Evaluation of Synthetic Aperture Radar (SAR) for Shoreline Extraction in Alaska

AK Geosummit, October 25th, 2023

Dr. Bindi Dave
TCarta Marine Canada
Senior Remote Sensing Scientist
bd@tcarta.com

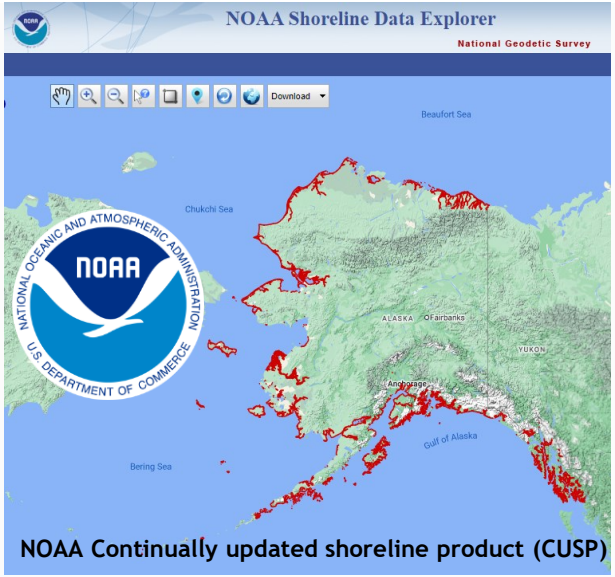
Natalie Treadwell
TCarta Marine LLC
Satellite Derived Bathymetrist
nt@tcarta.com

Collective goal: Map Alaska's 66,000 miles of coastline by 2030

Alaska Mapping Executive Committee (AMEC) published the Alaska Coastal Mapping Strategy Implementation Plan in June of 2022 with the following actionable step related to shoreline extraction:

"*The linear demarcation of the shoreline at different datums (e.g. Mean High Water, Mean Lower Low Water)... The focus of this [implementation plan] is on the coastal and nearshore areas that can be mapped with airborne and satellite remote sensing technology*"

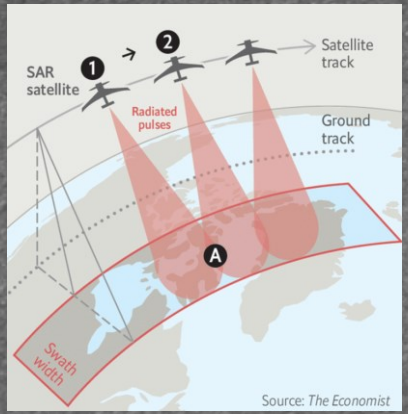
- Implementation plan for the Alaska Coastal Mapping Strategy



NOAA Continually updated shoreline product (CUSP)

Synthetic Aperture Radar (SAR)

Using a composite aperture approach, SAR satellites capture a microwave image, through all harsh weather conditions, creating a backscatter profile of the satellite swath. Through GIS applications, a clear delineation of the land water interface can be extracted from SAR imagery.



Applications of SAR data in Coastal Studies

- Coastal Features Classification
- HWL, LWL, Shoreline Extraction
- Coastal Bathymetry
- Coastal inundation study
- Ocean wave parameters, ocean currents
- Wave pattern identification
- Oil Spills
- Ship detection
- Sea-Ice and permafrost studies..etc

Capella Space

UAF
ALASKA SATELLITE FACILITY

Co-collected MSI & SAR - at Low Tide

Planetscope Image Date: 20 Aug 2022 (21:41 UTC)
Spatial resolution: 3 m , multi-spectral - 8 bands (R,G,B,NIR)
Tidal height (NOAA) at image acquisition time (predicted): 0.1m

Capella SAR Image Date: 21 Aug 2022 (21:17 UTC)
Spatial resolution: 1.5 m, Single band- HH polarization; Stripmap product
Tidal height (NOAA) at image acquisition time(predicted): 0.1m

