Estimated regional CO_2 flux and uncertainty based on an ensemble of atmospheric CO_2 inversions

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We estimate the uncertainties in the regional carbon flux using a suite of 16 inversion cases, derived from a single transport model (MIROC4-ACTM) but different sets of a priori (bottom-up) terrestrial biosphere and oceanic fluxes, as well as prior flux and observational data uncertainties (50 sites) to estimate CO_2 fluxes for 84 regions over the period 2000-2020. The ensemble inversions provide a mean flux (posterior fluxes) field that is consistent with the global CO_2 growth rate, land and ocean sink partitioning of -2.9± 0.3 (±1 σ uncertainty on mean) and -1.6±0.2 PgC yr^{-1}, respectively, for the period 2011-2020, offsetting about 22-33% and 16-18% of global fossil-fuel CO_2 emissions. Interannual variability and seasonal cycle in CO_2 fluxes are more consistently derived for different prior fluxes when a greater degree of freedom is given to the inversion system (greater prior flux uncertainty). The posterior fluxes are further evaluated using the independent aircraft and surface measurements (not used in the inversions), which raises our confidence in the ensemble mean flux rather than an individual inversion. Differences between 5-year mean fluxes show promises and capability to track flux changes under ongoing and future CO_2 emission mitigation policies.

Keywords: Carbon Cycle, MIROC4-ACTM, Inverse Modelling

