Clim. Past Discuss., 6, C182–C185, 2010
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Climate of the Past Discussions

Interactive comment on "Solar-forced shifts of the Southern Hemisphere Westerlies during the late Holocene" *by* V. Varma et al.

Anonymous Referee #1

Received and published: 18 May 2010

General comments

Motivated by rainfall changes in Southern Chile during the later Holocene (as derived from a previously studied marine sediment core) the authors explore the role of solar activity changes in driving these rainfall changes. The working hypothesis is that small variations in the solar constant caused by solar activity changes drive meridional shifts in the Southern Hemisphere Westerly Winds (SWW) and thus rainfall west of the Andes.

To this end they use the CCSM3 model in two runs varying solar constant by 0.15 %. They find that indeed this reduction leads to a meridional shift in the SSW. This is a very interesting result definitely worth to be published in CP, however, they authors fall short in explaining what dynamical processes cause these shifts. They refer to future

work, however, this should really be included in the revised paper to inform the reader adequately what physical processes are involved (in the model).

Instead a large part of the paper deals with the comparison of proxy data to support a link between solar activity and a SWW shift. While this is a good motivation for the model study, the additional benefit of this comparison is limited, especially since the observational evidence is not striking. Accordingly, a thorough discussion of the physical processes in the model seems to be more important.

Apart from this general point, the paper is very well written and should be published in CP after the authors include this discussion in a revised version of the paper.

Specific comments

1 Introduction:

The authors discuss extensively the literature that predicts a shift of the SWW and the potential consequences for the carbon cycle in the Southern Ocean. However, they should also mention the equally valid work that strongly questions such shifts and their effect on atmospheric CO2 (e.g. Tschumi, T., Joos, F., and Parekh, P., 2008, Paleoceanography 34 and Menviel, L., Timmermann, A., Mouchet, A., and Timm, O., 2008, Paleoceanography 23). In any case different models show different responses of the SWW on past climate conditions and that should be mentioned.

Also important seems to be the seasonality of the SWW, as also supported by the author's finding that the SWW respond differently in winter than in summer in the CCSM3 to a reduction of the solar constant. Looking at Fig. 1 it becomes clear that for recent conditions the SWW do not shift as a whole during winter but that they expand (mainly in northerly direction). The location of the highest wind speeds does not change clearly between summer and winter. In fact, the highest zonal wind speeds are found in summer. This should be consistently communicated throughout the paper.

2 Proxy evidence

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In the second paragraph the authors correlate the sediment precipitation record with solar activity reconstructions. The correlation is rather weak (only 20 % or 5 % of the variability is shared) and moreover the two solar activity reconstructions are quite different. Also for the precipitation proxy initially published in Lamy et al., 2001 the evidence for coastal precipitation changes connected to overall SWW shifts seems not completely unambiguous. Clearly this is not a criticism of THIS paper but shows that the observational evidence for such a link is still weak. Nevertheless the modeling exercise performed in this paper seems very important!

3. Model evidence

While this is the real stronghold of this paper, this section lacks a sufficient discussion of the processes that lead to the observed shifts in SWW. Especially, the seasonal varying response requires an in-depth evaluation.

In the fourth paragraph the authors look at precipitation changes which are rather small due to the insufficient resolution of topography in the model. What about precipitable water changes in the model?

4. Discussion

In the first paragraph the authors admit that the observational evidence for a sun - SWW link seems to break down completely for earlier stages of the Holocene. Again, this shows that the proxy evidence for a solar influence is weak.

In the last paragraph of this section the authors refer to future work to explain the observed shifts. This is highly unsatisfying and should be changed in the revised version of the paper.

Captions:

In the captions of Fig 3 and 4 I would suggest to add the pressure level (1000 hPa) at which the anomalies are plotted.

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