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Momentum and energy exchange mechanisms between wind and surface gravity waves

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The mechanisms by which wind inputs momentum and energy into ocean surface waves are important for local sea state and coastal weather forecasting as well as for global atmosphere-ocean momentum and scalar flux budgets. These mechanisms are, to date, not fully known and quantified. This is due, in part, to the difficulties involved in measuring small-scale airflow dynamics very close to the rapidly moving air-sea interface. Using high resolution laboratory and field PIV (Particle Image Velocimetry) measurements in the airflow above surface waves, we examine the contributions of wave-phase-resolved viscous, turbulent and wave coherent momentum fluxes to the total momentum flux into the wavy surface, as well as energy input rates into the waves. We find that the along-wave near-surface viscous stress peaks in the vicinity of wave crests, and drops downwind of crests, which is generally favorable to wave growth. We observe distinct regimes of momentum and energy flux patterns, depending on wave age and wave slope. The influence of airflow separation on the along-wave viscous stress, as well as the respective contributions of existing wave growth theories in different wave slope and wave age regimes, will be discussed.