Capella's Alaska Archives

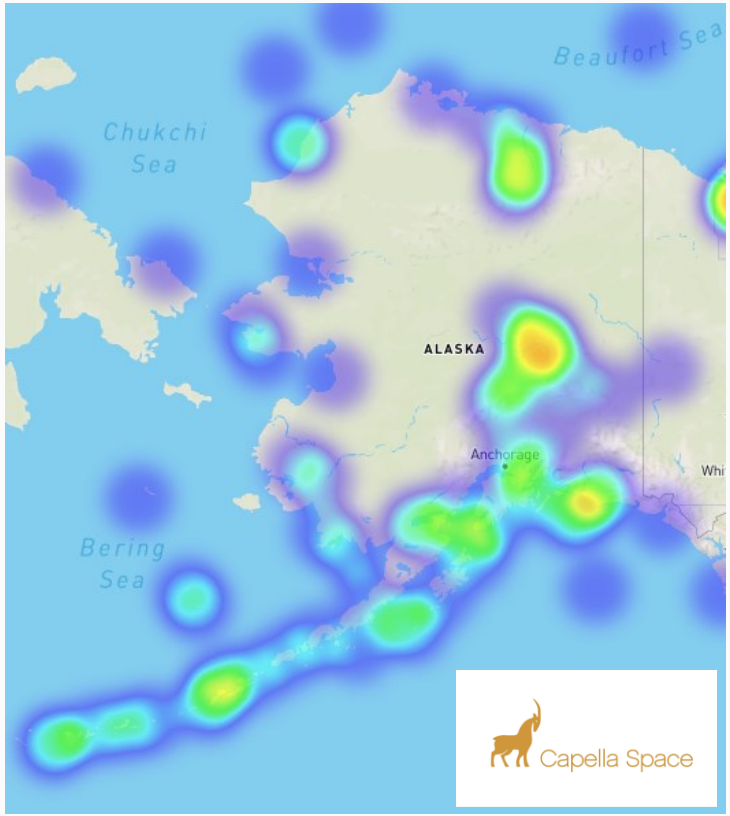


Figure 1: Nominal scene size of SAR imagery products for each imaging mode.

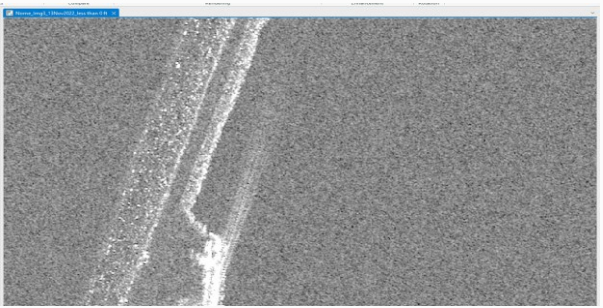
Image Product	Imaging Mode	Nominal Scene Size	# Of Looks	Azimuth Resolution	Ground Range Resolution	Pixel Spacing	Look Angle Range
Spot GEC/GEO	Spotlight	5 km x 5 km	9	0.5 m	0.4 m to 0.7 m	0.35 m	25° to 50°
Site GEC/GEO	Sliding Spotlight	5 km x 10 km	5	1.0 m	0.7 m to 1.2 m	0.6 m	25° to 50°
Strip GEC/GEO	Stripmap	5 km x 20 km	1	1.2 m	1.1 m to 1.6 m	0.8 m	25° to 50°

Table 5: Specification of the standard geocoded ellipsoid corrected (GEC) and geocoded terrain corrected (GEO) image product types.

