Filling in gaps

Fusing high resolution imagery products from remotely piloted aircraft (RPA) and on-ground measurements to understand the spatial distribution of sea ice morphological features at sub-floe scale

Adam Steer[1] Anca Cristea[1] Polona Itkin[2] Dmitry Divine[1] Sebastian Gerland[1]

[1]Norwegian Polar Institute; [2]Center for Integrated Remote Sensing and Forecasting, UiT, Tromso

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Photo: Polona Itkin

Acknowledgements

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Dmitry Divine, Polona Itkin, Anca Cristea and Bonnie Raffel endured cold, often pretty ordinary weather and polar bears to collect walked / skied transect data; Sebastian Gerland provided critical support for the purchase of our tiny, weather hardened aircraft and also support for new approaches to how to walk around on sea ice for data collection.

The crew of RV Kronprins Haakon got us there and back

Polona Itkin loaned us the skis we used to collect a lot of ground data, plus backup Magnaprobes and GEM2 instruments.

Also, we thank contributors to the many open source data processing and geospatial tools we use in this work.

A talk in three parts

Part 1: innovation

- What is the problem we need to solve?

Part 2: application

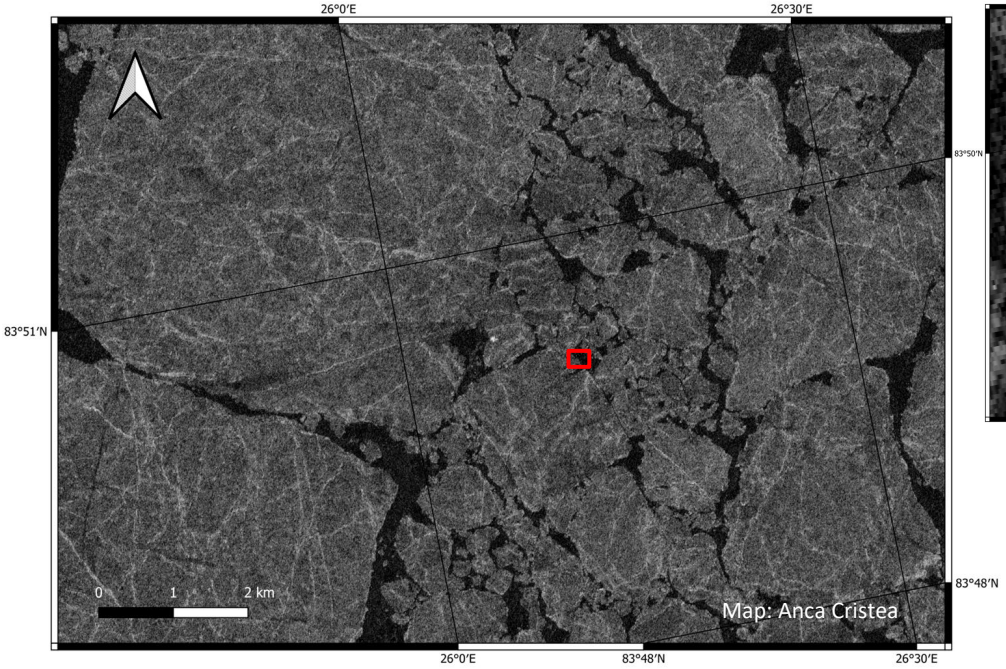
- What we do: measuring sea ice
- What is our innovative application?

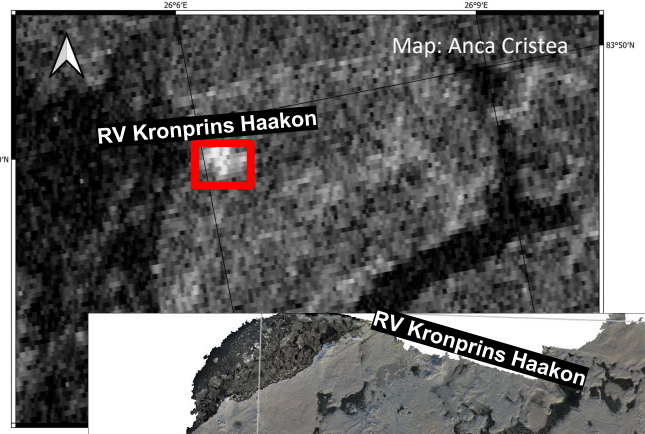
Part 3: implications

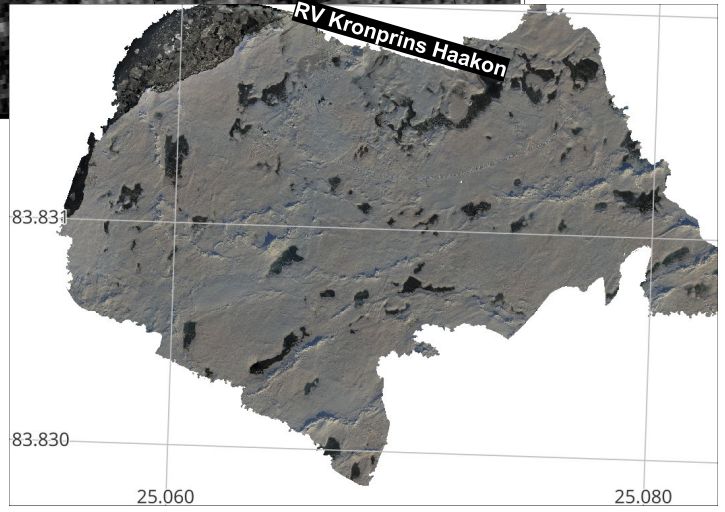
- What can we add to the sea ice picture?

Part 1: Innovation

What problem are we trying to solve?





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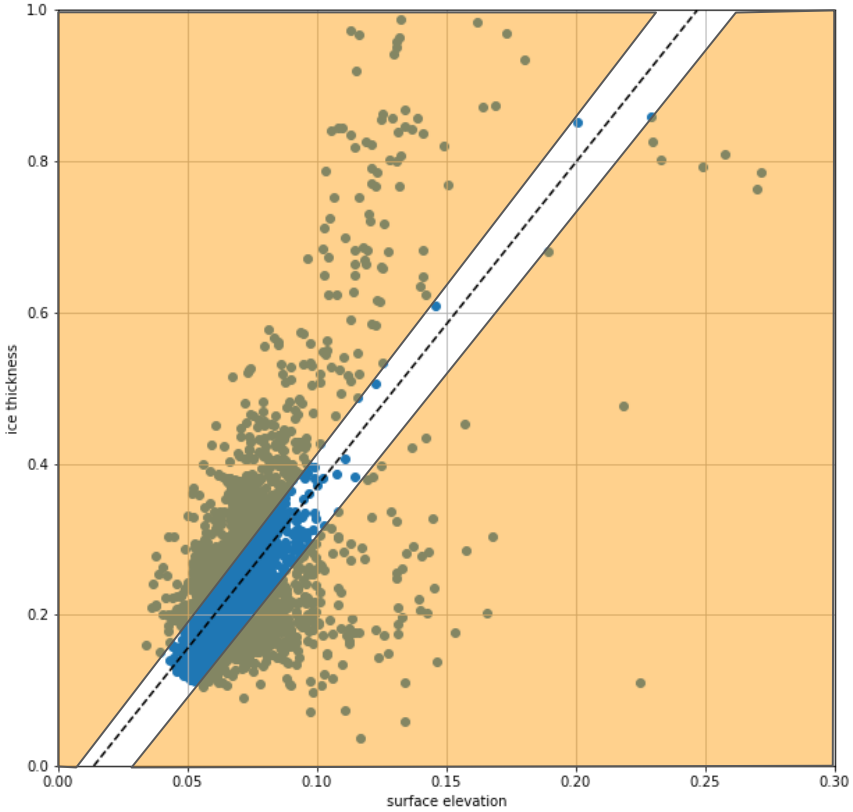
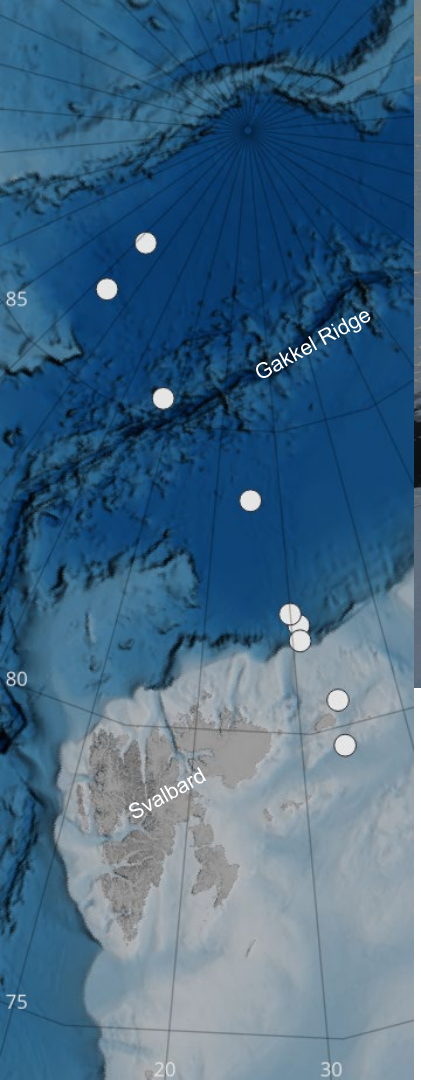
A list of problems from just this week:

- What does it look like inside a Sentinel 1 / Cryosat-2 pixel?
- If we aggregate enough data we get better relationships between properties - however the small scale variability doesn't disappear. How does that small scale variability impact larger scale inferences about sea ice?
- At scales where we can see deformed and undeformed ice, are there clear domain separations?
- How do we capture and characterise surface variability (roughness, distribution of surface features, morphology) at sub footprint scales?

The problem space we occupy





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Building on past work


Photo: Sebastian Gerland


Photo: M. Nicolaus

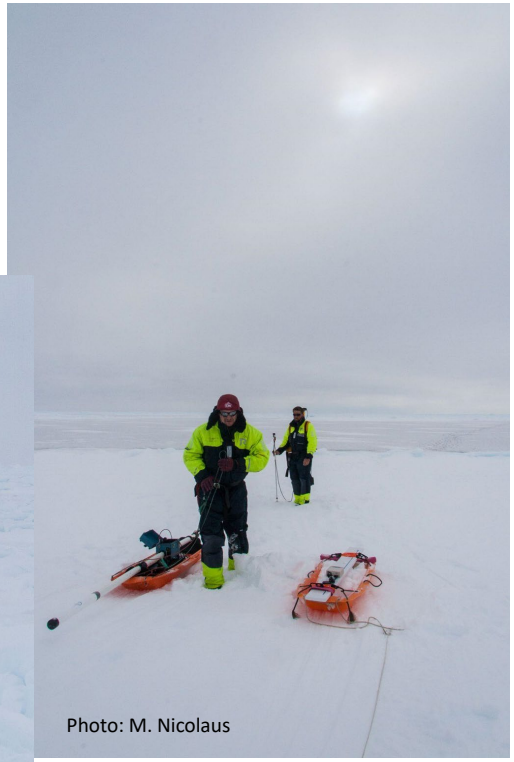
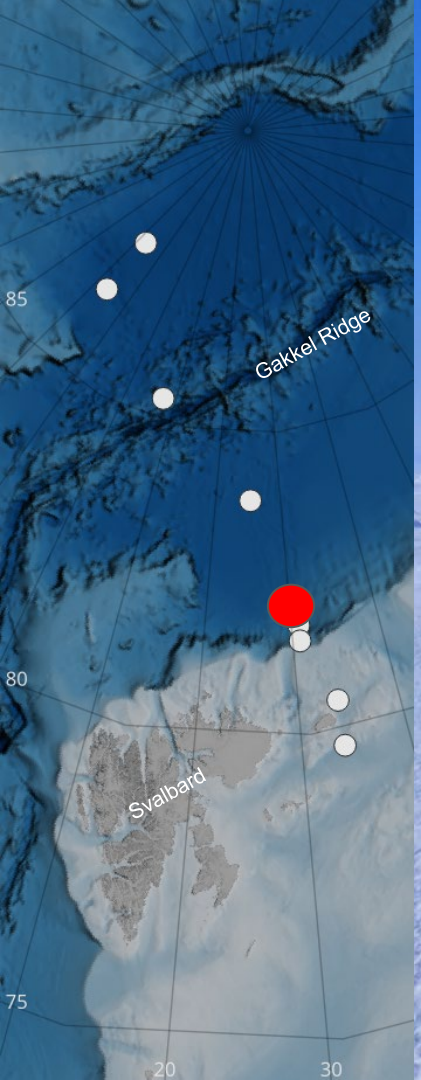


Photo: M. Nicolaus



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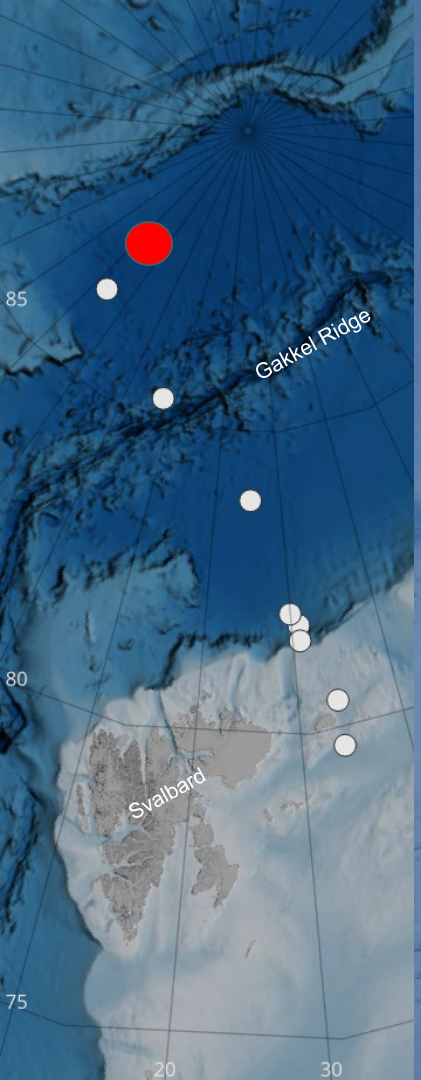

