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Estimating surface CO_2 source/sink over a small region in Japan using local scale inversion

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We devised a unique inversion framework for estimating surface CO_2 fluxes over a small region. Estimates of CO_2 fluxes were compared with flux measurements to evaluate the ability of our inversion framework to solve local CO_2 source/sink problems. Our inversion is different in several aspects from the existing CO_2 inversion approaches, while the basic principle of estimating sources/sinks by matching modelled concentration with observation, remains the same. It consists of: (1) atmospheric CO_2 measurement; (2) modelling of CO_2 transport; and (3) flux optimization. In our framework, four possible flux types were assumed according to land use data (urban, open water, forest and cropland) and an unknown parameter was assigned to each flux. The parameters have different physical meanings respectively (i.e. flux intensity for urban and open water and maximum photosynthesis rate for vegetation) and practically, they are optimized throughout inversion. As an inverse method, we used a Genetic Algorithm (GA), which is one of successful global search methods widely used in engineering problems. It searches for an optimal solution (i.e. an optimal combination of four parameters) by comparing the modelled concentration with observations and minimizing the misfit between them. We performed an inversion for August 2005 over a region of 126 km x 126 km in Japan using 10-day hourly CO_2 data (August 18 - 27; 240 hours). The estimated surface CO_2 flux was compared with CO_2 flux measurements conducted at approximately 40 km west of the CO_2 observation point using an eddy covariance method. Additionally, optimized CO_2 concentrations, which were calculated from optimized fluxes, were compared with the observed data at the site.