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COMMENT

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Comment on "Asynchronous variation in the East Asian winter monsoon during the Holocene" by Xiaojian Zhang, Liya Jin, and Na Li

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Abstract Comparing paleoproxy records throughout China and two climate models simulation results, Zhang et al. (2015) reported asynchronous Holocene spatiotemporal decline of the East Asian winter monsoon. Six sea surface temperature (SST) proxy records from the Atlantic Ocean and northern Indian Ocean and South China Sea were used to validate climate simulations results. However, the referred Mg/Ca SST record from the western Atlantic Ocean is simply nonexistent and the northeast Atlantic Mg/Ca SST data do not reflect winter SST as Zhang et al. (2015) argued to support the driving mechanisms. Furthermore, the western Indian Ocean SSTs data used in Zhang et al. (2015) do not reflect the winter SSTs or regional changes in the Holocene SSTs. Therefore, we question the validity of model simulation results and hence the reliability of conclusions in Zhang et al. (2015).

1. Introduction

Proxy records from four lakes throughout China were used to assess changes in the East Asian winter monsoon (EAWM) during the Holocene by *Zhang et al.* [2015]. The authors suggested that the northwestern Chinese climate declined between 10 and 7.5 ka, whereas the southern China and eastern Tibetan Plateau declined until after 6–4.5 ka. The authors also suggest that all the EAWM proxy records show strengthening of the EAWM between 4.5 ka and 2 ka which the authors attribute to a change in the sea surface temperatures (SSTs). To provide driving mechanisms that can account for the divergence between the two regions, *Zhang et al.* [2015] utilized the proxy records of sea surface temperatures (SSTs) from the Atlantic Ocean and Indian Ocean and South China Sea. However, the proxy SST records the authors referred to simply neither exist nor reflect the winter SSTs. In the following section, we briefly describe those three records of the subpolar North Atlantic Ocean and Indian Ocean. In addition, nine paleoproxy records are discussed to shed further light into various SST proxies and to support our comments.

2. SST of the Subpolar North Atlantic Ocean

Sachs [2007] reconstructed the Holocene SSTs using three northwestern Atlantic sediment cores, namely, OCE326-30GGC from the margin east of Nova Scotia (Emerald Basin), OCE326-26GGC from abyssal depth of the Laurentian Fan (northwestern Atlantic Ocean), and CH07-98-19GGC from the continental slope east of Virginia. The author estimated the SSTs by alkenone paleothermomerty, not the Mg/Ca-derived SST in core OCE326-26GGC referred by *Zhang et al.* [2015]. We plot the SSTs using alkenone concentration from those three cores in addition to the other SSTs records from the subpolar North Atlantic in Figure 1. It is clear in Figures 1a, 1b1, and 1c that there is no rising trend in SSTs between 4.5 ka and 2 ka as shown in Figure 11 of *Zhang et al.* [2015]. However, the Mg/Ca-derived SSTs in planktonic forams are available from core OCE326-26GGC [*Keigwin et al.*, 2005] which are also plotted in Figures 1b1 and 1b2 but not refereed in *Zhang et al.* [2015].

Keigwin et al. [2005] reconstructed the Mg/Ca SSTs using planktonic forams *Neogloboquadrina pachyderma* (sinistral) and *Globigerina bulloides* (Figures 1b1 and 1b2). The seasonality and ensuing fluxes of *N. pachyderma* (s) and *G. bulloides* [*Tolderlund and Bé*, 1971; *Keigwin and Pickart*, 1999; *Jonkers et al.*, 2010, 2013; *Farmer et al.*, 2008] in the subpolar North Atlantic Ocean are well known. Briefly, *N. pachyderma* (s) records surface water conditions during the late spring (April to May) and late summer (August to September) [*Jonkers et al.*, 2013], whereas *G. bulloides* largely record surface water conditions between April and December [*Jonkers et al.*, 2013] in the northern North Atlantic. However, the production of *G. bulloides* may vary depending on the latitude

