

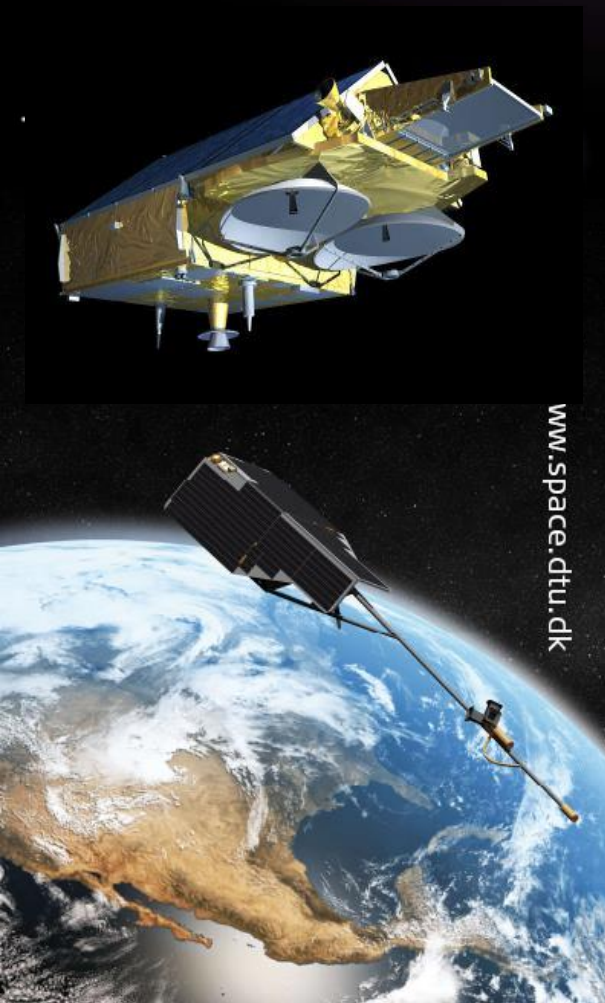
25 years of airborne multi-band altimetry ESA CryoVEx campaigns and related campaigns in the Arctic and Antarctica

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S Simonsen and other DTU Space colleagues*

+

Malcolm Davidson, Tania Casal (ESA)

www.space.dtu.dk



DTU Space Airborne remote sensing 1996-present

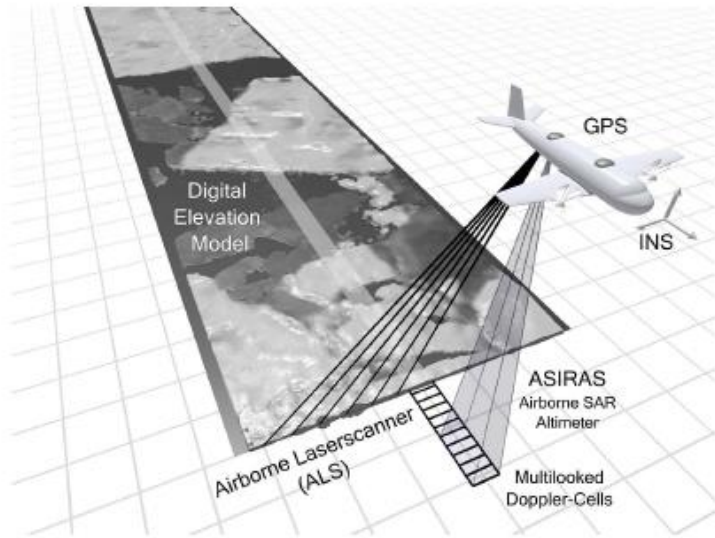
Primary platform: Twin-Otter "POF", Air Greenland / Nordlandair, Akureyri, Iceland

- *Historical Twin-Otter (ex CIA - covert operations in Vietnam War), services radar stations on Greenland ice sheet from 1976, military Sirius patrol, Greenland settlements re-supply, polar expeditions in Arctic and Antarctica, NASA GC-NET ++*
- *Versatile and easy installation of instruments, long operational range (5.5+ hr)*



