Climate of the Past
Discussions

Interactive comment on "On the validity of foraminifera-based ENSO reconstructions" *by* Brett Metcalfe et al.

Anonymous Referee #2

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In their manuscript Metcalfe et al. present a forward modeling approach through FAME to investigate the use of individual foraminifera analysis (IFA) for ENSO reconstruction. Based on the modeling results, they conclude that this proxy is only valid in part of the Pacific Ocean. However, these regions are often characterized by low sedimentation rate, therefore limiting the use of this proxy.

While the effort to incorporate forward models into paleoceanographic studies is commendable, I fail to see the practical application of this study. Inverse modeling would be impossible and the lack of comparison between the pseudo-proxy distributions and actual distributions of foraminifera prevents validation of the method.

Major comments

Inverse problem

The manuscript focuses on forward modeling of IFA analysis. Although definitely a valuable exercise for data-model comparison (assuming that the climate model can make use of the forward model), it doesn't solve the inverse problem. It would be almost impossible to evaluate the growth factor in the d18O record.

It's also not visually obvious what the difference between the output of a non-weighted model is vs FAME in Figure S1. Some statistics would help, or plotting the resulting kernel distributions on a separate panel,

Further, bioturbation is also likely to have a large impact on IFA, especially in areas of low sediment accumulation. Why not connect FAME to a bioturbation model and disentangle the influence of these factors?

Statistical analysis

Page 6, Line 25: Multiplying the bin counts will effectively skewed the results of a significance test. In practice, it would be impractical if not impossible to obtain 1000 samples in each bin. Similarly, page 7, line 4, how many foraminifera were artificial picked to produce these maps?

IFA model - data comparison

There are a number of recent studies with IFA results from the past ∼1000 years (some of them cited in the current manuscript). How do these distributions compare to the statistical ones?

Effect of SAR

Since a model of bioturbation was not implemented here, it's hard to examine the effect of bioturbation on the IFA. Furthermore, rapid accumulation rates should be possible around islands. The coarse map overlaid here fails to account for these. I would suggest adding to the text that in strategic locations (in the blue areas), sedimentation

rates may still be high enough.

Improper referencing

This is not the first study to use pseudo-proxy to examine whether IFA can be used for ENSO reconstruction. Thirumalai et al. present a model that can be more easily applied to a real application. First, reference this study (and others) at the beginning of the manuscript and second, why not extend their "picking" model to also evaluate the contributions of sample size?

Minor comments

Abstract: Should state that this is an IFA technique. Page 1, Line 23: specify that the interaction on interannual timescale is known as ENSO. On decadal, it's known as the PDO. Page 1, Line 27: SO is part of ENSO. Should rephrase as we have long instrumental records of the atmospheric variability but not the ocean. Page 3, line 3: Stott et al is not the only reconstruction in the Western Pacific, either use e.g., or as done previously cite multiple sources. Page 3, Line 30: Mg/Ca is not a simple function of temperature. There is a growing body of evidence that suggests that Mg/Ca is also sensitive to salinity and pH. In addition, the calcite saturation of the bottom waters on post-depositional preservation of the signal. Page 5, Line 3: Why not used species-specific equations? Page 5, Line 12: Not sure what is meant by "Which can compute eight foraminiferal species". Do you mean growth? Page 6, line 11: There is an abundant body of literature dealing with the definition of an ENSO event. Why not start there? Page 9, line 20-25: Most of these studies are based on pooled samples and were referencing to an ENSO-like signal rather than the interannual mode of variability that IFA is targeting.