

Supplement of Geosci. Model Dev. Discuss., 7, 6949–6996, 2014
<http://www.geosci-model-dev-discuss.net/7/6949/2014/>
doi:10.5194/gmdd-7-6949-2014-supplement
© Author(s) 2014. CC Attribution 3.0 License.



Supplement of

**GNAQPMS-Hg v1.0, a global nested atmospheric mercury transport model:
model description, evaluation and application to trans-boundary
transport of Chinese anthropogenic emissions**

H. S. Chen et al.

Correspondence to: Z. F. Wang (zifawang@mail.iap.ac.cn)

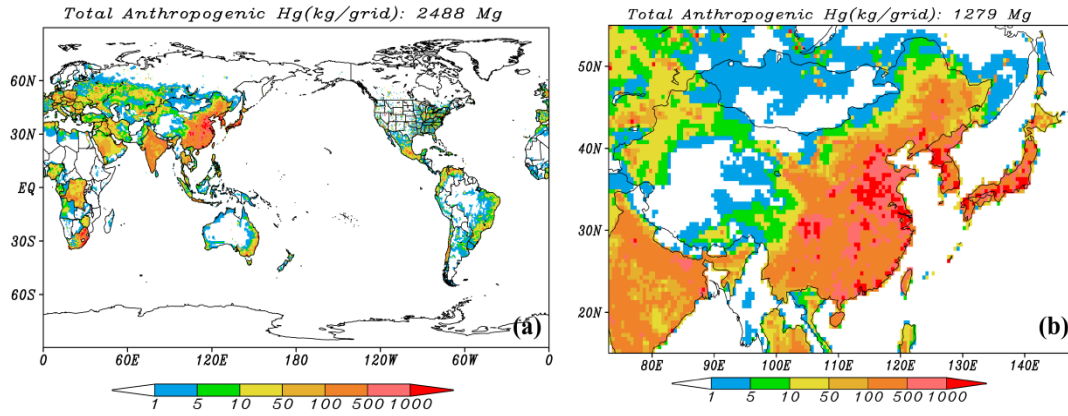


Fig. S1. Global (a) and East Asia (b) annual anthropogenic Hg emissions (kg/grid).

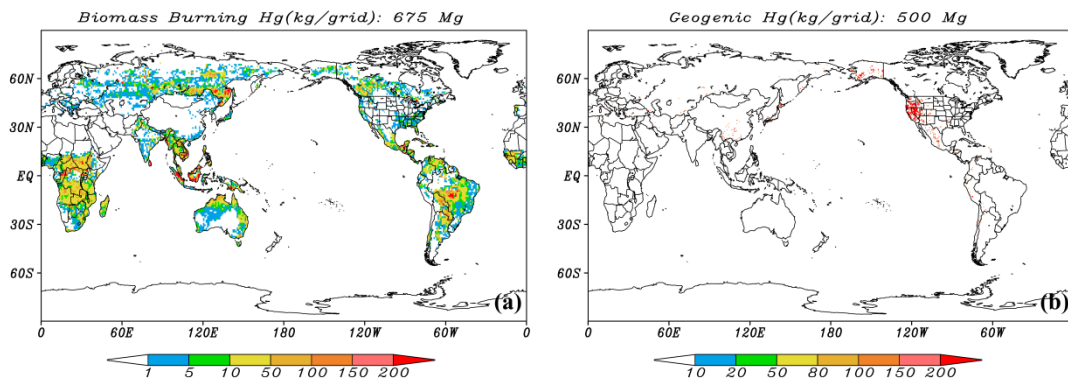


Fig. S2. Global annual biomass burning (a) and geogenic (b) Hg emissions (kg/grid).

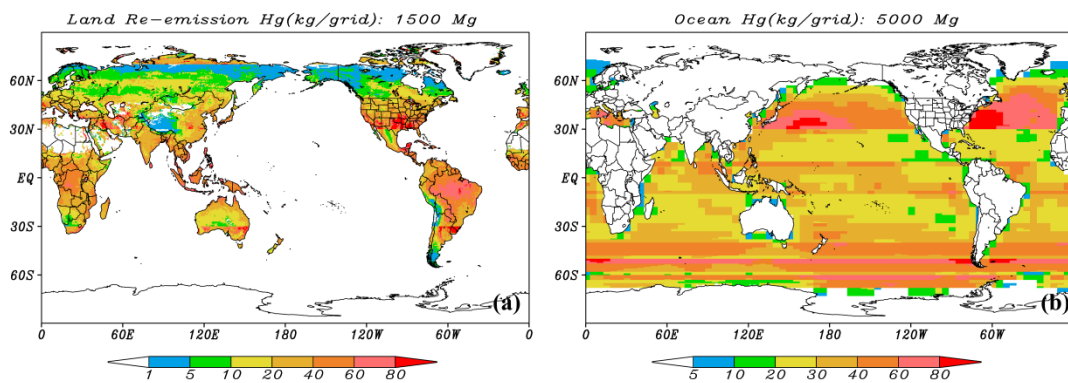


Fig. S3. Global annual land re-emission (a) and total ocean emissions (b) of Hg (kg/grid).

