

Reply to editor's comments from 26/12/2021:

We have added several sentences to section 3.1 to make it clearer that we are not using a simplified SO₂ tracer in this study but the SO₂ tracer from the comprehensive CB05 chemistry scheme:

In the original version of the volcanic SO₂ plume forecasting system described by Flemming and Inness (2013), there was a dedicated "volcanic SO₂ tracer", with oxidation based on a simple fixed timescale approach. By contrast, in the progression of the volcanic SO₂ system described here, the volcanic SO₂ emissions, and data assimilation of SO₂, is applied to the SO₂ tracer within the CB05 chemistry scheme (Flemming et al., 2015), with oxidation to sulphate aerosol occurring, based on the kinetics specified in the chemistry scheme. The main SO₂ loss in the coupled chemistry-aerosol system is the conversion to sulfuric acid. There are two pathways for this (i) in the gas phase via the hydroxyl radical (OH) and (ii) in clouds (aqueous phase). Pathway (i) via OH is the main pathway in the stratosphere. Heterogenous conversion on ash particles, is not directly modelled in the IFS. Other loss processes are wet deposition and surface dry deposition. As described in Flemming et al. (2015) the IFS uses a semi-Lagrangian advection scheme. Since the semi-Lagrangian advection does not formally conserve mass, a global mass fixer is applied to the chemical tracers, including to the SO₂ tracer, and a proportional mass fixer as described in Diamantakis and Flemming (2014) was used for the runs presented in this paper. More details about the CB05 chemistry scheme can be found in Flemming et al. (2015, 2017), Remy et al. (2018) and Huijnen et al. (2019).