

## ***Interactive comment on “A model-data comparison of the Holocene global sea surface temperature evolution” by G. Lohmann et al.***

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Part of the differences in the magnitude of Holocene SST trends between model simulations and derived paleo-temperatures can be reconciled by considering shifts in seasonality and habitat depth. We extensively discuss possible mechanisms for both the models and the interpretation of the proxy derived paleo-temperatures.

Besides the insolation forcing, changes in greenhouse gases may play a role. However, the radiation effect due to CO<sub>2</sub> during the Holocene is rather small and has a negligible influence on our results. Internal variability is expected to have a minor effect on the overall hemispheric temperature trends. Variations in regional SST trends can be attributed to a pattern related to the Arctic Oscillation/North Atlantic Oscillation (Rimbu et al., 2003) and modulations of the Icelandic Low (Lohmann et al., 2005), Pacific-North

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Atlantic and North-South teleconnections (Rimbu et al., 2004). Rimbu et al. (2004) found moderate SST variability on millennial timescales (ca. 900 and 2300 years), but of much weaker amplitude than the trend. Wirtz et al. (2010) analyzed the variability of multi-centennial and millennial time scales and identified clusters on a subcontinental scales with similar variability behaviour. Wirtz et al. (2010) found that variability in the climate system seem to be amplified in certain regions, especially at the upwelling areas. Their analysis included records of cosmogenic nuclide production (Be-10 and C-14 flux) as well as reconstructed sunspot number of Solanki et al. (2004). Time components identified with SSA on the sunspot number reconstruction show 6500, 2500, 950, and 550-year variability components (Dima and Lohmann, 2009), but none of the three records contains firm evidence for millennial modes with a time scale of 1500 years (Wirtz et al., 2010). Debret et al. (2007) already questioned the hypothesis of Bond et al. (2001) that the 1500 yr cycles are due to variations in solar activity. The possibility of solar variability being amplified by oceanic feedbacks or other indirect effects can not be excluded (Renssen et al., 2006; Dima and Lohmann, 2009) and a possible influence has been documented by proxy data (e.g., Hodell et al., 2001), but there is no evidence that solar variability affects the long-term SST trends from the mid-to-latest Holocene (e.g., Weber et al., 2004; Wagner et al., 2007).

Our work is related to Holocene SST trends, and in our case we concentrate on the last 6000 years until the pre-industrial climate. The evaluation of the variability on the above mentioned time scales is an interesting topic, but of little relevance for the Holocene temperature trend. The comment (Luening, 2012) suggests us some basic clarifications are necessary on radiative forcing for insolation and radiative forcing for solar activity. It was proposed that "a higher radiative forcing for insolation also means a higher radiative forcing for solar activity in general", a statement which is -according to our knowledge- not covered by the data. The exact transformation of sunspot number into climate forcing is under discussion (e.g., Lean, 2000; Haigh et al., 2012; Krivova et al., 2010; Shapiro et al., 2011; Steinhilber et al., 2009; Muscheler et al., 2007; Harder et al., 2009; Vieira et al., 2011), but no processes could change the variability dominated

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timeseries into trends. We attached a figure with current estimates of Holocene solar activity (Fig. 1).

The last sentence of the comment (Luening, 2012) is not related to the topic of our paper which deals with Holocene temperature trends. It seemed to be more a personal statement about the discussion of recent climate change without a reference to scientific articles.

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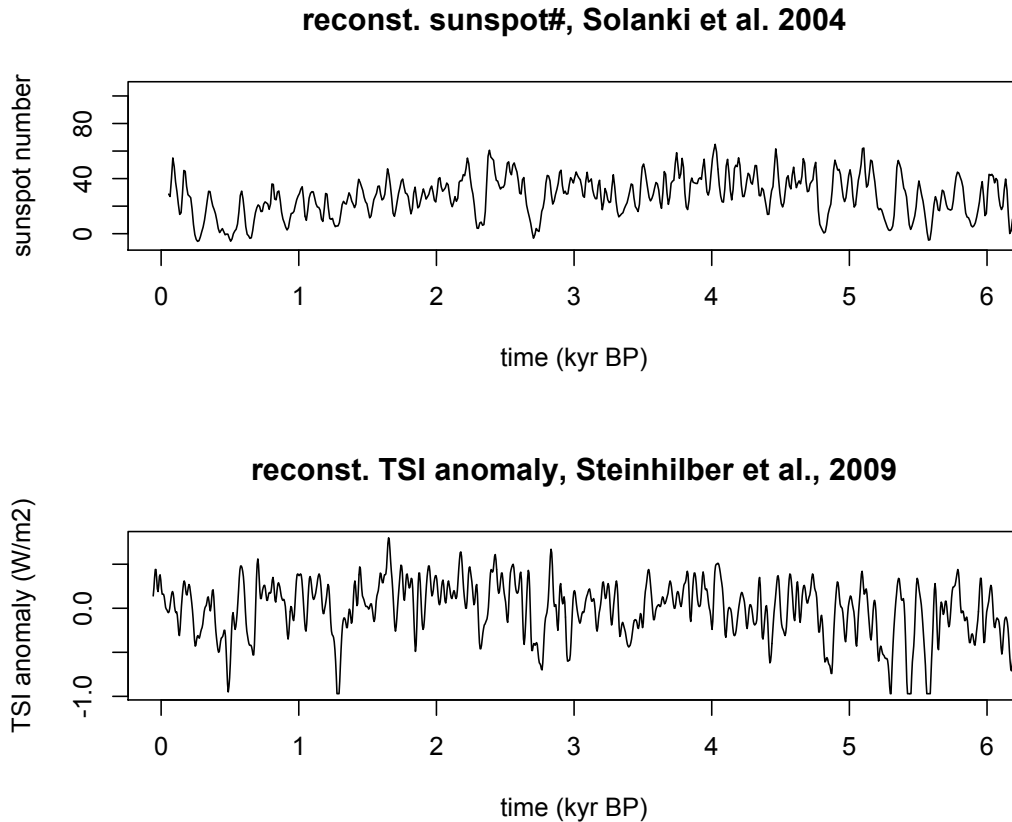
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Fig. 1.

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