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High-resolution CO_2 flux inverse modeling using ground-based observations

We report recent progress in our development of the high-resolution CO_2 flux inversion system that is based on the Lagrangian-Eulerian coupled tracer transport model and estimates surface fluxes from atmospheric CO_2 data collected by the global in-situ network. We apply the Lagrangian particle dispersion model (LPDM) FLEXPART to estimate the observation footprints at a 0.1 degree spatial resolution. The LPDM is coupled to a global atmospheric tracer transport model (NIES-TM). The adjoint of the coupled transport model is used in an iterative optimization procedure based on a either quasi-Newtonian algorithm or singular value decomposition. A flux error covariance operator is implemented via implicit diffusion. Weekly flux corrections to prior flux fields are estimated for the period of 2008 to 2012 from in-situ CO_2 data from global observation network included in Obspack dataset and data for Siberian station network JR-STATION. High-resolution prior fluxes were prepared for fossil fuel combustion (ODIAC), biomass burning (GFAS), and terrestrial biosphere (VISIT). Terrestrial biospheric flux was constructed using a vegetation mosaic map and separate simulation of CO_2 fluxes at daily time step by VISIT model for each vegetation type. The prior flux uncertainty for terrestrial biosphere is scaled proportionally to monthly mean GPP by MODIS product. The flux estimates were validated by comparing seasonal cycle of the CO_2 fluxes at regional level with the lower resolution inverse model estimates. The use of high-resolution atmospheric transport in flux inversion has advantage of obtaining more accurate flux corrections to natural fluxes by adding an ability to separate observations strongly influenced by local sources such as anthropogenic emissions and forest fires.