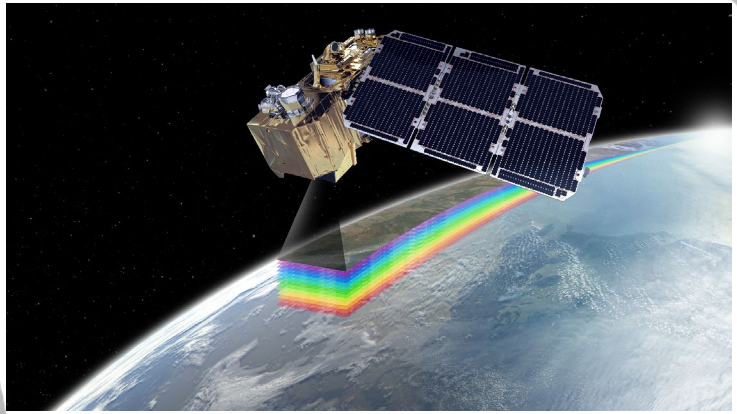
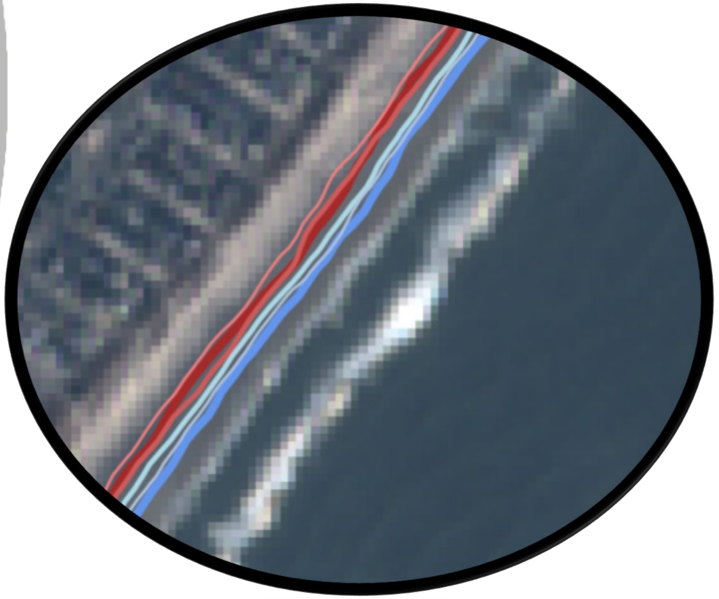
DEVELOPMENT OF A SATELLITE-DERIVED SHORELINE TOOL FOR DISTRICT USE



Ian Conery, Shannon Brown, Nicholas Olsen, Kate Brodie, Katherine DeVore, Mike Forte

District PDT Members

Monica Chasten (NAP), Jessica Podoski (POH), Jonathathan Waddell (LRE)



COASTAL INLETS RESEARCH PROGRAM

Technical Discussion

Tiffany Burroughs
HQ Navigation Business Line Manager

Eddie Wiggins
Technical Director, Navigation

Brian McFall
Acting Associate Technical Director, Navigation

CIRP
Mission Support
Technology Transfer
Research & Development

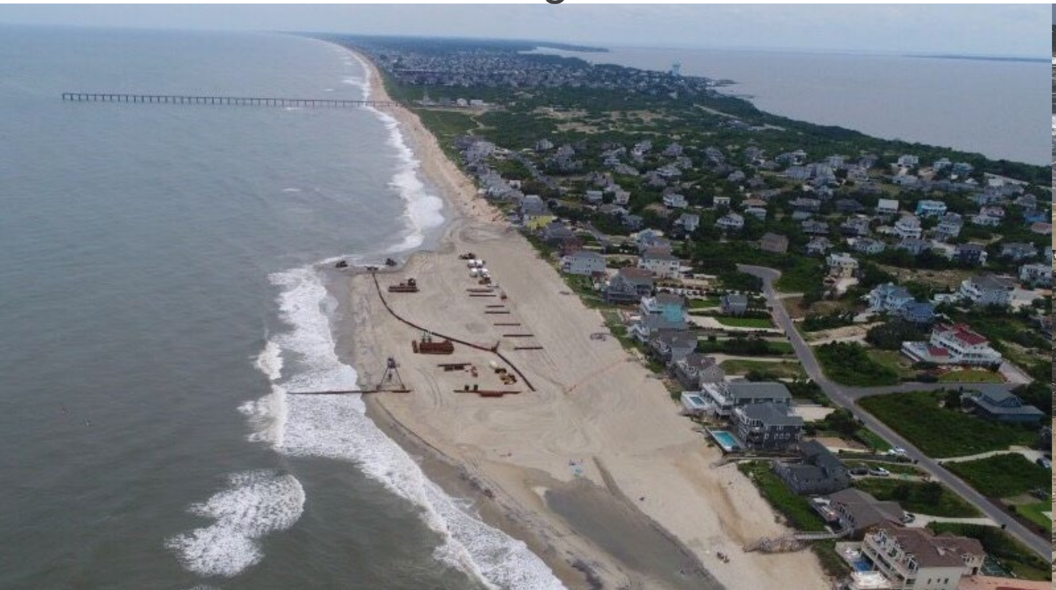
US Army Corps of Engineers®

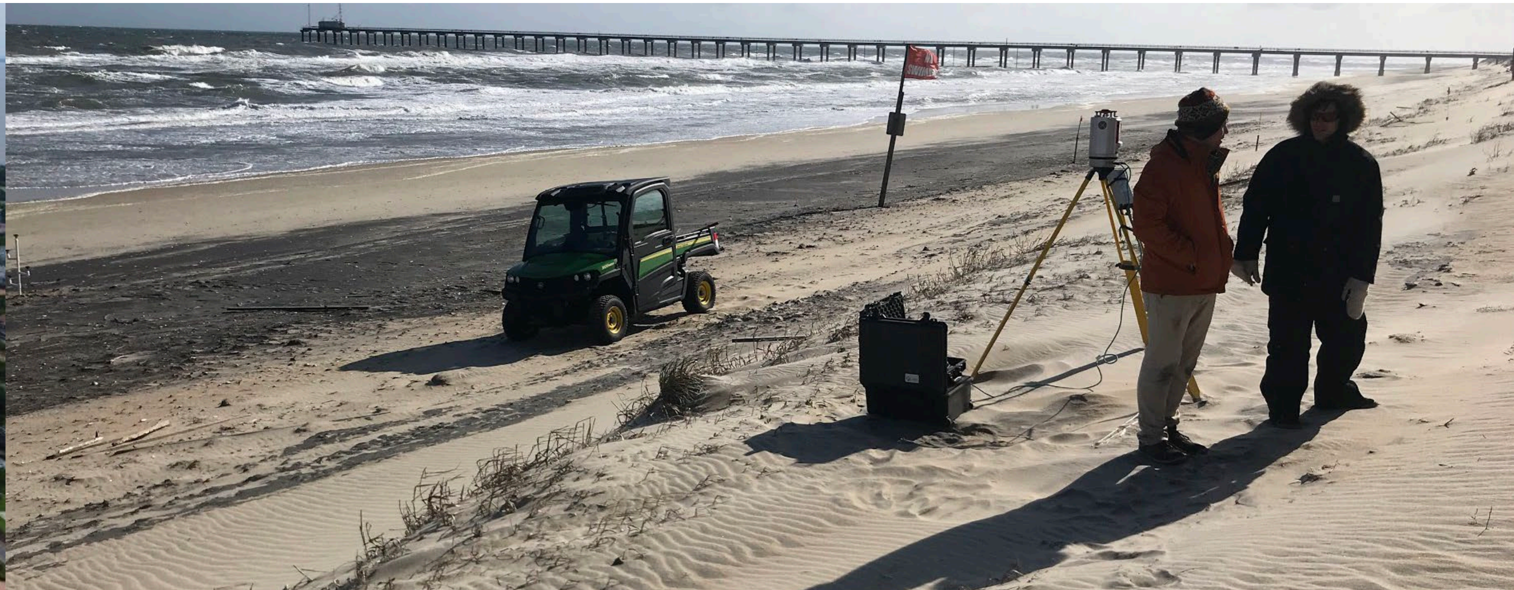
CHL COASTAL & HYDRAULICS LABORATORY

ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

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





Capability and Strategic Impact Statement

Satellite-based tool is expected to provide USACE Districts access to a ***new data source***, enabling wide-spread ***frequent*** coastal data with ***low cost*** and personnel commitment.

Adds ability to examine shoreline variability (short and long term), "***now state***" of coastline and help with preliminary planning for districts managing beach projects and storm impacts (e.g., nourishments, nearshore berms, dredging, etc.)

Mission Support Technology Transfer CIRP Research & Development

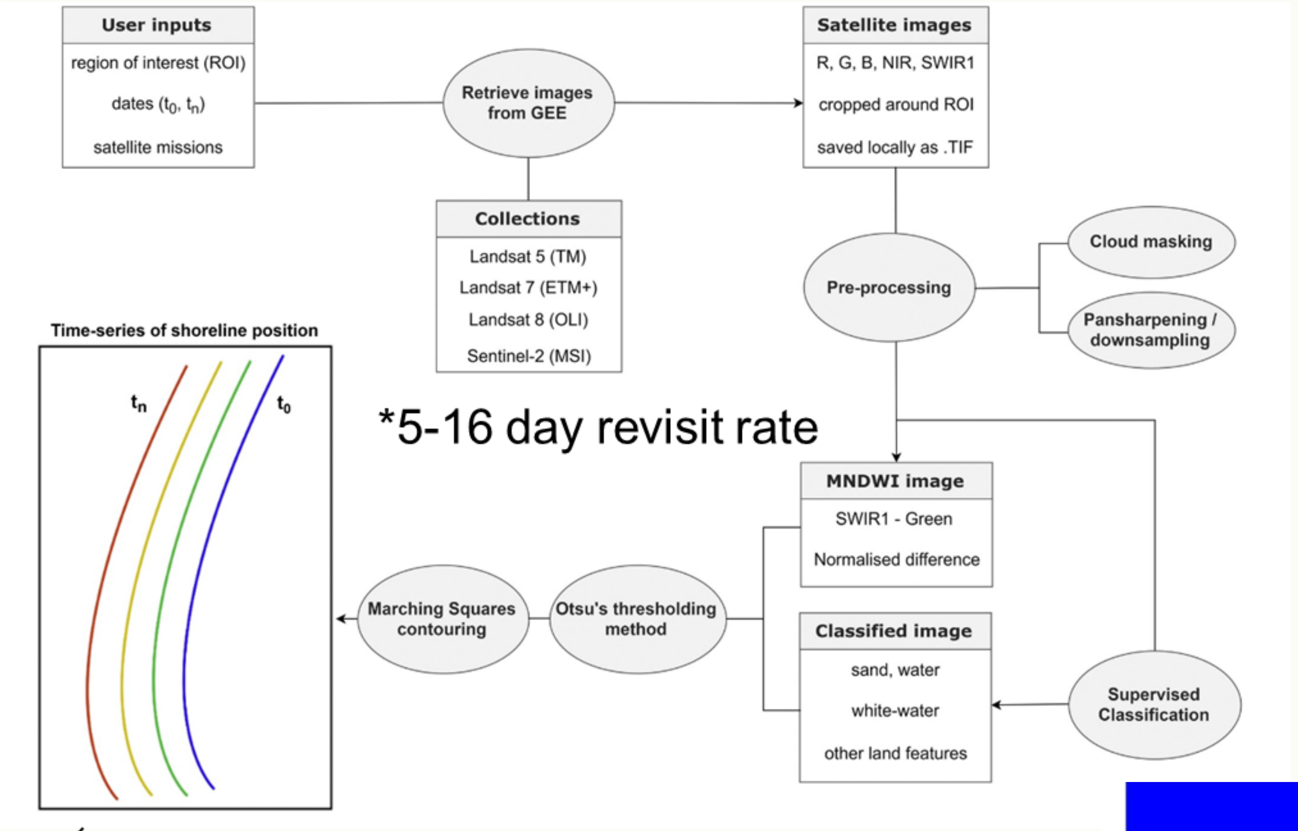
Project Objectives

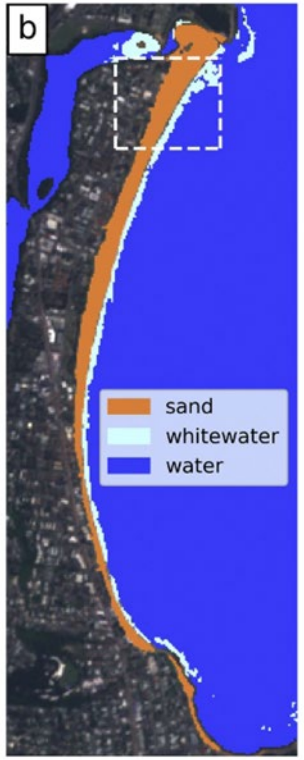
- Evaluate open-source satellite shoreline extraction algorithm accuracy at a range of test sites (CoastSat – UNSW; Vos et al., 2019)
- Assess how imagery can be used for management applications
- Create user-friendly ArcTool for USACE District use

