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Dispersion Model Evaluation for the Sulfur Dioxide Plume from the 2019 Raikoke Eruption using Satellite Measurements.

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Volcanic eruptions pose a serious threat to the aviation industry causing widespread disruption. To identify any potential impacts, nine Volcanic Ash Advisory Centres (VAACs) provide global monitoring of all eruptions, informing stakeholders how each volcanic eruption might interfere with aviation. Numerical dispersion models represent a vital infrastructure when assessing and forecasting the atmospheric conditions from a volcanic plume.

In this study we investigate the 2019 Raikoke eruption, which emitted approximately 1.5 Tg of sulfur dioxide (SO_2) representing the largest volcanic emission of SO_2 into the stratosphere since the Nabro eruption in 2011. Using the UK Met Office's Numerical Atmospheric-dispersion Modelling Environment (NAME), we simulate the evolution of the volcanic gas and aerosol particle plumes (SO_2 and sulfate, SO_4) across the Northern Hemisphere between 21st June and 17th July. We evaluate the skills and limitations of NAME in terms of modelling volcanic SO_2 plumes, by comparing our simulations to high-resolution measurements from the Tropospheric Monitoring Instrument (TROPOMI) on-board the European Space Agency (ESA)'s Sentinel 5 – Precursor (S5P) satellite.

Our comparisons show that NAME accurately simulates the observed location and shape of the SO_2 plume in the first few weeks after the eruption. NAME also reproduces the magnitude of the observed SO_2 vertical column densities, when emitting 1.5 Tg of SO_2, during the first 48 hours after the eruption. On longer timescales, we find that the model-simulated SO_2 plume in NAME is more diffuse than in the TROPOMI measurements, resulting in an underestimation of the peak SO_2 vertical column densities in the model. This suggests that the diffusion parameters used in NAME are too large in the upper troposphere and lower stratosphere.

Finally, NAME underestimates the total mass of SO_2 when compared to estimates from TROPOMI, however emitting 2 Tg of SO_2 in the model improves the comparison, resulting in very good

agreement with the satellite measurements.