

Supplement of Atmos. Chem. Phys., 16, 8939–8962, 2016  
<http://www.atmos-chem-phys.net/16/8939/2016/>  
doi:10.5194/acp-16-8939-2016-supplement  
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Atmospheric  
Chemistry  
and Physics  
Open Access  
EGU

*Supplement of*

## **Global combustion sources of organic aerosols: model comparison with 84 AMS factor-analysis data sets**

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**Table S1.** Statistical evaluation of EMAC simulated inorganic gas and aerosol concentrations against monthly average observations from North America during 2001–2010. The units are in ppb for gas and in  $\mu\text{g m}^{-3}$  for aerosol species.

<b><u>EPA Network for gas-phase species and IMPROVE Network for aerosols</u></b>					
<b>Metric</b>	<b>SO<sub>2</sub></b>	<b>NO<sub>2</sub></b>	<b>SO<sub>4</sub><sup>2-</sup></b>	<b>NO<sub>3</sub><sup>-</sup></b>	<b>NH<sub>4</sub><sup>+</sup></b>
<b>Observed</b>	3.35	12.07	1.50	0.71	1.12
<b>Simulated</b>	1.89	4.22	0.83	0.52	0.82
<b>MAGE</b>	2.03	8.07	1.12	0.50	0.54
<b>MB</b>	-1.46	-7.85	-0.67	-0.19	-0.30
<b>NME (%)</b>	61	67	75	70	49
<b>NMB (%)</b>	-44	-65	-44	-26	-27
<b>RMSE</b>	4.27	10.36	1.76	1.06	0.65
<b>Number of comparisons</b>	53094	46250	17129	39056	481

**Table S2.** Statistical evaluation of EMAC simulated inorganic gas and aerosol concentrations against monthly average observations from Europe during 2001–2010. The units are in  $\mu\text{g m}^{-3}$  for both gas and aerosol species.

<b><u>EMEP Network</u></b>					
<b>Metric</b>	<b>SO<sub>2</sub></b>	<b>NO<sub>2</sub></b>	<b>SO<sub>4</sub><sup>2-</sup></b>	<b>NO<sub>3</sub><sup>-</sup></b>	<b>NH<sub>4</sub><sup>+</sup></b>
<b>Observed</b>	1.54	6.98	1.35	1.12	0.83
<b>Simulated</b>	2.93	7.28	1.00	1.34	0.76
<b>MAGE</b>	1.90	3.58	0.82	1.17	0.48
<b>MB</b>	1.39	0.3	-0.35	0.22	-0.07
<b>NME (%)</b>	123	51	61	105	58
<b>NMB (%)</b>	90	4	-25	19	-8
<b>RMSE</b>	2.97	7.18	1.27	2.14	0.74
<b>Number of comparisons</b>	9130	8626	16707	9307	7787

**Table S3.** Statistical evaluation of EMAC simulated inorganic gas and aerosol concentrations against monthly average observations from Eastern Asia during 2001–2010. The units are in ppb for gas and in  $\mu\text{g m}^{-3}$  for aerosol species.

<b><u>EANET Network</u></b>					
<b>Metric</b>	<b>SO<sub>2</sub></b>	<b>NO<sub>2</sub></b>	<b>SO<sub>4</sub><sup>2-</sup></b>	<b>NO<sub>3</sub><sup>-</sup></b>	<b>NH<sub>4</sub><sup>+</sup></b>
<b>Observed</b>	2.80	14.40	3.78	1.13	1.05
<b>Simulated</b>	1.74	2.07	1.07	0.75	0.67
<b>MAGE</b>	1.90	12.59	2.84	0.93	0.68
<b>MB</b>	-1.06	-12.33	-2.71	-0.38	-0.38
<b>NME (%)</b>	68	87	75	82	64
<b>NMB (%)</b>	-38	-86	-72	-33	-36
<b>RMSE</b>	3.39	16.94	5.17	2.01	1.74
<b>Number of comparisons</b>	7076	926	2965	2862	2897