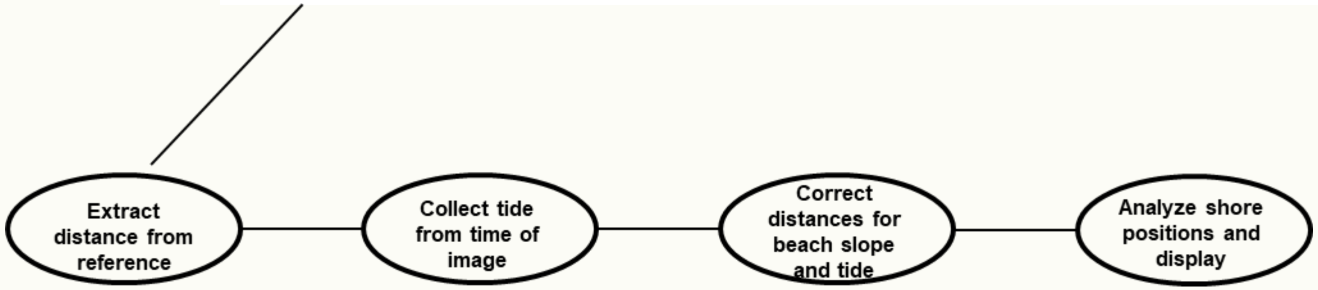
Approach

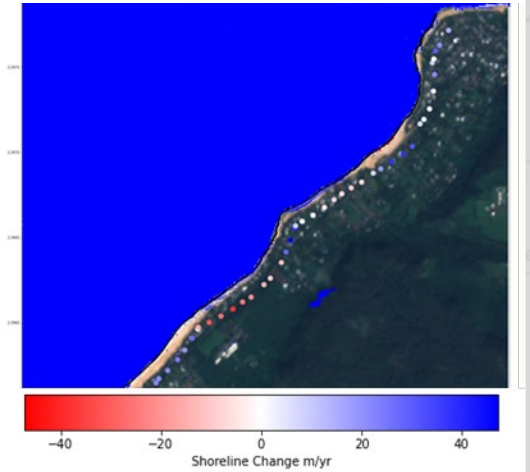
ERDC Technical Advancements:

- Tool migration to CoastSat 2.0
- Improved image sorting
- Continuing automated QA/QC for bad shorelines
- Shapefile tidal shifts







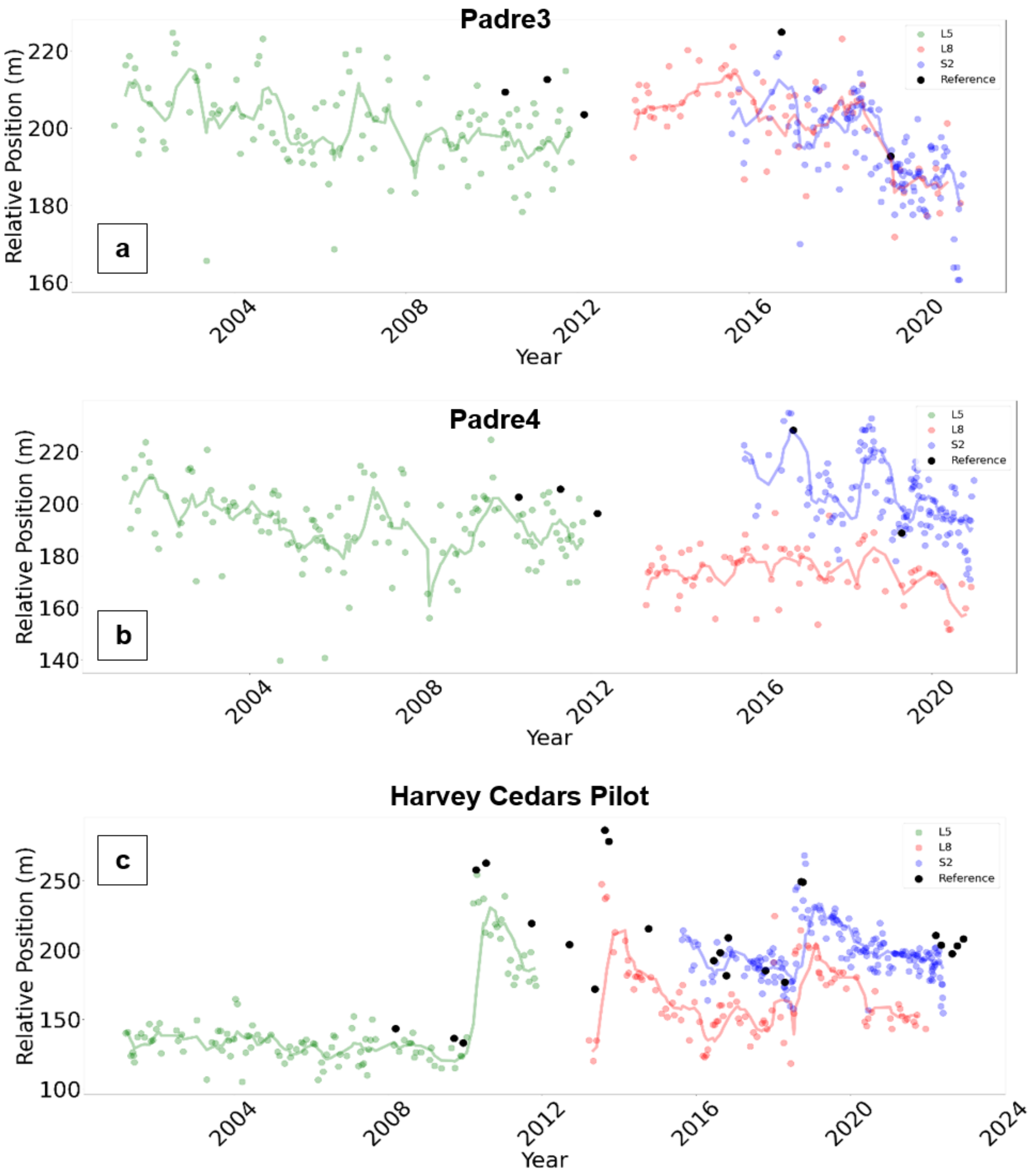


Site Selection

20 year runs
at > 270 km

Google Earth Engine Issue

- Vos et al. validations on individual transects, small spatial scales
- Modified recently in CoastSat 2.1
- With focus on performance of ML shoreline selection algorithm, these sites were discarded



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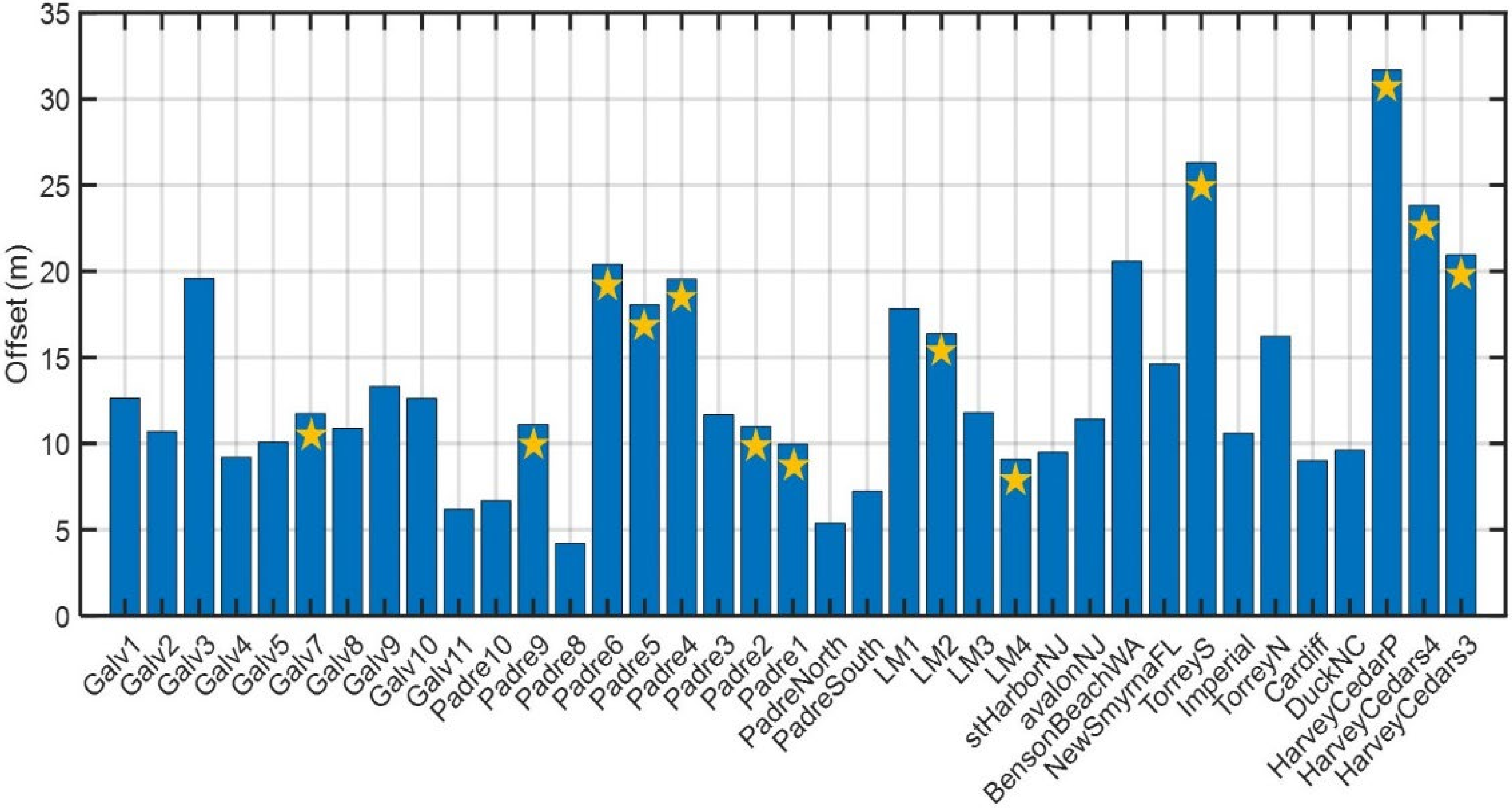
ENGINEER RESEARCH & DEVELOPMENT CENTER

