Biogeosciences Discuss., 5, S555–S561, 2008
www.biogeosciences-discuss.net/5/S555/2008/

Biogeosciences Discussions

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

G. Vali (Referee)

vali@uwyo.edu

Received and published: 16 May 2008

Until recently, knowledge about the ice nucleating ability of bacteria was based almost totally on cold-plate drop-freezing experiments and observations with plants. This paper reports on experiments with aerosol dispersions of bacteria in freshly condensed clouds; therefore, it represents important new information regarding processes by which these bacteria may initiate ice in atmospheric clouds. The experimental work was extensive and conducted by proven methods.

Regrettably, the paper has problems in presentation. The list of comments that follow point to some lapses in logic, discrepancies in information, and difficulties in communi-

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

cation.

Most importantly, the experimental design that includes pairs of runs, with and without expansion, and the reasoning of how this leads to interpretations regarding the mode of ice nucleation, are not well described. The distinction between the two types of experiments can only be discovered well into the main body of the paper. It would be beneficial to explain this early on, and to show sample results for both. The two figures now included in the paper show results only for the expansion type experiments. Both Chapters 4 and 5 include procedural matters as well as some results; this is confusing.

Even though the drop-freezing tests were meant to supplement the cloud chamber results, these tests seem to have yielded only crude results and this makes it questionable whether they should be included in this paper.

page/line(s)

1448/1-2 Move here from page 1450, lines 8-9 the identification of what these series are.

1448/8-9 A better phrasing of this might be: "... initiate rapid freezing of droplets from spray guns that are used by ski areas for artificial snow making."

1448/12-19 The concentration estimates are confusing. The difference between SM1 and SM2 is stated to be a factor 10, yet the numbers in the chamber were 160 and 40 cm-3 respectively. Also, the reason that concentrations are stated to be minima should be explained. Most likely the authors refer to possible clumping of the cells. In the last sentence 'losses' are referred to and not clarified.

1448/21 Replace "warm temperatures" with some other phrase.

1448/22 "... samples were tested for their ..."

1448/26 " .. frozen .." instead of "frosted"; better yet " Chinese cabbage that suffered frost damage "

BGD

5, S555–S561, 2008

Interactive Comment

1449/1 "The two samples were combined in order to ..." instead of current text

1449/8-9 Enhanced activity by cooler storage is not a new observation.

1449/11 Doesn't centrifuging separate rather than eliminate the substrate?

1449/12-13 Does the relationship between optical density and cell number need a reference?

1449/15-16 The first two sentences could be combined into one of more precise phrasing. "INA" is a new acronym and is used here rather loosely (as a verb, as a noun, ...).

1449/21 What is the purpose and importance of the 30-second delay? If the number frozen was indeed recorded for each temperature interval, than the activity spectrum can be presented. If only the temperature for certain frozen fraction(s) was recorded the description should say that. Was only one sample tested? Does this really merit a separate section in the paper? Why not mention this in the discussion, if at all?

1450/11-12 The sentence "As described later ..." seems superfluous.

1450/17 " .. constant and homogeneous temperature control ..." is an ambiguous characterization.

1450/27 The summary of instrumentation in this one very long sentence is hard to read. Please simplify. Also, the designation of instruments in Fig. 1 is different than what is used in this paragraph.

1451/17-20 The partial evaporation of droplets can only be stated credibly after the presentation of data. Here it may be said to be a design goal of the experimental conditions. Otherwise, leave it for later. In any event, 1451/18 mentions incomplete evaporation, while 1451/21 states full evaporation. Whether cells were in liquid or not, and to what humidities they experienced is crucial for the interpretation of the results and it is disconcerting to find a lack of clarity on this point.

1451/22 "The two instruments ..." instead of "Both instruments ..."

BGD

5, S555–S561, 2008

Interactive Comment

1451/27 Again, the use of 'both' is not optimal.

1452/6 'also' misspelled

1452/10 'respectively' can be omitted without loss of meaning.

1452/12-14 To explain the small mode of the size distribution as residues of empty droplets should be justified quantitatively, based on the purity of the water used and droplet sizes. Otherwise, the possibility exist that those droplets contain fragments of cells which could then contribute to nucleation of ice.

1452/16 Is there any known reason for the Sonoma cells to be larger than the same 31R1 from a different culture? Is the difference due to measurement uncertainty?

1452/24 "sum of two lognormal distributions" instead of "a bimodal lognormal"

1453/1-4 Can these numbers be reconciled with the concentration of cell in suspension and the mean size of the droplets in the spray?

