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## Application of back trajectory modelling to TROPOMI SO<sub>2</sub> observations to retrieve sub-daily volcanic fluxes

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The use of polar-orbiting satellite instruments to monitor volcanoes has been an established technique for decades. However, a major limitation is the temporal resolution provided by these satellite platforms. For UV instruments, one or occasionally two observations per day are possible for tropical latitudes, though an improved temporal resolution is seen at high latitudes. The SO<sub>2</sub> altitude within the atmospheric column is usually highly unconstrained and is one of the largest sources of uncertainty within the SO<sub>2</sub> retrieval. This method assigns a best-fit altitude to each pixel, instead of using a single value for the whole plume.

TROPOMI is an UV spectrometer, launched on the Sentinel-5P platform in October 2017. The instrument has a swath of 2600 km and a spatial resolution of 5.5x7.5 km (improving to 3.5x7.5 km from August 2019). Sentinel-5P flies with the A-Train constellation, with an equatorial overpass time of 13:30 local time.

Applying the NOAA HYbrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) back trajectory model, the injection time, injection and measurement altitudes of the SO<sub>2</sub> in each pixel within the satellite image is derived. Back trajectories are run for each pixel at a range of altitudes. The natural variability in the wind field at different altitudes (wind shear) means that only some of those trajectories will return to the volcano, constraining the measurement altitude to those trajectories. The SO<sub>2</sub> concentration is interpolated to this altitude. Finding the point in the trajectory when it most closely approaches the volcano provides the time and altitude of injection.

Combining the corrected SO<sub>2</sub> concentrations with the injection time produces the SO<sub>2</sub> flux that generated the observed SO<sub>2</sub> cloud, and with the injection altitude to calculate the mass eruption rate. These parameters can also be used to improve eruption plume modelling by improving the constraints on the eruption column characteristics.

The method is applied to the December 2019 eruption of White Island, New Zealand.