Bioaerosol Characteristics in South China: Contributions of Fungi Spores to Ambient Aerosol in a Tropical Rainforest

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Introduction

Background, Motivation & Objectives
1. Bioaerosol – What is it and why study it?

- Various kinds of bioaerosols can be found in ambient air, such as fungi, bacteria, mosses and fern spores, viruses, pollen, algae and plant as well as animal debris

- Bioaerosols are ubiquitous in the atmosphere and play important roles in atmospheric chemical and physical processes, climate forcing, biological systems and public health

- Bioaerosol contributions to the aerosol budget are significant on a global scale

2. Research Objectives

- Investigation of bioaerosol characteristics in a tropical region of South China

- Quantification of molecular source tracers for primary biogenic aerosol

- Estimation of fungi spore contributions to ambient aerosol
Source Apportionment by Molecular Tracers
Sources + Selected Products/Tracers

Molecular Tracer/Marker Methods

“Compounds with unique properties that by their pure existence allow for a conclusion about their sources or formation.” (Rudich et al., Ann. Rev. Phys. Chem., 2007)

- Specific emission from one source type
- Conservation of tracers (i.e., sufficient stability during atmospheric lifetime of tracer species)
- Availability of sensitive and accurate analytical methods

Tracer Examples:

- Glycerol
- Erythritol
- Xylitol
- Mannitol
- Xylose
- Glucose
- Levoglucosan
- Methyl tetrols
- Fungi Spores
- Biomass Burning
- Isoprene SOA
METHODOLOGY
Jianfeng Mountain
- 18°40' N, 108°49' E
- Tropical virgin rain forest
- National Reserve Park
- Located 115 km from Sanya
- Altitude: 820m asl.
Tracer Analysis: HPAEC-PAD Method

High Performance Anion Exchange Chromatography (HPAEC)

- Alkaline eluent (NaOH) converts carbohydrates and polyols to their anionic form
- Ion chromatographic (IC) separation of aqueous samples
- Electrochemical Detection: Pulsed Amperometric Detection (PAD)

Advantages:

- Filter extraction with water
- No chemical derivatization necessary
- Highly selective + sensitive
- Simple and fast operation

*Engling et al., AE, 2006; Iinuma et al., AE, 2009*
Bioaerosol Characteristics

Fungi Spores in Ambient Aerosol in Tropical South China
Bioaerosol Characteristics
Fungi Tracer Concentrations at Jianfeng Mountain

Arabitol concentrations in PM10 (ng/m³)

Arabitol concentrations in PMcoarse (ng/m³)

Zhang et al., ERL, 2010
Bioaerosol Characteristics
Fungi Tracer Concentrations at Jianfeng Mountain

![Graph showing Mannitol concentrations in PM10 and PM2.5 over time]

\[ y = 0.9692x - 15.342 \]
\[ R^2 = 0.9865 \]
Bioaerosol Characteristics
Fungi Tracer Concentrations at Jianfeng Mountain

\[ y = 1.5472x + 3.3429 \]
\[ R^2 = 0.8862 \]
Bioaerosol Characteristics
# Fungi Tracer Measurements

## Arabitol and Mannitol Concentrations at Various Locations

<table>
<thead>
<tr>
<th>Region</th>
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<th>Particle size</th>
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</thead>
<tbody>
<tr>
<td>JFL (China)</td>
<td>Spring</td>
<td>PM₂.₅</td>
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# Fungi Tracer Measurements

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## Relative Contributions of Fungi to Ambient Aerosol

- **PM₁₀**: 8% (2 – 18%)
- **OC₁₀**: 12% (5 – 26%)
Characteristics of Fungi Spore Tracers

- The average concentrations of arabitol and mannitol in PM_{10} were rather high (44 and 71 ng/m^{3}).
- Good correlation of tracers with each other, especially in coarse-mode particles (PM_{2.5-10}).
- Tracer levels in PM_{10} show dependence on relative humidity, temperature and amount of rainfall.

Contributions of Fungi Spores to Ambient Aerosol

- Estimations of source contributions using the measured tracer and OC (and PM) concentrations.
- High contributions of fungal spores to ambient PM_{10} mass and to OC (max of 18% and 26%).

Future/On-going Research

- Investigation of fungi spore chemical composition as a function of location and ambient (meteorological) conditions.
- Determination of fungi tracer "emission factors" for subtropical and tropical areas.
- Comparison of molecular tracer methods with traditional culture techniques and DNA sequencing.
- Exploration of tracers for additional bioaerosol species (e.g., bacteria).
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  - Dr. Y.S. Li