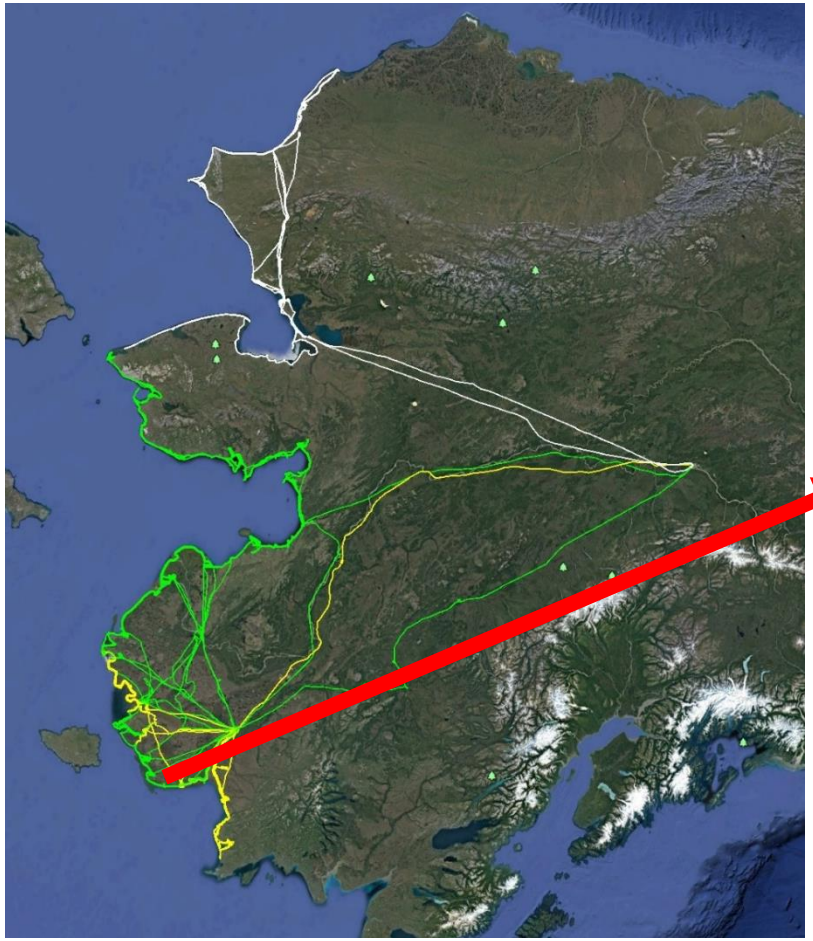
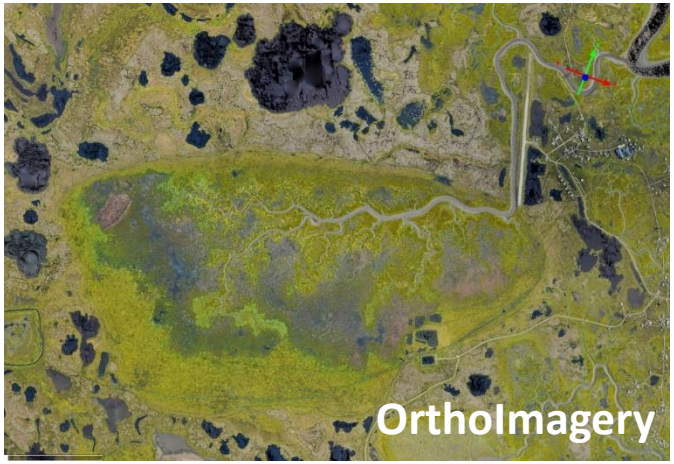
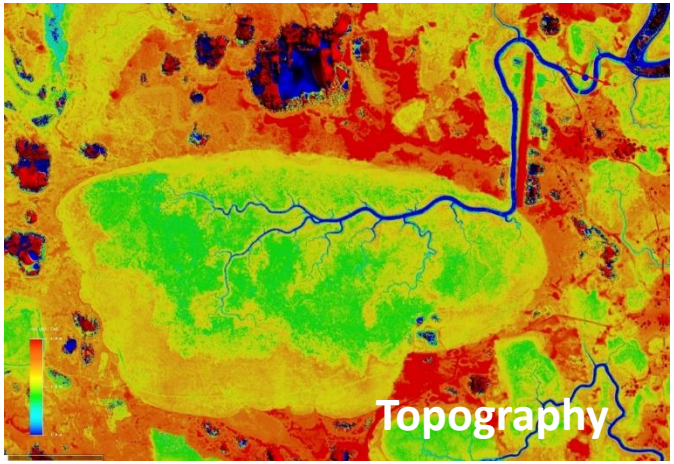
Two hundred billion pixels of digital coastal paradise: Mapping a mile wide swath of Alaska's west coast at 10-20 cm GSD with Fodar

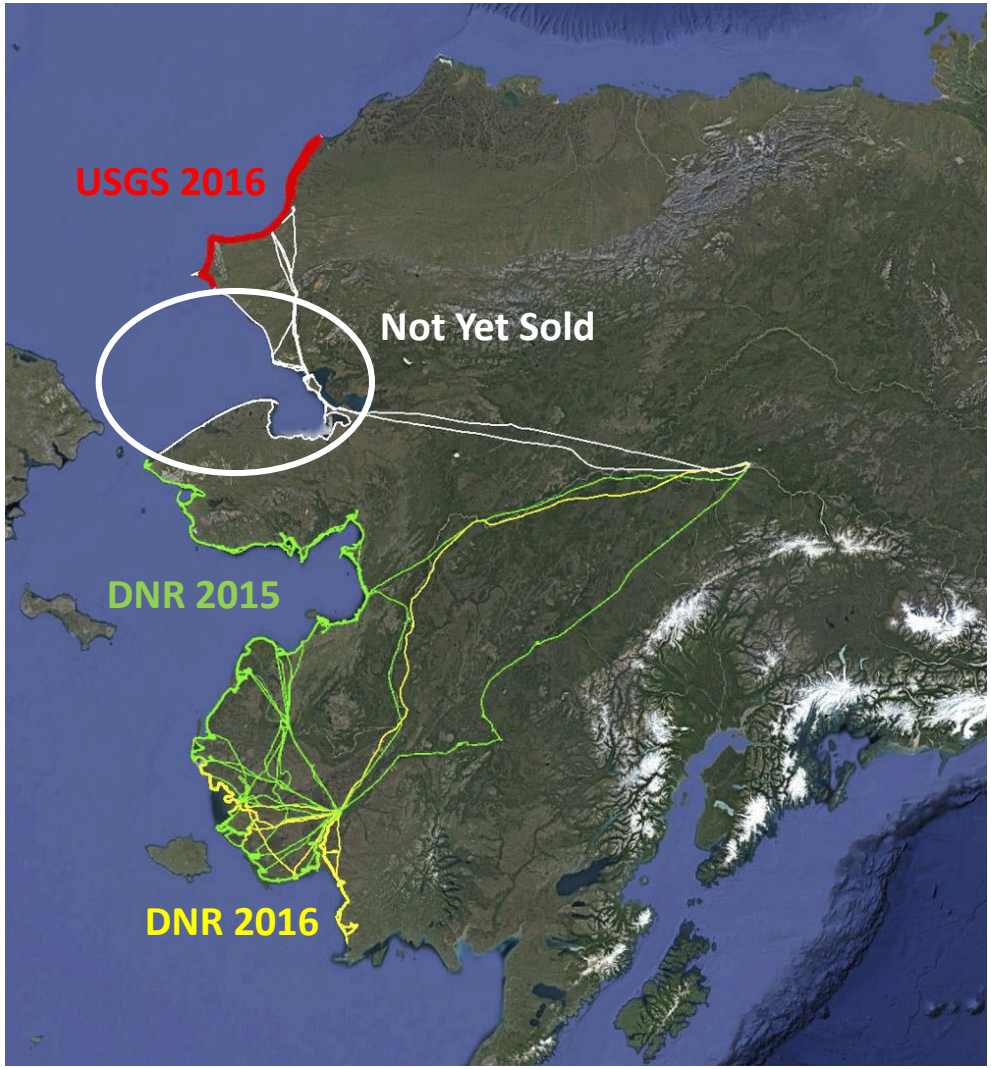
Matt Nolan
www.FairbanksFodar.com







Data Coverage Overview



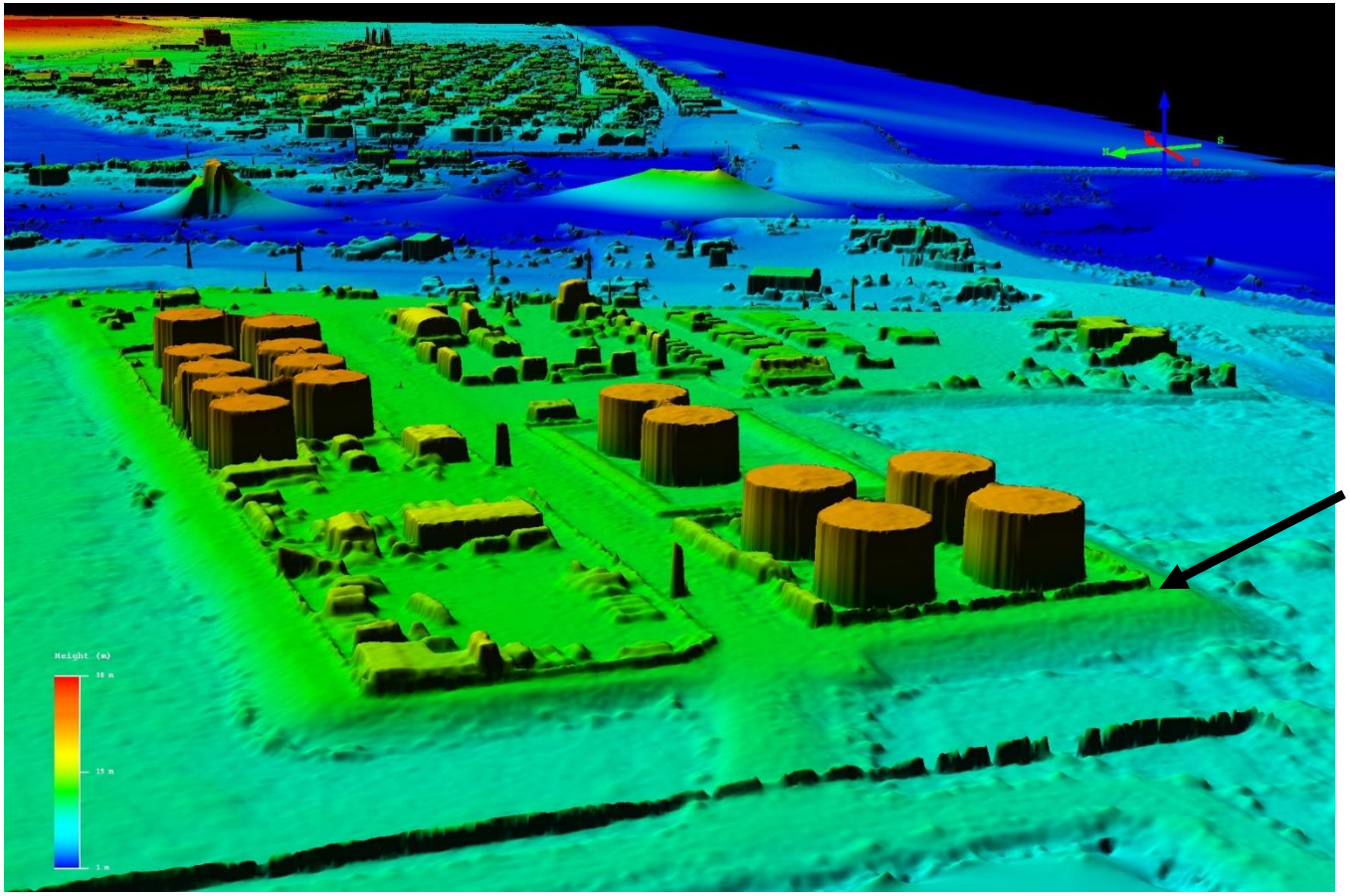
Fodar is a proprietary form of survey-grade SfM photogrammetry in development since 2010.