Other platforms used:
BAS Twin-Otter (Antarctica)
Ken Borek DC3 + Twin-Otter (Arctic Ocean + Antarctica)





KAREN Radar:

- Ka-band 34.525 GHz
- Footprint area: 12m x 5m
- Range resolution: 0.1650m

ASIRAS Radar:

- Ku-band 13.5 GHz
- Footprint area: 10m x 3m
- Range resolution: 0.1098m

Laser scanner (Riegl LMS Q240i)

- Near-infrared, 40 Hz
- Resolution: 1m x 1m
- Swath width: 300m

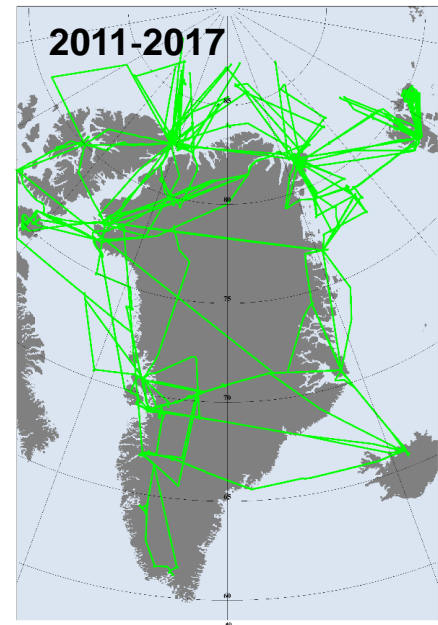
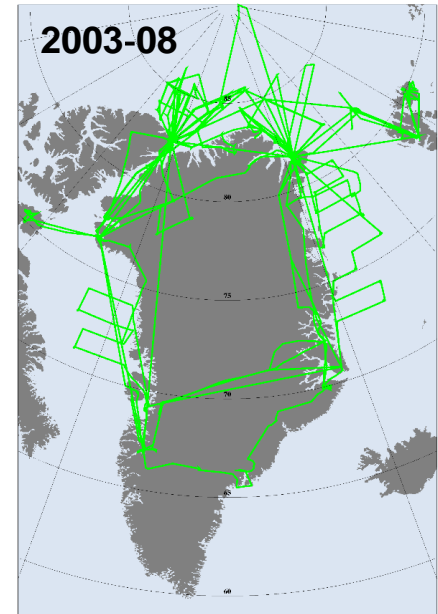
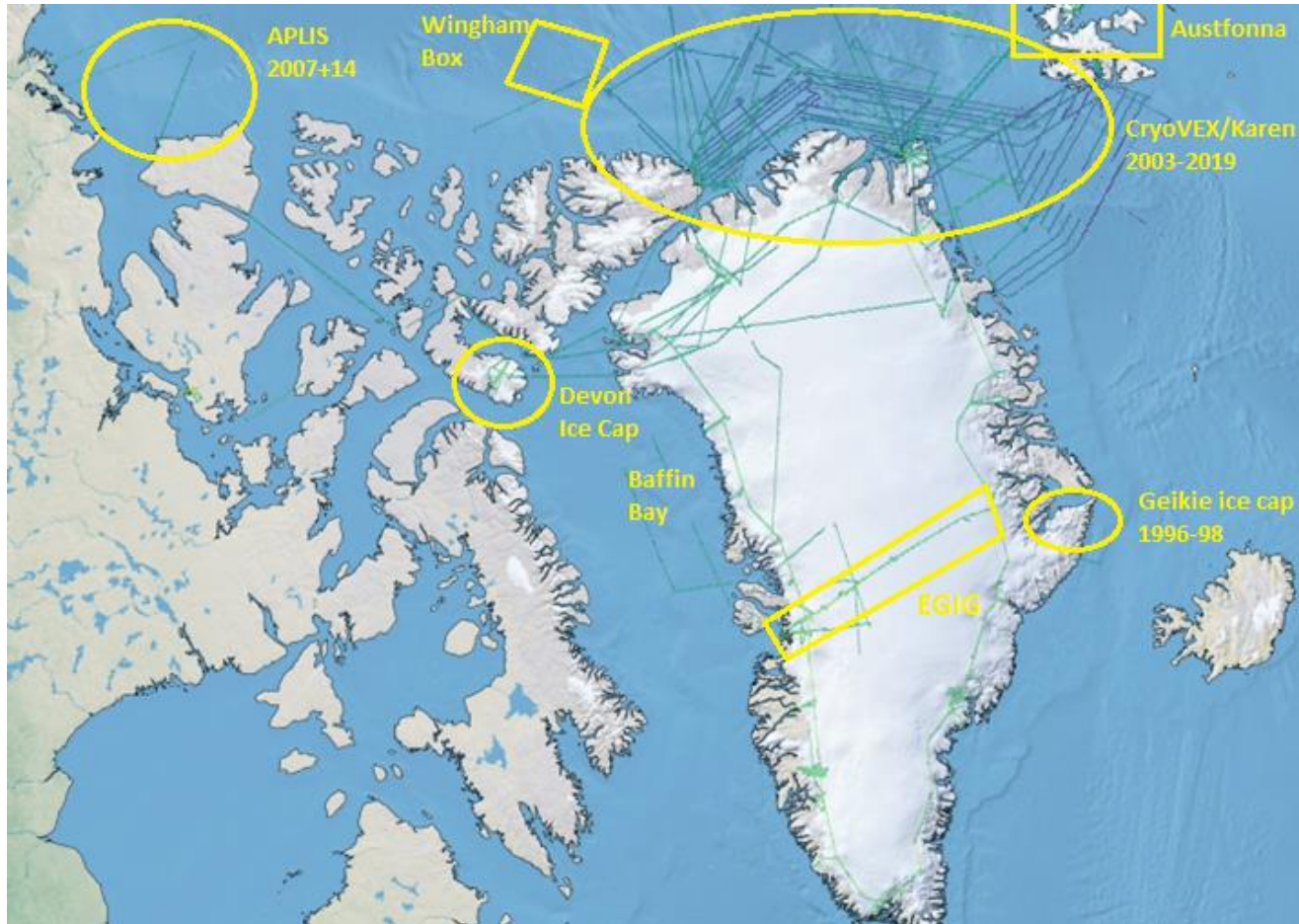
GPS/INS precise positioning+attitude

