



Supplement of

Siberian Arctic black carbon: gas flaring and wildfire impact

Olga B. Popovicheva et al.

Correspondence to: Nikolaos Evangeliou (nikolaos.evangeliou@nilu.no)

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Supplementary Tables

Table S 1. Monthly median EBC (880) with 25th and 75th percentiles and BC simulated by FLEXPART with ECLIPSEv6 and BCRUS emissions (ng m⁻³).

Month	EBC (880) Measured	25 th percentile	75 th percentile	BC ECLIPSEv6- CAMS	BC BCRUS- CAMS
08.2019	11.8	4.9	35.4	38.6	36.8
09.2019	15.9	8.2	31	23.3	23.0
10.2019	32.7	20.8	55.1	44.9	51.4
11.2019	39.5	11.7	67.7	19.3	20.5
12.2019	117.6	68.0	242.3	123.5	127.6
01.2020	61.7	35.7	93.6	63	75.1
02.2020	81.7	58.2	113.5	119.5	124.1
03.2020	39.8	24.9	55.8	26.6	29.8
04.2020	41.8	35.2	51.3	12.3	7.3
05.2020	27.0	15.8	45.2	11.5	11.5
06.2020	11.1	9.4	18.2	6.1	5.2
07.2020	21.0	11.1	41.9	32.4	33.8
08.2020	14.4	8.6	47.3	23.4	23.8
09.2020	30.7	16.9	70.5	24.4	24.4
10.2020	14.3	6.7	27.4	14.8	14.6
11.2020	57	32.8	96.9	70.3	72.7

Table S 2. Monthly mean BC contributions from domestic (DOM), energy (ENE), gas flaring (FLR), industry (IND), shipping (SHP), waste burning (WST), traffic (TRA), and biomass burning (BB) sectors (%) simulated by FLEXPART with ECLIPSEv6-CAMS emissions.

Date	DOM	ENE	FLR	IND	SHP	WST	TRA	BB
08.2019	2.8	0.7	29.6	3.3	1.0	0.3	5.9	56.1
09.2019	4.9	1.1	37.4	2.9	1.0	0.5	8.1	43.5
10.2019	4.6	0.6	37.6	3.5	0.1	0.5	4.9	47.8
11.2019	11.5	1.6	65.9	4.6	0.4	0.7	7.7	7.3
12.2019	15.6	2.0	65.8	6.8	0.2	0.9	8.2	0.2
01.2020	15.2	1.3	68.0	6.2	0.2	0.8	7.7	0.4
02.2020	25.2	1.0	50.6	9.5	0.2	1.4	11.5	0.2
03.2020	18.1	2.4	60.5	5.1	0.5	0.8	9.1	3.3
04.2020	3.0	1.7	46.8	2.2	0.3	0.2	3.5	42.0
05.2020	6.0	7.3	56.3	4.7	0.9	0.7	9.7	14.0
06.2020	2.7	1.1	35.8	2.0	0.8	0.3	4.6	52.4
07.2020	1.2	0.3	11.3	1.1	1.1	0.2	3.4	81.1
08.2020	1.4	0.5	22.2	1.4	0.7	0.2	3.2	70.0
09.2020	4.6	0.5	28.0	5.1	0.5	0.8	8.3	51.7
10.2020	11.4	0.8	47.5	6.5	0.5	1.2	11.9	19.8
11.2020	32.1	1.1	30.4	8.6	0.4	1.7	15.2	10.3

Table S 3. Monthly and annual (from September 2019 to August 2020) median BC concentrations simulated by FLEXPART with ECLIPSEv6 and BCRUS emissions from anthropogenic (ANT) sources as well as with CAMS emissions from BB sources (ng m^{-3}). Annual averaged concentrations (ng m^{-3}) and contributions (%).

Date	ECLIPSEv6-CAMS		BCRUS-CAMS	
	BB	ANT	BB	ANT
09.2019	17.7	22.9	17.7	28.2
10.2019	60.5	65.8	60.5	89.2
11.2019	3.0	38.1	3.0	36.7
12.2019	0.4	195.6	0.4	272.5
01.2020	0.4	104.2	0.4	144.6
02.2020	0.3	136.3	0.3	178.0
03.2020	1.5	43.3	1.5	53.2
04.2020	21.1	29.1	21.0	37.0
05.2020	4.4	27.0	4.5	21.3
06.2020	20.8	18.9	20.7	27.0
07.2020	36.8	8.6	36.8	9.7
08.2020	48.6	20.8	46.4	23.8
Annual concentration	18.0	59.2	17.8	76.8
Annual contribution	23.3	76.7	18.8	81.2

Table S 4. Monthly and annual median BC concentrations simulated by FLEXPART with ECLIPSEv6 and BCRUS emissions from gas flaring (FLR) sector (ng m^{-3}). Annual averaged concentrations (ng m^{-3}) and contributions (%).

