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Modelling highly non-linear waves with depth integrated models

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Tsunamis induced by rockslides plunging into fjords constitute a severe hazard towards local coastal communities. The rockslide impact may give rise to highly non-linear waves in the near field. The waves are relatively short crested and frequency dispersion comes to play. The fjord system constitutes a rugged terrain with steep slopes. As a consequence, the combination of the non-linear and dispersive nature of waves propagating and at the same time inundating the steep fjord coastlines poses a major challenge to tsunami modellers. Generally, this calls for primitive or Boussinesq type models allowing for inundation. We have analyzed and run a range of depth averaged models as well as one full potential solver, focusing both on inundation on steep slopes and propagation over steep shelves. Demanding test cases with solitary like waves with amplitudes ranging from 0.1 to 0.5 were applied, and slopes were ranging from 10 to 50 degrees. The test cases revealed that some models were prone to instabilities for large non-linearities and fine resolution. The instabilities are linked to short crested undulations on the grid scale, and appear on fine resolution both during inundation and for propagation of highly non-linear waves. As a consequence, convergence was not always obtained. This may put clear restrictions on the accuracy of current operational Boussinesq solver towards tsunami simulations in fjords.