Supplement of Atmos. Chem. Phys., 17, 10795–10809, 2017
https://doi.org/10.5194/acp-17-10795-2017-supplement

Atmospheric Chemistry and Physics
Open Access

Supplement of

Regional temperature change potentials for short-lived climate forcers based on radiative forcing from multiple models

Borgar Aamaas et al.

Correspondence to: Borgar Aamaas (borgar.aamaas@cicero.oslo.no)

1. Forcing-response coefficients

The background of the forcing-response coefficients applied are presented here. Table S1 shows the CO_2 coefficients tabulated in Shindell and Faluvegi (2010), Table S2 presents the O_3 coefficients tabulated in Shindell and Faluvegi (2010), and Table S3 shows the BC forcing-response coefficients from Shindell and Faluvegi (2009) as tabulated in Collins et al. (2013). The coefficient for Arctic to Arctic BC deposition in snow is estimated based on Flanner (2013). He found that snow in the Arctic has a perturbation sensitivity of 1.4 K/(Wm^{-2}). The forcing-response coefficients are found by dividing the regional response coefficients in Table S1, Table S2, and Table S3 by the global climate sensitivity. As we have calculated feedbacks independently, the global climate sensitivity is the same for all species (0.43 K/(Wm^{-2})).

Table S1: CO_2 coefficients in K/(Wm^{-2}).

CO_2 response	Forcing region			
Response region	90-28S	28S-28N	28-60N	60-90N
90° S-28° S	0.19	0.05	0.02	0
28° S-28° N	0.09	0.24	0.1	0.02
28° N-60° N	0.07	0.17	0.24	0.06
60° N-90° N	0.06	0.16	0.17	0.31

Table S2: O_3 coefficients in K/(Wm^{-2}).

Ozone response	Forcing region			
Response region	90-28S	28S-28N	28-60N	60-90N
90° S-28° S	0.19	0.13	-0.06	-0.03
28° S-28° N	0.09	0.26	0.09	0.02
28° N-60° N	0.07	0.15	0.2	0.06
60° N-90° N	0.06	0.13	0.05	0.07

Table S3: BC coefficients for atmosphere effects in K/(Wm^{-2}).

BC response (atmosphere)	Forcing region			
Response region	90-28S	28S-28N	28-60N	60-90N
90° S-28° S	0.19	0.06	0.02	0
28° S-28° N	0.09	0.17	0.07	0.02
28° N-60° N	0.07	0.24	0.14	0.08
60° N-90° N	0.06	0.31	0.15	Depends on altitude

2. ARTPs

Here, we provide absolute regional temperature change potentials (ARTPs) per K/Tg, as in Fig. 1 and Fig. 2, for four different time horizons (10, 20, 50, and 100 years). Rest of the World (ROW) is land-based emissions outside of Europe and China. The values are given for two seasons, Northern Hemisphere (NH) summer (May-October) and NH winter (November-April).

Table S4: ARTPs given as K/Tg emitted for various SLCFs.

EUR summer	**Time horizon**	**BC [C]**	**OC [C]**	**SO2 [SO2]**	**NH3 [NH3]**	**NOx [N]**	**CO [CO]**	**VOC [C]**	**CH4 [CH4]**
90° S-28° S	10	2.5E-04	-9.7E-05	-6.2E-05	-8.0E-06	-4.3E-05	8.2E-07	7.4E-06	2.5E-05
	20	8.3E-05	-3.2E-05	-2.1E-05	-2.6E-06	-2.9E-05	8.1E-07	5.3E-06	1.5E-05
	50	1.2E-05	-4.6E-06	-2.9E-06	-3.7E-07	-4.1E-06	1.2E-07	7.6E-07	2.2E-06
	100	8.6E-06	-3.4E-06	-2.1E-06	-2.7E-07	-1.5E-06	2.8E-08	2.6E-07	8.7E-07
28° S-28° N	10	8.7E-04	-5.1E-04	-2.9E-04	-4.1E-05	-1.1E-04	5.5E-06	3.3E-05	5.8E-05
	20	2.9E-04	-1.7E-04	-9.5E-05	-1.4E-05	-7.2E-05	3.1E-06	1.8E-05	3.4E-05
	50	4.1E-05	-2.4E-05	-1.3E-05	-1.9E-06	-1.0E-05	4.4E-07	2.5E-06	4.8E-06
	100	3.0E-05	-1.8E-05	-9.9E-06	-1.4E-06	-3.9E-06	1.9E-07	1.1E-06	2.0E-06
28° N-60° N	10	2.1E-03	-1.1E-03	-5.7E-04	-9.7E-05	-1.3E-04	7.3E-06	3.7E-05	6.3E-05
	20	6.9E-04	-3.7E-04	-1.9E-04	-3.2E-05	-8.0E-05	3.8E-06	1.9E-05	3.7E-05
	50	9.8E-05	-5.2E-05	-2.7E-05	-4.6E-06	-1.1E-05	5.4E-07	2.8E-06	5.3E-06
	100	7.2E-05	-3.8E-05	-2.0E-05	-3.4E-06	-4.3E-06	2.5E-07	1.3E-06	2.2E-06
60° N-90° N	10	3.6E-03	-1.2E-03	-7.0E-04	-7.6E-05	-1.2E-04	6.1E-06	3.2E-05	6.4E-05
	20	1.3E-03	-4.0E-04	-2.3E-04	-2.5E-05	-8.1E-05	3.6E-06	1.9E-05	4.0E-05
	50	1.8E-04	-5.6E-05	-3.3E-05	-3.6E-06	-1.2E-05	5.1E-07	2.7E-06	5.7E-06
	100	1.3E-04	-4.1E-05	-2.4E-05	-2.6E-06	-4.0E-06	2.1E-07	1.1E-06	2.2E-06
Global	10	1.1E-03	-5.7E-04	-3.1E-04	-4.6E-05	-9.7E-05	4.7E-06	2.7E-05	5.1E-05
	20	3.8E-04	-1.9E-04	-1.0E-04	-1.5E-05	-6.2E-05	2.7E-06	1.5E-05	3.0E-05
	50	5.4E-05	-2.7E-05	-1.5E-05	-2.1E-06	-8.9E-06	3.8E-07	2.1E-06	4.3E-06
	100	3.9E-05	-2.0E-05	-1.1E-05	-1.6E-06	-3.3E-06	1.6E-07	9.2E-07	1.8E-06

(continued on next page)

Table S4 (continued)

