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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Contribution of fungi to primary biogenic aerosols in the atmosphere: active discharge of spores, carbohydrates, and inorganic ions by Asco- and Basidiomycota" *by* W. Elbert et al.

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The manuscript by Elbert and co-workers aims to estimate the contribution of air-borne fungi to the carbohydrate and inorganic ion content of aerosols. The authors have clearly indicated the consequences that these compounds could have for the atmosphere, and they also have revealed the paucity of information about the contribution of micro-organisms to this aspect of atmospheric chemistry. To write this review I have engaged the help of a colleague mycologist. As microbiologists (C.E. Morris and M. Bardin, Plant Pathology Research Unit, INRA-Avignon, France) working with air-borne

organisms, we have specific comments about the presentation of the biology and the taxonomy of fungi in the introduction, and about methodology for estimating the abundances of ascomycetes and basidiomycetes reported in this paper.

Firstly, the authors present a description of the biology of fungi that indicates the importance of active spore release as a means of liberation of carbohydrates and ions in the atmosphere. It should be noted that active spore release is often reserved to the liberation of sexual spores. However, asexual spores are probably the most abundant contribution of fungi to the environment in terms of number and total matter released. The fungi referred to as the imperfect fungi in the introduction are the asexual forms of fungi, usually of ascomycetes, and include genera such as Penicillium, Alternaria and Cladosporium that are known for their abundance on plants and other surfaces and in the atmosphere. Furthermore, surfaces of both sexual and asexual spores have sugars that would be released into liquid used in the protocols of chemical analysis. How would these be differentiated from other origins of carbohydrates in their samples? Secondly, active spore release is not a universal property of ascomycetes and basidiomycetes. In fact, many fungi - and basidiomycetes in particular - can release spores via passive dropping from the fruiting body from which the spores are suspended. Given that this property is not universal among ascomycete and basidiomycete fungi, it would be useful if the authors clearly stated what genera or species of fungi they have taken into account in this work. We bring up this point again below for other reasons. Finally, in the introduction, the authors present four categories of fungi. As “mitosporic” fungi they include Chytridomycota (pg. 11321, lines 5-6). This statement is erroneous. The Chytrids are part of a class of more primitive fungi very different from the imperfect fungi. In the paper cited as a reference (Ribes et al, 2000), we did not find mention of the chytrids as part of the mitosporic fungi.

To identify fungi in air samples, the authors made direct observations with a light microscope at up to 1500x magnification and identified spores by morphology. But they have not indicated how spores were categorized as AAS and ABS. What morpholog-

ACPD

6, S4960–S4963, 2006

ical criteria were used? Although some spores of ascomycetes and basidiomycetes have distinctive morphologies (such as Alternaria conidia), fruiting bodies are generally necessary for definitive identification as members of these groups. For example, morphological differentiation of Botrytis conidia (deuteromycete - ascomycete) from Ustilago teliospores (basidiomycete) has proven to be difficult based on the observation with a light microscope even with the help of image analysis (see Benyon et al. 1999. Aerobiologia 15:211-223). Furthermore, some pollen particles may resemble fungal spores. Moreover, the authors pointed out that quantified fungal spores were in the 1-10μm size range. However, some fungal spores can reach lengths greater than 10μm. Based on our observations of air samples, we have found it very difficult to accurately distinguish particles, even as experienced mycologists.

We believe that methods for quantifying AAS and ABS need to be clarified. Images showing fields of view from their microscopic observations may be useful to substantiate the morphological criteria used. Information concerning the fungal genera investigated and categorized as AAM or ABM fungi would clearly be useful for the reader.

We wonder: If the authors simply evaluated the contribution of fungal spores (without using the AAS and ABS categories) to carbohydrate and ion concentration in aerosols, would it change the overall conclusion of the paper? We understand that they put their results into context and make extrapolation based on information about the abundances of these two types of fungi and about the mechanisms by which spore release generates aerosols of sugars and ions. However, their extrapolations are already likely to be overestimates given that they derive global emissions from observations conducted in the Amazon. Much of this emission would be from plant surfaces. There are about 10e9 km2 of leaf surfaces on Earth. Tropical forests contribute to about 10-15% of this. Boreal and temperate forests, savanna and cultivated land also constitute a large proportion of the plant surfaces on Earth. These biomes could contribute fungi to the atmosphere, but most likely at intensities different from that of the Amazon. (For details about the different ecosystems contributing to total planetary leaf surfaces see:

ACPD
6, S4960–S4963, 2006

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Morris C.E., Kinkel L.L. 2002. Fifty years of phyllosphere microbiology: Significant contributions to research in related fields. pp. 353-363 In: Lindow S.E., Poinar E., Elliot V. (eds.) Phyllosphere Microbiology, APS Press, Minneapolis.) We propose that they clearly state that these extrapolations are based on certain assumptions, and that they give an indication of maximum values.

Interactive comment on Atmos. Chem. Phys. Discuss., 6, 11317, 2006.