Author's response to referee #1

The authors would like to thank the referee for providing helpful and constructive comments. You can find our response below each comment.

1. Please add the specific latitude and longitude information of the four stations in Section 2.1.

Added the requested in information in the location descriptions.

2. In ground-based instrument observations, calibration is an important factor affecting inversion accuracy. In Section 2.1, many instruments (CIMEL, PFR, BTS) in the manuscript have conducted continuous observations for many years. Please provide additional information on how often these instruments are calibrated.

Added information about the calibration procedures in the sections 2.1.1, 2.1.2 and 2.1.3.

The PFRs used in Davos are part of the AOD world reference triad. The stability of the GAWPFR triad is monitored by co-located instruments calibrated with the Langley plot method at Izana, Tenerife and Mauna-Loa, Hawaii. The average frequency of stability checks is 6 months. The instruments from these two sites are calibrated again with the Langley plot method the first month after their return to the Izana or Mauna Loa. The stability check in Davos continues for a period of at least 15 days with clear Sun. Re-calibration of the reference instruments is implemented when necessary, according to the results of the stability checks.

The PFR operated at Izana is calibrated with the Langley plot method with an average recalibration rate of 6 months depending on the stability of the instrument and operation conditions (mainly alignment to sun).

The PFR at Hohenpeissenberg (GAW-PFR site) is exchanged every 2-3 years and the data is reprocessed based on the two calibrations initial and upon return to PMOD/WRC.

The Lindenberg (associated station) PFR is operated by Deutscher Wetterdienst (DWD and the instruments are sent to PMOD/WRC for calibration every 2 years, following a rotation schema among the DWD sites.

AERONET CIMELs from Izana are calibrated on site every 6 months with calibration transfer against another CIMEL acting as reference. The two reference instruments are calibrated with the Langley plot method one at a time in rotation every three months.

The calibration of the Davos CIMEL is performed at the Laboratoire d'Optique Atmosphérique - Université de Lille (LOA) by comparison with master instrument. Since 2018 a calibrated instrument is provided for exchanging the field instrument on a yearly basis. Previously the instrument was shipped to LOA for calibration after 1-1.5 years of operation.

Lindenberg and Hohenpeissenberg include two CIMELs that are transported to University of Valladolid alternatingly one at a time, approximately once per year to be calibrated with calibration transfer from a master instrument.

BTS are calibrated yearly though, measurements of irradiance from 1000W lamps in PMOD/WRC (Davos) optic lab. Every 2 months measurements of irradiance from portable 200 W lamps are used to monitor the stability of the BTS.

3. In Section 2.1.3, it is mentioned that BTS has two detector arrays, and there is a part of the repeated spectra (300–1050 nm and 950–2150 nm). How are the repeated spectral ranges, such as 1020 nm, selected and processed?

The solar spectra are combined at 1000 nm. All channels at shorter wavelengths are used from BTS measuring the shorter wavelengths (BTSVIS), while all channels with wavelengths longer than 1000 nm are used from BTS measuring only in the infrared (BTSIR). An overlapping region between 980 and 1020 nm is used as diagnosis but not corrected. However, the ratio between BTSIR to BTSVIS is usually well within 1%.

Added in the manuscript the information that all selected wavelengths above 1000 nm are taken from BTSIR.

4. In Figure 1, there are slight differences in the criteria used for the observed and extrapolated AODs for 7 and 16 bands. For example, in the 7 bands, AOD-obs uses 0.015, but AOD-ext uses 0.011, and so on. Why not use the same filter criteria for the same number of channels?

As it happened when we reduced the number of wavelengths, using the extrapolated AOD resulted in easier convergence for the model, which reduced the inversion residuals compared to the use of observed AOD. These smaller residuals do not necessarily result in more accurate aerosol properties (which we can observe in the comparisons with AERONET as well). Therefore, we used stricter selection criteria for the extrapolated AOD as we did for the reduced number of wavelengths (PFR compared to CIMEL and 7 BTS wavelengths compared to 16).

However, this is no longer relevant as we removed the GRASP retrievals from the AOD-ext as response to comments from another referee.

5. What does "P95-P5" mean in Table 1? Please explain.

This is the difference between the 95th and 5th percentiles. Added explanation in the caption. P95 and P5 will now appear on the abbreviations table in the appendix.

6. In Figures 6 (c) and (d), what does "a" mean in the last item of the title filtering conditions? Is it AE? Please check.

Yes, corrected.

7. For better comparison, it is recommended to unify the horizontal axis range of the upper and lower groups of Figure 8.

Unified the range of horizontal axes.

8. In the table, some table parameter columns (Table 2) use bold fonts, and some table parameter columns (Tables 3-6) use normal fonts. Please check and unify them according to the requirements of the journal.

Corrected.

9. In Section 4 (Line 635), the manuscript mentions that there is an underestimation of radius and concentration in the GRASP inversion results, but according to Figure 12 and the previous description, it seems to be an overestimation. Please check.

Corrected to 'overestimation'.

Modifications not requested by the referee:

1) Added a citation regarding the Canadian wildfires in line 482 (Section 3.3.2).

Masoom, A., Kazadzis, S., Modini, R. L., Gysel-Beer, M., Gröbner, J., Coen, M. C., Navas-Guzman, F., Kouremeti, N., Brem, B. T., Nowak, N. K., Martucci, G., Hervo, M., and Erb, S.: Long range transport of Canadian Wildfire smoke to Europe in Fall 2023: aerosol properties and spectral features of smoke particles, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2025-2755, 2025.

Rephrased in lines 482-483:

'Canadian wildfires caused unusual AOD observations (Masoom et al., 2025), where the highest AOD occurred at 500 nm rather than the shortest available wavelength, leading to'

To:

'Canadian wildfires caused unusual AOD observations in several locations (Masoom et al., 2025) including Davos, where the highest AOD occurred at 500 nm rather than the shortest available wavelength. This led to'

2) Line 608: changes 'retrained' to 'retained'.

3) Added acknowledgements about local operators for the PFR and CIMEL datasets.

Major modifications as response to another referee:

1) Added information in Sections 3.1 and S1 about the comparisons of GRASP-AOD retrievals from PFR AOD and AERONET for the full datasets (without the selection criteria for AOD differences, $AOD_{f/c}$ and AE).

2) Removed from Sections 2.4, 3.2 and related discussion all mentions and results of GRASP-AOD retrievals from interpolated or extrapolated AOD using the Ångström approximation. We retained Fig. 7.

3) Shortened the introduction and discussion about BTS spectroradiometer related retrievals to be clearer and more focused on the main objectives of the manuscript.