

Reply to the Second Reviewer's comments.

General comments:

“...a central goal of the paper is to demonstrate the applicability of the so-called global monsoon (GM) concept by showing coherent variability across all timescales in all the different regional monsoonal sub-systems.” But it may “give the impression that the global monsoon concept on one hand and a coherent variability of all subsystems on the other, are interdependent”. The reviewer emphasizes, “I do not think that the global monsoon concept depends on coherent variability of subsystems at all timescales. I also argue above that such a coherent variability at all timescales is actually very unlikely.”

First, we need to clarify what the “coherent variability” of the regional monsoons means. The “coherent variation” does not mean that the regional monsoons have no difference or they have to vary in the same manner. For instance, even on the annual time scale when the coordination of regional monsoons by insolation is the strongest, the northern and southern hemisphere monsoons vary out of phase! However, these out-of-phase (a hemispheric antisymmetric) variations manifest the global monsoon is a **coherent** circulation system and the hemispheric antisymmetric variation is bounded by the global divergent circulation or Hadley cell associated with the GM.

The GM is a planetary scale circulation system with a seasonal reversal of three-dimensional monsoon circulation accompanied by migration of the monsoon rainfall zones (three quarters of the ITCZ). The variability of the GM across time scales must differ depending on the forcing mechanisms; especially we expect regional monsoon subcomponents vary differently in general and not necessarily in a uniform manner. However, these variations of the regional monsoons may remain to be coordinated and coherent (intrinsically incoherent), to some extent, beyond the individual regional monsoons. As such, the GM concept can be used to characterize these coherent responses across different regional monsoons and beyond the annual time scale. This is precisely as reviewer pointed out, “Even if one would identify differences between regional sub-systems, it would not argue against the concept of a global monsoon”.

Specific comments:

✘ Page 2179, line 11: “I think Ruddiman is the wrong reference here, I would suggest one of Steve Clemens papers here”.

Done.

✘ “The review would benefit from some additional references”.

Agree. Along with those mentioned in the referee's comments, a number of new references are added.

※ *“Another, interesting open issue that is not yet mentioned in the paper is related to the MIS 13 debate”.*

Yes, the MIS 13 is an interesting topic, but the debate mainly deals with the mechanism of monsoon variations which is the subject of our second synthesis paper. Here the question is only briefly mentioned.

※ Page 2228, Conclusion 4. *“I would not necessarily agree with that comment. There is a large community working on “deep-time” climate variability on an ice-free planet, also investigating the paleomonsoon in those time intervals (e.g. PETM). Maybe these studies are not sufficiently considered in this review.”*

Indeed, there is a significant progress in “deep-time” paleoclimatology during the recent years, but the focus is largely laid on carbon cycle (such as PETM) or astronomical cycles. Since our synthesis is focused on monsoon, the PETM event is not discussed.

While preparing the synthesis, we paid special attention to publications on Pre-Quaternary paleo-monsoon studies. In result, we found that the attention paid to low-latitude hydrological cycles remains much less than that to the ice-related processes. With conclusion “4”, we wish to underscore the role of GM in Pre-Quaternary climatology.