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Atmospheric Measurement Techniques Discussions

Interactive comment on "ChAMBRe: a new atmospheric simulation Chamber for Aerosol Modelling and Bio-aerosol Research" *by* Dario Massabò et al.

Anonymous Referee #1

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Review of the manuscript amt-2018-147 with title: "ChAMBRe: a new atmospheric simulation Chamber for Aerosol Modelling and Bio-aerosol Research" by Massabò et al.

General comments:

This manuscript describes a new atmospheric simulation chamber and its potential use to simulate the interaction of trace gases and biological aerosol particles like bacteria. Therefore, it fits well in the scope of the journal of atmospheric measurement techniques and focusses on an interesting scientific topic which is rarely addressed in other existing simulation chambers. The manuscript aims to describe the chamber,

its equipment, its instrumentation, and to characterize the aerosol particle behavior (lifetimes), trace gas wall losses, and background levels of particles and trace gases. Furthermore, specific procedures for handling, aerosolizing, and sampling of bacteria are described and results of first test experiments on the viability of bacterial aerosol in the chamber are presented. Due to the focus on chamber characterization and first tests the scientific results are only of limited significance. Rather poor are the overall presentation quality, the English, and the scientific quality. While standard methods are described in great detail the applications or connection to the new simulation chamber are not given in a sufficient manner. Furthermore, several aspects of the tests and experiments are described insufficiently. Hence this manuscript should only be accepted for publication after major improvements.

Specific comments

Page 1 line 1: It isn't evident why and how the new simulation chamber facility can potentially contribute to aerosol modelling. Therefore the title is misleading. Either change the title or add a detailed explanation of the potential aerosol modelling link to the chamber.

Page 2 line 43: Explain specific what you mean. How can bacteria be chemically active in the atmosphere?

Page 2 line 44: Explain what you mean. How can bacteria favor the formation of condensation nuclei?

Page 2 line 54: Specify how many or which types of organisms can survive and what you mean with a long airborne transport. Give typical atmospheric transport or lifetimes.

Page 2 line 63-64: Explain which biogeochemical issue you mean.

Page 2 line 64-65: Explain what you mean with complex ecosystem.

Page 3 line 73: You should skip "mainly" in this sentence.

Page 3 line 74-75: The cited work is related to aerosol-cloud interaction but not to cloud chemistry.

Page 3 line 79-80: Be more precise what you mean.

Page 3 line 84-86: You should be more specific about the subjects of previous studies.

Page 3 line 93-96: Do you mean that ASCs with realistic simulation capabilities should be combined with biological facilities for adequate handling and characterization of bio aerosols? You should reformulate this sentence.

Page 3 line 104: Mention the modelling tools in this section.

Page 3 line 108: In Figure 1 the central ring has a height of 60 cm. Please be consistent.

Page 3 line 110: Figure 1 shows 4 flanges of 10 cm and 2 of 40 cm diameter. Please be consistent between text and figures.

Page 4 line 115: What do you mean with an ad-hoc metallic structure?

Page 4 line 121: Explain carefully if there are other means to retain pump oil to diffuse into the chamber. Explain why a two-step process to refill the chamber is needed.

Page 4 line 129: Give the fan speed in terms of revolutions per minute.

Page 4 line 131: Give the manufacturers of all components you mention in this section.

Page 4 line 138-139: Give positions and sensitivities for these sensors. How do these sensors interact with reactive trace gases like ozone?

Page 4 line 142: Are both lamps permanently installed or can the second one be installed on purpose? Give type and manufacturer for both lamps.

Page 5 line 160: It seems not necessary to me to describe an SMPS instrument in such detail.

Page 5 line 163: Reformulate this sentence.

Page 5 line 163: Note that a pre-impactor is required for a correct SMPS measurement to prevent false sizing due to multiple charged particles.

Page 5 line 170: I suppose the CPC is sensitive to particles larger than 4.5 nm.

Page 5 line 173: It is quite important to describe the design of the sampling lines and potential losses that could occur in them. E.g. sedimentation losses of larger aerosol particles in horizontal tubes.

Page 5 line 175: Explain how you calibrate your instruments and how you ensure their traceability.

Page 5 line 185-188: Explain how you distinguish between NO2 and NOx.

Page 5 line 190: I suppose you mean aerosol particle lifetime here. You must be precise with your language here since aerosol means a mixture of gas and particles.

Page 5 line 191: Some processes proceed on time scales of seconds.

