Comments from Reviewer #1

General comments

This study used the results of three black carbon instruments, AE33, PAX, and OCEC, combined with offline component analysis, to analyze the optical properties of black carbon and brown carbon. Some of the results are very interesting and important (i.e., Lines 252-265), and it is recommended to publish them after minor revisions.

Specific points

(1) Conclusion and Abstract: Both mention E_{abs}, but there is no introduction of E_{abs} in the main text, only MAC. It is suggested to add it, e.g., near Fig. 11.

Our responses: The introduction of E_{abs} was added to section 3.5 as suggested: "*the light absorption enhancement (E_{abs}) factors were estimated to be...*" **(see lines 561-562)**.

(2) Lines 45-47, 52-62: The effectiveness of China's air pollution policy is evident to all. However, it seems that the background content in this study is too lengthy. However, the 'various detection approaches' are difficult for readers. Suggest adding introductions comparing devices such as PAX, AE33, and OCEC.

Our responses: Thanks for the suggestion. In the revised manuscript, we shortened the descriptions of China's air pollution policy **(see lines 57-61)** and expanded the introduction to BC measurement approaches: "*...measured BC were frequently found to differ by several times among various detection approaches such as the thermal-optical (e.g., carbon analyzer), light absorption (e.g., Aethalometer) and laser-induced incandescence (e.g., single-particle soot photometer) ones. These techniques are mainly based on the high thermal-stability, strong light-absorbing, and refractory properties of black carbon, respectively, while none of them has been established as a reference method*" **(see lines 46-51)**.

(3) Lines 116-117: First of all, I completely agree with your point of view: the default correction of AE33 seems too rough, but such important content, which is also the core of this article, should not be included in the attachment. Or at least it needs to be clarified in the text that PAX is a standard measurement used to compare with AE33.

Our responses: Thanks for the suggestion. We modified the descriptions in the Methods section and clarified that PAX was used as the reference method compared to AE33: "*While the in-situ approach PAX was used as the reference method for light*

absorption measurements, the AE33, which was operated with M8060 filter tapes, provided aerosol absorption coefficients at seven wavelengths..." **(see lines 114-116)**. Given the importance of this point, we highlighted it again in the Conclusions section: "*PAX was used as the reference method to constrain the scattering-associated artifacts in the AE33-based absorption measurement*" **(see lines 577-578)**.

(4) Figure 1: Considering the stage comparison in the following text, it is recommended to clarify the time periods corresponding to different stages in this section. Maybe use different color.

Our responses: Thanks for the suggestion. Following this comment, we incorporated the filter sampling information, especially the segments corresponding to the four groups of samples (i.e., dust-impacted, fire&dust-impacted, fire-impacted and typical ones), into Figure 1. As can be seen from the updated figure below, for different group of samples (i.e., cases A–D), the distributions of their sampling segments were highly irregular during the spring campaign, suggesting dramatic variations of aerosol sources for the measurement period. We prefer to present these discussions, which were more strongly associated with section 3.2, after the definition of the four cases **(see lines 343-345 and Figure S5)**.