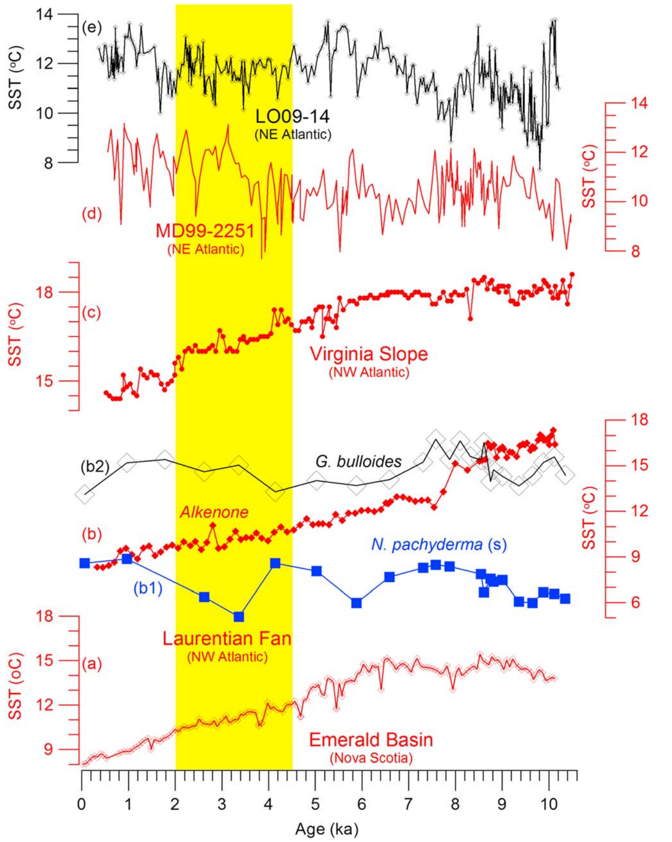

Figure 1. Proxy records of sea surface temperatures (SSTs) from five subpolar North Atlantic Ocean sediment cores are plotted according to their independent age models. Alkenone-derived SSTs from cores (a) Emerald Basin OCE326-30GGC, (b) Laurentian Fan OCE326-26GGC, and (c) Virginia slope CH07-98-19GGC [*Sachs*, 2007]; Mg/Ca-derived SSTs from the planktonic foram (b1) *Neogloboquadrina pachyderma* (s) and (b1) *Globigerina bulloides* from Laurentian Fan core OCE326-26GGC [*Keigwin et al.*, 2005], and (d) northeast Atlantic Ocean core MD99-2251 [*Farmer et al.*, 2011]. (e) Diatom assemblage-derived SSTs from core LO09-14 [*Berner et al.*, 2008]. Note the vertical yellow shaded column indicates the interval of interest of *Zhang et al.* [2015].

[*Tolderlund and Bé*, 1971; *Duplessy et al.*, 1991; *Farmer et al.*, 2008]. Therefore, neither the *N. pachyderma* (s) nor the *G. bulloides* reflects winter SST in the subpolar North Atlantic Ocean. Furthermore, the SSTs data in Figures 1b, 1b1, and 1b2 provide insight about the dynamics of mixed and thermocline layers. For example, alkenone SST data show an onset of cooling trend at 7.6 ka similar to the onset of cooling observed in *G. bulloides* Mg/Ca SST. However, the Mg/Ca SST in *N. pachyderma* (s) show an onset of warming at 9.2 ka which lasted until 6 ka (Figure 1b1). There are significant divergences between *N. pachyderma* (s) and *G. bulloides* Mg/Ca SSTs in the interval (i.e., 4.5 ka and 2 ka) of interest of *Zhang et al.* [2015].

