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Supplement of

Trends of inorganic and organic aerosols and precursor gases in Europe: insights from the EURODELTA multi-model experiment over the 1990–2010 period

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Supplement

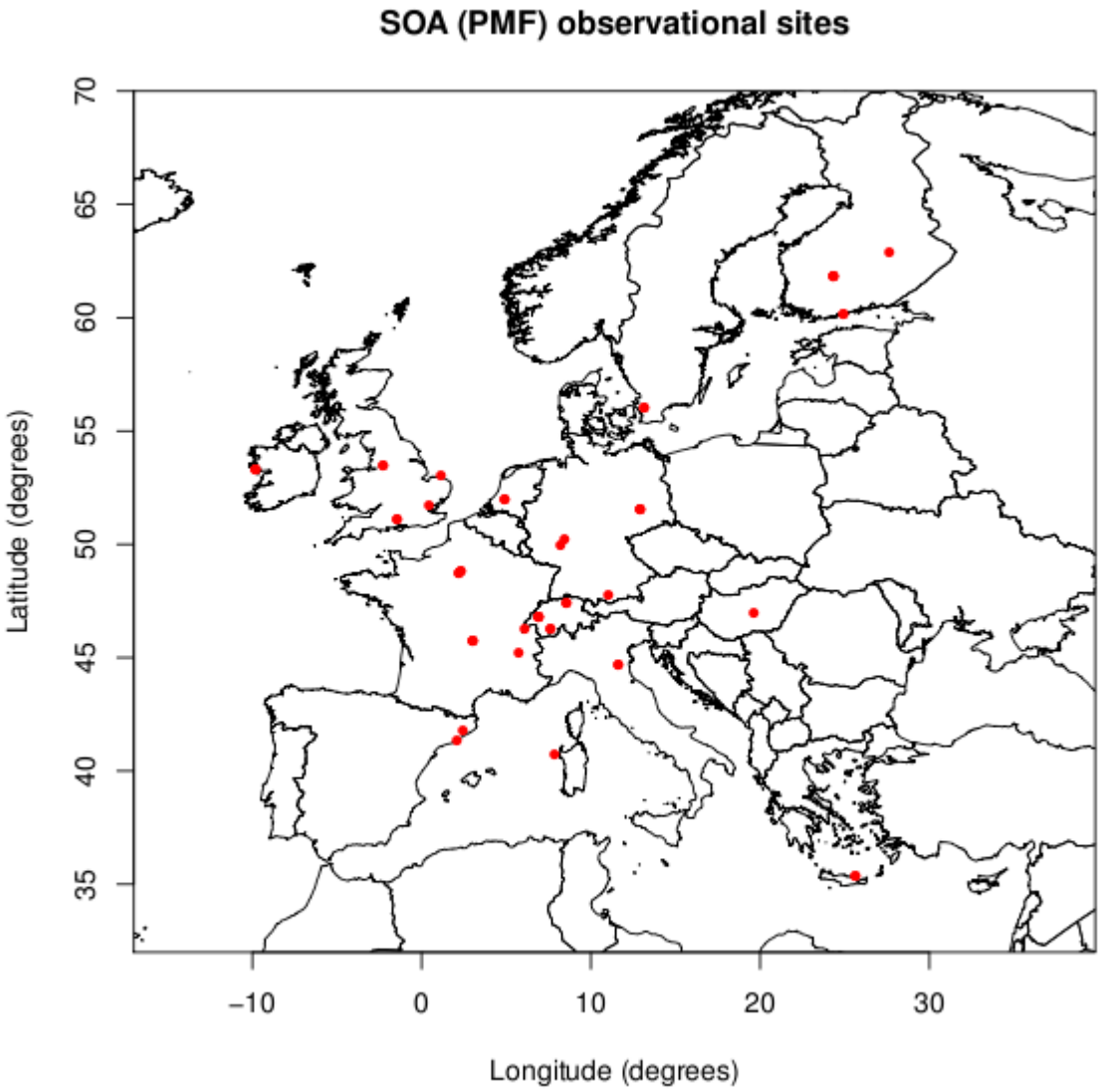


Figure S1: Spatial distribution of the observational sites for SOA (retrieved from PMF analysis). Total number of sites is 28. Sites with averages concentration above 7 µg m^{-3} over the measuring period were excluded from the analysis. Information on the sites and periods of the measurements are reported in Table S2.

