AGU FALL MEETING
San Francisco | 14 – 18 December 2015

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR-
UND MEERESFORSCHUNG

The impact of the snow cover on sea-ice thickness products, retrieved by Ku band radar altimeters

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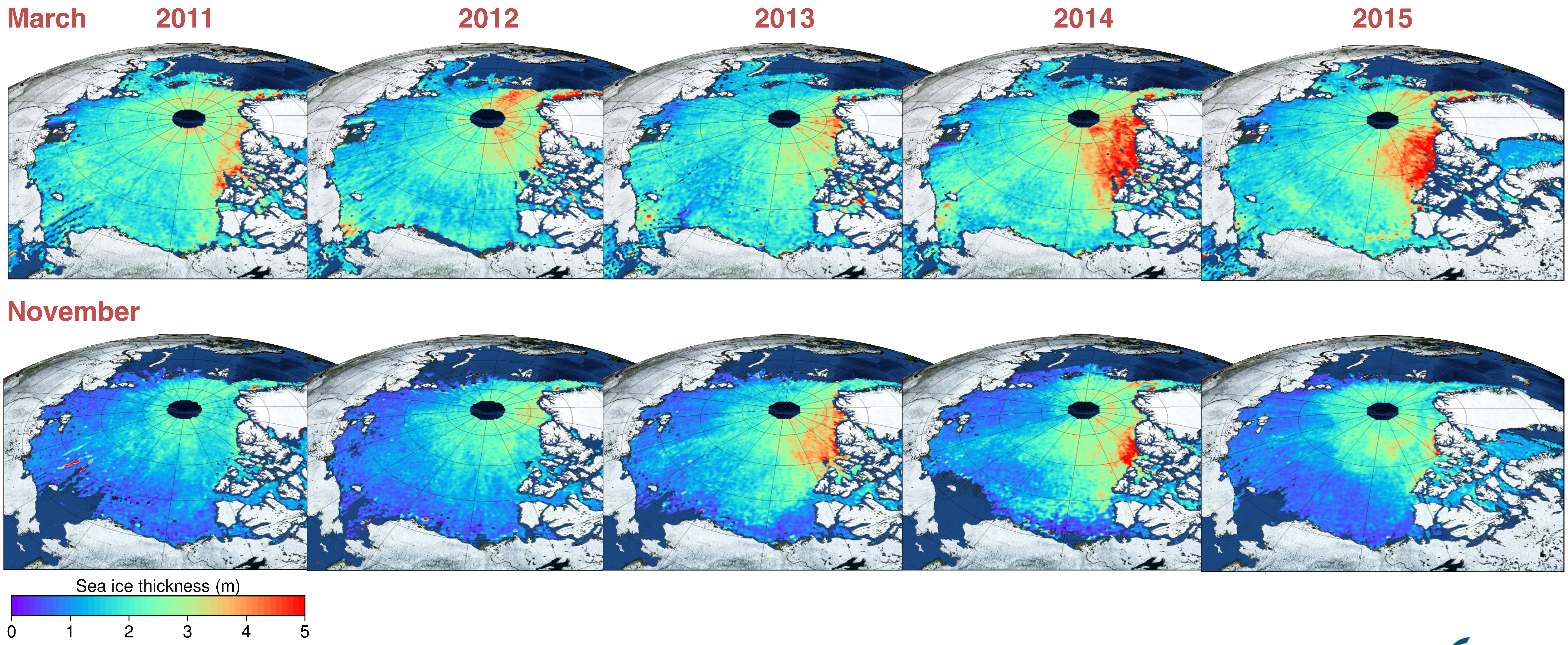
Motivation

CryoSat-2 along-track measurements are averaged within 1 month on a 25 x 25 km EASE2 grid. Time series from 2011-2015 reveal strong inter-annual variations:



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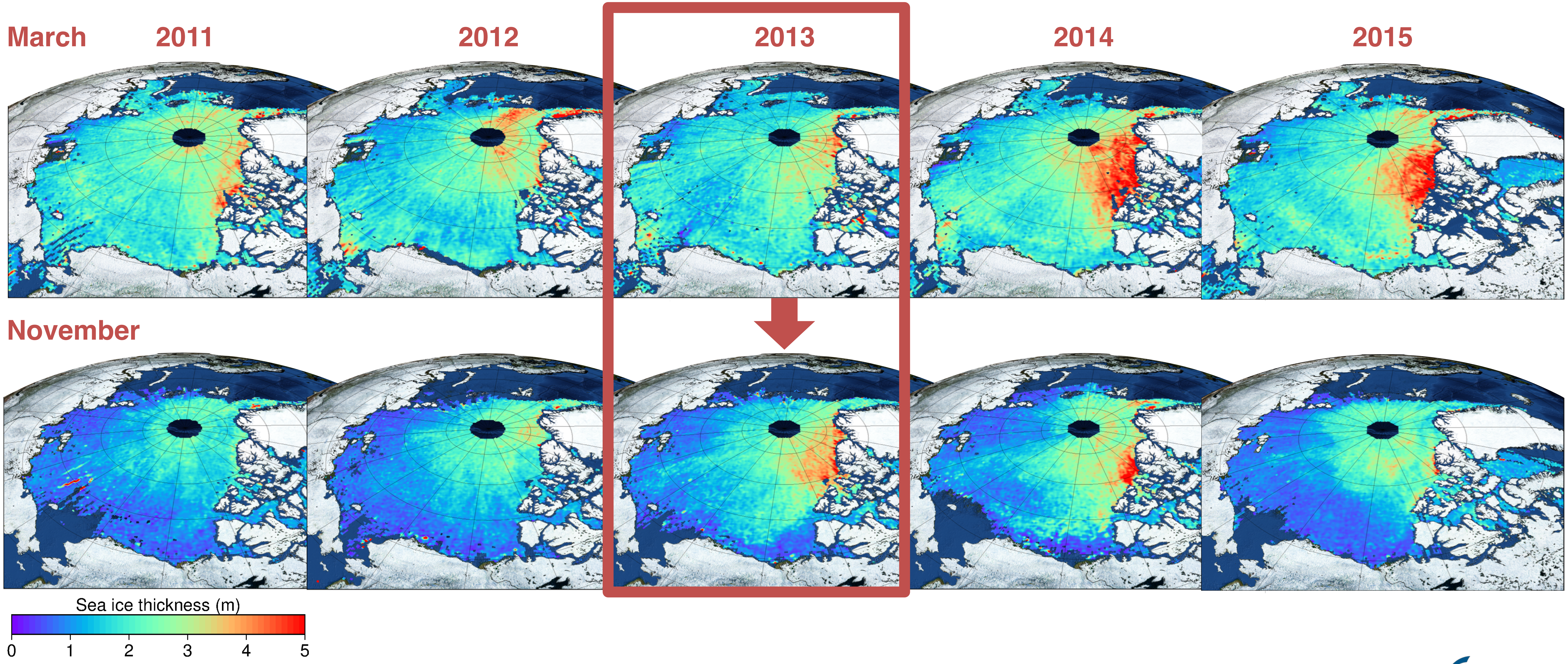

