Evaluation of a revised global high-resolution inverse model with CO_2 observations over Siberia.

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We apply a revised version of the global inverse model NTFVAR (NIES-TM-FLEXPART-variational) to make top-down estimates of regional carbon dioxide fluxes based on data from the Japan-Russia Siberian tall tower inland observation network (JR-STATION) in Siberia and NOAA's global monitoring network for 2008-2017. In the revised coupled modeling system, the global tracer transport model NIES-TM uses ERA-5 reanalysis winds interpolated to 42 hybrid-pressure levels with a horizontal resolution of 2.5 and 3.75 degrees, while the FLEXPART model uses 0.1-degree resolution and includes a diurnal cycle. Simulation of advection in the transport model and its adjoint was revised to a 3rd order upwind scheme. The land biosphere fluxes are provided by the global upscaling product based on tower flux data at a resolution of 0.1 degrees (Zeng et al. 2020). Fossil emissions are provided by ODIAC, fire emissions by GFAS, and oceanic fluxes by the upscaling product based on surface ocean pCO_2 observations (Landschü tzer et al. 2015). The diurnal cycle of biospheric CO_2 exchange is simulated by combining data for gross ecosystem production and ecosystem respiration. The respiration and oceanic fluxes are scaled to match the global CO_2 growth rate. Corrections to the prior fluxes are estimated on a bi-weekly time step for two sets of observational data, one includes only background observation sites of the global network and another adds JR-STATION data to it by taking afternoon averaged data once a day for each site. Flux optimization with the global background network results in a good match and strong correlation with JR-STATION data over West Siberia, demonstrating that the combination of accurate transport and prior fluxes make background observations useful for constraining large scale fluxes. Addition of the Siberian observations further reduces the bias of the CO_2 simulations at the sites and improves the match in the cold season. The comparison shows the importance of adding regional observations for improving regional carbon dioxide flux estimates.

Landschützer, P., et al. The reinvigoration of the Southern Ocean carbon sink, Science, 349, 1221-1224, 2015.
Zeng, J., et al. Global terrestrial carbon fluxes of 1999–2019 estimated by upscaling eddy covariance data with a random forest. Sci Data 7, 313, 2020.

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