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Internal and forced eddy variability in the Labrador Sea

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Water mass transformation in the Labrador Sea, widely believed to be one of the key regions in the Atlantic Meridional Overturning Circulation (AMOC), now appears to be strongly impacted by vortex dynamics of the unstable boundary current. Large interannual variations in both eddy shedding and buoyancy transport from the boundary current have been observed but not explained, and are apparently sensitive to the state of the inflowing current. Heat and salinity fluxes associated with the eddies drive ventilation changes not accounted for by changes in local surface forcing, particularly during occasional years of extreme eddy activity, and constitute a predominant source of "internal" oceanic variability. The nature of this variable eddy-driven restratification is one of the outstanding questions along the northern transformation pathway.

Here we investigate the eddy generation mechanism and the associated buoyancy fluxes by combining realistic and idealized numerical modeling, data analysis, and theory. Theory, supported by idealized experiments, provides criteria to test hypotheses as to the vortex formation process (by baroclinic instability linked to the bottom topography). Ensembles of numerical experiments with a high-resolution regional model (ROMS) allow for quantifying the sensitivity of eddy generation and property transport to variations in local and external forcing parameters. For the first time, we reproduce with a numerical simulation the observed interannual variability in the eddy kinetic energy in the convective region of the Labrador Basin and along the West Greenland Current.