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Discussions

Interactive comment on "Rapid and reliable assessment of methane impacts on climate" *by* Ilissa B. Ocko et al.

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I agree with the authors about the value of simple analytical tools for quantifying the physical impact of individual greenhouse gas mitigation options, and see this paper as a good contribution to the literature of evaluating how these simple tools might compare to more complex ones. I have a couple of comments for the authors' consideration.

1) MAGICC is, of course, one of the most widely used tools for this purpose, and therefore a reasonable choice. However, it might be worthwhile for the authors to discuss a couple of alternatives.

a. Hector is in a similar class of model as MAGICC, but has the advantage of being fully open-source (see comment on 11-21 from Referee 1). Hector

is described in Hartin et al. 2014, https://core.ac.uk/download/pdf/25503085.pdf. Also relevant is a thesis by Schwarber on comparing Hector and MAGICC at https://www.atmos.umd.edu/theses_archive/2016/aschwarber_masters.pdf. I am not suggesting running Hector for this paper, as that would be a large lift, but a citation and brief mention of the benefits of open source could be worthwhile.

b. Meanwhile, there are approaches that are even simpler than MAGICC. Melvin et al. (2016), for example, estimated the physical impacts resulting from methane mitigation by using the simplified expressions from AR5 for concentration and radiative forcing and from Shine et al. (2005) for temperature. It could be a valuable sensitivity analysis to take one of these simplified approaches as an additional comparison. These simplified equations may be better suited to analyzing the marginal effect of perturbations in emissions, rather than to simulate overall global temperature change from total anthropogenic emissions: however, it seems to me that this kind of marginal analysis is consistent with the goals of this paper.

c. The NAS in their report on valuing climate damages (https://www.nap.edu/catalog/24651/valuing-climate-damages-updating-estimation-of-the-social-cost-of) suggest the use of the FAIR model: this would fall between Hector/MAGICC and the GTP-style equations in terms of complexity.

2) As with Referee 1, I find it surprising that the AM3 forcing results only diverge in the last couple decades in contrast with MAGICC which shows a slowly growing divergence over the entire run. Would there be any effect of running AM3 with different initial conditions, which could show whether this is a robust result or a result deriving from internal variability? The only other explanation that comes to mind other than initial condition sensitivity is that somehow CO2 and CH4 forcing have differential sensitivity to SSTs or sea-ice extent. Maybe a constant-concentration experiment could be informative in terms of whether the forcing of methane and CO2 might respond differently to the historical changes of SST & sea-ice?

3) I do find this comparison of more complex models to simple models to be an informative exercise (see Sarofim 2012 where I used both the MIT IGSM and MAGICC to calculate the 100-year sustained GTP for methane: https://link.springer.com/content/pdf/10.1007%2Fs10666-011-9287-x.pdf). But, as Referee 1 notes, this comparison is complicated by the variability inherent in more complex models, even as at the same time, this is one of the motivators behind the use of simple models for investigating the effect of emissions perturbations that are expected to have temperature effects smaller than the internal variability of the complex models. I don't have a good answer for this, other than averaging even larger ensembles in order to reduce initial-condition-based noise even more.

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