Supplement to "Detection and climatology of Saharan dust frequency and mass at the Jungfraujoch (3580 m asl, Switzerland)"

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1 Instruments life cycle at JFJ
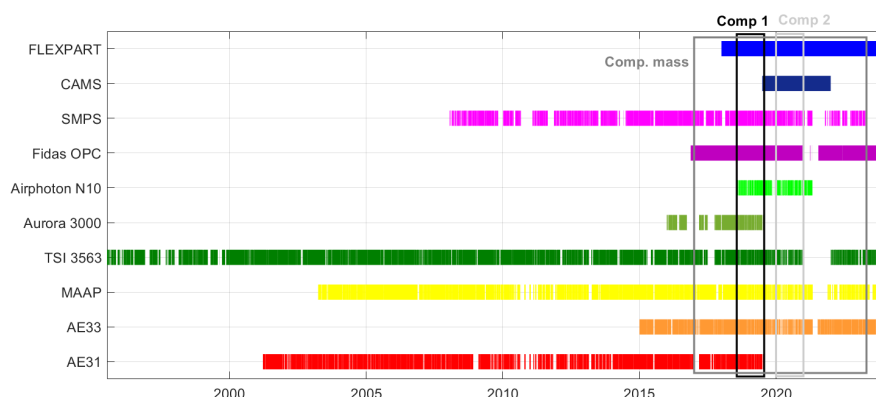
Figure S1. Availability of the instruments at the JFJ and of the CAMS dust product and FLEXPART source sensitivities. Comp. 1 corresponds to the period with the comparison between all in-situ detection methods, comp. 2 to the period with the comparison between the in-situ methods, CAMS dust product and FLEXPART source sensitivities and comp. mass to the period allowing the mass estimation from the size distributions from the SMPS and FIDAS.

 2 Effect of the application of a threshold on the scattering and absorption coefficients on the SDE detection
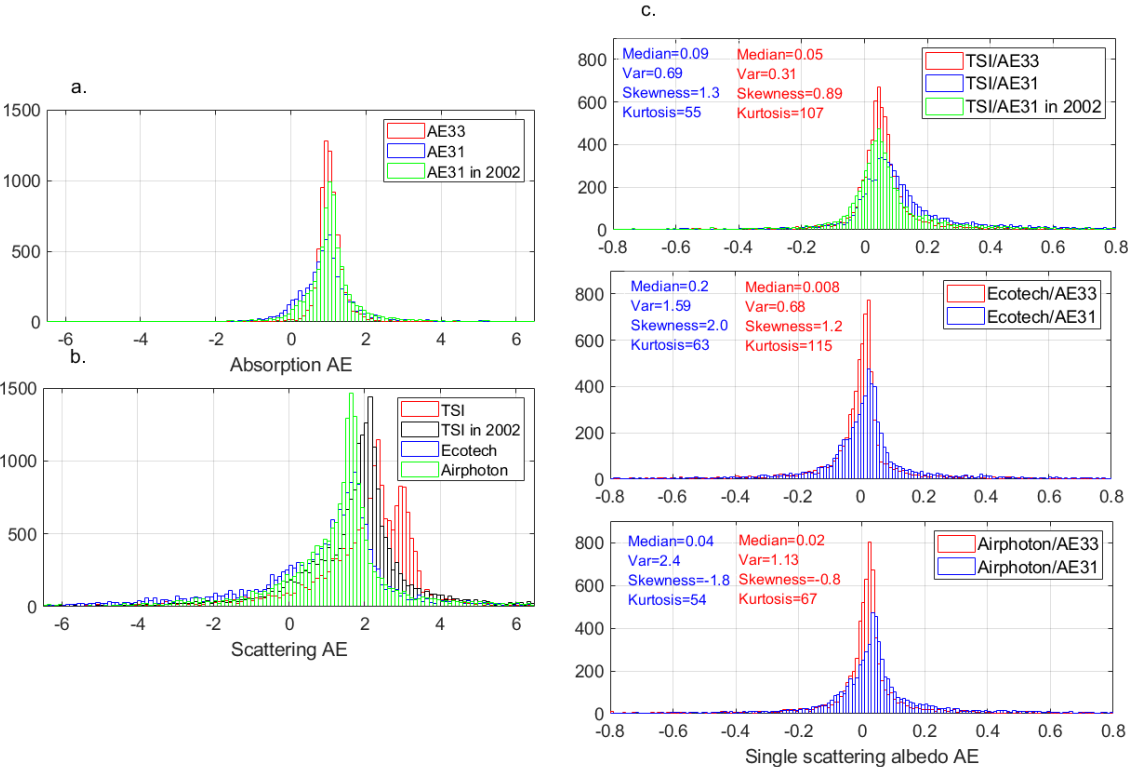
Figure S2. Histogram of the Ångström exponents for the simultaneous measurement period (August 2018 to July 2019) without threshold applied to the scattering and absorption coefficients for a) AAE for the AE31 and AE33, as well as AAE histogram for the first year of AE31 observation in 2002, b) SAE for the TSI, Ecotech and Airphoton nephelometers and c) SSAAE for all pairs of instruments

