

Interactive comment on “Observational study of aerosol hygroscopic growth factors over rural area near Beijing mega-city” by X. L. Pan et al.

Anonymous Referee #1

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This paper examines the relationship between $f(\text{RH})$ determined from RH-controlled nephelometer measurements and attempts to relate these to aerosol chemical composition and transport pathways.

"Hygroscopic growth factors" are referred to in the title and various places in the paper. Hygroscopic growth factors $[D(\text{rh})/D(\text{dry})]$ were not measured. What was measured is $f(\text{RH}) - [B_{\text{sp}}(\text{rh})/B_{\text{sp}}(\text{dry})]$. References to hygroscopic growth factors should be removed and replaced with $f(\text{RH})$, which is enhancement of B_{sp} due to hygroscopic growth.

There is also a reference to deliquescence RH on p. 5095. There is no clear evidence for deliquescence in Fig. 4 and the conclusions state that $f(\text{RH})$ varied smoothly and monotonically.

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There is a fundamental deficiency in the experimental design in that the nephelometers measured TSP while the chemistry presented represents PM_{2.1}. Table 5 shows that the PM_{2.1}/PM₁₁ ratio was 50% or less. Thus, the $f(\text{RH})$ must be depressed by the presence of a significant mass of large particles. The results are thus inconsistent with those of Day and Malm, for example, who used nephelometers preceded by size-selective inlets.

It is difficult for the authors to obtain quantitative light scattering closure based on measured $f(\text{RH})$ and PM_{2.1} chemical composition. Because of the large coarse composition, the relationship between $f(\text{RH})$ and chemistry is more qualitative than quantitative. I suggest that the authors attempt to do some closure calculations to make the results more quantitative. They could use dry scattering efficiencies used in the IMPROVE equation, i.e., 3 m²/g for ammonium sulfate and ammonium nitrate, 4 for organic carbon mass, 1 m²/g for fine dust, and 0.6 m²/g for coarse material > 2.1 μm. The authors routinely use a factor of 1.4 to convert OC to OMC. This may be appropriate for fresh urban emissions but aged OMC should display a higher ratio, e.g., 1.8 (Pitchford et al., 2007, AWMA, 57, 1326-1336). Closure could be obtained if particles larger than 2.1 μm are composed of non-hygroscopic dust with $f(\text{RH}) = 1$. The case would be difficult for periods where there was a high proportion of coarse sea salt, which is very hygroscopic. The authors would have had a much better opportunity to explain $f(\text{RH})$ in terms of chemical composition had they used a size-selective inlet with their nephelometers.

The authors attempt to relate some cases of high $f(\text{RH}) > 2$ with high proportions of aged OMC. While authors such as Dinar et al. and Gysel et al. have shown that ambient organics are hygroscopic, the measured growth factors were never high enough to produce an $f(\text{RH}) > 2$.

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