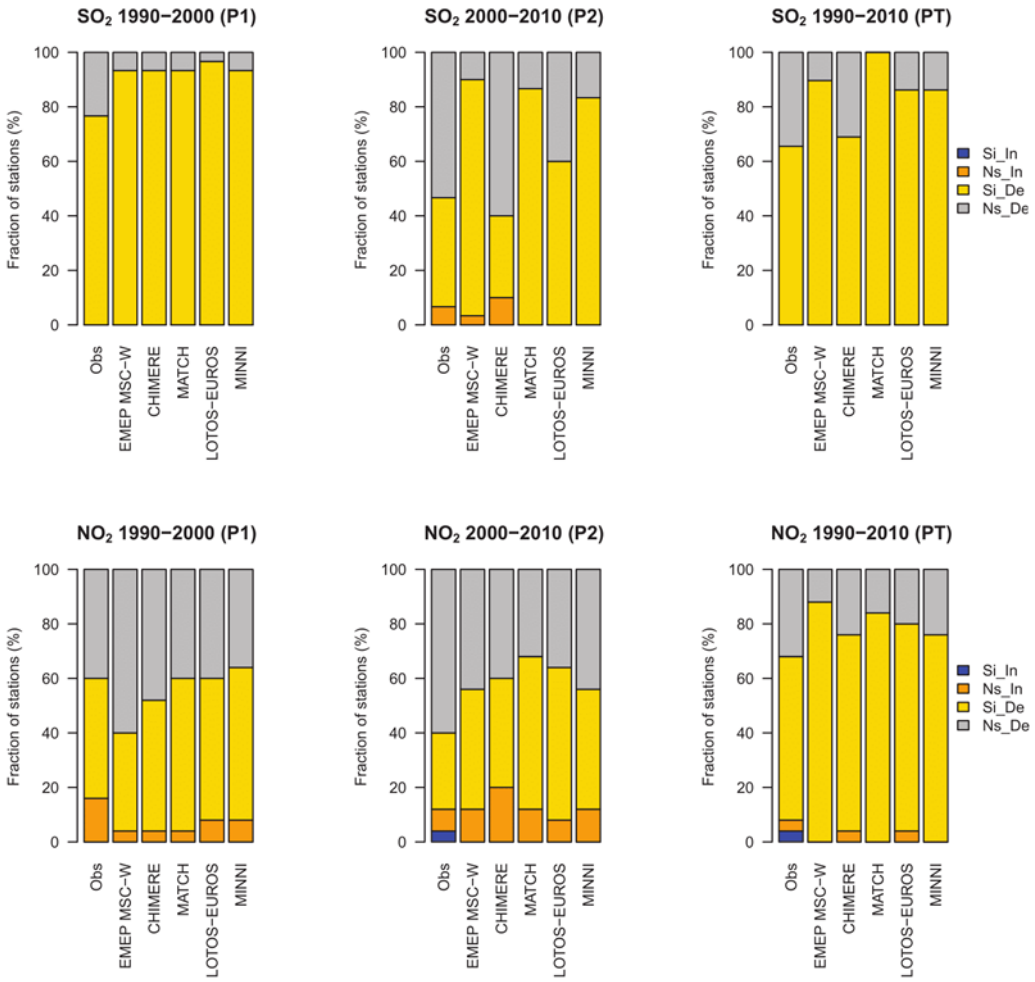


Figure S2: Percentage of statistically significant/non-significant (Si, Ns) increasing/decreasing (In, De) trends in the observations and modeled data for SO_2 (upper-panel) and NO_2 (lower-panel) for the P1 (1990–2000), P2 (2000–2010) and PT (1990–2010) periods (left to right) using a generalized least squares (GLS) fit model.