Auxillary instruments:

Radiometer (HUTRAD-CIMREX2019)
Imagery, video, NIR imagery, gravity,
ESA/ONERAcold atom interferometry
(Iceland 2017) ...



Key Arctic campaign areas ..

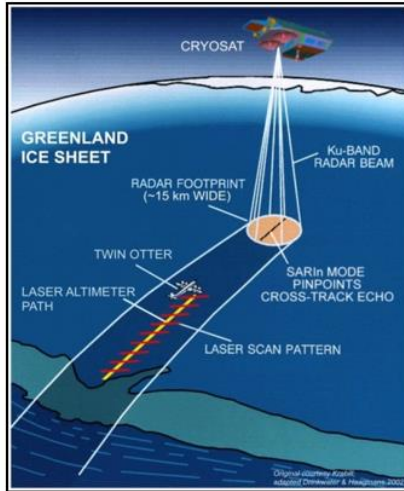
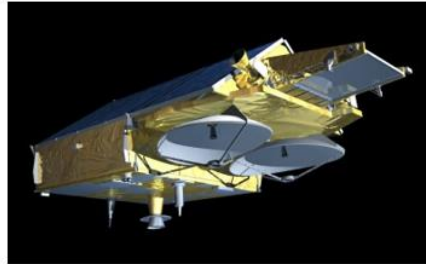


Logistics operations bases: Station Nord, Alert, Eureka, Svalbard, Ilulissat



CryoVEx validation 2003-present ..

