

Interactive comment on “Migrating subtropical front and Agulhas Return Current affect the southwestern Indian Ocean during the late Quaternary” by D. K. Naik et al.

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Received and published: 23 January 2014

Authors' Response to Referee's Comments:

Referee's Comment: This paper investigates changes in the Agulhas return current over the late Quaternary. The Agulhas system is believed to be an important component of the global thermohaline circulation. Furthermore, changes in the Agulhas system before and after interglacials have been modelled to have impacts on the global climate by regulating and changing the strength of the Atlantic thermohaline circulation and therefore the amount of heat transfer from the southern to northern hemisphere. Because of this, there has been a push in recent years to try to understand changes

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of the Agulhas current over numerous glacial and interglacials. However, despite this effort, very little research has been conducted focusing on the Agulhas return current in the Indian Ocean. This article addresses changes in this system. Overall, the scientific importance of this paper is that it addresses changes in a major oceanic system that has not been previously studied but is thought to be an important part of the global climate system. The paper also demonstrates significant original thinking. However, before being published, a number of revisions are necessary to help clarify points raised in the article. Once these are addressed, I have no problem recommending this article for publication. Authors' Response: We thank the reviewer for appreciating our efforts.

Referee's Comment: Another revision needs to be done with regards to making the article more accessible to general paleoclimate scientists. Right now the article is aimed and written for researchers with a background in foraminiferal studies. However, it needs to be aimed more towards a more general audience. A few edits and additions should make this possible. Authors' Response: We have modified the introduction as well as added a few more sentences at appropriate places to make the text simpler.

Referee's Comment: One good example of this is the section 6.1 comparing the paleo record to the modern distributions of foraminifera. I did not get a sense of why this section was important and why the differences could not just be explained by natural processes that effect the preservation of foraminifera on sea floor. Rewrite this section to make it clearer why it is important. Authors' Response: In order to assess the reliability of the faunal assemblages, elemental and stable isotopic ratio in SWIOC, the core top data is compared with the previous studies, including water column, surface sediments as well as core-tops from the nearby regions. We agree with the referee that the differences could be because of diagenetic processes that affect foraminiferal preservation and the same has also been included in the revised manuscript.

Referee's Comment: Also the discussion of the possibility of dissolution effecting the Mg/Ca ratio is confusing and may benefit from streamlining the discussion to make it

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less wordy. Authors' Response: The possible diagenetic alteration of Mg/Ca, especially due to dissolution has been discussed in detail.

Referee's Comment: The introductory paragraph spends a great deal of time discussing the *Globigerina bulloides* proxy but only briefly and confusingly talks about why the Authors decided to use the *Neogloboquadrina pachyderma* (dex.). The justifications for why *pachyderma* (dex) is an important climatic indicator are missing from the introduction. Authors' Response: We agree with the referee and have included addition text supported by relevant references to justify application of *N. incompta* as an important climate indicator.

Referee's Comment: Also, the discussion of the advantages/disadvantages or motivations behind the use of the Mg/Ca temperature reconstruction is too late in the paper. While these are discussed later in the paper a sentence or two up front may help improve the flow of the paper. Authors' Response: As suggested by the referee, the basics and advantages/disadvantages of Mg/Ca as seawater temperature proxy has been added in the introduction.

Referee's Comment: The paper suggests that, because *pachyderma* (dex) is primarily deposited in the summer months at the core site, the increased amounts are indicative of warmer temperatures. However, this needs to be clarified. It could be that the increased amount of *pachyderma* (dex) is only indicative of higher rates of productivity during the warmer months and not higher temperatures. This is especially the case because most studies I have seen associate *N pachyderma* (dex) with colder environments such as the polar fronts or an upwelling system. Therefore the authors need to make the link between the higher *pachyderma* (dex) and higher temperatures more explicit or change their analysis slightly to make the reasoning behind the conclusion clearer. Authors' Response: We agree with the referee and wish to clarify that we have used *pachyderma* (dex.) mainly as an additional evidence to suggest productivity. Since the referee has also pointed out that *pachyderma* (dex.) also indicates higher productivity during warmer months, we have used the same property to assess

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seawater temperature.

Referee's Comment: The authors need to look at some of the more recent papers about the northward movement of the STF, as there have been some recent changes in thinking about the interaction of the Agulhas current and STF. The conclusions in Bard and Rickaby (2009) are no longer assumed to be correct and may change some of the conclusions about the location of the STF. Authors' Response: We agree with the reviewer that the changes in Agulhas leakage which in turn control ARC are controlled not only by the position of STF but also by the wind strength, position and inertia (Beal et al., 2011). The Agulhas leakage will increase due to reduced inertia if the wind strength decreases without an accompanying latitudinal shift, and vice-versa. The combined effect of equatorward or poleward shift of wind regime accompanied by a change in wind strength is, however not clear. The strengthened retroflexion as inferred from planktic faunal changes, is difficult to clearly attribute to STF position or wind strength, as we do not have any direct proxy for wind strength. The same has been mentioned in the revised manuscript.

Referee's Comment: The figure 4 need s some corrections to make it clearer. Figure 4 is hard to read due to the two data sets being placed on top of each other. Making figure 4 more like figure 3 would make the data easier to read. Authors' Response: We have revised the figure 4 as suggested by the reviewer.

Referee's Comment: Sentence starting on line 5 is missing some words. Authors' Response: The sentence has been modified.

Interactive comment on Clim. Past Discuss., 9, 5521, 2013.

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