

## ***Interactive comment on “A Late Pleistocene sea level stack” by R. M. Spratt and L. E. Lisiecki***

### **Anonymous Referee #3**

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Understanding long-term variations in Pleistocene sea level is critical to unraveling the interaction between the carbon cycle, climate, and the cryosphere. A hinderance to unraveling this interaction is the scarcity of precise and accurate records of sea level. To overcome this, Spratt and Lisiecki take available sea level reconstructions derived from a number of proxy and model approaches and “stack” these records to increase the signal to noise ratio. Using the stack, the authors provide some initial observations, based on comparing their sea level stack with the LRO4 d18Oc stack, on the % contribution of d18Osw and relative contributions of BWT and ice volume for the H-LGM. Although this is an useful exercise, and a stack such as this, would be useful in exploring the evolution of sea level change across the late Pleistocene, I find the authors didn’t not do a thorough job in treating the data in a rigorous manner, exploring the stack features fully, or explaining their approach in a clear and concise manner. I suggest the paper be resubmitted in a revised manner before fully being considered

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for publication.

Firstly, Spratt & Lisiecki use a handful of records from a range of different proxy/model approaches. In doing so, they use the published error associated with initial publication. I believe this is inadequate and need to apply a more rigorous, possibly a probabilistic assessment, to fully evaluate the uncertainties in each record. For example, the Mg/Ca-BWT derived records both quote a  $\pm 1$  to  $\pm 1.1^\circ\text{C}$  on BWT estimates, however, both records are based on core-top calibrations that are either regional or bootstrapped. Consideration of the uncertainty around this needs to be revisited along with the other records. Also both Mg/Ca-derived BWT records lead the d18Osw record by 10-20 kyr. How does this phasing affect the alignment or interpretation of peak interglacial sea level estimates?

The authors do not clearly provide a criteria for their choice of sea level records. And although they provide a general review of the chosen records it does not seem to be exhaustive. Available for the late Pleistocene are the records of Dwyer et al. 1995 (ostracod Mg/Ca-BWT) and the record of Martin et al. 1999 (benthic foram Mg/Ca-BWT record). Additionally, they omit they record of Siddall et al. 2010 who expands up the technique of Waelbroeck et al 2002 applying a benthic d18Oc-coral regression. Does the stack have a sensitivity to records included or excluded?

More clarification around the age model alignment for each record is needed. In the paper they authors state “ the LRO4 age model has an uncertainty of 4ka” and state that their “age model alignment involved either aligning. . . to the LRO4 d18Oc stack or aligning ..to other sea levels . . .on the LRO4 age model”. Details about the alignment and records used need to be fully explained.

Secondly, the authors seem to only briefly explore the features of the record. They make the point that roughly 40% of the benthic d18Oc record is derived from ice volume change and 60% BWT change. How does this %ice:%BWT contribution change over the course of the record? The establishment of the stack allows for it to be compared

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to available CO<sub>2</sub> records and other paleoclimate indicators to elucidate some basic appreciate for the Pleistocene climate. The authors are lacking a critical discussion beyond the stack features and contribution to the δ<sup>18</sup>O<sub>c</sub> variability. I would suggest they attempt to provide some added observations.

Thirdly, the authors choose to use PCA analysis for this task but don't specify the criteria they used to choose the most appropriate method.

Specific comments: Section 1 The introduction would be more suitable if the authors provided additional background info around Pleistocene sea level variations, mechanisms, and gaps. Currently it is missing some critical references and doesn't fully introduce the topic

Section 6 -the authors state that 40-65% of the benthic change is related to ice volume- does this derive from their H-LGM estimate and Pleistocene stack approximation? - The 607 mg/ca-bwt record shows a lead of temperature over ice volume as well. -the authors apply a 2ka lag to the smoothed LRO4 stack to improve the correlation-specify reason for lag

Figure 4C-it is hard to decipher between the two regression lines

Overall, the authors need to be more precise in their referencing as some are missing.

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Interactive comment on Clim. Past Discuss., 11, 3699, 2015.