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Interactive comment on "Stratification of surface waters during the last glacial millennial climatic events: a key factor in subsurface and deep water mass dynamics" *by* M. Wary et al.

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Short comment on Wary et al. 'Stratification of surface waters during the last glacial millennial climatic events: a key factor in subsurface and deep water mass dynamics'.

My comments are on some of the methodological aspects of this paper and focus mainly on the planktonic foraminifera proxies. I think these issues need to be addressed before the data can be interpreted in terms of stratification.

Planktonic foraminifera assemblage based temperature estimates.

The authors argue that the MAT temperature estimates (F-Temp) reflect temperature

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at the depth where the planktonic foraminifera lived. While I don't disagree that planktonic foraminifera occupy a depth range similar to the 0-300 m the authors state, the argument that the F-Temp estimates reflect subsurface temperatures is not correct. This is because MAT approach used by the authors yields temperatures at 10 m depth by design (the down core assemblages are compared to core-top assemblages and modern temperatures at 10 m depth). Without going into the details on the accuracy of the reconstructions (which should be addressed in a revised manuscript), this basically means that the present reconstruction of stratification is based on two estimates of sea surface temperature, which cannot be right. If the authors want to reconstruct temperature deeper in the water column, then they need to i) demonstrate that the modern assemblages in the training set are better described/explained by temperature variability over say the upper 300 m (instead of the surface; see e.g. [Pflaumann et al., 1996]) and ii) 'recalibrate' the MAT by comparing the fossil assemblages to temperatures at this depth range. If i) can be demonstrated then this will change the F-Temp estimates considerably because temperatures at depth are generally lower than at the surface and less variable (i.e. resulting in a less steep calibration curve so to say). To summarise, while part (and not all) of the planktonic foraminifera population may live deeper in the water column, the authors need to demonstrate that subsurface temperatures are a better predictor of assemblage variability in the core top data set and if so repeat the MAT with sub surface temperatures rather than SST. Simply inferring that the foram-based SSTs actually reflect subsurface temperatures because they are lower and show a smaller seasonality (but see below) than the dynocyst-based SSTs is not sufficient to reconstruct stratification.

Seasonality

Seasonal temperatures in the modern ocean are highly correlated, thus impeding independent reconstruction using transfer functions [Kucera et al., 2005]. The estimates of seasonality are thus not independent and should not be used as an indicator for the depth reflected by the temperature estimates. (Also, the estimates for past seasonality

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are ∼8 x (forams) and ∼5 x (dynocysts) larger than modern observations, which would require some additional discussion/questioning.)

Seawater δ18O estimates

N. pachyderma generally lives in the subsurface and its major flux pulse is somewhere in spring-summer. However, the calcification depth and season of N. pachyderma are likely to have varied through time (perhaps as a function of climate) e.g. [Jonkers and Kučera, 2015]. The estimates of δ18Osw based on the MAT derived sea surface temperatures are thus inherently flawed because they do not (necessarily/always) reflect calcification temperature of N. pachyderma.

References:

Jonkers, L., and M. Kučera (2015), Global analysis of seasonality in the shell flux of extant planktonic Foraminifera, Biogeosciences, 12(7), 2207-2226. Kucera, M., et al. (2005), Reconstruction of sea-surface temperatures from assemblages of planktonic foraminifera: multi-technique approach based on geographically constrained calibration data sets and its application to glacial Atlantic and Pacific Oceans, Quaternary Science Reviews, 24(7-9), 951-998. Pflaumann, U., J. Duprat, C. Pujol, and L. D. Labeyrie (1996), SIMMAX: A Modern Analog Technique to Deduce Atlantic Sea Surface Temperatures from Planktonic Foraminifera in Deep-Sea Sediments, Paleoceanography, 11(1), 15-35.

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