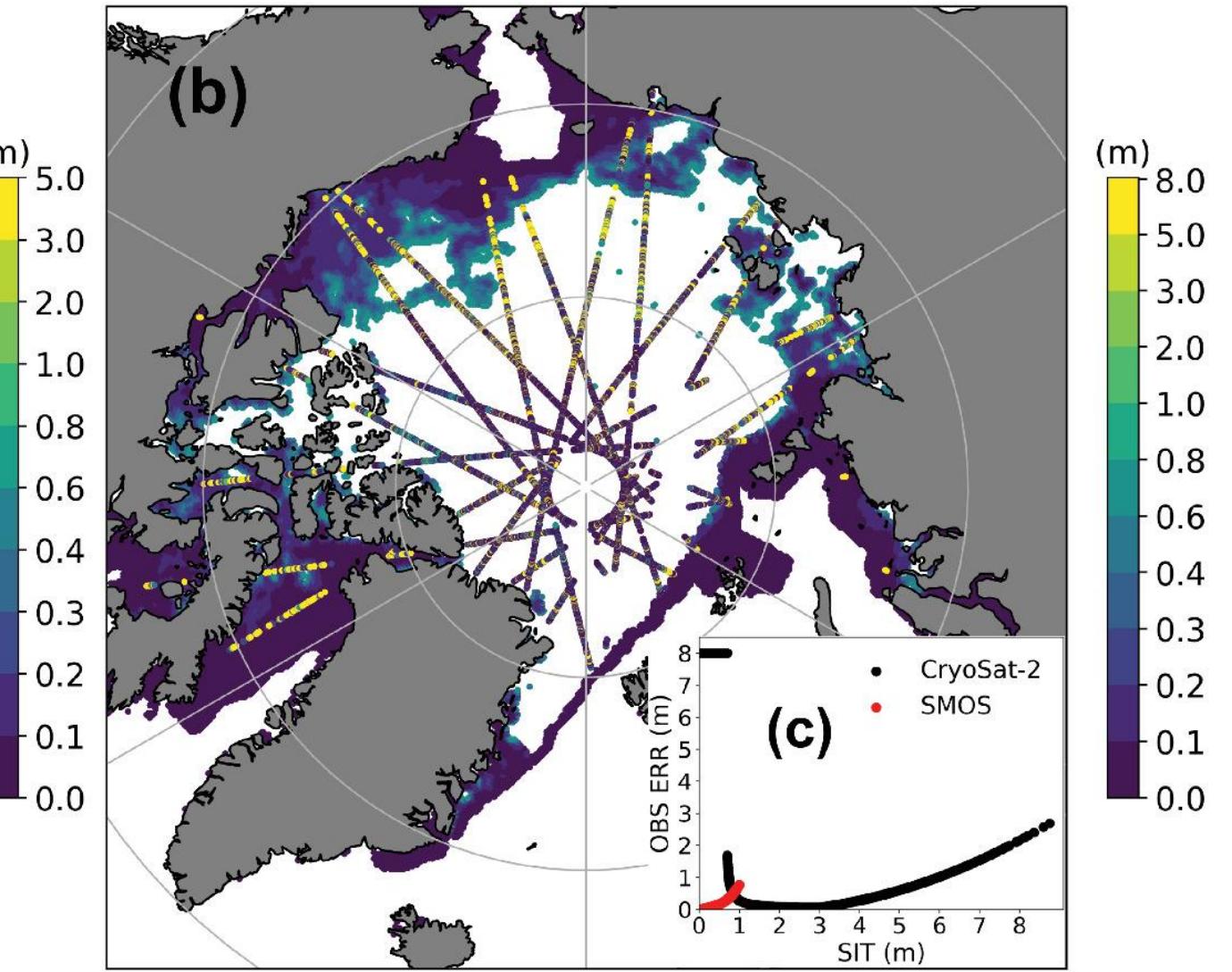
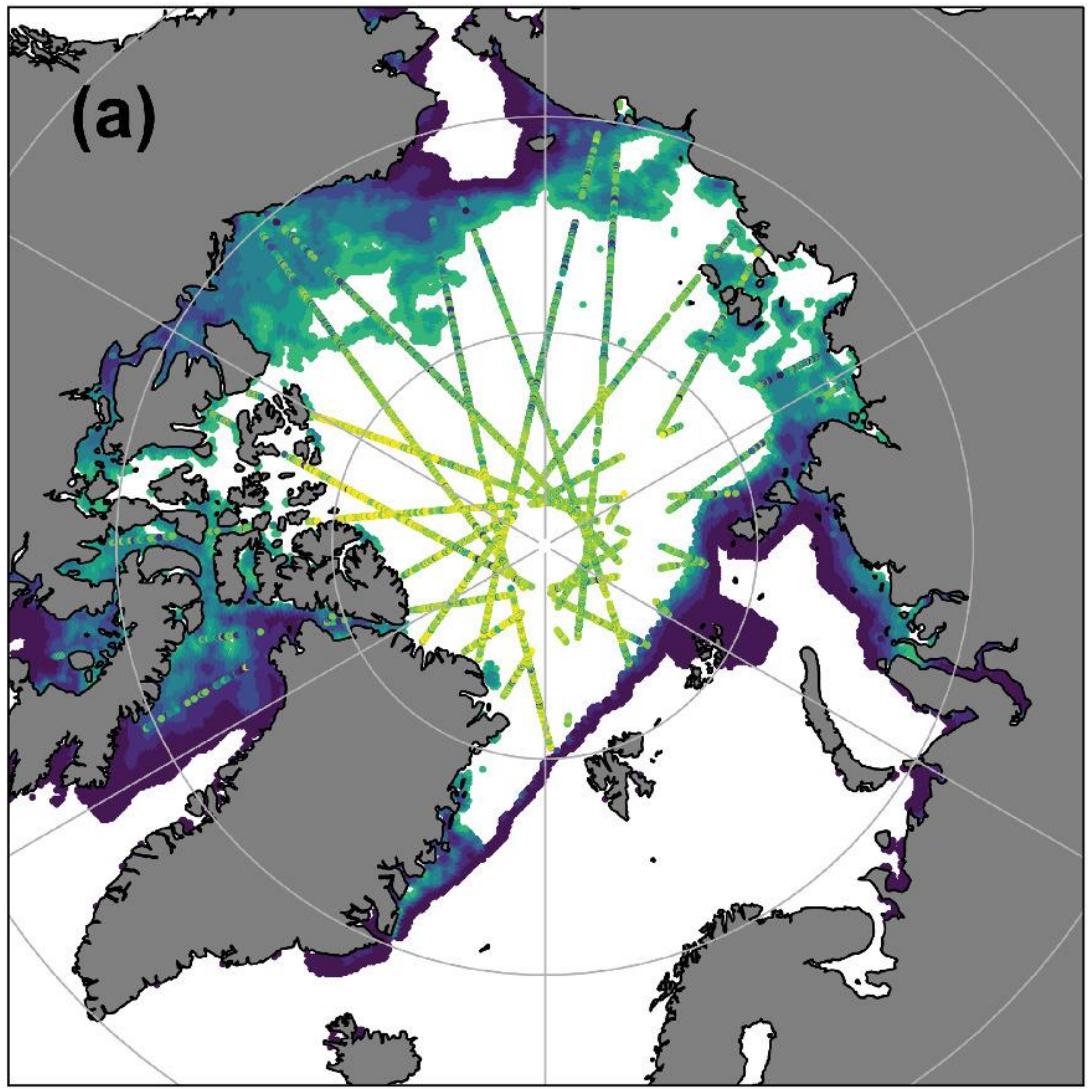


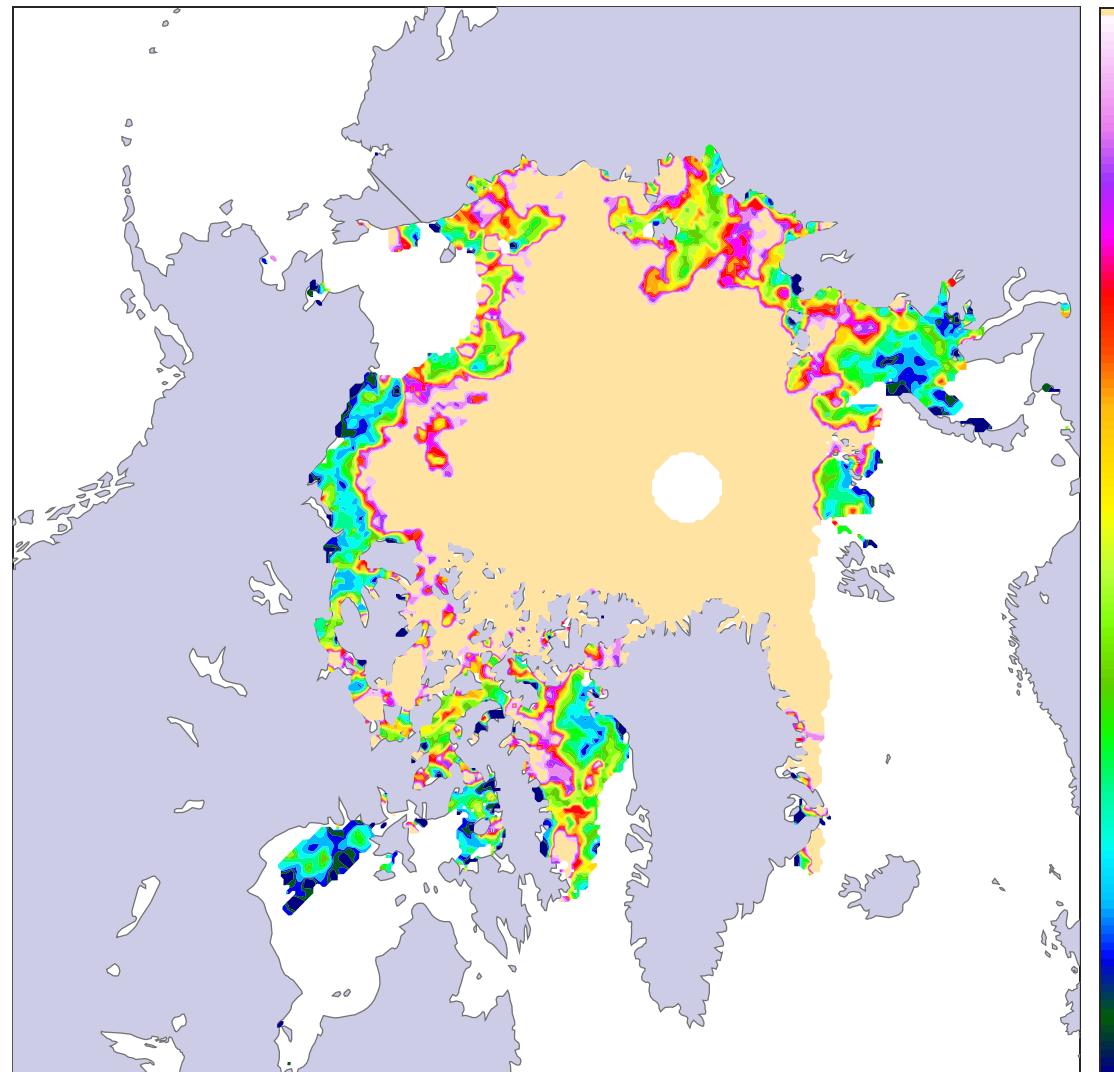
CS2 performance over thin sea ice

0 – 1 m thickness

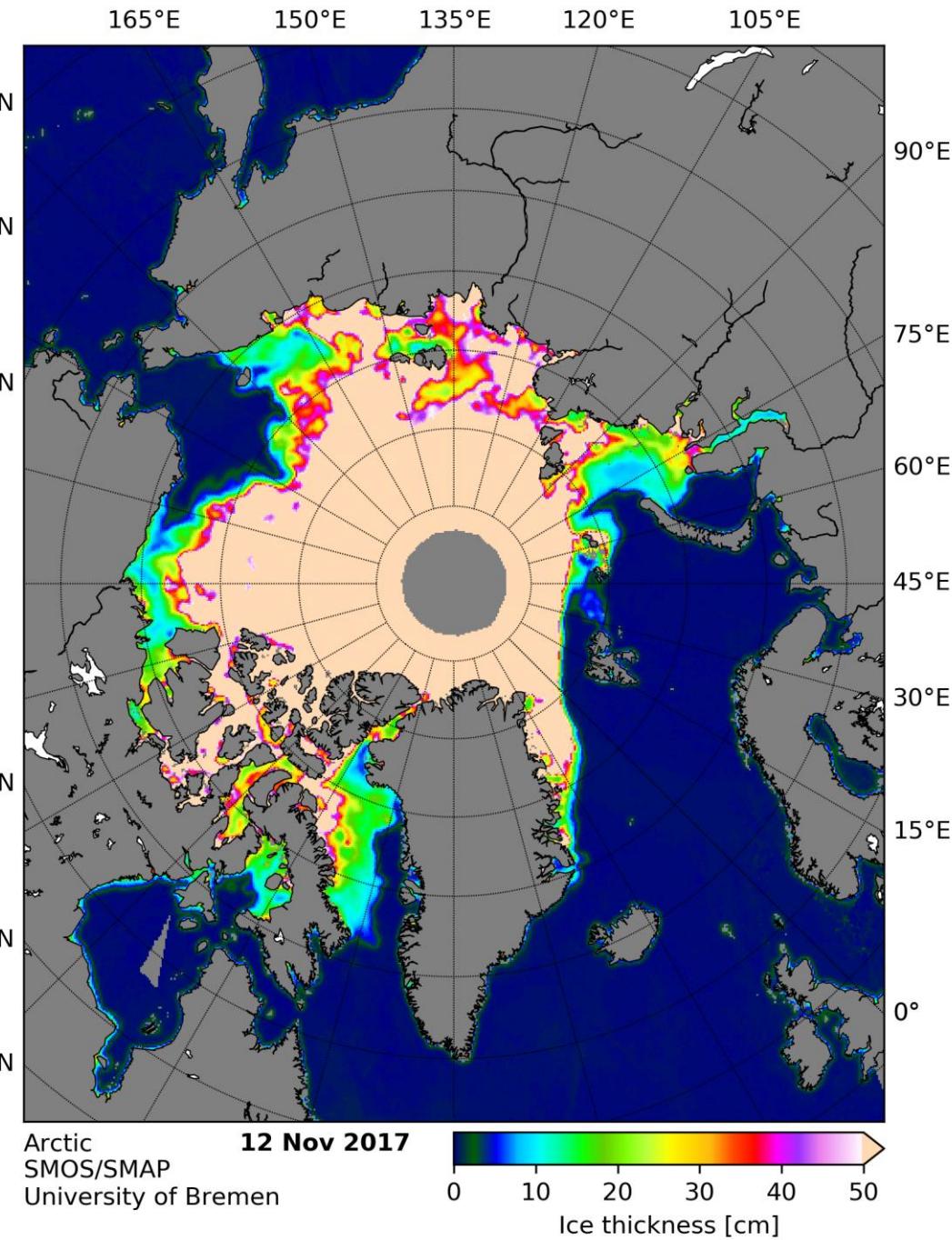


Mignac et al 2022: (a) Assimilated sea-ice thickness derived from CryoSat-2 and SMOS within a 24-hour time window, and their uncertainties (b) as a spatial map and (c) as a function of their SITs for 25 November 2016. Note the irregular colour bar intervals in both (a) and (b) to highlight the distinct sea-ice thickness observations and the differences in uncertainty between the satellites. Units are in metres

CryoSat-2 November 2017 Mean SIT (LARM+SMLG)



[only data where SIC>70%]

