

Clim. Past Discuss., author comment AC3  
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## Reply on CC1

Rebecca Orrison et al.

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Author comment on "South American Summer Monsoon variability over the last millennium in paleoclimate records and isotope-enabled climate models" by Rebecca Orrison et al., Clim. Past Discuss., <https://doi.org/10.5194/cp-2022-6-AC3>, 2022

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We appreciate your time and consideration of our manuscript. The *italicized comments* have been broken up so we are able to reply to each aspect separately in **bold text**.

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*This is a useful contribution that analyzes hydroclimatic variability in tropical and subtropical South America for the last Millennium. The authors use palaeoclimatic and modeling data. Time series of the proxy results are shown in Figure 2. It is clear that hydroclimatic trends for the key pre-industrial climate anomalies (Medieval Climate Anomaly, MCA; Little Ice Age, LIA) may be spatially different. It would be good if the authors can display the proxy-based hydroclimatic trends in a clearer way.*

**While we do compare proxy records and isotope-enabled climate models, our analysis is not focused on trends in the records or in the Principle Component time series. Instead, our results examine the South American Summer Monsoon during the Medieval Climate Anomaly (MCA) and the Little Ice Age (LIA), two periods during which the SASM exhibits multi-centennial departures from its mean state (Campos et al., 2019). The comparison is focused on the mean  $\delta^{18}\text{O}$  values in paleoclimate records and the isotope-enabled climate model during these periods. Our results in Figure 5 show that the proxies and isotope-enabled models show consistent mean state departures.**

*Which regions got wetter/drier during the MCA and LIA? Please add arrows wetter / drier to the charts. Lüning et al. 2018 have mapped out such trends for the MCA of Africa: <https://doi.org/10.1016/j.palaeo.2018.01.025> See Figure 4 of that paper.*

**Figure 5a,f shows the precipitation patterns modeled during the MCA/LIA. This clearly shows which parts of the SASM region would be expected to get wetter/drier during these periods.**

*The influence of the Atlantic Multidecadal Oscillation and other well known modes of variability are discussed for Africa. What role do parameters such as Southern Annular*

*Mode (SAM), AMO or ENSO play for SAMS in South America?*

**Though modes such as the SAM, AMO, and ENSO do contribute to South American climate variability, we do not discuss them directly in conjunction with our results because they do not emerge as leading drivers of the monsoon modes highlighted in this proxy-model comparison.**

**The influence of different SAM phases on SASM variability is derived from the changes in anticyclonic wave breaking activity within the southern jet. Transient cyclones migrate farther north during the negative SAM phase relative to the positive phase, enhancing baroclinic activity in the South Atlantic Convergence Zone and the local precipitation anomalies (Kodama, 1993; Reboita et al., 2009).**

**The influence of the AMO is largely due to its influence on the SST variability of the SASM moisture source in the South Atlantic. A negative AMO phase corresponds to a warmer South Atlantic, displacement of the tropical rainbelt to the south, an increase in the amount of moisture flowing into the SAMS region and an increase of convection and rainfall in the monsoon basin. The opposite phenomenon occurs during the positive AMO phase (Chiessi et al., 2009, He et al., 2021).**

**The ENSO influence on the SASM is most notable on interannual timescales. In observations and in annually resolved and precisely dated archives, the ENSO signal can easily be identified in the isotopic composition of precipitation (Vuille and Werner, 2005; Hurley et al., 2019). These studies show that the influence of ENSO is indirect, via modulation of the monsoon mean state through perturbations of the Walker circulation, rather than directly affecting the precipitation or temperature at the proxy sites. However, the paleorecord network analyzed in this study does not have the temporal resolution nor the dating precision required to capture the ENSO signal on these timescales.**

*Can you illustrate all isotope proxy records individually in the Supplement? It would be good to see how uniform or different these individual records are.*

**All the isotope records used in this analysis have been previously published (apart from the MV record) and are accessible in their original publications. Furthermore, the isotopic time series of the proxy network generated in the MCEOF analysis have already been published (see supplemental information in Campos et al., 2019). We encourage the interested reader to seek out this publication for further detail.**

*It would also be good if you can briefly discuss the potential impact of temperature variability of the Last Millennium in South America. The MCA and LIA are well represented in parts of the continent. See the synthesis published by Lüning et al. <https://doi.org/10.1016/j.quaint.2018.10.041> Did the warmer climate during the MCA and the colder climate during the LIA have any impact on hydroclimate? Worth discussing.*

**There exist no continuous high-resolution temperature records covering the last millennium from this part of the world, and no records that document temperature during the MCA in particular. Our analysis of the MCA and LIA documents departures from the mean hydroclimate state of the SASM. This is not related to temperature, as temperature changes can not explain the observed**

**isotopic excursions seen in tropical South American proxy records over the past millennium (see discussions on this aspect in Bird et al., 2011; Hurley et al., 2019).**

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