Page 5 line 192: The manuscript describes the lifetime of NaCl particles within the simulation chamber for different particle sizes. Indeed an important characteristic for aerosol simulation chambers. However, the manuscript doesn't explain sufficiently how these lifetimes are defined, why the lifetimes for the different particle sizer are different, and the relevance of the lifetimes for experiments with typical bio aerosols. Several questions in this respect remain open. An important aspect is for example also the role of mixing in the chamber. How are the mixing times determined and how does the mixing fan influence the particle or trace gas lifetimes in the chamber? How is the mixing and particle lifetime influenced by injecting the sliding shelf? How broad is the particle lifetime distribution e.g. for bacterial aerosol particles ranging between 2.5 - 6.5 μm in length? The discussion of the possible time scales for studying typical bio aerosols in the new chamber compared to typical atmospheric residence or aging times is missing. Regarding Figure 3: You may combine the particle size measurements

done by the SMPS (mobility size) and OPC (optical size) instruments to obtain the geometrical particle size. Explain the very high particle lifetimes obtained only from analysis on the OPC data for the size range $\sim$300-500 nm. Are these data realistic? Explain how you calculate the uncertainties for size and lifetime and show them.

Page 6 line 197: Give type and manufacturer for the BLAM nebulizer. Consider adding this information to section 2.

Page 6 line 199: Explain what you mean with "a full range of particle dimension."

Page 6 line 202: Is the rotation speed of 5 Hz 5 revolutions per second? Explain how you determined the mixing time of 1 minute.

Page 6 line 204: How did you determine the mass decay curves?

Page 6 line 210: Replace aerosol lifetime by particle lifetime. According to figure 3 the NaCl particle lifetime ranges from about 1 h for particle diameters of 20 nm and 3 μm to about 10-15 h for particle diameters of 300 nm. Hence the 4 days are not justified. Which lifetimes did the two different bacteria strains have in your chamber? You should add this to figure 3 for comparison. What was the relative humidity for the lifetime studies with NaCl particles?

Page 6 line 214: No all trace gases are lost to the chamber walls.

Page 6 line 220: Typically, ozone wall losses also depend strongly on its concentration showing a bi-exponential behavior with much faster loss rates for the first few ppb.

Page 6 line 224: You should replace aerosol by particles here. How many particles (number & mass) are generated when you add ozone to the chamber and how does this change for subsequent experiments or after several cleaning cycles with high ozone concentrations.

Page 6 line 227: Reformulate this sentence better explaining the cleaning procedure.

Page 6 line 228: Reformulate this sentence and give the detection limit of your particle

measurements to define what no significant particle presence means. Didn't you count the particles directly with a CPC?

Page 6 line 228: Filling the simulation chamber with air from the laboratory through a HEPA filter can lead to changing amounts of trace gases in the chamber e.g. VOC which may impact the experiments and their reproducibility. An additional filter with an activated surface could improve this. Determination of the air quality in the chamber as well as controlling it constituents should be described in detail. Please note that it is not necessary to describe how a gas monitor works if you give type and maker but you should explain how you generate, dose and control the different gases including water vapour. The relative humidity is of special importance for many bioaerosols. Please note that the Humicap sensors typically suffer from exposure to higher ozone concentrations. Did you double check the humidity calibration after experiments with high ozone concentrations?

Page 7 line 233: Handling of bacteria is described in detail but it is not clear where this handling can be done and e.g. how quickly they can be transferred from the biological laboratory to the simulation chamber. It could be a unique strength of this simulation chamber facility e.g. if the handling would be possible in a nearby biological laboratory. Therefore, this aspect should be described in detail.

Page 7 line 246-247: Give a reference for this statement.

Page 7 line 270: How good could you estimate the number of cells.

Page 7 line 273: Explain OD600nm at first occurrence.

Page 8 line 278: Give the parameters in the equation and compare them to literature values.

Page 8 line 287: Give proper uncertainties for the CFU numbers and OD600nm values. Always use the same abbreviation throughout the text e.g. OD600nm not OD600. What was the OD600nm for E.coli.?

Page 8 line 289: Give the uncertainty for the “OD600 around 0.6” e.g. OD600nm of (0.6$\pm$0.3).

Page 8 line 290: What do you mean with excessive bacterial concentration?

Page 8 line 292-305: The technical details e.g. of the BLAM should be described in section 2 including the dimensions of the tubing.

Page 8 line 305: Define the nebulizing efficiency.

Page 8 line 307: Replace “tiny droplets” by a proper description of the droplet size distribution.

Page 8 line 309-310: Give the size distribution (e.g. mean diameter and standard deviation) generated and define what you consider respirable range. Explain why the respirable range is of interest here.

Page 9 line 321-329: How do you avoid contamination of the Petri dishes, as they seem to be exposed to laboratory air?

Page 9 line 335: Explain the gravitational settling method. What is the settling time distribution for the bacteria you studied? Compare the average settling times with the typical atmospheric residence times of those bacteria.