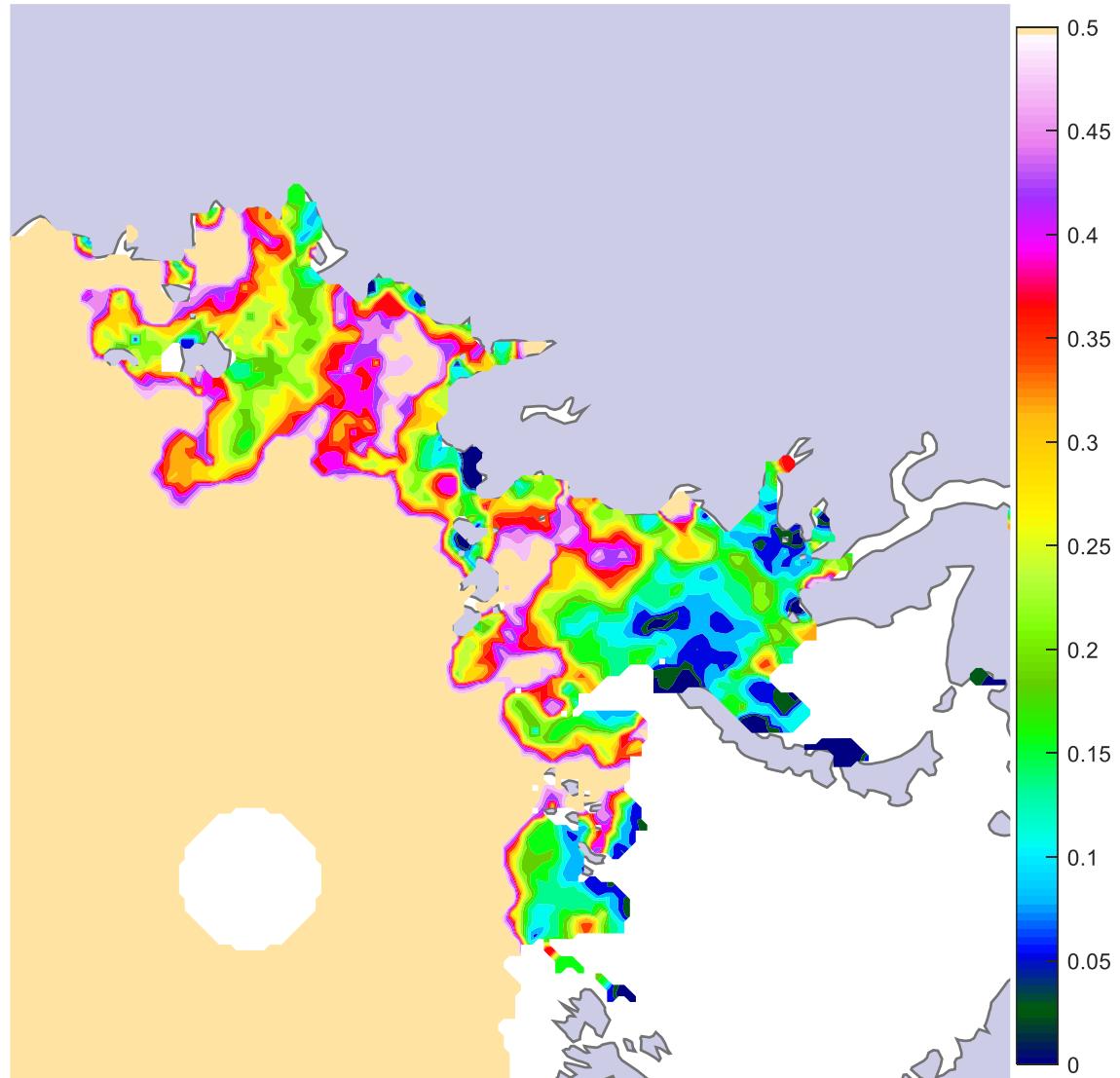


Arctic
SMOS/SMAP
University of Bremen

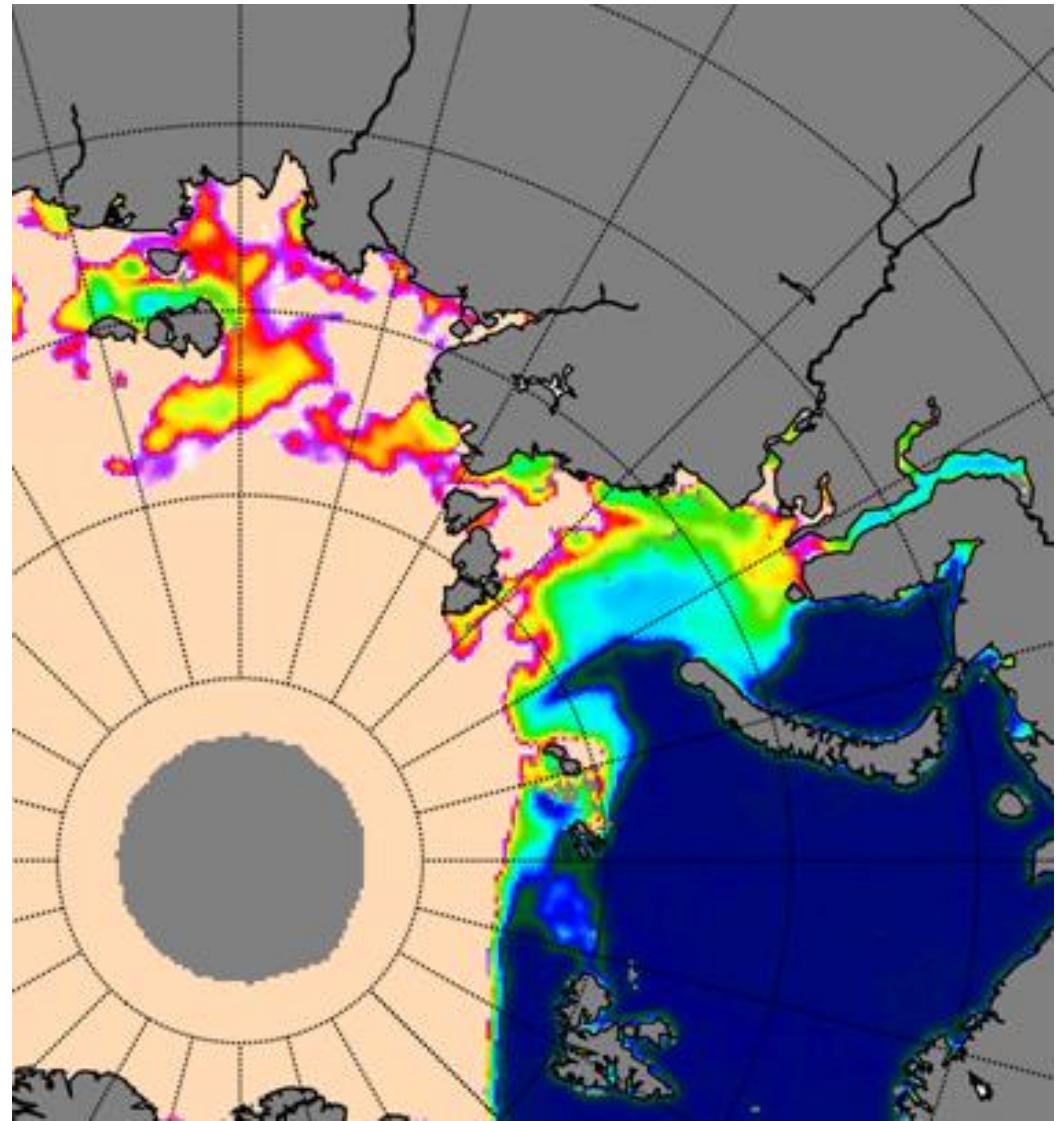
12 Nov 2017

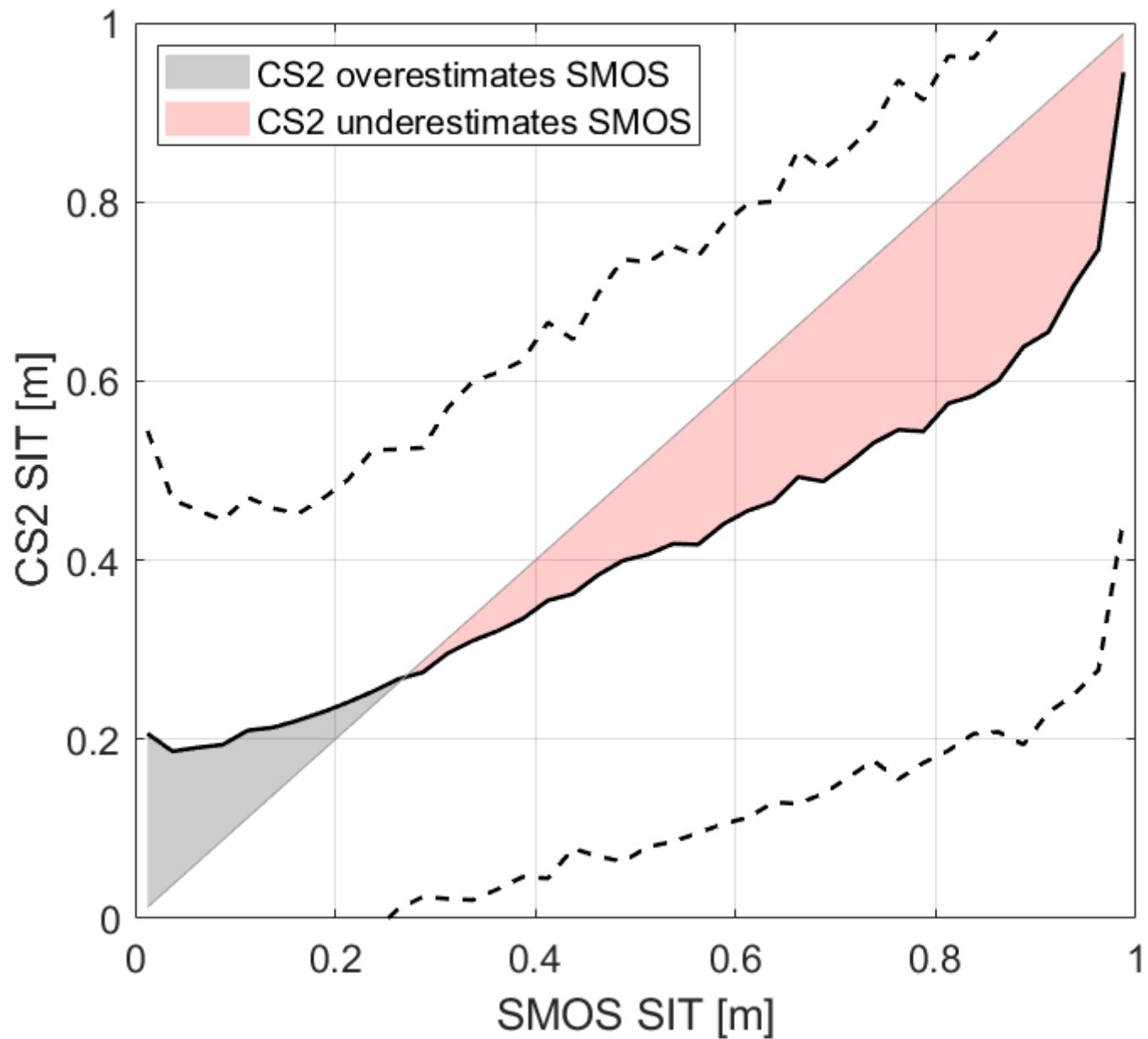
0 10 20 30 40 50
Ice thickness [cm]

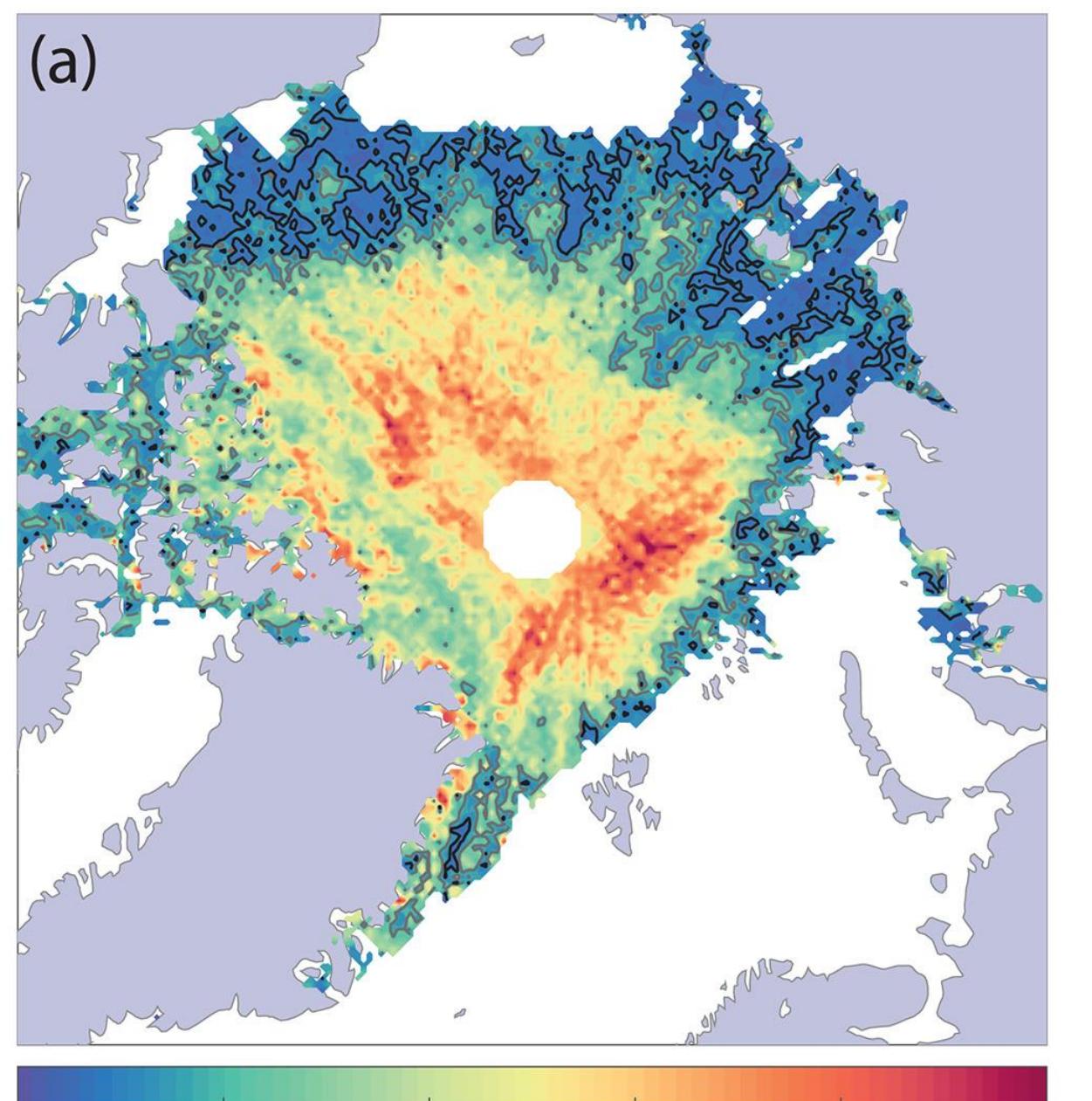
CryoSat-2 November 2017 Mean SIT (LARM+SMLG)



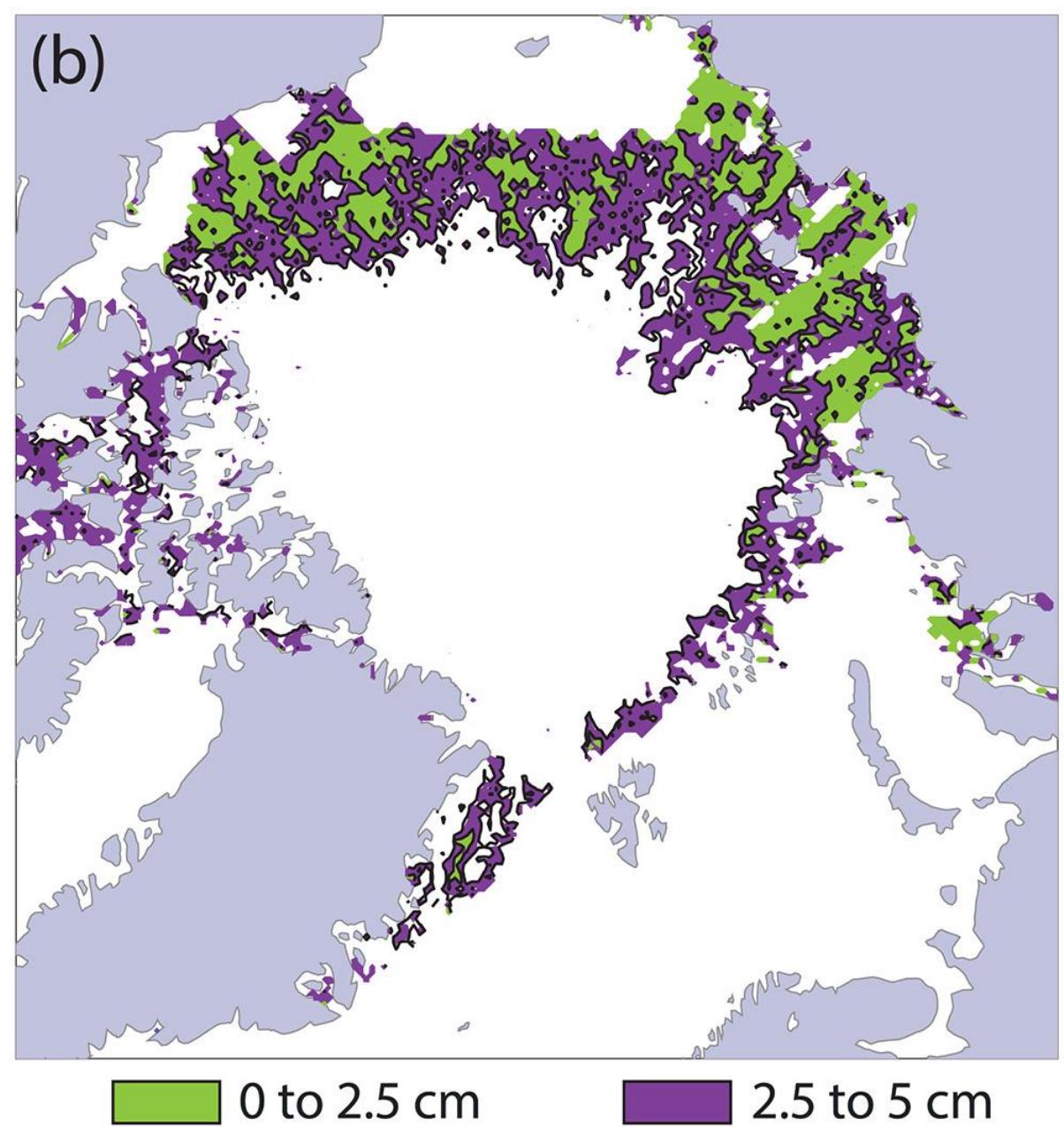
[only data where SIC>70%]