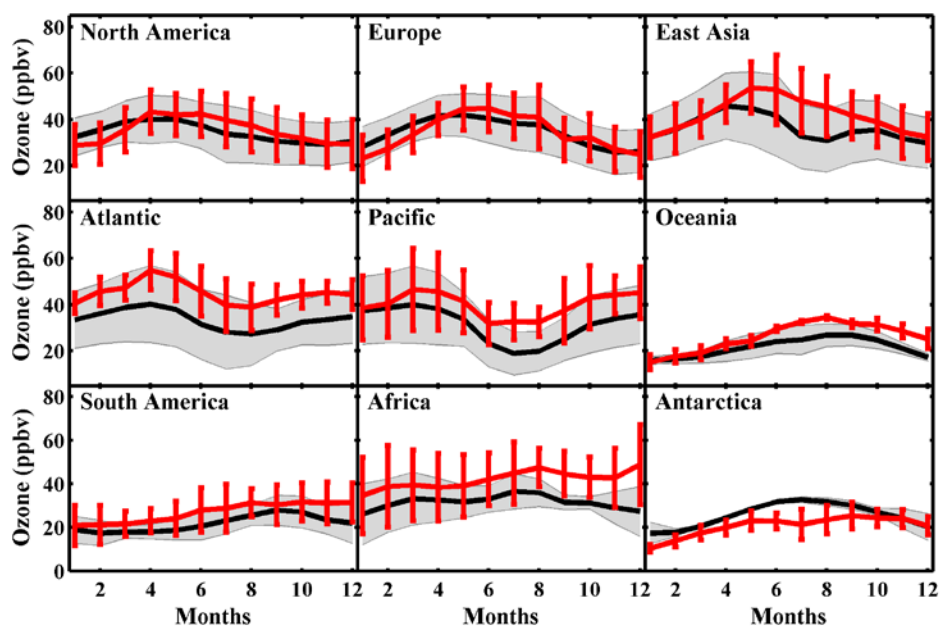


Fig. S4. Mean seasonal variation of surface ozone at 9 subregions in 2001. Gray shaded areas and red vertical bars show one standard deviation over the sites for observations and for model results. Observations are from the WDCGG (World Data Centre for Greenhouse Gases) and EANET (Acid Deposition Monitoring Network in East Asia) network.

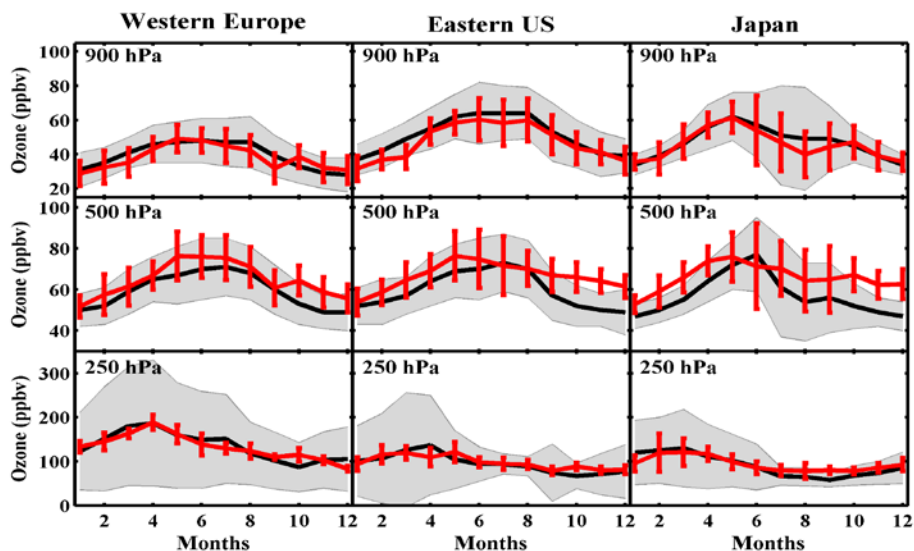


Fig. S5. Comparison of the ozone seasonal cycle between ozonesonde observations (black lines) and model results (red lines) in 900, 500 and 250 hPa in Western Europe, Eastern US and Japan. Gray shaded areas and red vertical bars show one standard deviation over the ozonesonde locations for observations and for model results. Observations are from Tilmes et al. (2012).