EUR winter	**Time horizon**	**BC**	**OC**	**SO2**	**NH3**	**NOx**	**CO**	**VOC**	**CH4**
90° S-28° S	10	2.0E-04	-5.9E-05	-1.7E-05	-5.2E-06	-1.4E-05	1.7E-06	-2.0E-05	2.5E-05
	20	6.7E-05	-2.0E-05	-5.7E-06	-1.7E-06	-1.0E-05	1.2E-06	-5.1E-06	1.5E-05
	50	9.5E-06	-2.8E-06	-8.0E-07	-2.4E-07	-1.5E-06	1.7E-07	-7.2E-07	2.2E-06
	100	7.0E-06	-2.0E-06	-5.9E-07	-1.8E-07	-4.7E-07	5.7E-08	-6.9E-07	8.7E-07
28° S-28° N	10	1.5E-03	-2.7E-04	-8.4E-05	-2.6E-05	-5.1E-05	6.1E-06	1.4E-05	5.8E-05
	20	5.0E-04	-8.9E-05	-2.8E-05	-8.8E-06	-3.0E-05	3.5E-06	8.1E-06	3.4E-05
	50	7.0E-05	-1.3E-05	-4.0E-06	-1.2E-06	-4.3E-06	5.0E-07	1.1E-06	4.8E-06
	100	5.1E-05	-9.2E-06	-2.9E-06	-9.1E-07	-1.7E-06	2.1E-07	4.7E-07	2.0E-06
28° N-60° N	10	3.8E-03	-6.2E-04	-1.8E-04	-6.3E-05	-6.4E-05	7.3E-06	4.7E-05	6.3E-05
	20	1.3E-03	-2.1E-04	-5.9E-05	-2.1E-05	-3.6E-05	4.1E-06	2.0E-05	3.7E-05
	50	1.8E-04	-2.9E-05	-8.3E-06	-3.0E-06	-5.1E-06	5.8E-07	2.8E-06	5.3E-06
	100	1.3E-04	-2.1E-05	-6.0E-06	-2.2E-06	-2.2E-06	2.5E-07	1.6E-06	2.2E-06
60° N-90° N	10	1.0E-02	-5.9E-04	-1.9E-04	-4.9E-05	-4.9E-05	6.6E-06	2.9E-05	6.4E-05
	20	3.7E-03	-2.0E-04	-6.5E-05	-1.6E-05	-3.2E-05	4.0E-06	1.4E-05	4.0E-05
	50	5.4E-04	-2.8E-05	-9.2E-06	-2.3E-06	-4.6E-06	5.7E-07	2.0E-06	5.7E-06
	100	3.8E-04	-2.0E-05	-6.7E-06	-1.7E-06	-1.7E-06	2.3E-07	1.0E-06	2.2E-06
Global	10	2.2E-03	-3.0E-04	-9.2E-05	-3.0E-05	-4.3E-05	5.2E-06	1.2E-05	5.1E-05
	20	7.5E-04	-1.0E-04	-3.1E-05	-9.8E-06	-2.6E-05	3.0E-06	7.2E-06	3.0E-05
	50	1.1E-04	-1.4E-05	-4.3E-06	-1.4E-06	-3.7E-06	4.3E-07	1.0E-06	4.3E-06
	100	7.7E-05	-1.0E-05	-3.2E-06	-1.0E-06	-1.5E-06	1.8E-07	4.2E-07	1.8E-06

(continued on next page)

Table S4 (continued)

EAS summer	Time horizon	BC	OC	SO2	NH3	NOx	CO	VOC	CH4
90° S-28° S	10	2.9E-04	-6.2E-05	-4.1E-05	-3.8E-06	-3.7E-05	1.0E-06	-8.3E-07	2.5E-05
	20	9.7E-05	-2.1E-05	-1.4E-05	-1.3E-06	-2.7E-05	8.4E-07	1.3E-06	1.5E-05
	50	1.4E-05	-2.9E-06	-1.9E-06	-1.8E-07	-3.9E-06	1.2E-07	1.9E-07	2.2E-06
	100	1.0E-05	-2.1E-06	-1.4E-06	-1.3E-07	-1.3E-06	3.5E-08	-2.9E-08	8.7E-07
28° S-28° N	10	7.5E-04	-3.3E-04	-2.0E-04	-1.9E-05	-6.3E-05	6.1E-06	2.9E-05	5.8E-05
	20	2.5E-04	-1.1E-04	-6.7E-05	-6.3E-06	-5.6E-05	3.2E-06	1.3E-05	3.4E-05
	50	3.5E-05	-1.6E-05	-9.4E-06	-9.0E-07	-8.0E-06	4.6E-07	1.9E-06	4.8E-06
	100	2.6E-05	-1.1E-05	-6.9E-06	-6.6E-07	-2.2E-06	2.1E-07	1.0E-06	2.0E-06
28° N-60° N	10	1.6E-03	-6.5E-04	-3.8E-04	-4.5E-05	-7.2E-05	7.8E-06	4.1E-05	6.3E-05
	20	5.3E-04	-2.2E-04	-1.3E-04	-1.5E-05	-6.3E-05	3.9E-06	1.8E-05	3.7E-05
	50	7.5E-05	-3.1E-05	-1.8E-05	-2.1E-06	-8.9E-06	5.6E-07	2.5E-06	5.3E-06
	100	5.5E-05	-2.2E-05	-1.3E-05	-1.5E-06	-2.5E-06	2.7E-07	1.4E-06	2.2E-06
60° N-90° N	10	2.3E-03	-5.6E-04	-3.7E-04	-3.2E-05	-1.0E-04	6.1E-06	2.7E-05	6.4E-05
	20	7.8E-04	-1.9E-04	-1.2E-04	-1.1E-05	-7.6E-05	3.5E-06	1.4E-05	4.0E-05
	50	1.1E-04	-2.6E-05	-1.8E-05	-1.5E-06	-1.1E-05	5.0E-07	1.9E-06	5.7E-06
	100	8.0E-05	-1.9E-05	-1.3E-05	-1.1E-06	-3.4E-06	2.1E-07	9.4E-07	2.2E-06
Global	10	9.0E-04	-3.4E-04	-2.0E-04	-2.1E-05	-6.0E-05	5.1E-06	2.3E-05	5.1E-05
	20	3.0E-04	-1.1E-04	-6.8E-05	-7.0E-06	-5.1E-05	2.8E-06	1.1E-05	3.0E-05
	50	4.2E-05	-1.6E-05	-9.6E-06	-9.9E-07	-7.3E-06	3.9E-07	1.6E-06	4.3E-06
	100	3.1E-05	-1.2E-05	-7.0E-06	-7.2E-07	-2.1E-06	1.8E-07	8.0E-07	1.8E-06

(continued on next page)

Table S4 (continued)

