

## ***Interactive comment on “Projected changes in the seasonal cycle of the Atlantic meridional heat transport in MPI-ESM” by Matthias Fischer et al.***

### **Anonymous Referee #1**

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The authors examine the Atlantic meridional heat transport in their model in the present day and in the future and attempt attribute the cause of the changes. The paper is well written and clear. There is a lot of good background and the work is good. Technically, it fits into the scope of ESD as heat transport is very much a climate variable, not just an ocean variable, and it fits into aims and scope (2) Earth System Change. That said, the sister journal Ocean Science would also be a good fit.

I have two major issues that need addressing. Firstly, the shift in latitude of the seasonal cycle causes some shifts in time. This is not properly treated. I would suggest comparing the seasonal cycles of HISTmean and RCPmean shifted by five degrees to try to quantify this. See further comments below.

Secondly, One of the main conclusions of the paper is that all changes to the seasonal

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cycle are explained by changes in the wind. Or at least that is the impression the reader gets. However, comparing Fig 8f with 6d although the wind explains most of what changes close to the equator, it does not have a magnitude large enough to explain what happens north of 30N. What is happening there? If there is a feedback that amplifies the signal or another contributing process this needs to be clearly written in the text, even if at this stage it is a little bit speculative.

Title: projected for when?

Page 1 Line 6: "For the total OHT seasonal cycle," I do not understand what follows this statement. The last part of the abstract needs to be revised so that it is clearer.

Page 1 Line 11: What changes in the gyre? Don't just say that it changes, say how it changes.

Page 2 Line 7: I don't think it is correct to say that the storm track will move northwards in light of the results of Zappa et al (2013).

Page 8 Line 11: "the equator the pole"?

Page 8 Line 19: "can not be fully explained by the northward shift" - which features do you refer to here? The following sentence indicates that it is at the gyre boundaries, but then the sentence after that claims the changes there "result from the northward shift", which leaves the reader confused. The only region that cannot to first order be explained as a northward shift is north of 50N, but as the values are so small there this may not be a robust result.

Page 9 Line 25: You should point out to the reader here that the seasonal cycle is more than three times larger in amplitude in the subtropics than in the subpolar gyre, just in case they do not look at the axis labels.

Page 10 Section 4.1.3: There are some references here to Fig 8, which I think are meant to be Fig 9. Otherwise this paper has no references to Figure 9!

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Page 10 Lines 18-25: To my eye, the Figures show that the seasonal cycle of MHT between 30N-40N cannot be explained by the Ekman component. Figure 11 shows that NADW is changed at these latitudes, so could it be that this part is not wind driven but due entirely to the collapse of the AMOC? This is not acknowledged in this part of the text.

Page 11 Line 35: Although it is difficult to separate global warming and AMOC slow down in surface temperature, their footprints in outgoing longwave and absorbed short-wave radiation are very distinct, making attribution possible (Dirfjhout, 2015)

Page 12 Conclusion 1: Some of the shift in time is due to the shift in latitude. The way this conclusion is written it could be interpreted to mean that they are separate.

Page 12 Conclusion 4: Are the changes in the gyre heat transport seasonal cycle also due to wind-driven changes? It doesn't appear so from Figures 8 and 9. So what is causing it?

Fig 3 caption, last line: "(v)" should be "(b)"?

Fig 6 (e,f): you could add another line from RCPmean, which is the seasonal cycle 5 degrees further North. This would back up your statement on page 8 saying that the approximate shift of the pattern is 5 degrees. Though if these panels (and the equivalent ones in Fig 8) are meant to characterise the subtropical and subpolar gyre, then perhaps an average over a range of latitudes in each gyre would be better? After all, you wouldn't believe that the model can predict the climate change impact at one specific latitude, but you would be more confident that an average over most of the gyre is representative.

Fig 8 (a-b): What is the point of the vertical profile of the boundary layer only? It would be much more informative to have the winds at say 925hPa with latitude on the y-axis and month on the x-axis as in the other plots in this figure (which would be less confusing as well)

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Sybren Dijkstra (2015) Competition between global warming and an abrupt collapse of the AMOC in Earth's energy imbalance *Scientific Reports* 5, Article number: 14877 (2015)

Giuseppe Zappa, Len C. Shaffrey, Kevin I. Hodges, Phil G. Sansom, and David B. Stephenson (2013) A Multimodel Assessment of Future Projections of North Atlantic and European Extratropical Cyclones in the CMIP5 Climate Models *Journal of Climate* 2013 26:16, 5846-5862

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Interactive comment on *Earth Syst. Dynam. Discuss.*, doi:10.5194/esd-2016-25, 2016.

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