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## ***Interactive comment on “Aerosol optical hygroscopicity measurements during the 2010 CARES Campaign” by D. B. Atkinson et al.***

**Anonymous Referee #2**

Received and published: 4 January 2015

The paper by Atkinson et al. titled “Aerosol optical hygroscopicity measurements during the 2010 CARES Campaign” presents results on the influence of water uptake on the aerosol optical properties. The aim of study was to investigate the hygroscopic properties of oxygenated organic aerosol (OOA) and supermicron particles, based on observations made at two ground sites during the 2010 CARES field campaign. Optical closure calculations were performed between measurements of particle chemical composition, size distribution and optical properties at different relative humidity. The results showed that OOA is moderately hygroscopic and the retrieved hygroscopicity parameter  $\kappa_{\text{OOA}}$  is consistent with previous studies. Supermicron particles were found to be highly hygroscopic, which is consistent with substantial contributions of sea salt-containing particles in this size range. Analysis of the dependence of  $\kappa_{\text{super}}$

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on chemical composition indicated correspondence between the chloride fraction on sea salt particles and  $\kappa_{\text{super}}$ . The authors attribute the variability of  $\kappa_{\text{super}}$  to atmospheric processing involving chloride displacement by nitrate and the accumulation of secondary organics on supermicron particles. The paper is somewhat original in addressing hygroscopicity of ambient particles from optical measurements. In particular, there are still lots of open questions in the hygroscopicity of ambient supermicron particles and the manuscript presents important results in this field. The experimental part is accurately described and provide extensive detail on the limitation of each instruments. The authors discuss also the limitation of the data treatment and provide information on the effect of the particles mixing state on the results. The manuscript is in the scope of ACP and is certainly suitable for publication in this journal. However, I have a few comments and questions that should be considered before publication.

General comments:

Optical closure was performed by using measured particle size distribution from SMPS and APS. Size distributions were measured up to 20  $\mu\text{m}$  using the APS. The authors imputed directly the measured size distributions in Mie computation and therefore did not take into account particles larger than 2  $\mu\text{m}$  (Figure S1 clearly shows missing particles larger than 2  $\mu\text{m}$ ). In contrast, scattering coefficients which are used for optical closure represent the overall size distribution. I recommend that size distributions obtained with the SMPS and APS to be fitted with log-normal size distributions in order to take into account the missing coarse mode particles.

As underlined by Dr. A. Jefferson in her comments, truncation corrections of the nephelometer measurements should be performed. The authors answered that this correction cannot be done due to missing measurements of Angstrom coefficient. However, the correction can be performed by Mie-calculations using the retrieved size distributions, bulk real refractive index, the limited angular range and the intensity function of the nephelometer. I recommend that the authors incorporate this correction in the manuscript (Müller et al., 2009).

Nephelometer measurements can suffer from heating induced by the lamp within the cell of the instrument. This heating can be critical for your measurements since it can cause a reduction of the sample RH and thus an underestimation of  $f(\text{RH})$  (Kus et al., 2004). Did the authors use the RH at the entrance of the nephelometer or within the cell for  $\gamma$  calculations? If they used the RH at the entrance of the nephelometer, a correction for the sample RH must be applied or they should indicate at least the errors on RH,  $\gamma$  and  $\kappa$  induced by the heating.

The authors assumed a single density value to convert aerodynamic size distributions to equivalent size distributions. Size distributions in Figure 1 C and F does not always seem to fit well together. Did you check the overlapping of SMPS and APS size distributions throughout the campaign? The authors could show an example of overlapping of SMPS and APS size distribution (in Figure S1 for example) and estimate the error on the calculated parameters ( $\gamma$  and  $\kappa$ ) due to the assumption of a single density value throughout the campaign.

Specific comments:

Paragraph 3.1, page 31208, line 14 : Please replace (Zaveri et al., 2012) by Zaveri et al. (2012).

Paragraph 3.2.2, page 31209, line 24-25 : Please indicate the three RH values.

Paragraph 3.4, page 31214, line 6 : Please replace (Setyan et al., 2014) by Setyan et al. (2014).

Table 1: Please add references of the values used for model calculations.

References:

Kus, P., Carrico, C., Rood, M., and Williams, A.: Measured and modeled light scattering values for dry and hydrated laboratory aerosols, *Journal of Atmospheric and Oceanic Technology*, 21, 2004.

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Müller, T., Nowak, A., Wiedensohler, A., Sheridan, P., Laborde, M., Covert, D. S., Marinoni, A., Imre, K., Henzing, B., Roger, J.-C., dos Santos, S. M., Wilhelm, R., Wang, Y.-Q., and de Leeuw, G.: Angular Illumination and Truncation of Three Different Integrating Nephelometers: Implications for Empirical, Size-Based Corrections, *Aerosol Science and Technology*, 43, 581-586, 10.1080/02786820902798484, 2009.

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