Table S1. Number of hours with SDE detected by the various pairs of instruments from 1st of August 2018 to the 31st of July 2019 without thresholds for the scattering and absorption coefficients.

Nb hours with SDE	$\geq$ 4h	$\geq$ 6h	$\geq$ 12h	$\geq$ 24h	$\geq$ 48h
TSI-AE31	218	126	67	0	0
TSI-AE33	274	183	67	0	0
Ecotech-AE31	1232	888	447	115	52
Ecotech-AE33	1795	1378	807	309	111
Airphoton-AE31	940	573	277	144	86
Airphoton-AE33	1433	1035	501	184	85
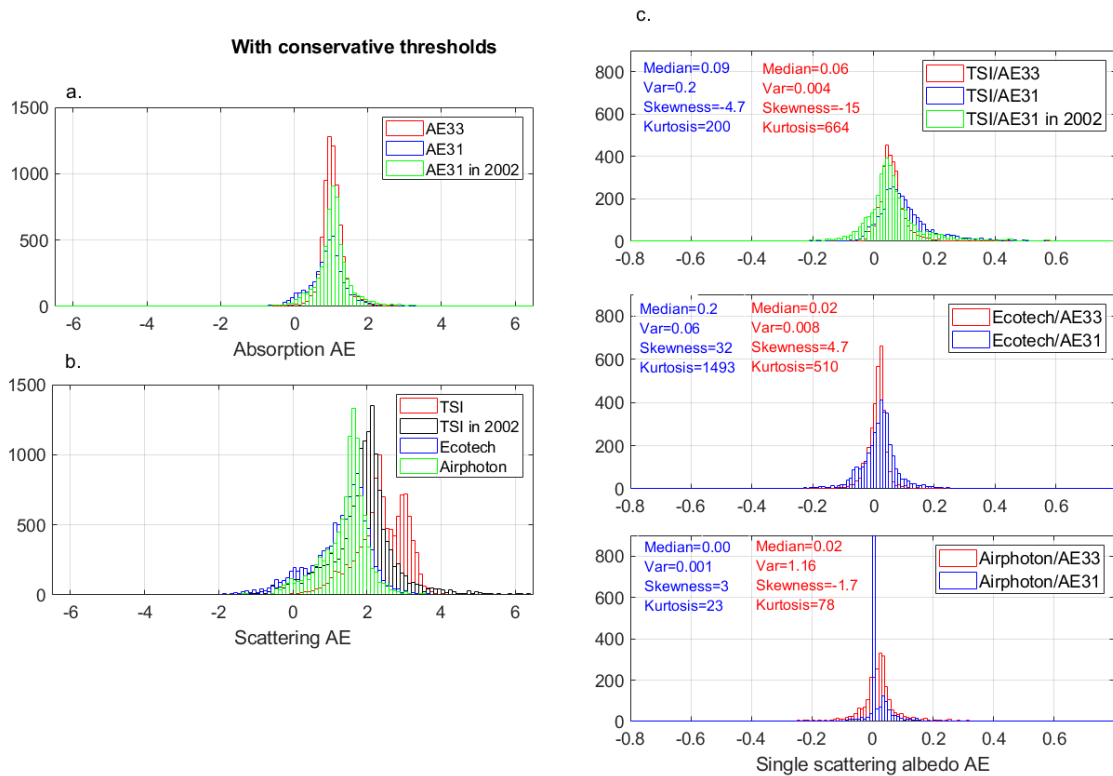
Figure S3. Histogram of the Ångström exponents for the simultaneous measurement period (August 2018 to July 2019) with conversative thresholds applied to the scattering (1e-6 m^{-1}) and absorption (1e-7 m^{-1})coefficients are restricted for a) AAE for the AE31 and AE33, as well as AAE histogram for the first year of AE31 observation in 2002, b) SAE for the TSI, Ecotech and Airphoton nephelometers and c) SSAAE for all pairs of instruments

