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Adaptive regularization for the tomographic reconstruction of gas distributions using DOAS measurements

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Differential Optical Absorption Spectroscopy (DOAS) applications can be used for the remote sensing of atmospheric constituents, and are notably well suited for the retrieval of UV-absorbing trace gases. In this work we perform a tomographic reconstruction from DOAS data.

Since the number of measurements is often limited, the tomographic inversion is an ill-conditioned problem that must be regularized in order to find a satisfactory unique solution. We use a new regularization approach that embeds key physical aspects of the sought solution to constraint the inversion: (i) the spatial distribution must be smooth enough; (ii) the extent of the solution is bounded by a suitable region of interest; (iii) the reconstructed concentration must be nonzero everywhere. Furthermore, we augment the reconstruction algorithm with a geometry-dependent weighting for the regularization, which takes into consideration the non-uniform spatial sampling of the plume cross-section. This provides an adaptive-regularization scheme to our reconstruction approach.

The algorithm is first tested on an artificial ensemble of trial gas distributions and then to reconstruction of the NO_2 emissions of a power plant from DOAS measurements performed in 2015 in Montevideo.