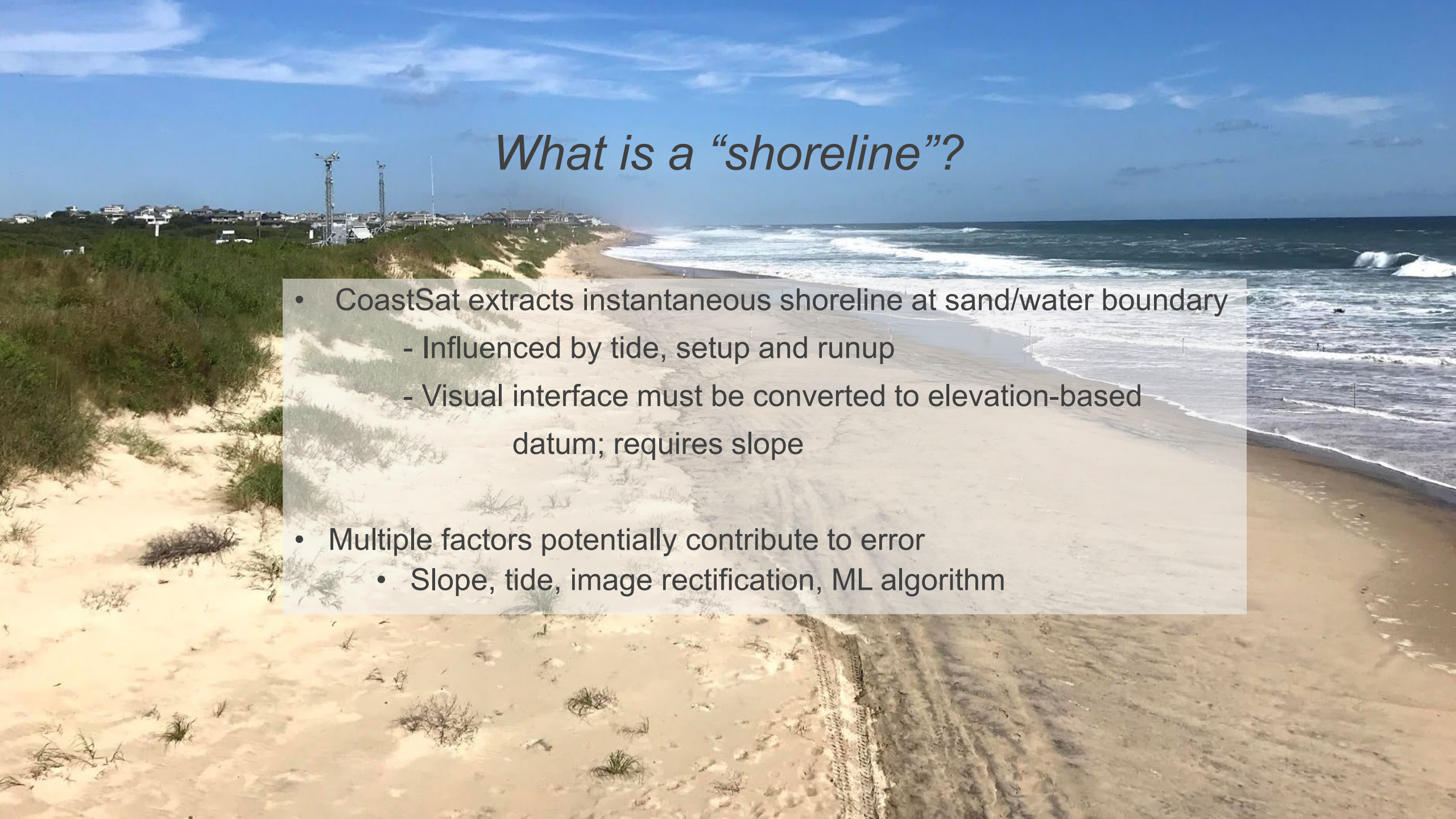
- User specifies AOI
- Publicly available satellite imagery collected every 5-16 days (Landsat and Sentinel-2 missions)
- Google Earth Engine ingests rectified imagery
- Machine learning approach automatically classifies imagery and extracts shoreline to create shoreline shapefile time series
- Shapefile time series is tidally adjusted based on image time



Vos et al. (2019)





