Comments to "The GRISLI-LSCE contribution to ISMIP6, Part2: projections of the Antarctic ice sheet evolution by the end of the 21^{st} century"

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1 General comments

This paper is based on the Ice Sheet Model Intercomparison project (ISMIP6) on the Antarctic ice sheet. The results of individual ice-sheet model GRISLI are discussed. Apart from the standard experiments described in Seroussi et al., 2020, forcings derived from some CMIP6 model simulations are implemented in this study. Furthermore, experiments with atmospheric forcing only and oceanic forcing only are taken to study their roles separately. Finally, the authors did sensitivity tests on the basal friction coefficient and enhancement factor to address the influence of initial conditions.

Generally, I believe studies based on individual models could be a good complement or further study beyond the intercomparison paper (Seroussi et al., 2020). For example, by implementing different schemes in the single model, uncertainties could be better understood. Though, it's not clear to me what the strong points of this paper are. I have a few concerns about this paper:

- The main results and the induced conclusions are in line with the model intercomparison paper and don't add more information. Therefore I'm not sure why is it important to publish the single model result? There should be more discussion about the regions where the GRISLI model

shows different behavior compared to the mean ISMIP6 model results. (See also specific comments).

- Apart from the standard experiments introduced in Seroussi et al., 2020, the authors added sensitivity experiments on basal drag coefficient and enhancement factor by simply changing the value proportionally. The experiments are only shortly described in the discussion without any contribution to the conclusions. The authors didn't work deeper in this direction of studying the uncertainties from initial conditions.

2 Specific comments

Hyphenation should be used between adjective-noun pairs, such as "ice-sheet model", please check through the manuscript.

P1L10: 'sub-shelf basal melt' is a repeated expression.→'sub-ice-shelf melting/melt rates'.

P1L22: 'increased in mass loss'→'acceleration of mass loss'

P2L3: 'ice sheet dynamics'→'ice-sheet dynamics', again, please check through

P2L2:'....remains largely uncertain' need references.

P2L2: delete 'Thus, altogether'?

P2L5: a wide spread in **the prediction/assessment of** the magnitude

P2L9: cite Seroussi et al., 2020

P3L10: I wonder if the total velocity is a weighting function of SIA and SSA as Bueler and Brown, 2009 described or simply added the two velocities? In the later case, the reference should be Winkelmann et al., 2011 (https://doi.org/10.5194/tc-5-715-2011).

P3L24: 'and impose'

P3L28: 'basal drag **coefficient** reduced for ice thickness overestimation', so is the next sentence 'basal drag **coefficient** remains...'

P3L28: 'e.g. basal drag reduced for ice thickness overestimation': how does the coefficient reduce corresponding to the thickness change? The authors should describe the formula clearly, or supply the related references. Similarly, in the sentence of L30, 'The ice thickness mismatch...is used to modify the basal drag coefficient for the next iteration.' How does the ice thickness mismatch modulate the basal drag coefficient?

P3L33: 'Le clec'h et al. (2019)'→'(Le clec'h et al., 2019)'

section 2.2 Model and initialisation: Sensitivity experiments are taken for basal drag coefficient and the enhancement factor, however, the enhancement factor is not introduced in this section. I think it's necessary to describe the parameter, how it influence the stress field and what value do you use in the standard simulations.

P4L8: 'an observational dataset'→'a combination of observational datasets'

P4L25: 'of'→'at'

P4L25–: I suggest to give the non-local quadratic parameterisation formula instead of only refer to the paper. The manuscript heavily discussed the influence of ocean forcing, such as 'sub-shelf melt rates sensitivity to temperature' and the uncertainties related to the 'low','high' and 'medium' methods. However, It's not explained what's the parameter, and what do 'low','medium' and 'high' mean.

P4L28, In the standard experiments, the gamma (sensitivity parameter) has been calibrated to reproduce the total amount of observed sub-ice-shelf melt rate around Antarctica (Rignot et al., 2013).

P4L33, also because there are dense observational data available in Pine Island glacier.

P5L3: Maybe also label the standard calibration as MeanAnt to be consistent with Jourdain et al., 2019.

P5L4: The first sentence need a reference.

P5L7: I didn't find 'SC' used thereafter. Is the sentence needed?

