The Cryosphere Discuss.,
https://doi.org/10.5194/tc-2020-145-RC1, 2020

The Cryosphere Discussions
Open Access
EGU

Interactive comment on "The Antarctic sea ice cover from ICESat-2 and CryoSat-2: freeboard, snow depth and ice thickness" *by* Sahra Kacimi and Ron Kwok

Rachel Tilling (Referee)

rachel.l.tilling@nasa.gov

Received and published: 16 July 2020

Summary

This paper presents the first Antarctic-wide combination of ICESat-2 and CryoSat-2 data over sea ice to provide snow depth, freeboard, thickness and volume. Honestly, I was concerned that the first paper of this type to cover Antarctica would feel rushed and leave me with a lot of unanswered questions. But this manuscript was clearly-structured and very thorough. I appreciate that the authors were transparent about the limitations of the method, but have still published what is an interesting, unique study. I'm happy to say that I learned a lot. I commend the authors' efforts and strongly

Printer-friendly version

Discussion paper

recommend this paper for publication. However, I do have some comments that should be addressed first. The number of comments is due to the length of the paper, not a reflection on the quality.

———————————- General comments ———————————-

- The authors need to be very clear and consistent with which "freeboard" they are referring to, i.e. radar(CS2)/lidar(IS2)/ice/snow. “Total” freeboard should really be “IS2 freeboard” for consistency with the fact that they are using “CS2 freeboard” as separate to “ice freeboard”. We’re still not fully aware of the uncertainties associated with IS2 penetration and retrievals, so to frame it as undisputed total freeboard is misleading.

- I’d like to know why they did not use a whole year of data

- The long sentences are confusing at times (e.g. P1L12-15). I appreciate this is a style preference but it was an issue for me. I suggest the authors re-read the paper and check for clarity throughout.

———————————- Specific comments ———————————-

P1P7: “. . .freeboards, snow depth, **ice thickness** and ice volume

P1P7: “. . .April **1st**. . .”

P1L8: The phrase “stands out” isn’t very explanatory, How about “is the thickest” or similar

P1L15: Don’t need the word “broadly” (or “surprisingly” above). These types of phrases distract from the narrative.

P1L15: This relates to my general comment above, about clarity regarding real and observed freeboard. The authors mention “biases in CryoSat-2 freeboards” but a more accurate statement would be “"biases in CryoSat-2 measurements of the ice freeboard".

P2L2: “several decades” -> “four decades”

P2L21: The statement that Kurtz and Markus (2012) “assumed that the snow depth is equal to the ice freeboard” is misleading. The Kurtz and Markus paper assumed that snow depth is equal to snow/lidar/total freeboard (“ice freeboard” should unambiguously be used to refer to the snow-ice interface). Better phrasing might be "assumed that the ice freeboard is zero, and so snow depth is equal to the total freeboard". They should really spell it out here because it’s a key concept of the manuscript.

P2L23: “ice **and snow** cover”

P2L23-25: How are the author’s familiar with the pros and cons of each method – have they been validated? If so, please provide references.

P22L26-27: Does “these approaches” refer to all approaches, or just empirical?

P3L11-12: Why do the authors use the 10 km product and not the 150-photon aggregate product? It would be useful here to explain that higher spatial resolution IS2 products are available, and why they chose this one.

P3L23: “. . .freeboard estimates **in the Arctic**.”

Section 2.2: Are they using individual waveform thicknesses, and how is the concentration weighting done?

P3L26: “. . .thickness measurements **in the Arctic**. . .”

P4L10-13: This is a really nice summary!

P5L28-29: From this I understand that they’re using the whole month for CS2 but only 2 weeks for IS2? This wasn’t clear in the manuscript until now, or in the abstract. I’d suggest repeating the analysis for just 2 weeks of CS2 so it’s a like-for-like comparison even though I know this isn’t ideal for coverage. If they really feel strongly that they shouldn’t, then the averaging windows and reasoning needs to be very clear in Section 2 and the abstract.

Printer-friendly version

Discussion paper

P5L33: Would benefit from a more up-to-date reference than Lange & Eicken, 1991

P7L15-19: Although it's inferred, perhaps really spell it out here that wave propagation is more of an issue in the Pacific and Indian Ocean Sectors because of the small spread in extent. I appreciate that the authors are consistently transparent about the complexities of the signal.

Section 4.1: What's the reference for a bulk density of 0.32 g/cm3 and uncertainty of of $\pm$0.07 g/cm3 for Antarctic sea ice?

Section 4.1.2: I struggled with this description of the method. The way I understand it, they create daily snow depths only in grid cells where data are available. Therefore, the monthly composites should be weighted by the number of measurements in each grid cell. Please describe if/how this weighting was done. How do they account for anomalous cells, or cells that are only present for a few days and may bias averages (especially as they're allowing such large temporal separation)? This is a critical section, and the method should be made clearer.

P9L10-11: Are the IS2 thickness estimates also concentration weighted?

P9L32: "may be" or "is"? There's an important distinction!

Section 4.3: I appreciate that they've included this section, but I think it's unnecessarily complicated. The same point could be made by just this final sentence on Page 10. That sentence does need rewording, for clarity, and I suggest something like "The negative intercepts observed in the scatterplots imply that hˆf is an underestimate of true snow depth by +2.4 to +3.9 cm."

P11L4: Reference for the -5C value? I'd really like to read this work.

P12L33: A more accurate statement would be that "the ASPeCt data are biased towards thin and level ice types"

——————————————- Technical comments ——————————————

-

P4L7: “export” -> “exports”

P5L26” Remove “generally”

P5 L28: Delete “due”

P6L9: “on” -> “in”

P6L13: “The tails **of** freeboard. . .”

P7L19: “. . .**but** some. . .”

P11L31: Delete “viz”

P12L27: “data set” -> “data”

P13L37: “sector” -> “section”

Interactive comment on The Cryosphere Discuss., https://doi.org/10.5194/tc-2020-145, 2020.