Fairbanks Fodar acquired ~2000 miles of coastline, to ~ 1 mile inland including 35 villages, at 10 - 20 cm GSD with an accuracy and precision of 10 - 20 cm @95%.

Sample Fodar Results

A primary goal for the data was to assess the vulnerability of coastal villages to storms and sea level rise and guide policy accordingly.

Sample Fodar Results



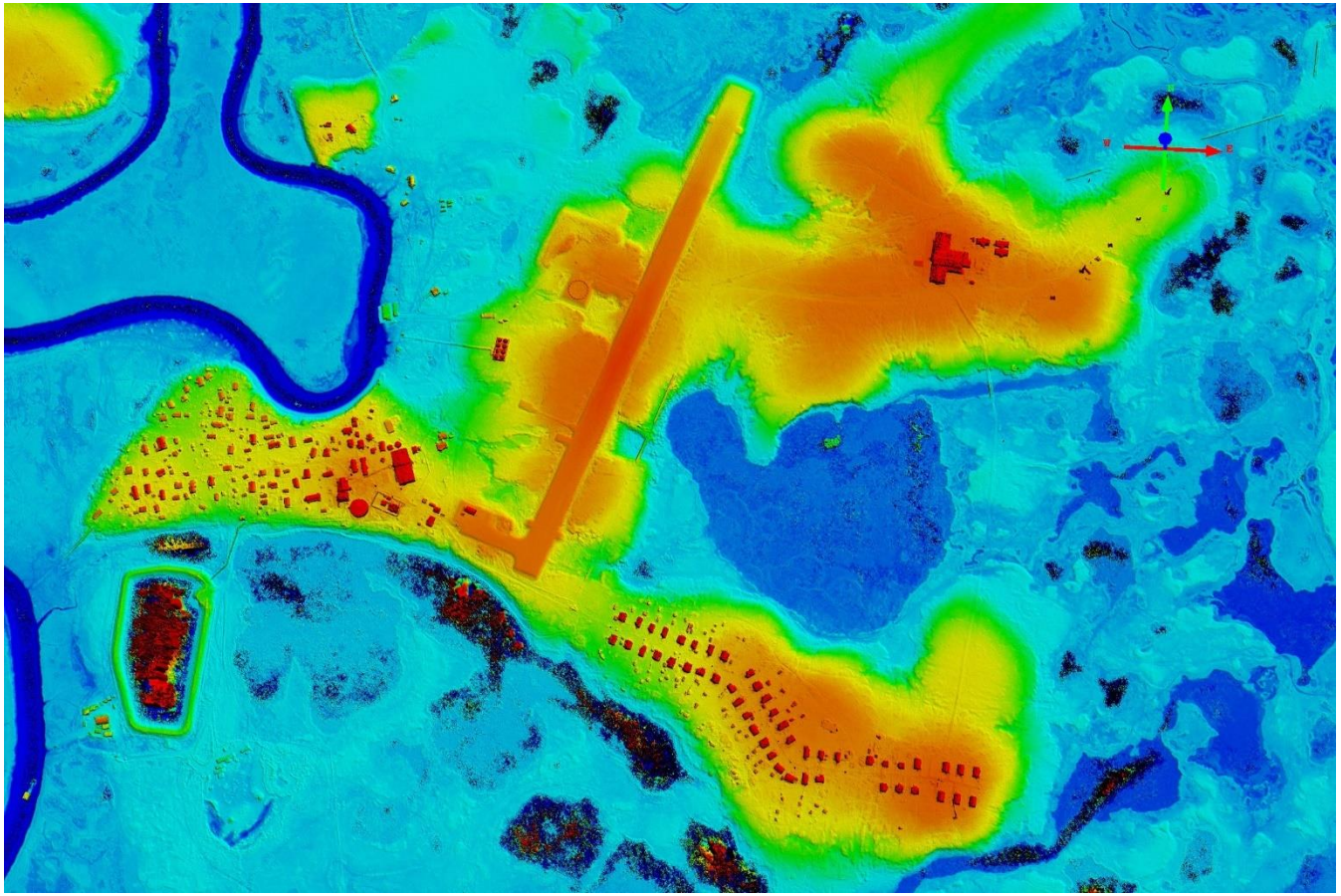
Is this embankment high enough?

These data are now being used by State and Federal stakeholders for exactly that purpose, as we've seen in this meeting.

Sample Fodar Results

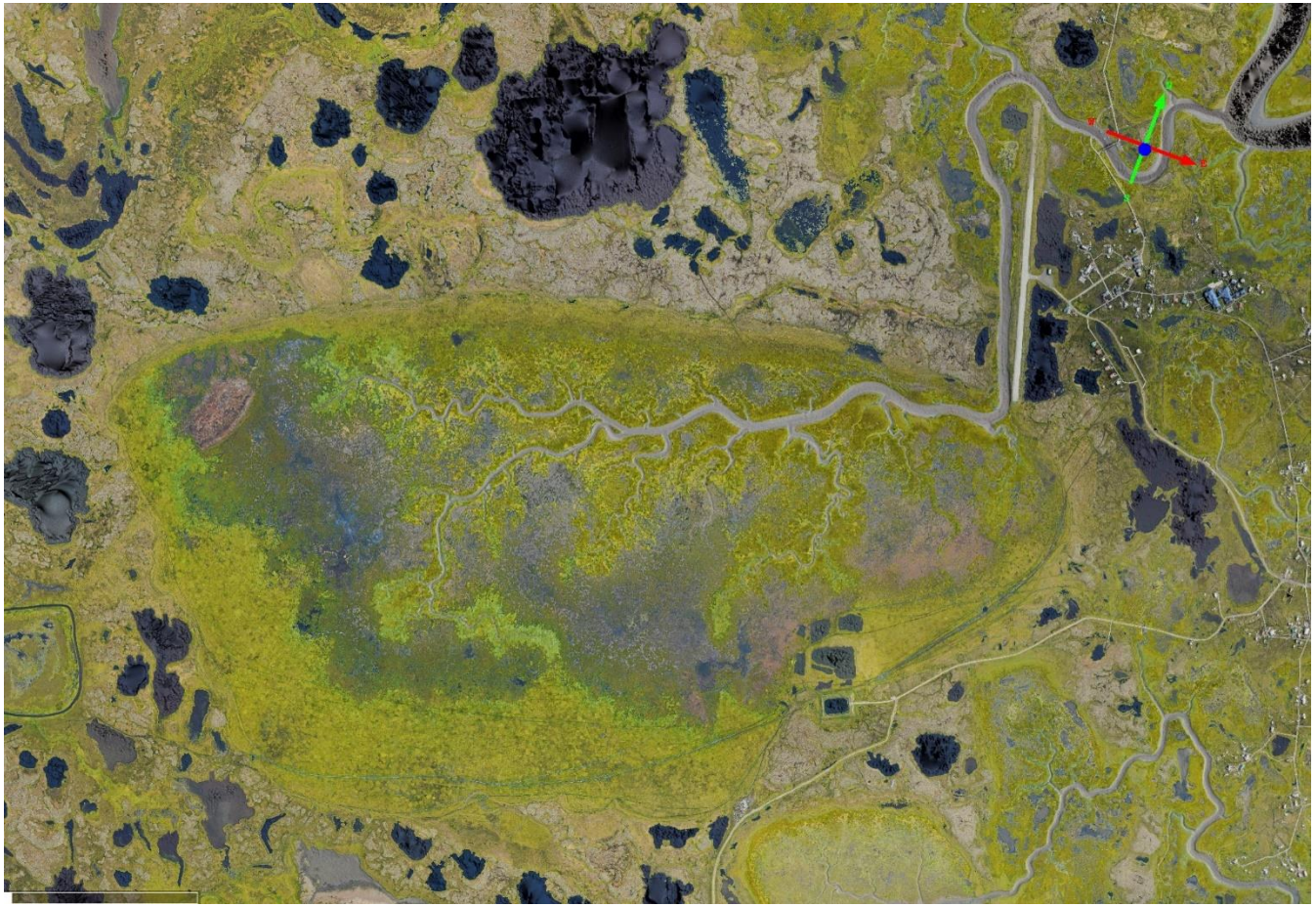
Kongiganak has a strange layout…

Sample Fodar Results



Kongiganak has a strange layout…
… until you realize its built on a island!
This is a serious problem for many villages.