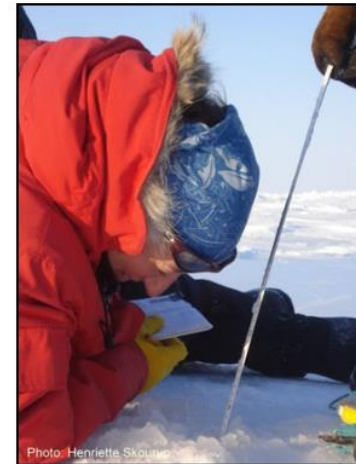
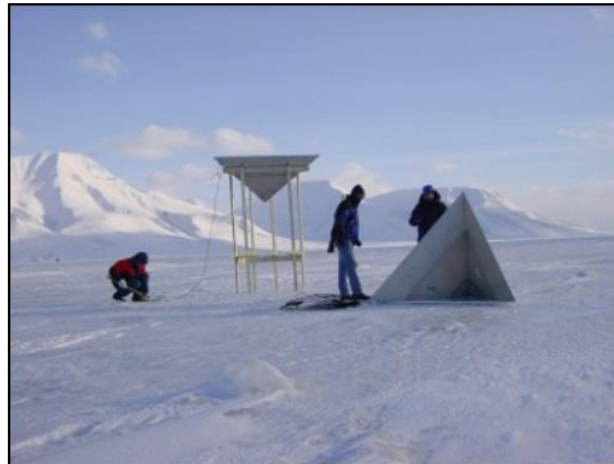
Global



Regional



Local



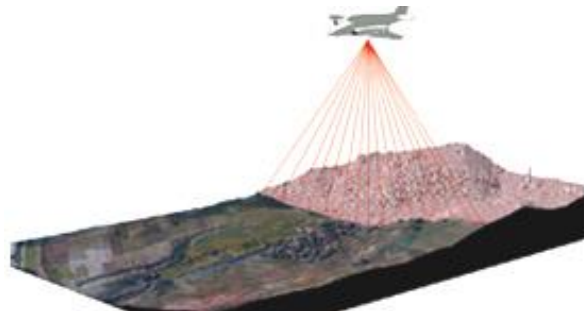
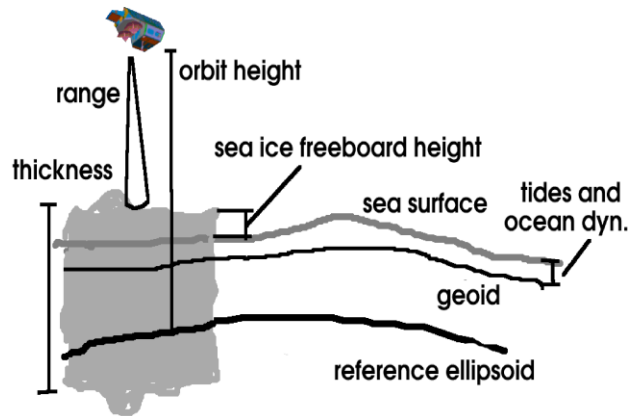
Sea ice thickness from aircraft ..

Principle: measurement of ice freeboard ..

