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Atmospheric Chemistry and Physics Discussions

Interactive comment on "On the competition among aerosol number, size and composition in predicting CCN variability: a multi-annual field study in an urbanized desert" *by* E. Crosbie et al.

Anonymous Referee #2

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This paper presents a detailed climatology of CCN concentrations, characteristics, and related aerosol properties based on two years of measurements in an "urbanized desert." In addition, CCN closure analyses are conducted and the predictive skill of parameterized models of CCN concentrations are explored. This paper makes important contributions to the field by presenting long-term measurements in an under-studied environment; however, this paper would benefit from a more thorough discussion of some of the methodology and the broader implications of this work. I recommend publication after the consideration of the following comments.

Specific Comments

1. Two years of CCN measurements conducted at a supersaturation of 0.2% are presented. The authors should consider noting briefly why this value was chosen. Is this somewhat arbitrary or does it reflect a "typical" updraft condition/conditions specific to the climate of interest?

2. Details regarding the cluster analysis are provided in the supplement; however, some of this information should be provided in the main text. In addition, further information is needed to describe this portion of the methodology, either in the supplement or the main text. Specifically:

- The reasoning for the selection of 4 clusters in the K-means clustering analysis should be included in the main text, as should a brief description of the definition of cluster associations/cluster assignment weights, especially given the presentation of this latter metric in Figure 5.

- Because the "fuzzying" of the cluster associations is outside of the more traditional application of K-means clustering, in which distributions are assigned to a single cluster, a justification of this choice should be provided. Would changing the number of clusters be another method by which the authors could achieve their goal of considering the transitions between/combination of physical process/regimes? While the objective was to retain the smallest number of clusters, was there evidence that other potentially important physical processes/aerosol regimes contributed to variability in particle size distribution properties when more clusters were considered?

3. Under some circumstances, cluster-derived parameters led to improvements in model performance. How do the authors envision the application of the presented clustering methodology in future field studies in other geographic regions and climates? I am particularly interested to know if there is evidence for the potential of a more generalized approach that could be applied to a large number of sites. In other words, some of the clusters presented here are likely to be specific to the region of interest or other very similar climates/sites. In their clustering analysis, did the authors see evidence

for the potential for defining the clusters such that they more broadly represent the processes influencing size distributions at a wide number of sites?

4. Along similar lines, with the aim of improving the representation of cloud properties and processes in large-scale models, in what ways does this work inform future similar campaigns in which long-term measurements of CCN and aerosol properties are measured? What measurements are crucial to this effort?

5. Particle composition measurements are for PM2.5, while size distribution measurements cover a range of 13 – 748 nm. Could differences in composition and/or mixing state for particles larger and smaller than 748 nm contribute to heterogeneity in the degree of variance in CCN concentrations explained by size and composition? Could the influence of this vary temporally, on hourly and seasonal scales?

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 3863, 2015.