Sample Fodar Results



This tidally-filled lake at Kwigillingok is an excellent example of the detail derived from fodar. Note the size of the lake compared to the size of the village (upper right)

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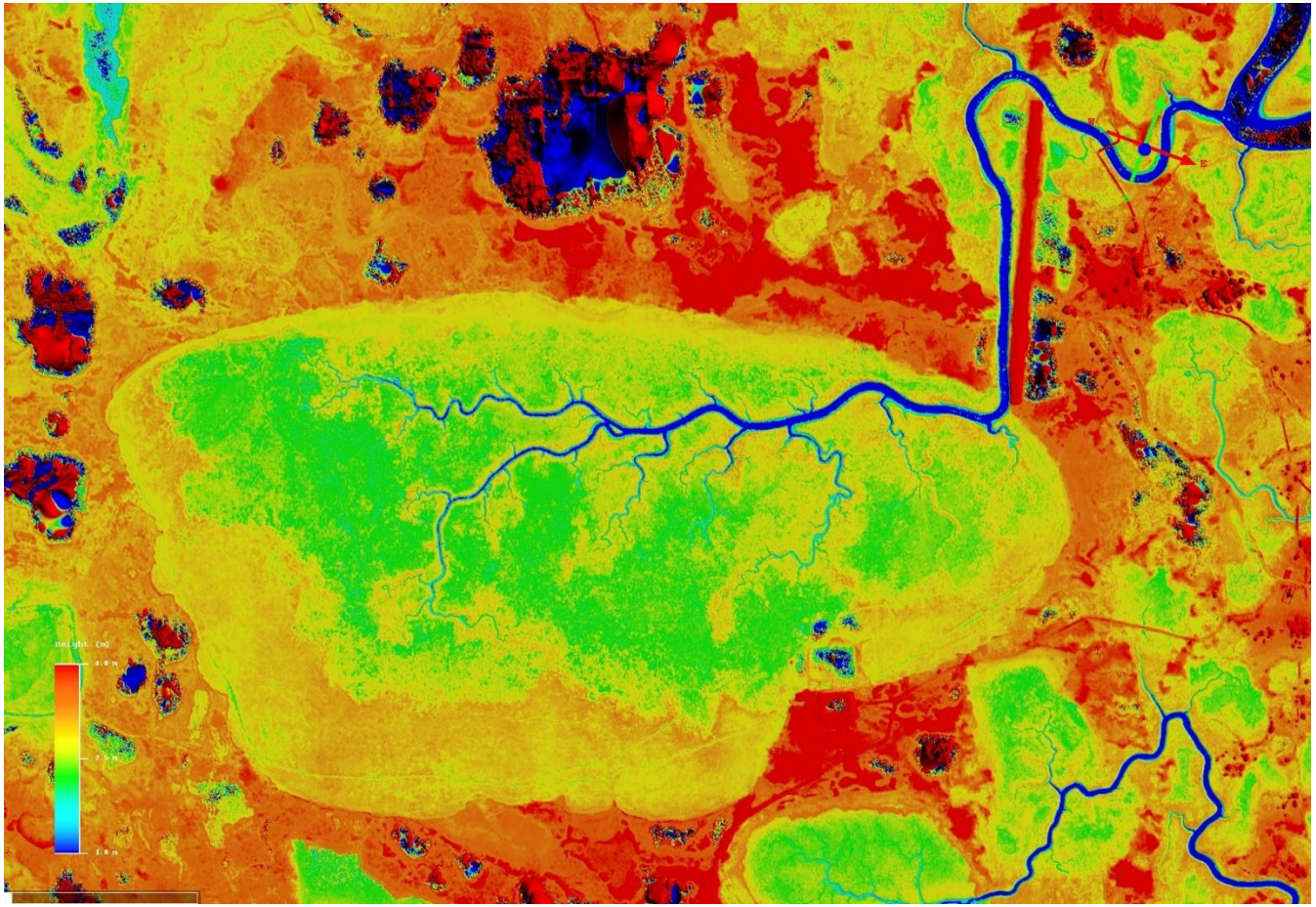

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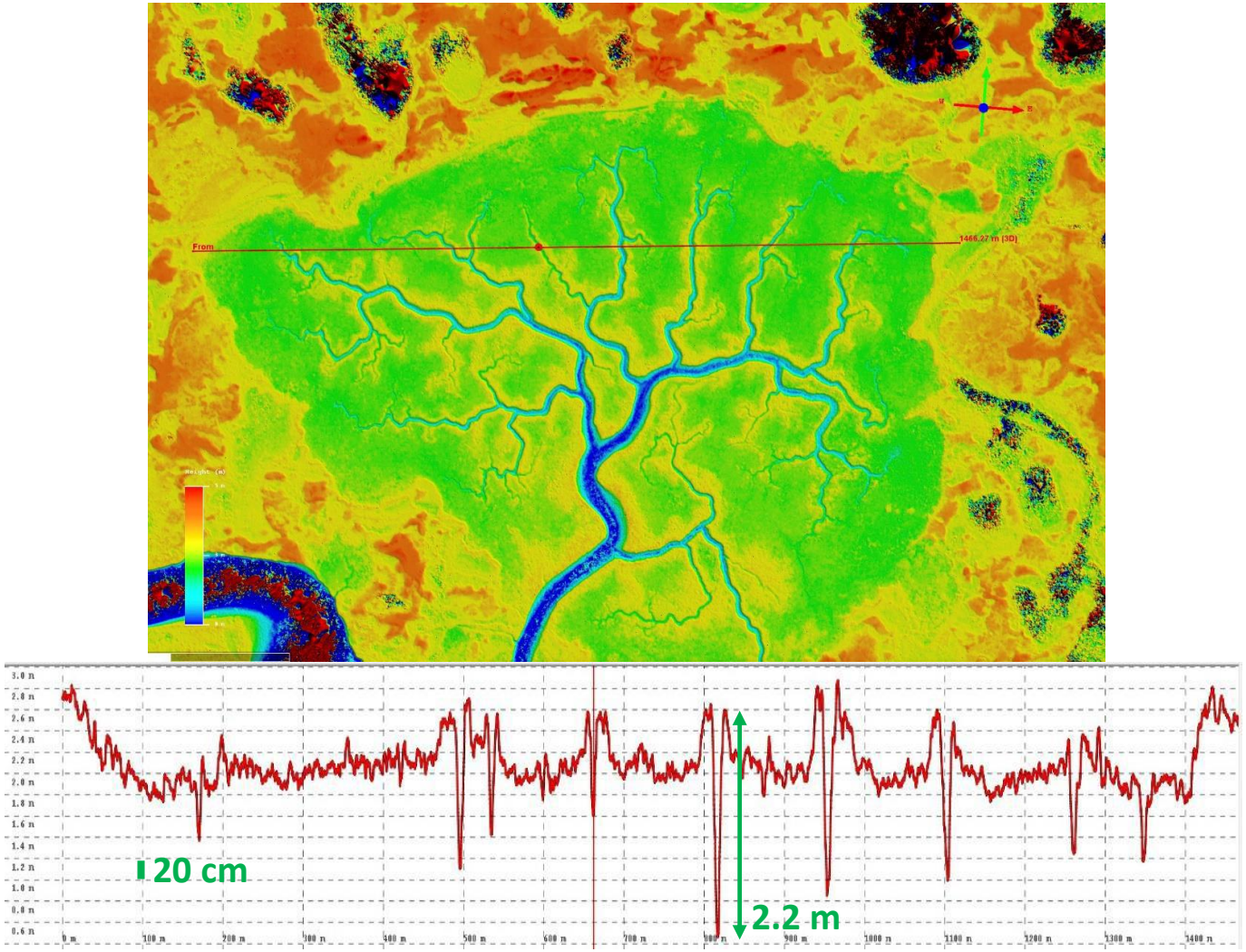
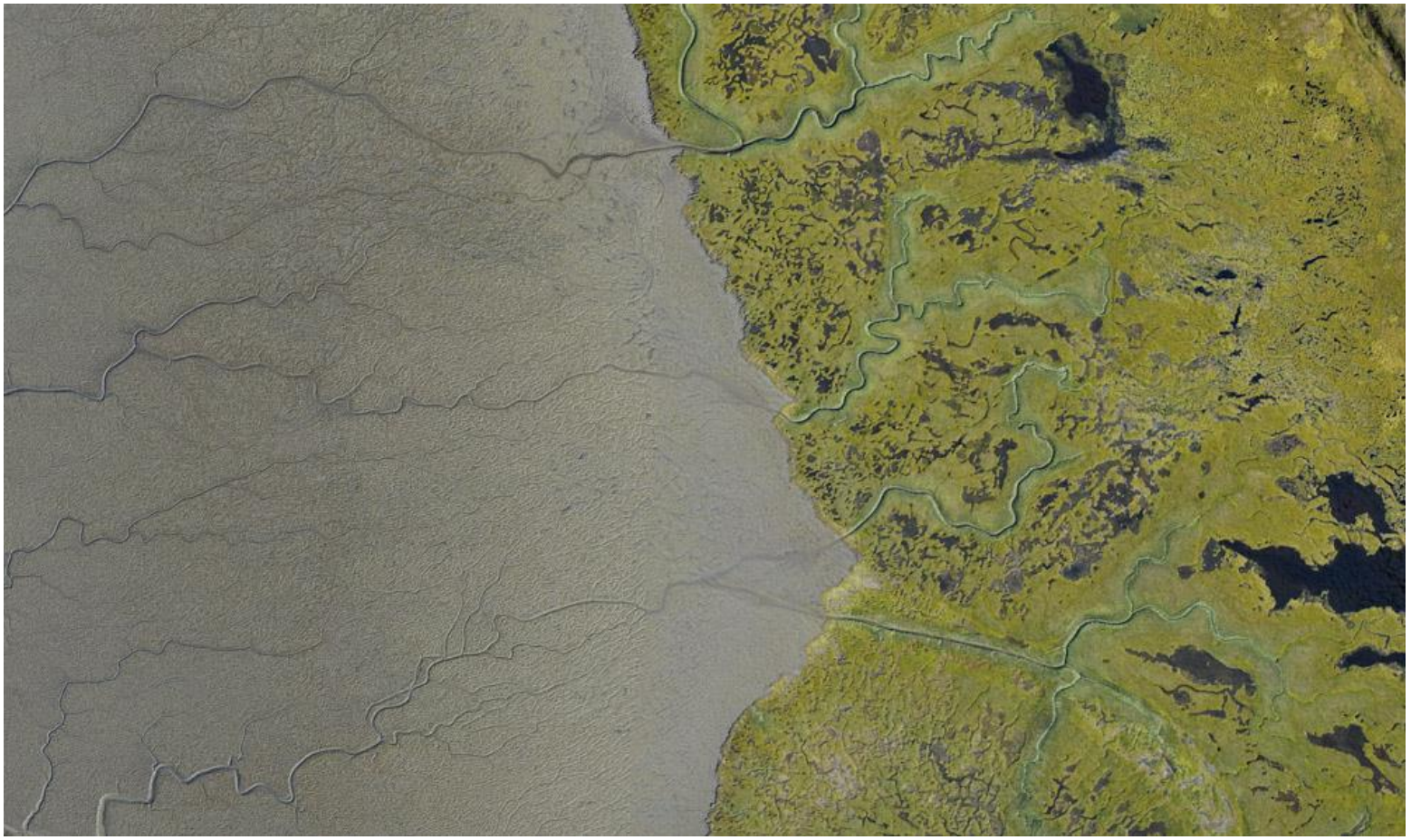


