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Advances in understanding the physical processes controlling vertical heat transport in the tropical North Atlantic

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Observational and modelling studies of the tropical ocean mixed layer have demonstrated the dominant role of turbulent vertical diffusive heat flux in maintaining sea surface temperature in the tropical Atlantic. Significant progress has been made in identifying the processes that enhance turbulent mixing in the upper stratified ocean. At the equator, vertically sheared large-scale circulation provides an energy source capable of overcoming stratification and driving turbulence, commonly referred to as deep-cycle turbulence. North of the equator, near-inertial waves and tropical instability waves increase shear at the base of the mixed layer, thereby enhancing vertical diffusive heat flux out of the mixed layer. In this study, we analyse an extensive observational dataset comprising 22 month-long cruises, including measurements of upper-ocean turbulence, velocity, hydrography, and wind forcing, to quantify the seasonal variability of turbulent vertical heat flux associated with near-inertial waves in the tropical eastern North Atlantic. We find that the mean mixed-layer heat loss attributable to near-inertial waves is approximately 35 W/m^2 , with enhanced heat loss during boreal summer. Furthermore, we show that increased upper-ocean turbulence and associated mixed-layer heat loss also arise from instabilities within the North Equatorial Countercurrent during boreal summer and autumn. These findings are evaluated in the context of the previously unexplained residual in mixed-layer heat budgets at PIRATA sites in the northern tropical Atlantic.