Supplement of Atmos. Chem. Phys., 17, 8999–9017, 2017
https://doi.org/10.5194/acp-17-8999-2017-supplement
© Author(s) 2017. This work is distributed under
the Creative Commons Attribution 3.0 License.

Atmospheric Chemistry and Physics
Open Access

Supplement of

Subtropical subsidence and surface deposition of oxidized mercury produced in the free troposphere

Viral Shah and Lyatt Jaeglé

Correspondence to: Viral Shah (vshah@uw.edu)

The copyright of individual parts of the supplement might differ from the CC BY 3.0 License.

Table S1: List of stations with observations of Hg wet deposition used in this study

Site ID	Site Name	Latitude	Longitude	Elevation (m.a.s.l.)	Measurement period	Network/ Region
CO96	Molas Pass	37.75	-107.69	3248	2013-2014	MDN[a]
FL11	Everglades National Park-Research Center	25.39	-80.68	2	2013-2014	MDN
WA18	Seattle/NOAA	47.68	-122.26	11	2013-2014	MDN
TX21	Longview	32.38	-94.71	103	2013-2014	MDN
VT99	Underhill	44.53	-72.87	399	2013-2014	MDN
VA28	Shenandoah National	38.52	-78.43	1072	2013-2014	MDN
WI36	Trout Lake	46.05	-89.65	509	2013-2014	MDN
WI99	Lake Geneva	42.58	-88.50	288	2013-2014	MDN
PA29	Kane Experimental Forest	41.60	-78.77	618	2013-2014	MDN
PA42	Leading Ridge	40.66	-77.94	287	2013-2014	MDN
PA72	Milford	41.33	-74.82	212	2013-2014	MDN
TN11	Great Smoky Mountains	35.66	-83.59	640	2013-2014	MDN
MN18	Fernberg	47.95	-91.50	524	2013-2014	MDN
ME02	Bridgton	44.11	-70.73	222	2013-2014	MDN
ME96	Casco Bay-Wolfe's Neck	43.83	-70.06	15	2013-2014	MDN
NC08	Waccamaw State Park	34.26	-78.48	10	2013-2014	MDN
PA13	Allegheny Portage Historic	40.46	-78.56	739	2013-2014	MDN
PA90	Hills Creek State Park	41.80	-77.19	476	2013-2014	MDN
SC19	Congaree Swamp	33.81	-80.78	34	2013-2014	MDN
IL11	Bondville	40.05	-88.37	212	2013-2014	MDN
FL34	Everglades Nutrient	26.66	-80.40	10	2013-2014	MDN
FL05	Chassahowitzka National Wildlife Refuge	28.75	-82.56	3	2013-2014	MDN
GA09	Okefenokee National Wildlife Refuge	30.74	-82.13	45	2013-2014	MDN
PA00	Arendtsville	39.92	-77.31	269	2013-2014	MDN
KS32	Lake Scott State Park	38.67	-100.92	863	2013-2014	MDN
ME98	Acadia National Park-McFarland Hill	44.38	-68.26	150	2013-2014	MDN
ME00	Caribou	46.87	-68.01	191	2013-2014	MDN
ME09	Greenville Station	45.49	-69.66	322	2013-2014	MDN
MN16	Marcell Experimental Forest	47.53	-93.47	431	2013-2014	MDN
MN23	Camp Ripley	46.25	-94.50	410	2013-2014	MDN
MN27	Lamberton	44.24	-95.30	367	2013-2014	MDN
MO03	Ashland Wildlife Area	38.75	-92.20	257	2013-2014	MDN
MT05	Glacier National Park-Fire Weather Station	48.51	-114.00	964	2013-2014	MDN
NE15	Mead	41.15	-96.49	352	2013-2014	MDN
NY20	Huntington Wildlife	43.97	-74.22	500	2013-2014	MDN
NY68	Biscuit Brook	41.99	-74.50	634	2013-2014	MDN