EAS winter	Time horizon	BC	OC	SO2	NH3	NOx	CO	VOC	CH4
90° S-28° S	10	1.4E-04	-1.9E-05	-1.6E-05	-6.8E-06	-6.3E-06	1.6E-06	-8.9E-06	2.5E-05
	20	4.5E-05	-6.3E-06	-5.3E-06	-2.2E-06	-1.0E-05	1.2E-06	-1.5E-06	1.5E-05
	50	6.4E-06	-9.0E-07	-7.5E-07	-3.2E-07	-1.5E-06	1.7E-07	-2.1E-07	2.2E-06
	100	4.7E-06	-6.6E-07	-5.5E-07	-2.3E-07	-2.2E-07	5.7E-08	-3.1E-07	8.7E-07
28° S-28° N	10	7.8E-04	-1.2E-04	-7.2E-05	-3.4E-05	-1.0E-04	6.4E-06	8.6E-06	5.8E-05
	20	2.6E-04	-4.0E-05	-2.4E-05	-1.1E-05	-5.3E-05	3.6E-06	6.3E-06	3.4E-05
	50	3.7E-05	-5.7E-06	-3.4E-06	-1.6E-06	-7.6E-06	5.1E-07	8.9E-07	4.8E-06
	100	2.7E-05	-4.1E-06	-2.5E-06	-1.2E-06	-3.5E-06	2.2E-07	3.0E-07	2.0E-06
28° N-60° N	10	1.9E-03	-2.3E-04	-1.2E-04	-7.1E-05	-1.5E-04	7.7E-06	2.0E-05	6.3E-05
	20	6.2E-04	-7.7E-05	-4.0E-05	-2.4E-05	-7.1E-05	4.2E-06	1.0E-05	3.7E-05
	50	8.8E-05	-1.1E-05	-5.7E-06	-3.3E-06	-1.0E-05	5.9E-07	1.5E-06	5.3E-06
	100	6.4E-05	-8.0E-06	-4.2E-06	-2.4E-06	-5.2E-06	2.7E-07	6.7E-07	2.2E-06
60° N-90° N	10	3.1E-03	-1.7E-04	-1.2E-04	-5.2E-05	-9.5E-05	6.7E-06	1.6E-05	6.4E-05
	20	1.1E-03	-5.8E-05	-3.9E-05	-1.7E-05	-5.5E-05	4.0E-06	9.4E-06	4.0E-05
	50	1.6E-04	-8.2E-06	-5.5E-06	-2.4E-06	-7.8E-06	5.7E-07	1.3E-06	5.7E-06
	100	1.1E-04	-6.0E-06	-4.0E-06	-1.8E-06	-3.3E-06	2.3E-07	5.4E-07	2.2E-06
Global	10	9.8E-04	-1.2E-04	-7.0E-05	-3.5E-05	-8.6E-05	5.4E-06	6.6E-06	5.1E-05
	20	3.3E-04	-4.0E-05	-2.3E-05	-1.2E-05	-4.6E-05	3.1E-06	5.2E-06	3.0E-05
	50	4.7E-05	-5.6E-06	-3.3E-06	-1.7E-06	-6.5E-06	4.4E-07	7.4E-07	4.3E-06
	100	3.4E-05	-4.1E-06	-2.4E-06	-1.2E-06	-3.0E-06	1.9E-07	2.3E-07	1.8E-06

(continued on next page)

Table S4 (continued)

ROW summer	**Time horizon**	**BC**	**OC**	**SO2**	**NH3**	**NOx**	**CO**	**VOC**	**CH4**
90° S-28° S	10	7.1E-04	-1.9E-04	-9.1E-05	-3.4E-06	-5.1E-05	2.0E-06	1.1E-05	2.5E-05
	20	2.4E-04	-6.3E-05	-3.0E-05	-1.1E-06	-5.1E-05	1.2E-06	6.5E-06	1.5E-05
	50	3.3E-05	-9.0E-06	-4.3E-06	-1.6E-07	-7.3E-06	1.7E-07	9.3E-07	2.2E-06
	100	2.4E-05	-6.5E-06	-3.1E-06	-1.2E-07	-1.7E-06	6.9E-08	3.8E-07	8.7E-07
28° S-28° N	10	1.2E-03	-7.0E-04	-3.3E-04	-1.4E-05	-1.3E-04	5.7E-06	2.8E-05	5.8E-05
	20	4.2E-04	-2.3E-04	-1.1E-04	-4.7E-06	-1.2E-04	3.2E-06	1.6E-05	3.4E-05
	50	5.9E-05	-3.3E-05	-1.5E-05	-6.7E-07	-1.7E-05	4.5E-07	2.3E-06	4.8E-06
	100	4.3E-05	-2.4E-05	-1.1E-05	-4.9E-07	-4.4E-06	2.0E-07	9.7E-07	2.0E-06
28° N-60° N	10	2.5E-03	-7.0E-04	-5.1E-04	-2.4E-05	-1.6E-04	6.3E-06	3.1E-05	6.3E-05
	20	8.3E-04	-2.3E-04	-1.7E-04	-8.1E-06	-1.4E-04	3.5E-06	1.7E-05	3.7E-05
	50	1.2E-04	-3.3E-05	-2.4E-05	-1.1E-06	-2.0E-05	5.0E-07	2.5E-06	5.3E-06
	100	8.5E-05	-2.4E-05	-1.8E-05	-8.4E-07	-5.5E-06	2.2E-07	1.1E-06	2.2E-06
60° N-90° N	10	3.6E-03	-6.3E-04	-5.7E-04	-1.9E-05	-2.2E-04	5.8E-06	2.9E-05	6.4E-05
	20	1.2E-03	-2.1E-04	-1.9E-04	-6.2E-06	-1.7E-04	3.5E-06	1.8E-05	4.0E-05
	50	1.7E-04	-2.9E-05	-2.7E-05	-8.8E-07	-2.5E-05	5.0E-07	2.5E-06	5.7E-06
	100	1.2E-04	-2.2E-05	-2.0E-05	-6.4E-07	-7.6E-06	2.0E-07	1.0E-06	2.2E-06
Global	10	1.5E-03	-5.6E-04	-3.2E-04	-1.4E-05	-1.2E-04	4.8E-06	2.4E-05	5.1E-05
	20	5.0E-04	-1.9E-04	-1.1E-04	-4.5E-06	-1.1E-04	2.7E-06	1.4E-05	3.0E-05
	50	7.1E-05	-2.6E-05	-1.5E-05	-6.4E-07	-1.6E-05	3.9E-07	2.0E-06	4.3E-06
	100	5.2E-05	-1.9E-05	-1.1E-05	-4.7E-07	-4.1E-06	1.7E-07	8.3E-07	1.8E-06

(continued on next page)

Table S4 (continued)