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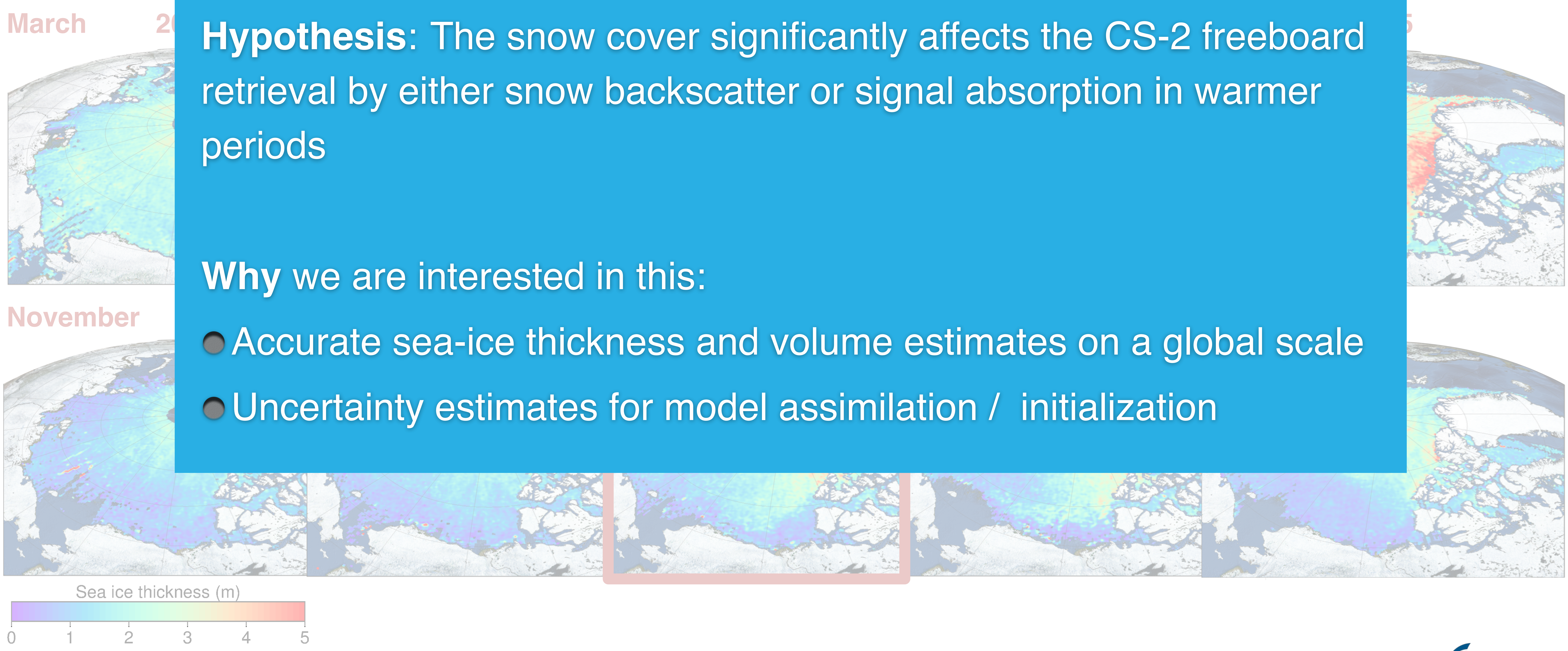
Hypothesis: The snow cover significantly affects the CS-2 freeboard retrieval by either snow backscatter or signal absorption in warmer periods

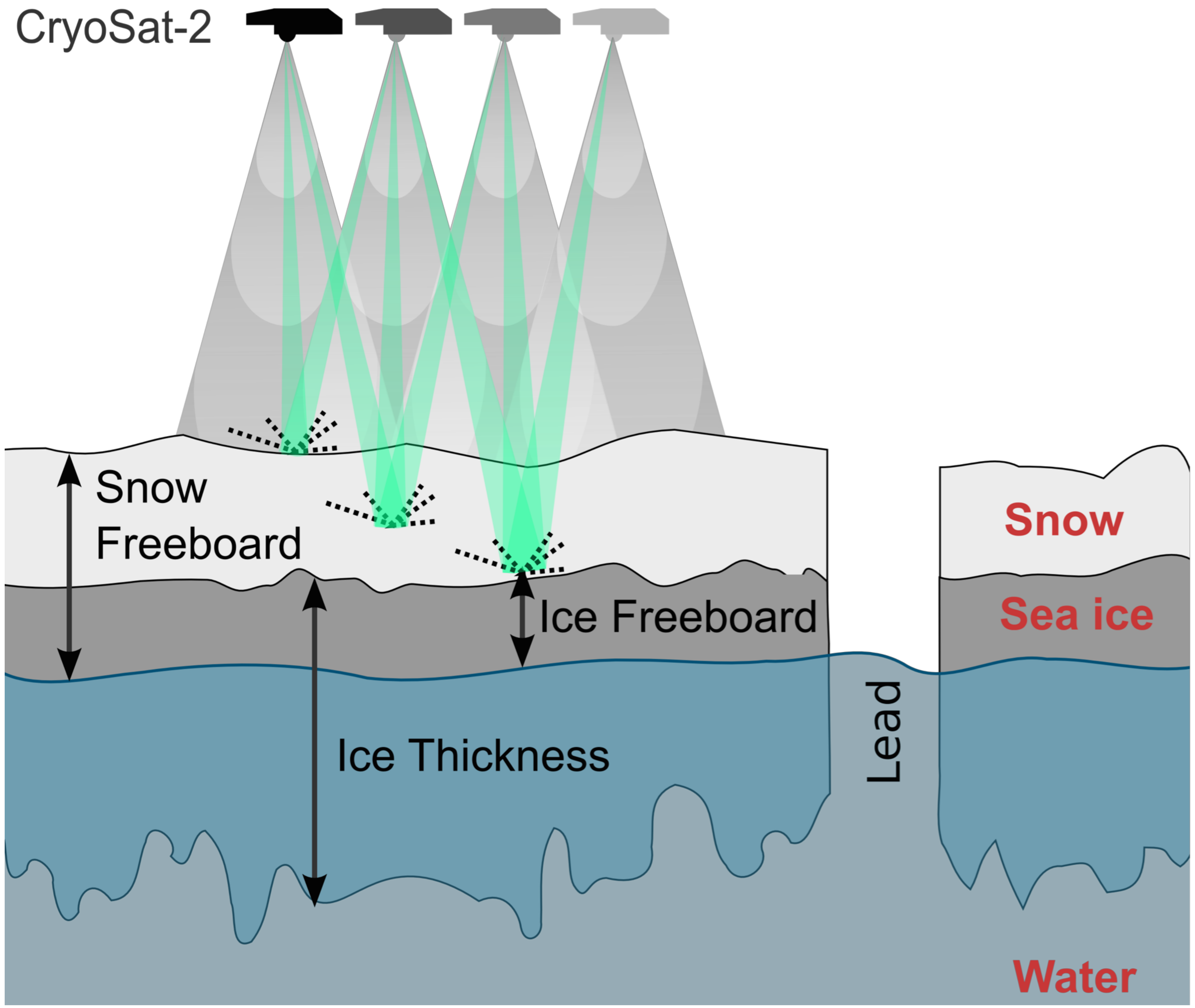
Why we are interested in this:

- Accurate sea-ice thickness and volume estimates on a global scale
- Uncertainty estimates for model assimilation / initialization



CryoSat-2 Ku-Band altimetry

- Satellite altimeters sense the **sea-ice freeboard**, the height of the ice surface above the water level