Table S1 continued

Site ID	Site Name	Latitude	Longitude	Elevation (m.a.s.l.)	Measurement period	Network/ Region
PA37	Waynesburg	39.82	-80.29	452	2013-2014	MDN
MI48	Seney National Wildlife Refuge-Headquarters	46.29	-85.95	220	2013-2014	MDN
SC05	Cape Romain National	32.94	-79.66	1	2013-2014	MDN
SC03	Savannah River	33.25	-81.65	90	2013-2014	MDN
PA60	Valley Forge	40.12	-75.88	46	2013-2014	MDN
PA30	Erie	42.16	-80.11	177	2013-2014	MDN
AL03	Centreville	32.90	-87.25	135	2013-2014	MDN
GA40	Yorkville	33.93	-85.05	395	2013-2014	MDN
MO46	Mingo National Wildlife Refuge	36.97	-90.14	105	2013-2014	MDN
KY10	Mammoth Cave National Park	37.13	-86.15	236	2013-2014	MDN
MS22	Oak Grove	30.98	-88.93	100	2013-2014	MDN
WI31	Devil's Lake	43.44	-89.68	389	2013-2014	MDN
PA47	Millersville	39.99	-76.39	84	2013-2014	MDN
GA33	Sapelo Island	31.40	-81.28	3	2013-2014	MDN
OK99	Stilwell	35.75	-94.67	299	2013-2014	MDN
NV02	Lesperance Ranch	41.50	-117.50	1388	2013-2014	MDN
MD99	Beltsville	39.03	-76.82	46	2013-2014	MDN
MD08	Piney Reservoir	39.71	-79.01	769	2013-2014	MDN
NJ30	New Brunswick	40.47	-74.42	21	2013-2014	MDN
ON07	Egbert	44.23	-79.79	196	2013-2014	MDN
WI10	Potawatomi	45.56	-88.81	570	2013-2014	MDN
WA03	Makah National Fish	48.29	-124.65	6	2013-2014	MDN
CA94	Converse Flats	34.19	-116.91	1724	2013-2014	MDN
CA20	Yurok Tribe-Requa	41.56	-124.09	110	2013-2014	MDN
OK01	McGee Creek	34.32	-95.89	195	2013-2014	MDN
OK31	Copan	36.91	-95.88	255	2013-2014	MDN
SD18	Eagle Butte	44.99	-101.24	742	2013-2014	MDN
MD00	Smithsonian	38.89	-76.56	20	2013-2014	MDN
FL97	Everglades-Western Broward County	26.17	-80.82	4	2013-2014	MDN
UT97	Salt Lake City	40.71	-111.96	1297	2013-2014	MDN
OK04	Lake Murray	34.10	-97.07	245	2013-2014	MDN
PA52	Little Pine State Park	41.36	-77.36	228	2013-2014	MDN
KS03	Reserve	39.98	-95.57	265	2013-2014	MDN
KS24	Glen Elder State Park	39.51	-98.34	456	2013-2014	MDN
KS99	Cimarron National Grassland	37.13	-101.82	1021	2013-2014	MDN
OK06	Wichita Mountains	34.73	-98.71	492	2013-2014	MDN
KS04	West Mineral	37.27	-94.94	274	2013-2014	MDN
NY43	Rochester	43.15	-77.55	136	2013-2014	MDN
NY06	Bronx	40.87	-73.88	68	2013-2014	MDN

