

Comment on acp-2022-145

Anonymous Referee #1

Referee comment on "Absorption enhancement of black carbon particles in a Mediterranean city and countryside: effect of particulate matter chemistry, ageing and trend analysis" by Jesús Yus-Díez et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-145-RC1>, 2022

This manuscript investigated light absorption by black carbon aerosols (BCA) at urban and regional background sites in the Western Mediterranean. At both sites, long-term records (~ 10 years) were obtained for online light absorption coefficients of BCA ($b_{\text{abs}@637 \text{ nm}}$), and offline mass concentrations of BC as well as other aerosol components. Additional measurements were also performed at the urban site in 2018, including online b_{abs} (at seven wavelengths) and aerosol compositions. Then these observational results were integrated to explore the mass absorption cross-section (MAC) and absorption enhancement (E_{abs}) of BCA. The topic of this manuscript falls well within the scope of ACP. However, I could not support its publication in the current form, as I have substantial concerns on the methodologies.

1. The use of a constant correction factor (C) to account for the multiple scattering effect of AE33. According to the reference provided (AMT 2021, 14: 6335-6355), the C values actually had considerable variations for the urban site (2.44 ± 0.57). Thus, instead of applying a constant C to the AE33 results, the wavelength-resolved b_{abs} should be determined using the MAAP-based $b_{\text{abs}@637 \text{ nm}}$ and the AE33-based AAE, given that the C values showed little wavelength dependence (AMT 2021, 14: 6335-6355).

2. Consistency of online and offline EC for the urban site. It is essential to present their relationship, e.g., using a scatter plot, and quantitatively determine the inter-method discrepancy. Unless this discrepancy could be properly accounted for, it does not make sense to compare the online and offline E_{abs} (or MAC) results. In addition, the MAC of uncoated BC, i.e., MAC_{ref} , were calculated for the urban site using both the online and offline EC. But it appears that the results differed substantially (Figures S1 and S2, after accounting for the wavelength dependence). This does not make sense, again raising concerns on whether the online and offline E_{abs} (or MAC) results were comparable.

3. The assumption that "the lensing-driven absorption enhancement for BC particles was wavelength independent" was not supported by the references provided, even for the

clear coating scenario (e.g., as indicated by Figure 5 in Cappa & Lack, ACP 2010).

4. The effects of brown coating were ignored, indicating the discussions on mixing state were highly uncertain, especially for the cold season when the influence of biomass burning was stronger.