Sensitivity of Flux Accuracy to Setup of Fossil Fuel and Biogenic CO_2 Inverse System in an Urban Environment

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The Indianapolis Flux Experiment (INFLUX) aims to utilize a variety of measurements and a high resolution inversion system to estimate the spatial distribution and the temporal variation of anthropogenic greenhouse gases (GHGs) emissions from the city of Indianapolis. Here we present the sensitivity of inverse flux estimates to inverse system configurations by performing Observing System Simulation Experiments (OSSEs). The a priori carbon diovide (CO_2) emissions from Hestia were aggregated to 1km resolution to represent emissions from the Indianapolis metropolitan area and its surroundings. With the Weather Research Forecast (WRF) model and Lagrangian Particle Dispersion Model (LPDM), the influence function that represents the relation between concentrations at the tower locations and emissions at the surface were simulated at 1 km spatial resolution, hourly. Using a Bayesian inversion method, the effect of adding fossil fuel CO_2 measurements, the presence of biogenic fluxes, reduced transport error and increased prior flux noise spatial correlation length on inverse flux estimates were tested in the OSSEs. The results indicate that adding hourly fossil fuel CO_2 observations could compensate the presence of biogenic fluxes and improve the posterior fossil fuel fluxes over a larger area in terms of error reduction. The improvement in retrieving fossil fuel and biogenic flux components by reducing the transport error are 31% and 38%, respectively. In addition, the magnitude and spatial correlation length in prior flux noise are highly related to the magnitude and extent of the error reduction in inverse flux estimates. We finally present some results about how the magnitude and uncertainty of biogenic fluxes affect the ability to improve the estimation of fossil fuel fluxes.

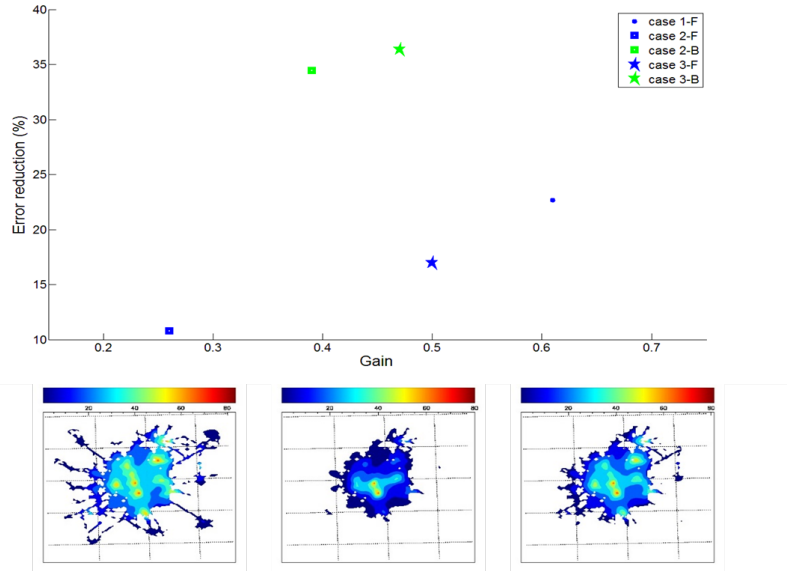

Figure 1. Comparison of 10 day fossil fuel emissions inversion results for 3 different scenarios: fossil fuel flux with total concentration measurements (Case 1), fossil fuel and biogenic fluxes with total concentration measurements (Case 2), fossil fuel and biogenic fluxes with total and fossil fuel concentration measurements (Case 3). The gain and spatially averaged error reduction are presented in the top panel. Spatial distribution of error reduction (Units: %) for case 1 (left), case 2 (middle) and case 3 (right) are located at the bottom.