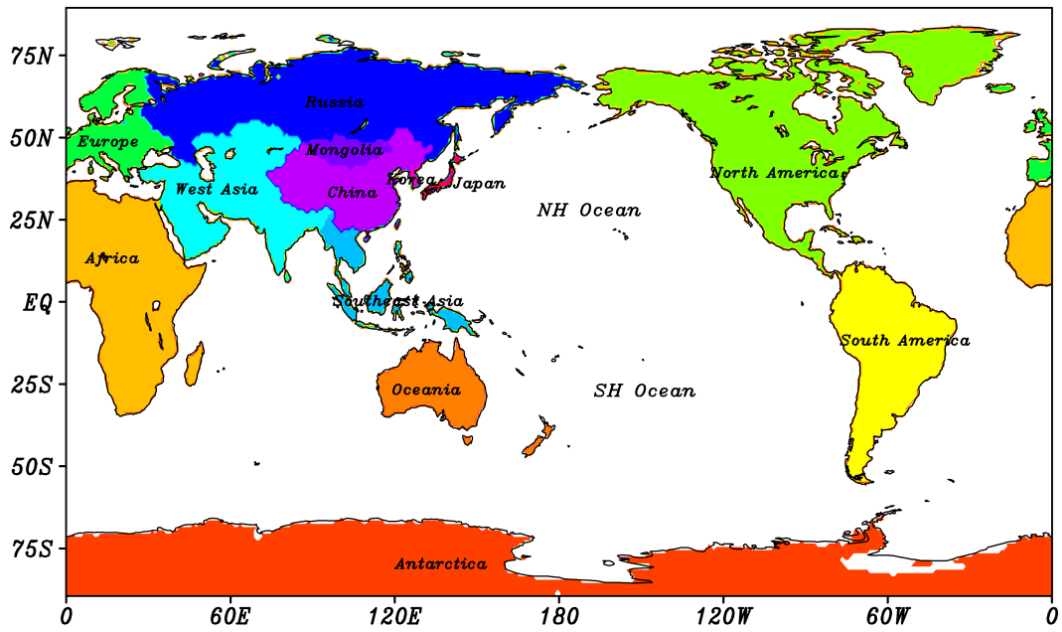


Fig. S6. 15 geographical areas used in this study, colors represent subregions over land while ocean is divided into two parts used the equator as boundary.

Table S1. Long-term TGM/GEM measurements used for model evaluation (ng m^{-3}).

Site ^a	Years	Conc ^b	Reference
Alert, Canada (83N, 62W)*	1995-2002	1.55	Environment Canada (2003)
FortChipewyan, Canada (59N, 111W)	2000-2001	1.36	Temme et al. (2007)
Kuujuarapik, Canada (56N, 78W)*	1999-2000	1.82 [#]	Steffen et al. (2005)
Esther, Canada (52N, 110W)	1997-1999	1.65	Kellerhals et al. (2003)
Mingan, Canada (50N, 64W)	1997-1999	1.62	Kellerhals et al. (2003)
Bratts Lake, Canada (50N, 105W)	2001-2005	1.53	Temme et al. (2007)
Reifel Island, Canada (49N, 123W)*	1997-1999	1.67	Kellerhals et al. (2003)
Delta, Canada (49N, 123W)	1999-2001	1.73	Environment Canada (2003)
Burnt Island, Canada (46N, 83W)	1997-1999	1.58	Kellerhals et al. (2003)
St.Andrews, Canada (45N, 67W)*	1997-1999,2001	1.42	Environment Canada (2003)
St.Anicet, Canada (45N, 74W)*	1997-1999,2001	1.64	Kellerhals et al. (2003); Poissant et al. (2005)
Kejimkujik, Canada (44N, 65W)*	2001	1.45	Environment Canada (2003)
Egbert, Canada (44N, 80W)	1997-1999	1.67	Kellerhals et al. (2003)
Pt.Petre, Canada (44N, 77W)	1997-1999	1.78	Kellerhals et al. (2003)
Cheeka Peak, USA (48N, 125W)*	2001-2002	1.56	Weiss-Penzias et al. (2003)
NewcombNY, USA (43N, 74W)*	2006-2007	1.45	Choi et al. (2008)
PacMonadnock, USA (43N, 72W)*	2007	1.38 [#]	Sigler et al. (2009)
RenoDRI, USA (40N, 120W)*	2002-2005	2.10	Stamenkovic et al. (2007)
AthensOH, USA (39N, 82W)*	2004-2005	1.63 [#]	Yatavelli et al. (2006)
PensacolaOLF, USA (31N, 87W)*	2004-2006	1.34 [#]	Edgerton et al. (2006)
Pallas, Finland (68N, 24E)*	1998-2002	1.38	EMEP (2005)
Zingst, Germany (55N, 13E)*	2000	1.64	EMEP (2005)
Neuglobsow, Germany (53N, 13E)*	2004-2005	1.70	EMEP (2009)
Langenbruegge, Germany (53N, 11E)*	2002	1.98	EMEP (2005)
Mace Head, Ireland (54N, 10W)*	1995-2001	1.69	Ebinghaus et al. (2002)
SanLucido, Italy (39N, 16E)	2004-2005	1.80	EMEP (2009)
Zeppelin, Norway (79N, 12E)*	2000-2004	1.58	EMEP (2005)
Andoya, Norway (69N, 16E)*	2004	1.66	EMEP (2009)
Birkenes, Norway (58N, 8E)*	2005-2007	1.82	EMEP (2009)
Lista, Norway (58N, 7E)*	2000-2003	1.70	EMEP (2005)
Amderma, Russia (70N, 62E)*	2001-2003	1.66 [#]	Steffen et al. (2005)
CaboDeCreus, Spain (42N, 3E)*	2005	1.73	EMEP (2009)
Rao, Sweden (57N, 12E)*	2001	1.66	EMEP (2005)
Rorvik, Sweden (57N, 12E)*	2001-2002	1.66	EMEP (2005)
Cape Point, South Africa (34S, 19E)*	1998-2002, 2007-2008	1.22	Baker et al. (2002); Slemr et al. (2011)
Neumayer, Antarctica (70S, 8W)*	2000	1.06	Ebinghaus et al. (2002)
Changchun, China (44N, 125E)	1999-2000	15.10	Fang et al. (2004)
ChangbaiMt, China (42N, 129E)	2005-2006	3.15	Wan et al. (2009a)
Beijing, China (40N, 116E)	2005	6.60 [#]	Wang et al. (2007)
Chengshantou, China (37N, 123E)	2007-2009	2.17 [#]	Ci et al. (2011a)

Table S1. Continued.

