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Simulating the dynamics and damage zonation of the May 18, 1980 lateral blast of Mount St. Helens

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After three decades from its occurrence, the dynamics of the May 18, 1980 blast of Mt.St.Helens (MSH) is still a controversial issue. In this study we investigate the dynamics of this phenomenon by numerical simulation. We adopted the transient, multidimensional, and multiphase flow PDAC code (Neri et al., JGR 2003; Esposti Ongaro et al.,Parallel Computing 2007) to describe the rapid decompression of a pressurized porous dome, the expansion of the eruptive mixture, and the associated propagation of the blast cloud. We parameterised the initial source conditions according to geological constraints, including gas content, mass of juvenile and entrained rocks, temperature, grain size distribution, and pre-eruption pressure distribution in the cryptodome. Model results show that the main blast can be schematized by a burst phase, lasting on the order of ten seconds, followed by collapse and pyroclastic density current (PDC) phases. In the burst phase the pressure forces dominate, and the flow can reach supersonic velocities and generate pressure waves. In the PDC phase the flow is gravity-driven and its dynamics are strongly controlled by its vertical stratification and the 3D topography. The simulations suggest that much of the severe damage observed at MSH can be explained by high dynamic pressures in gravity currents, and that the rapid decrease of damage and dynamic pressure from proximal to distal areas could be related to rugged topography beyond the North Fork Toutle River valley rather than to the presence of a Mach disc which marks a change from supersonic to subsonic flow. Although the source models investigated thus far represent a simplification of the actual geometry and complex sequence of initial events, we find that the explosion mechanisms and characteristics are significantly robust over a wide range of initial conditions, and are consistent with first-order observations of the process.