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Biogeosciences Discussions

Interactive comment on "Global fungal spore emissions, review and synthesis of literature data" *by* T. N. Dallafior and A. Sesartic

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We would like to thank referee 1 for the helpful comments and careful evaluation of the manuscript. The referree's comments and our responses follow.

Specific comments

Data from tropical forests: Considering the tropical forests as a separate biome area is surely negotiable as there are seven sources providing data about tropical and subtropical regions. It is a matter of definition as to how divide land masses into different biome areas. We decided to use the same biome grouping as Burrows et al. (2009a) did for bacteria, in order to facilitate the comparison between bacteria and fungal spores, especially in view of using the data for modelling the impact of fungal spores acting as ice nuclei. However, we agree with the referee's comment

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that it would improve the presented information if the tropical forests where treated separately, and have thus grouped them in a new category.

Grassland emissions: These findings are supported by results regarding bacterial emissions being also lower in grasslands than in shrubs and crops (Burrows et al., 2009a). However, the available observational data for both bacteria and fungal spores are scarce and we cannot rule out observational biases or errors.

Calculation of flux estimates: The formula for calculation of the flux estimates has been completely reworked and explained in detail in the revised paper. All calculations have been made anew and corrected for errors, leading to new results compared to the discussion paper, and being now in the same order of magnitude as those in Elbert et al. (2007).

Escape fraction, p. 8447 (instead of erroneously p.8448 as noted by reviewer), lines 25-26: The measured concentrations are a blend of local emissions and advected spores. It is difficult to distinguish between those two groups. A possible distinction criterion might be the size or shape since larger particles are deposited more easily than smaller ones. However, Heald et al. (2009) note that the larger size fraction is less well investigated due to measurement device constraints. The farther away the sampling device is from the spore source, the more is the measured concentration influenced by deposition and other processes. This can lead to devices in immediate proximity to the ground measuring the actually emitted spore numbers, whereas other devices on higher levels might measure the escape fraction only. As most observational data was taken further away from the ground, we assume our estimate to represent the escape fraction.

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Treatment of data: Considering the scarcity of useful data as much data as was available was taken into account. The simplifying assumptions such as no diurnal or seasonal cycles make a weighting of data in our opinion unnecessary.

Particle size: Using a spore mass of 65pg as derived by Elbert et al. (2007), instead of the used 33pg from Winiwarter et al. (2009) would lead to a doubled mass flux. However, heavier particles also sediment more quickly. Currently we have another manuscript in preparation where we use the here collected fungal spore data as input for the global climate model ECHAM5-HAM. There, we simulate the emission and transport of fungal spores, as well as their impact on clouds and precipitation. Sensitivity studies in the forthcoming paper will address how different assumptions for fungal spore properties (among them also the weight) effect their transport behaviour.

Culturability: As already elaborated in the paper, there is not sufficient information available to account for differences between CFU and total counts. It is desirable that measurement campaigns always take the bias between CFU and total counts into account and if possible provide counts of both. This would enable a more accurate knowledge on the share of viable spores in a sample. Based on the present knowledge it is hardly possible to estimate the size of the bias caused by CFU and total counts.

Seasonal or daily cycles: As repeatedly noted, data availability was insufficient to take seasonal and daily cycles into account. As with culturability it is desirable that daily cycles are taken into account which to date has only been done in very few studies, and thus cannot be extended to all biomes and species.

Abstract and p. 8450, lines 12-13: The referee's comment should correctly refer to p. 8449, lines 12-13. Exclusion criteria were lack of information about mea-

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surement sites, biomes, measurement period, only absolute spore counts instead of concentrations, and petri dish samplings. This information was now added to the paper.

Technical corrections

p. 8447, line 12: corrected

p. 8450, lines 14-15: corrected

p. 8451, lines 17-20 and Fig. 2: We had JSBACH ecosystem data available and thus used it to create the map. However, JSBACH uses a slightly different division of ecosystems than Olson (2001) does. The observed fungal spore concentrations were attributed to the corresponding ecosystem depending on the ecosystem at the measurement location (see also our remark on the calculation of flux estimates).

p. 8453, line 2: corrected

p. 8454, line 6: corrected

p. 8454, lines 26-27: corrected

p. 8455, lines 14-15: Kieft Ruscetti (1990) found that proteins are crucial for the ice nucleation activity of the lichen fungus Rhizoplaca chrysoleuca. Similar observations have been done for bacteria (Kajava Lindow, 1993). Therefore, it is not the viability of a cell that does affect the CCN/IN activity of a fungal spore, but whether the ice nucleation active proteins on its surface are denatured or not. If the protein

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conformation is intact, it can trigger ice nucleation, regardless of the cell's viability. However, it is important that the cell has been alive at one point in order to produce the ice nucleation proteins in the first place. This information has been added to the manuscript.

p. 8457, lines 15-18: The mass flux given for Elbert et al. (2007) was corrected in order to account for total global emissions of fungal spores, and not only those of ascomycota, as well as the fact that Elbert et al. (2007) give only emissions over land, and not a global average. The newly calculated fungal spore mass emission flux according to Elbert et al. (2007) accounts to 2.26×10^{-11} kg m^{-2} s^{-1}.

p. 8458, lines 25-26: corrected

Appendix, Table A1: The blank fields denote information which is missing from the original publications. It was now replaced with n/a denoting "not available". Additionally, it is now noted which articles consider not the total number of spores but the sum of a set of species.

Appendix, Table A2: The table was sorted primarily by ecosystem and then by author, according to the referee's suggestions. Additionally, a column was added noting whether the analysis was done using culture or culture-independent techniques.

References

Elbert, W. et al. Contribution of fungi to primary biogenic aerosols in the atmosphere: wet and dry discharged spores, carbohydrates, and inorganic ions. Atmos. Chem.

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Kajava, A.V., and Lindow, S.E. A model of the three-dimensional structure of ice nucleation proteins. J. Mol. Biol. 232, 709-717 (1993).

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Winiwarter, W. et al. Quantifying emissions of primary biological aerosol particle mass in Europe, Atmos. Environ., 43, 1403-1409, (2009).

Interactive comment on Biogeosciences Discuss., 7, 8445, 2010.