

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 #1

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General Comments

While the study addresses an important issue, namely the inclusion of interactive desert dust in a coupled climate-carbon cycle model including iron fertilization, the resulting change in dust mobilization and iron deposition in a climate change scenario is fairly small. The authors then artificially increase the variability of the dust module performing a 2x dust and a 0.5x dust experiment to increase the response of the climate system and the carbon cycle. Much of their conclusions then are based on these experiments rather than the interactive dust experiment. The additional sets of

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experiments (NONEQ, TRAJ, AEROSOL) I find more confusing than illuminating, and generally they decrease the readability of the figures.

The ms. could benefit from more careful phrasing and a better guidance through the figures - often it is more or less left to the reader to decipher the details of the - often too small - figures.

The figures must be improved with regard to readability and contents of the captions. In the state they are, it is difficult to evaluate the ms.

Specific Comments

p. 6620 | 28 No, see Stier et al., Atmos. Chem. Phys., 6, 3059-3076, 2006. (in particular sec 2.2). But you are the first to use dynamical vegetation and N-limitation in this context.

p 6621 | 12 'The estimates range from changes of +/- 60% ...'? do the estimates range from -60% to +60%? rephrase.

p 6622 | 15 'iron deposition in dust' 'from' dust? deposition of iron in dust?

p 6623 | 25ff The description of the model experiments is quite confusing: First it is stated that these are grouped into three types, then 'cases' are introduced, but case is simultaneously used for groups of experiments (like 'BASE') and individual experiments ('case names' in Tab.1) and control vs. transient (p 6624 | 10/11). It would be helpful to add the case names (BASE, NONEQ, etc) after the section headings 2.2.1 to 2.2.4

p 6624 | 25 correct 'land, atmosphere and atmosphere...'

p 6625 | 19 a uniform global mean CO₂ 'distribution' → value

which is set to the same as the BASE1 simulation →

which is taken from the BASE1 simulation?

p 6628 | 15 if you add 'with units of ppm/AOD' after 'carbon dioxide', it becomes clearer

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why the epsilon is within the paranthesis in eq. 8.

p6629 | 15 net uptake of 'anthropogenic' CO2?

l 22/23 clarify this sentence ('response of the CCCM to the sensitivity studies and aerosols included in the different cases' is unclear)

p 6630 | l2 make clear that 'This' refers to the model trajectory of (atmospheric) CO2 on p6629 | 24 (and not to the surface temperature from the previous sentence)

l 27 | I presume the ref to Fig2. refers to the sentence starting at line 25, not to the cooling of the atmosphere. (But 2x Dust is not shown in Fig. 2, so maybe the ref to Fig.2 just should not be there.

p 6631 | 9 'Denitrification tends to decrease in the future due to climate change,....' If oxygen is depleted in a warmer, less well mixed ocean I would expect denitrification to increase, unless there is a significant decrease in export production. Can you give a reference for your statement?

l 13 | If adding interactive dust results in an increase in dust deposition (that would likely be the yellow line in Fig 3b, but it is impossible to see if that's above or below zero, or the yellow bar in Fig4a, slightly positive) then I do not understand why an increase in N-fixation would cause a stronger decrease in marine productivity than without dust. Likewise I do not understand how you derive the sentence starting at line 15 (Thus, for nitrogen fixation and productivity changes including aerosols is more important than simulating increasing CO2)

l 21 | 'The temporal evolution of ... illustrate(s) that these increase at first with higher dust deposition, but then productivity starts going down (Fig.5)' - from fig 5, productivity reaches its peak around 1900, when the dust source factor of the 2x DUST experiment is only around 1.17. I have difficulties to see a dust-triggered signal here, it looks more like random variability. Also, the control experiments seem to have a similar temporal behaviour as the transient experiments - so what are we looking at?(again, the figure

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is barely readable)

p 6632 | 13 Does 'aerosol cases' here mean DUST and AEROSOL experiments? Or only the DUST experiment?

l 28 | Fig. 7a shows the radiative forcing of non CO2 GHGases, not the climate sensitivity discussed in the preceding sentence

p 6634 | 6 In this para it is only mentioned that 'there are' statistically significant changes in predictions of the surface temperature, without any hint on the significance criteria or the size of the change. This should be added or the para dropped (and Fig. 8)

l 10 | As for para above and Fig. 9

l 14 | The sentences starting here are unclear (and hard to relate to the again too small figure 10). what you show is flux at the end of the run minus flux at the beginning of the run. Does a negative value here mean that the flux is reduced or increased? It also seems that also much of the high latitudes are 'blue', i.e., like in the tropics.

