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Wind effects on waves propagating to the shore: experimental and numerical investigations

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Wind effects on water-waves propagating towards the shore are still not well known. Cross-shore winds blowing on-shore may induce perturbations on water-wave dynamics, wave kinematics, wave breaking in the surf zone, and wave run-up in the swash zone.

We conducted experiments in the Ecole Centrale Marseille laboratory wave tank and in the large air-sea interaction wind-wave facility of the IRPHE laboratory in Marseille, to study wave transformation in the surf zone, with and without cross-shore winds (Kimmoun and Branger 2007). Wave gauges, doppler current meter, camera visualisations and particle image velocimetry were extensively used to monitor wave height, water currents, wave phase speed, and run-up heights.

Different numerical models were used to simulate some of the experimental runs. a) Large Eddy Simulation (LES) solving the Navier-Stokes equations, in air and water, coupled with a dynamic subgrid scale turbulence model (Lubin et al 2006, Lubin et al 2010); b) GERRIS open source Navier-Stokes equation solver, in air and water, with an automatic mesh refinement (see Fuster et al 2009 for a description and examples); and c) Boussinesq-like model (Bingham et al 2009) including wave dissipation by breaking and wind momentum input by Jeffreys (1925)/Miles(1957) mechanism, and run-up modelisation (Lynett et al 2002).

Experimental and numerical results are presented. Qualitative and quantitative comparisons are made, more particularly on wave crests and wave trough envelope, mean water level, velocity vectors, wave phase speed and run-up. It is shown that wind has strong effects on water wave amplification, breaking location, run-up and beach flooding if the wind is very strong.

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