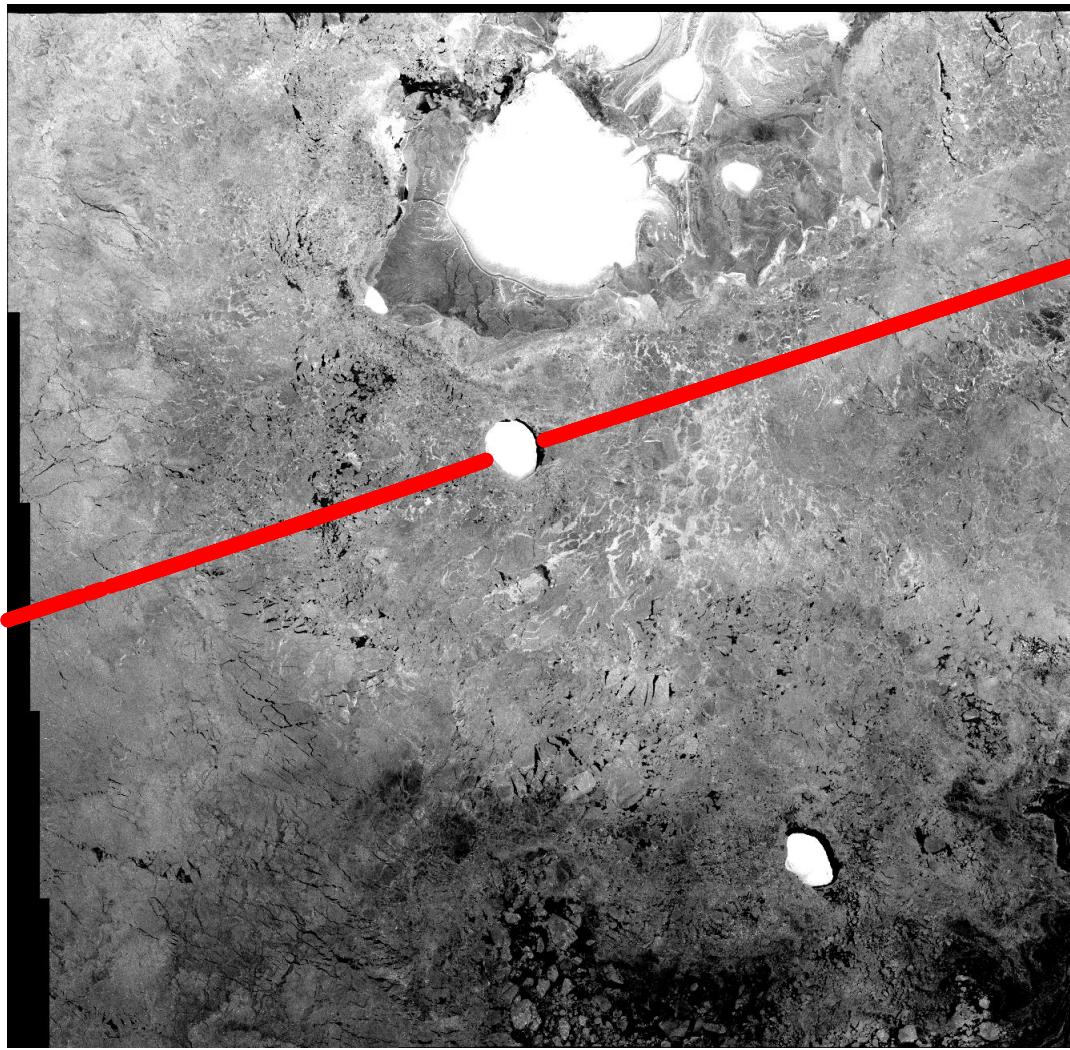


0 5 10 15 20 25
Radar Freeboard [cm]

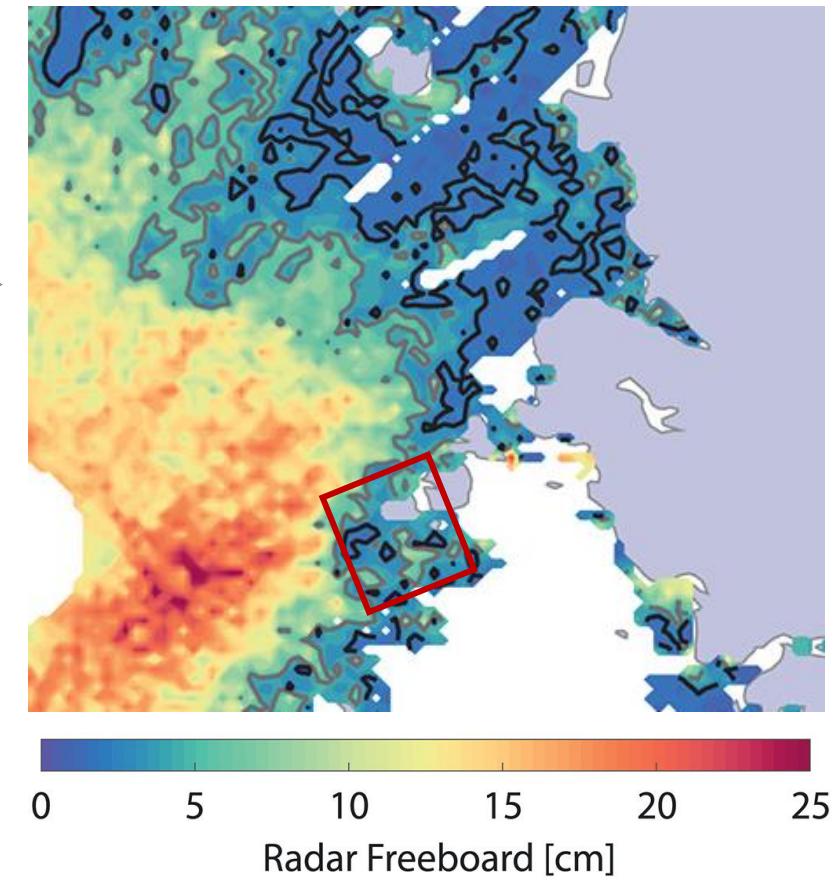
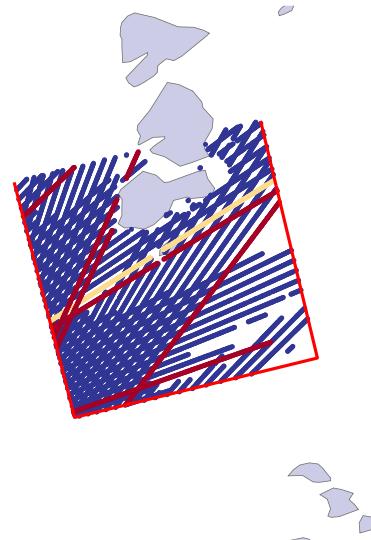


0 to 2.5 cm 2.5 to 5 cm

October 2015

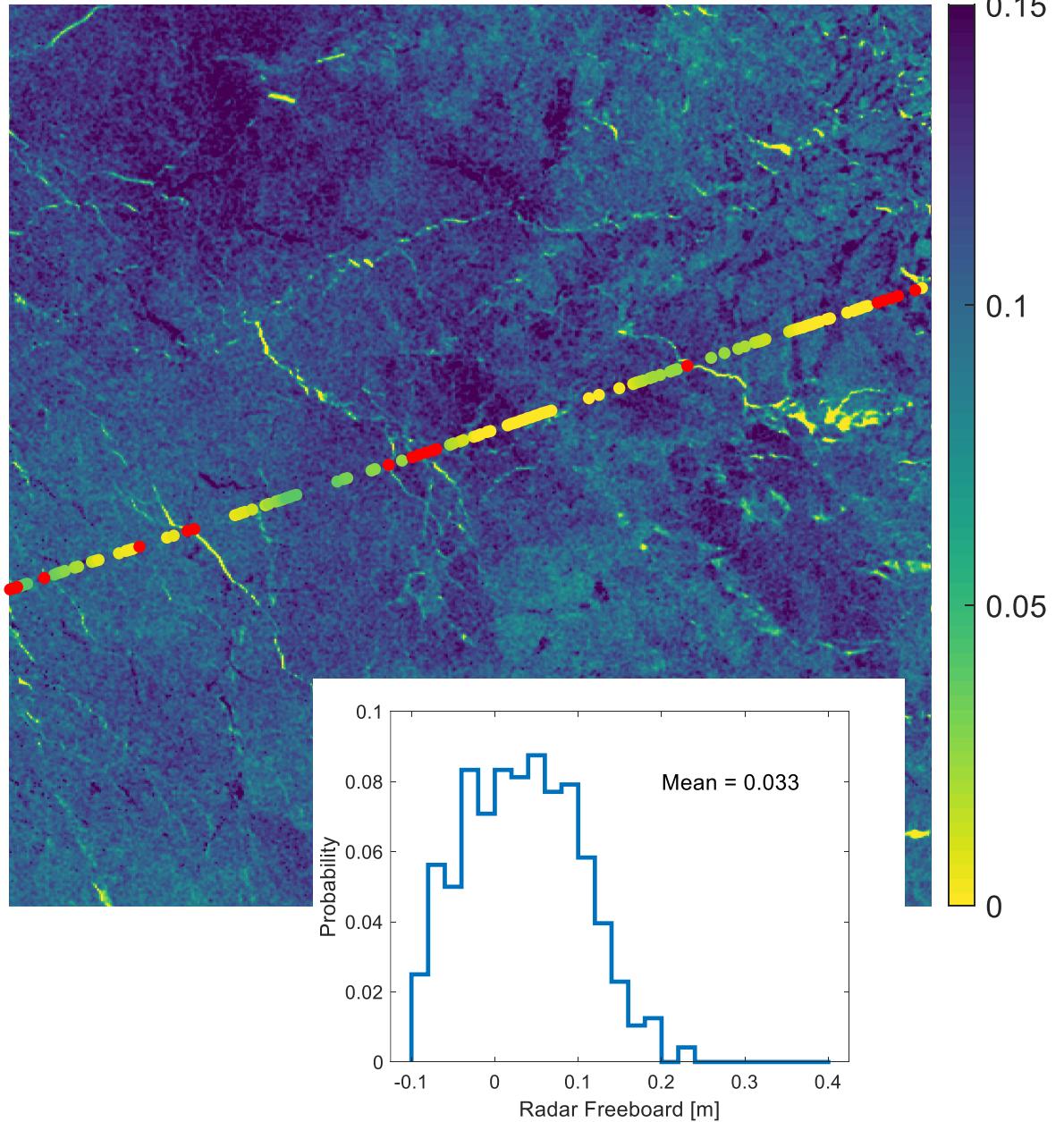


12 min time diff

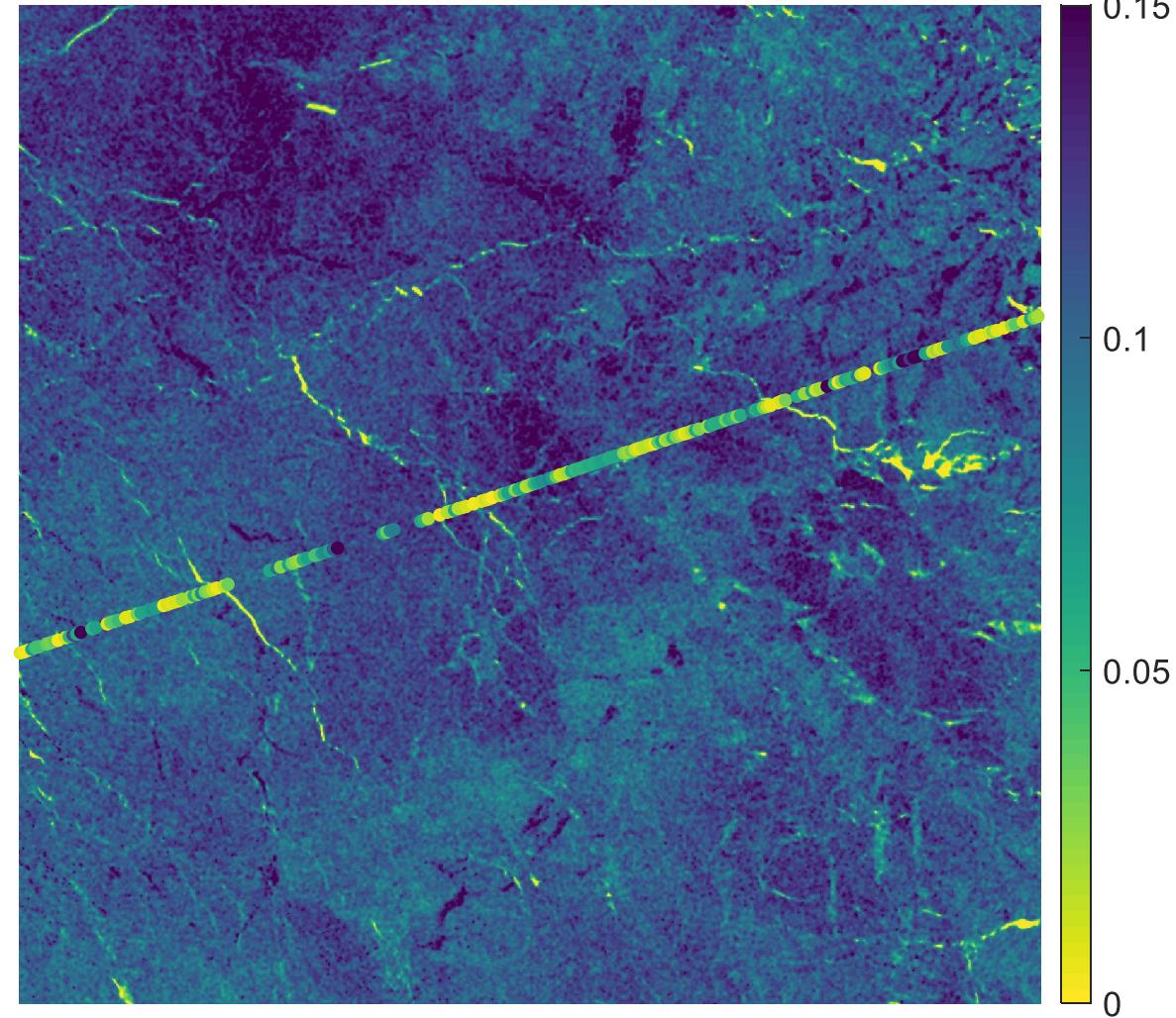


October 2014

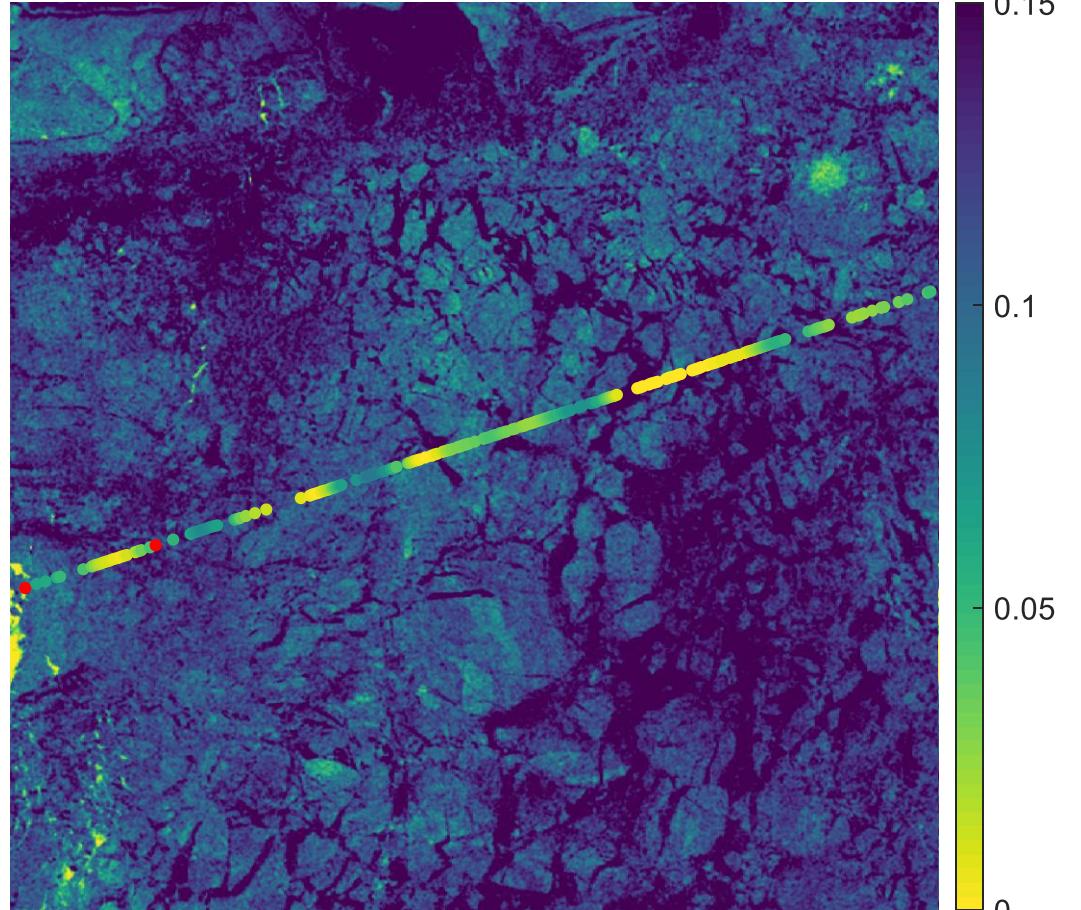
Radar Freeboard [m]