Site^a	Years	Conc^b	Reference
Waliguan,China (36N, 101E)	2007-2008	1.98	Fu et al. (2012)
Shanghai, China (31N, 121E)	2008-2010	7.79	Zhang et al. (2012)
GonggaMt, China (30N, 102E)	2005-2006	3.89	Fu et al. (2008a)
Chongqing, China (30N, 107E)	2006-2007	6.74 [#]	Yang et al. (2009)
Shangri-La, China (28N, 100E)	2009-2010	2.59	Zhang (2011)
Guiyang, China (27N, 107E)	2001-2002	6.95	Feng et al. (2004)
LeigongMt, China (26N, 108E) *	2008-2009	3.03 [#]	Fu et al. (2010c)
LulinMt, China (24N, 121E) *	2006-2007	1.62 [#]	Sheu et al. (2010)
Guangzhou, China (23N, 113E)	2010-2011	4.86	Liu et al. (2012)
Tokyo, Japan (36N, 140E)	2000-2001	2.70	Sakata and Marumoto (2002);
Chiba, Japan (36N, 140E)	1991-1996	11.90	Nakagawa and Hiromoto (1997)
Hayama, Japan (35N, 140E)	1991-1996	13.20	Nakagawa and Hiromoto (1997)
Chuncheon, Korea (38N, 127E) *	2006-2009	2.11	Holmes et al. (2010)
Seoul, Korea (37N, 127E)	1997-2002	4.42	Kim et al. (2005)
Kanghwa, Korea (37N, 126E)	2008-2009	1.92	Han et al. (2011)
An-Myun,Korea (37N, 126E)	2005	4.27	Nguyen et al. (2007)
Jeju Island, Korea (33N, 126E)	2006-2007	3.58	Nguyen et al. (2010)

^a Asterisk indicates that monthly mean observations are also available from the references.

^b Pound sign indicates GEM measurements.

Table S2. Mercury measurements from ship cruises used for model evaluation.

Cruise	Region	Date	Obs	Reference
Lamborg1999	South and equatorial Atlantic Ocean	May to Jun, 1996	TGM	Lamborg et al. (1999)
Temme2003	Atlantic Ocean	Feb 2001	TGM	Temme et al. (2003)
Laurier2003	North Pacific Ocean	May to Jun, 2002	TGM/RGM	Laurier et al. (2003)
Soerensen2010	North Atlantic, Indian Ocean, South Pacific	Aug 2006 to Apr 2007	GEM	Soerensen et al. (2010)
Fu2010	South China Sea	Aug 2008	GEM	Fu et al. (2010a)
Ci2011	Yellow Sea	Jul 2010	GEM	Ci et al. (2011b)

Table S3. Long-term RGM and TPM measurements used for model evaluation (pg m^{-3})^a.

Site	RGM	TPM	Total	Period	Reference
St.Anicet, Canada (45N, 74W)	3	26	29	2003	Poissant et al. (2005)
Barrow, USA (71N, 157W)	24	NA	24	1999-2001	Landis et al. (2002)
Potsdam, USA (45N, 75W)	4.2	NA	4.2	2002-2003	Han et al. (2005)
Sterling, USA (43N, 77W)	6	NA	6	2002-2003	Han et al. (2005)
Stockton, USA (42N, 79W)	5.7	NA	5.7	2002-2003	Han et al. (2005)
Durham, USA (36N, 79W)	16	NA	16	1999-2001	Landis et al. (2002)
Baltimore, USA (32N, 77W)	23	NA	23	1999-2001	Landis et al. (2002)
Everglades, USA (26N, 81W)	15	NA	15	1999-2001	Landis et al. (2002)
Zingst, Germany (55N, 13E)	25	22	47	1998-1999	Munthe et al. (2003)
Neuglobsow, Germany (53N, 13E)	18	25	43	1998-1999	Munthe et al. (2003)
Mace Head, Ireland (54N, 10W)	18	5	23	1998-1999	Munthe et al. (2003)
Avspretten, Sweden (58N, 17E)	8	9	17	1998-1999	Munthe et al. (2003)
Rorvik, Sweden (57N, 12E)	15	5	20	1998-1999	Munthe et al. (2003)
Changchun, China (44N, 125E)	NA	192.5	192.5	1999-2000	Fang et al. (2004)
ChangbaiMt, China (42N, 129E)	65	77	142	2005-2006	Wan et al. (2009b)
Beijing, China (40N, 116E)	NA	930	930	2003-2004	Wang et al. (2006)
Waliguan,China (36N, 101E)	7.4	19.4	26.8	2007-2008	Fu et al. (2012)
Hefei, China (32N, 117E)	NA	330	330	2008-2009	Wang (2010)
Shanghai, China (31N, 121E)	NA	560	560	2004-2006	Xiu et al. (2009)
GonggaMt, China (30N, 102E)	6.2	30.7	36.9	2005-2006	Fu et al. (2008b)
Chongqing, China (30N, 107E)	NA	416	416	2005	Wu (2006)
Shangri-La, China (28N, 100E)	8.2	43.5	51.7	2009-2010	Zhang (2011)
Guiyang, China (27N, 107E)	35.7	368	403.7	2009	Fu et al. (2011)
LulinMt, China (24N, 121E)	12.1	2.3	14.4	2006-2007	Sheu et al. (2010)
Seoul, Korea (38N, 127E)	27.2	23.9	51.1	2005-2006	Kim et al. (2009)
Tokyo, Japan (36N, 140E)	NA	98	98	2000-2001	Sakata and Marumoto (2002)

^a The sum of RGM and TPM is defined as total oxidized mercury and compared to the sum of Hg(II)+Hg(P) in the model.

