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Assimilation of thermal observations into numerical models of lava flow

Yulia Starodubtseva (1,2), Alik Ismail-Zadeh (1,3), Igor Tsepelev (1,2), Alexander Korotkii (1,2,4), Oleg Melnik (1,5)

(1) Institute of Earthquake Prediction Theory and Mathematical Geophysics, Russian Academy of Sciences, Moscow, Russia (aismail@mitp.ru), (2) Institute of Mathematics and Mechanics, Russian Academy of Sciences, Yekaterinburg, Russia, (3) Karlsruhe Institute of Technology, Institute of Applied Geosciences, Karlsruhe, Germany (alik.ismail-zadeh@kit.edu), (4) Institute of Mathematics and Computer Sciences, Ural Federal University, Yekaterinburg, Russia, (5) Institute of Mechanics, Lomonosov Moscow State University, Moscow, Russia

In this study, measured temperature and inferred heat flux at the upper surface of a steady state lava flow are assimilated into the lava's interior to determine its temperature and flow velocity. The basic principle of this assimilation is to consider unknown temperature at the lava bottom as a control variable and to optimize this temperature in order to minimize the misfit between the observed and modelled thermal characteristics of the lava flow at its upper surface. The lava rheology depends on temperature and the volume fraction of crystals. The optimization problem is based on the iterative solutions of direct and adjoint problems using known temperature and heat flux at the upper surface. Synthetic data ("observations") for the optimization model are generated by a model of the lava flow with a realistic radiative and convective heat transfer at the interface of lava with the atmosphere. Various flow conditions at the upper surface are used, and the planar and topographic surfaces on which the modelled lava flows are introduced. The lava temperature, the velocity, and the viscosity are determined from the optimization model after about a few dozens of iterations. Numerical results show the efficiency of the chosen optimization method.