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**Biogeosciences Discussions**

# *Interactive comment on* "Impact of an extremely large magnitude volcanic eruption on the global climate and carbon cycle estimated from ensemble Earth System Model simulations" *by* J. Segschneider et al.

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Review of Impact of an extremely large magnitude volcanic eruption on the global climate and carbon cycle estimated from ensemble Earth System Model simulations by J. Segschneider et al.

This is a clear and well written manuscript which deals with simulations designed to explore the climate/carbon-cycle response to a large (100x Pinatubo) volcanic eruption. It is becoming more commonn to assess such ESMs using forcing events such as



volcanic eruptions and compare with observed real-world response, but it is still novel to look at the impact of much larger eruptions.

As there are no observations of the carbon cycle response to an eruption this large the study can't be used as model evaluation, but rather it is an interesting look at the mechanisms within the model. The study uncovers the interesting result that the carbon response to a larger eruption is more complex than a simple scaling due to the larger climate response. I think it would be nice to try to explore this further and extend the paper beyond just these simulations but also to compare them more directly with results from smaller eruptions (which I believe have also been run with this model - as in Brovkin et al). The dependence and relative strength of GPP on changes in light and climate, and of respiration to cooling differ and so the net carbon effect varies in sign and magnitude both in time and for different eruption strengths.

for example what about a summary figure looking at the respiration and GPP response, and net carbon response, to different volcanic eruption strengths? see attached a very simple schematic. You could make this at various process-levels such as respiration vs GPP, soil vs veg, tropics vs extra-tropics. I've only put here land in the schematic, but you could clearly add ocean too...

This addition isn't vital, and I would recommend publication pending a few minor comments below. But I hope the authors consider it, as this non-linearity in the net response would make the paper more interesting I think.

Chris Jones

- p.8700, lines 15-20. You mention diffuse light later, but could discuss it here as a potentially large driver of post-volcanic response. Angert et al and Mercado et al are both relevant references. Also include on figure 1?

- p.8710. line 3. you say the land flux doesn't depend directly on the atmos CO2 conc. This is not strictly true - you could say that it doesn't depend "as strongly as the ocean".

- p.8710, line 12. Units of NPP here should be GtC PER YEAR.

- p.8713. discussion on strength of climate-carbon cycle feedback. In the linear C4MIP framework the size of perturbation shouldn't matter, the feedback gain would be the same and simply provides a scaling for the response. e.g. for a gain, "g" of 0.2, one gets a feedback factor of 1/(1-g)=1.25. So the signal should be scaled by +25% compared with a simulation without the feedback. So I don't understand why you get a much smaller response (you claim a delta T of only 1% due to carbon cycle feedback). Is your carbon cycle sensitivity smaller for small perturbations? or is this a feature of the timescale of the perturbation? what is the MPI-ESM gain?

- p.8713. can you define "tephra" for the non-volcano experts

- figure 8. When discussing reversibility of the carbon cycle state and that this lags the SAT response, it might be illustrative to plot the carbon pools against SAT itself. A completely reversible signal would simply follow the same path down and up, whereas the lags in the system would show up as a loop on this figure (not strictly a hysteresis, but looking similar).

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Interactive comment on Biogeosciences Discuss., 9, 8693, 2012.



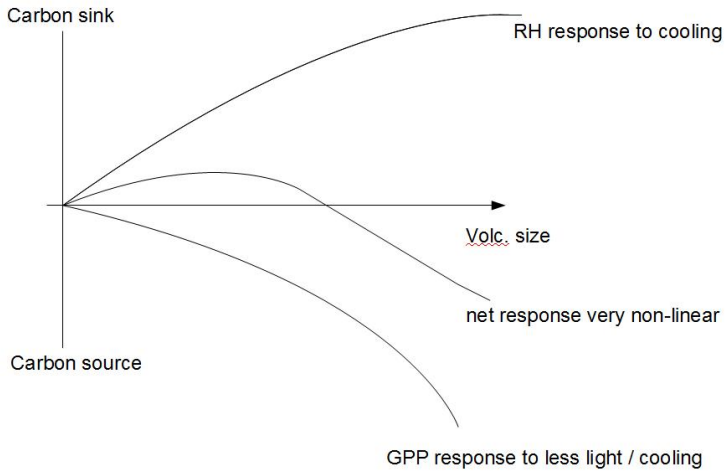


**Fig. 1.**