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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Long-term observations of atmospheric aerosol, cloud condensation nuclei concentration and hygroscopicity in the Amazon rain forest – Part 1: Size-resolved characterization and new model parameterizations for CCN prediction" *by* Mira L. Pöhlker et al.

Anonymous Referee #1

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General comments: The manuscript discusses measurements of size-resolved atmospheric aerosol (particles size ranging from 20 to 245 nm) and cloud condensation nuclei (CCN) (supersaturation ranging from 0.11 to 1.10 %) concentrations as well as hygroscopicity at the remote Amazon Tall Tower Observatory (ATTO) in the central Amazon Basin over a full seasonal cycle from March 2014 to February 2015). This work finds little temporal variability (diurnal-seasonal) for hygroscopicity, but a pronounced temporal variability for CCN number concentrations, mostly driven by aerosol

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particle number concentration and size distribution. A novel parametrization for CCN concentration is proposed to be applied in future modelling studies. The manuscript is generally well-written, the subject is important, especially for modelling studies, and I recommend it for publication in ACP.

Specific comments: In section 1.2 the authors discuss the hydrological regime of the Amazon forest. Onset and end of the rainy season in the central Amazon Basin, where the authors conducted their measurements, show the largest variations compared to other parts of the basin. Satellite-based outgoing longwave radiation (OLR) measurements and the low-level wind field show that in the central Amazon, onset is associated with anomalous anticyclones and enhanced trade winds in the Atlantic. In addition, there is an apparent association between sea surface temperature anomalies in the tropical Atlantic and Pacific and the onset and end of the rainy season in the central Amazon, in that a warm Pacific and cold Atlantic result in a delayed onset and early withdrawal. It is not clear in the text to what extent the clean (wet) and polluted (dry) seasons of the studied period (March 2014 to February 2015) are being impacted by large-scale atmospheric circulations, especially the temperatures of the Pacific and Atlantic and El Nino-Southern Oscillation.

In section 2.1 of the methodology the authors describe the characteristics of the measurement site and period. Although they justified in section 1.2 their preference for defining seasonality in terms of aerosol sources rather than meteorological variables, I suggest to include the monthly rainfall of the period of study overlayed the climatology of the central Amazon. Rainfall is a good indicator of how anomalous is the period of measurements. The monthly precipitation shown in the paper of Andreae et al. (2015), reported as a reference for an overview of the atmospheric conditions at the site, is incomplete for the year 2014.

Page 10 (lines 14-19): Using hygroscopicity parameter as reference, the authors state that particles' chemical composition is stable throughout the year and the maximum in CCN concentration during the dry season is mainly related to the overall increase in

aerosol concentration. In addition they considered their results as consistent with the previous result of Andreae et al. (2004) showing CCN efficiency (expressed as the ratio of CCN to CN) for the Amazonian wet and dry season aerosol. I do not particularly see condition to compare the two different studies. First, the finds of this study is unique in the sense it is the first time that we see a full year of CCN measurements in the Amazon. Therefore, there is no parallelism with the field campaigns CLAIRE-98 and SMOCC-2002, which are short campaigns. Second, they are measurement sites completely different. The only comparable CCN efficiencies are observed between SMOCC-2002 (cloud-processed smoke at altitude 2000 – 4500 m, cloud-processing might change the chemical composition and increase the hygroscopicity) and CLAIRE-98 (background ground-based measurements, naturally hygroscopic).

Page 10, lines 30-34: Even with a sparse occurrence of particles in the nucleation mode, did the authors find any seasonality in the number of nucleation episodes, such as the three representative days shown by Ortega et al. (2014) in Figure 9? How do the climate and forest of the central Amazon affect the absence of new particle formation, mainly when compared to other continental background locations such as the Manitou Experimental Forest Observatory (MEFO) described by Ortega et al. (2014)?

Page 11, lines 32-37 (discussion involving size dependence of hygroscopicity parameter): Why the values of hygroscopicity parameter, when averaged over the entire campaign (0.13 ± 0.03 - Table 2 & Fig. 3) are practically constant in the Aitken mode? This is not observed in the accumulation mode. Could the differences be explained by the chemical composition or the cloud processing of the particles in the accumulation mode?

Page 13, lines 29-30: There are studies suggesting that aerosols from biomass burning is an ingredient to invigorate convective clouds. This is based on the fact that aerosols have a major impact on the microphysics of continental mixed-phase convective clouds. In addition to the solar heating suggested by the authors, could the aerosol effect also be a plausible explanation for the small Hoppel minimum and high cloud peak

supersaturation in the dry season?

Page 14, lines 28-32: The inclusion of the diurnal cycle of NCN, similar to Fig. 7, could enrich the discussion on the non detectable diurnal trend in the hygroscopicity parameter.

Page 34, Table 1: Hygroscopicity parameter is calculated as 0.13±0.03 for both supersaturation 0.47% and 1.10%. However, looking at Fig. 01c, the parameter seem to be more dispersed at 1.10% than at 0.47% throughout the year. Is it correct a same std of 0.03 for both hygroscopic parameters?

Technical corrections: Page 10 (lines 8, 9 and 10) and wherever in the text: Please standardize the symbol for critical diameter Da(S) Page 17 and 19: It may be better to define a symbol for "width" in equations 7 and 8, considering its potential use in future articles.

Page 39: Fig. 1 is very useful to inform about seasonal trends in time series. However a plot of the diurnal cycle is missing for better understanding.

Page 41: Change "Aiken" to Aitken in the legend of Fig. 3.

Page 43: CCN activation curve at supersaturation of 0.47% shows strange values in the plots of the Fig. 5, including values of NCCN/NCN above 1.0.

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