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Mixed layer lateral eddy fluxes mediated by air-sea interaction

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The modulation of air-sea heat fluxes by geostrophic eddies due to the stirring of temperature at the sea surface is discussed and quantified. It is argued that the damping of eddy temperature variance by such air-sea fluxes enhances the dissipation of surface temperature fields. Depending on the timescale of damping relative to that of the eddying motions, surface eddy diffusivities can be significantly enhanced over interior values. The issues are explored and quantified in a controlled setting by driving a tracer field, a proxy for sea-surface temperature, with surface altimetric observations in the Antarctic Circumpolar Current (ACC) of the Southern Ocean. A new, tracer-based diagnostic of eddy diffusivity is introduced which is related to the Nakamura effective diffusivity. Using this, we quantify the surface lateral eddy diffusivities associated with (i) eddy stirring and small-scale mixing and (ii) surface damping by air-sea interaction. In the ACC, a diffusivity associated with surface damping of a comparable magnitude to that associated with eddy stirring ($\sim$500m^2/s) is found. In frontal regions prevalent in the ACC, an augmentation of surface lateral eddy diffusivities of this magnitude is equivalent to an air-sea flux of 100W/m^2 acting over a mixed layer depth of 100m – a very significant effect. Finally, the implications of our results for other tracer fields such as salinity, dissolved gases and chlorophyll are discussed.