Instantaneous Shoreline Comparison Results



- 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

Instantaneous Accuracy by Satellite

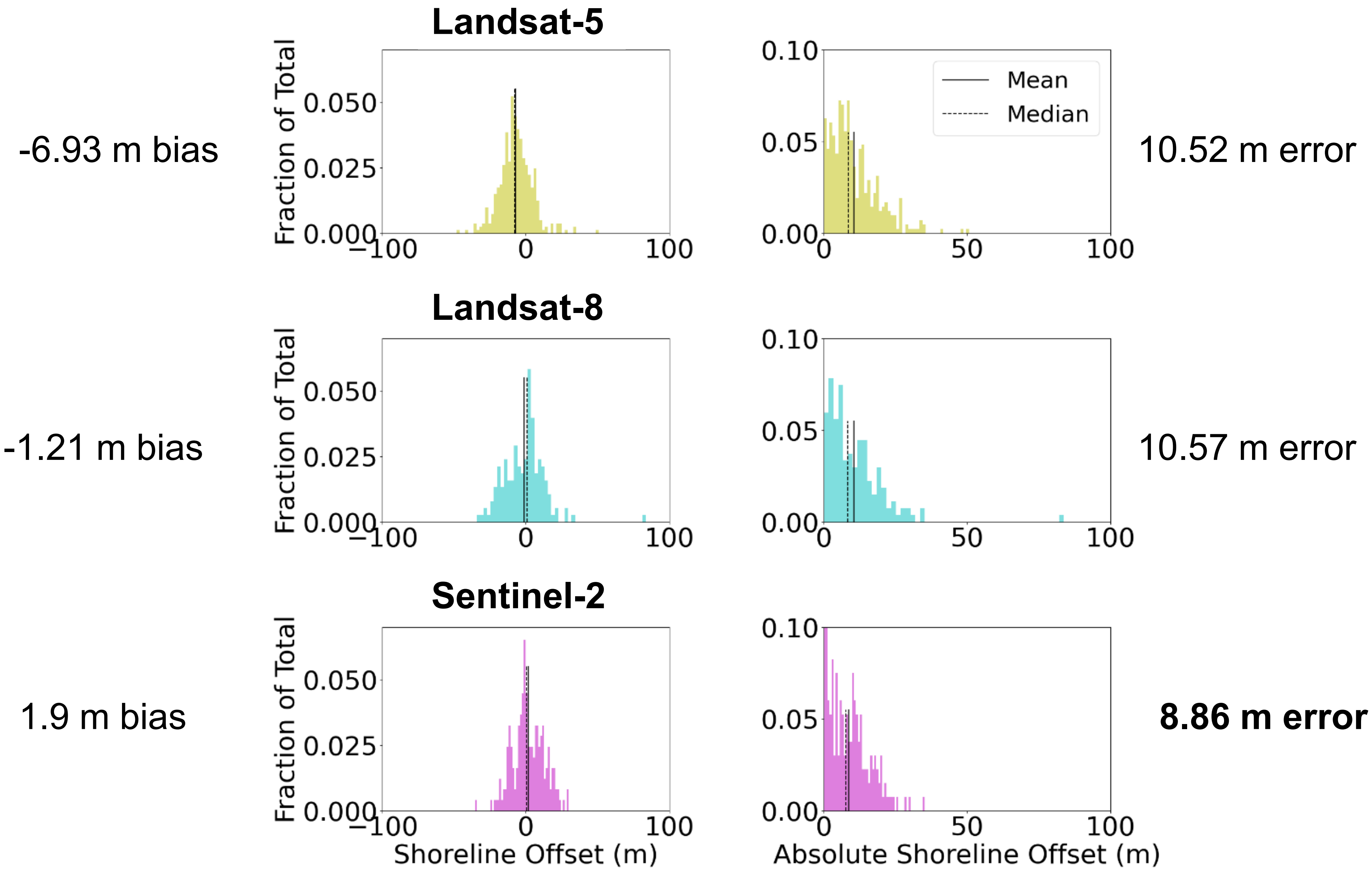
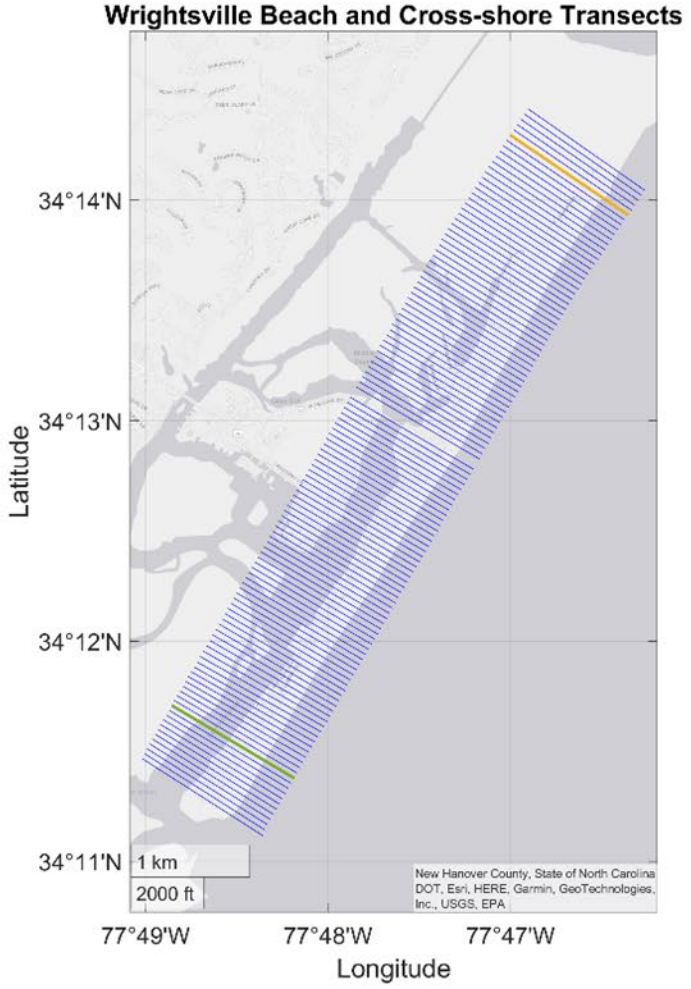
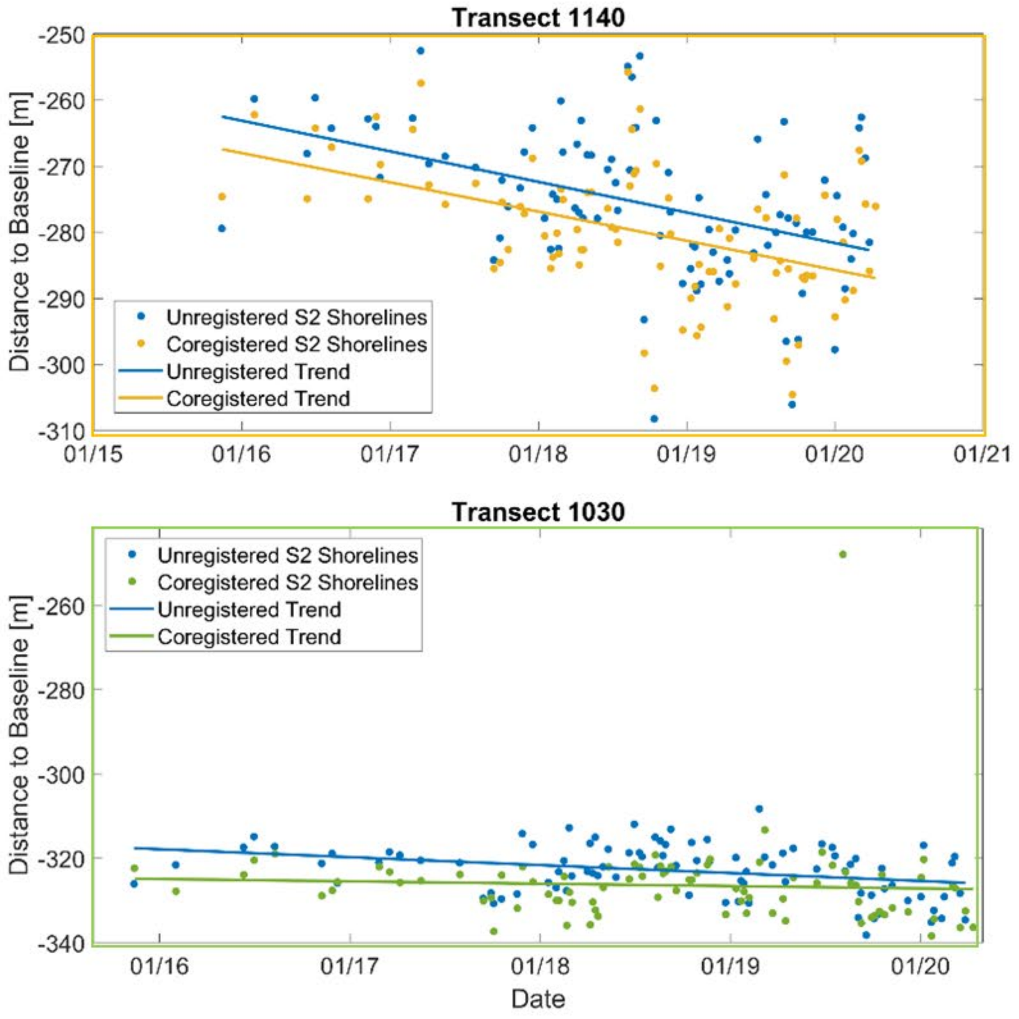


Image Coregistration: AROSICS and ArcPy

- Workflow integration challenges. ArcPy faster.
- Detrended std. dev. reduction of ~1-3 m at Wrightsville transects.
- Sentinel-2 co-registration only improved Duck shorelines by 6 cm.
- Mission to mission registration stronger influence.





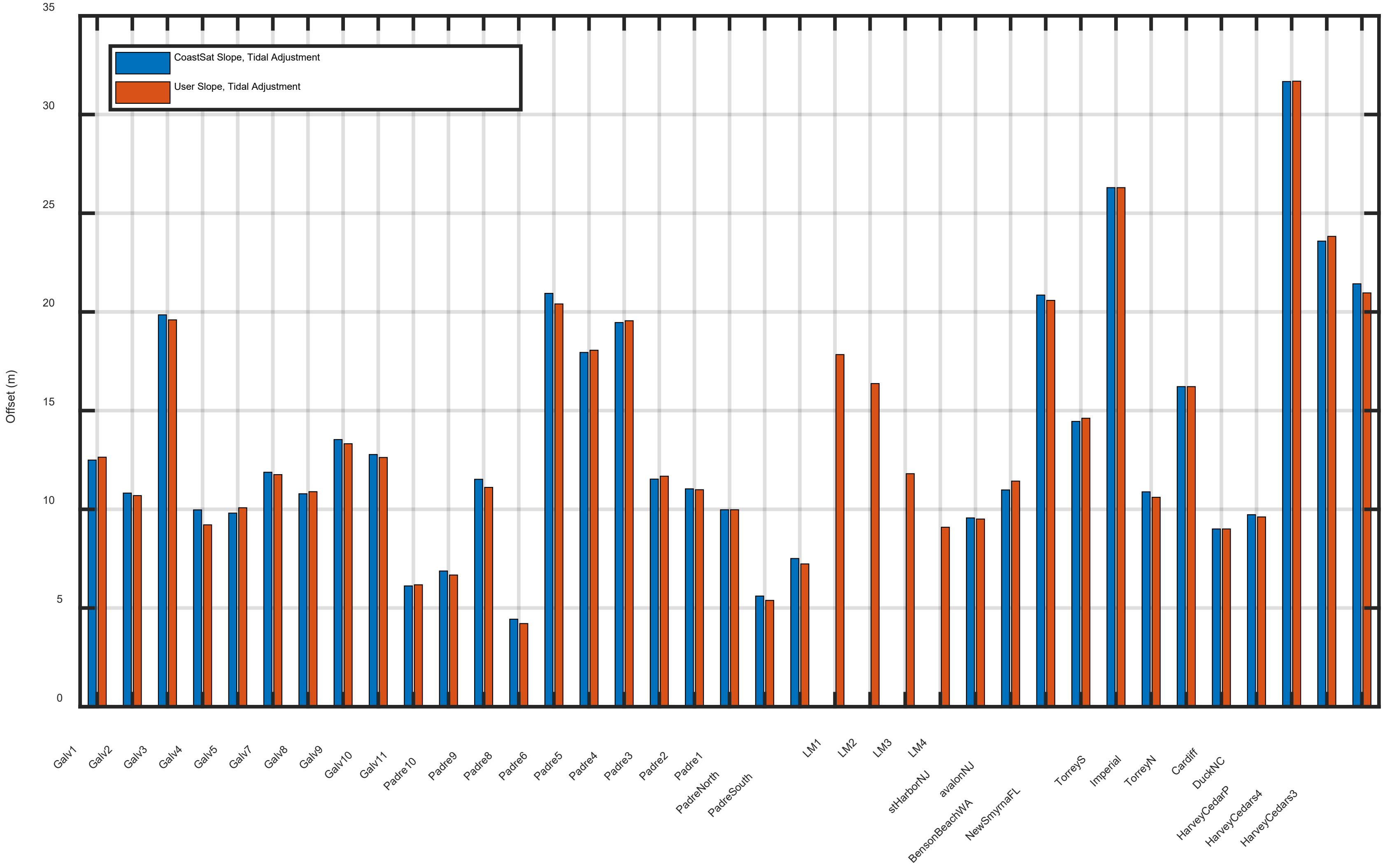
CoastSat Slope vs. User Slope

- Vos et al., 2022: Gentle and steep beaches have best predicted slopes; intermediate beaches worst

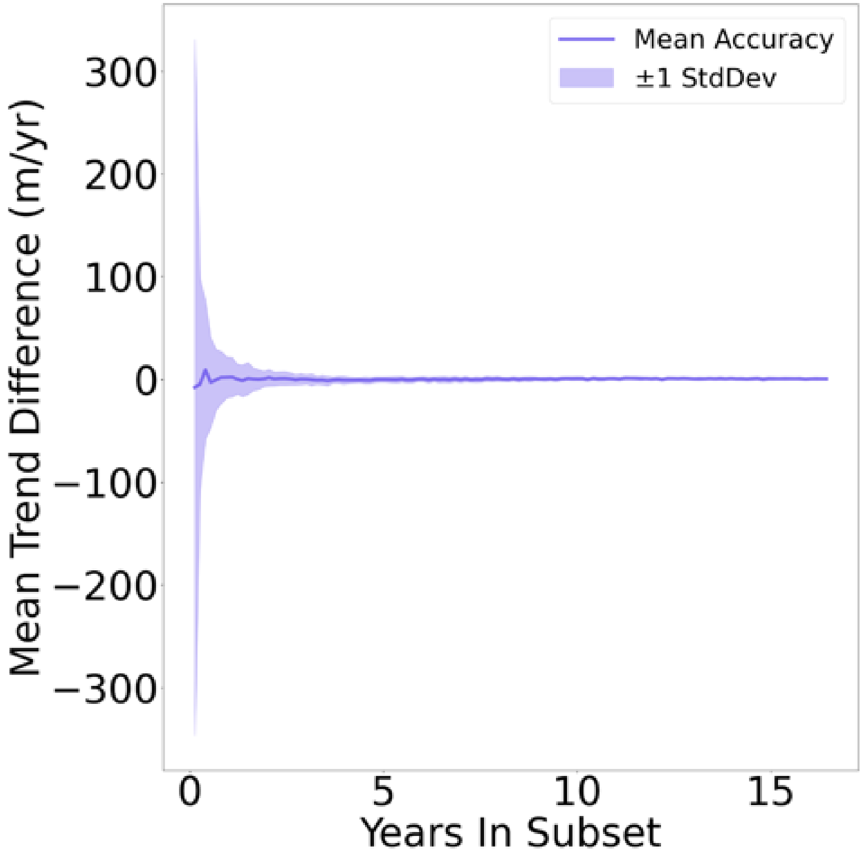
- Benson Beach, WA
  - CoastSat slope = 0.08
  - User-defined slope = 0.025

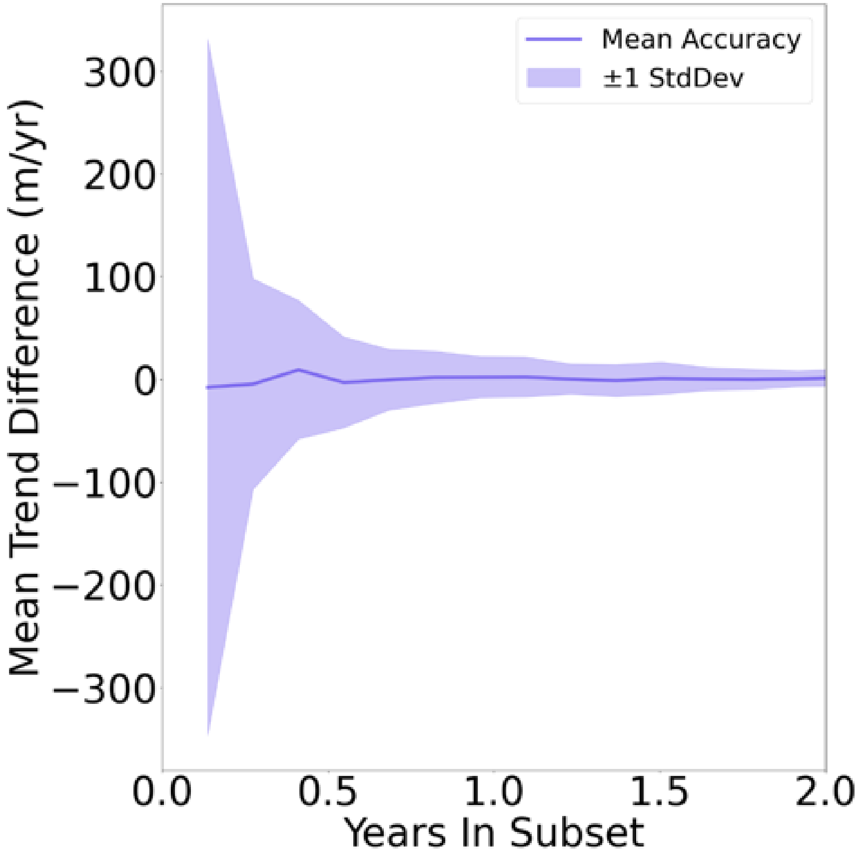
- Galveston, TX
  - CoastSat slope = 0.035
  - User-defined slope = 0.04

