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The Tropical Forest and Fire Emissions Experiment: overview and airborne fire emission factor measurements

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Abstract. The Tropical Forest and Fire Emissions Experiment (TROFFEE) used laboratory measurements followed by airborne and ground based field campaigns during the 2004 Amazon dry season to quantify the emissions from pristine tropical forest and several plantations as well as the emissions, fuel consumption, and fire ecology of tropical deforestation fires. The airborne campaign used an Embraer 110B aircraft outfitted with whole air sampling in canisters, mass-calibrated nephelometry, ozone by UV absorbance, Fourier transform infrared spectroscopy (FTIR), and proton-transfer mass spectrometry (PTR-MS) to measure PM₁₀, O₃, CO₂, CO, NO, NO₂, HONO, HCN, NH₃, OCS, DMS, CH₄, and up to 48 non-methane organic compounds (NMOC). The Brazilian smoke/haze layers extended to 2–3 km altitude, which is much lower than the 5–6 km observed at the same latitude, time of year, and local time in Africa in 2000. Emission factors (EF) were computed for the 19 tropical deforestation fires sampled and they largely compare well to previous work. However, the TROFFEE EF are mostly based on a much larger number of samples than previously available and they also include results for significant emissions not previously reported such as: nitrous acid, acrylonitrile, pyrrole, methylvinylketone, methacrolein, crotonaldehyde, methylethylketone, methylpropanal, "acetol plus methylacetate," furaldehydes, dimethylsulfide, and C₁-C₄ alkyl nitrates. Thus, we recommend these EF for all tropical deforestation fires. The NMOC emissions were ~80% reactive, oxygenated volatile organic compounds (OVOC). Our EF for PM₁₀ (17.8±4 g/kg) is ~25% higher than previously reported for tropical forest fires and may reflect a trend towards, and sampling of, larger fires than in earlier studies. A large fraction of the total burning for 2004 likely occurred during a two-week period of very low humidity. The combined output of these fires created a massive "mega-plume" >500 km across that we sampled on 8 September. The mega-plume contained high PM₁₀ and 10–50 ppbv of many reactive species such as O₃, NH₃, NO₂, CH₃OH, and organic acids. This is an intense and globally important chemical processing environment that is still poorly understood. The mega-plume or "white ocean" of smoke covered a large area in Brazil, Bolivia, and Paraguay for about one month.

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The smoke was transported >2000 km to the southeast while remaining concentrated enough to cause a 3–4-fold increase in aerosol loading in the São Paulo area for several days.

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