ROW winter	**Time horizon**	**BC**	**OC**	**SO2**	**NH3**	**NOx**	**CO**	**VOC**	**CH4**
90° S-28° S	10	6.5E-04	-1.7E-04	-7.3E-05	-4.7E-06	-5.1E-05	2.3E-06	9.8E-06	2.5E-05
	20	2.2E-04	-5.8E-05	-2.4E-05	-1.6E-06	-5.3E-05	1.4E-06	6.5E-06	1.5E-05
	50	3.0E-05	-8.1E-06	-3.4E-06	-2.2E-07	-7.5E-06	2.0E-07	9.3E-07	2.2E-06
	100	2.2E-05	-6.0E-06	-2.5E-06	-1.6E-07	-1.8E-06	8.1E-08	3.4E-07	8.7E-07
28° S-28° N	10	1.4E-03	-6.1E-04	-2.1E-04	-2.2E-05	-1.7E-04	6.3E-06	3.0E-05	5.8E-05
	20	4.6E-04	-2.0E-04	-7.1E-05	-7.5E-06	-1.4E-04	3.6E-06	1.8E-05	3.4E-05
	50	6.5E-05	-2.9E-05	-1.0E-05	-1.1E-06	-1.9E-05	5.1E-07	2.5E-06	4.8E-06
	100	4.8E-05	-2.1E-05	-7.3E-06	-7.7E-07	-5.7E-06	2.2E-07	1.0E-06	2.0E-06
28° N-60° N	10	2.9E-03	-5.8E-04	-2.6E-04	-3.4E-05	-2.1E-04	6.8E-06	3.5E-05	6.3E-05
	20	9.5E-04	-1.9E-04	-8.7E-05	-1.1E-05	-1.6E-04	3.9E-06	2.0E-05	3.7E-05
	50	1.3E-04	-2.7E-05	-1.2E-05	-1.6E-06	-2.3E-05	5.5E-07	2.8E-06	5.3E-06
	100	9.8E-05	-2.0E-05	-9.0E-06	-1.2E-06	-7.2E-06	2.3E-07	1.2E-06	2.2E-06
60° N-90° N	10	5.3E-03	-5.1E-04	-2.5E-04	-2.7E-05	-2.5E-04	6.5E-06	3.3E-05	6.4E-05
	20	1.9E-03	-1.7E-04	-8.5E-05	-8.9E-06	-1.8E-04	4.0E-06	2.0E-05	4.0E-05
	50	2.7E-04	-2.4E-05	-1.2E-05	-1.3E-06	-2.6E-05	5.6E-07	2.9E-06	5.7E-06
	100	1.9E-04	-1.8E-05	-8.8E-06	-9.2E-07	-8.5E-06	2.2E-07	1.2E-06	2.2E-06
Global	10	1.7E-03	-4.8E-04	-1.9E-04	-2.0E-05	-1.5E-04	5.4E-06	2.6E-05	5.1E-05
	20	5.9E-04	-1.6E-04	-6.3E-05	-6.8E-06	-1.2E-04	3.1E-06	1.5E-05	3.0E-05
	50	8.3E-05	-2.3E-05	-8.8E-06	-9.6E-07	-1.7E-05	4.4E-07	2.2E-06	4.3E-06
	100	6.1E-05	-1.7E-05	-6.5E-06	-7.0E-07	-5.2E-06	1.8E-07	8.9E-07	1.8E-06

(continued on next page)

Table S4 (continued)

SHP summer	Time horizon	BC	OC	SO2	NH3	NOx	CO	VOC	CH4
90° S-28° S	10	3.3E-04	-3.3E-04	-9.4E-05	NA	-1.7E-04	3.1E-06	1.7E-05	2.5E-05
	20	1.1E-04	-1.1E-04	-3.1E-05	NA	-1.3E-04	1.6E-06	1.0E-05	1.5E-05
	50	1.5E-05	-1.6E-05	-4.4E-06	NA	-1.8E-05	2.3E-07	1.5E-06	2.2E-06
	100	1.1E-05	-1.1E-05	-3.2E-06	NA	-5.9E-06	1.1E-07	5.9E-07	8.7E-07
28° S-28° N	10	5.7E-04	-1.5E-03	-3.8E-04	NA	-4.6E-05	9.2E-06	3.9E-05	5.8E-05
	20	1.9E-04	-4.9E-04	-1.3E-04	NA	-1.8E-04	4.3E-06	2.4E-05	3.4E-05
	50	2.7E-05	-6.9E-05	-1.8E-05	NA	-2.5E-05	6.2E-07	3.4E-06	4.8E-06
	100	2.0E-05	-5.0E-05	-1.3E-05	NA	-1.6E-06	3.2E-07	1.3E-06	2.0E-06
28° N-60° N	10	1.2E-03	-2.7E-03	-6.1E-04	NA	3.0E-05	1.1E-05	4.0E-05	6.3E-05
	20	4.0E-04	-9.0E-04	-2.0E-04	NA	-1.7E-04	5.2E-06	2.5E-05	3.7E-05
	50	5.7E-05	-1.3E-04	-2.8E-05	NA	-2.4E-05	7.4E-07	3.6E-06	5.3E-06
	100	4.2E-05	-9.3E-05	-2.1E-05	NA	1.0E-06	3.9E-07	1.4E-06	2.2E-06
60° N-90° N	10	2.3E-03	-2.3E-03	-5.4E-04	NA	-2.9E-04	8.8E-06	4.2E-05	6.4E-05
	20	8.1E-04	-7.7E-04	-1.8E-04	NA	-3.0E-04	4.5E-06	2.7E-05	4.0E-05
	50	1.2E-04	-1.1E-04	-2.6E-05	NA	-4.3E-05	6.4E-07	3.9E-06	5.7E-06
	100	8.3E-05	-8.0E-05	-1.9E-05	NA	-1.0E-05	3.0E-07	1.5E-06	2.2E-06
Global	10	7.5E-04	-1.5E-03	-3.6E-04	NA	-8.0E-05	8.0E-06	3.4E-05	5.1E-05
	20	2.5E-04	-4.9E-04	-1.2E-04	NA	-1.7E-04	3.8E-06	2.1E-05	3.0E-05
	50	3.6E-05	-6.9E-05	-1.7E-05	NA	-2.4E-05	5.4E-07	2.9E-06	4.3E-06
	100	2.6E-05	-5.0E-05	-1.2E-05	NA	-2.8E-06	2.8E-07	1.2E-06	1.8E-06

(continued on next page)

Table S4 (continued)

SHP winter	Time horizon	BC	OC	SO2	NH3	NOx	CO	VOC	CH4
90° S-28° S	10	3.2E-04	-2.2E-04	-8.4E-05	NA	-1.5E-04	3.5E-06	1.5E-05	2.5E-05
	20	1.1E-04	-7.3E-05	-2.8E-05	NA	-1.4E-04	2.0E-06	9.4E-06	1.5E-05
	50	1.5E-05	-1.0E-05	-4.0E-06	NA	-2.0E-05	2.9E-07	1.3E-06	2.2E-06
	100	1.1E-05	-7.6E-06	-2.9E-06	NA	-5.0E-06	1.2E-07	5.2E-07	8.7E-07
28° S-28° N	10	1.0E-03	-7.3E-04	-2.6E-04	NA	-2.7E-04	9.3E-06	3.7E-05	5.8E-05
	20	3.4E-04	-2.4E-04	-8.7E-05	NA	-2.9E-04	5.1E-06	2.2E-05	3.4E-05
	50	4.8E-05	-3.4E-05	-1.2E-05	NA	-4.1E-05	7.2E-07	3.1E-06	4.8E-06
	100	3.5E-05	-2.5E-05	-9.0E-06	NA	-9.3E-06	3.2E-07	1.3E-06	2.0E-06
28° N-60° N	10	2.4E-03	-1.0E-03	-3.1E-04	NA	-3.4E-04	1.2E-05	3.9E-05	6.3E-05
	20	7.9E-04	-3.4E-04	-1.0E-04	NA	-3.3E-04	6.1E-06	2.4E-05	3.7E-05
	50	1.1E-04	-4.9E-05	-1.5E-05	NA	-4.7E-05	8.6E-07	3.4E-06	5.3E-06
	100	8.2E-05	-3.6E-05	-1.1E-05	NA	-1.2E-05	4.0E-07	1.3E-06	2.2E-06
60° N-90° N	10	5.9E-03	-8.8E-04	-2.8E-04	NA	-5.4E-04	1.0E-05	4.1E-05	6.4E-05
	20	2.1E-03	-2.9E-04	-9.2E-05	NA	-4.3E-04	5.9E-06	2.6E-05	4.0E-05
	50	3.1E-04	-4.2E-05	-1.3E-05	NA	-6.1E-05	8.4E-07	3.6E-06	5.7E-06
	100	2.2E-04	-3.0E-05	-9.5E-06	NA	-1.9E-05	3.5E-07	1.4E-06	2.2E-06
Global	10	1.4E-03	-6.6E-04	-2.3E-04	NA	-2.7E-04	8.3E-06	3.2E-05	5.1E-05
	20	4.9E-04	-2.2E-04	-7.5E-05	NA	-2.7E-04	4.5E-06	1.9E-05	3.0E-05
	50	6.9E-05	-3.1E-05	-1.1E-05	NA	-3.8E-05	6.4E-07	2.7E-06	4.3E-06
	100	5.0E-05	-2.3E-05	-7.8E-06	NA	-9.2E-06	2.9E-07	1.1E-06	1.8E-06

