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Climate of the Past Discussions

Interactive comment on "The evolution of sub-monsoon systems in the Afro-Asian monsoon region during the Holocene – comparison of different transient climate model simulations" *by* A. Dallmeyer et al.

Anonymous Referee #1

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The manuscript "The evolution of sub-monsoon systems in the Afro-Asian monsoon region during the Holocene - comparison of different transient climate model simulations" by Dallmeyer et al. investigates the ability of five climate models to simulate spatio-temporal characteristics of the northern hemispheric monsoon systems during the Holocene. Firstly, they analysed if precipitation and lower-level atmospheric circulation characteristics under pre-industrial climate conditions are captured by the models. They find that the models represent the observed patterns, but also pointed out some differences between model and observational data. Furthermore, it is shown that the

general rainfall signal between 6ka and 0ka (found in proxy data) is captured by the models. Secondly, the authors aim to answer the question if precipitation over the different monsoon regions responds synchronously during the last 6000 years. In general, they find decreasing rainfall trends over India, North Africa and East Asia over the last 6000 years. Additionally, they suggest a coupling between the monsoon regions of northern Africa and India as these regions show similar temporal variability. Thirdly, the effect of changes of the seasonal insolation during the last 9000 years on rainfall for the different regions is investigated.

Major Points:

My major points mainly concern the test of the global monsoon concept using the AOGCM data in general. Additionally, I would recommend to "streamline" the manuscript even more by highlighting the important points and reduce the paragraphs with redundant information.

1) Evaluation of the global monsoon concept using pre-industrial AOGCM results:

The major aim of section 3.4 is to prove the global monsoon hypothesis on interannual time scales, which is done by correlating rainfall time series from different sub-monsoon systems with each other. The authors conclude on page 2324 that "rainfall variations are only partly correlated". I miss an evaluation of the global monsoon hypothesis under pre-industrial climate conditions. As this work aims to investigate if this hypothesis is still true for millennial time scales, it is crucial to investigate the relationship of rainfall between the sub-monsoon regions. The main question are: i) Is rainfall over the sub-monsoon regions positively correlated if using annual rainfall amounts for, e.g. the last 120 years from the simulation? ii) Does this dependency change during the time period from 6ka BP until present.

2) Interannual Variability of rainfall over the sub-monsoon regions

Yearly rainfall amounts are used in section 3.4 to calculate the correlations between the

different regions. The authors find only weak correlations between the North African monsoon and the Indian monsoon. This is inline with the study from Feudale and Kucharski, 2013, who also found that West Asian monsoon and Indian monsoon are only weakly correlated on the interannual time-scale but found high correlations on the decadal time scale. Thus, I suggest computing correlations also for decadal to multi-decadal time-scales to compare with the results from Feudale and Kucharski, 2013 for the ISM-NAM connection.

3) Time dependent correlation: (related to #1 and #2)

To test the global monsoon concept, I suggest to calculate sliding correlations using different window sizes. This would help to investigate if regional monsoon teleconnections weakened or strengthened under varying orbital parameters

4) Sub-monsoon regions

Figure 1 shows the sub-monsoon regions used in this study, but only four regions are discussed in the manuscript (NAM,ISM,EASM,NEASM). For regions "SARAB" only the rainfall trend during the Holocene is investigated, but no validation has been performed in section 3.1.

Minor Points:

1) section 3.1

Which time period has been used regarding ERA-40 and GPCP data? Please clarify how many years are used to calculate the average for figure 2,3,4,5

2) Figure 2: I suggest performing a significance test and shade only those areas where the differences are statistically significant (as in Figure 6)

3) Figure 3 and p. 2305:

Is the Taylor diagram showing spatial correlation, spatial standard deviation and normalized RMSE from the spatial data? It is difficult to follow the conclusions drawn in

section 3.1.1 about the temporal variability. It seems, that only the average of 120 (12) model years of 0k is used.

4) Figure 4:

Both plots in the bottom row have the same title ("EASM")

5) Figure 5:

Maybe it is a good idea to show anomaly plots to highlight the regions with the largest differences?

6) Figure 6:

Is the legend also valid for the reconstructions data (dots)?

7) Figure 7:

How large is the monsoon region for pre-industrial climate using GPCP data? Which models performs best?

8) Figure 11:

What about ERA-40, and the other model simulations? Which model captures the observed moisture flux best?

9) p. 2305, l. 1

How is "the entire monsoon region of North Africa and Asia" defined? Is it the whole region in figure 1?

10) p. 2305, l. 5

Which standard deviation is summed up over all grid-boxes? Sentence is difficult to understand.

11) p. 2305, l. 13

Again: how can temporal correlation be assessed. Is standard deviation calculated from 120 years (unaccelerated) and 12 model-years accelerated?

12) p. 2305, l. 26

“Thus, with respect to precipitation PLASIM does not identify the North African monsoon as “monsoon region”. This contradicts with p. 2309, l. 25 and figure 7. In figure 7 monsoonal regions over Africa are well present also in PLASIM, using the ratio between summer and annual precipitation. Thus, for figure 7 PLASIM identifies this area as monsoonal and the index is also based on precipitation.

13) p. 2307, l.15

It’s difficult to compare the results of the models with ERA just using figure 5. Is it possible to calculate spatial correlations, maybe also for special regions?

14) p. 2314, l. 2

Where do you show the climatological interannual variability?

15) p. 2316, l. 20

Which time-scale are you talking about when writing “temporal variability” ?

16) p. 2316, l.18-28

This complete paragraph is also mentioned in the Summary section.

17) section 4.3 and section 4.3.1

How is the onset and withdrawal defined? I am not convinced that it is possible to conclude differences of the onset date in 9ka, 6ka, 3ka, 0ka using monthly mean precipitation data as used in section 4.3.1. Furthermore this analysis might be difficult as only 12 model years are used for each time-slice to calculate climatological mean rainfall amounts.

18) I can’t find the link between section 4.3.1 and section 4.3.2.

In section 4.3.1 the authors analyse the seasonal cycle of rainfall during 9ka, 6ka, 3ka and 0ka. Section 4.3.2 discusses the start, mid-point and end of the wettest period derived from proxy data. Could you please highlight the linkage between the output from this analysis and the model data?

Interactive comment on Clim. Past Discuss., 10, 2293, 2014.