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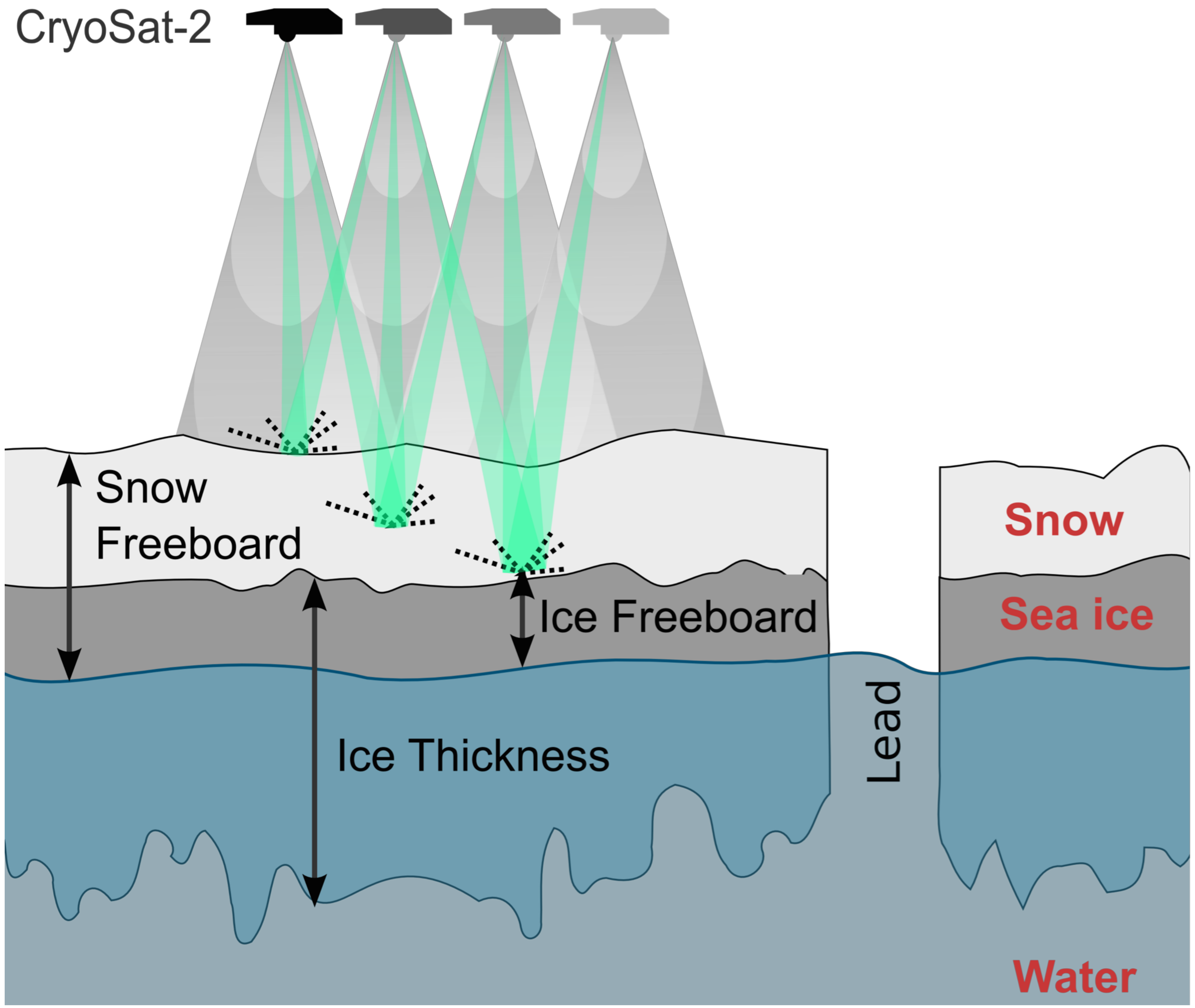

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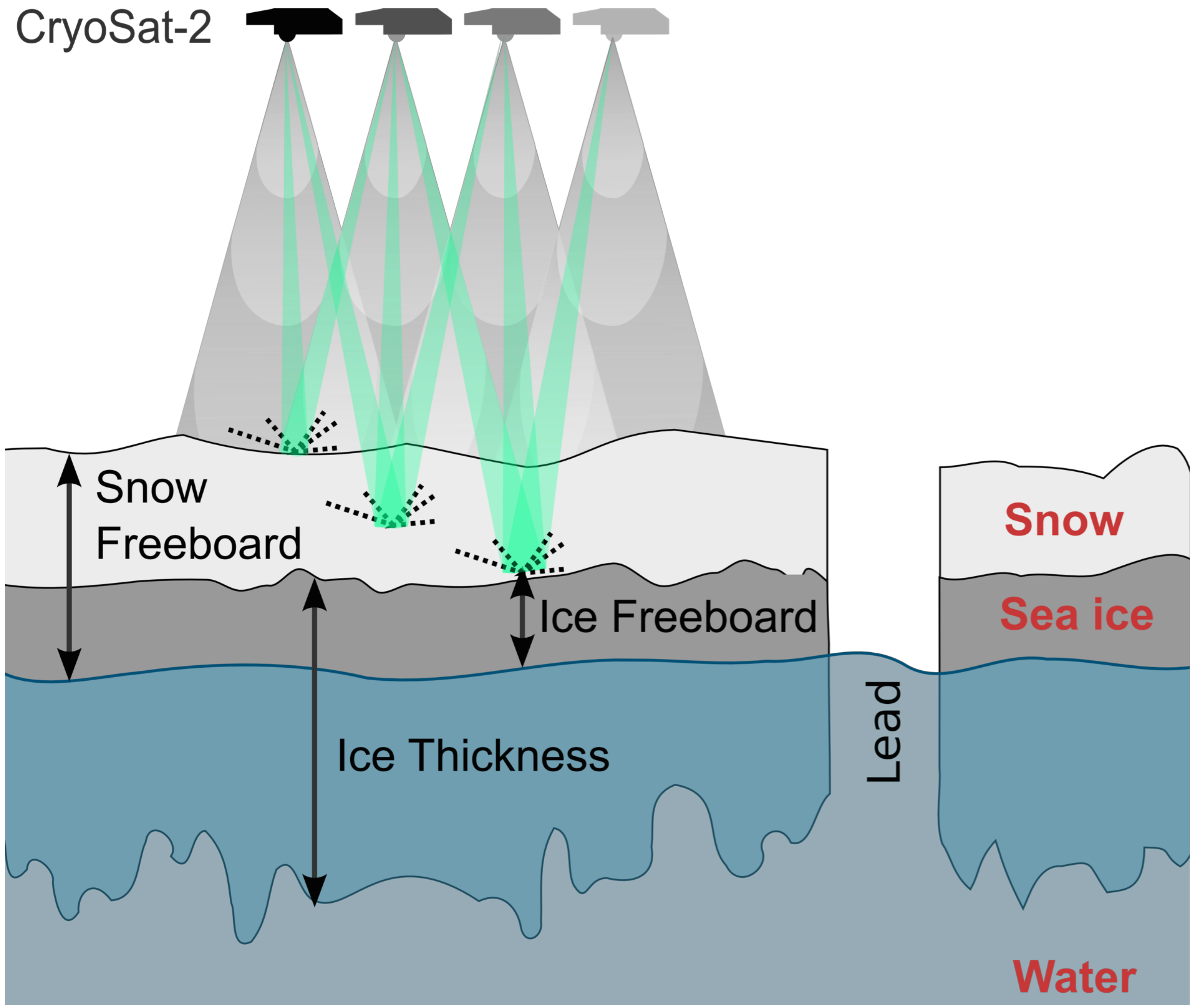
- **Snow depth** adds to the uncertainty of the ice thickness retrieval in different ways:



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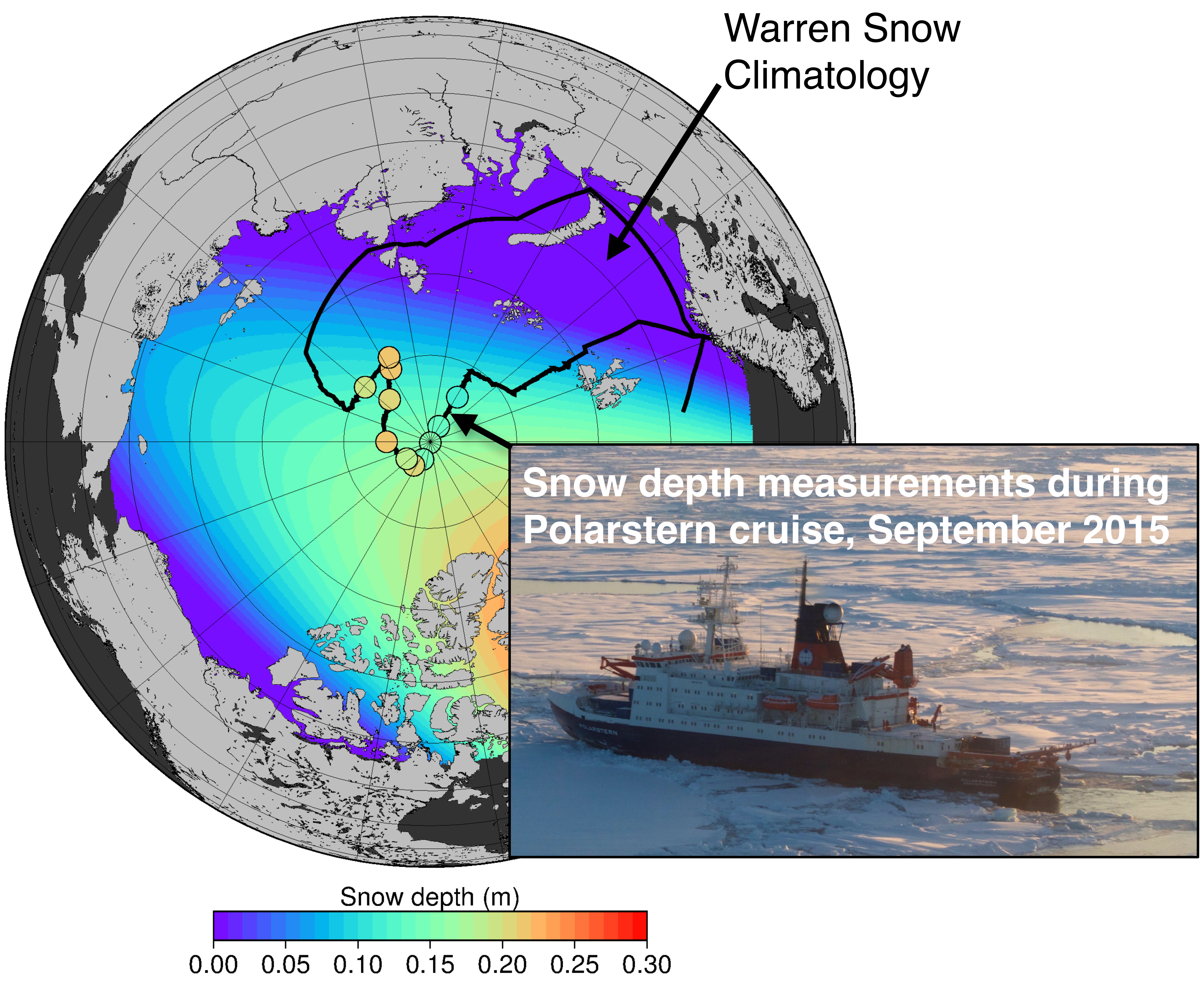