Table S1 continued

Site ID	Site Name	Latitude	Longitude	Elevation (m.a.s.l.)	Measurement period	Network/ Region
MN98	Blaine	45.14	-93.22	275	2013-2014	MDN
MS12	Grand Bay NERR	30.43	-88.43	2	2013-2014	MDN
PA21	Goddard State Park	41.43	-80.15	385	2013-2014	MDN
FL96	Pensacola	30.55	-87.38	45	2013-2014	MDN
AL19	Birmingham	33.55	-86.81	200	2013-2014	MDN
DE0008R	Schmücke	50.65	10.77	937	2013-2014	EMEP[b]
FI0036R	Pallas (Matorova)	68.00	24.24	340	2013-2014	EMEP
GB0036R	Harwell	51.57	-1.32	137	2013-2014	EMEP
GB0048R	Auchencorth Moss	55.79	-3.24	260	2013-2014	EMEP
NO0001R	Birkenes	58.38	8.25	190	2013-2014	EMEP
SE0005R	Bredkälen	63.85	15.33	404	2013-2014	EMEP
SE0011R	Vavihill	56.02	13.15	175	2013-2014	EMEP
SE0014R	Råö	57.39	11.91	5	2013-2014	EMEP
NYA	Ny-Ålesund	78.90	11.88	12	2013-2014	GMOS[c]
MHE	Mace Head	53.33	-9.91	5	2013	GMOS
ISK	Iskrba	45.56	14.86	520	2013-2014	GMOS
SIS	Sisal	21.16	-90.05	7	2013-2014	GMOS
AMS	Amsterdam Island	-37.80	77.55	3	2013-2014	GMOS
CGR	Cape Grim	-40.68	144.69	94	2013-2014	GMOS
MCB	Mt. Changbai	42.41	128.11	736	2011-2014	China[d]
MDM	Mt. Damei	29.63	121.57	550	2012-2014	China
MLG	Mt. Leigong	26.39	108.20	2176	2008-2009	China
MAL	Mt. Ailao	24.53	101.11	2450	2011-2014	China
MWA	Mt. Waliguan	36.29	100.90	3816	2012-2014	China
BYB	Bayinbuluk	42.89	83.72	2500	2013-2014	China
PEN	Pengjiayu	25.63	122.07	102	2009	Taiwan[e]
PR20	El Verde	18.32	-65.82	380	2015	MDN[a]

(a) http://nadp.sws.uiuc.edu/mdn/
(b) http://www.nilu.no/projects/ccc/index.html
(c) Sprovieri et al. (2017)
(d) Fu et al. (2016)
(e) Sheu and Lin (2013)

Table S2: List of ground stations with observations of Hg(II) surface concentrations used in this study

Site ID	Site Name	Latitude	Longitude	Elevation (m.a.s.l.)	Measurement period	Network/ Region
AL19	Birmingham	33.55	-86.81	177	2009-2012	AMNet[a]
CA48	Elkhorn Slough	36.81	-121.78	10	2010-2011	AMNet
FL96	Pensacola	30.55	-87.38	44	2009-2012	AMNet
GA40	Yorkville	33.93	-85.05	394	2009-2012	AMNet
MD08	Piney Reservoir	39.71	-79.01	761	2009-2012	AMNet
MD96	Beltsville_B	39.03	-76.82	47	2009-2012	AMNet
MD97	Beltsville	39.03	-76.82	47	2009-2012	AMNet
MS12	Grand Bay NERR	30.41	-88.40	1	2009-2012	AMNet
MS99	Grand Bay NERR_B	30.41	-88.40	1	2009-2012	AMNet
NH06	Thompson Farm	43.11	-70.95	25	2009-2011	AMNet
NJ05	Brigantine	39.46	-74.45	8	2009-2012	AMNet
NS01	Kejimkujik	44.43	-65.20	158	2009-2012	AMNet
NY06	New York City	40.87	-73.88	26	2009-2012	AMNet
NY20	Huntington Wildlife Forest	43.97	-74.22	502	2009-2012	AMNet
NY43	Rochester	43.15	-77.62	154	2009	AMNet
NY95	Rochester_B	43.15	-77.55	154	2009-2012	AMNet
OH02	Athens	39.31	-82.12	274	2009-2012	AMNet
OK99	Stilwell	35.75	-94.67	300	2009-2012	AMNet
PA13	Allegheny Portage	40.46	-78.56	739	2009-2012	AMNet
UT96	Antelope Island	41.09	-112.12	1285	2009-2011	AMNet
UT97	Salt Lake City	40.71	-111.96	1099	2009-2012	AMNet
VT99	Underhill	44.53	-72.87	397	2009-2012	AMNet
WI07	Horicon	43.46	-88.62	272	2009-2012	AMNet
WV99	Canaan Valley Institute	39.12	-79.45	985	2009-2012	AMNet
AMS	Amsterdam Island	-37.80	77.55	70	2012-13	GMOS[b]
RAO	Råö	57.39	11.91	7	2012-15	GMOS[c]
LON	Longobucco	39.39	16.61	1379	2013	GMOS[d]
MAN	Manaus	-2.89	-59.97	110	2013	GMOS[d]
WAL	Waldhof	52.80	10.76	74	2009-2011	Germany[e]
MCH	Mt. Changbai	42.40	128.11	740	2013-2014	China[f]
MWA	Mt. Waliguan	36.29	100.90	3816	2007-2008	China
MAL	Mt. Ailao	24.53	101.02	2450	2011-2012	China
SLA	Shangri-La	28.02	99.73	3580	2009-2010	China
MYU	Miyun	40.48	116.76	220	2008-2009	China
MDA	Mt. Damei	29.63	121.57	550	2011-2013	China
MGO	Mt. Gongga	29.65	102.12	1640	2005-2007	China
LABS	Lulin Atmospheric Background Station	23.51	120.92	2862	2006-2007	Taiwan[g]
ALE	Alert	82.49	-62.34	210	2009-2011	Canada[h]

