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Breaking of internal solitary waves over a sloping surface and implications for sediment entrainment

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We used high-resolution 3-D Large Eddy Simulations in order to investigate the effects of internal solitary waves (ISWs) breaking over a sloping boundary. The lock release method is applied in a two-layer stratified fluid system to generate ISWs characterized by three different breaking mechanisms, i.e. plunging, collapsing and surging breakers. The different breaking mechanisms are investigated in terms of their effects on the dynamics of the ISW and the interaction of the ISW with the sloping boundary. The simulations allow estimating the bed friction velocity distributions on the sloped boundary once the ISW starts interacting with this surface. This is important, given that the bed friction velocity is one of the main variables that affect the flux of sediment entrained from the sloped boundary in the case of a loose bed. We focused our attention on how the differences in the bed friction velocity distributions, during the successive stages of the evolution of the ISW, affects its overall capacity to entrain sediment from the sloped boundary. The bed shear stress and the local flux of sediments entrained from the bed are estimated to investigate the effects of the ISW breaking on the inclined surface. The collapsing breaker mechanism generates boundary layer separation, which in turn induces whirling instabilities. Results also show that the ISW interaction with the inclined surface occurs in its close proximity for the collapsing breaker mechanism, which explains why the largest bed shear stresses and sediment resuspension are predicted in the simulation where a collapsing breaker mechanism is observed. This confirms that the consequent anticlockwise vortex generated is more energetic in this case compared to the surging breaker case. The plunging mechanism is characterized by instabilities that develop mostly in the interior flow and not in close proximity to the sloping bottom. For this reason, we observed that the time interval over which the local flux of sediment assumes relatively large values is the lowest with respect to the other cases.