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Supplement of

Evaluation of the performance of four chemical transport models in predicting the aerosol chemical composition in Europe in 2005

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Supplementary figures and tables for model-measurement comparison

Figure S1. The locations of the EMEP stations that included chemically speciated measurements of PM in 2005. The underlying map originates from Google Earth.

Table S1. EMEP station locations and the species observed in these stations.

Station name	Code	Lat °N	Lon °E	Altitude m	Species observed
Illmitz	AT0002R	47.767	16.767	117	PM10, PM2.5, SO4, SO2, NO3, HNO3+NO3, HNO3, NH4, NH3+NH4, NH3, Na, Ca, NO2, EC/OC 02-03
University Of Gent	BE0005R	51.050	3.717	0	EC/OC 02-03
Vorhegg	AT0005R	46.678	12.972	1020	PM10, NO2
Zoebelboden	AT0048R	47.839	14.441	899	PM10, PM2.5, NO2
Jungfraujoch	CH0001G	46.548	7.985	3578	SO4, SO2, NO3, NH4, Na, Ca, NO2
Payerne	CH0002R	46.813	6.945	489	PM10, PM2.5, SO4, SO2, HNO3+NO3, NH3+NH4, NO2
Tänikon	CH0003R	47.480	8.905	539	PM10, NO2
Chaumont	CH0004R	47.050	6.979	1137	PM10, PM2.5, SO2, NO2
Rigi	CH0005R	47.068	8.464	1031	PM10, SO4, SO2, HNO3+NO3, NH3+NH4, NO2
Svratouch	CZ0001R	49.733	16.050	737	PM10, SO4, SO2, HNO3+NO3, NH3+NH4, NO2
Kosetice	CZ0003R	49.583	15.083	534	PM10, PM2.5, SO4, SO2, HNO3+NO3, NH3+NH4, NO2, BaP, EC/OC 02-03
Westerland	DE0001R	54.926	8.310	12	PM10, SO4, SO2, NO3, HNO3+NO3, HNO3, NH4, NH3+NH4, NH3, Na, Ca, NO2
Waldhof	DE0002R	52.802	10.759	74	PM10, PM2.5, SO4, SO2, NO3, HNO3+NO3, HNO3, NH4, NH3+NH4, NH3, Na, Ca, NO2, EC/OC 02-03
Schauinsland	DE0003R	47.915	7.909	1205	PM10, PM2.5, SO4, SO2, NO3, HNO3+NO3, HNO3, NH4, NH3+NH4, NH3, Na, Ca, NO2
Neuglobsow	DE0007R	53.167	13.033	62	PM10, SO4, SO2, NO3, HNO3+NO3, HNO3, NH4, NH3+NH4, NH3, Na, Ca, NO2