(a) http://nadp.sws.uiuc.edu/amn/
(b) Angot et al. (2014)
(c) Wängberg et al. (2016)
(d) Travnikov et al. (2017)
(e) Weigelt et al. (2013)

(f) Fu et al. (2015)
(g) Sheu et al. (2010)

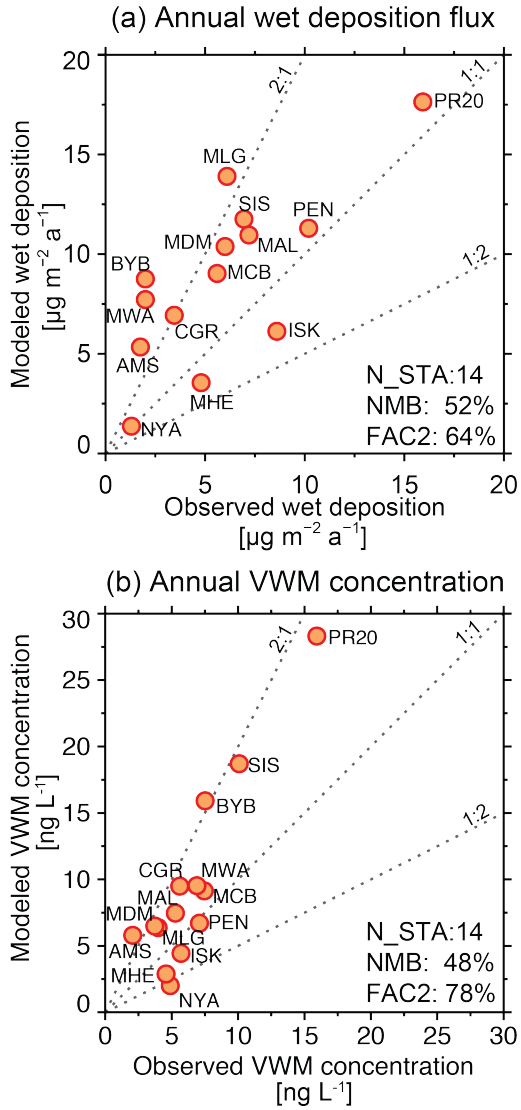

Figure S1 (a) Simulated and observed Hg wet deposition flux for GMOS and other stations listed in Table S1. (b) Simulated and observed annual volume-weighted mean (VWM) Hg concentration for GMOS and other stations listed in Table S1. The number of stations (N_STA), normalized mean bias (NMB; $\mathrm{NMB} = \sum_i (\mathrm{M_i} - \mathrm{O_i}) \Big/ \sum_i \mathrm{O_i} \times 100\%$ **), and FAC2 (percentage of points where** $0.5 \le \mathrm{M_i}/\mathrm{O_i} \le 2$ **where O_i and M_i are observed and simulated values, respectively) is included in both panels.**