(continued on next page)

Table S4 (continued)

GLB summer	Time horizon	BC	OC	SO2	NH3	NOx	CO	VOC	CH4
90° S-28° S	10	5.8E-04	-1.6E-04	-7.1E-05	-3.8E-06	-5.1E-05	1.8E-06	9.9E-06	2.5E-05
	20	1.9E-04	-5.3E-05	-2.4E-05	-1.3E-06	-4.7E-05	1.1E-06	5.9E-06	1.5E-05
	50	2.7E-05	-7.5E-06	-3.4E-06	-1.8E-07	-6.7E-06	1.6E-07	8.4E-07	2.2E-06
	100	2.0E-05	-5.5E-06	-2.5E-06	-1.3E-07	-1.8E-06	6.1E-08	3.4E-07	8.7E-07
28° S-28° N	10	1.1E-03	-6.2E-04	-2.8E-04	-1.7E-05	-1.2E-04	5.8E-06	2.8E-05	5.8E-05
	20	3.7E-04	-2.0E-04	-9.4E-05	-5.8E-06	-1.1E-04	3.2E-06	1.5E-05	3.4E-05
	50	5.2E-05	-2.9E-05	-1.3E-05	-8.2E-07	-1.6E-05	4.5E-07	2.2E-06	4.8E-06
	100	3.8E-05	-2.1E-05	-9.7E-06	-6.0E-07	-4.1E-06	2.0E-07	9.7E-07	2.0E-06
28° N-60° N	10	2.3E-03	-7.0E-04	-4.7E-04	-3.5E-05	-1.5E-04	6.6E-06	3.1E-05	6.3E-05
	20	7.5E-04	-2.3E-04	-1.6E-04	-1.2E-05	-1.3E-04	3.6E-06	1.7E-05	3.7E-05
	50	1.1E-04	-3.3E-05	-2.2E-05	-1.6E-06	-1.8E-05	5.1E-07	2.4E-06	5.3E-06
	100	7.8E-05	-2.4E-05	-1.6E-05	-1.2E-06	-5.1E-06	2.3E-07	1.1E-06	2.2E-06
60° N-90° N	10	3.3E-03	-6.3E-04	-5.1E-04	-2.7E-05	-2.0E-04	5.8E-06	2.9E-05	6.4E-05
	20	1.1E-03	-2.1E-04	-1.7E-04	-8.8E-06	-1.5E-04	3.5E-06	1.7E-05	4.0E-05
	50	1.6E-04	-3.0E-05	-2.4E-05	-1.2E-06	-2.2E-05	5.0E-07	2.4E-06	5.7E-06
	100	1.1E-04	-2.2E-05	-1.8E-05	-9.1E-07	-6.8E-06	2.0E-07	9.9E-07	2.2E-06
Global	10	1.3E-03	-5.1E-04	-2.8E-04	-1.8E-05	-1.1E-04	4.9E-06	2.4E-05	5.1E-05
	20	4.5E-04	-1.7E-04	-9.3E-05	-6.0E-06	-9.9E-05	2.7E-06	1.3E-05	3.0E-05
	50	6.3E-05	-2.4E-05	-1.3E-05	-8.4E-07	-1.4E-05	3.9E-07	1.9E-06	4.3E-06
	100	4.6E-05	-1.8E-05	-9.6E-06	-6.2E-07	-3.9E-06	1.7E-07	8.2E-07	1.8E-06

(continued on next page)

Table S4 (continued)

GLB winter	Time horizon	BC	OC	SO2	NH3	NOx	CO	VOC	CH4
90° S-28° S	10	4.5E-04	-1.2E-04	-4.8E-05	-5.3E-06	-4.5E-05	2.1E-06	5.4E-06	2.5E-05
	20	1.5E-04	-4.0E-05	-1.6E-05	-1.8E-06	-4.4E-05	1.4E-06	4.6E-06	1.5E-05
	50	2.1E-05	-5.7E-06	-2.2E-06	-2.5E-07	-6.2E-06	1.9E-07	6.5E-07	2.2E-06
	100	1.6E-05	-4.2E-06	-1.6E-06	-1.8E-07	-1.5E-06	7.3E-08	1.8E-07	8.7E-07
28° S-28° N	10	1.2E-03	-4.4E-04	-1.5E-04	-2.6E-05	-1.5E-04	6.3E-06	2.6E-05	5.8E-05
	20	3.9E-04	-1.5E-04	-5.0E-05	-8.6E-06	-1.2E-04	3.6E-06	1.5E-05	3.4E-05
	50	5.5E-05	-2.1E-05	-7.1E-06	-1.2E-06	-1.7E-05	5.1E-07	2.1E-06	4.8E-06
	100	4.1E-05	-1.5E-05	-5.2E-06	-8.8E-07	-5.1E-06	2.2E-07	8.9E-07	2.0E-06
28° N-60° N	10	2.5E-03	-4.7E-04	-2.0E-04	-4.6E-05	-1.9E-04	7.1E-06	3.2E-05	6.3E-05
	20	8.4E-04	-1.6E-04	-6.8E-05	-1.5E-05	-1.4E-04	4.0E-06	1.8E-05	3.7E-05
	50	1.2E-04	-2.2E-05	-9.6E-06	-2.2E-06	-1.9E-05	5.6E-07	2.5E-06	5.3E-06
	100	8.7E-05	-1.6E-05	-7.0E-06	-1.6E-06	-6.5E-06	2.4E-07	1.1E-06	2.2E-06
60° N-90° N	10	5.0E-03	-4.2E-04	-2.0E-04	-3.5E-05	-2.1E-04	6.5E-06	3.0E-05	6.4E-05
	20	1.8E-03	-1.4E-04	-6.7E-05	-1.2E-05	-1.5E-04	4.0E-06	1.8E-05	4.0E-05
	50	2.6E-04	-2.0E-05	-9.4E-06	-1.6E-06	-2.1E-05	5.7E-07	2.5E-06	5.7E-06
	100	1.8E-04	-1.4E-05	-6.9E-06	-1.2E-06	-7.2E-06	2.2E-07	1.0E-06	2.2E-06
Global	10	1.5E-03	-3.6E-04	-1.4E-04	-2.5E-05	-1.3E-04	5.4E-06	2.2E-05	5.1E-05
	20	5.1E-04	-1.2E-04	-4.6E-05	-8.3E-06	-1.0E-04	3.1E-06	1.3E-05	3.0E-05
	50	7.2E-05	-1.7E-05	-6.5E-06	-1.2E-06	-1.5E-05	4.4E-07	1.8E-06	4.3E-06
	100	5.3E-05	-1.2E-05	-4.7E-06	-8.6E-07	-4.6E-06	1.8E-07	7.6E-07	1.8E-06