Table S4. Long-term dry and wet depositions measurements in East Asia used for model evaluation (Units for deposition and precipitation are $\mu\text{g m}^{-2} \text{yr}^{-1}$ and mm).

Site	Lat	Lon	Period	Dry	Wet	Prec	Reference
ChangbaiMt, China	42.4	128.5	2005-2006	16.5	8.4	613	Wan et al. (2009b)
Changchun, China	43.8	125.4	1999-2000	131.8	108.0	567	Fang et al. (2004)
Beijing, China	40.1	116.3	2003	338.3	NA	NA	Wang et al. (2006)
Shanghai, China	31.4	121.4	2008-2009	NA	250.5	947	Zhang et al. (2010)
Chongqin, China	29.6	104.7	2005-2006	256.0	77.6	1403	Wang et al. (2009)
GonggaMt, China	29.6	102.2	2005-2007	66.4	26.1	1818	Fu et al. (2010b)
Wujiang, China	26.5	106.1	2006	NA	34.7	963	Guo et al. (2008)
LeigongMt, China	26.4	108.2	2005-2006, 2008-2009	44.0	16.2	1437	Fu et al. (2010c) Wang et al. (2009)
Bekkai, Japan	43.4	145.1	2002-2003	4.4	5.8	1117	Sakata and Marumoto (2005)
Hayakita, Japan	42.7	141.6	2002-2003	5.2	7.1	882	Sakata and Marumoto (2005)
Akita, Japan	40.2	140.0	2002-2003	9.4	14.9	1576	Sakata and Marumoto (2005)
Fukushima, Japan	37.6	140.7	2002-2003	6.8	10.0	1599	Sakata and Marumoto (2005)
Ishikawa, Japan	37.2	136.9	2002-2003	6.6	14.2	2076	Sakata and Marumoto (2005)
Tokyo, Japan	35.6	139.6	2002-2003	NA	16.7	1912	Sakata and Marumoto (2005)
Aichi, Japan	35.0	137.5	2002-2003	13.2	13.1	1679	Sakata and Marumoto (2005)
Hyogo, Japan	34.8	134.8	2002-2003	8.2	14.0	1481	Sakata and Marumoto (2005)
Hiroshima, Japan	34.4	132.7	2002-2003	9.7	14.3	1624	Sakata and Marumoto (2005)
Nagasaki, Japan	33.3	129.7	2002-2003	8.3	17.7	2317	Sakata and Marumoto (2005)
Korea	35.9	127.8	2006-2008	NA	9.4	1068	Ahn et al. (2011)