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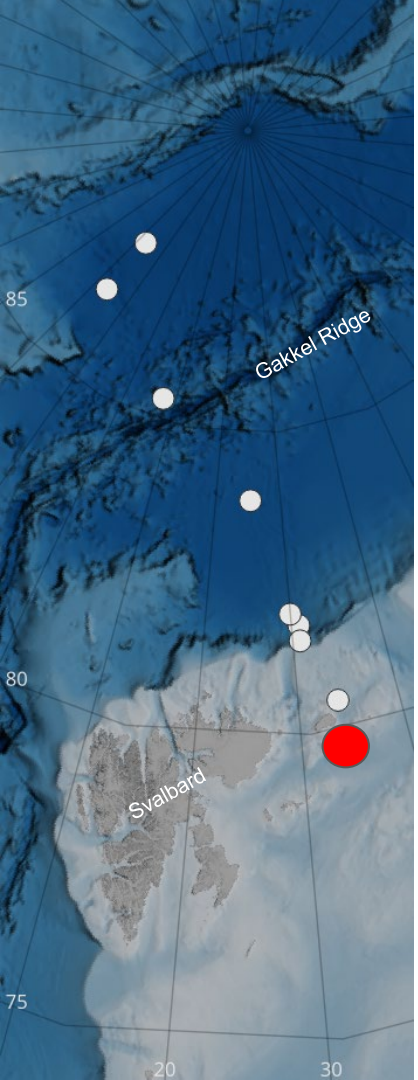
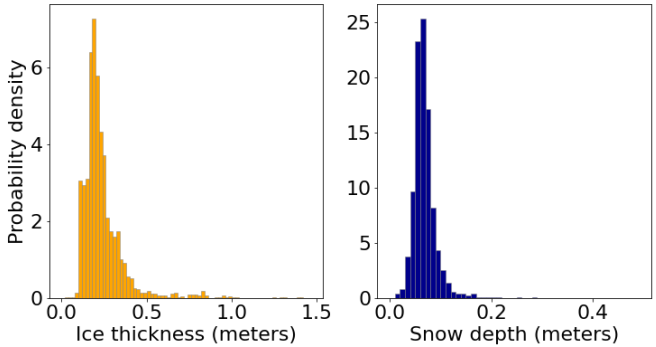
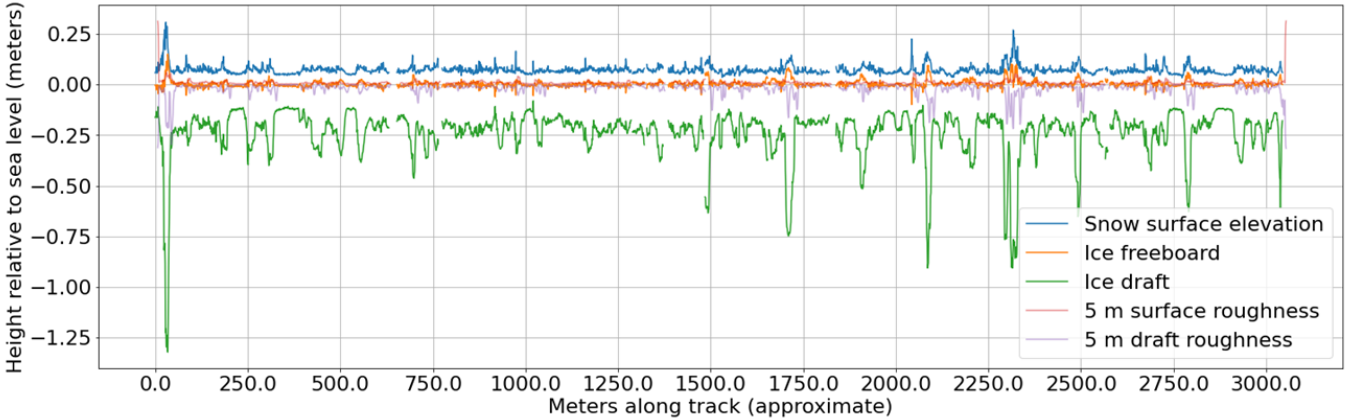
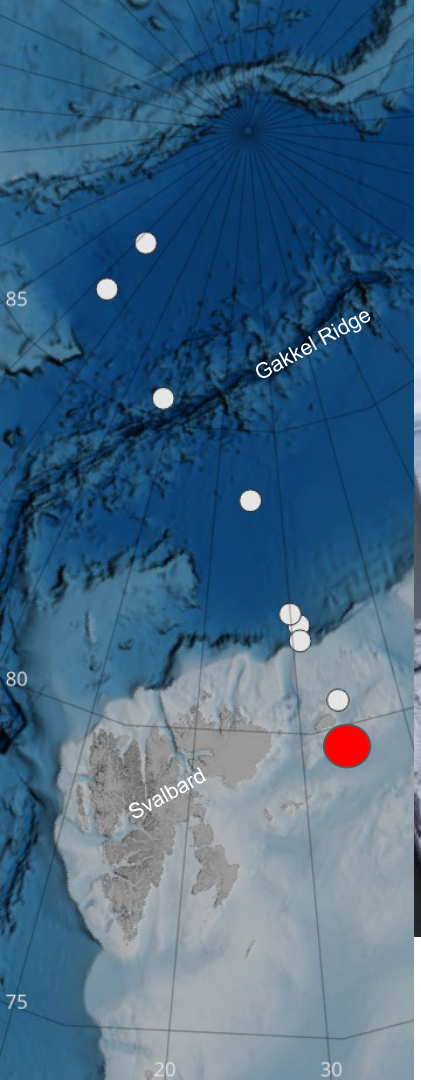

85
80
75
20
30
Gakkel Ridge
Svalbard


Probability density
0
2
4
6
0.0
0.5
1.0
1.5
Ice thickness (meters)
0
5
10
15
20
25
0.0
0.2
0.4
Snow depth (meters)


Height relative to sea level (meters)
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.25
0.0
250.0
500.0
750.0
1000.0
1250.0
1500.0
1750.0
2000.0
2250.0
2500.0
2750.0
3000.0
Meters along track (approximate)
Snow surface elevation
Ice freeboard
Ice draft
5 m surface roughness
5 m draft roughness



