

Interactive comment on “Representative surface snow density on the East Antarctic Plateau” by Alexander H. Weinhart et al.

Anonymous Referee #1

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Review of

Representative surface snow density on the East Antarctic Plateau

by Alexander H. Weinhart

General

This paper describes density observations along two over-ice transects from Kohnen station to Dome F on the plateau of the East Antarctic ice sheet. The observational techniques are state-of-the-art, resulting in small errors and highly significant results. These results show that 0-1 m average density shows little variation along the traverse, with a mean value of about 355 kg m⁻². This is an important result, as it can be used to improve the snow/firn modules in (regional) climate models and the interpretation of

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satellite altimetry observations. However, the writing needs to be improved, as many formulations are unclear (for some examples, see below, but this listing is not exhaustive). The figure quality can also be improved in places.

Major comments

p. 1, l. 25: "The difference in the total mass equivalent of measured and modelled density yields a 3% underestimation by models, which translates into 5 cm sea level equivalent. " It is unclear how these numbers are obtained, see comment below on Section 4.3.

p.2, l.3: " Accurate quantification of the current state and rate of change of SMB is therefore one of the most important quantities..." A quantification is not a quantity. Please critically re-assess your formulations to improve this throughout the paper.

p. 3, l. 5: " The coldest 10 m firn temperature is recorded at Plateau Station (...), which makes the area the best modern analog of glacial firn." This is another example of a sentence that is really hard to understand. Coldest on Earth? What do you mean by "an analogue of glacial firn"? Please clarify.

Section 4.3: It is unclear to me how the density errors in previous studies lead to the SMB error results in a 5 cm sea level equivalent? Over what period? SMB is usually derived from regional climate models that quantify mass directly, i.e. irrespective of density. Mass changes by GRACE are also direct mass measurements, only satellite altimetry suffers from uncertainties in the density of the material at which the elevation change takes place, but this is valid for changes in elevation, not for steady densities as presented here.

Section 4.4: Are the Ligtenberg (2011) data also valid for the first 1 m? I think they use a simple parametrization to calculate surface density, hardly a 'model' as it is called here. It would also be valuable to provide the time span covered by the first 1 m of snow, this will vary with accumulation. In how far can climate variability be responsible

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for part of the differences with other studies?

Based on its findings, does the current paper recommend to redefine 'surface density' as the average density of the first m? If so, this is an important recommendation that could be made more explicit.

Minor comments

p. 1, l. 10: "Wrong estimates of snow and firn density can lead to significant underestimations of the surface mass balance." underestimations of -> uncertainties in

p. 1, l.17: "liner" ? This has not been explained yet, so please don't use it here.

p. 1, l.23: "provided by a regional climate model" These models usually don't 'provide' density, but either prescribe it or use a simplified expression based on temperature, wind etc. Suggest to replace by 'used'.

p. 1, l. 25 and further: Note that regional climate models DO explicitly calculate accumulated mass, so using a wrong surface density does not influence the surface mass balance directly, only indirectly (through blowing snow threshold friction velocity, vertical heat transport in snow affecting surface temperature and hence sublimation etc.).

p. 2,l.2: on -> of; Greenlandic -> Greenland.

p. 2, l. 5: " Satellite altimetry is state of the art" -> Satellite altimetry is a state of the art method/technique...

p.2, l.13: " snow density is parameterized " -> snow density in models is often parameterized

p. 2, l. 30: This sentence is unclear, please reformulate.

p.3, l. 4: Remove " In order to avoid misunderstandings"

p. 3, l. 5: coldest/warmest temperatures -> lowest/highest temperatures (change this throughout the text, please)

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p.9, l. 8: good -> well

Figures: Please include solid axes where missing.

p. 18, l. 23: This AWS has been installed and serviced by Utrecht University and AWI; please provide proper credit.

Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2020-14>, 2020.

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