Imposing strong constraints on tropical terrestrial CO_2 fluxes using passenger aircraft based measurements

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Better understanding of the global and regional carbon budget is needed to perform a reliable prediction of future climate with an earth system model. However, the reliability of CO_2 source/sink estimation by inverse modeling, which is one of the promising methods to estimate regional carbon budget, is limited because of sparse observational data coverage. Very few observational data are available in tropics. Therefore, especially the reconstruction of tropical terrestrial fluxes has considerable uncertainties.

In this study, regional CO_2 fluxes for 2006—2008 are estimated by inverse modeling using the Comprehensive Observation Network for Trace gases by Airliner (CONTRAIL) in addition to the surface measurement dataset of GLOBALVIEW-CO2. CONTRAIL is a recently established CO_2 measurement network using in-situ measurement instruments on board commercial aircraft. Five CONTRAIL aircraft travel back and forth between Japan and many areas: Europe, North America, Southeast Asia, South Asia, and Australia. The Bayesian synthesis approach is used to estimate monthly fluxes for 42 regions using NICAM-TM simulations with existing CO_2 flux datasets and monthly mean observational data.

It is demonstrated that the aircraft data have great impact on estimated tropical terrestrial fluxes. By adding the aircraft data to the surface data, the analyzed uncertainty of tropical fluxes has been reduced by 15 % and more than 30 % uncertainty reduction rate is found in Southeast and South Asia. Specifically, for annual net CO_2 fluxes, nearly neutral fluxes of Indonesia and Sahel, which is estimated using the surface dataset alone, turn to positive fluxes, i.e. carbon sources. In Indonesia, a remarkable carbon release during the severe drought period of October—December in 2006 is estimated, which suggests that biosphere respiration or biomass burning was larger than the prior fluxes. Comparison of the optimized atmospheric CO_2 with independent aircraft measurements of CARIBIC tends to validate results of the inversion system. It is expected that the use of instantaneous observational data with more sophisticated inversion methods will provide more accurate estimation of surface CO_2 fluxes.