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Effects of heterogeneous surface boundary conditions on parameterized oceanic deep convection

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Vertical mixing and deep convection are routinely parameterized in basin-scale and global ocean general circulation models. These parameterizations are designed to work with homogeneous surface boundary conditions for an individual grid cell. A partial ice cover, however, yields heterogeneous fluxes of buoyancy that are not resolved by the computational grid. The effects of such heterogeneous surface boundary conditions are explored by comparing coarse resolution models with three common parameterizations for mixing and deep convection with large eddy simulations (LES) of free convection in idealized scenarios. Generally, models with parameterized convection reproduce the temperature profiles of the LES reference accurately when the surface boundary conditions are resolved by the grid. Significant biases are introduced when the surface boundary conditions are not resolved and buoyancy fluxes are averaged horizontally. These biases imply that mixing depths may locally be too shallow in large scale simulations without proper handling of heterogeneous boundary conditions during convective events; also the grid-cell averaged density may be vertically homogenized within the shallow boundary layer. Adaptation of present mixing schemes may overcome these spurious effects of horizontally averaging the surface buoyancy fluxes.