Svalbard as a Supersite for Cryosphere Observing Satellite Reference Measurement Collection

Ashley Morris[1], Eero Rinne[2], Ann Mari Fjæraa[3], Shridhar Jawak[3], Bartlomiej Luks[4], Tom Rune Lauknes[5], Eirik Malnes[5], Geir Moholdt[6], Michał Laska[7], Eleanor Jones[1], Øystein Godøy[1,8], Daan Kivits[1], Zoé Brasseur[1], Christiane Hübner[1], Rudolf Denkmann[1], Heikki Lihavainen[1]

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[3] Norwegian Institute for Air Research, Norway
[4] Institute of Geophysics, Polish Academy of Sciences, Poland
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9. februar 2026

SIOS
SVALBARD INTEGRATED ARCTIC EARTH OBSERVING SYSTEM

Introduction to Svalbard

- Norwegian High Arctic archipelago midway between the Norwegian mainland and the North Pole.

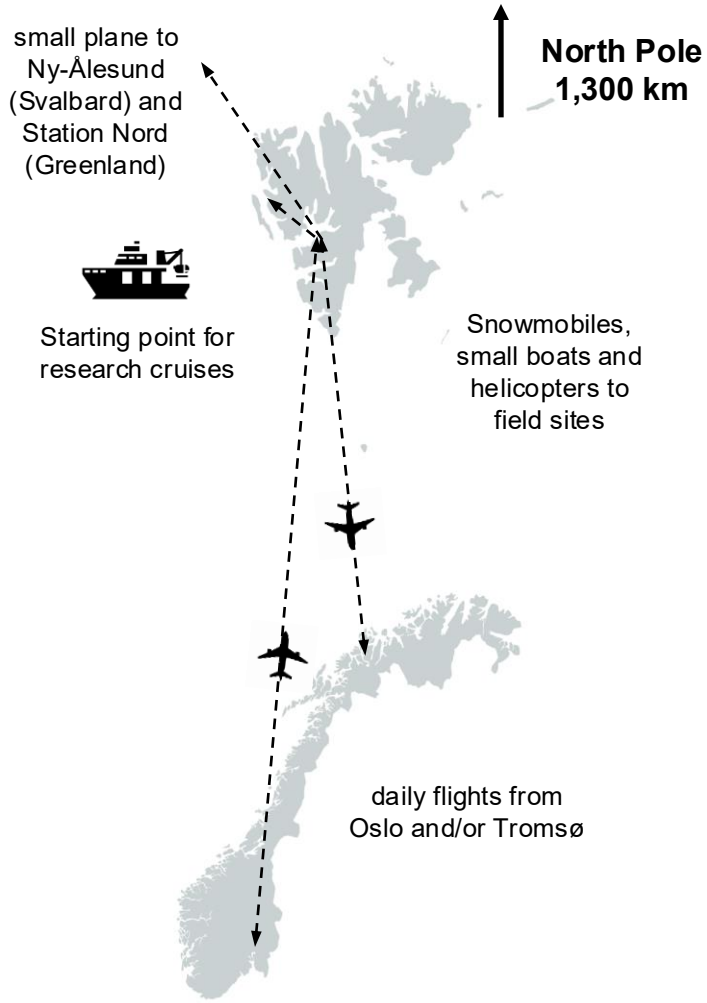


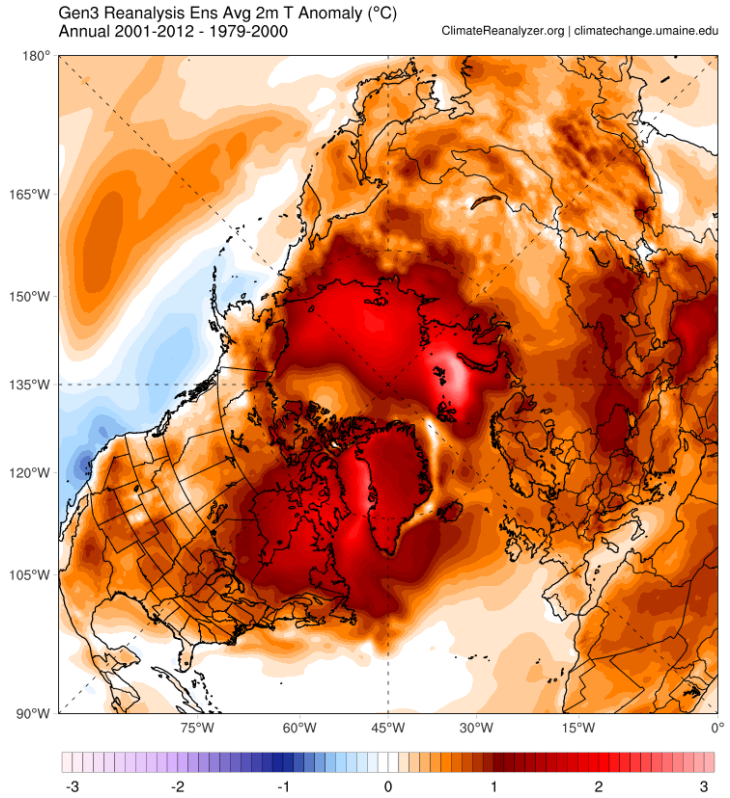


Image: Wikipedia Commons

Introduction to Svalbard

- Norwegian High Arctic archipelago midway between the Norwegian mainland and the North Pole.

- Amongst the **fastest warming** locations on Earth



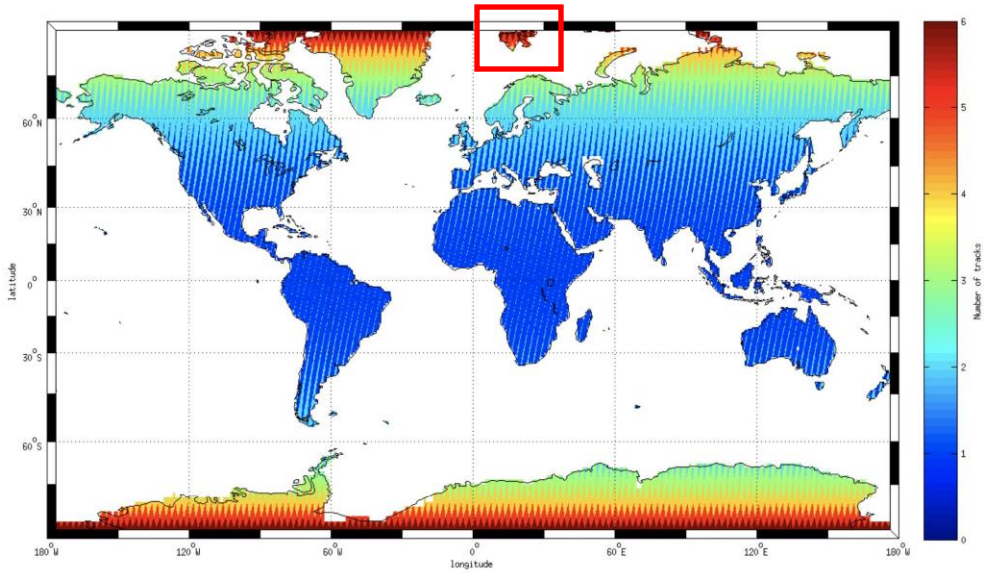
Climate Reanalyzer, Climate Change Institute, University of Maine



Image: Wikipedia Commons

Introduction to Svalbard

- Norwegian High Arctic archipelago midway between the Norwegian mainland and the North Pole.
- Amongst the **fastest warming** locations on Earth
- High latitude location results in frequent satellite overpasses (SvalSat is an important data downlink facility).



https://sentiwiki.copernicus.eu/web/s2-mission



Image: Wikipedia Commons

Introduction to Svalbard

- Climatic gradient from **warmer, Atlantic-influenced** south and west to **cold, polar** northeast leads to diverse cryospheric conditions.

- ~55% of the archipelago is covered by glacier ice, varying from valley glaciers to ice fields and ice caps (including a high proportion of surge-type glaciers). Seasonal snow cover across remainder.

- Landfast sea ice in some western fjords, pack ice to the east.



Introduction to Svalbard

- **Natural laboratory** for glacier, seasonal snow, permafrost, sea ice, atmosphere, aurora, geology, and biology research (and more); home to the **University Centre in Svalbard**, educating the next generation of Arctic scientists



- High-quality **research infrastructure** operated by institutes from numerous countries (many members of **SIOS**); provision of Arctic safety training and field logistical support.

