Influences of Time-Dependent Precipitation on the AMOC

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The influences of time-dependent precipitation on the meridional overturning circulation in an idealized subpolar gyre with a marginal sea are examined using theoretical and numerical models. The theory predicts the temperature and salinity anomalies of deep convective water masses as well as the heat flux across the sill, heat storage, heat lost to the atmosphere, and the strength of overturning within the marginal sea. The theory reveals that there are three inherent timescales: relaxation timescales of temperature and salinity, which rely critically on lateral eddy fluxes, and the precipitation timescale. In a nondimensional framework, it is these three timescales, together with the precipitation amplitude, that determine the properties of convective water masses, heat fluxes, and strength and phase of the MOC. The theory makes clear how the amplitude, phase, and parameter dependencies of the response depend strongly on the frequency of the variations in precipitation and the relative strength of thermal and haline atmospheric forcing. It is demonstrated that the theoretical predictions agree qualitatively well with results from an eddy-resolving numerical model.

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