

The Cryosphere Discuss., referee comment RC4
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Comment on tc-2021-227

Anonymous Referee #4

Referee comment on "A comparison between Envisat and ICESat sea ice thickness in the Southern Ocean" by Jinfei Wang et al., The Cryosphere Discuss.,
<https://doi.org/10.5194/tc-2021-227-RC4>, 2021

This paper presents a comparison of sea ice thickness estimates between Envisat and ICESat in the Southern Ocean. These estimates are further assessed with a comparison to upward looking sonar (ULS) data in the Weddell Sea. Results show that estimates from both satellites are in better agreement during the spring. The assessment with ULS data shows an overestimation of SIT from the satellites. This study aims to explore the possible factors responsible for the observed differences between the two satellite datasets and concludes that these differences are mostly explained by radar range biases rather than snow depth configuration for ice thickness retrieval. I believe this paper could represent a valuable contribution to the field of sea ice remote sensing as we have limited large scale observations of sea ice thickness in the Southern Ocean. However, I believe that more work needs to be done, I therefore recommend to decline the manuscript in its current state. See my comments below.

Major comments:

-One of my main concerns has to do with the actual validity and usefulness of the comparison between the satellite estimates and the ULS data. As clearly stated by the authors, there are significant differences in temporal and spatial sampling. The authors

even point out that the results are not consistent. I believe it would be more beneficial to the paper to focus solely on the intercomparison between Envisat and ICESat data.

- Another major concern is the way that the comparison between the Envisat and ICESat-2 SIT is carried out. I think the paper would be more robust if a comparison of the actual freeboards and snow depths (total freeboards for ICESat) was introduced. The assumption made on snow depth can have a huge impact on the mean and variability of the derived sea ice thickness.

- While the authors explored the possible causes of the observed differences between the two satellite datasets, I think this should be looked at more carefully and in more detail. Based on their uncertainty analysis, the authors conclude that most of the bias is probably explained by radar penetration issues. I do not believe that the authors successfully demonstrated this, especially given that the assumptions on snow depth and snow density are different for the two instruments.

- Some of the phrasing needs to be reviewed carefully. Especially in the introductory part of the paper, some sentences are poorly constructed and lack clarity. It challenges the understanding of the paper.

Minor comments:

P1L9: the sentence "The crucial role that Antarctic sea ice plays in the global climate system is strongly linked to its thickness" does not really mean anything. Maybe you mean that thickness is important to evaluate the role of Antarctic sea ice in the global climate system?

P1L10-11: What do you mean by "on a hemispheric scale, satellite radar altimetry data can be applied with a promising prospect"? Do you mean that large scale estimates of SIT are achievable with radar altimetry? Again revise the wording to make clearer statements.

P1L28: Replace "declines" by "decline".

P2L59: Replace "CyroSat-2" by "CryoSat-2".

P2L60-61: I suggest rephrasing this sentence: "The SICCI product covers the entire Antarctic sea ice for the complete annual cycle from 2002 to 2017, and it is finally a combined data set of Envisat and CyroSat-2" to "The SICCI product is derived using measurements from Envisat and CryoSat-2 and covers the entire Antarctic sea ice for the complete annual cycle from 2002 to 2017".

P3L76: "This data set has been investigated for many years". I believe this dataset has been used in several investigations, not investigated.

P4L94: "between the two datasets" please specify that you are referring to the satellite data.

P5L127: Replace "are conducted with" by "are characterized by"

P6L163: Replace "derived" by "from"

P6L171: Please revise: "For each period, we choose the corresponding time period during

which Envisat monthly data are used”.

P6, L175-177: Please revise :” The weighting has taken into account periods where only Envisat SIT of one month are present, i.e., we use this equation for grid cells where we have valid SIT data from both months, while we only use the Envisat SIT of the respective month without weighing for those grid cells where we only have valid data from either month.”.

P8L236: I suggest to replace “Envisat does not show the young ice in the Ross Sea” by “Thin ice in the Ross Sea is not captured by Envisat”.

P9L244-255: Revise “Compared to summer, the differences in the western Weddell Sea spread to the whole Weddell Sea sector and decrease from west to east.”. The statement is not clear.

P12L345: Replace “Previous study reveals” by “Previous studies show”.

P14L389: Remove “Firstly”. The comparison to ULS data is carried out first.