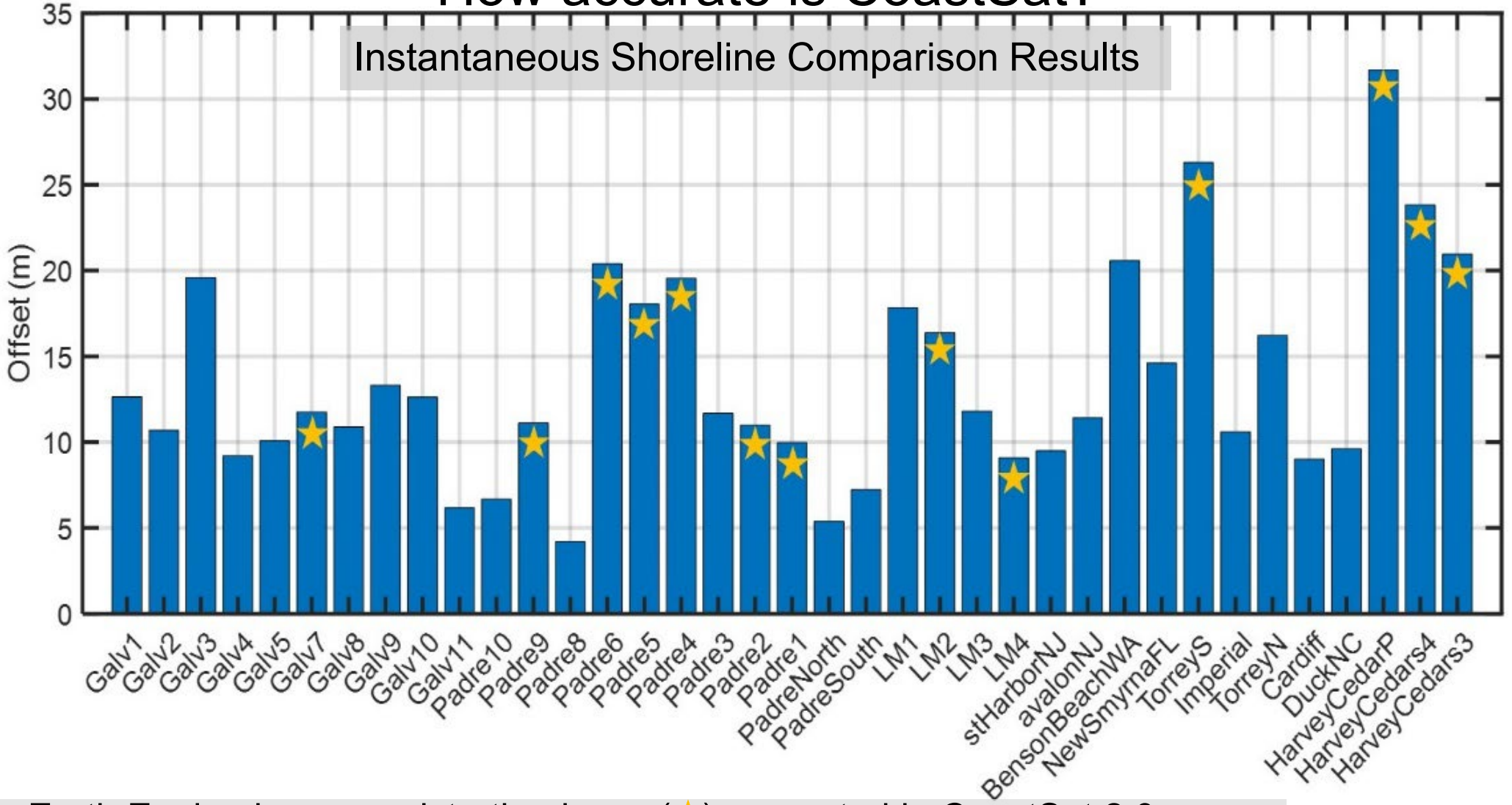


What is a “shoreline”?

- CoastSat extracts instantaneous shoreline at sand/water boundary
  - Influenced by tide, setup and runup
  - Visual interface must be converted