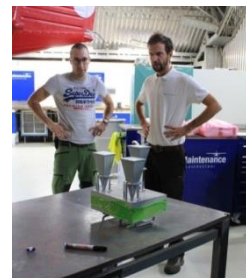
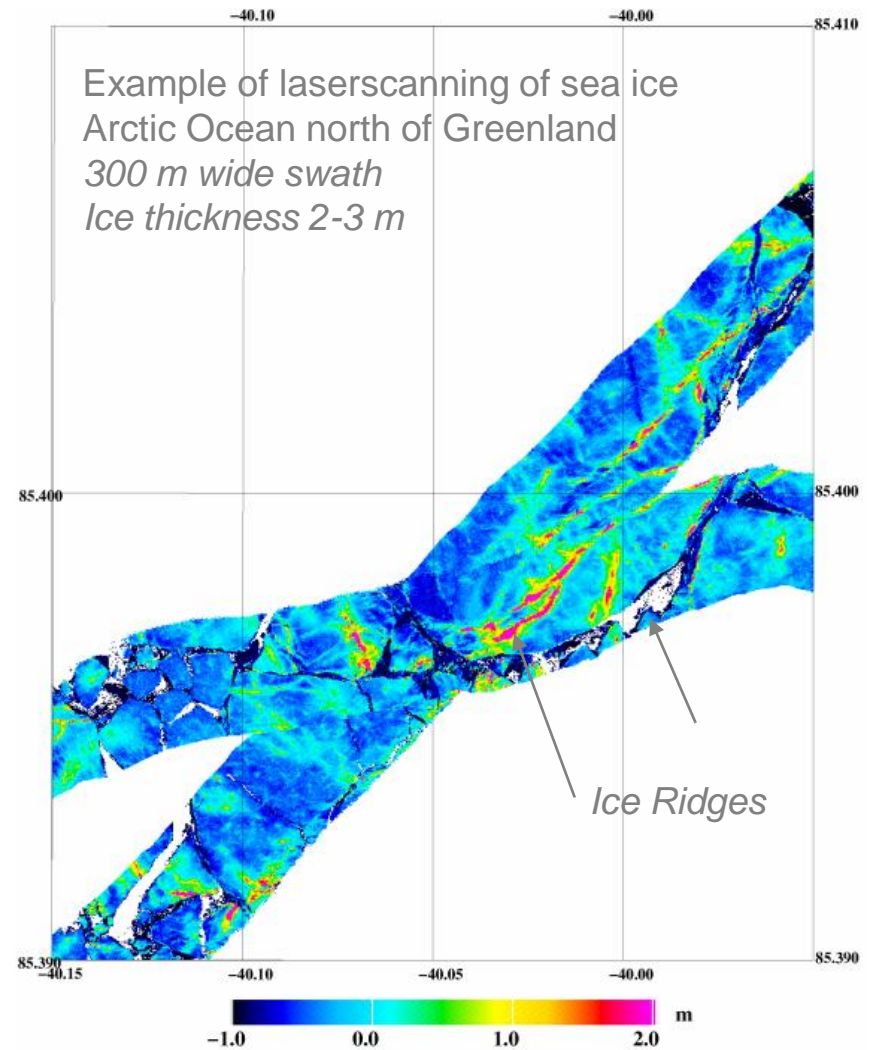
Instruments: Lidar, Ku-band radar (ASIRAS),

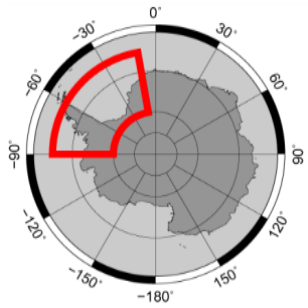
Since 2016:

Ka-band radar (MetaSensing, CRESIS)