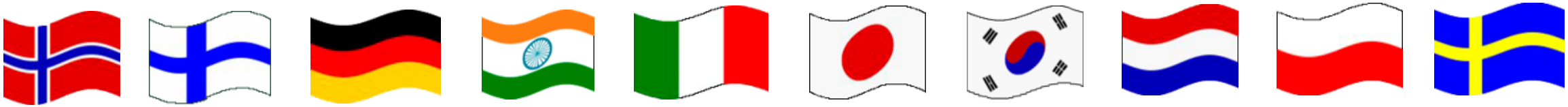


SIOS

www.sios-svalbard.org

Svalbard Integrated Arctic Earth Observing System

- **SIOS** is...a **consortium** of 29 universities and research institutes from 10 countries conducting **Earth system science** (ESS) research and operating **Research Infrastructure** in Svalbard.



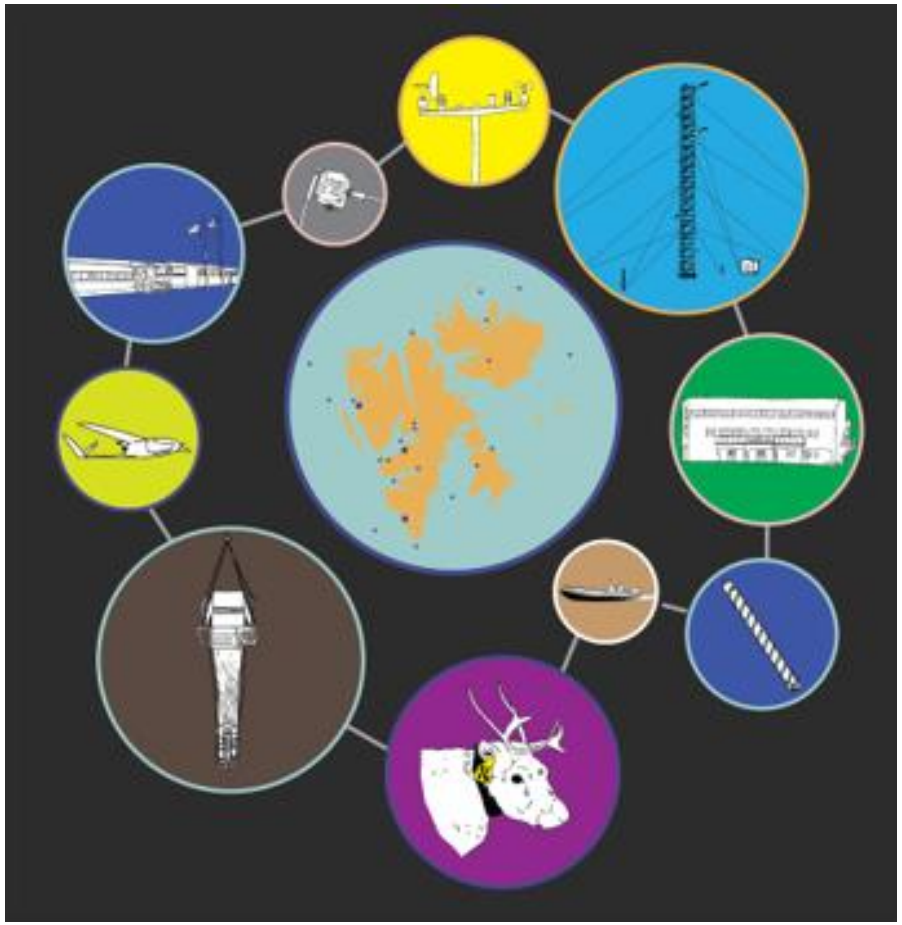
AWI ALFRED-WEGENER-INSTITUT HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG
NORSAR
INAR
KOPRI Korea Polar Research Institute
Institute of Marine Research
NTNU
Andøya Space
National Research Council of Italy
NiPR National Institute of Polar Research
NGI
NIVA Norsk institutt for vannforskning
UNIS
UiT The Arctic University of Norway
NERSC Nansen Environmental and Remote Sensing Center
University of Bergen
Institute of Geophysics Polish Academy of Sciences
POLARFORSKNINGS SEKRETARIATET Swedish Polar Research Secretariat
Norwegian Meteorological Institute
University of Silesia in Katowice
Geological Survey of Norway - NGU -
NVE
Norwegian Polar Institute
UiO : University of Oslo
university of groningen
NORCE
Kartverket
nilu
NCPOR
NINA Norwegian Institute for Nature Research

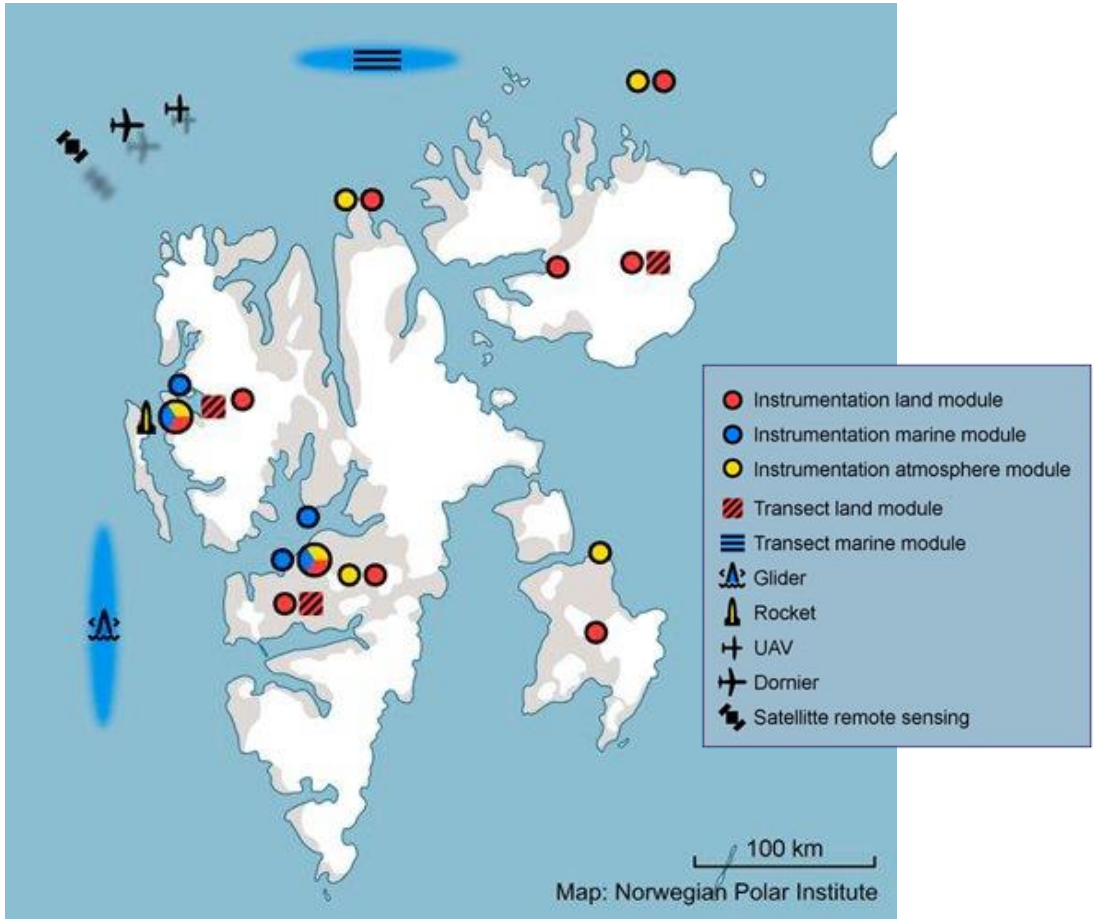
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Svalbard Integrated Arctic Earth Observing System

- **SIOS** is...a **Research Infrastructure** and a driving force for research infrastructure development in Svalbard.