Schmücke	DE0008R	50.650	10.767	937	PM10, SO2, NO2
Zingst	DE0009R	54.433	12.733	1	PM10, SO4, SO2, NO3, HNO3+NO3, HNO3, NH3+NH4, NH3, Na, Ca, NO2
Melpitz	DE0044R	51.530	12.930	86	PM10, PM2.5, SO4, NO3, NH4, Na, Ca, EC, OC
Tange	DK0003R	56.350	9.600	13	SO4, SO2, HNO3+NO3, NH4, NH3+NH4, NH3, Na
Keldsnor	DK0005R	54.733	10.733	10	PM10, SO4, SO2, HNO3+NO3, NH4, NH3+NH4, NH3, Na
Anholt	DK0008R	56.717	11.517	40	SO4, SO2, HNO3+NO3, NH4, NH3+NH4, NH3, Na, NO2
Ulborg	DK0031R	56.283	8.433	10	SO4, SO2, HNO3+NO3, NH4, NH3+NH4, NH3, Na
Víznar	ES0007R	37.233	-3.533	1265	PM10, PM2.5, SO4, NO3, HNO3+NO3, NH3+NH4
Niembro	ES0008R	43.442	-4.850	134	PM10, PM2.5, SO4, NO3, HNO3+NO3, NH3+NH4, BaP
Campisabalos	ES0009R	41.281	-3.143	1360	PM10, PM2.5, SO4, NO3, HNO3+NO3, NH4, NH3+NH4, Na, Ca
Cabo de Creus	ES0010R	42.319	3.317	23	PM10, PM2.5, SO4, NO3, HNO3+NO3, NH3+NH4
Barcarrota	ES0011R	38.476	-6.923	393	PM10, PM2.5, SO4, NO3, HNO3+NO3, NH3+NH4
Zarra	ES0012R	39.086	-1.102	885	PM10, PM2.5, SO4, NO3, HNO3+NO3, NH3+NH4
Penausende	ES0013R	41.283	-5.867	985	PM10, PM2.5, SO4, NO3, HNO3+NO3, NH3+NH4
Els Torms	ES0014R	41.400	0.717	470	PM10, PM2.5, SO4, NO3, HNO3+NO3, NH3+NH4
Risco Llamo	ES0015R	39.517	-4.350	1241	PM10, PM2.5, SO4, NO3, HNO3+NO3, NH3+NH4
O Saviñao	ES0016R	43.231	-7.700	506	PM10, PM2.5, SO4, NO3, HNO3+NO3, NH3+NH4
Montseny	ES1778R	41.767	2.350	700	PM2.5, SO4, NO3, NH4, Na, Ca, EC, OC
Lahemaa	EE0009R	59.500	25.900	32	SO2, NO2
Vilsandi	EE0011R	58.383	21.817	6	SO2, NO2
Hyytiälä	FI0050R	61.850	24.283	181	PM10, PM2.5
Utö	FI0009R	59.779	21.377	7	SO4, SO2, HNO3+NO3, NH4, NH3+NH4, Na, Ca
Virolahti II	FI0017R	60.527	27.686	4	SO4, SO2, HNO3+NO3, NH4, NH3+NH4, Na, Ca, EC/OC 02-03
Pallas (Matorova)	FI0036R	68.000	24.240	340	SO4, SO2, HNO3+NO3, NH4, NH3+NH4, Na, Ca, BaP
Vert-le-Petit	FR0001R	48.533	2.367	64	SO4, SO2
Donon	FR0008R	48.500	7.133	775	SO4, SO2
Revin	FR0009R	49.900	4.633	390	SO2
Morvan	FR0010R	47.267	4.083	620	SO4, SO2
Iraty	FR0012R	43.033	-1.083	1300	SO4, SO2
Montandon	FR0014R	47.300	6.833	836	SO4, SO2
La Tardière	FR0015R	46.650	-0.750	133	SO4, SO2
Le Casset	FR0016R	45.000	6.467	1750	SO4, SO2
Montfranc	FR0017R	45.800	2.067	810	SO4, SO2
Eskdalemuir	GB0002R	55.313	-3.204	243	SO4
Lough Navar	GB0006R	54.443	-7.870	126	SO4
Barcombe Mills	GB0007R	50.867	-0.033	8	SO4
Yarner Wood	GB0013R	50.596	-3.713	119	SO4
High Muffles	GB0014R	54.334	-0.808	267	SO4, NO, BaP
Harwell	GB0036R	51.573	-1.317	137	PM2.5
CEH Edingburgh	GB0046R	55.950	-3.217	180	EC/OC 02-03
K-puszta	HU0002R	46.967	19.583	125	SO4, SO2, NO3, HNO3+NO3, HNO3, NH4, NH3+NH4, NH3, NO2