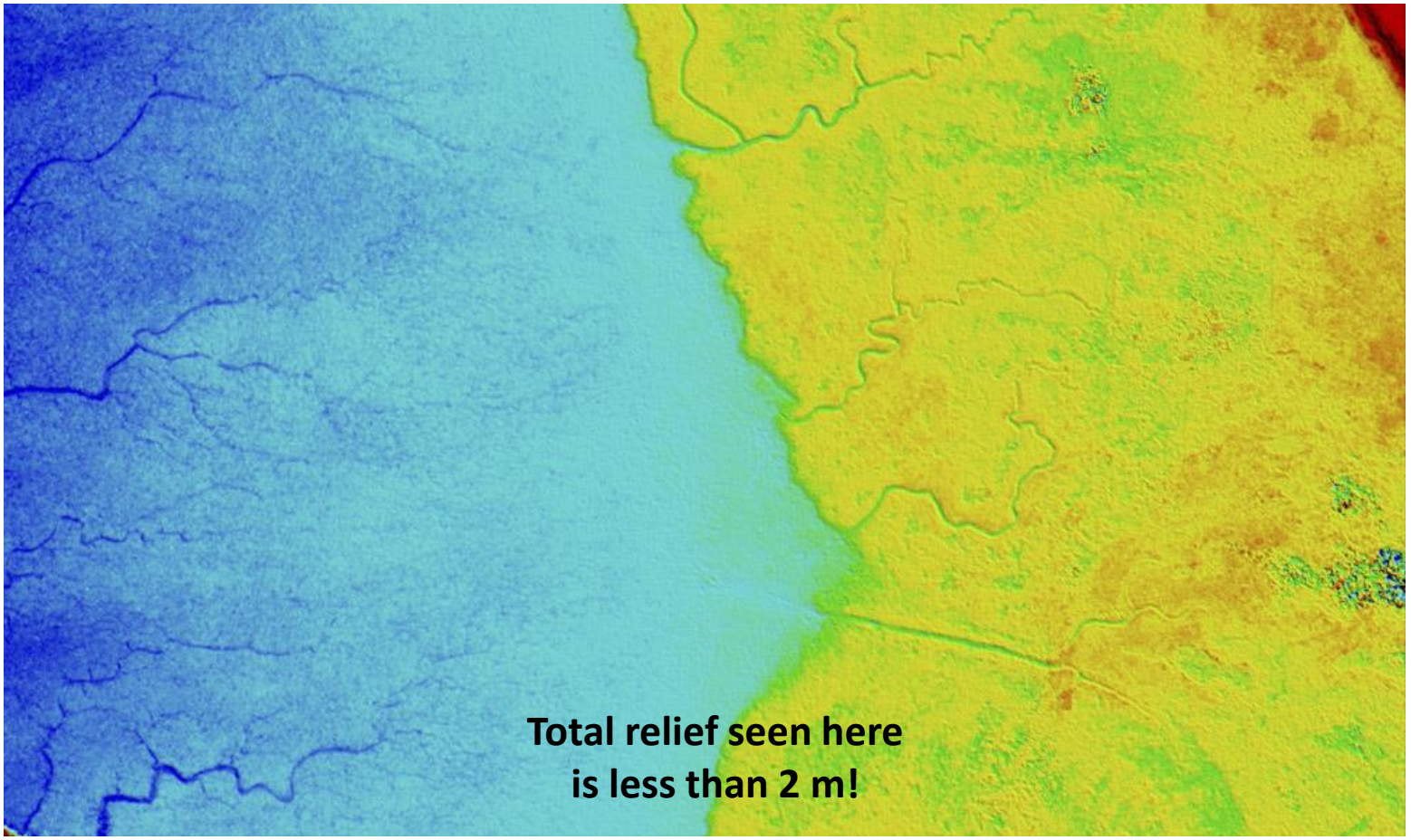
We can not only measure the depth of small stream channels, but the height of the vegetation growing along their edge.

Sample Fodar Results



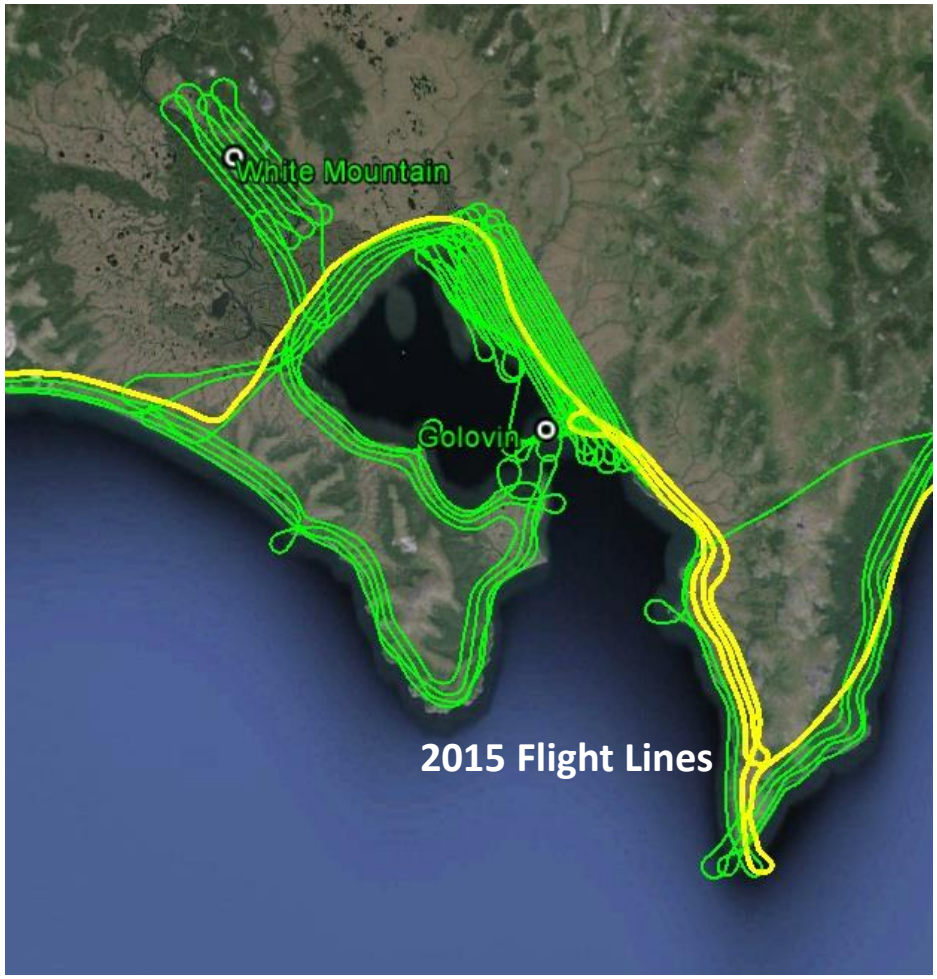
I acquired the entire coast with tide below MHW (and most of it below MLW I think).
That is, acquisition dates and times were pinned to the tide predictions.

Sample Fodar Results



I love mapping mud flats.

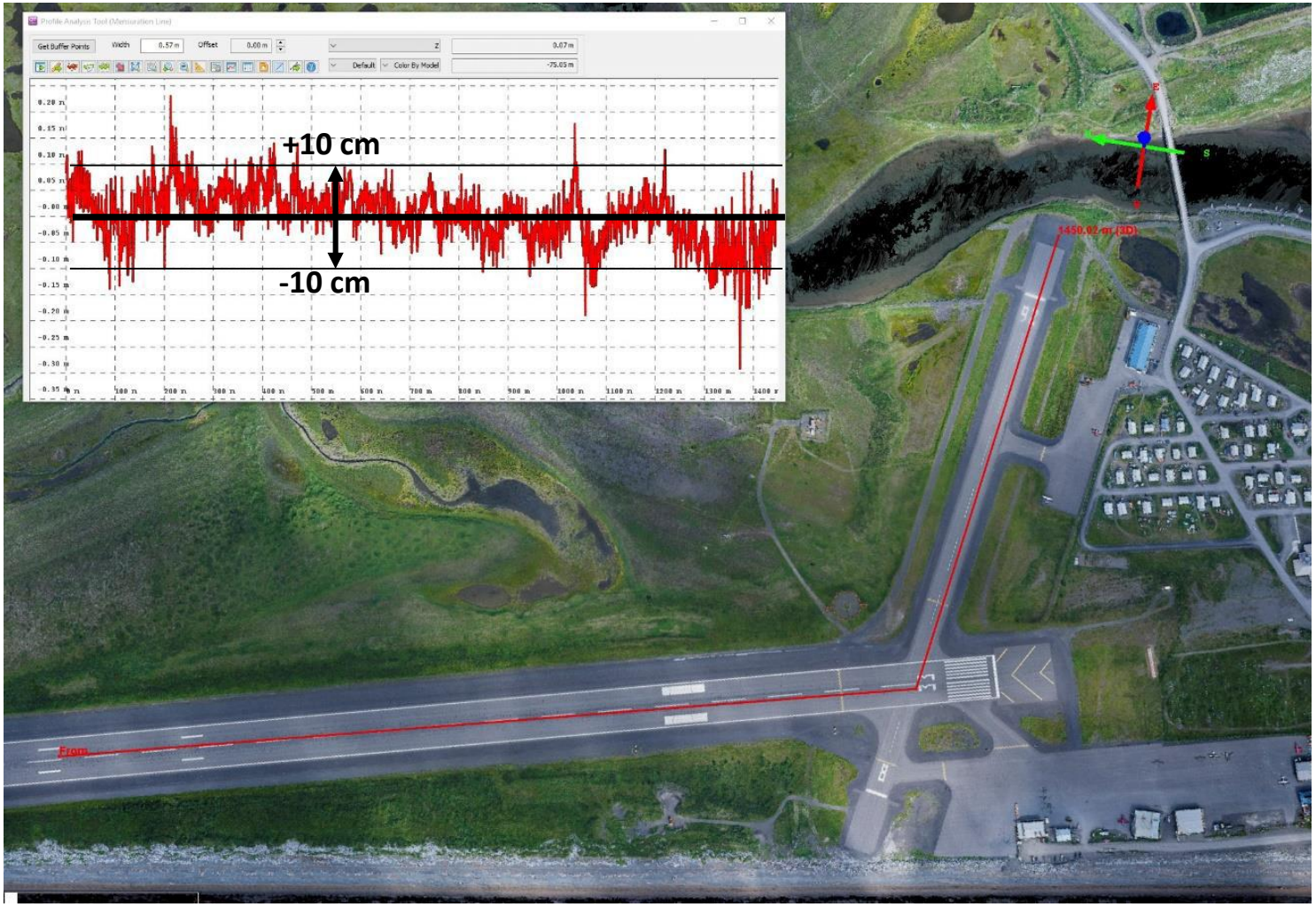
Methods



About 25,000 miles of flying, over 30 days in 3 campains.

Golovin Bay is beautiful. I'll offer deep discounts for more mapping there…

Data Validation



The best means of validating these huge raster data sets is by comparing to another. Here I assessed vertical precision by comparing fodar of Unalakleet from 2014 and 2015 and found that 95% of difference is less than 8 cm (~4 cm stdev).

