

## ***Interactive comment on “Sea ice led to poleward-shifted winds at the Last Glacial Maximum: the influence of state dependency on CMIP5 and PMIP3 models” by Louise C. Sime et al.***

**Anonymous Referee #1**

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**General Comments** This manuscript addresses the issue of how the southern hemisphere westerly winds changed during the last glacial maximum. Changes in the winds have been invoked as a significant player in the glacial-interglacial CO<sub>2</sub> variations (the so called “wind-hypothesis”), hence there has been in recent years a number of papers trying to gain insight on this issue from a modelling perspective. A conclusive support or disapproval of the “wind hypothesis” has remained elusive. This paper uses the same existing simulations reported in at least 3 other papers (Chavaillaz et al, 2013, Rojas, 2013 and Liu et al, 2015), in this sense there is a feeling that the results presented are not very new. The main hypothesis for explaining the variety of wind responses to LGM conditions is the sea-ice response of the model and the

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state dependency. The sea-ice hypothesis has also been invoked in other papers, but the complete analysis of the relationship with the presented day simulation of the winds is novel. In this respect the paper is a contribution towards settling this long-standing issue. However there are at least two important papers that have not been cited: Liu et al 2015: The deâ€correlation of westerly winds and westerlyâ€wind stress over the Southern Ocean during the Last Glacial Maximum. Journal of Climate At the end we are interested in understanding if changes in winds can be responsible for part of the glacial-interglacial atmospheric CO<sub>2</sub> variations, by helping to outgas CO<sub>2</sub> from the southern ocean. This aspect is addressed in Liu et al 2015. And in this paper this issue is left at a secondary plane. Also, given that sea-ice is diagnosed as a critical component of the LGM response of the system in the southern hemisphere, authors should discuss: Roche, D. M., Crosta, X., & Renssen, H. (2012). Evaluating Southern Ocean sea-ice for the Last Glacial Maximum and pre-industrial climates: PMIP-2 models and data evidence. Quaternary Science Reviews, 56(C), 99–106. <http://doi.org/10.1016/j.quascirev.2012.09.020>

This paper is PMIP2, so it would be interesting to include in the analysis presented in this paper PMIP2 simulations as well (Rojas 2013, shows the zonal mean winds in PMIP2 and PMIP3).

Although the title refers to the conclusion that sea-ice must have been responsible for shifting the SHW poleward during the LGM, the discussion in the paper is too much centered on the modelling errors and how those errors have therefore hindered to date to use models to prove or disprove the “wind-hypothesis”. I would re-emphasize the final objective which is to know if the winds were weaker, stronger or shifted during the LGM compared to present day, or pre-industrial climate. Paper requires revisions.

**Specific Comments**

Line 66: is PI defined? Line 69: include reference to Liu et al 2015 Line 113: include: “..global Ocean circulation and hence CO<sub>2</sub> exchange..” Line 135: Why do you

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only analysis annual means, when literature seems to indicate that summer sea-ice is important?? Lines 153-155: can you put those values in a table? Line 178: Does the Geresonde paper indicate summer/winter differences? Line 203: change 0 hPa to top level? Line 217-218: "...poleward shift in the jet in both models, especially in MRI-CGCM3". Line 261: but can only be captured if the PI jet position is accurately simulated. Line 262: include discussion of real world! Lines 265-268: discuss implication for CO2.

In section 4: Can you discuss more on the implication of your finding on CO2 variations? How reliable is the sea-ice reconstruction?

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