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North Atlantic deep water formation and AMOC in CMIP5 models

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North Atlantic deep water formation processes and properties in climate models are indicative of their ability to simulate future ocean circulation, ventilation, carbon and heat uptake, and sea level rise. Historical time series of temperature, salinity, sea ice concentration and ocean transport in the North Atlantic subpolar gyre and Nordic Seas from 23 CMIP5 (Climate Model Intercomparison Project, phase 5) models are compared with observations to reveal the causes and consequences of North Atlantic deep water formation in models. Deep convection occurs at the sea ice edge and is most realistic in models with accurate sea ice extent, mostly those using the CICE model. The trigger of deep convection varies among models; for one third it is intense surface cooling only, while the remaining two thirds also need upward mixing of subsurface warm salty water. The models with the most intense deep convection have the most accurate deep water properties, which are warmer and fresher than in the other models. They also have the strongest Atlantic Meridional Overturning Circulation (AMOC). For over half of the models, 40% of the variability of the AMOC is explained by the volumes of deep water produced in the subpolar gyre and Nordic Seas, with 3 and 4 years lag respectively. Understanding the dynamical drivers of the AMOC in models is key to realistically forecast a possible slow down and its consequences on the global circulation and marine life.