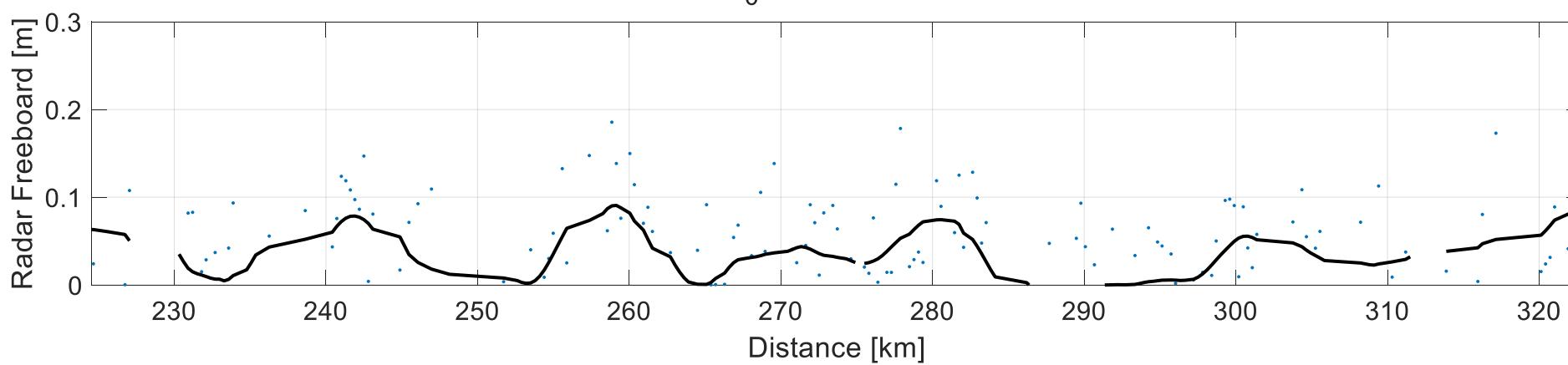
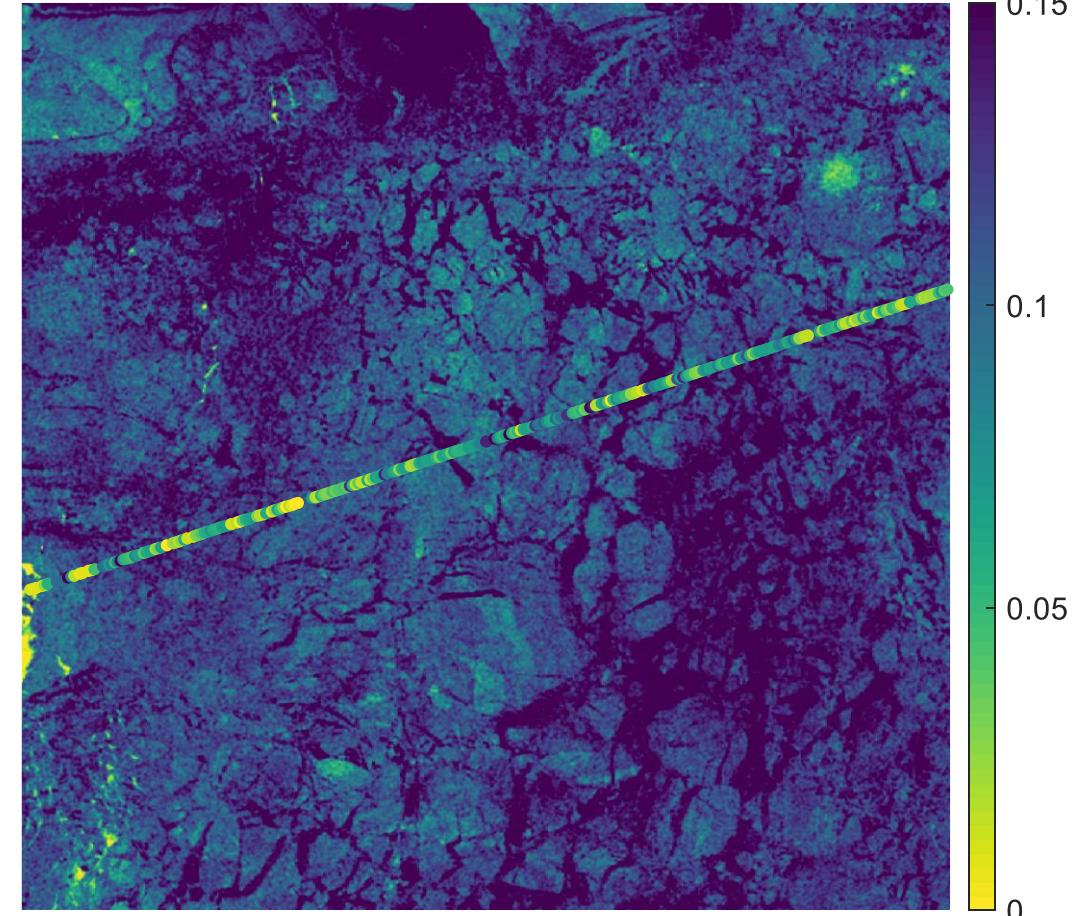
Surface Roughness [m]

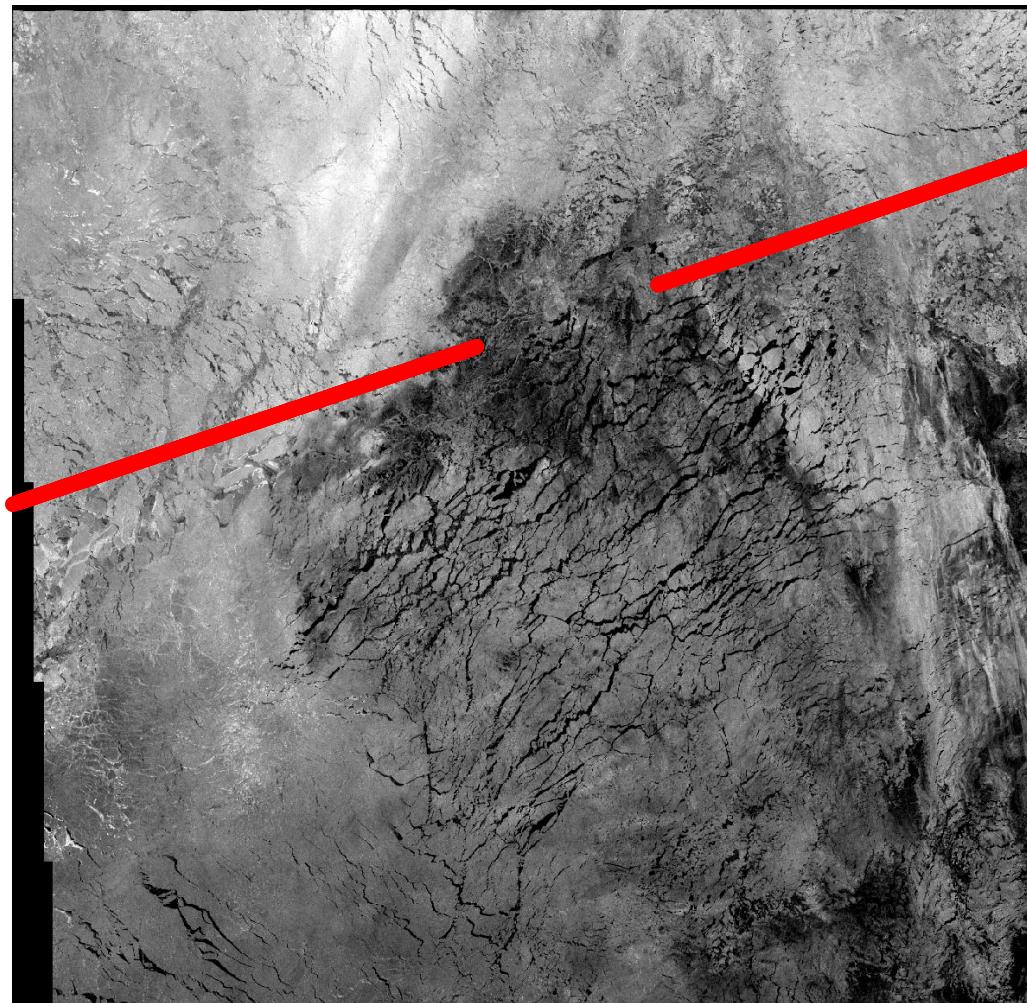


Radar Freeboard [m]

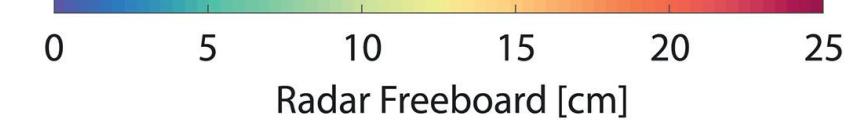
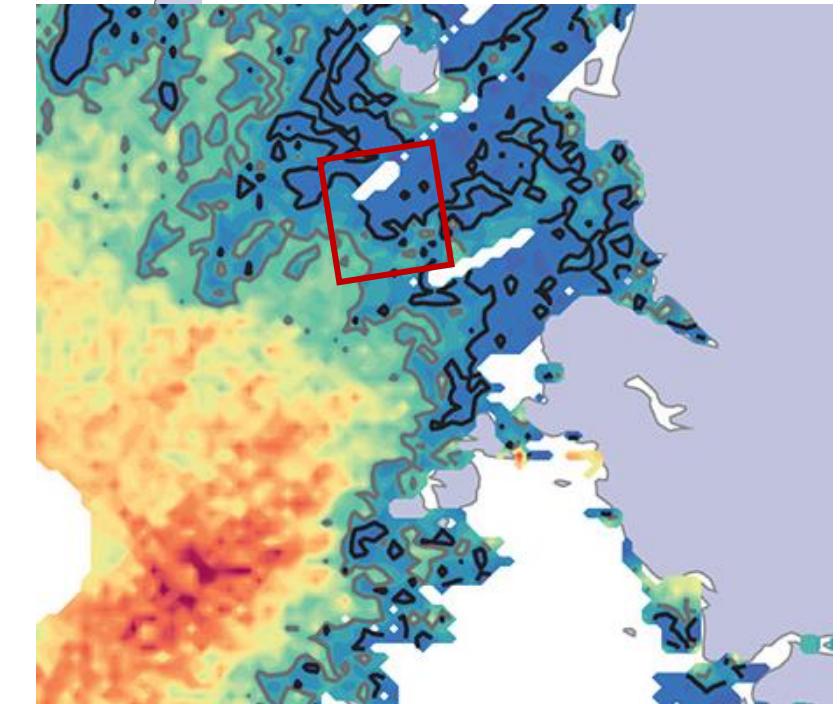
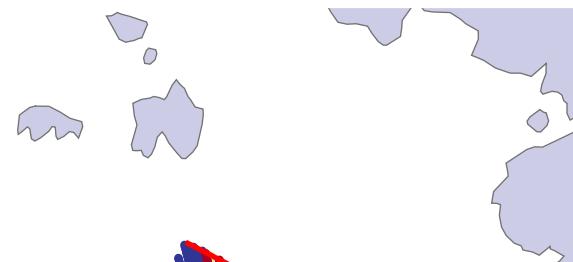


Surface Roughness [m]