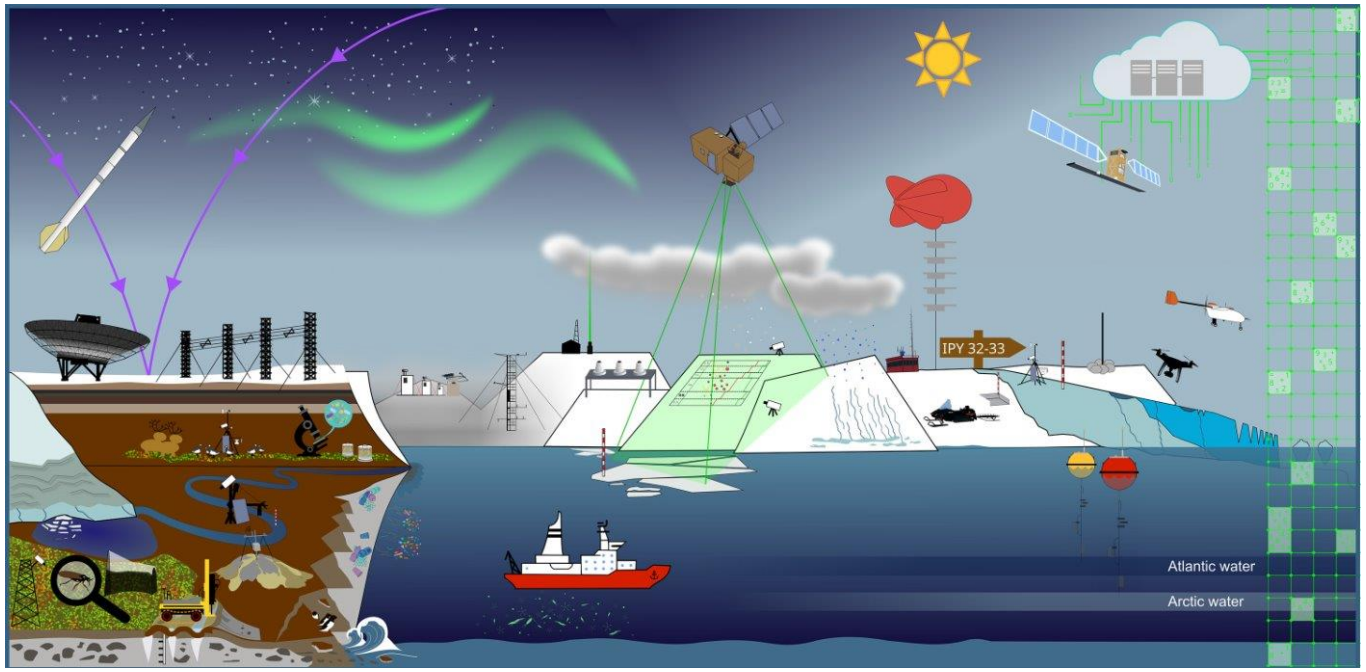


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Svalbard Integrated Arctic Earth Observing System

- **SIOS** is...an **Observing System** for Earth system science focusing on process in – and interactions between – the geosphere, cryosphere, atmosphere, hydrosphere and biosphere.

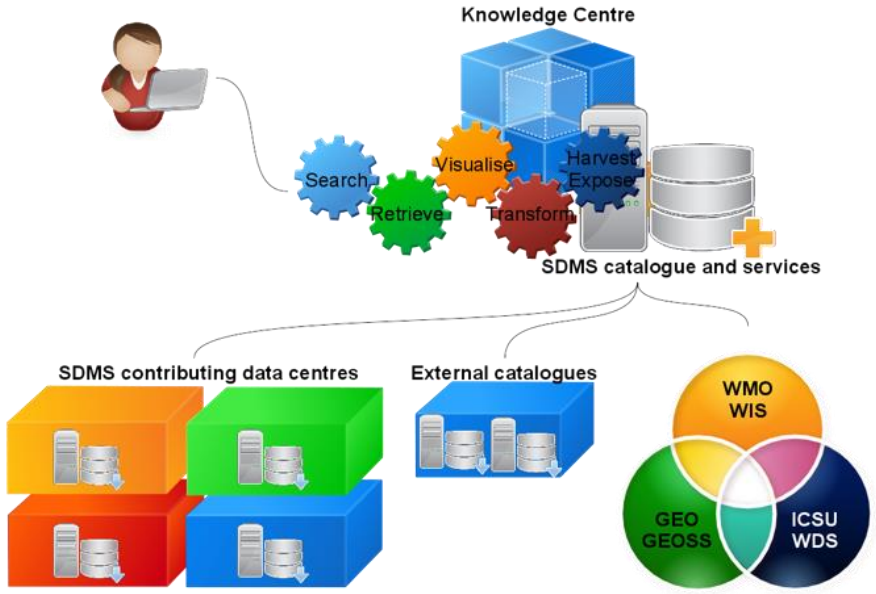


Geosphere
Cryosphere
Atmosphere
Hydrosphere
Biosphere



Svalbard Integrated Arctic Earth Observing System

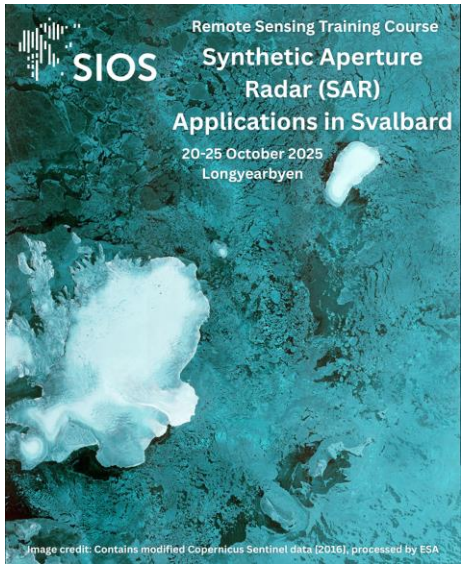
- **SIOS** services include Remote Sensing, Access and Logistics, Training, and Data Management



The **SIOS Data Access Portal** offers unified access to Earth system science data from distributed data centres, and allows visualisation and transformation.



The **SESS Report** is the authoritative source of information on the state of the environment in and around Svalbard.



Copernicus AMBASSADOR

As a **Copernicus Ambassador**, SIOS offers annual remote sensing training courses.

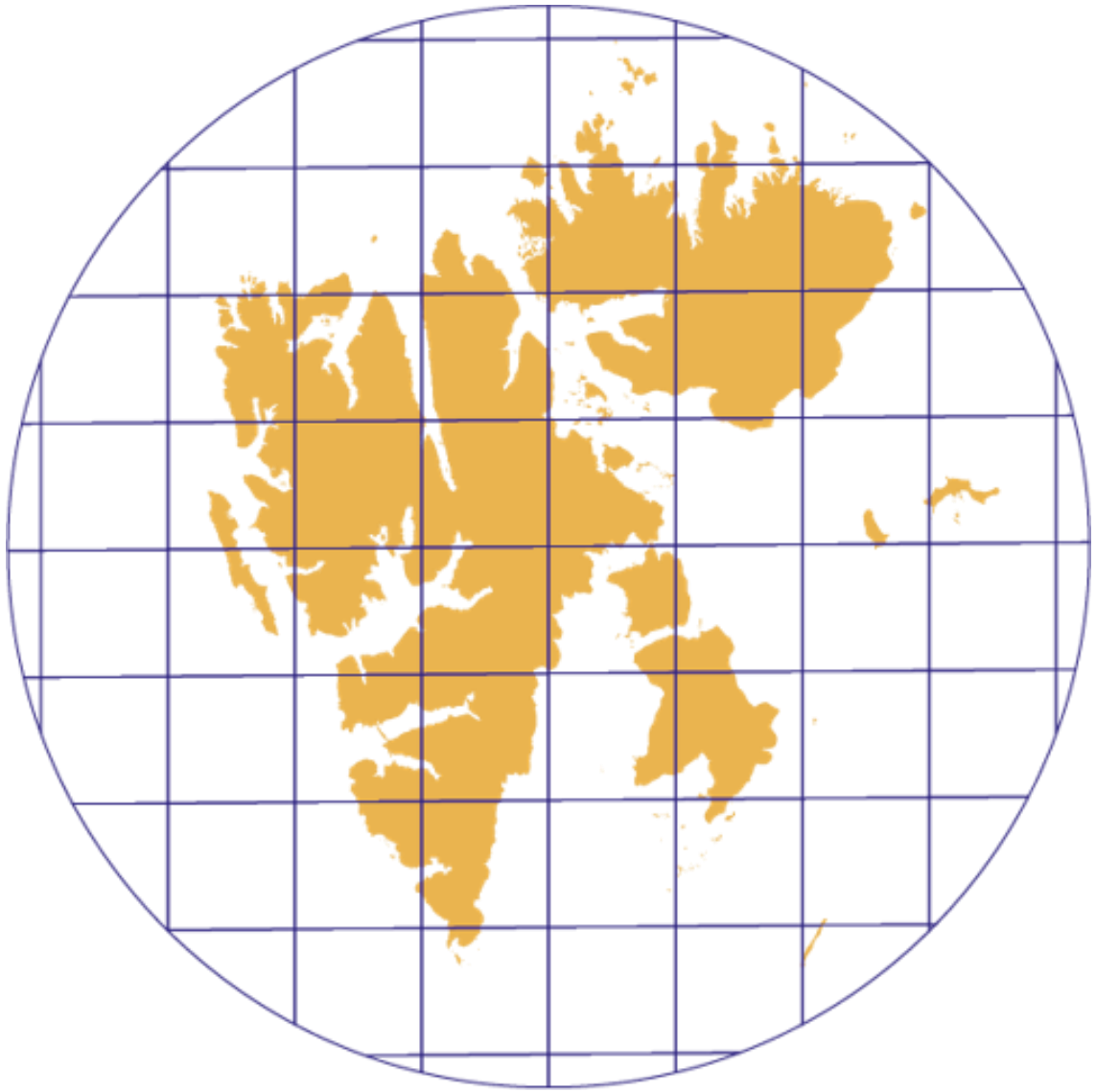
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Svalbard as a reference measurement site

