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Interactive Comment

Interactive comment on "Role of volcanic forcing on future global carbon cycle" *by* J. F. Tjiputra and O. H. Otterå

Anonymous Referee #2

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Review – Tjiputra and Ottera – "Role of volcanic forcing on future global carbon cycle"

In this manuscript, Tjiputra and Ottera use a fully coupled global climate-carbon cycle model to assess the role of volcanic eruptions on 21st century climate-carbon cycle feedbacks. They present three 100-yr long simulations from 2000-to-2100, in which the model is forced by IPCC-A2 carbon emissions and variable (frequency, amplitude) external volcanic forcings. They show that frequent (every 5-yr) Pinatubo-type eruptions could lower atmospheric CO2 by almost 50 ppm in 2100 and attribute this reduction to increased land carbon uptake due to the eruptions-induced cooling. They conclude on the potential of sulphur-injection geoengineering method to offset anthropogenic increase in atmospheric CO2.

The manuscript is clearly written. The experiments are well presented and the results are correctly discussed. I am however a bit uncomfortable with the manuscript in its present form. If the main focus is to understand the role of volcanic forcing on the global carbon cycle, then I find the experimental design and the analysis performed a bit too short and too simplistic. If the main focus is to address the potential of sulphur-injection geoengineering scheme to decrease atmospheric CO2, then the scope of the paper has to be changed. In its present form, I don't recommend publication. Here are a few suggestions that I hope could improve the manuscript.

1). Experimental design:

Only 2 sensitivity experiments are presented here: one with frequent (5-yr) and relatively weak eruptions, another one with less frequent (25-yr) and large eruptions. This set-up makes it difficult to conclude on the role of frequency vs amplitude of volcanic eruptions on the carbon cycle. An additional simulation at least, with weak and unfrequent eruptions for example could help in that matter.

2). Model comparison: Some recent modelling studies (Jones and Cox, 2001, Brovkin et al. 2010, Frolicher et al. 2011) have discussed the role of volcanic eruptions on the global carbon cycle. These studies have indentified the land component as the main driver of atmospheric pCO2 changes but propose different mechanisms by which the land component drives a decrease in atmospheric CO2 (tropics vs high lat., respiration vs. photsynthesis). Tjiputra discuss most of these publications in light of their model results, but we are left with no clear hypothesis on why the models differ. In the summary section, Tjiputra and Ottera suggest that increased carbon uptake in the Northern Hemisphere (opposite result to Brovkin and Jones and Cox) is probably due to the additional CO2 fertilisation effect in their simulation. An additional simple & short sensitivity simulation mimicking the Pinatubo eruption would help in that matter.

3). Ocean carbon cycle. I am not convinced by the discussion on the ocean carbon component. Tjiputra and Ottera explain the weak differences between the simulations for the ocean carbon uptake by the balance between : (1) increased CO2 solubility

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due to sea-surface cooling and (2) decreased atmospheric CO2 because of increased land carbon uptake. These effects have been identified for some time now in coupled carbon-climatge simulations (see Cox et al. 200 for example). But Tjiputra and Ottera then mention another effect due to the impact of the induced cooling on inorganic carbon chemistry. It is not very clear how these additional effects come into play and even if they play a significant role here. I would reformulate this section and try to be much more quantitative.

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