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# Fluxes and structures in diffusive convection

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This study explores the dynamics of oscillatory diffusive convection which occurs when cold, fresh water overlies warm and salty. Diffusive convection is generally observed in high-latitude regions, particularly in the Arctic Ocean, between the base of the mixed layer and the top of the Atlantic water. We separately consider two distinct diffusive regimes: (i) the smooth gradient configuration in which convection supports a statistically steady and spatially homogeneous state and (ii) the staircase regime characterized by the spontaneous formation of the well mixed layers separated by thin high-gradient interfaces. In both cases, we use a combination of high-resolution direct numerical simulations, data analysis, and analytical considerations to estimate the vertical heat/salt mixing rates and their dependencies on the large-scale environmental parameters. For smooth gradient configuration, we propose a simple physically based flux-gradient law, which expresses the heat and salt diffusivities as a function of the background density ratio. The ice-tethered profiler data from the Beaufort Gyre are analyzed to determine the origin of the thermohaline staircases and the mechanism for selection of the preferred layer thickness. The evolution of staircases in time is explained by considering the secondary instabilities of a series of diffusive interfaces. On the basis of our preliminary estimates, we suggest that the vertical heat flux driven by the diffusive convection could be one of the key processes controlling the melting rates of Arctic ice.