

Review of Thompson-Munson et al.: *An evaluation of a physics-based and a semi-empirical firn model across the Greenland Ice Sheet (1980–2020)*

by Vincent Verjans.

This study applies two state-of-the-art firn models at the scale of the Greenland Ice Sheet (GrIS). The Community Firn Model is used with the semi-empirical NASA GSFC-FDMv1.2 .1 densification scheme (CFM-GSFC). SNOWPACK is a more physically-detailed snow compaction model. The goal of this study is to compare results from these two different approaches to firn modeling over the GrIS. The authors also perform a comparison of model output against in-situ firn core observations. The authors have thoroughly reworked the manuscript since its first version. This includes an improved evaluation of model output with respect to firn core data, and a better interpretation of the results. This review only includes specific comments, which are still important to be addressed. I recognize the thorough work of the authors to address all my comments from the first round of reviews, and I sincerely appreciate their extensive answers in the author responses. Provided some very minor issues in the updated manuscript are addressed by the authors, I encourage the publication of this study in *The Cryosphere*.

Specific comments

1 45-46

Change “*in both observations (e.g., Vandecrux et al., 2019; Benson, 1996; Braithwaite et al., 1994; Sørensen et al., 2011; Kuipers Munneke et al., 2015) and models (e.g., Medley et al., 2022)*” to “*in both observations (e.g., Vandecrux et al., 2019; Benson, 1996; Braithwaite et al., 1994) and models (e.g., Sørensen et al., 2011; Kuipers Munneke et al., 2015; Medley et al., 2022)*”.

1 69

Change “*densification based constitutive*” to “*densification based on constitutive*”.

1 82

Change “*e.g.* “ to “*e.g., “.*

1 124

Change “*from the MERRA-2 grids*” to “*from the MERRA-2 fields*”.

1 131

Change “*in adjacent layers*” to “*between adjacent layers*”.

1 149-150

Change “*it is important to specific*” to “*it is important to specify*”.

1 156-159

I suggest removing the sentences “*The CFM-GSFC uses a layer-merging scheme at 5- and 10-m depth to reduce computational demands. The CFM-GSFC is coded so that each model time step adds a new layer. As such, daily time stepping generates many thin layers.*” And changing the next sentence to “*To reduce computational demands associated with many daily accumulation events, we use the CFM-GSFC’s layer merging scheme.*” This makes the text less repetitive.

1 227

Add a comma: “*In these shallow cores, where densification*”.

1 248-249

Change “*values comparable to*” to “*values comparable or improved with respect to*”.

1 284-285

Remove “*, which represents the averaged difference in FAC between the two models,*” because this is an incorrect definition of the RMSD.

1 355

Specify “*remains relatively constant (Fig. 9a, 9b)*” to make clear that this statement refers to the northwest and central west basins.

1 413

Change “*Verjans et al., 2021*” to “*Verjans et al., 2019*”.

1 511

Change “*is likely*” to “are likely”.

1 539

Change “*not often well-represented*” to “often not well-represented”.

1 542

Change “*Verjans et al., 2021*” to “Verjans et al., 2019”.

1 549

Change “*Model error is higher in comparisons with deeper cores than in shallower ones*” to “Model error is higher with respect to deeper cores than to shallower ones”.

1 569

Change “*from a model*” to “from a regional climate model”.

1 581

Change “*drawback*” to “drawbacks”.

1 582

Change “*biased toward available observational data*” to “constrained toward available observational data”.

1 582-583

Change “*This may result in more realistic simulations of firn properties under future climate conditions,*” to “This avoids simulations beyond the calibration range of the firn model under future climate conditions,”.