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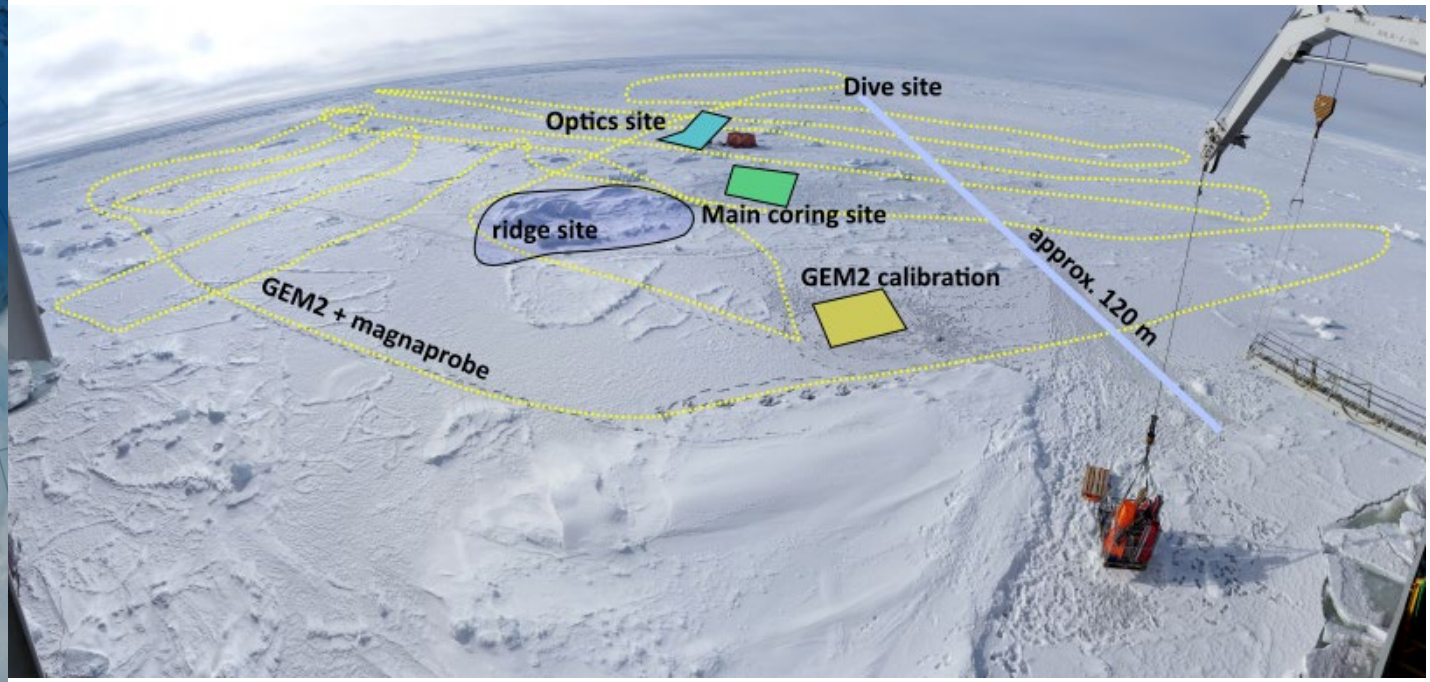
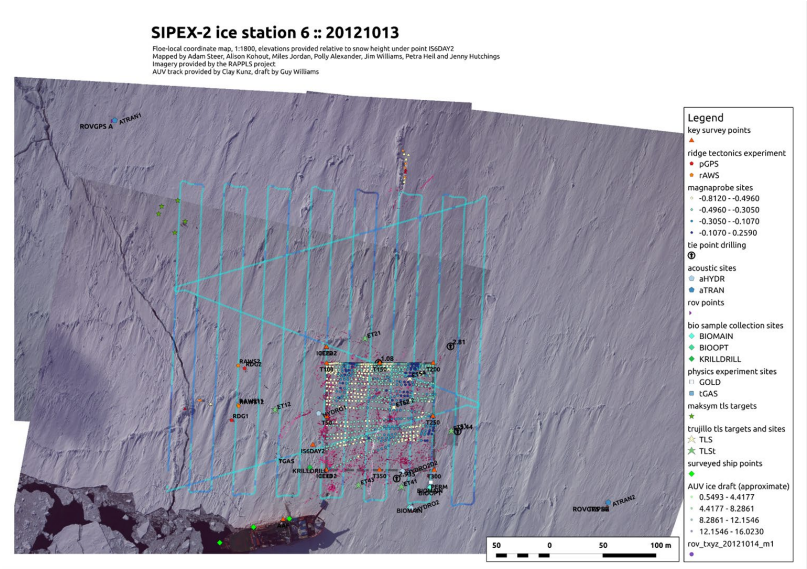
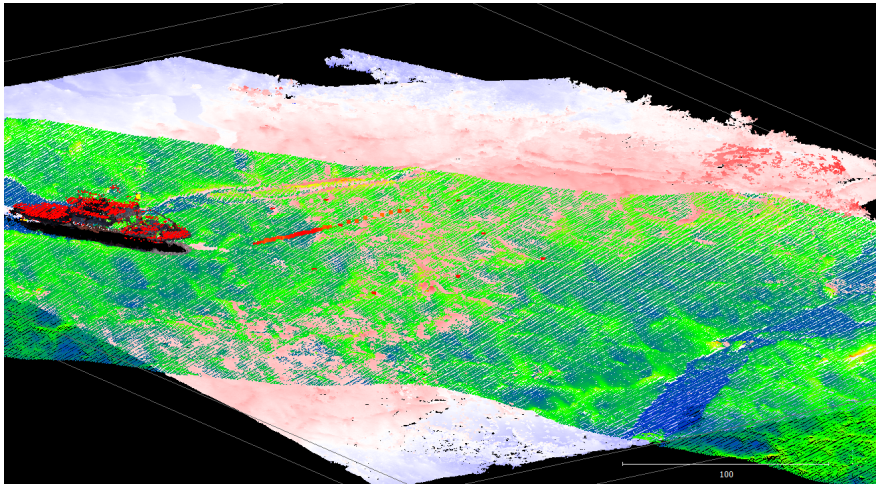


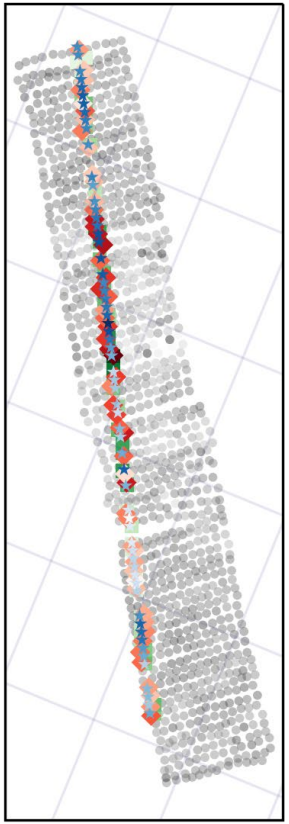
Building on past work

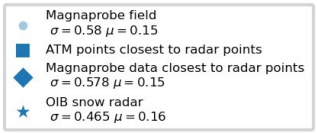


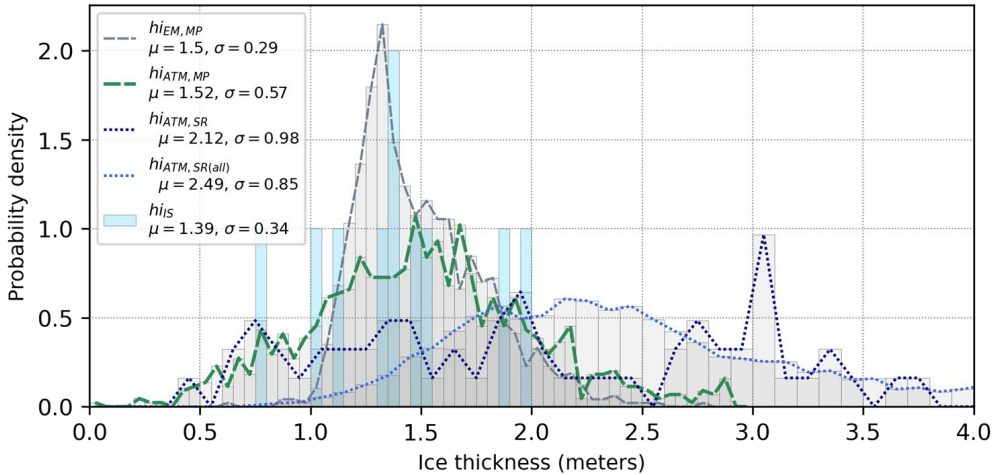


Beyond Point Measurements: Sea Ice Floes Characterized in 3-D. http://doi.wiley.com/10.1002/2013EO070002
Estimating small-scale snow depth and ice thickness from total freeboard for East Antarctic sea ice. https://doi.org/10.1016/j.dsr2.2016.04.025

Building on past work







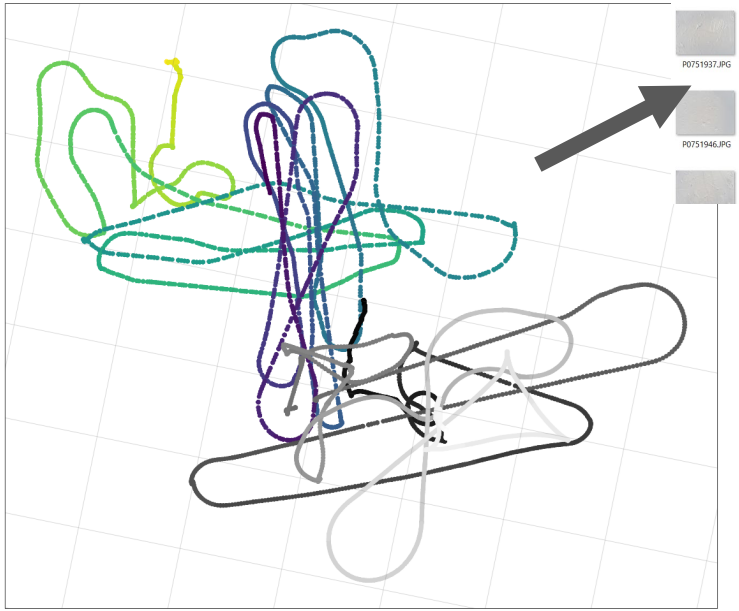
Implications of surface flooding on airborne thickness measurements of snow on sea ice.
https://doi.org/10.5194/tc-15-2819-2021

