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What can tracer observations in the continental boundary layer tell us about surface-atmosphere fluxes?

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Abstract. We analyze the potential for inferring spatially resolved surface fluxes from atmospheric tracer observations within the mixed layer, such as from monitoring towers, using a receptor oriented transport model (Stochastic Time-Inverted Lagrangian Transport model - STILT) coupled to a simple biosphere in which CO_2 fluxes are represented as functional responses to environmental drivers (radiation and temperature). Transport and biospheric fluxes are coupled on a dynamic grid using a polar projection with high horizontal resolution (~20 km) in near field, and low resolution far away (as coarse as 2000 km), reducing the number of surface pixels without significant loss of information. To test the system, and to evaluate the errors associated with the retrieval of fluxes from atmospheric observations, a pseudo data experiment was performed. A large number of realizations of measurements (pseudo data) and a priori fluxes were generated, and for each case spatially resolved fluxes were retrieved. Results indicate strong potential for high resolution retrievals based on a network of tall towers, subject to the requirement of correctly specifying the a priori uncertainty covariance, especially the off diagonal elements that control spatial correlations. False assumptions about the degree to which the uncertainties in the a priori fluxes are spatially correlated may lead to a strong underestimation of uncertainties in the retrieved fluxes, or, equivalently, to biased retrievals. The framework presented here, however, allows a conservative choice of the off diagonal elements that avoids biasing the retrievals.

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