Valentia Observatory	IE0001R	51.940	-10.244	11	SO4, SO2, HNO3+NO3, NH3+NH4, Na, Ca, NO2

Oak Park	IE0005R	52.869	-6.925	59	SO4, NO3, NH4, Na, Ca
Malin Head	IE0006R	55.375	-7.343	20	SO4, NO3, NH4, Na, Ca
Carnsore Point	IE0008R	52.185	-6.368	9	SO4, NO3, NH4, Na, Ca
Mace Head	IE0031R	53.167	-9.500	15	EC/OC 02-03
Montelibretti	IT0001R	42.100	12.633	48	PM10, SO4, SO2, NO3, HNO3, NH4, NH3, NO2
Ispra	IT0004R	45.800	8.633	209	PM10, PM2.5, SO4, SO2, NO3, NH4, NO2, EC, OC, EC/OC 02-03
ISAC Belogna	IT0008R	44.483	11.333	0	EC/OC 02-03
Preila	LT0015R	55.350	21.067	5	SO4, SO2, HNO3+NO3, NH3+NH4, NO2
Rucava	LV0010R	56.162	21.173	18	SO4, SO2, NO3, HNO3+NO3, NH3+NH4, Na, NO2, BaP
Zoseni	LV0016R	57.135	25.906	188	SO4, SO2, NO3, HNO3+NO3, NH4, NH3+NH4, NO2, BaP
Kollumerwaard	NL0009R	53.334	6.277	1	SO4, NO3, NH4, EC/OC 02-03
Vredepeel	NL0010R	51.541	5.854	28	SO4, NO3, NH4
De Zilk	NL0091R	52.300	4.500	4	NO3, NH4
Birkenes	NO0001R	58.383	8.250	190	PM10, PM2.5, SO4, SO2, NO3, HNO3+NO3, HNO3, NH4, NH3+NH4, NH3, Na, Ca, NO2, EC, OC
Kårvatn	NO0039R	62.783	8.883	210	SO4, SO2, NO3, HNO3+NO3, HNO3, NH4, NH3+NH4, NH3, Na, Ca, NO2
Zeppelin	NO0042G	78.900	11.883	474	BaP
Karasjok	NO0055R	69.467	25.217	333	SO4, SO2, NO3, HNO3+NO3, HNO3, NH4, NH3+NH4, NH3, Na, Ca, NO2
Hurdal	NO0056R	60.372	11.078	300	SO4, SO2, NO3, HNO3+NO3, HNO3, NH4, NH3+NH4, NH3, Na, Ca, NO2
Jarczew	PL0002R	51.817	21.983	180	SO4, SO2, NO3, HNO3+NO3, NH4, NH3+NH4, NO2
Sniezka	PL0003R	50.733	15.733	1603	SO4, SO2, NO3, HNO3+NO3, NH4, NH3+NH4, NO2
Leba	PL0004R	54.750	17.533	2	SO4, SO2, NO3, HNO3+NO3, NH4, NH3+NH4, NO2
Diabla Gora	PL0005R	54.150	22.067	157	PM10, SO4, SO2, HNO3+NO3, NH3+NH4, NO2
Braganca	PT0001R	41.817	-6.767	690	EC/OC 02-03
Kamenicki vis	RS0005R	43.400	21.950	813	SO2, NO2
Janiskoski	RU0001R	68.933	28.850	118	SO4, SO2, NO3, NH4
Bredkälen	SE0005R	63.850	15.333	404	SO4, SO2, HNO3+NO3, NH3+NH4, NO2
Hoburgen	SE0008R	56.917	18.150	58	SO4, SO2, NO2
Vavihill	SE0011R	56.017	13.150	175	PM10, PM2.5, SO4, SO2, HNO3+NO3, NH3+NH4, NO2
Aspvreten	SE0012R	58.800	17.383	20	PM10, PM2.5, BaP, EC/OC 02-03
Råö	SE0014R	57.394	11.914	5	SO4, SO2, HNO3+NO3, NH3+NH4, NO2, BaP
Iskrba	SI0008R	45.567	14.867	520	PM10, PM2.5, SO4, SO2, HNO3+NO3, NH3+NH4, Na, Ca, NO2
Chopok	SK0002R	48.933	19.583	2008	SO4, SO2, NO3, HNO3, NO2
Liesek	SK0005R	49.367	19.683	892	SO4, SO2, NO3, HNO3, NO2
Starina	SK0006R	49.050	22.267	345	SO4, SO2, NO3, HNO3, NO2
Topolniky	SK0007R	47.960	17.861	113	SO4, SO2, NO3, HNO3, NO2
Cubuk II	TR0001R	40.500	33.000	1169	SO4, SO2, NO3, HNO3+NO3, HNO3, NH4, NH3+NH4, NH3, NO2

