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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The relationship between cloud condensation nuclei (CCN) concentration and light extinction of dried particles: indications of underlying aerosol processes and implications for satellite-based CCN estimates" *by* Y. Shinozuka et al.

Anonymous Referee #1

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This study examines the relationship between CCN and light extinction using multiple datasets from short-term aircraft campaigns and long-term ground-based observations in different regions around the world, and proposes a new parameterization for estimating the CCN concentration from the aerosol light extinction measurements. The underlying aerosol processes and the implications for satellite-based CCN estimates related to this study are also discussed in details. The study is very important in that it

provides an in-depth analysis of a widely used relationship between CCN and aerosol optical properties which may help reduce the large uncertainties resulting from the use of satellite-based estimates of AOD as a proxy for estimating CCN that is notoriously difficult to measure, let alone on large scales. While the concept, and some of the datasets used are not new especially in light of a recent similar study by Liu and Li (2014, ACP), use of a bivariate regression method has a merit of reducing or removing a potential bias resulting from uncertainties in both the input and output variables, although the results as shown in Figures 1 and 2 do not reveal much differences. Given the large scattering of the data, such differences may not be statistically significant, which should be tested but was not done. As far as this is concerned, more distinctions should be made to make the study original enough to warrant the publication, as the bulk of the measurements used were made at the same sites over similar periods as those used in Liu and Li with a similar objective but somewhat different approaches. If the paper is published, both similarity and distinctions should be highlighted in the abstract. One distinction, for example, lies in the use of the aircraft measurements in ARCTAS Canada. The introduction isn't well organized. Most of the text is concerned with two themes: relationship between CCN and aerosol optical prosperities and use of the relationship for ACI studies. However, the discussion mixes up the two themes and elaborate them back and forth without a clear flow of information. The discussion should be rearranged. Besides, no references are given in numerous places where they are apparently warranted such as: Page 2747, Line 22m after "ACI studies" (add such refs as Kaufman et al. 2005; Nakajima et al. 2001;) Page 2748, Line 1 after "CCN-AOD relationships", and Line 23 after "several parameterizations"; such references should be added as Andrea (2009), Liu and Li (2014) Page 2750, Line 22, It is not true that "hygroscopicity is not directly accounted for". In fact, the parameterization of Liu and Li (2014) includes a term of relative humidity to explicitly account for the hygroscopicity. Page 2750, Line 29, explain the meaning of "one kilometer horizontal resolutions" for airborne and ground-based observations. Page 2751, A brief introduction of the ARCTAS Canada should be given, if there is no pertinent paper available.

Page 2754, line 23-26: A two-point ïňĄt to the power law distribution isn't a valid way to analyze the scattering hygroscopic growth as the error is large enough to make the calculated values meaningless. The aircraft data with 2 nephelometers at set RH values weren't scanned over a wide range. Thus further discussions on the uncertainties due to this limitation are necessary here. Page 2756, line 18-20: The CCN concentration is averaged over 11s, which means that the points in figure 1 are the mean values of CCN at different altitude. If so, it is better to give the information on the altitude of the points by using the color map since the CCN-AOD relationship significantly depends on the vertical distribution of aerosol properties, such as concentration, size and composition. Page 2757ïijŇ explain the term "deviation within a factor of "

Page 2758, line 10-13: the study seems to suggest that the regression is insensitive to the choice of wavelength of the AOD. One of the challenges to estimate the CCN concentration from aerosol optical quantities lies in that the contributions of aerosol to its CCN and to optical quantities are dominated by different aerosol particle size ranges: larger to the optical extinction than to the CCN concentration. This implies that the optical quantities at short wavelength should be a better proxy for CCN than those at longer wavelengths. Please elaborate more clearly. Page 2770: The new parameterization for estimating the CCN concentration in this study uses the Angstrom exponent (AE) as the indicator of the aerosol size. The implications for satellite-based CCN estimates based on the new parameterization significantly depend on the AE retrieval from satellite. Unfortunately, the retrieval of the AE still has very large uncertainties (see discussion on Rosenfeld et al., 2014).

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