Observations of molecular clusters and nucleation mode particles in the Amazon

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Keywords: atmospheric ions, new particle formation, rainforest

Introduction

Aerosol particles have global effects on Earth's climate and regional effects on air quality. Aerosol particles are emitted to the atmosphere either directly or they are formed from gas-phase precursors. Globally secondary pathways can, as a global average, produce 45% of the climatically active particles in terms of their number (Merikanto et al. 2009). Secondary formation of atmospheric nanoparticles is a multi-stage process where stable clusters form from gas phase precursors. The initial steps involve molecular clustering, followed by cluster activation for enhanced growth (Kulmala et al, 2014).

Although the secondary aerosol formation is occurring readily in the atmosphere in many environments (Kulmala et al. 2004), the Amazon area is the location, where the initial steps of the nanoparticles have not been previously observed from ground based measurements. In the Amazon, emissions of volatile organic compounds, their oxidation (e.g. Lelieveld et al. 2008) and formation of condensable vapors, aerosol activation to cloud droplets and eventually rain is tightly connected and interlinked with meteorological processes, such as boundary layer development (Martin et al, 2010).

Methods

The data collection was done in two different places. First, the ion spectrometer (Manninen et al 2010) was measuring inside the rainforest canopy (TT34; -2.5946° Lat, -60.2093° Long) from 2011-1013. Similar measurements took place as part of the GoAmazon2014/5 campaign during two intensive observation periods (IOP1/2) covering wet and dry season. In both IOPs the ion spectrometer was used. The GoAmazon2014/5 took place outside the rainforest canopy (T3; -3.2133° Lat, -60.5987° Long).

In IOP2 additionally an ultrafine condensation particle counter was used for studying the sub-3 nm aerosol particles. The condensation particle counter (CPC) is using diethylene glycol (DEG), which has a low saturation vapour pressure and is hygroscopic. The instrument is a Particle Size Magnifier (PSM; Vanhanen et al., 2011), which is a mixing type CPC. Using the mixing type CPC allows for measuring the total particle concentration in the size range from 1.5 to 6 nm and for determining particle growth rates.

Results

We made two interesting observations:
First, no new particle formation (NPF) under the rain forest canopy was observed, but when measuring outside the canopy (e.g. on a clearing), nicely growing NPF events can be observed during the wet season. Secondly, we observed much higher (~3-7x) cluster ion concentrations in Amazon rain forest compared to e.g. continental Europe. Similar observations were made in Australian Eucalyptus forest, with on average 2000 - 4000cm^{-3} cluster ions (Suni et al, 2008).

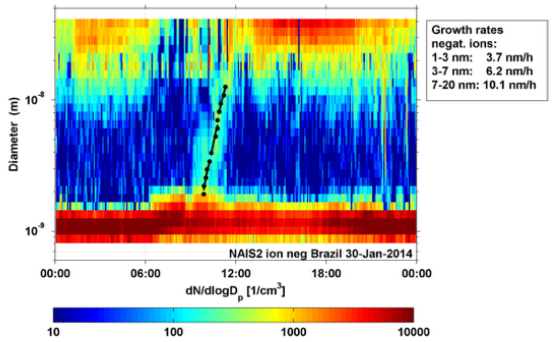

Figure 1. Example for an NPF event observed on ground in the Amazon during wet season.

We acknowledge the Academy of Finland Centre of Excellence program (project no. 1118615 and grant no. 272041), the Nordic Center of Excellence "Cryosphere atmospheric Interaction in a Changing Climate (CRAICC)" and the Atmospheric Radiation Measurement (ARM) Climate Research Facility, a U.S. Department of Energy Office of Science user facility sponsored by the Office of Biological and Environmental Research.

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