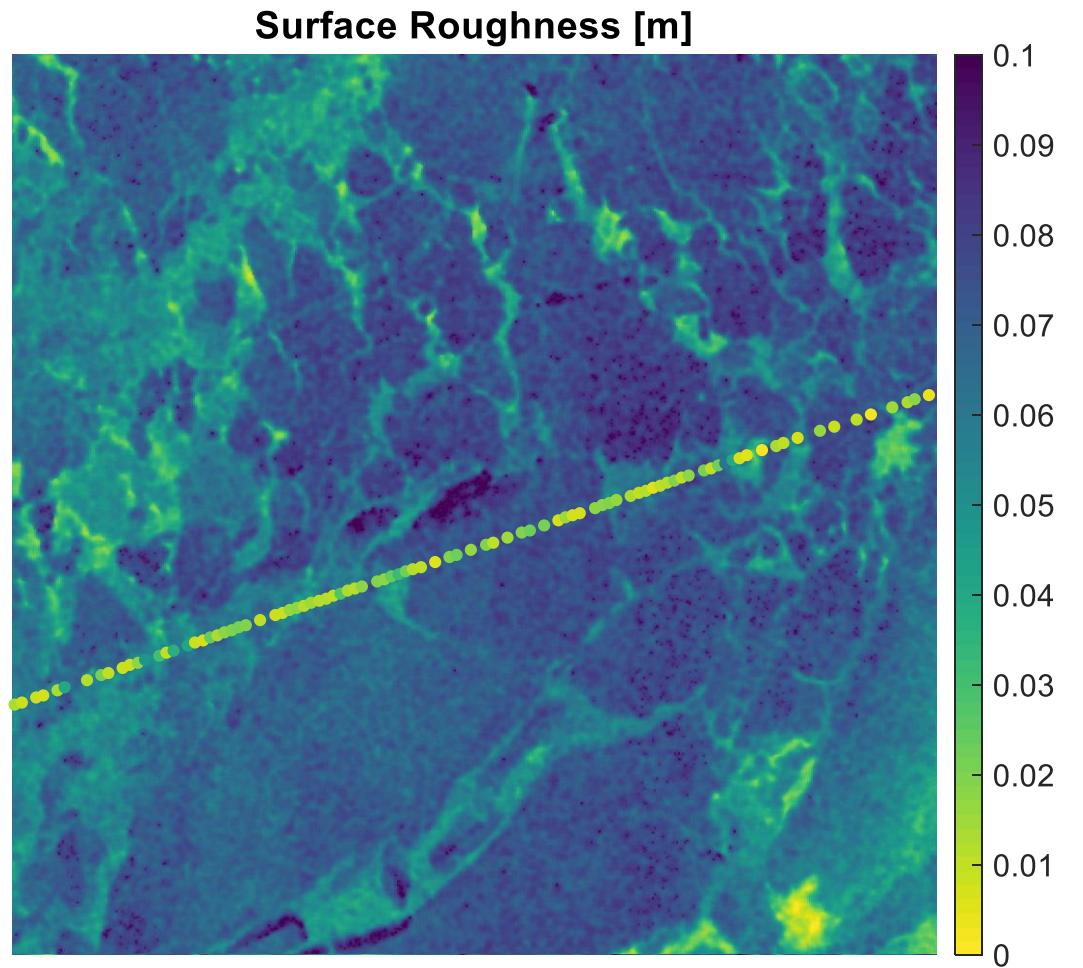
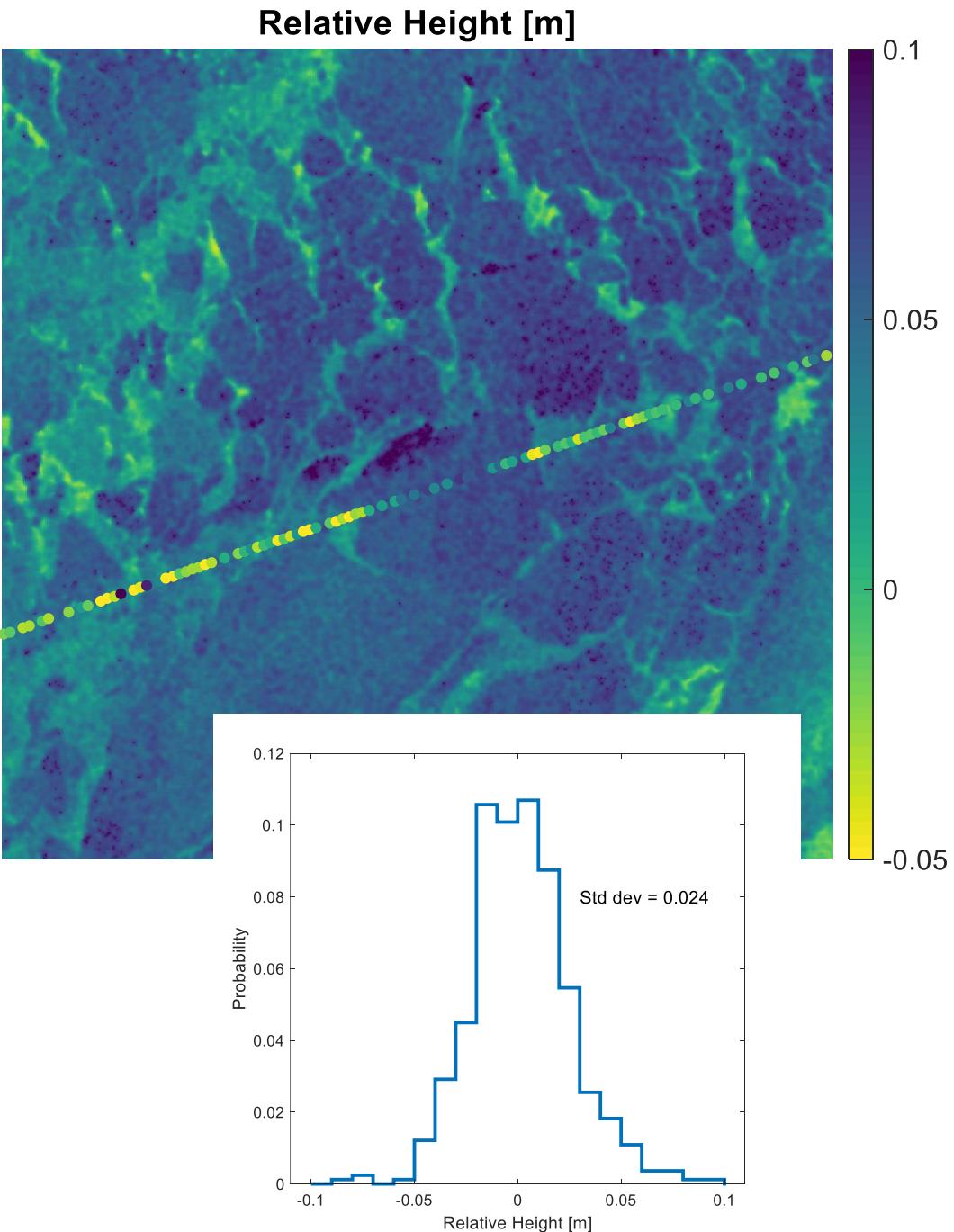




12 min time diff



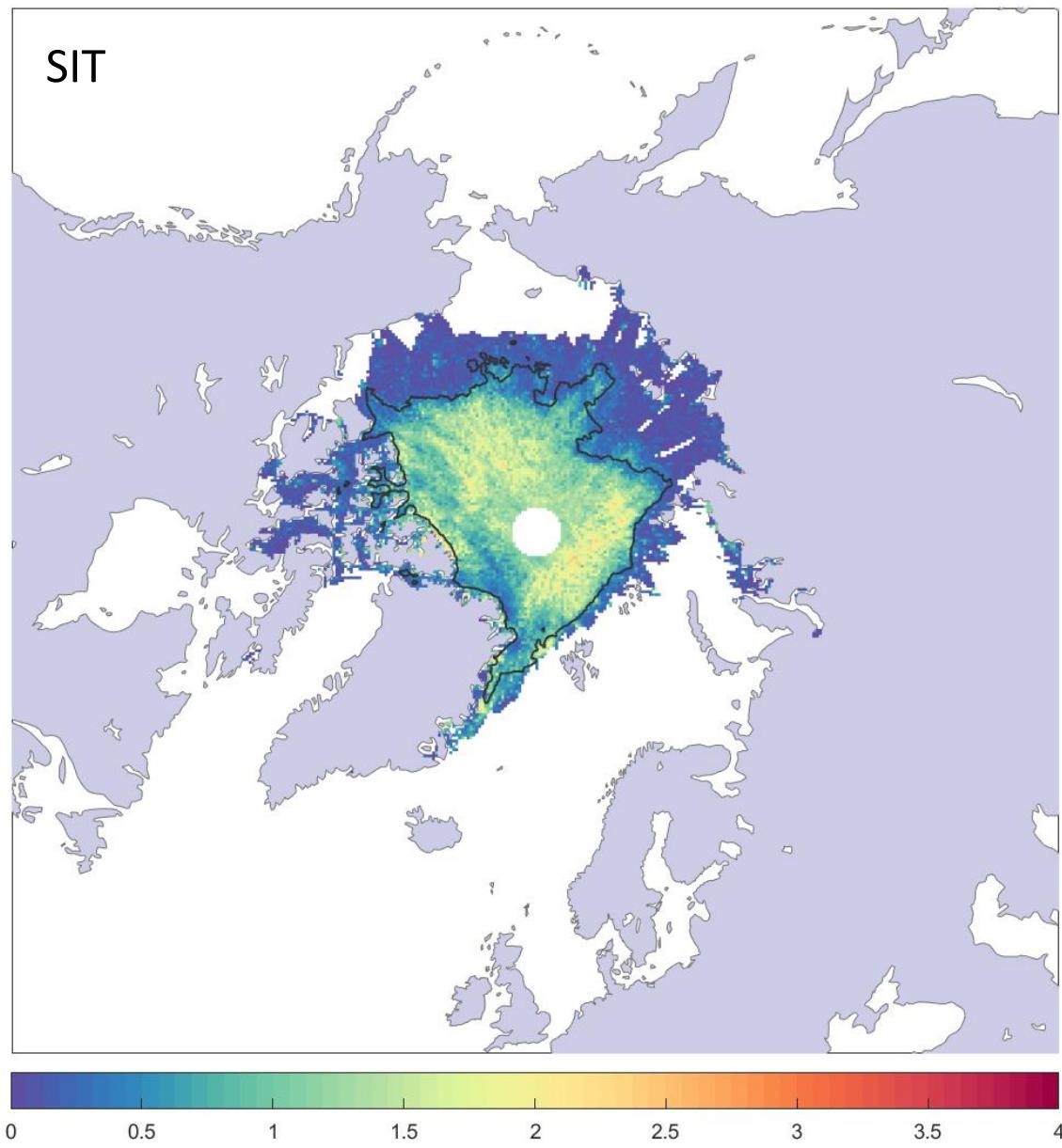
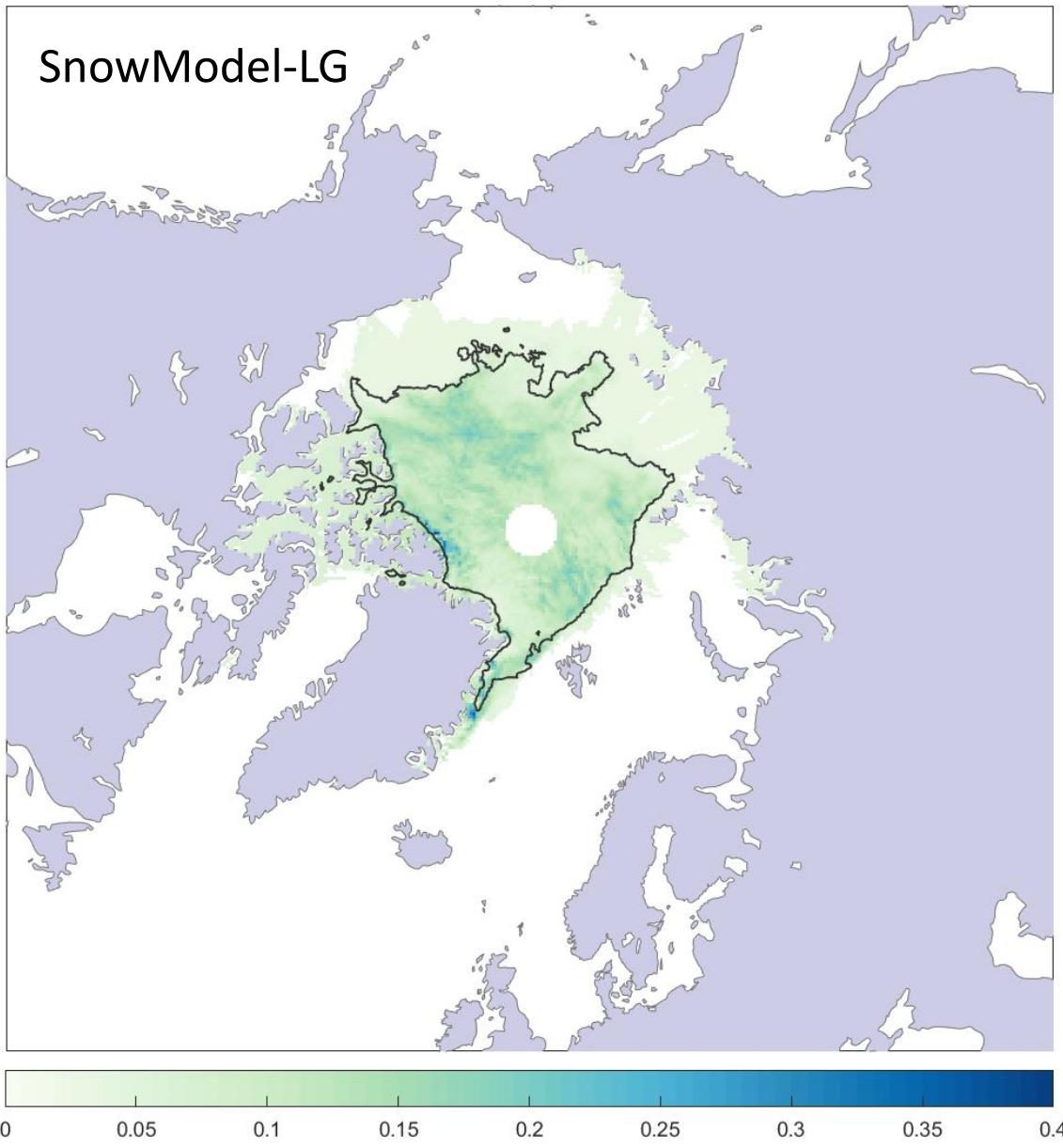
October 2015

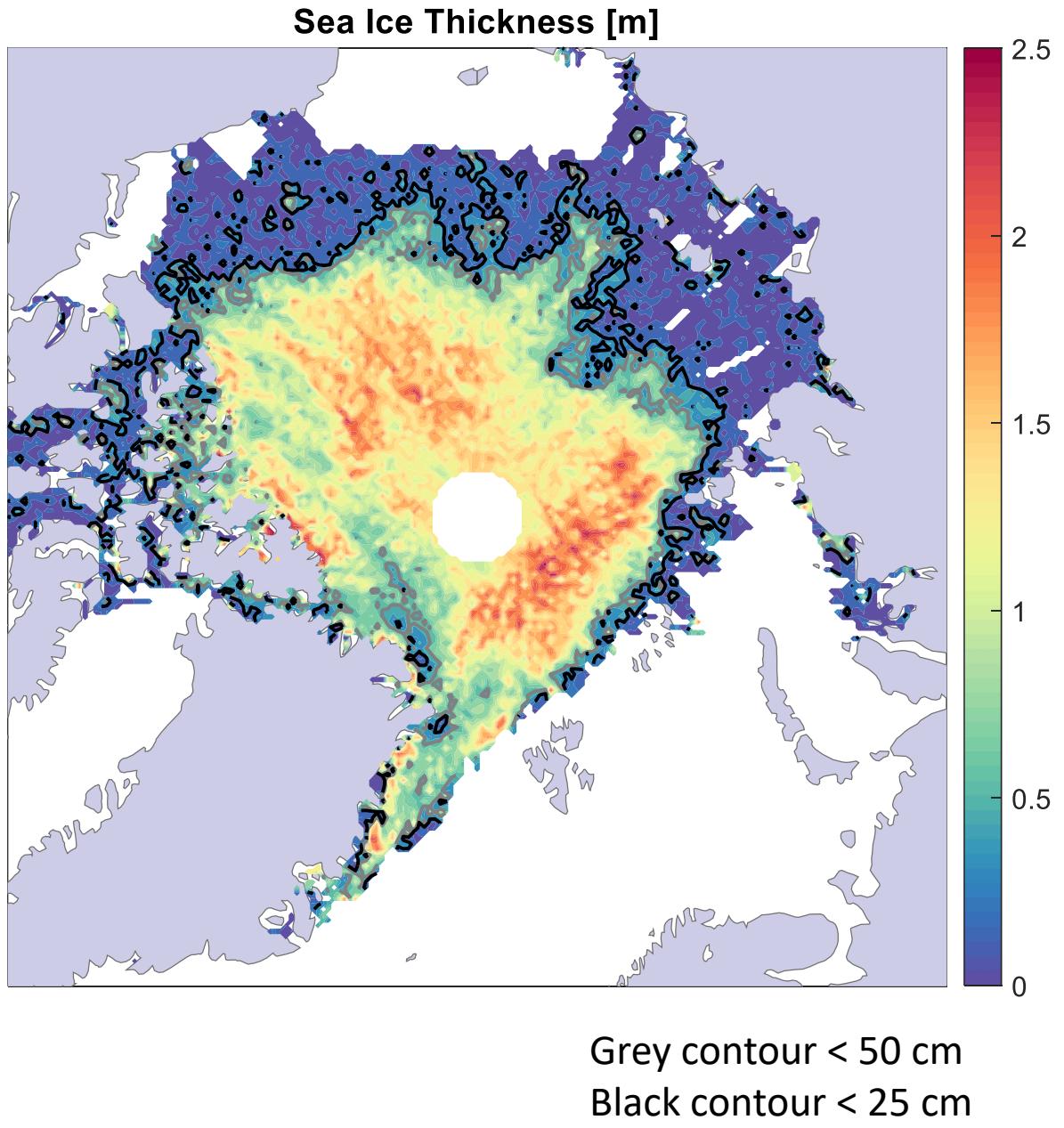
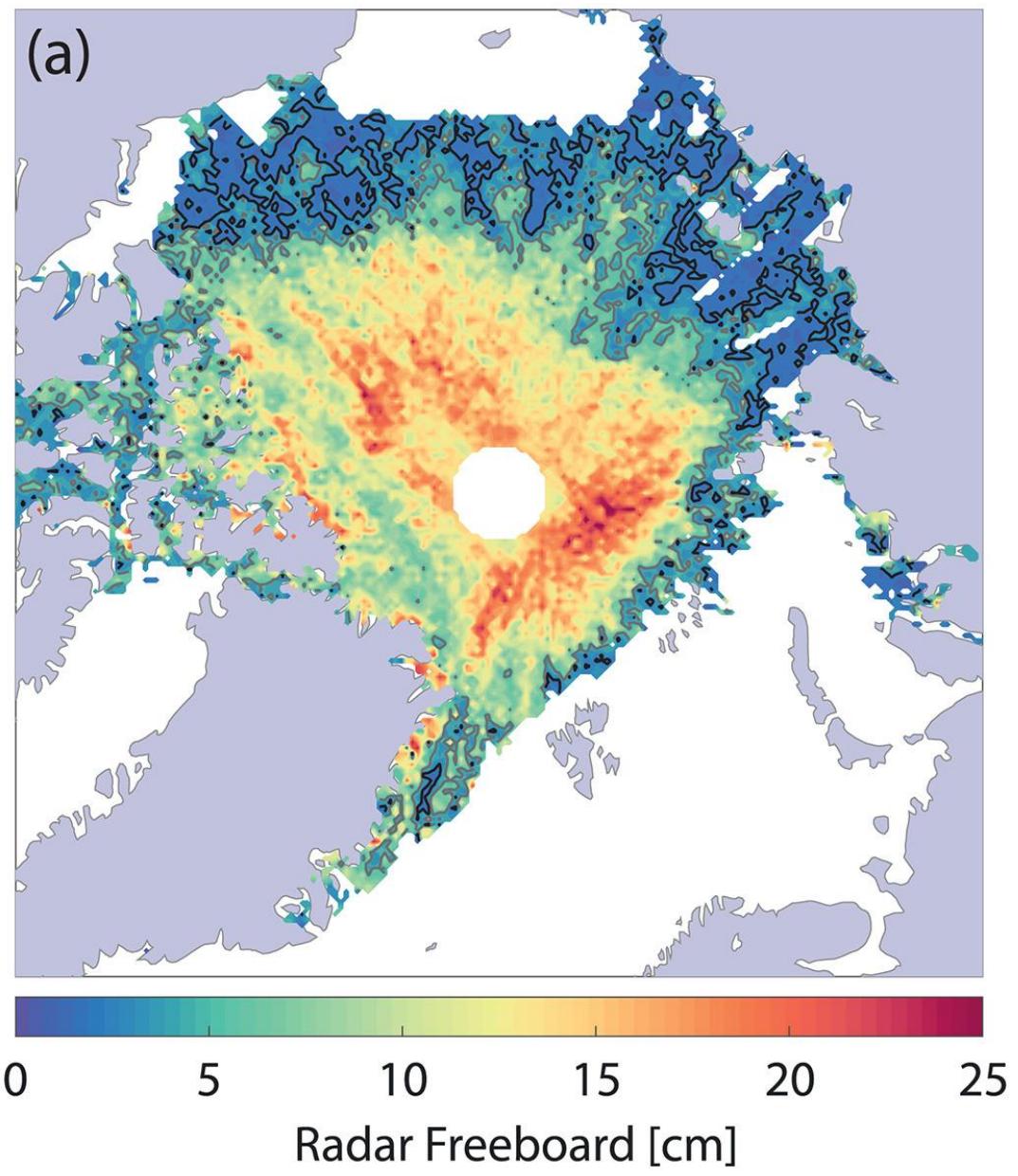


