Chemical characterization of submicron aerosol particles during the dry and wet seasons in the Amazon forest – ATTO station

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The study of the chemical composition of aerosol particles in the Amazon forest represents a step forward to understand the strong coupling between the atmosphere and the forest. For this reason submicron aerosol particles were investigated in the pristine Amazon forest, where biogenic and anthropogenic aerosol particles coexist at the different seasons (wet/dry). The measurements were performed at the ATTO station, which is located about 150 km northeast of Manaus. At ATTO station a unique online instrumentation set is operated continuously, such as the Aerosol chemical speciation monitor (ACSM, Aerodyne), the 3-wavelength Nephelometer (Ecotech, Aurora 3000), the Scanning mobility particle sizer (SMPS, TSI, model 3080) and the Multiangle absorption photometer (MAAP, Thermo 5012). In this study, long-term measurements (near-real-time, ~30 minutes) of PM_1 chemical composition were investigated for the first time in this environment during the dry (July-December, 2014) and wet season (January-March, 2015).

The mass concentration obtained by the ACSM (sum of the organic and inorganic components) and MAAP (black carbon) were compared to the SMPS (number of particles were converted into mass concentration) and confirmed the collection efficiency (CE) value of 1 reported by Chen et al (2009) for the wet season. However, a CE value closer to 0.5 was obtained during the dry season. One possible explanation for the different CE values could be related to the presence of water associated with the organic and inorganic ions during the wet season. Under those conditions the aerosol particles could be partly in the liquid phase, and therefore collected more efficiently by the ACSM vaporizer. While, during the dry season, the particles contained less associated water and were mostly in the solid phase, which caused the bouncing effect in the ACSM vaporizer, decreasing the CE value.

The wet season presented lower concentrations than the dry season (~5 times). In terms of chemical composition, both seasons were dominated by organics (75 and 63%) followed by sulfate (11 and 13%), figure 1. The ionic mass balance indicated that the aerosol particles were neutralized most of the time, except for few acidic episodes. Nitrate presented low values (~0.15) for the ratio between the mass-to-charge 46 to 30 (main nitrate fragments) suggesting the presence of organic nitrate during both seasons, especially during the wet. In addition, four episodes with elevated amount of chloride, likely in the form of sea-salt from the Atlantic Ocean, were observed during the wet season. During those episodes, chloride comprised up to 7% of the PM_1. Moreover, the constant presence of sulfate and BC thought the seasons suggests a local anthropogenic source. BC concentration was 2.5 times higher during the dry season. Also the aerosol scattering coefficient (525 nm) was 3 times larger during this season due to the strong biomass-burning influence in this region over the dry season. Further characterization of the organic fraction was accomplished with the positive matrix factorization (PMF), which revealed four different organic aerosol components with very distinct chemical characteristics.

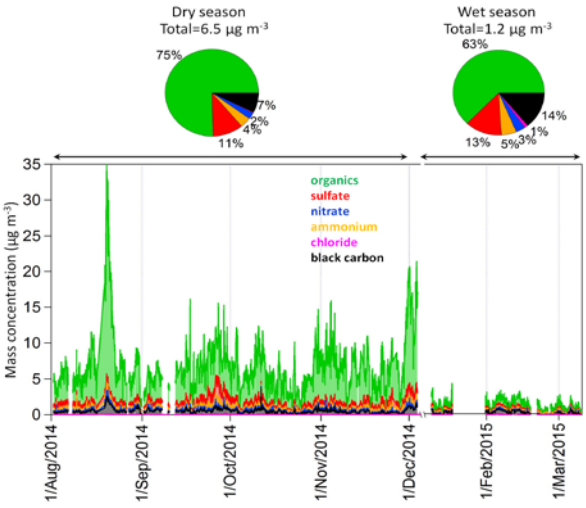

Figure 1. Mass concentration of organic, sulfate, nitrate, ammonium, chloride and black carbon measured at the ATTO station in the Amazon forest.

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