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Wave decay in air/water sheared turbulence

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In the present study we use Direct Numerical Simulations (DNS) to explore the nonstationary wave-decay process of a countercurrent (horizontal) air/water flow. The motion of the air/water interface is computed by solving a pure advection equation for the interface vertical elevation (boundary fitted method). At each time step, the physical domain is mapped into a rectangular domain using a nonorthogonal transformation. Continuity and Navier-Stokes equations are first solved separately in each domain, then coupled at the interface through the continuity of velocity and stress.
The physical problem is described in terms of three dimensionless numbers: the Reynolds number (Re, which measures the importance of inertia compared to viscosity), the Weber number (We, which measures the importance of inertia compared to surface tension) and the Froude number (Fr, which measures the importance of inertia compared to gravity).
Regardless of the physical parameters, the transient evolution of the interface waves is characterized by
an initial exponential decay followed by a new asymptotic steady state condition (characterized by a dynamical balance between gravity and capillarity).
At the new steady state condition, the air/water interface is characterized by the superposition of longer gravity waves: most of the interface energy is associated to gravity, whereas the surface tension affects mainly the smoothness of the interface.

The interface deformation modifies also the turbulence activity/transfer mechanisms across the interface. In particular, the non-zero value of the Turbulent Kinetic Energy (TKE) at the interface implies that turbulence persists near the interface and enhances momentum transfer across the interface itself.
All these considerations may also have important implications on the statistical description of the interface (probability density functions) and on intermittency phenomena in wave turbulence.