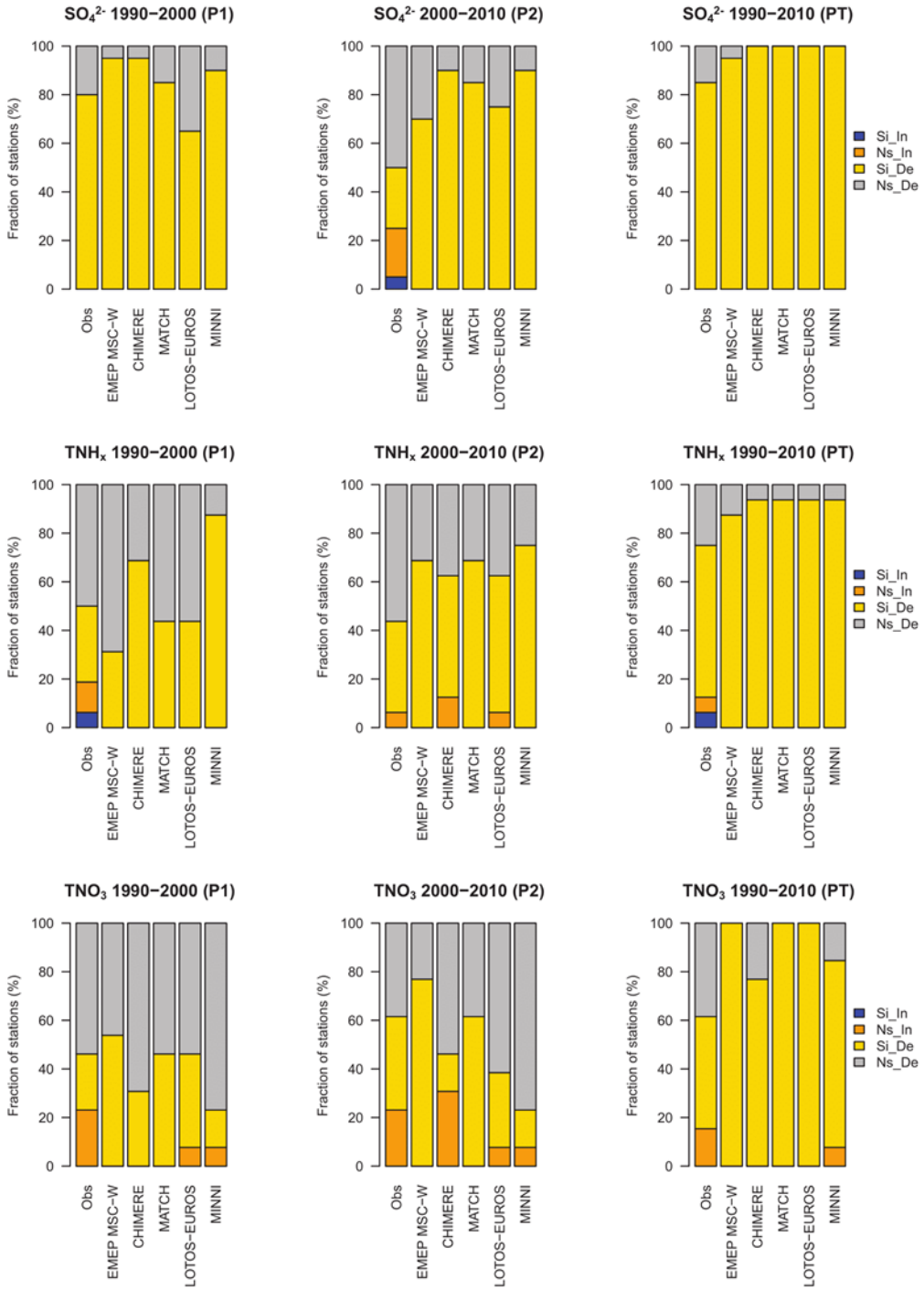
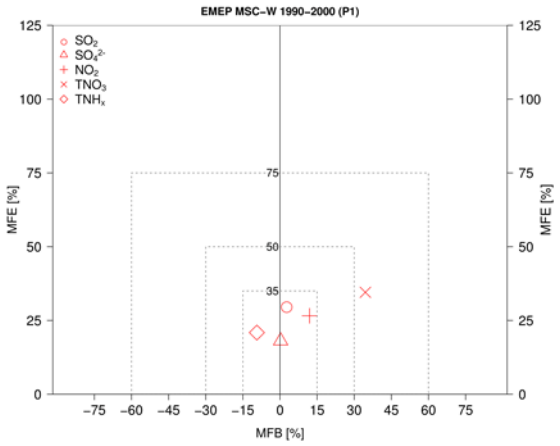
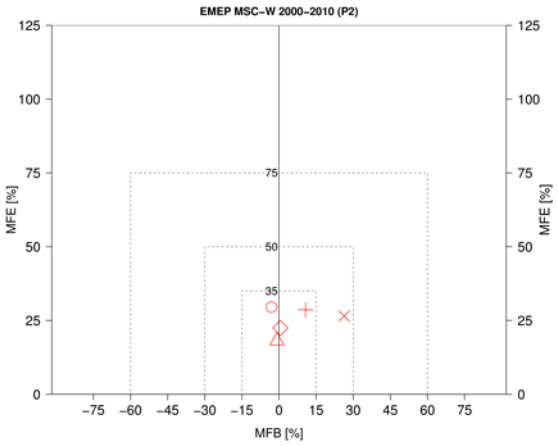
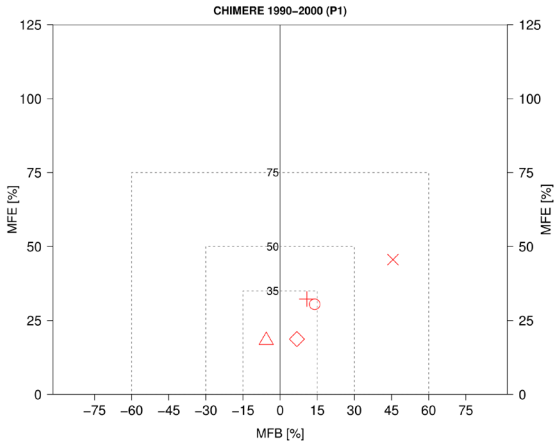
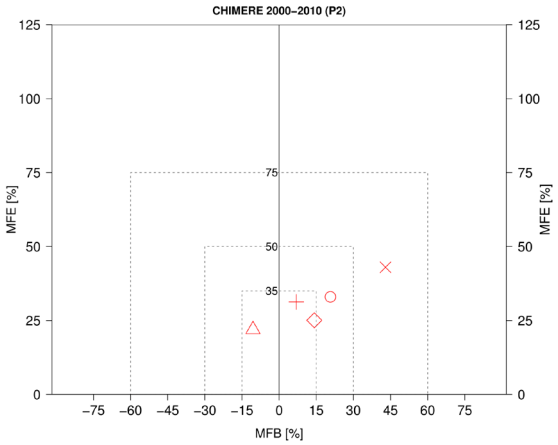


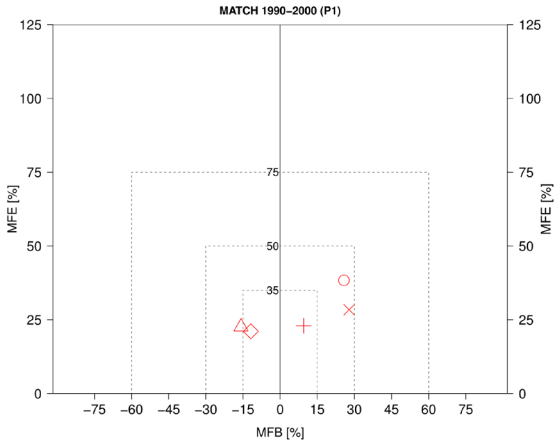
Figure S3: Percentage of statistically significant/non-significant (Si, Ns) increasing/decreasing (In, De) trends in the observations and modeled data for SO_4^{2-} (upper panel), TNH_x (middle panel) and TNO_3 (lower panel) for the P1 (1990–2000), P2 (2000–2010) and PT (1990–2010) periods (left to right) using a generalized least squares (GLS) fit model.

