

Airborne LiDAR and stereo-photogrammetric characterization of permafrost landscapes and thaw subsidence

I. Nitze, G. Grosse, J. Boike, M. Langer, H. Lantuit, S. Lange, Inge Grünberg, V. Helm, T. Sachs, J. Hartmann, A. Kumar, J. Brauchle, T. Bucher, M. Gessner, K. Kohnert



Introduction



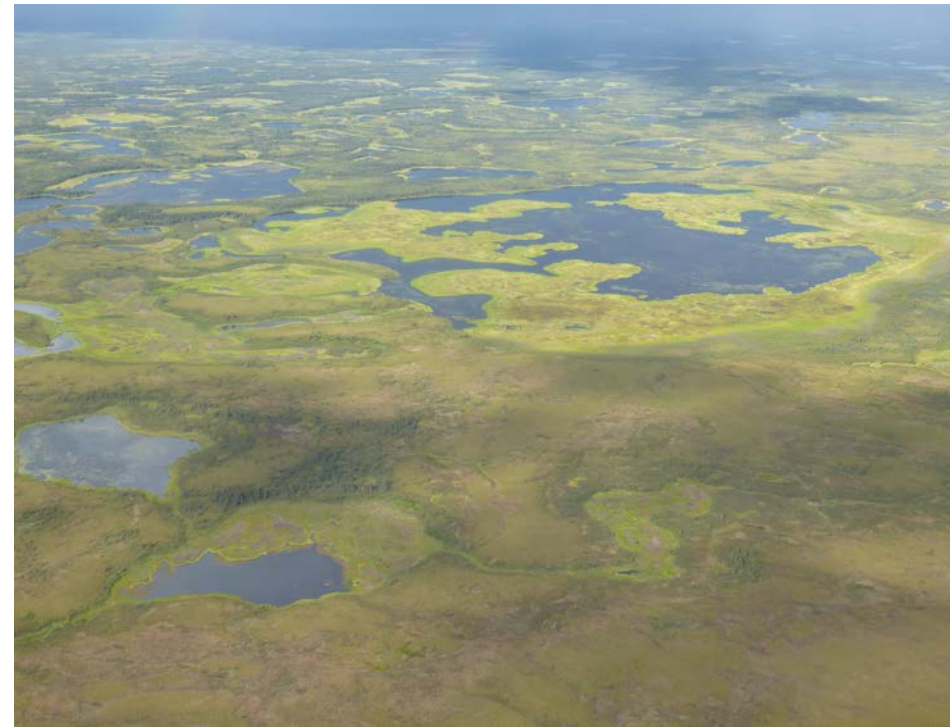
Introduction

- Dynamics of permafrost landscapes
 - Horizontal and vertical displacement
 - Erosion, subsidence, frost heave



Introduction

- Bio-geochemical Cycles
 - Carbon, Hydrology



Introduction



- Infrastructure
 - Roads, Houses, Pipelines, Cultural Heritage



Photo: J. Moore, Alaskan Highway, Alaska



Introduction



Platform & Instruments



Target: Multitemporal VHR Elevation

Lidar: Point, Full-waveform

VHR optical: DLR MACS, Nikon Cam (Photo+Video)

