Net Ecosystem Exchange Estimates for Europe Using a Bayesian Atmospheric Inversion

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Atmospheric observations of CO_2 have been used in carbon cycle studies since the early 1990s. In particular, these studies constrain the atmosphere to land flux of CO_2 using atmospheric inversions. This involves a model of atmospheric transport to relate CO_2 fluxes to changes in atmospheric concentrations, and optimizing the fluxes to best match the observations. The estimated atmosphere to land flux of CO_2 is the balance of fossil fuel and cement emissions, fluxes due to natural and anthropogenic disturbances, and net ecosystem exchange (NEE). Using independent statistics-based estimates for the fossil fuel and cement emissions, the residual NEE and disturbance fluxes can be estimated.

Over the past decade, increasing attention has been paid to developing atmospheric CO_2 inversions on regional scales, with spatial resolutions relevant for guiding policy and for determining national carbon greenhouse gas budgets. Here, we present estimates of NEE for Europe for 2006 to 2015 using the FLEXINVERT atmospheric inversion framework. This work was carried-out in the framework of the EUROCOM inversion model intercomparison project supported by the ICOS Carbon Portal. FLEXINVERT is based on the Lagrangian transport model FLEXPART, and has been developed to be easily adapted to any domain size and resolution. NEE was estimated at $0.5° \times 0.5°$ spatial and 5-day temporal resolution, although sub-daily corrections to the diurnal cycle of NEE are also made. We examine the spatial distribution of NEE in Europe and its inter-annual variability in relation to meteorology.