Estimation of air-sea gas and heat fluxes from infrared imagery and surface wave measurements.

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Water surface infrared images as well as surface wave slope data were obtained during the GASEX2001 experiment in the South Equatorial Pacific waters and during the laboratory experiment at AEOLOTRON wind wave tank at University of Heidelberg in October 2004. Previous laboratory and field experiments suggest that at low to intermediate wind regimes the surface gas fluxes are better correlated with surface wave slope rather than with wind speed or wind stress [Frew et al., 2004]. Our observations of infrared imagery and wave slope during these experiments also indicate the same trend. Furthermore, they reveal two distinct regimes of heat and gas fluxes. The surface wave slope data show the existence of sporadic steep slope events, whilst the infrared imagery demonstrates intermittent passage of strong temperature fronts with steep gradients in the heat flux estimates. They therefore suggest the coexistence of weak background turbulence and intermittent small scale breaking events. The former yields moderate heat fluxes, while the latter are associated with enhanced subsurface turbulence and much higher heat fluxes. In addition, the infrared imagery analysis reveals potentially significant effects of near surface temperature stratification on the heat and gas flux estimation and highlights ambiguity in the present definition of the “bulk temperature”. Previous interpretations of the infrared images relied on the surface renewal model, in which the water surface is assumed to be occasionally renewed by bursts of turbulent eddies reaching the water surface [Garbe et al., 2004]. A new complementary model based on stationary and spatially periodic turbulent eddies is developed to reinterpret the infrared images. It is also shown that the difference in the surface boundary conditions for heat and gas affects the gas transfer velocity estimates based on the observed heat transfer velocity using the Schmidt number scaling.

REFERENCES