Dual-frequency airborne radar measurement for potential estimates of snow depths

2021 DUAL-CRYO | Workshop on Dual-Band Altimetry of the Cryosphere

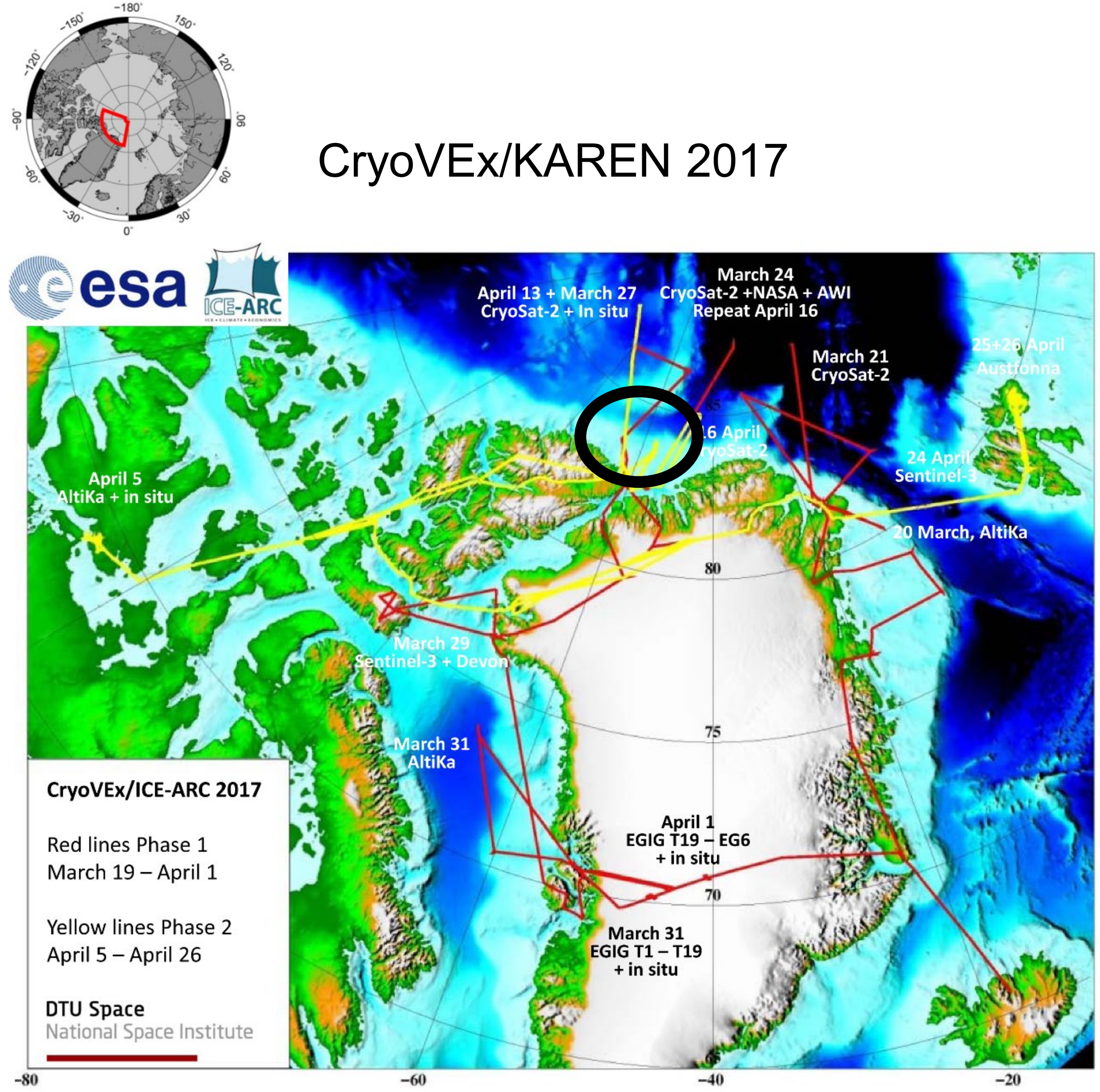
H. Skourup, S. M. Hvidegaard, A. Di Bella, M. L. Kristensen, R. Forsberg,
A. Coccia, V. Helm, R. Tilling, T. Casal, and M. W. Davidson