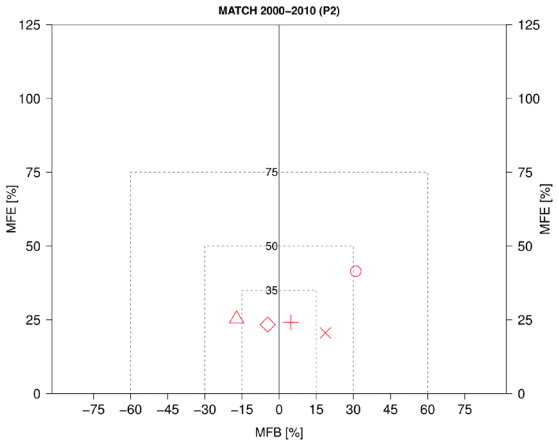

EMEP MSC-W 1990-2000 (P1)
SO2
SO4 2-
NO2
TNO3
TNHx
MFE [%]
MFB [%]

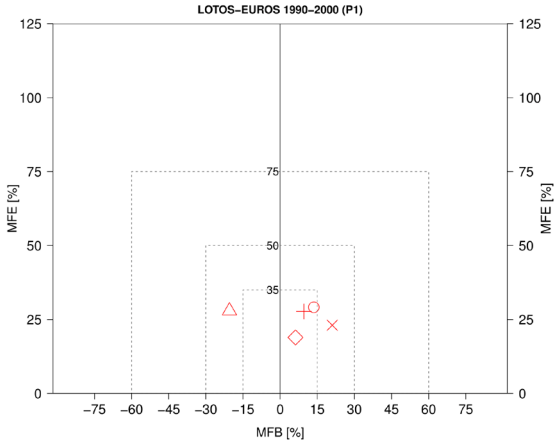

EMEP MSC-W 2000-2010 (P2)
MFE [%]
MFB [%]

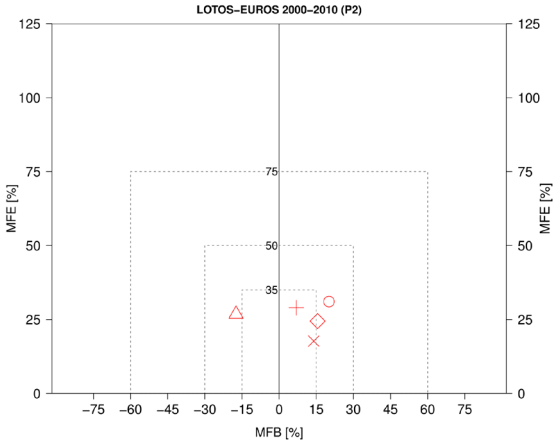

CHIMERE 1990-2000 (P1)
MFE [%]
MFB [%]


CHIMERE 2000-2010 (P2)
MFE [%]
MFB [%]


MATCH 1990-2000 (P1)
MFE [%]
MFB [%]


MATCH 2000-2010 (P2)
MFE [%]
MFB [%]


LOTOS-EUROS 1990-2000 (P1)
MFE [%]
MFB [%]


LOTOS-EUROS 2000-2010 (P2)
MFE [%]
MFB [%]

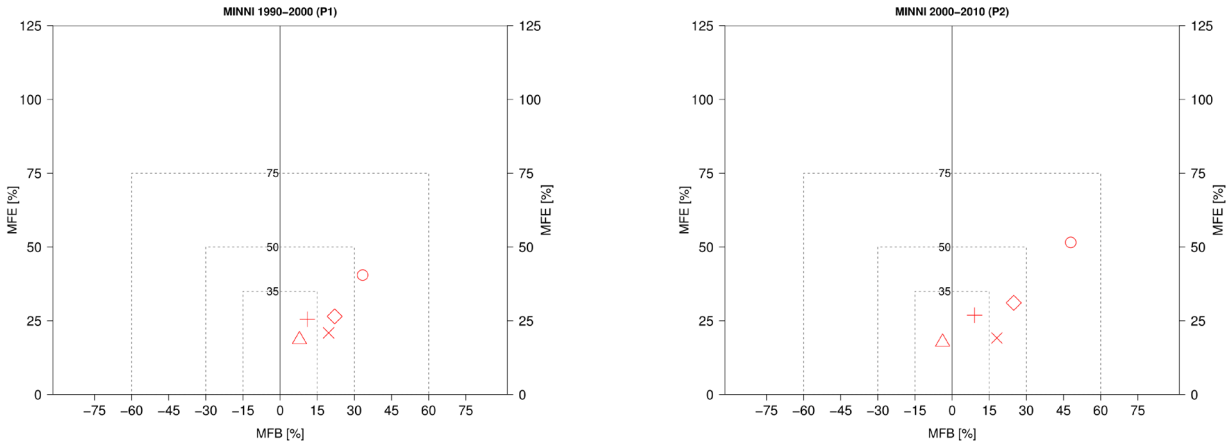


Figure S4: Soccer-goal plots for yearly concentrations of SO_2, SO_4^{2-}, NO_2, TNO_3 and TNH_x for the 1990–2000 (P1) period (left) and 2000–2010 (P2) period (right). Rows; from top to bottom: EMEP MSC-W, CHIMERE, MATCH, LOTOS-EUROS, MINNI. MFB: mean fractional bias; MFE: mean fractional error.