l 22 | What is the ref to Moore et al., 2006 implying here? Aren't the 2xDUST and 0.5xDUST experiments made for this study?

p 6635 | 20 '...shows a similar to the BASE case...' makes no sense

p 6636 | 27 '...the model predicts a large increase in precipitation, precipitation minus evaporation, and a' but Fig. 14b shows a decrease of P-E, please clarify

p 6637 | 5 the source strength is not responding ... (not are)

l 24 | what is meant by (similar to what was seen in Fig. 8)? Fig 8 shows SST

p 6638 | 1 | I cannot follow the reasoning here. if 2xDUST and 0.5xDUST are compared (a factor of 4, not 2) Fig.14d implies that the dust mobilization in South America is little changed in 2xDUST relative to PI (~20%), but strongly changed for 0.5xDUST(~-

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70%). Deposition in SA +10% and -60%, respectively (Fig.14e). Surely not constant dust? Then, what do the relatively small changes in Chl in Fig. 15d imply? Did you mean to compare 2xDUST and PI?

I 12 correct sentence ...have a slightly lower the mixed layer depth...

I 15 Regions that are thought to be iron limited have an increase in productivity...

I 17 Some regions that are thought to be iron limited show less decline with....

Maybe change I15 to 'Some' regions in productivity 'even if dust deposition is reduced (red line in Fig. 16. f-h) while some of those regions show a decline (e.g., Fig. 16c) which is reduced with higher dust input. [this seems to imply that other reasons than dust input trigger the changes - check I 24/25]

I 24 'changes in ocean productivity which are as large as changes in climate' makes no sense

p 6640 I 5 'The sensitivity studies conducted in this model' make no sense

I 9 carbon 'cycle'? 'budget'?

I 11 see ref to Stier et al above

I 17 correct 'has a slightly negatively sensitive to climate'

p 6641 I 7 Inclusion of realistic desert dust does significantly impact....

if one compares the black and yellow bars in Fig4, the delta is smaller than the black bars, so I have difficulties to see

I11 why 'changes in desert dust are as important or more important as changes in (atmospheric) carbon dioxide'

p 6649 Tab.1 the use of 'case' is confusing

p 6652 Fig.1 (b) is missing in caption, labels too small, cases -> experiments

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p 6653 Fig.2 minus sign is missing for -10, -15, change e.g. to i.e.

p 6654 Fig.3 figure and labels too small, Fig. not readable

p 6656 Fig.5 labels too small

p 6657 Fig.6 labels too small, units missing

p 6658 Fig.7 labels too small, (c) missing in caption

p 6659 Fig.8 base in capitals helpful, 95% 'level', labels on color bar have funny values (also other figs.)

p 6661 Fig10 does <0 mean reduced or increased uptake?

p 6662 Fig11 95% 'level', Notice that cases(!) (b),(c),(e), and (f) -> note that panels (b-d) show differences.... (also Fig A5) units?

p 6663 Fig12 perhaps add pos= release of stress, neg= increasing stress

p 6664 Fig13 change colors to colored lines

p 6665 Fig14 figure and labels too small, caption not consistent with figure (a,b) vs. a-e

p 6667 Fig16 Fig and labels too small, regions as in Fig 14e, note different scaling for different panels

p 6668 Fig17 from the simulations presented here (colored and solid black line) or simply 'solid lines'mean: dashed black, various models: dotted black (I think this should read)

p 6669 Fig A1 labels much too small

p 6671 Fig A3 correct caption to 1980-1999, base->BASE, 95% level,

DUST2080-2099 -> DUST2030-2049

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BASE2080-2099 -> BASE2030-2049

p 6673 Fig A5 check 'first 20 years' against 1870-1899 (30 years)

Technical errors

spell greenhouse gases consistently (greenhouse, green house both used)

p 6620 l 5 & l 23 correct to: Friedlingstein et al

p 6627 l 16 Friedlingstein et al. (2006) show(s) [delete s]

p 6629 l 21 correct to: Globally averaged response

p 6630 l 7 simulation ...BASE1 has (just one)

p 6634 l 7 change 'of' regional

l22 show(s) (add s, the comparison shows)

p 6635 l 12 base -> BASE

l 24 Fig. 8 -> Fig. 9

p 6650 Tab. 1 , DUST experiments, aerosols pre(s)cribed [add s]

p 6670 Fig A2 correct 'base- don'

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