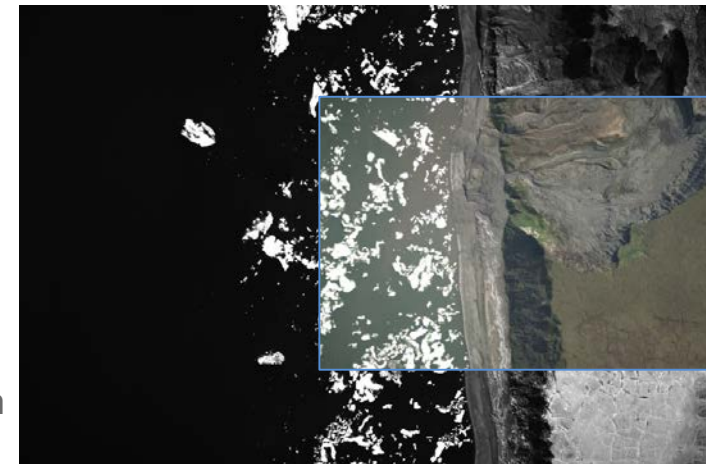
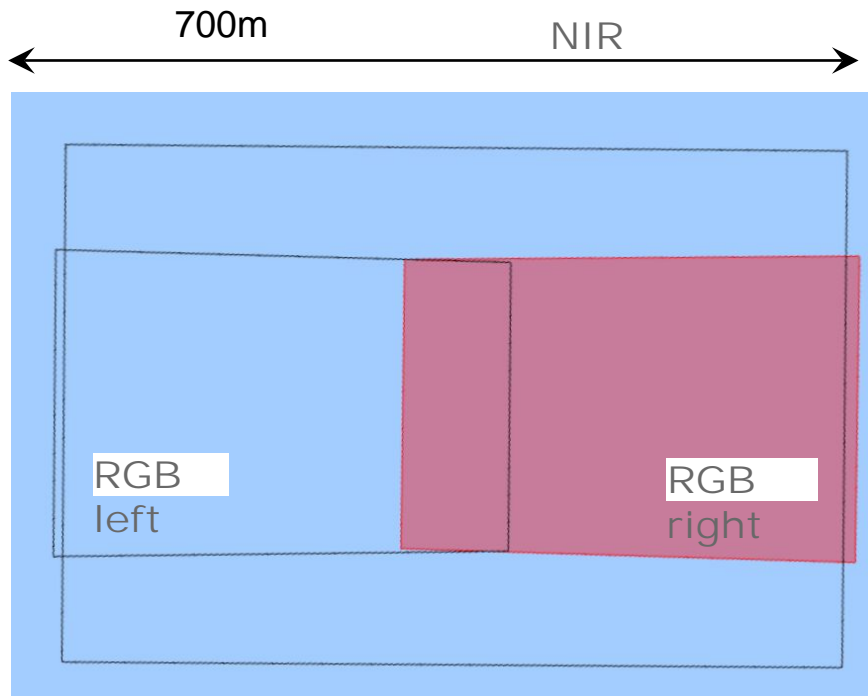
(Atmosphere: Methane, CO₂, ...)

(Radar)



MACS

- GSD NIR: 15 cm per pixel
- GSD RGB: 9 cm per pixel → ~120 pixel per m²
- Overlap @ 3 fps: 93%
- 1 scene = 3*20 MB