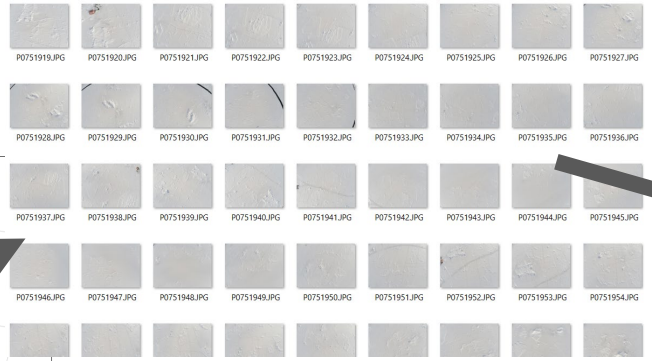
No big aircraft? Use a tiny one

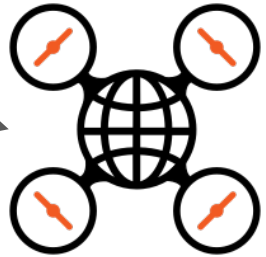
Part 2: Application

Photo: Polona Itkin

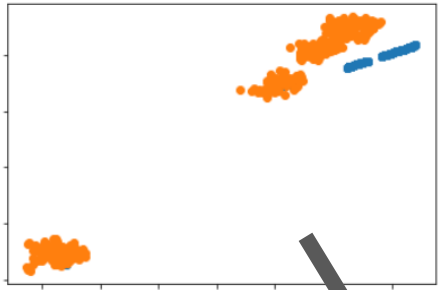
‘Reality capturing’ sea ice



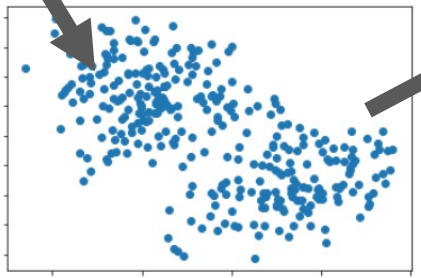




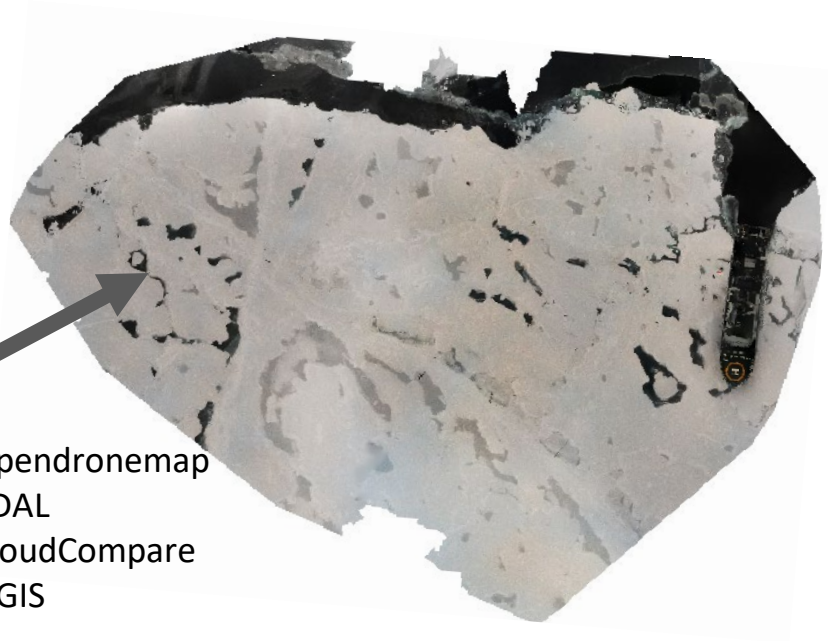
What about drift?



