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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Ice melt, sea level rise and superstorms: evidence from paleoclimate data, climate modeling, and modern observations that 2 °C global warming is highly dangerous" *by* J. Hansen et al.

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Much of the later modelling work in this paper is very welcome, and fills a large void in the literature. However, the analogy of timescale of a future WAIS collapse needs questioning. Section 2.1 has ignored a substantial amount of recent literature on Eemian sea level, which needs to be at least discussed, rather than the comments on how "unlikely" the scenarios described is.

I could go in to how Glacial Isostatic Adjustment (GIA) modelling could mean that global

sea level during the Eemian could be entirely below present (Lambeck et al., EPSL, 2012), but I don't think anyone is convinced of that. Maybe more worth talking about how global sea level is supposed to be around 6m because of a data consensus, where less popular data can be ignored (e.g. Murray Wallace et al., JGSL, 2001), but again, too unlikely to be worth discussing here...

More to the point, Eemian temperature data shows a clear lead in the Antarctic records (Capron et al., QSR, 2014). While this will not translate directly to sea level contribution, probabilistic GIA modelling has hinted that the sea level shows the same Antarctic lead (Kopp et al., Nature, 2001), although they are not a very confident analysis. A large ensemble of GIA modelling may determine this more definitively.

Ice sheet near field evidence must be included in such a discussion. The maximum Greenland contribution was late Eemian, as shown by multiple modelling studies (e.g. Stone et al., Clim. Past, 2013), and ice core gas content elevation proxy data (NEEM community members, Nature, 2013). Given the timing of both Greenland temperature and ice sheet response, it is most plausible that the second peak in sea level data was sourced from Greenland.

Antarctic ice sheet has no direct evidence which could determine the timing of a West Antarctic ice sheet (WAIS) collapse. Indeed, no near field evidence of such a collapse has been found- no evidence from the Ross Sea (review in IPCC AR5, chapter 5) or Amundsen Sea embayment (Hillenbrand et al., 2002) has determined a retreat which is definitely dated in the Eemian. Drilling into the marine-based WAIS has not reached the base in a location without basal melt to be able to determine Eemian ice existence (Byrd and WAIS divide ice cores). Two areas of Eemian blue ice are known to be located in Marie Byrd land, and survived the Eemian- Mt. Waesche, at low elevation, close to the proposed region of collapse (Dunbar et al., ISAES abstract, 2007), and Mt. Moulton, where model-data comparison cannot determine a collapse, but was definitely not a rapid one (Stieg et al., 2015). Thus, there remains no evidence for Eemian WAIS collapse.

It is frequently assumed that WAIS collapse can happen rapidly, if started from present boundary conditions. We need to consider if this assumption of modern boundary conditions is valid. Early Holocene climatic forcing caused a small retreat of the Amundsen Sea Embayment, but not a WAIS collapse (Johnson et al., Science, 2014). Similar conditions may have occurred in the Eemian.

Ice sheet modelling is still under rapid development, and so while it could theoretically permit rapid collapse, there is a lack of consensus that this could have occurred. It is possible that minor perturbations in climate pushed the WAIS over a tipping point into a mode of collapse, but given the multiple lines of evidence listed above, all suggesting that this did not occur in the late Eemian, if at all, then such a collapse should not be considered. Using the Eemian as an analogy for future collapse, based on a very one sided argument on limited sea level data (I won't go into the problems with the papers referenced in the study, see other review comments) will not suffice, and requires a full discussion of all the papers discussed above.

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