



Supplement of

Earth system modeling of mercury using CESM2 – Part 1: Atmospheric model CAM6-Chem/Hg v1.0

Peng Zhang and Yanxu Zhang

Correspondence to: Yanxu Zhang (zhangyx@nju.edu.cn)

The copyright of individual parts of the supplement might differ from the article licence.

Table S1. The ground-based observations of total gaseous mercury (TGM) concentrations worldwide for model evaluation.

Region ^a	Number of sites	Period	Reference ^b
Arctic	5	2011–2015	[1], [2]
Northern America	33	2009–2015	[3], [4]
Europe	15	2009–2015	[2], [5], [6]
Asia	26	2006–2018	[2], [7]
Tropics	5	2013–2014	[2]
Southern Hemisphere	8	2011–2015	[1], [2], [6], [8]

^a Arctic refers to the region north of 66°N. Tropics refers to the region between 23°S–23°N (excluding Australia). Southern Hemisphere refers to the region south of 23°S.

10 ^b [1] Angot et al. (2016); [2] Sprovieri et al. (2016); [3] NADP Atmospheric Mercury Network (AMNet) (<http://nadp.slh.wisc.edu/amnet/>); [4] Environment and Climate Change Canada (ECCC) (<https://data.ec.gc.ca/data/air/monitor/monitoring-of-atmospheric-gases/total-gaseous-mercury-tgm/>); [5] European Monitoring and Evaluation Programme (EMEP) (<http://emep.int/index.html>); [6] AMAP/UNEP, 2018 [7] Han et al. (2014); Xu et al. (2015); Zhang et al. (2015); Yu et al. (2016); Xu et al. (2017); Nguyen et al. (2021); Fu et al. (2021); [8] Mossison et al. (2015); Howard et al. (2017, 2018).

15

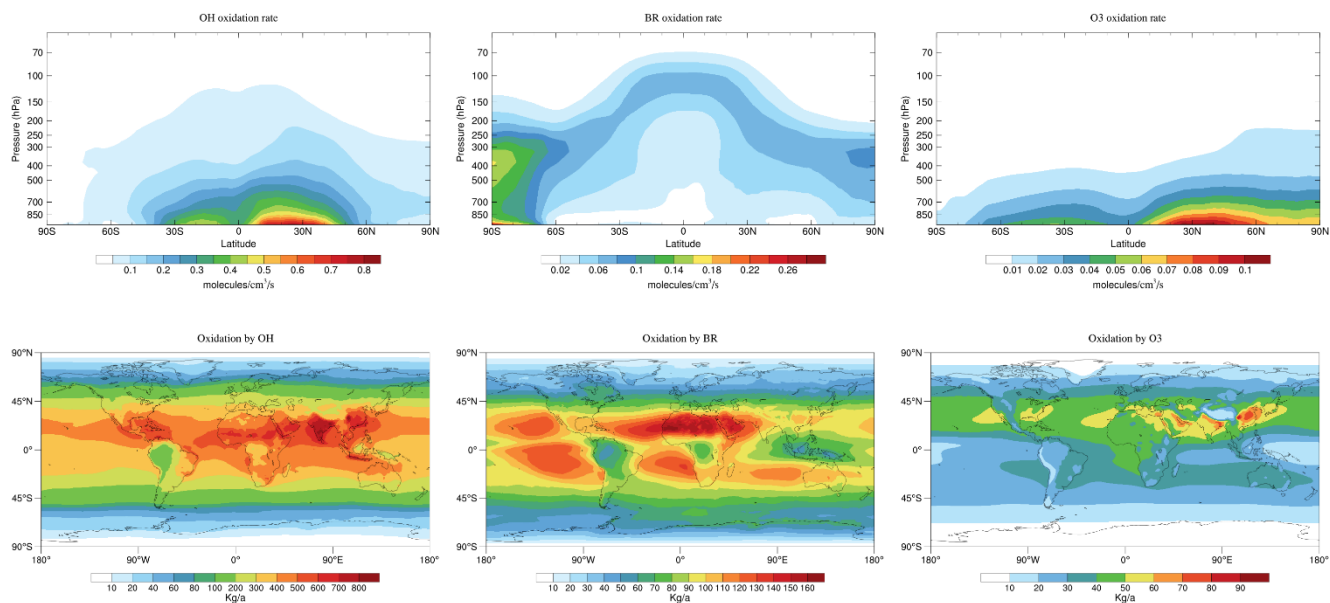
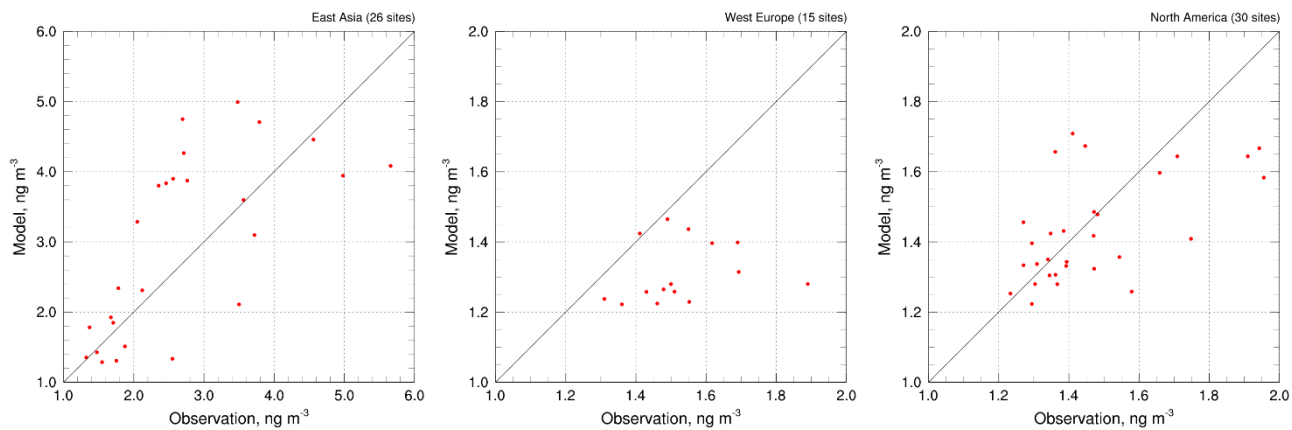


