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Isopycnal mixing controls NADW stability

W. P. Sijp (1), M. H. England
The University of New South Wales, Sydney 2052, Australia,

We show that increasing the value of along-isopycnal diffusivity in a coupled model leads to enhanced stability of NADW formation with respect to FW perturbations. This is because the North Atlantic (NA) surface salinity budget is dominated by upward salt fluxes resulting from winter convection for low values of along-isopycnal diffusivity, whereas along-isopycnal diffusion exerts a strong control on NA surface salinity at higher diffusivity values. Shut-down of wintertime convection in response to a FW pulse allows the development of a surface FW lens responsible for the suppression of deep sinking, leading to a reduction in transport of of warm saline subtropical water into the subpolar gyre and causing further freshening. In contrast to convection, Isopycnal tracer diffusion proves more robust at removing the surface FW lens, as surface freshening leads only to a flattening of isopycnals, leaving diffusive removal of anomalous surface FW in place. As a result, multiple equilibria are altogether absent for sufficiently high values of isopycnal diffusivity. Furthermore, the surface salinity budget of the North Pacific is also dominated by along-isopycnal diffusion when diffusivity values are sufficiently high, leading to a breakdown of the surface FW lens there and the associated onset of deep water formation.