Earth Syst. Dynam. Discuss., 6, C472–C475, 2015
www.earth-syst-dynam-discuss.net/6/C472/2015/

Earth System Dynamics
Discussions

Interactive comment on "Understanding land surface response to changing South Asian monsoon in a warming climate" *by* M. V. S. Ramarao et al.

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Received and published: 7 August 2015

The manuscript by Rao et al. is an attempt to understand the changes in land surface processes under a global warming scenario. They use the simulations from LMDZ, which is coupled to the ORCHIDEE LSP model. The work is useful and timely. While results from a single model on such issues cannot be the last word, they provide a possible scenario of what may happen, with plausible dynamical and physical explanations, thereby providing a basis for other relevant science research and policy making. From this context, I find this work to be straight, clear, and adequate. The manuscript has been written well. I suggest that the manuscript be formally published after incor-

poration of the following minor comments.

Response: We are grateful to the reviewer for providing valuable reviews and offering important suggestions for improvement of the manuscript. The reviewers' comments and suggestions are being addressed and incorporated in the revised manuscript.

Specific comments :

1. The authors apparently use the APHROITE datasets to validate the LMDZ simulations. I wonder how well the LMDZ simulations compare with the Rajeevan datasets, which are also available at 0.25 degrees resolution. Further, in a recent paper, Collins et al. (2013, Nature Climate Change), have shown that there is a lot of spread in the available rainfall datasets for India, which will have serious implications for model validation. I suggest that the authors at least make a brief comment about how the LMDZ model results compare with the Rajeevan rainfall observations.

Response: Thanks for this useful suggestion. As suggested by the reviewer, we have also used the 0.25 deg x 0.25 deg high-resolution rainfall dataset from IMD (Pai et al. 2014) in addition to the APHRODITE dataset. We understand the referees' point that there is considerable spread among the different observed precipitation datasets over India (eg., Collins et al. 2013, Kim et al.2015). Nevertheless, it is seen that the area-averaged summer monsoon rainfall over India is comparable in both the APHRODITE and the 0.25 deg IMD datasets, in terms of the climatological mean, interannual variability and long-term linear trend (added as a supplementary figure in the revised manuscript). This point is discussed in the revised manuscript.

2. Page 4: Ground water depletion is a complex issue. It may not necessarily be due to a rainfall decrease, but can be due to increased use by expanding habitats that do not have access to municipal water.

Response: We agree with the reviewer that the ground water depletion is a complex issue which is not only linked with rainfall, but is also connected to water use, irrigation,

human activities, etc. The sentence related to this issue will not be included in the revised manuscript.

3. Last paragraph, page 7: It is clear that bias-corrected SST was used for the historical simulation. How about that for the RCP simulation? If the authors apply the same bias for the current climate, they should clarify this. This is bit of an issue that the bias may change with the future climate, and this need not even be linear. If this comment is applicable, the authors should briefly discuss this limitation. Having said that, I can see some value in use of such technique.

Response: We understand the reviewers' point. In our simulation experiments, the SST anomalies for HIST, NAT and RCP4.5 experiments of IPSL are superposed on the observed climatological mean SST from the AMIP (Atmospheric Model Intercomparison Project). The climatological mean SST from the IPSL model and AMIP are both for the same period 1979-2005. This methodology assumes the statistical stationarity hypothesis i.e., relationships inferred from historical data remain valid under a changing climate. We understand the referee's concern that the mean can change in the future climate. As suggested by the reviewer, we have briefly mentioned this point in the revised manuscript.

4. I wonder whether the LMDZ model captures the rainfall peak over the Bay of Bengal.

Response: The LMDZ simulated JJAS rainfall climatology compares reasonably well with observations over the Bay of Bengal. This analysis is added as a supplementary figure in the revised manuscript.

5. It is not clear whether the coupling of ORCHIDEE to the LMDZ is two ways, or essentially in offline. This needs to be mentioned.

Response: The LMDZ and ORCHIDEE models are fully coupled with two way interactions between atmosphere and land surface. The text in the revised manuscript is modified accordingly.

Technical comments:

1. The figures 4c and 5c look rather cluttered, and unclear. Response: Thanks for the comment. The modified figures are included in the revised manuscript (Figs 5 & 6 in the revised manuscript).

Interactive comment on Earth Syst. Dynam. Discuss., 6, 943, 2015.