to elevation-based datum; requires slope

- Multiple factors potentially contribute to error
  - Slope, tide, image rectification, ML algorithm

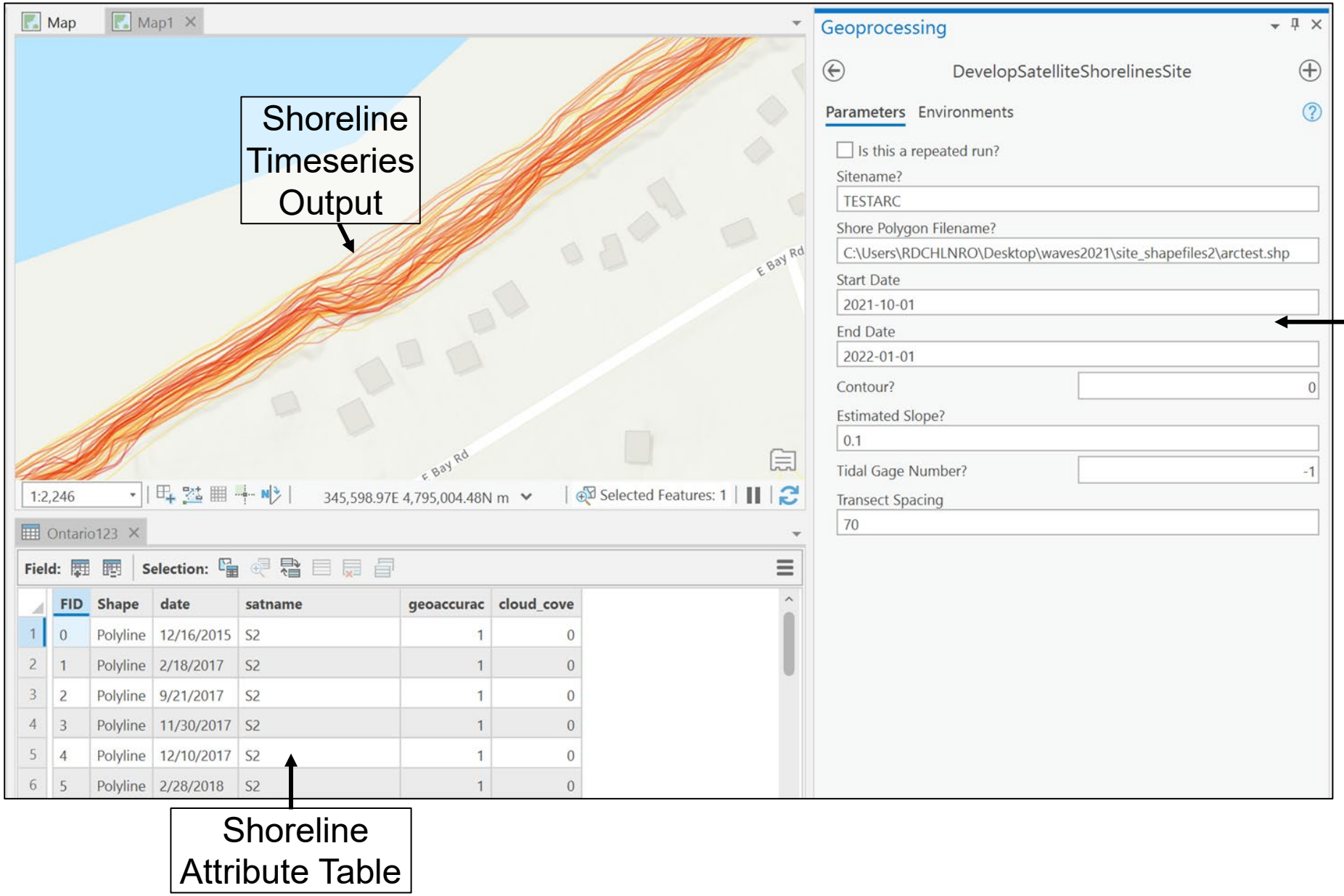
How accurate is CoastSat?