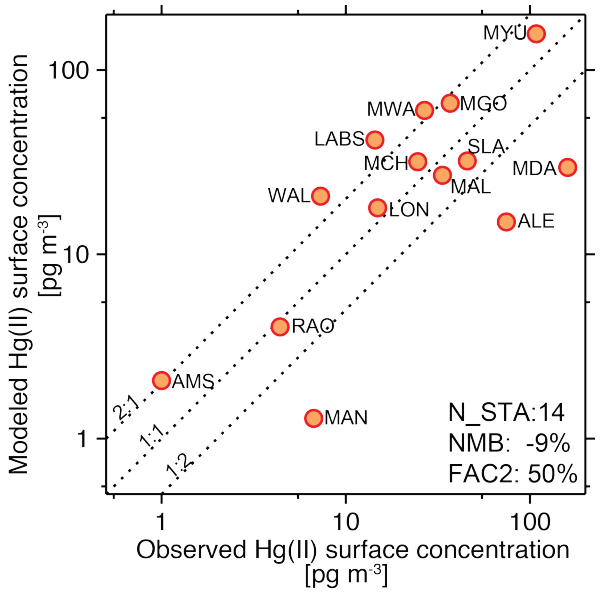

Figure S2 Simulated and observed surface Hg(II) concentration for GMOS and other stations listed in Table S1. Note the logarithmic scale on both axes.

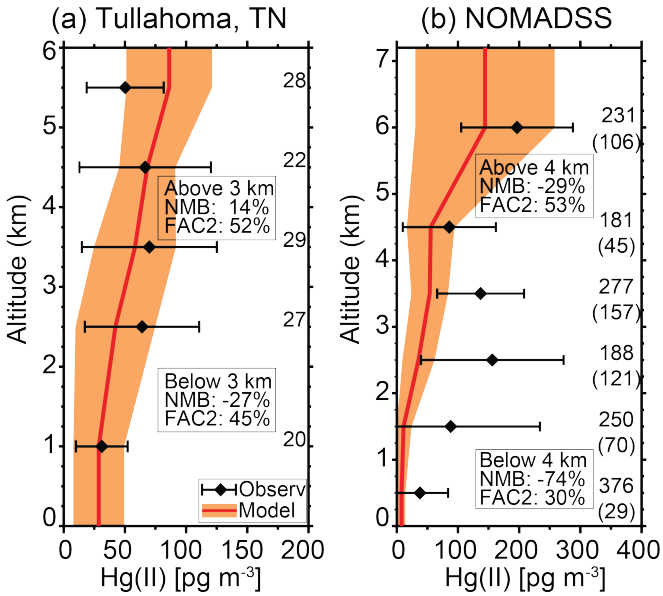

Figure S3 (a) Simulated and observed Hg(II) concentrations for aircraft-based campaign over Tullahoma, TN, USA (2012-2013) (Brooks et al., 2014). (b) Simulated and observed Hg(II) concentrations for the NOMADSS aircraft-based campaign (2013) (Shah et al., 2016). The number of model-observation pairs in each height bin is shown in panel (a). In panel (b), the number of model-observation pairs in each height bin, and, in parentheses, the number of model-observation pairs where the observations were above the instrument detection limit, are shown.

References

Angot, H., Barret, M., Magand, O., Ramonet, M. and Dommergue, A.: A 2-year record of atmospheric mercury species at a background Southern Hemisphere station on Amsterdam Island, Atmospheric Chem. Phys., 14(20), 11461–11473, doi:10.5194/acp-14-11461-2014, 2014.

Brooks, S., Ren, X., Cohen, M., Luke, W. T., Kelley, P., Artz, R., Hynes, A., Landing, W. and Martos, B.: Airborne Vertical Profiling of Mercury Speciation near Tullahoma, TN, USA, Atmosphere, 5(3), 557, doi:10.3390/atmos5030557, 2014.

Fu, X., Yang, X., Lang, X., Zhou, J., Zhang, H., Yu, B., Yan, H., Lin, C.-J. and Feng, X.: Atmospheric wet and litterfall mercury deposition at urban and rural sites in China, Atmospheric Chem. Phys., 16(18), 11547–11562, doi:10.5194/acp-16-11547-2016, 2016.

