

Interactive comment on “Long-term observations of cloud condensation nuclei in the Amazon rain forest – Part 2: Variability and characteristic differences under near-pristine, biomass burning, and long-range transport conditions” by Mira L. Pöhlker et al.

Anonymous Referee #2

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Review of "Long-term observations of cloud condensation nuclei in the Amazon rain forest – Part 2: Variability and characteristic differences under near-pristine, biomass burning, and long-range transport conditions" by M. Pöhlker et al.

This study describes in detail the characteristics of air masses and CCN under a range of conditions that are frequently observed at the ATTO site. The authors distinguish between near-pristine, biomass burning, long-range transport and mixed-pollution con-

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ditions. The study builds on a companion paper "Long-term observations of cloud condensation nuclei in the Amazon rain forest – Part 1: Aerosol size distribution, hygroscopicity, and new model parameterizations for CCN prediction" as well as on a number of other studies that have been conducted on aerosol, trace gases and air mass characteristics at ATTO. Many detailed results are presented that help the understanding of aerosol processes, and the main finding of the present work highlights the different sensitivities of CCN towards changes in various supersaturations ranges. While in clean conditions CCN are sensitive to the entire supersaturation range, in the various pollution cases sensitivity is enhanced towards the lower end. Overall, the study is of high quality and well written. While I have generally only minor comments, it is very important that the authors clarify the meaning of "near-pristine" before the work can be published.

General comments:

The meaning of "near-pristine" is not very well defined. In section 2.3 the definition of NP excludes periods with concentrations of EBC that surpass a certain threshold to identify "the cleanest aerosol conditions" (p. 6, l. 22). Clean aerosol conditions and pristine conditions are however not the same. "Pristine" hints towards a natural aerosol state. Before anthropogenic emissions natural aerosol conditions would have included LRT of Saharan dust and natural forest fire emissions occasionally. Hence, defining "near-pristine" as the absence of any other natural aerosols and only taking into account the rain forest generated particles is not representative of the variability of pristine conditions. Calling them "near"-pristine does not help, because this is with reference to the unavoidable anthropogenic influences. From how the "near-pristine" conditions are identified and described, I understand that they are meant to reflect unperturbed aerosol conditions that are dominated by the Amazon rain forest as particle and precursor source. It is also evident from page 12, l. 39 that the authors hope to provide data for the preindustrial-like Amazonian atmosphere with the near-pristine cases. In this context it is even more important to acknowledge that clean cases exclude other

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conditions as mentioned above that were however present in the preindustrial time. For that reason, I urge the authors to rename their “near-pristine” classification into “clean” conditions as this reflects the actual definition much better, “near-pristine” is misleading. As more and more work is being done to extract preindustrial-like information in various environments it is important to be clear about the terminology.

I am also surprised that “near-pristine” periods are only defined via EBC. Why did the authors not include CO and ozone mixing ratios or back trajectories which are all at hand? If particles were removed through precipitation, EBC can be low, while CO is elevated and hence the air mass cannot be classified as “near-pristine” or rather clean, even though the focus is on aerosol particles.

The results of the paper would be even more informative if the authors provided the fraction in time throughout which the four different conditions are present. How often do clean conditions prevail? How often the mixed-polluted? It would be very informative if these simple statistics could be added.

The paper is well written, however there many qualifiers and redundancies in the text. In the technical comments section some instances are mentioned, but it would be helpful if the authors worked through the manuscript again to remove those. Additionally, the use of some terms is rather unusual. The term “pulses” should be replaced by “events”. Also the precise meaning of “aerosol cycling” needs to be explained. Is cloud processing meant, or atmospheric processing? Please use the exact description. The word “trend” is frequently used in contexts, where no trends can be observed. The meaning is rather “variability, curve shape etc.”. Below this is pointed out in detail.

Specific comments:

Please go through the references again. Often XY et al. yyyyb comes before “a”.

p.2, l. 14: At this point it is not clear what the efficiency spectrum is, a brief explanation is required.

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p.2, l. 27: the reference to volcanic emissions is confusing without any explanation, either provide one or do not mention volcanic influence here.

p.2, l. 30f: No D_{ait} is provided for the size distributions, but κ_{ait} is given. Be consistent in providing all information.

p.2, l. 33: Why is the sensitivity of the CCN population towards changing supersaturation not mentioned for the mixed pollution cases?

p. 3, l. 36: “multi-month trends” are not trends but rather changes or variability across the time period, also l. 38, not diurnal “trends” rather “diurnal cycle”

p. 4, l. 1: Include info on what is the relevant size range?

p. 4, l. 7: please provide a reference for “previous studies”

p.4, l. 13f: Provide information on what the relevant supersaturation range is for the ATTO region. Regarding the introduction, I would have expected a short paragraph that introduces the relevant literature on the ATTO site on which this study builds. After reading the abstract one expects to learn at least more about air mass transport towards ATTO in the introduction. Please introduce a short paragraph on this.

Why do the authors invent a new abbreviation for equivalent black carbon? The standard is “EBC” (Petzold et al., 2013). Please use this one.

The equations are not numbered. There is no need to repeat Eq. 1 without ammonium. It suffices to describe the change in the text as it is trivial.

p. 5, l. 32: Generally the phrase is “sth. corresponds to” not “with”. Please replace all cases throughout the manuscript.

In the methodology section, information on how the CCNC was operated is needed. Even though this is described in the Part 1 paper, readers should get the essential information here (e.g., monodisperse mode, duration of a scan, covered range of diameters).