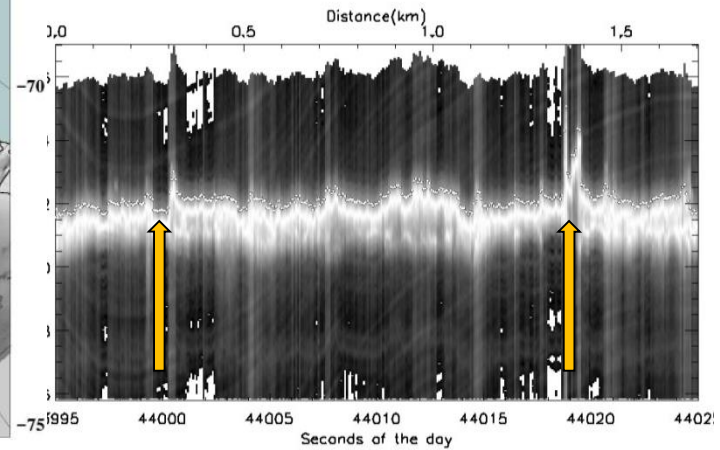
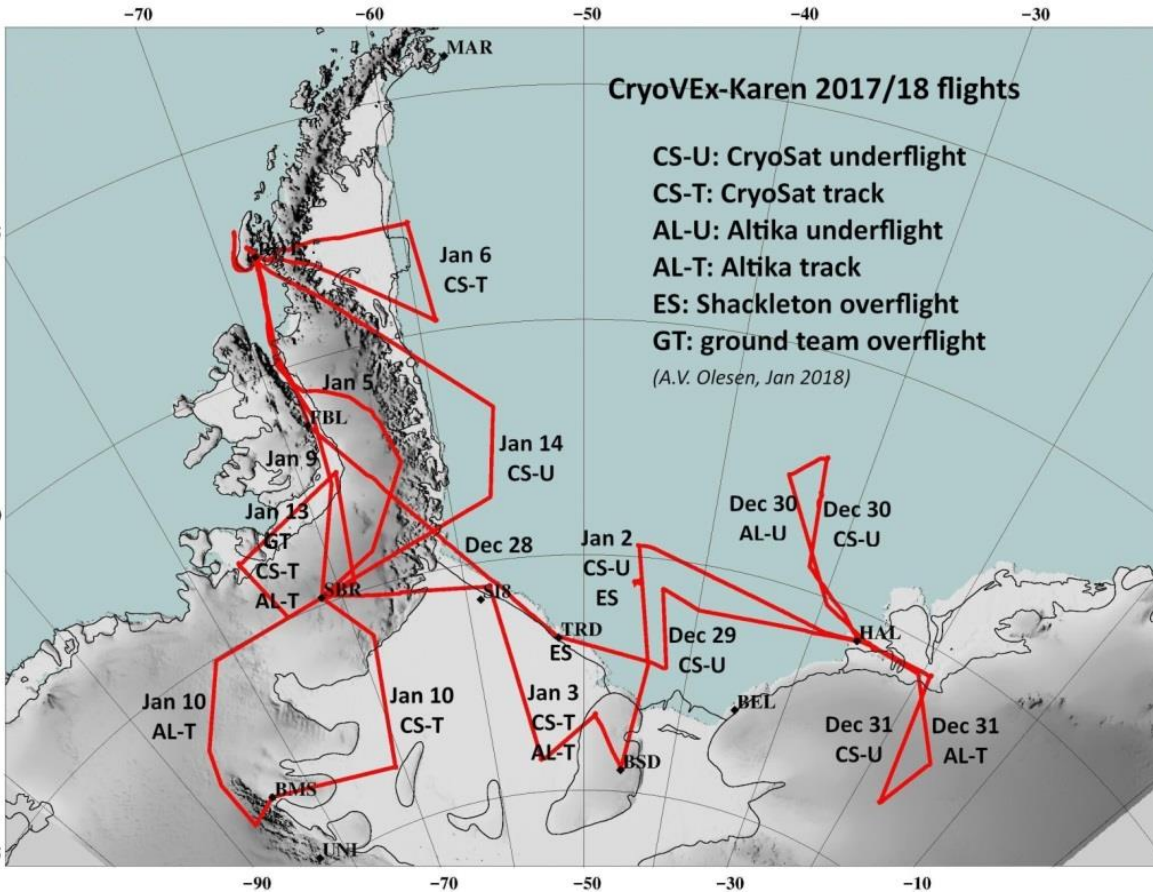
Example of laserscanning of sea ice
Arctic Ocean north of Greenland
300 m wide swath
Ice thickness 2-3 m





