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Biogeosciences Discussions

Interactive comment on "Ice-nucleation negative fluorescent pseudomonads isolated from Hebridean cloud and rain water produce biosurfactants" *by* H. E. Ahern et al.

H. E. Ahern et al.

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Many thanks to the referee for his/her positive and constructive comments.

As with Roland Psenner (please refer to our response) we appreciate the desirability of more samples. As regards to site differences between the samples; these mountains could be considered roughly as replicate sampling events from the same general air mass at the same time (the peaks were in clear sight of each other). But if the reviewer is also referring to more physico-chemical analyses as stated by Roland Psenner then we agree (please refer to our response).

As per our discussion we do/did agree that the negative ice nucleation results are not conclusive (Section 3.2 pg 1575 lines 4-15). Regarding the importance of location

of biosurfactant production it may not be essential for them to be synthesised whilst airborne. They may already be coating the colonies on the ground and then be released/dissolved once in the droplet. Alternatively they may be at high concentration in the film of water that surrounds the bacteria when they start to activate if they are CCN. However we are developing a quantitative reverse transcriptase PCR methodology to assess bacterial metabolic activity in future samples. We have changed the final 2 paragraphs of section 3.1 to include this information and speculate on the differences in origin of cloud and rain water samples as recommended. We have also rephrased the points regarding Pseudomonads using clouds as an environmental niche as suggested. Please see the revised paragraph below - pg1573 line 17 to pg 1574 line 2 replaced with the following:

The second largest OTU (OTU C) comprised 19 clones which again were dominated by clones from cloud samples. Representative clones had a 99% sequence similarity to Acinetobacter spp. of psychrophilic marine origin. Amato et al. (2005) also found that psychrophilic bacterial species had a significant presence in their samples. Interestingly, in the Hebridean samples, 80% of OTUs with two or more clones were found only in cloud or only in rain water. This could reflect an intrinsic difference in bacterial composition between clouds and rain. That each rain sample was also distinct may reflect the spatial and temporal variability of aerosols in different air masses captured when scrubbed by the rain. Ion species and concentrations are very dependent on the air mass from which the cloud derives. In areas of anthropogenic activity ions are predominately related to pollution, such as SO42-, NO3- and NH4+. Clouds derived from air masses of marine origin are high in Na+ and Cl- ions (Gioda et al., 2006). The high conductivity of the cloud samples reflects the marine origin of the winds, and the exceptionally high conductivity of the sample collected from Caepabhal (Table 2) could additionally have been caused by dry salt deposition on the wires of the collector. The conductivities of the rain samples were much lower than the cloud samples because rain is formed higher in the atmosphere, a cleaner environment? (Blas et al., 2004). This further raises the question of the origin of the bacteria in the cloud

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samples. It is possible that the clouds were enriched with locally-derived phyllosphere bacteria, which may have been activated into CCN (section 3.3). Local enrichment, however, seems less likely because in subsequent sampling of heath vegetation in the region (samples shaken vigorously in water then aliquots plated on cetrimide agar) pseudomonads were recovered from only two out of nine samples and were abundant in only one. Also, the fact that almost half of the OTUs were related to bacteria from psychrophilic, polar environments suggests that this was their primary source. We are currently developing a quantitative reverse transcriptase PCR methodology to assess bacterial metabolic activity in future samples. This should indicate which, if any, are capable of using clouds as an environmental niche.

Pg 1577, line 9-10: This suggests that the fluorescent pseudomonads may be using the clouds as an environmental niche: Has been changed to:

Further studies using RNA will be used to investigate if the fluorescent pseudomonads could be using the clouds as an environmental niche

The following two references have been added:

Gioda, A., Mayol-Bracero, O., Rodriguez, A., Morales-Garcia, F. and Morales R.: Chemical characterization of cloud water at the East Peak, Puerto Rico, during the rain in cumulus over the ocean experiment (RICO), in: Proceedings of 12th Conference on Cloud Physics, American Meteorological Society, 2003.

Blas, M., Sobik, M. and Twarowski, R.: Changes of cloud water chemical composition in the Western Sudety Mts., Poland, in: Proceedings of the third International Conference on Fog, Fog Collection and Dew, NetSys International, 2004.

Interactive comment on Biogeosciences Discuss., 3, 1561, 2006.