Responses to final review

Paragraph beginning on pg 4, line 4: It is a combination of meridional and _vertical_ momentum fluxes by the eddies that reduces the sensitivity to wind stress. Subsequent studies by Farneti (Ocean Modelling, 39, 135-145 ,2011) and Gent (Journal of Climate, 24 ,19 , 4992-4998, 2011) show that the cited result is largely an artifact of the tapering scheme used in that particular implementation of GM, not a general property of low-resolution models.

We have replaced this paragraph with the following text, incorporating the two suggested references:

Ocean models run on horizontal grids fine enough to resolve eddies in the Southern Ocean show “eddy saturation”, where increased vertical transport of momentum and meridional transport of heat away from the Antarctic Circumpolar Current (ACC) by the eddy field in response to increases in wind stress mean that the isopycnal slopes and therefore the circumpolar transport is relatively insensitive to changes in the wind forcing (Tansley and Marshall, 2001; Hallberg and Gnanadesikan, 2006; Munday et al, 2013). This is not observed in lower resolution models where the eddy transports are parameterised by diffusive schemes. A similar insensitivity of the global overturning circulation to the Southern Ocean wind forcing (“eddy compensation”) is also seen in eddy-resolving models (Viebahn and Eden, 2010, Farneti et al, 2010) although some studies have suggested that eddy compensation can be achieved in lower resolution models using a variable Gent-McWilliams coefficient and modified tapering scheme at the base of the mixed layer (Gent and Danabasoglu, 2011; Farneti and Gent, 2011).

page 6, line 25: should be m^4/s

This has been corrected.

page 13, line 15-18: briefly state what the MLD criterion is, delta-T, delta-rho? Is exactly the same criteria used in the model as in the climatology (i.e., derived from instantaneous profiles or climatological averages).

The MLD is calculated according to a variable density criterion based on a temperature change of 0.2°C, as used in the climatology, and calculated from 5-day mean model outputs. We have now stated this explicitly at the beginning the relevant paragraph in Section 5.1.1. We have also added hatching in Figure 2 to the model mixed layer depth where there is ice cover for at least part of the year, to facilitate comparison with the observational fields.

page 15, line 15: ... over the later decade ...

We have inserted the missing “the”.

page 15, line 23 these simulations (yours) or those simulations (Hirschi's) ?

We refer to the simulations referred to in Hirschi et al. We have replaced “these simulations” with “the simulations of Hirschi et al.” to remove this ambiguity.

page 17, line 19: do the cited transport numbers include the transport within the BBL parameterization or only that of the resolved flow? What about the impact of the diffusive component of the BBL scheme?

The model uses the bottom boundary layer (BBL) parameterization following Beckmann and Döscher (1997), which permits a direct communication between two adjacent bottom cells at different model levels. In the current implementation of the BBL only the tracers are modified, not the velocities (Madec et al., 2008). Therefore, the advective transports calculated from the time-averaged velocities output from the model are the transports consistent with model dynamics; we have clarified this in the text.

page 22, line 2 (Fig 9): It is unclear of the observations are inter-annually varying, or if the same climatological year is being subtracted from each model year?

The zonal mean model fields are compared with the corresponding month and year of the Reynolds et al climatology, which varies interannually. We have clarified this in the text.