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- p. 6, l. 10: What was done with a₂? Was there an assumption or was it fitted?
- p. 7, l. 6: Are the 1000 m above sea level or above ground? If a.s.l. how high above the measurement site?
- p. 9, l. 31: Does this statement refer to the Amazon or is it a general statement?
- There is no need for footnotes. They can all be included in the main text which is already quite detailed. It is not apparent why some details are moved to footnotes. Specifically on p. 10, delete the 2nd sentence in the footnote, because it is a repetition.
- p. 11, first paragraph: What about the influence of more local anthropogenic emissions?
- p. 16, l. 4: What is meant by “perception”? Please clarify.
- p. 18, l. 19f: Is the fraction of long-range transported mineral dust and sea salt really large? Please include the values in the text: What is the fraction of supermicron dust and salt in mass or number concentration?
- p. 20, l. 21: How can the ratios of 26 and 49 be consistent? That's a factor 2.
- p. 21, l. 32: Define aerosol “cycling”
- p. 22, l. 29: The African volcanic emission appear out of nowhere. Were they never observed before at ATTO? Why can the authors be so sure that they have observed volcanic emissions?
- p. 24, l. 35: The here defined NP conditions are very selective because they describe only clean conditions. They are hence not an approximation of a preindustrial state, but represent only a potential fraction of the preindustrial atmosphere in that region. ÅÃ
- Technical comments:
- p.2, l. 24: What do you mean by “CCN cycling in relation to aerosol-cloud interactions”?

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- p.3, l. 20: change to “Ndb ranges from few hundred... for clean to 1000 and ... for polluted conditions”
- p. 3, l. 32: delete “of this endeavor”
- p. 4, l. 3: D_a has not been defined yet.
- p. 4, l. 10f: Delete the last sentence of the paragraph, this information is not really needed and the paper can benefit from being shortened.
- p. 4, l. 7: Delete “ As a particularly...concept”. This is a qualifier that does not help the reader to understand the efficiency spectra better.
- p.4, l. 29f: delete “particularly interesting”
- p. 4, l. 38: What is an “efficient CCN prediction?” Is this method particularly fast or do you mean effective?
- p. 5, l. 19: delete “predicted”
- P. 9, l. 4: Spell out Mar
- p. 9, l. 7f: The sentence beginning with “First, the...” is not a grammatically correct sentence.
- p.9, l. 17: a reference is missing
- p. 9, l. 28: replace “trend” by “behavior”
- p. 9, l. 32: Shorten this paragraph: “Figure 1 provides... sections will focus on detailed aerosol and CCN characteristics in wet... year 2014.” Delete the rest as is has been mentioned already.
- p. 10, l. 28: delete “in the context of this study”.
- p. 11, l. 10: replace “trend” with “observations”
- p. 11, l. 13 ff: delete this sentence, it has already been said.

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- p. 11, l. 31: replace “in more detail of” with “on”
- p. 12, l. 1: preplace “pendant” with “counterpart”
- p. 12, l. 13: Do you mean N_{cn10}? There are a couple of other instances where “10” has been omitted.
- p. 12, l. 28: delete “interesting” this qualifier is not needed.
- p. 13, l. 16: What is meant by aerosol cycling here?
- p. 14, l. 39: delete “mode”
- p. 15, l. 14: replace “ranged” with “was”, and its “contributions”
- p. 15, l. 29: delete “solid”
- p. 15, l. 35: write just “a tool”
- p. 16, l. 34f: remove “as a particularly instructive example”
- p. 17, l. 11: shouldn't the units of SW_{in} in the figures be W per square meter?
- p. 17, l. 24: A “LRT pulse” does not make sense, replace by “LRT event”
- p. 17, l. 28: remove “exactly”
- p. 18, l. 10: Do the authors refer to natural or anthropogenic fires, or both?
- p. 19, l. 20: remove “fortunate”
- p. 19, l. 23: remove “rather”
- p. 20, l. 27: remove the sentence beginning with “It. . .”. This has already been said.
- p. 21, l. 28: Delete this sentence, redundancy.
- p. 21, l. 31: delete “pulses”
- p. 22, l. 24: delete “such as industrial emissions, . . .River”, This has already been said.

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- p. 22, l. 33: delete “far”
 - p. 23, l. 34f: shorten to “CCN efficiency spectra serve as CCN signatures.”
 - p. 23, l. 38: delete “trends” because trends are not discussed in this paper.
 - p. 23, l. 39: Why “could”? Can they or can they not?
 - p. 24, l. 1: it seems that D_H has not been introduced.
 - p. 24, l. 12f: replace “trends” with “curve shapes”, and again with “shapes”
 - p. 24, l. 17: replace “pulses” with “events”
 - p. 24, l. 38: replace “pulses” with “events”
 - p. 25, l. 9: delete “very”
 - p. 25, l. 15f: “growth as well as to enhance the . . .” otherwise the sentence is grammatically not correct.
 - p. 25, l. 33: Be more specific regarding what is meant with cycling.
 - p. 26, l. 5 delete “instructive”
 - p. 26, l. 14: delete “very” and “highly”
 - p. 26, l. 22: “The aerosol particles are composed of. . .”
 - p. 26, l. 31: “on event-basis” instead of “pulse-wise”
 - p. 27, l. 11: “mixed” instead of “superimposed”
 - p. 27, l. 25: “behaviors” instead of “trends”
 - p. 27, l. 25 f: The sentence starting with “The array of . . .” is cryptic for saying that there exists large variability, rephrase.
- Reference: Petzold, A., Ogren, J. A., Fiebig, M., Laj, P., Li, S. M., Baltensperger, U.,

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Holzer-Popp, T., Kinne, S., Pappalardo, G., Sugimoto, N., Wehrli, C., Wiedensohler, A., and Zhang, X. Y.: Recommendations for reporting "black carbon" measurements, *Atmos. Chem. Phys.*, 13, 8365-8379, 2013.

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