

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

H. Renssen et al.

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Response to referee #1

First of all, we would like to thank the reviewer for the constructive comments.

Concerning general comments:

1. As proposed by the first referee, we will add in the revised manuscript several new figures (Fig. 5 and 6a-d) that provide information on what happens during the events with “deep convection failure”. These figures provide information on maximum deep convection during normal (i.e. also present-day) conditions and during the cold events, on the typical duration, and the associated anomalies in sea-ice and temperature. In

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addition, a brief comparison with the events discussed by Goosse et al. (2002) will be included.

2. To improve the quantitative analysis of the relation between TSI anomalies and local convection failures, we will include a new Table 1 and discussion in Section 3.1, in which we compare the probability during major TSI anomalies with a reference probability level that was calculated using an experiment without TSI variability. It would have been ideal to compare the probability in the solar-forced ensemble experiment with the probability in several ensemble members without TSI variability, but unfortunately, only one such reference experiment is available. Running additional reference experiments is not feasible, as this would take at least a few months of computation on an expensive machine.

3. As suggested by the referee, we will make the model-data comparison internally consistent by comparing the data with (new) Figure 6.

Concerning specific comments

a) As suggested, we will modify in the revised manuscript the subtitle “solar forcing triggers oceanic feedback” into “oceanic feedback amplifies solar forcing”.

b) As proposed, we will rephrase the abstract.

c) According to referee #1, a “comparison with Hall and Stouffer (2001) is not very relevant”, because (1) they found only one event in 15,000 years of simulation and (2) their event did not occur in the area of deep convection (viz. Southeast of Greenland). Concerning point (1), it should be noted that Goosse et al. (2002) found in their ECBilt-CLIO simulation with constant forcings two events in 13,000 years of simulation, which is not very different from the finding of Hall & Stouffer (2001). And point (2) is not true, as in the GFDL model version used by Hall & Stouffer, the main site of deep convection is situated Southeast of Greenland. So in our view, the occurrence of ‘spontaneous’ events may be comparable in Goosse et al. (2002) and Hall & Stouffer (2001), and we

propose therefore to keep the reference to the latter paper.

d) p 218. We will clarify that the “stable site temperature for Greenland ice cores” refers to the local conditions in Greenland.

e) Fig 2. As explained in Section 3.1 and in the caption of Figure 2, we define “major TSI anomalies” as anomalies with maximum TSI reduction of more than 2 W/m^2 , which is the 2-standard deviation level. In Figure 2, these anomalies are indicated by yellow bars. The start and end of these “major TSI anomalies” is defined as the moment where TSI reaches the overall mean value of -1.27 W/m^2 . This will be clarified in the new figure caption. The yellow bars thus reflect the total duration of these major anomalies relative to the long-term mean TSI anomaly value for the last 9000 years. The rationale for choosing -1.27 W/m^2 (i.e. the overall mean TSI anomaly calculated over 9000 years) instead of -2 W/m^2 is that it is not only the magnitude of the forcing that matters but also the duration of the anomaly (see discussion in revised manuscript).

f) Figure 3a: Indeed this figure shows in blue the global mean ocean temperature, i.e. the temperature integrated over all depth levels of the oceans.

g) We will replace Figure 4c by a new Figure 6d, which is more appropriate

h) We agree that Figure 5 isn't providing a lot of useful information. Therefore, we will omit this figure in the revised manuscript as suggested by the referee

Interactive comment on Clim. Past Discuss., 2, 209, 2006.