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  - recent studies show that a thick snow cover can cause a significant sea-ice thickness bias due to **snow volume backscatter**

Credit S. Arndt

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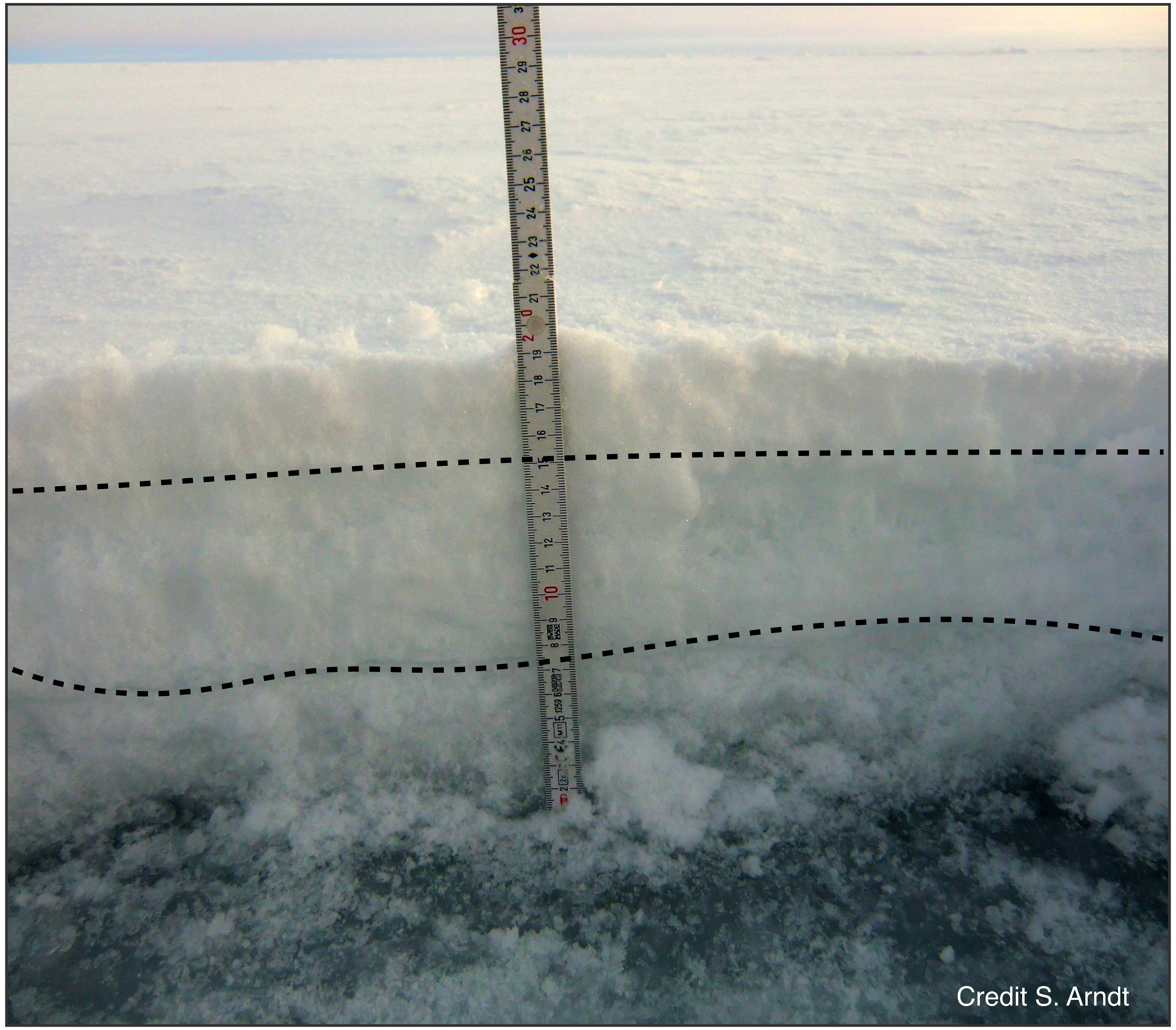
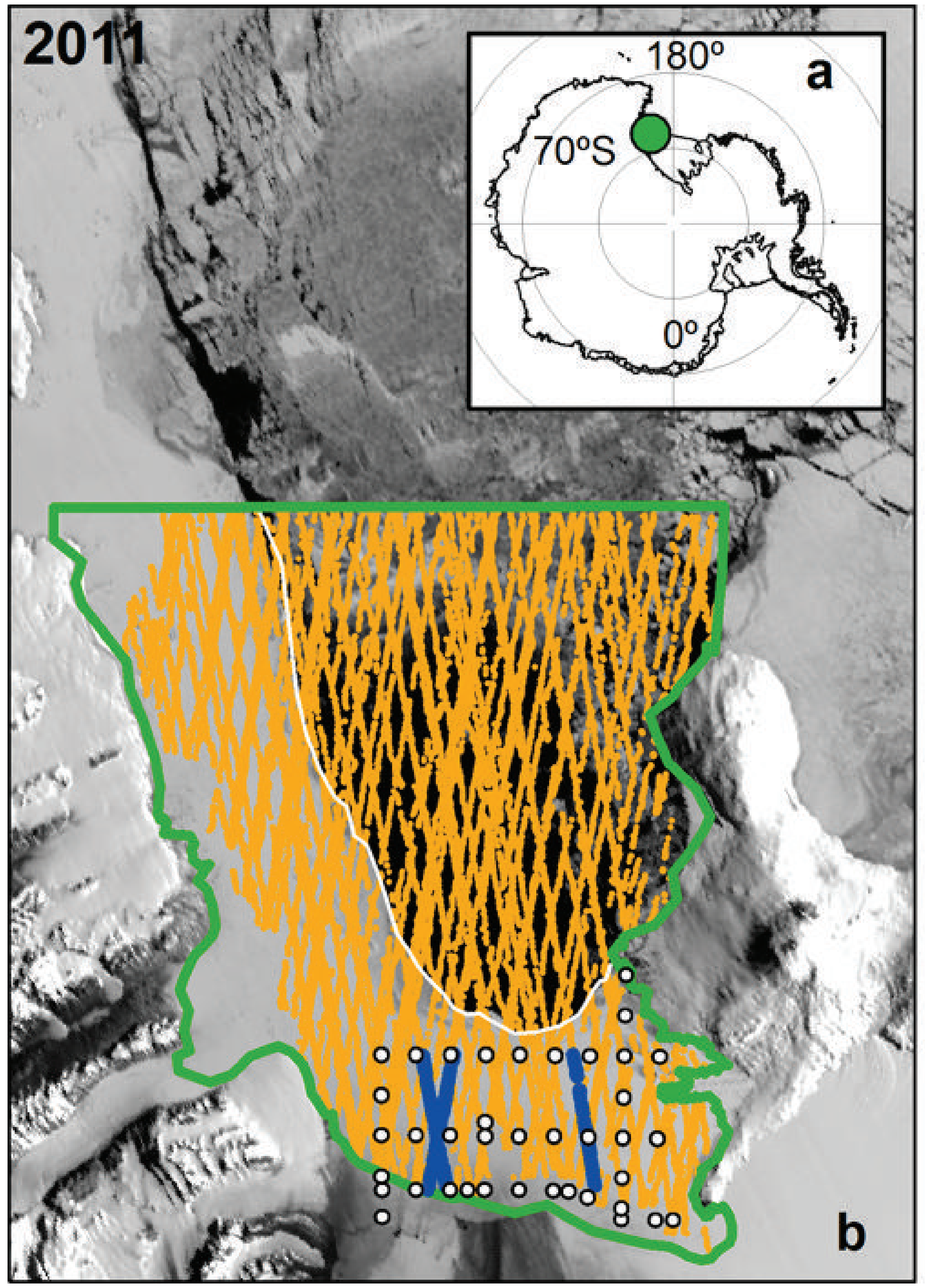