Data Validation

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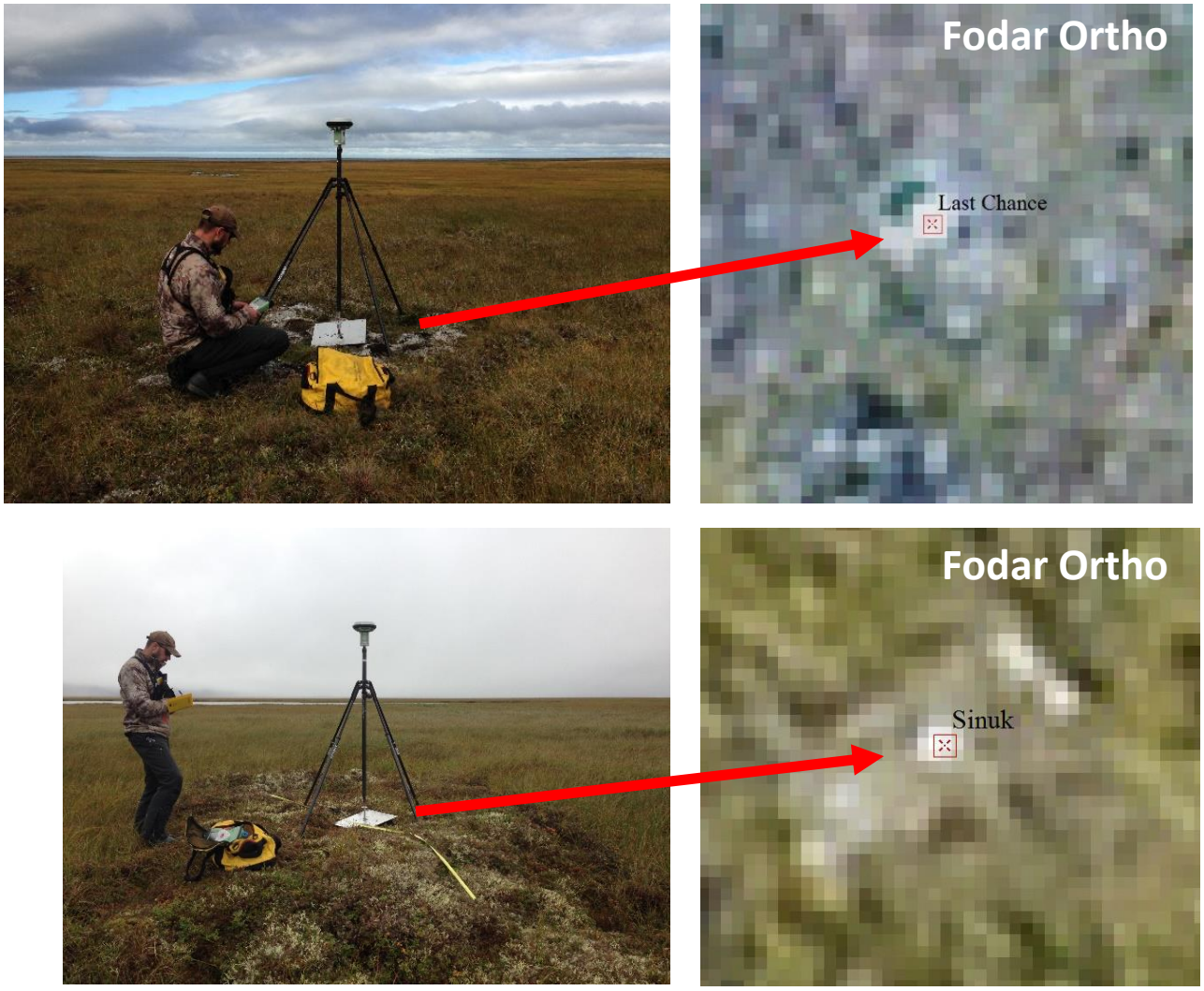
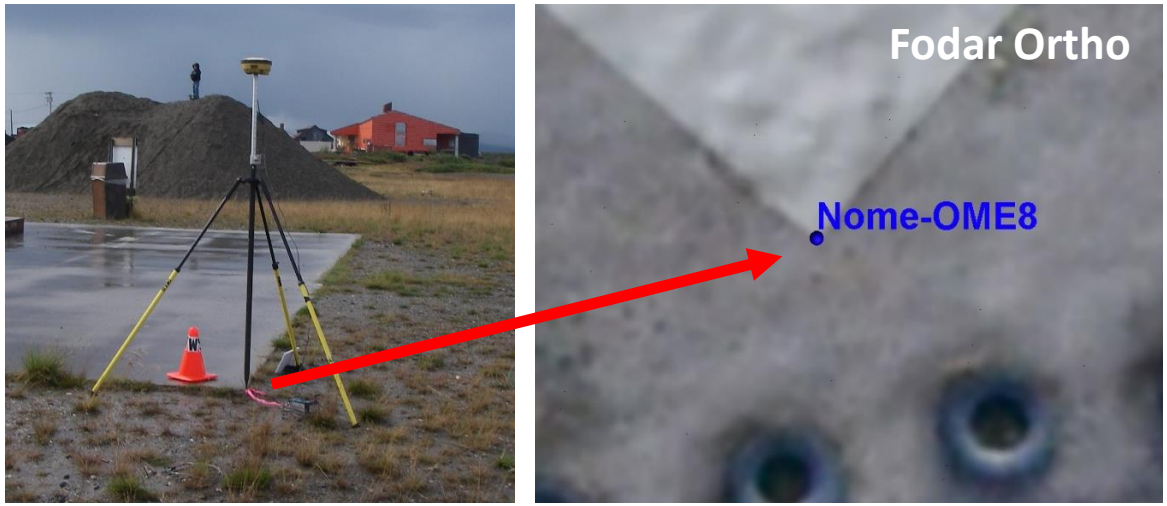


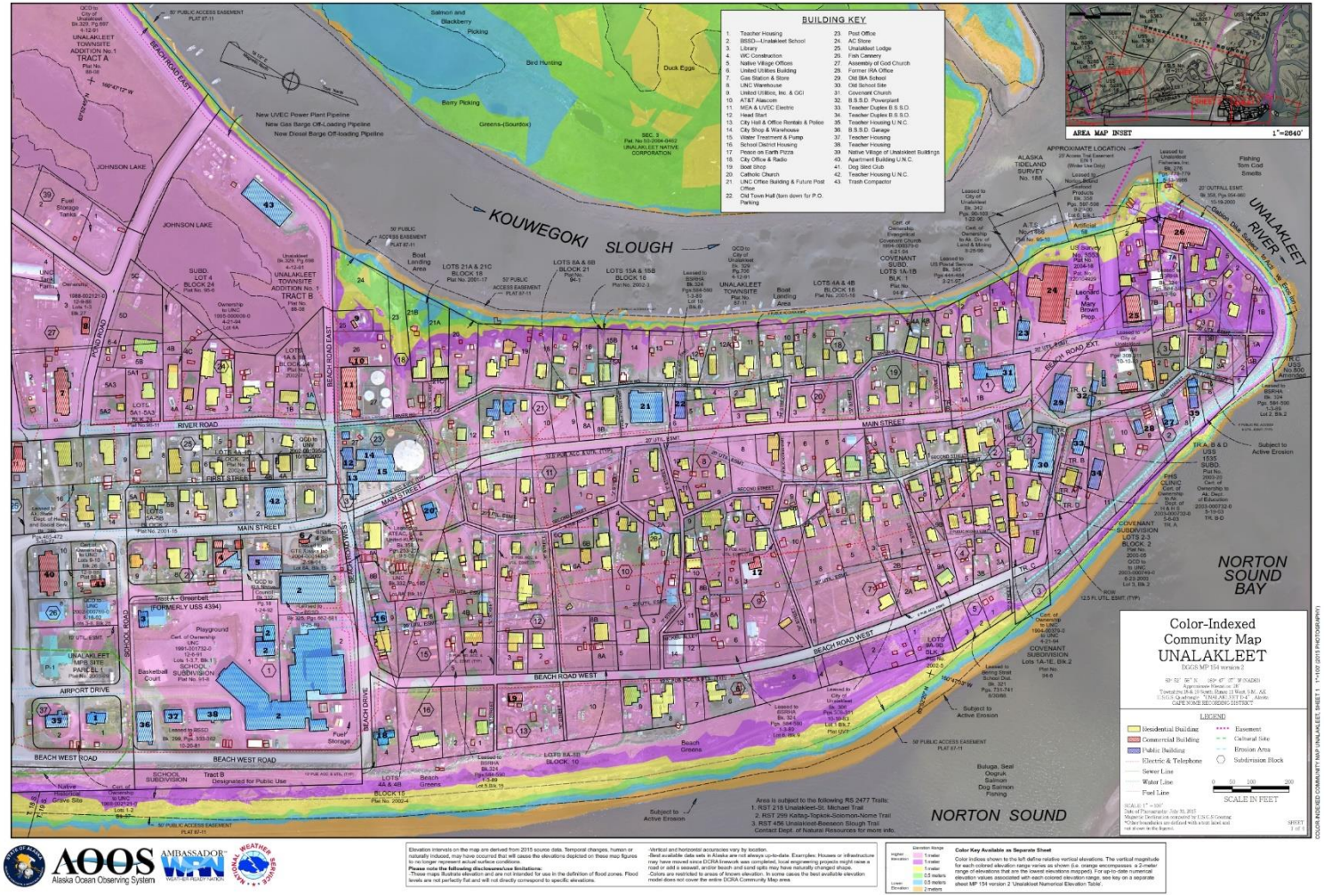
Some photo-identifiable targets are better than others; these are good ones. Regardless, comparing 120 GCPs to 120 billion pixels is an undersampling, though they are quite useful for blunder checking.