- Lake Michigan
  - CoastSat slope = 0.25
  - User-defined slope = 0.25



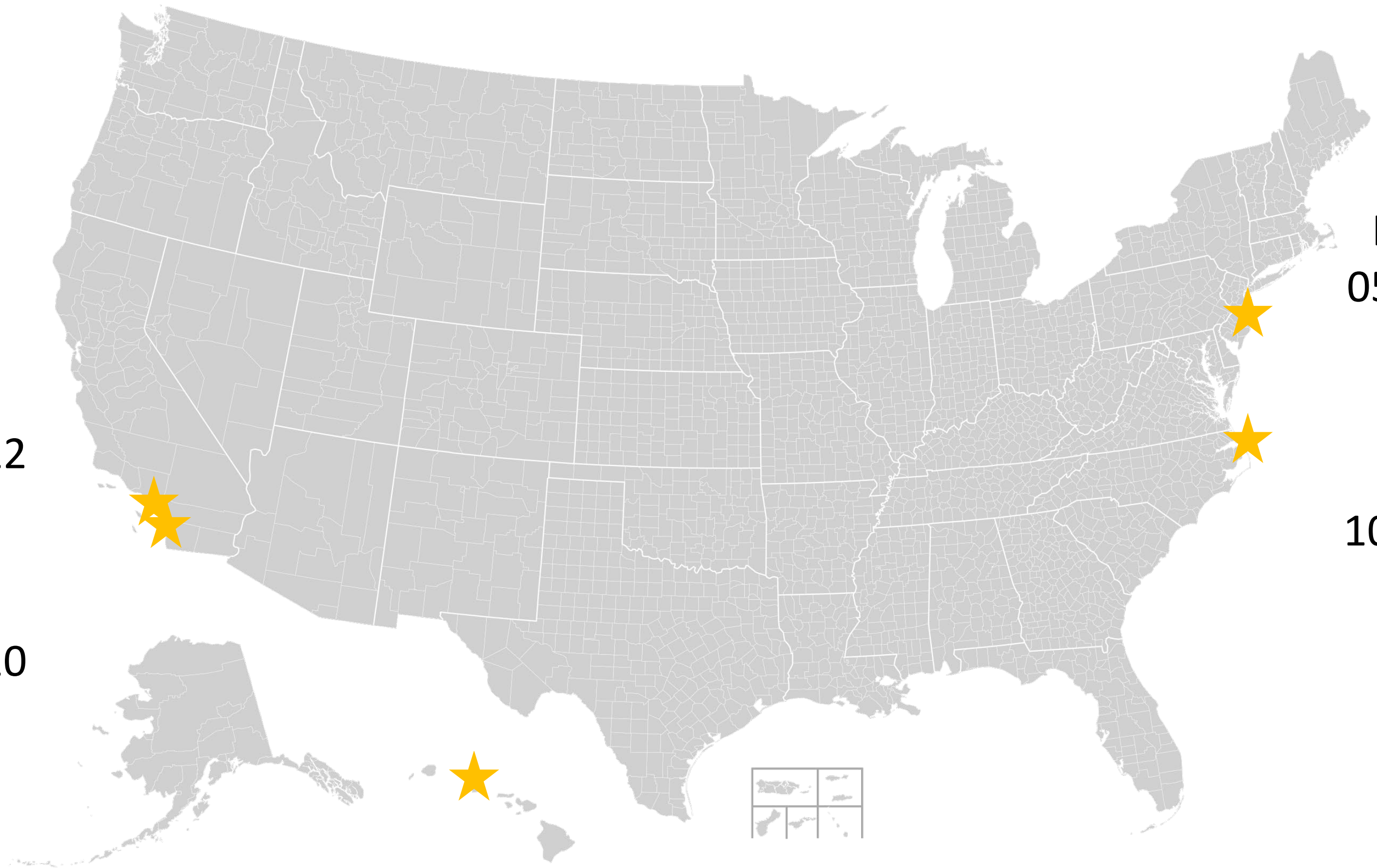
Decadal Trends





- Good trend agreement with ground truth
- 200 days data mean difference = -3.10 m/yr; 650 days of data mean difference = -0.04 m/yr

CoastSat.PlanetScope Sites



Encinitas, CA
06/2018 – 05/2022
176 Images

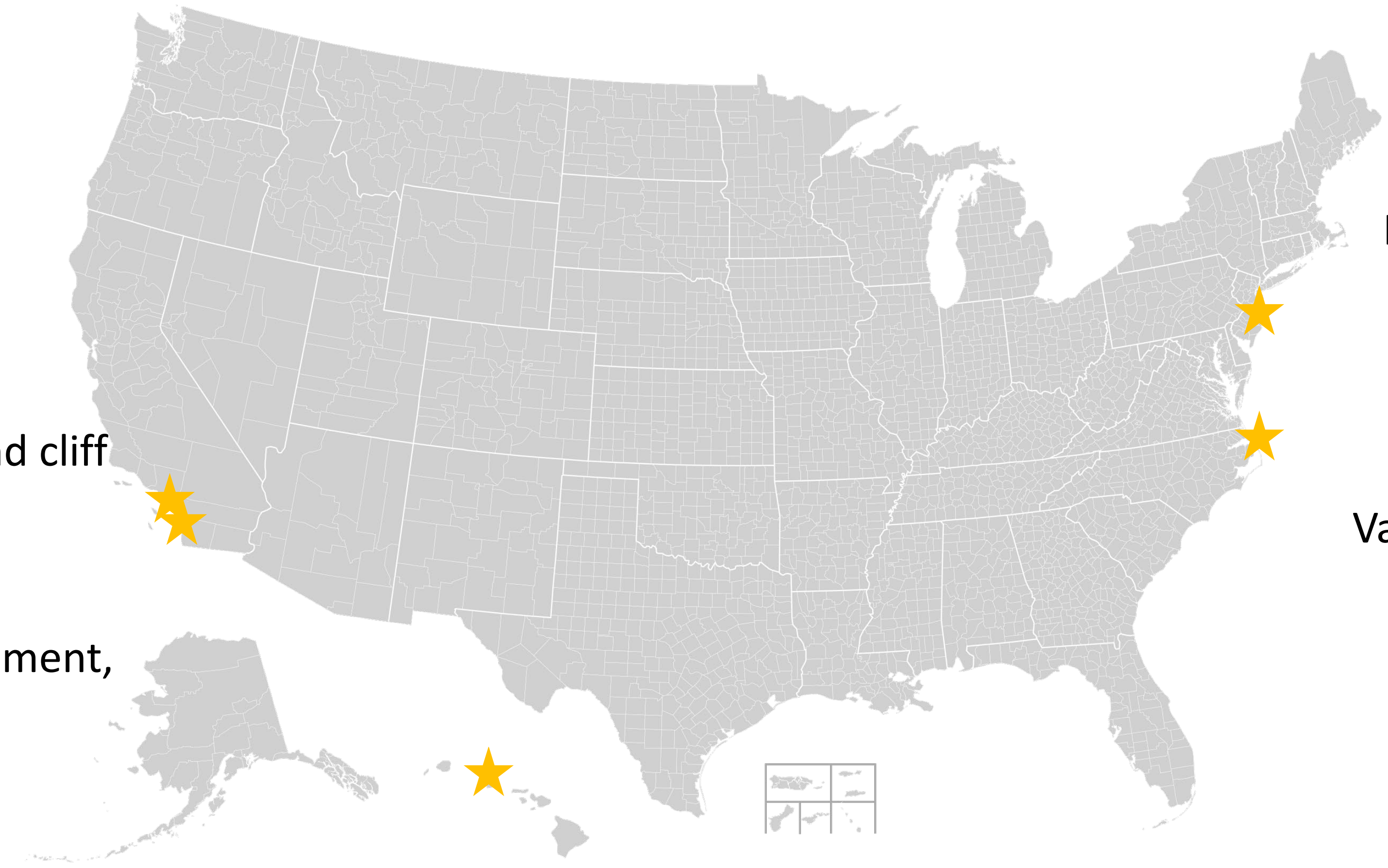
Ponto, CA
10/2018 – 03/2020
62 Images

Sunset Beach, HI
03/2017 – 03/2020
74 Images

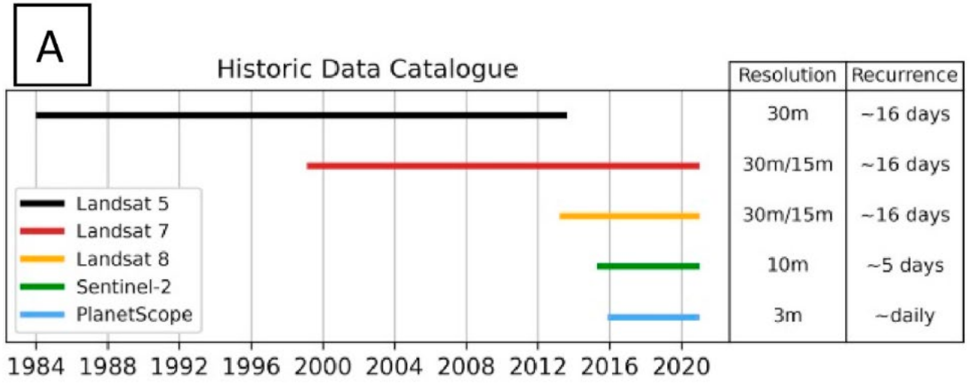
Harvey Cedars, NJ
05/2021 – 02/2022
43 Images

Duck, NC
10/2016 – 07/2022
475 Images

CoastSat.PlanetScope Sites

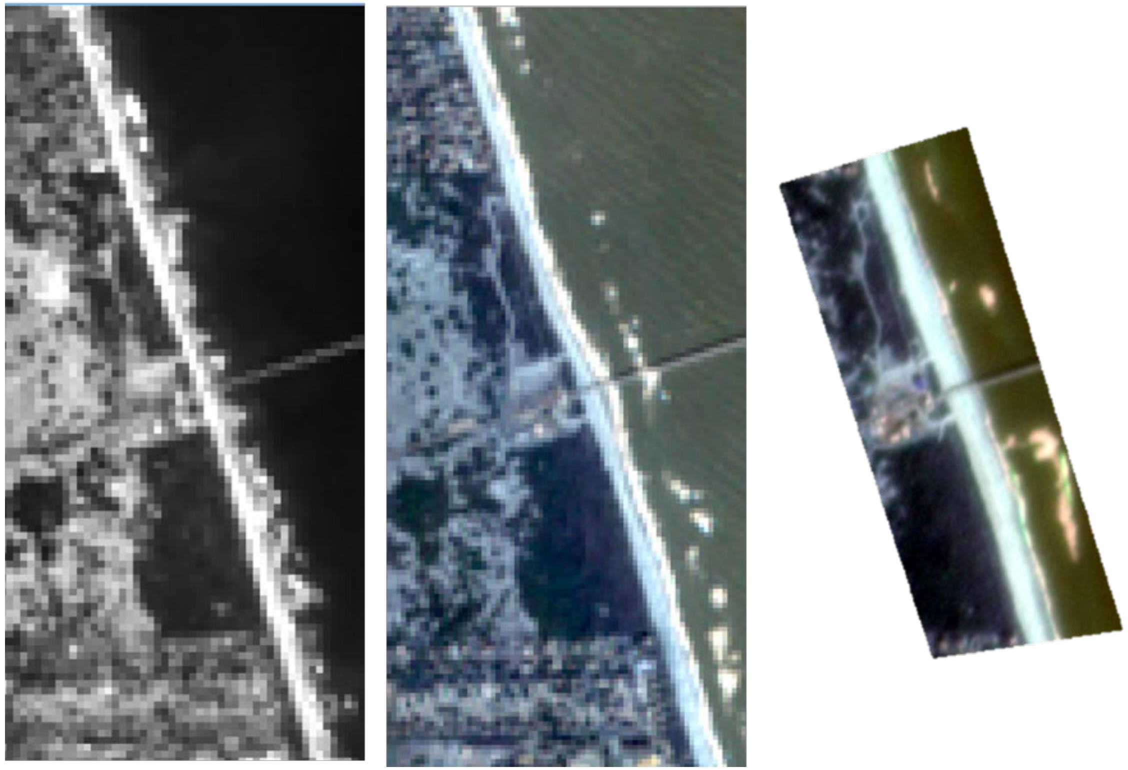


Coastsat.PlanetScope vs. CoastSat



(Doherty et al. 2022)