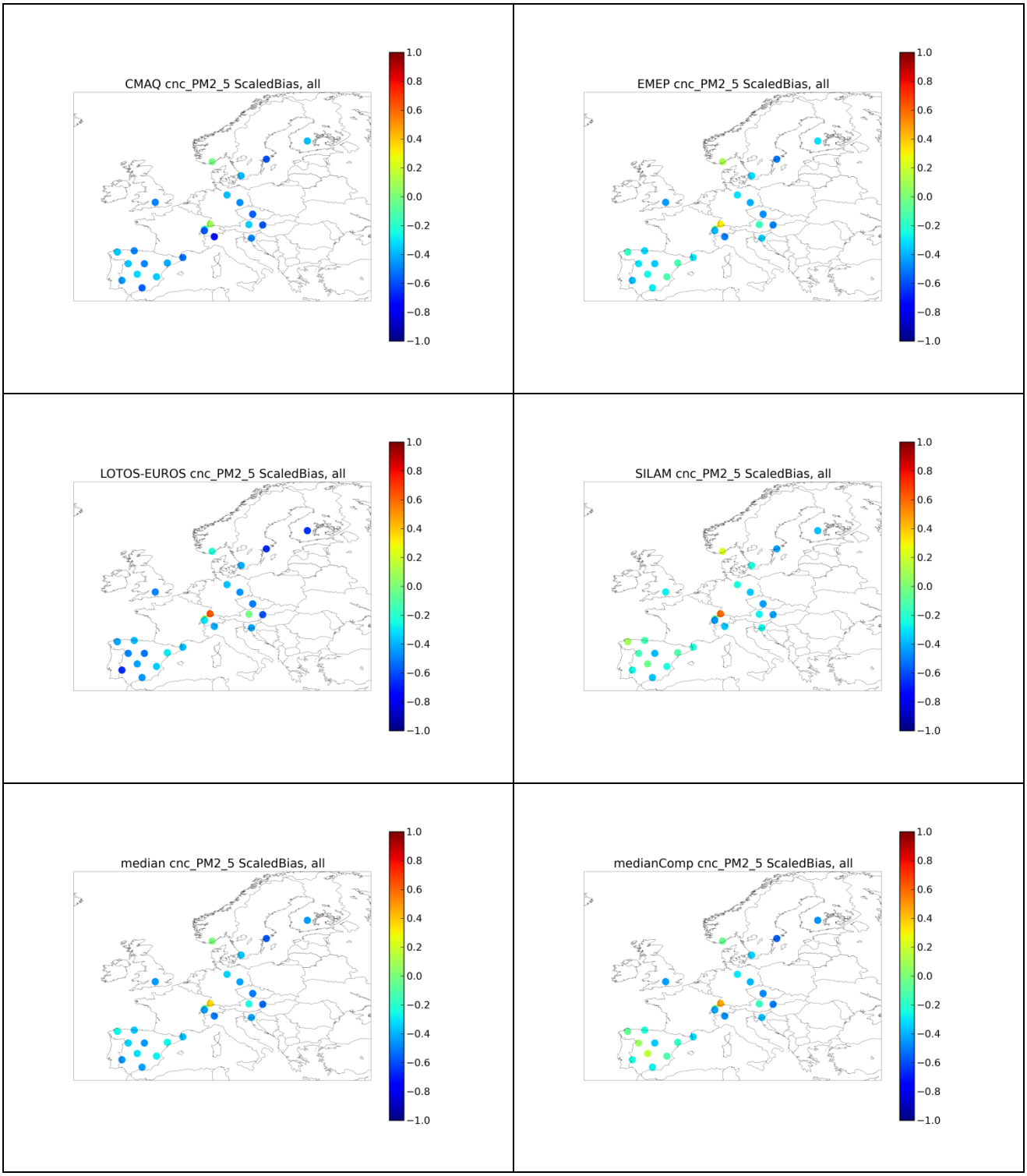

Figure S2. Annual average bias of each model for $PM_{2.5}$ scaled with the observed mean concentration values [relative unit].

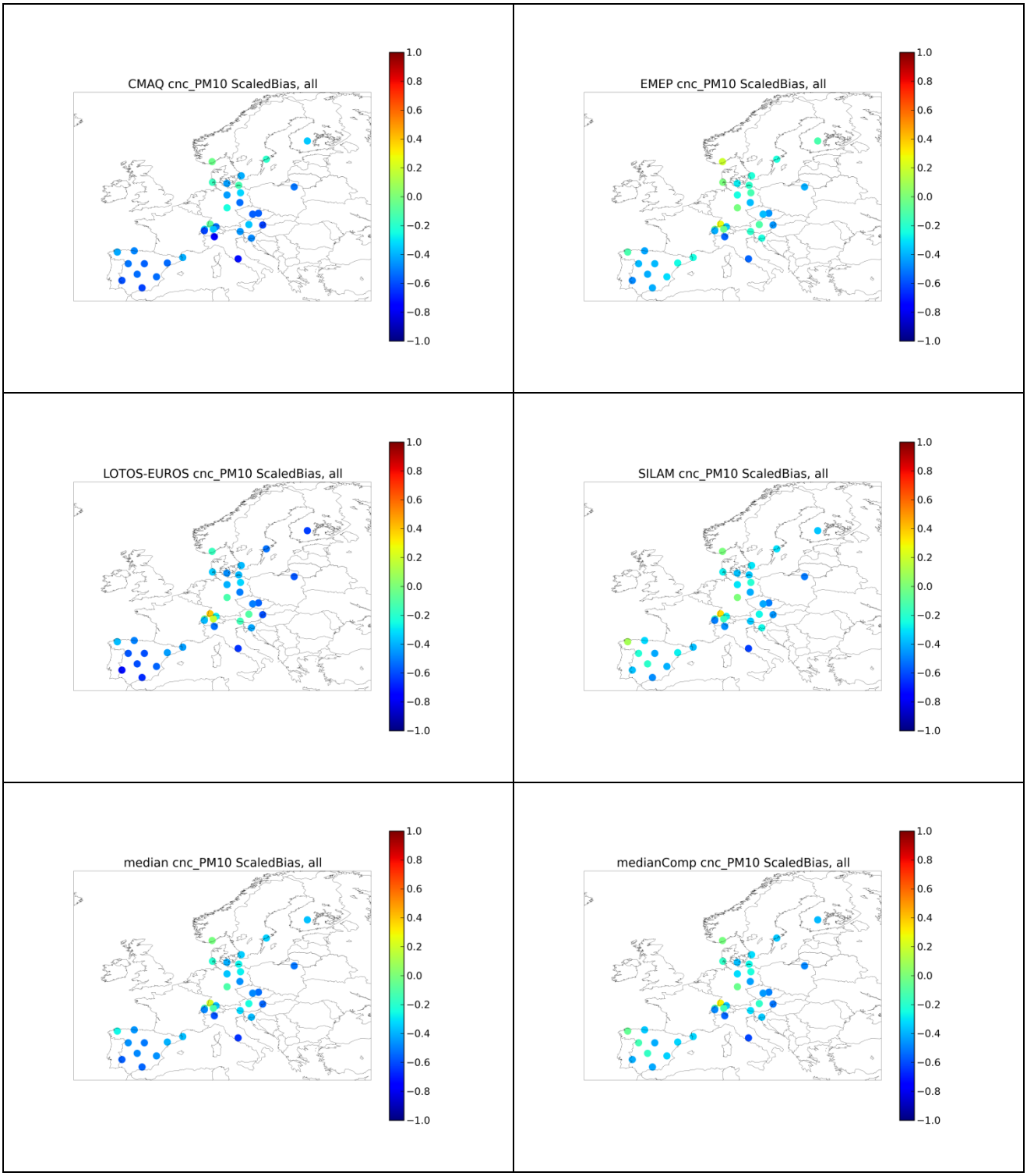

Figure S3. Annual average bias of each model for PM_{10} scaled with the observed mean concentration values [relative unit].

