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# Early stages of wind wave and drift current generation under non-stationary wind conditions.

Lucia Robles-Diaz (1), Francisco J. Ocampo-Torres (1), and Hubert Branger (2)

(1) The Waves Group, Physical Oceanography Department, CICESE, Ensenada, BC, Me´xico. (lrobles@cicese.edu.mx), (2) Institut de Recherche sur les Phe´nome`nes Hors Equilibre, Aix-Marseille Universite, CNRS, Marseille, France.

Generation and amplification mechanisms of ocean waves are well understood under constant wind speed or limited fetch conditions. Under these situations, the momentum and energy transfers from air to water are also quite well known. However during the wind field evolution over the ocean, we may observe sometime high wind acceleration/deceleration situations (e.g. Mexican Tehuano or Mediterranean Mistral wind systems). The evolution of wave systems under these conditions is not well understood.

The purpose of these laboratory experiments is to better understand the early stages of water-waves and surface-drift currents under non-stationary wind conditions and to determine the balance between transfers creating waves and surface currents during non-equilibrium situations.

The experiments were conducted in the Institut Pythéas wind-wave facility in Marseille-France. The wave tank is 40 m long, 2.7 m wide and 1 m deep. The air section is 50 m long, 3 m wide and 1.8 m height. We used 11 different resistive wave-gauges located along the tank. The momentum fluxes in the air column were estimated from single and X hot-film anemometer measurements. The sampling frequency for wind velocity and surface displacement measurements was 256 Hz. Water-current measurements were performed with a profiling velocimeter. This device measures the first 3.5 cm of the water column with a frequency rate of 100Hz. During the experiments, the wind intensity was abruptly modified with a constant acceleration and deceleration over time.

We observed that wind drag coefficient values for accelerated wind periods are lower than the ones reported in previous studies for constant wind speed (Large and Pond 1981; Ocampo-Torres et al. 2010; Smith 1980; Yelland and Taylor 1996). This is probably because the turbulent boundary layer is not completely developed during the increasing-wind sequence. As it was reported in some theoretical studies (Miles 1957; Phillips 1957; Kahma and Donelan 1988), we observed that the wave growth presents a linear tendency in the earliest stage of the accelerated wind period. This is associated with local wind-wave generation. Then, when the wind velocity reaches 2-3 m/s, the wave growth is exponential due to the presence, the evolution and propagation of waves along the tank. The injection energy from wind to currents seems to be a continuous process that starts with the development of the air turbulent boundary layer. The increased surface current intensity is associated with increased wind friction velocity, . However, wave evolution depends more on the intensity of wind-acceleration, and therefore on the development stage of air turbulent boundary layer. For lower acceleration experiments, it exists a further development of the air turbulent boundary layer: there is first a downshift of the wave-spectral peak frequency, then this downshift is followed by an increase of the significant wave height. On the other hand, when the acceleration is high, the boundary layer is poorly developed, and the increase of the wave height occurs before the frequency peak downshift. For intermediate wind accelerations, the current and wave evolution occur at the same time. Some results for the wind-deceleration period will be also presented.

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