- Copernicus Polar Roadmap for Service Evolution: *"There is an essential need for additional and sustainable in-situ observations, which are still too sparse in Polar Regions. These would not only validate space observations but also provide data that cannot be measured from space"*





SIOS

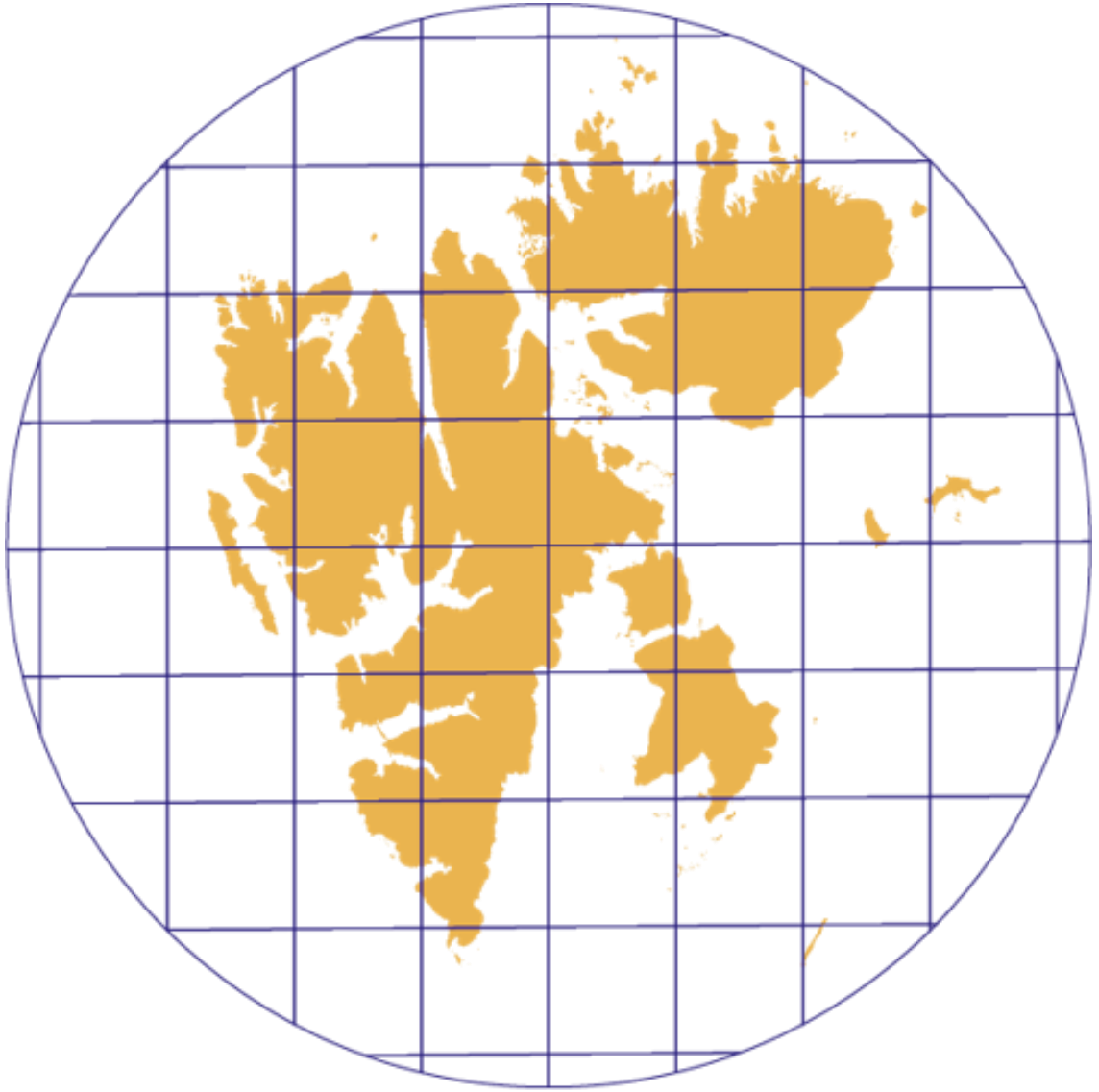
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- Potential to provide reference measurements for in orbit Copernicus Programme satellites and upcoming Copernicus Expansion missions.



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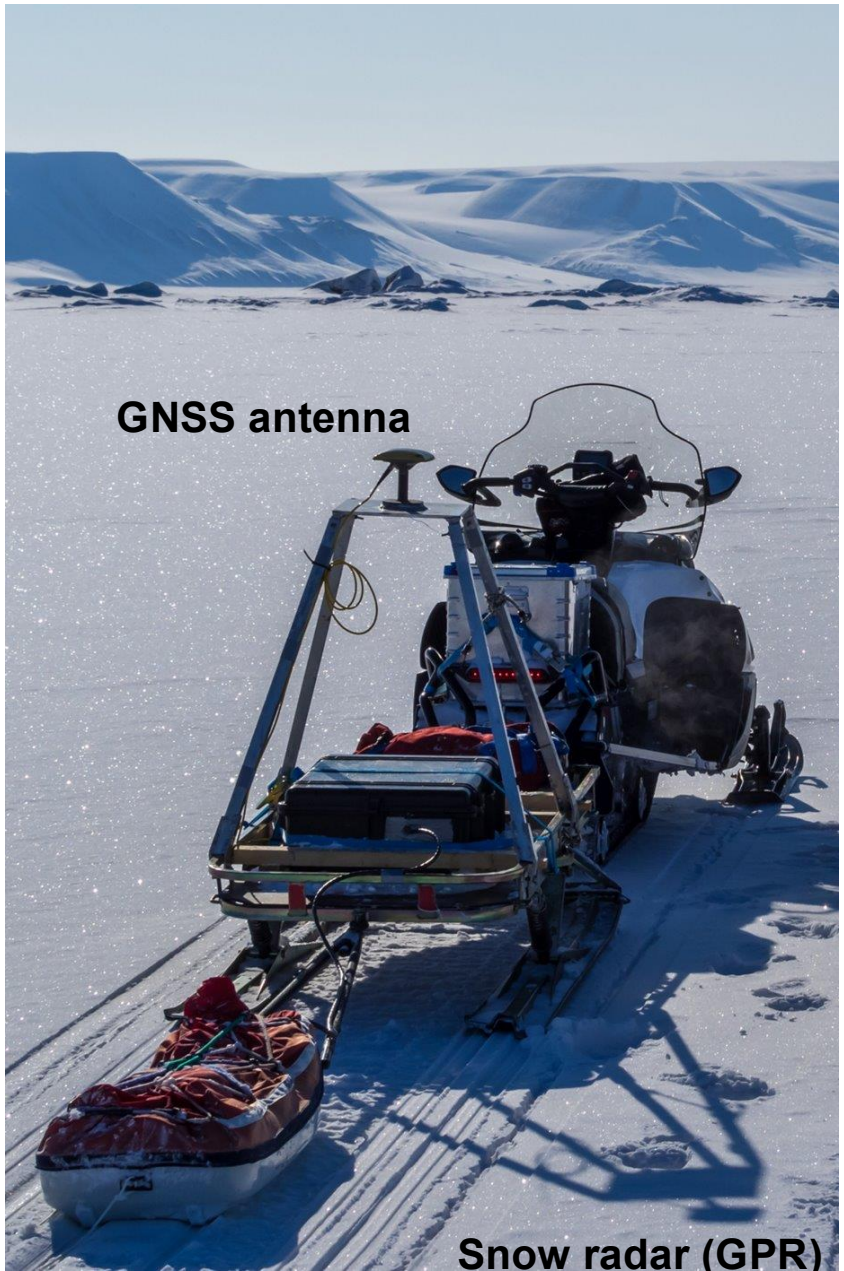
- Take inspiration from what has been achieved at the Sodankylä Cal/Val Supersite.