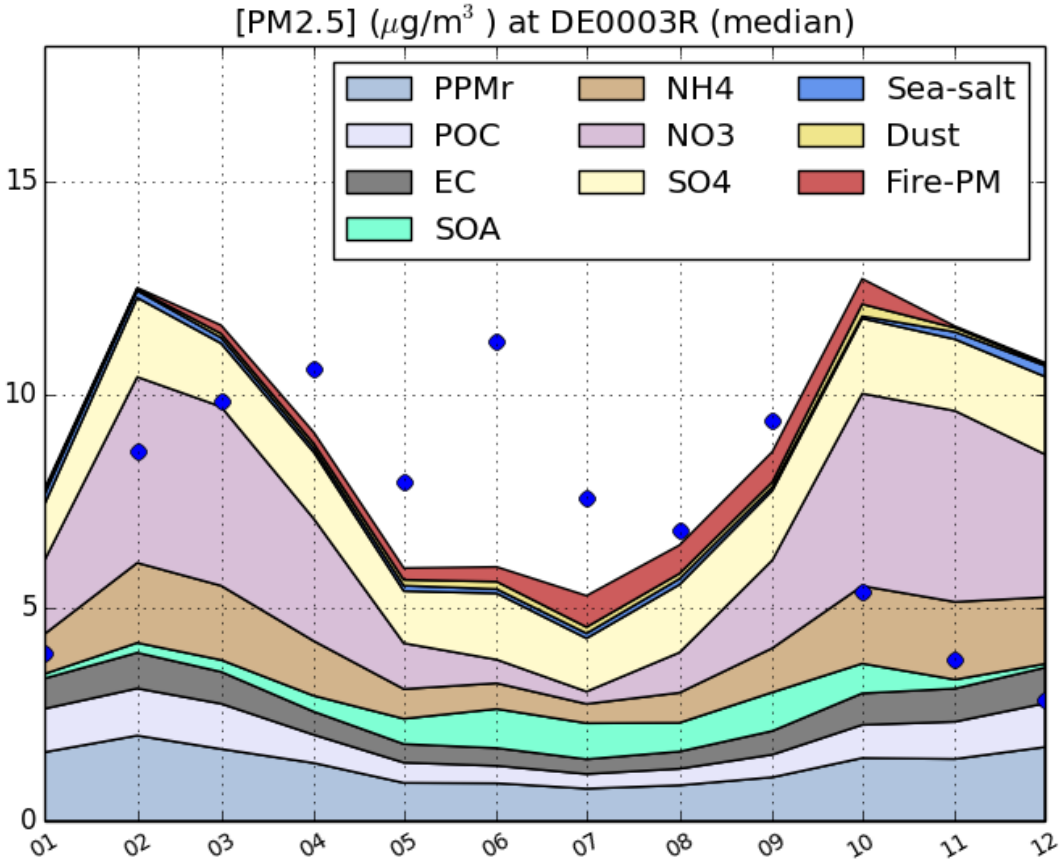

Figure S4. Monthly average $PM_{2.5}$ concentration in Schauinsland (µg/m^3). Blue dots – observed $PM_{2.5}$, colours – ensemble median of the PM components. The stacked components sum up to the $PM_{2.5}$ concentration of the medianComp model.

Fire-PM – PM originating from wild-land fires.
PPMr – non-carbonaceous part of the anthropogenic primary PM.

