Objectives:

The objective of the MoPaV research program is to model the processes of formation and transport of volcanic plumes near sources. Two main numerical improvements have been performed in the MesoNH atmospheric model: the development of a volcanic convection scheme and the implementation of the thermodynamic and chemical surface fluxes associated to the lava flows.

Main results:

From a technical point of view, one main result of the MoPaV program has been the development of the MesoNH model capabilities to simulate the volcanic plumes at the local and regional scales. The first main contribution is the development of a new parameterization of the volcanic plume injection height based on the reformulation of the shallow convection scheme (named EDKF) in MesoNH. The improved parameterization better accounts for the kinetic of the gas and material ejected and the lateral entrainment of ambient air in the updrafts (Silvia et al., 2015).

The second development was designed to represent the surface distribution of the lava and its associated fluxes in MesoNH. The numerical representation was based on the Forefire model which has been modified to include the lava propagation and/or the lava surface distribution. An emission flux scheme has been developed to represent the sensible heat flux above the lava, the latent heat flux and water vapor flux in the area of entrance of the lava in the sea. Furthermore, chemical fluxes have been added to represent the emission of SO2 at the vent, the combustion of vegetation (emission of CO2) and the emission of HCl above the sea (thesis of J. Durand, 2016). The simulation of the eruption of April 2007 has been used to evaluate these developments. The main scientific results have shown the importance of the lava heat flux to transport the main plume of SO2 in altitude. As a consequence, the SO2 concentration simulated at the surface was limited at the surface (500 µg/m3) and in the same order of magnitude as observation. Sensitivity studies have shown that the surface concentration of SO2 was 50 times higher without the parameterization of the sensible heat flux released by the lava (Durand et al., 2014).

The entrance of the lava in the sea has generated a deep convection (laze plume). The MeteoSat images have shown that the altitude entrainment of this cloud reached the Mauritius Island. Several simulations have been forced to reproduce this detrainment altitude of the cloud by modifying the water vapor emitted by the entrance of the lava in the sea. This top-down approach combining the altitude of the plume and the vertical wind shear is probably the first study able to estimate the water and the latent heat emitted by a laze plume (paper in preparation).

In the framework of the MoPaV program the way the different sources of convection have interacted and their feedbacks on the distribution of acid precipitation was also analyzed.

New sensitivity studies (in progress) show how the breeze associated to the lava heat flux is able to modify the position of the updrafts of the laze convection and the convection above the vent. This strongly affects the vertical transport of SO2 (emitted at the vent) and HCl (emitted on the sea) and the areas of aqueous mixing between these two species.
**Caption 1:** Comparison of SO2 vertical profiles between LES and modified EDKF parameterization during the 2010 Piton de la Fournaise eruption.

**Caption 2:** Tri-dimensional view of Piton de la Fournaise eruption, simulated by the MesoNH model on April 2007. Distribution of the lava (red); formation of a laze plume (water vapor in white) by the entrance of the lava in the sea; and distribution of the SO2 (color) emitted at the vent of the crater.

**Future of the project:**
The future of this program will be conducted in the frameworks of the ANR STRAP. The main objectives of STRAP are to study and model the nucleation and the aging of new particles formed by volcanic sulfates and the emission of halogens compounds. These analyzes will focus on the Piton de la Fournaise (Reunion island) and the Etna (Sicilia).

---

**Nombre de publications, de communications et de thèses**
(citer au maximum 5 publications en lien direct avec le projet)

Thèse de S. Sivia: Simulations numériques et paramétrisation de panaches volcaniques observés à l’Île de la Réunion. Soutenue en décembre 2014


3 articles ACL et 8 communications.