DTU

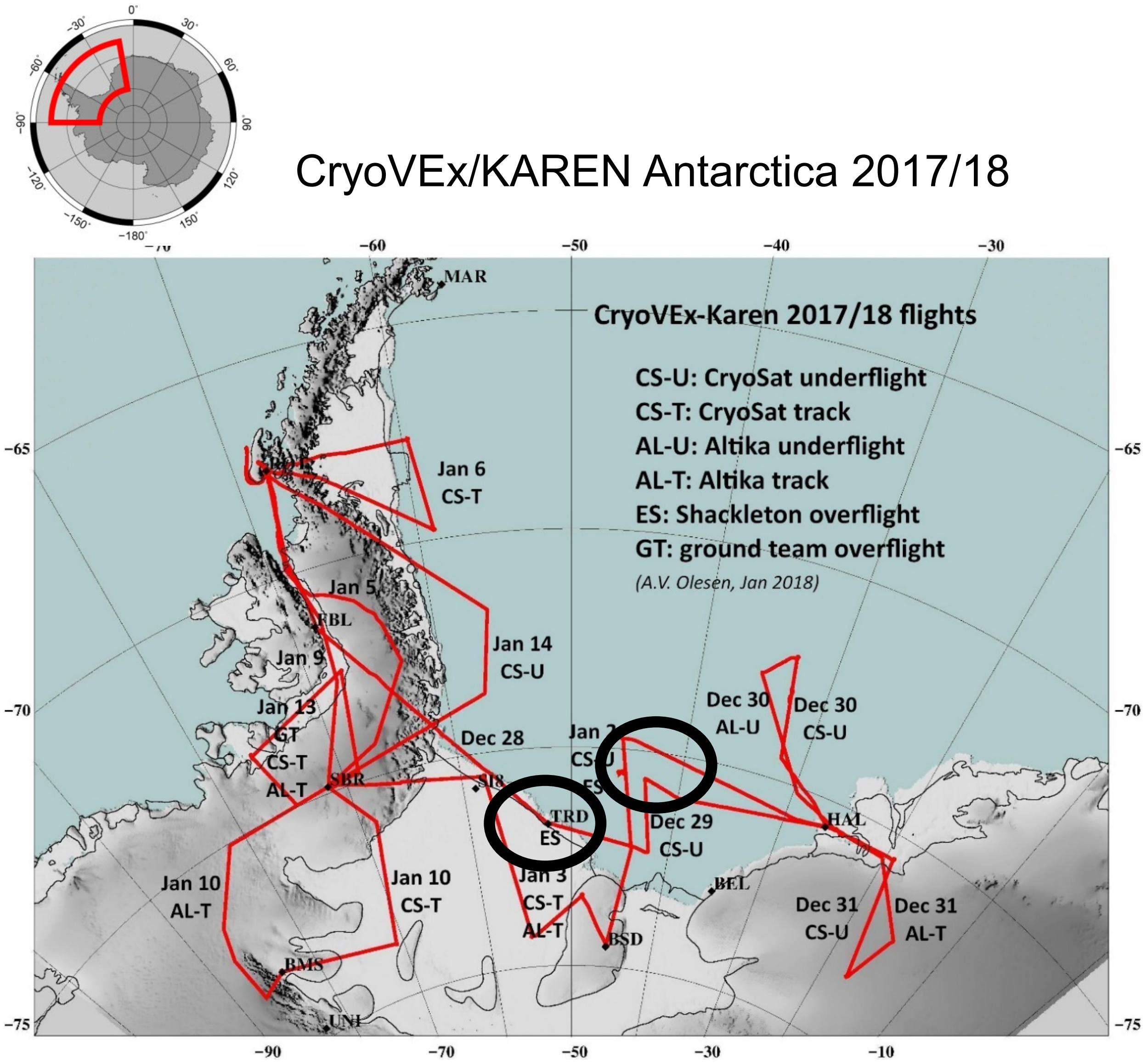
DTU Space
National Space Institute

Overview

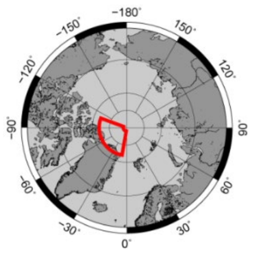
CryoVEx/KAREN 2017



CryoVEx/KAREN Antarctica 2017/18

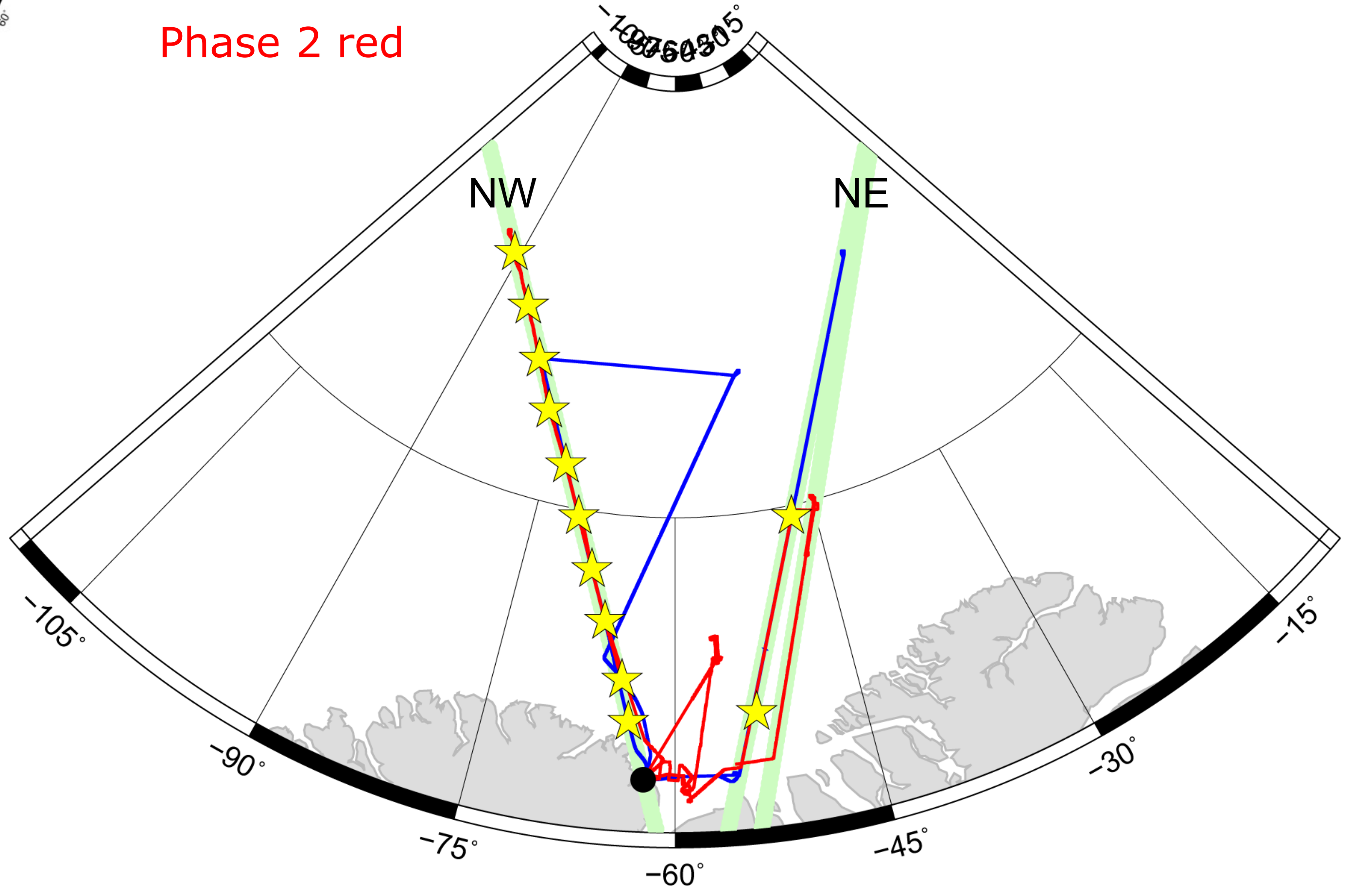


CryoVEx 2017 campaign



Phase 1 blue