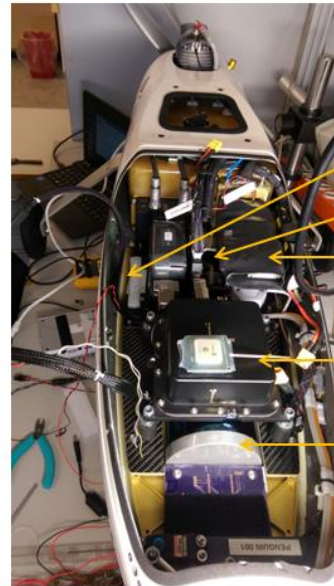
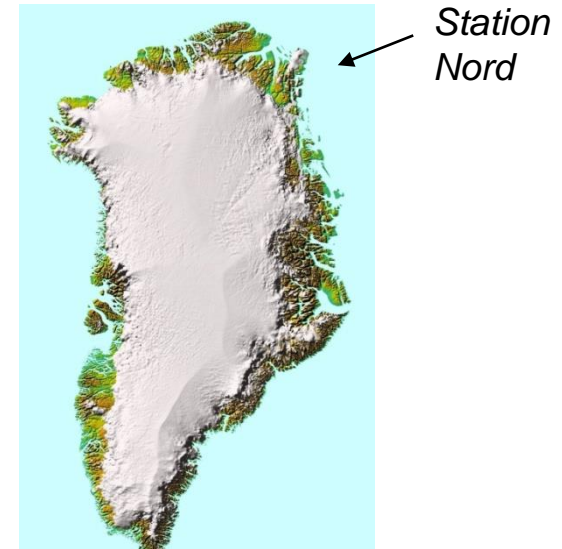
CryoVEx-KaREN Antarctica 2017/18

Lidar + ASIRAS (Ku) + Metasensing (Ka)
Ice cap and sea ice ground truth: U Leeds/UCL

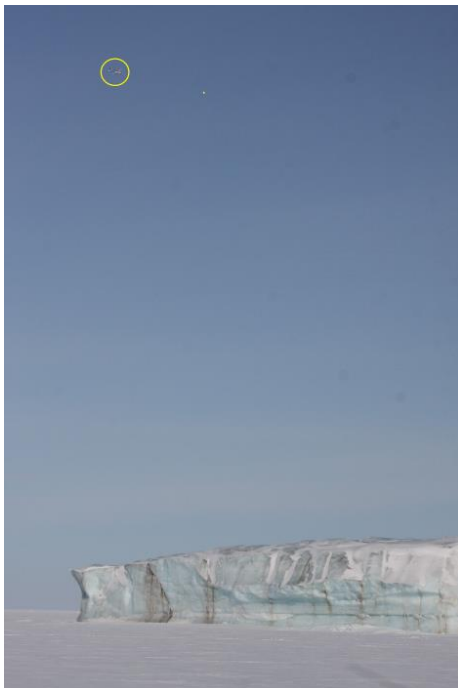
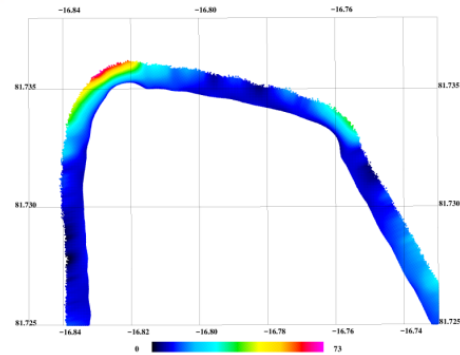


Lidar supplement: Penguin B lidar drone – St. Nord 2018 -

Payload 10 kg – primary use: sea ice monitoring, Fram Strait
 Year-round BVLOS operations ... 300 km range, 5 cm accuracy
 No Nord access 2019 (Svalbard Schengen issues), 2020 (Covid-19) ...



- Science computer
- Autopilot controller
- GoPro camera below
- Iridium
- GPS/IMU
- Lidar



Upcoming campaigns:

- CryoVEx 2021 – Station Nord??
 - Yackel / Stroeve sea-ice ground truth along coincident CS-2/IS-2 track
 - AWI EM-bird coordinated flights
- CryoVEx 2022 – Nord, Eureka, EGIG line
 - Canadian ground truth teams
 - New CRESIS broad-band snow radar

ESA CryoVEx campaigns continue to deliver reach data series over ice caps and sea ice for validation and research ..

<https://earth.esa.int/eogateway/campaigns>

