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Earth System Dynamics
Discussions

Interactive comment on "The impact of land cover generated by a dynamic vegetation model on climate over East Asia in present and possible future climate" *by* M.-H. Cho et al.

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We appreciate the comment for this manuscript. The comments of the reviewer and the corresponding corrections are listed.

The authors test the sensitivity of the climate dynamics in East Asia to different land cover datasets, including one dataset derived from DGVM, and to the modified dust loadings resulting from the different land cover. They base the experiment and the analysis on a previous study that had a Southeast Asia focus. Results show substantial regional differences in energy fluxes, surface temperature and precipitation when the different land cover datasets are used, in large part due to a major difference in bare soil

fraction over northern China. This study is a great example of how a basic issue in ESM model predictions can be compounded, or even compensated for, by the response in other model processes. Future precipitation in some areas also appears to be sensitive to the land cover although regionally averaged surface temperatures were insensitive to the future changes examined. Changes in dust loading have even larger impacts on the lower-level wind patterns than the land cover changes (present day). These are interesting questions to address and I have several major comments and suggestions for how the paper could be improved.

Major comments:

1. I think in this case it is important to be very specific about how this study is different from ML12 since the same datasets are being used and it was unclear whether any additional modeling was done for this study. It is noted of course (pg 1322, L19) that this is an extension of ML12 to East Asia, but it would be helpful to include additional references in ML12 in Section 2 to remind the reader where the model setup and results are coming from. For example, Pg 1323, L16 you could change "The experiment configuration..." to "The experiment configuration from ML12...". Also, somewhere in this section it could be mentioned that while ML12 apply certain specific methods to southeast Asia, we apply them in the same way (or in a different way if that is the case) to East Asia.

Answer: The current study uses the same experiments as ML12 and there is no additional new modeling. Much of the analysis methodology is also in common, although some additional fields are analyzed, such as surface fluxes and roughness length, for the particular investigation in the East Asian region. The close connection between our study and ML12 has been mentioned more explicitly in section 2.

To clarify the methodology of this study, we have changed line 98-101 on page 4 and line 112 on page 5.

2. The authors mention a couple times, citing ML12, that the increase in bare soil

over northern China is unrealistic or excessive, a result of the precipitation bias in the particular model used to generate the land cover. In fact, if my understanding of the use of "fractions" in Fig. 4c,f is correct, then a huge area in northern China that was >50% grass becomes >60% bare ground. This is indeed a major change and it is likely that the dust response would be large. However, given the unlikeliness of the DGVM land cover, it is also unlikely that this study could hope to show realistic responses in dust emissions, loading, and impacts. It is, therefore, more useful as a sensitivity study showing what would happen if these major land cover changes were ever to take place, or how the differences in model land cover could lead to different model climates. The authors do a nice job of stressing that this is the purpose of the study, even in the abstract, but to place this study into context better some discussion could be added about whether the dust response would still be important for more subtle land cover changes, or land cover changes in general that do not include huge increases in bare soil cover. I think this is a way of saying "do the authors have a sense for how specific these results are to these two land cover datasets and this one particular region of precipitation bias in the GCM?"

Answer: We agree that our analysis, and that of ML12, serves more as a sensitivity study of the impact of model biases on the model representation of present-day climate and on projections of future climate change, than as a study of the impacts of possible realistic land cover changes and, as the reviewer mentions, we have been careful to point this out in this paper. Experiments with more subtle or realistic possible land cover changes have not been carried out for this region with this model, and those using other models (such as Lee et al. (2011) cited in the paper) have not examined the feedbacks on dust. Therefore, while we do think that many of these results may be specific to the combination of processes and biases in this GCM, we are unable to speculate on the relative importance of the dust feedback effects under more subtle or realistic possible land cover change scenarios. In response to the reviewer's concern, we have emphasized the need for further studies to address this question. We have made changes in the last paragraph to make this more explicit in line 395-409 on page

15.

3. Since the impacts of dust are a main part of this study and also seem to play a major role in the climate response to the land cover changes, it would be helpful to include more details in Section 2 about how the model treats these processes. Specific questions: How are dust emissions modeled and how dependent is this on the bare soil fraction? It appears that dust are radiatively active in the LW and SW but this is not explicitly stated in the methods section. Is dust microphysically active? Does the model represent the semi-direct effect on clouds from atmospheric heating from increased dust? If the answer to either of the last two questions is yes then more discussion of how these dust effects might impact the climate response would probably be needed. Further simulations would be required to really isolate these effects, dust vs. no-dust simulations, probably beyond the scope of this study. In any case it should be explicitly stated in the methods section what effects are included in the phrase "dust radiative effects" and something should be said about how the results might change if excluded radiative or microphysical effects were considered.

