

Interactive comment on “On the glacial and inter-glacial thermohaline circulation and the associated transports of heat and freshwater” by M. Ballarotta et al.

Anonymous Referee #1

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M. Ballarotta and co-authors present an interesting comparison of the global ocean thermohaline circulation during glacial and inter-glacial times using general circulation model experiments. They use a variety of streamfunction coordinates, and a key result seems to be the contrast in the haline structure of the circulation between model experiments and the effectiveness of thermohaline coordinates in highlighting this. However, this paper is poorly written throughout, making it difficult and often impossible for the reader to understand the points the authors are attempting to make. The first sentence, for example, is poorly structured: “The thermohaline circulation (THC) is the large time- and spatial-scales ocean circulation associated with the transports of heat and salt, and is known to control the climate variability”. There are at least seven other examples of

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similar grammatical, word order and typographical errors within the introduction alone, and many more within the rest of the text. In addition, there is generally a lack of clear progression throughout the paper. Typically, for example, the authors skip between experiments and coordinate systems with no particular clarity, in a different order to the numbering given to the figures. The assumed pedagogical approach intended, given the order of the figures, should be maintained to improve the structure and clarity of the paper. The goals of the study are also confusing. The author states three apparent goals that could be combined into one concise aim/goal to make it clearer to the reader what precisely this paper is attempting to achieve. These issues should therefore be addressed prior to publication and the manuscript should be proof read by each of the co-authors for typographical errors and poor use of language.

Specific Comments:

Within the abstract the authors should be clearer about the aspects of the LGM circulation to which they are referring throughout, specifying whether they are referring to regional or global circulation. They refer to the term “maximum volumetric distribution” without definition. There also seems to be a contradiction when describing the connections between the Atlantic and Pacific basins, where the authors specify that the conveyor belt circulation during the LGM is driven by the enhanced salinity contrast between basins, but state in the next sentence that the Atlantic circulation is more isolated from the Pacific circulation.

The introduction is lacking an explanation of the current understanding of the thermohaline circulation of the global ocean during the LGM, which should be included to put the results described throughout into context. In addition, the authors should refer to additional examples of tracer-latitude coordinate systems from the literature, for example: Ferrari R. and D. Ferreira, 2011, “What processes drive the ocean heat transport?”, Ocean Modelling.

Within section 2, it would be advantageous for the reader if the atmospheric forcing

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used in LGME were described at least briefly; otherwise it becomes difficult to understand the results from LGME in the context of the different forcing regimes.

The model comparison within section 4 is difficult to interpret, and it would be clearer to the reader if the difference between models were more explicitly stated. There are also several vague statements within this section, for example, the authors refer to the circulation south of Greenland, without being more specific.

In the first sentences of section 5 the authors attribute the higher salinity during the LGM to two causes separately in two sentences, which seems unnecessary. Further, the authors describe the difference between coordinate frameworks without describing within the section the frameworks used. This results in several vague statements about the comparison between frameworks from line 22 onwards. As in the abstract the authors refer to the “maximum volumetric distribution” without clear definition.

The mathematical formulations used are unclear as written. The order of integration for each of the meridional overturning circulations is incorrect, each should be integrated first zonally and then vertically. The formulation describing the calculation of the streamfunctions within latitude-temperature and latitude-salinity coordinates are unclear. As they stand, they have units of $\text{m}^2 \text{s}^{-1}$ and $\text{m}^2 \text{s}^{-1}$ respectively. As in Döös et al. 2012, the thermohaline streamfunction should be the integral of the dot-product of the three-dimensional Eulerian velocity and element area. Further, within the appendix the authors consistently neglect to define units.

Figures:

Within figure 4 it would be useful to state specifically which panels correspond to which ocean. Also state that temperature is contoured in the lower panel.

Technical Comments:

Throughout the paper streamfunction should be written as one word. Also, each coordinate system used should be consistently referred to as a combination of two co-

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ordinates (i.e. temperature-latitude coordinates) rather than by one coordinate (i.e. temperature coordinates)

Page 984. Line 9-14: Explain specifically which coordinate frameworks will be used.

Page 985. Line 1: Make clear that the poleward heat transport is shown in the figure.

Page 985. Line 15: Specify which “North Atlantic gyre”.

Page 985. Line 16: This is an unclear definition of the overturning, which is typically defined as the maximum meridional overturning streamfunction.

Page 987. Line 23. Uses the term “z-coordinates” but have not defined “z” up to this point.

Interactive comment on Ocean Sci. Discuss., 11, 979, 2014.

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