Geophysical Research Abstracts, Vol. 9, 01094, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-01094

Fluxes of volatile organic compounds from Amazonian rainforest: implications for atmospheric chemistry and the local carbon budget

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Three different micrometeorological flux measurement approaches – a tower-based surface layer gradient (SLG) technique, an eddy accumulation (REA) technique, and airborne measurements within the convective boundary layer applying the mixed layer gradient (MLG) technique – were used to estimate the isoprene and monoterpene source strengths of a pristine tropical forest site located north of Manaus in the central Amazon Basin. The observed VOC fluxes from tower-based observations are in good agreement with simulations using a single-column chemistry and climate model (SCM) including common emission algorithms (G 95).

In contrast, the model-derived mixing ratios of VOC were by far higher than observed, indicating that chemical processes in the tropical boundary layer may not be adequately represented in the model. The observed vertical gradients of isoprene and its primary degradation products methyl vinyl keton (MVK) and methacrolein (MACR) suggest that the oxidation capacity in the tropical CBL is much higher than previously assumed. A simple chemical kinetics model was used to infer OH radical concentrations from the vertical gradients of the ratio (MVK+MACR)/isoprene. The estimated range of OH radical concentrations for the tropical CBL during daytime was 3-8 x 10^6 molecules cm^{-3}, i.e., an order of magnitude higher than estimated by current state-of-the-art atmospheric chemistry and transport models. Moreover, SCM model calculations specifically constrained by the mixing ratios of chemical constituents observed during the campaign also supported high OH concentration estimates.

The relevance of the VOC fluxes for the local carbon budget of the tropical rainforest

site during the measurements campaign was assessed by comparison with the concurrent CO_2 fluxes, estimated by three different methods (eddy correlation, Langrangian dispersion, and mass budget approach). Depending on the CO_2 flux estimate, 1-6% or more of the carbon gained by net ecosystem productivity appeared to be re-emitted through VOC emissions.