Answer: Dust is only emitted from the bare soil fraction of a grid-box, and therefore is sensitive to changes to this fraction when the DGVM is used. We have tried to clarify this in section 2. Dust affects both shortwave and longwave radiative fluxes. The semi-direct effect is included implicitly with absorption by the dust feeding back onto the atmospheric heating profiles and subsequently cloud distributions, but the dust is not microphysically active, so the experiments where the radiative effects are switched off effectively reduce the dust to a passive tracer. We have described this in section 2 in line 157-161 on page 6.

Minor comments:

Pg 1322, L13-14: I had trouble understanding this sentence and I am not sure my suggestion will carry the original intended meaning, but I would suggest something along these lines: "ML12 investigated the impacts on climate of land cover changes

and associated dust effects that resulted from model systematic biases."

Answer: We agree and have taken the reviewer's suggestion. We have changed it line 78-79 on page 3.

Pg 1323, L2: I suggest changing "performed" to "produced"

Answer: We agree and have corrected it in line 100 to page 4.

Pg 1324, L1-10: Please provide references for the greenhouse gas forcing and future land use datasets.

Answer: We have already provided the references for future land use dataset in line 141 of page 6, and the references for the CMIP5 forcing datasets is Taylor et al (2012) as on page 5 line 126 - the latter has been added to the first paragraph of page 5 to clarify that this also includes the RCP8.5 scenario.

Pg 1324, L11-13: In this sentence I would suggest making it clear that the only difference between the simulation sets is the land cover.

Answer: Agreed and added. Line 135-137 of page 5.

Pg 1325, L10: Thank you for providing a table, this makes it much easier to navigate the shorthand.

Pg 1325, L19: I recommend changing "typical" to "climatological"

Answer: Agreed and corrected in line 179 on page 7.

Pg 1327, L1-3: See major comment #3: it is not clear exactly how the dust is impacting the rainfall, whether through semi-direct effects, or through a sfc temperature response?

Answer: As in our response to comment #3, the dust can only affect the rainfall through the direct radiative response. The effects of the increased dust loading on the clear-sky radiative fluxes was shown in ML12 (their Fig. 7) and the effects on daytime (cooling)

and nighttime (warming) temperatures was mentioned. Further reference to the discussion in ML12 has been made in the current paper on page 8 in line 213-218.

Pg 1327, L7-10: This sentence was difficult to understand, I recommend something like "This suggests that precipitation over East Asia is more sensitive to the radiative effects of dust associated with land cover changes than to the land cover change alone."

Answer: Agreed and the reviewer's suggestion taken up.

Pg 1328, L13: Change "soil" to "bare soil"

Answer: Agreed and corrected in line 250 on page 10.

Pg 1328, L22-23: I suggest changing "are represented by" to "lead to"

Answer: Agreed and corrected in line 265 on page 10.

Pg 1330, L12: Referring to some of the CMIP5 models as "good" might be too subjective a description. Rather, refer to the models used in the cited paper as a "subset of CMIP5 models". Also in this sentence, there are several references for CMIP5 predictions of precipitation change under RCP8.5 (IPCC AR5 for example) that would make a better comparison here than RCP6.0. I suggest replacing this citation with a reference to precipitation changes in RCP8.5.

Answer: The description "good CMIP5 models" comes from the paper of Seo et al. (2013) and is based on their measure of skill for precipitation simulation. We agree that, without qualification, the use of the word "good" is unhelpful.

Figure 1 caption: Assuming both panels show JJA data, it would be more clear to note that they are JJA in the description of panel a and panel b instead of only at the end.

Answer: Agreed and corrected

Figure 2 caption: Define "observations" here (GPCP). Also, if it is not difficult to do, it would be helpful to have the region acronyms (NC, KR, SC) written in the appropriate

locations in Fig. 2c,d.

Answer: Agreed and added the appropriate locations in Figure 2

Figure 5 caption: Same, note which observations are being used (GPCP again I believe).

Answer: Agreed and corrected.

Figure 6, 14 caption: Despite the definition of summer in the main text, for consistency I prefer using "JJA" in the place of "summer" here.

Answer: Agreed and corrected

Please also note the supplement to this comment:
http://www.earth-syst-dynam-discuss.net/5/C652/2014/esdd-5-C652-2014-supplement.pdf

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Interactive comment on Earth Syst. Dynam. Discuss., 5, 1319, 2014.