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Interactive comment on "Southern Hemisphere orbital forcing and its effects on CO_2 and tropical Pacific climate" *by* K. Tachikawa et al.

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Italic part indicates the comment of the referee and the following text is our answer.

At the heart of this paper lies a new Mg/Ca sea surface temperature reconstruction from tropical core MD05-2920 off Papua New Guinea. A modelling component which seems to address a different question. The connection between the data and modeling seems disjointed. The paper needs to be refocused on the tropical Pacific data and how they inform our understanding of tropical processes (ENSO dynamics, east-west gradient, monsoon variability etc).

We agree with Referee #2. As shown in the answer to Referee #1, we decided to concentrate on the processes affecting the WPWP SST on orbital timescales by data-

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model comparison. We will develop the discussion about the tropical processes in the revised version. The part corresponding to the sea ice and Ekman pumping efficiency on orbital timescales will be presented elsewhere as an independent work.

Page 1873, line 25: what exactly is meant by "we mainly used data concerning the s.s. morphotype"? Clarify.

We did not exclusively use s.s. morphotype but examined the relative proportion and Mg/Ca ratios of each morphotype for selected intervals. During Holocene (5.7 ka), s.s. morphotype presents 69 % (number of total counted tests, n=240) of the total G. ruber (white) population and 74% (n=183) during LGM (21.3 ka). Since Mg/Ca ratios of s.s. and s.l. morphotypes give identical values within analytical uncertainty, we did not distinguish the two morphotypes for Mg/Ca analysis. Over the whole studied period, s.s. morphotype was dominant as shown for the examined intervals. We will add this information in the revised version.

Page 1875, line 5: "The test weight varies from 8.2 to 14.5 μg for G. ruber...". This is the mean G. ruber weight at each stratigraphic level, correct?

This is the mean individual test weight that was estimated by weighing 30 individuals for each sample (Figure S2). We will replace "μg" by "μg/ind." to clarify the point.

Page 1878, line 14 to page 1879 line 2: The model gets only half the amplitude of the reconstructed warm pool SST. This is rationalized in the context of PMIP multi-model uncertainties and the statement that "the warm pool heat budget is delicately balanced by rather large individual contributions...". This may be so but it is not a very satisfying explanation here. What is needed is some sense for why this particular model has low tropical SST sensitivity and how this might affect the interpretations.

Both unknown bias of SST proxy and missing feedbacks from clouds, vertical stability profiles (and linearized radiative tranfer model for shortwave and long wave radiation) in the model could contribute to creating the difference. Furthermore, one has to keep in mind that the reconstructed SST are point-estimates in a semi-enclosed ocean area, whereas the SST in our model is representing a grid average on a spatial resolution too coarse to resolve the regional details. In revised version, we will evaluate potential bias on foraminiferal Mg/Ca by salinity, pH and carbonate ion concentration (Kisakurek et al., 2010;Lea et al., 1999;Russell et al., 2004).

Page 1879, lines 7-12: Here the residual Mg/Ca SSTs (after removing the CO_2 component, which itself is a questionable thing to do since it depends on a statistical correlation) is compared with the model strength of the wind-driven current off Papua New Guinea, and a high correlation of 0.88 is reported. If this mechanism is correct it should also hold in the model. Residual SST in the model and current strength in the model should correlate. Do they? If yes, fine. We applied Blackman-Turkey cross spectral analysis to determine the relationship between the residual TR400 SST and the model strength of the wind-driven current off Papua New Guinea. The result indicates a high coherence of 0.96 at precessional timescales of 23 kyr, further supporting our hypothesis.

We note that the statistical separation of the CO_2-driven variability is also supported by the model experiments (with greenhouse gas-fixed simulation) values. We will add this simulation result to emphasis the major role of CO_2 radiative forcing and robust estimation of regional/local effects on SST record. Furthermore, we have extended the analysis of the precessional signals in the tropical Pacific SST using EOF analysis and regression methods. From those results we were able to relate wind-driven changes, to SST and surface current changes in the ocean. These results will become part of the revised manuscript.

Page 1879, lines 22-29: I have trouble understanding what was done here. Consider rewriting. We will revise the text to improve the clarity.

Page 1880, line 1: change “primary drivers” to “potentially primary drivers”. The primary role of CO_2 has been demonstrated by previous studies and our results support

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it. We do not think "potentially" is necessary.

Page 1880, line 3: change "understandable" to "not surprising". It will be revised.

Page 1881, line 7: insert "arguably" before "reflects". We will remove the part corresponding to benthic temperature variability from the text because the benthic part was used to explain the link with southern hemisphere that will be separated in the revised version.

Page 1882 line 21, to page 1883 line 6. Since this part corresponds to the hypothesis of mechanism of CO2 degassing from the southern hemisphere, which will be separated from the manuscript, we do not answer this comment.

References Kisakurek, B., Eisenhauer, A., Bohm, F., Hathorne, E. C., and Erez, J.: Controls on calcium isotope fractionation in cultured planktic foraminifera, Globigerinoides ruber and Globigerinella siphonifera, Geochimica Et Cosmochimica Acta, 75, 427-443, 2010. Lea, D. W., Mashiotta, T. A., and Spero, H.: Controls on magnesium and strontium uptake in planktonic foraminifera determined by live culturing, Geochim. Cosmochim. Acta, 63, 2369-2379, 1999. Russell, A., Honisch, B., Spero, H. J., and Lea, D. W.: Effects of seawater carbonate ion concentration and temperature on shell U, Mg, and Sr in cultured planktonic foraminifera, Geochim. Cosmochi. Acta, 68, 4347-4361, 2004.

Interactive comment on Clim. Past Discuss., 9, 1869, 2013.