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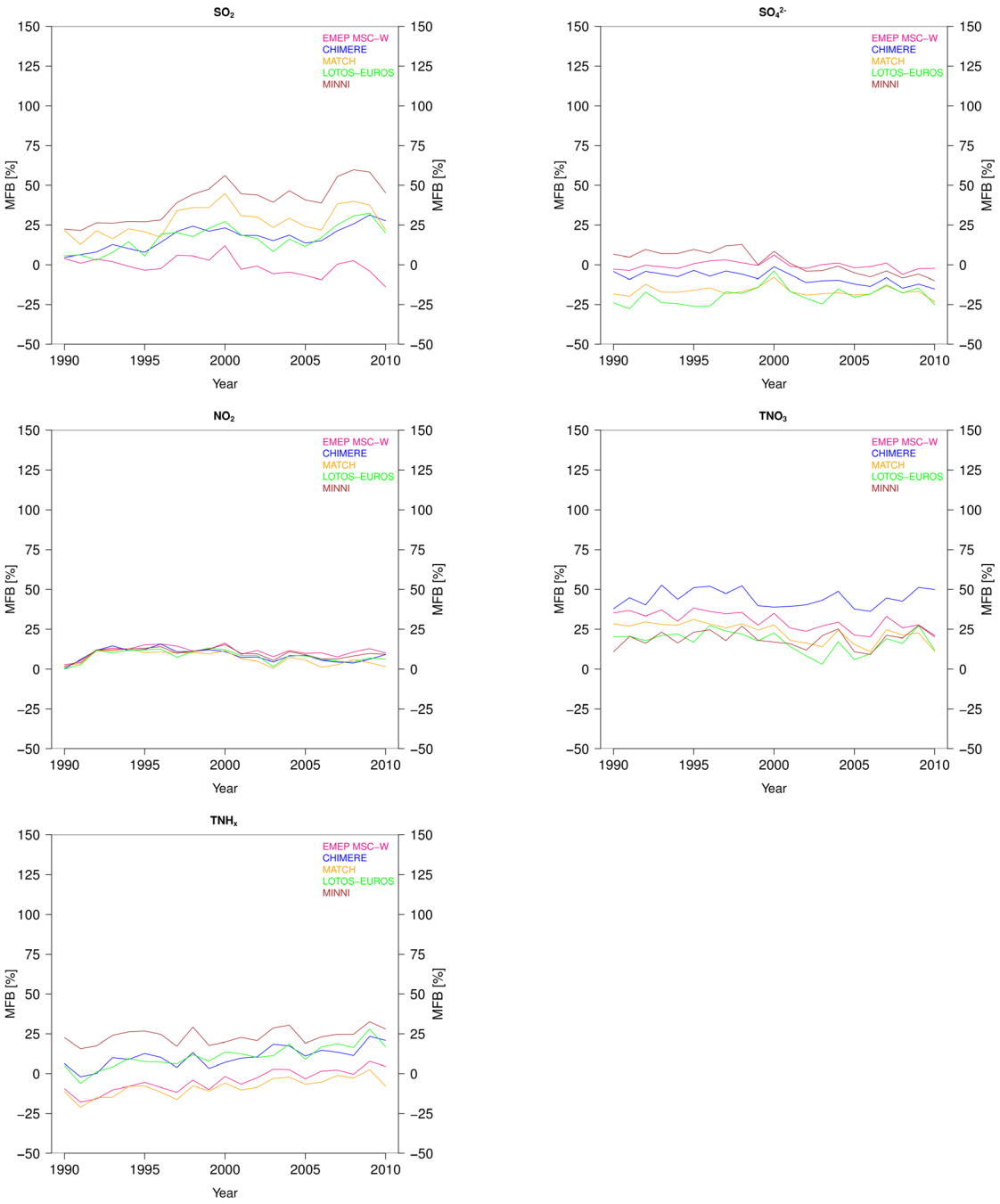

Figure S5: Evolution of the mean fractional bias (MFB) for SO_2, SO_4^{2-}, NO_2, TNO_3 and TNH_x over the 1990–2010 period.

