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Geoscientific Model Development Discussions

# *Interactive comment on* "Description and Evaluation of the Community Ice Sheet Model (CISM) v2.1" *by* William H. Lipscomb et al.

**J. Sutter (Referee)**

johannes.sutter@awi.de

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The paper by William H. Lipscomb et al. in my opinion is a well written and extensive description of the features of the new version 2.1 of the Community Ice Sheet Model (CISMv2.1) and fits very well in the scope of GMD. The reader is provided with a detailed lay out of the approximations (and their numerical implementation) to the 3D full stokes flow equation used in the model as well as the user choices regarding model parameterizations of features such as basal sliding or calving. The fundamental equations and their implementation in the model are well documented allowing the reader to appreciate the physical aspects of ice flow incorporated in CISMv2.1.

Before providing a more specific review of the paper I want to mention 2 general minor



points which might improve the manuscript.

1. The authors mention that CISMv2.1 so far is limited to Greenland applications and that support for Antarctic model settings is deferred to future model releases. Reading the manuscript, I got the feeling that all major features required for modelling the Antarctic Ice Sheet (AIS) are included in CISMv2.1, e.g. calving and a simplified scheme prescribing ice shelf melt rates. Maybe one or two sentences as to which features are missing to make AIS simulations feasible (e.g. forcing interfaces, melt rate parameterizations, grounding line migration schemes) and whether AIS simulations with CISM are a near term option or require more extensive work would be helpful. Furthermore, since the model is freely available via github maybe there is an interactive development platform in which new features can be committed for dedicated developers (similar to e.g. the PISM approach).

2. It would be interesting to see which implementations and aspects in CISMv2.1 provide a different or similar approach as compared to other models on the market (such as Sicopolis, PISM, ISSM, BISICLES etc.) both regarding the physics and performance of the model. Differences and similarities could be explicitly pointed out at relevant sections of the paper which would allow potential future users of the model to quickly grasp the strengths and specialties of CISMv2.1.

In the following I will address specific points of the manuscript:

Page 2:

Line 32: Here, a condensed list of the main changes (pointing to the sections in the manuscript) between v2.0 and 2.1 would be helpful to give the reader familiar with CISMv2.0 a quick overview.

Page 5:

Line . 2: but will be in the near future?

Page 9:

Line 27: may be faster? Can this be quantified? What is the definition of large problems here? Here a back of the envelope estimate might be useful.

Page 13

Line 3-5: put in a reference to Figures 4,5,13 in which differences of BP and DIVA solution are visualised?

Page 14

Line 16: is there a flag pointing out that the run didn't converge? I guess it would be problematic e.g. in ensemble simulations or intercomparisons to mix converged runs with non-converged runs.

Page 22

How is basal melting handled in partially filled ice shelf cells?

Page 23

Lines 25-30: How does this approach differ from (DeConto, R. M. Alley, R. B.Pollard & DeConto, 2015, Potential Antarctic Ice Sheet retreat driven by hydrofracturing and ice cliff failure)? Has it been tested against runaway marine ice sheet retreat, i.e. would it lead to realistic solutions in an Antarctic setting for present day climate conditions?

Page 24 (Standard Test Cases)

Is CISMv2.1 tested for reproducibility on long (e.g. tens of thousands of years) paleo simulations? Experience with other models has shown that e.g. dynamic choice of FFT's can lead to small changes in the results which build up on long time scales leading to a lack of reproducibility. A paleo-repro test would be very helpful to check whether the model choices ensure identical solutions for identical model settings. I'm aware that such a test is not standard in comparable models with paleo applications but wonder wether it has been looked at in CISMv2.1.



Page 25

Line 17-21: Doesn't it make more sense to compare test cases applying the same time step? So either 1yr or 5yr in both applications.

Line 19: errors expressed in percent thickness change would be more instructive.

Line 29: what makes them particularly useful?

Page 26

Line 31/32: how does the model perform in the stream tests using a range of resolutions e.g. 4,8,16 km? This could be plotted in Figures 6-7.

Page 27

Line 18: is there a reason for the 6.8 km resolution?

Page 28

Line 22: maybe change to "[. . .], it is constrained by reanalysis at model boundaries and well validated against observations, therefore its SMB is more realistic compared to a global climate model."

Page 29

Line 3/4: Maybe change to: model parameters should always be thoroughly tested and reviewed depending on the intended application.

Line 11/12: why not use temperature and surface mass balance from the same climatology?

Page 30

âĂÍLine 12: which is probably due to boundary conditions (e.g. geothermal heat flux) and the parameterization of subglacial hydrology?

Line 30: maybe "A more detailed investigation would be needed [. . .]"

Page 31 âĂÍLine 31: “Simulated GL migration would differ [. . .] run at different resolution [. . .]”

Page 32

Line 10-20: I wonder whether this discussion and the associated Figure 17 can be omitted as the authors point out correctly, that the form and shape of the ice shelves would change given different parameter choices.

Line 22: “modelling challenge for Grenland” -> “[challenge for modelling ice shelves in general]”

Page 33

Line 3: “in both idealized and real world applications”

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