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Comparison of measured reactive trace gas profiles with a multi-layer canopy chemical exchange model in an Amazonian rainforest

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In 2011, an 80 m high walk up tower for atmospheric research was erected at the ATTO (Amazon Tall Tower Observatory) site (02°08'38.8"S, 58°59'59.5"W) in the remote Amazonian rainforest. The nearly pristine environment allows biosphere-atmosphere studies within an ecosystem far away from large anthropogenic emission sources. Since April 2012 vertical mixing ratio profiles of H_2O, CO_2 and O_3 were measured at 8 different heights between 0.05 m and 79.3 m. During five intensive campaigns (Oct-Dec 2012, Oct-Nov 2013, Mar 2014, Aug-Sep 2014, Oct-Dec 2015) nitric oxide (NO) and nitrogen dioxide (NO_2) were also measured.

We applied the Multi-layer Canopy Chemical Exchange Model – MLC-CHEM to support the analysis of the observed profiles of NO_x and O_3. This includes inferring bi-directional surface-atmosphere exchange fluxes as well as the role of the canopy interactions between the emissions, dry deposition, chemistry and turbulent transport of trace gases. During our investigation of diurnal and seasonal differences between model and measurements, we conducted a set of sensitivity studies to analyse the effects of changes in NO_x-soil emissions, in-canopy turbulence and resistances for O_3 and NO_2 uptake on wet surfaces. These analyses suggest some modification in the representation of some of the poorly constrained canopy processes resulting in a significantly better comparison between the simulated and measured exchange fluxes and concentrations.