

Reply to Referee 2 on the manuscript "Role of surface hydrology in determining the seasonal cycle of Indian summer monsoon in a general circulation model"

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[Thank you for your valuable feedback and suggestions and your time!](#)

Comment: Role of surface hydrology in determining the seasonal cycle of Indian summer monsoon in a general circulation model by Shubhi Agrawal and Arindam Chakraborty. It is a very interesting work, which highlights effects of soil moisture bias on the simulation Indian summer monsoon rainfall and particularly on the monsoon onset. The manuscript is well written, results are convincing and nicely organized. This study shows how the excessive dry soil condition (bias) over western Central Asian region can lead to excessive monsoon rainfall during the month of June. On the other hand local soil moisture plays important role during rest of the monsoon season. This study may have real implications on the understanding of the sources of predictability of the ISMR and hence improving the forecast skill. Overall it will be a good contribution towards our understanding of land-atmosphere interactions over the south Asian monsoon region.

[Reply: Thank you for sharing your thoughts on the implication of this work!](#)

Comment: These are comments (minor), which needs to be addressed before it is accepted for publication. 1) The result of this modeling study is very much consistent with Rai et al. (2015), which is based on only observations. Pre-onset (April-May) rainfall and 2m air temperature, which can be also used as proxy for soil moisture/land-surface conditions, shows strong inverse link with the first phase (June-July) of monsoon rainfall (see Figure 1,2 in Rai et al 2015).

[Reply: We have already discussed this relevant paper of Rai et al. \(2015\) in the Introduction section \(P2L5\). In the revised manuscript, we plan to discuss further results from this paper, similar to our model simulation results.](#)

Similarly there are previous study by Parthasarathy et al., 1992; Singh et al., 1995 . The point is here that this modeling study should be build on such note and finally this study shows that model is able to capture this observed teleconnection faithfully.

[Reply: Thank you for these references. We will include these references in relevant result sections.](#)

2) Many previous observational study have pointed out that pre-onset land surface conditions, particularly over the heat-low regions (Iran, Afghanistan, Arabian region) have significant impact on the performance of ISMR. This could be one of the non-ENSO sources of predictability in a forecast model.

Reply: This goes in line with the future applicability of the present study. Our results in this paper are based on model simulations with climatological SSTs and still we see a significant change in seasonal cycle over Gangetic Plains, highlighting the importance of land-atmosphere coupling over this region.

Unfortunately we do not have deeper layer soil moisture observation, which can be feed into land data assimilation system.

5 Reply: We agree with the reviewer on this. More observational data from deeper soil layers, like soil moisture, soil temperature, infiltration, etc, will be very useful in evaluating and improving land model.

3) *In the summary and conclusions part “It follows from our work that the surface soil moisture anomalies bear serious consequences ” It is not anomaly but a system- atic bias.*

Reply: Thank you for your suggestion. We will modify this as per suggestion.

10 4) *Soil moisture shown in Figure 5 is from top model layer? In nudged experiment, only top soil layer is nudged? What about the deeper layers, what kind of effects it can have on the results ?*

Reply: Yes, soil moisture shown in Figure 5 is from top layer of model. Depths of top two layers in the model are 0.007100635m, 0.027925m. In the nudged runs these top two layers are nudged, as the satellite based observation based volumetric soil moisture data (ESACCI) represents a depth between 0.005-0.02m.

15 Vertical profile of soil column over GP (area averaged soil moisture) is plotted against day of the year in below Figure. This figure shows the effect of nudging over GP on the deeper soil layer. Soil moisture values for deeper layer are marginally different in the CNTL and WCAGP_NDG experiments.

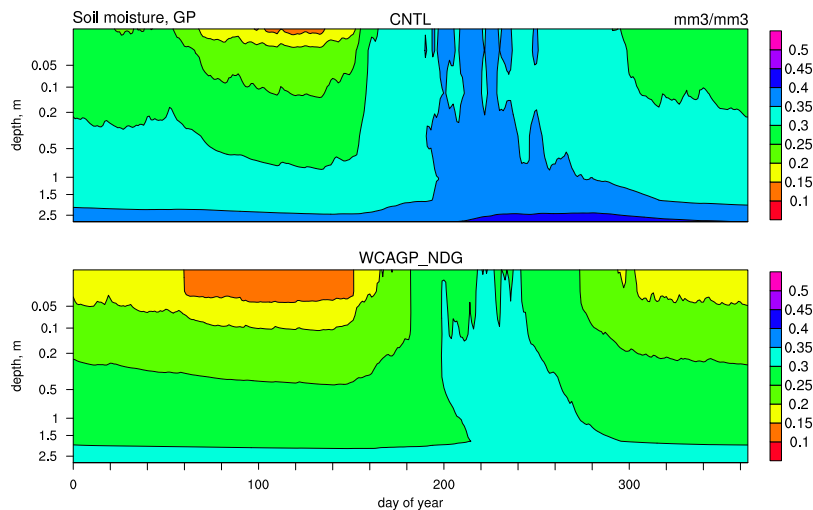


Figure 1. Vertical profile of volumetric Soil moisture area averaged over Gangetic plain (76–88 E, 22–28 N) plotted against calendar days for CNTL (top panel) and WCAGP_NDG (bottom panel).

5) *In page 2, “ The contribution of land-atmosphere interaction.....” is a very big sentence, hard to read. Please split it into smaller sentences.*

20 Reply: We will modify the sentence as per suggestion to make it more clear.