Phase 2 red



NW-track:
March 27
- ESA CryoVEx (ALS, ASIRAS, KAREN)

April 11-18
- In Situ measurements

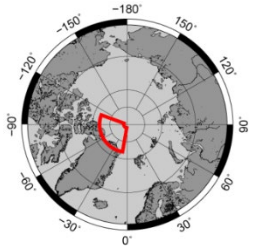
April 12
- CS2 orbit # 37159
- NASA OIB (ATM, snow depth)

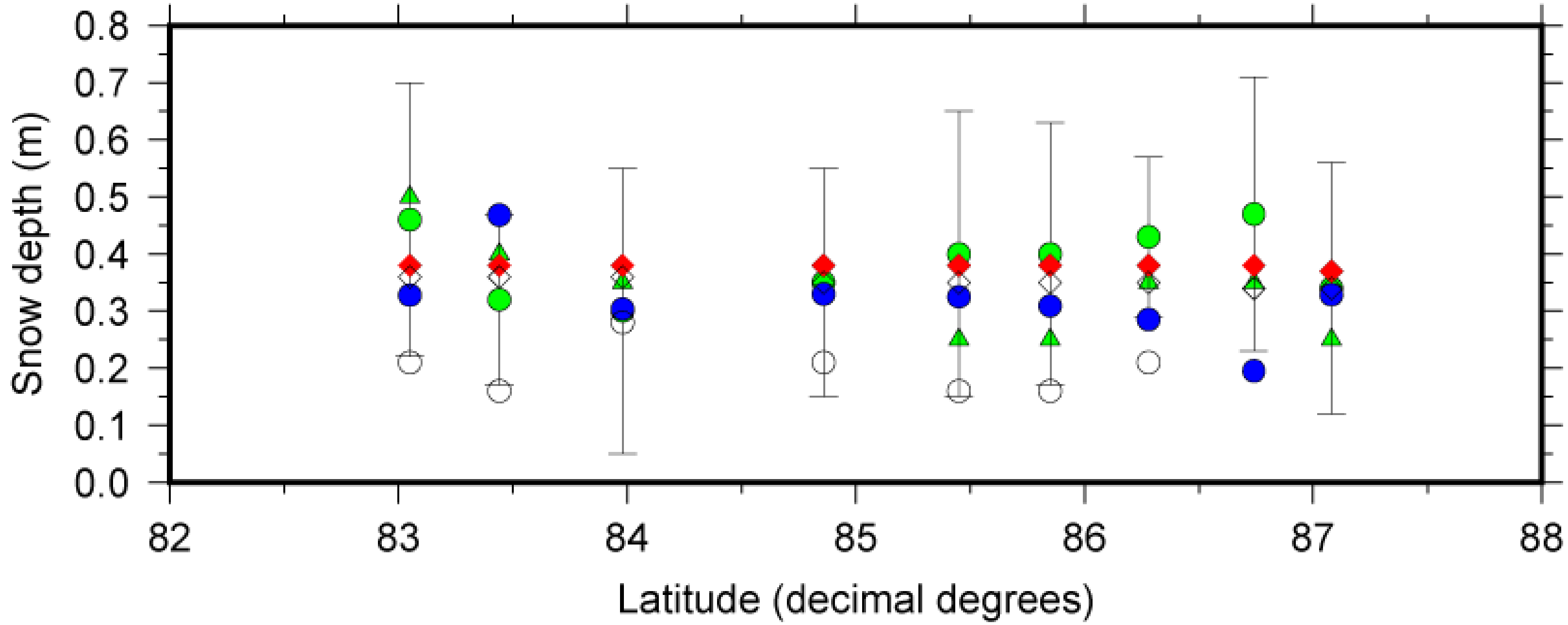
April 13
- ESA CryoVEx (ALS, KAREN)

