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Laboratory experiments on shoaling internal solitary waves

Giovanni La Forgia[1,2], Claudia Adduce[1] and Federico Falcini[2]

1) Department of Engineering, University of RomaTre, Rome, Italy
2) CNR-ISAC, Rome, Italy

Internal solitary waves (ISWs), occurring within estuaries and the coastal oceans, are manifest as large amplitude undulations of the pycnocline, the portion of the water column with a sharp change in density, mostly due to difference in water temperature or salinity. They can be generated by river plumes or by the interaction between tidal flow and the continental slope. The breaking of an ISW of depression shoaling upon a uniformly sloping boundary was investigated experimentally. Breaking dynamics beneath the shoaling waves causes both mixing and wave-induced near-bottom vortices suspending and redistributing the bed material.
Laboratory experiments were conducted in a Perspex tank through the standard lock-release method. The tank was divided in two regions, i.e. the channel and the lock, by a vertical gate and it was filled with a stratified two-layer fluid system. A displacement between the pycnoclines of these two regions was produced. ISWs generation is thus caused by gravity collapse upon raising the vertical gate. Each experiment was recorded with a CCD camera, then an image analysis technique was used to measure the instantaneous pycnocline position, in order to obtain both geometric and kinematic features of the ISW: amplitude, wavelength and celerity.
An empirical model was improved in order to predict the ISW main features depending on the geometrical parameters that define the initial experimental set up: the density difference between the layers, the total depth, the layers depth ratio, the aspect ratio, and the displacement between the pycnoclines. The approach of a solitary wave of depression toward a uniform slope was also investigated in the present experiments. Depending on wave and slope characteristics, different breaking processes were observed. Sediments were sprinkled on the slope to visualize boundary layer separation in order to analyze the suspension e redistribution mechanisms due to the wave breaking.