EGU2020-844
https://doi.org/10.5194/egusphere-egu2020-844
EGU General Assembly 2020

Centennial variability driven by salinity exchanges between the Atlantic and Arctic in a coupled climate model

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The centennial to multi-centennial variability of the Atlantic Meridional Overturning Circulation (AMOC) is studied in a 1200-yr pre-industrial control simulation of the IPSL-CM6-LR atmosphere-ocean coupled model. In this run, a spectrum analysis finds a periodicity of the low-frequency variability of AMOC, with a period of about 200-year. This variability alters the Northern Hemisphere climate over the land and modulates the Arctic sea ice extent and volume. The associated density variations show large positive (negative) salinity-driven density anomalies in the Nordic Seas and subpolar gyre associated with a strong (week) AMOC state. The positive salinity anomalies in the Greenland Sea are found to be generated by anomalous southward salinity transport in the Fram Straits. The gradual AMOC increase and the associated oceanic northward heat transport melt the sea ice in the Arctic and build shallow negative salinity anomalies in the central Arctic. In parallel, the AMOC is also associated with a northward salt transport into the Eastern Arctic, by an inflow of Atlantic water from the Barents Sea to the East Siberian Ocean. The accumulated surface freshwater in the central Arctic is ultimately exported into the Atlantic mainly through the Fram Strait via intensified East Greenland Current, lowering the upper ocean density and enhancing the stratification at the regions where the cold deep limb of AMOC is formed. The positive salinity anomalies at subsurface then slowly reach the surface though diffusion, increasing the surface salinity. The oscillation then turns into the opposite phase.