Page 9 line 336: Define in which respect you consider this method as efficient.

Page 9 line 338: Describe how the filter samples are collected.

Page 9 line 340: What do you mean with “tendency to aggregation”? Do you refer to sampling artifacts or to coagulation?

Page 9 line 348: Explain what kind of filter unit you used.

Page 10 line 369: Give an uncertainty for the estimated living bacteria concentration in the chamber e.g.: (10ˆ5 $\pm$??) CFU mˆ-3 = 0.1 CFU cmˆ-3. Compare the number concentration of living and dead bacteria. Compare the number and size (mass)

concentrations of the aerosol particles measured with the dead and living bacteria concentrations.

Page 10 line 373: What do you mean with “statistically compatible”, significant?

Page 10 line 377: Do you mean no significant effect related to RH? Would you expect a significant effect related to the variations of relative humidity? How could this be related to the residence time or drying time of the bacteria?

Page 10 line 382: Explain how the relative humidity in the chamber was increased and what you mean with the environmental value.

Page 11 line 395: Indicate if the uncertainty in the slope of the correlation ($\pm$5 %?) includes the uncertainties of the individual measurement values in the plot. Replace “about 5 %” and “around 10 %” with well-defined values.

Page 11 line 399: Explain how the use of the optical density measurements influences the uncertainty of the cell quantification.

Page 11 line 404-408: Double check these observations by comparison with the particle measurements in the chamber.

Page 11 line 410: The conclusions should be reformulated and extended including a comparison of typical atmospheric residence times for bacteria with those that can be achieved within ChAMBRe.

Table 1: Explain the range of relative humidities.

Tabel 3: For which times during the experiments did you determine the relative humidities and temperatures?

Tabel 4: Can you estimate the ratio of CFU vs. non-CFU deposited on the Petri dishes e.g. based on the bacteria concentrations, sedimentation rate and area of the Petri dishes?

Figure 1: Explain the different parts of the chamber in the caption. Is there any air guiding tube surrounding the fan? Is the fan efficiently mixing the upper and typically warmer part of the chamber? What is the typical vertical temperature gradient? Would it be possible to heat the chamber to 37°C?

Figure 3: Indicate RH and temperature for the experiment in the caption.

Figure 4: Include uncertainties for the individual data points. Compare the optical density measurement to the CFU data and/or literature data.

Figures 5&6: Indicate if the uncertainties for the individual data points are included in uncertainties of the slopes.

Technical corrections:

Page 1 line 16: . . .processes at realistic but controlled conditions.

Page 1 line 21: . . .is made of stainless steel. . .

Page 1 line 22: . . .10 to 2 hours.

Page 1 line 24: . . . have impact on several levels as: . . .

Page 1 line 25: . . ., and geochemistry.

Page 2 line 40: . . .and maintain their pathogenic potential, . . .

Page 2 line 41-42: check wording

Page 2 line 44: . . .chemical, and biological properties. . .

Page 2 line 61-63: Reformulate sentence without brackets.

Page 3 line 109: . . .height.

Page 4 line 114: . . .designed to move specific samples inside the chamber as described. . .

Page 4 line 120: . . .failure it automatically closes in less than one ms, . . .

Page 4 line 127: . . .with four metallic arms of 25 cm length each. . .

Page 4 line 131: . . .and an accuracy of $\pm$10% of its reading. . .

Page 4 line 133: The pressure transducer contains. . .

Page 5 line 185: . . .concentrations are monitored. . .

Page 7 line 236-238: Reformulate the sentence in correct English.

Page 7 line 255: Reformulate the sentence in correct English.

Page 7 line 257: . . .prior to the injection.

Page 7 line 268: In both cases,. . .

Page 8 line 278: The cultivable cell concentration. . .

Page 8 line 288: . . .was prepared for nebulization. . .

Page 8 line 290: . . .was diluted (. . .

Page 8 line 306: . . .with a cavity depth and a cone diameter of . . .

Page 8 line 313-314: . . .completely separate the cylinder, which can be connected to the main chamber or. . ..

Page 9 line 316: This volume can be evacuated through a by-pass to the. . .

Page 9 line 325: Valve V2 is closed and the volume inside the pipe is flushed with clean air from the chamber.

Page 9 line 332: . . .bacteria have been injected. . .

Page 9 line 33: After exposure to the chamber atmosphere, . . .

Page 9 line 345: . . ..were not done in this case as the study. . .

Page 10 line 345: . . ..were not done in this case as the study. . .

Page 10 line 371: . . ..contributions.

Page 10 line 374: . . .appears to be adequate. . .

Page 11 line 402: . . .second set of experiments providing the Gram-negative microorganisms a more. . .

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