Fu, X. W., Zhang, H., Yu, B., Wang, X., Lin, C.-J. and Feng, X. B.: Observations of atmospheric mercury in China: a critical review, Atmospheric Chem. Phys., 15(16), 9455–9476, doi:10.5194/acp-15-9455-2015, 2015.

Shah, V., Jaeglé, L., Gratz, L. E., Ambrose, J. L., Jaffe, D. A., Selin, N. E., Song, S., Campos, T. L., Flocke, F. M., Reeves, M., Stechman, D., Stell, M., Festa, J., Stutz, J., Weinheimer, A. J., Knapp, D. J., Montzka, D. D., Tyndall, G. S., Apel, E. C., Hornbrook, R. S., Hills, A. J., Riemer, D. D., Blake, N. J., Cantrell, C. A. and MauldinÂ III, R. L.: Origin of oxidized mercury in the summertime free troposphere over the southeastern US, Atmospheric Chem. Phys., 16(3), 1511–1530, doi:10.5194/acp-16-1511-2016, 2016.

Sheu, G.-R. and Lin, N.-H.: Characterizations of wet mercury deposition to a remote islet (Pengjiayu) in the subtropical Northwest Pacific Ocean, Atmos. Environ., 77, 474–481, doi:10.1016/j.atmosenv.2013.05.038, 2013.

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(20), 2393–2400, doi:10.1016/j.atmosenv.2010.04.009, 2010.

Sprovieri, F., Pirrone, N., Bencardino, M., D'Amore, F., Angot, H., Barbante, C., Brunke, E.-G., Arcega-Cabrera, F., Cairns, W., Comero, S., Diéguez, M. D. C., Dommergue, A., Ebinghaus, R., Feng, X. B., Fu, X., Garcia, P. E., Gawlik, B. M., Hageström, U., Hansson, K., Horvat, M., Kotnik, J., Labuschagne, C., Magand, O., Martin, L., Mashyanov, N., Mkololo, T., Munthe, J., Obolkin, V., Ramirez Islas, M., Sena, F., Somerset, V., Spandow, P., Vardè, M., Walters, C., Wängberg, I., Weigelt, A., Yang, X. and Zhang, H.: Five-year records of mercury wet deposition flux at GMOS sites in the Northern and Southern hemispheres, Atmospheric Chem. Phys., 17(4), 2689–2708, doi:10.5194/acp-17-2689-2017, 2017.

Travnikov, O., Angot, H., Artaxo, P., Bencardino, M., Bieser, J., D'Amore, F., Dastoor, A., De Simone, F., Diéguez, M. D. C., Dommergue, A., Ebinghaus, R., Feng, X. B., Gencarelli, C. N., Hedgecock, I. M., Magand, O., Martin, L., Matthias, V., Mashyanov, N., Pirrone, N., Ramachandran, R., Read, K. A., Ryjkov, A., Selin, N. E., Sena, F., Song, S., Sprovieri, F., Wip, D., Wängberg, I. and Yang, X.: Multi-model study of mercury dispersion in the atmosphere: atmospheric processes and model evaluation, Atmospheric Chem. Phys., 17(8), 5271–5295, doi:10.5194/acp-17-5271-2017, 2017.

Wängberg, I., Nerentorp Mastromonaco, M. G., Munthe, J. and Gårdfeldt, K.: Airborne mercury species at the Råö background monitoring site in Sweden: distribution of mercury as an effect of long-range transport, Atmospheric Chem. Phys., 16(21), 13379–13387, doi:10.5194/acp-16-13379-2016, 2016.

Weigelt, A., Temme, C., Bieber, E., Schwerin, A., Schuetze, M., Ebinghaus, R. and Kock, H. H.: Measurements of atmospheric mercury species at a German rural background site from 2009 to 2011 – methods and results, Environ. Chem., 10(2), 102–110, doi:10.1071/EN12107, 2013.