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The Cryosphere
Discussions

Interactive comment on "Surface melting over the Greenland ice sheet from enhanced resolution passive microwave brightness temperatures (1979–2019)" *by* Paolo Colosio et al.

Anonymous Referee #1

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General comments:

This study analyzes the newly developed NASA MEaSUREs calibrated enhanced resolution ($\sim$ 3.125 km) passive microwave dataset (37 GHz horizontally polarized channel) (Brodzik et al., 2016, cited in this paper) to examine whether the dataset can be used for studies on the Greenland ice sheet (GrIS) surface melt. The dataset was developed by using the data from the following satellite microwave radiometers: The Nimbus-7 Scanning Multichannel Microwave Radiometer (SMMR) and Defense Meteorological Satellite Program (DMSP) Special Sensor Microwave/Imager (SSM/I). Because the frequency of the GrIS surface melt has been increasing recently due to the ongoing

rapid warming, the GrIS surface melt commands considerable attention. Therefore, the topic explored by the authors fits very well with the scope of this journal.

In this paper, the authors compare five post-processing methods applied to the new dataset: the M+ΔT methods with changing ΔT values of 30, 35, and 40 K, the 245 K fixed threshold method, and the MEMLS (Microwave Emission Model of Layered Snowpack) method. All these five methods can be categorized into the threshold-based method. The first four methods are very simple, whereas the MEMLS method is relatively physically based but its threshold value does not change dynamically. These methods give threshold values of passive microwave brightness temperatures to detect the surface melt. In case a (measured and) post-processed value from a satellite becomes higher than a threshold value, the occurrence of the surface melt can be estimated. Based on the comparisons of the melt detection results with in-situ meteorological/snow data from automated weather stations on the GrIS and the regional climate model MAR, the authors conclude that the MEMLS method shows the best performance in terms of capturing the GrIS surface melt. Finally, the authors present inter-annual variations of the GrIS surface melt area extent obtained from this study.

My honest impression is that this paper contains so many information that many readers will find it difficult to follow the discussion. Tedesco et al. (2013, cited in this paper) already have demonstrated the effectiveness of the MEMLS method over the GrIS, so that, I think results from the M+ΔT methods and the constant 245 K method can be removed. It is because they are very simple compared to the MEMLS method. I do not find interests showing these results in this paper. The authors also compare their results with the outputs from the MAR model. I completely agree with the point that the MAR model is very sophisticated; however, the model output is not the reality. Therefore, I cannot understand why the authors want to compare them in this study, although I have confirmed from Figure 7 again that the MAR model performs very well over the GrIS.

In the global scientific community studying the GrIS surface melt, the dataset by Mote

(2007), which utilizes data from the 18 and 19.35 GHz horizontally polarized channels in the same sensors/satellites as those used in this study, has long been utilized widely. As fat as I know, the dataset employs a dynamically changing threshold method to detect the GrIS surface melt. Because the horizontal resolution of the dataset by Mote (2007) is 25 km, it seems to me that the new dataset has a big advantage. Therefore, the authors should compare their MEMLS-method-based results with the dataset by Mote (2007). Without this, readers cannot know advantages/significances of the new dataset presented in this study.

Also, I would like to suggest that the data and methods section (Sect. 2) is a mix-up of data, methods, results, and discussion, which confuses readers. Figures 2, 3, and 4, as well as Tables 3 and 4 should be presented in the results and discussion section. Please reformulate the section.

I would like to suggest that the authors should attend to the above-mentioned major issues before considering its publication.

Other specific comments are as follows:

Specific comments:

L. 25: More detailed explanation of "local scale processes" is needed here.

L. 86 $\sim$ 90: It is necessary to introduce why such a high-resolution dataset from the Ka band product were not available until recently. What is the key innovation that enabled us to use the Ka band data for the detection of the ice sheet surface melt? It is also important to explain the difference in sensitivities of the K and Ka bands data to the liquid water clouds.

L. 130: "2.2 Greenland air/surface temperature data": It is necessary to explain how the authors obtain surface temperature from the AWS (automated weather station) data. It is because the AWSs do not measure surface temperature directly.

L. 132 $\sim$ 133: Strictly speaking, even if the surface temperature reaches 0 degreeC, it

does not ensure that meltwater exits at the surface. How do the authors detect whether meltwater exits at the surface or not from the AWS data?

L. 185 $\sim$ 186: "Building on Tedesco (2009), we considered the two LWC values of 0.1 % and 0.2 %": Please explain more in detail about this process. It is unclear why 0.1 and 0.2% are chosen here.

L. 193: For MEMLS, why do the authors consider only the case of 0.2% LWC?

L. 193 $\sim$ 196: "As we explain below, this choice was driven by the performance of the different considered algorithms. Moreover, we found that the fixed-threshold algorithm is more sensitive to persistent melting where the MEMLS-based one can detect sporadic melting. This allows us to analyze both melting conditions (sporadic vs. persistent) and analyze them within the long-term, large spatial scales that the PMW data can provide.": I think it is not necessary to state them here. They can be removed.

L. 304: "with the MEMLS being the most sensitive": The authors' intention is unclear. Sensitive to what?

Technical corrections:

L. 16: "MeASUREs": Its definition should be indicated here.

L. 17: "Km" -> "km"

L. 19: "MEMLS model": Brief explanation of the model or the definition of the abbreviation should be indicated here.

L. 82: Please provide the definition of the abbreviation "rSIR".

L. 103: "SMMR": Please provide its definition here.

L. 131: "In order, to" -> "In order to"

L. 146 $\sim$ 147: "Lateral and lower boundary conditions are prescribed from reanalysis datasets." -> "Lateral and lower boundary conditions of the atmosphere are prescribed from reanalysis datasets."

L. 153: "meltwater extent" -> "melt extent"

L. 195: "where" -> "whereas"

L. 211 $\sim$ 214: Please follow the instruction how to indicate date and time in the text. https://www.the-cryosphere.net/submission.html#math

L. 576 $\sim$ 579: Brodzik et al. is updated in 2020.

References:

Mote, T. L.: Greenland surface melt trends 1973–2007: evidence of a large increase in 2007, Geophys. Res. Lett., 34, L22507, https://doi.org/10.1029/2007GL031976, 2007.

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