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Examining the accuracy of satellite retrievals of trace-gas emissions and lifetimes using high-resolution plume modelling.

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A recent method uses satellite measurements to estimate lifetimes and emissions of trace-gases from point sources (Fioletov et al., 2015). Emissions are retrieved by fitting measured vertical column densities (VCDs) of trace-gases to a three-dimensional function of the wind speed and spatial coordinates. In this study, a plume model generated "synthetic" satellite observations of prescribed emissions to examine the accuracy of the retrieved emissions. The Lagrangian transport and dispersion model FLEXPART (v10.0) modelled the plume from a point source over a multi-day simulation period at a resolution much higher than current satellite observations. The study aims to determine how various assumptions in the retrieval method and local meteorological conditions affect the accuracy and precision of emissions. These assumptions include that the use of a vertical mean of the wind profile is representative of the transport of the plume's vertical column. In the retrieval method, the VCDs' pixel locations are rotated around the source based on wind direction so that all plumes have a common wind direction. Retrievals using a vertical mean wind for rotation will be compared to retrievals using VCDs determined by rotating each altitude of the vertical profile of trace-gas using the respective wind-direction. The impact of local meteorological factors on the two approaches will be presented, including atmospheric mixing, vertical wind shear, and boundary layer height. The study aims to suggest which altitude(s) of the vertical profile of winds results in the most accurate retrievals given the local meteorological conditions. The study will also examine the impact on retrieval accuracy due to satellite resolution, trace-gas lifetime, plume source altitude, number of overpasses, and random and systematic errors. Sensitivity studies repeated using a second, "line-density", retrieval method will also be presented (Adams et al., 2019; Goldberg et al., 2019).