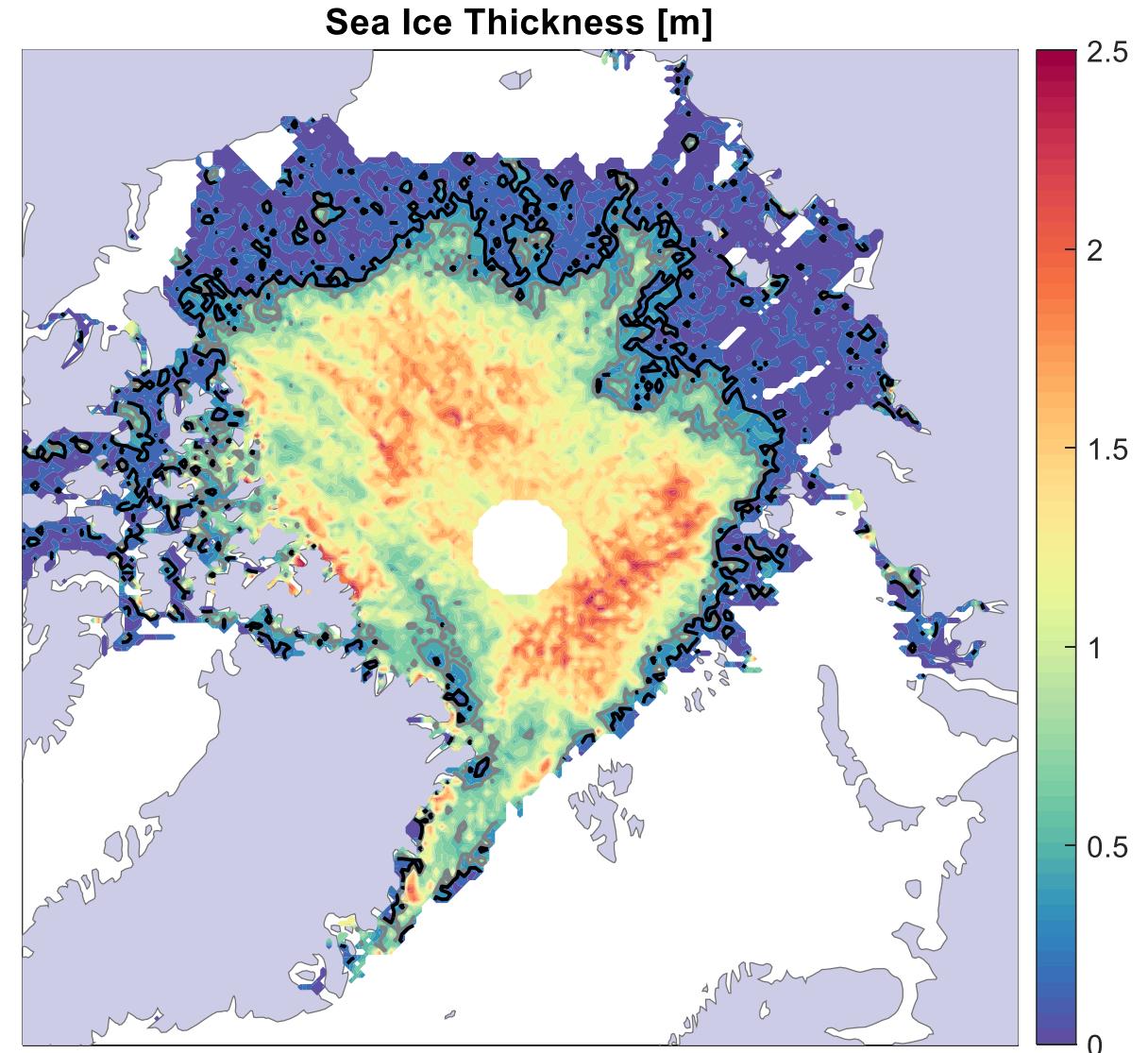
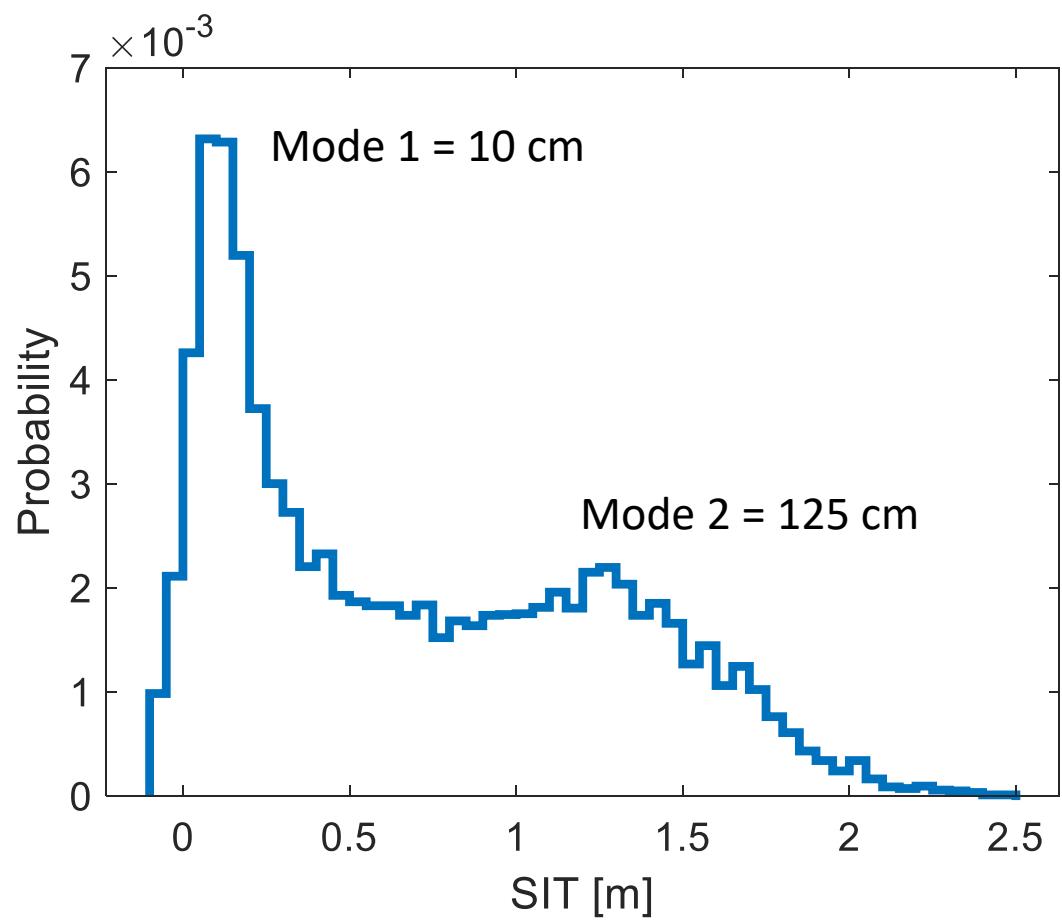
Mainly unclassified or classified as leads
but SIC > 90% from SAR scene

Modal roughness <1 cm

Conversion to SIT

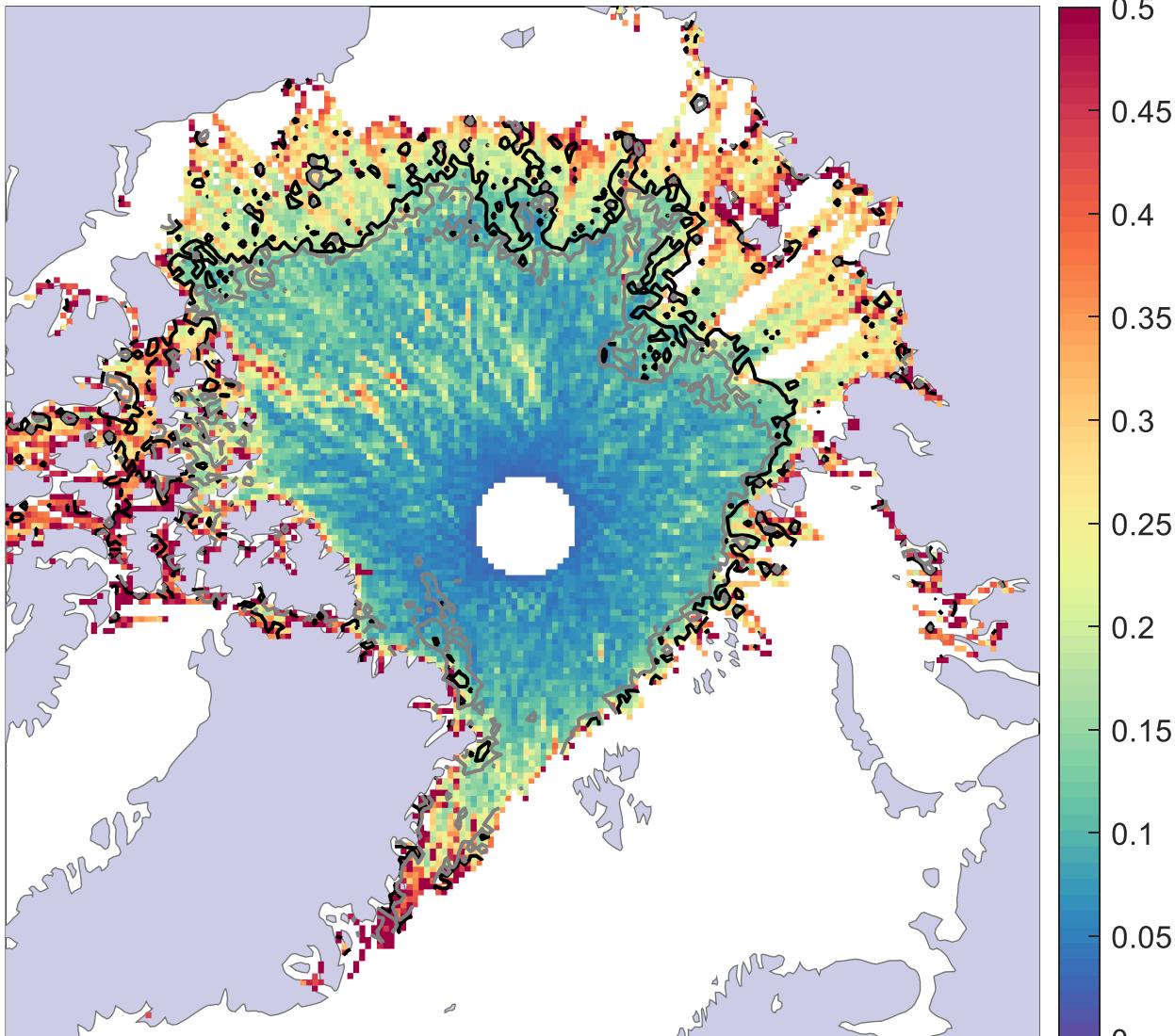




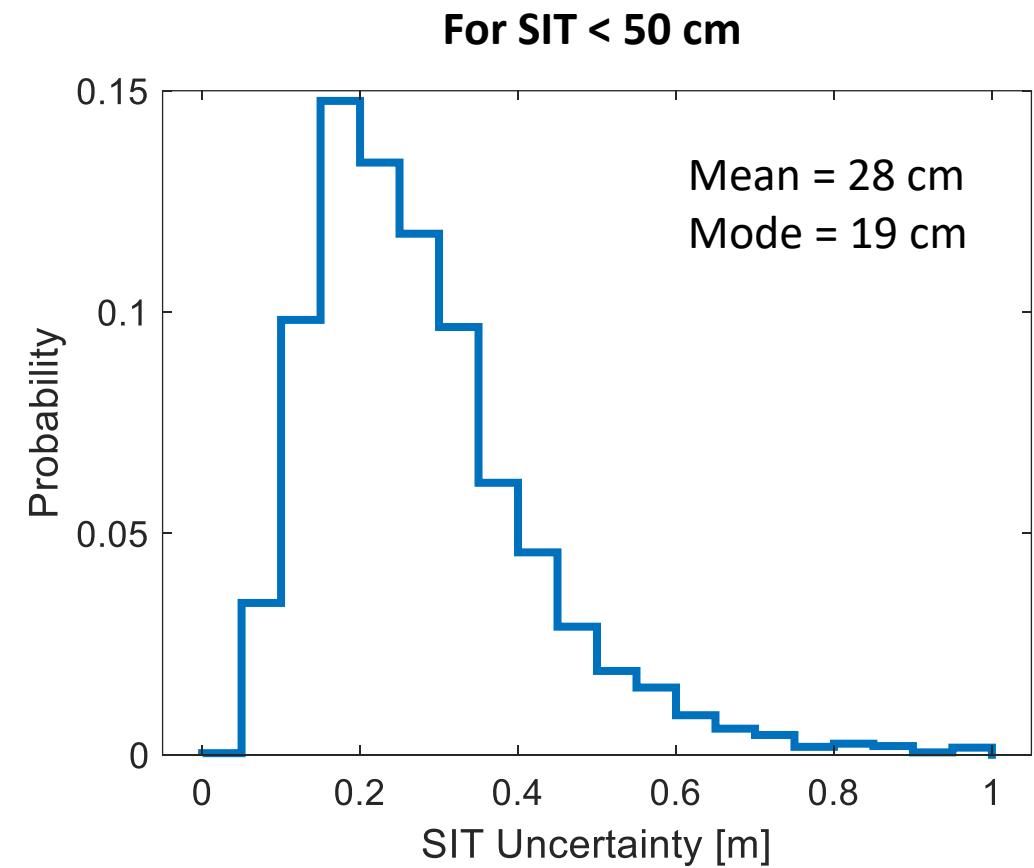
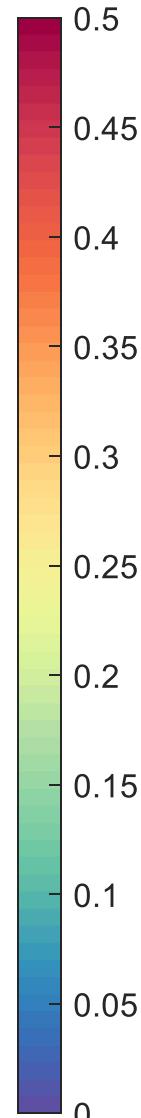