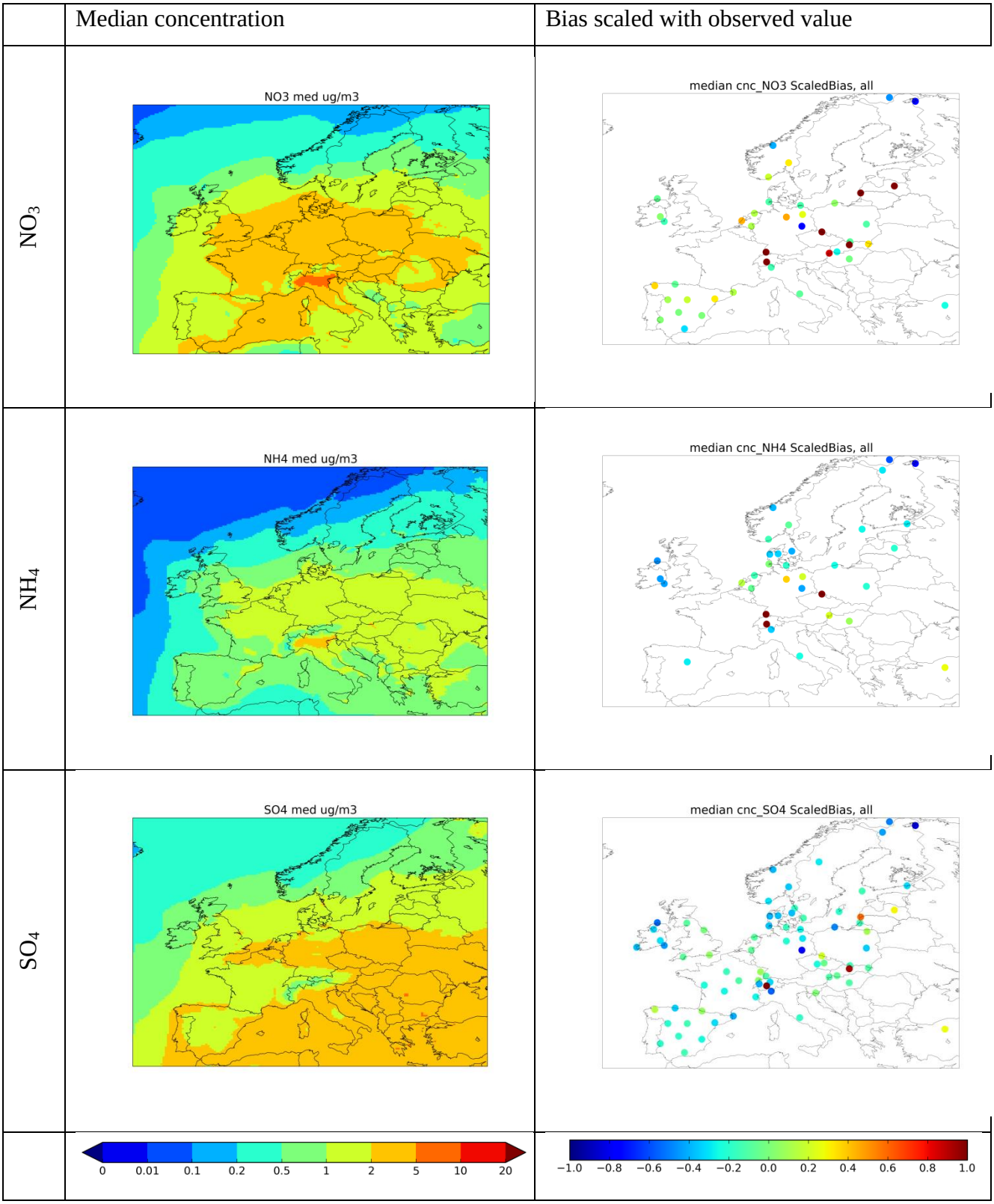

Figure S5. Average annual concentrations of secondary inorganic aerosols (left) and the bias of the ensemble median scaled with the observed value (right).

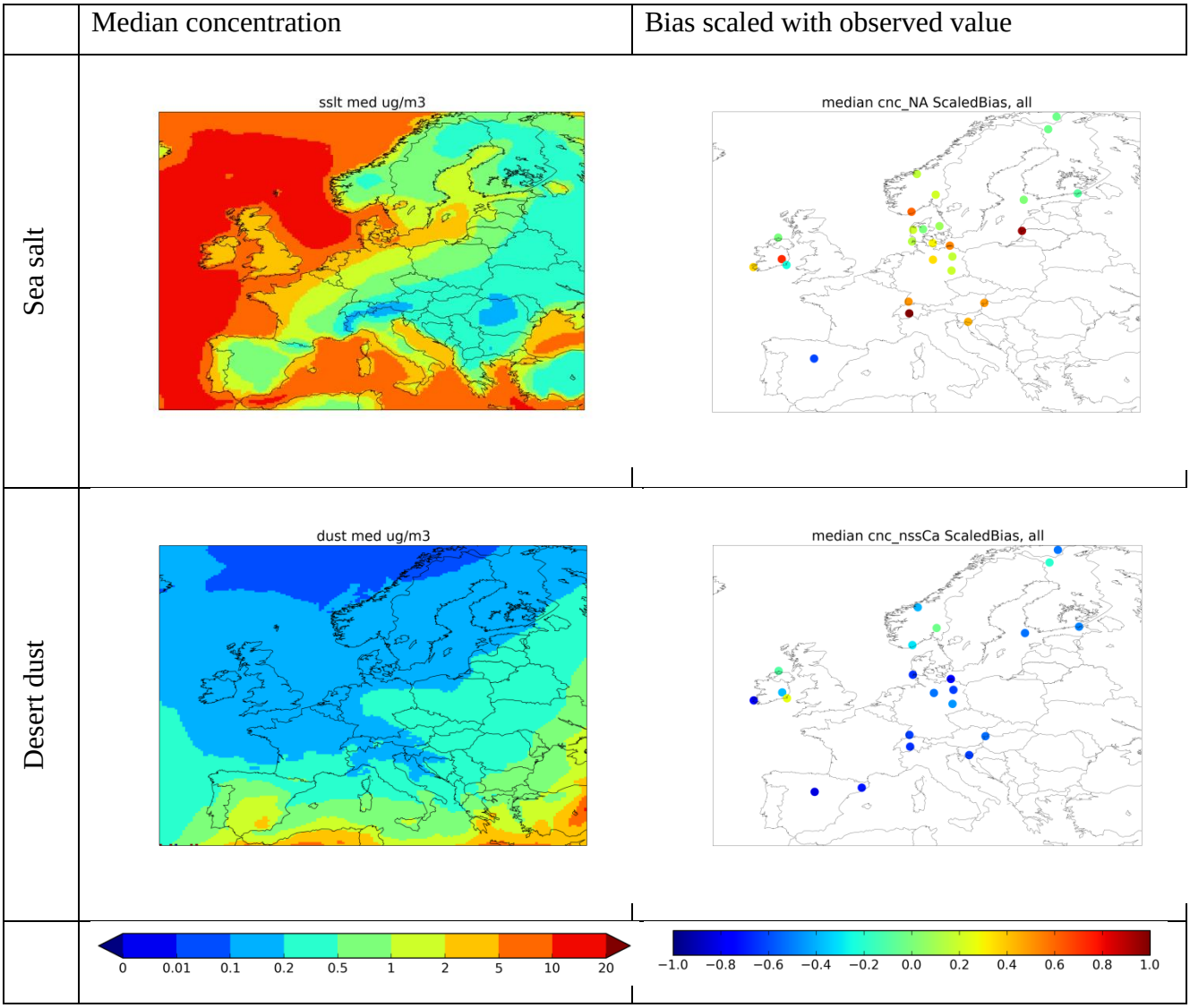

Figure S6. Average annual concentrations of natural aerosols (left) and the bias of the ensemble median scaled with the observed value (right). The desert-dust map is based on EMEP and SILAM models, which provided it as a separate species.

