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Mathematical simulation of boulder dislodgement by high-energy marine flows in the western coast of Portugal

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The study of coastal boulder deposits related with marine abrupt inundation events has been addressed by several authors using conventional numerical solutions that simulate particle transport by storm and tsunami, sometimes with contradictory results (Nandasena et al. 2011, Kain et al. 2012).
The biggest challenge has been the differentiation of the events (storm or tsunami), and the reconstruction of wave parameters (e.g. wave height, length, direction) responsible for the entrainment and transport of these megaclasts.
In this study we employ an inverse-problem strategy to determine the cause of dislodgement of megaclasts and to explain the pattern of deposition found in some locations of the Portuguese western coast, well above maximum records of sea level. It is envisaged that the causes are either flows originated by wave breaking, typically associated to storms, which would impart large momentum in a short time interval (herein impulsive motion), or long waves such as a tsunamis, that would transport the clasts in a mode analogous to bedload (herein sustained motion).
The geometry of the problem is idealized but represents the key features of overhanging layers related with fractures, bedding and differential erosion of sub-horizontal layers. In plan view, concave and convex coastline shapes are testes to assess the influence of flow concentration. These geometrical features are representative of the western Portuguese coast.
The fluid-solid model solves numerically the Navier-Stokes equations for the liquid phase and Newton's motion equations for solid bodies. The discretization of both fluid and solids is performed with Smooth Particle Hydrodynamics (SPH). The model is based DualSPHyics code (www.dual.sphysics.org) and represents an effort to avoid different discretization techniques for different phases in motion.
This approach to boulder transport demonstrates that the ability of high-energy flow events to entrain and transport large particles largely depends on fluid velocity, flow characteristic wavelength and local geometry. The results of the model allow for a classification of the deposition patterns associated with the combinations of hydrodynamic parameters characteristic of short (storms) and long waves (tsunamis).

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