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Simulations of hydrographic properties in the north western North Atlantic Ocean in Global Climate Models

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The performance of Global Climate Models (GCM) in simulating the hydrographic structure and variability of the north western North Atlantic Ocean, in particular the Labrador and Irminger Sea, has been assessed. This area plays a important role in the Meridional Overturning Circulation (MOC), but is difficult to simulate because of the strong presence of small scale (parameterized) processes like deep convection. Hydrographic properties of the pre-industrial run of eight GCMs used in the IPCC AR4 report are compared with observations from the AR07 World Ocean Circulation Experiment repeat section. The mean and standard deviation of 20 years of simulated data are compared in three layers representing the surface waters, intermediate waters and deep water masses. Two models simulate an extremely cold, fresh surface layer with model biases down to -1.7 psu and -4.3 degrees Celcius, much larger than the observed ranges of variability. The intermediate and deep layers are generally too warm and saline, with biases up to 0.7 psu and 3.7 degrees Celcius. Results indicate that deep convection is (partly) inhibited by high surface stratification. Thus, intermediate water formed by convection is partly replaced by warmer water from the south. Further analysis of two 200-year segments of GCM simulations show that the model biases are not the result of an oscillation peak captured within the shorter segment. A comparison of the GCMs with an ocean model and ocean reanalyses indicates that most model biases are caused by the coupling to the atmospheric component of the GCM. Model drift during long spin up periods allows the initially small biases to become

significant.