

Review of Nowicki, Sophie M.J. and others (Geoscientific Model Development, gmd-2016-105)

The manuscript of Nowicki and others describes the foundation and reasoning of the Ice Sheet Model Inter-comparison Project (ISMIP6) and its relation to the coming CMIP6 exercise.

Under the frame of the Climate and Cryosphere (CliC) and World Climate Research Project (WCRP) model inter-comparisons have been and will be a tool to project the future evolution of the earth's climate system. The understanding of how massive land ice masses --- such as Antarctica and the Greenland ice sheet --- will melt under a changing climate and contribute to an already globally raising sea level is crucial in the context of climate adaptation and mitigation efforts. The manuscript clearly contrasts the difference between various model experiment setups and motivates the usage of these experiments. It also highlights the relationship to former and coming "traditional" CMIP experiments. The manuscript will certainly act as the reference for the described ISMIP6 exercise.

The manuscript is very well written, has a clear structure and all tables and figures are necessary and well prepared. It was a pleasure to review this manuscript. I hope that the manuscript could be published soon, because I will be extremely helpful to have this information for the involved groups as well as the wider CMIP6 audience.

I recommend the publication of the manuscript after few minor corrections.

Major Issues

None

Minor Issues

First I give general comments and afterwards specific comments.

General Comments

In the manuscript I prefer a consistent spelling of either "preindustrial" or "pre-industrial".

Since this manuscript will probably be a reference for the research groups participating, you may add a small table with the essential deadlines to the section 3.4 "Prioritization of experiments and timing". It could act like a "checkbox" table. Please share your thoughts about it.

In the tables A1, A2, and A3 or/and in the appendix A "Variable Request", I would like to see the definition of the flux direction (sign convention). Is ablation (ice loss) a positive or negative flux? Please clarify the text and add (also) please a short remark to the corresponding table captions.

Specific comments

In the following specific comments are made, where "P3L23" means line 23 on page 3, for instance.

P4L21: The term "offline", may not be known to a general audience. You may rephrase item ii): 'standalone dynamic ice sheet models (ISMs) that are driven by provided forcing fields ("offline").'

P4L26: I personally find the suddenly appearing “XXX” confusing. You may add the sub-clause: where XXX stands for different forcing scenarios as described later.

P5L16: In the bracket the term “fixed is vague. You may mean “reference ice sheet extent and topography”? If so, please specify a possible reference for illustration.

P5L27: You may add “pre-industrial” to obtain:” ... is meant to capture the pre-industrial quasi-equilibrium state of the climate system.”

P6L25: You state to use the same ice sheet initial condition, which comes from the coupled *XXX-withism* run, for the *XXX-withism* and the *ism-XXX-self* simulations. Since the geometry of the ice sheet could be quite different between the standard AOGCM and the coupled AOGCM-ISM in terms of ice sheet elevation, for instance, the starting conditions and climatic forcing of the standard AOGCM may not be consistent with the *XXX-withism* ice sheet. Hence the forced ice sheet may show a considerable drift and ultimately this drift overprints the actually wanted impact of the difference between coupled vs uncoupled simulations for simulations of about 150 years. Could be please be so kind and comment.

P7L8: I’m unsure if a ‘the’ is missing:” The choice of the ice sheet model,”

P7L14: You may add:” However, any correction... .”

P7L22-23: I’m skeptical about the implicit statement that internally computed surface mass balance (SMB) calculations are automatically mass and energy conserving while externally computed SMB are not. A wrong regridding from the probably coarse atmospheric grid to the finer ice sheet model grid could break the conservation (Fischer et al., 2014), regardless if the computation is performed inside or outside the AOGCM. I would like to suggest a more general phrasing such as:”... SMB is obtained from energy-based method that conserves mass and energy. It facilitates interpretation of the drivers of SMB variability and change”

P7L29: I guess I understand what is meant by a “realistic” state, but I would claim that this state is uncertain for the pre-industrial era and that an ice sheet state that is consistent with the driving AOGCM climate is more important. Hence you may agree in replacing “... to produce a realistic non-drifting coupled state” with “... to produce a consistent non-drifting coupled state”.

P7L29: As mentioned above, the pre-industrial state is likely different than the contemporary observed state. Hence you may add the following sub-clause:”... to the pre-industrial (1850) climate, which is different from the contemporary state (Kjeldsen et al., 2015).”

P10L29: I would like to suggest a slight clarification:” ... temperature changes using the relation of Rignot and Jacobs (2002) of $10 \text{ yr}^{-1} \text{ }^{\circ}\text{C}^{-1}$ for temperatures above the actual ocean’s freezing temperature.” Please use “ $^{\circ}\text{C}$ ” instead of “C”.

P11L11: For the first time initMIP is mentioned. Please either introduce it or mention where it is described below.

P11L12: I’m sorry, but I do not understand or could not find the referenced section provided in the bracket. Please clarify. In addition this information seems to disagree with the information in the bracket below (P11L22).

P11L23: In my humble opinion a 1% raising atmospheric CO₂ concentration has not a linear trend. Hence I suggest:” considers a 1%/year atmospheric CO₂ concentration rise until quadrupled concentration and stabilization thereafter.”

