**Climate
of the Past
Discussions**

Interactive
Comment

Interactive comment on "Information on the early Holocene climate constrains the summer sea ice projections for the 21st century" *by* H. Goosse et al.

Anonymous Referee #1

This paper is very timely given the release of observations that summer sea-ice extent has reached record lows in September of 2007. The experimental design is adequate and the writing is reasonably clear. It does seem that the authors could go a bit further in their analysis which might strengthen their conclusions. So while the paper is a reasonable illustration of how one can use paleo climate data to attempt to constrain unknown climate model response, it seems to be overly restrictive in its scope and perhaps overly unfettered in its conclusions.

I agree with the authors that reducing projection uncertainties is a "a major challenge". Validation of trends in climate models has always been one of the reasons for attempt-

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ing paleo-climate simulations. The models have many poorly known parameters and trying to improve part of a simulation often makes another part worse. It is difficult to set up objective criteria for evaluating a model simulation and even more difficult to determine optimal tuning.

The authors focus almost entirely on Arctic sea-ice extent. I think this unnecessarily limits the value of the work. Even if the focus is to improve estimates of Arctic sea-ice why is Antarctic sea-ice not also used to help constrain the parameters being tested? Are the authors worried that some southern hemisphere model biases make the south polar region unsuitable as a testing ground for the parameter sets? One could also imagine using other better observed climate variables, such as surface air temperature, to further constrain parameters.

I understand the authors reasons for choosing the early Holocene as a test of their model parameters since it is similar to expected future forcing, but why not also use the LGM? The LGM is clearly a different climate state but one would hope that the parameters sets used for warmer climates are also valid for cooler climates. This is a time period with reasonable ice extent data - although here too there is a fair bit of uncertainly. I also think that the title might be overstating the main focus of the paper. Only one of 5 parameter sets is discounted by comparing early Holocene simulations with data. Given the sparse data from this period, this hardly constrains the model parameters very much. The data model comparison for the Holocene seems a bit subjective at best. Given that current estimates put the 2007 minimum sea-ice extent at slightly more than 4 million square kilometers it makes me wonder if the "E5" parameter set can be discounted after all.

Looking at figures 3 or 5 I am not sure that the there is much useful information in the trend of the data. It seems that one could add or subtract a constant offset and get the data to reasonably fit any of the model simulations, especially given the variability shown by the ensembles - except perhaps for the "E1" parameter set. It really seems that the trend data is not long enough to constrain the parameters much. The total

area at present day is more of a constraint but this could be a bias in the original preindustrial "tuning". How well constrained is the preindustrial ice-area? It may be that all the parameter sets had similar preindustrial sea-ice but if the similar area was slightly bigger or smaller or the ice was a bit thicker or thinner, this would change the simulated area at present day. So do we really have enough confidence in the preindustrial ice climatology to say this is not biasing the area predicted for today?

So maybe the place to start from is the place where we know sea-ice area well. The model could have been "tuned" to give similar present day sea-ice area and then used to look back to preindustrial and previous periods and see if any data from these periods can help constrain the model. I realize that tuning to a transient state may be more difficult but I would have more confidence that the base state we are comparing to was correct. This is why using more data to evaluate the parameter sets would be helpful. It would seem that ice area on its own is not well enough known to constrain the models parameters very well.

What was the reason to simulate from the Holocene to preindustrial? There is no use of the intervening simulation. I assume this was done for another purpose. Equilibrium solutions at 8 kBP and early preindustrial would have been sufficient for these experiments, How is the E3 data set eliminated? Is it because the trend data for 1979-2006 in table 2 is too small? It certainly looks similar in figure 3. I really see very little difference between E3 and E4. Can you give me an objective reason why one is better? Even the trend from table 2 is within the observed trend when both uncertainties are taken into account.

I would like to see Antarctic sea-ice included in the analysis of the suitability of the parameter sets. I would have liked to see a simulation of the LGM as well but this may be beyond the scope of the current paper. I also think other climate variables should be considered in constraining the model. Surface air temperature would be a reasonable one to start with. I think without further constraints the conclusions are not well justified.

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What follows are a few editorial comments that the authors might like to consider:

page 100 line 2: "on projections" should be "of projections" line 6: " allowing to reduce this uncertainty" should be something like: "allowing us to reduce" or "allowing one to reduce" or "allowing for the reduction of". line 23: it should be "one of the strongest images"

page 1004 line 17: remove the first "respectively".

page 1005 line 3: "in January" should be "on January" line 12: "biases with magnitude of" should be "biases with magnitudes of"

page 1006 line 12: "is still relatively small to" might be changed to "is still too small to"

page 1007 line 23: "From these evidences" should be "From this evidence". Probably I would just get rid of this and start with "The future ..." line 26: "nearly disappearance" should be "near disappearance"

page 1009 line 5: "allowing to compute the" should be something like "allowing one to compute the " or "allowing us to compute the " or "allowing for the computation of the"

Table 1 and 2: adding data estimates of simulated values would be useful (when available). Figure 2 needs to be bigger. There is a lot of wasted white space.

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