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VECTOR COASTLINE FEATURES FROM 'STRUCTURE FROM MOTION'-DERIVED ELEVATION DATA

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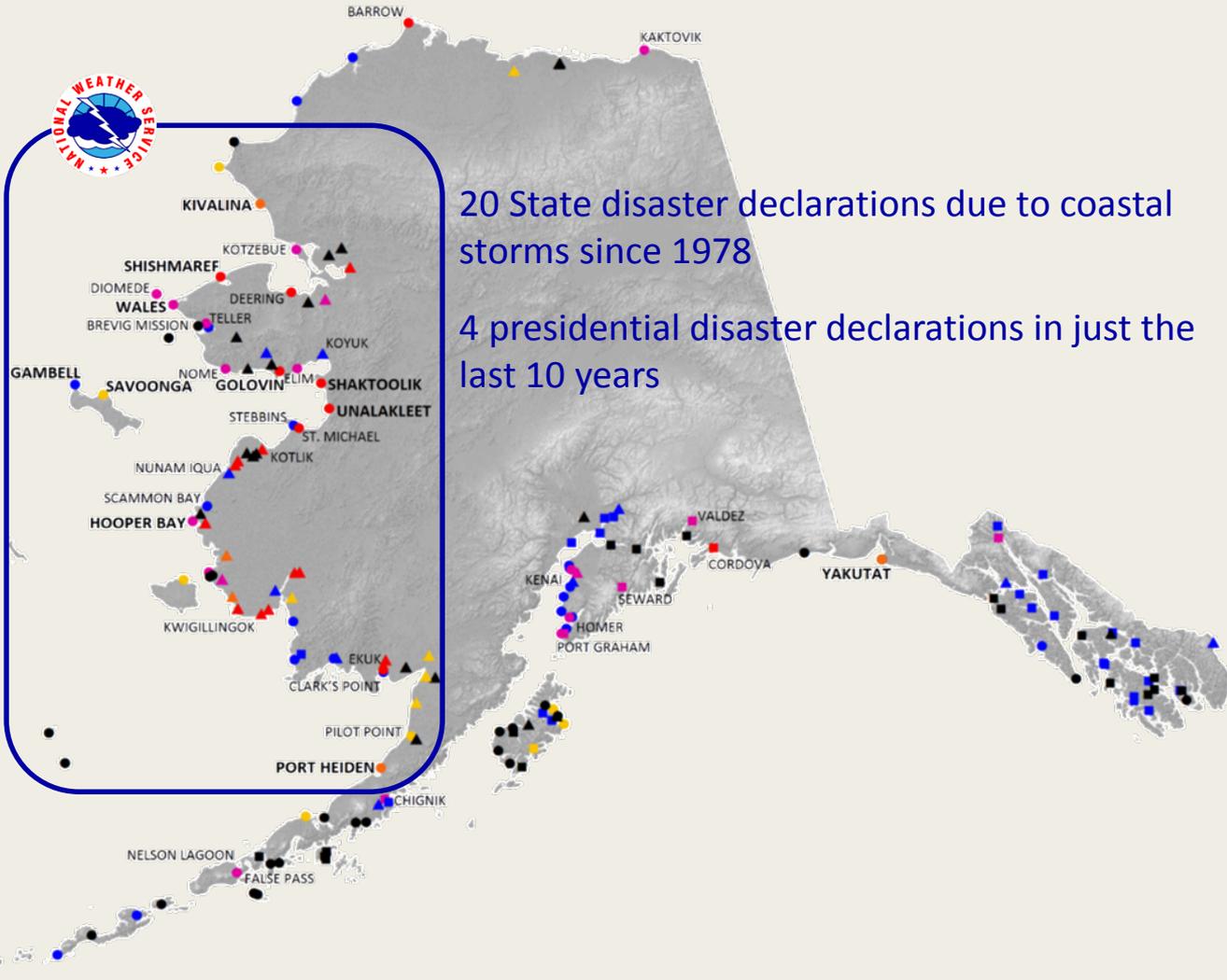
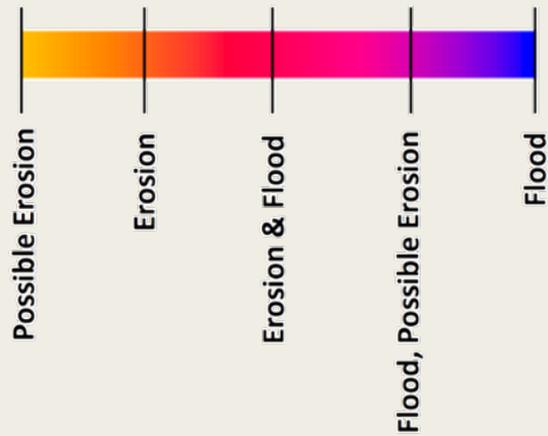
Coastal Sediments '15

Relevant Science for Changing Coastlines: A Tribute to Gary Griggs - May 12, 2015

Alaska Coastal Populations Vulnerable to Flooding and Erosion

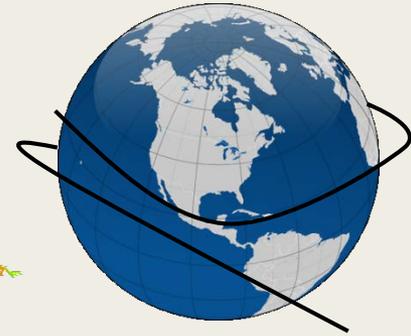
Key

- Exposed Coast
- Sheltered Coast
- ▲ Riverine Coast



- Alaska ceased participation in the Coastal Zone Management Program in July 2011
- ~12% of AK communities do not participate in the National Flood Insurance Program

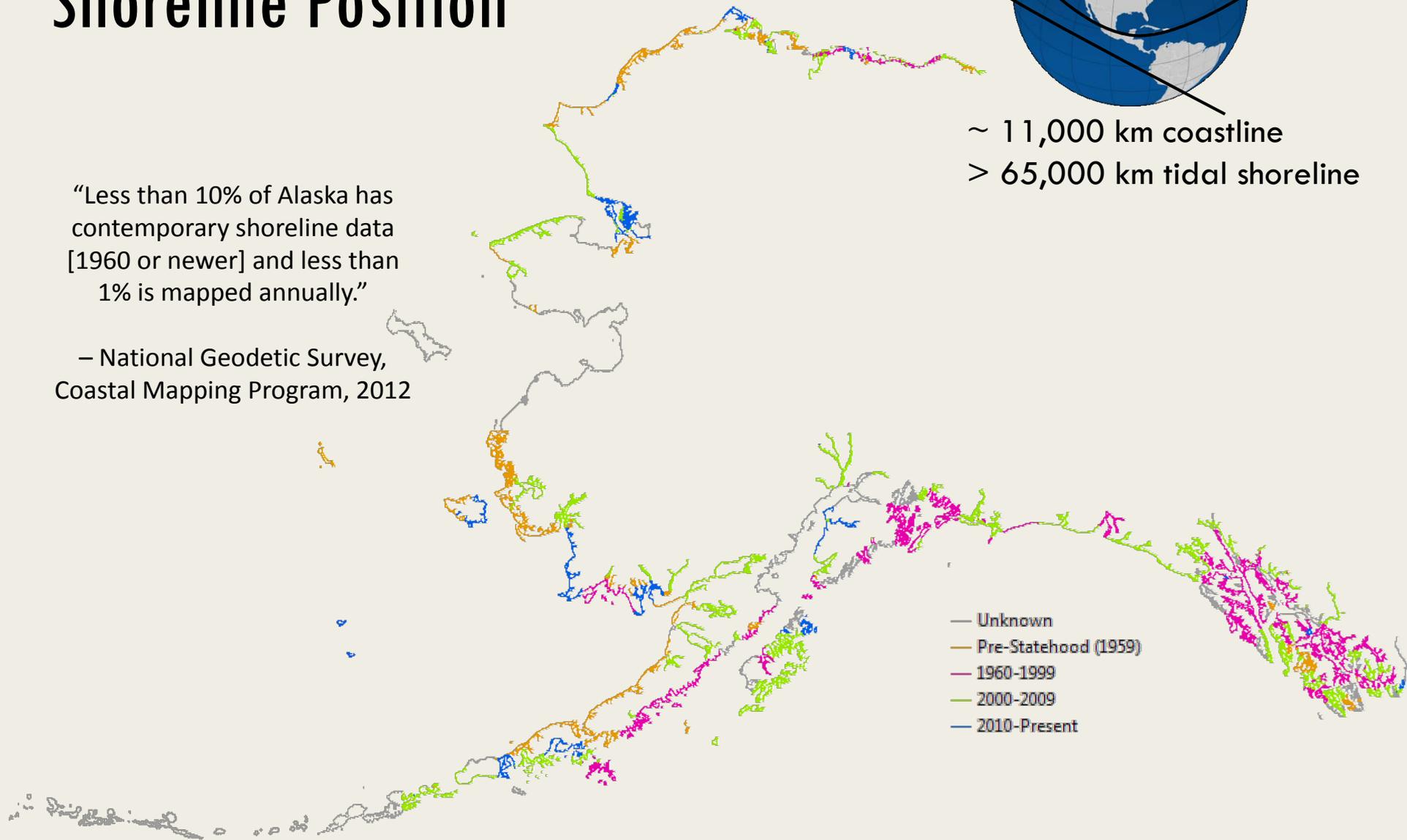
ALASKA IS DATA LIMITED: Shoreline Position