**Table S4.** Secondary organic aerosol mass yield<sup>1</sup> parameters

<i>VOC Species</i>	<i>C* in <math>\mu\text{g m}^{-3}</math> at 298K</i>			
	1	10	10 <sup>2</sup>	10 <sup>3</sup>
Benzene, Toluene	0.003	0.165	0.300	0.435
Trimethyl Benzenes, Xylene, and other Aromatics	0.002	0.195	0.300	0.435
Pentanes	0.000	0.038	0.000	0.000
Hexanes, other higher Alkenes	0.000	0.150	0.000	0.000
Propene	0.001	0.005	0.038	0.150
Other Alkenes	0.003	0.026	0.083	0.270
Isoprene	0.009	0.030	0.015	0.000
Monoterpenes	0.107	0.092	0.359	0.600

<sup>1</sup>The SOA yields are based on an assumed particle density of 1.5 g cm<sup>-3</sup>.

**Table S5.** AMS and EMAC average concentrations for OA species over urban areas. In all cases the averages are over all the available data for each campaign. The period and the exact location of the each site are also listed.

Location	Coordinates		Time Period	AMS						EMAC				Reference
	Lat	Lon		HOA	BBOA	OOA	SVOOA	LVOOA	POA	SOA	Fresh SOA	Aged SOA		
Manchester , UK	53.5	-2.22	14/06/01- 25/06/01	1.9	-	3	-	-	-	0.35	0.64	-	-	Allan et al., 2003 ; Jimenez et al., 2009
New York , US	40.74	-73.92	30/06/01- 5/08/01	1.1	-	4.8	1.8	3	-	0.81	2.64	1.11	1.53	Drewnick et al. 2004; Jimenez et al., 2009
Vancouver, CA	49.25	-123.13	11/08/01- 24/08/01	2.4	-	2.5	-	-	-	0.26	2.81	-	-	Boudries et al., 2004; Jimenez et al., 2009
Manchester , UK	53.5	-2.22	17/01/02- 28/01/02	1	1.5	0.6	-	-	-	0.45	0.15	-	-	Allan et al., 2003; Jimenez et al., 2009
Pittsburgh, US	40.44	-79.94	06/09/02- 22/09/02	1.4	-	3.1	0.5	2.6	-	0.42	3.86	1.96	1.89	Zhang et al., 2004; Jimenez et al., 2009
Mexico City , MX	19.48	-99.15	13/04/03- 16/04/03	3.24	1.48	10.26	-	-	-	2.81	4.69	-	-	Salcedo et al., 2006; Tsimplidi et al., 2010
Boulder, US	40.02	-105.27	07/06/03- 20/06/03	0.5	-	2.5	1.5	1	-	0.26	2.46	1.56	0.90	Nemitz et al., 2008; Jimenez et al., 2009
Tokyo , JP	35.67	139.75	23/07/03- 14/08/03	1.9	-	4.7	1.5	3.2	-	0.48	2.95	0.89	2.06	Takegawa et al., 2005; Jimenez et al., 2009
New York , US	40.74	-73.92	07/01/04- 06/02/04	2.2	-	2.6	-	-	-	0.58	0.24	-	-	Drewnick et al. 2004; Jimenez et al., 2009
Tokyo , JP	35.67	139.75	20/01/04- 10/02/04	3.7	1	2.3	-	-	-	0.68	1.14	-	-	Takegawa et al., 2006; Jimenez et al., 2009
Mainz, DE	49.98	8.23	16/09/04- 01/10/04	0.8	-	1.1	-	-	-	0.74	2.76	-	-	Vester et al. 2007; Jimenez et al., 2009