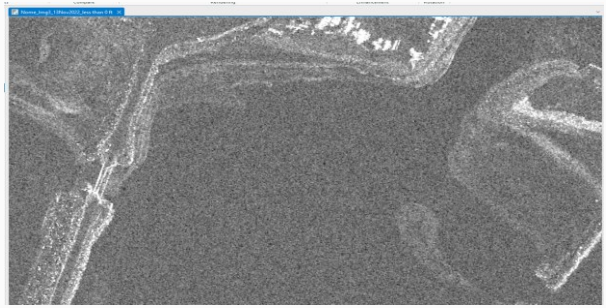
Approx. 3000 scenes available in Alaska

Shoreline Extraction in Nome, Alaska

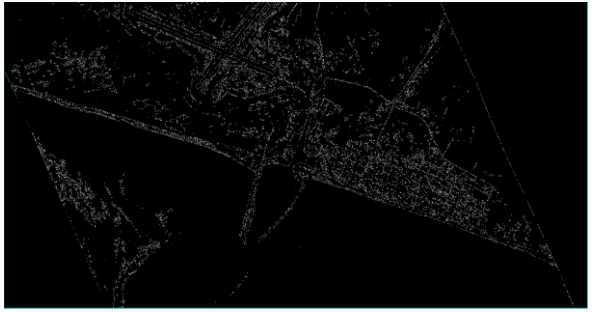
Before georef with OPUS gps points



After georef with OPUS gps points



Edge Extraction



Rough vs. Smoothed shoreline extraction

Final shoreline

Nome High Tide vs Low Tide

Nome- Shoreline extraction from Capella SAR "Single image " (sliding spot light - 0.6 m resolution)

Image Acq Date/time: 13 Nov 2022 / 9:20 pm utc
Tidal range : -1.11 to -1.12 ft

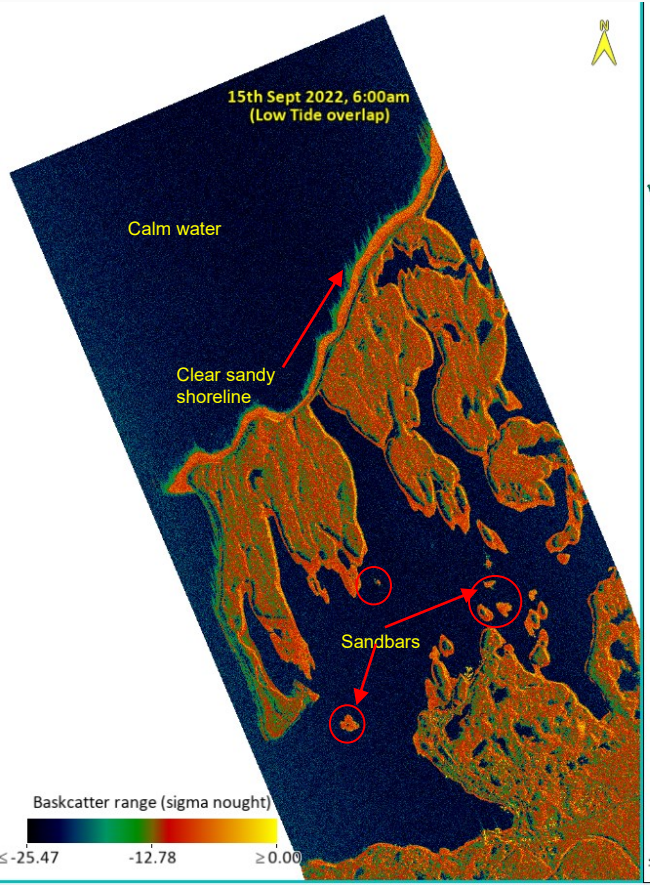
Image Acq Date/time: 28 Nov 2022 / 7:25 am utc
Tidal range : 2.12 to 2.09 ft

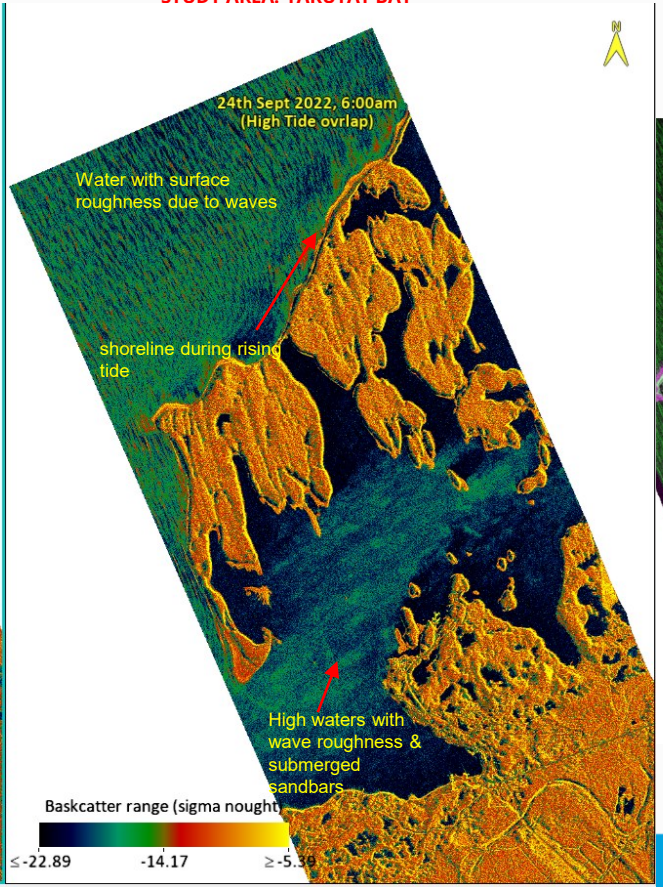
Both shorelines overlaid
Shoreline @ -1.11 to -1.12 ft
Shoreline @ 2.12 to 2.09 ft