~ 11,000 km coastline
> 65,000 km tidal shoreline

“Less than 10% of Alaska has contemporary shoreline data [1960 or newer] and less than 1% is mapped annually.”

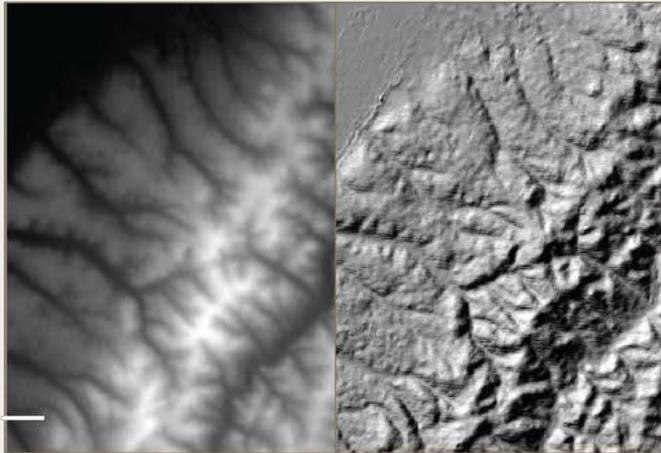
– National Geodetic Survey,
Coastal Mapping Program, 2012



ALASKA IS DATA LIMITED:

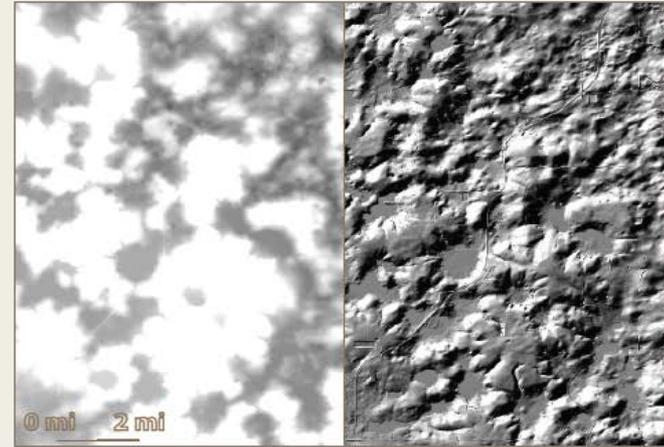
Elevation Models and Aerial Imagery

Example along the east shore of Norton Sound



Full Coverage, 30 m spatial resolution

Example in Spring Hills, Florida



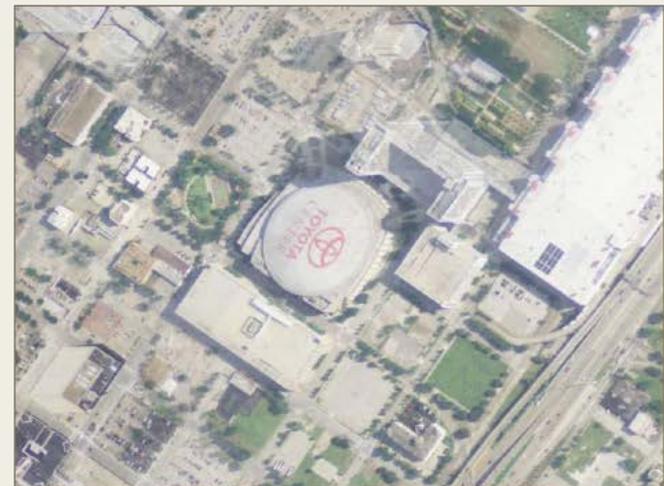
Full Coverage, 10 m spatial resolution

Example location at Fairbanks International Airport



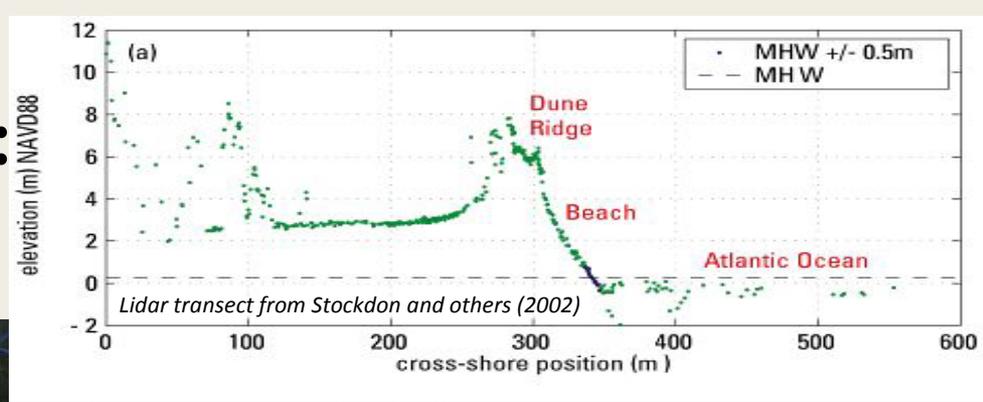
98% Coverage, 2.5 m spatial resolution

Example location at Toyota Center in downtown Houston, Texas



Full Coverage, 1 m spatial resolution