**Table S5.** Continued

Location	Coordinates		Time Period	AMS						EMAC				Reference
	Lat	Lon		HOA	BBOA	OOA	SVOOA	LVOOA	POA	SOA	Fresh SOA	Aged SOA		
URBAN Riverside, US	33.95	-117.4	14/07/05- 13/08/05	1.2	0.6	7	4.2	2.8	1.16	10.9	4.73	6.17	De Carlo et al., 2006; Jimenez et al., 2009	
Zurich , CH	47.4	8.5	14/07/05- 04/08/05	0.46	0.65	4.31	1.44	2.87	0.5	3.37	1.55	1.82	Lanz et al. 2007; Lanz et al. 2010	
Zurich , CH	47.4	8.5	06/01/06- 25/01/06	0.32	1.75	2.53	-	-	1.08	0.49	-	-	Lanz et al. 2008; Lanz et al. 2010	
Mexico City , MX	19.48	-99.15	10/03/06- 30/03/06	4.6	2.5	7.5	-	-	2.13	4.01	-	-	Aiken et al., 2008; Aiken et al., 2009	
Beijing, CN	40.0	116.0	09/07/06- 21/07/06	11.5	-	16.6	4.3	12.3	3.95	11	3.45	7.54	Sun et al., 2009; Jimenez et al., 2009	
Grenoble, FR	45.18	5.73	14/01/09- 30/01/09	0.4	1.56	1.7	-	-	1.43	0.43	-	-	Favez et al., 2010; Lanz et al. 2010	
Barcelona, ES	41.39	2.12	25/02/09- 26/03/09	1.97	0.66	4.02	1.64	2.38	0.43	1.19	0.41	0.78	Mohr et al., 2012; Crippa et al., 2014	
New York , US	40.74	-73.92	13/07/09- 03/08/09	0.91	-	4.07	2.14	1.93	0.8	2.98	1.15	1.82	Sun et al., 2011	
Paris, FR	48.83	2.36	01/07/09- 31/07/09	0.7	-	1.7	-	-	0.6	1.58	-	-	Crippa et al., 2013a; Fountoukis et al., 2015	
Paris, FR	48.83	2.36	12/01/10- 16/02/10	2.7	-	3.2	-	-	1.4	0.24	-	-	Crippa et al., 2013b; Fountoukis et al., 2015	
Fresno, US	36.81	-119.78	09/01/10- 23/01/10	1.74	1.26	3.4	-	-	0.23	0.49	-	-	Ge et al. 2012	
Pasadena, US	34.14	-118.12	15/05/10- 16/06/10	0.84	-	4.62	2.38	2.24	0.9	4.64	2.00	2.64	Hayes et al. 2013	

**Table S6.** AMS and EMAC average concentrations for OA species over urban downwind areas. In all cases the averages are over all the available data for each campaign. The period and the exact location of the each site are also listed.