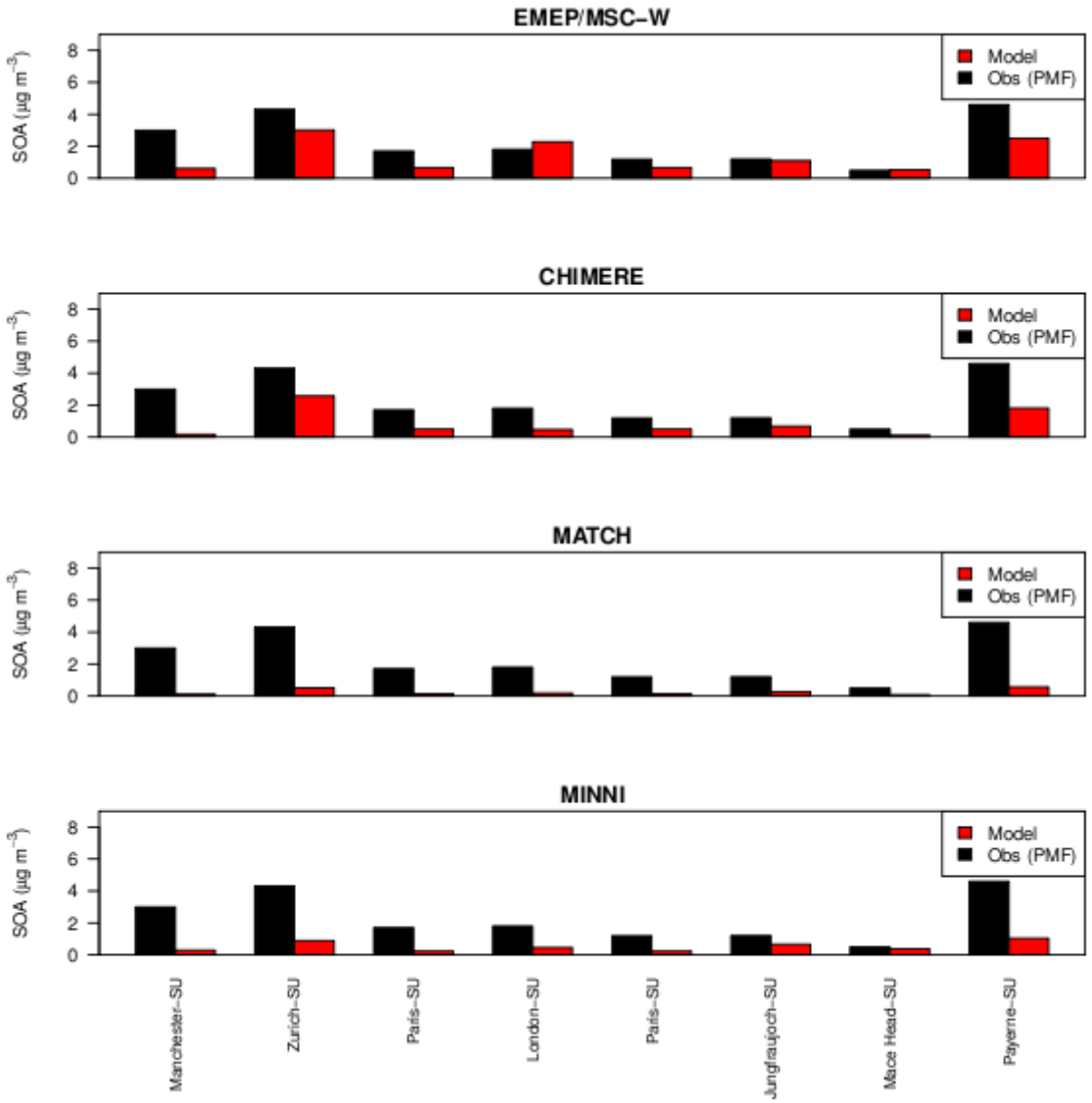

Figure S6: Modeled (red) and observed (black) SOA fraction at measurement stations during summer periods (8 sites).