NE-track:
March 24
- CS2 orbit # 36892
- ESA CryoVEx (ALS, ASIRAS, KARE N)
- AWI Polar-5 (EM sounder)
- NASA OIB (ATM, snow depth radar)
- NASA JPL GLISTIN (Topographic interferometer (ka))

April 16
- ESA CryoVEx (ALS, KAREN)

CryoVEx 2017 snow depth





In situ mean (April 11-18)

In situ mode

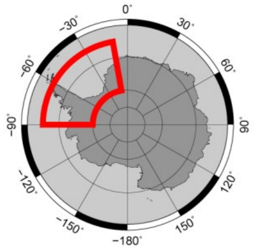
NASA OIB qlooks (April 12)

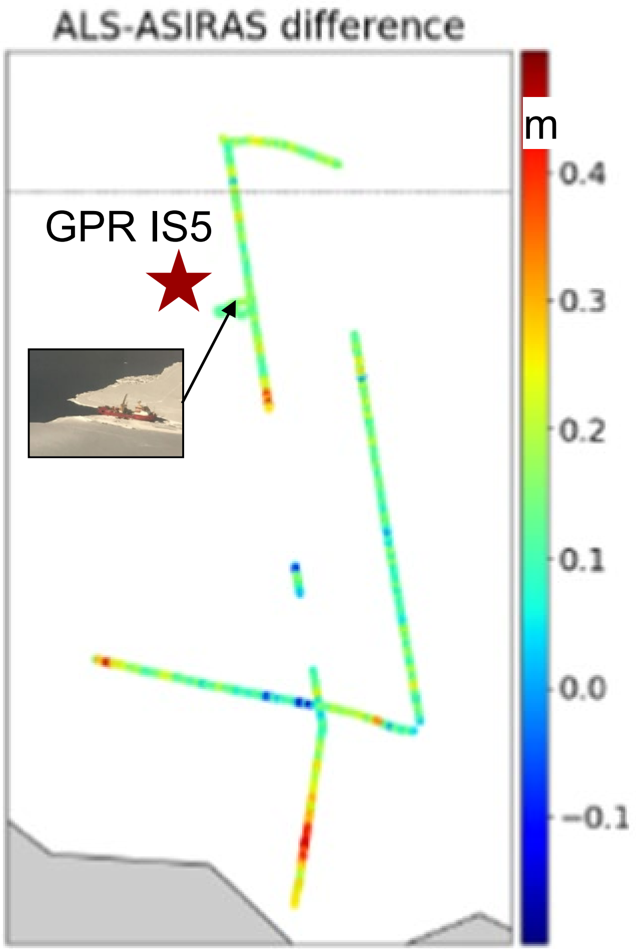
KAREN-ASIRAS TRMFA 50% (March 27)

