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Tomographic reconstruction of gas plumes using scanning mini-DOAS instruments

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The scanning mini-DOAS instruments use UV absorption spectroscopy based on scattered sunlight to derive the total SO_2 columns. By means of a scanning device the receiving telescope of the instrument can be pointed in different directions and thus scanning part of the sky over an angular interval. This paper describes a technique to derive 2-dimensional concentration fields downwind a source, by scanning the plume using two scanning DOAS instruments situated on each side of the plume. The total column information obtained from these instruments has then been combined to yield a tomographic reconstruction of the plume.

The algorithm used is based on minimizing the squared difference between the measured column and the line integrated concentration from the calculated tomography.

The main problem with tomographic reconstruction is the low number of equations giving rise to an ill-posed problem. In this paper this ill-posed problem has been converted into an over determined problem by imposing several constraints on the spatial derivatives of the SO2 concentration in the plume.

The technique has been applied on studies of gas emissions from several power plants and volcanoes, including Andorra power station in Spain and Etna volcano on Sicily. Results from these field-campaigns are presented, as well as simulations showing the potential errors of the reconstruction and a setup for the instruments that minimizes these errors.