Inverse modeling of passive atmospheric tracers using entropy-based assimilation methods

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An important issue in air quality is to trace sources of chemical species dispersed through the atmosphere, with increasing precision in the source resolution. This need stems from many problems : being able to estimate the emissions of pollutants, spotting a source of radionuclides, evaluating diffuse gas fluxes, etc.

The high-resolution retrieval at a continental scale of the source of an atmospheric passive tracer is studied, given a set of concentration measurements. An information-theoretical approach consists in using *the principle of maximum entropy on the mean*. It offers a general framework in which the prior information on the source, implemented as a Kullback-Leibler information term, is used in a flexible and controlled way. By a dual transformation into the space of observations, the inversion is shown to be equivalent to the minimization of a numerically efficient functional. Examples of such functionals are given for different priors of interest to the retrieval of an atmospheric tracer. Variational assimilation (4D-Var) techniques are obtained as off-springs of the method. This construct is enlarged to incorporate noisy data in the inversion scheme. An indicator of the performance of the reconstruction is proposed, generalizing classical r.m.s. indicators to the case where the prior is not Gaussian. Examples of reconstructions based on the European ETEX experiment are given.