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Inversion of atmospheric tracers and the representativeness error: Coupling 4D-Var with a simple subgrid statistical model

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Abstract

A four-dimensional variational data assimilation system (4D-Var) is developed to retrieve carbon monoxide (CO) fluxes at regional scale, using an air quality network. The air quality stations that monitor CO are proximity stations located close to industrial, urban or traffic sources. The huge representativeness errors of these observations lead to a strong bias (simulated concentrations minus observed concentrations) of the order of magnitude of the concentrations. 4D-Var leads to a mild improvement in the statistical indicators because it cannot adequately handle the representativeness issue. For this reason a simple statistical subgrid model is introduced and is coupled to 4D-Var. In addition to CO fluxes, the optimisation seeks to retrieve an influence coefficient for each station that accounts for its representativeness. The method leads to a much better representation of the CO concentration variability, with a very significant reduction of the bias and a Person correlation of 73% well above the 20 – 30% expected for a CO simulation compared with in situ observations. The resulting increase in the total inventory estimate is very close to the one obtained from remote sensing data assimilation. More generally, this methodology and experiments suggest that it is possible to extract useful information from atmospheric constituent observations strongly impacted by representativeness errors.

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