Data Validation



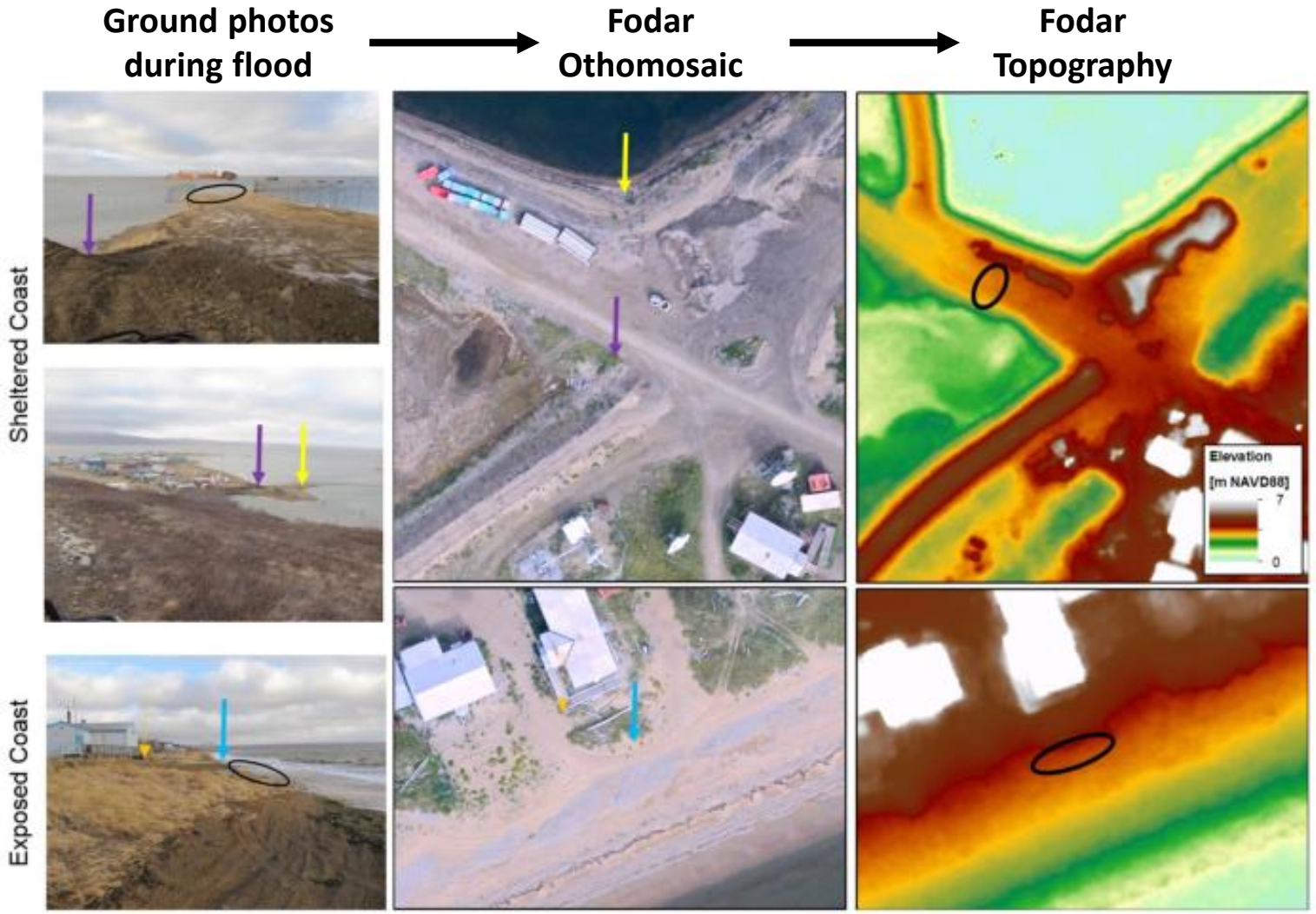
About 120 GCPs were collected by a professional land surveyor.
Horizontal accuracy was found to be perfect (subpixel).
Note that no ground control was used in fodar processing.

Applications: Policy Decision Facilitation



DGGS Conclusion: Fodar is suitable for creation of maps for land-use and emergency planning.

Applications: Flood Inundation Mapping



DGGS Conclusion: Fodar is suitable for determining flood inundation extents using suitable ground photographs.

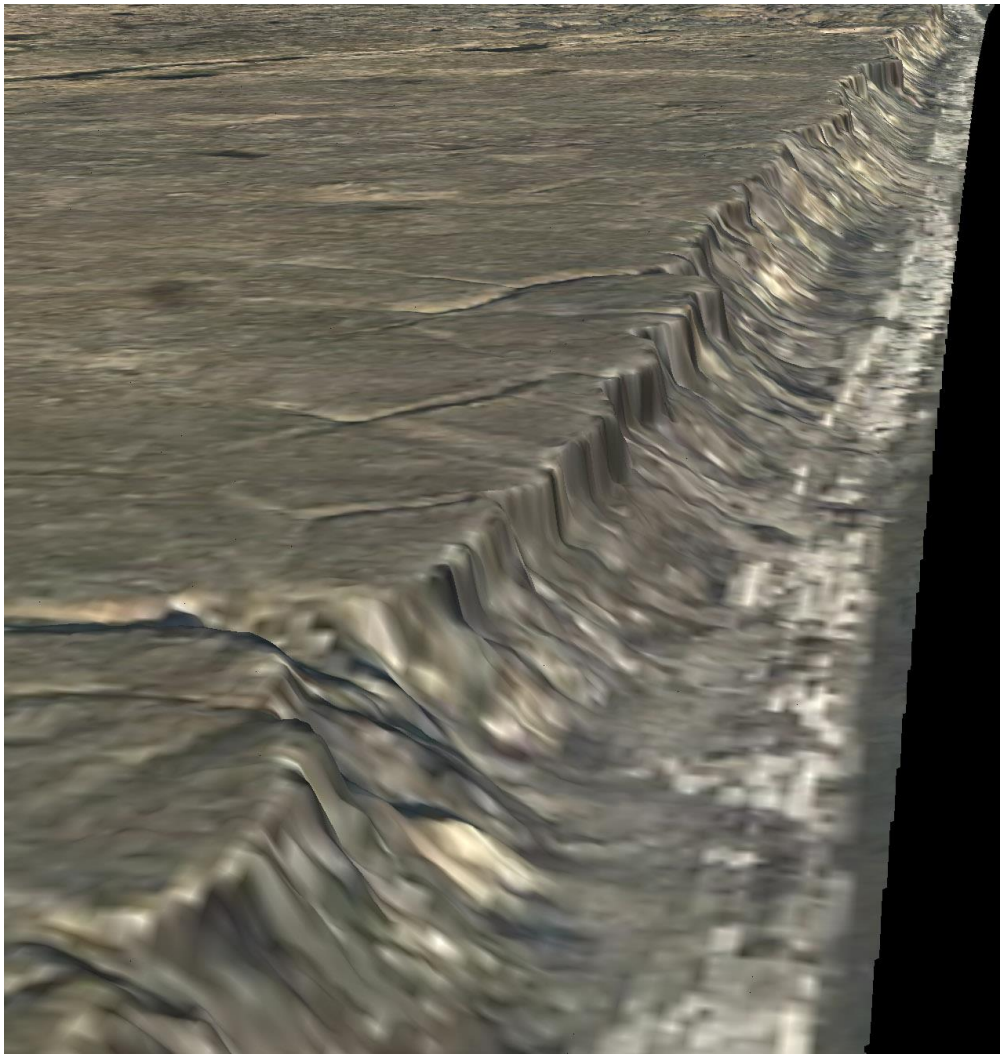
Applications: Coastline delineation

Nicole Kinsman, Ann Gibbs, and Matt Nolan, 2015. **EVALUATION OF VECTOR COASTLINE FEATURES EXTRACTED FROM 'STRUCTURE FROM MOTION'-DERIVED ELEVATION DATA**.
In *The Proceedings of the Coastal Sediments 2015*.

Conclusion: Fodar is suitable for creating accurate shoreline vectors from both orthoimage and DSM.

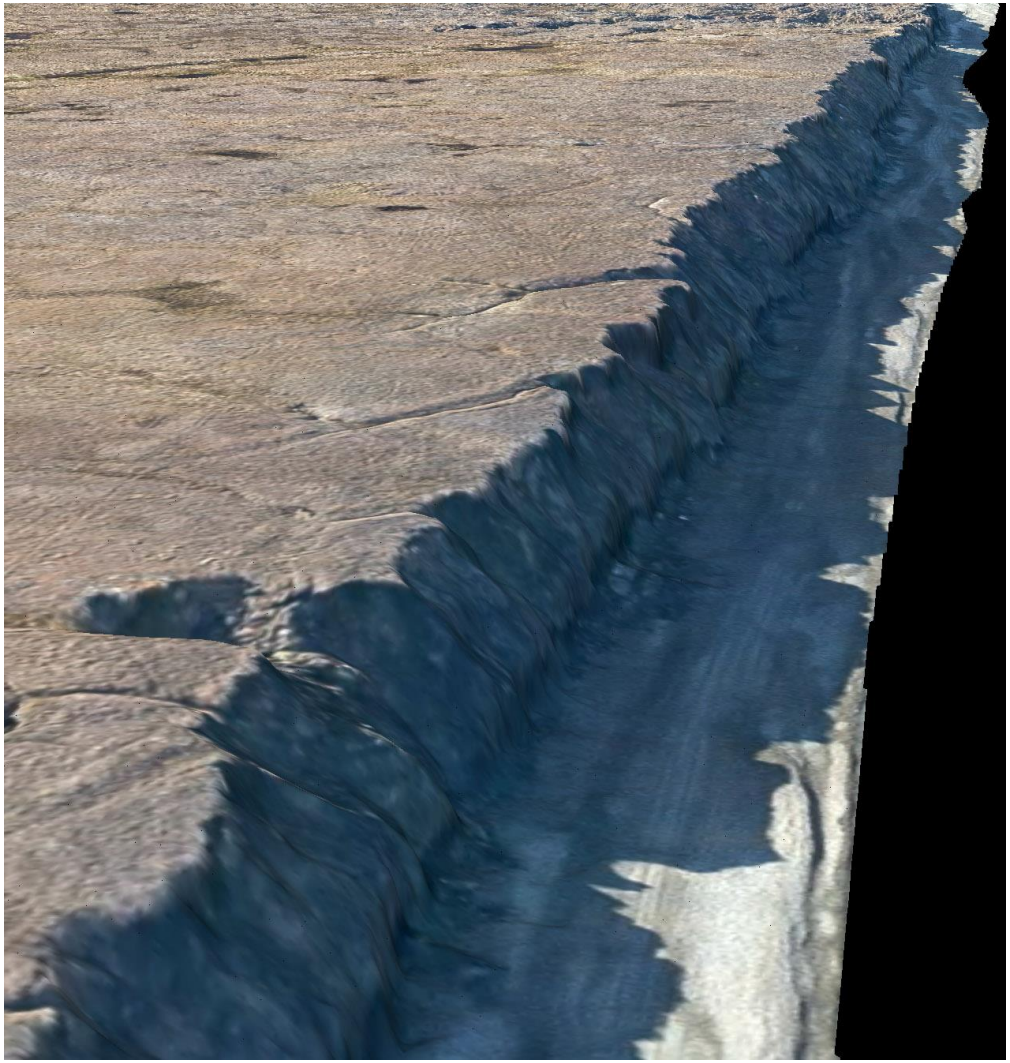
Indeed, DGGS is currently doing just that.

