High-resolution CO_2 flux inversion model for regional study in Siberia

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We develop and test an iterative inversion framework that is designed for estimating surface CO_2 fluxes at a high spatial resolution using a Lagrangian-Eulerian coupled tracer transport model and atmospheric CO2 data collected by the global in-situ network and satellite observations. In our inverse modeling system, we employ the Lagrangian particle dispersion model FLEXPART that was coupled to the Eulerian atmospheric tracer transport model (NIES-TM). We also derived an adjoint of the coupled model. Weekly corrections to prior fluxes are calculated at a spatial resolution of the FLEXPART-simulated surface flux responses (0.1 degree). To obtain a best fit to the observations we tested a set of optimization algorithms, including quasi-Newtonian algorithms and implicitly restarted Lanczos method. The square root of covariance matrix for surface fluxes is implemented as implicit diffusion operator, while the adjoint of it is derived using automatic code differentiation tool. The prior flux uncertainty for terrestrial biosphere is scaled proportionally to monthly mean GPP by MODIS product MOD17. The model was applied to assimilating one year of Obspack data, and produced satisfactory flux correction results. Regional version of the model was applied to inverse model analysis of the CO_2 flux distribution in West Siberia using continuous CO2 observation data by tower observation network JR-Station.