P11L27: Here you may add:” ... to pre-industrial conditions, which is probably weaker, constrained than the contemporary state.”

P11L31: Is the leading “to” needed?

P12L28: You may indicate that some groups have provided longer runs by stating:” ... each run for at least one hundred years.”

P13L8/9: I’m not sure but maybe a pronoun is missing:” ... geometric changes in these forward experiments.” Please check.

P14L31: I would like to suggest to add a more recent citation for the HIRHAM model: (Langen et al., 2015; Lucas-Picher et al., 2012)

P15L4: For the Greenland ice sheet a very valuable set of observations in the ablation zone comes from the PROMICE network. Therefore I suggest the following change:” ... known as the GC-Net (Steffen and Box, 2001), PROMICE network with a focus on the ablation zone (Ahlstrøm et al., 2008)“.

P15L28: In addition to the common glaciological estimates I would like to add the following:” ... can be compared with glaciological estimates of ice shelf melting around Antarctica (Rignot et al., 2013; Depoorter et al., 2013) as well as independent tracer-oceanographic estimates (Loose et al., 2009; Rodehacke et al., 2006).”

P17L27: You may highlight the coupled simulations in the conclusion by extending:” ... no dynamic ice sheets, coupled AOGCM-ISM, and standalone....”

P19L16: Some glaciologists may feel more welcome when instead ‘lost’ the common term ‘ablation’ is also used. What do you thing about:” ... and ablation to the ocean by either calving or melting.”

Tables

Here I refer to the table number

Table 2: Please correct the entry for the EC-Earth model. Here the Danish Meteorological Institute (DMI) in Denmark has expressed the interest in the name of the entire consortium.

Table A1, A2, A3: I believe the fractional quantities refer to the total ice covered area. Please clarify and mention it in the table caption.

Table A1, A2, A3: Please indicate in the table caption the sign convention of the fluxes, as already mentioned the general comments section above.

Table A2: Please clarify what is the base line of the “Global Average Thermosteric Sea Level Change”? Is it the beginning of each individual simulation or since the historical period started in 1850, for instance?

Figures

The figure numbers are given.

Figure A2: Since runoff leaves the snowpack, I would prefer that the arrow points beyond the snowpack.

References

- Ahlstrøm, A. P., Gravesen, P., Andersen, S. B., van As, D., Citterio, M., Fausto, R. S., Nielsen, S., Jepsen, H. F., Kristensen, S. S., Christensen, E. L., Stenseng, L., Forsberg, R., Hanson, S., Petersen, D. and Team, P. P.: A new programme for monitoring the mass loss of the Greenland ice sheet, Copenhagen, Denmark. [online] Available from: http://www.geus.dk/DK/publications/geol-survey-dk-gl-bull/15/Documents/nr15_p61-64.pdf, 2008.
- Fischer, R., Nowicki, S., Kelley, M. and Schmidt, G. A.: A system of conservative regridding for ice–atmosphere coupling in a General Circulation Model (GCM), *Geosci. Model Dev.*, 7(3), 883–907, doi:10.5194/gmd-7-883-2014, 2014.
- Kjeldsen, K. K., Korsgaard, N. J., Bjørk, A. A., Khan, S. A., Box, J. E., Funder, S., Larsen, N. K., Bamber, J. L., Colgan, W., van den Broeke, M., Siggaard-Andersen, M.-L., Nuth, C., Schomacker, A., Andresen, C. S., Willerslev, E. and Kjær, K. H.: Spatial and temporal distribution of mass loss from the Greenland Ice Sheet since AD 1900, *Nature*, 528(7582), 396–400, doi:10.1038/nature16183, 2015.
- Langen, P. L., Mottram, R. H., Christensen, J. H., Boberg, F., Rodehacke, C. B., Stendel, M., van As, D., Ahlstrøm, A. P., Mortensen, J., Rysgaard, S., Petersen, D., Svendsen, K. H., Aðalgeirsdóttir, G. and Cappelen, J.: Quantifying energy and mass fluxes controlling Godthåbsfjord freshwater input in a 5 km simulation (1991–2012), *J. Clim.*, 28(9), 3694–3713, doi:10.1175/JCLI-D-14-00271.1, 2015.
- Loose, B., Schlosser, P., Smethie, W. M. and Jacobs, S.: An optimized estimate of glacial melt from the Ross Ice Shelf using noble gases, stable isotopes, and CFC transient tracers, *J. Geophys. Res.*, 114(C8), C08007, doi:10.1029/2008JC005048, 2009.
- Lucas-Picher, P., Wulff-Nielsen, M., Christensen, J. H., Aðalgeirsdóttir, G., Mottram, R. and Simonsen, S. B.: Very high resolution regional climate model simulations over Greenland: Identifying added value, *J. Geophys. Res.*, 117(D02108), 16pp, doi:10.1029/2011JD016267, 2012.
- Rodehacke, C. B., Hellmer, H. H., Huhn, O. and Beckmann, A.: Ocean/ice shelf interaction in the southern Weddell Sea: results of a regional numerical helium/neon simulation, *Ocean Dyn.*, 57(1), 1–11, doi:10.1007/s10236-006-0073-2, 2006.