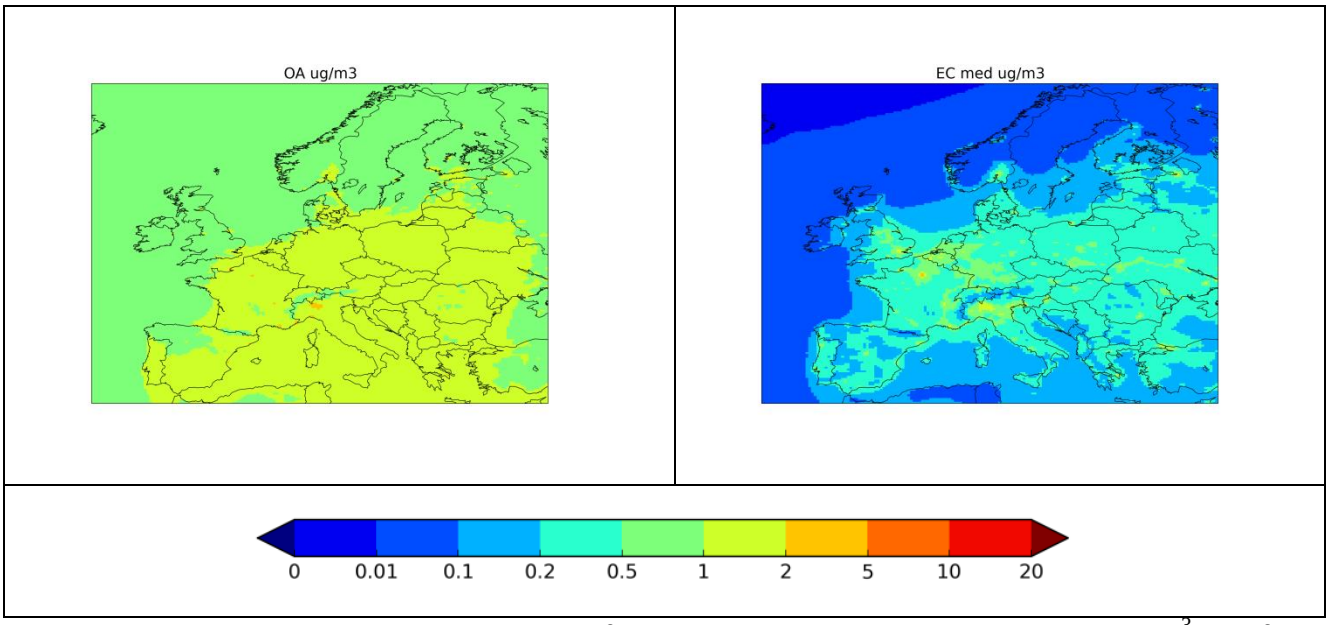

Figure S7. Annual average concentration of the carbonaceous PM components (μg/m^3). Left – organic aerosol, primary + secondary, without wild-land fire contribution; right – elemental carbon. The OA map is based only on EMEP model, which provided it as a separate species.

