Atlantic Multidecadal SST Signal Modulated by the Low-Frequency Mixed Layer Depth Variability

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Atlantic Multidecadal Oscillation (AMO) has conventionally been attributed to the heat transport associated with the Atlantic Meridional Overturning Circulation. A recent study, however, challenged this paradigm and indicated that the North Atlantic basin-wide sea surface temperature (SST) pattern analogous to AMO can emerge owing to the atmospheric stochastic forcings in slab ocean models, without an active ocean. Subsequent studies have disputed this finding, arguing that the cause of the SST warming differ between the slab ocean models and fully-coupled models; however, a consensus is yet to be reached.

In this study, we take an approach to resolve this conundrum, by partitioning the multidecadal SST tendency into a part that is induced by the surface heat fluxes and another by the ocean, using a latest version of a fully-coupled climate model, MIROC6. We found that the heat flux term is primarily responsible for the North Atlantic subpolar SST warming, opposing the cooling caused by the oceanic term, despite that the associated heat flux anomalies are upward. Further decomposition of the heat flux term indicates that it is the mixed layer depth (MLD) deepening that makes the ocean less susceptible for cooling. This MLD variability is essentially induced by the anomalous salinity transport by the Gulf Stream modulated by the multidecadal North Atlantic Oscillation. The tropical North Atlantic SST signal, in contrast, arises due to the surface heat fluxes. Our study thus implies the key role of both air-sea fluxes and the ocean dynamics in the emergence of the AMO signal.

Keywords: Atlantic Multidecadal Oscillation/Variability, Gulf Stream, mixed-layer depth