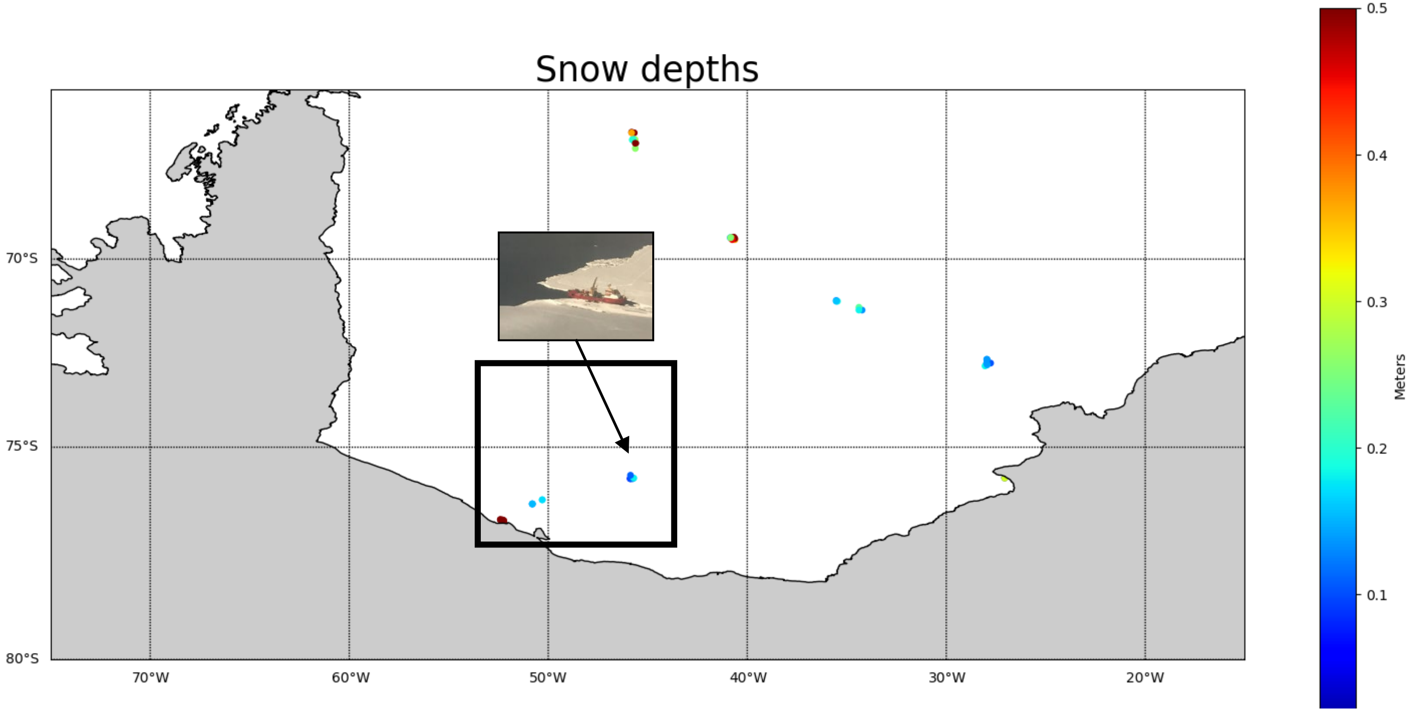
Warren 99 (March)

Warren 99 (April)