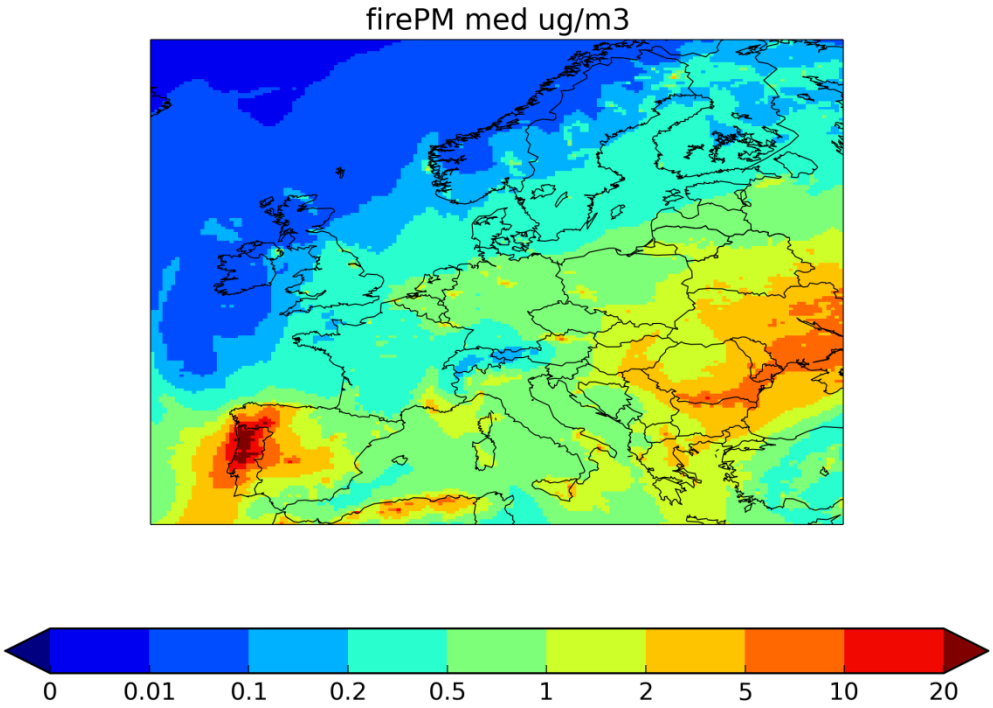

Figure S8. The ensemble median annual average concentration of the wild-land fire emitted unspeciated PM_{10}. The map is based on EMEP, LOTOS-EUROS and SILAM models, which provided it as a separate species.

Table S2 Model skill scores for carbonaceous aerosols, with and without the contribution from wild-land fires.

Species	Model	*Without firePM* Scaled bias	tCor	Fac2	*With firePM* Scaled bias	tCor	Fac2
EC in $PM_{2.5}$	CMAQ	-0.61	0.51	0.35	-0.61	0.51	0.35
Ave obs:	EMEP	-0.60	0.56	0.43	-0.56	0.53	0.4
1.08 µg C/m^3	LOTOS-EUROS	-0.42	0.58	0.45	-0.34	0.51	0.44
	SILAM	-0.17	0.61	0.41	-0.17	0.61	0.4
	median	-0.51	0.61	0.37	-0.45	0.6	0.38
OC in $PM_{2.5}$	CMAQ	-0.80	0.52	0.26	-0.80	0.52	0.26
Ave obs:	EMEP	-0.38	0.58	0.64	-0.25	0.54	0.6
3.61 µg C/m^3	median	-0.59	0.60	0.58	-0.52	0.54	0.61
EC in PM_{10}	CMAQ	-0.69	0.42	0.32	-0.69	0.42	0.32
Ave obs:	EMEP	-0.70	0.43	0.37	-0.66	0.46	0.35
1.32 µg C/m^3	LOTOS-EUROS	-0.53	0.43	0.45	-0.48	0.39	0.44
	SILAM	-0.36	0.43	0.37	-0.35	0.45	0.38
	median	-0.61	0.46	0.38	-0.58	0.49	0.37
OC in PM_{10}	CMAQ	-0.85	0.36	0.18	-0.85	0.36	0.18
Ave obs:	EMEP	-0.51	0.38	0.52	-0.37	0.46	0.52
4.78 µg C/m^3	median	-0.67	0.40	0.45	-0.61	0.46	0.48

Table S3. Model skill scores for NO_2

Species	Model	Scaled bias	tCor	Fac2
NO_2	*CMAQ*	-0.06	0.57	0.59
Ave obs: 1.76 µg N/m^3	*EMEP*	0.19	0.52	0.6
	LOTOS-EUROS	0.26	0.45	0.58
	SILAM	0.39	0.54	0.57
	median	0.16	0.56	0.61

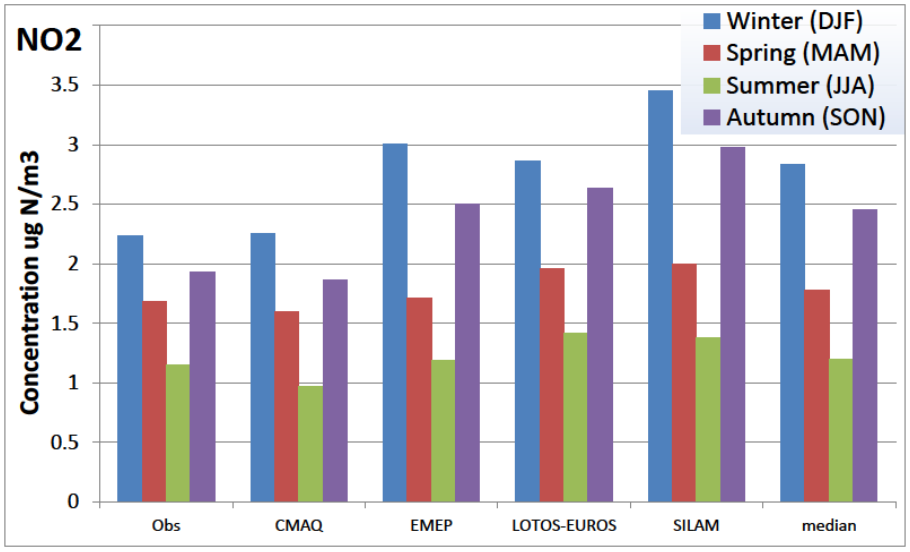

Figure S9. Observed and predicted seasonal concentrations of NO_2, mean over the EMEP stations [µg m^{-3}] in 2005.