L8 Image	S2 Image	PS Image
30 m	10m	3.7 m
10/15 m	10/15 m	3.5/5 m



Traditional CoastSat

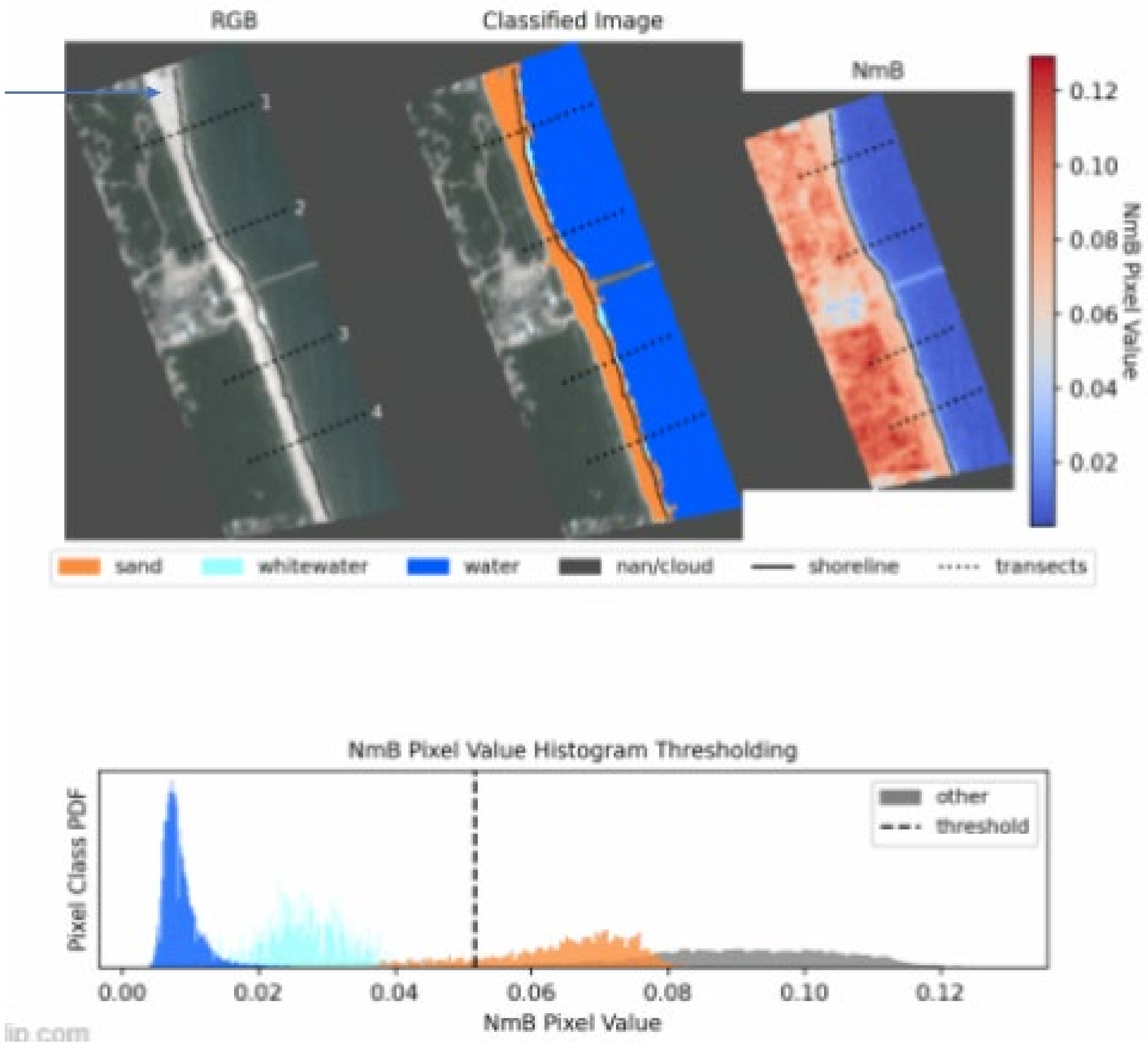
- 1 shoreline/ week
- Longterm change

CoastSat.PlanetScope

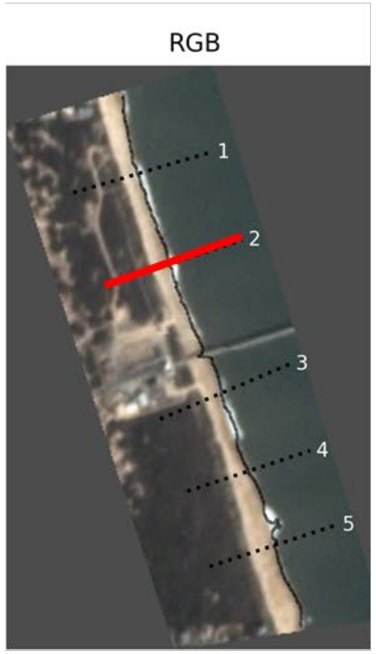
- 1 shoreline/ day
- Enables storm response
- Smaller management project monitoring

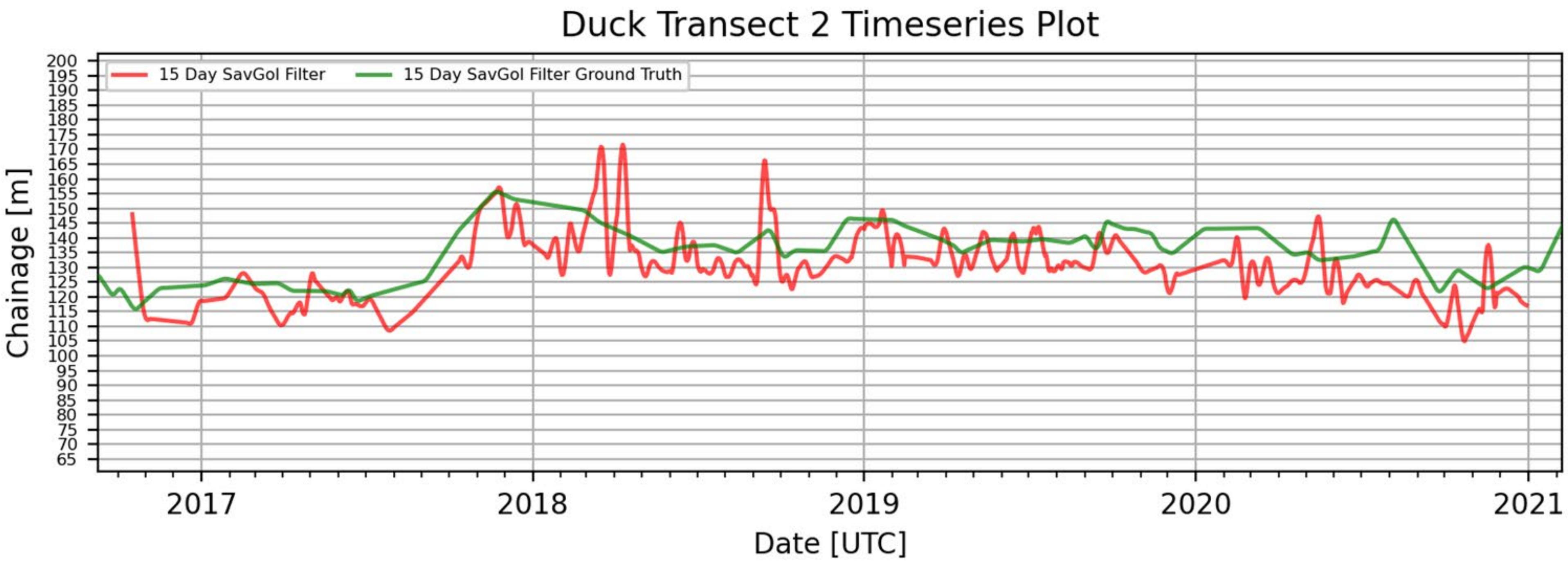
Coastsat.Planetscope Duck Shoreline Timeseries

Edge of Duck Nourishment



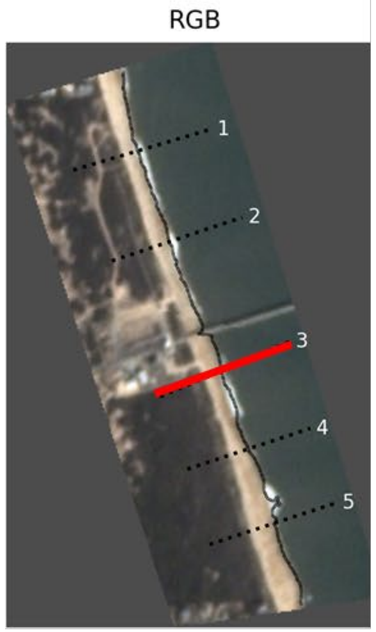
CoastSat.PlanetScope vs. Ground Truth

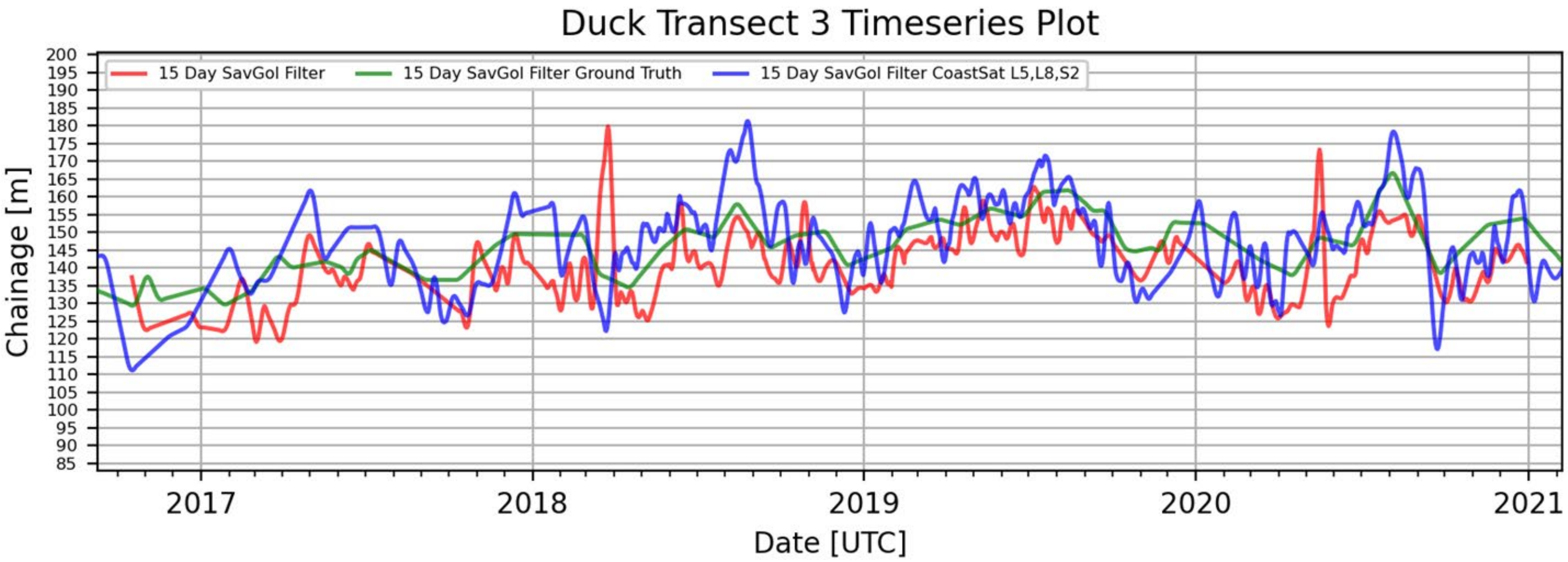




	# Shorelines	RMSE (m)	Bias (m)	St. Dev. (m)
CoastSat.PlanetScope	430	4.7	-0.01	11.8

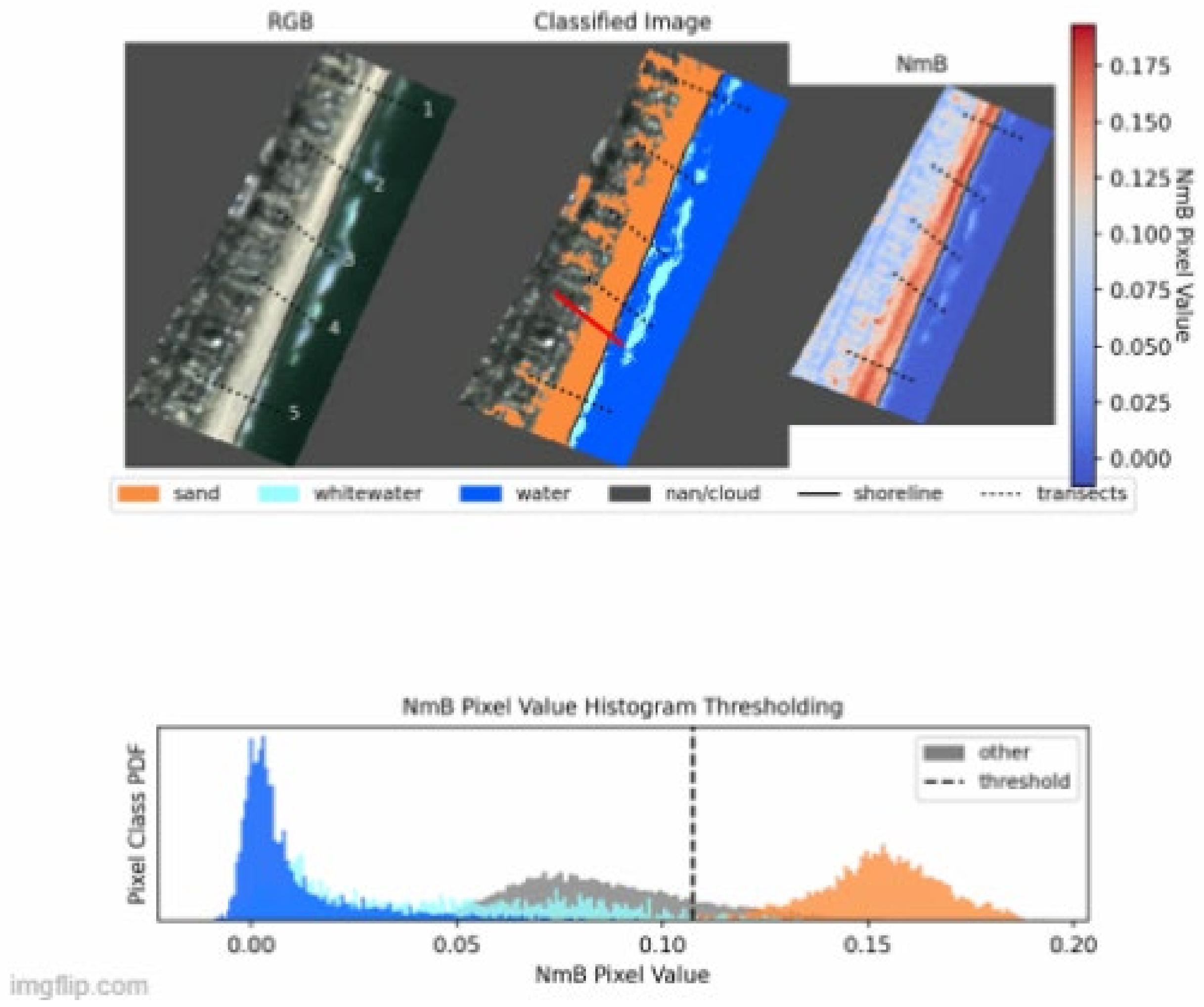
CoastSat.PlanetScope vs. CoastSat vs. Ground Truth



