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The Cryosphere Discussions

Interactive comment on "Estimating the snow depth, the snow-ice interface temperature, and the effective temperature of Arctic sea ice using Advanced Microwave Scanning Radiometer 2 and Ice Mass Balance buoys data" *by* Lise Kilic et al.

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Review of Lise Kilic et al. Estimating the snow depth, the snow-ice interface temperature, and the effective temperature of Arctic sea ice using Advanced Microwave Scanning Radiometer 2 and Ice Mass Balance buoys data.

General comments:

More discussion about the impact of ice type on the results should be included. The Markus & Cavalieri snow depth algorithm is only supposed to work properly over first

year ice, most of the OIB and IMB data are from areas of multi-year ice. These issues and their impact on the results should be more clearly identified and discussed.

There should be a clearer wording about when the results for Tsnow-ice are derived using in-situ snow depth and when they are derived using the estimated snow-depth from this study. Both in the abstract and in the conclusions, error numbers assuming in-situ snow depth measurements are given, but these are not generally available, so the uncertainties for the retrievals using satellite snow depths are generally more relevant.

The concept of effective temperature is based on an assumption of constant emissivity. It is here even referred to as surface emissivity. In reality the emissivity varies with depth as does the temperature, and in particular the emissivity at the surface is small since the emissivity of snow is very small during Winter (no absorption = no emissivity). It should be better explained what is actually the emissivity referred to as the surface emissivity, and some considerations about it's variability with temperature and salinity for example would be appreciated.

More detailed comments:

P1L20: Sea ice dynamics and thermodynamics -> Sea ice thermodynamics

P2L1: reduced -> reduces

P2L9: Advance -> Advanced

P2L11 and reference section: The RRDP should be referred to as Pedersen et al, 2018, https://figshare.com/articles/Reference_dataset_for_sea_ice_concentration/6626549

P2L24: In principle this should also be "surface effective emissivity" (see above), and it should be better explained how to estimate this emissivity.

P3L5: See comment P2L11 above

P3L10-11: Note that neither the OIB nor the IMB data in the RRDP are guaranteed 100% ice. This should be considered and the impact on the results should be dis-

cussed.

P3L15: See P2L11 above. In addition the resolution matching of AMSR2 is carried out by JAXA and should be referred to as Maeda et al, 2011 Maeda, K., Y. Taniguchi and K. Imaoka, (2016), GCOM-W1 AMSR2 Level 1R Product: Dataset of Brightness Temperature Modified Using the Antenna Pattern Matching Technique, IEEE Transactions on Geoscience and Remote Sensing, VOL. 54, NO. 2.

P3L19-20: The acoustic sounder only measures the position of the snow surface. The position of the ice surface is assumed from deployment or from the Summer measurements at the end of the ablation period. The sensor is mounted on a pole frozen into the ice, looking down at the snow surface. It measures distance between the instrument and the snow surface, thus recording the changes in the snow depth.

P3L21: IMB buoys -> IMBs. The B in IMB means Buoy and does not have to be repeated. There are many instances of this in the text.

P3L23: bouys -> buoy

P3L29: OIB radar -> the OIB snow radar. OIB operates other radars as well.

P5L1-5: Please include a bit more details about the simulated data, such as number of datapoints, types of ice etc.

P5L30: satisfying -> satisfactory

P6L1-10: Discuss also the potential for a seasonal variation in the regression. OIB data are all from late Winter to Spring, whereas the IMB data are for all Winter. What impact could that have, and why do you expect your regression from OIB to work also during other parts of the Winter.

P6L21-27: Here you need to discuss why you think the Markus and Cavalieri snow depth algorithm can be applied to MY-ice.

P6L31: Please provide a reference to the OIB uncertainties quoted here. Also note

that the RRDP OIB dataset contains information about the variability of the snow depth over the 50 km sections. This could have been used to filter out the OIB data with too much variability. The RRDP also contains ASCAT C-band scatterometer data that could be used to distinguish ice types.

Figure 2: You should not apply the Markus and Cavalieri algorithm to MY-ice and you should discuss the importance of ice type for your own snow depth retrievals.

P7L7-8: The temperature gradient is a function of the thermal conductivities and the depth of snow and ice respectively. The temperature gradient in snow is certainly not always 35 K/m! Please rephrase this sentence.

Section 4.1: This methodology is rather crude. It assumes thermodynamic equilibrium (which is not always the case, please discuss), and it could have been refined to a better estimate of the snow/ice interface temperature by the method outlined in section 4.1.5 of the RRDP manual (identifying the crossing point of the linear temperature profile in ice and in snow respectively). This might have reduced the quantization 'noise' in the IMB Tsnow-ice data.

P10L5-14: Equations (2), (3) and (4) do not make sense as they stand. The TBs should have been delta-TBs and you should specify the center TBs you subtracted to get to the delta TB and you should more clearly specify that these are NOT TBs.

P11L5-7: This should have been mentioned earlier and could have been fixed by applying the method from the RRDP manual described above under Section 4.1.

P12L3: Explain a bit more what Teff is and why you need simulated data.

P12L4: are simulated together -> are all simulated

P12L10: simulated data -> simulated TB data

P12L13-15: These biases are presumably in the MEMLS simulations and not in the TB data, so you should bias-correct the MEMLS simulations and not the AMSR2 TB data.

(This applies to figure 10)

P12L20-21: Explain more (f.ex using a reference) why H pol TBs are more noisy?? Figure 11: The figure text must be wrong. This figure must be for only one frequency (which)?

P13L4+5: As stated in the general comments, all layers emit, to the concept of “an” emitting layer is an abstraction and should be explained more carefully.

P13L8: section -> sections

P14L10-11: According to Warren (1999) the snow depth in general is not supposed to decrease from November to January, so this reference seems wrong. If this behavior is seen in certain regions please be more specific.

P16L6: The U-Bremen MY-ice fraction is NOT “completely independent” since it uses microwave radiometer data (AMSR2 or SSMIS) at the same polarizations and frequencies as the current study.

P16L14: A RMSE -> An RMSE

P16L14: on the estimated snow depth -> between the estimated and reference snow depths

P16L15: and the snow depth -> and in-situ snow depth And you should quote the results obtained using your estimated snow depth as well since in-situ snow depths are not generally available

The discussion lacks considerations about the importance/impact of ice type.

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