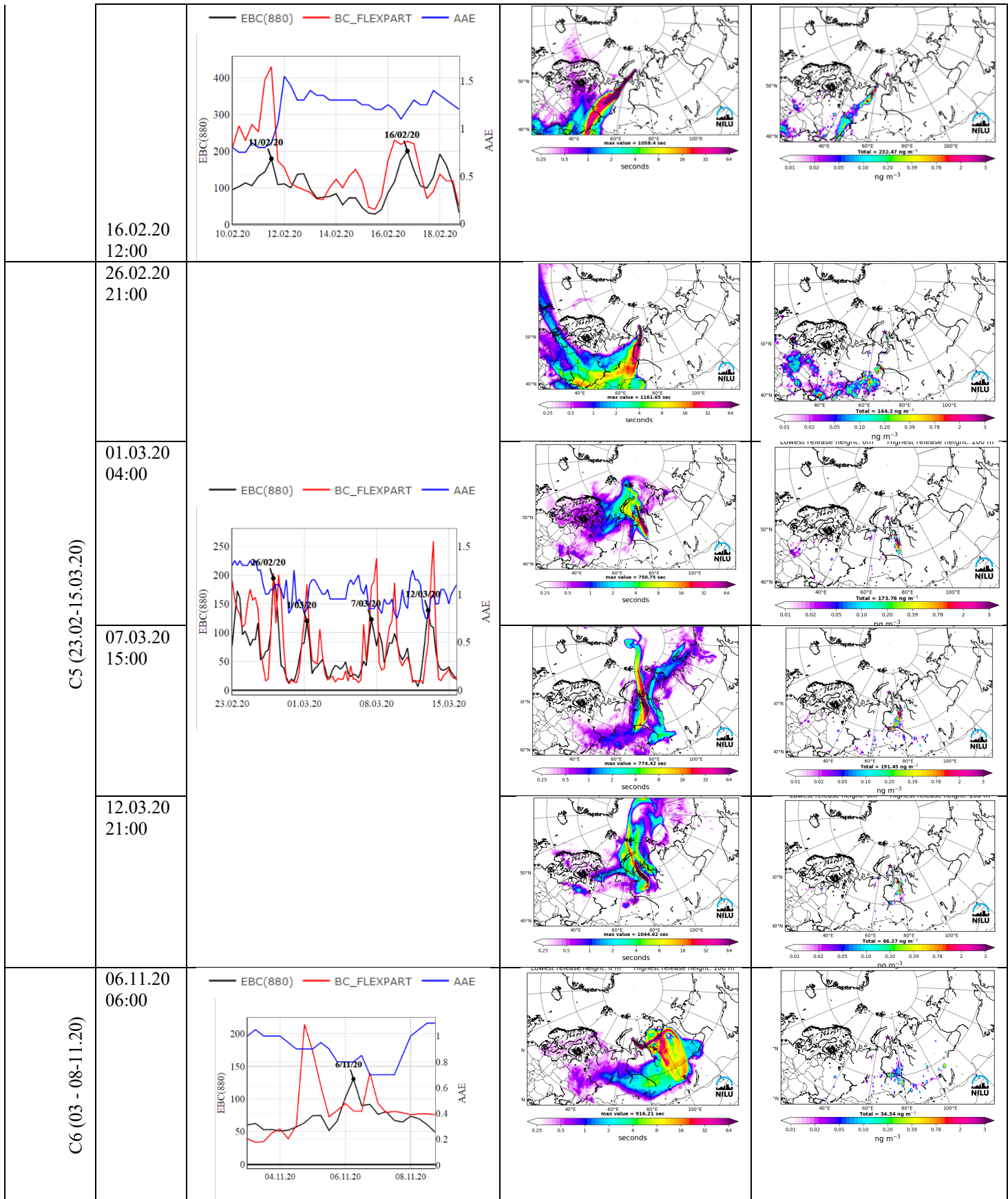
Date	ECLIPSEv6	BCRUS
09.2019	15.2	20.50
10.2019	47.5	70.87
11.2019	27.1	25.70
12.2019	129.1	206.00
01.1900	70.6	110.93
02.2020	69.1	110.47
03.2020	27.1	36.79
04.2020	23.5	31.43
05.2020	17.7	11.98
06.2020	14.2	22.35
07.2020	5.2	6.36
08.2020	15.4	18.47
Annual concentrations	38.5	56.0
Annual contribution	49.9	59.2