Location	Coordinates		Time period	AMS					EMAC				Reference	
	Lat	Lon		HOA	BBOA	OOA	SVOOA	LVOOA	POA	SOA	fresh SOA	aged SOA		
Urban Downwind														
Hohenpeissenberg, DE	47.8	11.0	19/05/02-31/05/02	0.5	-	2.85	-	-	0.43	2.21	-	-	Hock et al., 2008; Lanz et al., 2010	
East coast 1, US	37.95	-74.3	18/07/02-26/07/02	0.4	-	5.4	-	-	0.88	5.40	-	-	DeGouw et al., 2005; Zhang et al., 2007	
East coast 2, US	37.95	-74.3	29/07/02-10/08/02	0.58	-	4.4	-	-	0.33	4.26	-	-	DeGouw et al., 2005; Zhang et al., 2007	
NE London, UK	51.7	0.4	29/07/03-31/08/03	0.8	-	1.8	0.4	1.4	0.60	3.66	0.80	2.85	Cubison et al., 2006; Jimenez et al., 2009	
Norfolk coast, UK	53.0	1.1	25/04/04-26/05/04	0.56	-	1.5	-	-	0.27	1.06	-	-	Gysel et al., 2007; Zhang et al., 2007	
Wiesbaden, DE	50.22	8.45	14/07/04-04/08/04	1.6	-	7.9	3.4	4.5	0.63	2.8	1.35	1.46	Dusek et al., 2006; Jimenez et al., 2009	
Mexico City, MX	19.7	-98.98	10/03/06-30/03/06	1.3	-	4.6	-	-	2	3.94	-	-	Aiken et al., 2008; Tsimpidi et al., 2011	
Po Valley, IT	44.65	11.62	30/03/08-20/04/08	0.79	0.26	1.95	-	-	0.28	1.32	-	-	Saarikoski et al. 2012	
Puijo, FI	62.90	27.65	27/09/08-21/10/08	0.2	-	0.7	0	0.7	0.10	0.13	0.07	0.06	Crippa et al., 2014	
Helsinki 1, FI	60.2	24.95	09/01/09-13/03/09	0.41	0.35	1.87	0.47	1.4	1.00	0.41	0.23	0.18	Carbone et al., 2014	
Montseny, SP	41.76	2.4	21/02/09-27/03/09	0.25	0.32	2.91	0	2.91	0.45	1.13	0.41	0.73	Crippa et al., 2014	
Helsinki 2, FI	60.2	24.95	09/04/09-08/05/09	0.34	0.57	2.13	0.34	1.79	0.5	1.13	0.30	0.83	Timonen et al., 2012	
Paris, FR	48.72	2.21	01/07/09-31/07/09	0.5	-	1.19	0.67	0.52	0.59	1.54	0.68	0.86	Crippa et al., 2013a	
Paris, FR	48.72	2.21	12/01/10-16/02/10	2.4	-	3.3	-	-	1.36	0.23	-	-	Crippa et al., 2013b; Fountoukis et al., 2015	
Cool, US	38.88	-121.0	02/06/10-28/06/10	0.22	-	2.17	1.2	0.97	0.23	1.86	1.30	0.56	Setyan et al., 2012	



**Table S7.** AMS and EMAC average concentrations for OA species over rural/remote areas. In all cases, the averages are over all the available data for each campaign. The period and the exact location of the each site are also listed.

Location	Coordinates		Time Period	AMS				EMAC				Reference	
	Lat	Lon		HOA	BBOA	OOA	SVOOA	LVOOA	POA	SOA	Fresh SOA		Aged SOA
Rural/Remote													
Cheju Island, KR	33.51	126.50	11/04/01-30/04/01	0.3	-	4	-	-	1.53	4.27	-	-	Topping et al., 2004; Jimenez et al., 2009
Jungfraujoch, CH	46.3	7.6	28/06/02-17/07/02	0	-	1.2	0.4	0.8	0.40	3	1.41	1.57	Jimenez et al., 2009
Mace Head, CH	53.3	-9.8	01/08/02-31/08/02	0	-	0.49	-	-	0.05	0.37	-	-	Alfarra et al., 2004; Zhang et al., 2007
Fukue Island, JP	32.69	128.84	18/03/03-03/04/03	0.3	-	3.8	-	-	0.7	2.30	-	-	Takami et al., 2005; Zhang et al., 2007
Fukue Island, JP	32.69	128.84	03/04/03-16/04/03	0.36	-	5.8	-	-	1.51	4.96	-	-	Takami et al., 2005; Zhang et al., 2007
Hyytiälä, FI	61.8	24.3	19/03/03-13/04/03	0.09	-	1.2	-	-	0.3	0.81	-	-	Zhang et al., 2007
Fukue Island, JP	32.69	128.84	10/05/03-03/06/03	0.39	-	7	-	-	1.58	6.17	-	-	Takami et al., 2005; Zhang et al., 2007
Okinawa, JP	26.87	128.25	03/10/03-28/10/03	0	-	3.1	-	-	0.17	1.96	-	-	Takami et al., 2005; Zhang et al., 2007
Okinawa, JP	26.87	128.25	28/10/03-02/12/03	0	-	1.9	-	-	0.08	0.73	-	-	Takami et al., 2005; Zhang et al., 2007
Okinawa, JP	26.87	128.25	02/12/03-24/12/03	0	-	3.1	-	-	0.25	1.09	-	-	Takami et al., 2005; Zhang et al., 2007
Okinawa, JP	26.87	128.25	13/03/04-08/04/04	0	-	1.7	-	-	0.15	1.14	-	-	Takami et al., 2005; Zhang et al., 2007
Okinawa, JP	26.87	128.25	08/04/04-27/04/04	0	-	2.7	-	-	0.29	3.36	-	-	Takami et al., 2005; Zhang et al., 2007

