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Introduction

There is an ongoing discussion on the relevance of bacterial aerosols for atmospheric processes, such as atmospheric ice nucleation and turnover of atmospheric chemicals. It is unknown, however, whether airborne bacteria can remain viable and sustain relevant metabolic activity. In laboratory studies related to these issues it has often been difficult to study bacteria at conditions similar to those found in the atmosphere.

The objective of this work was to design a bioaerosol chamber with large bacterial residence times and high bacterial densities. We tested the chamber by performing a spectral analysis of pigmented airborne bacteria. Such data may, for instance, have implications for studies on life in exoplanetary atmospheres.

Methods

The experimental set-up is illustrated in Figure 1. Four strains of bacteria were used: two strains *Methylobacterium sp.*, one strain of *Microbacterium sp.*, (different types of carotenoid pigments), and one strain of *Chlorococcus sp.*, (containing both chlorophylls and carotenoid pigments). The cells were grown to late exponential phase and concentrated to densities of between 10^{11} and 10^{12} cells per ml. Cell aggregates were disrupted by sonication.

A sparging liquid aerosol generator (SLAG, CH Technologies, Inc) was used to aerosolize the bacteria into a vertical cylinder. This aerosol generator was chosen because of its high output, stability over time and low consumption of solution (Löndahl et al. 2012). The aerosol was diluted by 10-70 lpm of particle free air.

The particle size distribution was measured in the range 10-650 nm with a scanning mobility particle sizer (SMPS, custom-built) and in the size range of 0.5-20 µm with an aerodynamic particle sizer (APS, model 3321, TSI).

A tungsten halogen light source (HL-2000-HP-FHSA, Ocean Optics) was used to produce a broad spectrum in the VIS-NIR range (360-2400 nm). A narrow beam was obtained with a collimating lens. The absorption and scattering of the light was measured in the range 200-2500 nm (for 200-850 nm with USB4000 UV-VIS, Ocean Optics, and for 800-2500 with NIRQuest512, Ocean Optics).

Conclusions

Since only small spectral changes were expected, the set-up was designed to get as strong signal as possible: long path length (10 m), high output of bacteria and well-defined light source.

The particle concentration measured with the APS was around 2000-6000 cm^{-3} with a peak approximately at the same size as bacterial cells, i.e. 1-2 µm. A background of particles smaller than 0.5 µm was also produced – presumably containing residues from the bacterial suspension.

Preliminary results indicate that at least the *Chlorococcus sp* produces a detectable signal. However, a detailed statistical analysis is needed before any conclusion about the significance of the signal could be drawn.

Due to the possibility of achieving large residence times and high densities of bacteria, this bioaerosol chamber could in future be used for experiments that include sensitive microbial analysis, e.g. looking into bacterial activity by analysing activity indicators, such as ATP and mRNA.

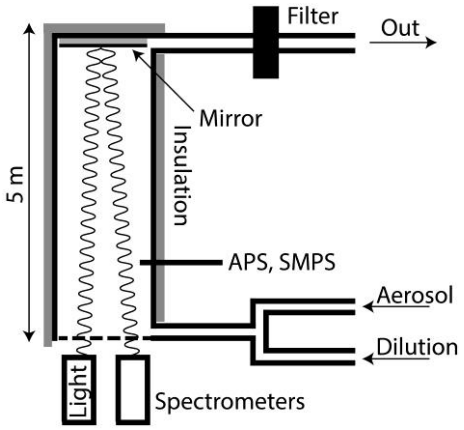

Figure 1. Experimental set-up

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