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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Hygroscopic properties and mixing state of aerosol measured at the high altitude site Puy de Dôme (1465 m a.s.l.), France" *by* H. Holmgren et al.

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Holmgren et al. describe tandem DMA hygroscopic growth factor measurements performed at an elevated site to assess external mixing for particles of different sizes, and to connect particle hygroscopicity with seasonality and transport from other regions. The value of this dataset lies both in its comprehensive nature, representing 4 years of nearly continuous coverage, and in the site location, at high altitude influenced by the planetary boundary layer. The length of the dataset strengthens conclusions regarding seasonality and associations of hygroscopicity with air mass origin. The authors report that external mixing, based on the number of growth factor modes observed in

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the growth factor probability density function (GF-PDF) data, increases as a function of particle diameter. Data are fit using multiple Gaussian distributions. Smaller particles (25 and 50 nm) predominantly exhibit 1-2 modes, described as "less hygroscopic" and simply "hygroscopic". The larger particles (165 nm) also exhibit an additional third, "more hygroscopic" mode, associated with sea salt/marine aerosol, and are thus the most externally mixed particles investigated. The highest variability in mean GF values is also observed for these 165 nm particles. Lower mean GF values are observed in the winter months for particles of all sizes, associated with a higher influence from local-to-regional scale combustion emissions. Finally, a parameterization of hygroscopic growth at different RH values is discussed, together with kappa values for future reference. Overall, this paper is concise, well written, and presents useful long term data for aerosol mixing state and hygroscopicity at a high altitude site that will be of interest to the atmospheric science community. The manuscript should be suitable for publication in Atmospheric Chemistry & Physics provided that the following minor points are addressed.

Minor comments:

Page 6769: If local home heating devices contribute to aerosol with very low GF values (1.0-1.1) when the site is influenced by the PBL in winter, then what fuel is likely to be used? Biomass burning aerosol is associated with much higher GF values earlier in the text, presumably if the organic aerosol content is high, or if secondary inorganic ions are internally mixed. The very low GF values observed here point to either BC-rich biomass burning aerosol or BC-rich particles associated with combustion of a different fuel. Some discussion of potential heating fuels would be useful here. Referring to previous SP2 measurements of fossil fuel and biomass burning plume BC mode diameters may also be useful, for example [Schwarz et al., 2008]. Furthermore, if the seasonality controls the PBL intrusions, isn't it possible that more fossil fuel combustion aerosol, associated with traffic, for example, is observed in the winter because of the PBL effect?

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Page 6770, first paragraph: Particles with relatively high GF values may still contain BC. If the inorganic ion volume fraction is very high, it is not possible to assess whether a small BC core is or is not present using this method.

Page 6773: Is it possible that partitioning of nitrate or ammonium nitrate at lower temperatures at night also contributes to the higher nighttime mean GF values?

Page 6775, line 1: Do the authors mean that the primary marine particles are internally mixed? Displacement of sea salt chloride by nitric acid during mixing with anthropogenic plumes? Or do sea salt particles have a minimal contribution to number at 165 nm? A GF of 1.8 would be too high for an OA-ammonium sulphate internal mixture, but may be reasonable for a particle composed predominantly of sodium nitrate.

Fig. 10 caption: How is this seasonal variation? Is this not classified based on air mass origin?

Fig. 11 is perhaps not necessary as the GF depends more on season than air mass origin as discussed in the text.

Specific comments:

Page 6765: Should be “Matlab”

Page 6766: should be “biomass burning aerosol”

Page 6766: Duplissy et al 2011 observed higher GF values for aged SOA in simulation chamber studies [Duplissy et al., 2011]

Perhaps shorten discussion around Fig. 11. The main point is that there is a dependence upon season but not necessarily air mass origin.

References:

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