Comments on "Laser-induced fluorescence lidar detection of weak biomass burning aerosols at Nanping, South China" by Zhekai Li et al.

Summary:

This manuscript presents laser-induced fluorescence lidar measurements at Nanping, South China. Four measurement cases in April and May 2024 are considered to discuss the fluorescence properties of urban and biomass burning aerosol (BBA) particles in the lower troposphere. Furthermore, back-trajectory analyses are used for source attribution of one observed BBA layer. By using satellite observations and radiosonde data, the authors discuss potential transport processes of the BBA from the source region to the lidar site.

General comment:

The main benefit of this study is the geographical location where the presented measurements were performed. While the laser-induced fluorescence technique has been mainly characterized for lidar measurements in Europe, this study applies it also to measurements of BBA and urban aerosol in Asia.

However, the aerosol classification by means of the optical properties retrieved from the lidar measurements is not yet fully convincing. Up to now, the authors only use extensive optical properties (spectral fluorescence backscatter coefficient and aerosol extinction coefficient) and argue qualitatively ("distinct fluorescence [..] despite relatively low [extinction]") that the fluorescing aerosol layer in Case 1 should be BBA. Therefore, I suggest a major revision regarding the aerosol classification and recommend to show and discuss also the spectral fluorescence **capacity** (Reichardt, 2014), which is a **quantitative** measure for the distinction between different aerosol types (Veselovskii et al., 2022).
Furthermore, only one weak BBA layer at the end of the fire season has been considered so far. In the future, more cases also during the peak fire activity should be analyzed to gain a more mature insight into the optical properties of BBA over this region.

The structure of chapter 2 could be revised as some of the section titles are not representative for the data described in the sections. For details, please refer to the specific comments below.

Specific comments:

l. 49: *"The system emitted 355 nm lasers from an Nd:YAG laser…"*
Please mind to be precise in the language. I assume this should be: "The system emitted **a 355 nm laser beam** from an Nd:YAG laser…"?

l. 51: In my opinion, *"…echo signal…"* is not a suitable word here. Maybe use "backscattered signal" or "return signal" instead?

l. 61: *"2.2 Satellite and weather observations"*
Where are weather observations introduced in this section? Furthermore, AERONET (introduced in l. 70) is neither satellite nor weather observation – it is ground-based passive aerosol remote sensing. Please consider to find a more suitable section title or restructure the sections in this chapter, as the meteorological data are introduced in Section 2.3.

l. 74: *"…their geographic locations are marked as red rectangles in Fig. 5e."*
Looking at Fig. 5e, the locations of the AERONET stations are actually marked as red **triangles**.

l. 95: *"3 Calibration and retrieval of LIF lidar"*
Please be more concise: The retrieval of which LIF lidar quantity do you mean?

ll. 101-105: Regarding the correction of ghost contributions: Wouldn't it be better to use several "clean" cases (i.e., with only background signal) and average over them to get an average correction factor for each ghost line instead of using only one reference case?

l. 115: *"...where the superscripts "aero" and "mole" are quantities related to aerosols and molecules…"*
I would rather use "indicate" instead of "are" here.

l. 126: *"So the total fluorescence backscattering coefficient…"*
Please introduce the symbol β_{F} already here.

l. 141: *"…Multiple cloud layers are identifiable via high $\alpha_{\mathrm{L}}^{\mathrm{aero}}(z)$ values in Fig. 2d, consistent with observations reported by Sugimoto et al."*
What do you mean with this consistence? Did Sugimoto et al. report similar fluorescence values for clouds? Please clarify.

ll. 142-143: *"During the observation period, both β_F and α_L^{aero} (0.8–1.4 km layer, Fig. 2d and f) closely match the local PM concentration trends (Fig. A1a)."*
This is not really evident, according to the figures. It may hold for $\alpha_{\mathrm{L}}^{\mathrm{aero}}$, but β_{F} is very different for case 1 and case 4, although these cases show similar PM concentrations.

l. 145: *"These lines of evidence support that low-altitude fluorescence is largely attributable to urban aerosols."*
This statement sounds a bit too general to be concluded from 4 measurement cases only. If applicable, you could draw this conclusion only for your station. Anyway, there can be other fluorescing aerosol types present in the boundary layer. For example, how about pollens? Do they play a role for the boundary layer aerosol load at your station?