**Table S7.** Continued

Location	Coordinates		Time period	AMS						EMAC				Reference	
	Lat	Lon		HOA	BBOA	OOA	SVOOA	LVOOA	POA	SOA	Fresh SOA	Aged SOA			
Rural/Remote															
Storm Peak, US	40.45	-106.7	04/04/04-02/05/04	0.2	-	0.7	-	-	0.07	0.83	-	-		Richardson et al., 2007; Jimenez et al., 2009	
Pinnacle Park, US	43.0	-76	14/07/04-05/08/04	0.3	-	5.4	2.7	2.7	0.33	2.53	1.13	1.39		Bae et al. 2007; Jimenez et al., 2009	
Nova Scotia, CN	43.76	-66.1	07/07/04-14/08/04	0.2	-	1.5	0.6	0.9	0.12	1.92	0.49	1.43		Holzinger et al., 2007; Jimenez et al., 2009	
Duke Forest, US	35.97	-79.1	13/09/04-21/09/04	0.1	-	1.3	0.5	0.8	0.26	2.81	1.48	1.33		Jimenez et al., 2009	
Hyytiälä, FI	61.8	24.3	31/03/05-15/04/05	0	-	1.2	0.6	0.6	0.23	0.48	0.14	0.34		Allan et al. 2006; Jimenez et al., 2009	
Harkinggen, CH	40.74	7.82	12/05/05-30/05/05	0.99	-	7.26	2.72	4.54	0.5	2.23	0.93	1.30		Lanz et al., 2010	
Thompson, US	43.11	-70.95	09/07/05-15/08/05	1.1	-	4.2	2.9	1.3	0.56	3.78	1.77	2.01		Cottrell et al., 2008; Jimenez et al., 2009	
Payerne, CH	46.8	6.95	31/05/06-03/07/06	0.36	-	4.6	0.97	3.63	0.59	0.21	0.07	0.14		Lanz et al. 2010	
Massongex, CH	46.24	6.14	23/11/06-17/12/06	0.31	1.1	0.81	-	-	1.27	0.50	-	-		Lanz et al. 2010	
Payerne, CH	46.8	6.95	12/01/07-17/02/07	0.65	1.1	5.66	2.05	3.61	0.34	4.1	2.09	2.02		Lanz et al. 2010	
San Pietro, IT	44.65	11.65	31/03/08-21/04/08	0.38	0.46	2.96	1.06	1.9	0.28	1.32	0.36	0.96		Saarikoski et al. 2012; Crippa et al., 2014	