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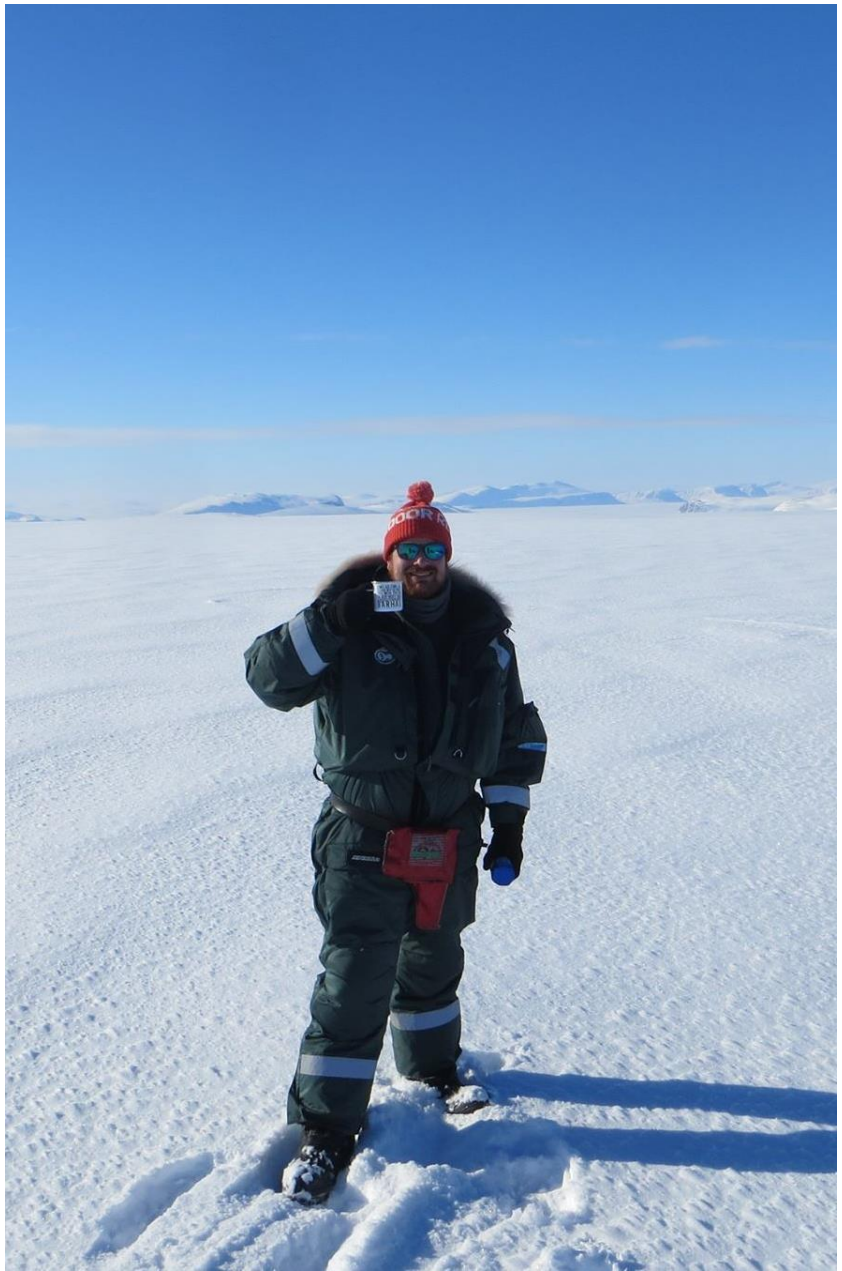
Svalbard as a reference measurement site





- Norwegian Polar Institute and University of Oslo mass balance and satellite altimetry reference measurement campaigns on Austfonna annually in April/May since 2004.
- Surface elevation transects from snowmobile mounted GNSS. Snow depth and characteristics from GPR, snow pits and probing.
- Transects adapted to provide reference measurements for ICESat, CryoSat-2, ICESat-2, Sentinel-3 and CRISTAL.
- Smooth terrain suitable for investigating radar penetration.

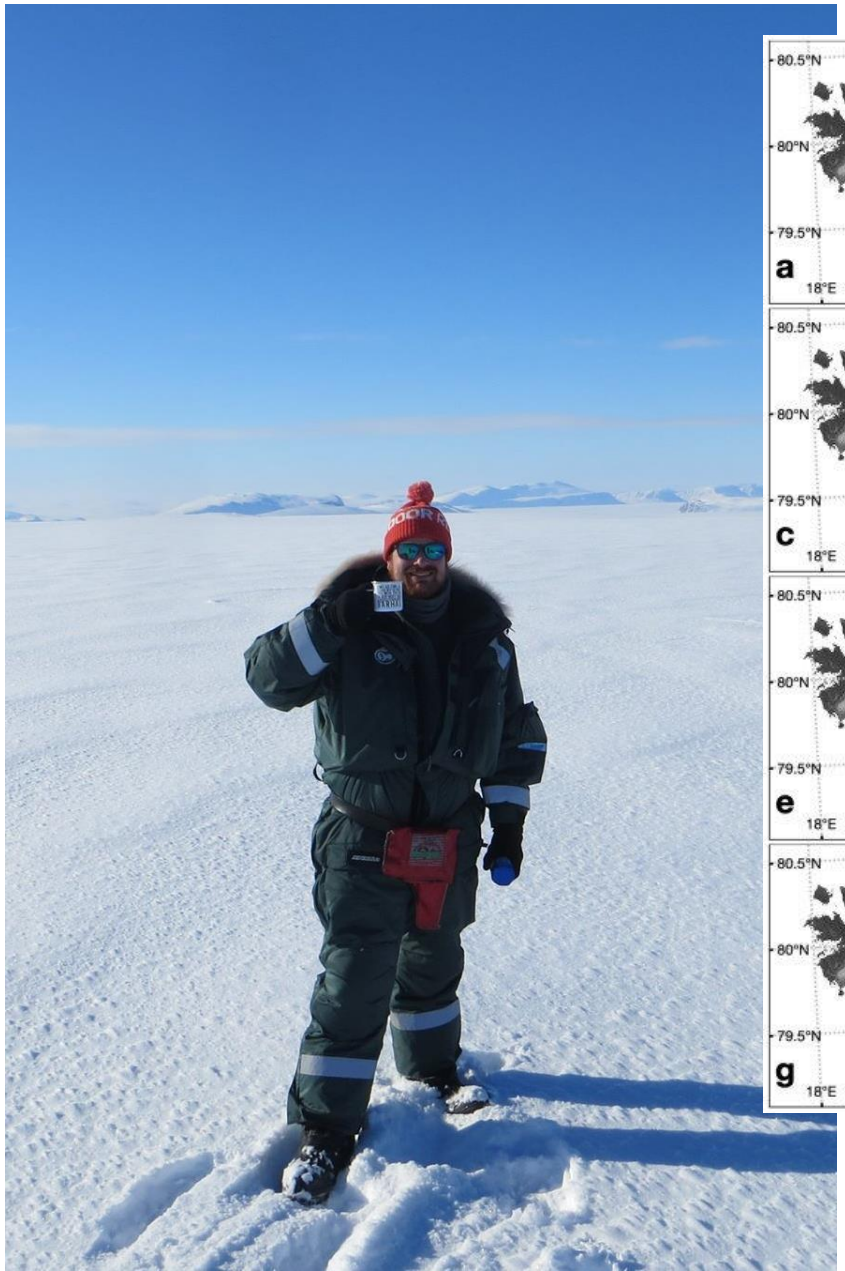
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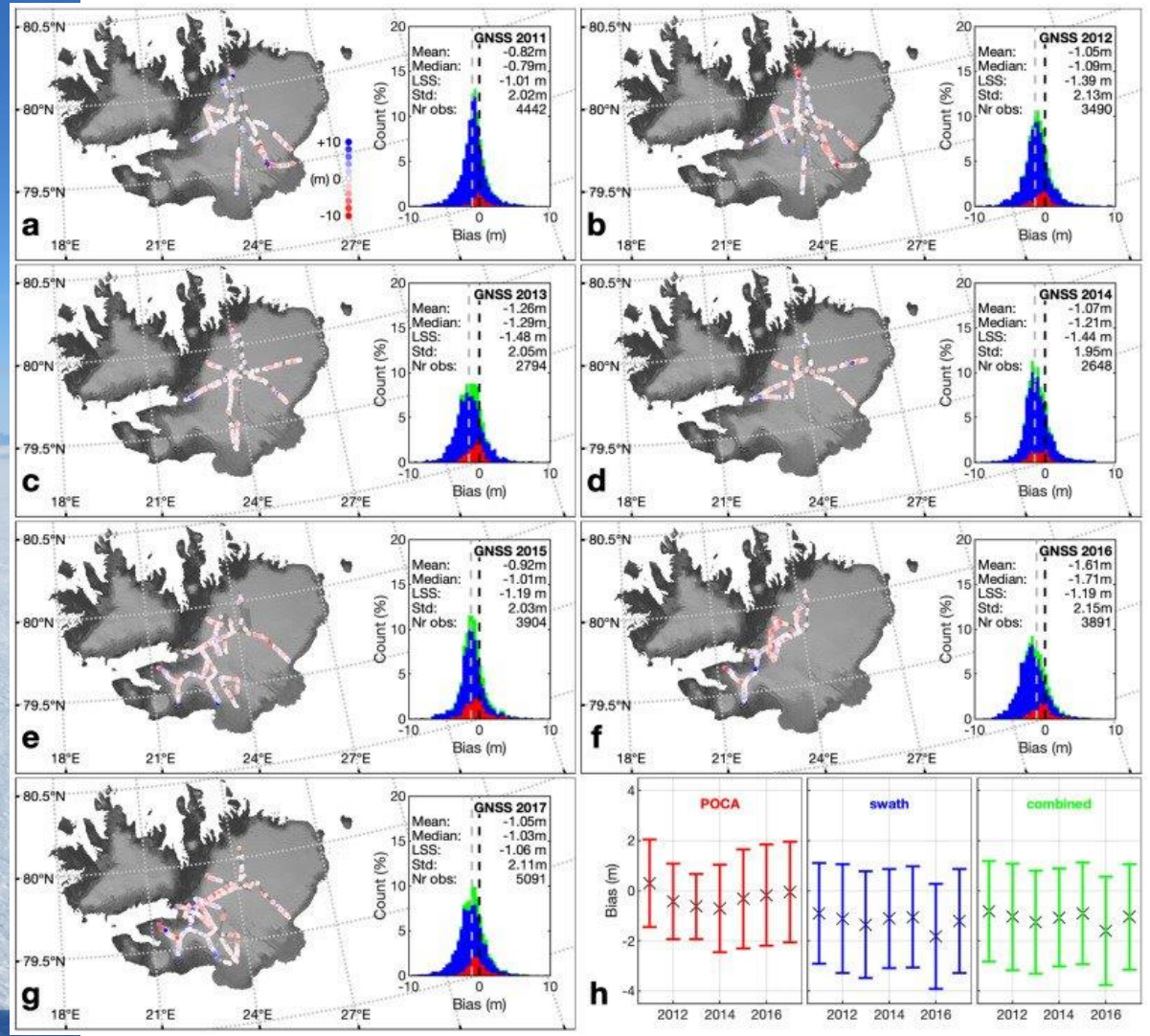




