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On the parameterization of turbulent fluxes over the tropical Eastern Pacific

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Abstract. We present estimates of turbulent fluxes of heat and momentum derived from low level (~30 m) aircraft measurements over the tropical Eastern Pacific and provide empirical relationships that are valid under high wind speed conditions (up to 25 ms^{-1}). The estimates of total momentum flux and turbulent kinetic energy can be represented very accurately (r^2=0.99, when data are binned every 1 ms^{-1}) by empirical fits with a linear and a cubic terms of the average horizontal wind speed. The latent heat flux shows a strong quadratic dependence on the horizontal wind speed and a linear relationship with the difference between the air specific humidity and the saturated specific humidity at the sea surface, explaining 96% of the variance. The estimated values were used to evaluate the performance of three currently used parameterizations of turbulence fluxes, varying in complexity and computational requirements. The comparisons with the two more complex parameterizations show good agreement between the observed and parameterized latent heat fluxes, with less agreement in the sensible heat fluxes, and one of them largely overestimating the momentum fluxes. A third, very simple parameterization shows a surprisingly good agreement of the sensible heat flux, while momentum fluxes are again overestimated and a poor agreement was observed for the latent heat flux (r^2=0.62). The performance of all three parameterizations deteriorates significantly in the high wind speed regime (above 10–15 ms^{-1}). The dataset obtained over the tropical Eastern Pacific allows us to derive empirical functions for the turbulent fluxes that are applicable from 1 to 25 ms^{-1}, which can be introduced in meteorological models under high wind conditions.

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