AIRFLOW STRUCTURE ABOVE SHOALING WAVES WITH A BLOWING WIND

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ABSTRACT

It is known that ocean waves have a strong influence on the drag coefficient C_d (or the equivalent roughness length). In coastal waters, wave shoaling alters a wave train in several ways. When deep-water waves travel through shallow waters, they become steeper, their phase speed is reduced, and they tend to break more frequently. Furthermore, the shoaling wave shape is modified by wind forcing. The different wave shape influences the airflow field above, and as a result the mean speed profiles, the form drag, and the frequency/degree of flow separation are significantly modified if compared to deep waters. In the past, field and numerical studies showed an enhancement of C_d as a result of wave shoaling. In order to test the airflow structure above shoaling waves, we performed a set of experiments of mechanically-generated regular waves affected by shoaling and interacting with wind. A combination of PIV (Particle Image Velocimetry) and LIF (Laser Induced Fluorescence) techniques are used to observe the 2D+time airflow field as close as O(0.5mm) to the surface, to reconstruct the wave shape and to estimate the wave speed. A triple decomposition of the velocity is performed to separate mean, periodic and turbulent components. As a consequence, we can show the phase-dependent velocity, turbulent kinetic energy, and vorticity fields during the shoaling process, and we can retrieve the relative contribution of the viscous stress, wave drag and turbulent stress.