- Google Earth Engine image registration issue (★); corrected in CoastSat 2.0
- Mean horizontal difference from ground truth = **11.32** m; -3.51 m onshore bias
- Trends show good agreement with ground truth
  - 200 days data mean difference = -3.10 m/yr; 650 days of data mean difference = -0.04 m/yr

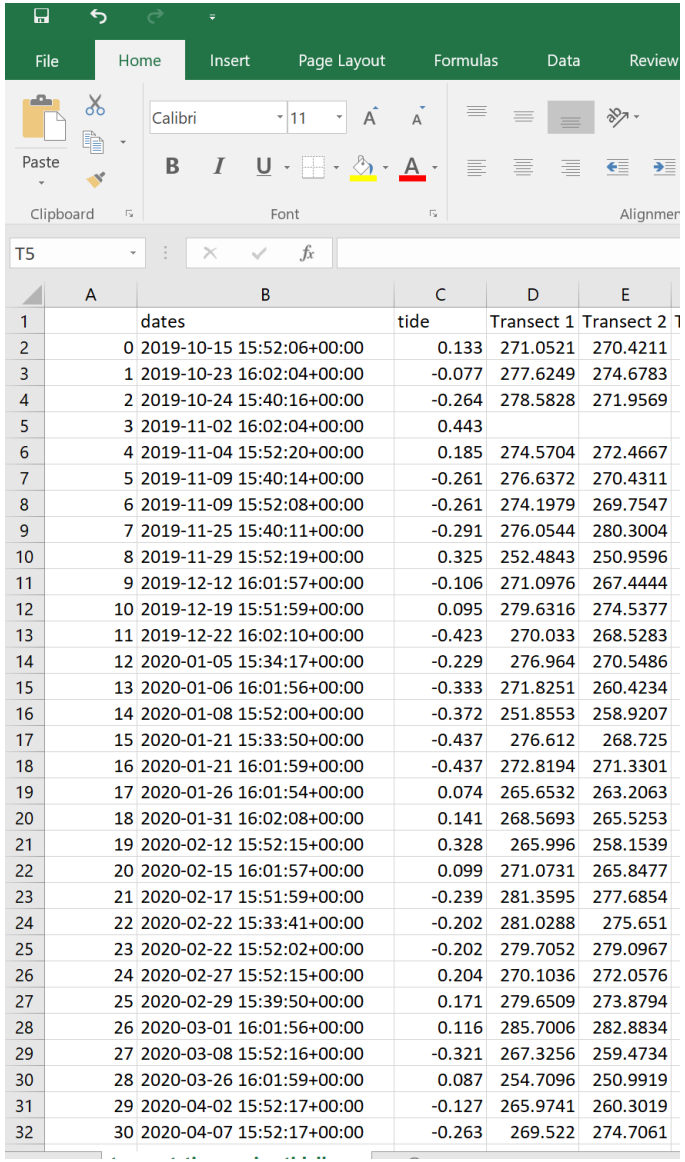
CoastSat ERDC Desktop ArcTool

- Satellite shoreline mapping algorithm developed University of New South Wales (Vos et al., 2019)
- Required python coding expertise, so ERDC created ***user-friendly*** ArcGIS desktop tool
- Uses free, public imagery available every ***5 – 16*** days
- Expected to be ***new*** data source for many USACE coastal applications



