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Climate of the Past Discussions

Interactive comment on "Using data assimilation to investigate the causes of Southern Hemisphere high latitude cooling from 10 to 8 ka BP" *by* P. Mathiot et al.

Anonymous Referee #1

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Review of the manuscript 'Using data assimilation to investigate the causes of Southern Hemisphere high latitude cooling from 10 to 8 kaBP'

by

P. Mathiot et al.

General:

The authors carry out model simulations with a model of intermediate complexity using data assimilation of proxy data to investigate climate changes over the high latitude southern hemisphere in the late glacial/early Holocene between 10 ka and 8 ka BP.

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Interactive Discussion
Discussion Paper

The hypotheses and the according experimental model setup are explained in detail and results are presented in a concise manner and in the context of already existing studies. Moreover, the topic fits well into the scope of Climate of the Past. I therefore suggest publication of the article with minor revisions outlined below.

Specific comments:

Abstract:

In the abstract mechanisms and hypotheses are somehow mixed: one might just include information on the origin of the hypotheses, i.e. " Based on empirical information from [proxy #1) the hypothesis related to a change in atmospheric circulation was suggested. Information contained in [proxy #2] provoked the hypothesis of a cooling in the Southern Ocean. With our model study we addressed theses hypotheses by. . ." This would help the reader to see at a glance which proxy or which combination of proxy record supports the respective hypothesis. This differentiation might also be helpful to account for the different susceptibility of different proxies to different processes.

Introduction

P 5547, ll 1ff: one should also include internal variability as a potential factor – the large oceanic areas around Antarctica including sea ice and land ice might also show long term internal changes that might indirectly respond to external forcings. A second issue relates to changes in greenhouse gases, for instance the release of CO2 from the southern ocean in the late glacial.

A general paragraph addressing the basic concepts of data assimilation would ensure that also the reader who is not familiar with those concepts gets an introduction into the field – a good overview can be found in the paper of Widmann et al. (2010)

The paragraph could also include some statements fact that the assimilation also helps to investigate large-scale atmospheric and oceanic patterns that is essential in understanding late-glacial climate change. A short paragraph justifying the application of an

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EMIC could also be helpful in setting the stage for the paper. For instance, with EMICs it is possible to carry out multiple simulations with different initial conditions and different combinations in external forcing within a short time. The large ensemble allows a probabilistic view of the scientific problem in terms of how likely/unlikely a certain hypothesis inferred from empirical evidence might be. One could also stress that with model simulations it is possible to test the physical plausibility of hypotheses derived from proxy data, although some of the initial conditions and the complexity of the full system might not be available.

A critical point might be however the horizontal and vertical resolution of the model components concerning the oceanic studies, especially for fresh water flux experiments. Some studies for the North Atlantic indicate that the horizontal resolution could be quite crucial for the exact pathways for water masses and related climatic effects (Spence et al., 2012) – even one could not address this point with a coarsely resolved EMIC one could at least address this issue to leave some room for potential inconsistencies between model results and empirical reconstructions.

Experiment setup:

p. 5550 l.16: The authors state that the atmospheric component of the model only consists of three levels – one should add a word which implications this low vertical resolution might have on the conclusions drawn on changes in atmospheric circulation, i.e. how well is the structure of the southern hemispheric jet streams and low-level mean atmospheric circulation represented by the model.

p. 5550 l. 20: – the same for the ocean model – which implication might the restricted depth of 500 m have on oceanic processes such as deep water production, for instance related to fresh water experiments including glacier melt.

The WAIS fresh water flux experiment is explained very well with abundant and critical information from the literature – one might add a sentence that despite these uncertainties modelling studies provide a framework the assess the potential bandwidth of

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possible climatic evolutions taking into account the uncertainties related to the simplicity of the climate model used.

Results:

p. 5557, l. 25: again, internal variability could be a potential mechanism explaining at least part of the cooling

p. 5558, l. 10. please change 'observations' to (proxy) reconstructions

p. 5559, l. 25ff. the changes in SWW might be more complicated and depending on the very specific latitudinal position of the proxy site. For instance, changes in high-level jet streams and according wave train patterns could lead to increases of surface winds over some regions (longitudinal bands), while others experience decreases or vice versa.

Conclusions:

It would be nice to see some concluding remarks on the critical points of the study and its limitations – this could then also be used as an outlook for potential future studies with other modelling tools (more complex models incl. internal variability, higher resolution) or changes in the experimental setup.

Figures:

For the difference plot a statistical test on the significance would be helpful even though it can be assumed that most differences are statistically significant regarding the number of degrees of freedom for each experiment.

Suggested further References:

Spence, P., O. Saenko, W. Sijp, and M. England, 2012: North Atlantic climate response to Lake Agassiz drainage at coarse and ocean eddy-permitting resolutions. J. Climate. doi:10.1175/JCLI-D-11-00683.1, in press.

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Widmann, M., H. Goosse, G. van der Schrier, R. Schnur and Jan Barkmeijer, 2010: Using data assimilation to study extratropical Northern Hemisphere climate over the last millennium. Climate of the Past, 6, 627-644.

Interactive comment on Clim. Past Discuss., 8, 5545, 2012.