Table S2. Number of hours with SDE detected by the various pairs of instruments from 1st of August 2018 to the 31st of July 2019 for scattering coefficient larger than 1 Mm^{-1} and absorption coefficient larger than 0.1 Mm^{-1} (conservative threshold)

Nb hours with SDE	$\geq$ 4h	$\geq$ 6h	$\geq$ 12h	$\geq$ 24h	$\geq$ 48h
TSI-AE31	105	91	67	0	0
TSI-AE33	106	100	67	0	0
Ecotech-AE31	596	888	447	115	52
Ecotech-AE33	613	1378	807	309	111
Airphoton-AE31	91	195	158	85	85
Airphoton-AE33	497	867	370	72	0

3 Number of hours with SDE detected by various pairs of instrument from August 2018 to July 2019
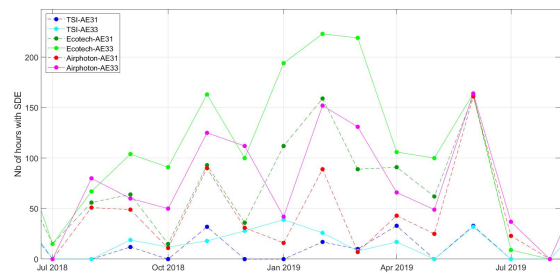
Figure S4. Number of hours with SDE detected by the various pairs of instruments for the simultaneous measuring period from 1st of August 2018 to the 31st of July 2019 for SDE duration of at least 6h without threshold.

4 Comparison of all SDE detection methods

Table S3. Number of dust hours detected by the various methods in 2020 without threshold for the scattering and absorption coefficients.

Nb hours with SDE in 2020	$\geq$ 4h	$\geq$ 6h	$\geq$ 12h	$\geq$ 24h	$\geq$ 48h
TSI-AE33	914	700	478	325	178
TSI-AE33 cor	900	691	463	325	178
Airphoton-AE33	1451	1072	590	375	231
FIDAS	1074	1003	813	524	153
FIDAS+FLEXPART	685	671	522	380	81
CAMS	1224	1198	1107	860	547
FLEXPART	1807	1759	1557	1255	956

Table S4. Number of dust hours detected by the various methods in 2020 for scattering coefficient larger than 1 Mm^{-1} and absorption coefficient larger than 0.1 Mm^{-1} (conservative thresholds).

