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Abstract

Glacier outburst floods or jökulhlaups from subglacial geothermal areas, marginal lakes and subglacial volcanic eruptions are common in Iceland and they pose a substantial hazard to settled areas as well as to roads, communication lines and other infrastructure near glaciers. They can be categorized into two groups, slowly and rapidly rising, with marked differences in the flood hydrographs. Slowly-rising jökulhlaups are traditionally explained by the theory of Nye (1976) through a conduit-melt-discharge feedback mechanism. The initial subglacial propagation and the development of the flood hydrograph of rapidly-rising jökulhlaups is, on the other hand, not quantitatively understood. We present a glacier outburst flood model for rapidly-rising jökulhlaups implemented with the Elmer/Ice Open-Source Finite-Element Software. The model describes the subglacial propagation of the jökulhlaup front using a visco-elastic model for the overlying glacier ice combined with a turbulent sheet model for the subglacial water flood. The evolution of the subglacial flooded area is simulated numerically through the solution of a contact problem that represents the lifting of the ice from the underlying glacier bed where the subglacial water pressure exceeds the normal stress in the ice at the sole of the glacier. The aim of the model is to explain the speed of propagation of the subglacial flood front at the beginning of the flood as well as the time-dependent flood hydrograph after the flood bursts out from under the glacier at the ice margin.