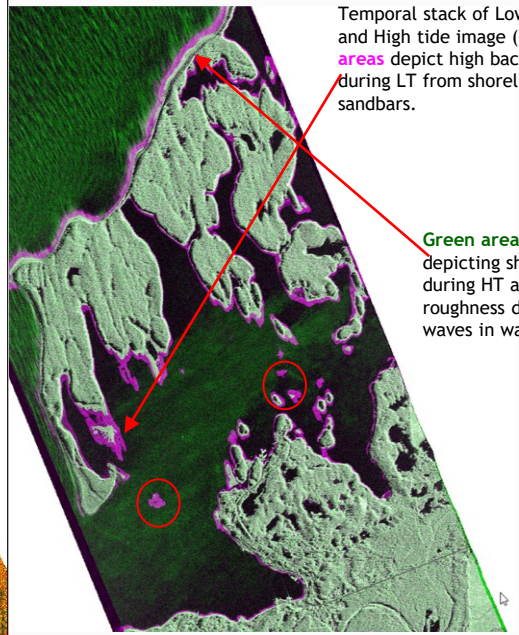
Synthetic Aperture Radar Shoreline Identification

Coastal Feature identification and Temporal changes in backscatter values(feature wise) during HT & LT

STUDY AREA: YAKUTAT BAY







Temporal stack of Low tide and High tide image (**Purple areas** depict high backscatter during LT from shoreline, and sandbars.

Green areas depicting shoreline during HT and surface roughness due to waves in water)