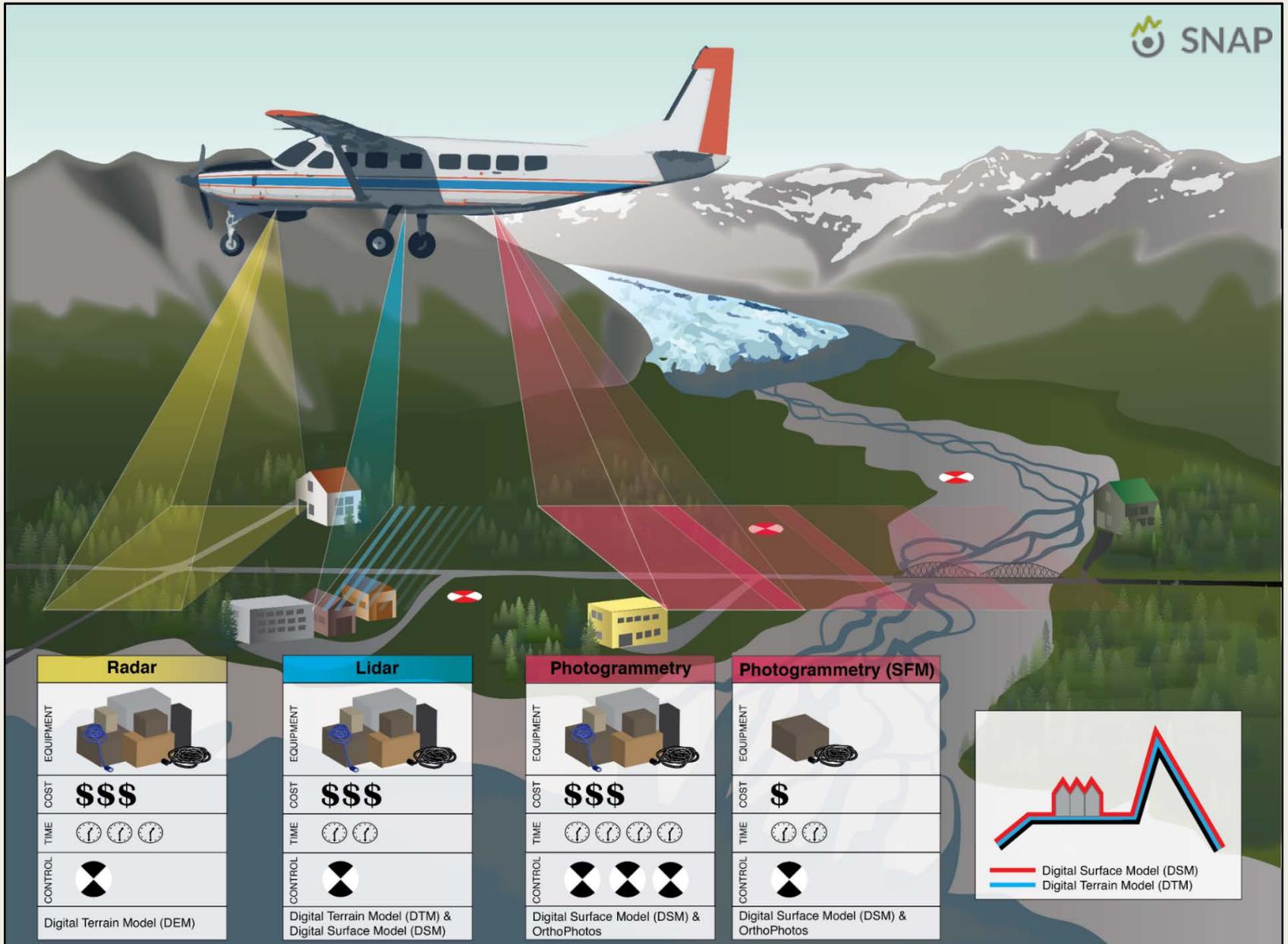
ALASKA IS DATA LIMITED: Vertical Datums



*Sea of VERTCON
& VDATUM*

Alaska

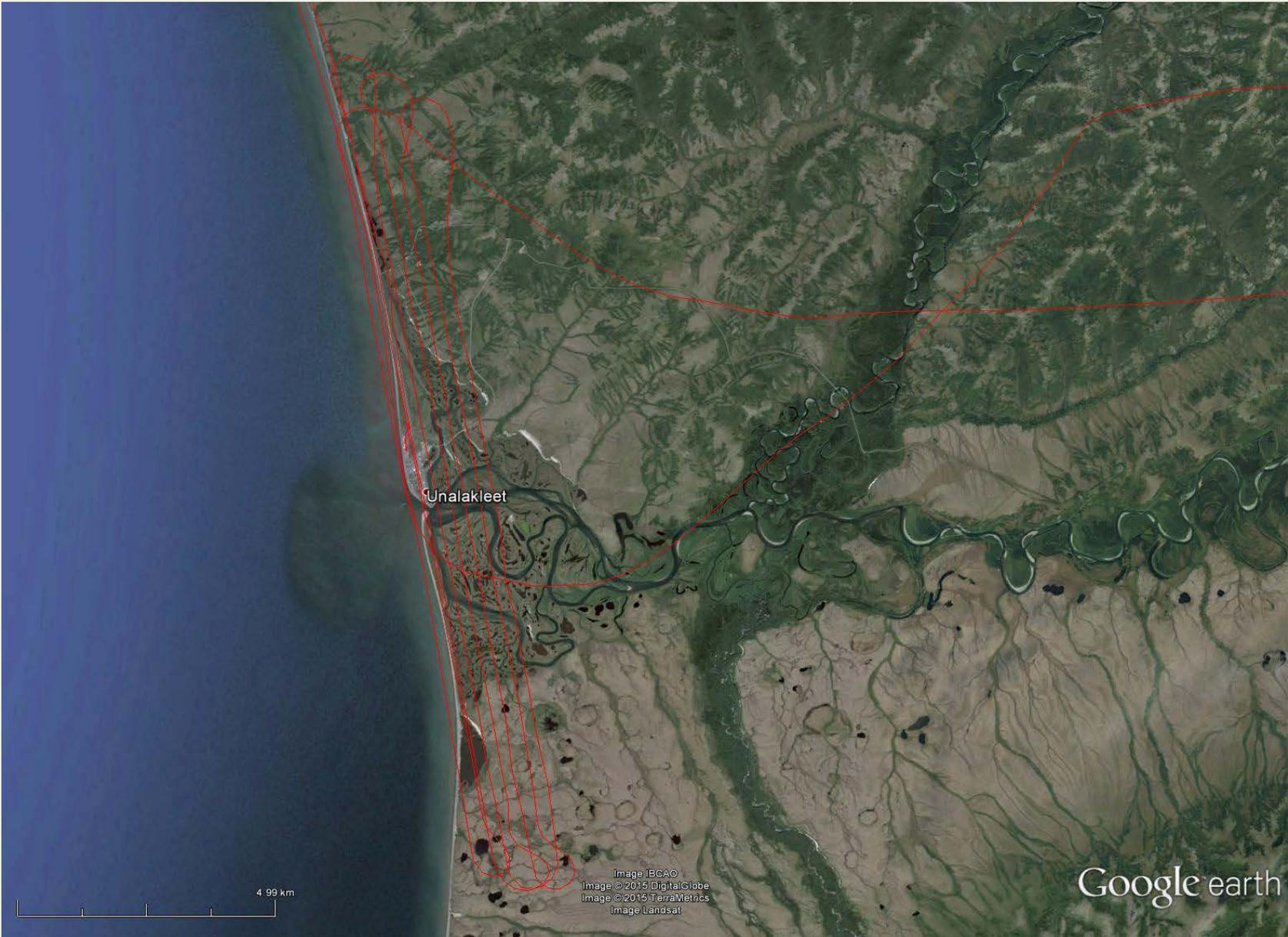
STRUCTURE FROM MOTION PHOTOGRAMMETRY



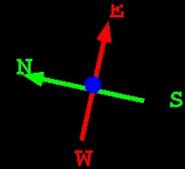
STUDY AREA: UNALAKLEET, ALASKA



SEPTEMBER 2014 AIRBORNE IMAGE COLLECTION



SEPTEMBER 2014: PROJECT EXTENT



1000 photos w/ a DSLR camera time-linked to a GPS receiver

~ 12 x 2 km area

Processed with AgiSoft Photoscan

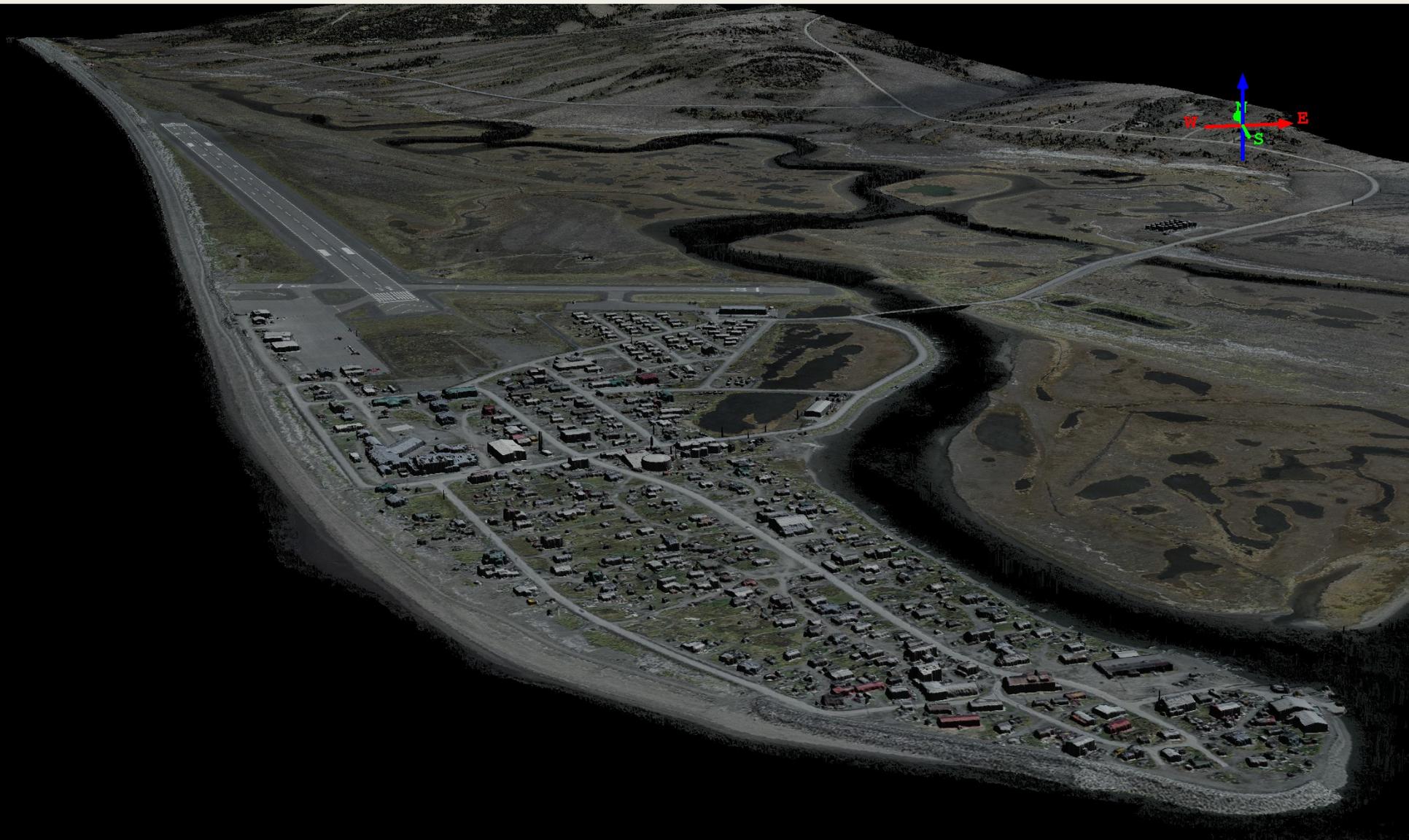
Used archived, 2011 photo-identifiable ground control