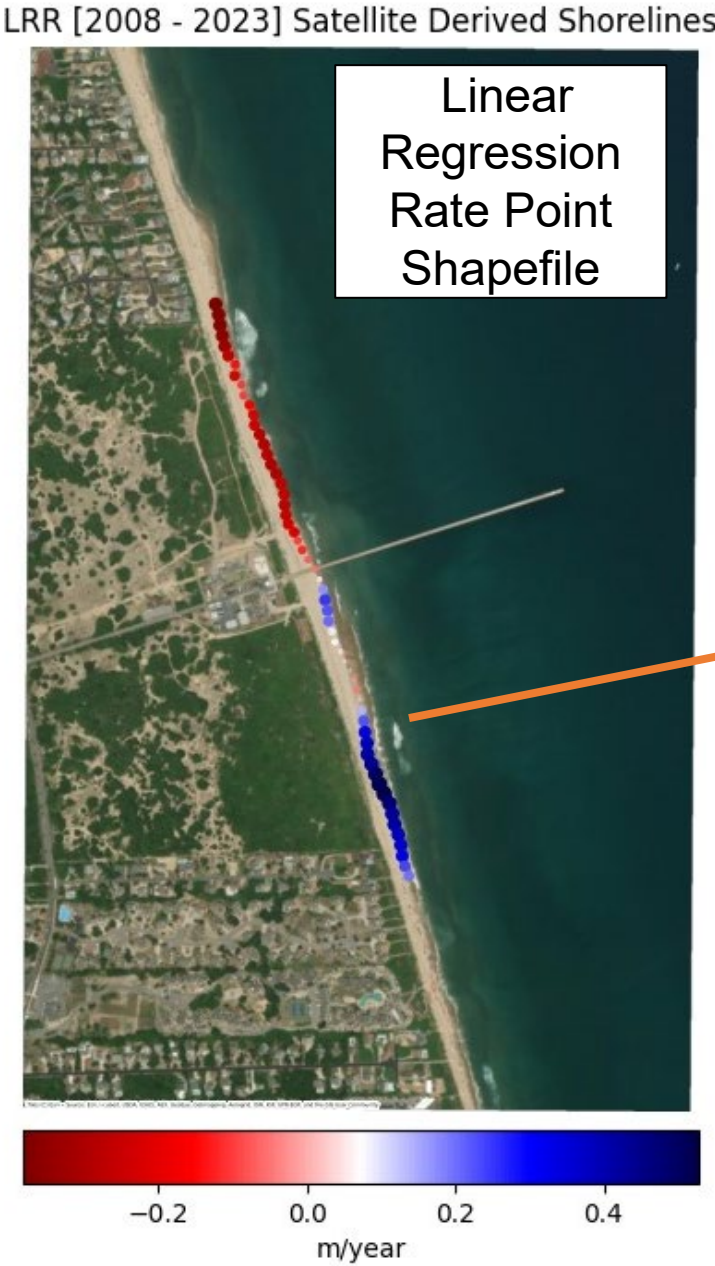
Other Tool Products

Summary .csv

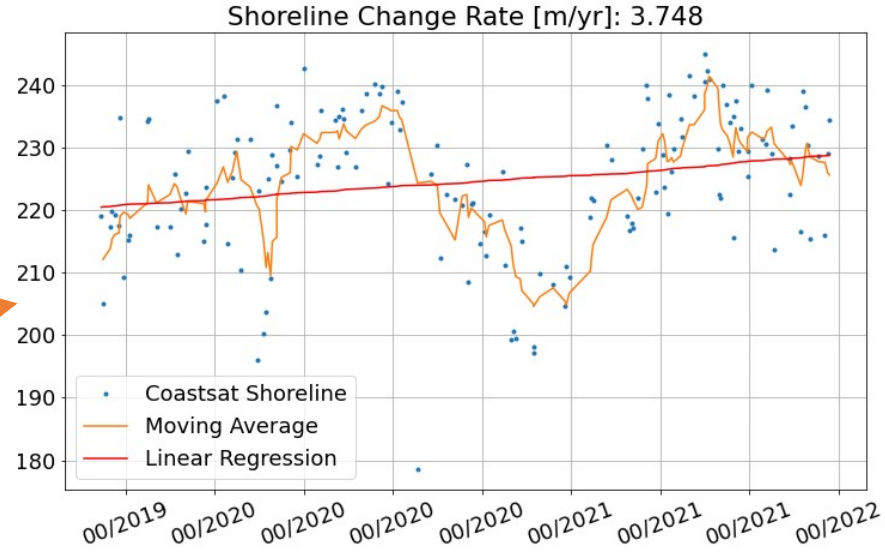


	A	B	C	D	E
1		dates	tide	Transect 1	Transect 2
2	0	2019-10-15 15:52:06+00:00	0.133	271.0521	270.4211
3	1	2019-10-23 16:02:04+00:00	-0.077	277.6249	274.6783
4	2	2019-10-24 15:40:16+00:00	-0.264	278.5828	271.9569
5	3	2019-11-02 16:02:04+00:00	0.443		
6	4	2019-11-04 15:52:20+00:00	0.185	274.5704	272.4667
7	5	2019-11-09 15:40:14+00:00	-0.261	276.6372	270.4311
8	6	2019-11-09 15:52:08+00:00	-0.261	274.1979	269.7547
9	7	2019-11-25 15:40:11+00:00	-0.291	276.0544	280.3004
10	8	2019-11-29 15:52:19+00:00	0.325	252.4843	250.9596
11	9	2019-12-12 16:01:57+00:00	-0.106	271.0976	267.4444
12	10	2019-12-19 15:51:59+00:00	0.095	279.6316	274.5377
13	11	2019-12-22 16:02:10+00:00	-0.423	270.033	268.5283
14	12	2020-01-05 15:34:17+00:00	-0.229	276.964	270.5486
15	13	2020-01-06 16:01:56+00:00	-0.333	271.8251	260.4234
16	14	2020-01-08 15:52:00+00:00	-0.372	251.8553	258.9207
17	15	2020-01-21 15:33:50+00:00	-0.437	276.612	268.725
18	16	2020-01-21 16:01:59+00:00	-0.437	272.8194	271.3301
19	17	2020-01-26 16:01:54+00:00	0.074	265.6532	263.2063
20	18	2020-01-31 16:02:08+00:00	0.141	268.5693	265.5253
21	19	2020-02-12 15:52:15+00:00	0.328	265.996	258.1539
22	20	2020-02-15 16:01:57+00:00	0.099	271.0731	265.8477
23	21	2020-02-17 15:51:59+00:00	-0.239	281.3595	277.6854
24	22	2020-02-22 15:33:41+00:00	-0.202	281.0288	275.651
25	23	2020-02-22 15:52:02+00:00	-0.202	279.7052	279.0967
26	24	2020-02-27 15:52:15+00:00	0.204	270.1036	272.0576
27	25	2020-02-29 15:39:50+00:00	0.171	279.6509	273.8794
28	26	2020-03-01 16:01:56+00:00	0.116	285.7006	282.8834
29	27	2020-03-08 15:52:16+00:00	-0.321	267.3256	259.4734
30	28	2020-03-26 16:01:59+00:00	0.087	254.7096	250.9919
31	29	2020-04-02 15:52:17+00:00	-0.127	265.9741	260.3019
32	30	2020-04-07 15:52:17+00:00	-0.263	269.522	274.7061