CryoVEx ANT 2017/18

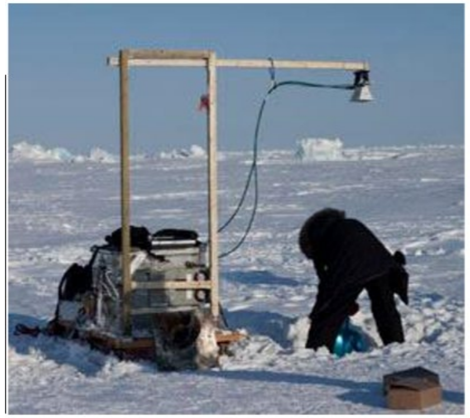


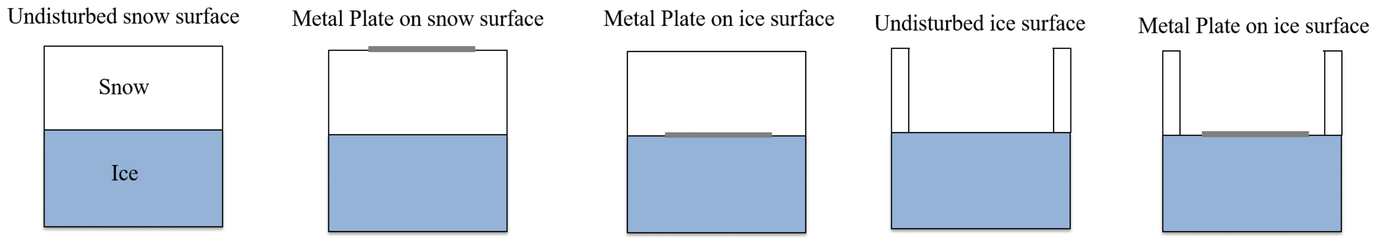




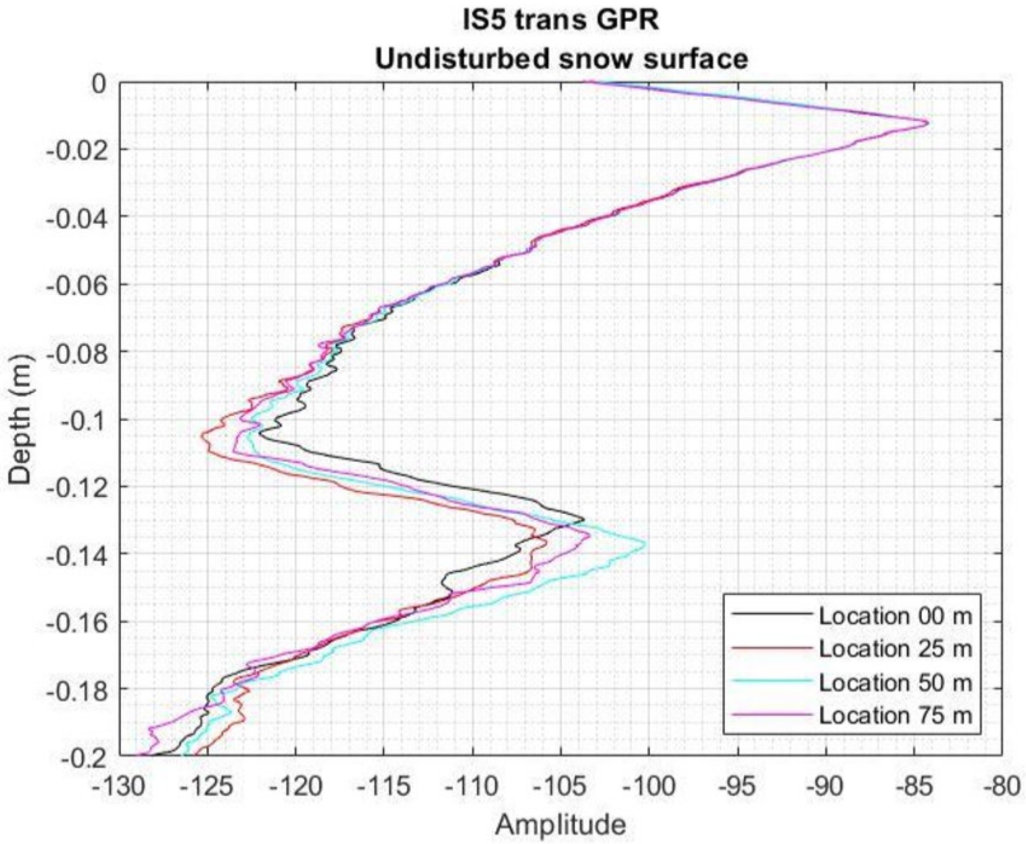
Snow depth (cm)	Mean	std
ALS – ASIRAS[80%]	15.8	8.2
KAREN[50%] - ASIRAS[80%]	10.2	9.9

CryoVEx ANT 2017/18 - GPR





Ground penetrating radar (GPR) works in the microwave band (UHF/VHF frequencies). It is a non-destructive method that uses high frequency polarized waves. During this expedition frequencies between 2-18 GHz were used. By courtesy R. Tilling



Compares the GPR return signal from the undisturbed surface, in 4 different locations. The mean peak to peak distance is 12.25 $\pm$ 1.49 cm By courtesy: Søren Sandbæk Bendtsen, 2021

Conclusions

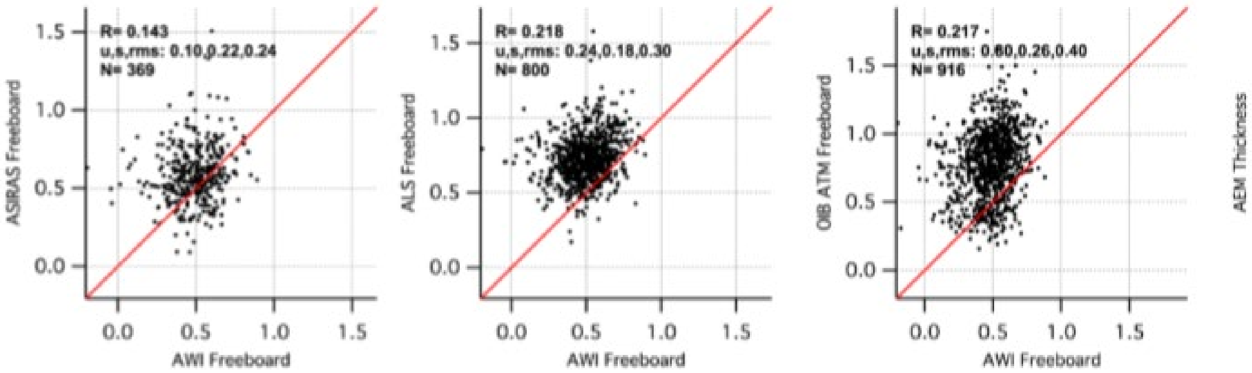
- Retracking needs further investigation
  - Regional dependency
  - Surface roughness
- Can and should be further constrained/validated by in situ measurements
- Link to satellites here especially Antarctica lacks accessible processed sea ice freeboards from satellites
- Link satellite footprint to airborne and in situ measurements