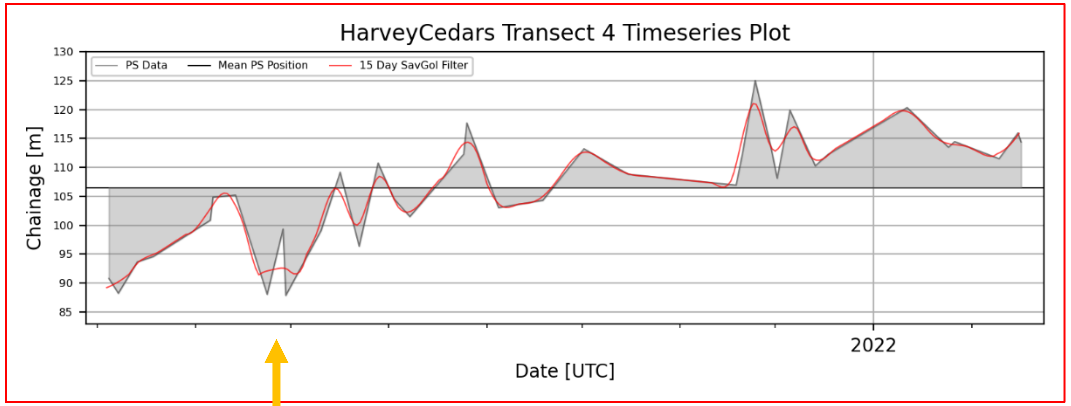


	# Shorelines	RMSE (m)	Bias (m)	St. Dev. (m)
CoastSat.PlanetScope	430	4.7	-0.01	11.8
CoastSat	387	8.5	-0.4	12.6

NmB Water Index with Peak Fraction Thresholding



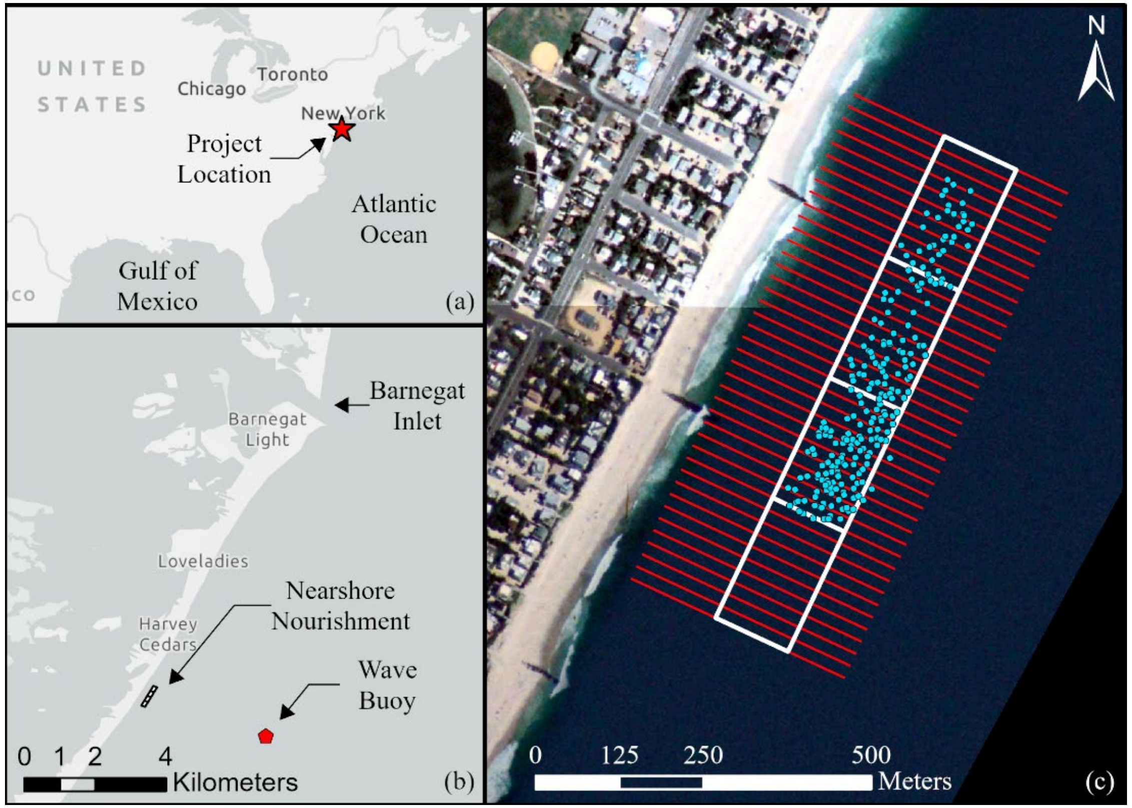
Harvey Cedars, NJ

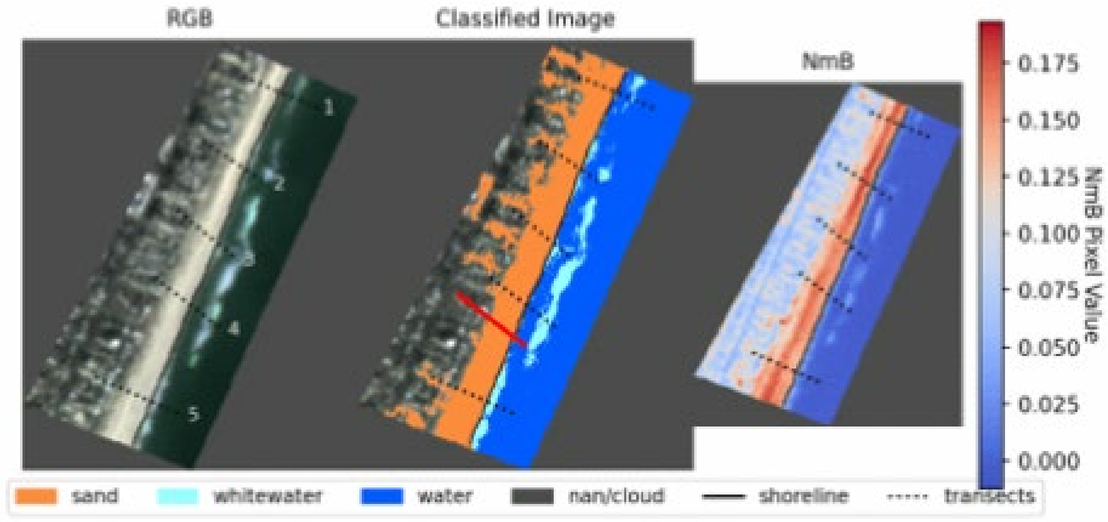


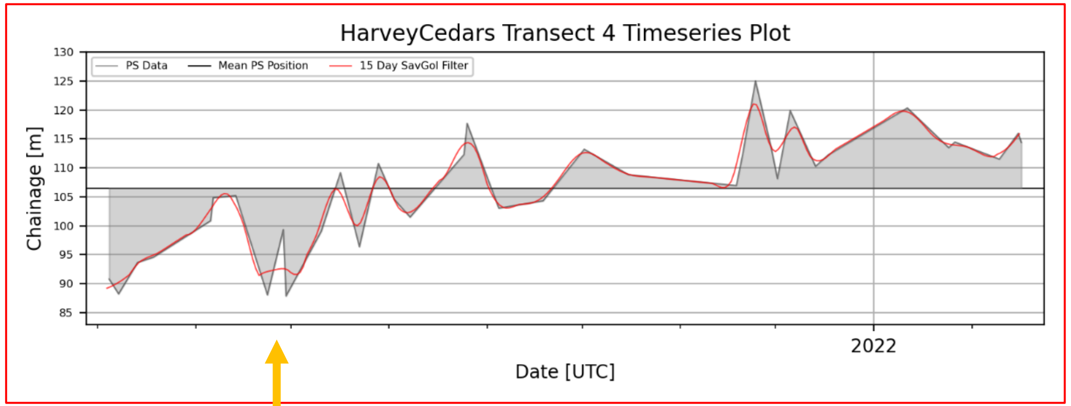
Nearshore Berm Placement

*McGill et al. 2022

Harvey Cedars, NJ

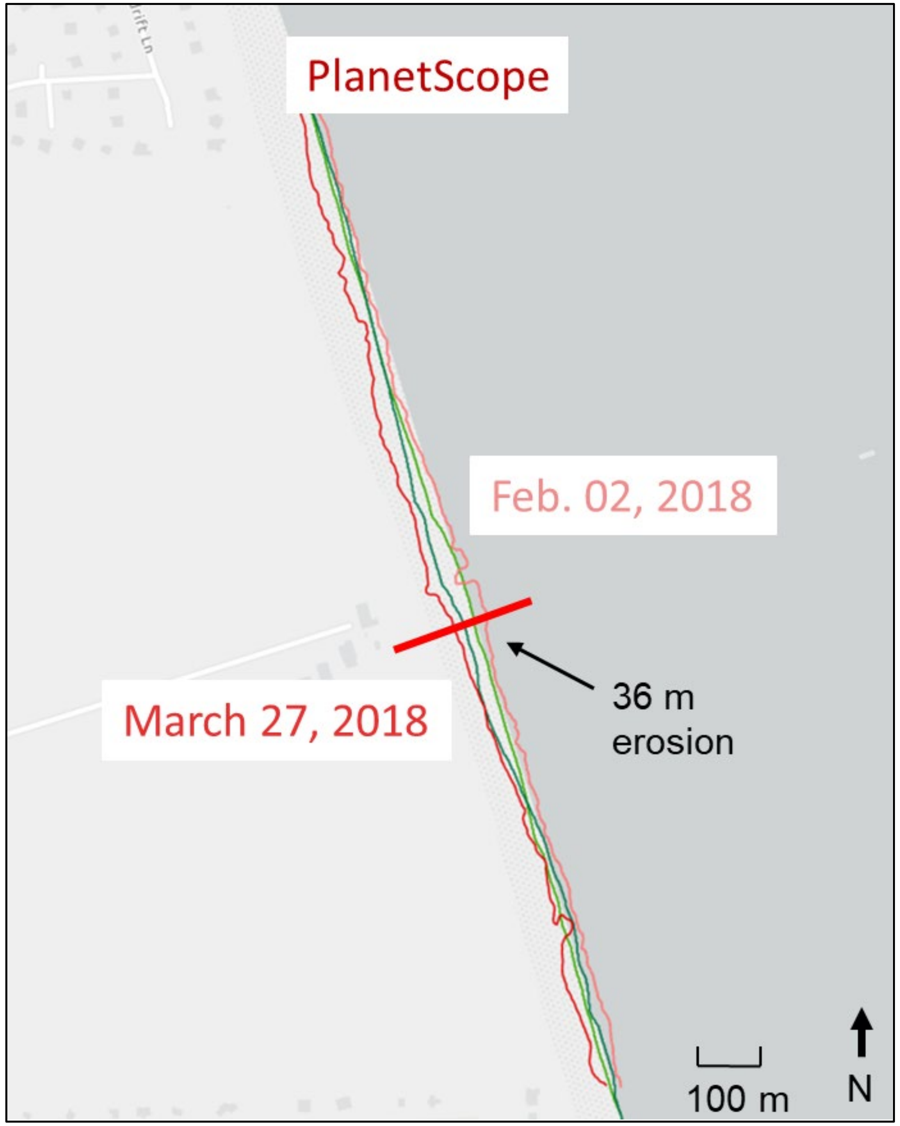




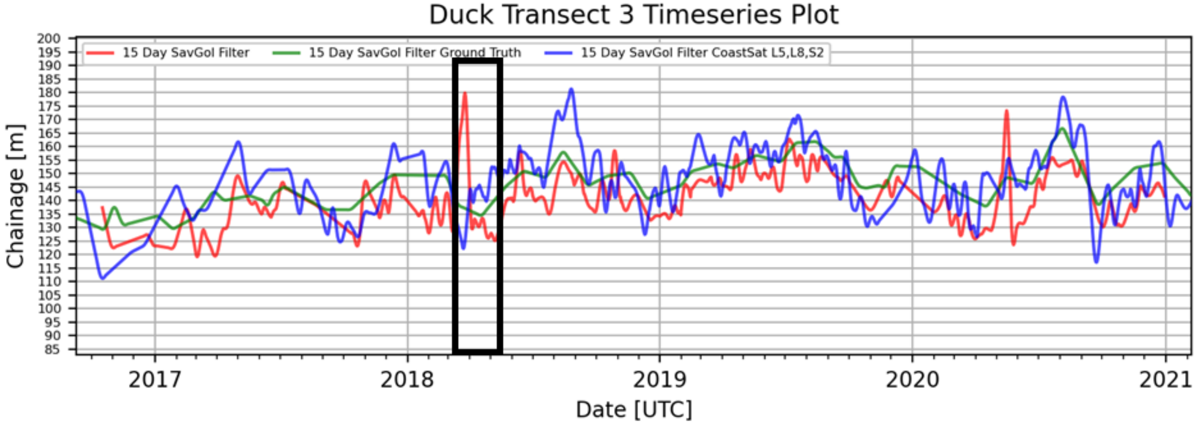


Nearshore Berm Placement

*McGill et al. 2022