Past Campaigns



2016
2019

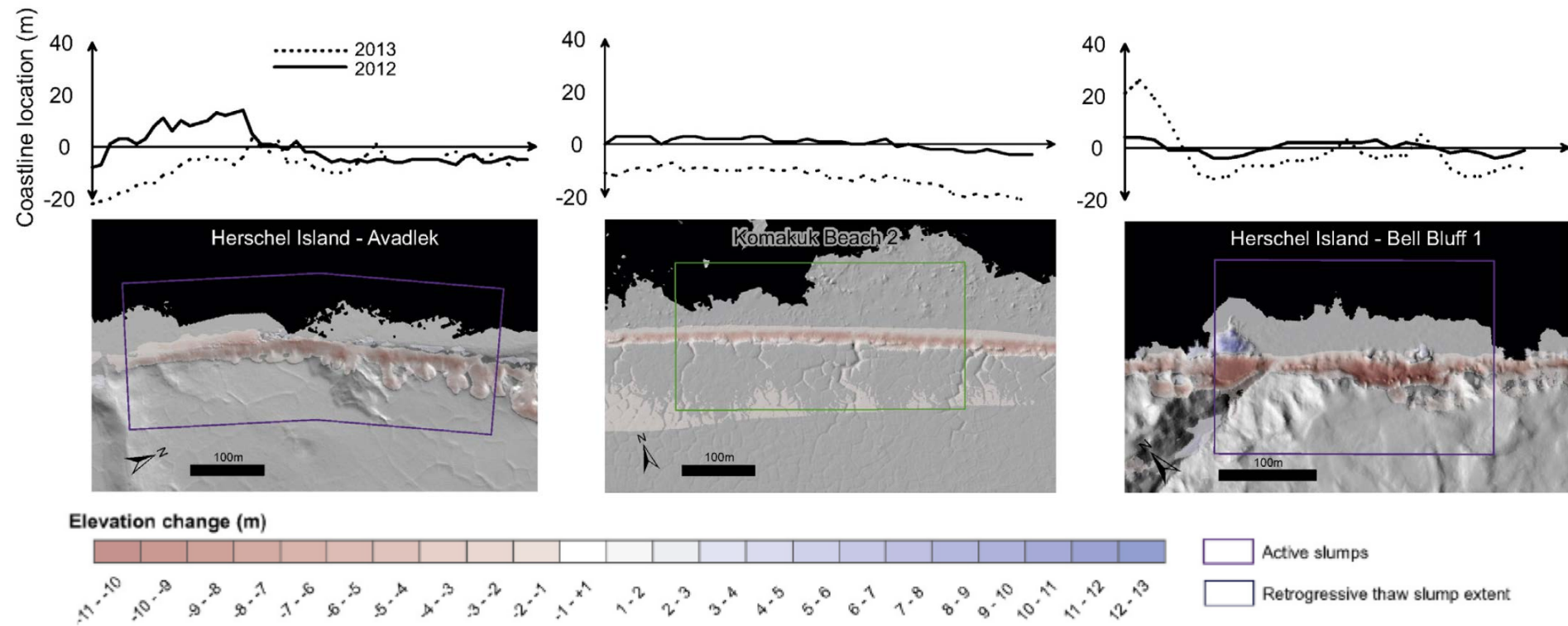
2012
2013
2016
2018

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2018 Google
Image Landsat / Copernicus
US Dept of State Geographer

Go

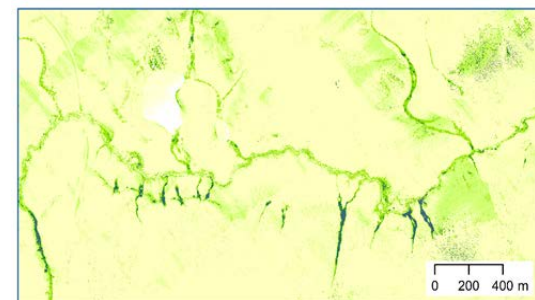
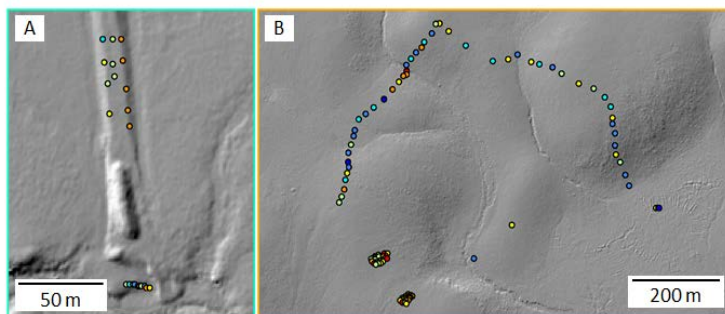
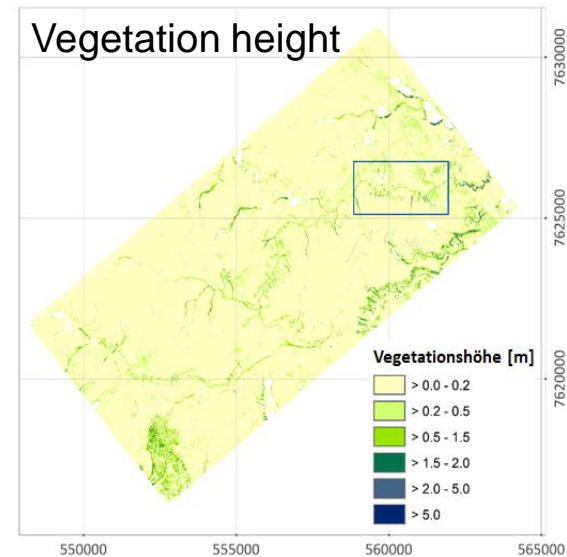
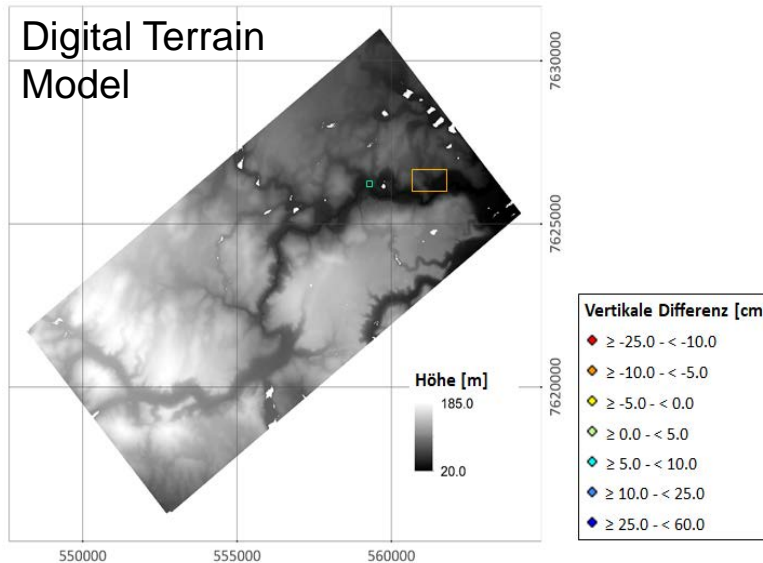
Yukon Coast Changes