Nb hours with SDE in 2020	$\geq$ 4h	$\geq$ 6h	$\geq$ 12h	$\geq$ 24h	$\geq$ 48h
TSI-AE33	625	556	421	306	172
Airphoton-AE33	969	1072	590	375	231
FIDAS	1074	1003	813	524	153
FIDAS+FLEXPART	685	671	522	380	81
CAMS	1224	1198	1107	860	547
FLEXPART	1807	1759	1557	1255	956
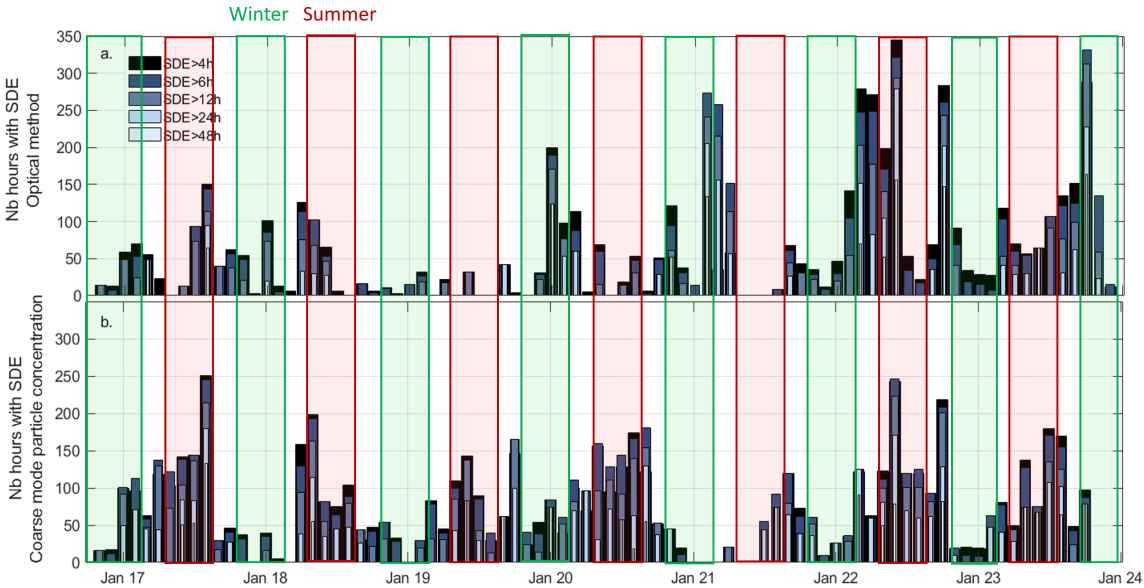
Figure S5. Monthly number of SD hours detected by a) the optical method with the noise threshold and b) the coarse mode particle concentration for 2017-2021.
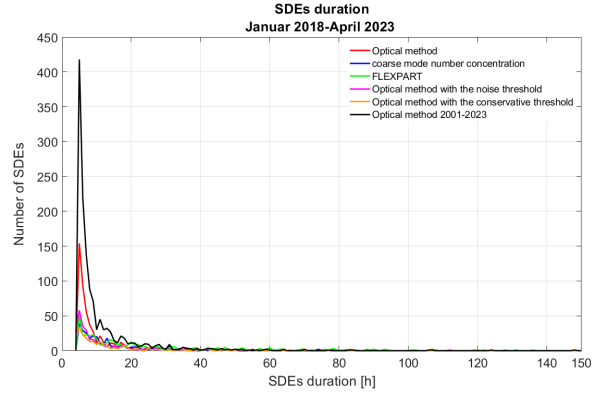
Figure S6. Histogram of the SDEs duration for the optical method applied to TSI-AE33 without threshold and with the noise and conservative thresholds, the coarse mode particle concentration, and the FLEXPART source sensitivities for the period from Januar 2018 to April 2023.
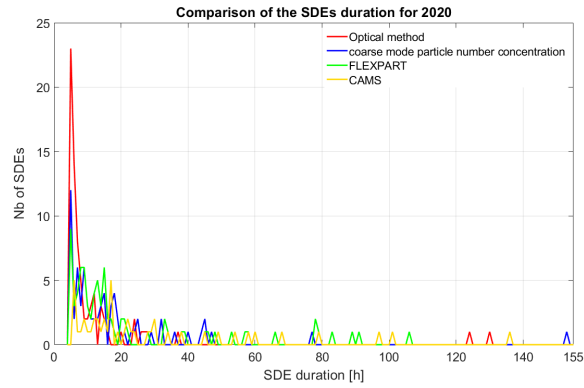
Figure S7. Histogram of the SDEs duration for the optical method applied to TSI-AE33 without threshold, the coarse mode particle concentration, the FLEXPART source sensitivities, and CAMS dust product for 2020.