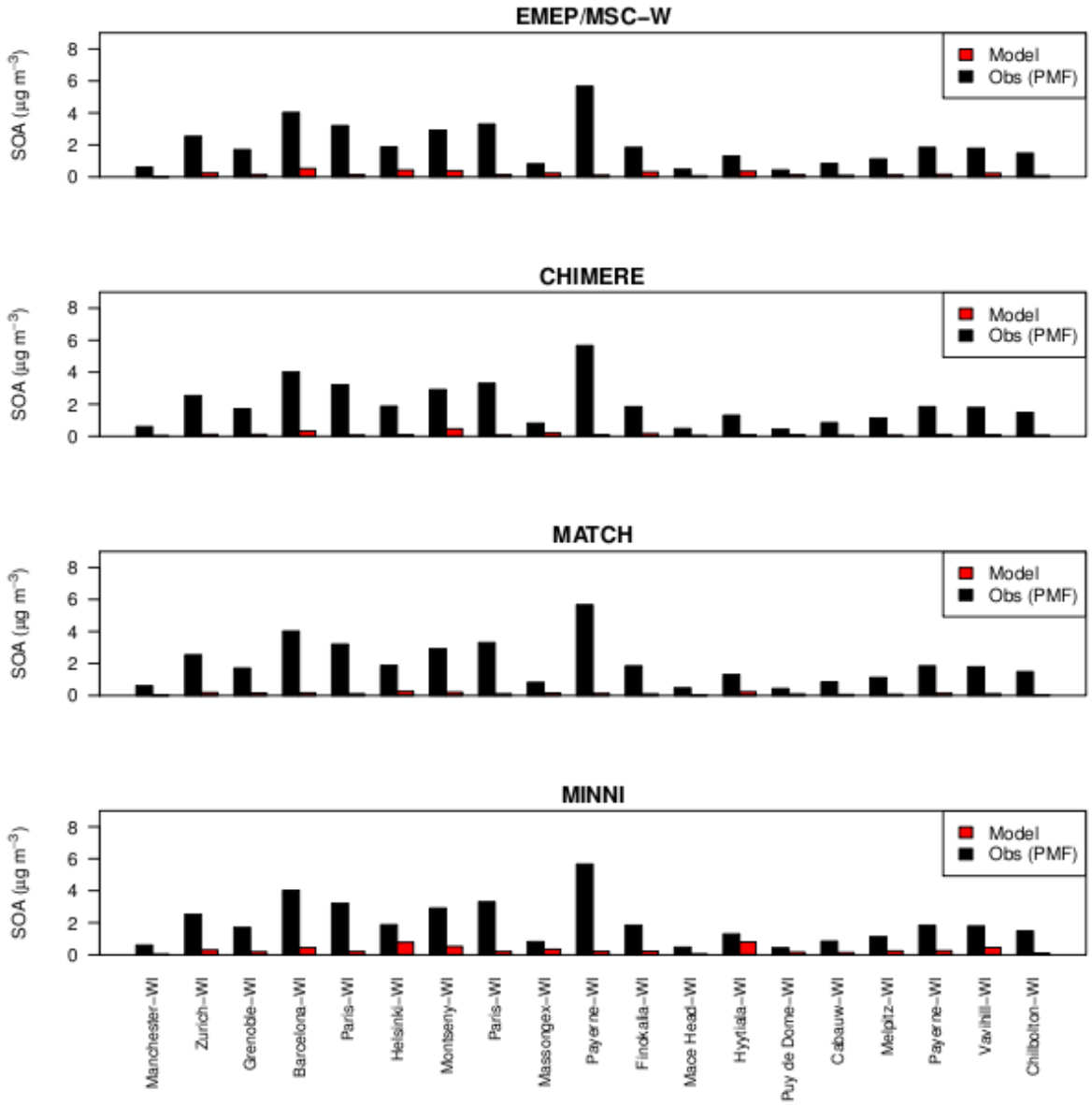

Figure S7: Modeled (red) and observed (black) SOA fraction at measurement stations during winter periods (19 sites).

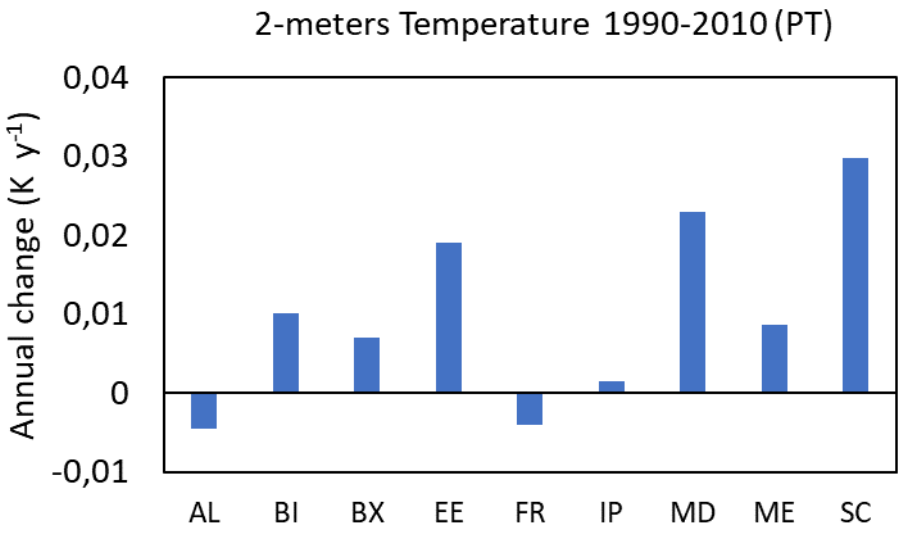

Figure S8: Modeled absolute trends in 2-meters Temperature for the 1990–2010 (PT) period as available in ERA-interim forcing data for the different PRUDENCE zones (Figure 1).

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Table S1: List of the EMEP stations available for the trends analysis for each investigated species (https://wiki.met.no). The numbers of observational sites are 30, 20, 25, 13 and 16 for SO_2, SO_4^{2-}, NO_2, TNO_3 and TNH_x, respectively.

Stations	Latitude	Longitude	SO_2	SO_4^{2-}	NO_2	TNO_3	TNH_x
AT0002R	47.77	16.77	X				
AT0005R	46.68	12.97	X				
BE0011R	51.02	2.58			X		
BE0013R	51.25	3.35			X		
BE0032R	51.46	6.00			X		
CH0001G	46.55	7.99	X				
CH0002R	46.81	6.94	X	X	X		
CZ0001R	49.73	16.05	X	X			
CZ0003R	49.58	15.08	X	X	X		X
DE0001R	54.93	8.31	X		X		
DE0002R	52.80	10.76	X		X		
DE0003R	47.91	7.91			X		
DE0005R	48.82	13.22					
DE0007R	53.17	13.03	X				
DE0044R	51.53	12.93					
DK0003R	56.35	9.60	X	X		X	X
DK0008R	56.72	11.52	X	X		X	X
FI0004R	62.53	24.22	X			X	
FI0009R	59.78	21.38	X	X		X	X
FI0017R	60.53	27.69	X	X		X	X
FI0022R	66.32	29.40	X	X		X	X
FI0037R	62.58	24.18		X			X
GB0014R	54.33	-0.81				X	X
GB0037R	53.40	-1.75	X		X		
GB0038R	50.79	0.18			X		
HR0002R	45.90	15.96					X
HU0002R	46.97	19.58				X	
IE0001R	51.94	-10.24	X	X	X		
IT0004R	45.80	8.63	X		X		
LT0015R	55.35	21.07	X	X	X		X
LV0010R	56.16	21.17	X		X		
NL0009R	53.33	6.28	X		X		
NL0010R	51.54	5.85			X		
NO0001R	58.38	8.25	X	X	X		X
NO0002R	58.39	8.25				X	
NO0015R	65.83	13.92	X	X	X		
NO0039R	62.78	8.88	X	X	X	X	X
NO0042G*	-	-	X	X			
PL0002R	51.82	21.98	X	X	X	X	
PL0003R	50.73	15.73	X	X	X		X
SE0002R	57.42	11.93	X				
SE0005R	63.85	15.33	X	X	X		X
SE0011R	56.02	13.15	X	X	X	X	X

SE0014R	57.39	11.91		X	X	X	X
SK0002R	48.93	19.58	X	X	X		

*Available in the data-set but outside the modeling domain.