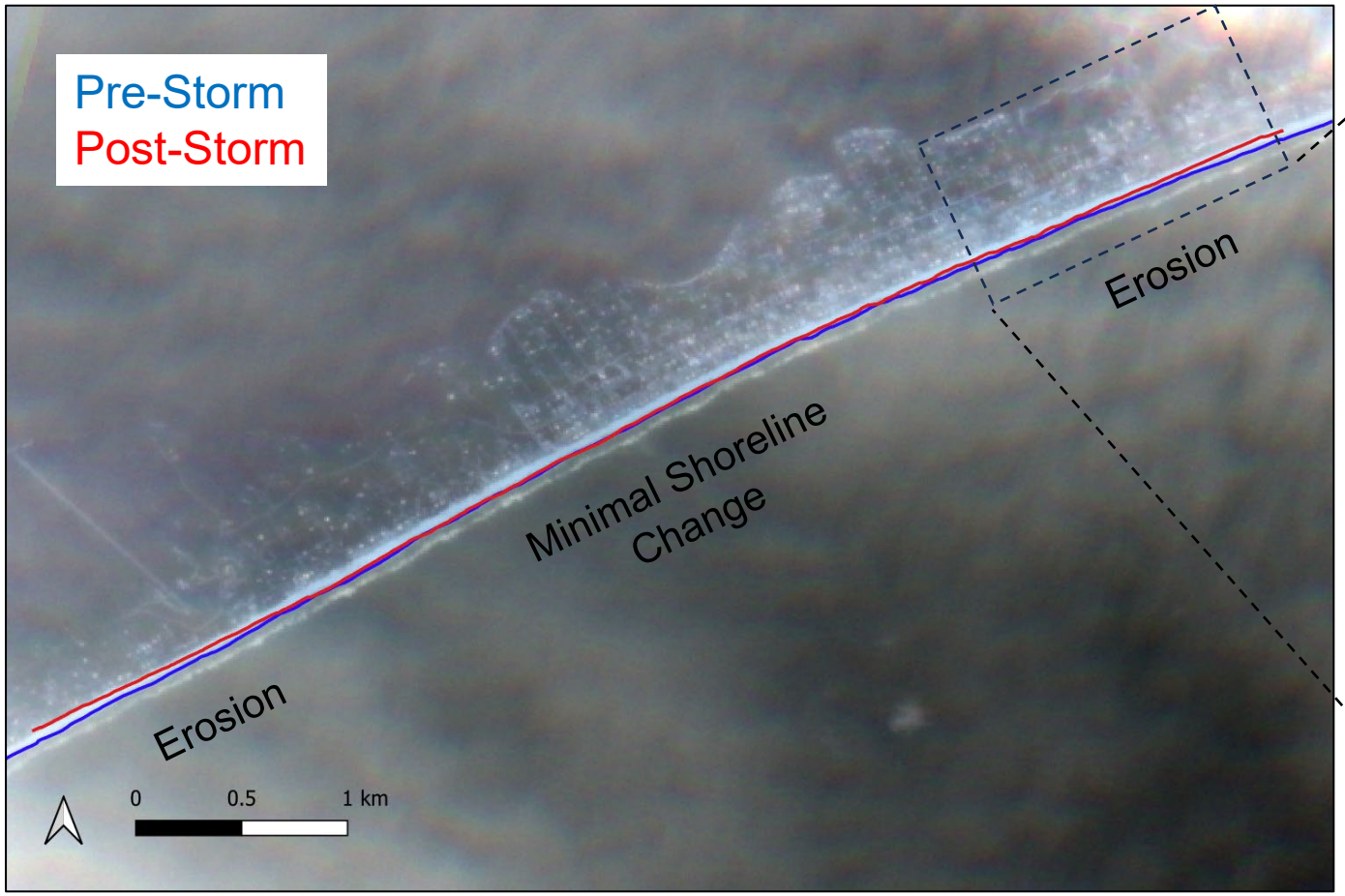
Linear Regression Rate Point Shapefile

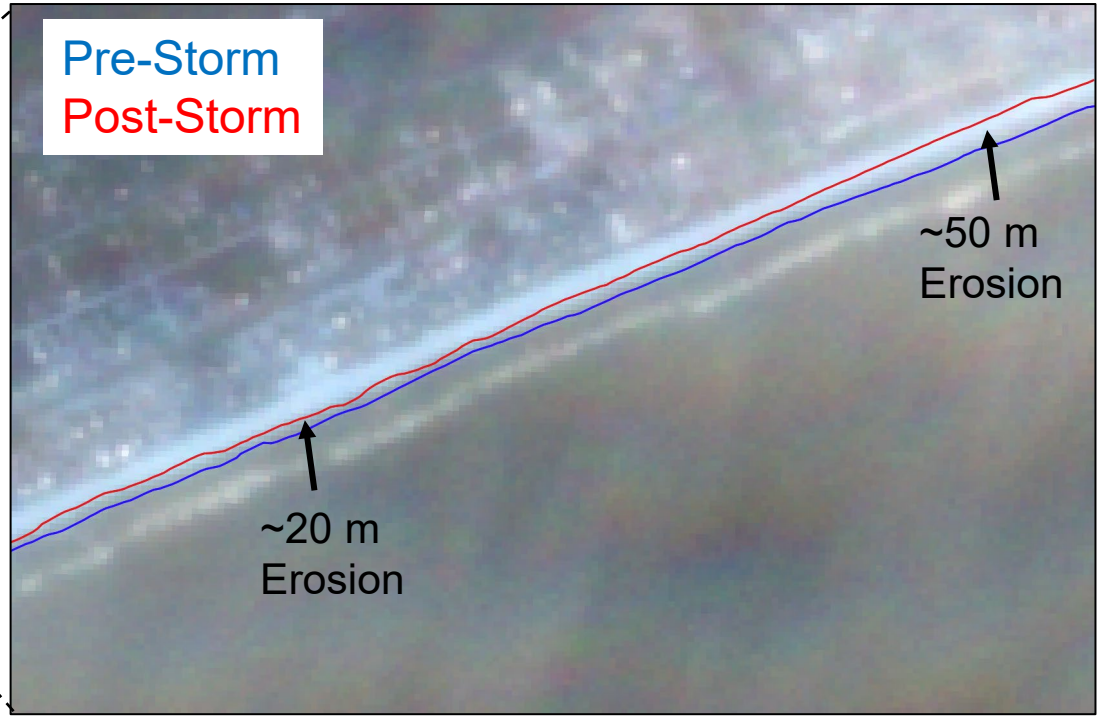


Individual Transect Trend Plots



Applications of ERDC Satellite Shoreline Mapper : Rapid Storm Impact Assessment
Hurricane Idalia, Aug. 30, 2023: St. George, FL



