Earth System
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Discussions

Interactive
Comment

Interactive comment on "The influence of dynamic vegetation on the present-day simulation and future projections of the South Asian summer monsoon in the HadGEM2 family" *by* G. M. Martin and R. C. Levine

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Anonymous Referee #2

General Comments

This study presents an analysis of the South Asian summer monsoon (SASM) as simulated by the HadGEM2 family of climate/Earth System models. The authors pay particular attention to the importance of the representation of vegetation and dust emissions, both in current and future climates. The paper is well written and argued. However,

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I believe that in its present format it falls between two stools. On the one hand, it is a comprehensive description of the SASM in a bunch of similar but different models, on the other it is a sensitivity study on the importance of vegetation and dust on the simulation of the SASM. I firmly believe that within the content there is an advancement of scientific understanding worthy of publication but I would argue that the authors consider reformatting so that the conclusions are presented more simply and coherently. (If the number of figures could be reduced as well that would be welcome. Pouring over 22, often multi-panel maps, makes for quite a demanding read!). Therefore, my comments below are concerned less with scientific issues but more with points on presentation.

[Reply:] The background to this study was the finding that the present-day representation of SASM rainfall differed between the HadGEM2 configurations with and without interactive vegetation, and that this was related to interaction between the existing rainfall bias and the dynamic vegetation, largely via the dust loading. This highlighted that including additional processes in models can lead to unexpected results when these interact with existing model biases. As models become increasingly complex, that universal point will be important across the model development community, and could affect projections of future climate.

[Reply cont.] So the intention was for this paper to highlight this point, and, in addition, to show how errors in the present-day representation of vegetation cover, both locally and remotely, can affect the SASM rainfall. The use of the model family for this purpose is ideal because they share a common physical framework, making understanding the reasons for differences between the monsoon simulations from the family members more straightforward.

[Reply cont.] We agree that revisions to the structure of the paper and reducing the number of figures would help to clarify these intentions and our conclusions. In the revised version we have removed the discussion of the 4xCO2 simulations (including Fig.s 14, 15 and 16), which were originally included because it was examination of

these which motivated the study in the first place, but they are superceded by the time-slice experiments. In addition, we have removed Fig. 5. We have followed the reviewer's recommendations below for making changes which emphasise the main conclusions.

Specific comments:

(1) Section 2. I would recommend the authors consider re-naming and editing Section 2. You describe model integrations here not experiments. It would be beneficial to introduce the model configurations here too. I appreciate you reference the HadGEM2 Development team but for the purposes of this paper it would be useful to tell the reader what are the important scientific differences between them; i.e. how is vegetation represented in the models? How is vegetation prescribed in HadGEM2-A(O)? Is it seasonally-varying?

[Reply:] More detail has been added about the model configurations, the simulations and their forcing, and the section title has been changed.

(2) Is it necessary to present the results of HadGEM2-CCS?

[Reply:] This configuration was included because it illustrates that it is the inclusion of dynamic vegetation, not the tropospheric chemistry, that is associated with the differences in SASM rainfall in the ES configuration. It could be excluded and the point made verbally, although this would save very little space in both the text and the figures, so we have decided to leave it in.

(3) Sections 4.1 and 4.2 The impact of dust emission is a very interesting indirect vegetation effect but seems to get a little lost amongst discussion on the effects of vegetation locally (4.1) remotely (4.2). I do not have a solution for this but encourage the authors to consider editing these sections.

[Reply:] The impact on and of dust emission is a (albeit dominant!) side effect of the interaction between the dynamic vegetation and the existing rainfall bias. Having

established its impact, we remove it in order to focus on the vegetation itself. However, we agree that the potential influence of changes in dust emission is just as interesting and warrants further study, perhaps with more realistic changes in dust. We have added this point to section 5 and have included discussion of the implications of the feedback on dust in light of other studies in section 4.1.

(4) I think the paper would benefit from greater discussion on how these results affect our understanding of the SASM in the real not simulated world. Also, there is no mention of missing land-surface processes that might be important. Recent studies have shown that the increase in the use of irrigation by agriculture has affected vegetation cover which has impacted on near-surface temperatures and rainfall (Roy et al. JGR, 112, D21108, 2007 and Lee et al. Int. J. of Climatol. 29, 573-581, 2009). Some discussion of whether the models have the potential to capture this effect or not would be welcome.

[Reply:] We feel that this study may not shed much light on the influence of vegetation changes on the SASM in the real world. Such studies have been done by other authors (e.g. Turner and Slingo 2011) using real present-day vegetation variations, and several modelling groups are investigating the influence of potential realistic land use change scenarios, as well as the role of other missing land surface processes such as irrigation, as the reviewer mentions. Our study is more focussed on the potential pitfalls of including more complex Earth system processes in models with existing systematic errors with which these processes can interact. Understanding and reducing these systematic errors is of fundamental importance if models are to be used to understand impacts of vegetation variations and feedbacks in the real world and, ultimately, to provide useable information on future climate to policy makers. This point is made in section 5, but we have attempted to clarify it further in the revision. We have also added mention of potential feedbacks on vegetation cover from irrigation.

Technical corrections:

(1) Figures 9, 10, 11, 12, 13, 14, 15, 16, 18, 21 are missing the (a), (b), (c), (d) labels.

[Reply:] Added.

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