Applications: Coastal Erosion from Repeat Mapping



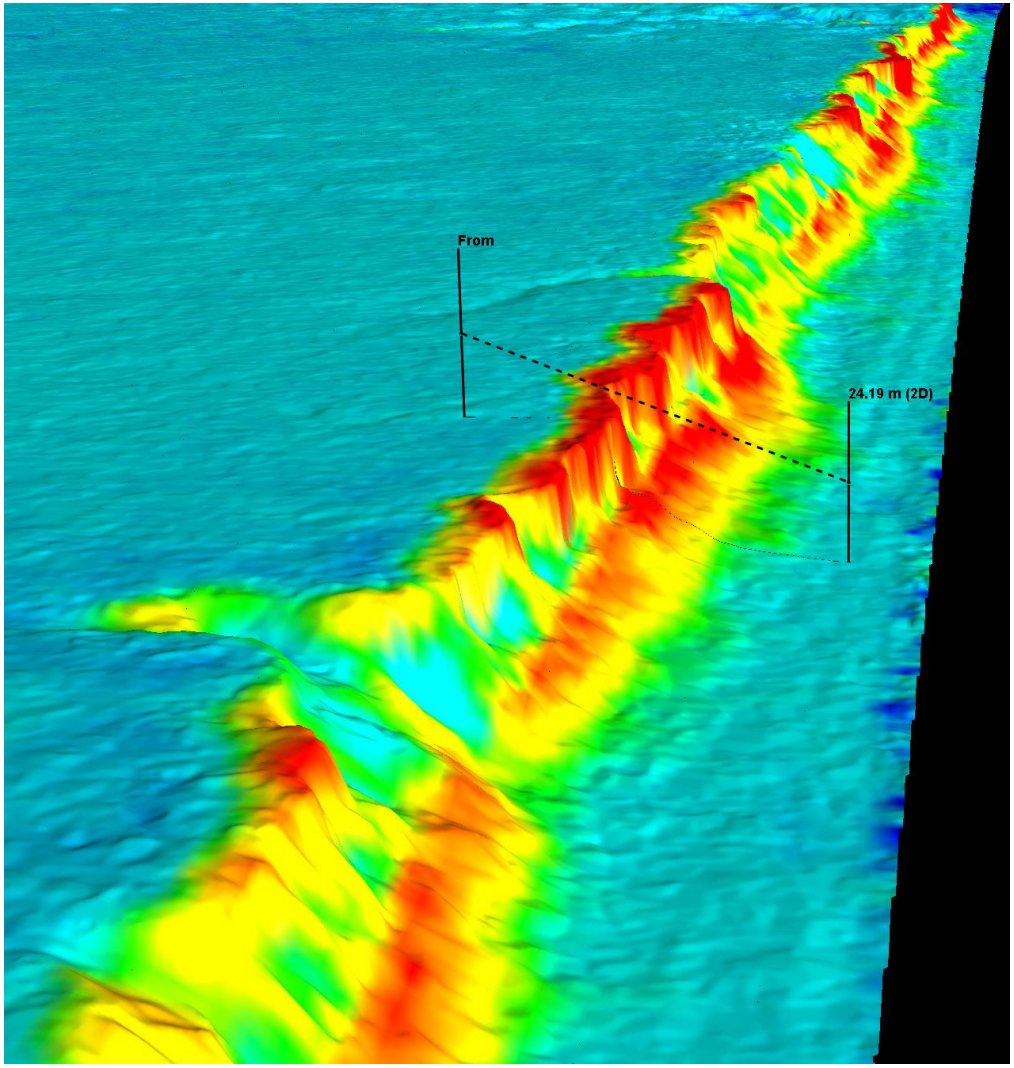
Here is some fodar data of a beach on Barter Island from July 2014.

Applications: Coastal Erosion from Repeat Mapping



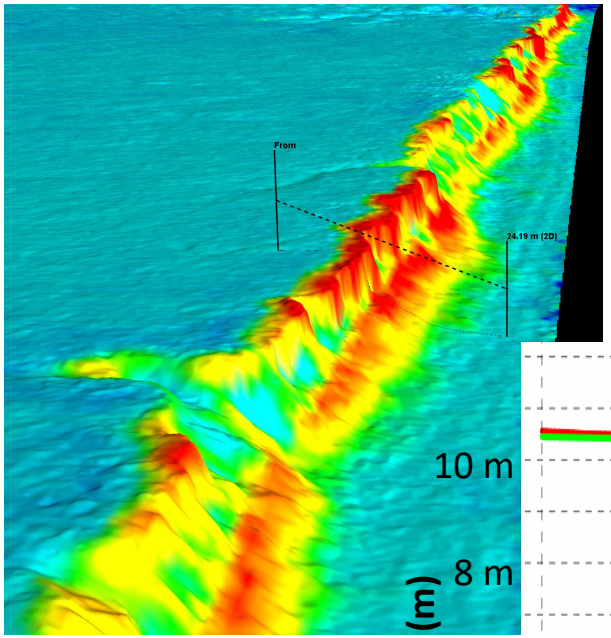
Here is the same stretch of beach from September 2014, two months later.

Applications: Coastal Erosion from Repeat Mapping

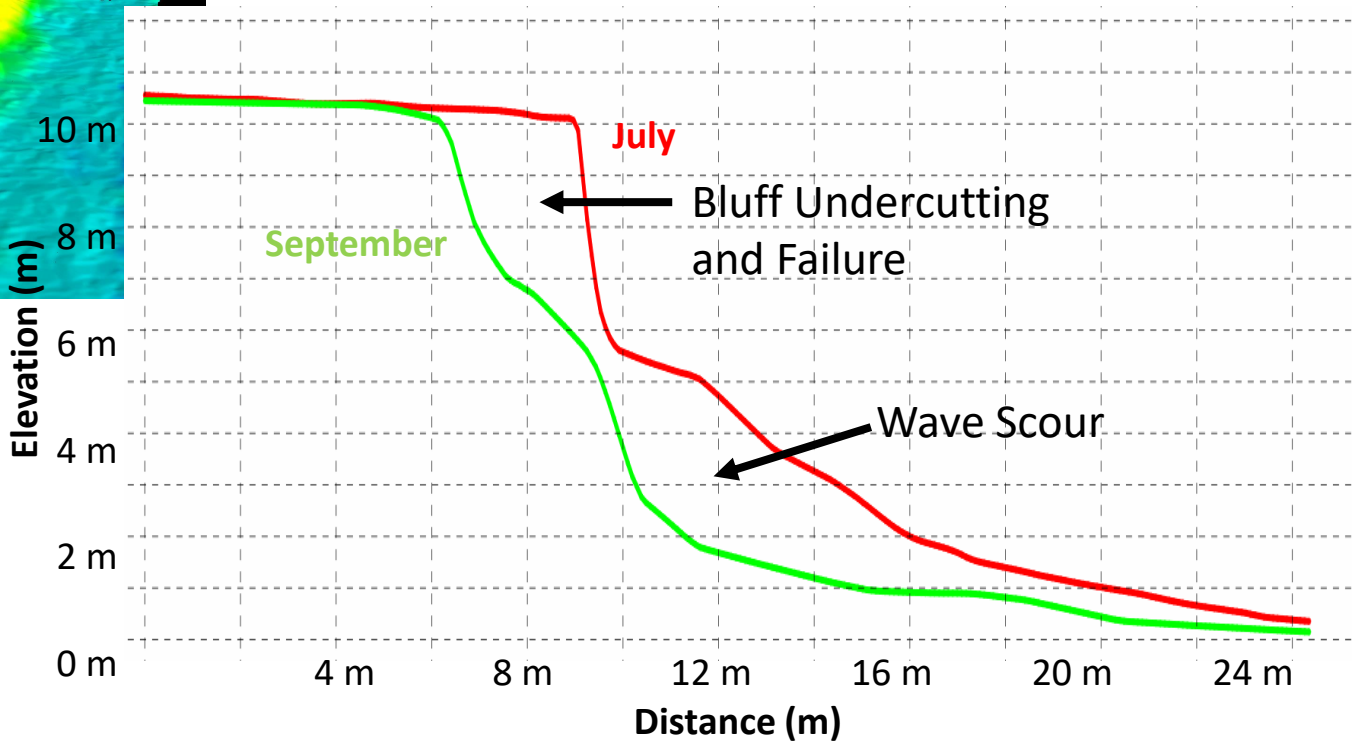


Here is the erosion that occurred in those two months, with reds, yellows, and greens showing loss.

Applications: Coastal Erosion from Repeat Mapping

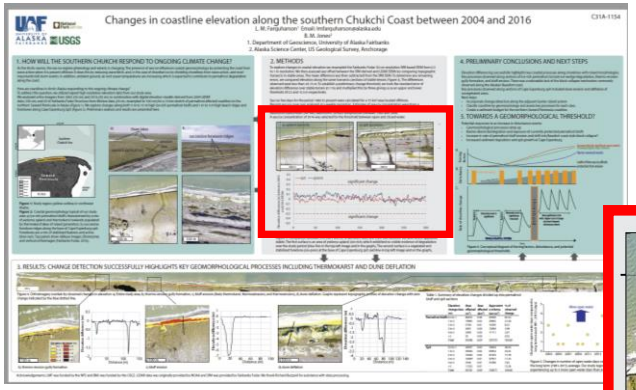


Ann Gibbs, Matt Nolan, and Bruce Richmond, 2015.
EVALUATING CHANGES TO ARCTIC COASTAL BLUFFS USING REPEAT AERIAL PHOTOGRAPHY AND STRUCTUREFROM-MOTION ELEVATION MODELS.
In *The Proceedings of the Coastal Sediments 2015*.



