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New strategies for chemistry-transport modelling of volcanic plumes: application to the case of Mount Etna eruption in March 18, 2012

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Atmospheric modelling allows to study large spatial scale events such as volcanic eruptions, which can emit large amounts of plume-confined particulate matter and gases, to evaluate their transport in the atmosphere and their subsequent impacts. However, to study more precisely these events, different issues have to be addressed. One notable example of these issues is the well-known excessive numerical diffusion in the atmospheric column in Eulerian models leading to excessive plume dispersion misrepresentation of the plume three-dimensional morphology and subsequent geographical extent of its impacts. Mount Etna volcano's moderate eruption of March 18, 2012, which released about 3kT of sulphure dioxide in the atmosphere, has been simulated in this study with the CHIMERE chemistry-transport model. The simulated plume has been observed and tracked with satellite instruments (OMI and IASI) for several days during its transport over the Mediterranean Sea in order to compare with model outputs.

Sensitivity tests have been performed to evaluate the impact of injection altitude and profile shape on the subsequent trajectory of the plume. It was shown that altitude is the most sensitive parameter when results remain weakly sensitive to the vertical shape of injection.

In order to effectively address the problem of excessive numerical diffusion, we have included a new antidiffusive transport scheme in the vertical direction and a new strategy to use directly the vertical wind field provided by the forcing meteorological model. We show that both these improvements permit a substantial reduction in numerical diffusion. The use of the new antidiffusive vertical scheme has brought the strongest improvement in our model outputs. To a lesser extent, a more realistic representation of the vertical wind field has also been shown to reduce volcanic plume spreading. In summary, we show that these two improvements bring an improvement in the representation of the plume which is as strong as the improvement brought

by increasing the number of vertical levels, but without an additional burden in computational power.

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