Credit S. Arndt

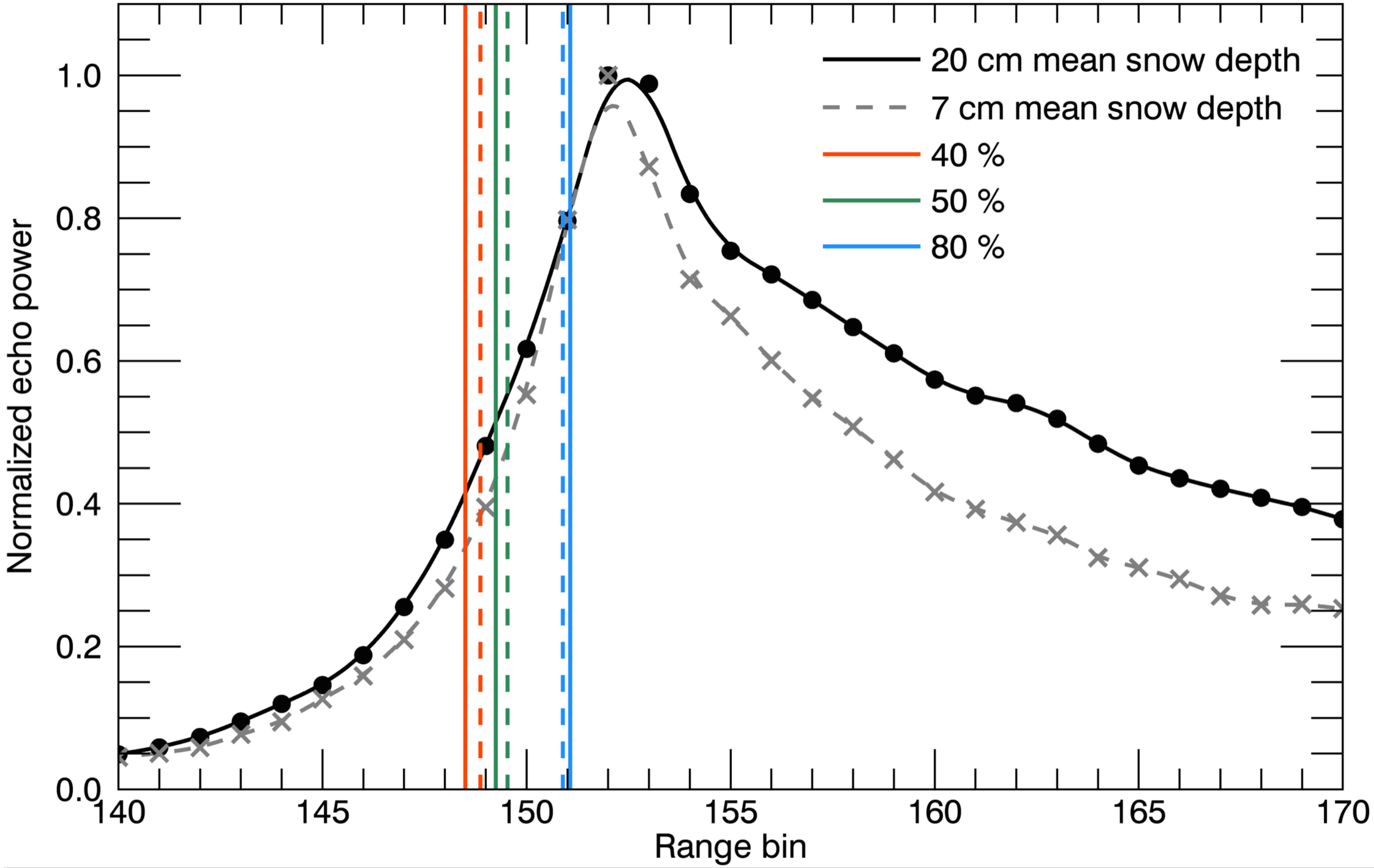
The impact of snow on the waveform

CryoSat-2 validation lines on fast-ice in McMurdo Sound (Antarctica):



Price et al. (2015): *Evaluation of CryoSat-2 derived sea ice freeboard over fast-ice in McMurdo Sound, Antarctica.*

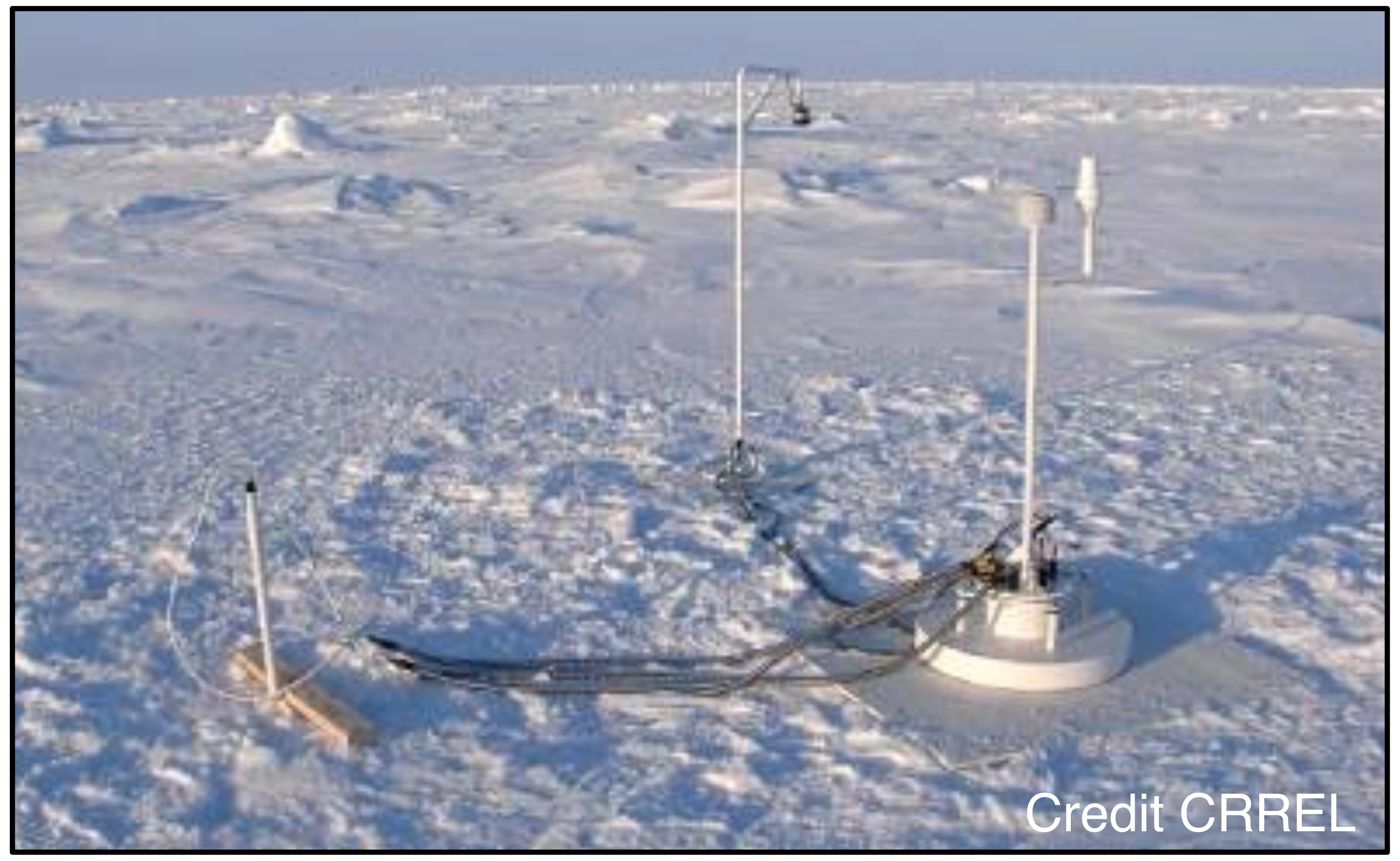
Different power thresholds applied on two stacked CryoSat-2 waveforms:



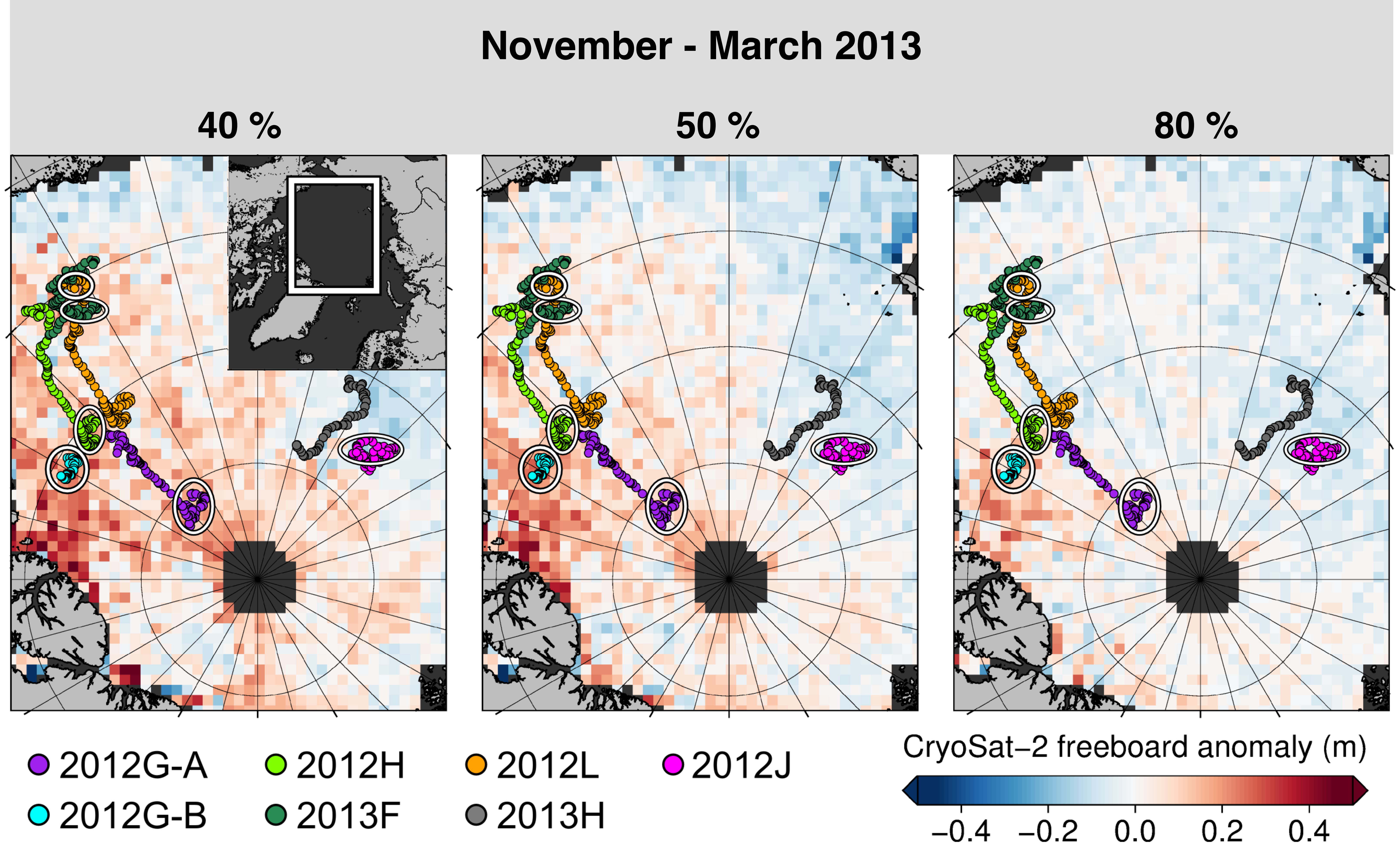
re-plotted, Price et al. (2015)

An observational approach with buoy data

- Differences in gridded CryoSat-2 Arctic modal freeboard between **November** 2013 and **March** 2013 retrievals
- We apply three different retracker **thresholds**: **40 %**, **50 %** and **80 %**



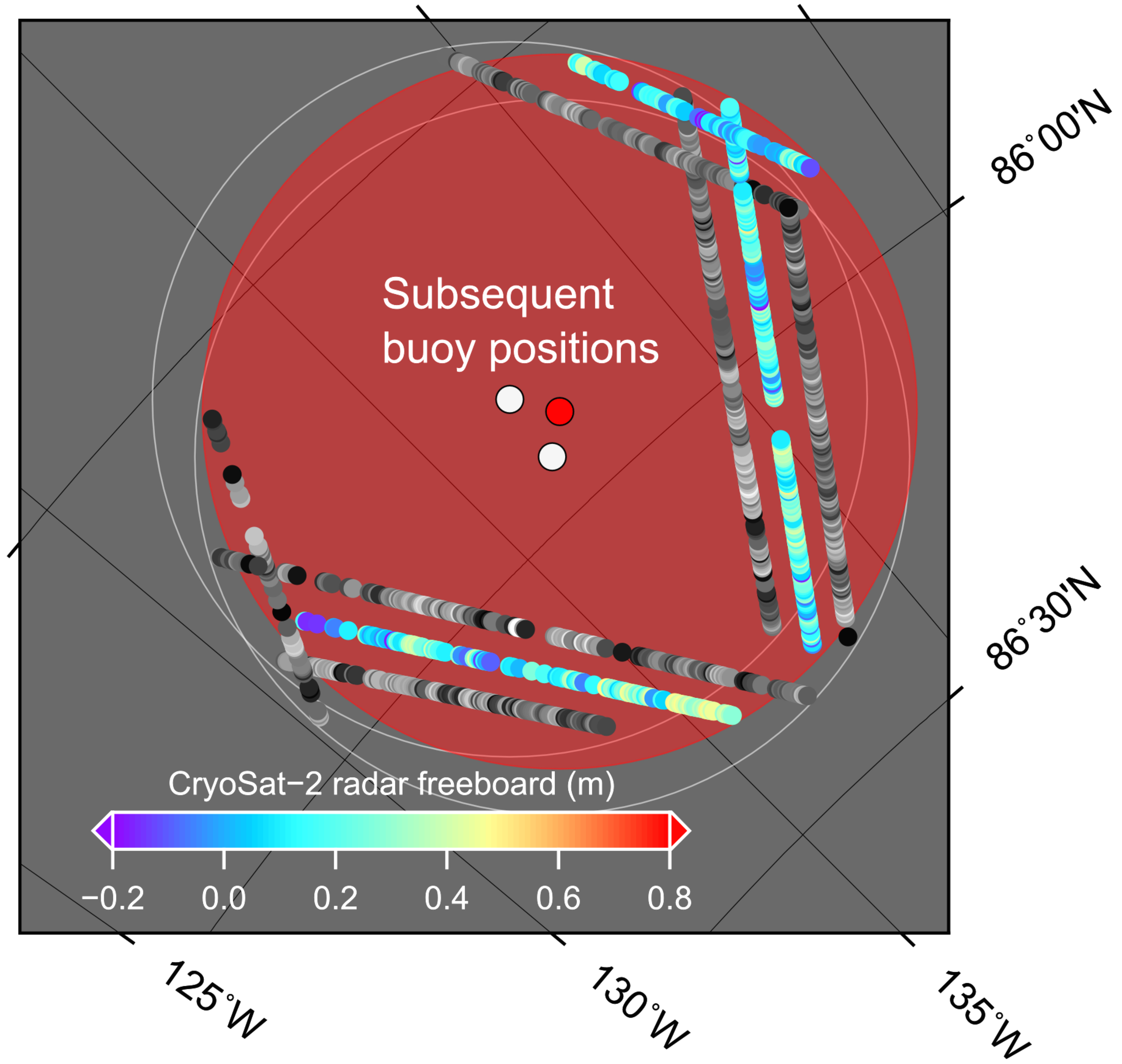
Ricker et al. (2015): *Impact of snow accumulation on CryoSat-2 range retrievals over Arctic sea ice: an observational approach with buoy data.*

