Answers to the reviewer 1 comments on

“Detection and climatology of Saharan dust frequency and mass at the Jungfraujoch (3580 m asl, Switzerland)”

First, we would like to thank the reviewer for the valuable, in-depth comments on our manuscript. The answers to the comments and questions are written in italic thereafter.

Overall Comments:

* It is not always clear in the text whether this refers to the complete data set or to data with applied noise thresholds (eg. L 225 ff, L 585 f)

- The manuscript is effectively confusing since the noise and conservative thresholds are only described in section 2.3.2 SDEs detection at low aerosol concentrations whereas they are already used in section 2.3.1. Section 2.3.2 is consequently not at the right place in the manuscript and was moved as a new paragraph in section 2.2.1 describing the optical method. The fact that the noise thresholds are used for all the presented results is now introduced in the Experiment section, allowing us to clarify its usage in the Results and Discussion sections.

Answering this comment allowed also to correct the fact that the result section was a subsection of the experiment section. The numbering is now correct with 1. Introduction, 2. Experimental, 3. Results, 4. Discussion and 5. Conclusion.

* The article focuses very much on Jungfraujoch data and the role of Mt. Helmos is not clear for the reader

- A major part of this study is dedicated to evaluating and comparing the different methods commonly used to estimate the frequency of SDE occurrence and their contribution to PM mass. As part of this analysis, we assessed the sensitivity of SDE detection to different combinations of instruments measuring scattering (nephelometers) and absorption (aethalometers) coefficients. The sensitivity of SDE detection to different nephelometer types was directly evaluated at the Jungfraujoch, where a one -year comparison between three nephelometer was available. However, since only one type of absorption photometer was used at this

station, the inclusion of Mt Helmos data was necessary to assess SDE detection using two filter-based absorption photometers.

A comparison of the dust climatology at both sites would be very interesting, but we considered it more appropriate for a separate study, as a thorough analysis of several auxiliary parameters and meteorological conditions would be required to consider the unique characteristics of each site and accurately assess the SDE impact at each station. The length of the submitted manuscript prevents us from adding further content.

* With regard to the noise threshold values, an evaluation should be carried out to rule out the possibility that this could introduce a certain influence or bias. Since the upper wavelength range (red or IR) will be the decisive criterion for the threshold value in both the nephelometer and the aethalometer (lowest scattering and absorption), a change in the AE also influences whether or not the noise threshold value is exceeded and hence, this might introduce a slight artifact.

The chosen wavelength for the noise threshold is not the upper/red wavelength, but the green one in the middle of the spectrum (550 nm for the nephelometer measuring between 450 nm and 630/700 nm and 520 nm for the Aethalometer measuring between 370 nm and 950 nm). When the scattering or absorption coefficients at 550/520 nm are below the threshold, the data at all the wavelengths are no more considered for the SD detection. In that sense, no bias is introduced due to the use of only part of the wavelengths.

Detailed suggestions:

L 109: as far as I know, AE31 measures at different wavelengths: 370, 450, 520, 590, 660, 880 und 950 nm

The AE31 measures at the same seven wavelengths as the AE33, as specified in the sentence. The second wavelength is 470 nm and not 450 nm.

Diagram 1: The differences in detail are very difficult to identify. For example, AE could be restricted to the range from -2 to 5.

All plots of Figs. 1, S2 and S3 were restricted to smaller x-ranges to increase their readability.

L 266f : The line implies that the hours of Saharan dust at Sonnblick are overestimated. There is no evidence to support this assumption.

The researchers at Sonnblick limit the SDE detected by the optical properties based on an AE33 and an Ecotech by the PM10 mass. The results not shown here concern a comparison of SDE detected at JFJ, Sonnblick and Zugspitze during winter, when aerosol concentrations are very low, which indicates that the SDE frequency at SON is much higher than at ZUG and JFJ without any restriction applied. However, since these results are not presented in the paper, this sentence has now been removed from the manuscript.

L 282 ff: which thresholds were used for Ecotech Nephelometer

The same thresholds were used for all nephelometers and were always applied to the green channel (550 nm or 525 nm). The analysis of the SDE frequency (Figures and Tables of §2 and §4 of the supplemental material) clearly demonstrates that the differences in SDE frequency as a function of the nephelometer type are similar without thresholds applied to the scattering and absorption coefficients or with the noise or the conservative thresholds.

L 416: space after comma between February and May

Thanks, it is now corrected

L 445 ff: As mentioned in the article, the Flexpart method also has its issues, and it could also be events that were detected using coarse-mode particle concentration but do not contain Saharan dust at all.

Yes, our FLEXPART analysis does not take into account the meteorological conditions in the potential dust source areas (dust activation). Moreover, events with high concentrations of non-dust coarse-mode particles could be explained by the presence of bioaerosols, that are mostly released from March to September. The emissions and concentrations of bioaerosols are now referenced in the manuscript. The lack of chemical analysis and of aerosol typing does not allow us to identify such cases.

The manuscript was modified to clarify this point: "The relative source sensitivities of events detected by the coarse-mode particle concentration but not confirmed by the optical method (Fig. S12 d and e) clearly designate Spain, eastern Europe and Turkey as main sources/path regions. These pathways lead to longer travel times over land with a higher exposition to continental pollution, particularly grass, crop and forest fires, which are important in Turkey and the Iberian Peninsula in summer. Bio-aerosol larger than 1 µm comprises pollen, spores, plants debris and bacteria and their number and mass concentrations account typically for around 30\% in urban and rural air (Fröhlich-Nowoisky et al., 2016) with the highest European emission in the Iberian Peninsula, Turkey and Greece (Sesartic and Dallafior, 2011). Finally, the Anatolian plateau is also an arid region with potential

dust emission Hatzianastassiou et al., 2009; Aslanoglu et al., 2022). These events detected only by the coarse-mode particle concentration can then be explained by dust mixed with a high density of polluted accumulation mode aerosol impeding the detection by the optical method or by a high number of natural non-dust coarse-mode particles."

L 571: 24 years or 23 years? I understand the difference between 24 calender years and 23 years time series but Ok, not important

That's right, it was corrected to 23 years.