6 Size distribution of number, surface and volume concentration
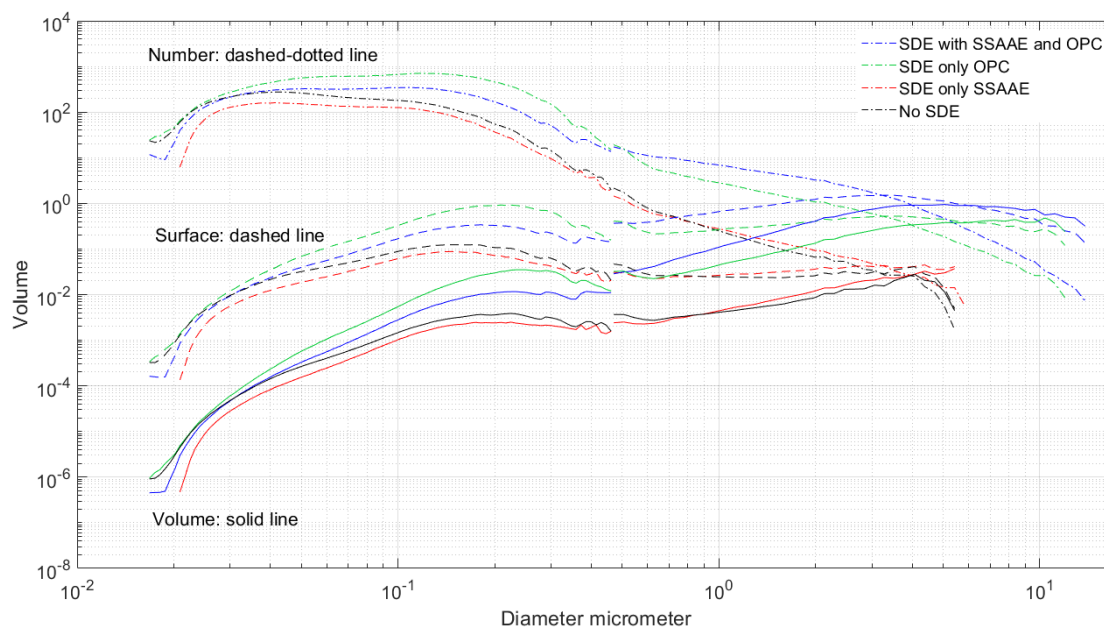
Figure S8. Number, surface and volume concentrations as a function of the particle diameter SDE detected by both in-situ methods without threshold in blue, by only the coarse mode particle concentration in green, by only the optical method in red and non-dust aerosol in black
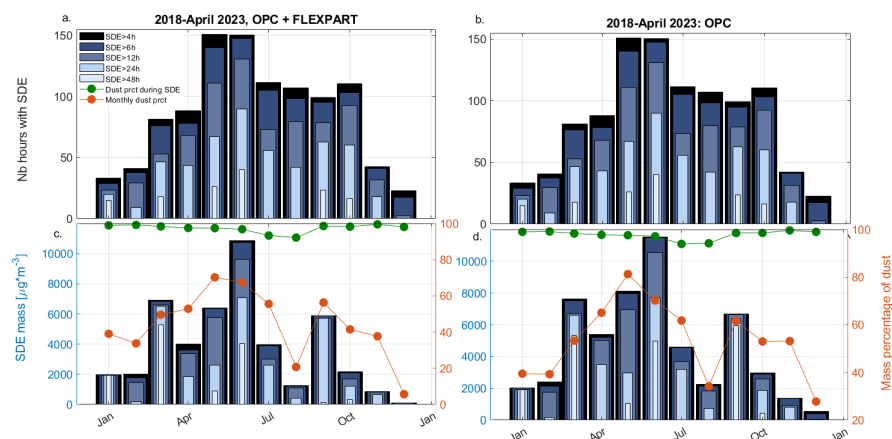
Figure S9. 1.2018-4.2023 monthly climatology of SDE hours and mass detected by a) the coarse mode particle number concentration and the FLEXPART source sensitivity corresponding to the real method described by Duchi et al., 2016 and b) only the coarse mode particle concentration.
