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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Observations on aerosol optical properties and scavenging during cloud events" *by* Antti Ruuskanen et al.

Anonymous Referee #2

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GENERAL REMARKS

The manuscript reports results from a multi-annual study on aerosol optical properties and scavenging effects, observed at the Puijo measurement station in Kuopio, Finland. Observed properties include number concentrations of different aerosol modes, size distributions, scattering and absorption coefficients. The authors investigate the impact of environmental parameters (temperature, relative humidity, in-cloud and clear sky conditions) on the scavenging and wet deposition of various aerosol parameters. The experimental part of the study is very well designed and carefully conducted. The resulting data are of high quality and of high relevance for the investigation of the aerosol indirect effect because the data set covers a long period in time and thus a large variety of weather situations and atmospheric conditions. The interpretation

of the presented data, however, remains largely on the level of describing observed phenomena, whereas modelling studies for quantitative analyses are lacking.

In summary, the topic of the manuscript fits well into the scope of the journal. The manuscript can be accepted for publication in ACP after major revisions have been considered which are specified in the following.

SPECIFIC COMMENTS

1. The authors discuss the influence of environmental parameters like temperature and relative humidity on the properties of the sampled aerosol, and in particular of the scavenging efficiency. In the abstract and also later in the main text of the manuscript, the authors discuss the impact of air temperature on the observations just as if there is a direct dependency of temperature on the observed properties. However, particularly the impact of air temperature on the observed effects is only of indirect nature, since the aerosol population and constituents change with season and thus with temperature because of changing sources. An even better wording could be to describe the link between temperature and the observed effects as a correlation instead of a dependency. This fact should be clearly stated because in the current manuscript it reads like there is a clear temperature-dependence on aerosol properties like number concentrations etc.; see e.g. lines 19 to 22 of the abstract. The same is probably true for the impact of relative humidity since scavenging efficiencies at the same relative humidity level may change between, e.g., spring and fall conditions with different aerosol chemical compositions. Again, the effect of relative humidity on the hygroscopic behaviour of the aerosols is not only related to the level of relative humidity but also to the difference in chemical composition.

2. In its current version, the analyses presented in Figures 3 to 6 may suffer from pooling different aerosol chemical compositions and thus different hygroscopic growth behaviour into single bins for temperature and relative humidity. The authors describe this effect on page 6 lines 12 to 25 for the data shown in Figure 4, but not in a quan-

titative manner. The missing quantification however, makes the data less valuable for modelling studies since key properties are missing in the analysis. To overcome this limitation, it might be worthwhile to investigate, e.g., the contributions of various parameters on the variability of the fraction of scavenged absorbing material at -7°C (Figure 5b). In the current analysis, this fraction is centred at 0.45 with a P10 value below 0.1 and a P90 value close to 0.8. A similar exercise could be conducted for most of the other analyses.

3. In the introduction section (page 2, lines 13 to 25), the authors describe the interaction of aerosol particles with water vapour. This section requires rewriting for several reasons. The effect of hygroscopic growth at relative humidity < 100%, and even more important, the effect of cloud condensation nucleus activation is not related to microphysical processing but to water uptake by hygroscopic material. A more precise description is needed here. Later in this paragraph, the authors discuss that due to the different hygroscopic properties which favour scavenging of water-soluble light-scattering material, light absorbing aerosol is enriched in cloud-processed air parcels compared to its initial state, the cooling effect of liquid-water clouds is reduced compared to the warming effect of light absorbing material. A more detailed description and references are needed here.

4. In Figure 5, the authors present a regression analysis of temperature dependence of the fractions of lights scattering and light absorbing material; see Section 3.2.2. The results of this regression analysis are also listed in the main conclusions of the manuscript. The authors explained that the errors of observations were taken into account by performing a Deming regression analysis. The applied method is a suitable choice, but the statistical significance of the obtained results needs to be discussed.

MINOR ISSUES

Page 2, line 39: The authors state that the effect of clouds and precipitation on aerosol properties has been studied in a few campaigns. However, there have been many field

campaigns conducted on this topic, which is also reflected in the list of references given in the manuscript. An adequate restatement is requested.

Page 5, line 6: The minimum diameter for the total aerosol should be stated here.

Page 6, line 35: At some positions in the manuscript an article is missing, e.g., “First, sampling system with ...” should read “First, a sampling system with ...”. Checking the manuscript text is recommended.

Page 7, line 12: a comma should be added after “Third”.

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