Table S 5. 6h median AAE. Contributions of emission sectors during the pollution events in the cold and warm periods (%).

season	Episode	Date	AAE	DOM	ENE	FLR	IND	SHP	WST	TRA	BB
COLD	C1	05.11.19 12:00	0.9	8.7	0.7	70.6	9.1	0.0	0.8	6.3	3.7
		12.11.19 12:00	1	11.9	1.3	54.0	7.2	0.7	1.1	11.1	12.7
		16.11.19 18:00	0.7	0.4	0.0	98.6	0.2	0.0	0.0	0.5	0.2
	C2	04.12.19 12:00	1	7.2	3.7	78.5	3.8	0.1	0.7	5.7	0.4
		19.12.19 12:00	1.05	10.8	1.6	72.6	8.1	0.0	0.8	6.0	0.1
	C3	04.01.20 06:00	0.9	6.6	1.9	82.5	3.0	0.1	0.5	5.3	0.1
	C4	11.02.20 03:00	0.8	3.4	0.3	91.0	1.3	0.1	0.2	3.7	0.0
		16.02.20 12:00	1.1	14.7	0.7	63.5	6.8	0.1	1.6	12.5	0.0
	C5	26.02.20 21:00	1.05	35.8	0.9	18.1	22.9	0.2	2.5	17.0	2.6
		01.03.20 04:00	0.85	5.4	2.6	88.4	1.2	0.1	0.2	2.0	0.1
		07.03.20 15:00	0.85	5.5	0.4	89.7	1.9	0.1	0.3	2.1	0.1
		12.03.20 21:00	0.75	8.6	0.4	85.3	1.7	0.1	0.3	3.4	0.2
	C6	06.11.20 06:00	0.8	7.6	0.3	21.6	4.2	0.1	0.6	7.4	58.2
	C7	16.11.20 12:00	1.1	72.8	0.4	0.3	3.2	0.5	1.3	19.9	1.4
		19.11.20 12:00	1.2	37.1	0.6	14.6	24.5	0.2	3.4	19.0	0.5
	C8	24.11.20 12:00	1.3	33.7	1.0	16.6	18.2	0.4	3.5	22.7	4.0
WARM	W1	04.09.19 18:00	1.05	20.4	0.5	5.9	7.4	4.1	2	36.3	23.4
		07.09.19 06:00	1.06	11.6	0.9	18	26.4	0.9	5	33.6	3.5
	W2	09.10.20 18:00	0.8	0.7	2.5	30.5	0.8	0.1	0.1	1.2	64.1
	W3	18.04.20 18:00	1.2	2.7	0.5	65.6	1.7	0.0	0.2	1.7	27.5
		23.04.20 18:00	1.35	3.7	0.7	64.0	2.9	0.4	0.3	8.8	19.1
	W4	07.07.20 12:00	1.3	1.9	0.1	1.4	1.2	1.3	0.4	4.0	89.6
	W5	03.08.20 12:00	1.05	3.3	1.5	64.3	5.6	0.6	0.7	8.8	15.2
	W6	19.08.20 06:00	1	1.0	0.1	26.0	1.2	2.9	0.1	5.7	63.1
		27.08.20 15:00	0.95	16.4	0.3	34.9	4.8	3.0	0.8	23.8	16.0
		28.08.20 18:00	0.95	9.0	0.4	45.1	7.7	2.0	1.1	21.7	13.0
		01.09.20 18:00	1.25	0.2	0.5	3.5	0.2	0.1	0.0	0.7	94.8
		02.09.20 06:00	1.35	0.0	0.0	0.2	0.0	0.0	0.0	0.2	99.5
	W7	31.10.20 15:00	1.05	11.3	0.6	73.9	4.2	0.3	0.9	8.2	0.5
		30.10.20 00:00	0.6	6.0	0.4	83.1	3.7	0.1	0.5	5.4	0.8
31.10.20 18:00		0.85	26	5	19.1	16.5	0.9	3.7	26	2.8	