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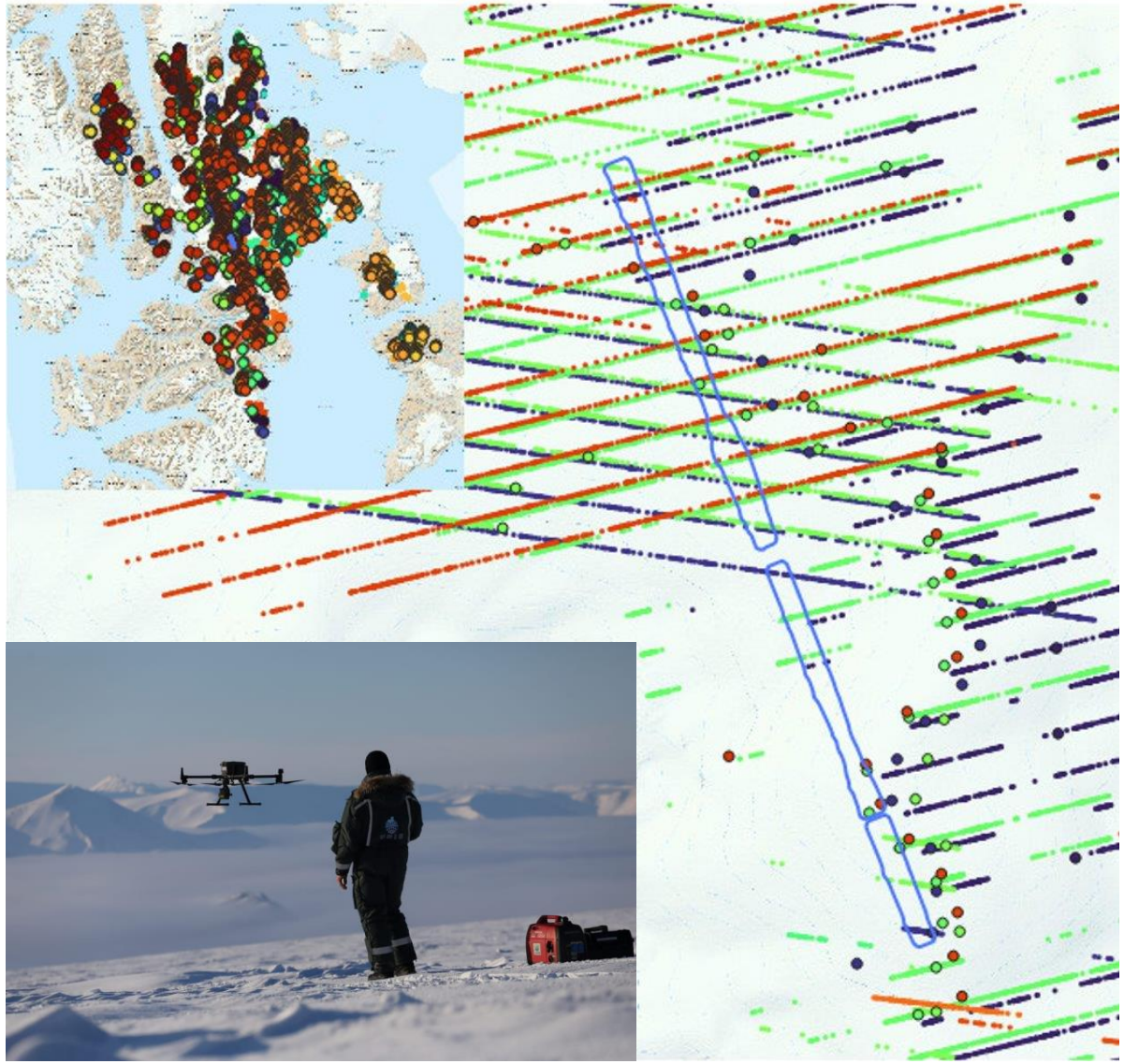


Morris et al. (2021)



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Svalbard as a reference measurement site

