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The Cryosphere Discussions

Interactive comment on "Melting trends over the Greenland ice sheet (1958–2009) from spaceborne microwave data and regional climate models" *by* X. Fettweis et al.

X. Fettweis et al.

xavier.fettweis@ulg.ac.be

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First of all, we want to thanks the reviewers for their constructive criticisms. We really appreciate their comments, which will contribute to improve this paper.

Before the end of the Interactive Discussion, here is a quick response to the major concerns of both reviewers about this paper.

From reviewer #1

1. *Why ExtXPGR?* According to Fettweis et al. (2005, 2006 and 2007), XPGR fails to detect melt over the ice sheet when rainfall events occur due to the use of

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the 37Ghz channel in XPGR. The 19 GHz channel is less sensitive to the dense clouds and atmospheric components than the 37 GHz, and therefore T19Hmelt can provide improved performance during these events. Complex corrections imposing the continuity of the melt season to remove gaps have been made in Fettweis et al. (2006) for improving XPGR. Here, we simply combine XPGR and T19Hmelt to improve the XPGR-based melt detection. A more detailed justification of the use of ExtXPGR interest will be given in the revised version of the paper.

2. *Snowpack behaviours influence the TB threshold value?* We fully agree with the reviewer that the snowpack behaviour influences the choice of the T19H threshold used for detecting melt. A microwave-emission model as in Mote (2007) should be used to determine a snowpack dependent T19H threshold for each pixel. But the Mote-like approach is much more complex and knowing that models compare already well with the simplest approach (i.e. the use of a fixe T19H threshold for every year and pixel), the simplest one suffices here. Moreover, grain size values used in Mote's model should be updated as melting and refreezing cycles continue, in view of the constructive metamorphism. As a future development (as said in Section 3.2.4), the RCM outputs could be used to prescribe the snowpack properties in the microwave-emission model. A map of the used GC-Net AWS will be given and a discussion about the limitation of the use of a fixed threshold will be given in Section 4.1. For example, it is likely that part of the difference between both RCMs and satellite data along the South-East coast is due to an artefact induced by the high accumulation rates found in this region. It is known that high accumulation rates induce increases of the Tb.

3. *No significant melt increase detected by XPGR in the coastal areas due to an increase in rainfall and CLW biasing XPGR?* Here, we do use Abdalati's original definition of XPGR. The hypothesis about the XPGR melt trend was made and justified in Fettweis et al. (2006). The MAR model shows a statistically significant

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increase in clouds containing liquid water in these areas due to the warming of the atmosphere. Knowing that XPGR is biased by these clouds, it is likely that those perturb the XPGR melt trend. A plot showing the increase of simulated clouds containing liquid water will be given in the revised version.

4. *Microwave derived melt versus albedo parametrization?* RACMO underestimates melt at the beginning of the melt season , unlike MAR. The MAR albedo drops earlier in summer (see Fig7) because it is a function of the snow grain size, which increases faster than the snow density used in RACMO to prescribe the snow albedo. MODIS-based albedo should be used to confirm this hypothesis. A better explanation of the link between the snow albedo parameterization and microwave derived melt will be given.

From reviewer #2

1. According to the editor's and Referee #2's comments, we suggest to merge Sections 3.1, 3.2 and 3.3 by focusing only on the melt retrieval algorithms (T19Hmelt and XPGR) that are used in this paper. The discussion about the strengths and weaknesses of the other approaches (including Fig. 1 and Fig. 2) will be given in the supplementary material; please advise.

2. *Use of passive microwave data in reanalysis*. To our knowledge, the passive microwave data are used only in the ECMWF reanalysis to prescribe the sea ice cover. The microwave brightness temperatures are also perhaps used to correct the surface temperatures (SST) in the reanalysis. However, the RCMs are only forced at the lateral boundaries of the integration domain and the surface conditions simulated by the RCM over the GrIS are quasi-independent of the surface conditions coming from the reanalysis over the ice sheet. According to Hanna et al. (2009, Hydrological Processes), the impacts of SST changes are for example negligible in MAR over the GrIS. Therefore, we do not think that the

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use (or not) of passive microwave data in reanalysis significantly influences the comparison of the RCMs with the satellite derived data. But we agree that this potential issue must be mentioned.

Interactive comment on The Cryosphere Discuss., 4, 2433, 2010.