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Biogeosciences Discussions

Interactive comment on "Desert dust and anthropogenic aerosol interactions in the Community Climate System Model coupled-carbon-climate model" *by* N. Mahowald et al.

Anonymous Referee #2

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General comments

This study addresses the impact of changing dust and anthropogenic aerosols on the climate-carbon retroactions in the 21st century. The authors make use of simulations with a coupled carbon cycle – climate model in which the dust cycle is fully interactive. The main result is that the inclusion of aerosols does not impact significantly the global average carbon cycle and the magnitude of the carbon-climate feedback. The authors attribute this weak response to the weak carbon- climate feedback of the model used. They show however significant responses of the ocean biogeochemistry to dust

deposition changes.

This is, to my knowledge, the first study in which both the dust cycle and the carbon cycle are fully included in a coupled climate model. The results are interesting but would benefit from a more careful and detailed description and analysis. I detail hereafter a few major and specific comments.

1. On the main conclusion. The authors conclude that "changes in desert dust significantly impact productivity and the nitrogen cycle, and are as important or more important as changes in CO2 and the resulting climate changes." This is fairly strong, but should be put into the context of the simulations that have been realized. In the "dust case", where dust cycle is fully interactive, the changes to productivity due to dust are fairly small. It is only in the sensitivity experiments (dust *2, and dust*0.5) that dust impact seems to overcome, in some regions, the direct impact of climate change. This conclusion has to be changed (although in the abstract).

2. On the review of literature. The manuscript clearly lacks references to key publications for some of the points that are developed. On the inclusion of aerosols in coupled carbon cycle models, Cadule et al. (2009, GRL) also analyse coupled climate-carbon cycle simulations with and without aerosols and compare their results to Jones et al. (2003). On the impact of changes in dust on marine biogeochemistry, many mechanisms that are present in these simulations have already been discussed elsewhere, and in more details (Parekh et al. 2006 GRL, Tagliabue et al. 2008 BG). The authors need to put their results into that context.

3. On the analysis. I have to admit that I have been a little frustrated at the reading of the manuscript. Some of the more interesting and new results are not detailed enough: for instance, what is the relative contribution of dust-induced climate changes and dust-direct iron deposition changes on marine biogeochemistry? This is new and could have been more detailed.

More specific comments.

BGD

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P6620 Line10 : “much reduced terrestrial carbon uptake, and a reduced climate feedback onto carbon” . . . All the models results that are listed here do not show reduced feedback when the land N-cycle is taken into account, but even may show accelerated warming (for instance Zaehle et al. GRL 2010).

P6620 Line 18 : “Sulfate and volcanic aerosols have been impletement in one coupled carbon cycle model. . . (Jones et al. 2003)”. Please check Cadule et al. 2009 GRL, where a comparison to Jones et al. 2003 is already presented.

P6622 Line 8 : “the model includes N-colimitation of plant growth”. Change to N-limitation of plant growth.

P6625 Desert dust experiments: It is not clear from one of previous paragraphs if the ocean biogeochemical model used in these experiments is different or not from the one used in the BASECASE scenario. Is sediment iron input taken into account in all simulations? If this is not the case, explain how it would interact / interfere with the results presented here.

P6626 Simple feedback analysis. I’m not convinced that all the equations have to be repeated here.

P6631. Impact of dust changes onto N-fixation / Denitrification. Please compare to previous results (Parekh et al., Tagliabue et al., . . .).

P6631. “Thus for productivity changes, including aerosols is more important than simulating increasing CO2”. This not clear and is contradicted by previous sentences.

P6631. Direct Effect of rising CO2. Please cite Oschlies 2009, in which it seems to be first-order effect.

P6637. Aerosols feeback onto the ocean. Could you be clearer on the physical mechanisms?

Interactive comment on Biogeosciences Discuss., 7, 6617, 2010.