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Swell dissipation by induced atmospheric shear stress

Yves Perignon (1), Fabrice Ardhuin (2), Marie Cathelain (1), and Marie Robert (1)

(1) LHEEA, Ecole Centrale de Nantes, France (yves.perignon@ec-nantes.fr), (2) LOS, Ifremer, Brest, France

Global observations of swell dissipation across oceans reveal a significant loss of energy [Ardhuin et al. 2008] that can be triggered by a large variety of processes. Among other candidate mechanisms, this paper examines the properties of the viscous air-sea boundary layer driven by swells by mean of numerical simulations. The induced atmospheric flow regimes and their associated viscous dissipation over swells are characterized through several series of 3D numerical experiments carried out with a RANS model and appropriate turbulence closure. The set of experiments exhibits laminar to turbulent transition in the near free-surface region for a common range of characteristic amplitudes and periods of swells. At low Reynolds number, laminar conditions prevail and computed decay rates conform to the analytical formulation μ_ν of the Stokes interfacial boundary layer for this problem [Dore, 1978]. The turbulent regimes are characterized as well above the turbulent threshold $Re = 1.5 \times 10^5$ (i.e. $H = 2a > 2.2m$ for a $T = 14s$ monochromatic wave). The new turbulent decay rates following a non-dimensional relation are inferred, up to 4 times above the laminar values, which is a factor 10 less than the largest rates estimated for global oceanic conditions.