Biogeosciences Discuss., 4, S1861–S1864, 2007
www.biogeosciences-discuss.net/4/S1861/2007/

Biogeosciences Discussions

Interactive comment on "Microbiology and atmospheric processes: the role of biological particles in cloud physics" *by* O. Möhler et al.

O. Möhler et al.

Received and published: 11 November 2007

We acknowledge the comments and questions from the referees and the editor of our paper, which have been very helpful to improve the manuscript.

In the following sections we respond to the comments from referee #2.

Answers to specific points:

p 2560, line 21: We agree with the reviewer and have decided to rewrite this entire paragraph as: 'Atmospheric aerosols influence cloud formation and precipitation development, and thus have important impacts on the global climate, the water cycle and atmospheric chemical reactions (e.g. Solomon et al., 2007). Much research has been done in this regard for particle types previously thought to represent the majority (by number) of aerosols in the atmosphere, for example, sulfates and organic particles

formed by nucleation processes, windblown sea salt and mineral dusts, primary pollutants, and smoke particles from natural and manmade forest fires. Less is known about what specific contribution is made by aerosols of direct (directly emitted into the atmosphere) biological origin to cloud formation through their effects on cloud droplet and ice crystal initiation. Their potentially high numbers in the lower levels of the atmosphere (Jaenicke 2005), wide distribution over vegetative surfaces and oceans, and likely strong seasonal and climatic variability compared to other organic or inorganic particles in the atmosphere make it important to focus on this group collectively. Also, indications that biogenic particles possess specific cloud-activation properties, such as preference for nucleation of liquid droplets and ice crystals, make them important for more focused future studies. It is the purpose of this article to examine what is known about the characteristics of primary biological aerosol particles (Mathias-Maser, 1998), cells (e.g., bacteria, spores, fungi, viruses, algae, pollen) or cellular material/fragments and proteins injected directly as particles from the biosphere, and to summarize the potential impact of these particles on atmospheric clouds.

p 2560, line 23: This terminology that encompasses the cloud nucleation behaviors of particles has a history dating to the late 1970's within the field of cloud physics (articles by Braham, Hobbs and colleagues). We have elaborated on the meaning in the manuscript.

p 2561, line 2: Origins of other aerosols that influence clouds are specified in the revised manuscript (e.g. mineral dust, sea salt, biomass smoke, pollution particles, particles nucleated from gas phase emissions of all types). They originate from primary sources (wind generation at the surface of dust and ocean spray, fires, man-made pollutants), and nucleation of particles from the gas phase at all levels of the atmosphere (from geochemical, biological, animal, and human-related emissions).

p 2561, line 11: This term was defined at a scientific workshop as described by Mathias-Maser (1998) and is still in use (Jaenicke 2005). See text for new description.

BGD

4, S1861–S1864, 2007

p 2561, last par.: An editorial change not suggested by the authors. In the revised manuscript we will try to follow the editorial rules for BG manuscripts.

p 2566, line 23: Ice nuclei number concentration as a function of relevant cloud conditions (temperature, supersaturation). We have changed the wording.

p 2566, line 26: New particles originate from riming-freezing and fragmentation mechanisms. See new description in text.

p 2567, line 1: Number concentration is meant here - changed in the revised manuscript.

p 2567, line 5: We removed this terminology to replace it with a clear statement that we considered analyses of data from a large number of studies as a single population.

p 2567, line 11: We have already addressed this point.

p 2570, lines 14-15: This a a very good comment that hits at the root of the issues and our ability/inability to describe them succinctly. To some extent, we cannot repeat here a historical review of work and discussions present in cloud physics textbooks that we reference. However, we may not have successfully stated the problems related to our present capabilities to measure ice nuclei, the multivariate dependencies of ice nuclei concentrations on aerosol concentrations and cloud thermodynamics and dynamics, and our present capabilities for measuring cloud particle concentrations and discriminating their phase. Many of these points were already mentioned prior to this point in the manuscript, but we have rewritten this paragraph to attempt to reiterate and encapsulate these things.

p 2578, final line: Clarified. Ice nuclei predict ice crystal concentrations.

Technical corrections:

All technical corrections will be considered. In the revised manuscript we will also avoid phrases like 'it is well-know' or 'it is well-established'. Further minor changes will be

BGD

4, S1861–S1864, 2007

undertaken to make the subject more accesible to the non-specialist.

Interactive comment on Biogeosciences Discuss., 4, 2559, 2007.