Responses to comments by reviewer David Bailey

We thank Dr. Bailey for his comments, and give our responses below.

This manuscript describes an update to the Met Office Global Coupled Model. The CICE model itself remains the same, but some of the internal parameters have changed. These do have the desirable effect of improving the Arctic Sea Ice simulation, but overall the Antarctic sea ice simulation is substantially degraded. While I agree that this is due to the change in the ocean model resolution, I believe that the experiments described here are fundamentally flawed and not worthy of publication at this point.

My main issue is that the nominal resolution of 0.25 degrees is not eddy-resolving as the authors suggest. A recent paper by Griffies et al. 2015 clearly outlines that a resolution of 0.25-degrees with no Gent-McWilliams or similar eddy parameterization leads to a substantially larger drift in the global ocean temperature (see their Figure 2). The results at 0.1-degree are closer overall in these metrics when compared to a 1-degree ocean simulation with GM. New simulations should be performed either at 0.25 degrees with a GM-like parameterization or at 0.1-degree to begin to assess the changes in the CICE model parameters.
The resolution of 0.25 degrees is, as the reviewer points out, not eddy-*resolving*. However, it is considered to be eddy-*permitting*, and it is this term that we use in the paper. The results presented by Griffies et al. (2015) do indeed indicate that the parameterisation of mesoscale eddies in the GFDL model at 0.25 degrees resolution requires additional vertical mixing. In NEMO at ORCA025 we use a latitude-dependent viscosity and isopycnal diffusion which result in similar SST biases for this $^{1}/_{4}$ degree model as we see in our $^{1}/_{12}$-degree NEMO configuration. In addition we do not observe the cool bias at depth as in the GFDL model. Consequently we do not think the issues described for the GFDL model are related to our biases. The Southern Ocean warm bias in NEMO at ORCA025 is solely related to the cloud-related surface short wave bias. We therefore do not expect that running at 0.1 degree, as suggested by the reviewer, would alter our results.

Also, the changes to the CICE parameters should be systematically evaluated to determine which of these has the largest effect in improving the Arctic sea ice. Also, once the ocean simulation has been improved, a similar analysis of the impacts of these on the Antarctic sea ice is needed.
We have published such a study previously (Rae et al., 2014). We mentioned this briefly at the beginning of Section 4 of the submitted manuscript: "In this section, the differences between GSI6.0 and GSI4.0 will be discussed, and put in the context of the findings of Rae et al. (2014)". However, we have now expanded this by adding the following summary of that paper: "That study found that snow albedo, and snow and ice thermal conductivities, had the largest effect on Arctic sea ice, and that the winter Arctic ice extent was strongly influenced by a move to higher ice-ocean model resolution, through its effect on sea-surface temperatures in the Labrador Sea. Rae et al (2014) also found that in the Antarctic, the effects of changing atmospheric and oceanic forcing generally dominated over those of changing sea ice parameters, and that the Antarctic sea ice simulation in the model was also strongly sensitive to increased ice-ocean resolution."

Reference:

Rae, J.G.L., Hewitt, H.T., Keen, A.B., Ridley, J.K., Edwards, J.M., and Harris, C.M.: A sensitivity study of the sea ice simulation in HadGEM3, Ocean Modell., 74, 60–76, doi:10.1016/j.ocemod.20, 2014 .