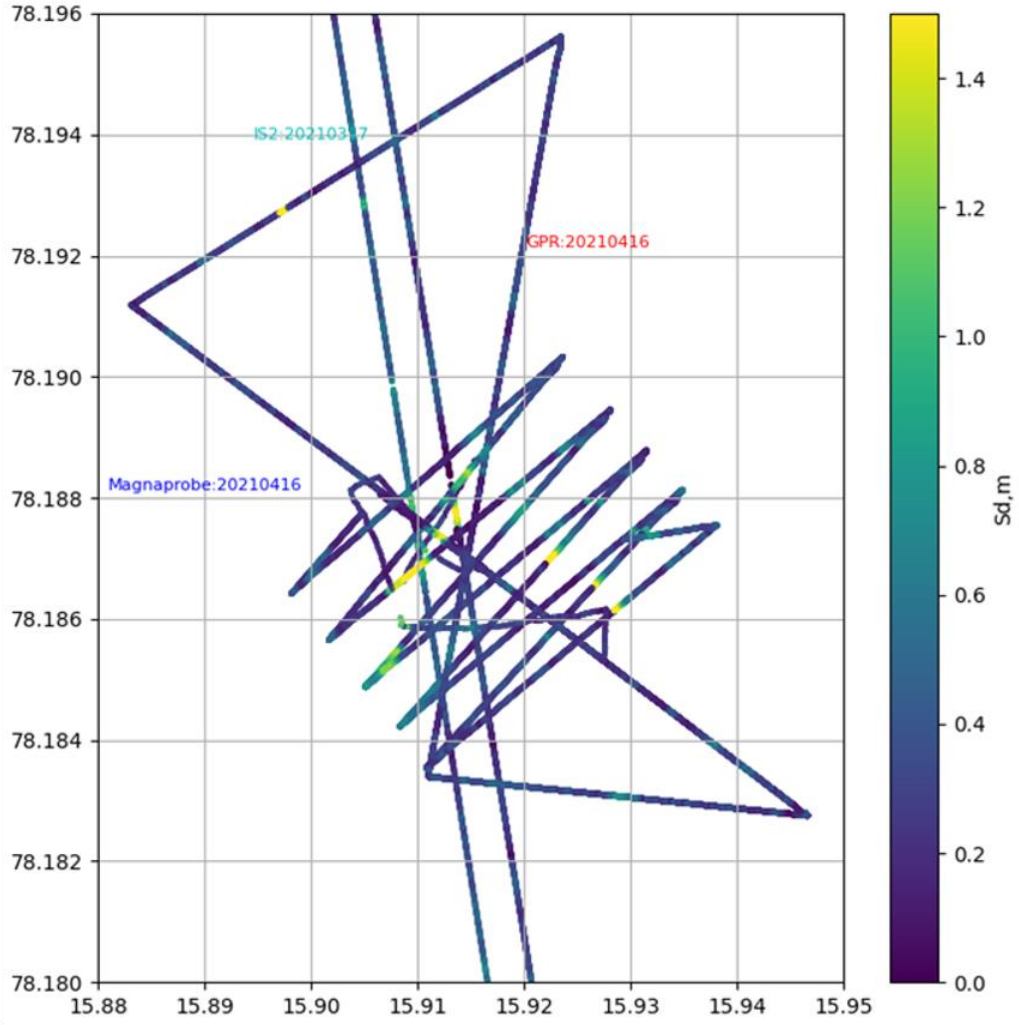




- Svalbard Sustainable Climate Reference Observatory project collects Cryosphere fiducial reference measurements.

- UAVs with laser scanners flown beneath ICESat-2, CryoSat-2 and Sentinel-3 laser and radar altimeter overpasses. Validation of CryoTempo swath elevations over rugged terrain of Lomonosovfonna. Measurement of snow parameters such as wetness and roughness on sea ice in van Mijenfjorden to explain Sentinel-3 waveform development.

Svalbard as a reference measurement site

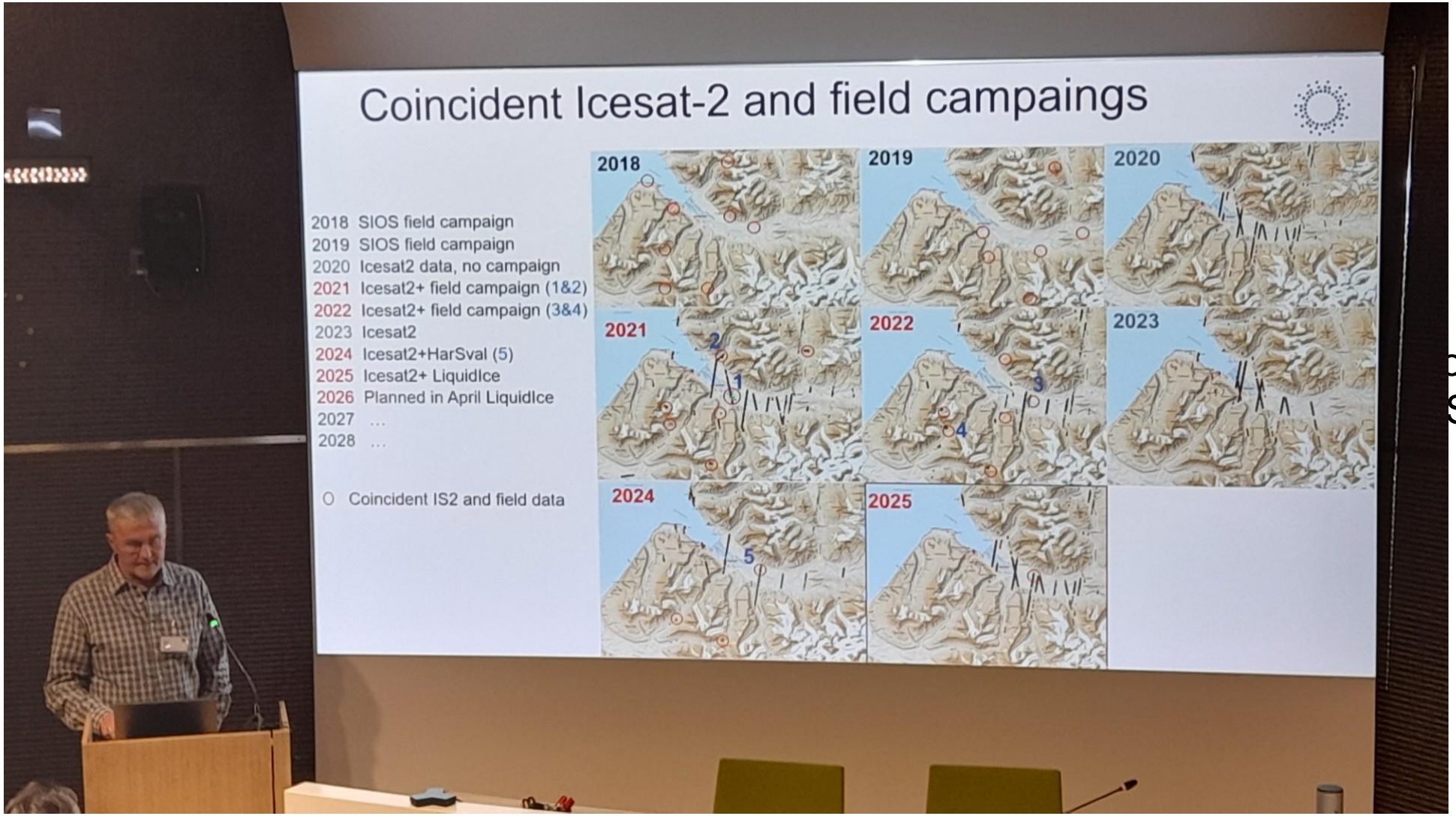






- NORCE Research validates snow related products including: snow depth from ICESat-2

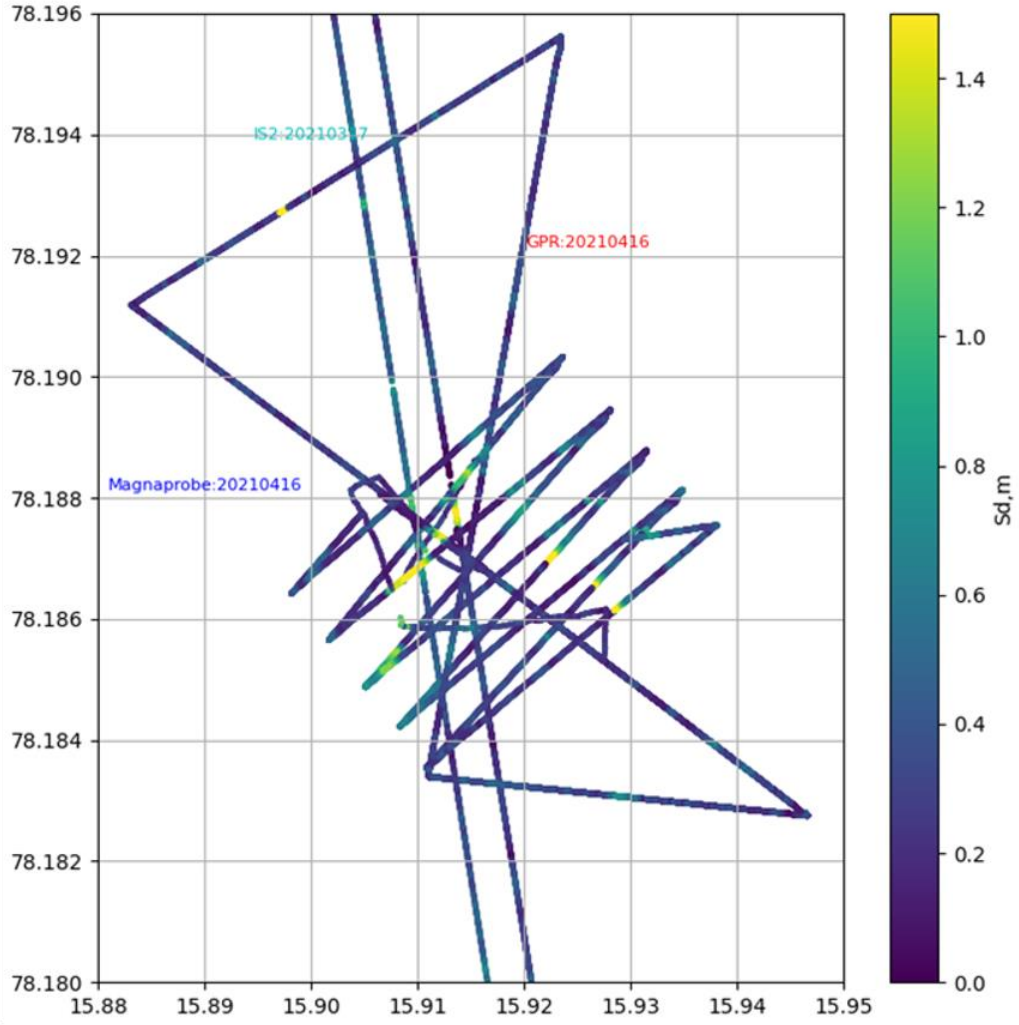
Svalbard as a reference measurement site