Table S2: List of stations used for the SOA evaluation. The total number of stations retrieved for Europe from the Tsimpidi et al., 2016 study is 28. Observational sites with average concentrations above 7 μg m^{-3} over the measuring period were removed from the analysis.

Site	Year	Latitude	Longitude	Season
Barcelona-WI	2009	41.39	2.12	Winter
Cabauw-SP	2008	51.97	4.93	Spring
Cabauw-WI	2009	51.97	4.93	Winter
Chilbolton-WI	2009	51.1	-1.40	Winter
Finokalia-SP	2008	35.33	25.66	Spring
Finokalia-WI	2009	35.33	25.66	Winter
Grenoble-WI	2009	45.18	5.73	Winter
Harwell-AU	2008	51.15	-1.44	Autumn
Helsinki-SP	2009	60.2	24.95	Spring
Helsinki-WI	2009	60.2	24.95	Winter
Hohenpeisseberg-SP	2002	47.8	11.00	Spring
Hyytiälä-AU	2008	61.8	24.3	Autumn
Hyytiälä-SP	2003	61.8	24.3	Spring
Hyytiälä-SP	2005	61.8	24.3	Spring
Hyytiälä-WI	2009	61.8	24.3	Winter
Jungfraujoch-SU	2002	46.3	7.6	Summer
Jungfraujoch-SU	2008	46.3	7.6	Spring
K-Pustza-AU	2008	46.96	19.58	Autumn
London-SU	2003	51.7	0.4	Summer
Mace head-SP	2008	53.3	-9.80	Spring
Mace Head-SU	2002	53.3	-9.80	Summer
Mace Head-WI	2009	53.3	-9,80	Winter
Mainz-AU	2004	49.98	8.23	Autumn
Manchester-SU	2001	53.5	-2.22	Summer
Manchester-WI	2002	53.5	-2.22	Winter
Massongex-WI	2006	46.24	6.14	Winter
Melpitz-AU	2008	51.54	12.93	Autumn
Melpitz-SP	2008	51.54	12.93	Spring
Melpitz-WI	2009	51.54	12.93	Winter
Montseny-WI	2009	41.76	2.4	Winter
Norfolk coast-SP	2004	53	1.1	Spring
Paris-SU	2009	48.83	2.36	Summer
Paris-SU	2009	48.72	2.21	Summer
Paris-WI	2010	48.83	2.36	Winter
Paris-WI	2010	48.72	2.21	Winter
Payerne-AU	2008	46.8	6.95	Autumn
Payerne-SU	2006	46.8	6.95	Summer
Payerne-WI	2007	46.8	6.95	Winter
Payerne-WI	2009	46.8	6.95	Winter
Po Valley-SP	2008	44.65	11.62	Spring
Puijo-AU	2008	62.9	27.65	Autumn
Puy de Dome-AU	2008	45.77	2.97	Autumn
Puy de Dome-WI	2009	45.77	2.97	Winter
San Pietro-SP	2008	44.65	11.65	Spring

Vavihill-AU	2008	56.02	13.15	Autumn
Vavihill-WI	2009	56.02	13.15	Winter
Zürich-SU	2005	47.4	8.5	Summer
Zürich-WI	2006	47.4	8.5	Winter

Table S3: Modeled and observed mean relative trends of SO_2 and SO_4^{2-}, NO_2, TNO_3 and TNH_x for the P1 (1990–2000), P2 (2000–2010) and PT (1990–2010) periods retrieved with a generalized least squares (GLS) fit model.

		SO_2	SO_4^{2-}	NO_2	TNO_3	TNH_x
P1	Obs	-84	-57	-24	-17	-39
	EMEP MSC-W	-77	-48	-17	-20	-19
	CHIMERE	-70	-53	-20	-16	-23
	MATCH	-67	-49	-19	-15	-22
	LOTOS-EUROS	-70	-42	-17	-18	-18
	MINNI	-66	-54	-17	-14	-28
P2	Obs	-42	-13	-13	-23	-22
	EMEP MSC-W	-54	-23	-15	-25	-15
	CHIMERE	-22	-31	-21	-9	-12
	MATCH	-46	-29	-22	-26	-16
	LOTOS-EUROS	-35	-29	-20	-16	-11
	MINNI	-39	-34	-15	-16	-16
PT	Obs	-84	-66	-36	-26	-52
	EMEP MSC-W	-86	-66	-40	-37	-29
	CHIMERE	-75	-71	-45	-26	-31
	MATCH	-80	-68	-44	-37	-34
	LOTOS-EUROS	-77	-61	-41	-34	-28
	MINNI	-75	-75	-39	-27	-39