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Four years of ozone measurements in the Central Amazon – Absorption mechanisms and reactions within the rainforest

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The ATTO (Amazon Tall Tower Observatory) site (02°08'38.8"S, 58°59'59.5"W) is located in the remote Amazon rainforest, allowing atmospheric and forest studies away from nearby anthropogenic emission sources. Starting with continuous measurements of vertical mixing ratio profiles of H_2O, CO_2 and O_3 in April 2012 at 8 heights between 0.05 m and 80 m above ground, the longest continuous record of near surface O_3 in the Amazon rainforest was established. Black carbon (BC), CO and micrometeorological measurements are available for the same period. During intensive campaigns, NO_x was measured as well using the same profile system, and therefore several month of parallel NO_x measurements are available. This data allows the analyses of diverse patterns regarding emission, deposition, turbulence and chemical reactions of trace gases within and above the rainforest for several rainy and dry seasons.

The remote Amazon generally serves as a sink for O_3 which is mainly deposited to the canopy. The deposition depends to a large extent on the aperture of the leaf stomata, which is correlated to temperature, humidity, solar radiation and water availability. Comparing these parameters with the in-canopy and above canopy gradients of O_3, considering the turbulent conditions and further chemical reactions of O_3 with NO_x and VOC molecules, we estimated the role of the forest for the removal of ozone from the atmosphere under different meteorological conditions.
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. Under pristine conditions, the forest soil is the major source for NO emissions, which are directly reacting with O_3 molecules, affecting the O_3 gradient within the sub-canopy. We have analyzed differences between model and measurements in sub-canopy NO and O_3 mixing ratios by the application of different NO soil emission scenarios and by the performance of several sensitivity analyses to investigate the deposition of O_3 and NO_2 in the canopy.