**Climate
of the Past
Discussions**

Interactive comment on "Simulation of the Indian monsoon and its variability during the last millennium" *by* S. Polanski et al.

Anonymous Referee #1

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This paper examines the Indian monsoon in last millennium simulations from three models with differing resolutions. The overarching goal is to assess the influence of external forcing (solar irradiance) and internal climate modes on monsoon variability. My main comments are on some possible improvements to the analyses and some further examination of the interpretations. In general, more discussion of the results is needed regarding how they compare with previous studies and our understanding of how the monsoon works (gained from both the instrumental record and from the Holocene paleo record).

Major comments

The differences between the five ensemble members in Figure 1 are striking. There seems to be very little consistency among them. Is there more consistency for global

or hemispheric temperature? My understanding is that all five have the same forcing and different initial conditions. More information should be given about the forcing, including references for the datasets used for solar irradiance, volcanoes, etc. Also, "The atmospheric CO_2 concentration is resolved interactively in the model." Does this mean that CO_2 forcing does or does not include anthropogenic effects? I realize that some of this information might be available in the Jungclaus reference, but this information is important enough to the interpretation that it should be provided.

p. 710 line 24, What is the reference period used for the proxies? For consistency with model anomaly plots, it should be 1800-2000 AD. These proxies are said to reflect "moisture." Does this mean some might contain a precipitation-evaporation signal rather than just precipitation? If so, it could be more fruitful to compare them with modeled P-E.

Statistical significance for differences: Please show for temperature and precipitation (possibly by adding stippling) in Figures 5, 6, 7. p. 717 lines 10-17 this could be presented in a table with statistical significance also shown.

I am confused regarding which results come from COSMO-CLM. The 30-yr time slices are described in the text and figure captions as coming from ECHAM, but this doesn't agree with Figure 1.

p. 720 and Figure 8: My understanding is that these correlations were calculated using the 30-year composites for wet and dry years. These composites are very short, though, and for the question you are trying to address – how does TSI (or internal mode) correlate with AIMR – it would probably be better to do a temporal correlation using all 200 years (or even all 1000 years).

p. 720: As someone more used to orbital time scales, the conclusion that increased solar irradiance causes a weaker monsoon doesn't completely make sense to me. Why does increased solar irradiance warm the ocean more than the land? Generally, you'd expect the opposite given land's lower thermal mass (this seems to be the case in

Figure 7c for 2-m air temperature). And, according to figure 6, proxies show that the MWP (higher solar irradiance) is wetter than the LIA (lower solar irradiance).

I'm skeptical about the use of the All India Monsoon Rainfall (e.g., Figure 1, Figure 8) because AIMR seems to combine regions that respond differently through time (e.g., Figures 5,6,7). Also, the recent paper by Conroy and Overpeck 2011 Journal of Climate 24: 4073 shows that precip does not change coherently across India on the interannual time scale.

Why isn't PDSI correlated with prescribed SSTs rather than SST observations? That would seem to be the most direct comparison since the modeled PDSI is responding to SSTs in the model. It would also allow for the analysis to be done for the other periods (MWP and LIA). As it stands, the PDSI section of the paper seems out of place because it moves away from the focus on the differences between MWP-LIA-REC. Also, it seems odd to focus on EOF#4. It explains only 5% of the variance, which is probably below the threshold for which PCs should be retained. What does the scree plot/log-eigenvalue diagram look like? Why aren't EOFs #2 and #3 discussed?

Minor comments

Some formatting with regards to paragraph breaks might have been lost. P. 706 line 7, new paragraph should begin at "Several…" P. 706 line 23, new paragraph should begin at "The following…" p. 720 line 2, new paragraph should begin at "Figure 8…"

Figure 3: The generalized wind vectors don't seem realistic, especially the ISM vector extending far north into China. It would be preferable to plot actual wind vectors from NCEP or another source. Also, for clarity, it should be specified that the dashed line shows the *maximum northward position* of the ITCZ/monsoon trough. What is the source of the line labeled "ITCZ?" The position you have drawn over the Tibetan Plateau is much further south than in other analyses, see for example Conroy and Overpeck, 2011 Journal of Climate 24: 4073.

p. 710 line 19, Similar to comment above regarding Figure 3 – Are these really affected by westerlies? Others would argue that the climate here is monsoonal.

p. 711 section 2.3.1 these two sentences seem contradictory (TSI = distinctive range, TSI=all wavelengths). Perhaps these sentences could be combined. What TSI reconstruction was used? Please provide reference.

Figure 4 caption: Explain that these are for temporal correlations with APHRODITE (I presume?) for the region 0-50N, 60-120E.

p. 714 line 20: Should this read 120 E rather than 12 E? This is much bigger than "a box over India."

p. 714 line 20-21: …interpolated to a coarser grid." I assume that only the high-res model was interpolated and that the coarser grid used was that of the lower-res model?

P. 714 line 23-25: Really the correlation shown in Figure 4 is between D/C and A, correct? From the figure, it is not clear whether D or C is better correlated to A or to B.

P. 714 line 25: "closer" than to what? APHRODITE?

p. 714 line 27: "which would also limit the potential agreement between model simulations due to interpolation errors." I don't fully understand. How does interpolation introduce error?

Figure 4: Would it be possible to also show non-interpolated results?

Figure 4: It seems odd that low resolution does better. Explanations for this?

p. 718 line 6, It is not clear to me that either more sites or higher resolution will fix this problem. It is likely related to the forcing or to model biases.

p. 718 line 23, What is a "dry rainfall event." This sounds like an oxymoron.

p. 719 line 25: "This relationship is approved for MWP and LIA respectively." Maybe instead: "This relationship is shown for both MWP and LIA." This sentence is one

example of the proofreading for English grammar that should be done for the entire paper.

Figure 8: Arrows from ONI and DMI to TSI could be interpreted as these modes having an effect on TSI.

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