Atmospheric Chemistry and Physics
An Interactive Open Access Journal of the European Geosciences Union

Atmos. Chem. Phys., 5, 2989-3002, 2005
www.atmos-chem-phys.net/5/2989/2005/

Airborne measurements of trace gas and aerosol particle emissions from biomass burning in Amazonia

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Abstract. As part of the LBA-SMOCC (Large-Scale Biosphere-Atmosphere Experiment in Amazonia - Smoke, Aerosols, Clouds, Rainfall, and Climate) 2002 campaign, we studied the emission of carbon monoxide (CO), carbon dioxide (CO_2), and aerosol particles from Amazonian deforestation fires using an instrumented aircraft. Emission ratios for aerosol number (CN) relative to CO ($ER_{CN/CO}$) fell in the range 14-32 cm^{-3} ppb^{-1} in most of the investigated smoke plumes. Particle number emission ratios have to our knowledge not been previously measured in tropical deforestation fires, but our results are in agreement with values usually found from tropical savanna fires. The number of particles emitted per amount biomass burned was found to be dependent on the fire conditions (combustion efficiency). Variability in $ER_{CN/CO}$ between fires was similar to the variability caused by variations in combustion behavior within each individual fire. This was confirmed by observations of CO-to-CO_2 emission ratios (ER_{CO/CO_2}), which stretched across the same wide range of values for individual fires as for all the fires observed during the sampling campaign, reflecting the fact that flaming and smoldering phases are present simultaneously in deforestation fires. Emission factors (EF) for CO and aerosol particles were computed and a correction was applied for the residual smoldering combustion (RSC) fraction of emissions that are not sampled by the aircraft, which increased the EF by a factor of 1.5-2.1. Vertical transport of smoke from the boundary layer (BL) to the cloud detrainment layer (CDL) and the free troposphere (FT) was found to be a very common phenomenon. We observed a 20% loss in particle number as a result of this vertical transport and subsequent cloud processing, attributable to in-cloud coagulation. This small loss fraction suggests that this mode of transport is very efficient in terms of particle numbers and occurs mostly via non-precipitating clouds. The detrained aerosol particles released in the CDL and FT were larger than in the unprocessed smoke, mostly due to coagulation and secondary growth, and therefore more efficient at scattering radiation and nucleating cloud droplets. This process may have significant atmospheric implications on a

regional and larger scale.

Final Revised Paper (PDF, 414 KB) Discussion Paper (ACPD)

Citation: Guyon, P., Frank, G. P., Welling, M., Chand, D., Artaxo, P., Rizzo, L., Nishioka, G., Kolle, O., Fritsch, H., Silva Dias, M. A. F, Gatti, L. V., Cordova, A. M., and Andreae, M. O.: Airborne measurements of trace gas and aerosol particle emissions from biomass burning in Amazonia, Atmos. Chem. Phys., 5, 2989-3002, 2005. Bibtex EndNote Reference Manager