9 cm imagery & 20 cm DSM

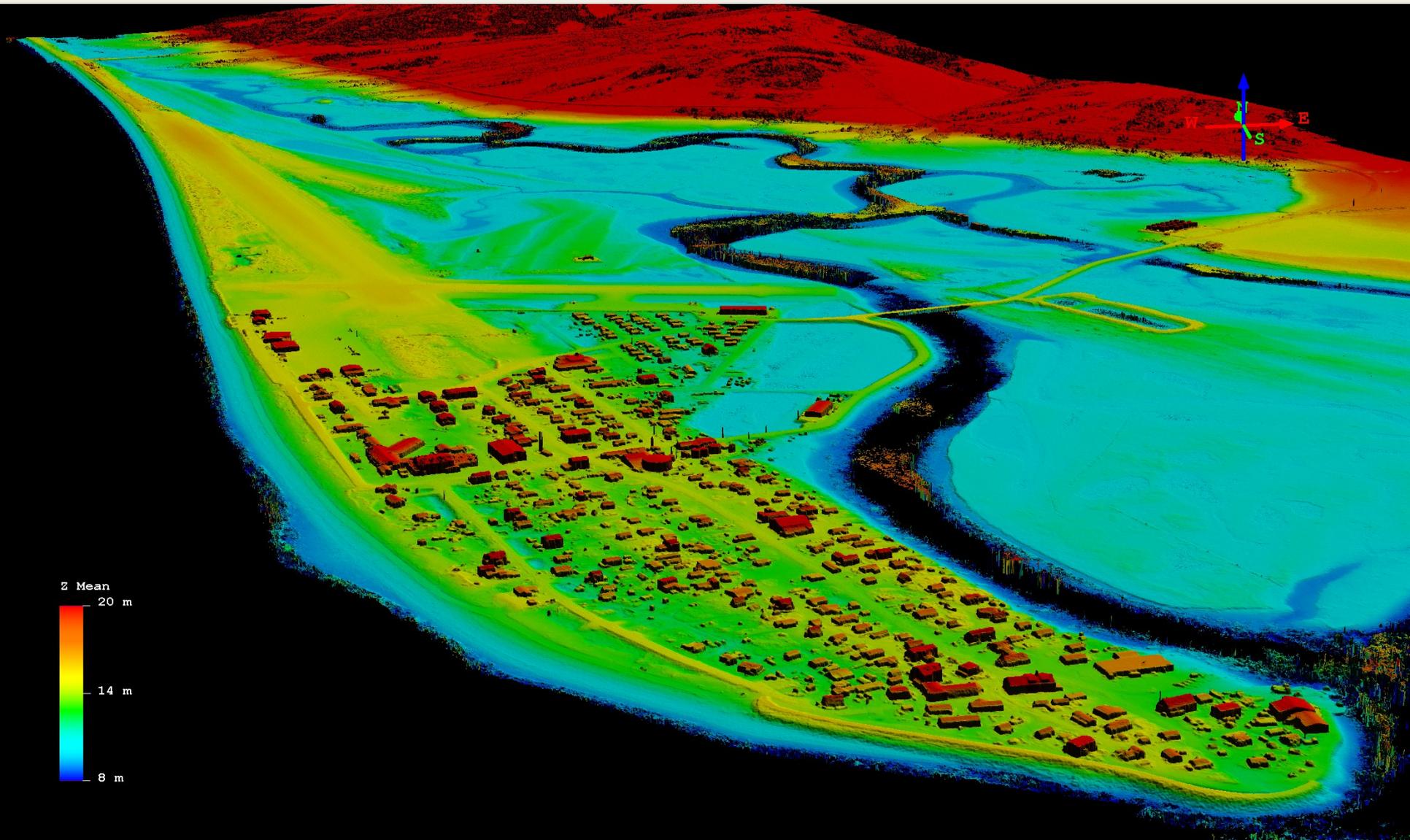
SEPTEMBER 2014 PROCESSING: ORTHOIMAGE



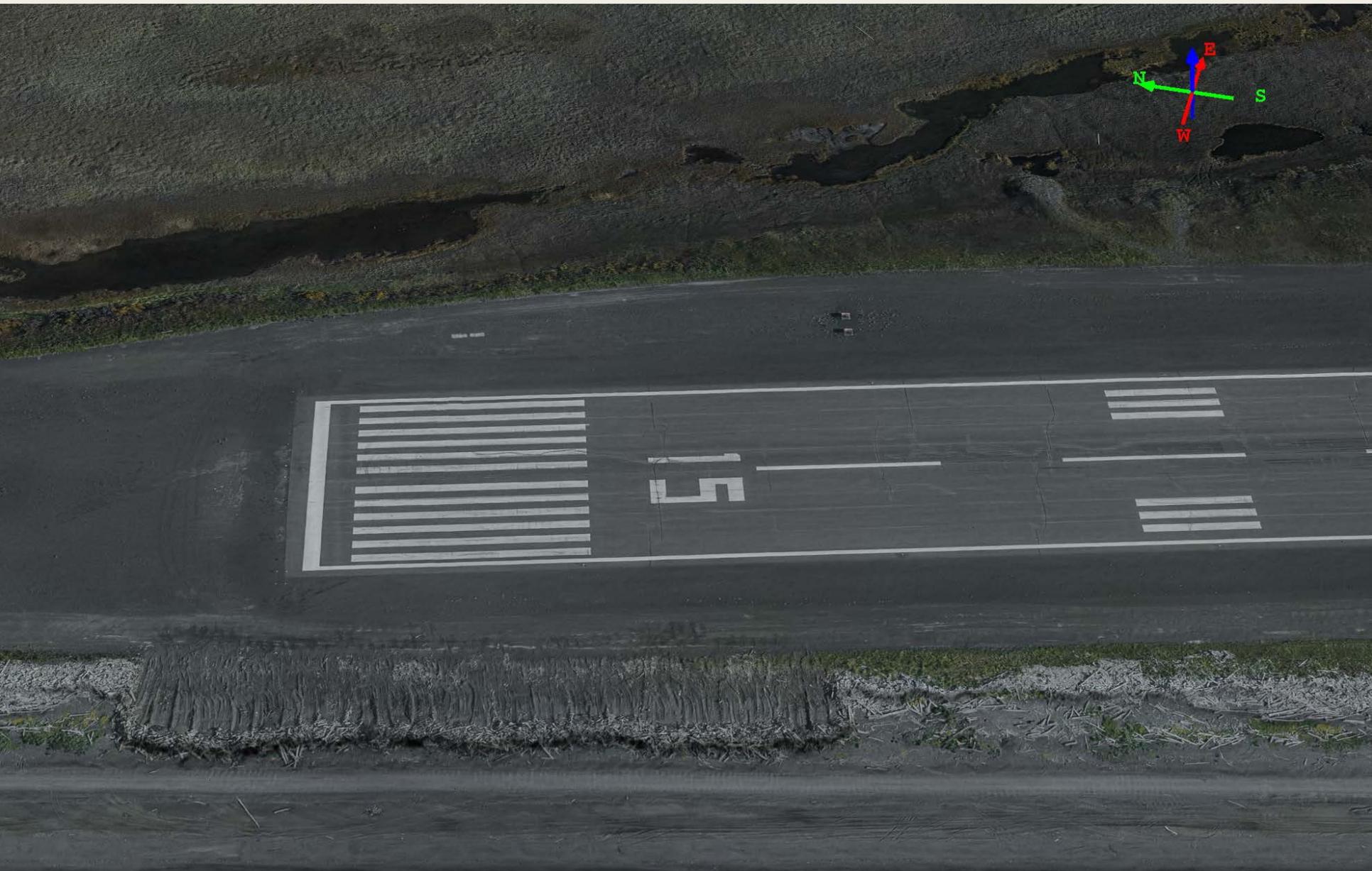
SEPTEMBER 2014 PROCESSING: DSM



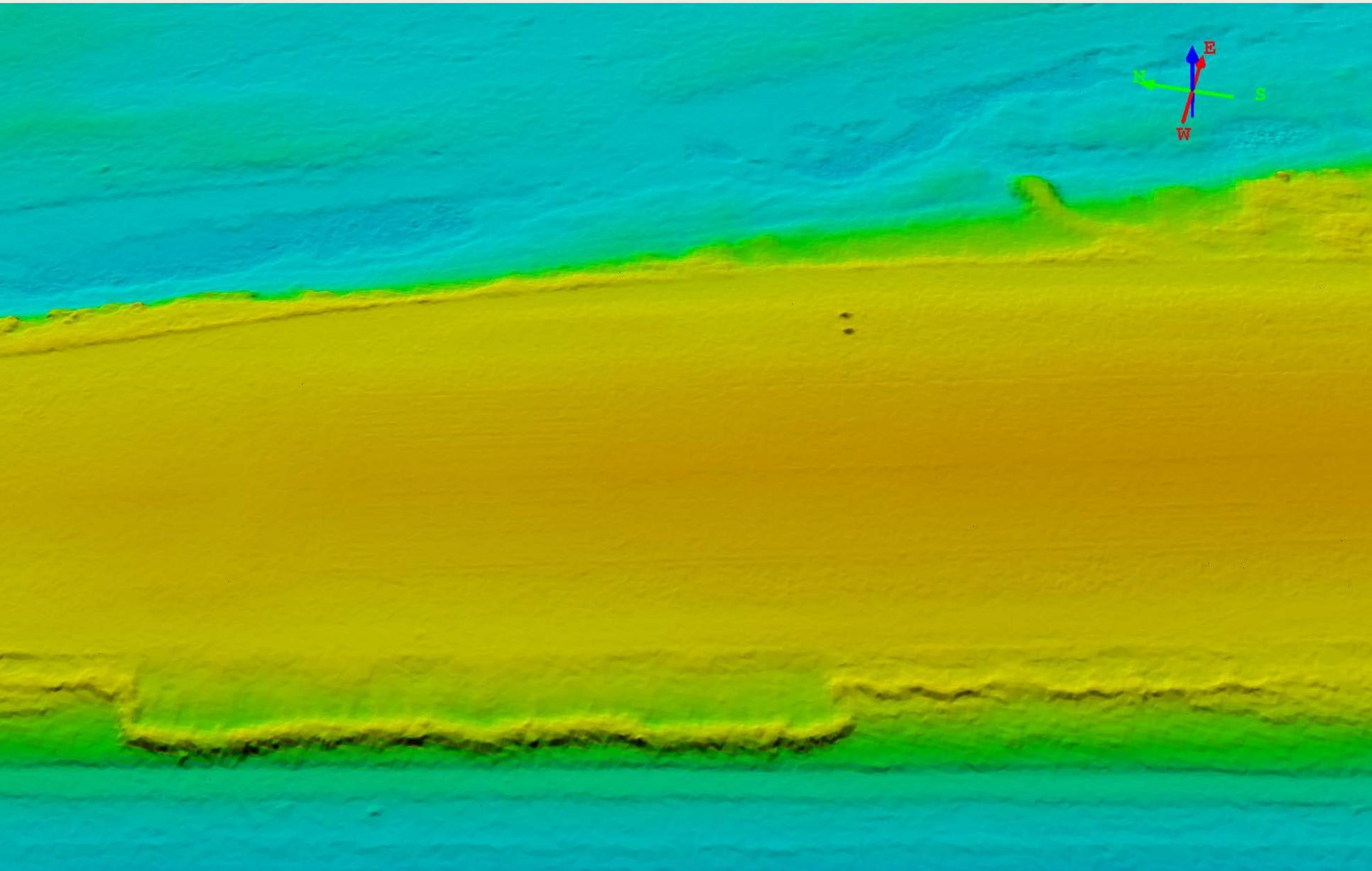
SEPTEMBER 2014 PROCESSING: DSM



SEPTEMBER 2014 PROCESSING: DSM



SEPTEMBER 2014 PROCESSING



OCTOBER 2014 INDEPENDENT GROUND CONTROL



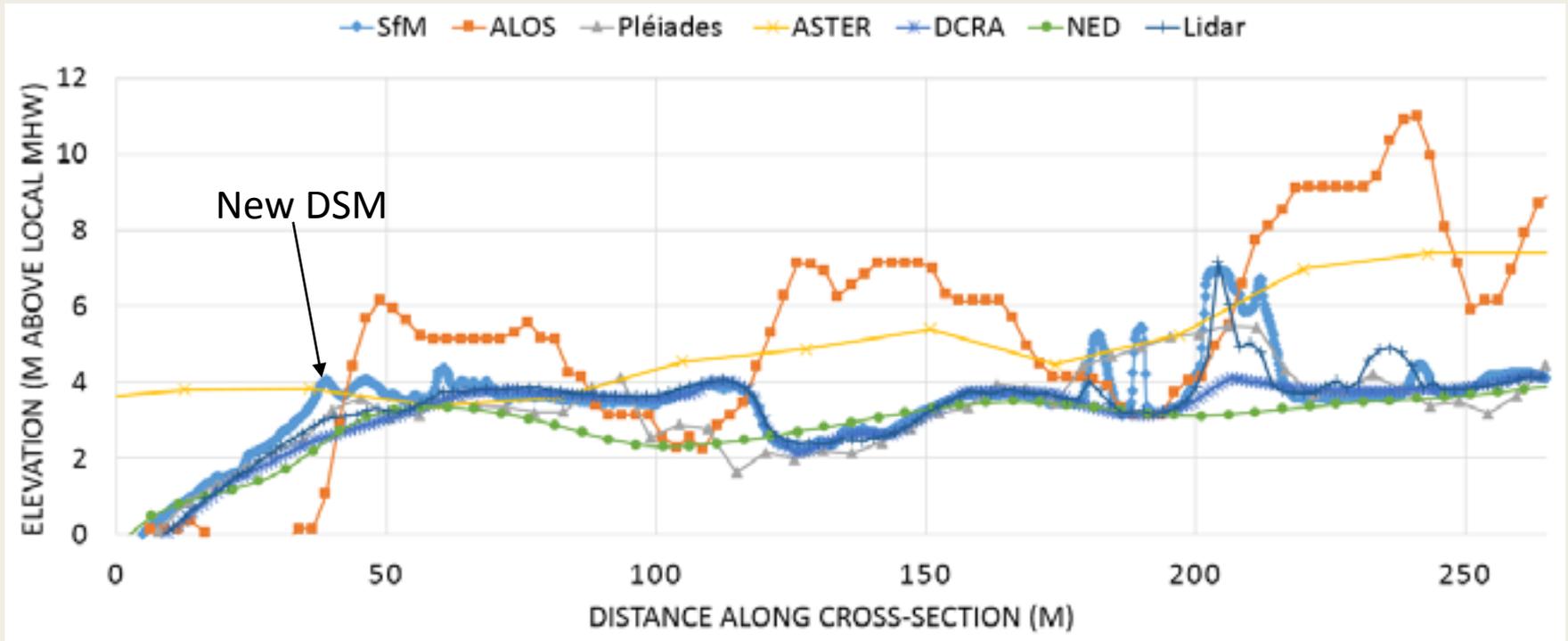
12 new photo-identifiable ground control points (z) collected in stable areas

GCP residuals compared in 6 existing and 1 new (SFM) datasets:



- Existing DSM/DTM (traditional photogrammetry, InSAR and Lidar)
 - Existing elevation models from 2004-2014
 - GSDs from 0.75 to 30 m (except for SFM)

DIGITAL ELEVATION MODEL COMPARISON



Mean residuals varied from 4-70 cm in the vertical

- Lidar 8 cm RMSE (z)
- Satellite photogrammetry (Airbus Pléiades) 44 cm RMSE (z)

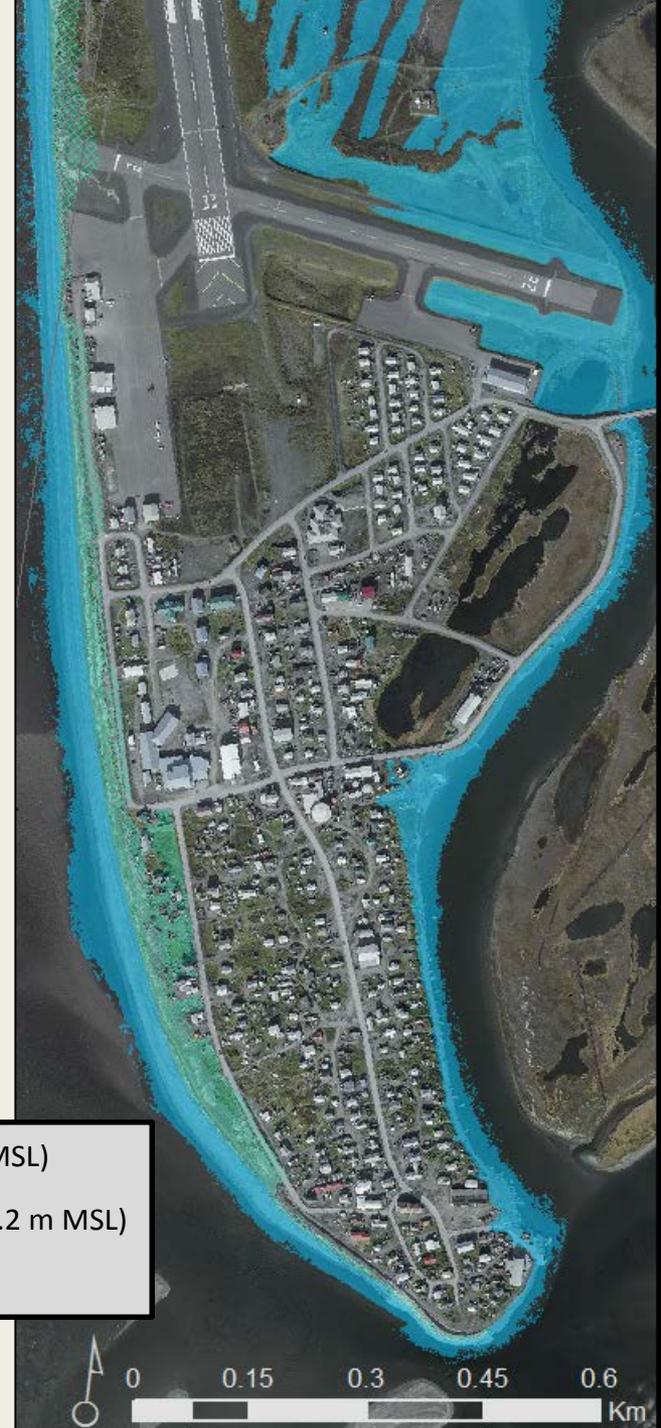
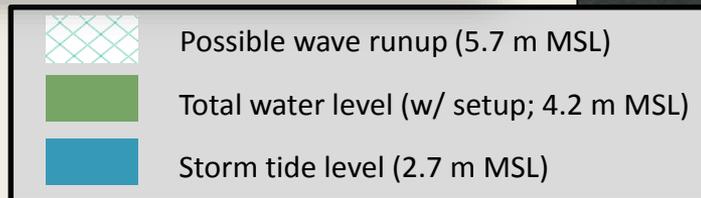
SfM data were adjusted to new ground control (16 cm z RMSE) to derive vector products