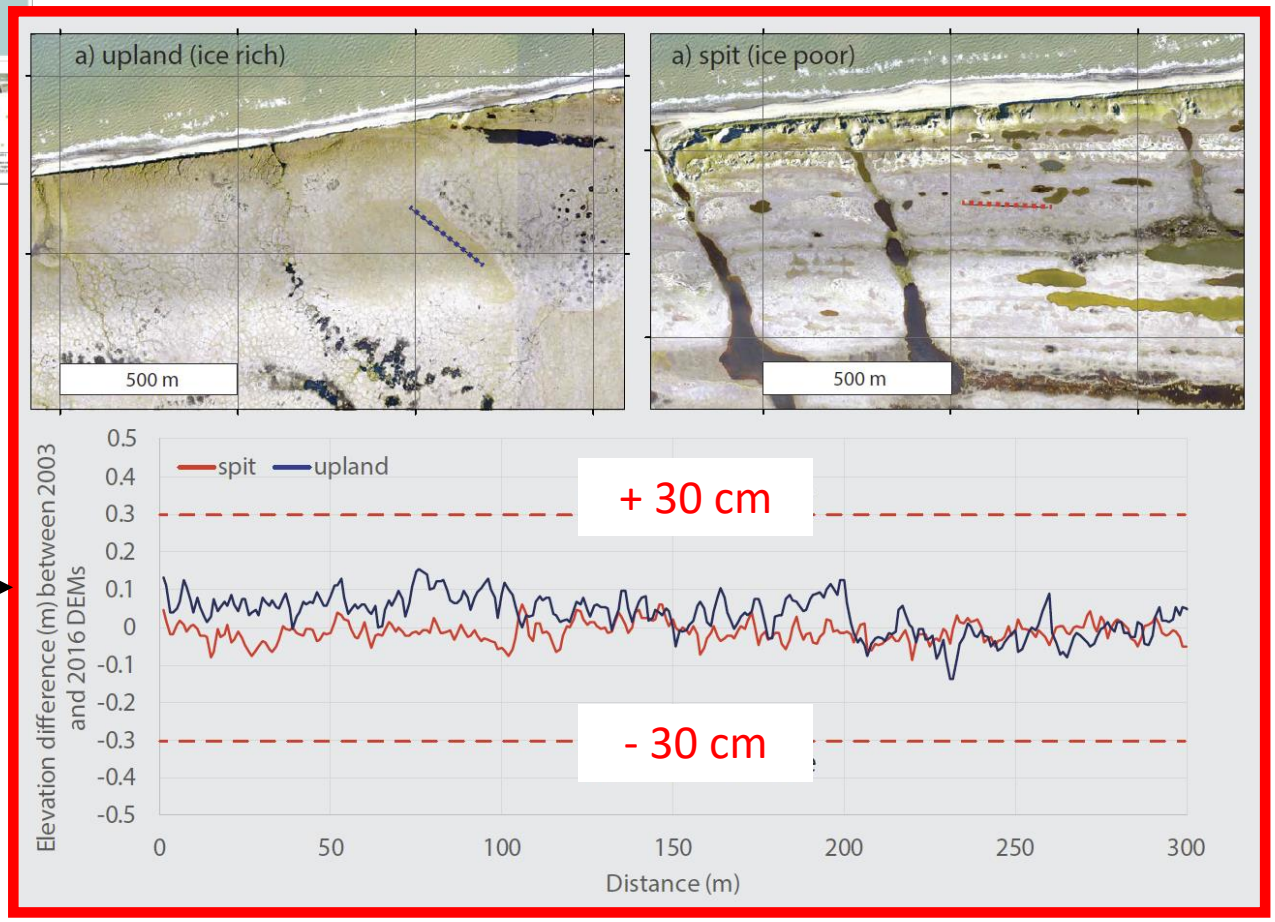
USGS Conclusion: Fodar is suitable for measuring coastal erosion at unprecedent accuracy.

Applications: Coastal Erosion from Repeat Mapping



Louise Farquharson and Ben Jones,
Changes in coastline elevation along the southern Chukchi Coast between 2004 and 2016.
AGU Fall Meeting 2018, C31A-1154.

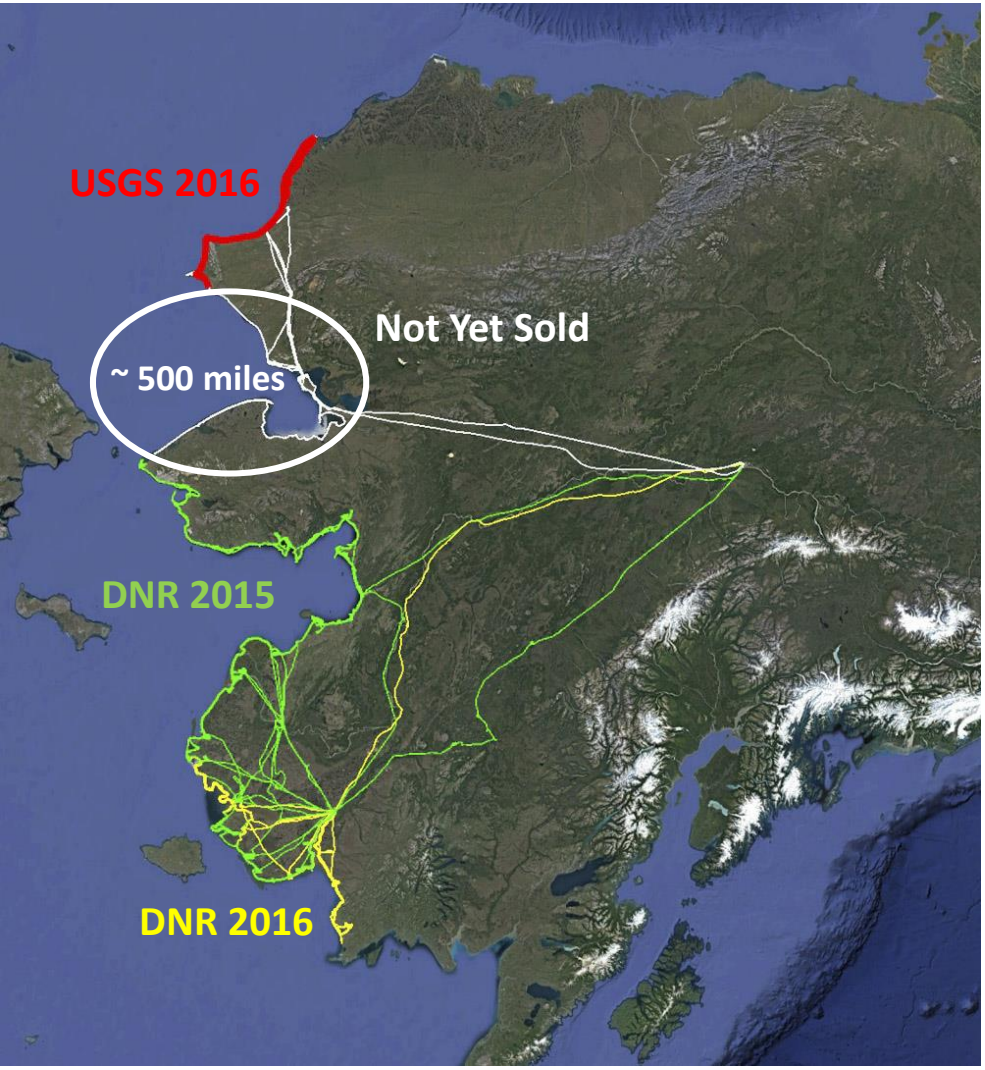
Between Shishmaref and Cape Espenberg



2004 Lidar
minus
2016 Fodar
near Shishmaref

UAF Conclusion: Fodar elevation values are within 10 cm of lidar and thus these data are suitable for coastal erosion measurements.

West Coast Overview



There has been some awesome work done with the existing data I don't want to hold up scientific and policy progress by waiting/hoping for an RFP for the missing data, but I can't release it for free either.

Total cost to date: $375,000.

Applying the DNR/USGS rates to these 500 miles, retail price should be $125,000,
and includes Shishmaref and Kivilina.
Data have the same specs as DNR/USGS,
But are only 700-1000 m wide.

I'm willing to reduce the price to $36,000 if…

… the people at this summit are excited to crowd fund this purchase and work together to figure out a mechanism.

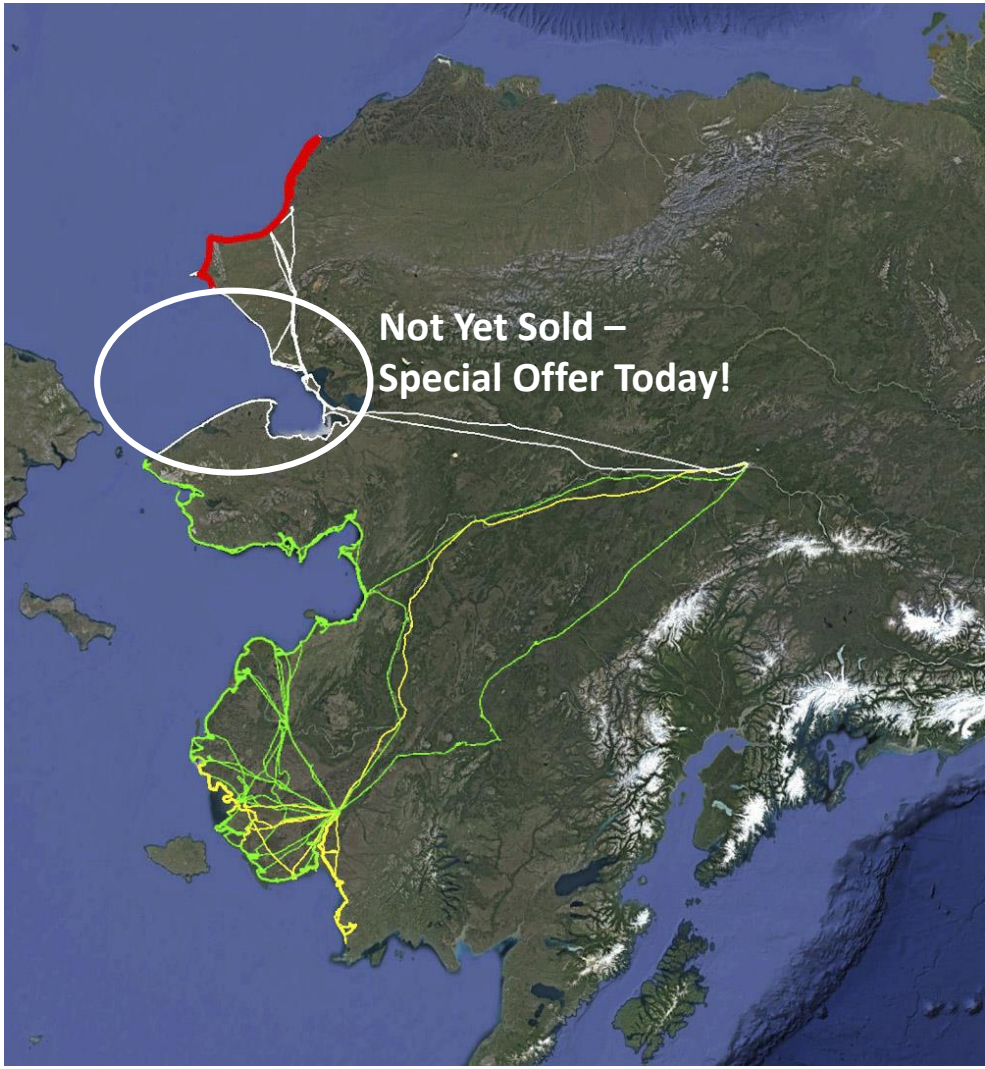
That's only $360/person attending!
Or 12 people @ $3000 each!

Take Home Messages

1) Fodar is awesome for coastal mapping and analysis. But don't just take my word for it…

2) I'm excited to map the rest of Alaska's coast!

3) COASTAL SUMMIT SPECIAL OFFER for WALES to PT HOPE Today: $36,000, but need a large expression of interest from this crowd and need to figure out the best mechanism to share costs.



Thank You!

Visit www.fairbanksfodar.com for more info!