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A02: Advances in Atmospheric Inverse Modeling of Land-Atmosphere Exchange Processes

Title: Carbon balance of South Asia constrained by passenger aircraft CO2 measurements

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Quantifying the fluxes of carbon dioxide (CO2) between the atmosphere and terrestrial ecosystems in all their diversity, across the continents, is important and urgent for implementing effective mitigating policies. Whereas much is known for Europe and North America for instance, in comparison, South Asia, with 1.6 billion inhabitants and considerable CO2 fluxes, remained terra incognita in this respect. The sole measurement site at Cape Rama does not constrain CO2 fluxes during the summer monsoon season. We use regional measurements of atmospheric CO2 aboard a Lufthansa passenger aircraft between Frankfurt (Germany) and Chennai (India) at cruise altitude, in addition to the existing network sites for 2008, to estimate monthly fluxes for 64-regions using Bayesian inversion and ACTM transport model simulations. The applicability of the model's transport parameterization is confirmed using multi-tracer (SF6, CH4, N2O) simulations for the CARIBIC datasets. The annual carbon flux obtained by including the aircraft data is twice as large as the fluxes simulated by a terrestrial ecosystem model that was applied to prescribe the fluxes used in the inversions. It is shown that South Asia sequestered carbon at a rate of 0.37±0.20 Pg C yr−1 (1Pg C = 1015 g of carbon in CO2) for the years 2007 and 2008, primarily during the summer monsoon season when the water limitation for this tropical ecosystem is relaxed. The seasonality and the strength of the calculated monthly fluxes are successfully validated using independent measurements of vertical CO2 profiles over Delhi and spatial variations at cruising altitude by the CONTRAIL program over Asia aboard Japan Airlines passenger aircraft (Patra et al., 2011). Major challenges remain the verification of the inverse model flux seasonality and annual totals by bottom-up estimations using field measurements and terrestrial ecosystem models.