Supplementary Figures

	Date	Pollution episode	Footprint emission sensitivity for BC	Anthropogenic contribution of BC
COLD				
C1 (05-16.11.19)	12.11.19 12:00			
	09.12.19 12:00			
29.12.19 12:00				
C3 (03 - 10.01.20)	04.01.20 06:00			
C4 (10.02- 18.02.20)	11.02.20 3:00			



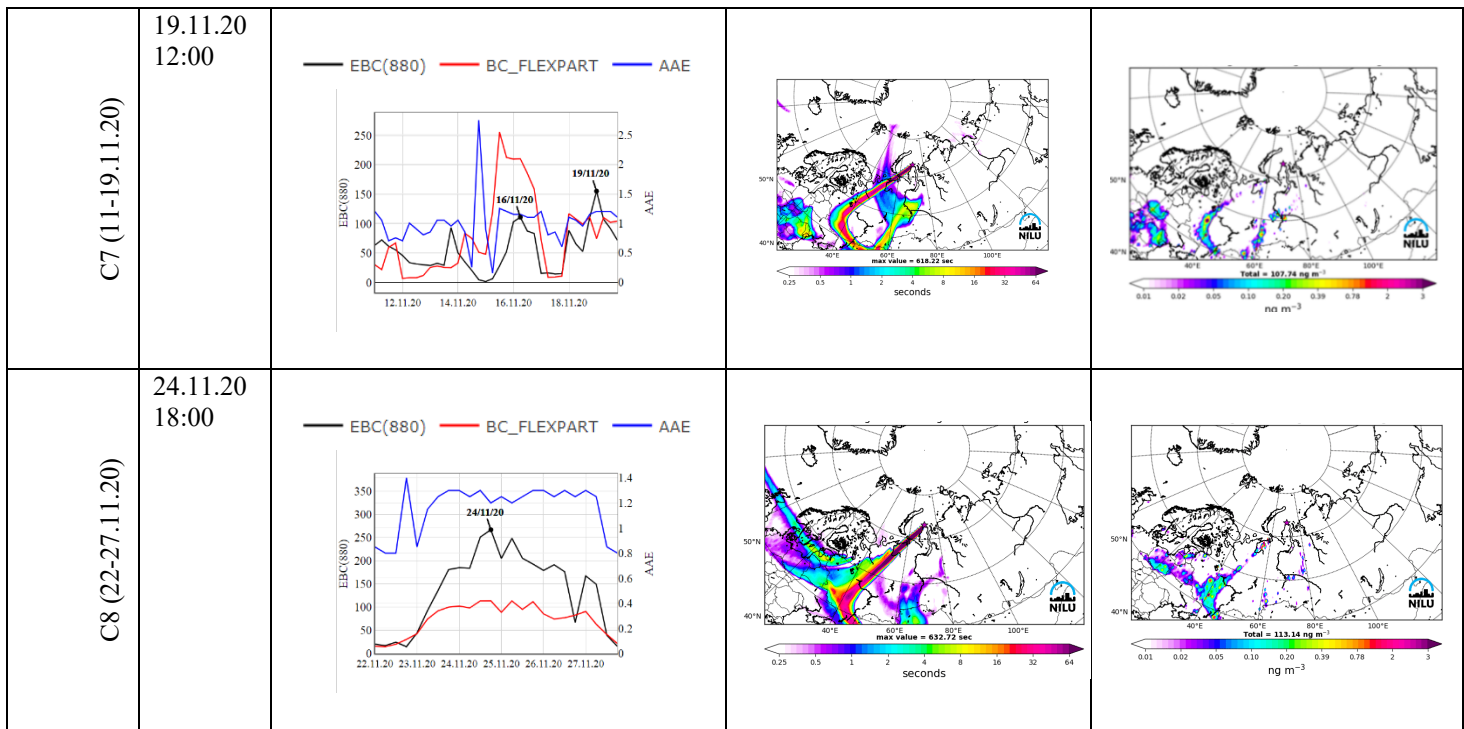
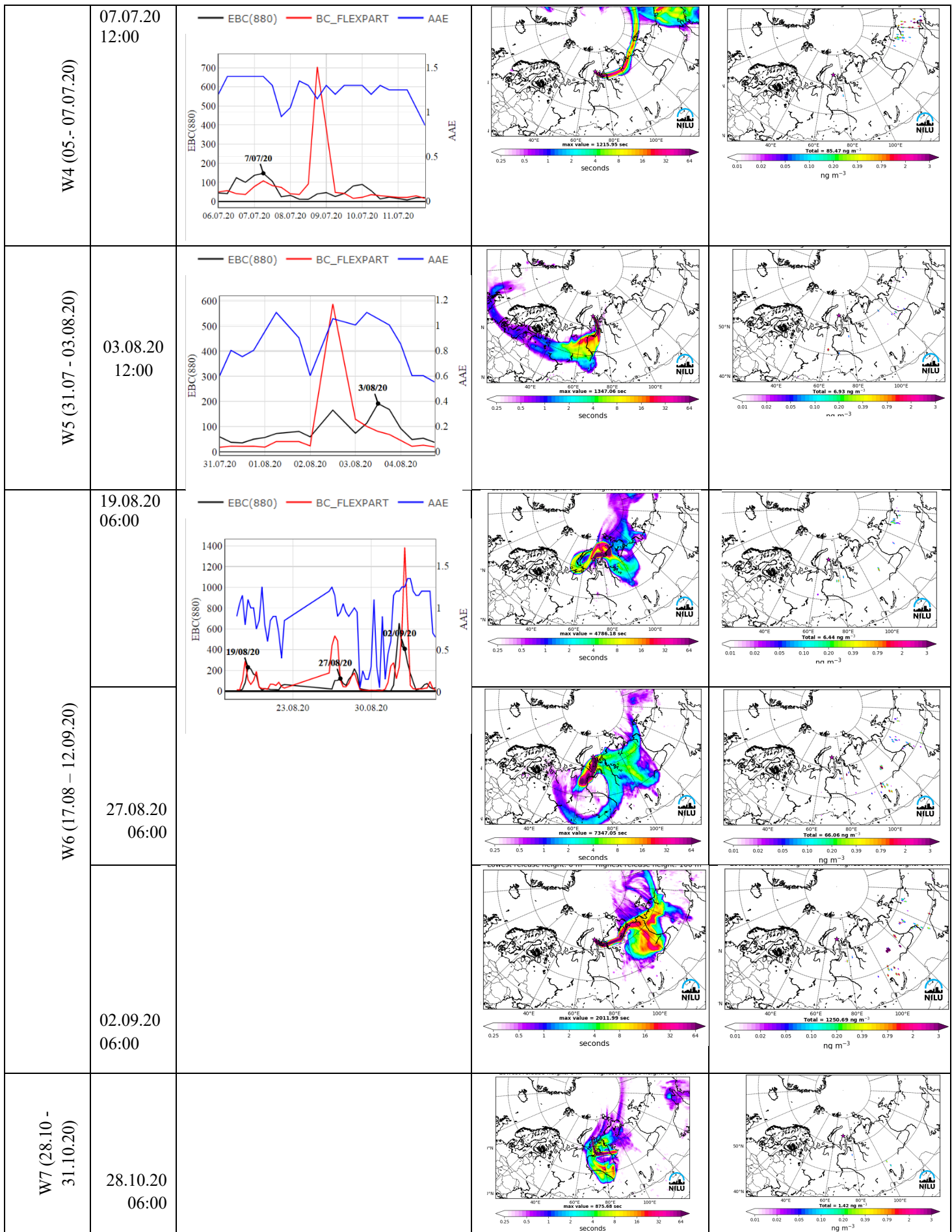