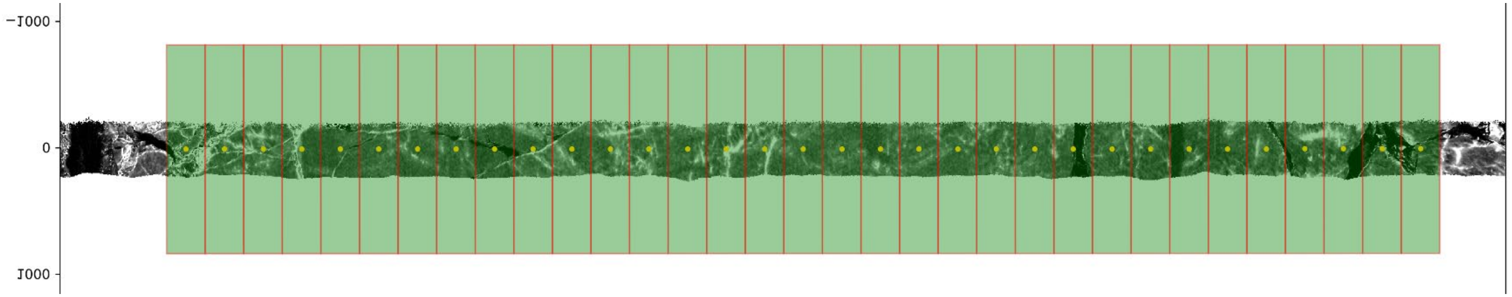
- Utilization of cryo2ice
- Design future campaigns

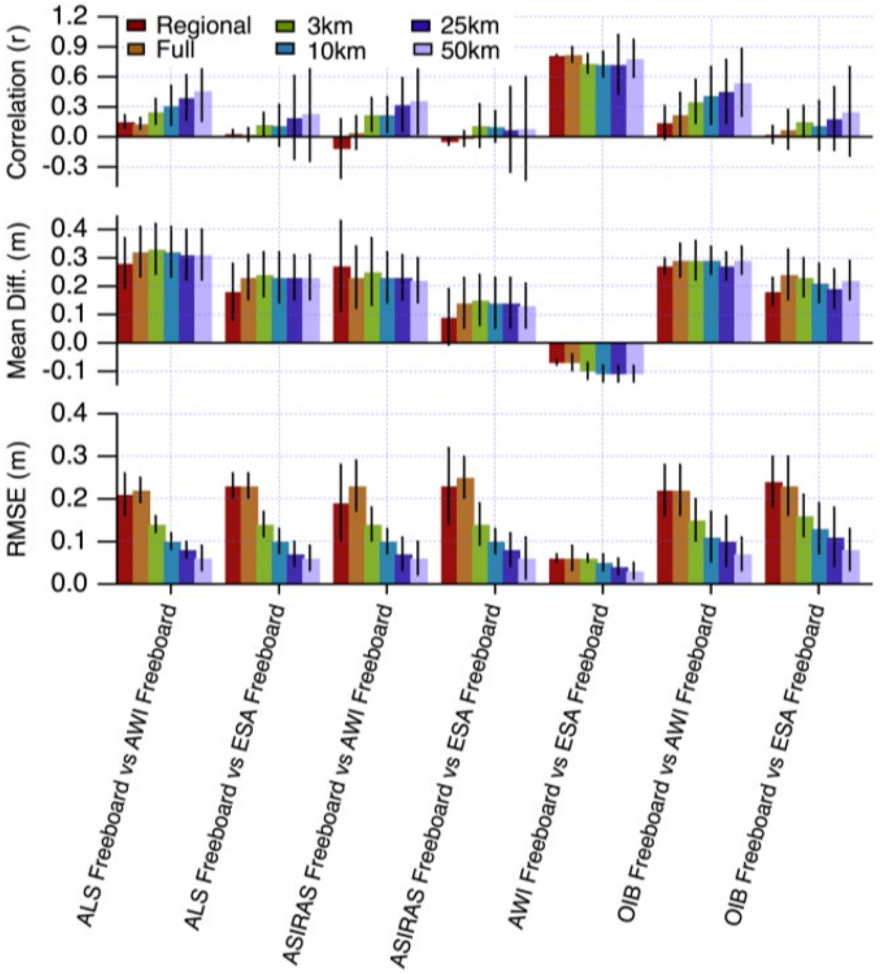
Footprints airborne vs satellites

Airborne sensors vs CS2 freeboards

Averaging airborne data over CS2 SAR footprint (300mx1600m)