- Repeat Lidar 2012, 2013
- Coastal Processes



Canada MacKenzie Delta Region

Polar 5 Airborne Laser Scanning 2016-Product examples

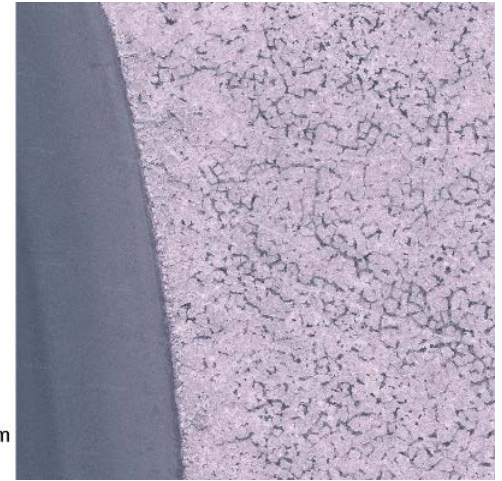
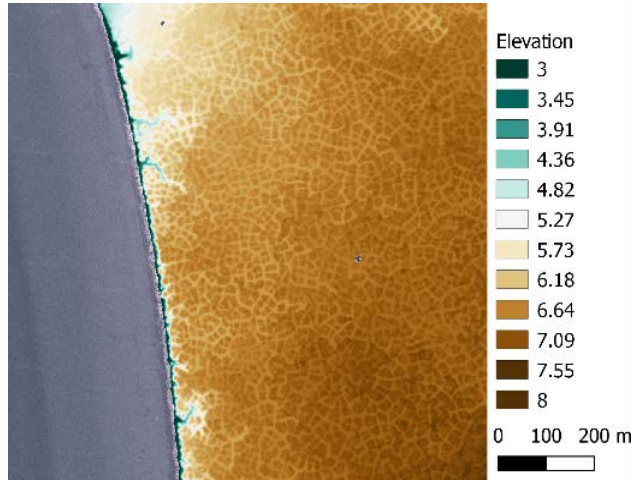
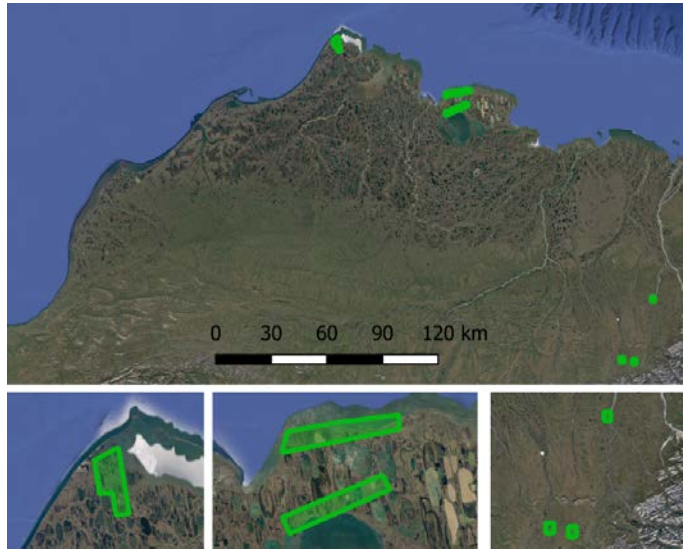


Antonova et al. 2019. Estimation of forest properties in a treeline zone using TanDEM-X and airborne laser scanning data. Remote Sensing of Environment.

