Geophysical Research Abstracts
Vol. 16, EGU2014-13351, 2014
EGU General Assembly 2014

Three-dimensional structure of the wind-driven water surface flow

Guillemette Caulliez
Aix-Marseille University, CNRS/INSU, IRD, MIO, UM 110, 13288 Marseille cedex, France
(guillemette.caulliez@univ-amu.fr, 0033-491-41-96-20)

The structure of the water boundary layer forced by wind underneath surface wind waves is investigated experimentally in the large Marseille-Luminy wind wave tank. Measurements of the vertical velocity profiles inside the subsurface shear layer were performed by a three-component Nortek acoustic Doppler velocimeter. An overview of the water surface flow patterns which develop at larger scales was provided by simultaneous flow visualizations. To that end, tiny hydrogen bubbles were generated by electrolysis along a 60 cm long thin wire set up crosswise to the wind direction at a short distance from the water surface. The bubble motions were recorded by a video camera looking vertically from below or above the water surface. Observations were made at low to moderate wind speeds for four fetches ranging from 2 to 26 m.

This work reveals that under such steady wind conditions, the transition of the water surface boundary layer to turbulent flow is marked by the fast development of coherent longitudinal vortices downstream the surface wave generation area observed at short fetches. These structures are characterized by the occurrence of intense upwellings localized in narrow streaks in the crosswise direction. There, the upper wind-induced shear flow is confined in a very thin layer. In the wider areas between these streaks, the surface flow exhibits a much more turbulent behaviour over a deeper but slightly-sheared boundary layer. In accordance with this inhomogeneous flow pattern, the velocity field observed at a fixed location over one vertical profile is highly variable in time. These three-dimensional large-scale structures present strong similarities with the so-called Langmuir circulations. This work will focus on the description of the qualitative and quantitative properties of these longitudinal vortices, in particular the conditions of their occurence and the dependency of their characteristic scales on wind forcing and surface wave development. The main features of such wind-induced water surface flow will be compared with the results of numerical simulations as described for instance by Tsai et al. (2005).