3. Robustness for individual species

By robustness, we mean that the individual models agree with the best estimate on which emission region (Europe/East Asia) and which emission season (summer/winter) for a single species cause the largest global temperature perturbation per unit of emissions, based on ARTP(20), in magnitude (see Table S5). We define here a model case as a comparison of results based on a single model and the best estimate, which there are 21 in total for all SLCFs in this study (4 cases each for the 3 aerosols and 3 cases each for the 3 ozone precursors). The cases are doubled to 42 as the best estimate for the emission region is calculated both for winter and summer and for the emission season for both European and East Asian emissions.

Table S5: Robustness. This is calculated as the share of model cases that agree with the best estimate on what emission season or region has the largest ARTP(20) value.

Species	Emission region	Emission season	In total
All species	81 %	93 %	87 %
Aerosols	79 %	96 %	88 %
Ozone precursors	83 %	89 %	86 %

For the four latitude response bands, we analyze whether the model cases agree with the best estimate on the ranking of temperature responses, based on ARTP(20). For instance, the best estimate and results based on all four models agree that European winter emissions of BC cause the largest temperature response in the Arctic latitude band and gradually reduced response moving southward. On the other hand, results based on HadGEM3 marginally disagree with the best estimate for East Asian winter emissions on whether the response is largest in the Arctic and northern mid-latitudes, but agree on the ranking for southern mid-high latitudes and the Tropics. As the ranking is here correct for two out of four latitude bands, we give a 50% agreement for this case. For BC, there are in total 24 model cases since there are four models, three emission regions (Europe, East Asia, and global), and two emission seasons. In total, this study includes 126 model cases for all SLCFs. The robustness, determined by this agreement percentage, is high also here. Overall for all the species, 75% of the model cases agree with the best estimate (see Table S6). Another 10% are marginally different. For the aerosols, most of disagreements is on whether the Arctic or the NH mid-latitude has the highest ARTP(20) values in magnitude. The models also disagree on the Tropics for some cases of the ozone precursors.

Table S6: Robustness. This is calculated as the share of model cases that agree with the best estimate on the ranking of the four latitude response bands.

Species	90S-28S	28S-28N	28N-60N	60N-90N	In total
All species	94 %	74 %	73 %	60 %	75 %
Aerosols	99 %	93 %	76 %	72 %	85 %
Ozone precursors	89 %	48 %	69 %	43 %	62 %

4. Global emissions in 2008

Table S7: Global annual emissions in 2008 (Klimont et al., In prep.).

Species	Emission
BC	7.14 Tg
OC	15.3 Tg
SO_2	108 Tg in SO_2
NH_3	55.9 Tg
NO_x	36.5 Tg in N
CO	570 Tg
VOC	66.2 Tg in C

5. Regional temperature response

The regional temperature response at time *H* in latitude band *m* for an emission scenario *E(t)* of species *i* in emission region *r* and emission season *s* is

$$\Delta T_{i,r,m,s}(H) = \int_0^H E_{i,r,s}(t) \times ARTP_{i,r,m,s}(H-t)dt. \quad \text{(S1)}$$

The regional temperature response for 20 years of sustained emissions is shown in Fig. S1.

