

## ***Interactive comment on “Contribution of oceanic and vegetation feedbacks to Holocene climate change in Central and Eastern Asia” by A. Dallmeyer et al.***

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The paper addresses the interesting question to what extent the mid Holocene Asian Monsoon changes were directly forced by the orbitally controlled solar insolation and how much are the contributions from ocean and vegetation feedbacks. For this purpose, a suite of numerical simulations have been conducted for 6,000 BP. With specifically designed experiments, the authors are able to separate the direct atmospheric response from the oceanic, vegetative and synergistic feedbacks. The major result is that oceanic feedbacks significantly contribute to the insolation-driven changes in precipitation, whereas the vegetation and synergistic effects play a minor role in under-

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standing the Monsoon response at 6,000 BP. Seasonally and regionally, however, the monsoon system response has ambiguous signatures in temperature and precipitation changes. Overall the study is an important contribution to our improved understanding how the Asian Monsoon system responds to external forcing and internal feedbacks. My major criticism is that the authors try to discuss too many aspects of the very complex Monsoon processes. A more concise and more compelling discussion of one monsoon season (e.g. the extended summer from spring to autumn) and focus on the key regions with significantly different contributions from the ocean/vegetation feedback would have been sufficient.

### **A note on the presentation quality:**

As outlined above, the biggest concern is the huge number of sub-results: Presenting and discussing 11 regions, 4 seasons, 4 response types for 2 variables is not manageable in one paper of this length. The result is that the subparagraphs are sometimes confusing (see examples below) and important physical feedback processes are not discussed in more comprehensive terms.

### **CP criteria:**

*Are the results sufficient to support the interpretations and conclusions?*

The model results are sufficient, but a statistical significance test of the feedback influence (especially from synergistic effects and vegetation) are required.

*Is the overall presentation well structured and clear?*

The result section needs to become more concise.

### **Individual comments:**

Abstract: lines 13-15: You mention the lagged ocean SST response to the seasonal forcing here and in the text. It is an important part of the feedback mechanism and deserves an extra figure in the result section. The abstract is a good summary of

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the major results. These would be worth to concentrate on throughout the result and discussion (e.g. the summer monsoon (Spring to Autumn) for Indian and East Asian Monsoon.

p2353 l.26: write "focusing on the direct response to orbital forcing [...] of rainfall over North Africa (Joussaume et al., 1999)"

p. 2355 l. 11-16: Since you use a lower resolution version of the model to study the regional aspects (currently 11 different regions you suggested need to be studied separately) a regional comparison with present day observations would still be helpful. This could be provided as supplementary figures.

p. 2357 l.10-20: the choice of regions is based on your 6,000BP results. Please make clear what the most important criteria are that justify the 11 regions.

p. 2357 l.15: write "It was found that these regions strongly [...]" p. 2357, l. 25: "robust": against what? Choice of grid boxes, time , model simulations? p. 2357 I suggest to end this section with a note that the main focus is on the regions of the Indian and East Asian Monsoon, for example.

Results Section 3:

General comment: Please make use of your defined 11 regions (if you decide to keep them) from Tab. 1 in the text. Otherwise it's very difficult to understand to what regions the results apply to. I'd like to see two or three key regions being followed throughout the result sections (East Asian Monsoon vs Indian and Tibet Plateau for example). Interesting outlier regions may then be mentioned in addition.

p. 2359 l.20-24: Define what regions you mean by 'the Asian monsoon regions' and 'in all other parts' by using the regions from Tab 1. p. 2360-2361 l.27 -l.3 : Please rewrite: It is not fully clear what physical mechanism in what region is meant. In my understanding you want to express that the Tibet Plateau prevents a further northward movement of the monsoon and that limits the vegetation zones north of the Himalaya?

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p. 2361 l. 13-14: rewrite: "The model indicates a significant shift of forests to the west. However, in the low resolution of the model this shift is expressed by one single grid box shift. A northward [...]" p. 2361 l. 25: what about the proxy ambiguity in their vegetation reconstruction? Is it only the coarse resolution that limits the agreement? A sketch of a map with the proxy-based reconstructions (maybe only in form of "+" and "-" regions would be helpful to illustrate this).