SAR vs. CUSP

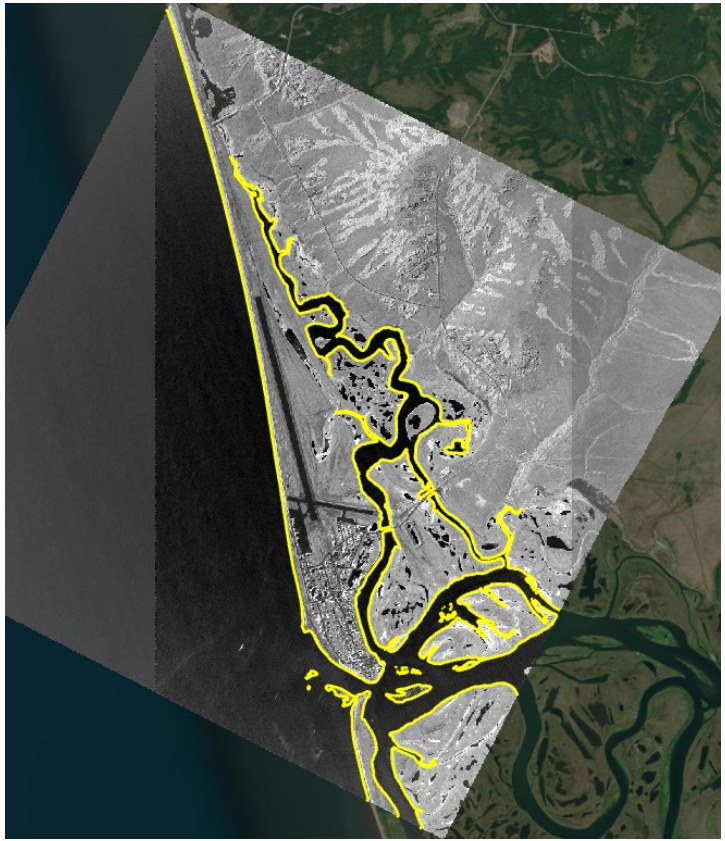
Study Area:
Unalakleet, Alaska

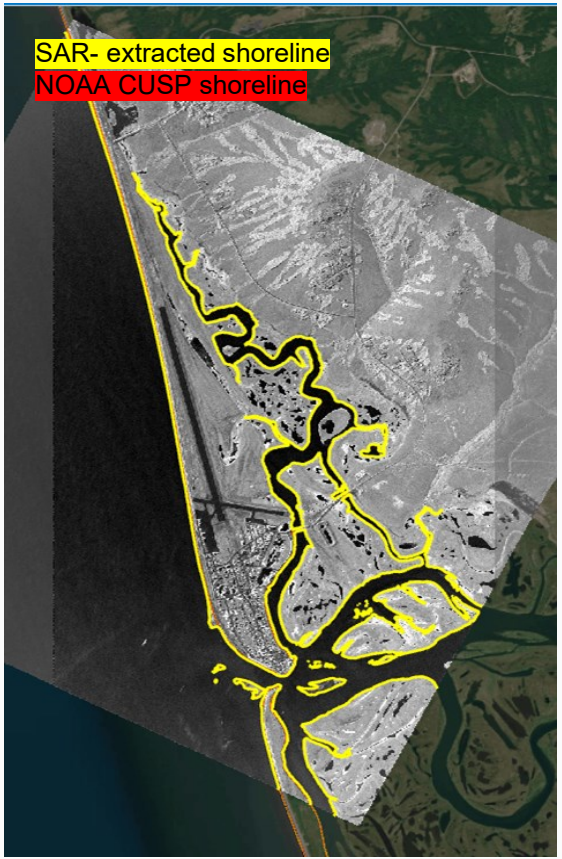
Date and Time of Image acquisition:

25 June 2022; 6:30 pm local time

Capella Image specifics:
HH polarization, Spotlight mode, 0.6m ground range spatial resolution

Tidal info:
0.9 ft (NOAA)