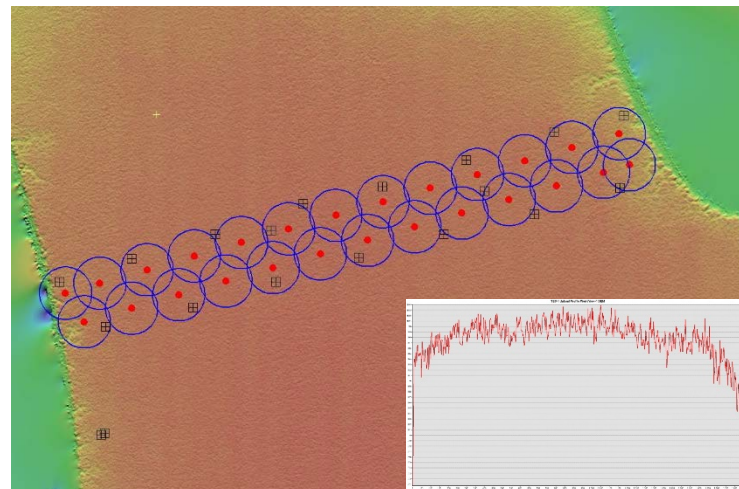
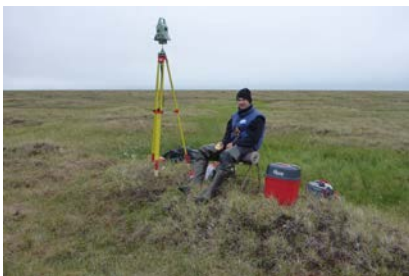
Alaska 2016



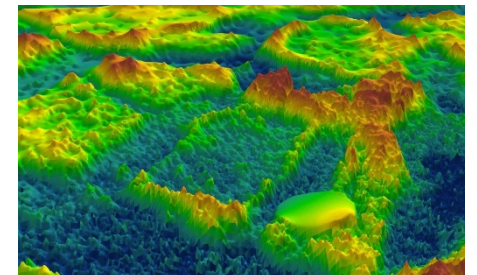
Multi-scale analysis: aerial and terrestrial survey



Teshepkuk Grid – Lidar DTM (Thx to Veit Helm)