References

- Ahn, M. C., Yi, S. M., Holsen, T. M., and Han, Y. J.: Mercury wet deposition in rural Korea: concentrations and fluxes, *J. Environ. Monit.*, 13, 2748-2754, doi:10.1039/c1em10014a, 2011.
- Baker, P. G. L., Brunke, E. G., Slemr, F., and Crouch, A. M.: Atmospheric mercury measurements at Cape Point, South Africa, *Atmos. Environ.*, 36, 2459-2465, 2002.
- Choi, H. D., Holsen, T. M., and Hopke, P. K.: Atmospheric mercury (Hg) in the Adirondacks: Concentrations and sources, *Environ. Sci. Technol.*, 42, 5644-5653, doi:10.1021/es7028137, 2008.
- Ci, Z., Zhang, X., Wang, Z., and Niu, Z.: Atmospheric gaseous elemental mercury (GEM) over a coastal/rural site downwind of East China: Temporal variation and long-range transport, *Atmos. Environ.*, 45, 2480-2487, doi:10.1016/j.atmosenv.2011.02.043, 2011a.
- Ci, Z., Zhang, X., Wang, Z., Niu, Z., Diao, X., and Wang, S.: Distribution and air-sea exchange of mercury (Hg) in the Yellow Sea, *Atmos. Chem. Phys.*, 11, 2881-2892, doi:10.5194/acp-11-2881-2011, 2011b.
- Ebinghaus, R., Kock, H. H., Temme, C., Einax, J. W., Lowe, A. G., Richter, A., Burrows, J. P., and Schroeder, W. H.: Antarctic springtime depletion of atmospheric mercury, *Environ. Sci. Technol.*, 36, 1238-1244, doi:10.1021/es015710z, 2002.
- Edgerton, E. S., Hartsell, B. E., and Jansen, J. J.: Mercury speciation in coal-fired power plant plumes observed at three surface sites in the southeastern US, *Environ. Sci. Technol.*, 40, 4563-4570, doi:10.1021/es0515607, 2006.
- Fang, F., Wang, Q., and Li, J.: Urban environmental mercury in Changchun, a metropolitan city in Northeastern China: source, cycle, and fate, *Sci. Total Environ.*, 330, 159-170, doi:10.1016/j.scitotenv.2004.04.006, 2004.
- Feng, X., Shang, L., Wang, S., Tang, S., and Zheng, W.: Temporal variation of total gaseous mercury in the air of Guiyang, China, *J. Geophys. Res.-Atmos.*, 109, D03303, doi:10.1029/2003jd004159, 2004.
- Fu, X., Feng, X., Zhu, W., Wang, S., and Lu, J.: Total gaseous mercury concentrations in ambient air in the eastern slope of Mt. Gongga, South-Eastern fringe of the Tibetan plateau, China, *Atmos. Environ.*, 42, 970-979, doi:10.1016/j.atmosenv.2007.10.018, 2008a.
- Fu, X., Feng, X., Zhu, W., Zheng, W., Wang, S., and Lu, J. Y.: Total particulate and reactive gaseous mercury in ambient air on the eastern slope of the Mt. Gongga area, China, *Appl. Geochem.*, 23, 408-418, doi:10.1016/j.apgeochem.2007.12.018, 2008b.
- Fu, X., Feng, X., Zhang, G., Xu, W., Li, X., Yao, H., Liang, P., Li, J., Sommar, J., Yin, R., and Liu, N.: Mercury in the marine boundary layer and seawater of the South China Sea: Concentrations, sea/air flux, and implication for land outflow, *J. Geophys. Res.-Atmos.*, 115, D06303, doi:10.1029/2009jd012958, 2010a.
- Fu, X., Feng, X., Zhu, W., Rothenberg, S., Yao, H., and Zhang, H.: Elevated atmospheric deposition and dynamics of mercury in a remote upland forest of southwestern China, *Environ. Pollut.*, 158, 2324-2333, doi:10.1016/j.envpol.2010.01.032, 2010b.
- Fu, X., Feng, X., Qiu, G., Shang, L., and Zhang, H.: Speciated atmospheric mercury and its potential source in Guiyang, China, *Atmos. Environ.*, 45, 4205-4212, doi:10.1016/j.atmosenv.2011.05.012, 2011.
- Fu, X., Feng, X., Dong, Z., Yin, R., Wang, J., Yang, Z., and Zhang, H.: Atmospheric gaseous

- elemental mercury (GEM) concentrations and mercury depositions at a high-altitude mountain peak in south China, *Atmos. Chem. Phys.*, 10, 2425-2437, 2010c.
- Fu, X., Feng, X., Liang, P., Deliger, Zhang, H., Ji, J., and Liu, P.: Temporal trend and sources of speciated atmospheric mercury at Waliguan GAW station, Northwestern China, *Atmos. Chem. Phys.*, 12, 1951-1964, doi:10.5194/acp-12-1951-2012, 2012.
- Guo, Y., Feng, X., Li, Z., He, T., Yan, H., Meng, B., Zhang, J., and Qiu, G.: Distribution and wet deposition fluxes of total and methyl mercury in Wujiang River Basin, Guizhou, China, *Atmos. Environ.*, 42, 7096-7103, doi:10.1016/j.atmosenv.2008.06.006, 2008.
- Han, J. S., Choi, E. M., Seo, Y. S., Yi, S. M., Lee, J., and Chung, Y. C.: Contribution of total gaseous mercury (TGM) using TGM concentrations measured in urban and background areas, Korea, 10th International Conference on Mercury as a Global Pollutant, Halifax, Nova Scotia, Canada, 2011.
- Han, Y. J., Holsen, T. M., Hopke, P. K., and Yi, S. M.: Comparison between back-trajectory based modeling and Lagrangian backward dispersion Modeling for locating sources of reactive gaseous mercury, *Environ. Sci. Technol.*, 39, 1715-1723, doi:10.1021/es0498540, 2005.
- Holmes, C. D., Jacob, D. J., Corbitt, E. S., Mao, J., Yang, X., Talbot, R., and Slemr, F.: Global atmospheric model for mercury including oxidation by bromine atoms, *Atmos. Chem. Phys.*, 10, 12037-12057, doi:10.5194/acp-10-12037-2010, 2010.
- Kellerhals, M., Beauchamp, S., Belzer, W., Blanchard, P., Froude, F., Harvey, B., McDonald, K., Pilote, M., Poissant, L., Puckett, K., Schroeder, B., Steffen, A., and Tordon, R.: Temporal and spatial variability of total gaseous mercury in Canada: results from the Canadian Atmospheric Mercury Measurement Network (CAMNet), *Atmos. Environ.*, 37, 1003-1011, doi:10.1016/s1352-2310(02)00917-2, 2003.
- Kim, K. H., Ebinghaus, R., Schroeder, W. H., Blanchard, P., Kock, H. H., Steffen, A., Froude, F. A., Kim, M. Y., Hong, S. M., and Kim, J. H.: Atmospheric mercury concentrations from several observatory sites in the northern hemisphere, *J. Atmos. Chem.*, 50, 1-24, doi:10.1007/s10874-005-9222-0, 2005.
- Kim, S. H., Han, Y. J., Holsen, T. M., and Yi, S. M.: Characteristics of atmospheric speciated mercury concentrations (TGM, Hg(II) and Hg(p)) in Seoul, Korea, *Atmos. Environ.*, 43, 3267-3274, doi:10.1016/j.atmosenv.2009.02.038, 2009.
- Lamborg, C. H., Rolffhus, K. R., Fitzgerald, W. F., and Kim, G.: The atmospheric cycling and air-sea exchange of mercury species in the South and equatorial Atlantic Ocean, *Deep-Sea Res. Pt. II.*, 46, 957-977, doi:10.1016/s0967-0645(99)00011-9, 1999.
- Landis, M. S., Stevens, R. K., Schaedlich, F., and Prestbo, E. M.: Development and characterization of an annular denuder methodology for the measurement of divalent inorganic reactive gaseous mercury in ambient air, *Environ. Sci. Technol.*, 36, 3000-3009, doi:10.1021/es015887t, 2002.
- Laurier, F. J. G., Mason, R. P., Whalin, L., and Kato, S.: Reactive gaseous mercury formation in the North Pacific Ocean's marine boundary layer: A potential role of halogen chemistry, *J. Geophys. Res.-Atmos.*, 108, 4529, doi:10.1029/2003jd003625, 2003.
- Liu, M., Chen, L., Tao, J., Xu, Z., Zhu, L., Qian, D., and Fan, R.: Seasonal and diurnal variation of total gaseous mercury in Guangzhou City (in Chinese), *China Environ. Sci.*, 32(9), 1554-1558, 2012.
- Munthe, J., Wangberg, I., Iverfeldt, A., Lindqvist, O., Stromberg, D., Sommar, J., Gardfeldt, K.,

