Regional estimates of CO_2 budget using inverse modelling for the past two decades (1996-2018)

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An improved understanding of the magnitude and location of the CO_2 sources (mainly from fossil fuel emissions) and sink (mainly from biospheric and oceanic uptake) is essential for the predictions of future climate feedback. Atmospheric inverse modelling is a powerful tool to estimate spatio-temporal variation of fluxes from an optimal fit to atmospheric CO_2 measurements.

Monthly CO_2 fluxes are estimated using a Time-Dependent Inverse (TDI) model, measurements from 30 sites across the globe and MIROC4-ACTM forward model for the period of 1996-2018. The inversion fluxes are evaluated in details using the independent CO_2 measurements made onboard aircraft over 74 sites across the globe. The simulations of CO_2 concentrations using inverted fluxes agree within 0.5 ppm at all the aircraft vertical profile sites. The long-term mean land CO_2 fluxes are estimated to the -2.2±0.5, 0.04±0.3 and -0.5±0.2 PgC yr^{-1} in the most recent decade (2009-2018), respectively, for the northern extratropics (NET: 30-90N), tropics (TR: 30S-30N) and southern extratropics (SET: 30-90S). The ocean CO_2 fluxes for the same time period and regions are estimated to be -0.9±0.1, 0.3±0.2 and -1.1±0.1 PgC yr^{-1}, respectively. Considering the fossil fuel emissions and land-oceanic sink, the NET and TR regions act as net sources while SET region acts as a net sink. A large fraction of the interannual variability in global CO_2 flux anomaly originates over the tropical land regions, induced by El-Niño southern oscillation. Sensitivity studies using different observational network suggest that the use of JAL/NIES CONTRAIL aircraft data between Japan and Australia helps us to better constrain the interannual variations in CO_2 fluxes over the Southeast Asia region.

Keywords: Atmospheric inversion, CO2 fluxes, regional scale