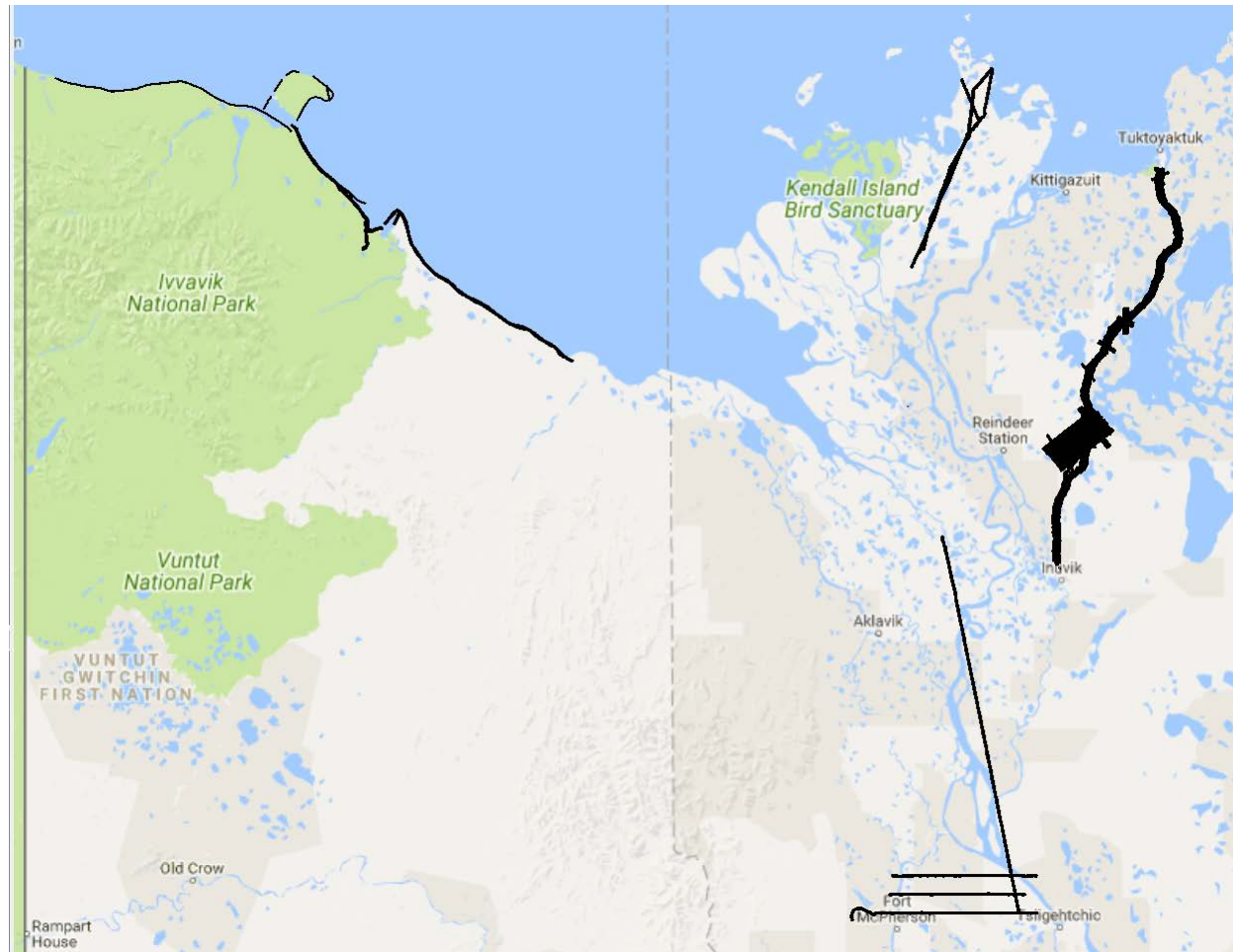
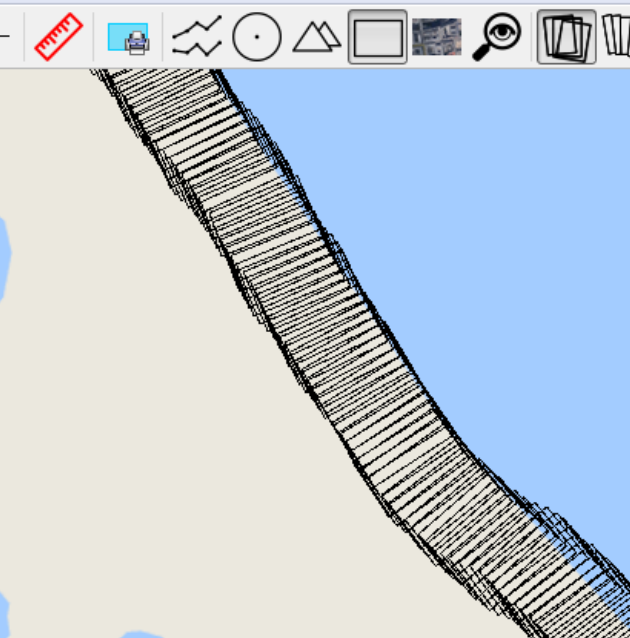
- ⊠ Benchmark
- MS50 Station
- Laser scan