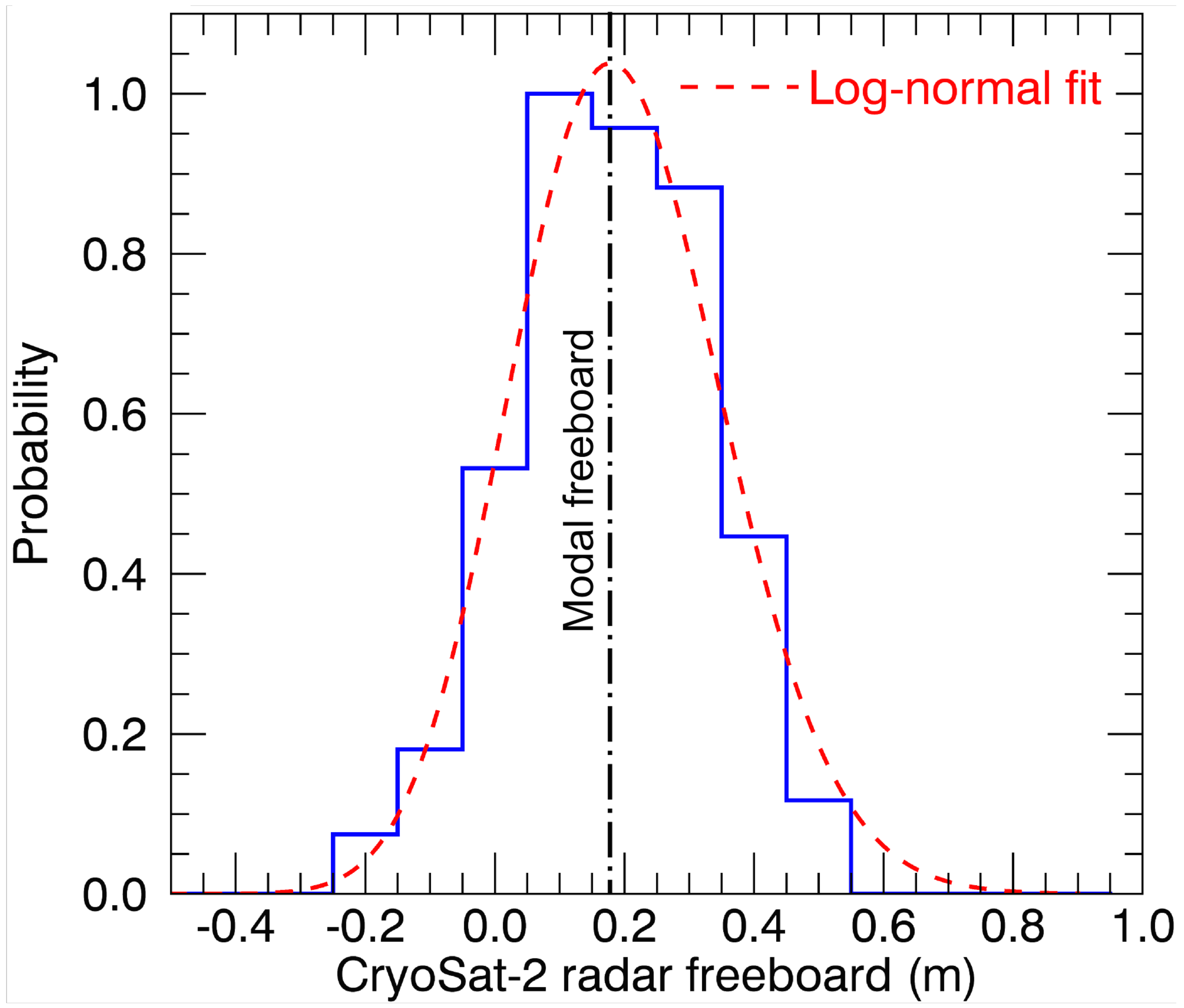


Methods

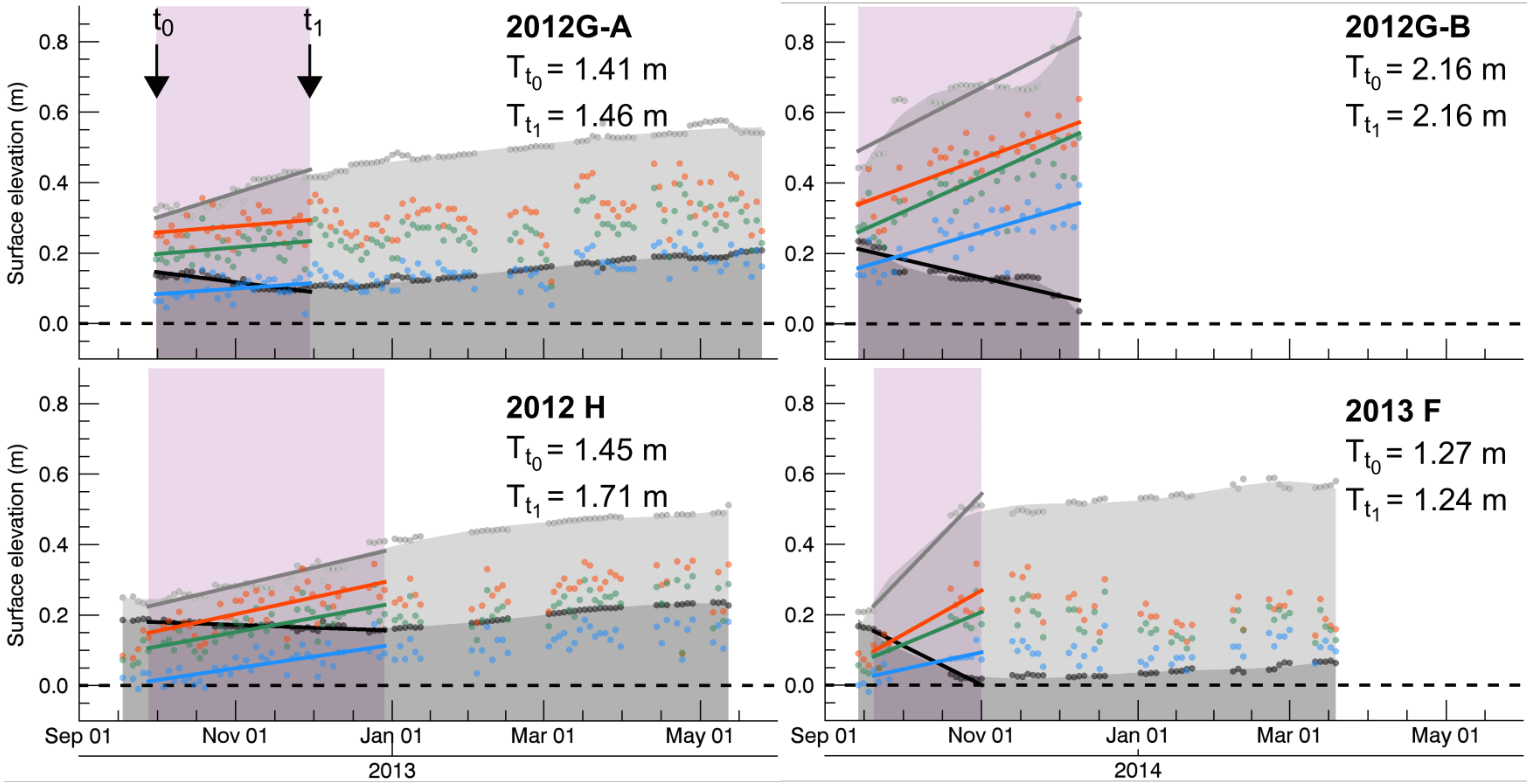
- CryoSat-2 measurements are collected within a **50 km** radius (red circle) around a considered buoy position (red dot)