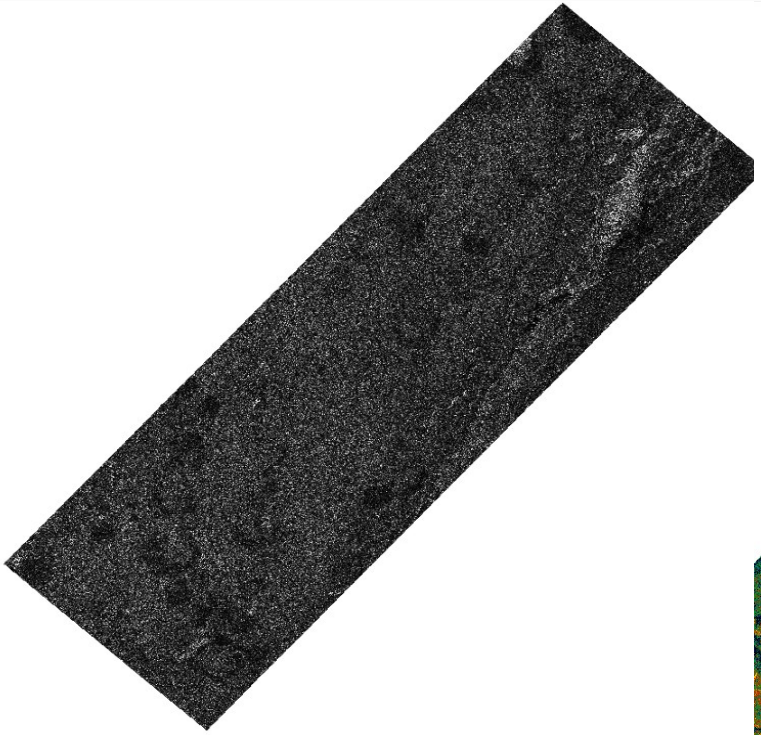


Identifying freeze and thaw signatures using SAR

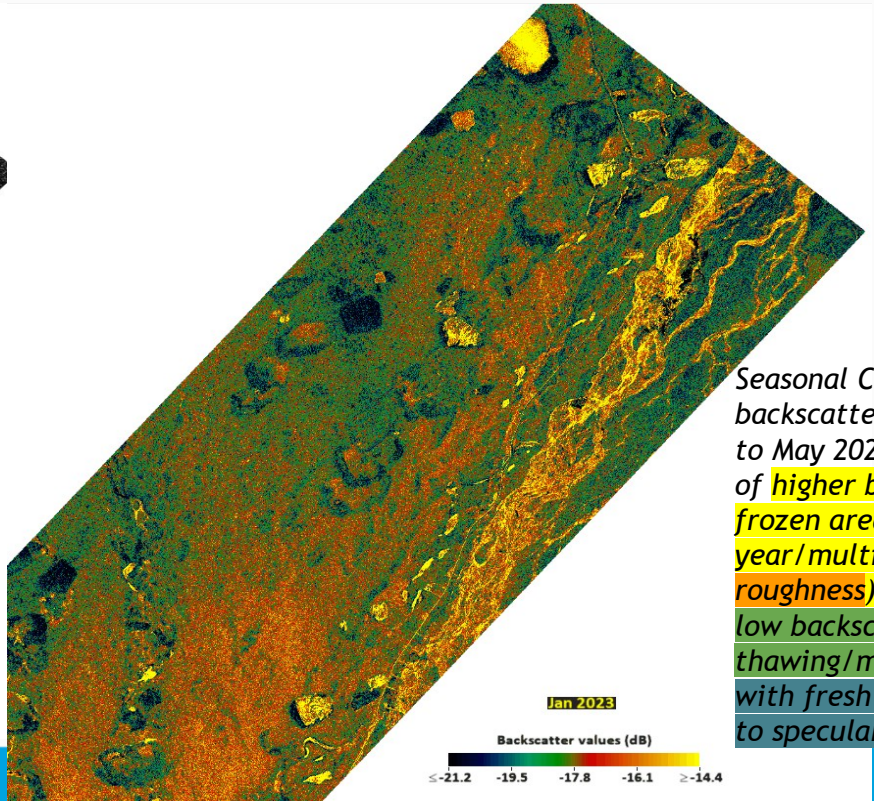
Deadhorse area (Sagavanirktok River)

Stripmap mode, VV polarization

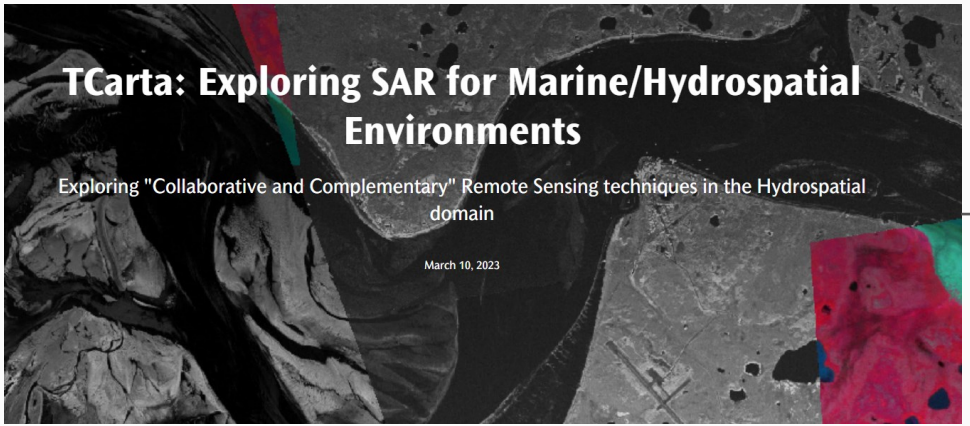
Dates (6 out 15 processed): 16 Jan 2023; 16 Feb 2023, 14 March 2023, 5 Apr 2023, 3 May 2023, 19 May 2023



16 Feb 2023 (VVpol): *Import/Scaled intensity image (dark image)* -> Gamma filter 5 -> gamma Filter 7x9, -> *bright filtered image (enhanced backscatter image)*



Seasonal Change in backscatter values from Jan to May 2023; also indicative of higher backscatter from frozen areas-first year/multi year ice(with roughness), sandy areas and low backscatter from thawing/moisture + areas with fresh smooth ice, due to specular reflection



Please direct inquiries to:

Bindi Dave
bd@tcarta.com

Natalie Treadwell
nt@tcarta.com