Atlantic Meridional Overturning Circulation in CFSv2 and its Potential Connection with North Atlantic Upper Ocean Freshwater Balance

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An ongoing effort is being made to examine the Atlantic Meridional Overturning Circulation (AMOC) in the Climate Forecast System, version 2 (CFSv2), which has recently been established as the operational climate model in the NCEP. Our analysis of a 30-yr simulation of the CFSv2 initialized with an ocean-atmosphere state from the CFS Reanalysis shows that the AMOC essentially is very weak at the beginning and practically does not exist by the end of the 30-year simulation. Initialized from an ECMWF-NEMOVAR oceanic state, it is found that the strength of AMOC is realistic in the first month of the simulation, at around 18Sv, but is weakened steadily during the integration and becomes as weak as the previous run after 30 years of simulation. It is concluded that the weakening of the AMOC is due to potential deficiencies in model physics, instead of initial states. Our further analysis suggests that the AMOC weakening is accompanied by a freshening of the northern part of the North Atlantic Ocean in the upper 200 to 300 meters, which may have several potential sources. Preliminary sensitivity experiments have been conducted to test the effects from some of these factors. One is the excessive melting of the Arctic sea ice, which significantly reduces the ice thickness and leads to the nearly complete ice melting in boreal summer. Another source is the leak of the brackish water from the Baltic Sea into the Atlantic basin in the first several years of the integration. In several experiments, the ice albedo is substantially increased, together with an adjustment of the temperature range for albedo change from dry to wet ice. These experiments show that the Arctic sea ice can be sustained realistically with a set of chosen parameters, which increases the salinity in the Arctic and northern North Atlantic Ocean and modestly increases the mean AMOC. Similarly, the raised sill in the channel connecting the Baltic Sea with the North Atlantic also reduces the brackish water into the Atlantic Ocean and decreases the freshening tendency in the North Atlantic. Several further experiments have been conducted to test the effects of other potential factors: such as river runoff, the sill depth of the Greenland channel and background vertical diffusion coefficient. The influences of the precipitation over the northern North Atlantic and the freshwater exchange with the subtropical North Atlantic are also being analyzed.