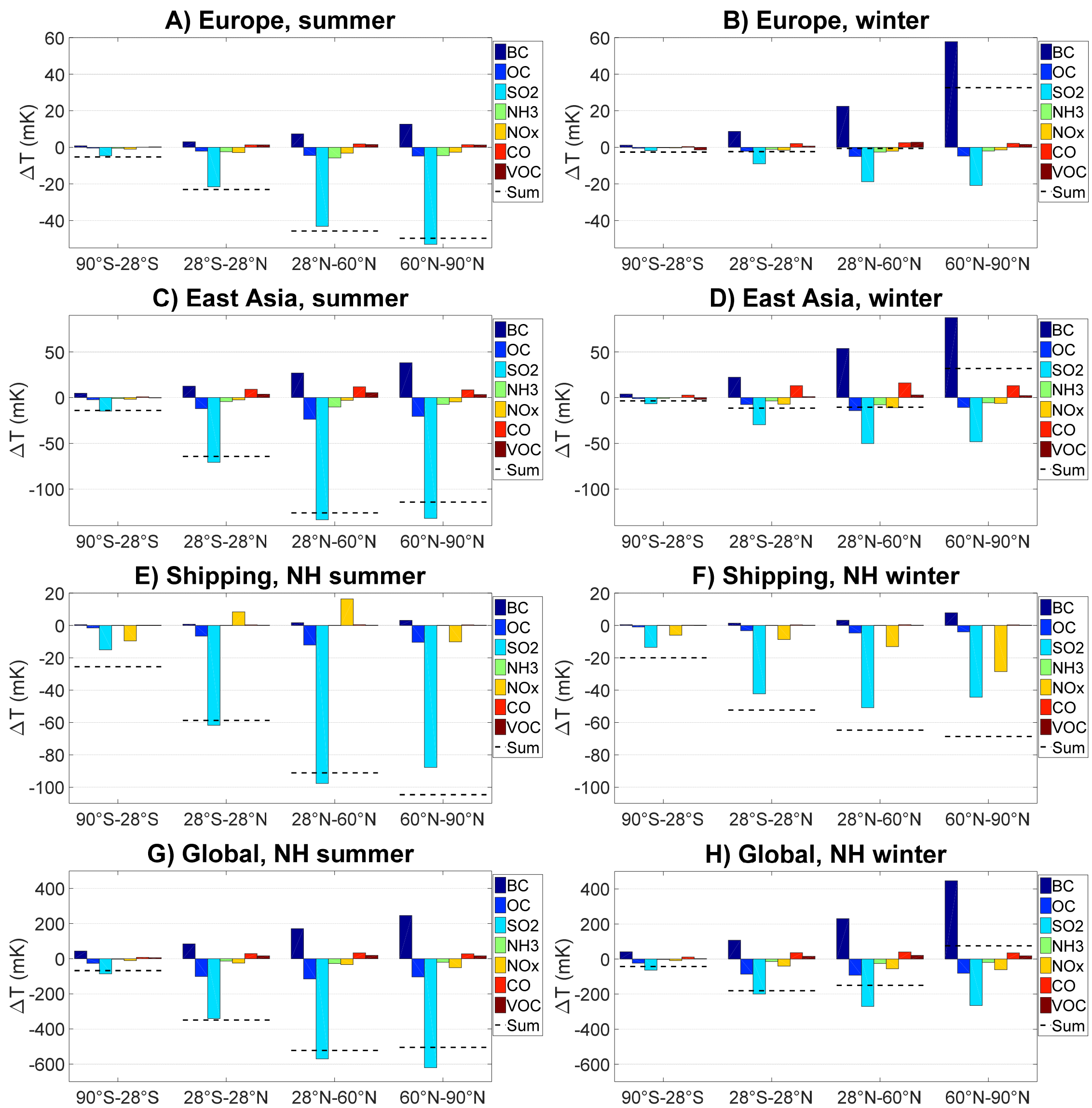

Figure S1: The regional temperature response for 20 years of sustained emissions. The four latitude response bands represent the SH mid-high latitudes, Tropics, NH mid-latitudes, and Arctic. From top to bottom, the emission regions are Europe, East Asia, the global shipping sector, and global. The emissions are split into NH summer season (May-October) to the left and NH winter season (November-April) to the right. Note that the y-axis differs for the regions. The horizontal dashed lines show the sum for each response band.

6. Global temperature response and AGTP

6.1 Global temperature change potentials

Aamaas et al. (2016) presented global temperature responses of regional emissions based on AGTP calculations of the same RF dataset (Bellouin et al., 2016) as in this article. The AGTP for emission region *r* in season *s* of species *i* is given as

$$AGTP_{i,r,s}(H) = \int_0^H RF_{i.r,s}(t) R_T(H-t)dt \ , \quad \text{(S2)}$$

where R_T *(H-t)* is the temperature response at time *H* to a unit RF at time *t*, identical to the impulse response function in Eq. (1).

6.2 Global temperature response for 2008 emissions

The global temperature response at time horizon *H* after a year of 2008 emissions E(t) of species *i* is

$$\Delta T_{i,r,s}(H) = E_{i,r,s} \times AGTP_{i,r,s}(H). \quad \text{(S3)}$$

We calculate the global temperature responses for time horizons of 10, 20, 50, and 100 years. As the ARTP calculations are based on an efficacy of 3 for BC deposition on snow, the same efficacy is applied in the AGTP calculations.

Figure S2 presents the global temperature response based on both AGTP and ARTP values. The global temperature response falls as ARTP values decrease rapidly with increasing time horizon. The total global temperature perturbation of the SLCFs excluding CH_4 causes in most cases a net cooling, while the different species cancel each other out for winter emissions in Europe and East Asia (see Figs. 4B and 4D). These findings are mostly in agreement with previous studies using AGTP values (Aamaas et al., 2013;Aamaas et al., 2016).

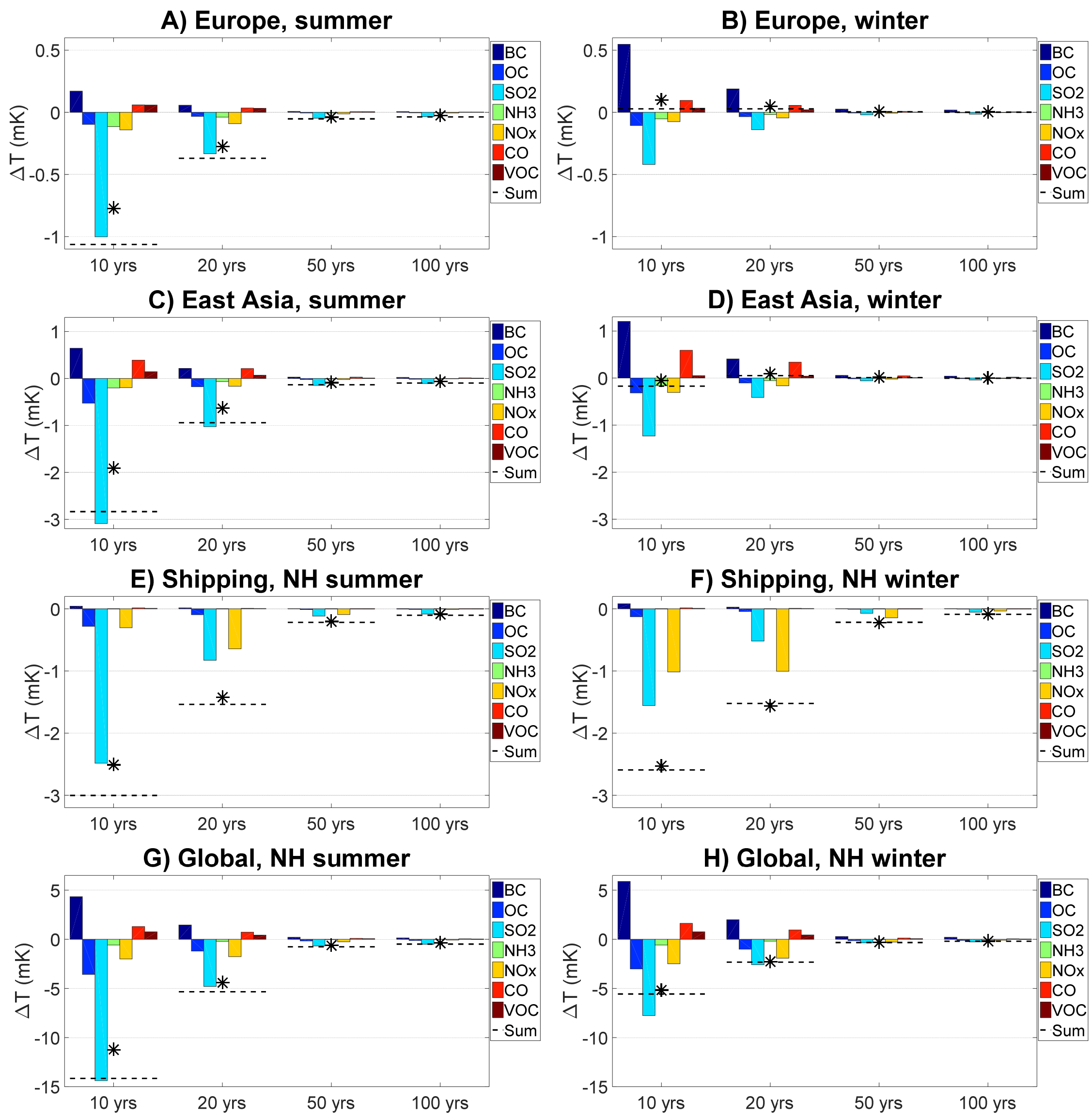

Figure S2: The global temperature response 10, 20, 50, and 100 years after regional and seasonal emissions in 2008 based on ARTP. The star indicates the temperature perturbation based on AGTP (Aamaas et al., 2016), but with an efficacy of 3 for BC deposition on snow. From top to bottom, the emission regions are Europe, East Asia, the global shipping sector, and global. The emissions are split into NH summer season (May-October) to the left and NH winter season (November-April) to the right. Note that the y-axis differs for the regions.