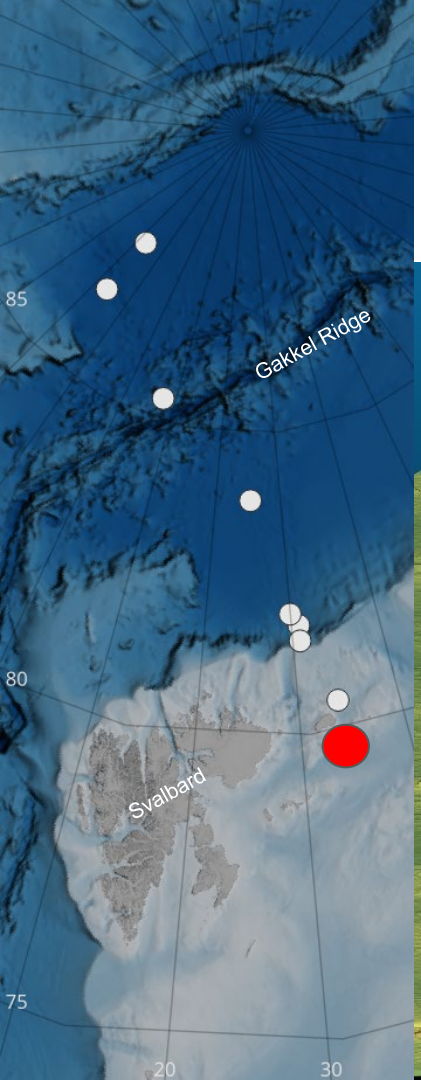
Exiftool
Proj4
Python



Opendronemap
PDAL
CloudCompare
QGIS



https://gitlab.com/adamsteer/aen/-/tree/main/notebooks



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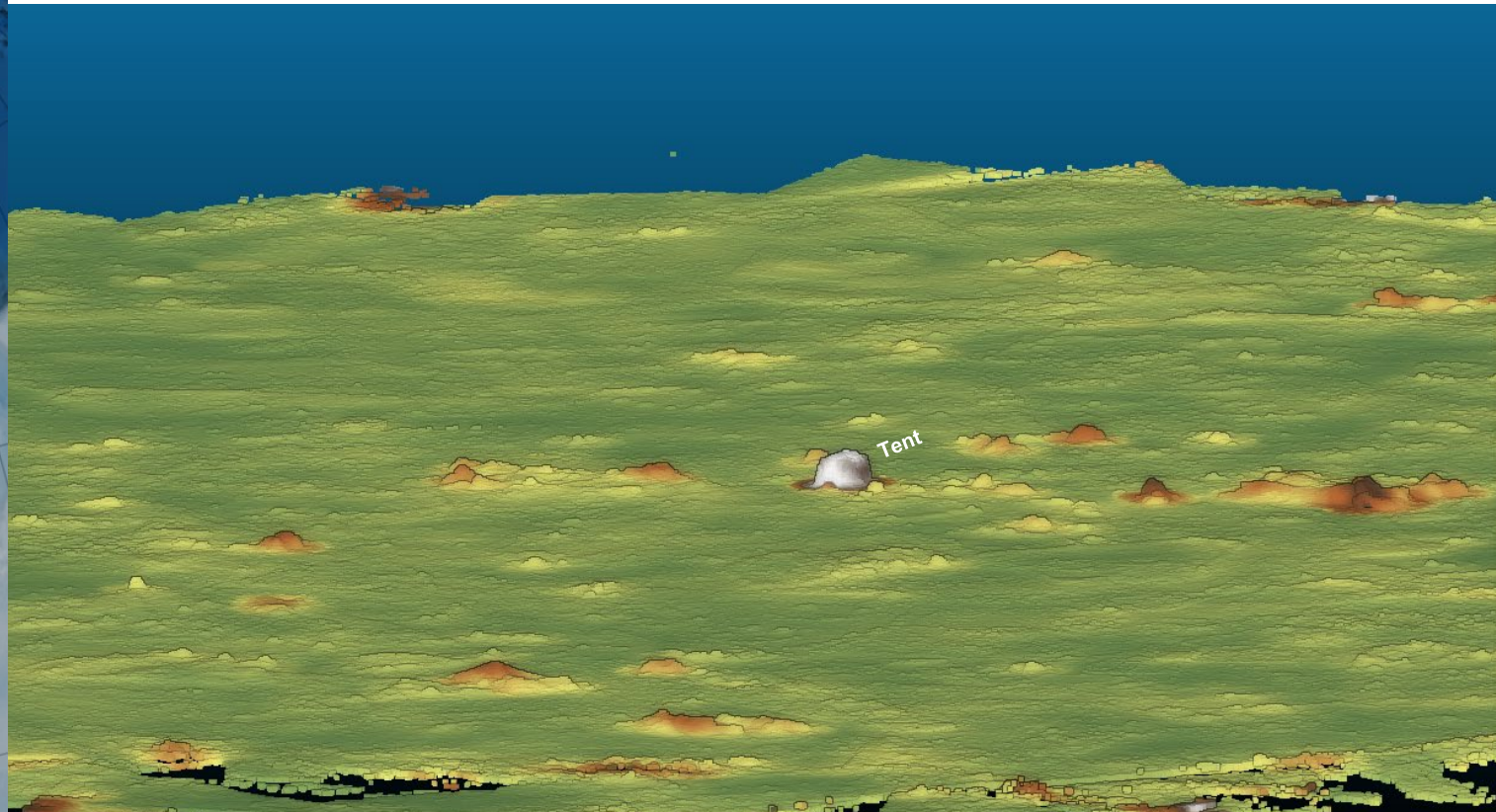

