

Response to Reviewer 2:

The paper presents a reconstruction of the Indian winter monsoon in the Arabian Sea for the last 6000 years based on paleobiological records with different complexity. Based on the analysis of sedimentary paleo-DNA and planktonic foraminifers the authors show that stronger winter monsoons occurred between ca. 4,500 and 3,000 years ago. They call this period Early Neoglacial Anomaly (ENA) and argue that this climate reorganization may have helped trigger the well-known metamorphosis of the urban Harappan civilization into a rural society. As a dynamical climatologist I could principally review the climatological part of the paper. I was not able to evaluate the methodological part of the sediment core analysis. Overall the paper presents an interesting analysis on the activity of the Indian Winter Monsoon and its impacts on the Harappan civilization.

We thank the reviewer for his/her overall positive judgement on our paper and suggestions.

I am personally cautious if a new term for a climate period is defined. Are the authors convinced the ENA is a global phenomenon with high significance? Is it not possible that similar climate periods marking the transition to the Neoglacial occurred even earlier and in other areas of the globe?

ENA is evident in many records (presented initially in our paper, in others that we added now and even more others that are cited). It does not need to have global extent although one may be detected in the future (similar to the initial description of the LIA as Western European event). However, the fact that records of interhemispheric temperature gradient document ENA, it is a good indication that it may have had a global effect. It is also not necessary to have strict time bounds either – for example in the southern hemisphere (see Neukom et al. paper suggested by reviewer) LIA would have been shorter and lagged to the NH definition if first discovered and defined there.

Lines 34-36: Avoid creating the impression the Little Ice Age was not global. It was but, due to the inertial effect of the large ocean areas in the Southern Hemisphere, the cooling effect occurred later in this area (see Neukom et al., 2014, Nature Climate Change 4, 362-367).

LIA appears to have indeed been global, although this is not universally accepted. On the other hand LIA was particularly strong and prolonged in the Northern Hemisphere (NH), which indicates either a cause or a positive feedback in the NH as discussed in references cited. We added in the text that LIA has a global extent and cited appropriate references. Reference suggested now added.

Lines 48-49: If you call a climate period as an optimum, it has to be related to a certain state or process. Therefore, I recommend using the classical term “Holocene Thermal Maximum”.

Done.

Lines 67-73: The Indian Winter Monsoon is, simply said, driven by the thermal contrast between the cold Asian continent and the adjacent warm oceans (see e.g. Trenberth et al. al., 2006, in: The Asian Monsoon, Springer; Wang and Chen, 2014, J. Climate 27, 2361-2374; Yancheva et al., 2007, Nature 445).

While references listed mainly concern the East Asian Winter Monsoon, a phenomenon with different dynamics and magnitude compared with the Indian Winter Monsoon (see e.g. Wang et al., 2003, Marine Geology or Munz et al., 2017), we have updated our text to incorporate the fact that the initial driver for the winter monsoon disturbances is potentially the thermal contrast between the Asian continent and the Indian Ocean (Dimri et al. 2016).

Line 116: Dimri et al., 2015?

Fixed.

Line 220: Pisias et al, 2013 is not in reference list.

Fixed.

Line 313: Böll et al., 2014.

Fixed.

Line 332 and lines 364-369: I do not recommend introducing a new term called Late Neoglacial Anomaly (LNA). First of all, this period consists of two cooler (Migration Period, Little Ice Age) and two warmer periods (Medieval Climate Anomaly and Modern Warming). Second, the dynamical background differs clearly from the so-called ENA: Orbital forcing set the stage, Grand Solar Minima, volcanic events and GHG forcing played a key role and, likely, internal variability had a significant influence (see Bradley et al., 2016, The Medieval Quiet Period. The Holocene, doi:10.1177/0959683615622552).

We see the reviewer's point. However, both ENA and LNA are composed of a series of anomalies (best expressed in the high resolution Cariaco ITCZ reconstruction but also in other records mentioned in the text - see figure 3) separated by a more quiescent interval. The problem then becomes the use of the singular form ("anomaly") that indeed does not reflect the above described situation. This is now addressed by changing to the use of plural form: ENA – Early Neoglacial Anomalies and LNA – Late Neoglacial Anomalies. At this stage, we do not and cannot tackle the ultimate causes of each of these anomalies but only a possible mechanism of transmitting them at larger geographical scales (i.e., the inter-hemispheric thermal balance).

Line 376: Büntgen et al., 2016

Fixed.

Lines 380-383: I agree, but we should not forget mentioning internal variability!

Internal variability was and is mentioned right at the top of the paragraph: "...could have provided favorable conditions for internal modes of climate variability, either tropical or polar, to become dominant..."

Lines 431-432, 437: You mention several local names. I ask me if you should also add a Figure with a local map?

We added a supplementary figure with a map of geographical names.



Lines 480-485: This is a very important question. I am asking me whether or not literature about this phenomenon is available?

We could not track such seasonality in literature. But a recently published paper (now cited) suggests increased rain during ENA in the Kutch/Saurashtra region.

Figure 1: I am not happy with the direction of the arrow marking the Summer Monsoon. Look at your Figure 2 A or consult Figure 1 in Chen et al., 2008, Quaternary Science Reviews 27, 351-364. Why did you not insert an arrow for Winter Monsoon?

Fig. 1 shows direction of the dominant moisture sources during summer and winter for the Harappan domain, which are not necessarily monsoons directions. Fig. 2 shows that instead. We clarified this more in the caption.

Caption now reads: *Fig. 1. Physiography and precipitation sources for the Harappan domain. The dominant source during summer monsoon is the Bay of Bengal while western disturbances provide the moisture during winter. The extent of the Indus basin and Ghaggar-Hakra (G-H) interfluve are shown with purple and brown masks, respectively. Locations for the cores discussed in the text are shown.*

Figures 2-5: In my opinion, for a better orientation, it would make sense to denominate the Figures 2-5 with letters A, B, C etc.

Fixed.

Abbreviations: The paper contains numerous abbreviations. It would possibly make sense adding a list of abbreviations at the end of the paper text.

We can certainly do that if the journal would accommodate it but wait for the editor's decision on this point.