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A method for producing digital probabilistic hazard maps for volcanic avalanches and pyroclastic flows using the TITAN2D code

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A hazard map that shows the probable extent of dangerous natural phenomena is the first stage towards conducting a risk assessment and developing a mitigation plan for an active volcano. Traditional hazard maps take tens of man-years of field investigations to complete. Volcanoes that become active following a long repose period typically lack sufficient geological information to allow construction of an adequate hazard map. When a crisis rapidly develops at a volcano with little prior study, time and data constraints present serious obstacles to risk analysis and mitigation planning. Computer modeling is a potential solution to this problem. However, the reliability of simple simulations is hindered by uncertainties in model parameters, spatial locations of flow initiation, and sizes of probable events. Monte Carlo solutions of complex computer codes generally require too much time to be practical. The method of polynomial chaos quadrature (PCQ of Dalbey et al., 2006) can solve the complex system on non-linear PDEs with stochastic parameters in the TITAN2D code to produce a spatial map of the probabilities of specified flow conditions. In this paper we first validate the model using data from pyroclastic flows produced during the 1991 eruptions of Unzen Volcano, Japan. The parameters used from the validation test set are then applied to Volcan Citlaltépetl (Pico de Orizaba), Mexico. The spatial probability of two types of pyroclastic flows at Citlaltépetl is compared with the published hazard map of this volcano that was created by earlier computer models.