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Climate of the Past Discussions

Interactive comment on "Coupled climate model simulation of Holocene cooling events: solar forcing triggers oceanic feedback" *by* H. Renssen et al.

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GENERAL COMMENTS

The authors, using an ensemble of transient Holocene model simulations, further explore their hypothesis early proposed by Goosse and Renssen (2004) that climate response to solar variability can be additionally amplified by intrinsic instability of deep convection in the Nordic Seas. I believe, this is a rather interesting idea and a possibility that high latitude convection is less stable under colder climate conditions corresponding to minimum in TSI is physically plausible. The paper, however, leaves numerous unanswered questions which have to be addressed.

1. I found it rather unfortunate that a comprehensive description of model performance

for present day climate is unavailable. The self-citations are eccessive (almost one third of all citations), but mentioning of all previous works performed with different versions of ECBILT-CLIO and ECBILT-CLIO-VECODE is not very helpful for the understanding results discussed in the paper. I would rather recommend to show on an additional figure the Atlantic meridional overturning circulation for the present day climate and a map of the maximum mixed layer depth for "normal" conditions and periods of "deep convection failure". In particular, it is not clear from the paper whether deep convection in the Nordic Seas completely ceases during the cold events or only its location is shifted. What is a typical duration of such cold events and how many such events simulated in the transient Holocene runs? A figure similar to Fig 2a but showing temperature anomaly over the northern North Atlantic would be helpful. Another question: what happens with the ocean circulation during cold events. On page 216 the authors mentioned "important reduction" in the MOC strength in the Nordic Seas from 3 to 2.5 Sv in two of nine ensemble members. This does not sound as a really important reduction. How it is compared with Goosse et al. (2002) paper, where 10 Sv decrease in the Nordic Seas MOC is reported during apparently similar events? Moreover, the Fig. 2 in Goosse et al. (2002) shows a very pronounced cooling of up to -10 C over the Nordic Seas which is hard to reconcile with Fig. 4 in the new paper. Does it mean that in the newest model version, abrupt cooling events are substantially different from the previous versions? If so, a figure like Fig. 2 in Goosse et al. (2002) showing a pure effect of deep convection failure on temperature is needed.

2. The author stated on page 215 that "the probability of a convection failure was significantly higher after large TSI anomalies". Does it mean "significant" is the statistical sense? It is very hard to derive any conclusion from Fig. 2. A solid statistical analysis on the relationship between TSI anomalies and extreme cold events is required.

3. Comparison of model results with paleoclimate data is internally inconsistent. First, on page 217 the authors stated that they consider the coldest ensemble member as the most appropriate for comparison (which makes sense to me) but on the next page

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the authors compare paleoclimate data with the ensemble mean. The authors should stick to one approach and either discuss a strong cooling over the whole North Atlantic (in the case of coldest ensemble member), or a warming over Iceland (in the case of ensemble mean). However, in the latter case the signal is so weak that it is unlikely to be detected in the real world.

SPECIFIC COMMENTS

The subtitle of the paper - “solar forcing triggers oceanic feedback” - makes no sense to me. The feedback proposed by the authors exists on its own and amplifies solar forcing rather than is triggered by solar forcing.

Page 210, Abstract. “TSI anomalies can trigger temporary reorganizations in the ocean circulation”. Firstly, as it is clear from the paper, the events are not triggered by TSI anomalies but rather their probability increases during large negative TSI anomalies. Secondly, it is not clear what sort of reorganizations in the ocean circulation is meant here. It is not discussed in the text apart from mentioning of 0.5Sv reduction in the Nordic Seas MOC in two experiments.

Page 214. Comparison with Hall and Stouffer (2001) is not very relevant. Firstly, Hall and Stouffer found only one such event in 15000 years long run. Secondly, the extreme cooling event in Hall and Stouffer (2001) occurred south-east of Greenland, i.e. not in the area of deep convection.

Page 218. What is “stable site temperature for the Greenland ice cores”?

Figure 2. a) What is the definition of TSI anomaly? Difference from the present day insolation? b) The width of the yellow bars is clearly inconsistent with the duration of periods when TSI anomalies exceed -2 W/m2.

Figure 3. “Global mean ocean temperature”. Is it global mean SST?

Figure 4c. Obviously, the magnitude of temperature changes in this pannel is well beyond the range -0.6 +0.4 C used in the figure. Either the range for all three figures

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should be extended, or, alternatively, a different range has to be used for Fig. 4c.

Figure 5. If only anomalies in Northern Africa are statistically significant, then I cannot see much sense in showing this figure.

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