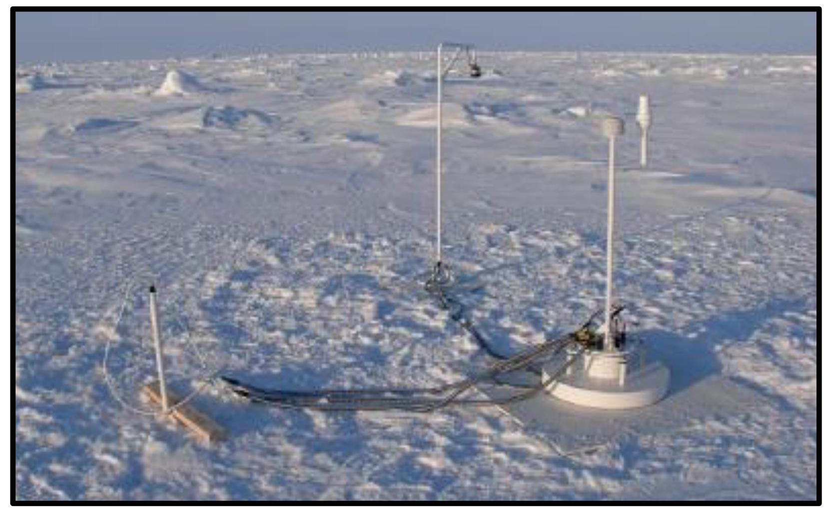
- A log-normal function is fitted to the CryoSat-2 freeboard distribution to retrieve the modal sea ice freeboard





CryoSat-2 and coincident buoy records

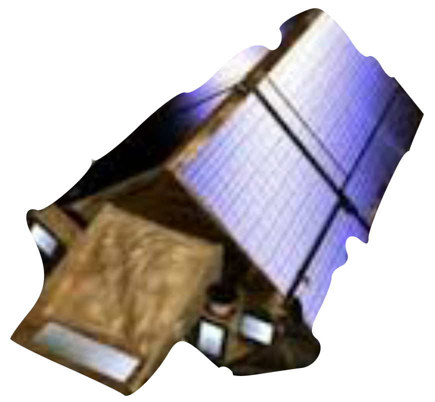




Snow freeboard

Ice freeboard

Event period



CS-2 freeboard 40 %

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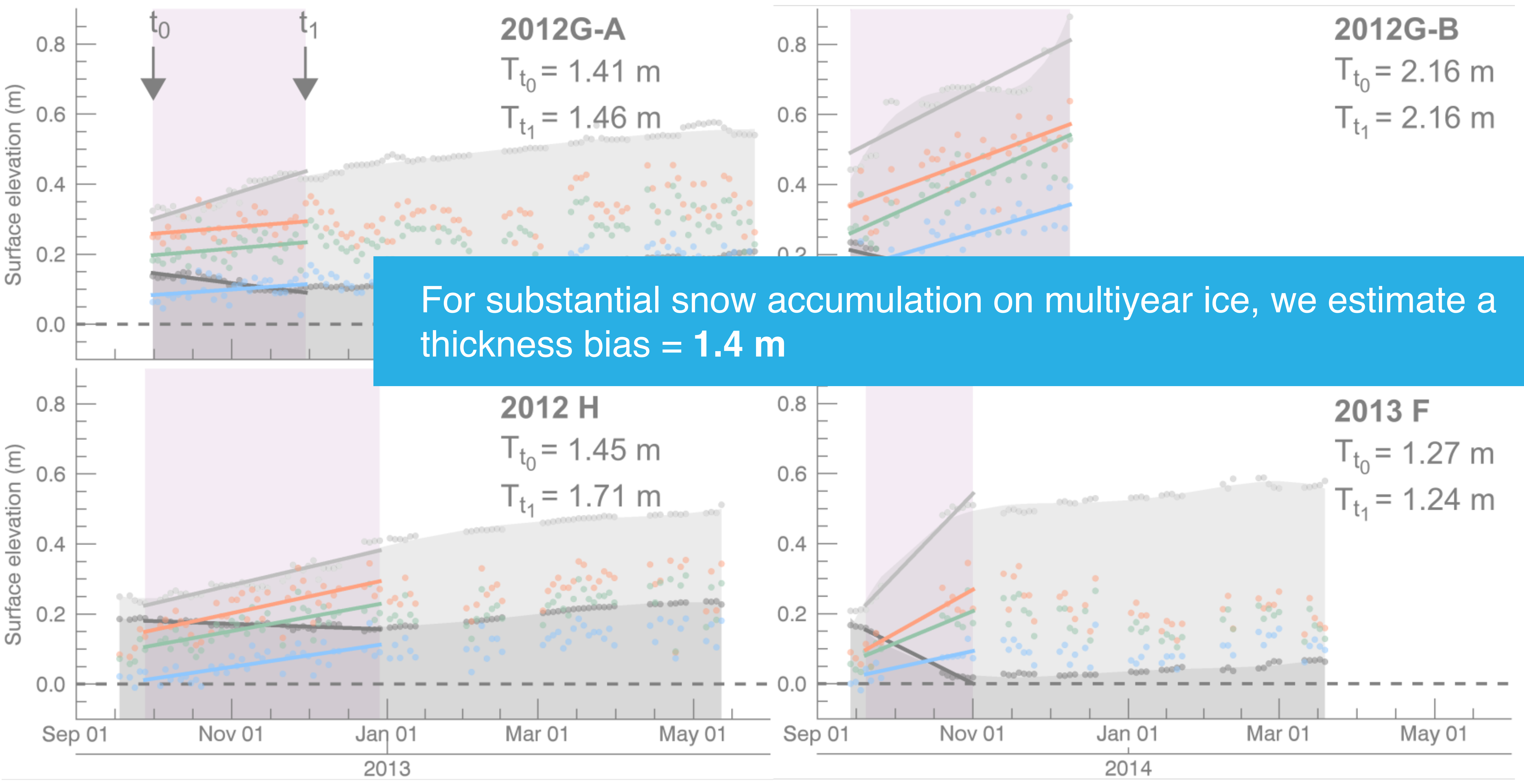

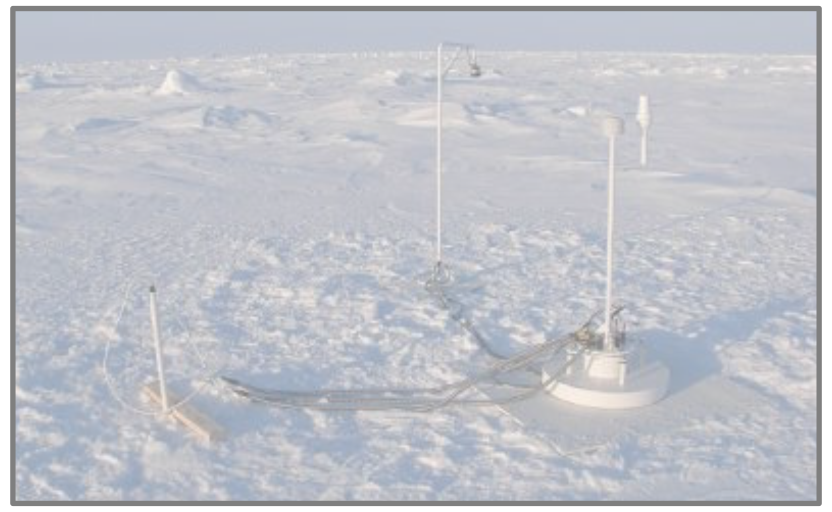

For substantial snow accumulation on multiyear ice, we estimate a thickness bias = **1.4 m**

Summary and Conclusion

- During the snow accumulation periods we only find **negative trends** for the **IMB ice freeboard** while the **IMB snow freeboard** trends are always **positive**
- Simultaneously we observe only **positive trends** for coincident **CryoSat-2 radar freeboard** estimates
- Assuming that the anomaly results from snow volume scattering only, the mean bias **over multiyear ice in 2013** is **1.4 m**
- Ice dynamics in the vicinity of the buoy locations can interfere with these quantifications