

Interactive
Comment

Interactive comment on “Heterogeneous ice nucleation activity of bacteria: new laboratory experiments at simulated cloud conditions” by O. Möhler et al.

O. Möhler et al.

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We acknowledge the valuable comments from the three referees of our paper. Based on these comments, a revised and improved version of the manuscript will be prepared and submitted for publication in BG. Here we respond to the comment by Referee 2.

General points: Following the referee comments we will modify the structure of the paper. The section title ‘Cloud simulation experiments’ will be changed to ‘Cloud chamber experiments’. This section will be structured into further subsections entitled ‘The AIDA cloud chamber facility’, ‘Aerosol formation and characterisation’, ‘Spray experiments’ and ‘Cloud expansion experiments’. For the subsection ‘Spray experiments’ we will include two more figures with time series from two selected spray experiments.

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These figures and also the former Figures 4 and 5 will include an additional panel with the optical diameters of all individual particles detected by the Welas2 optical particle counter. These plots will clearly show the distinct groups of droplets and ice particles that formed during the spray and expansion experiments. Care will be taken to separate the method description and results into the respective sections and to avoid repetitions of method descriptions.

The droplet freezing experiments were mainly done because the results were used to determine the optimum starting temperature and aerosol cell concentrations for the cloud chamber experiments. The main focus of the present study was not to compare the droplet freezing method to the cloud chamber method. This will be more clearly stated in the revised manuscript. We would not like to remove this piece of information from the paper. We agree to the referee that more comprehensive and systematic measurements would be required to compare both methods on a quantitative basis.

Answer to specific comments:

Title: The spray experiments are only sensitive to immersion freezing, but we can not rule out a contribution from condensation freezing during the initial stages of the expansion experiments. Both modes can not clearly be separated in these experiments. Therefore we would not like to mention the freezing mode in the title of the paper. The revised manuscript will include a more detailed description of the contributions from the different ice nucleation modes.

Section 2, second paragraph: The ice nucleation protein on the surface of bacteria is made of building blocks which assemble to form the active site. This assembly is enhanced by low temperatures.

Section 4, first line: The freezing modes are now already mentioned in the abstract and also at the end of the introduction section. As mentioned above we would not like to change the title of the paper.

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Section 4, 6th paragraph: This will be part of the new subsections ‘Spray experiments’ and ‘Expansion experiments’ (see general points above).

Section 6: If bacteria affect cloud development and initiation of precipitation should be investigated in appropriate cloud modelling studies. We have extended the conclusion section as follows: ‘The ice nucleation efficiencies of five different *P. syringae*, *P. viridiflava* and *E. herbicola* bacteria strains were investigated at simulated cloud conditions in the temperature range from -5.7 to -15 C. Within the detection limits of our experiments, no INA of the bacteria species was observed above -7 C. The results indicate that the bacteria investigated in the present study are mainly IN active in the temperature range between -7 and -11 C with an IN active fraction of the order of 10^{-4} . It should be investigated in appropriate cloud modelling studies if such low fractions of IN active bacterial cells could have an impact on cloud development and the initiation of precipitation through the ice phase. This of course also depends on the fraction of cloud droplets that contain bacterial cells and the actual properties of bacterial cell in clouds. Further studies are needed to measure the sources, distribution, and concentration of bacterial cells in the troposphere and to investigate the INA of cells extracted from cloud and rain water.

For the *P. syringae* strain 31R1, we measured an IN active fraction of 4×10^{-4} at -10 C in AIDA experiments, but only 4×10^{-6} at -9 C in freezing experiments with droplets deposited on a cooled aluminium foil. From the few droplet freezing experiments conducted during the present study we are not able to conclude if there is a systematic difference between AIDA results and the droplet freezing method according to Lindow (1982). This needs to be addressed in further experiments.’

Figures 4 and 5: The figures have been replotted with larger font sizes.

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5, S1517–S1519, 2008

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