Role of Atlantic Warm Pool-induced Freshwater Forcing in the AMOC

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Abstract

Recent studies have indicated that the multidecadal variations of the Atlantic Warm Pool (AWP) can induce a significant freshwater change in the tropical North Atlantic Ocean. The potential effect of the AWP-induced freshwater flux on the Atlantic Meridional Overturning Circulation (AMOC) is studied by performing a series of ocean-sea ice model experiments. Our model experiments demonstrate that ocean response to the AWP-induced freshwater flux is primarily dominated by the basin-scale gyre circulation adjustments with a time scale of about two decades. The positive (negative) freshwater anomaly leads to an anticyclonic (cyclonic) circulation overlapping the subtropical gyre. This strengthens (weakens) the Gulf Stream and the recirculation in the interior ocean, thus increases warm (cold) water advection to the north and decreases cold (warm) water advection to the south, producing an upper ocean temperature dipole in the midlatitude. As the freshwater (salty water) is advected to the North Atlantic deep convection region, the AMOC and its associated northward heat transport gradually decreases (increases), which in turn leads to an inter-hemispheric SST seesaw. In the equilibrium state, a comma-shaped SST anomaly pattern develops in the extratropical region, with the largest amplitude over the subpolar region and an extension along the east side of the basin and into the subtropical North Atlantic. Based on our model experiments, we argue that the multidecadal AWP-induced freshwater flux can affect the AMOC in such a way to recover the AMOC after it is weakened or strengthened - a negative feedback. The sensitivity of AMOC response to the amplitude of the AWP-induced freshwater forcing is also examined and discussed.