APPLIED USE: FLOOD MAPPING



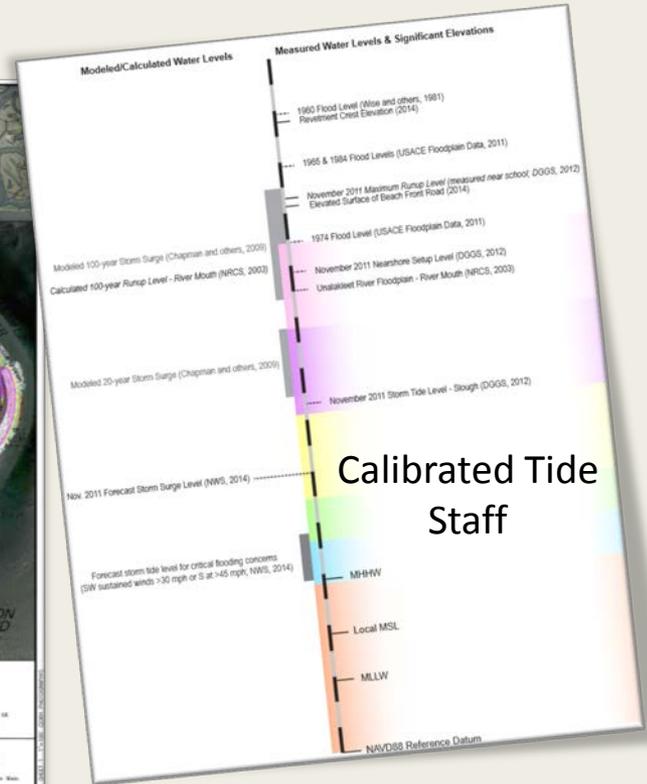
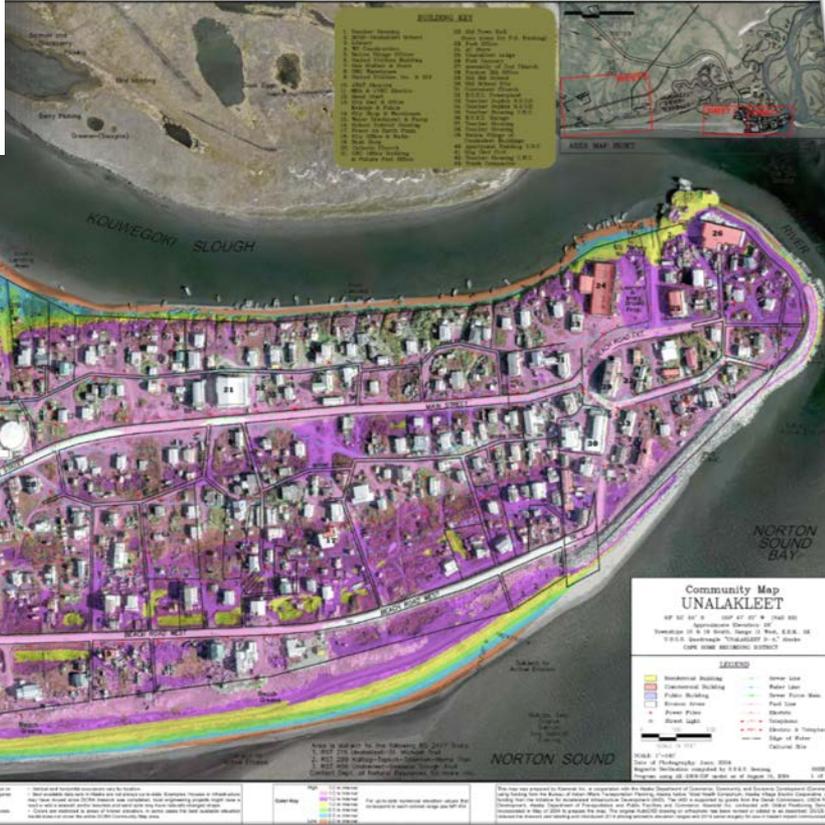
Used DSM to make map of 2011 coastal flood extent based on field measurements

Good qualitative agreement



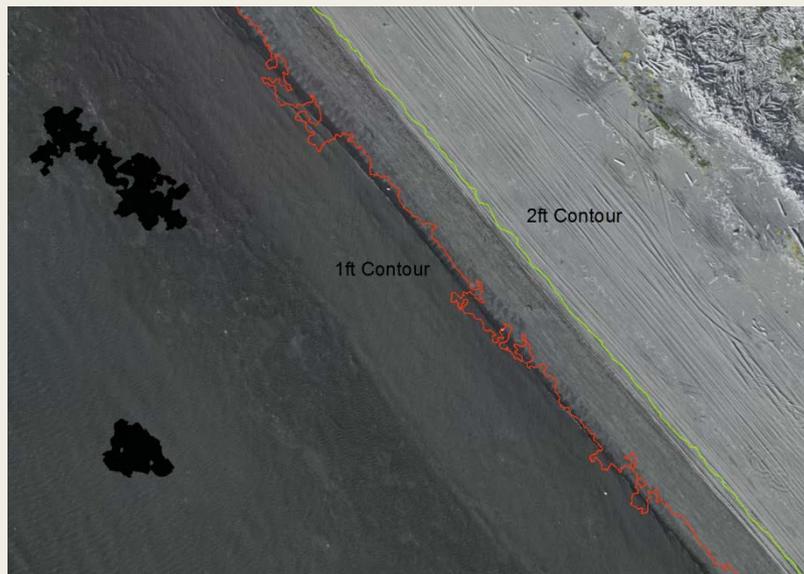
APPLIED USE: FLOOD COMMUNICATION

- Resource to improve 2-way communication about flood impacts
- Pilot project in 5 locations: UNK, SKK, GLV, SHH and KVL
- Color-indexed elevations



APPLIED USE: SHORELINE POSITION

- Best-available contemporary shoreline vector:
NHD, 1:63,360 of uncertain age
- Manually-digitized HWL vs. MHW (datum)
 - Good visual agreement
 - HWL 8 cm above MHW (landward)
 - Shoreline mapping ↔ datum derivation?
- MHW only due to poor solutions near swash:

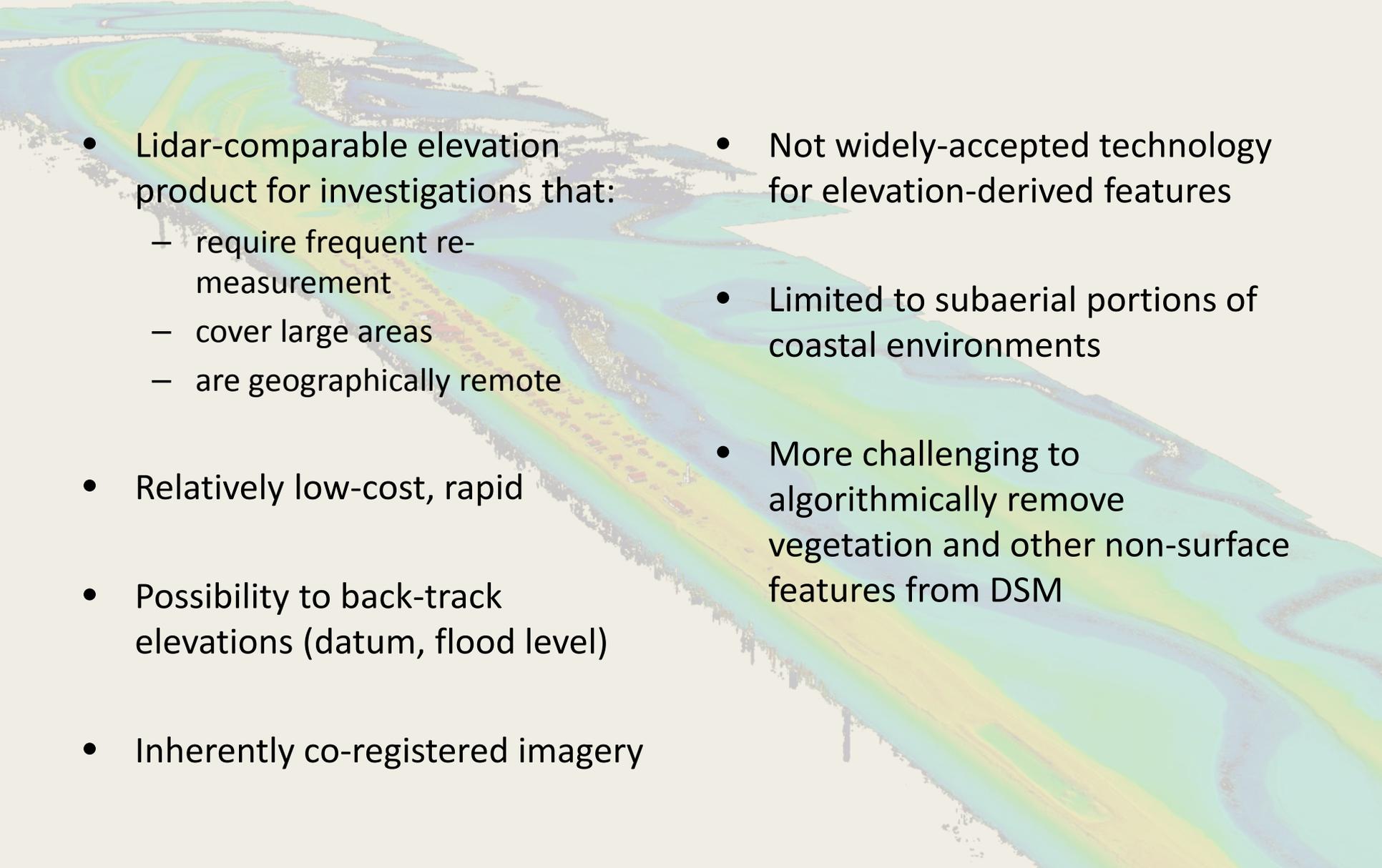


THE PROS

- Lidar-comparable elevation product for investigations that:
 - require frequent re-measurement
 - cover large areas
 - are geographically remote
- Relatively low-cost, rapid
- Possibility to back-track elevations (datum, flood level)
- Inherently co-registered imagery

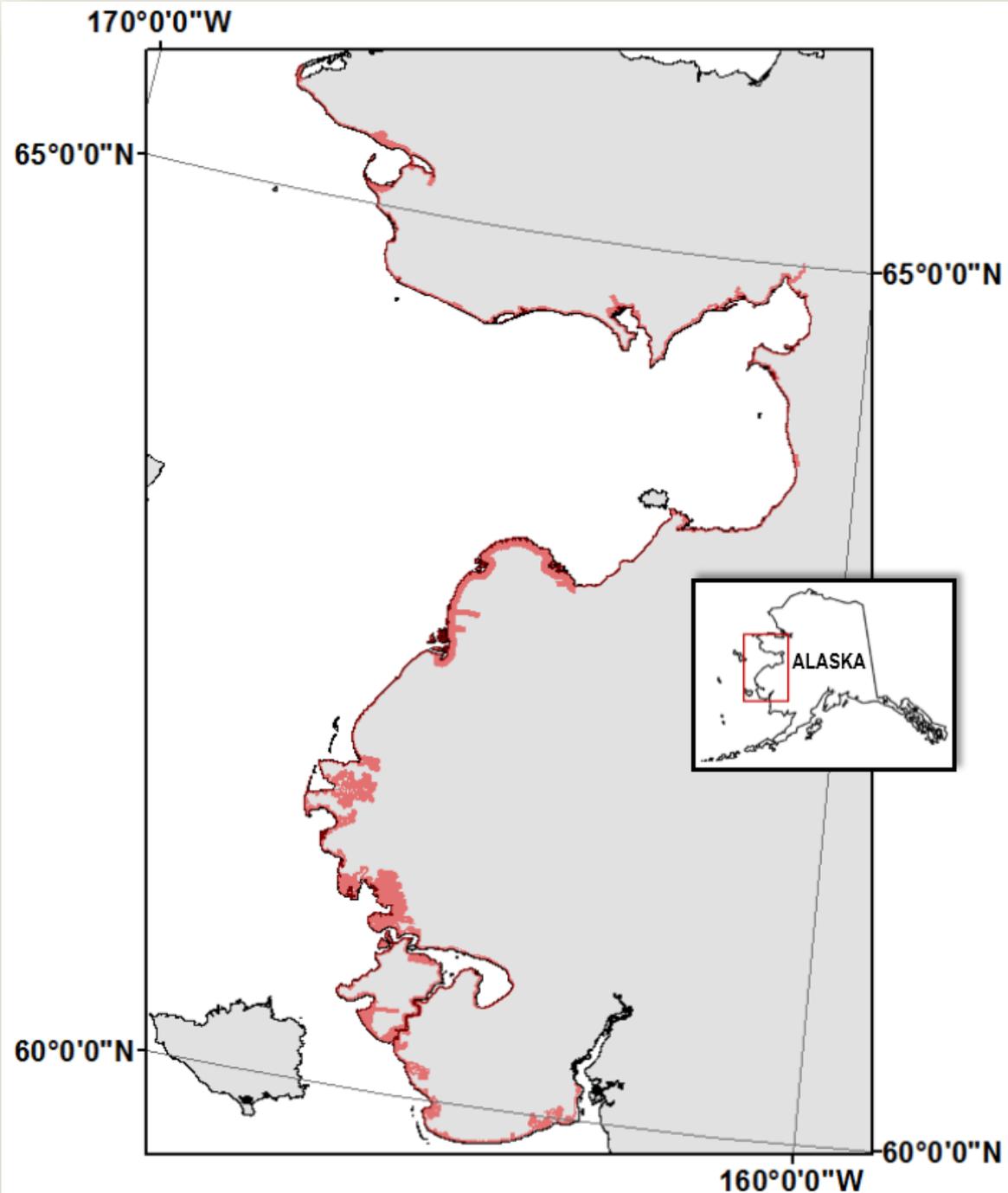
...AND CONS

- Not widely-accepted technology for elevation-derived features
- Limited to subaerial portions of coastal environments
- More challenging to algorithmically remove vegetation and other non-surface features from DSM



2015 PLANS

- Approximately 3,500 km collection
- 1.5 – 5 km swath
- Tide-coordinated
- Independent ground control
- Open-source data products



THANK YOU!

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Special thanks to Alex Gould (DGGs) and Fairbanks Fodar

Also, see paper for minimal DEM guidelines for elevation-derived vector projects

