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Climate of the Past Discussions

Interactive comment on "Eastern Mediterranean Sea circulation inferred from the conditions of S1 sapropel deposition" *by* K. Tachikawa et al.

Anonymous Referee #2

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In their submitted manuscript, Tachikawa and co-workers attempt to restore paleocirculation conditions at the time of the S1 sapropel deposition in the deep eastern Mediterranean Sea. Tachikawa et al. present new high resolution bulk sediment elemental composition (XRF and ICP-MS measurements) coupled to stable oxygen isotope analyses and benthic foraminifera assemblage data from a deep-sea core collected at 1780 m water-depth in the Eastern Levantine Sea. The age model of the studied core is based on 12 AMS 14C dates providing secular to millennial scale temporal resolution. The authors suggest, thanks to their results and existing data, that the S1 formation was induced by, marked fresh water inputs from the Nile river starting before its deposition between 15 to 12 ka and related to insolation changes. That would have had the effect to reduce the ventilation within the upper 1780 m. Finally, the authors propose a scenario characterizing the sapropel S1 interruption phase and S1 termi-

nation suggesting short-term re-oxygenation in the Levantine basin that was attained earlier within the upper 1780 m than at deeper depth. Within a general perspective, contributions, such as those of Tachikawa et al. should help to build a more extensive database of information about the state of ventilation of the deep Eastern Mediterranean Sea. This is a pivotal point for understanding the conditions and processes that regulate the Mediterranean Sea thermohaline circulation prior, during and after the S1 sapropel deposition. In conclusion, this study provides a consistent new dataset using complementary tracers to traditional stable oxygen and carbon isotopic data currently used in paleoceanography. The manuscript is overall well written and the figures are of a good quality. However, some passages of the manuscript reveal that interpretations flaw sometimes of originality when compared to previous studies. The authors focused on the period that preconditioned the S1 deposition, the S1 interruption phase and S1 termination. A more detailed analysis of the mechanisms leading to the second phase of sapropel (S1b just before S1 termination) would certainly have strengthened the quality of the manuscript. For any reasons mentioned above, and after careful considerations, I recommend publication of the manuscript after minor revisions.

In the following some additional issues listed below in the order in which they are encountered in the text:

Page 4659 line 17-20 : We are aware that, due to diagenetic processes and post-despositional diffusion that can modify boundary positions, precise timing for ventilation changes is difficult to obtain from bulk geochemistry.

This sentence is in contradiction with the objective of this study because precludes a precise interpretation of the geochemical dataset and a solid comparisons with other studies in the Eastern Mediterranean area. The Authors should provide a more robust explanation on this point.

Page 4659-4660 : Conditions of bottom water circulation prior to S1 deposition

To restore δ18Ow anomaly, the authors refer to SST reconstructions from core MD84-

632 by Essellami et al. (2007). I was wondering why the authors did not refer to the neighbor core MD84-641 (33°02âĂš N; 32°28âĂš E, 1375 m water depth) that benefits of detailed oxygen isotope record, SST estimates, benthic foraminifera assemblages analyses as well as a robust age model based on a large dataset of AMS 14C dates (i.e. Fontugne et al. 1994 ; Melki et al. 2010), mineralogical and chemical analyses of bulk sediment and organic carbon and carbonate analyses (Fontugne & Calvert, 1992; Calvert et al. 2001). It is surprising to note the absence of these references in the manuscript. Comparisons with previous studies on core MD84-641 could have provided useful insights and clues in interpreting the results of the present study. The Authors have to provide a compelling explanation on this point.

In the eastern Mediterranean Sea, slow circulation seems to have begun from 15 to 12 cal ka BP and to have affected waters at 700 to 1780m in depth, currently occupied by well-oxygenated EMDW. . .. . . Based on decreasing benthic foraminiferal δ13C values that began at 15 cal ka BP (Fig. 4), slower ventilation has also been estimated for a water depth of approximately 700m in the south Aegean Sea (site SL123) and for a water depth of approximately 900m in the southeast Levantine Sea (site SL112).

This step is confusing, slow ventilation starts for both Aegean and Levantine basin at 11 ka as indicated by benthic δ13C record in figure 4. Between 15 to 11 ka δ13C values at âĹij 1,5 ‰ suggest ventilation state at 700 and 900 m similar to present-day. Similarly, benthic δ13C record from the South Adriatic (Siani et al. 2013) and the North Aegean Sea (core SL148, Schmiedl et al. 2010) as well benthic assemblage oxygen index from core SL148 indicate the formation of well oxygenated deep-waters at least until 11 ka. Accordingly, the EMDW still persist to feed the deep Levantine basin at the Early Holocene like today. A comment from the author turns out necessary for this point of the discussion taking into account recent model studies proposing initial glacial conditions for deep waters preconditioning the S1 formation (Adloff et al., 2011; Grimm, 2012).

Page 4662-4663 : Re-ventilation in the middle of the S1 period

Our results indicate that during S1 formation, re-ventilation affected bottom water located at the upper limit of the anoxic layer at 1800m. By combining the results of core MD04-2722 with previously reported high-resolution records, we examine the spatial coverage of re-oxygenation. . ..

The authors should provide the benthic oxygen index record from core MD04-2722 and compare it with those of figure 5 (LC-31, SL123 cores). The curve of benthic foraminifera abundance alone is not representative of bottom water ventilation history for the deep eastern Mediterranean Sea. Furthermore, one should be cautious on the interpretation of the LC31 BOI record (Abu-Zied et al., 2008). As stated by Abu-Zied et al., the sapropel layer is interrupted between 85 and 80 cm by two light gray colored layers. One of these layers crosses only half the width of the core, and is interpreted as a small slump confirmed by AMS 14C dates showing a significant dating reversal at 84 cm. Therefore, the interpretation of large spatial distribution of the S1 interruption stays questionable. The Authors should clarify this point by providing a coherent explanation of any mechanisms that would induce a stronger oxygenation of the Levantine deep water (LC31, 2300 m) with respect to the S. Aegean intermediate waters (SL123, 728 m). A more plausible explanation would be attributable to a misleading age model of the LC31 core.

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