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Validation of numerical models for pyroclastic density currents (PDCs)

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Models of Pyroclastic Density Currents (PDCs) are widely used for fundamental research, but their use for hazard assessment is having a growing importance. Prediction of the impacts of PDCs is required for estimating the area that may be affected by the movement of a potential flow and to map hazard intensity parameters (i.e., velocity, temperature, dynamic pressure). Numerical models now exist, capable of approximating the motion of a given volume of pyroclastic material from its source to the deposition area. Because of the high impact that modeling and simulations can have, their credibility needs to be assessed. To assess the adequacy of numerical models for PDCs, a consensual validation procedure should be established. Validation is the process of demonstrating that a model reasonably represents the developer's/user's physical conceptual model for a process. Results produced by one fluid, depth-averaged mass-flow models, like Titan2D and VolcFlow, inherently contain errors and uncertainties that can affect the accuracy of its solutions. Such artifacts arise throughout multiple levels of the modeling process such as in theoretical, experimental, and numerical domains. Here, a suite of test cases with validation metrics are used to highlight uncertainties related to the numerical simulations of well-constrained concentrated PDCs from Merapi volcano (Indonesia) and Volcán de Colima (Mexico). Each of these test cases has a particular solution to which numerical results are compared. Through a series of such comparisons, it is hoped that a general validation methodology emerges that can be used in the future to maintain a measure of models' accuracy regarding the simulation of various concentrated PDC events and prediction of their related impacts.