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Topographic control on pyroclastic density currents: the example of Mount St. Helens 1980 blast

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Volcanic lateral blasts are among the most spectacular and devastating of natural phenomena, characterized by the violent release of a relatively low mass of magma producing a remarkably broad area of significant damage. The most known volcanic blast at Mount Saint Helens, on 18 May 1980, devastated an area of 600 squared km in about five minutes, being able to override topographic obstacles of several hundreds of metres.
By means of 3D multiphase numerical simulations we demonstrate that Mount St. Helens blast was generated by the rapid expansion (burst) of a pressurized polydisperse mixture of gas and particles and its subsequent gravitational collapse and that the observed front propagation, final runout and damage can be explained by the emplacement of an unsteady, stratified pyroclastic density current (PDC), controlled by gravity and terrain morphology.
Numerical results are able to describe the non-equilibrium sedimentation dynamics of volcanic particles during PDC propagation across the rugged topography characterizing the area devastated by the blast. In valleys and topographic lows, pyroclasts accumulate progressively at the base of the flow, after the passage of the flow head, forming a dense basal flow depleted in fines. Blocking and channelling of such basal flow by topographic ridges provides the mechanism for progressive current unloading. On ridges, sedimentation occurs from the upper, dilute wake region, which follows the current head.
Although the model formulation and the vertical numerical resolution do not yet allow the direct simulation of the deposit consolidation, present results provide a consistent, quantitative model able to interpret the observed stratigraphic sequence.