The manuscript focuses on characterizing aerosol hygroscopicity using remote sensing techniques. The innovative approach of utilizing Raman lidar measurements with fluorescence capacity is highlighted as a means to enhance this characterization. The use of the fluorescence backscatter coefficient as a weighting factor in tracking the evolution of aerosol concentration within the aerosol layer is deemed a valuable approach that addresses many limitations inherent in remote sensing techniques for such studies. Therefore, I recommend that the manuscript be published following the revisions suggested by the referees.

However, the study does face some limitations, particularly evident in the case studies presented. Both cases suffer from large uncertainties in relative humidity estimation, stemming from the combination of water vapor mixing ratio from the lidar and temperature from ERA-5 reanalysis databases. This could lead to increased uncertainties in the observed values of the hygroscopic parameter (gamma). Furthermore, the second case (9 March 2023) exhibits a narrow variation of RH in the hygroscopic case, potentially amplifying errors. Despite these limitations, the results demonstrate the potential of this new approach for future studies. It prompts the question of whether there are opportunities to improve the retrieval of relative humidity. Could combining water vapor profiles from the lidar with temperature data from microwave radiometers enhance the RH profile? This alternative approach could be compared with your results to evaluate its effectiveness.

Thank you very much for your comment. We agree with you that the high uncertainties are a huge limitation to the case studies presented in this paper. However, we consider that the main aspect of the article is to demonstrate the value added by the fluorescence when studying hygroscopicity using lidar, which is well demonstrated by these case studies as you mentioned.

At first, the water vapor profiles and temperature profiles from the radiometer were considered. However, concerning the water vapor profiles given by the HATPRO Radiometer, it was identified that these profiles were not accurate enough (the shapes of the profiles did not match between the lidar and the radiometer) it was thus decided to use the IWV measurement instead and to follow the method described in Foth et al., 2015. Concerning the temperature profile, we were advised to consider profiles from models instead of the ones given by the radiometer. Indeed, the ERA-5 reanalysis data are assimilating radiosounding data from Brussels (150 km away from the measurement site) we thus expect the temperature estimation to be more accurate. The comparison between the two has been made and the impact on the RH estimation could reach a change of 0.2 in some occurrence. However, in the absence of absolute reference, we considered that the information given by this comparison were limited.

Another aspect hindering aerosol characterization is the use of the FLARE-GMM model. Authors mention that the model is not trained below 1500 m, where the two hygroscopic layers are found. I suggest a more comprehensive identification and characterization of the aerosols presented in this case. Why not utilize aerosol measurements from your station, such as sun-photometer measurements during those days, Angström exponent profiles from the lidar, backtrajectory analysis, or models like CAMS to identify the type of aerosol?

Regarding the objections raised by referee 1 regarding the inclusion of the aerosol clustering method FLARE-GMM in this publication, I concur and refrain from adding further comments on this aspect.

The FLARE-GMM description has been removed from the article following comment from referee 1 but these remarks would be taken into account in the case of a future article on this matter.

Below are some minor comments:

- In the keywords section, consider replacing "classification" with "aerosol typing."

  The keyword has been removed since the article now focuses on hygroscopicity

- Line 45: Please provide explanations for the acronyms EARLINET/ACTRIS-FR.

  Precision added

- Lines 47-49: The following sentence is unclear; improve the wording: "The elastic signal is generated from the elastic scattering of laser light by atmospheric molecules and aerosols. The depolarized signal refers to the part of the elastic signal that retains laser polarization or becomes depolarized after scattering. Finally, the Raman signal results from inelastic scattering, or Raman scattering, by atmospheric molecules."

  This sentence has been removed following the comments from referee 1

- Line 68: Ensure a space between the number and units, e.g., "70 mJ at 355 nm."

  Correction made

- Line 121: Similarly, include a space between the number and units, e.g., "1.5 km."

  Passage removed from the text

- Line 172: Replace "materialized" with "observed."

  Passage removed from the text

- Line 239: Express time as "22:00 UTC" and "21:00 UTC" instead of "10 pm" and "9 pm," respectively, throughout the manuscript.

  Correction made

- Figure 7: Indicate whether altitude is measured above ground or sea level for all figures.

  Altitude is measured above ground level, precision added

- Figure 7: Consider showing a wider range of profiles to observe model and lidar measurements in the lower troposphere, including clean regions.

  More profiles can be found in Qiaoyun et al. (2022). Considering clean region, in general we avoid looking at them, especially because the PLDR measurement becomes extremely noisy.

- Line 256: Correct "bellow" to "below."

  Correction made

- Line 289: Ensure a space between the number and units, e.g., "532 nm."

  Correction made

- Line 299: Be cautious in asserting from this plot that potential temperature remains stable in the hygroscopic layer.

  More precision was added to the text

- Lines 355-356: Replace "and" with “an", “ .. of an urban: ..."

  Correction made

- Check for typos in citations (e.g., "Guzman et al." instead of "Navas-Guzmán et al."). Ensure all citations appear in the reference list.

  Correction made