7. Comparing ARTP and AGTP

Figure S2 shows that the net temperature response of SLCFs emissions for AGTP (star) is similar or slightly less negative than based on ARTP (dotted line) for all emission regions and emission seasons. A direct comparison is possible as the same RF dataset is used (Bellouin et al., 2016). The differences in global temperature perturbations when applying ARTP and AGTP are shown in Fig. S3. The absolute differences are generally larger for species with the largest net impacts, hence, nearly scaled with the total temperature response. In other words, the discrepancy is among the largest for

SO_2 because the temperature perturbation from SO_2 emissions is larger than most other species for most of the cases. For shipping, the NO_x emissions have a large impact; hence, the difference based on the two emission metrics is large for NO_x for this sector.

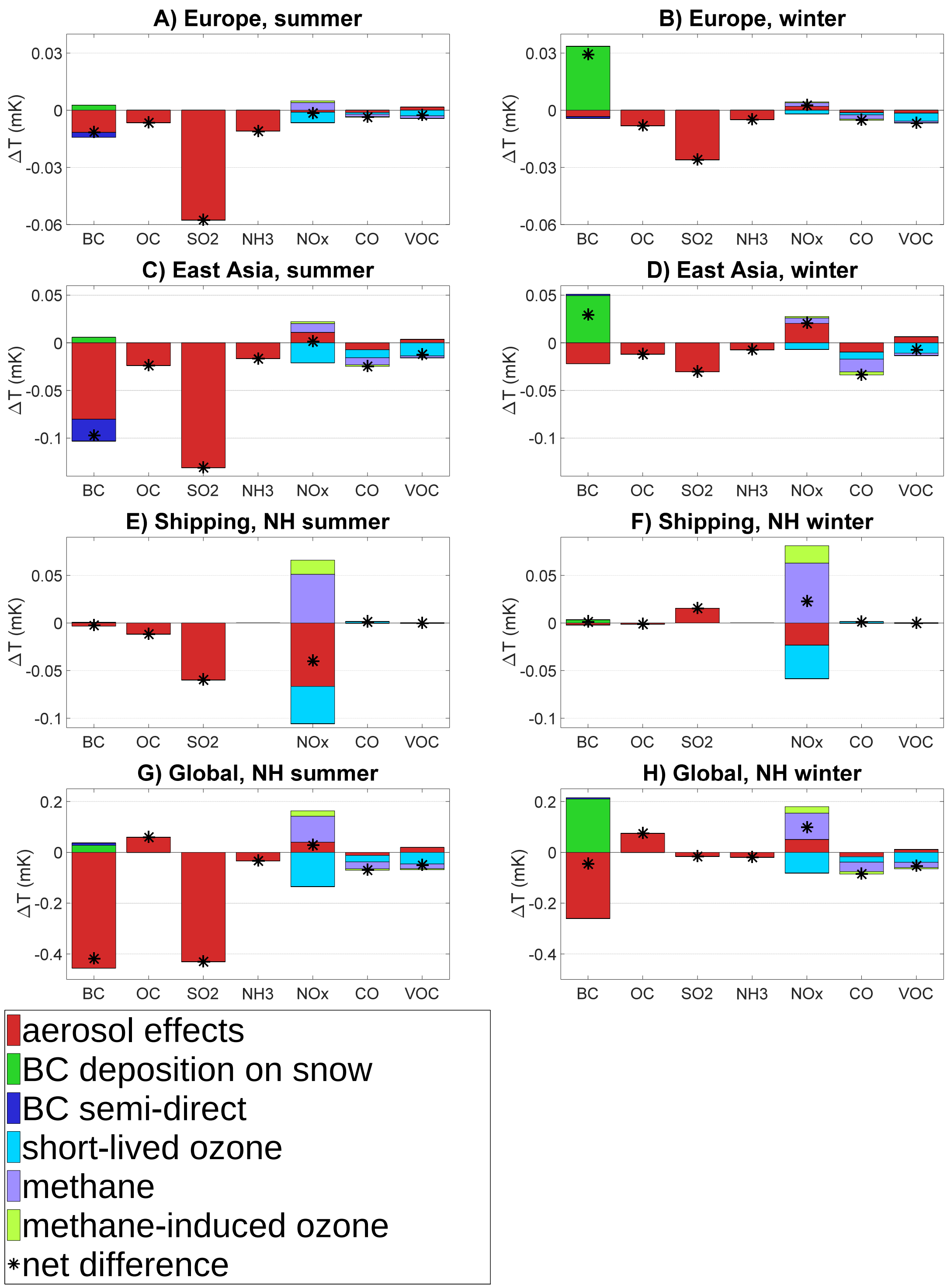

Figure S3: The difference in the global temperature response for a time horizon of 20 years between that based on ARTP given in Fig. 3 and on AGTP given in Fig. S2. From top to bottom, the emission regions are Europe, East Asia, the global shipping sector, and global. The emissions are split into NH summer season (May-October) to the left and NH winter season (November-April) to the right. Note that the y-axis differs for the regions.

References

Aamaas, B., Peters, G., and Fuglestvedt, J. S.: Simple emission metrics for climate impacts, Earth Syst. Dynam., 4, 145-170, 10.5194/esd-4-145-2013, 2013.
Aamaas, B., Berntsen, T. K., Fuglestvedt, J. S., Shine, K. P., and Bellouin, N.: Regional emission metrics for short-lived climate forcers from multiple models, Atmos. Chem. Phys., 16, 7451-7468, 10.5194/acp-16-7451-2016, 2016.
Bellouin, N., Baker, L., Hodnebrog, Ø., Olivié, D., Cherian, R., Macintosh, C., Samset, B., Esteve, A., Aamaas, B., Quaas, J., and Myhre, G.: Regional and seasonal radiative forcing by perturbations to aerosol and ozone precursor emissions, Atmospheric Chemistry and Physics, 16, 13885-13910, 10.5194/acp-16-13885-2016, 2016.
Collins, W. J., Fry, M. M., Yu, H., Fuglestvedt, J. S., Shindell, D. T., and West, J. J.: Global and regional temperature-change potentials for near-term climate forcers, Atmos. Chem. Phys., 13, 2471-2485, 10.5194/acp-13-2471-2013, 2013.
Flanner, M. G.: Arctic climate sensitivity to local black carbon, Journal of Geophysical Research: Atmospheres, 118, 1840-1851, 10.1002/jgrd.50176, 2013.
Klimont, Z., Höglund-Isaksson, L., Heyes, C., Rafaj, P., Schöpp, W., Cofala, J., Purohit, P., Borken-Kleefeld, J., Kupiainen, K., Kiesewetter, G., Winiwarter, W., Amann, M., Zhao, B., Wang, S. X., Bertok, I., and Sander, R.: Global scenarios of air pollutants and methane: 1990-2050, In prep.
Shindell, D., and Faluvegi, G.: Climate response to regional radiative forcing during the twentieth century, Nature Geoscience, 2, 294-300, 2009.
Shindell, D., and Faluvegi, G.: The net climate impact of coal-fired power plant emissions, Atmos. Chem. Phys., 10, 3247-3260, 10.5194/acp-10-3247-2010, 2010.