

Monitoring Arctic thin ice: A comparison between Cryosat-2 SAR altimetry data and MODIS thermal-infrared imagery, R1

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The authors have presented detailed, proper answers to most of my comments to the first version of the paper, and made corresponding changes and additions to the paper. I think that the paper has improved considerably. Below I have some minor comments for your consideration for further possible paper improvements.

“It is true that the SMOS dataset is not mentioned in the datasets. We would like to focus intentionally on Cryosat-2, MODIS and Sentinel-1, since these data were mainly used. In the case of SMOS, a ready-made data product was used. The dataset was taken unchanged as a basis for comparison and is therefore well documented and referenced, whereas in the case of Cryosat-2, MODIS and Sentinel-1 observations had to go through various pre-processing steps.”

I have to strongly disagree here, you should describe the SMOS dataset under Section 2.

line 38: “Numerous studies exist on the automatic detection of leads. These use altimeter data (e.g., Lee et al., 2018; Dettmering et al.; Wernecke and Kaleschke, 2015) or SAR images (e.g., Park et al., 2020; Boulze et al., 2020).”

Please include also Murashkin et al., 2018 here.

“This algorithm was developed at UB and AWI, so maybe the authors have access to it?”

You could discuss in the paper why did you not use automatic methods to detect leads/thin ice in SAR images.

Reference details missing:

Dettmering, D., Wynne, A., Müller, F. L., Passaro, M., and Seitz, F.: Lead Detection in Polar Oceans—A Comparison of Different Classification Methods for Cryosat-2 SAR Data, Remote Sensing.

“However, none of the existing studies has yet attempted to detect thin-ice using satellite altimetry data.”

I guess I have to trust you here; I don’t have time to do a survey on altimeter literature, and I have not worked much with altimeter data.

“Only manual visual screening was conducted as the MODIS cloud mask tends to eliminate especially very thin ice areas”

“Is snow on thin ice neglected in the TIT calculation?”

“Yes. This is one assumption in general for the retrieval of thin-ice thickness from MODIS in our and also other approaches and also outlined in, e.g., Paul et al (2015).”

Please give this information (snow and cloud screening) in Section 3.2.

“From ERA5 2m air temperature data, the average temperatures for the study period and region is always well below freezing point as one would expect in winter (about 253K depending on the exact location; a). However, there are rare occasions of above freezing-point temperatures (about 1.6%; b) especially over land, but also near the coast over sea-ice/fast-ice areas. While certainly the surface conditions change under these conditions and impact the received returns for CryoSat-2, we consider the overall impact on the UWC negligible.”

Please give this discussion on weather conditions in the paper.

“[...] the basic ESA Climate Change Initiative’s (CCI) CryoSat-2 surface-type classification with classes ‘sea ice’, ‘lead’, and ‘unknown’ [...]”

In the track changes doc ‘sea ice’, ‘lead’, and ‘unknown’ are missing.

“[...] there is currently only a single operational Arctic-wide thin-ice data product available [...]”

This is not exactly the case: there are two SMOS SIT products, one by UHAM (now AWI?) and one by UB, using same SMOS input data, but different algorithms. You should also give references to UB product.

“We follow the reviewer’s suggestion and provided numerical (Pearson) correlations. Please find a table in the Appendix.”

Yes, good to have these correlations, but you should also include some discussion on them to the text.

“We have added the sea ice concentration source products to the manuscript.”

Also references or web-links should be given.

l. 24: “Leads and polynyas are openings of varying size and shape between drift...”

Between ‘drift ice’? Leads and polynyas can also occur within landfast ice.

l. 69: “resolution to enable future monitoring of thin ice with a high spatial-temporal resolution”

You could define what mean by ‘high spatial-temporal resolution’, in context of which applications.

Start of Section 2.3 needs editing – two first sentences on Sentinel-1.

Finally,

“It would be interesting to also see how CS2 thin ice classification works as a function of MODIS TIT, a similar investigation is now conducted for CS2 waveform features. “

“This comment leads in the direction of the table shown in the comment above.”

This table is interesting and you could consider to include it to the paper with some discussion. I understand that coarse MODIS resolution causes some errors here (explain this in the paper).