Figure S 1. Case study during pollution episodes in the cold period, others from shown in figures of the paper. Duration of pollution episodes and events are indicated. Time series for **6h median** EBC (880) (black), BC simulated by FLEXPART (red), AAE (blue) of pollution. Footprint emissions sensitivity and anthropogenic contribution of BC.

WARM	Date		Footprint emission sensitivity for BC	Biomass burning contribution of BC
W1 (03-07.09.19)	04. 09.19 16:00			
	07. 09.19 06:00			
W2 (01-11.10.19)	09.10.19 18:00			
W3 (18-23.04.20)	18.04.20 18:00			
	20.04.20 03:00			



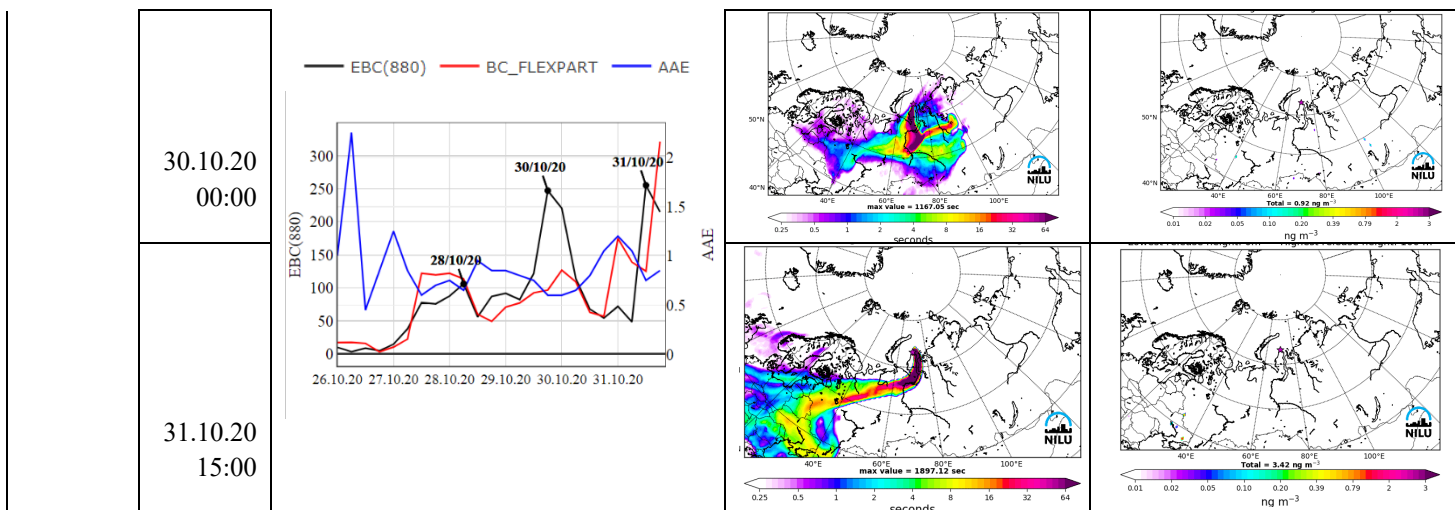


Figure S 2. Case study during pollution episodes in the warm period, others from shown in figures of the main paper. Similar to Fig. S1, biomass burning contribution of BC instead anthropogenic one.

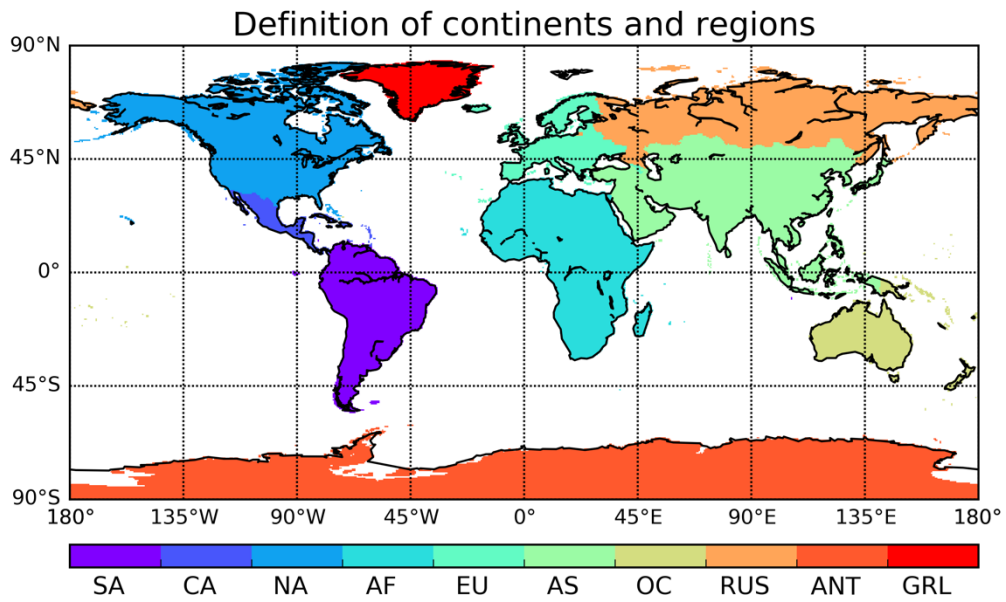


Figure S 3. Masked continents used in the present study for South America (SA), Central America (CA), North America (NA), Africa (AF), Europe (EU), Asia (AS), Oceania (OC), Russia (RUS), Antarctica (ANT) and Greenland (GRL).