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The NO-NO_2-O_3 biosphere-atmosphere exchange of forest ecosystems : studies on interlinking scales

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We performed multi-scale surface exchange measurements on the NO-NO_2-O_3 triad in two contrasting forest ecosystems, a primary rainforest in Rondônia/Brazil (LBA-EUSTACH; 1999) and a mixed deciduous forest at Jülich/Germany (AFO2000-ECHO; 2002&2003). On both sites, our measurements addressed (a) soil-atmosphere exchange, (b) in-canopy processes, and (c) net fluxes above the canopy through an integrated experimental approach : (a) dynamic & static chamber measurements at the rainforest floor to determine soil emissions of NO (CO_2, H_2O, ^{222}Rn), as well as the surface resistance of NO_2 and O_3; (b) vertical profiles of in-canopy concentrations of CO_2, H_2O, O_3, NO, NO_2 (followed by Surface Renewal and Inverse Lagrangian Modelling); and (c) turbulent flux measurements (eddy covariance, aerodynamic gradient) of momentum, sensible heat, CO_2, H_2O, NO, NO_2 and O_3 at different levels above and within the canopy. Corresponding results have been used to study in-canopy storage fluxes (e.g. O_3) and photochemical interconversions of the NO-NO_2-O_3 triad within and above the canopy. In both canopies, chemistry, plant physiology and turbulent transport determine the fate of soil biogenic NO. Once emitted from the forest soil, NO is rapidly oxidized by O_3 to NO_2. Consequently, only a fraction of NO emitted from soils will reach the atmospheric boundary layer (free troposphere), as also only a fraction of NO_X (=NO+NO_2), since NO_2 uptake by plants (and soil) is much more effective than NO uptake. This effect is usually termed the “canopy reduction factor” (CRF). For both (contrasting) forest ecosystems, we will report on different procedures and algorithms to determine the CRF using the concept of characteristic

chemical, biological, and turbulent time scales.