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Multi-source SO_2 emission retrievals from satellite data over Europe and North America

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This study uses Ozone Monitoring Instrument (OMI) satellite measurements of vertical column densities (VCD: the total number of molecules or total mass per unit area) of sulfur dioxide (SO_2), a criteria air contaminant, to establish a link between reported SO_2 emissions and SO_2 VCDs measured by satellites.

The approach is based on fitting of satellite SO_2 vertical column density (VCD) measurements to a set of functions of satellite pixel coordinates and wind speeds, where each function represented a statistical model of a plume from a single point source. The main parameters of the model were related to the emissions from the sources. Thus, SO_2 emissions for multiple sources were estimated using satellite data. These estimated emissions show good agreement with directly-measured emissions from U.S. power plants, confirming the reliability of the method. The approach was also used in reverse; that is, VCDs were reconstructed from reported emissions data using the same statistical model. OMI data were then analyzed for North America for the period 2005–2015 and a high degree of consistency between the reported emissions and measured SO_2 values was found, confirming the success of emission control measures in the U.S. and Canada over this period, i.e. the decline in reported SO_2 emissions was reflected in the decrease in SO_2 VCD and surface concentrations.

The method was also applied to Europe. The results illustrate the positive impact of EU legislation; the countries where no decreasing trends are observed are non-EU member states surrounded by EU countries with decreasing emissions. In general, the satellite-based results confirm the trends in reported SO_2 emissions from EU member states over the period 2004–2014, but some discrepancies were found that deserve further attention. In one case, for example, it seems that reported emissions already take into account certain planned or foreseen measures, but satellite-based estimates suggest that implementation of these measures was delayed by several years. Moreover, although the trend is clearly followed, the absolute emission levels suggested by the OMI SO_2 VCD fitting method are sometimes substantially higher than the reported emission levels for recent years. Whether these differences are due to underreporting or to methodological issues requires further study.