- Petersen, G., Ebinghaus, R., Prestbo, E., Larjava, K., and Siemens, V.: Distribution of atmospheric mercury species in Northern Europe: final results from the MOE project, *Atmos. Environ.*, 37, S9-S20, doi:10.1016/s1352-2310(03)00235-8, 2003.
- Nakagawa, R., and Hiromoto, M.: Geographical distribution and background levels of total mercury in air in Japan and neighbouring countries, *Chemosphere*, 34, 801-806, doi:10.1016/s0045-6535(97)00008-8, 1997.
- Nguyen, H. T., Kim, K. H., Kim, M. Y., Hong, S., Youn, Y. H., Shon, Z. H., and Lee, J. S.: Monitoring of atmospheric mercury at a global atmospheric watch (GAW) site on An-Myun Island, Korea, *Water Air Soil Pollut.*, 185, 149-164, doi:10.1007/s11270-007-9438-5, 2007.
- Nguyen, H. T., Kim, M. Y., and Kim, K. H.: The influence of long-range transport on atmospheric mercury on Jeju Island, Korea, *Sci. Total Environ.*, 408, 1295-1307, doi:10.1016/j.scitotenv.2009.10.029, 2010.
- Poissant, L., Pilote, M., Beauvais, C., Constant, P., and Zhang, H. H.: A year of continuous measurements of three atmospheric mercury species (GEM, RGM and Hg-p) in southern Quebec, Canada, *Atmos. Environ.*, 39, 1275-1287, doi:10.1016/j.atmosenv.2004.11.007, 2005.
- Sakata, M., and Marumoto, K.: Formation of atmospheric particulate mercury in the Tokyo metropolitan area, *Atmos. Environ.*, 36, 239-246, doi:10.1016/s1352-2310(01)00432-0, 2002.
- Sakata, M., and Marumoto, K.: Wet and dry deposition fluxes of mercury in Japan, *Atmos. Environ.*, 39, 3139-3146, doi:10.1016/j.atmosenv.2005.01.049, 2005.
- Sheu, G. R., Lin, N. H., Wang, J. L., Lee, C. T., Yang, C. F. O., and Wang, S. H.: Temporal distribution and potential sources of atmospheric mercury measured at a high-elevation background station in Taiwan, *Atmos. Environ.*, 44, 2393-2400, doi:10.1016/j.atmosenv.2010.04.009, 2010.
- Sigler, J. M., Mao, H., and Talbot, R.: Gaseous elemental and reactive mercury in Southern New Hampshire, *Atmos. Chem. Phys.*, 9, 1929-1942, 2009.
- Slemr, F., Brunke, E. G., Ebinghaus, R., and Kuss, J.: Worldwide trend of atmospheric mercury since 1995, *Atmos. Chem. Phys.*, 11, 4779-4787, doi:10.5194/acp-11-4779-2011, 2011.
- Soerensen, A. L., Skov, H., Jacob, D. J., Soerensen, B. T., and Johnson, M. S.: Global concentrations of gaseous elemental mercury and reactive gaseous mercury in the marine boundary layer, *Environ. Sci. Technol.*, 44, 7425-7430, doi:10.1021/es903839n, 2010.
- Stamenkovic, J., Lyman, S., and Gustin, M. S.: Seasonal and diel variation of atmospheric mercury concentrations in the Reno (Nevada, USA) airshed, *Atmos. Environ.*, 41, 6662-6672, doi:10.1016/j.atmosenv.2007.04.015, 2007.
- Steffen, A., Schroeder, W., Macdonald, R., Poissant, L., and Konoplev, A.: Mercury in the Arctic atmosphere: An analysis of eight years of measurements of GEM at Alert (Canada) and a comparison with observations at Amderma (Russia) and Kuujuarapik (Canada), *Sci. Total Environ.*, 342, 185-198, doi:10.1016/j.scitotenv.2004.12.048, 2005.
- Temme, C., Slemr, F., Ebinghaus, R., and Einax, J. W.: Distribution of mercury over the Atlantic Ocean in 1996 and 1999-2001, *Atmos. Environ.*, 37, 1889-1897, doi:10.1016/s1352-2310(03)00069-4, 2003.
- Temme, C., Blanchard, P., Steffen, A., Banic, C., Beauchamp, S., Poissant, L., Tordon, R., and Wiens, B.: Trend, seasonal and multivariate analysis study of total gaseous mercury data from the Canadian atmospheric mercury measurement network (CAMNet), *Atmos. Environ.*, 41, 5423-5441, doi:10.1016/j.atmosenv.2007.02.021, 2007.