Sediment core MD99-2251 was retrieved from the Gardar Drift of the subpolar North Atlantic Ocean. *Farmer et al.* [2011] reconstructed the Mg/Ca SSTs (Figure 1d) using the *G. bulloides* from this core. As stated above as well as in *Farmer et al.* [2008, 2011] that *G. bulloides* reflects surface water conditions during late spring to summer at site MD99-2251, not the winter SSTs. Nevertheless, there is a rising trend in SSTs but again the onset is not at 4.5 ka but at 3.6 ka as can be seen from Figure 1d. Diatoms assemblage-derived SSTs data (Figure 1e), which is assumed to reflect August SSTs in this region of nearby core LO09-14 [*Berner et al.*, 2008], do not show any rising trend in SSTs at 4.5 ka either.

In summary, we conclude that the paleoproxy SSTs data used by *Zhang et al.* [2015] do not reflect the winter SSTs of the subpolar North Atlantic Ocean.

3. Western Indian Ocean SST

To provide a driving mechanism for the decline of EAWM between 6 and 4.5 ka over the eastern Tibetan Plateau and southern China, *Zhang et al.* [2015] used the alkenone-derived SSTs from the northern tropical Indian Ocean core MD77-194. It is collected from the southwestern Indian continental margin at 1222 m water depth, a hydrographic setting not conducive for using alkenone concentration method of SST reconstruction. The Ganga and Brahmaputra rivers discharge a large volume of sediments into the lower Bay of Bengal shelf during the months of June-July-August. These fine-grained sediments and freshwater are carried by the East Indian Coastal Current (EICC) into the eastern Arabian Sea below the southern tip of Sri Lanka [*Shankar et al.*, 2002]. Furthermore, the EICC reverses its direction during the winter monsoon allowing for the transport of fine-grained sediments as far away as the Indus River [*Schott and McCreary*, 2001] via the West Indian Coastal Current (WICC) into the Bay of Bengal. Site MD77-194 is located in the center of both the EICC and the WICC and organic compounds such as alkenones primarily attached to fine-grained particles can suffer from lateral

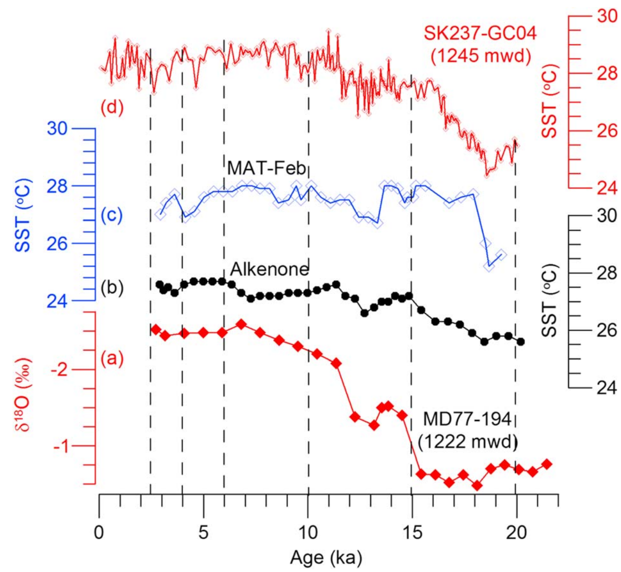

Figure 2. Proxy records of sea surface temperatures (SSTs) from two tropical eastern Indian Ocean sediment cores are plotted according to their independent age models. (a) Oxygen isotopic ratios in the planktonic foram *Globigerinoides ruber* (white variety) [*Duplessy*, 1982], (b) Alkenone [*Sonzogni et al*., 1998], and (c) modern analog technique (MAT) [*Cayre and Bard*, 1999]-derived SSTs from the eastern Indian continental margin sediment core MD77-194. (d) Mg/Ca SST from sediment core SK237-GC04 [*Saraswat et al*., 2013] nearby of core MD77-194 is also plotted. Note that the vertical discontinuous lines guide the various climate intervals discussed in the text.

transport [*Benthien and Muller*, 2000; *Mollenhauer et al*., 2005, and references therein]. Therefore, the SST reconstructed using the alkenone concentration at site MD77-194 is not a reliable in situ temperature. Furthermore, alkenone is generally assumed to be an annual average SST proxy [*Herbert et al*., 1998; *Sonzogni et al*., 1998; *Cayre and Bard*, 1999].

