The Cryosphere Discuss.,
https://doi.org/10.5194/tc-2019-209-RC1, 2019

The Cryosphere Discussions

Interactive comment on "Brief communication: CESM2 climate forcing (1950–2014) yields realistic Greenland ice sheet surface mass balance" *by* Brice Noël et al.

Anonymous Referee #1

Received and published: 18 October 2019

Remarks to the Authors

Review of "Brief communication: CESM2 climate forcing (1950-2014) yields realistic Greenland ice sheet surface mass balance" by Brice Noël et al.

The Cryosphere Discuss. Manuscript Number: tc-2019-209

General comments:

In this paper, the authors introduce present-day historical (1950-2014) global model simulation data generated by the Community Earth System Model version 2 (CESM2),

which can be utilized to force polar regional climate models (RCMs) like RACMO2 used in this study. If "stand-alone" CESM2 can provide realistic climate forcing data for polar RCMs, it means that such RCMs are allowed to conduct a seamless model calculation from past to the present and future without any bias corrections. This kind of seamless simulation by a polar RCM is a state-of-the-art challenge, so that it can provide more realistic information related to possible future changes in the physical conditions of polar ice sheets as well as terrestrial climate system (e.g., sea level rise). Here, the authors perform dynamical down-scaling of the CESM2 data using RACMO2 in the Greenland ice sheet (GrIS) and try to prove the effectiveness of CESM2 through validating GrIS SMB simulated by RACMO2 (equipped with the statistical down-scaling postprocessing). This reviewer thinks that this considerable challenge is deserved to be published in the journal The Cryosphere as a brief communication if it is addressed in an appropriate manner. Overall, this paper is well written and structured; however, this reviewer suggests the following points to be considered before the publication.

Please note that page and line numbers are denoted by "P" and "L", respectively.

Specific comments (major)

P. 1, L. 9 $\sim$ 10 (and Sect. 2.1): According to the paper by Van Kampenhout et al. (2019b), which I read before reviewing this manuscript, the CESM2 simulation by Van Kampenhout et al. (2019b) was conducted following the so-called AMIP (Atmospheric Model Intercomparison Project)-run procedure. Did the authors use the same procedure/data as those presented by Van Kampenhout et al. (2019b)? If YES, the authors cannot argue "This means that, for the first time, an Earth System Model (CESM2), without assimilating observations, can be used to reconstruct historical GrIS SMB and the mass loss acceleration that started in the 1990s." in my opinion. It is because Van Kampenhout et al. (2019b) prescribe ocean and sea ice data at monthly intervals in their CESM2 simulation following the AMIP protocol, which is a kind of observation

data assimilation (I mean observed ocean physical conditions can drive changes in atmospheric conditions in the model, although the atmosphere-ocean interaction would not be so strong in the model). If NO, there is no doubt that this study is amazing, and I would like to congratulate for the achievement. Anyway, please clarify this point in Sect. 2.1.

P. 6, L. 32 $\sim$ P. 7, L. 2: Why does CESM2-forced RACMO2.3p2 show the significant positive trend of total precipitation since 1990, which is not shown in the ERA-forced run? Please discuss.

Specific comments (minor)

P. 2, L. 24: If possible, please indicate/mention the GrIS ice discharge simulated by the ice sheet model CISM2.1 incorporated in CESM2, which might be of interest to readers of The Cryosphere.

P. 2, L. 25 $\sim$ 26: Please indicate data sources for "atmospheric greenhouse gas emissions (CO2 and CH4), aerosol concentrations, and land cover use".

P. 3, L. 4: What kind of impurities do the authors consider in RACMO2 applied in the GrIS? And, how do the authors give concentrations of the impurities in the model?

P. 3, L. 15: Please indicate data source of sea surface temperature and sea ice extent used here (maybe from the parent CESM2 simulation results?).

P. 3, L. 19 $\sim$ 21: This sentence is a bit difficult to understand to me. Does it mean the 5 % lowest bare ice albedo from MCD43A3 is 0.30?

P. 5, L. 30 $\sim$ P. 6, L. 1: I think the results from RACMO2.1 forced by HadGEM2 is not necessary in this paper, because it can confuse readers who do not know much about RACMO2. If the authors think this part is really important for this paper, they should at least indicate key differences between RACMO2.1 and RACMO2.3p2 briefly in Sect.

2.2. Also, brief introduction of HadGEM2 would be needed as well.

P. 6, L. 15 $\sim$ 16: Same as the above comment.

P. 6, L. 24: Please indicate quantitatively how realistic the simulated T700 is.

P. 6, L. 28 $\sim$ 29: This reviewer agrees with the authors' point that the attempt mentioned here is very interesting as long as the CESM2 data used in this study is not from the AMIP-type simulation. Please also see my first major comment.

Figure 3: Can the authors briefly comment on why CESM2-forced RACMO2.3p2 could not simulate the 2012 extreme melt, which is simulated successfully by the ERA-forced run? I think this point is related to "physical drivers of the warming" (P. 6, L. 28), and any comments/suggestions by the authors will be informative for readers.

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