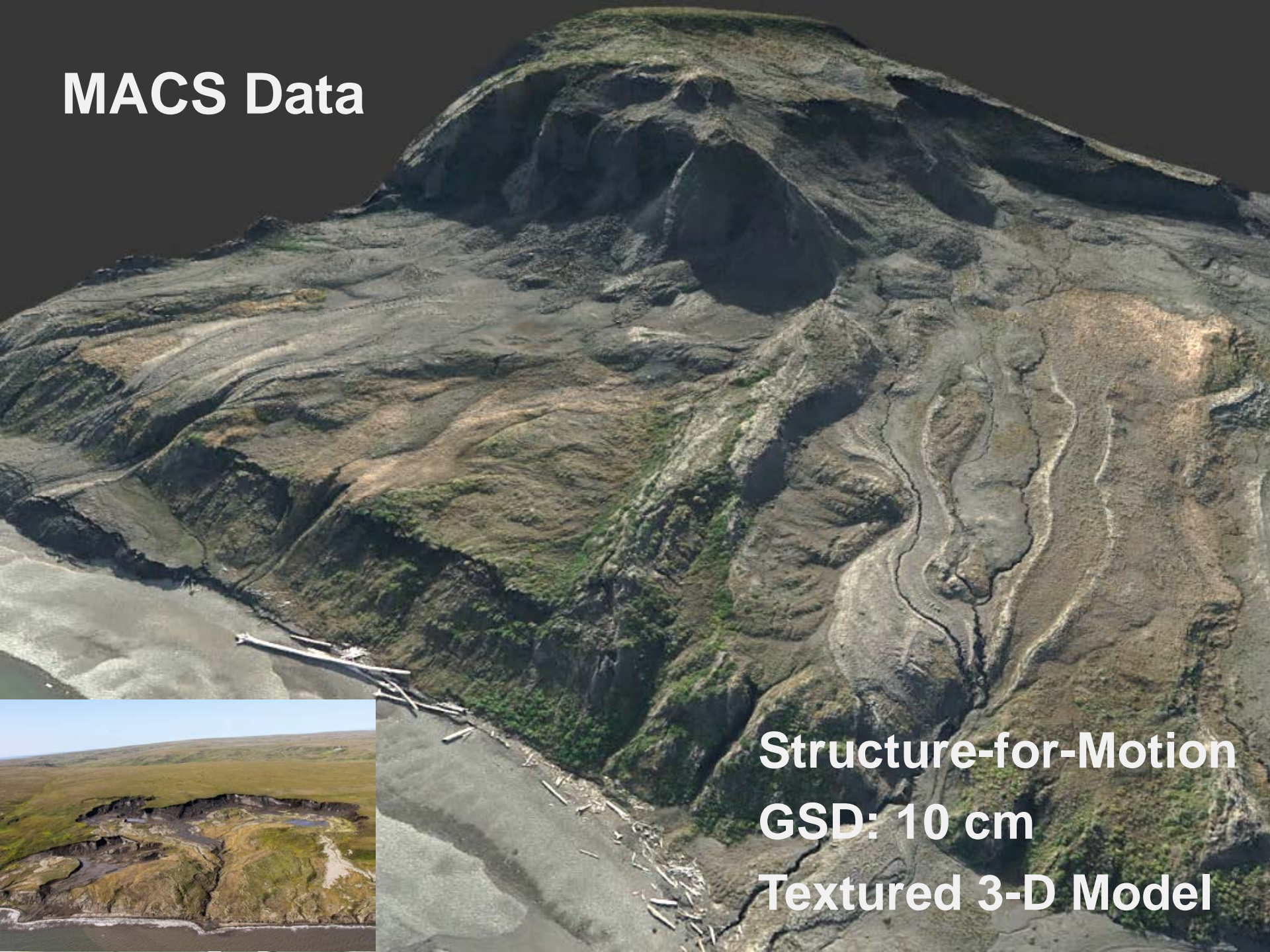
MACS Data – Canada 2018



- ca. 1,000 km² coverage
- 3 x 70,000 images
- 4 TB



MACS Data



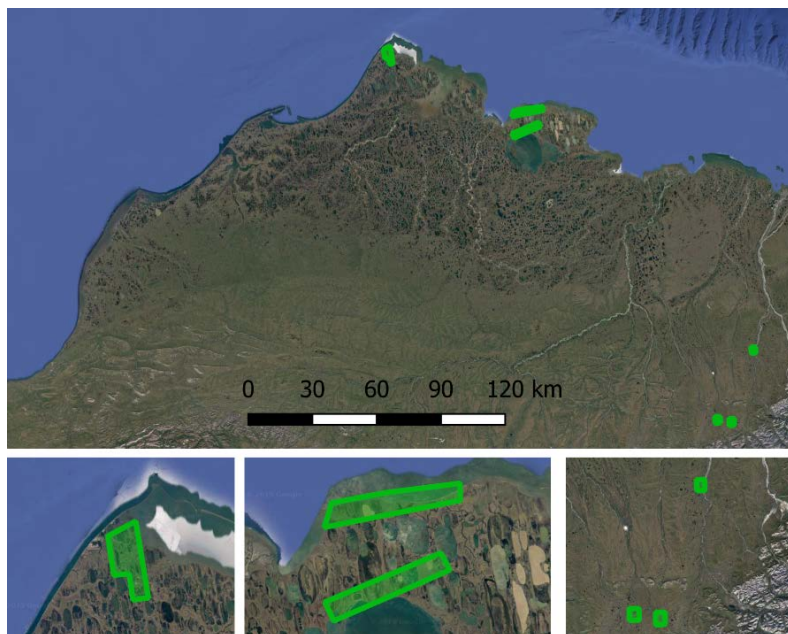
Structure-for-Motion
GSD: 10 cm
Textured 3-D Model



Alaska 2019 – start in 3 weeks

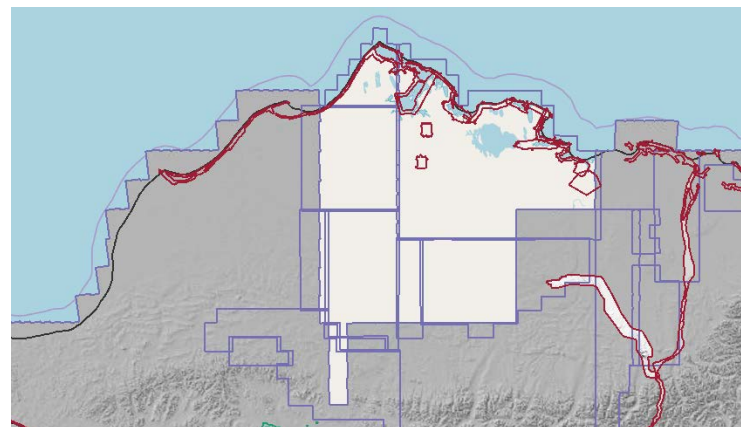


Campaign 2016

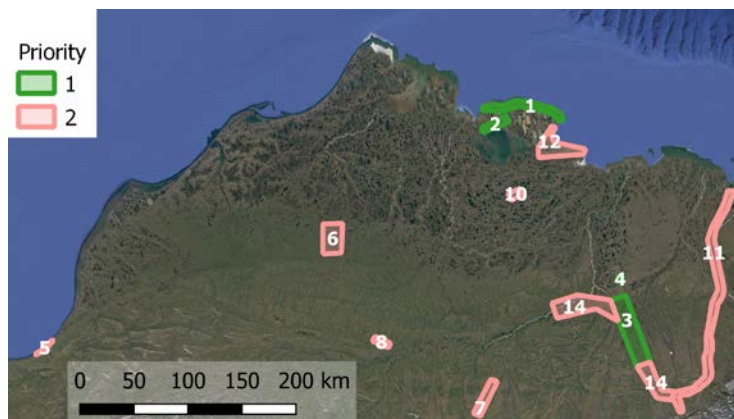


Publically available DEM

- Lidar
- IfSAR
- Structure For Motion



Repeat Measurements
Multitemporal VHR-
DEM/DSM



Challenges



- Data storage and processing
 - Increasing amounts of data
 - Who is processing them?
- Data heterogeneity
 - Lidar, optical
 - Spatial resolution
- Target specifics
 - Scale dependency
 - Challenging flight conditions

- AWI's aircraft infrastructure for
 - Creation of repeat DEM/DSM data
 - „Standard“ sensors: Lidar
 - „Experimental“ sensors from DLR
- Challenges
 - Amount of data
 - Data Heterogeneity
- Validation and Scaling
 - Terrestrial surveys

Thank You!



Contact: ingmar.nitze@awi.de