To decipher additional insight on evolution of temperature during the Holocene, we plot the SSTs reconstructed using the modern analog technique (MAT) from the same core MD77-194 [*Cayre and Bard*, 1999] in addition to the alkenone-derived SST [*Sonzogni et al*., 1998]. Furthermore, recent Mg/Ca SST data from a nearby core SK237-GC04 [*Saraswat et al*., 2013] are also plotted in Figure 2. A few observations can be summarized as follows:

1. The age model of core MD77-194 used in *Zhang et al.* [2015] has no validity as the core does not contain sediments younger than 2.71 ka [see *Cayre and Bard*, 1999; *Saher et al*., 2007].
2. Fluctuation of 0.3°C SST between 4.5 ka and 2 ka shown in Figures 2b2 and 2c2 of *Zhang et al.* [2015] is negligible given the combined instrumental and calibration errors in estimating the SSTs from alkenone concentration is larger than the 0.2–0.3°C [see *Sonzogni et al*., 1998; *Cayre and Bard*, 1999, and references therein].
3. Modern analog technique (MAT)-derived SST estimates [*Cayre and Bard*, 1999] from the same core (i.e., MD77-194) do not show the "apparent cooling of 0.2°C," rather it shows the warming trend which is bigger than 0.2°C (see Figure 2b).
4. Finally, the most important point as *Zhang et al.* [2015] stated that "the abrupt increase in western Indian Ocean (derived from site MD77-194) mirrors the rapid decline in the EAWM intensity from 6 to 4.5 ka" has no basis if one examines the paleoproxy records of SSTs in Figure 2. There is no abrupt increase in SSTs in the eastern (it is not the western) tropical Indian Ocean.

4. Conclusions

Estimates of past sea surface temperatures using various proxies require detailed knowledge as well as the hydrographic setting, seasonality, and flux rate of those climate signal carriers. In this context, the use of the SST records from the subpolar North Atlantic Ocean and northern tropical Indian Ocean by *Zhang et al.* [2015] remind us the utility of due diligence in assessing paleoproxies.

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References

Benthien, A., and P. J. Muller (2000), Anomalously low alkenone temperatures caused by lateral particle and sediment transport in the Malvinas Current region, western Argentine Basin, *Deep Sea Res., Part I*, *47*, 2369–2393.

Berner, K. S., N. Koç, D. Divine, F. Godtliebsen, and M. Moros (2008), A decadal-scale Holocene sea surface temperature record from the subpolar North Atlantic constructed using diatoms and statistics and its relation to other climate parameters, *Paleoceanography*, *23*, PA2210, doi:10.1029/2006PA001339.

Cayre, O., and E. Bard (1999), Planktonic foraminiferal and alkenone records of the last deglaciation from the eastern Arabian Sea, *Quat. Res.*, *52*, 337–342.

Duplessy, J.-C. (1982), Glacial to interglacial contrasts in the northern Indian Ocean, *Nature*, *295*, 494–498.

Duplessy, J.-C., L. Labeyrie, A. Juillet-Leclerc, F. Maitre, J. Duprat, and M. Sarnthein (1991), Surface salinity reconstruction of the North Atlantic Ocean during the Last Glacial Maximum, *Oceanol. Acta*, *14*, 311–324.

Farmer, E. J., M. R. Chapman, and J. E. Andrews (2008), Centennial-scale Holocene North Atlantic surface temperatures from Mg/Ca ratios in *Globigerina bulloides*, *Geochem. Geophys. Geosyst.*, *9*, Q12029, doi:10.1029/2008GC002199.

