

## ***Interactive comment on “Adding a dynamical cryosphere into iLOVECLIM (version 1.0) – Part 1: Coupling with the GRISLI ice-sheet model” by D. M. Roche et al.***

**Anonymous Referee #2**

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This manuscript presents the coupling of the GRISLI ice sheet model with the atmospheric component of the iLOVECLIM model. This tool offers great potential for simulating past climates and ice sheets. Whilst the current manuscript is interesting, useful and well written (apart from a few sentences here and there), it requires a bit more precision in the description of the coupling (especially with regards to orography and ice extent), more results, and a comparison of the coupling procedure and results with other similar models in the literature (unless this will be done in a separate paper).

MAIN COMMENTS Methodology: -How are the ice sheet model parameters chosen ? Please indicate a reference for the calibration of the ice sheet model. What was the calibration target ? -p5225 section 3.4 l16 : The orography on the GRISLI grid is C2111

aggregated to the ECBilt grid considering the closest (in distance) ECBilt cell center.” What does aggregated mean here ? This section needs more detail for reproducibility. -How do changes in orography influence ECBilt ? -L17: You haven’t mentioned how you interpolate the ice mask onto the ECBilt grid, nor what the surface properties of ice surface are in ECBilt (eg albedo). Does the albedo change if the surface is snow covered ?

Offline ice sheet: One result missing from this paper is the effect of simulating the ice sheet with a two way coupling as opposed to a one way forcing. I think the authors should run the ice sheet model offline with the precipitation and temperature forcing of CTRL and compare this ice sheet with the ice sheet in SNOW. Also, how does the GRISLI ice sheet look when forced with temperature and precipitation from the climatology ? We need to see these results to understand the effect of the ice sheet model uncertainty/calibration and approximations on the ice elevation and extent.

Mass balance :What is the effect of the temperature and accumulation biases on the mass balance of the ice sheet. I would like to see a more in depth discussion of the ice sheet mass balance here. How much is the accumulation overpredicted by? How about the effect of the warm bias on melting ? How long is the melt season ? Context of this study: There isn’t any comparison of the results with similar studies. There has been other coupling between climate models and ice sheet models (eg Fyke et al) published in this same journal. Please compare the coupling procedure and results with other such studies.

More minor comments and suggestions: P 5216 Line 26 : I suggest replacing “climate model” by “Earth system model”. P 5217 l3: “Hence,…” this sentence is missing a verb P 5220 l3: “Ice stream regions are determined for the saturation of the sediment layer as described in Peyaud et al. (2007).” I don’t understand this sentence. P 5220 l 6 : can you give more context to the description of the calving procedure. Why do you use option (b) ? P5221 l1: the ice sheet model is described as isolated with respect to the CLIO model. What is the implication for the precipitation falling on the ice sheet.

Is it re-routed to the nearby oceans or does it accumulate on the ice sheet ? P522113: "at the opposite to" -> as opposed to P522115: "This is an important requirement to consistently use the model in climate different from the present" The use of "consistently" is a bit confusing in this context. Prefer "This is an important requirement to be able to use the model to simulate climates different from the present in a consistent manner" P5222 section 3.2: why does the interpolation involve 15 surrounding points, I can only count 8 in a square grid. Is this because of the spectral grid ? P5224 Can you provide a plot of the temperature gradient/lapse rate or some numbers so that we can put it in context of other modelling frameworks ? How does this compare to data ? P5225: see previous comments P5226 l1: rephrase "This enables to" P5226 l23: "Differences between the CTRL and the SNOW or PRECIP experiments are due to the inclusion of ice-sheet dynamics and its feedbacks." I disagree with this statement. The ice sheet in CTRL is not at equilibrium with the climate, or rather the climate is not compatible with this ice sheet. The difference in ice sheet size is what causes the differences in the climate. In this sentence is a bit misleading, especially since the difference in shape of the ice sheets is more to do with the surface mass balance here, rather than ice dynamics. P5227 l1 : Is the observed ice sheet plotted on the GRISLI grid in figure 6 ? Section 4.2. Please comment on which accumulation treatment is preferred (SNOW or PRECIP). The results shown wouldn't allow us to discriminate one, but the authors might have a preference or some insights to give here. 5228l19: Again I don't like the use of "dynamical" here. It's not representative of the difference between PRECIP and SNOW. P5229 l27: "iLOVECLIM do not exhibit large systematic biases when looking at the Greenland area" Some would say that 2degC and even 5degC error is a large bias! In general in the manuscript, try not to overstate the match with observations. 5230l14: triggers -> causes p5231 l 19: "Aspect" to what ? p5231 l25: What does this last sentence mean ?

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