1. Motivation

Biogenic aerosols are ubiquitous in the Earth’s atmosphere and they influence atmospheric chemistry and physics, the biosphere, climate, and public health. They play an important role in the spread of biological organisms and reproductive materials, and they can cause or enhance human, animal, and plant diseases. Moreover, they influence the Earth’s energy budget by scattering and absorbing radiation, and they can initiate the formation of clouds and precipitation as cloud condensation nuclei (CCN) and ice nuclei (IN).

Primary biogenic aerosol (PBA) particles and components are emitted directly from the biosphere to the atmosphere. Examples of PBA particles are pollen, bacteria, fungal and fern spores, viruses, and fragments of animals and plants.

Fungi exist in terrestrial and aquatic habitats, and their reproduction proceeds via budding or sporulation, using a variety of dispersal mechanisms (Buller, 1909–1950; Ingold, 1971, 1999). Here we concentrate on those species of Ascomycota and Basidiomycota that actively discharge their spores into the air, which we designate as “actively spore-discharging Ascomycota” (AAM) and “actively spore-discharging Basidiomycota” (ABM).

Composite image of the flight of an Auricularia auricula-judae spore (Pongraf et al., 2005)

2. Atmospheric Contribution

Spores and related chemical compounds from AAM and ABM are primary biogenic components of air particulate matter (characteristic size range: 1–10 μm, characteristic boundary layer concentrations: 10–100 μg m⁻³). Measurement results and budget calculations based on investigations in Amazonia (Baldwin, Brazil, July 2001) indicate that the forcible discharge of fungal spores may account for a large proportion of coarse air particulate matter in tropical rainforest regions during the wet season (0.7–2.3 μg m⁻³). For the particle diameter range of 1–10 μm, the estimated proportions are ~25% during day-time, ~45% at night, and ~35% on average (Figure 4).

3. Chemical Compounds

ABM emissions may account for most of the atmospheric abundance of the sugar alcohol mannitol (10–68 ng m⁻³), and can explain the observed diurnal cycle, i.e. higher abundance at night (Figure 1).

ABM emissions of hexose carbohydrates might also account for a significant fraction of free monosaccharides in air particulate matter (>7–49 ng m⁻³), but the change of derived ratios are not consistent with the observed diurnal cycle, i.e. lower abundance at night (Figure 2).

AAM emissions appear to account for a large proportion of potassium in air particulate matter over tropical rainforest regions during the wet season (17–43 ng m⁻³), and they can also explain the observed diurnal cycle, i.e. higher abundance at night (Figure 3).

4. Global Emission Estimates

Multiplication of the average number concentration of 5 x 10⁻³ m⁻³ with an average continental boundary layer (CBL) height of 1000 m and division by an average residence time of 1 day yields an estimate of ~60 m m⁻³ for the globally averaged land surface emission flux of ABS.

By multiplication with an average spore mass of 65 pg, the global land surface area of 1.5 x 10¹⁴ m² and the duration of one year we have calculated a value of ~17 Tg yr⁻¹ as a first estimate for the global average emission rate of ABS over land surfaces. Comparisons with estimated rates of emission and formation of other major types of organic aerosol (~47 Tg yr⁻¹ of anthropogenic primary organic aerosol, 12–70 Tg yr⁻¹ of secondary organic aerosols) indicate that emissions from actively spore-discharging fungi should be taken into account as a significant source of organic aerosol.