



EGUsphere, author comment AC2
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Reply on RC2

Bastiaan van Dierenhoven et al.

Author comment on "Remote sensing of aerosol water fraction, dry size distribution and soluble fraction using multi-angle, multi-spectral polarimetry" by Bastiaan van Dierenhoven et al., EGU sphere, <https://doi.org/10.5194/egusphere-2022-670-AC2>, 2022

We thank the reviewer for the for the positive feedback and helpful comments. The comments are repeated below in italic script, followed by our replies.

Line 110. How low is the kappa and how small is the radii for ignoring the Kelvin term? What is uncertainty? Line 125. The authors should indicate the uncertainty of aerosol hygroscopicity for 150 nm particles if omitting the Kelvin term.

At line 110, we now cite Wex et al. (2008) and Ruehl et al. (2010) for a discussion on the effects of the Kelvin effect. The remark that the Kelvin effect "is only substantial for very low kappa" was from the perspective of a given growth factor, where lowering kappa implies increasing RH. To be more consistent with conclusions of Wex et al. 2008 and Ruehl et al. 2010, we now state that

"In practice, the Kelvin term is often ignored as its effect is only substantial for RH close to 100% and/or small radii (Wex et al., 2008; Ruehl et al., 2010)"

Furthermore, as suggested we indicate the uncertainty of the growth factor for the example shown in Fig 1 and added the sentence (line 127):

"To further justify neglecting the Kelvin effect in our analysis, we note that for a typical value of κ of 0.15, ignoring the Kelvin effect (Eq. 8) leads to an underestimation of the growth factor of less than 3% at a $f_w = 0.9$."

Line 130. It is not reasonable to classify aerosol as soluble and insoluble particles according to whether the aerosol hygroscopicity parameter (Kappa) is 0. Actually, the kappa of many organics is larger than 0 but they are insoluble. Here can be considered hygroscopic (kappa>0) and non-hygroscopic (kappa=0).

The terminology used in the literature is a bit muddled and the terms soluble/insoluble and hygroscopic/non-hygroscopic or hydrophilic/hydrophobic are often used exchangeable (see for example papers cited in line 133). In line 132, we defined our definition of insoluble as particles with $\kappa=0$. Here, we can refer to Petters & Kreidenweis 2007 who state (referring to a plot of critical supersaturation against dry size) state: "As kappa approaches zero, the particle becomes nonhygroscopic and the slope approaches that

expected for an insoluble but wettable particle as predicted by the Kelvin equation, i.e. -1 ."

Since we already define the terms "insoluble" and "soluble" in line 132, no changes were made to the manuscript related to this comment.

Line 250. More information about RSP is needed, such as the instrument configuration, detection ability, measurement uncertainty, and so on.

Quite some information on RSP is given already in lines 291 and further. About its accuracy we added the sentence (line 293):

"Accuracy of the measured intensity and degree of polarization is generally better than 3% and 0.2%, respectively."

And also (line 300):

"Uncertainties in the derived water fraction, soluble fraction and dry size distributions resulting from measurement uncertainties (see e.g., Knobelspiesse et al., 2012) are expected to be substantially smaller than those arising from the assumptions made in these derivations, as discussed in sections 2, 4 and 5."

Line 435. Whether sulfate is the principal chemical component. The authors can provide the mass fractions of aerosol chemical species measured by AMS.

The mass fractions of organics, ammonium and nitrate are now added to the table S3 in the supplement. We added the following to the text at line 445:

"Mass fractions of ammonium, nitrate and organics are given in table S3. Generally, the majority of the mass other than sulfate is composed of organics."

Figure 3. According to the κ_{extr} , the hygroscopicity of particles is very weak. If divided by 0.56 using Eq. 28, the κ of most particles is below 0.1, indicating a large number of organics with weak hygroscopicity. It may be inappropriate for the author to assume that soluble components are represented by sulfate in Line 320.

Daily average κ values derived from $f(RH)$ are given in table S3 and range from 0.05 to 0.3. Indeed, these κ values are low because of the large contribution of organics with low hygroscopicity. That is exactly our interpretation. Note that these are single values for bulk aerosol that is generally internally and externally mixed and sampled at 1 Hz. Hence, we do not expect to observe values of κ representing pure sulfate aerosol for example.

To further clarify this, to line 367 we added:

"Note that the f (80%, 20%) and κ_{ext} values represent the hygroscopicity of bulk aerosol observed at 1 Hz."

Figure 5, 6, 9, 11, 12, 14. Some in situ data were used to compare, but the measurement instruments were not introduced in the paper. This information can be added to the supplement. What's the uncertainty of these in situ measurements?

The in situ data are described in quite some detail already in section 3.3. Related to the previous comment, we added the data sampling resolution:

"Data are reported at 1 Hertz resolution."

Uncertainty of the water fraction derived from the in situ probes was also discussed already in lines 332 and further. We added a line with estimated uncertainties of the LAS probe to derived sizes and number concentrations at line 343:

"Uncertainty of the LAS data is estimated at 20%."

Figure 8. The scatter is not well consistent with the model line in (a) and (b). What's the reason?

Possible reasons were already discussed in the paper at line 420 and further:

"The spread in the data may be attributable to natural variation of aerosol dry size distributions during the observation period, as well as uncertainties in effective radius retrievals and water fraction estimates. "

We did not make changes to the paper related to this comment.

Line 330. "Therefor" should be "Therefore"

Thank you for catching the error. It is corrected.