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Climate of the Past
Discussions

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Interactive Comment

Interactive comment on "Salinity changes in the Agulhas leakage area recorded by stable hydrogen isotopes of C_{37} alkenones during Termination I and II" *by* S. Kasper et al.

Anonymous Referee #2

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Kasper and co-authors present records of hydrogen isotope (dD) ratios measured on combined di- and tri-unsaturated alkenones and alkenone-derived SST from two sediment cores from the Agulhas Leakage corridor in the southeast Atlantic across the last two glacial-interglacial transitions. The dD records show heavier values during both glacial periods followed by a gradual decrease during the terminations and lowest most depleted values during interglacials. The authors interpret the results in terms of a change from high salinities during glacials to low salinities during interglacials and suggest they reflect changes in Agulhas leakage from the Indian into the Atlantic Ocean.

General comments: While there is no doubt that the dD data are of good quality, I have some comments about the discussion of the data with respect to the available set of paleo-records from the Agulhas area and the interpretation of the results. The manuscript is missing detailed discussions of the methodology, results, and comparison with other data, as well as a detailed interpretation of the results. The manuscript therefore leaves the reader with the question of how the new record can help resolve the obvious discrepancy between different proxy records in the study area, and how it provides new insight into the dynamics of the Agulhas leakage in the past.

specific comments: The authors measured δD on combined di- and tri-unsaturated alkenones despite evidence that C37:2 and C37:3 show differences in their hydrogen isotopic composition with offsets of 20-40‰ (D'Andrea et al., 2007; Schwab and Sachs, 2009). Their choice of measuring δD on combined alkenones should be discussed in detail and with respect to their δD and SST results. Could the observed δD change be explained by this effect or would it increase the δD amplitude between glacial and interglacial periods?

Previous studies have shown clear differences between SST records derived from alkenones compared to those based on Mg/Ca ratios of foraminifera (e.g., Martinez-Mendez et al., 2008). Mainly, while UK'37-SST reconstructions suggest cold temperatures during the late glacial intervals, planktonic foram-derived SST and d18Osw records suggest anomalies of warm, saline conditions during the terminations, indicative of increased Agulhas leakage at these times (e.g., Martinez-Mendez et al., 2008). The authors mention these differences, but do not discuss them in detail with respect to their data and with respect to the implications with regard to changes in the Agulhas leakage. For example, Kasper and co-authors suggest that their dD records show the same changes as the d18Osw records of Martinez-Mendez et al. (2008) from the same cores, implying highest salinities during glacials. While this is true for the δD records, the d18Osw records show highest salinities during the terminations followed by a rapid decrease towards the interglacials. These are significant differences that are not discussed. Moreover, while the foraminiferal records show an association of high SSTs with high salinities, the opposite is observed for the alkenone-derived data that show an association of warm conditions with low salinities (depleted δD). It is not clear how the latter can be reconciled with changes in Agulhas leakage, since increased leakage would be expected to result in anomalies of warm, saline conditions in the southeast Atlantic.

The main questions the authors should consider and discuss are: 1) what climatic or oceanographic change can explain the change from saline, glacial to fresh, warm periods? And 2) how can the changes observed in the alkenone records be reconciled with those based on foraminifera, and what are the implications of this for the dynamics in the study area?

Abstract, last sentence: it has been demonstrated before, that δD of alkenones can be used to reconstruct salinity changes, this is not the first study.

Page 3211, line 1-10: could the salinity effect on Mg/Ca-SST explain the observed difference between alkenone- and foram-derived paleorecords? What are the different growth seasons of forams and coccolithophorids in the study area and could this indeed explain the observed differences?

What about a higher sensitivity of alkenones to current transport relative to forams, could this explain the differences between the proxies?

Page 3221 first paragraph: using your salinity reconstruction and applying it to the Mg/Ca record, assuming Mg/Ca is biased by high salinity, can you 'correct' for the salinity affect and arrive at the same timing of SST changes as seen in the alkenone-SST record? If you can show that this is the case, this would be a good step towards explaining the differences between temperature and salinity reconstructions from different proxy carriers in this area.

Line 17: if Agulhas leakage was increased at times of highest SST (early interglacials), why do you not see an association of highest temperatures with highest salinities but rather lowest salinities (based on δD) during peak warmth?

Technical corrections:

Page 3211, Line 9: you provide SST and salinity estimates or records, not proxies. Also page 3219

Line 12: 'The UK'37 proxy was ... warmer...' Rather, the UK'37-derived temperature was warmer. Line 12: AMOC and THC are used more or less interchangeably in the literature.

Line 16: Sebille et al., 2011 is missing from the reference list.

Page 3213, line 17: refer also to Englebrecht & Sachs, 2005.

Line 19: alkenone δD for salinity reconstructions has also been used in the Panama Basin (Pahnke et al., 2007).

Page 3220 line 1: clarify sentence ('...temperature differences...are significantly different..')

Line 8: remove 'variability' after 'modern ..SST'

Page 3222 line 19: how small is 'relatively small'? Quantify the effect this change in growth rate would have on the hydrogen isotopic composition.

Line 22: how can depleted d13Calkenone values suggest 'similar or smaller' growth rates? It should be either similar or smaller, it cannot be both.

Page 3223 line 1: The (absolute) abundance of oceanica was higher than that of E. huxleyi at the beginning of MIS5, the time when δD is most negative. So changes in species abundance could in fact play a role in the observed δD changes, although it is only a short period where G. oceanica shows higher abundance. During Termination 1, G.oceanica increased prior to the sharp increase in E.hux. and could account for some of the observed δD decrease at the beginning of the deglaciation. The authors

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should consider showing the abundance data relative to their δD record in an additional figure.

Figures 2 and 3: the vertical axes of SST and d18Osw should be stretched for better visibility of the changes.

Figure 4 caption: Mention that a) is MIS3-1 and b) is MIS6-5. Introduce abbreviation CBR somewhere in the text prior to the figure.

In summary, I recommend major and careful revision of the manuscript, especially of the discussion and the interpretation of the results. The authors need to work out the new insights that their data provide for the Agulhas area and the implications their data have for the observed discrepancies between proxies.

References: D'Andrea, W. J., Z. Liu, M. Da Rosa Alexandre, S. Wattley, T. D. Herbert, and Y. Huang. 2007. An efficient method for isolating individual long-chain alkenones for compound-specific hydrogen isotope analysis. Analytical Chemistry 79: 3430 - 3435.

Martínez-Méndez, G. and others 2010. Contrasting multiproxy reconstructions of surface ocean hydrography in the Agulhas Corridor and implications for the Agulhas Leakage during the last 345,000 years. Paleoceanography 25: PA4227.

Pahnke, K., J. P. Sachs, L. D. Keigwin, A. Timmermann, and S.-P. Xie. 2007. Eastern tropical Pacific hydrologic changes during the past 27,000 years from D/H ratios in alkenones. Paleoceanography 22: PA4214, doi:4210.1029/2007PA001468.

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Interactive comment on Clim. Past Discuss., 9, 3209, 2013.