SO$_2$ fluxes from Mt Etna (Italy) measured with TROPOMI validated with ground-based measurements

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The newly launched imaging spectrometer TROPOMI onboard the Sentinel-5 Precursor satellite provides atmospheric column measurements of sulfur dioxide (SO$_2$) and other gases with a pixel resolution down to 3.5 × 7 km$^2$. This permits mapping emission plumes from a vast number of natural and anthropogenic emitters with unprecedented sensitivity and spatial resolution. Volcanic SO$_2$ emission time series reflect magma dynamics, are used for risk assessment and calculation of global volcanic CO$_2$ gas flux. TROPOMI enables unprecedented insights into these fields. To test TROPOMI’s potential we retrieved SO$_2$ flux time series from TROPOMI satellite images with high temporal resolution (30 min) using HYSPLIT backtrajectory modeling. To validate the flux time series they are compared against fluxes retrieved from ground based instrumentation. Mt. Etna (Italy) emits SO$_2$ with fluxes ranging typically between 500 and 5000 t/day, measured automatically by the largest network of scanning UV spectrometers in the world, providing the ideal test-bed for this validation. A comparison of three SO$_2$ flux datasets, TROPOMI (one month), ground-network (one month), and ground-traverse (two days) shows acceptable to excellent agreement for most days. The result demonstrates that reliable, nearly real-time, high temporal resolution SO$_2$ flux time series from TROPOMI measurements are possible for Etna and, by extension, other volcanic and anthropogenic sources globally. This suggests that the potential of TROPOMI data can be realized, offering a transformation in our ability to monitor and study volcanoes and volcanic processes world-wide.