Characterisation of Water-Soluble Organic Compounds Present in Aerosols During the LBA-EUSTACH Campaigns

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1. Introduction

Globally, Amazonia represents one of the most important sources of organic atmospheric aerosols, with organic matter accounting for up to 90% of the total aerosol mass in this region. This is due to the fact that the vast rainforest provides a continuous natural release of aerosols, made up of vegetation detritus, pollen and the photo-oxidation products of volatile biogenic organic compounds. In addition, extensive deforestation by slash-and-burn techniques introduces large quantities of smoke aerosols into the atmosphere each year. The intense convective activity associated with Amazonia´s equatorial location mean that these aerosols may influence climate on a global scale.

Of particular interest from a climatic viewpoint are the organic compounds within aerosols that are water-soluble (WSOCs). These compounds may potentially enhance the ability of aerosols to nucleate cloud droplets, as well as influence the chemistry occurring within these droplets. The resulting changes in cloud properties could, in turn, impact on the radiation balance and hydrological cycle.

This poster presents results of the analysis of WSOCs in aerosols collected during the 1999 wet-to-dry and dry-to-wet season transitions in Rondônia, Brazil, as part of the European contribution to the Large Scale Biosphere-Atmosphere Experiment in Amazonia (LBA-EUSTACH).

2. Aerosol sampling

Primary rainforest site (Biological Reserve Jaru)

- Sampling at ca. 53 m above forest floor (20 m above canopy).
- Apr 10-May 21 (wet-to-dry transition) & Sep 1-Oct 31 (dry-to-wet transition).
- High Volume Dichotomous Sampler (HVDS), for collection of aerosols in "coarse" (> 2.5 µm) and "fine" modes.
- Micro Orifice Uniform Deposition Impactor (MOUDI), for collection of aerosols in ten different size ranges (cut point diameters: 10, 5.6, 3.2, 1.8, 1.0, 0.56, 0.32, 0.18, 0.1 and 0.56 µm).

Pasture site ("Fazenda Nossa Senhora")

- Sampling at ca. 4.5 m above ground level.
- Sep 1-Oct 31 (dry-to-wet transition only).
- HVDS
- Stacked Filter Units (SFUs), for collection of aerosols < 1.7 µm (Nucleopore pre-filter).

Samples were collected on ultra-clean quartz fibre filters (HVDS and SFUs) or aluminium substrates (MOUDI). Sampling times ranged from 12 to 72 hours.

3. GC-MS analysis

The WSOC fraction of aerosols is proposed to contain a mixture of polar, oxygenated compounds incorporating two or more COOH, C=O, CHO, OH, COC, $CONO_2$, CNH and/or $CONH_2$ groups per molecule. As a first step towards characterising this fraction, we have developed a method for analysing water-soluble organic acids, hydroxyacids and alcohols by Gas Chromatography-Mass Spectrometry (GC-MS).

Analytical procedure:

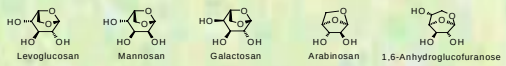
1) Extraction of filter with water (10 mL with vortex agitation).
2) Clean-up using ion exchange resin.
3) Evaporation of water with rotary evaporator and nitrogen stream.
4) Derivatisation with bis(trimethylsilyl)trifluoroacetamide (30 min, 70°C) to increase compound volatility and improve signal response.

$$R—COOH \rightarrow R—COOSiMe_3 \qquad R—OH \rightarrow R—OSiMe_3$$

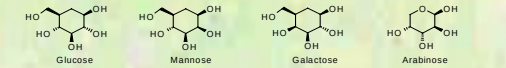
5) Analysis by GC-MS (identification & quantification using pure standards).

4. Identified compounds

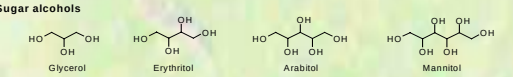
Anhydrosugars



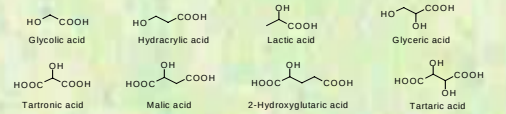
Sugars



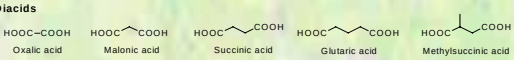
Sugar alcohols



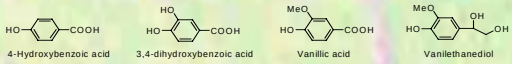
Aliphatic hydroxyacids



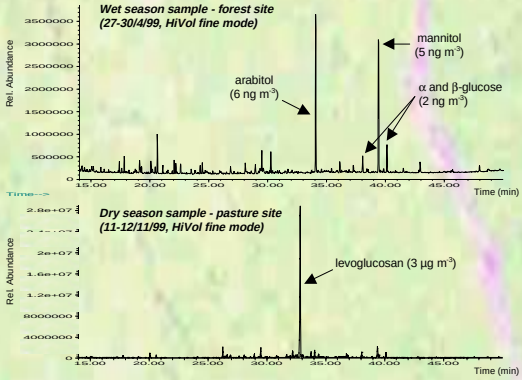
Diacids



Aromatics

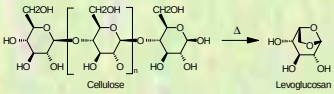


5. Sample chromatograms



6. Major findings

- Many polar, oxygenated compounds identified, some of which have not observed in aerosols previously.
- Anhydrosugars, produced from the combustion of plant polysaccharides, are the major WSOCs identified in the dry season samples. Levoglucosan, a cellulose breakdown product, is found in concentrations as high as 5 µg m^{-3}.



- Dry season samples from the pasture and forest sites show very similar WSOC compositions.
- Sugars and sugar alcohols are the major WSOC aerosol species identified in samples from the wet season (forest site).

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Photos by Greg Roberts