LANGMUIR CIRCULATION IN A SHALLOW SEA

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Wind blowing over the sea surface induces waves, while both wind and waves induce currents. In shallow seas, fine sediments, nutrients or contaminants originally on the sea bottom can be suspended by wave motion and then convected by the current.

Since upper-layer mixing is important to air-sea exchanges, Langmuir circulations near the sea surface have received considerable attention in the oceanographic literature. In view of environmental interest in shallow lakes such as Lake Okeechobee in Florida, USA, extensions of such studies for shallow seas are useful. In this talk we describe an instabiltiy theory coupling waves and currents in a sea of finite depth. As is clear from the earlier theory for deep water by Craik and Leibovich, the shear profile of the mean current is crucial to the longitudinal vortices representing Langumir circulations. A simple and reasonable eddy viscosity model will be introduced to first predict the basic current. Special attention will be paid to the real fluid effects in the core, and the wave boundary layers at the seabed and near the water surface. An instability theory will be described based on the following assumptions : (i) waves and the basic currents are two dimensional in the vertical plane, and (ii) Langmuir circulation, Stokes drift and mass transport induced by waves are all of the same order of magnitude. The mean current profile will be compared with availble experiments. In addition current shear near the sea bed will be shown to be equally importnat as that near the sea surface on the Langmuir circulation, which have implications to the exchange of fine sediments between the seabed and water, hence of interest to contaminant transport.

On-going work in the three-way and nonlinear interactions of wind, waves and current will be sketched.