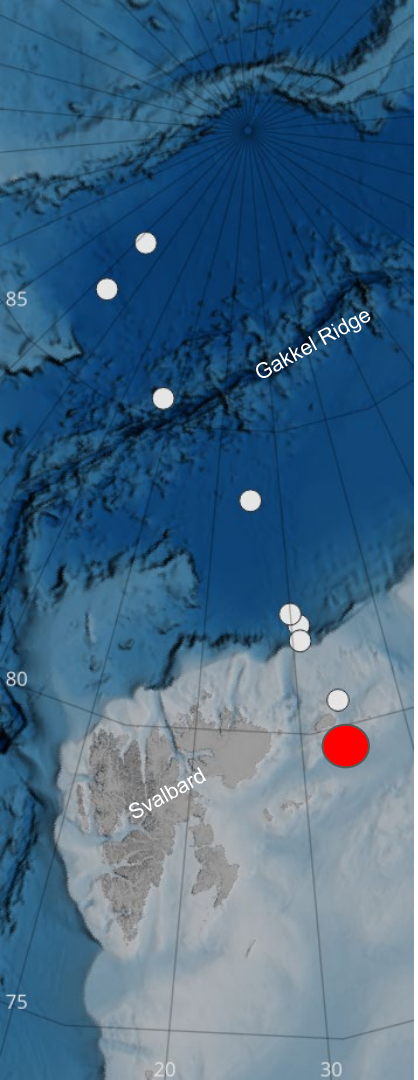

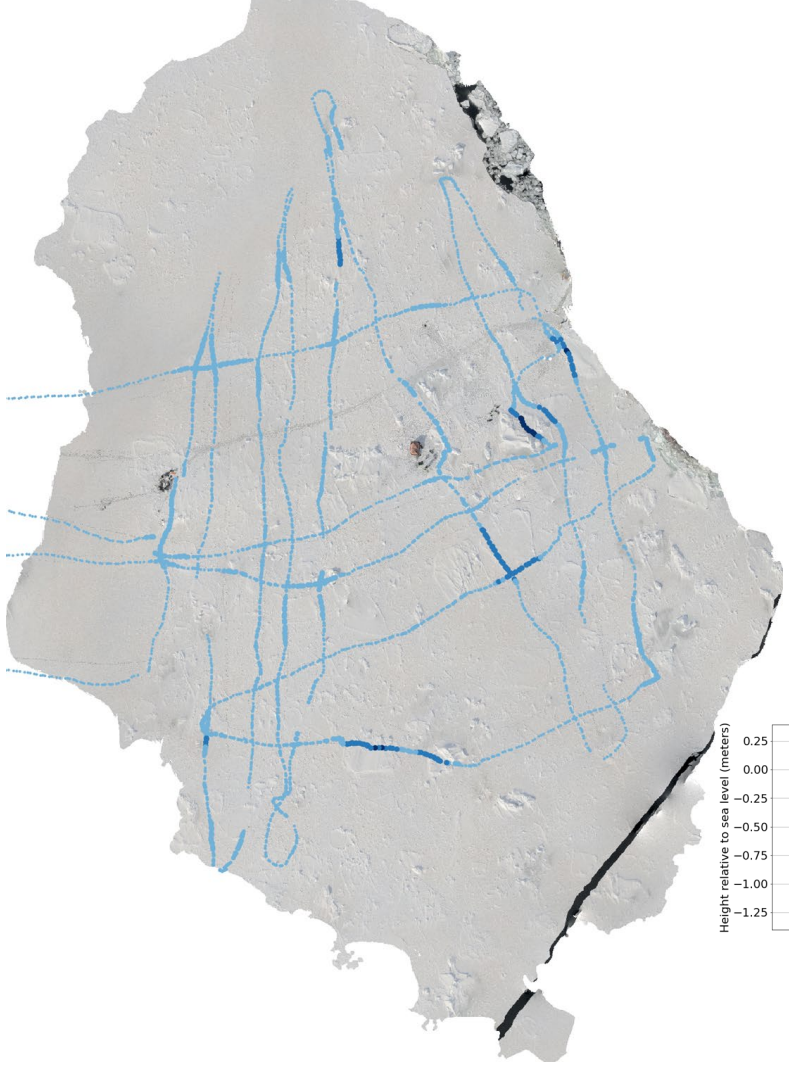

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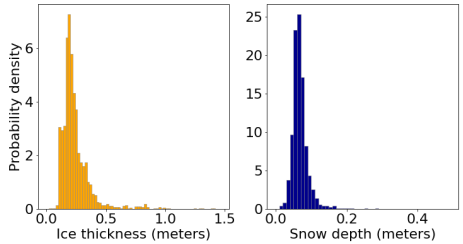
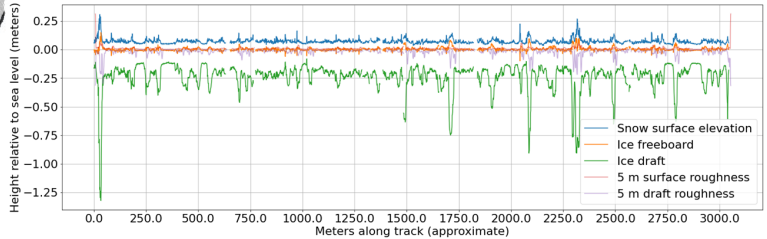
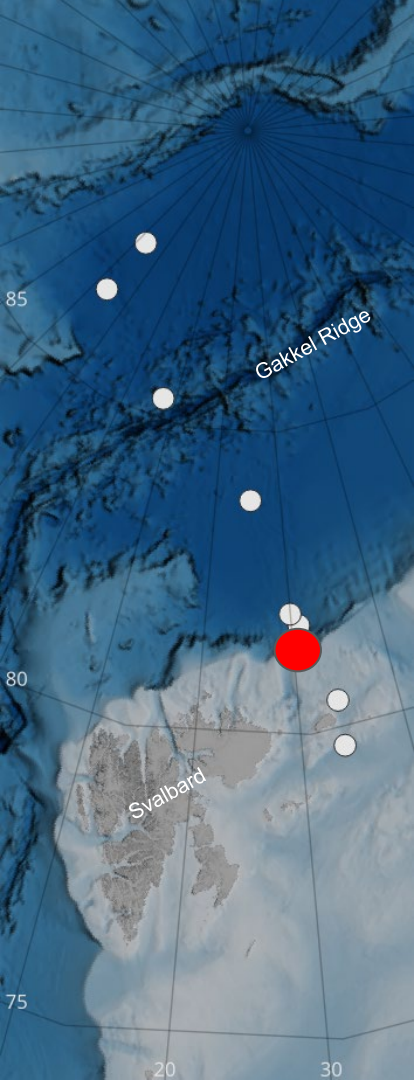
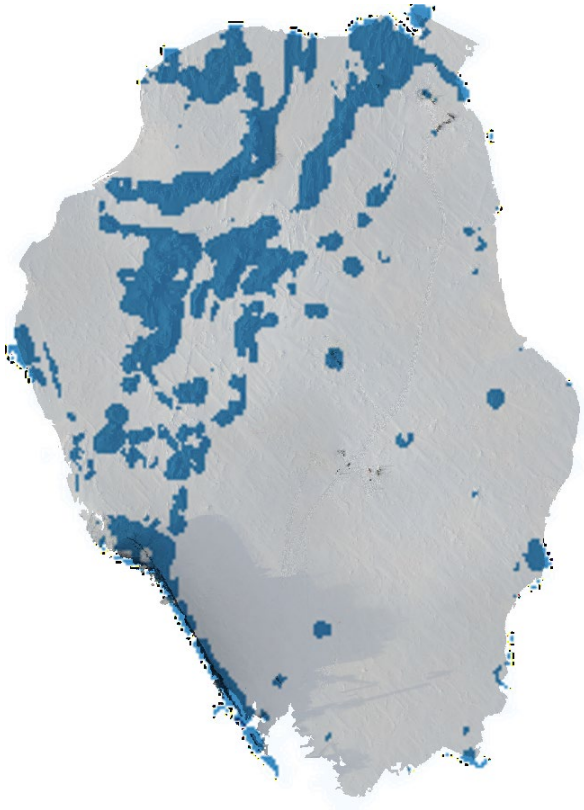