ow related products
Sat-2

Svalbard as a reference measurement site





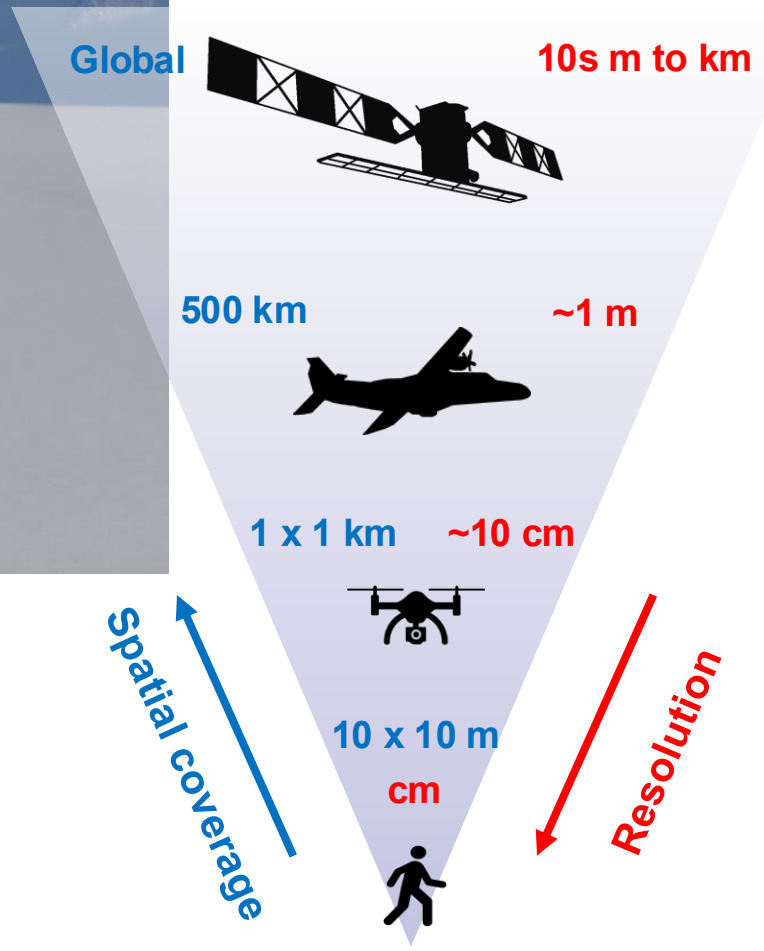


- NORCE Research validates snow related products including: snow depth from ICESat-2; snow cover fraction from MODIS and Sentinel-2 (time lapse cameras); wet snow detection from Sentinel-1 (meteorological stations, snow pit observations); avalanche detections from Sentinel-1 (citizen science).

Svalbard as a reference measurement site



- Crewed aircraft bridge the scale gap between in situ/UAV measurements and satellite data in observational pyramid.



- NORCE installed medium format camera and hyperspectral imager on Dornier D-228. Possibility for expansion with SAR sensor, laser scanner etc.

Svalbard as a reference measurement site

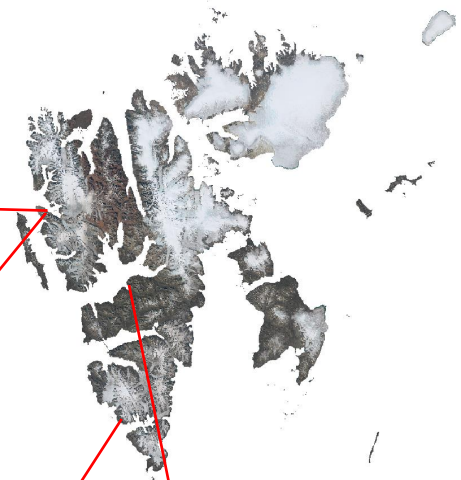
- Corner reflectors installed by CRIOS project in Ny-Ålesund, Longyearbyen and Hornsund.

- Pandora Spectrometer in Ny-Ålesund measures atmospheric composition. Used as Reference measurements for Sentinel-5P.









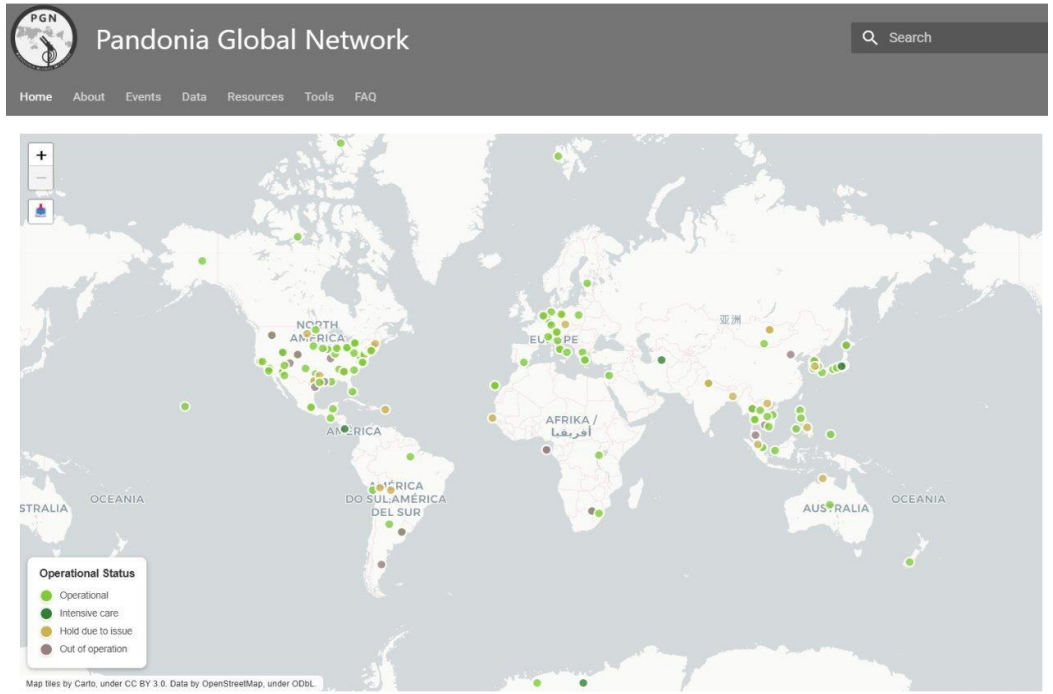




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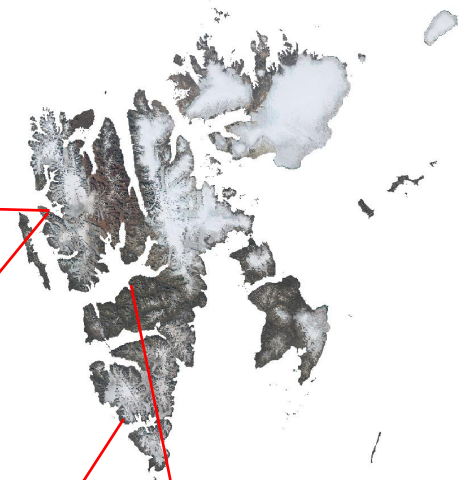
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Svalbard as a reference measurement site

- Svalbard is accessible, has established and extensive research infrastructure (including airborne platforms), and available logistical support and training.

- The high latitude location means high satellite overpass frequency, allowing potential for coincident in situ data collection for multiple satellite platforms in single campaign.

- Cryospheric data such as elevation profiles and snow parameters are being collected across the archipelago as part of field campaigns, education and dedicated reference measurement campaigns in snow, glacier and sea ice domains.

- Potential for University Centre in Svalbard (UNIS) students to be involved in FRM collection – educating the next generation. ~200 students per year engaged in field-based teaching







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Thanks for your attention
Any questions?

Photo: Christiane Hübner