

## ***Interactive comment on “Millennial-scale atmospheric CO<sub>2</sub> variations during the Marine Isotope Stage 6 period (190–135 kyr BP)” by Jinhwa Shin et al.***

### **Anonymous Referee #3**

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This manuscript presents new and important atmospheric CO<sub>2</sub> concentration data from the penultimate glacial period, also known as MIS6. The data concern so-called millennial-scale climate change, which has been well documented from Greenland ice cores. Because the Greenland ice cores do not extend back into MIS6, the natural archive in which to study millennial-scale climate for this period is Antarctic ice. The data appear to be of high quality and the discussion is appropriately oriented to the question of the temporal lag of peak CO<sub>2</sub> behind millennial-scale warm intervals. The lag is found to be larger in the colder intervals than in the warmer intervals, much as was previously found for the more recent period of MIS 3 to MIS 5.

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The one major thing I find lacking in this paper is replication of CO<sub>2</sub> data points from the same depth in the ice core. Replication of gas measurements in ice cores is fundamental in order to have confidence in the accuracy of the data. Furthermore, the authors should calculate a pooled standard deviation from the means of replicates cut from the same depth in the ice core. This is widely viewed in the field as the most reliable indicator of the overall precision of the measurement, including potential issues arising from the ice itself (such as in-situ CO<sub>2</sub> production). It is now well known that bacteria living in the ice can and do produce CO<sub>2</sub>. The only question is, how much? So it is absolutely essential to replicate CO<sub>2</sub> analyses on pieces of ice cut from the same depth (and therefore presumably the same age, and having been exposed to the same atmospheric gas concentrations).

Therefore the authors must return to the laboratory and measure essentially another 150 pieces of ice, before this manuscript can be published in CP. The authors must also quote their value they have found for the pooled standard deviation.

I also did not notice any mention of the number of samples that were rejected (but perhaps I just missed it). The authors must mention this number clearly in the main text (not in the Supplement).

Another problem with the manuscript as it stands is the large amount of speculation in the discussion. This doesn't add to the value of the paper and can be mostly cut out, or clearly labelled as speculation in the text.

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