Adaptive volcanic plume modeling using Discontinuous Galerkin Methods

Michel Bänsch, Universität Hamburg

Since the Eyjafjallajökull eruption in 2010, the volcanic modeling community has been focused on improving the prediction of ash dispersion and simulation of eruptive columns.
While many novel numerical methods have been developed for Computational Fluid Dynamics (CFD) and Atmospheric Modelling, very few have been integrated into models for volcanic eruptions. Conventional models for plume modeling usually lack high spatial resolution with increasing distance to the volcanic vent which can be an issue for precise estimations of the height of volcanic plumes.

Most algorithms for simulating 2D or 3D plumes that are currently available in the volcanic modeling community make use of spatial discretization methods such as Finite Difference (FDM) or Finite Volume (FVM) Methods. Instead of those discretizations, I will present an implementation that is based on the Discontinuous Galerkin Method (DGM) which, additionally, uses Adaptive Mesh Refinement (AMR) techniques to tackle resolution problems and speed up simulations.

This implementation of a plume model uses (explicit) Runge-Kutta (SSPRK) methods. With the use of AMR about 92% of CPU time can be saved while the development of the eruptive column resembles the uniform run qualitatively. I will present results from both uniform and adaptive runs, point out differences, discuss the viability of AMR for the volcanic plume modeling community and showcase issues that occur with the different spatial scales.