A high-resolution CO_2 inverse modeling using observations from the global ground-based monitoring network and the GOSAT satellite

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We present a high-resolution CO_2 flux inversion system designed to estimate surface fluxes from atmospheric CO_2 observational data collected by the GOSAT satellite as well as the global in-situ ground-based observation networks. Our inverse system NTFVAR is based on a coupled transport model combining the FLEXPART Lagrangian Particle Dispersion Model (LPDM) and the NIES-TM global Eulerian transport model. The system solves for flux corrections to the prior fluxes at a 0.1 x 0.1 degree spatial resolution via an iterative optimization procedure using the adjoint of the coupled transport model. We used high-resolution prior fluxes prepared from the ODIAC anthropogenic emissions data product, the GFAS global biomass burning dataset, the OTTM ocean model and the VISIT terrestrial biosphere model. The high-resolution version of VISIT biosphere flux was obtained using a separate VISIT CO_2 flux simulation implemented for each vegetation type identified by a vegetation mosaic map. The prior flux uncertainty for the land and ocean regions was scaled proportionally to monthly mean MODIS-GPP and the ocean flux variability. First, we estimated bi-weekly flux corrections over the period of 2010 to 2012 solely from in-situ CO_2 data by the ObsPack global observation network dataset. The application of the high-resolution atmospheric transport improved the representation of fine-scale anthropogenic CO_2 plumes. A comparison to NOAA’s CarbonTracker optimized simulations shows that our high-resolution model has some advantage at coastal and island observation sites, experiencing a mix of marine and continental air inflow. We also implemented an inversion using the ground-based data and the GOSAT satellite data. The GOSAT Level 2 data (NIES L2 v02.72) were corrected by estimating the deviation of GOSAT L2 data from an optimized simulation with the ObsPack for each latitude band and month. We confirmed the reduction of misfit between the GOSAT observations and the high-resolution model simulations after the inversion.

Keywords: inverse modeling, CO2, satellite observation, GOSAT