On the Coupling of Air and Sea

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Air and sea are coupled through specification of the fluxes of momentum, heat and mass across their common boundary – the air-sea interface. The waves on the interface accept some of the momentum from the wind and release a part to the underlying currents. The amounts transferred to and released by the waves depend on the wave directional spectrum and its relationship with the boundary layer winds. Consequently, momentum and kinetic energy coupling cannot be accomplished without a wave prediction model acting as “the middle man”. The fluxes of heat and mass are controlled by the diffusive sublayers O(mm) on both sides of the interface and are therefore dependent on Schmidt number as well as roughness Reynolds number. The fluxes of gases of low solubility in water are also enhanced by disruption of the aqueous diffusive sublayer by wave breaking. Bulk coefficients – drag coefficient, Stanton number, Dalton number and CO$_2$ transfer coefficient – are used to relate these coupling fluxes to mean variables in the boundary layers. Attempts, by the author and colleagues, to establish these coefficients over a wide range of wind speeds, are described. Field and tank measurements coupled with numerical models of waves and boundary layers lead to a generalized prescription of bulk coupling coefficients in neutral boundary layers.