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The Cryosphere Discussions

Interactive comment on "Brief communication: Understanding solar geoengineering's potential to limit sea level rise requires attention from cryosphere experts" *by* Peter J. Irvine et al.

Anonymous Referee #2

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This article reviews the links between solar radiation management (SRM) and the dynamic and surface mass balance (SMB) of ice sheets. However, there is no effort to understand or even reduce the uncertainty on the ice sheet component under SRM, except to provide an action plan to do this. The focus of climate modelers is on making future scenario based projections of sea level rise with new coupled ice sheet components. There is a long way to go before we can attempt to understand paleo-simulations much less SRM. Since the influence of SRM on ice sheet dynamics is unexplored, I would suggest the paper focus on SMB and should ideally include an analysis, however brief, of the GeoMIP model simulations. The article is bloated in comparison to what can be concluded from the small number of relevant simulations. In addition I find

some of the assertions at odds with the references omitted from this review, and these are commented on below.

P1:L28. You are referencing 'Expert Judgements' here, which do not really quantify projection uncertainty. The uncertainty should be expressed from model projections as described in AR5 (Ch 13). This is relevant since the next sentence refers to two such projections. P1:L29. Remove 'both of which were published in Nature'. This is a judgement statement implying quality of the referenced research (although this is not the use here, the commonality in source of the papers is irrelevant)! P1:L29-30. State the period at which these estimates of sea level equivalent apply. 2100? P1:L32-35. Evidence required. AR5 (Ch 12 & 13) provides this as does Bouttes (2013) below. Bouttes, N., J.M. Gregory, and J.A. Lowe, 2013: The Reversibility of Sea Level Rise. J. Climate, 26, 2502–2513, https://doi.org/10.1175/JCLI-D-12-00285.1 P2:L1. Carbon removal (e.g. Jones CD et al, 2016, Environ. Res. Lett. 11, 095012). P2:L29. RF and GHG not previously defined P4:L2-3. This is not self evident. Kravitz et al (2013) suggest that a polar warming might occur with over-cooling in the tropics, when compared against the reference state (Preindustrial). Kravitz, B., et al. (2013), Climate model response from the Geoengineering Model Intercomparison Project (GeoMIP), J. Geophys. Res. Atmos., 118, 8320–8332, doi:10.1002/jgrd.50646. P4:L9-15. Simple models do not show Greenland ice sheet decline for the strong climate mitigation scenario RCP2.6 either. P5:L3. Precipitation is decreased except for over the ice sheets (see fig 7 in Kavitz et al., 2013). P5:17-10. This is definitely not true. Nearly all modern Earth System Models now have a dynamic Greenland ice sheet and a few have mountain glaciers, and they are always, of course, driven by the ESM coupled fluxes (e.g. Lipsomb et al., 2013) . ISMIP6 is NOT using PPD for its offline models. Lipscomb, W.H., J.G. Fyke, M. Vizcaíno, W.J. Sacks, J. Wolfe, M. Vertenstein, A. Craig, E. Kluzek, and D.M. Lawrence, 2013: Implementation and Initial Evaluation of the Glimmer Community Ice Sheet Model in the Community Earth System Model. J. Climate, 26, 7352–7371, https://doi.org/10.1175/JCLI-D-12-00557.1 P6:L34. Actually, the hydrological cycle under SRM is increased over ice sheets (Kravitz et al., 2013). P7:L13.

Need to briefly state what “marine ice sheet instability” actually is. E.g. Grounding-line retreat leads to larger ice mass flux through the grounding-line generating further retreat. P7:L17 More precision, perhaps “They suggest that the atmospheric warming that led to the break-up of some Antarctic Peninsula ice shelves would, if the warming continued, destabilize the larger southern ice shelves in the future (Liu et al., 2015). The process is through the hydrostatic head of melt-water filled crevasses which results in “hydrofracture” and the rapid disintegration of the ice shelf.” Though actually it is the Ice Cliff Instability (ICI) that is the killer in DeConto and Pollard but the ice shelves need to go first and in any case SRM will never stop ICI. Stick to the key point from this paper is that air temperatures are perhaps important for ice sheet collapse and these can easily be reversed. You are spending too much time on in DeConto and Pollard given the uncertainty they themselves express in the paper. You can be much briefer here. P8:L3-9. This whole discussion belongs back at the first paragraph of this section. Putting it here leads to a disjointed argument and repetition. Getting circumpolar water up on to the shelves depends on the Ekman pumping which is a function of the circumpolar winds. If the winds shift because of SRM or associated ozone depletion then the basal melt will be different. I have not seen any study of changes in the southern ocean winds under SRM. Intermediate waters are not going to cool significantly on the timescale SRM might be deployed. P9:L25. Bouttes et al., 2013 is relevant to this discussion. P10:L15-30. A few coupled global climate models are now including an interactive Antarctic and Greenland ice sheet components. Such models would enable a more complete understanding of the impact of SRM on ice sheets, than the doggy offline components.

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