- Tilmes, S., Lamarque, J. F., Emmons, L. K., Conley, A., Schultz, M. G., Saunio, M., Thouret, V., Thompson, A. M., Oltmans, S. J., Johnson, B., and Tarasick, D.: Technical Note: Ozonesonde climatology between 1995 and 2011: description, evaluation and applications, *Atmos. Chem. Phys.*, 12, 7475-7497, doi:10.5194/acp-12-7475-2012, 2012.
- Wan, Q., Feng, X., Lu, J., Zheng, W., Song, X., Han, S., and Xu, H.: Atmospheric mercury in Changbai Mountain area, northeastern China I. The seasonal distribution pattern of total gaseous mercury and its potential sources, *Environ. Res.*, 109, 201-206, doi:10.1016/j.envres.2008.12.001, 2009a.
- Wan, Q., Feng, X., Lu, J., Zheng, W., Song, X., Li, P., Han, S., and Xu, H.: Atmospheric mercury in Changbai Mountain area, northeastern China II. The distribution of reactive gaseous mercury and particulate mercury and mercury deposition fluxes, *Environ. Res.*, 109, 721-727, doi:10.1016/j.envres.2009.05.006, 2009b.
- Wang, Y.: The speciation, levels and potential impacted factors of atmospheric mercury in Hefei, Central China (in Chinese), M.S. thesis, University of Science and Technology of China, China, 44 pp., 2010.
- Wang, Z., Chen, Z., Duan, N., and Zhang, X.: Gaseous elemental mercury concentration in atmosphere at urban and remote sites in China, *J. Environ. Sci.-China*, 19, 176-180, doi:10.1016/s1001-0742(07)60028-x, 2007.
- Wang, Z., Zhang, X., Xiao, J., Ci, Z., and Yu, P.: Mercury fluxes and pools in three subtropical forested catchments, southwest China, *Environ. Pollut.*, 157, 801-808, doi:10.1016/j.envpol.2008.11.018, 2009.
- Wang, Z., Zhang, X., Chen, Z., and Zhang, Y.: Mercury concentrations in size-fractionated airborne particles at urban and suburban sites in Beijing, China, *Atmos. Environ.*, 40, 2194-2201, doi:10.1016/j.atmosenv.2005.12.003, 2006.
- Weiss-Penzias, P., Jaffe, D. A., McClintick, A., Prestbo, E. M., and Landis, M. S.: Gaseous elemental mercury in the marine boundary layer: Evidence for rapid removal in anthropogenic pollution, *Environ. Sci. Technol.*, 37, 3755-3763, doi:10.1021/es0341081, 2003.
- Wu, L.: Study on atmospheric mercury of Chongqing City (in Chinese), M.S. thesis, Southwest University, China, 74 pp., 2006.
- Xiu, G., Cai, J., Zhang, W., Zhang, D., Bueeler, A., Lee, S., Shen, Y., Xu, L., Huang, X., and Zhang, P.: Speciated mercury in size-fractionated particles in Shanghai ambient air, *Atmos. Environ.*, 43, 3145-3154, doi:10.1016/j.atmosenv.2008.07.044, 2009.
- Yang, Y., Chen, H., and Wang, D.: Spatial and temporal distribution of gaseous elemental mercury in Chongqing, China, *Environ. Monit. Assess.*, 156, 479-489, doi:10.1007/s10661-008-0499-8, 2009.
- Yatavelli, R. L. N., Fahrni, J. K., Kim, M., Crist, K. C., Vickers, C. D., Winter, S. E., and Connell, D. P.: Mercury, PM_{2.5} and gaseous co-pollutants in the Ohio River Valley region: Preliminary results from the Athens supersite, *Atmos. Environ.*, 40, 6650-6665, doi:10.1016/j.atmosenv.2006.05.072, 2006.
- Zhang, G., Zheng, X., Zhou, L., Huang, W., Qian, P., and Wang, Y.: Atmospheric mercury wet deposition and its ecological impacts in Shanghai City (in Chinese), *Environ. Chem.*, 29(1), 147-148, 2010.
- Zhang, H.: Concentrations of speciated atmospheric mercury at a high-altitude background station in the Shangri-La area of Tibetan Plateau, China, 10th International Conference on Mercury as a

Global Pollutant, Halifax, Nova Scotia, Canada, 2011.

Zhang, Y., Xiu, G., Zhang, D., Zhang, M., and Zhang, R.: Total gaseous mercury in ambient air of Shanghai: its seasonal variation in relation to meteorological condition (in Chinese), *Environ. Sci. Technol.*, 34(12), 155-158, 2012.