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Biogeosciences Discussions

Interactive comment on "Coupling of fog and marine microbial content in the near-shore coastal environment" *by* M. E. Dueker et al.

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General comments:

We would like to thank Anonymous Referee 2 for constructive comments on our manuscript. We are pleased that the reviewer agrees that our objectives are relevant and that the results are interesting for the aerobiological sciences. Our manuscript presents information about microbial aerosols, culturable on LB media, deposited along the coast of Maine under foggy and clear conditions, including analysis of fallout rate, source, and microbial community composition. These results provide the first evidence of a change in community composition of culturable microbial aerosols associated with foggy vs. clear conditions. In addition, they provide a strong case for ocean to terrestrial transport of microbes in this coastal environment. The additional analyses suggested

by the reviewer (referred to as “lack of analysis”) will be addressed in specific comments below, but most are not possible due to the constraints of our data collection. While these additional analyses would be interesting if possible, our conclusions are based firmly on careful analysis of our data and are robust without the suggested additional analyses. We agree that the distinction between “culturability” and “viability” can be more clearly discussed/described and this will be addressed in the revised manuscript.

RC = reviewer comment; AC = author comment

Specific comments:

RC1: “Did you observe fungal colonies during incubation?”

AC1: Fungal colonies were observed and counted during this study, but molecular analyses were only conducted on prokaryotes. For the purposes of this paper we decided to keep the paper focused on bacteria. We will be more specific about this in the methods section of the revised manuscript.

RC2: “Could you specify the percentage of pigmented bacterial strains for each event?”

AC2: We recorded pigmentation information for each colony picked for sequencing. Overall, 86 per cent of the microbial aerosols colonies were pigmented, compared to 76 per cent pigmentation of the surface ocean colonies (significant difference, p less than 0.01). We will add a summary of this information in the text of the revised manuscript.

RC3: “In Dueker et al., 2011 (Environ. Sci. Technol.), total bacterial concentrations in fog sample were given. Here, the authors should give the proportion of culturable bacteria in fog samples. Quantitative and qualitative intra-variability of culturable bacteria should be presented for fog events (n = 21) on the one hand, and for clear conditions (n = 9) on the other hand. More cultivable cells in the samples do not indicate that there are more cells viable in these. The difference of percentage of culturable cells between foggy and clear conditions can give a little information to compare the difference of viability.”

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AC3: We agree that this would be an interesting comparison but with our data it is only possible on a very general level, due to sampling constraints on the timing of collection in the field. The total microbial aerosols reported in the previously published paper were not directly coupled (meaning not collected simultaneously over similar durations) with clear and fog exposures. Also, the total microbial aerosol collection was conducted using active pumping over 4 - 6 hours, while the clear and fog media exposures were collected passively over 30 minutes. Therefore, calculating the proportion of total microbial aerosols that are culturable cells would be an over-interpretation of the data given the sampling constraints. However, as reported in Dueker et al. (2011), fog presence/absence did not have a statistically significant effect on total microbial aerosol concentrations at this site, while a significant increase was observed in the number of culturable cells deposited during foggy conditions. This strongly supports the interpretation of increased microbial fallout during fog events as an increase in number of cells depositing and/or increased viability of cells depositing.

RC4: "It's difficult to correctly estimate the "microbial fallout rate" with the sampling conditions presented in this study. Generally, at least two altitude collections are required to evaluate it. For example, see: - Lighthart, B., and Shaffer, B.: Viable bacterial aerosolparticle size distributions in the midsummer atmosphere at an isolated location in the high desert chaparral, Aerobiologia, 11, 19-25, 1995; - Lindemann, J., Constantinidou, H. A., Barchet, W. R., and Upper, C. D.: Plants as sources of airborne bacteria, including ice nucleation-active bacteria, Appl. Environ. Microbiol., 44, 1059, 1982..."

AC4: The suggested references used Andersen cascade impactors and slit samplers (Lindemann, Constantinidou et al. 1982; Lighthart and Shaffer 1995) at various heights and were characterizing flux. By using active sampling methodologies they were sampling all culturable microbes suspended in the air column at that height, whether or not those microbes settled. In contrast, the sampling method described in our manuscript (and in the previously published paper Dueker et al. (2011)) was specifically designed to measure only those microbes falling out of the air column, thus depositing near-

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shore, and does not require measurement at two heights. That is why we use the term "microbial fallout rate" instead of deposition or flux.

Technical comments:

RC5: "p. 9610, l. 17: maybe replace "sequence" by "isolates"

AC5: We agree and will make this change in the revised manuscript.

RC6: "p. 9611, l. 16: add reference of this article, concerning the potential implication of microbes in atmospheric chemistry: Vaitilingom, M., Charbouillot, T., Deguillaume,L., Maisonobe, R., Parazols, M., Amato, P., Sancelme, M., and Delort, A.-M.: Atmospheric chemistry of carboxylic acids: microbial implication versus photochemistry, Atmos. Chem. Phys., 11, 8721-8733, doi:10.5194/acp-11-8721-2011, 2011."

AC6: We will add this reference to the revised manuscript.

RC7: "p. 9613, l. 4-6: this sentence is not correct; delete this word "genetically""

AC7: We will make this correction in the revised manuscript.

RC8: "p. 9617, l. 17-19: replace "55

AC8: We will make this correction in the revised manuscript.

RC9: "p. 9618, l. 10: just rewrite "Pseudoalteromonas"

AC9: We will make this correction in the revised manuscript.

RC10: "p. 9620, l. 9: "Amato et al. (2005)" replace 2005 by 2007."

AC10: We will make this correction in the revised manuscript.

RC11: "p. 9621, l. 17-18: "This study confirmed : : :. viability: : : environment.", this interpretation is incorrect in view of the results presented here"

AC11: The results from our study document a statistically significant increase in the number of cultivable cells, using LB media plate exposures, that deposit during foggy,

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as compared to clear, conditions. Our sequencing results also document a change in the microbial community composition falling out under foggy, as compared to clear, conditions. These results can be explained by a combination of increased gravitational settling rates, due to condensation of water on aerosol particles, and increased culturability of microbes from a marine source. In the revised manuscript we will re-write this paragraph to explain this conclusion more clearly, and will replace the word “confirms” with “supports” and “viability” with “culturability”.

Works Cited:

Dueker, M. E., K. C. Weathers, et al. (2011). "Environmental Controls on Coastal Coarse Aerosols: Implications for Microbial Content and Deposition in the Near-Shore Environment." Environmental Science Technology 45(8): 3386-3392.

Lighthart, B. and B. T. Shaffer (1995). "Viable bacterial aerosol particle size distributions in the midsummer atmosphere at an isolated location in the high desert chaparral." Aerobiologia 11: 19-25.

Lindemann, J., H. A. Constantinidou, et al. (1982). "Plants as sources of airborne bacteria, including icea nucleation-active bacteria." Applied And Environmental Microbiology 44(5): 5.

Interactive comment on Biogeosciences Discuss., 8, 9609, 2011.