P5L13: 'climate forcings (surface temperature...)' is surface temperature implemented as a forcing?

P5L15: Which forcing is used for the ctrl experiment?

P6L8: delete 'namely GRISLI'?

P6L11: 'These errors are the results of ...' I guess the errors are also from the iterative procedure of initialisation?

P6L15: What do you mean by 'most of the time'?

P6L19 Figure 1: It's not easy for me to tell the yellow color from white. It seems that in the Amundsen sea embayment, there are ∼50 m underestimation of ice thickness in the Getz ice shelf region but ∼50 m overestimateion in Pine Island glacier and Thwaites glacier?

P6L20 'the Filchner-Ronne ice shelf grounding line'→ grounding line of the Filchner-Ronne ice shelf

P6L30: 'The velocity errors for the grounded part...' Why?

P6L31: 'Thus,...' need a more detailed explanation.

P6L7: It's declared in the section 2 that the initialisation method is same with Le clec'h 2019, where the basal drag coefficient is also modulated by velocity. But here you does not have any constraints on the velocities?

P7L20: 'This inconsistency can be due to...' Why? Could you give more specified explanation?

P7L24: '1000 km^3' Could you use consistent unit when mentioning the mass change? km^3, Gt or sea level equivalent? Right now all of the three units are implemented, making it hard to compare.

P7L26: '...and Filchner-Ronne ice shelves'. Upstream Pine Island, Getz and Totten ice shelves are also quite high? It's not easy to tell from Figure 2d.

P7L32: Using 'MeanAnt' same as Jourdain et al., 2019 instead of 'sub-shelf...dataset' will make it much easier to follow.

P8L27 & Figure 5: 'For both forcings,...' For NorESM1-M the ice-shelf thinning of Totten ice shelf is more pronounced?

P8L31: delete the second 'also'.

P8L33 & Figure 5: This is a very interesting figure which could compare to the Figure 6 of Seroussi et al., 2020. There the mean model result shows an important thinning as well as acceleration in Pine Island, Thwaites and Totten glacier, while the model result for these regions are all quite stable here. However, the explanation here ' This is likely due to the fact that our control experiment tends to produce an ice thickening in this region (Fig. 5b) which tends to stabilise this region, resulting in a smaller sensitivity' is insufficient. Why do you have a thickening trend in the control experiment and why it results in a smaller sensitivity to climate forcings? I noticed from the equations that GRISLI implement linear basal friction law. Brondex et al., 2019 claimed that the Pine Island glacier is sensitive to the sliding laws and an exponent of 8 is suggested for the region. As descriptions of models are listed in Seroussi et al., 2020, I hope the authors can have a more specific discussion.

P9L6: From Figue 6 and Figure 3,4, we can see UkESM1 has more total mass loss compare to NorESM1, and their surface and basal mass balance have similar trend, why NorESM1 has $\sim$20 mm sea level contribution and UkESM has negative contribution? Is it because of the spatial distribution of forcing?

P9L13: The first sentence can be removed.

P9L16: 'scenarios'

P9L16: 'The model that...' the colors for the three models are really similar.

P9L30: Again, the comparison with the ensemble model results could be interesting.

P11L17: 'NorESM1-M climate forcing'→'NorESM1-M climate forcing under RCP8.5'

P11L18: How does the decrease of surface velocity of ice shelves associated with ice thinning?

P11L31: From Figure 11b, the dynamic contribution in West Antarctica has strong spatial variabilities, e.g. thinning of Siple coast and thickening in Amundsen sea region.

P12L8: '...suggested in other studies' Could you give the numbers from these references?

P12L9: 'One reason for this disagreement...This methodology is thus not suited...' Why this type of initialisation cause the disagreement? And is this the only reason causing disagreements?

P12L19: Enhancement factor appears here for the first time. It should be defined in the methodology. And the author should explain why this parameter is interesting for a sensitivity test.

Figure 12: Explain in the caption or in the text what's the meaning of positive and negative percentages.

P13L8: '...when using the same forcing' I don't think the parameterisations in the open experiments are using the same forcing. At least for PICO, PICOP and Plume, ocean temperature and salinity are used instead of thermal forcing.

P13 section Conclusion: There is not much new information comparing

to the Seroussi et al., 2020 paper.