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Modelling new particle formation in a passive volcanic plume using a new parameterisation in WRF-Chem - effects on climate-relevant variables at the regional scale

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New particle formation (NPF) is an important source of aerosol particles at global scale, including, in particular, cloud condensation nuclei (CCN). NPF has been observed worldwide in a broad variety of environments, but some specific conditions, such as those encountered in volcanic plumes, remain poorly documented in the literature. Yet, these conditions could promote the occurrence of the process, as recently evidenced in the volcanic eruption plume of the Piton de la Fournaise (Rose at al. 2019); a dominant fraction of the volcanic particles was moreover found to be of secondary origin in the plume, further highlighting the importance of the particle formation and growth processes associated to the volcanic plume eruption. A deeper comprehension of such natural processes is thus essential to assess their climate-related effects at present days but also to better define pre-industrial conditions and their variability in climate model simulations.

Sulfuric acid (SA) is commonly accepted as one of the main precursors for atmospheric NPF, and its role could be even more important in volcanic plume conditions, as recently evidenced by the airborne measurements conducted in the passive volcanic plumes of Etna and Stromboli (Sahyoun et al., 2019). Indeed, the flights performed in the frame of the STRAP campaign have allowed direct measurement of SA in such conditions for the first time, and have highlighted a strong connection between the cluster formation rate and SA concentration. Following these observations, the objective of the present work was to further quantify the formation of new particles in a volcanic plume and assess the effects of the process at a regional scale. For that purpose, the new parameterisation of nucleation derived by Sahyoun et al. (2019) was introduced in the model WRF-Chem, further optimized for the description of NPF. The flight ETNA13 described in detail in Sahyoun et al. (2019) was used as a case study to evaluate the effect of the new parameterisation on the cluster formation rate and particle number concentration in various size ranges, including CCN (i.e. climate-relevant) sizes.

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