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Ocean circulation features of the GFDL CM2.6 and CM2.5 high-resolution global coupled climate models

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Sustained model development efforts and the availability of enhanced computer resources have allowed researchers at NOAA's Geophysical Dynamics Laboratory (GFDL) to construct a pair of new, higher resolution, global climate models. These models are being applied to problems spanning seasonal-to-interannual up to decadal-to-century time scales. Based on MOM 4.1, the GFDL CM2.6 model's ocean has 50 vertical levels and horizontal resolution that varies from 10 km in the tropics to 3 km in polar regions (nominally, one-tenth of a degree). In the GFDL CM2.5 model, the ocean's horizontal resolution is 28 km in the tropics and 8 km in polar regions (nominally one-quarter of a degree). While the global CM2.5 ocean model can be considered 'eddy-permitting', the CM2.6 model's ocean is 'eddy-resolving'. Both models employ an atmospheric model with cubed sphere geometry having approximately 50km horizontal resolution (C180) and 32 vertical levels. The ocean and atmosphere model components of these global coupled climate models exchange fluxes once an hour. For analysis purposes, the CM2.6 model's fine ocean resolution allows it to be viewed as both a first-class global model of the physical climate system and as a series of interconnected regional models. Taking a global view, we see that the CM2.6 ocean is more energetic than previous generations of GFDL's global climate models, with CM2.6 model-simulated maps of eddy kinetic energy (EKE) agreeing well with satellite-derived observations (the magnitude of the EKE in CM2.5 is somewhat less than observed). On a more regional scale, finer spatial resolution and more realistic ocean bathymetry allows these models to better represent currents in key areas. For example, in the North Atlantic these enhancements affect complex flow patterns through the Intra-American Seas, the position and strength of the Gulf Stream, and circulation in the water mass formation regions of the Labrador, and Greenland-Iceland-Norwegian Seas. Several choices made during the construction of these models together allow sharp gradients in both the horizontal and vertical to be maintained - characteristics that are especially notable in boundary currents and the thermocline. Using CM2.6 to conduct experiments in which atmospheric CO_2 increases will allow analysis of the simulated role of eddies on the oceanic uptake of heat - a factor that can influence the global transient climate change response.