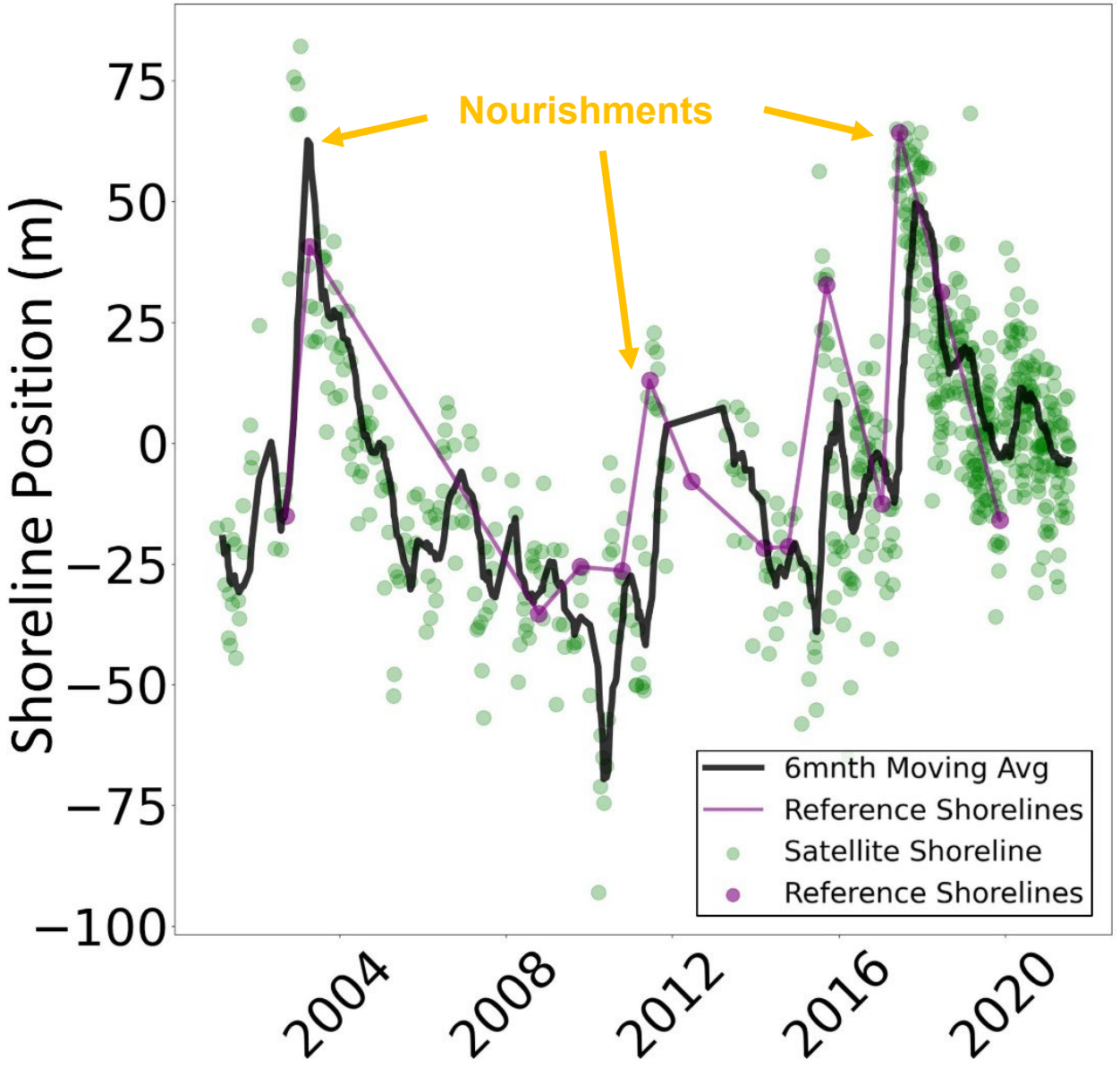


BLUF: Automated algorithms detected shoreline in pre (3 days) & post-storm (4 days) imagery, indicating up to 50-m of erosion and dune collision along eastern end of study site, minimal change in the center, and 20-m of beach erosion (half the pre-storm beach) to the west.

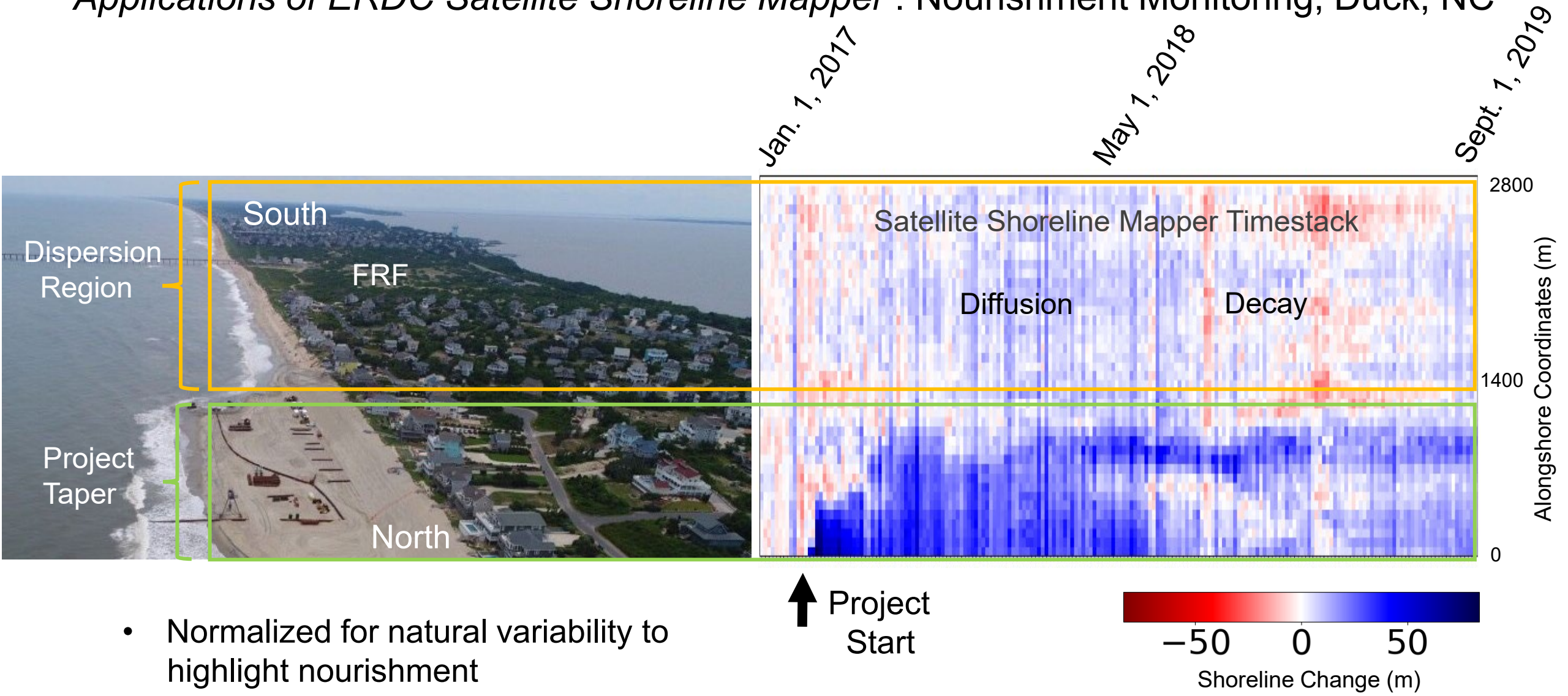
Applications of ERDC Satellite Shoreline Mapper : Decadal Trends and Nourishment Monitoring, Avalon, NJ

