

Interactive comment on “Bacteria in the global atmosphere – Part 2: Modelling of emissions and transport between different ecosystems” by S. M. Burrows et al.

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This paper ties into Burrows et al. (2009) which reviews measurements of bacteria concentrations in the atmosphere, and uses these observations in a model simulation in order to produce a first estimate of regional bacteria emission fluxes. It is a very interesting and important first step into defining global bacteria emissions. This data is very valuable as it can be used in further modeling studies to gain insight into the impact of primary biological aerosol particles (such as bacteria) on clouds and climate.

General comment:

I suggest that the authors explain more clearly whether by bacteria they mean any
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bacteria found in the atmosphere in general, or just those species, which exhibit ice nucleating and/or cloud condensation nuclei forming abilities.

The inversion method to obtain bacteria emission fluxes seems extremely uncertain, as there are so many uncertain steps along the way. Nevertheless, the authors discussed the uncertainties quite carefully.

Specific comments:

Page 10831, line 3: cite the source of the claim that bacteria “remain in the atmosphere for an average period of a few days”.

Page 10832, line 15: Please elaborate why you chose to simulate bacteria as aerosol tracers of $1\mu\text{m}$ diameter and 1gcm^{-3} density. According to Hinds (1999), bacterial density is indeed around 1gcm^{-3} . However, their diameters can vary from 0.3 to $10\mu\text{m}$. Endospores, i.e. the dormant versions of bacteria, are usually smaller in size with 0.5 to $3\mu\text{m}$. As endospores are rather resistant to external atmospheric stresses, I assume that this might be the reason for choosing a diameter of $1\mu\text{m}$? Otherwise you might want to assume a size distribution rather than a fixed size, if possible.

Hinds, W. C. (1999) Bioaerosols in “Aerosol Technology”, Wiley New York, p. 394-401

Page 10832, line 17: I suggest you point here to the list of emission rates in Figure 3.

Page 10833, line 19: Explain why you chose to investigate the CCN activity as a factor influencing the residence time and distribution of bacterial aerosols, and not the IN activity of bacteria. In this context you might want to quote Bauer et al. (2003).

Bauer, H. and Giebl, H. and Hitzenberger, R. and Kasper-Giebl, A. and Reischl, G. and Zibuschka, F. and Puxbaum, H., “Airborne bacteria as cloud condensation nuclei”, Journal of Geophysical Research-Atmospheres, vol. 108, No. D21, 2003.

Page 10834, lines 9, 10, 20 and 21: In lines 9 and 10 you write that particles from coastal regions are among those having the longest residence times. Yet in lines 20

and 21 you state that one of the shortest particle lifetimes are found above the seas. Should not particles, which originate from coasts, also have quite short lifetimes if they are transported over seas?

Page 10835, line 5 and 6: I am surprised that column densities of the total bacteria are highest in polar regions. The CCN-ACTIVE simulation should have the most realistic scavenging characteristics, including both CCN scavenging and ice-phase scavenging (as you also remark in lines 21 and 22 of this page), but nevertheless it produces high column densities in the polar regions. Please explain why this could be so. Are the bacteria found in the polar regions transported there and stay in the atmosphere due to low precipitation? Another factor you might want to mention in this context is the phenomenon of the Arctic haze, which leads to the persistence of aerosols and anthropogenic pollutants during the Arctic spring (e.g. see Law and Stohl, 2007)

Law, K. S. and A. Stohl. Arctic Air Pollution: Origins and Impacts. 16 March 2007. Science.

Page 10835, line 12 and 13: You correctly state that in the absence of efficient scavenging, the column densities are highest in the tropics. This, you argue, is probably caused by strong convective lifting, resulting in a longer lifetime. I think that it is also important to add that the tropics with its dense vegetation are also an abundant source of bioaerosols, and this also contributes to the high column densities.

Page 10835, line 25: Your assumption that bacteria sources are constant is not very realistic and might produce false results. Is it possible to include seasonal variability into your model, e.g. by coupling the emissions to either the leaf area index or the net primary production of the biomes?

Page 10838, lines 26 and 27: Shouldn't negative fluxes and concentrations mean that there is a particle sink? In that case, constraining fluxes to be non-negative would lead to misleading results.

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Page 10843, line 10-14: You use the results of the exact solution ensemble as a best estimate of the global emissions, yet in chapter 5 use the Method 2 best fit values. Explain why.

Page 10848, line 5: As the concept of "bioprecipitation" might be confused with the precipitation of dissolved substances (e.g. heavy metals in groundwater) by microbial action, you might want to clarify it by explicitly pointing towards Sands et al. (1992) or Caristi et al. (1991).

Caristi, J., Sands, D.C., and D.G. Georgakopoulos. "Simulation of epiphytic bacterial growth under field conditions". Simulation, Vol. 56, No. 5, 295-301 (1991). DOI: 10.1177/003754979105600505

Page 10865, Table 5: In the row 'Mean global load (cells)' the homogeneous emissions are four orders of magnitude higher than the adjusted emissions. Please explain why.

Page 10868, Table C2: The table heading is lacking the dimension (I assume it is the number of bacteria per cubic meter of air).

Page 10869, Table C3: As in table C2, the dimension is lacking (m^{-3}).

Table C4 and Fig.4: Please state what are the sources and what the destination ecosystems. I assume that as in Table C1, the source ecosystems are listed across the top, and the destination ecosystems on the left.

Page 10877, Fig. 5 and 6: Please state what are the sources and what the destination ecosystems, i. e. what does the x-axis represent and what are the graph lines.

Typographical errors:

Page 10842, line 17: Replace "eensemble" with "ensemble"

Page 10842, line 18: Replace "fluxa" with "flux"

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 10829, 2009.

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