Enhancement of the collision efficiency between basidiospores and cloud droplets by electrostatic charges carried on freshly emitted basidiospores

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In the coarse biogenic particles of the atmospheric aerosol, basidiospores are among the main fungal components (Fröhlich-Nowoiskya *et al.*, 2009). In bulk (about 20 000 species) of basidiomyceteous fungi, sexual spores expel themselves from their perches. Becoming airborne, these ballistic basidiospores (diameter 2−16 µm) carry an electrostatic charge (from tens to one thousand elementary charges) (Saar and Salm, 2013). Washout is one of mechanisms of sedimentation of fungal spores, but the role of basidiospore primary electric charges in this process is not yet studied. The effect of electric charges on collisions between water droplets or between water droplets and aerosol particles has been studied for a long time, up to the present time (Fletcher, 2012). In (Tripathi and Harrison, 2002), the considered ranges of the size and density of aerosol particles include those of basidiospores (Table 1). Based on this result, we evaluated the effect of charges for basidiospores of *Phellinus tremulae* and *P. nigricans*, members of the *P. igniarius* group, one of the most important wood-rotting fungi of many of deciduous trees.

These basidiospores are subglobose, smooth, with density of 1 g cm^{-3} or a bit more (1.2 g cm^{-3}), and represent the smallest and the biggest spores in the group. In *P. tremulae*, the mean equivalent diameter is 4.4 µm (99.7% of the variation of mean spore sizes is within the range of 3.9−4.7 µm) and the mean primary electric charge is 117 e (95% confidence intervals of mean spore charges is within the range of 46−222 e), and in *P. nigricans*, 6.1 µm (5.6−6.5 µm) and 204 e (107−496 e) (Saar, 2013). In the case of the droplet diameter D = 84 µm, the particle charge q enhances the collision efficiency if it has magnitude $|q| \geq 50$ e in particles of 4 µm or $|q| \geq 100$ e in particles of 6 µm. This shows, that in both *P. nigricans* and *P. tremulae* the primary charge enhances collision efficiency between basidiospores and cloud, fog or drizzle droplets of diameter about 80 µm.

Results of Tripathi and Harrison (2002) for the droplets D = 104 µm and the particles with density 2 g cm^{-3} show that the enhancement of collision between *P. nigricans* and *P. tremulae* spores and droplets may cease in the vicinity of D = 100 µm. Here as well as in the case of medium size cloud droplets the numerical calculation of particle's trajectories is needed to investigate collision efficiency.

Table 1. Collision efficiency for a droplet of diameter 84 µm and charged particles of 1 g cm^{-3} and 4−8 µm, expressed with respect to the collision efficiency in the case of neutral particles (0.00063 for d=4 µm, 0.0013 for d=5 µm, 0.0028 for d=6 µm, and 0.04 for d=8 µm).

Particle charge (e)	Particle diameter (µm)			
	4	5	6	8
10	1	1	1	1
20	1	1	1	1
50	1.4	1.2	1	1
100	2.4	1.5	1.1	1
500	28.6	11.5	5.0	1.1

The primary electrostatic charges of basidiospores could enhance the collision efficiency between spores and water droplets with D<100 µm not only near the ground, but also in the higher layers of the atmosphere. Due to the relaxation time of 23 minutes, highly charged spores can spread over a considerably area depending on the wind velocity (Saar and Salm, 2013).

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