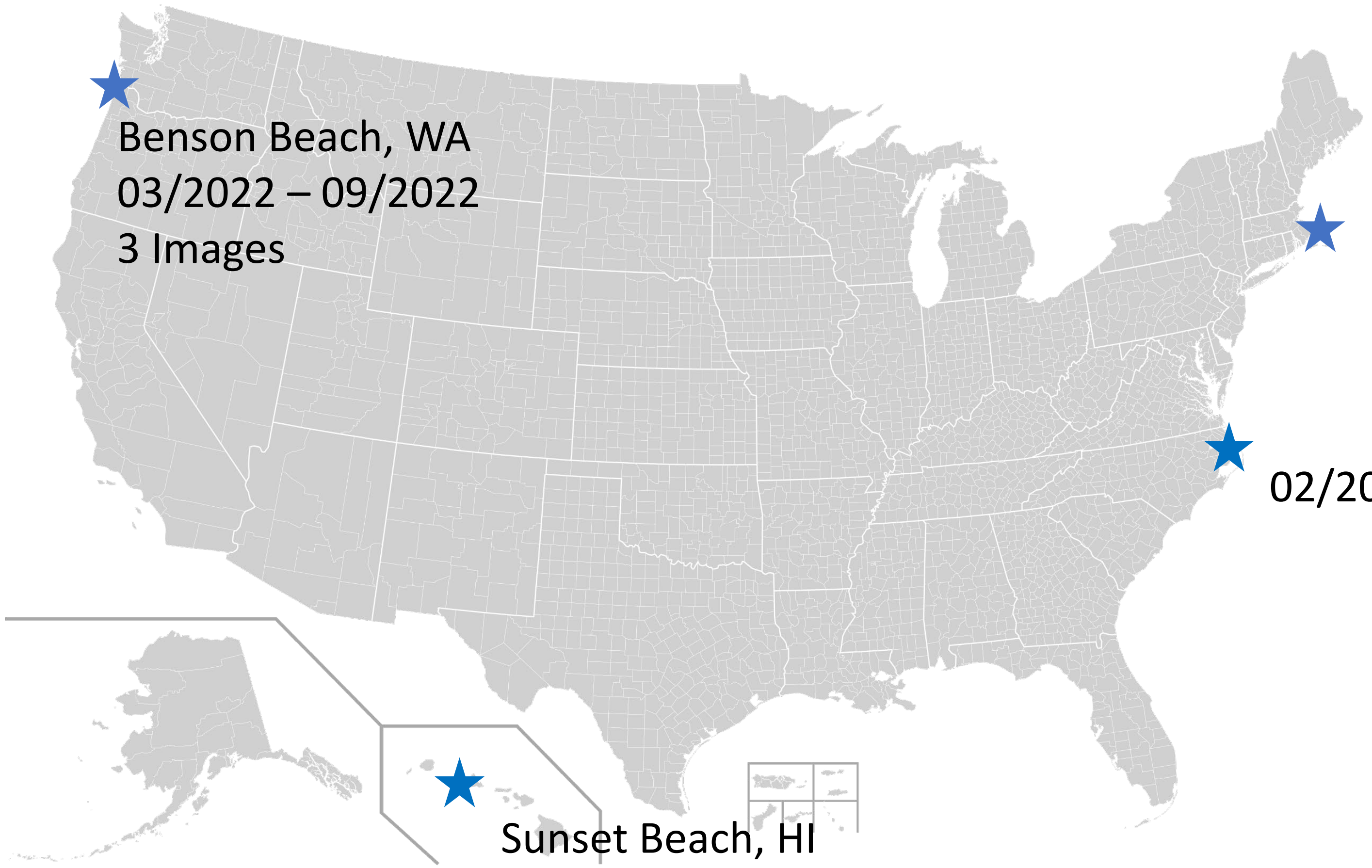


Duck, NC
Nor'Easter March 4, 2018

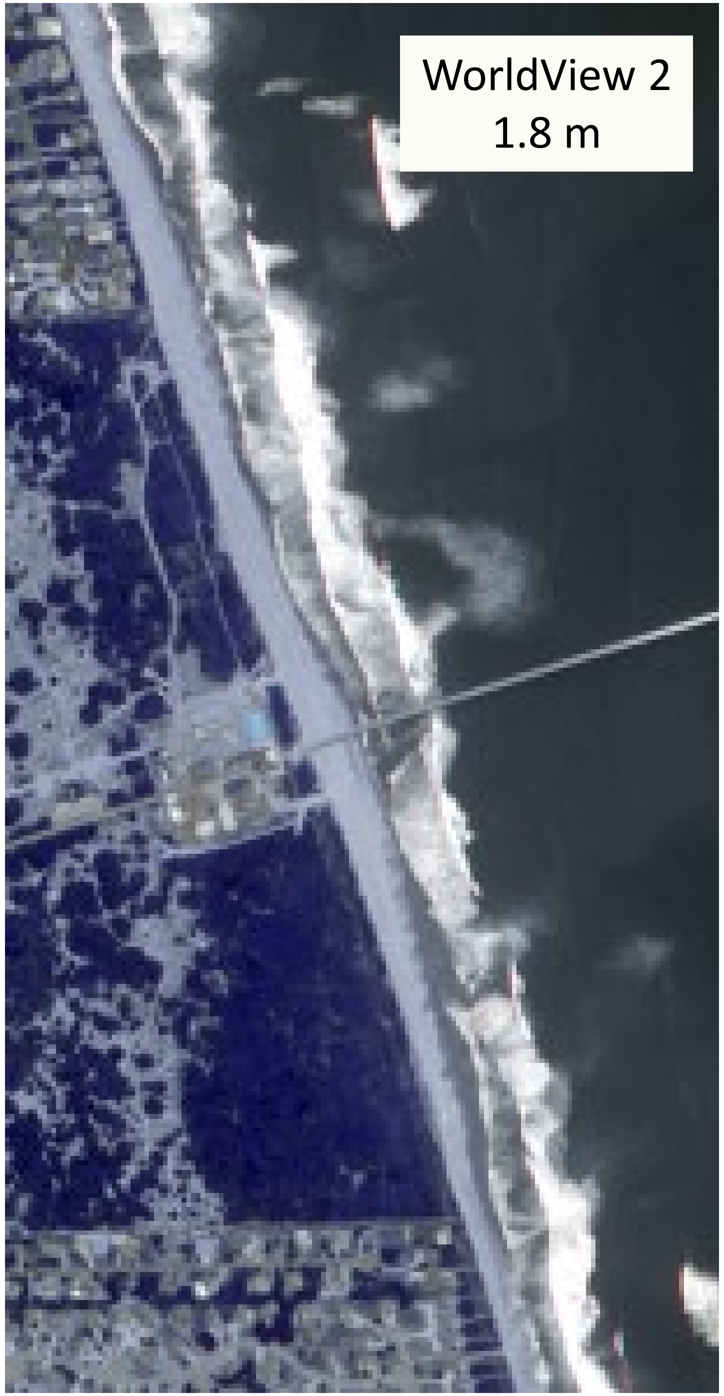


https://www.wral.com/nor-easter-leaves-some-outer-banks-islands-inaccessible/17391444/

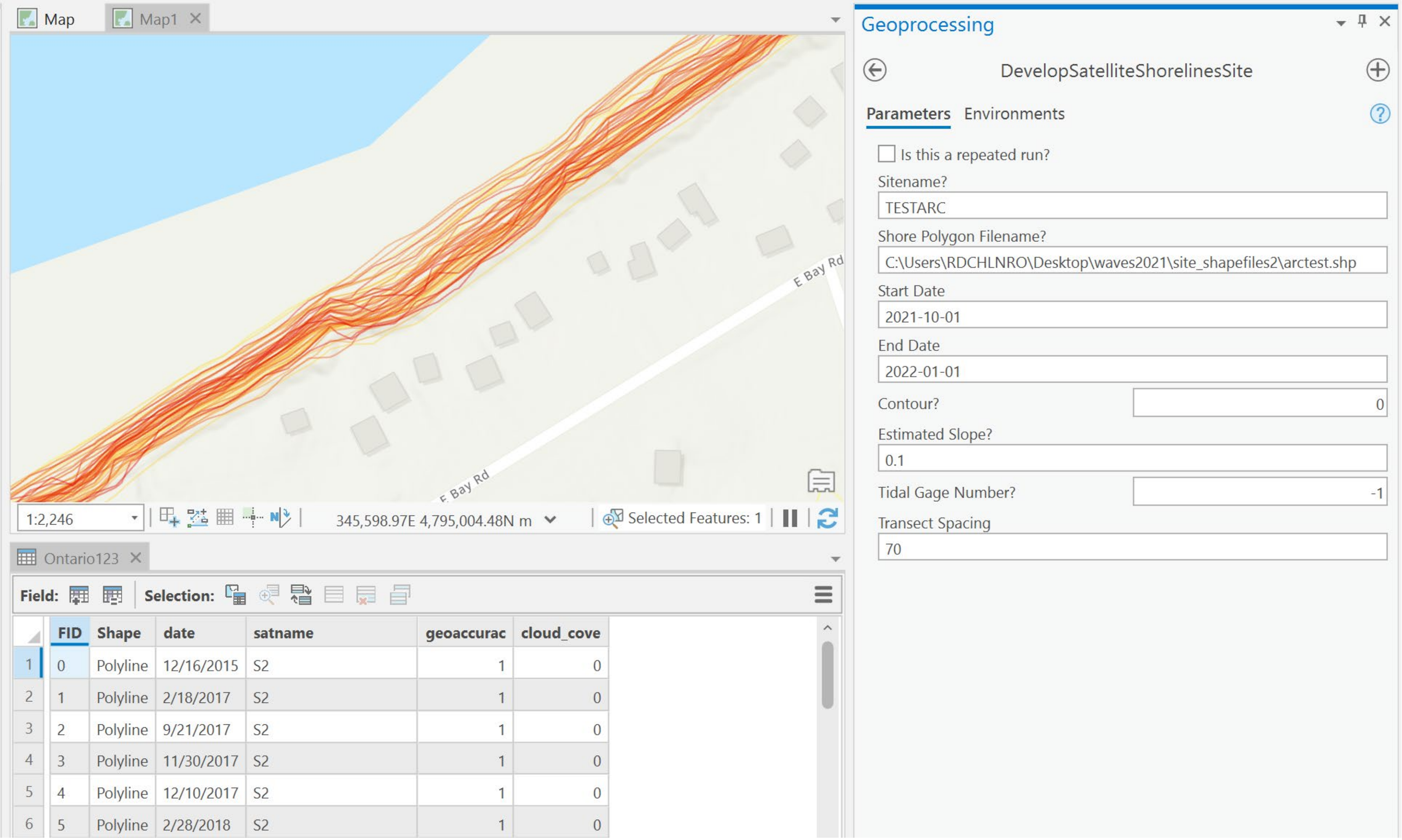
Maxar Sites



***Free to Districts with justification**

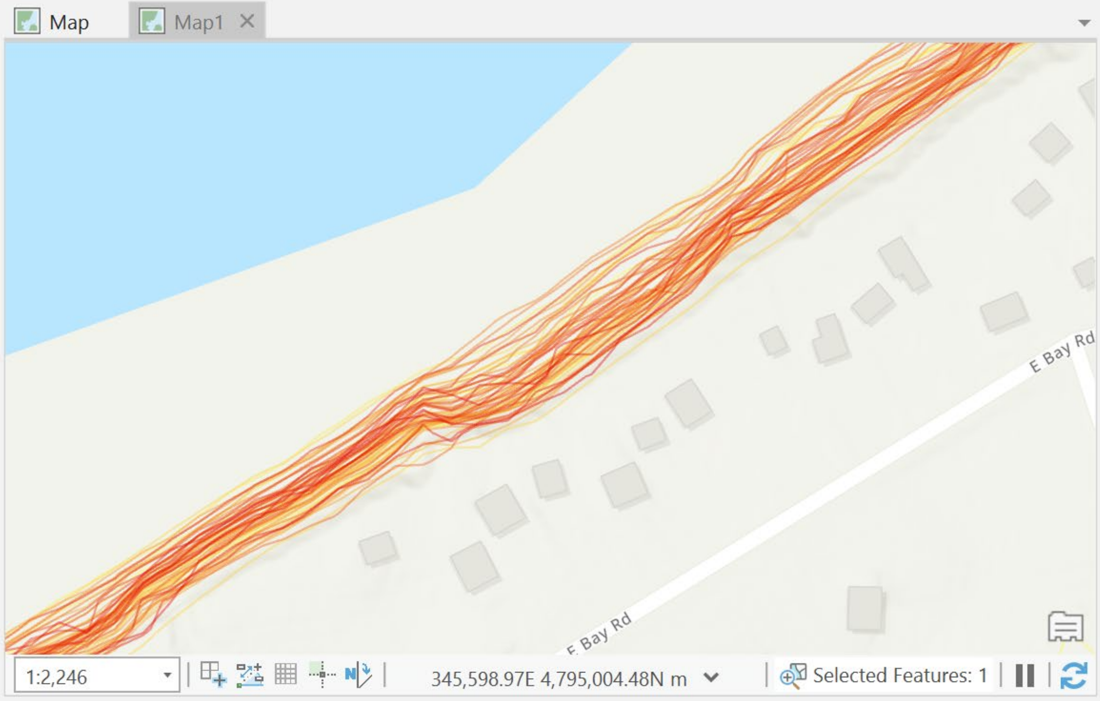


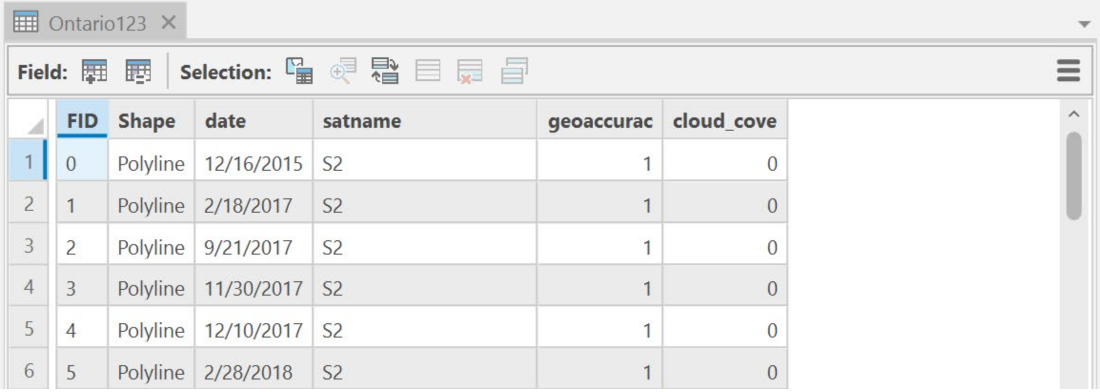
Tool Development and Analysis Products



- Beta tool version
- M. Forte Arc
- User manual
- District Training Webinar in summer
- Potential to incorporate PlanetScope and Maxar in future

