Global ocean model development for CMIP6 in Meteorological Research Institute and its performance in reproducing ocean general circulation

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Meteorological Research Institute/Japan Meteorological Agency (MRI/JMA) has been developing an Earth System Model, MRI-ESM2.0, for CMIP6. Its ocean component called GONDOLA_100 is a global eddy-less model based on MRI Community Ocean Model (MRI.COM) version 4. This model employs the tripolar grid of Murray (1996) and its horizontal resolutions are primarily 1 degree in longitude and 0.5 degree in latitude with meridional refinement down to 0.3 degree within 10 degrees north and south of the equator. This model has 60 layers and 1 bottom boundary layer and its layer thickness ranges from 2 meters to 700 meters. We have made several improvements from our CMIP5 ocean model. For example, we adopt the second order moment scheme of Prather (1986) for tracer advection with a flux limiter of Morales Maqueda and Holloway (2006) method B. Thickness diffusion coefficients are calculated from buoyancy frequency with the use of Danabasoglu and Marshall’ s (2007) scheme with modification of Danabasoglu et al. (2008). Isopycnal tracer diffusion turns into horizontal diffusion near the sea surface and in the steep slope region by using tapering method of Danabasoglu and Marshall (1995) and Large et al. (1997). This tapering method enables us to relax the upper limit of isopycnal slopes from 0.001 to 0.1. This model was integrated over 300 years by repeatedly imposing the corrected inter-annual forcing version 2 of Coordinated Ocean-ice Reference Experiments. The Atlantic meridional overturning circulation (MOC) at 26.5N reaches 16 Sv in the average from 2005 to 2007, which is still smaller than observational estimate (RAPID-MOC) but larger and more realistic than that in our old model. An unrealistic open-ocean polynya in the Weddell Sea is suppressed in GONDOLA_100, whereas our old model suffers from its frequent occurrence. Here, we discuss relationships between model developments and improvements in MOCs in our ocean model.