1453/4 The introductory sentence to this paragraph is repetitious and unnecessary here. It does not contain more detail than what has been already stated before.

1453/16 'pumping expansion' is an odd phrase; 'expansion' would suffice here.

1453/19 the word 'volume' is unnecessary

1453/19 'homogeneous conditions' is surely an overstatement; could refer to minimal gradients, or some such less definitive characterization

1453/23 'temperature profile' is in contradiction with the uniformity claimed above

1453/24 'relative humidity .... is ...' in singular should be used (one concept even though it has many values)

1453/24-30 Two descriptions are given for water vapor measurement; only one is needed and that should be part of the text on pages 1450-51. Same comment for the SDR mentioned in the next paragraph.

BGD

5, S555–S561, 2008

Interactive Comment

1454/11 Do droplets arrive at the CPC3010?

Section 4 It would be useful to explain in this section how the experimental conditions were varied to achieve a difference, or what observations were made to discriminate between activation by the condensation or immersion modes. If the results do not differentiate between these two, but the sum of them is determined, that should be stated early in the paper when these concepts are introduced.

1455/8 'zero volume' is a bad substitute for 'a value of zero in this column of the table'.

1455/8 ... This design of a constant temperature experiment followed by an expansion should be explained in Section 4 in a much clearer way than the alternate 0's in Table 2. Reference here, and later on to "spray experiments" is not the best description for distinguishing these from the expansion runs. A different naming convention is recommended. Also, the time interval between runs should be given.

1455/10 the sentence referring the reader back to section 4 is not really needed

1455/16 Is there some explanation for the difference between Bio02.04 and Bio03.06? Reduced cell concentration in Bio03.06 makes detection more difficult. Is that the only reason? Later on a detection limit of $<$10-4 is quoted (1457/14)

Table 2 The values given for active fraction are with one significant figure in all but 3 cases. Should one conclude that the accuracy of these values is correspondingly low? In any case, some estimates of the accuracies of concentration and activity ratio values should be given.

1455/21 'example' or 'illustration' or 'illustrative example'

1455/24-27 The explanation of the short SDR peak is not very convincing. Can the ice crystals really grow enough and fall fast enough for this to be credible?

1456/6-9 Evidence for droplet evaporation comes from the measurements. The start time of 20 s is perhaps the detection limit for this taking place. The description here

BGD

5, S555–S561, 2008

makes it sound like the TDL and SDR data only confirm some a priori estimate.

1456/12 'confirmed' rather than 'approved'; 'expansion' instead of 'pumping expansion'

1456/14 77%

1456/15 'detectable' instead of 'strong'

1456/16 increased ??

1456/20 Ward and DeMott results are cited only qualitatively, both here and on the preceding page. Were there no quantitative results in that work?

1456/26 replace "at least most" with "the majority" or with "almost all"

1456/28 probably "settling" is meant here, not "depositional"

1457/1 This is the first time that the possibility that cell fragments existed is brought up. See also my comment re.

1452/12-14.

1457/5 This is the first mention of an experiment with a filtered Snowmax sample. The information given is incomplete to judge what this means, and the fact that this was done should have been introduced earlier.

1457/19 'experiment before' to be replaced with 'preceding experiment' , and refer to Bio03.08.

1457/20-21 The point to be made here is not that the experiments are 'consistent' but that immersion freezing and condensation freezing activities are the same. But, only at -9.7, not at higher temperatures. In addition, the performance of the instrumentation can be said to be independent of the experimental procedure used.

1458/3-8 Why is the possibility excluded that ice nucleation at colder temperatures would take place if condensation were also delayed to those values? This conclusion of a specific narrow range of temperatures for ice nucleation activity is hard to accept

BGD

5, S555–S561, 2008

without further proof.

1458/9 ... The comparison of drop freezing and AIDA measurements is almost too vague to deserve mention.

1458/19 'ice nucleation by' instead of 'ice activity of'. A few line down 'ice-active' is used again. Such slang is undesirable, or need specific definition in the paper. Both the meaning, and a quantitative interpretation need to be defined.

1458/23-27 Wouldn't differences between results obtained by the two methods arise from factors such as time of immersion, solute concentration, changes in the bacterial cells, etc.? Why can't the comparison be made at some specific temperature?

1459//5 ... The deactivation idea is not well explained. Why would it happen? What is meant by 'during the first activation event'?

Interactive comment on Biogeosciences Discuss., 5, 1445, 2008.