Tool Development and Analysis Products





	FID	Shape	date	satname	geoaccurac	cloud_cove
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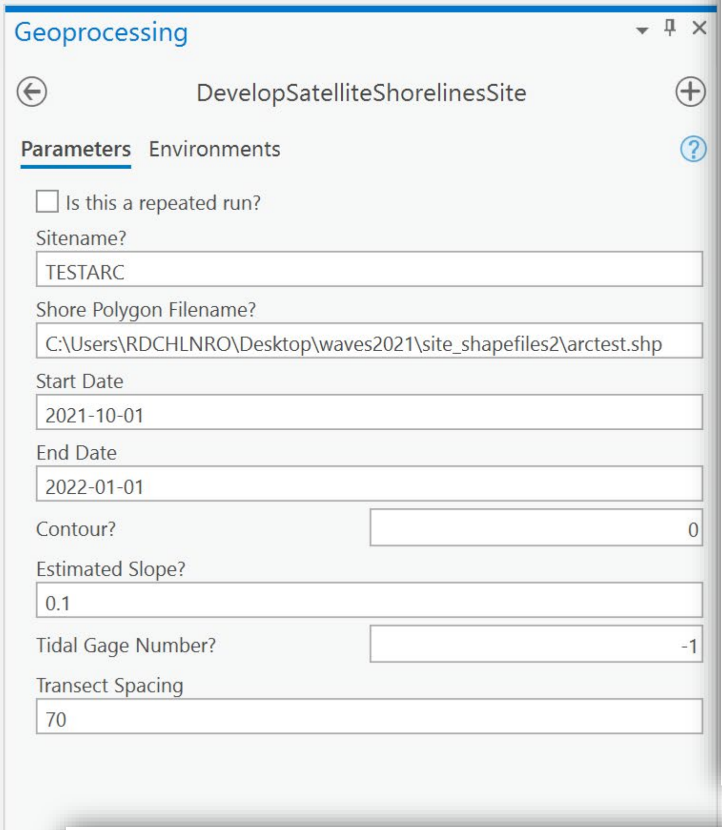
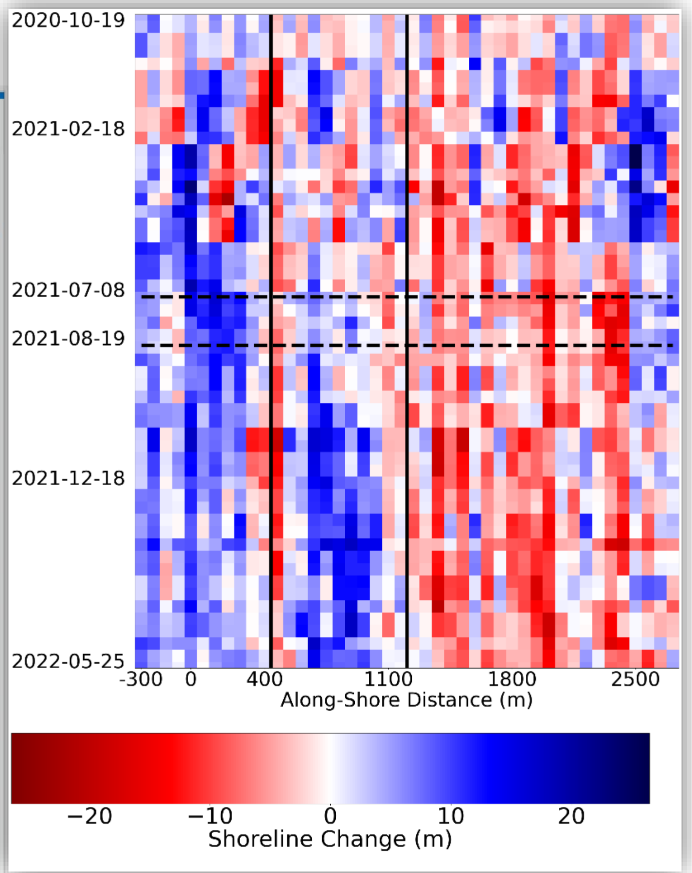
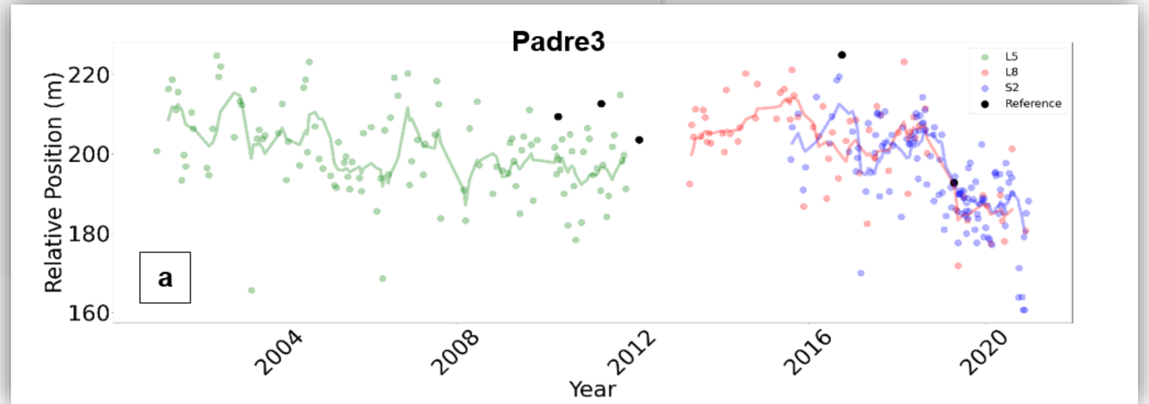
2	1	Polyline	2/18/2017	S2	1	0
3	2	Polyline	9/21/2017	S2	1	0
4	3	Polyline	11/30/2017	S2	1	0
5	4	Polyline	12/10/2017	S2	1	0
6	5	Polyline	2/28/2018	S2	1	0







* Open to suggestions!

Lake Ontario Shoreline Mapping – Detroit District

- Great Lakes Coastal Resiliency Study
- ~700 miles
- 390 tiles

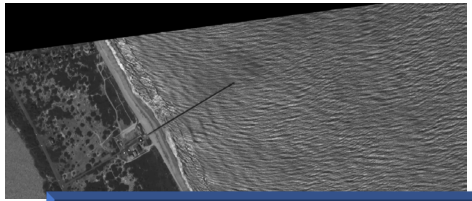
Summary

- CoastSat instantaneous differences from ground truth ranged from 4 to 20 m.
  - Overall mean of 11.32 m and slight onshore bias of -3.51 m.
- CoastSat-generated slopes produced similar accuracies as user-defined slopes.
- Decadal trends agree well with ground truth data. Provide much more context.
- Satellite-derived shorelines useful for free, high frequency project monitoring/design, feasibility studies, storm impact assessments, etc.
- Collaborations and exploration of other products crucial
- User-friendly ArcTool in development. Stay tuned for webinar.

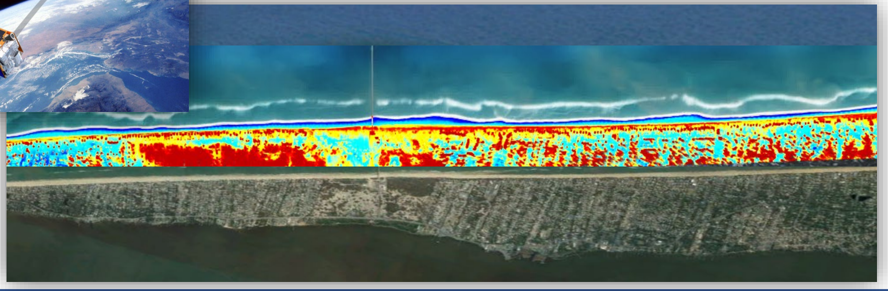
Integrated Coastal Observations

***Goal:* layered technology to monitor USACE coastal project sites continuously ensuring timely information on coastal state is available, which enables:**

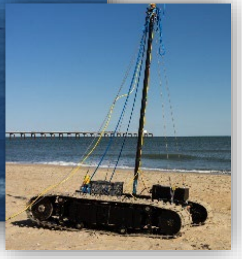
- Rapid Pre-Storm Risk Assessments
- Post-Storm Damage Assessments
- Adaptive Management Strategies



High revisit rate satellite imagery for national scale coastal project monitoring

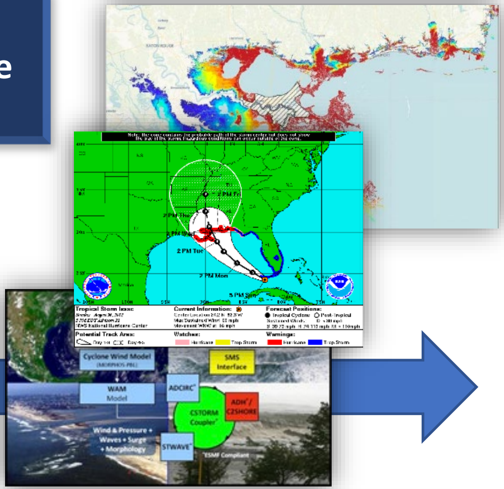


On-site Rapid Detailed Pre-Storm Survey



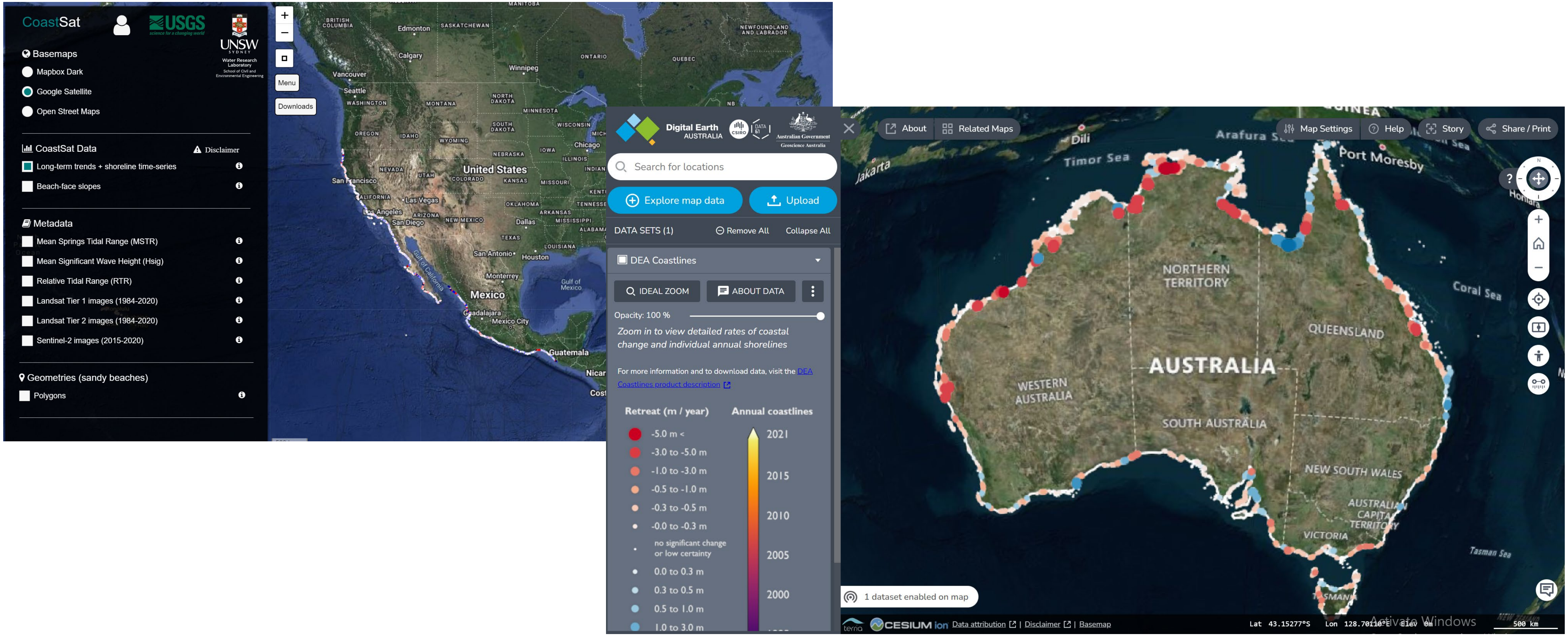
Continuous detailed monitoring from CorpsCam at high priority sites

In-situ network of buoys & unmanned systems to measure waves in critical locations



Integrated coastal "Now-State" observations are assimilated by ERDC Modeling tools for informed risk predictions with quantified uncertainty

Down the road…



- Next lofty goal: full, scale, automated, national implementation Comprehensive Water Risk Management SFA

Group Discussion

- What analysis products would help you and your projects?
- What time scales are you interested in? Short-term or historical trends?
- Any other Maxar users?
- What scale of error is acceptable?
- We need tool testers!

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