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Glacial Atlantic Overturning in CMIP/PMIP models and MIROC AOGCM

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Multiple tracer evidence at the Last Glacial Maximum (LGM) particularly show that the water originated from the North Atlantic (NADW) was shoaler than the present day ocean and the Atlantic meridional overturning circulation (AMOC) may have been weaker. Athough it is expected to be a good test for the fully coupled atmosphere-ocean general circulation models (GCM) which are used for future climate projection, many models forced with glacial condition, however, fail to simulate the glacial AMOC, which is an obstacle to understand the response of ocean to climatic forcings. Here we analyse the latest multi models of CMIP5 and PMIP experiments as well as MIROC model and show that the deepening of AMOC simulated in most of the models come from the warm bias in Southern ocean. We further show that the models which don't have shoeler glacial AMOC have even stronger AMOC because of the existence of ice sheets, through the feedback between the AMOC, sea ice and wind stress in the north Atlantic. The winter sea ice in the North Atlantic governs the AMOC by playing as a "shutter" on/off not only for the deep ocean convection, but for the wind stress. It is consistent with a hypothesis that the weakening of the AMOC is caused by the cooling due to the Lower Greenhouse Gas level and larger Antarctic ice-sheet, while the strengthening of the AMOC is caused by the Northern Hemisphere ice sheet. We suggest that the improvement of cloud scheme in GCM atmosphere-ocean-ice processes in the high latitude region and sufficient calculation to obtain the equilibrium state especially around Antarctica is crucial for more appropriate AMOC simulation both for the past and future climate change.