Grey contour = 50 cm
Black contour = 25 cm

Sea Ice Thickness Uncertainty [m]

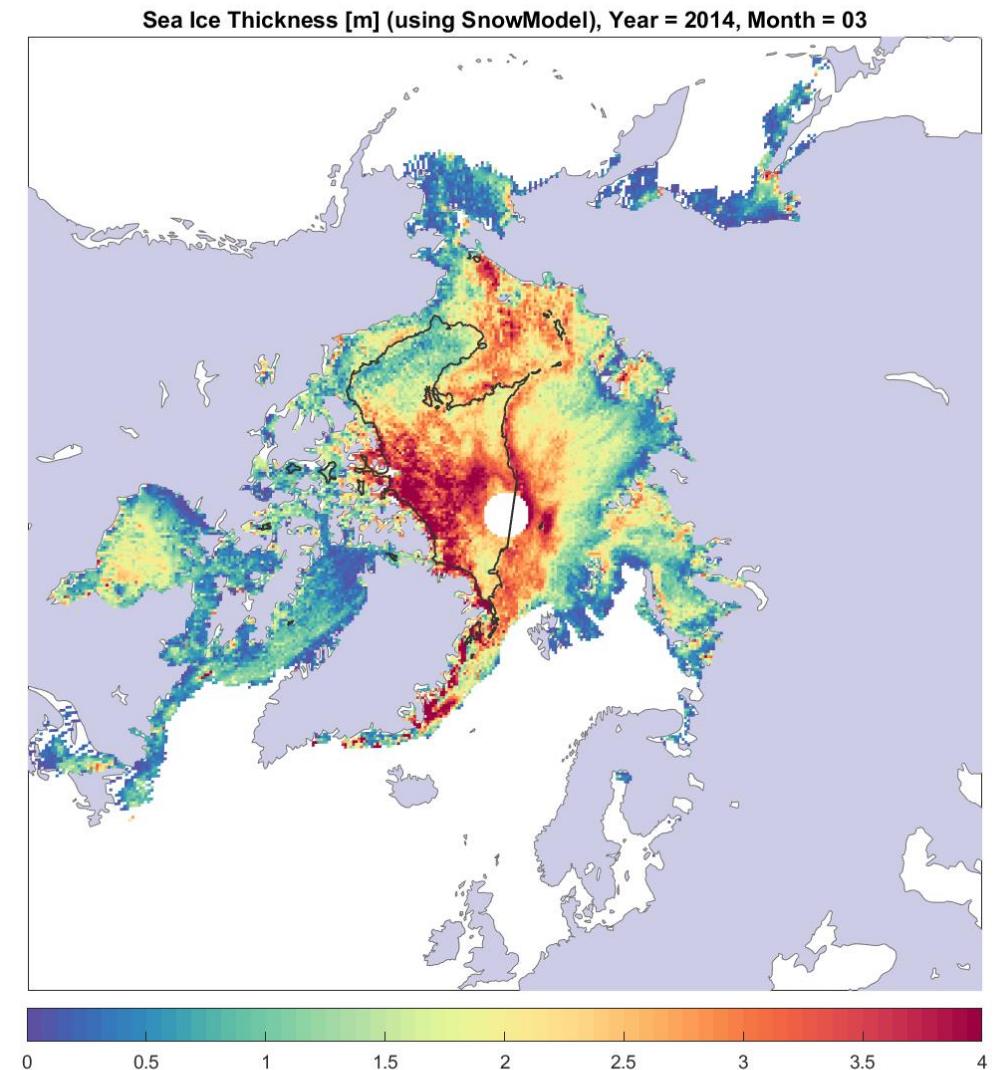
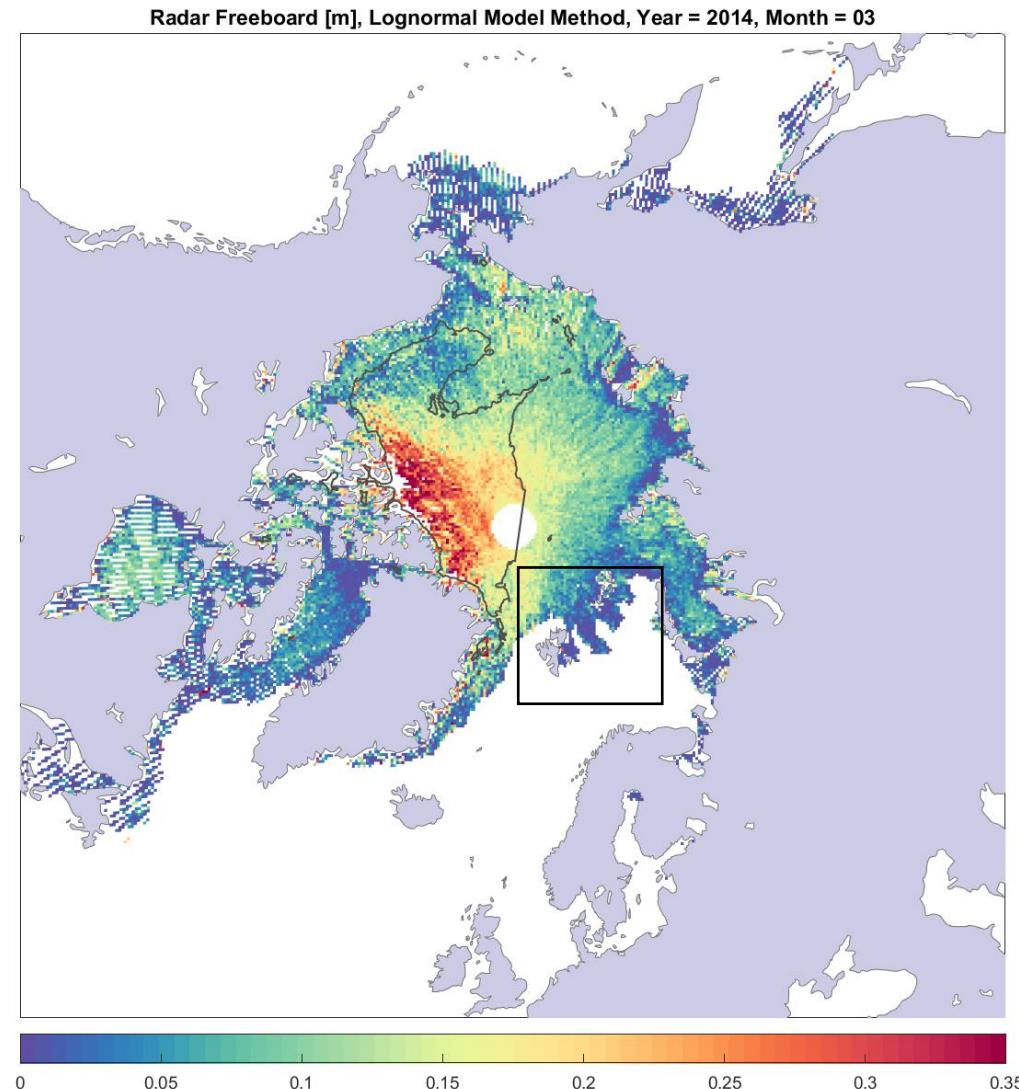


Grey contour = 50 cm
Black contour = 25 cm

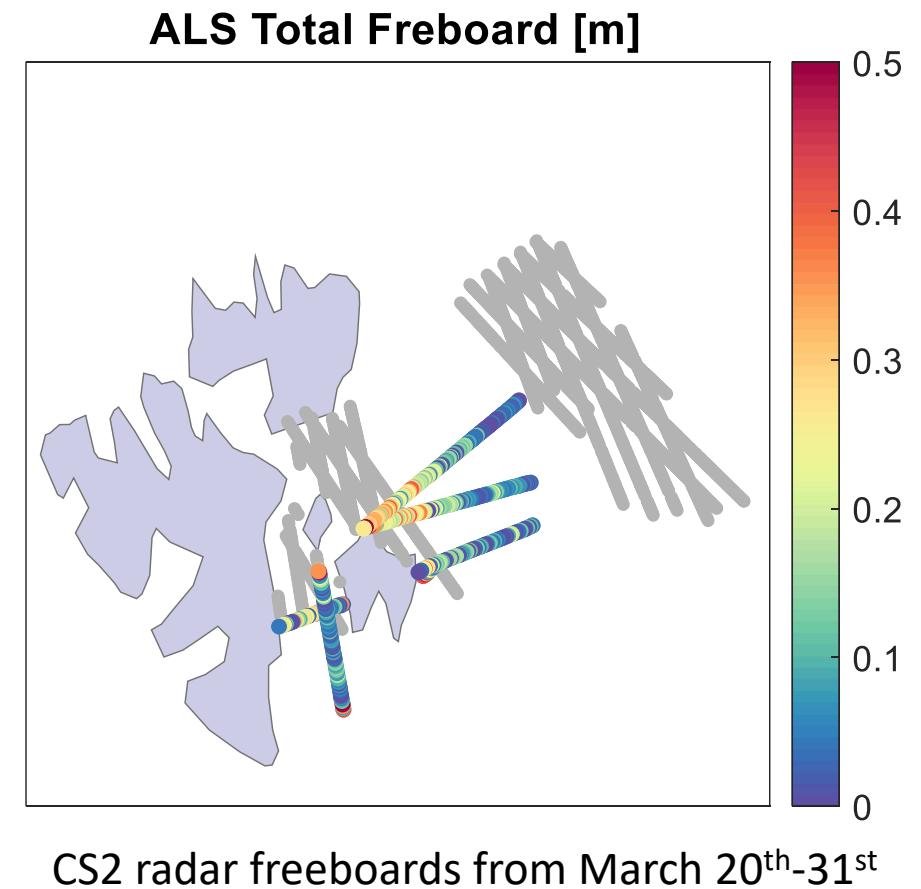
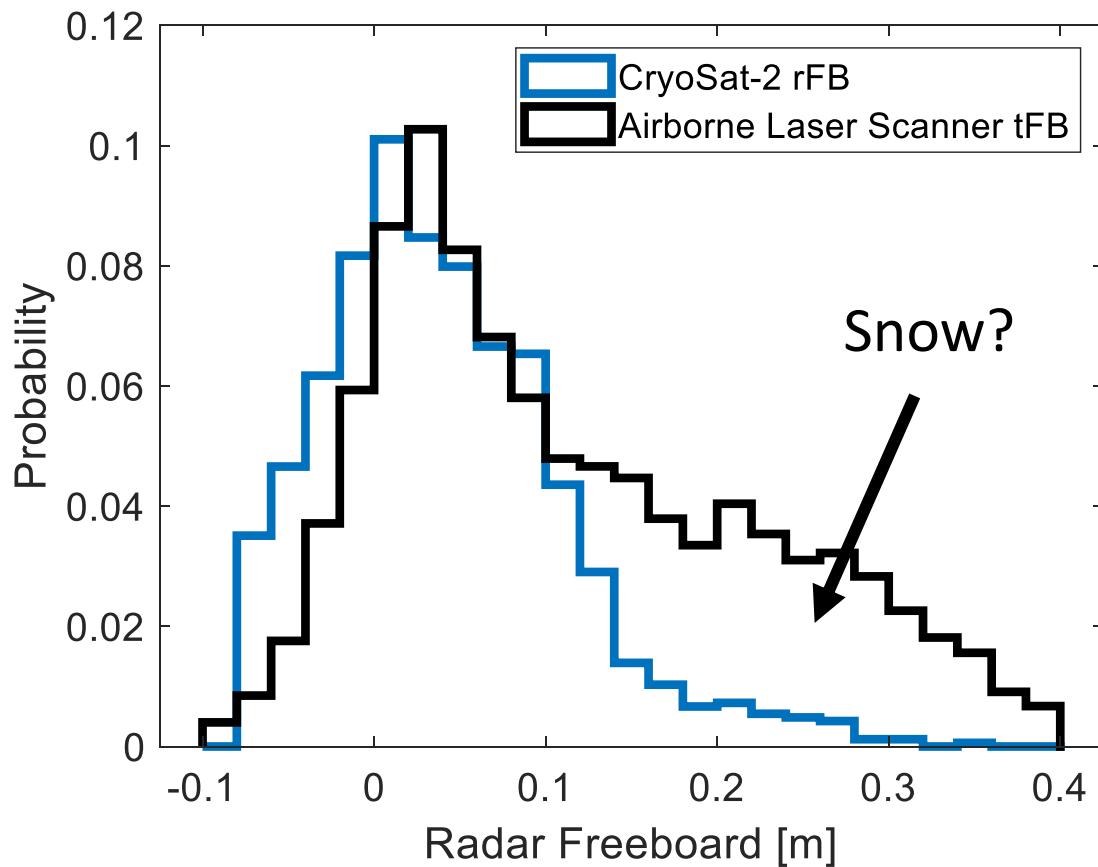


Given the consistency of thin ice retrievals
do these estimates need to be re-evaluated?
Too high...?

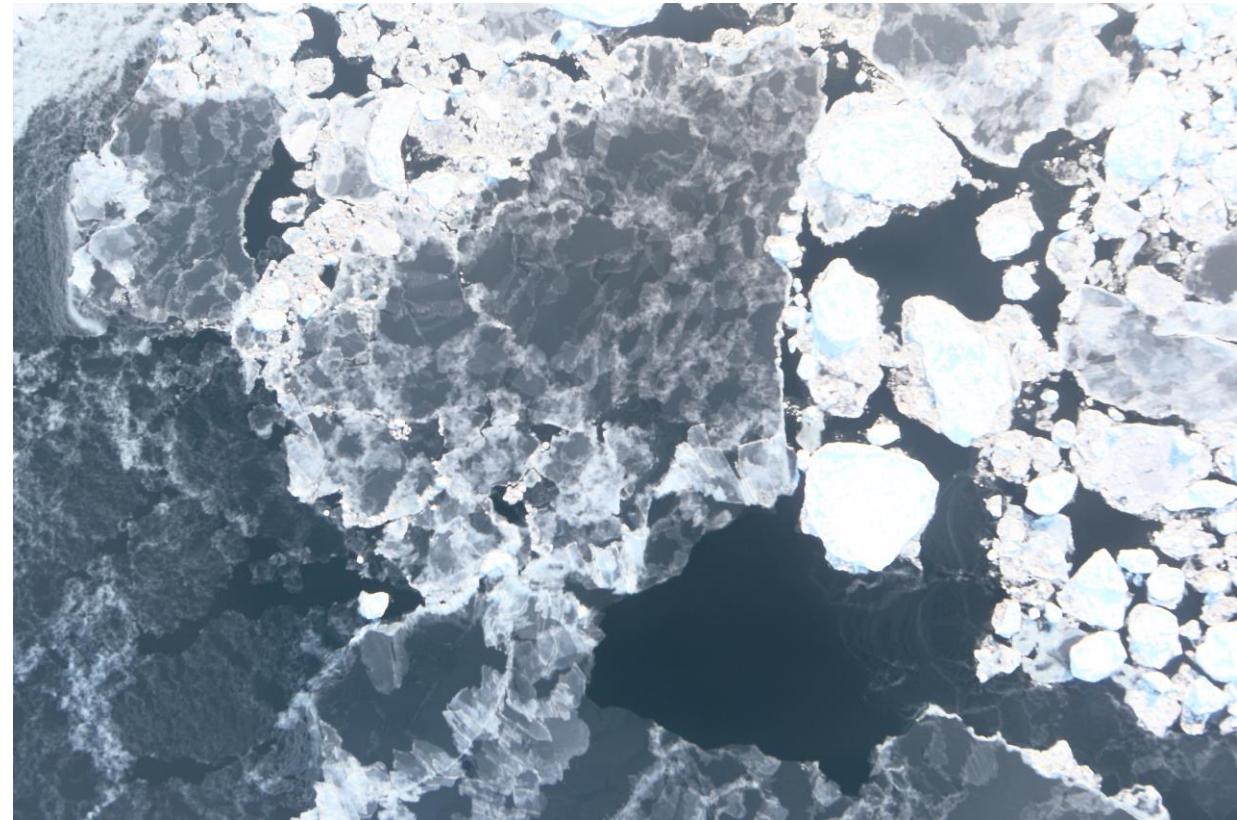
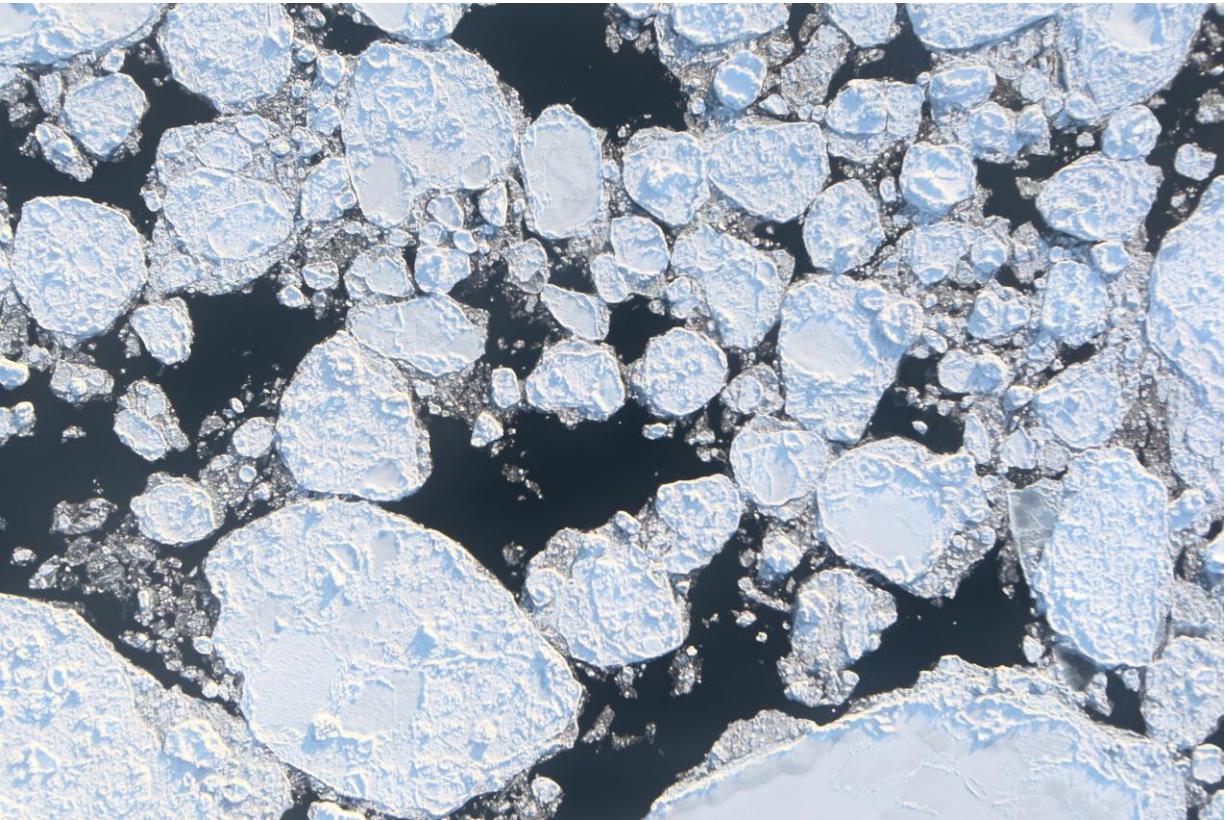
Comparison to data from SMOSice Validation campaign – March 2014



