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Climate of the Past Discussions

Interactive comment on "Oxygen isotopic analyses of individual planktic foraminifera species: implications for seasonality in the western Arabian Sea" *by* P. D. Naidu et al.

Anonymous Referee #1

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The manuscript aims at analyzing the dispersion of d18O analyses performed on single foraminifer shells picked in several intervals from an ODP site off the Oman Coast. Changes in this dispersion across the last 20 ka are discussed in terms of past evolution of seasonal variability in the Arabian Sea. The foraminifer d18O is then corrected for temperature changes using foraminifer assemblage-T° reconstructions in order to extract the seawater d18Osw variability, interpreted in terms of changes in seasonality of evaporation/precipitation.

Although the approach is very promising and has been already used by other authors to extract seasonal or inter-annual variability in marine sediments, I see several important weaknesses in the manuscript at this stage and suggest that it should be rejected.

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Interactive Discussion
Discussion Paper

1/ First, the method needs to be discussed more in depth:

What is the amount of material (μg) analyzed when picking individual G sacculifer and N dutertrei in the 500-600 μm size fraction?

Is the external reproducibility given in 1sigma or 2 sigma? I assume it is 1sigma. Yet, even at 1 sigma, this reproducibility (i.e. 0.05‰ seems low for small samples. Koutavas et al (2006) reported a 1 sigma uncertainty of $\sim$ 0.1‰ in their mono-foraminifer study, and in our laboratory, using a more recent and sensitive machine than the MAT250, we obtained a 1 sigma uncertainty of about 0.08‰ for 10-20 μg carbonate samples. Thus, I wonder whether the calibration exercises using NBS-20 had been performed with powder masses similar to those of mono-foraminifer analyses?

The number of individual analyzed per samples should be specified in the manuscript. From the figures, it seems that about 18-20 G sacculifer were analyzed/sample .. but only about 7-8 N dutertrei. I doubt that 7-8 specimens will make it possible to pick up the full range of variability in any given sample. And I'm not sure whether 18-20 G sacculifer specimens is enough either... Previous studies devoted to mono-foraminifer analyses have been using much larger batches of individual analyses (50-100). The authors should address this issue in depth and use statistics to decipher whether the size of their mono-foraminifer batches is adapted for their purpose. With a reduced sampling (18-20 specimens), I suspect that the results could be more easily biased by productivity (i.e. instead of retrieving the full range of seasonal variability, the analyzed foraminifer population could be biased towards the more productive period(s) of the year).

2/ I see major problems in the way the authors correct their foraminifer d18O for temperature effect and estimate seasonal differences in SSS:

From what I understood, it seems that extreme, individual foraminifer d18O values in each sample (min and max d18Oc) are corrected for temperature effect using the summer and winter SST estimated from planktonic foraminifer assemblages. To me, there

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is clearly a major flaw in that approach... Modern SSTs in the studied area show a seasonal variability of about 5°C. In contrast, the temperature estimates obtained in the uppermost sample of ODP 723 core - at 0.5 ka - only reveal a winter/summer SST difference of 0.4°C (all the reconstructed Holocene DeltaSST are in the range 0.1-0.7°C). This clearly suggests that SST reconstructions using foraminifer assemblages fail to extract the full range of seasonal temperature variations at this location. Using foraminifer assemblage SST to correct individual d18Oc will result in a strong underestimation of the temperature effect and, consequently, will put too much emphasis on d18Osw variability.

Once the d18Osw has been obtained, the authors use a modern empirical equation to convert these d18Osw values into sea surface salinity. They do not discuss whether they consider that this modern equation can be confidently used across the entire 0-20 ka interval.

3/ Two other key aspects require also much in depth discussion:

Why do the authors assume that the d18Oc dispersion chiefly (only?) reflects seasonal variability? What about inter-annual variability? Apart from varved sediments where annual or seasonal deposits are preserved, cm-thick marine core samples usually contain a mix of foraminifers that have deposited other decades to centuries (or more in low sedimentation rate areas). Thus, potentially, the range of recorded variability may far exceed seasonal variability alone. I wonder, therefore, whether extreme d18Oc values observed in several ODP 723 samples (i.e. values clearly away from the main group of data) reflect "normal" seasonal extremes or could rather reflect longer-term, inter-annual variability and extreme events.

Because site ODP723 is located within the modern OMZ, the authors indicate that bioturbation is likely reduced (without discussing direct evidence, however). But OMZ has changed in the past in response to changes in productivity and/or intermediate water circulation. Thus, it is likely that bioturbation intensity has evolved accordingly.

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To my knowledge, sediments retrieved from this ODP site are not varved, and some amount bioturbation is likely. I wonder to what extent bioturbation could explain part of the extreme variability observed during the deglaciation; an interval in which even small vertical mixing of foraminifers could have a major impact on the dispersion of individual d18O analyses.

Interactive comment on Clim. Past Discuss., 10, 3661, 2014.