Figure 3: What do the red and blue arrows stand for in the plots? Please explain.

l. 147: *"This upward shift is further evident in Fig. 3, where the β_{F} in the low-altitude layers decays rapidly in all cases except Case 3."*
Which layers do you refer to as low-altitude here – don't you mean the boundary layers in the different cases?

ll. 148-151: *"In Case 1, a distinct fluorescence layer accompanied by enhanced water vapor was observed at ~1.8 km despite relatively low α_L^{aero} (Fig. 2c, e, and f and Fig. 3). Such fluorescence enhancement is absent in the other three cases (Fig. 3). We attributed the 1.8–2.4 km layer in Case 1 to BBA transported from the ICP."*
As already addressed in the general comment, this argumentation with extensive aerosol properties is too qualitative and not sufficient for aerosol classification. The fluorescence capacity should also be shown and discussed to draw this conclusion.

ll. 159-160: *"By contrast, the BBA layer (1.8–2.4 km layer in Case 1) exhibits stronger fluorescence with distinct peaks"*
What do you mean with stronger fluorescence here? A higher fluorescence capacity? Then show this, please!

l. 162: *"Instead, its mean spectrum exhibits a weak peak closely resembling the higher-altitude (1.8–2.4 km) BBA signature"*
This is not clearly discernible to me. In my opinion, case 1 (0.8–1.4 km) looks more similar to case 2 (1.8–2.4 km) from the spectral structure. So, both could be urban aerosol. Even case 1 (1.8-2.4 km) does not show a "typical" smoke spectrum as seen in previous studies. Could this even be smoke mixed with some urban aerosol? Again, the fluorescence capacity could help the discussion here!

l. 165: *"…during 16–18 April, 2024 (Fig. 5c)."*
This should be Fig. 5**d**, shouldn't it?

l. 173: *"The BBA then underwent vertical lifting to a higher altitude (Fig. 5c)."*
2-3 km is not very high. Please name the height range to be more precise.

ll. 179-180: *"On the contrary, HYSPLIT trajectories results with a starting altitude of 1 km show that the low-altitude fluorescence was not affected by the transported BBA (Fig. B1)."*
Thus, it could probably be urban aerosol, as discussed in the comment to l. 162.

ll. 184-185: *"Fire activity peaks in March but declines sharply by late April (Huang et al., 2016)."*
If fire activity peaks in March, it would be very interesting to show also a case from then. Are data from March available for that time?

ll. 189-190: *"This study highlights the high sensitivity of the LIF lidar: even in late April 2024 (weak ICP fire activity), it still detected a weak BBA layer over South China."*
The high sensitivity of LIF lidar to smoke has already been shown in detail in previous studies (Gast et al., 2025, Reichardt et al., 2025). Please account for that here.

Typos:

l. 2: "… (LIF) lidar is **a** (powerful tool for detecting …"

l. 6: "$\mathrm{Mm}^{-1}\mathbf{s}\mathrm{r}^{-1}\mathrm{nm}^{-1}$" (s in sr has to be small).

l. 43: "…signatures that differ~~ent~~ from those of urban aerosols."

l. 71: *"…by the University of Lille ~~1~~, the French…"*

References:

Gast, B., Jimenez, C., Ansmann, A., Haarig, M., Engelmann, R., Fritzsch, F., Floutsi, A. A., Griesche, H., Ohneiser, K., Hofer, J., Radenz, M., Baars, H., Seifert, P., and Wandinger, U.: Invisible aerosol layers: improved lidar detection capabilities by means of laser-induced aerosol fluorescence, Atmospheric Chemistry and Physics, 25, 3995–4011, https://doi.org/10.5194/acp-25-3995-2025, 2025.

Reichardt, J., 2014: Cloud and Aerosol Spectroscopy with Raman Lidar. J. Atmos. Oceanic Technol., 31, 1946–1963, https://doi.org/10.1175/JTECH-D-13-00188.1.

Reichardt, J., Lauermann, F., and Behrendt, O.: Fluorescence spectra of atmospheric aerosols, Atmospheric Chemistry and Physics, 25, 5857–5892, https://doi.org/10.5194/acp-25-5857-2025, 2025

Veselovskii, I., Hu, Q., Goloub, P., Podvin, T., Barchunov, B., and Korenskii, M.: Combining Mie–Raman and fluorescence observations: a step forward in aerosol classification with lidar technology, Atmos. Meas. Tech., 15, 4881–4900, https://doi.org/10.5194/amt-15-4881-2022, 2022.