

## Response to Anonymous Referee #2

We thank Anonymous Referee #2 for his/her thoughtful and insightful comments on our manuscript. We have responded to the comments below (in red).

From the reference to the paper by Weaver and co-authors, UVic needs a choice between options, like humidity transport or diffusive. It also looks as if the atm wind can be prescribed or sensitive to SAT and density. Evidently, such options impact the feedbacks in UVic. I suggest a table to summarize these options, and the feedback concerned.

The referee is correct in noting that UVic contains options regarding atmospheric transport/diffusion and atm winds. In the first paragraph of section 2.1 (4th sentence), we have stated that we are using UVic version 2.9, which includes the atmospheric heat diffusion feedback (diffusion as a function of global mean surface air temperature). This is a feedback that the latest version of UVic includes and we make note that it has been shown to improve the latitudinal temperature gradient for the Last Glacial Maximum (when compared with proxy data; Fyke and Eby, 2012).

To isolate the effect of cloud feedbacks in our emulator, we choose to prescribe atm wind stress (no SAT feedback). However, large differences in the surface boundary conditions at the LGM (ice sheets) have been shown to greatly impact wind stress anomalies in LGM simulations (Muglia and Schmittner, 2016). The optional wind-SAT feedback would not capture these changes; therefore, we apply wind stress anomalies as diagnosed from the LGM GCM results (see end of section 2.4).

To be consistent in our model design, we also prescribe modern wind stress for our 4xCO<sub>2</sub> simulations. Wind stress anomalies across the CMIP5 4xCO<sub>2</sub> experiments are small; therefore, we use the prescribed wind stress fields of the control UVic 2.9 model. Upon reviewing our manuscript, we discussed the use of LGM wind stress anomalies at the end of section 2.4, but did not note our wind stress boundary condition for the 4xCO<sub>2</sub> simulations. We have added an additional sentence at the end of section 2.4 that further discusses the prescribed wind stress for the 4xCO<sub>2</sub> simulations.

In the same views, the way cloud feedback, as approximated by the atm-albedo could be explicitly described for clarity. The description of some feedback-loops would be of great help. For instance, atm-albedo -> SAT-> OLW etc How is the ocean dynamics impacted? What changes are observed concerning the thermohaline circulation, the thermocline etc What about the sea-ice extent?

We provide a description of the nature of cloud feedback loops (through their impact on SW and LW radiative balance) in our introduction.

Regarding ocean dynamics and sea-ice, we have chosen to concentrate this manuscript on how our linear parameterization of cloud feedbacks helps capture the change in radiative balance that would otherwise be missing in UVic (or similar EMIC). We have focused our discussion of radiative feedbacks on surface air temperature evolution and climate sensitivity, by association with the 4xCO<sub>2</sub> experiments of the CMIP5 coordinated framework. Therefore, we have not included any analysis on the impacts of these radiative changes on ocean dynamics in this study.

Some comments are already included in the RESULTS sections that could be related more closely to the UVic extended results others that the averaged global results directly as support to the comparison with the seven GCMs.

See responses to comments from other reviewer/editors.