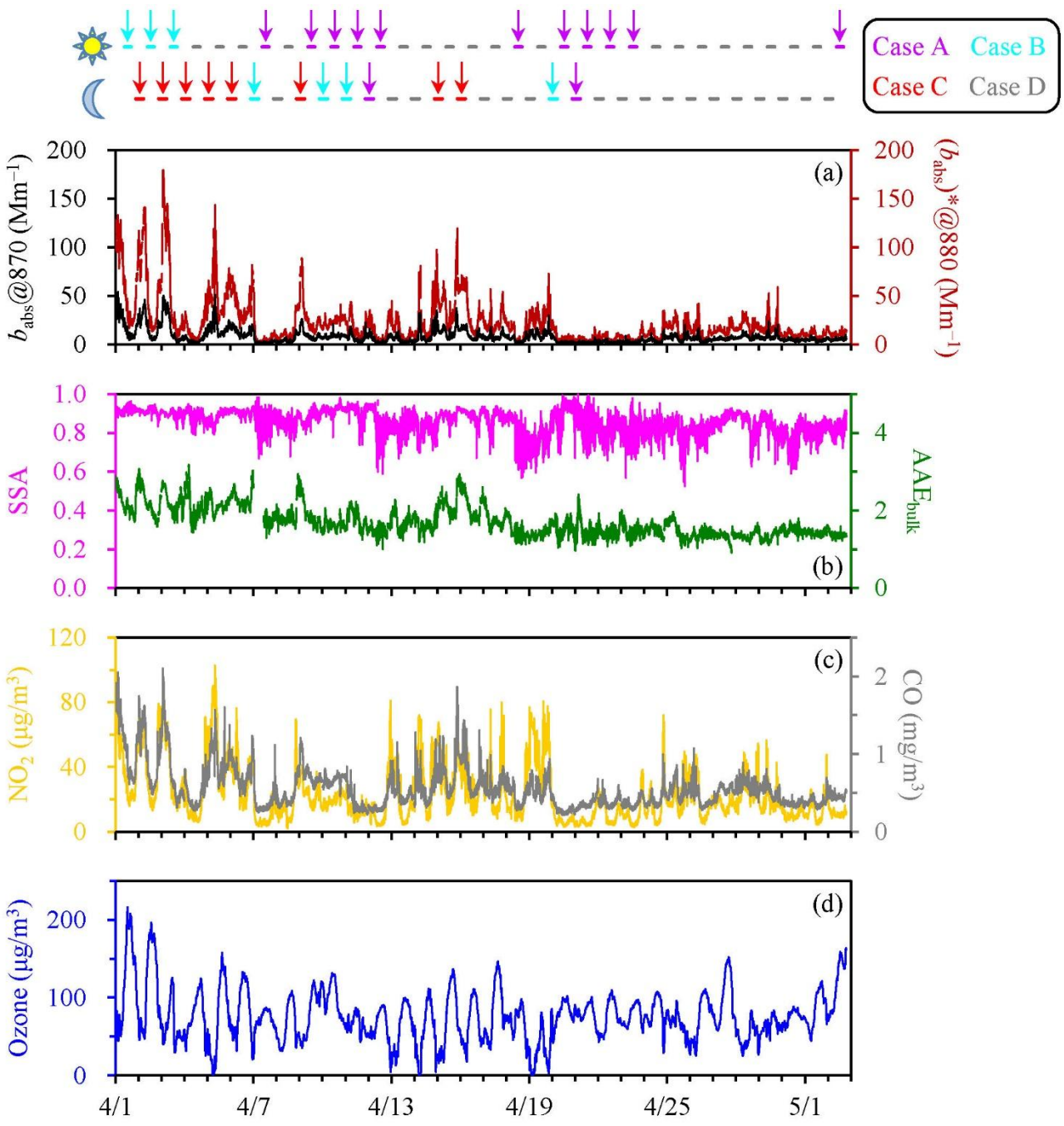

Figure R1. Distributions of the sampling segments for different groups of filter samples. Cases A to D correspond to the dust-impacted, fire&dust-impacted, fire-impacted and typical samples, respectively. The segments are color-coded by sample types, while for the distinct episodes (cases A to C), the samples in each group are also highlighted by the arrows. The sun and moon symbols indicate the daytime and nighttime samples, respectively. The on-line measurement results are also shown, with (a) for the PAX-based b_{abs} at 870 nm and the AE33-based $(b_{abs})^*$ at 880 nm, (b) for the PAX-based SSA and the AE33-based AAE_{bulk}, (c) for NO_2 and CO, and (d) for ozone. This figure was presented as Figure S5 in the revised manuscript.

(5) Table 1: Have you considered conducting machine learning simulations on C^* in your future work?

Our responses: Thanks for the suggestion. We will try to predict C^* using machine learning in future studies, e.g., by linking the C^* vs. SSA relationship and the aerosol composition vs. SSA relationship.

(6) Lines 195-196: Quartz film is a half day sample, so how to compare AE33 with offline needs to be introduced.

Our responses: This point was clarified as suggested: "*The time-resolved $(b_{abs})^*$@632 results were first averaged for the filter sampling segments and then compared to the off-line $(b_{abs})^{\#}$@632*" **(see lines 209-211)**.

(7) Lines 203-210: It is not clear for readers to understand why to discuss filter tapes?

Our responses: Here we found that the off-line carbon analyzer always reported higher light absorption coefficient values compared to the on-line AE33. The comparison was performed at the same wavelength (i.e., 632 nm; **see lines 206-209**) and as explained in our response to the previous comment (#6), the difference in measurement resolution had been accounted for **(see lines 209-211)**. Thus we think the most likely cause for the observed carbon analyzer vs. AE33 discrepancy was the difference in filter media used by the two instruments (quartz filter vs. M8060 filter tape). The discussions above were incorporated into the revised manuscript: "*As the differences in measurement wavelength and time resolution had been accounted for, a likely cause for the observed discrepancies was the difference in filter media used by the two instruments*" **(see lines 213-215)**. We think the related contents could be easier to follow after the revisions.