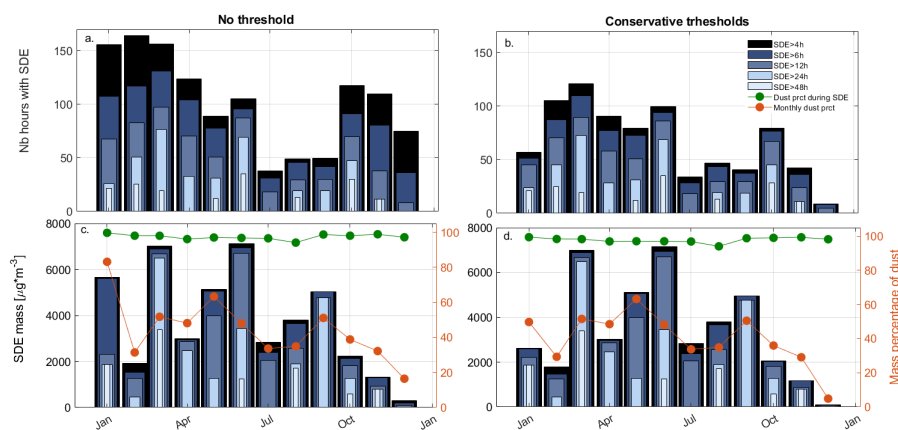
Figure S10. 1.2017-4.2023 monthly climatology of SDE hours and mass detected by the optical method a) and c) with no threshold and b) and d) with the conservative thresholds of $1*10^{-6}$ and $1*10^{-7}$ m^{-1} applied to the scattering and absorption coefficients.
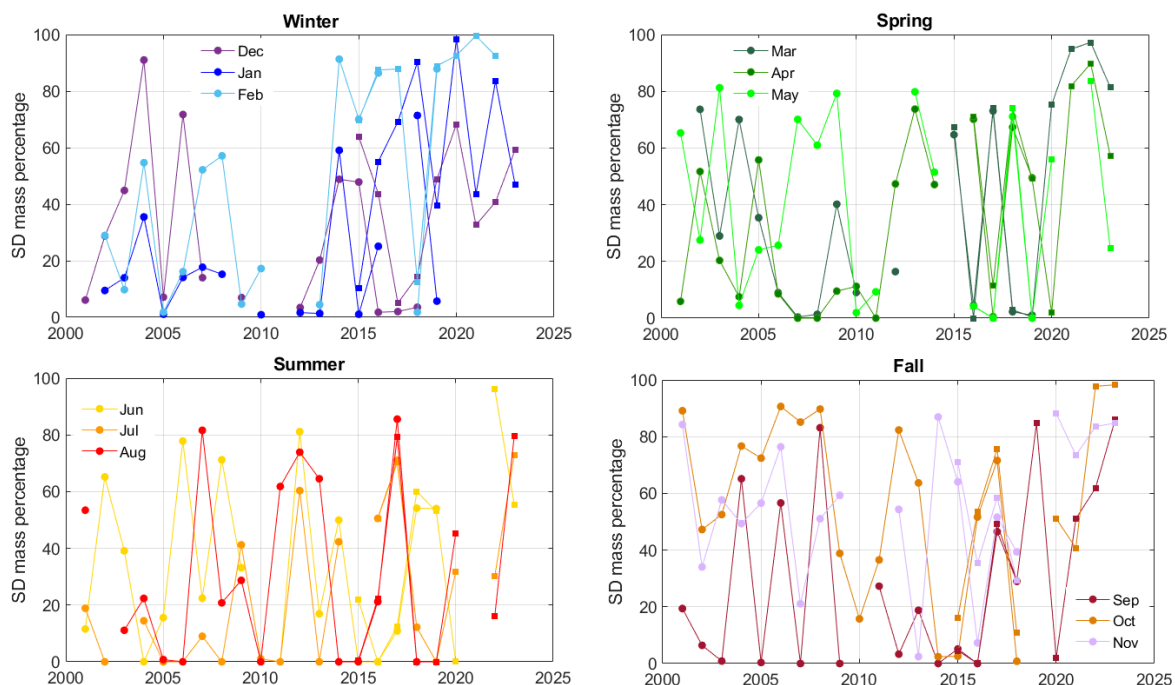
Figure S11. Monthly climatology of the mass percentage of SD for the TSI-AE31 (circles) pair until July 2019 and the TSI-AE33 (squares) pair since January 2015 during a) winter, b) spring, c) summer and d) fall. Months with less than 50% of measurement are not reported and the noise threshold was applied to all intruments.

