**A review of "Does a difference in ice sheets between Marine Isotope Stages 3 and 5a affect the duration of stadials?" By Sam Sherriff-Tadano et al.**

In this paper the Authors present results from a series of coupled climate model experiments to show how and why the AMOC returns to it's original state after the imposition of a large freshwater hosing. They show that the background climate that the experiments are run under causes different responses with the size of the ice sheet playing a particularly important role. Using a nice set of "partially coupled" simulations the Authors are able to show that it is a change in the winds, caused by the different ice sheet configurations, that causes the largest difference in the responses.

This study is well motivated with a clear question and the modelling simulations are well conceived. The paper is admirably succinct. However, there are some occasions where the brevity has lead to a loss of clarity. This paper ought to be published as it fits well within the scope of Climate of the Past.

I detail below some general criticisms and follow up with some more specific comments.

I would like to thank the Authors for taking the time to prepare the manuscript so well. Too often manuscripts that are closer to drafts are submitted to review. Not having to wade through poorly constructed plots with unintelligible text made reviewing this manuscript a joy rather than a chore. Thanks!

**General Comments.**

This paper presents results from a series of hosing simulations. There's a long history to these type of simulations and we can learn things about the climate system from them. However, the link between arbitrarily dumping freshwater into the North Atlantic and climate events is still not clear (Barker et al 2015). Since this paper is so clearly aimed at understanding actual climate events, DO events, there needs to be more in the Introduction about how to link the hosing simulations to real events.

Ultimately, as is stated in the Discussion, the results presented here show how the climate system responds to the cessation of an external forcing. This needs to be made clear not just at the end of the paper.

There are a number of climate models which can now simulate DO like events without the need for external forcing. It would be useful to describe these in a bit more detail in the Introduction. There are 2 reasons for this: first to show that external forcing is not the only way to change the AMOC; second, and more importantly, to give some context for how the results presented in this manuscript might apply to those simulations. For example Vetoretti and Peltier (2016/2014) describe the balance between sea ice/salinity/AMOC that is at play in their oscillations. This will clearly be modulated by the processes shown in this study. If you can link your study with that of e.g. Vetoretti and Peltier, you can make a much stronger case that the results presented here can apply far more generally than just in the case of external forced AMOC shutdowns. This Reviewer, who is a hosing sceptic, would find this much more satisfying. In the last paragraph of the Discussion this idea is mentioned I would encourage you to expand this to make the links between this study and the others clearer. Doing this should make this will make this study much more applicable to interpreting the coupled oscillations not just hosing type runs.

Figure 8 shows that the state of the climate at the end of the hosing is quite different in MIS3H and MIS3-5iceH. Could it not be the case that the different response time of the AMOC in the 2 experiments is a result of the different state from which the AMOC is recovering? The partially coupled experiments show that wind affects the response time from the MIS3 weak state, but this

does not necessarily imply that this is also the cause of the altered response time in MIS3-5aice. I think that the discussion about the winds suggests that the different sea ice and salinity distributions shown in Fig 8 can be linked to the winds but it would help a reader to be explicit about this. Fig 8 is, to this reviewer, the key figure in this paper. All of the other discussion is around trying to explain it. It would therefore help to come back to it at the end of the PC experiments to apply what you have shown.

**Specific Comments**

The title "Does a difference in ice sheets between Marine Isotope Stages 3 and 5a affect the duration of stadials?" is very snappy but ultimately in the experiments presented what determines the duration of the stadial period is how long the freshwater forcing is applied. A slightly more conservative "Does a difference in ice sheets between Marine Isotope Stages 3 and 5a affect the time it takes for the AMOC to recover from a weakening?" or similar would be a little more accurate.

Paragraphs beginning Line 246/269 – It would help to expand the description of the resumption of the AMOC in these paragraph. This would make it easier to understand the rest of the paper as a reader would better understand the set of processes (ice, salinity, convection) that lead from weak AMOC to strong. The summary sentences at the end of these paragraphs are very helpful.

Line 256 - "Four hundred years after the cessation of hosing, the surface salinity and sea ice thickness reached a quasi-equilibrium state, whereas the subsurface temperature continuously increased" how about: "an apparently steady state, however subsurface is still warming…." As it's not a quasi-eqm state.

Line 275 - "Because the surface salinity was sufficiently high in the weak phase of the AMOC, deepwater could form continuously." This suggests that deep water formation was happening during the weak AMOC phase, which I don't think is the case?

"Deepwater formation region in MIS3H" this can be seen in Fig. 5(b) correct? If so refer a reader to this figure for ease of comparison.

Line 290 - "With the southward-shifted westerly wind and strong northerly wind over the western North Atlantic, less sea ice was transported to the deepwater formation region in MIS3H" – worth saying this weakens the westerly wind formerly moving the sea ice. Confusing otherwise.

Line 291 "Therefore, even though the atmosphere was colder, less sea ice existed over the deepwater formation region." How do we know that the atmosphere was colder? You should show it.

In parts of the manuscript the link between the winds and the ice and salinity is a bit unclear. This is likely because different aspects of the overall wind change affect ice and salinity differently. So, for example, at Line 340 "It was found that the difference in surface wind played a role in causing the difference between MIS3H and MIS3-5aiceH. The cyclonic surface wind at mid-high latitudes was stronger in MIS3H than in MIS3-5aiceH. In addition, a strong northerly wind anomaly was induced over the western North Atlantic. As a result, the wind-driven transport of salt to the deepwater formation region was larger and wind-driven sea ice transport smaller in MIS3H compared with MIS3-5aiceH." It would help a reader to spell out which of the northerly anomaly and the stronger cyclonic surface wind affects sea ice and which affects salinity.

Line 318 – state that the MIS3 heat flux should lead to cooler temperatures. You say it later but a reader may already be confused.

Line 320 – “This long stadial state was caused by the very thick sea ice over the deepwater formation region, associated with stronger surface cooling by the MIS3 ice sheet (Fig 12b,d)” this is confusing, because this seems to suggest that the change in sea ice in _windwater is due to a different mechanism, surface cooling, than _wind, advection. Which is not the case? Also Fig 12b,d doesn’t show stronger surface cooling in any of its plots. It would, however, be very helpful to show this.

Line 332 – “Therefore, the larger (smaller) MIS3 (MIS5a) ice sheet reduced (increased) the recovery time of the AMOC by reducing (increasing) the input of atmospheric freshwater flux over the deepwater formation region.” Do not try and compress 2 sentences into 1 using brackets. It is totally unintelligible. Just write out:” Therefore, the larger MIS3 ice sheet reduced the recovery time of the AMOC by reducing the input of atmospheric freshwater flux over the deepwater formation region when compared to MIS5a.”

Line 340 – add reference to Fig 10 – for a reader who comes in halfway through.

**Figures**

All time series plots need to have marks to show where the hosing is or it not occurring. E.g. Fig 8. Put some hatching over the time 0-500 to show that hosing happens here.

Fig 10. Show the deep water formation areas to allow a comparison. It’s important to know where one is looking for the changes in surface fields.