EGUsphere, author comment AC3
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Reply on RC3

Antonis Dragoneas et al.

Author comment on "The realization of autonomous, aircraft-based, real-time aerosol mass spectrometry in the upper troposphere and lower stratosphere" by Antonis Dragoneas et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-33-AC3, 2022

Dear Referee 3,

thank you for your overall positive feedback and suggestions. Below, we are addressing all your comments.

a)

Referee comment: *Calculated particle transmission efficiency is shown in Figure 3, but were there any laboratory tests of transmission efficiency performed? It would be difficult to test the aircraft inlet without a wind tunnel, but what about the instrument inlet? It might have been published elsewhere, but it is important enough to merit description here as well.*

Answer: The particle transmission of the employed constant pressure inlet (CPI) system was experimentally studied in Molleker et al. (2020), as mentioned in Line 324. This study covers a wide range of inlet pressures from sea level down to 65 hPa. For the aerosol sampling line, as discussed in Section 3.2, we have calculated its transmission efficiency based on the study from von Der Weiden et al. (2009), using the same software tool. Therefore, we are confident that the tube transmission losses presented in Fig. 3 are realistic. The only missing contribution to particle losses is the aspiration efficiency of the aerosol inlet intake, which indeed, would require wind tunnel tests.

Changes: We suggest making no changes in this case, as this topic is covered in detail by Molleker et al. (2020) and this reference is given in the text.

b)

Referee comment: *Similarly, it is stated that 60 nm is considered to be the limit of detection for ERICALAMS, and it would be good to see some data from the optical transmission tests that were used to arrive at this number.*

Answer: We would like to clarify that 60 nm is the lower particle size limit of the ERICA-AMS. The size range of the detected and ablated particles of the ERICA-LAMS is discussed in Section 4.3 (i.e. 92 nm to 4186 nm). Detailed information about the optical measurements is given in Section 3.2 of the companion paper by Hünig et al. (2022), and in Molleker et al. (2020).

Changes: To avoid confusion, we have rephrased the sentence in Line 312 to "*At the lower end, where a size of 60 nm has been found to be the detection limit of the ERICA-AMS, the tube transport losses are below 5%*".

c)

Referee comment: *The manuscript covers a lot of ground on best practices of ERICA deployment on aircraft, but it would be useful to also describe the calibration protocols and frequency during these aircraft campaigns.*

Answer: Regarding the calibration procedures, the optical components of the ERICA-LAMS were aligned, adjusted and characterized before and after each field campaign. The ERICA-AMS is typically calibrated every 2-3 flights by performing a single-ion-signal measurement and a total ionization efficiency calibration. Moreover, thanks to the telemetry system of the instrument, continuous monitoring of all its critical parameters was carried out by ground operators during each flight, regardless of its autonomous operation.

Changes: We have added this information to Section 4.1 (circa Line 581).

d)

Referee comment: *For Figure 8, the distribution of particle sizes sampled, it would be particularly useful to know the inlet and optical system transmission curves to assess how representative of the actual aerosol population this size distribution is.*

Answer: There are four factors contributing to the overall size distribution of the particles which ultimately yield spectra. These are: (a) the sampling line transmission, (b) the transmission of the constant pressure inlet (CPI), (c) the optical detection efficiency, and (d) the so-called hit rate (i.e. ratio of recorded spectra over the number of ablation laser shots). From the factors, the prevalent and most size-dependent one is the hit rate (factor d), for which detailed information is shown in Fig. 8 in the companion paper by Hünig et al. (2022).

The remaining factors mostly affect the size ranges above one micrometre or below 100 nm; this assumption is confirmed by the sampling line transmission (factor a) data shown Fig. 3, as well as by the CPI transmission measurements (determined by factors b and c), which are given in Fig. 8 of Molleker et al. (2020).

Changes: The first paragraph of this answer has been added to Section 4.3 (circa Line 635).

e)

Referee comment: *What other instruments were co-deployed with ERICA during the two field campaigns described? It would be very useful to see an intercomparison with a co-located size distribution measurement, such as a UHSAS, to quantify any sampling biases and losses.*

Answer: Regarding your question on the instruments deployed together with the ERICA during the StratoClim project, M-55 Geophysica was equipped with a comprehensive set of gas-phase, aerosol and remote-sensing instruments in all flights. A list of relevant publications is given in a special issue of ACP/AMT (Stratoclim; https://acp.copernicus.org/articles/special_issue1012.html). Unfortunately, a project overview paper remains to be published.

Addressing your specific question on particle size distribution, a UHSAS, specially modified for high-altitude measurements, indeed operated during those flights (Mahnke et al., 2021). Nevertheless, we believe that a comparative study between the UHSAS measurements and those of the optical detection system of the ERICA-LAMS extends beyond the scope of this paper. However, they such comparison definitely be included in a future study. Furthermore, it is worth underlining that the optical detection system of the ERICA-LAMS measures the vacuum aerodynamic diameter (d_{va}). This quantity differs from the optical diameter (d_{opt}) measured by the UHSAS, which calculation also depends on assumptions about the refractive indices of the sampled particles.

Changes: We suggest making no changes in this case.

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