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Decadal changes in the heat and freshwater content of the subpolar North Atlantic

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During the last five decades striking changes occurred in the freshwater and heat content of the subpolar North Atlantic (SNA). An intriguing feature of the observational record is the tight co-variability of the freshwater and heat content: an extended period of freshening and cooling since the late 1960s was replaced by a rapid warming and salinification trend after 1995, reversing to a progressive cooling and freshening since about 2006. Here we use a sequence of experiments with high resolution (1/4° and 1/20°) ocean-sea ice models to unravel the spatial patterns, temporal evolution, and dynamical mechanisms governing these inter-decadal changes. Hindcast simulations of the oceanic response to the atmospheric variability during 1958-2017 based on the new JRA55-do forcing products capture the decadal variability in the integral properties of the SNA as reconstructed from historical salinity and temperature data, and reproduce pertinent observational indices of the mid-latitude transport variability. Analysis of the freshwater and heat budgets illustrate how the SNA property changes evolve through changes in the inflow of warm and saline water from the subtropical North Atlantic that can be understood as a delayed response to decadal variations in the meridional transports associated with the AMOC. We show that most of the decadal AMOC variability can be traced to the buoyancy-forced changes in the density of the Labrador Sea, suggesting a possible predictive capability of Labrador Sea indices (e.g., SSH records) for the future evolution of the SNA heat and freshwater content.