Farmer, E. J., M. R. Chapman, and J. E. Andrews (2011), Holocene temperature evolution of the subpolar North Atlantic recorded in the Mg/Ca ratios of surface and thermocline dwelling planktonic foraminifers, *Global Planet. Change*, *79*, 234–243, doi:10.1016/j.gloplacha.2011.02.003.

Herbert, T. D., J. D. Schuffert, D. Thomas, C. Lange, A. Weinheimer, A. Peleo-Alampay, and J.-C. Herguera (1998), Depth and seasonality of alkenone production along the California margin inferred from a core top transect, *Paleoceanography*, *13*, 263–271, doi:10.1029/98PA00069.

Jonkers, L., G.-J. A. Brummer, F. J. C. Peeters, H. M. van Aken, and M. F. De Jong (2010), Seasonal stratification, shell flux, and oxygen isotope dynamics of left-coiling *N. pachyderma* and *T. quinqueloba* in the western subpolar North Atlantic, *Paleoceanography*, *25*, PA2204, doi:10.1029/2009PA001849.

Jonkers, L., P. Jiménez-Amat, P. G. Mortyn, and G.-J. A. Brummer (2013), Seasonal Mg/Ca variability of *N. pachyderma* (s) and *G. bulloides*: Implications for seawater temperature reconstruction, *Earth Planet. Sci. Lett.*, *376*, 137–144, doi:10.1016/j.epsl.2013.06.019.

Keigwin, L. D., and R. S. Pickart (1999), Slope water current over the Laurentian fan on interannual to millennial time scales, *Science*, *286*, 520–523.

Keigwin, L. D., J. P. Sachs, Y. Rosenthal, and E. A. Boyle (2005), The 8200 year B.P. event in the slope water system, western subpolar North Atlantic, *Paleoceanography*, *20*, PA2003, doi:10.1029/2004PA001074.

Mollenhauer, G., M. Kienast, F. Lamy, H. Meggers, R. R. Schneider, J. M. Hayes, and T. I. Eglinton (2005), An evaluation of ^{14}C age relationships between co-occurring foraminifera, alkenones, and total organic carbon in continental margin sediments, *Paleoceanography*, *20*, PA1016, doi:10.1029/2004PA001103.

Sachs, J. P. (2007), Cooling of Northwest Atlantic slope waters during the Holocene, *Geophys. Res. Lett.*, *34*, L03609, doi:10.1029/2006GL028495.

Saher, M. H., S. J. A. Jung, H. Elderfield, M. Greaves, and D. Kroon (2007), Sea surface temperatures of the western Arabian Sea during the last deglaciation, *Paleoceanography*, *22*, PA2208, doi:10.1029/2006PA001292.

Saraswat, R., D. W. Lea, R. Nigam, A. Mackensen, and D. K. Naik (2013), Deglaciation in the tropical Indian Ocean driven by interplay between the regional monsoon and global teleconnections, *Earth Planet. Sci. Lett.*, *375*, 166–175, doi:10.1016/j.epsl.2013.05.022.

Schott, F. A., and J. P. McCreary (2001), The monsoon circulation of the Indian Ocean, *Prog. Oceanogr.*, *51*, 1–123.

Shankar, D., P. N. Vinaychandran, and A. S. Unnikrishnan (2002), The monsoon currents in the north Indian Ocean, *Prog. Oceanogr.*, *52*, 63–120.

Sonzogni, C., E. Bard, and F. Rostek (1998), Tropical sea-surface temperatures during the last glacial period: A view based on alkenones in Indian Ocean sediments, *Quat. Sci. Rev.*, *17*, 1185–1201.

Tolderlund, D. S., and A. W. H. Bé (1971), Seasonal distribution of planktonic foraminifera in the Western North Atlantic, *Micropaleontology*, *17*, 297–329.

Zhang, X., L. Jin, and N. Li (2015), Asynchronous variation in the East Asian winter monsoon during the Holocene, *J. Geophys. Res. Atmos.*, *120*, 5357–5370, doi:10.1002/2014JD022585.