Example takeaways:

- After 2003 beach nourishment, equilibration occurred resulting in shoreline recession at a rate of ~37.6 m/yr. This high rate of shoreline retreat following nourishment is likely attributable to a very active 2004 hurricane season which included impacts from four storms: Bonnie (August), Charlie (August), Gaston (August) and Ivan (September).
- Prior to the next major nourishment in 2011, the erosion from Hurricane Barry in May 2007 is clear (8 m shoreline retreat).
- After significant beach narrowing around 2010, two large nourishments followed in 2011 and 2013 totaling 2,040,583 CY.
- The last notable nourishment of 1,636,685 CY was conducted in 2017. Over the next 2.25 years, the beach equilibrated to pre-project width, at a recession rate of 23.2 m/yr.

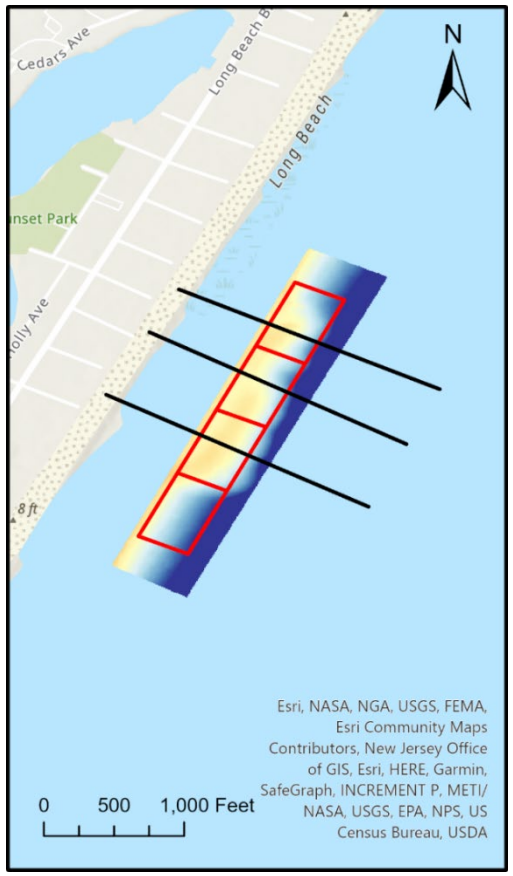


Applications of ERDC Satellite Shoreline Mapper : Nourishment Monitoring, Duck, NC

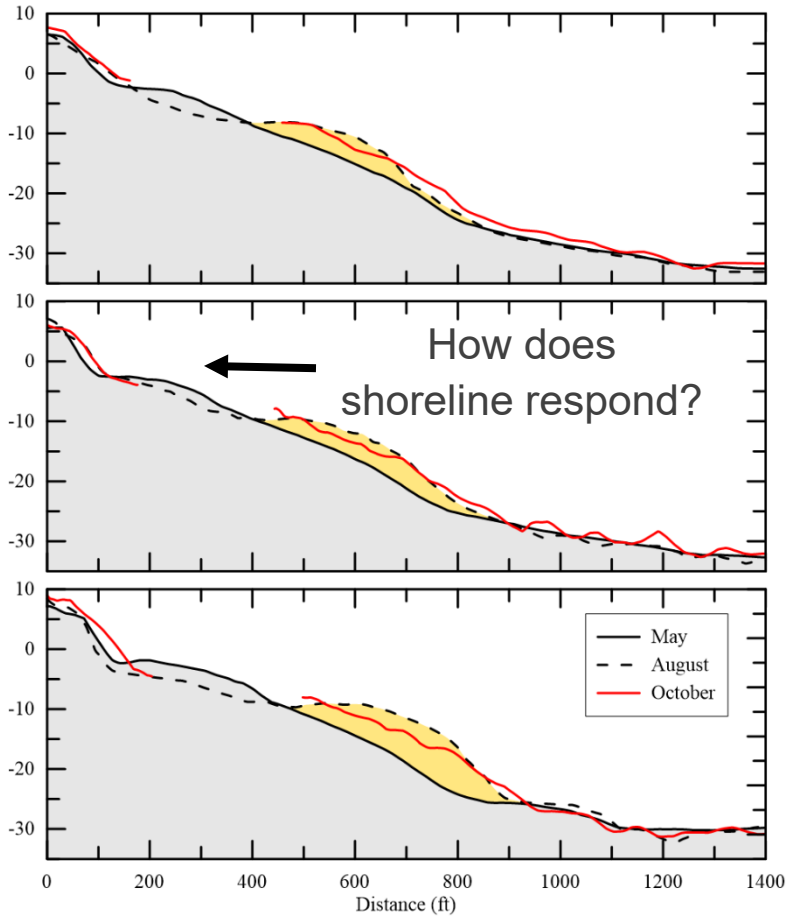


- Normalized for natural variability to highlight nourishment
- Longshore dispersion to south

Applications of ERDC Satellite Shoreline Mapper : Nearshore Berm Placement Monitoring, Harvey Cedars, NJ



- Beneficial Re-Use
- Volume: ~60k cu yd.
- Drops: ~210
- Berm Length: 1,400 ft
- Time: 42 days



- Collaboration with McGill et al. (ERDC)
  - Hydrodynamics