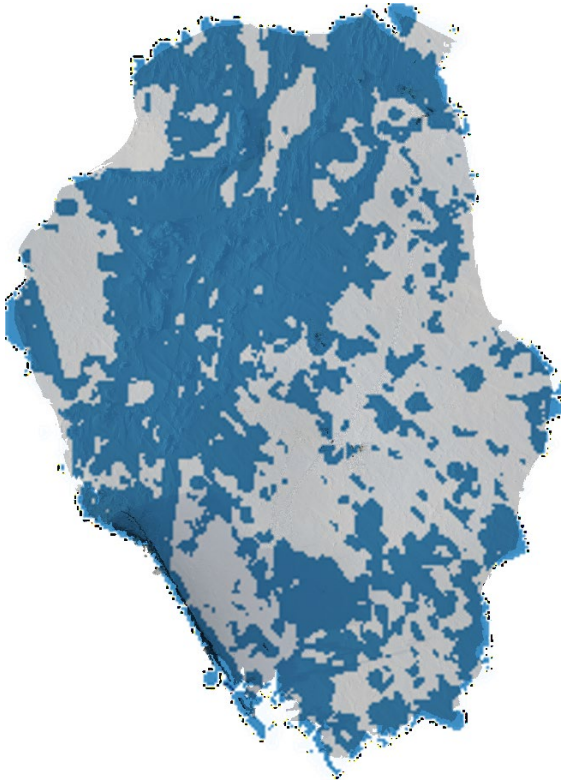


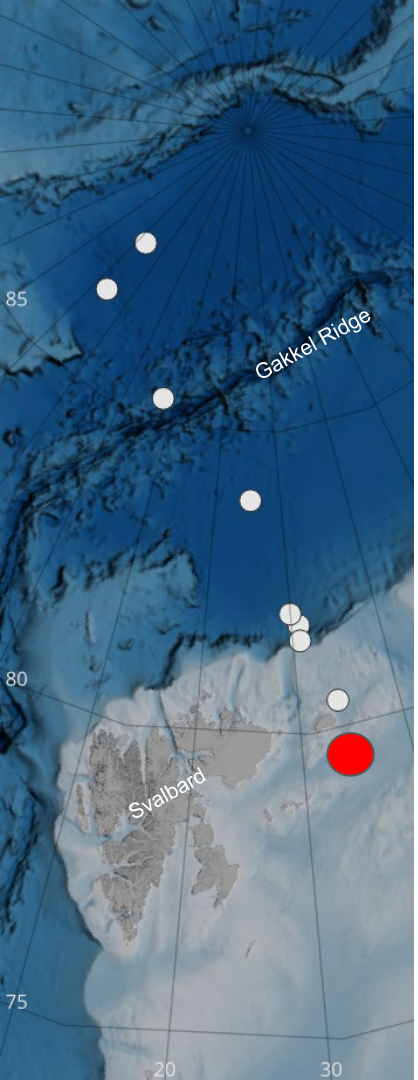
Part 3: Implications

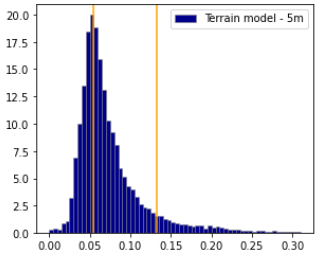
Sea ice roughness

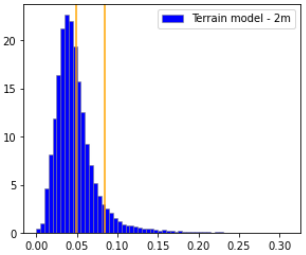


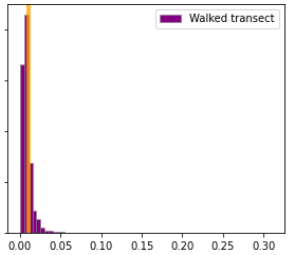


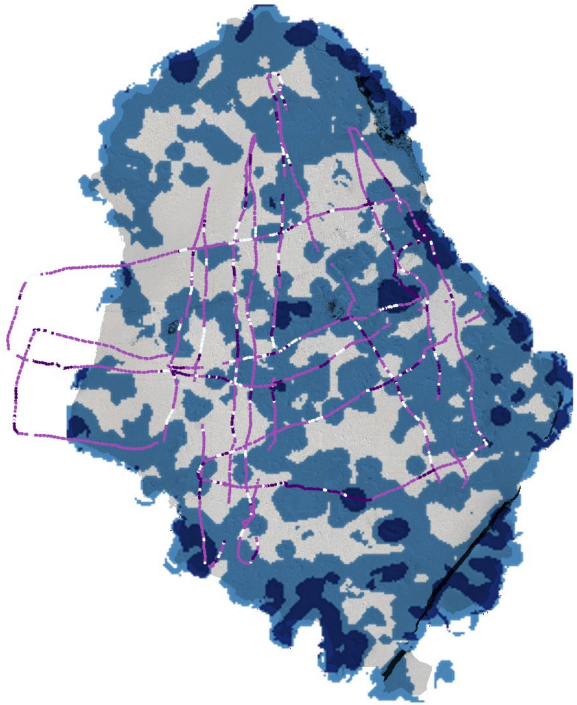


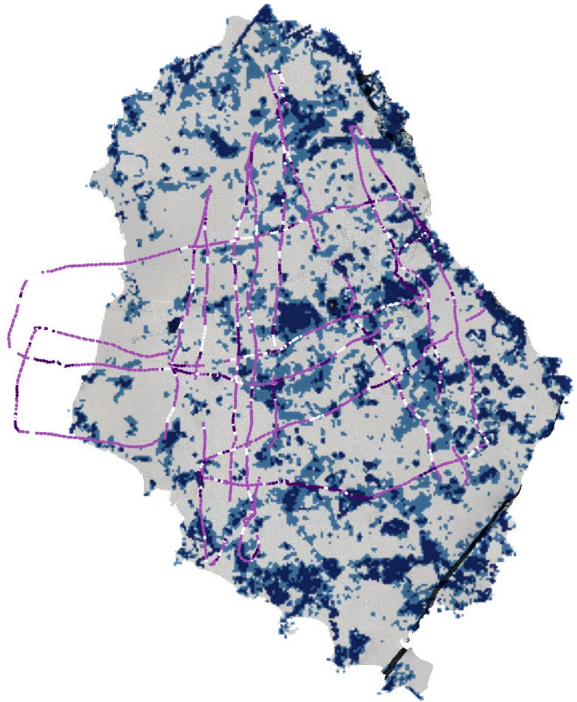












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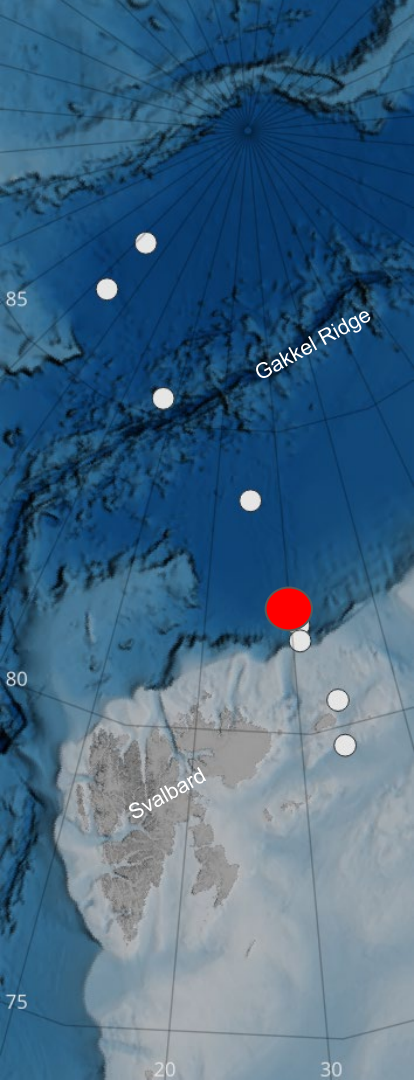

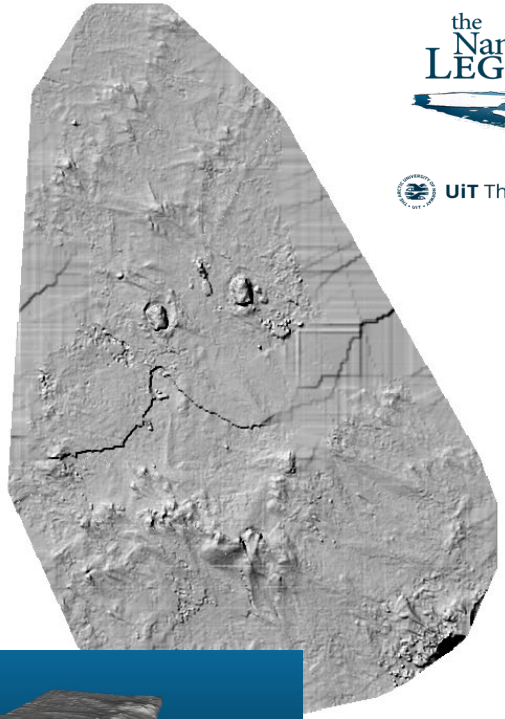

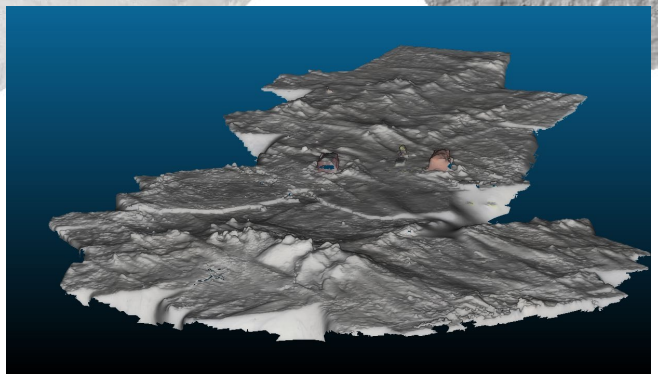

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Some flight notes for high latitudes

How to fly off sea ice and ships

Prepare and plan - know your estimated pixel size for a given flight height

Practice estimating drone position in the air - a lot!

Think about flight patterns which help to visually track the aircraft more easily

Calibrate, calibrate, calibrate

Keep moving - avoid hover states

Adjust constantly - wind might be very different at 60m than at sea level

Collect a continuous timeseries of reference position data

Be lucky - use all of the above to increase the odds of being lucky!

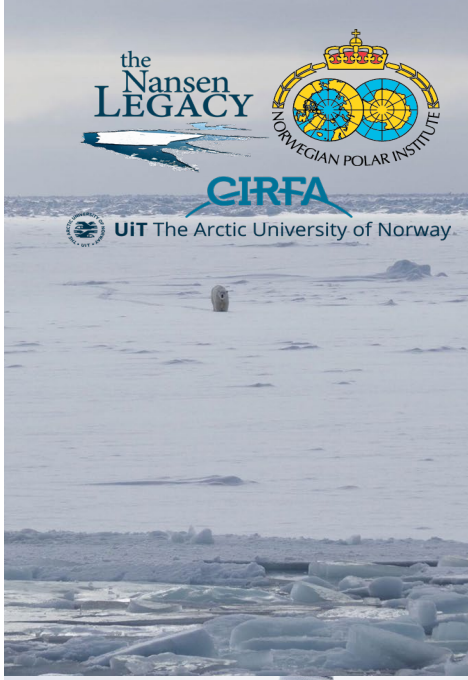

Photo: Polona Itkin

Thanks

adam.steer@npolar.no :: adam.d.steer@gmail.com

@adamdsteer :: @oceanseaicenpi

Posters - A9.06 Sea Ice Remote Sensing, 12:20 - 14:00

Coordinated SAR satellite observations, airborne and ground surveys over Arctic sea ice and snow for different seasons - ***Sebastian Gerland***

Towards automatic detection of newly formed sea ice and lookalikes in the Barents Sea using Wide-Swath Synthetic Aperture Radar - ***Anca Cristea***