Comment on "AMO-like variations of Holocene sea surface temperatures in the North Atlantic Ocean" by S. Feng et al.

The paper deals with the Atlantic Multidecadal Oscillation (AMO) found in the instrumental record (since AD 1850). The authors claim that they found that this decadal oscillation pattern is indeed the dominant SST pattern for the entire Holocene. The authors also address two climate events: the cold 8.2 ka event and the Medieval Warm Period (c. AD 800–1300) in relation to the AMO. Although this paper addresses an interesting aspect to describe the Holocene SST variability, I feel that their argument is not fully supported by the current Holocene proxy data. I have difficulties with the interpretation of the pattern, cooling in the North Atlantic is not related to AMO or NAO, it is related to the response mainly to the insolation. NAO may explain some heterogeneities. My specific comments that the authors should consider for their paper are listed below.

1. Compilation of the Holocene SST data:
To investigate the Holocene SST variability and its similarity with the AMO in the Atlantic Ocean, the authors used mostly the GHOST data (Kim, J.-H., Schneider R.R., (2004), GHOST global database for alkenone-derived Holocene sea-surface temperature records. Available from: http://www.pangaea.de/Projects/GHOST) but added a few additional Mg/Ca and $\delta^{18}O$ records to their Holocene dataset. The statistics and interpretations by the authors are therefore based on this mixed proxy dataset. In my view, this approach strongly biased the results and thus influenced their interpretation. Recently, Leduc et al. extended the GHOST dataset and compiled a new dataset for the Mg/Ca (the paper is accepted for the publication in Quaternary Science Reviews). They confirmed the SST distribution pattern previously described based on alkenone data. However, comparison of Holocene SST records derived from two different methods reveals contrasting – sometimes divergent – SST evolution, particularly at low latitudes where SST records are abundant enough to infer systematic discrepancies at a regional scale. This suggests that a strong contrast in the ecological responses of coccolithophores and planktonic foraminifera to winter and summer oceanographic conditions can be the ultimate reason for seasonal differences in the origin of the temperature signal provided by these organisms. In summary, it is not appropriate to use a mixed dataset derived from different proxies.

2. First EOF: long-term trend vs centennial-millennial cycles
The most dominant SST pattern (EOF1) in Fig. 3a,b is a trend, which has been interpreted as a response to insolation changes in previous studies as well as in the paper presented here. However, it is not entirely clear how this insolation-driven trend is related to the AMO pattern. Are they the same thing? The trend can be considered more reasonably insolation-driven glacial-interglacial cycles while the AMO pattern might be associated with shorter (centennial to millennial) cycles at the best, like shown in Fig. 4. The authors should clarify whether they are referring both trend and cycles in relation to the AMO. If yes, firstly, it should be explained how both insolation and AMO are connected to the SST trend. Secondly, it should be explained how significant the residual of PC1 showing millennial cycles is. Most proxy records presented in this study can be used to study the Holocene SST trend with confidence. However, considering the time resolution of proxy records and the amplitude of SST changes during the Holocene, it is uncertain how credible the residual of PC1 is for the investigation of centennial to millennial

cycles. For example, the analytical uncertainty of alkenone records can be about 0.5°C and the calibration uncertainty can be +/- 1.5°C.

3. AMO-SST vs. NAO-SST pattern:

This paper describes the monotone SST pattern for the entire Atlantic Ocean, which resembles the AMO SST pattern (see Fig. 3a). However, if we consider only alkenone records (see also the comments above), which is the most dominant records considered in this paper, the SST pattern is indeed heterogeneous, showing a contrasting pattern between the North Atlantic and tropical western Atlantic as well as between eastern Mediterranean/Northern Red Sea and western Mediterranean/eastern North Atlantic. Such patterns do not appear in any seasonal AMO-SST patterns. The authors claim that the Holocene AMO-SST pattern can be explained by the THC changes. If it is the case, the Holocene SST pattern in the South Atlantic should show an anti-phase compared to that of the North Atlantic. At least, the existing data do not fully support this interpretation. The core showing a warming in the Southeast Atlantic is not necessarily representative of the whole South Atlantic. This record can be also explained as a local signal according to the original paper (Kim et al., 2003) considering the local oceanic frontal system in the eastern boundary system in the Southeast Atlantic. It is also worth to note that the authors describe a whole basin wide homogeneous SST pattern in the Atlantic Ocean in relation to the AMO (see Fig. 3a) but the THC mechanism predicts an anti-phase SST pattern between the North and South Atlantic. The authors also argued that the basin-wide homogeneous SST pattern in the North Atlantic induced dipolar SLP pattern in the Atlantic region and thus an anti-phase SST pattern between the eastern Mediterranean and the North Red Sea and the rest Atlantic. However, AMO related SLP pattern does not produce such an anti-phase SST relationship. That is why the NAO has been introduced to explain this SST pattern in the previous studies. It should be also noted that the NAO-related SST pattern is not considered as the dominant Holocene SST pattern in the previous studies. It is rather considered as a secondary order pattern superimposed on the insolation induced SST pattern.

3. 8.2 ka event and MWP:

It is obvious from Figure 5 that most records are coming from the Northern Hemisphere and only a few records from the Southern Hemisphere. The provided Southern Hemisphere records do not provide strong supporting evidence of the homogeneous SST pattern, especially for the MWP. Therefore, their interpretation related to 8.2 ka event and MWP are still speculative. Definitely, more records are needed from the Southern Hemisphere to confirm or disprove their claim. Most interestingly, the SST pattern for 8.2 ka event and MWP in Fig. 5 is not the same as that in Fig 3 (EOF01). Therefore, it is not clear whether the physical mechanisms behind them should be the same at all.