**Table S7.** Continued

Location	Coordinates		Time period	AMS						EMAC				Reference
	Lat	Lon		HOA	BBOA	OOA	SVOOA	LVOOA	POA	SOA	Fresh SOA	Aged SOA		
Finokalia , GR	35.33	25.66	09/05/08-05/06/08	0.1	-	2.37	0.86	1.51	0.21	3.74	0.56	3.18	Hildebrandt et al. 2010; Crippa et al.,2014	
Jungfraujoch , CH	46.3	7.6	01/05/08-29/05/08	0.04	0.07	0.55	0	0.55	0.47	2.81	1.01	1.80	Crippa et al.,2014	
Mace Head , CH	53.3	-9.8	16/05/08-13/06/08	0.11	0.14	0.6	0.25	0.35	0.15	1.21	0.26	0.95	Dall'Osto et al., 2010; Crippa et al.,2014	
Cabauw , NL	51.97	4.93	29/04/08-30/05/08	0.59	0.42	2.56	0.92	1.64	0.68	2.2	0.80	1.41	Mensah et al., 2012 ; Crippa et al.,2014	
Melpitz , DE	51.54	12.93	24/05/08-09/06/08	0.05	-	0.86	0.46	0.4	0.67	3.36	1.56	1.80	Poulain et al., 2011; Crippa et al.,2014	
Hyytiälä , FI	61.8	24.3	11/09/08-15/10/08	0.05	0.03	0.72	0.34	0.38	0.35	1.12	0.65	0.46	Crippa et al. 2014	
Puy de Dome , FR	45.77	2.97	14/09/08-18/10/08	0.02	0.16	1.59	0.97	0.62	0.59	3.12	1.33	1.79	Freney et al, 2011; Crippa et al.,2014	
K-Pusztá, HU	46.96	19.58	17/09/08-15/10/08	0.64	0.58	4.08	1.75	2.33	1.2	4.18	1.82	2.37	Crippa et al., 2014	
Payerne, CH	46.8	6.95	18/09/08-16/10/08	0.32	0.65	4.37	1.51	2.86	0.78	3.43	1.46	1.97	Crippa et al. 2014	
Melpitz , DE	51.54	12.93	17/09/08-03/11/08	0.31	0.55	3.05	1.37	1.68	0.7	1.42	0.76	0.66	Poulain et al. 2011; Crippa et al.,2014	
Vavthill , SE	56.02	13.15	01/10/08-07/11/08	0.74	0.44	2.52	0	2.52	0.2	0.32	0.12	0.20	Crippa et al., 2014	

**Table S7.** Continued

Location	Coordinates		Time period	AMS					EMAC				Reference	
	Lat	Lon		HOA	BBOA	OOA	SVOOA	LVOOA	POA	SOA	Fresh SOA	Aged SOA		
Rural/Remote														
Harwell, UK	51.15	-1.44	20/09/08-22/10/08	0.23	0.42	2.57	1.03	1.54	0.23	0.34	0.10	0.24	Crippa et al., 2014	
Finokalia, GR	35.33	25.66	27/02/09-26/03/09	0	-	1.84	0.92	0.92	0.08	0.92	0.15	0.77	Hildebrandt et al. 2011; Crippa et al., 2014	
Mace Head, CH	53.3	-9.8	27/02/09-27/03/09	0.1	0.22	0.47	0	0.47	0.06	0.18	0.05	0.13	Dall'Osto et al., 2010; Crippa et al., 2014	
Hyytiälä, FI	61.8	24.3	04/03/09-01/04/09	0.04	0.07	1.3	0.39	0.91	0.43	0.4	0.16	0.23	Crippa et al., 2014	
Puy de Dome, FR	45.77	2.97	23/02/09-10/03/09	0.03	0.1	0.43	0.21	0.22	0.37	0.65	0.28	0.37	Freney et al, 2011; Crippa et al., 2014	
Cabauw, NL	51.97	4.93	25/02/09-25/03/09	0.23	0.12	0.84	0.41	0.43	0.71	0.29	0.12	0.17	Crippa et al., 2014	
Melpitz, DE	51.54	12.93	10/03/09-27/03/09	0.13	0.15	1.12	0.39	0.73	0.39	0.4	0.16	0.24	Poulain et al. 2011; Crippa et al., 2014	
Payern, CH	46.8	6.95	01/03/09-24/03/09	0.29	0.37	1.84	1.11	0.73	0.37	0.54	0.19	0.35	Crippa et al., 2014	
Vavinih, SE	56.02	13.15	26/02/09-02/04/09	0.55	0.26	1.79	1.3	0.49	0.32	0.28	0.10	0.18	Crippa et al., 2014	
Chilbolton, UK	51.1	-1.4	25/02/09-26/03/09	0.5	0.5	1.48	0.48	1	0.37	0.25	0.09	0.16	Crippa et al., 2014	
Puy de Dome, FR	45.77	2.97	22/06/10-29/06/10	0	-	11.58	3.76	7.82	0.36	2.99	1.43	1.56	Freney et al, 2011	
S. Great Plains, US	36.61	-97.49	01/12/10-31/12/10	0	0.74	3.21	1.17	2.04	0.21	0.53	0.24	0.29	Parworth et al., 2015	

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