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Climate of the Past Discussions

Interactive comment on "Hypersensitivity of glacial temperatures in Siberia" *by* Pepijn Bakker et al.

Anonymous Referee #1

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Bakker et al. look to understand the mechanisms responsible for Siberian climate at the LGM. To do so, they use a combination of PMIP2/3 simulations and CESM1 sensitivity tests. The authors find that the Siberian region has a large temperature and precipitation spread among models. Using their CESM1 sensitivity tests, Bakker et al. explore the sensitivity of the Siberian region to model physics, ice sheet configuration, and vegetation response. They find that the Siberian temperature response is most significantly influenced by the vegetation, especially when using CAM5, but ice sheet geometry and model physics are also important. Overall, this is a nice study that I believe will be a valuable contribution to understanding climate in a largely overlooked region at the LGM. However, I have a few questions about the model configurations and would like a bit more detailed exploration of mechanisms before publication.

Major Comments:

Additional information about the model setup is required. How was the original LGM simulation, from which these experiments were branched, configured? This is important, because as the authors find, the climate produced by CAM4 and CAM5 can be quite different. Therefore, despite branching from a previous run, I am not convinced that 200 years of spin up is sufficient. Including top-of-atmosphere energy imbalance would provide a first order estimate of how close these simulations are to equilibrium. Also, are 30 year averages enough to produce true climatologies in this region? There are a lot of decadal oscillations that can impact climate for long periods (e.g. Deser et al. 2012). I don't think that this will significantly change results, but I do recommend a quick comparison with a longer average, such as 50 years, to make sure. Finally, how were the CLM4 cases with "interactive vegetation" spun up? If not spun-up properly, it can take hundreds of years for the carbon cycle to come into equilibrium, which could impact your vegetation distribution.

Limiting the analyses to JJA limits the mechanistic understanding. Are you sure that the summer changes are mainly a result of summer processes? Also, a more rigorous exploration of the local radiative effects versus heat transport would be useful. For example, albedo and cloud radiative forcings would be more insightful than snow and cloud cover.

The authors argue for the necessity of additional CESM simulations based in part on the number of variables available for analysis from the PMIP simulations, but proceed to explore only basic outputs from their CESM experiments. Additional analyses to explore why the temperature changes in CESM with different configurations is warranted. At a minimum, areas of perennial snow cover are worth including. What about sea ice? Maybe a PDD and/or energy balance calculation would be insightful. With additional information, the authors could make a much more significant statement about which simulations would produce an ice sheet in Siberia at the LGM. From there, additional model assessment with proxies is possible. Are the models that produce a Siberian ice

sheet too cold (probably) or too wet, etc. . .? What does this suggest about Siberian climate at the LGM?

Specific:

P1 Line 20: Further south than 50°N in many locations in North America. P1 Line 21: Much of Alaska also did not have ice. P1 Line 25: Didn't some of these modeling studies limit their ice domain to exclude Siberia? Double check. P2 Line 2: Citation for the sea level statement? P2 Line 30: This dust feedback is mentioned in earlier (e.g. Mahowald et al., 1999; Ganopolski et al., 2010). What about the direct radiative effect of dust (e.g. Schneider et al., 2006)? P4 Line 1: Link is messed up. P4 Line 10: Should be 1.9x2.5° P5 Line 16: Shouldn't this citation be for an ice sheet reconstruction paper? Peltier et al. (2015) maybe? P5 Line 34: Not sure that ensemble is the correct word. P6 Line 5: Need to spell out LGM_CAM5_noVeg first. P6 Line 14: Why not look at the snow cover in the model? P6 Line 4: Cloud radiative forcing would be more insightful. P6 Line 13: Did you analyze CCSM3, as used in Liakka et al. (2016), to better understand this discrepancy? Could use a bit of additional discussion. Figure 1: Make the continental outlines thicker. Figure 2: Darker green would make it easier to see. Figure 3: Add winds and/or height anomalies to better highlight the circulation changes. P10 Line 16: Why not plot the same variables as in the PMIP runs with CESM? P10 Line 22: How is surface roughness over the ice sheets configured? The results of Brady et al. (2013) suggest that this is important. P10 Line 8-2?: It would be great to plot some of the differences mentioned. . . P11 Line 20: How do you define vegetation density? P11 Line 22: This vegetation feedback has been found to be important for Arctic climate before (e.g. Jahn et al., 2005; Tabor et al., 2014). Figure 5 A: There must be a strong local feedback in Siberia. Maybe plot snow cover or albedo? P11 Line 23: Does this mean the vegetation dies? P11 Line 26: Does Lawrence et al. (2011) discuss this Arctic LAI issue? Figure 6: How were your PI runs configured for your LGM-PI anomalies? The vectors are very hard to see in panel C. Please change the color. Figure 7: Extend the temperature range in panel B.

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