#### Section 4:

p.2362: Please make sure you reference the regions by using your 11 region acronyms from Tab. 1. For example line 15-16: "[...] in a large area between the Tibetan Plateau and the east coast of China [...]"

l. 20: "[...] in the other regions [...]"

p. 2363 l. 11: write: "[...] atmosphere-only runs: Despite the fact [...]"

p. 2365 l. 11: write: "land masses" what regions are meant by "northern Asia" p. 2365, l.17-19: Significance of the differences? T-test? p. 2366, l6-29: please indicate after each region which of the regions in Tab. are included in terms like Indochina, India, Yangte-Huanghe-Plain, Central Asian continent.

p. 2367, l. 7: Are the changes small compared with the summer changes or are they considered small relative to the winter mean precipitation?

p. 2368, l. 1-10: Here is one of the most interesting results of the paper, in my opinion: The ocean feedback can counteract the direct atmospheric response. Without ocean feedback IND would appear drier in the 6,000BP period. very interesting result. Also, later in the summary figure 9 and the discussion it seems to me that the regionality matters: whether regionally or averaged over the entire region, the feedback can be interpreted as either positive or negative feedback.

p. 2368-2369 l. 24-l.6: Here it would be important to make a statistical test of the significance: First it is said the differences are small. Then, the feedback is described

as "mostly positive in except for winter." And in spring there is a north-south gradient with a highlighted center around the Tibetan Plateau. But all this is under the overall assumption that everything is statistically significant and robust regarding the model and its resolution?

p. 2369, l. 13-17: Statistical significance test? And is the contribution measured against the overall changes. In figure 6. the green bars look as 'important' as in the other seasons compared with the total length of the bars. I suggest to add for each season and each region an extra bar (maybe at the top of the plots) that indicates the minimum difference that is still significant (using a t-test for example or ANOVA). Or at least an indicator for the variance in the model runs (divided by the square root of the sample size).

Summary and Discussion:

p. 2370 l. 8: write "[...] change over land for each [...]"

p2370, l. 20-25: is everything explained by the thermal inertia of the ocean SST. Could ocean dynamics, feedbacks for example in the upwelling region off the Arabian coast, or suppressed variability when ocean SST are held fixed lead to monsoon changes?

p. 2371, l. 2-4: Maybe add: " The detailed mechanism behind the feedback between ocean and the Tibet Plateau is still not fully understood, though. (a figure of the annual cycle in temperature over the Plateau with/without feedback would be good to support the discussion) p 2371, l. 13-14: write: "Despite the very different [...]"

p. 2371 l. 15: remove "respectively" p. 2371 l. 17: which regions according to Tab. 1?

p.2372, l. 5: Check: "If applicable [...]" or "Where applicable [...]"

p. 2372 l.10: This is important to emphasize: If averaged over the larger region (Fig 9b.) the ocean feedback appears as an positive feedback (enhances the atmosphere-only response). But in regional analysis of Fig. 6, we find that several regions have opposing signs in atmosphere-only and ocean feedback response. It seems as if the

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strong feedback IND (more precipitation) dominates the ocean feedback signal over the entire region, and the direct atmospheric response over all other regions outside IND dominate the response. If this is robust (i.e. it could be seen in other model studies) this would be a very important contribution to the understanding of the paleo-monsoon response, because it is not as simple as a conceptual model based on figure 9b would suggest. And probably coarse resolution models would not allow the proper inferences.)

p. 2373, l. 17 clarify: winter warming (seen in which studies the two latter citations?)

p. 2373, l. 20-22. Could you discuss further, how proxies could help to validate model results. Do you think that the proxy data allow already to validate the regional aspects of your simulation and even higher resolution (regional paleomodeling) are really necessary to (a) understand the proxy records in their spatial complexity or (b) to represent the Indian and East Asian Monsoon interplay and the oceanic-vegetative feedbacks in a proper way [to understand the paleo-evidence from proxies].

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