8   SDE source sensitivity
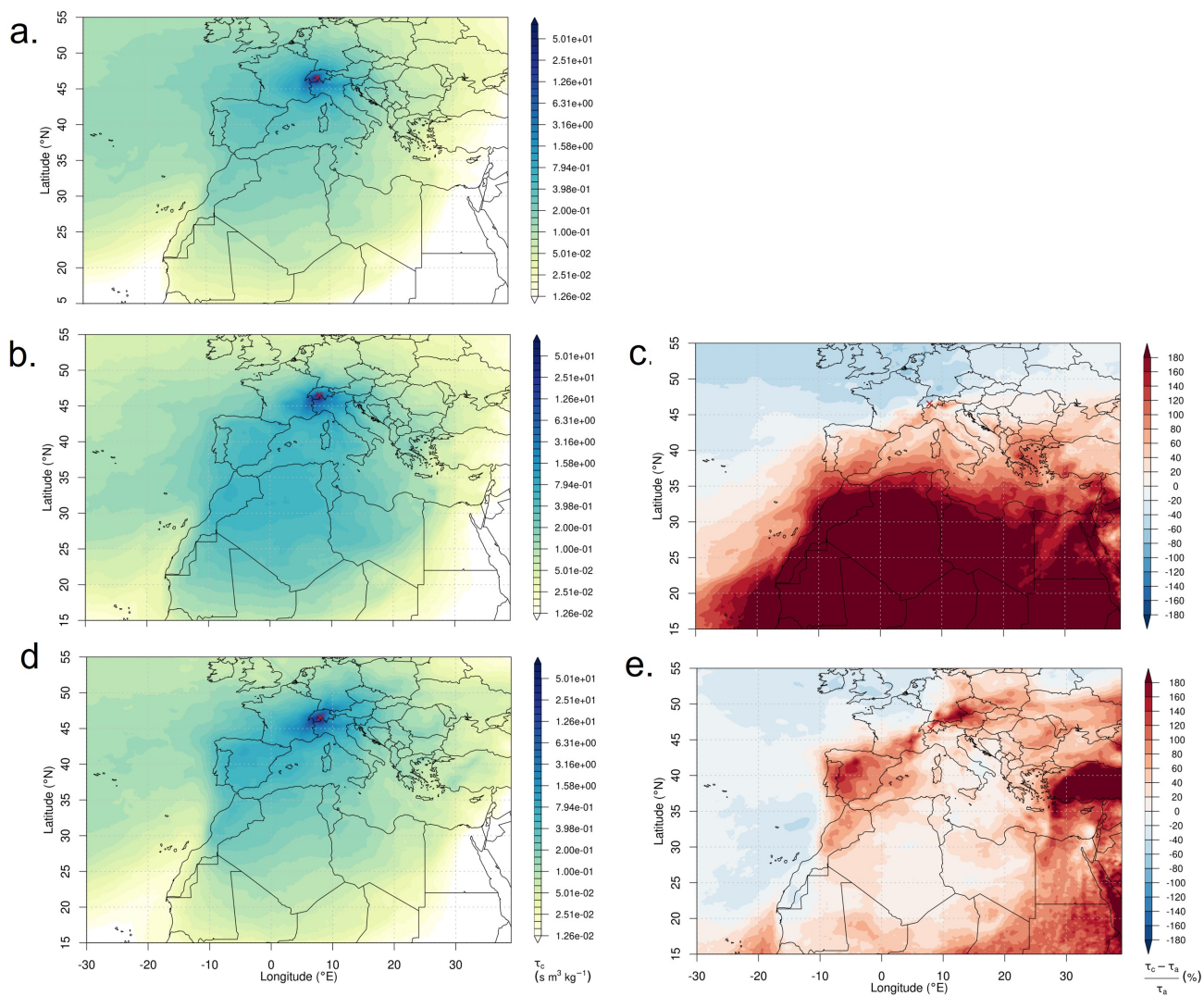
Figure S12. Average (a, b and d) and relative (c and e) source sensitivity based on 2018-2023 FLEXPART simulations a) for the whole period, b) and c) during SDE detected by the optical method and the coarse mode particle concentration and d) and e) during SDE detected by the coarse mode particle concentration but not by the optical method. Relative source sensitivities are derived by dividing specific SDE average source sensitivities (b, d) by the period-average source sensitivity (a). The minimum SD duration is 4 h for all the plots.