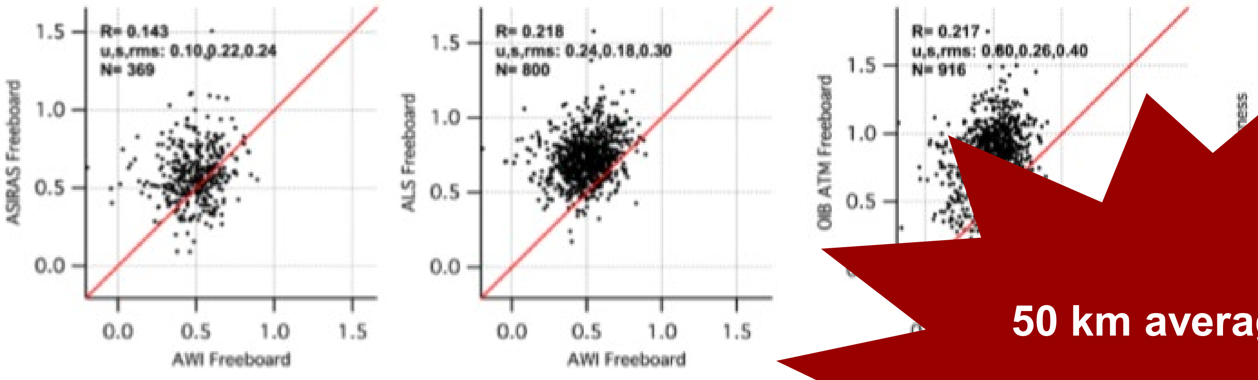




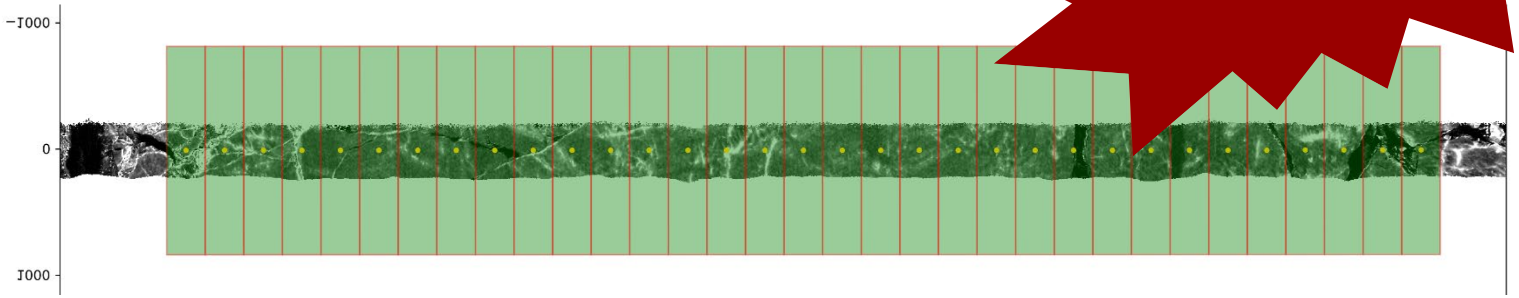
Footprints airborne vs satellites

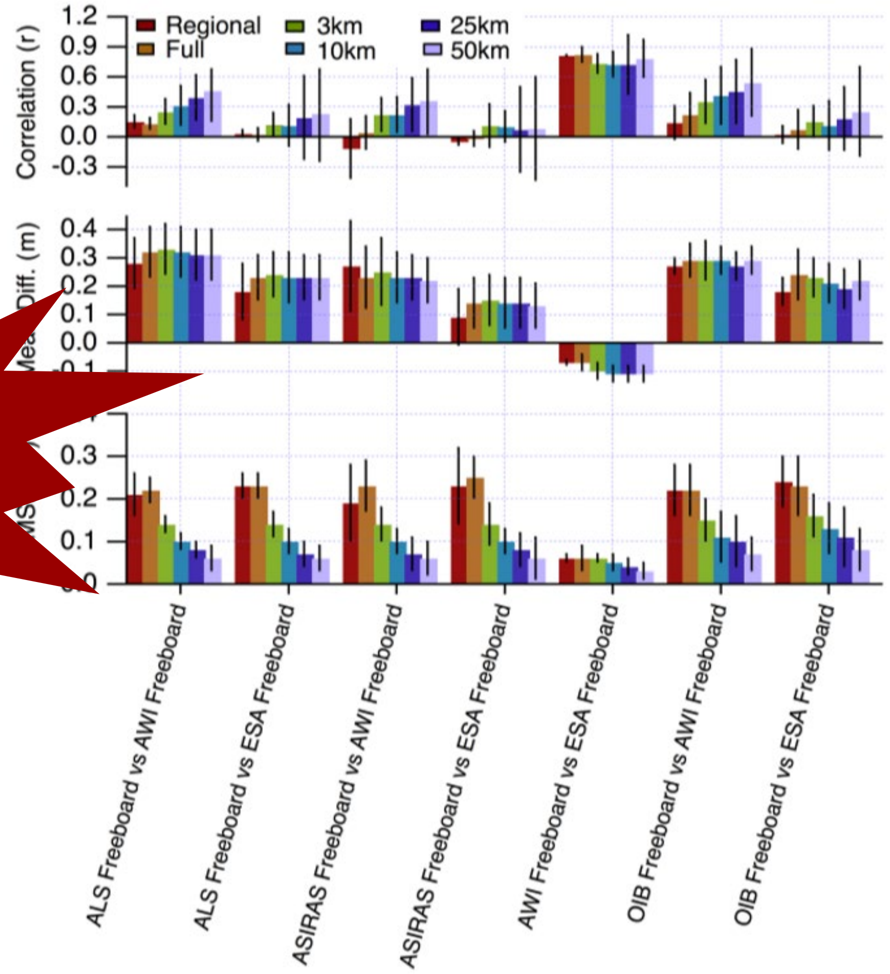
Airborne sensors vs CS2 freeboards

Averaging airborne data over CS2 SAR footprint (300mx1600m)



50 km average





Footprints airborne vs satellites

Airbor ... oards

Averaging airborne ... rint (300mx1600m)