Review comments to manuscript acp-2023-33

The variation of particle number size distribution during the rainfall: wet scavenging and air masses changing

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Review Comments

The paper investigates possible sources of discrepancy in the below-cloud wet scavenging coefficient (BWSC), a metric related to the ability of rainfall to remove suspended particles, between observations and theoretical results. Past studies have highlighted that the BWSC inferred from measured particle number size distributions (PNSD) are larger than the theoretical ones, but sources of these discrepancies remain unclear. This paper uses long-term (i.e., 7 years, ~1800 days after data quality control) PNSD data collected at the SORPES station in eastern China to quantify BWSC in a polluted atmosphere and to investigate sources of discrepancies between observed and theoretical BWSC. Auxiliary to the analysis is the ERA5 and TRMM data that provide meteorological and rainfall information over the area, respectively. The authors select rainfall days above a certain intensity and duration and exclude extreme events and frontal passages that will significantly impact PNSD. This leads to 170 events being analyzed. Two categories of events are identified based on BWSC (high and normal events). Events are also classified based on changes in synoptic systems that may lead to a different role played by the BWSC. Pollutant concentrations (e.g., CO) are also used as tracers to track changes in air masses. The manuscript is well written, the results are innovative, and topic is of high relevance for Atmospheric Chemistry and Physics. However, the following concerns should be addressed to be considered suitable for publication.

General comments:

- Few results are shown for the normal scavenging vs high scavenging events in terms of PNSD. Two specific events are shown in Fig 3, but it would be interesting to know more about the overall statistics. How do the two distributions differ on average? What is the variability/uncertainty in the PNSD and rainfall distribution over time for these two types of events over the analyzed period?
- More details should be provided in the methods on how the different events are classified in terms of BWSC and also in terms of the synoptic driving systems. Also for example, in Figure 6 it's not clear what the trajectory height means and how it is computed. Rainfall events may be synoptic driven or more locally generated. How are these differences accounted for?
- The dependence of BWSC on the pre-existing particle number concentrations is very interesting, but more details are needed. Does this relationship vary as a function of the particle size as well or is it constant from the smallest to the largest diameters? Does the pre-existing PNSD play a role in dictating BWSC or is the total particle number the key driver?
- How generalizable these results are? The authors could contextualize the emission regimes, the typical PNSD, the type of air mass changes, with those observed in other studies and comment on which regions the BWSC could be impacted by some of the identified drivers.