

## ***Interactive comment on “About uncertainties in sea ice thickness retrieval from satellite radar altimetry: results from the ESA-CCI Sea Ice ECV Project Round Robin Exercise” by S. Kern et al.***

### **Anonymous Referee #1**

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#### General Comments:

This manuscript provides an assessment of the quality a RA and RA-2 derived freeboard and thickness data set. The altimeter data set is compared to ice draft from submarines and moorings, freeboard and snow depth from OIB, and snow depth from Warren et al., 1999. There are large differences in these data sets: each data set has limitations and not all of them are understood and there are a lot of issues in the conversion from freeboard to ice thickness. These limitations in available observations is acceptable as long as they are addressed.

There are two key findings: 1) the Warren climatology is not adequate for basin scale

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usage; and, 2) that ice density could cause significant biases in the estimation of thickness (although this needs to be demonstrated in more detail).

One topic that is missing is a discussion of the limitations/noise of the RA and RA-2 retrievals. With their large footprints, their estimates may be biased due to preferential sampling of areas with lower density of open water (i.e., thicker ice). In fact, that was one of the reasons why the CryoSat-2 design reduced the footprint of the radar by a Doppler processing technique. In any case, it would be important to understand the instrument issues before attribution of the biases to geophysical parameters. Perhaps this is not under the purview of the round robin exercise but certainly this is something that is required in this examination of the uncertainties of thicknesses from radar altimeters.

The text is somewhat difficult to wade through as there are a lot of details and could be improved. Detailed comments follow.

#### Detailed Comments:

page-line 1521-9: This is not in the reference list at the end of the manuscript.

1521-21: Just a clarification - is the starting point for the study here the averaged freeboard in these 2 deg by 0.5 deg grids? Please indicate so.

1521-22: What is the expected uncertainty in altimetric height after the averaging process?

1522-1: Are the freeboards and snow depths both 'monthly' averages within these grid cells?

1522-12: The Baffin Bay area is outside the domain of validity of the Warren data set even though the polynomials could be evaluated in these regions. This is an incorrect use of the data set and thus the statement should be deleted.

1523-2: Why is a 12 deg by 30 deg (lat/lon) box required? Please add a statement to

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justify size of box.

1524-5: Minimum should read lowest.

1527-6 & Fig. 4: Again, this is not a fair comparison. The W99 climatology is valid only inside the Arctic, it does not extend to the Fram Strait. If you mean that W99 should not be used outside the Arctic, then OK? But, the data set does not claim and is not expected to be useful in regions outside the Arctic.

1527-6 to 20 (Fig. 5): Once more, W99 should not be used in the Canadian Archipelago. Please delete all comparisons with W99 in the Canadian Archipelago.

Fig. 5: Isn't there more extensive coverage of the Arctic by OIB than just the data shown here?

1528-23: Okay, so the authors recognize that the W99 estimates are extrapolated into these the Canadian Archipelago. So, what's the rationale of showing these results? Is there something to be learned by showing comparisons that are not expected to be valid.

1529-1: W99 does show the expected interannual variability, that should be quoted.

1529-7: Was there a reason why ASIRAS did retrieve the ice-snow interface? Is there a reference one could provide?

1529-15: So, perhaps the rationale for using the W99 data should be clarified at the outset otherwise it would be very confusing to try do understand why one would attempt such comparisons.

Fig. 6: Are these comparisons at all OIB tracks?

1529-26: I think this is expected as W99 pertains to multiyear ice.

Table 4: What is BS 1994, BS 1996, BSS 2007, etc.? Please provide legend.

1530-23: Please show that the area is mostly multiyear ice during these years or pro-

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vide a reference. The statement, as is, is too qualitative.

1531-5: So, perhaps it is attributable to snow or ice densities. But, isn't it also possible that the RA estimates are biased towards retrieval of higher freeboards?

Table 5, Table 6 and Fig, 9: pretty discouraging for RA-2.

Fig. 9: Which OIB year is this?

1532-paragraph starting at 19: Again, it is possible the RA freeboards, because of the large footprints of the radar, are themselves biased (thicker) in areas with thinner or FY ice? Thus, the signal you are seeing could actually be due to freeboard issues rather than density issues.

1533-3 to 15: The authors are too eager to attribute the issues to snow densities. I am not entirely convinced.

1534-20: almost all ULS data are acquired under MYI ice? What percentage?

1536-3 to 24: The argument is difficult to follow: there is noise in all these measurements. There is the underlying assumption that the average freeboard within each grid cell provide the true mean, deviations from that due to sample size and biases in RA freeboard could be issues. It would be useful to convince the reader of that before discussion of ice densities.

1536-15: Should you obtained the same ice density that OIB used? I am confused.

1538-5: This is over seasonal ice?

1539-5: the length scale issues are important as there could be significant gradients in freeboard within your large grid cells.

1540-1: The issues of radar biases that is ice type dependent need to be understood as well.

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Interactive comment on The Cryosphere Discuss., 8, 1517, 2014.

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