Airborne/ship based field campaign to collect snow and sea ice information over thin ice in the Barents Sea
 Airborne laser scanner, helicopter EM thickness, radiometer, camera, (snow radar malfunctioned)

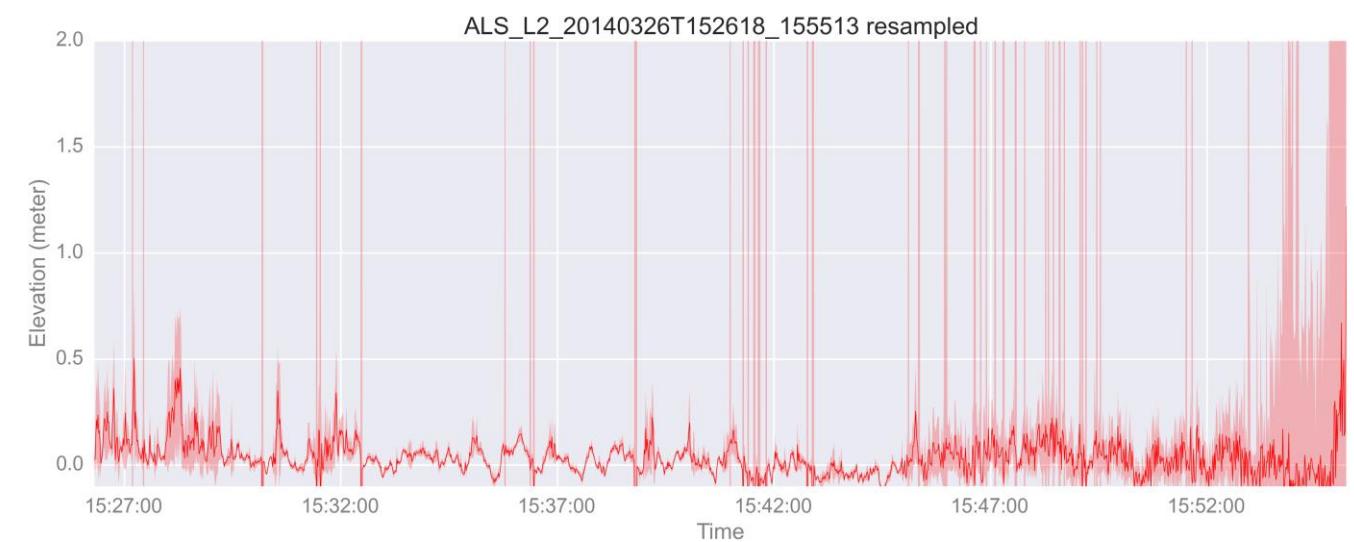
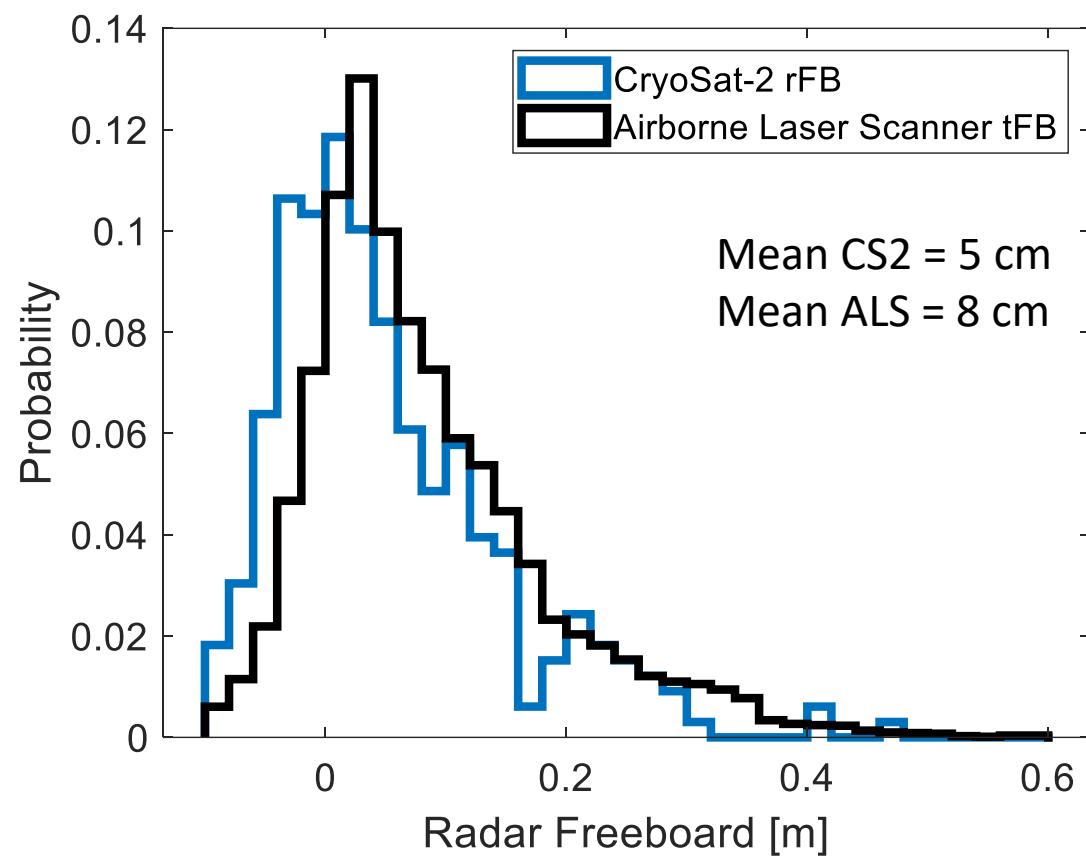
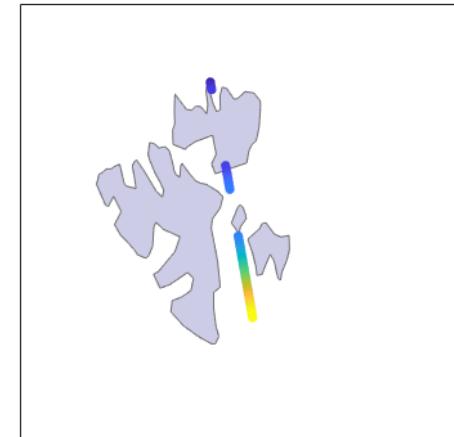


Mixed stages of development

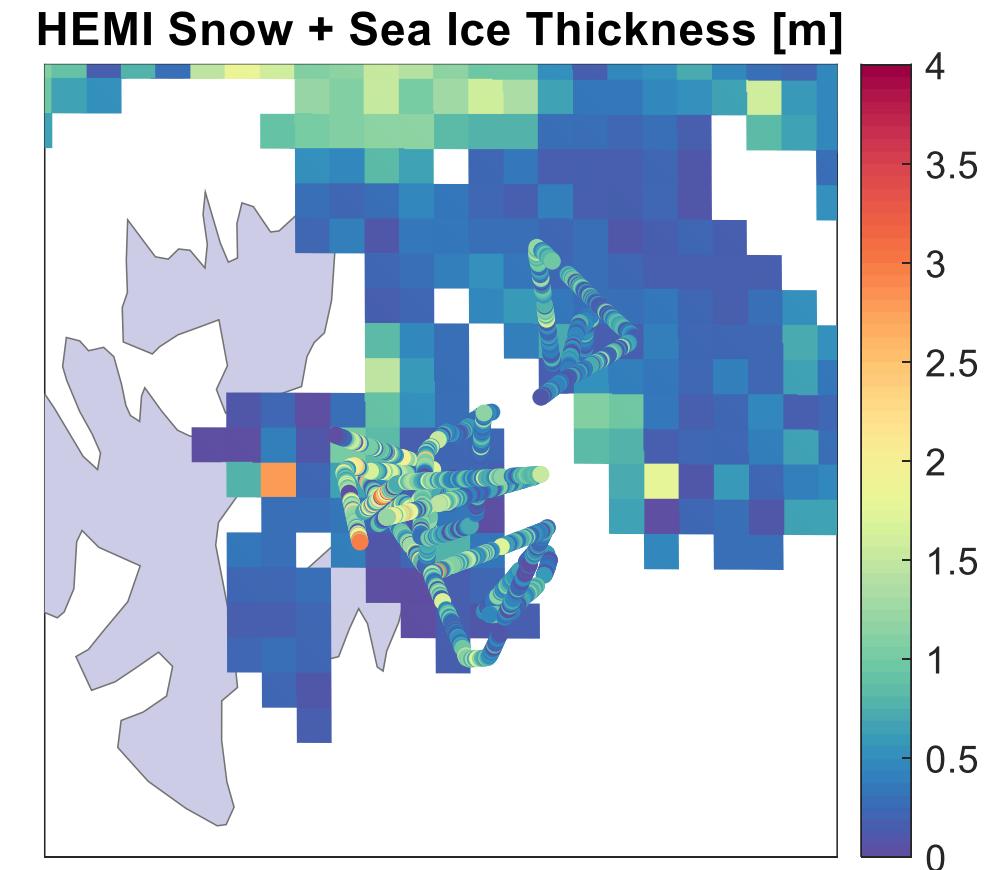
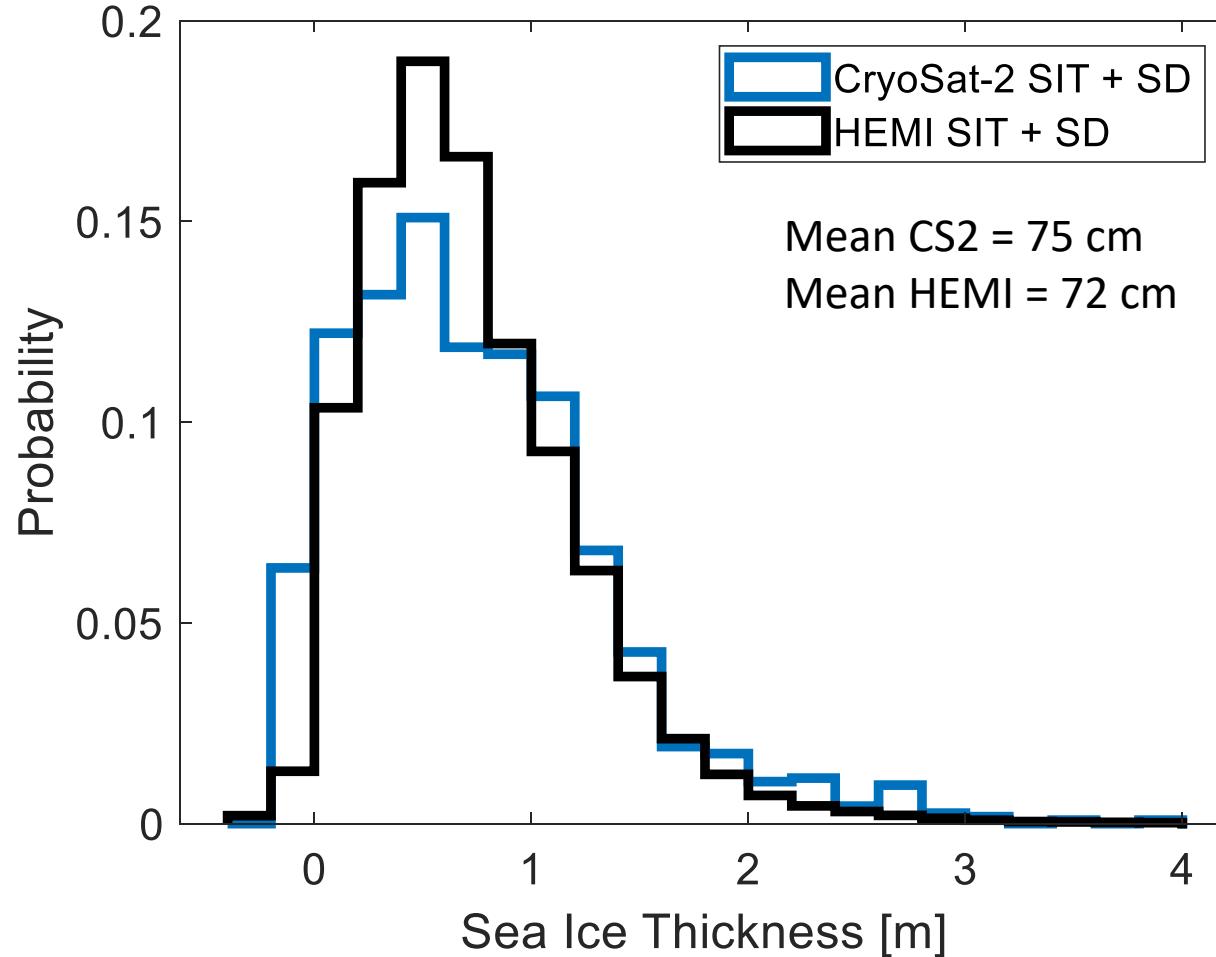


Flight on 26th March 2014

Comparison along track of CS2 underflight March 26th



HEMI flights from Lance



Assuming 8 cm snow depth (mean diff between ALS and CS2 freeboards)
And 916 kg/m³ sea ice density

Summary

- CS2 sea ice thickness conventionally assumed to be unreliable < ~1m thickness
- Essentially unused for data assimilation in models because CS2 data is discarded or errors estimated to be 100s% (1-10 m) in thin ice areas
- Physically-based retracker sets no lower limit on detectable range difference between leads and ice floes
- Crucial to include intermediate thin ice returns as floes in classification algorithm
- Only overestimates SMOS below ~25 cm thickness
- Large regions of Oct-Nov sea ice pack with modal SIT as low as 10 cm
- Compares well to ESA SMOSice thin ice validation data (ALS and HEMI)