

## ***Interactive comment on “A coupled climate model simulation of Marine Isotope Stage 3 stadial climate” by J. Brandefelt et al.***

**M. F. Sanchez Goñi (Referee)**

mf.sanchezgoni@epoc.u-bordeaux1.fr

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### General comments

Brandefelt et al. apply the coupled ocean-atmosphere-sea ice-land surface climate model CCSM3 to simulate the climate of Greenland Stadial 12 (GS12), a Marine Isotope Stage (MIS) 3 stadial climate which occurred at  $\sim 44$  ka. Although they are aware that MIS 3 climate may not have reached equilibrium, they use constant forcing and boundary conditions for  $\sim 1500$  years to reach a quasi-equilibrium state for GS12. This simulation allows them to test whether a state-of-the-art coupled global circulation model (CGCM) is able to simulate an MIS 3 stadial climate in agreement with proxy records and to investigate, taken as an example the ENSO teleconnections, if the equilibration can influence the climate variability. Their main findings are that: a)

in the simulated GS12 climate the AMOC is reduced by 50% without additional fresh-water forcing, in contrast with previous simulations performed with an Earth model of intermediate complexity. This discrepancy between models allows them to say that the dynamics of the MIS 3 climate are highly model-dependent, b) the equilibration (the last century of the simulation) produces a better agreement between simulated and proxy reconstructed sea surface temperatures (SSTs) than the first centuries of simulation and, c) this equilibration also influences the climatic variability. This work is interesting and deserves publication in *The Climate of the Past*. However, I have two main concerns that the authors should address before the manuscript is definitively accepted: a) forcing and boundary conditions and, b) comparison between reconstructed and simulated SSTs.

#### Specific comments

1 – Concerning forcing and boundary conditions with respect to ice sheets, topography and bathymetry.

In their model, the GS12 simulation is forced with LGM conditions, -120 m instead of -75 m as indicated by sea level reconstructions for MIS 3. Therefore, the Barents and Kara Seas are on land instead of below sea level. They argue that at the coarse scale of the global model the impact on the simulated oceanic circulation would be small. However, I wonder whether this effect substantially influences brine formation and sea ice cover extent in the Nordic Sea regions, a key zone for AMOC dynamics. Does the simulated reduction by 50% of the AMOC and lower SSTs in comparison with the proxy reconstructed SST could be explained by this boundary condition?

2 – SST response.

The authors find that the simulated GS12 SSTs are in agreement with reconstructed SSTs in 30-50% of the proxy sites. In my view this is a weak agreement. It is for this reason that I would like the authors to explain in more detail the tracers from which the SSTs have been reconstructed. We know, after the MARGO conclusions for the

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Last Glacial Maximum (LGM) (MARGO et al., Nature Geosciences, 2009), that divergences can occur between different SST proxies. Is there a particular proxy which better converge with simulated SSTs?

#### Technical corrections

In the abstract the authors should modify “The simulated Greenland stadial 12...is 5.5°C higher... and 1.3°C lower...” to read “The simulated Greenland stadial 12...is 5.5°C lower... and 1.3°C higher...” Also in the abstract, the authors should replace “The results presented here...rather than...” with “The results presented here...rather than...”

In the Conclusions section (paragraph 5), the authors should specify that the reconstructed temperature differences from ice cores in Greenland and Antarctica refer to TGS12-TLGM and TGS12-TRP.

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