Figure S1. (Top) Annual zonal mean oxidation rates (molecules cm⁻³ s⁻¹) of Hg⁰ by OH (left), Br (middle) and O₃ (right). (Bottom) Global spatial distribution of annual mean Hg⁰ oxidized (sum of all levels, Kg a⁻¹) by OH (left), Br (middle) and O₃ (right). Note that the scale is different for different oxidant.

20



25 **Figure S2.** Comparison between modeled and observed annual mean atmospheric TGM in East Asia (left), West Europe (center), and North America (right).

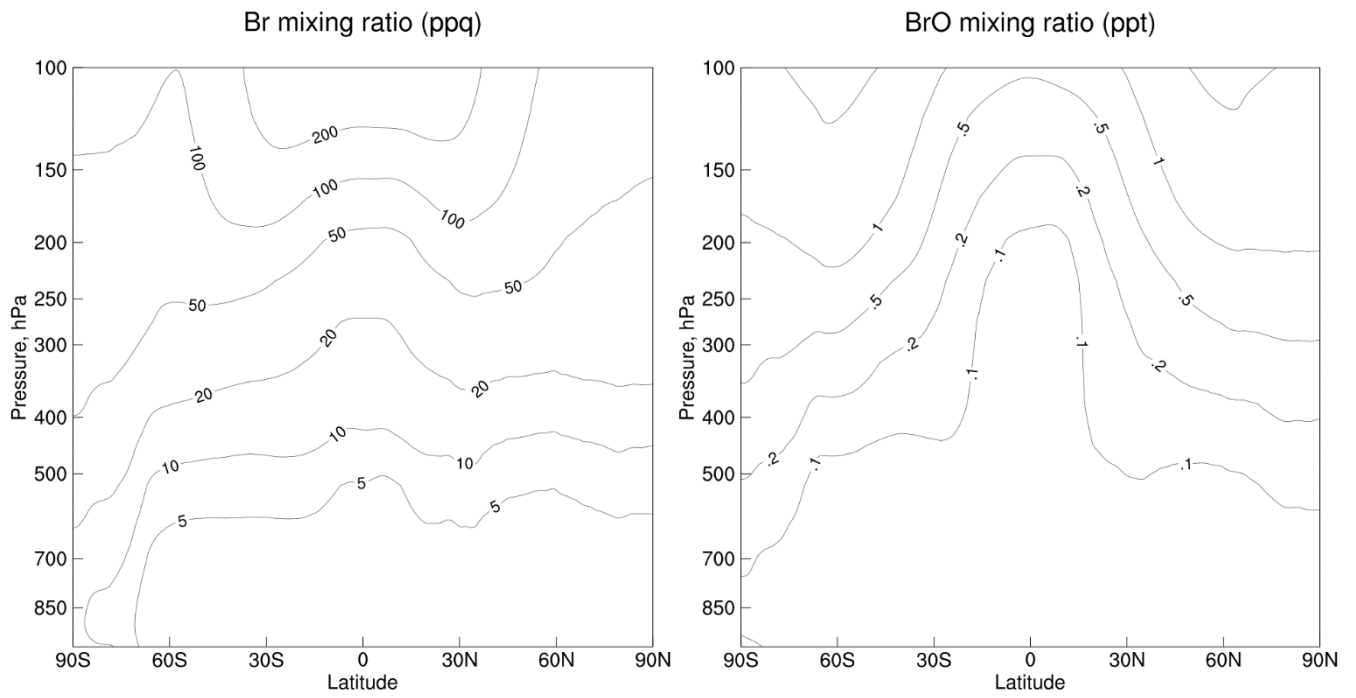
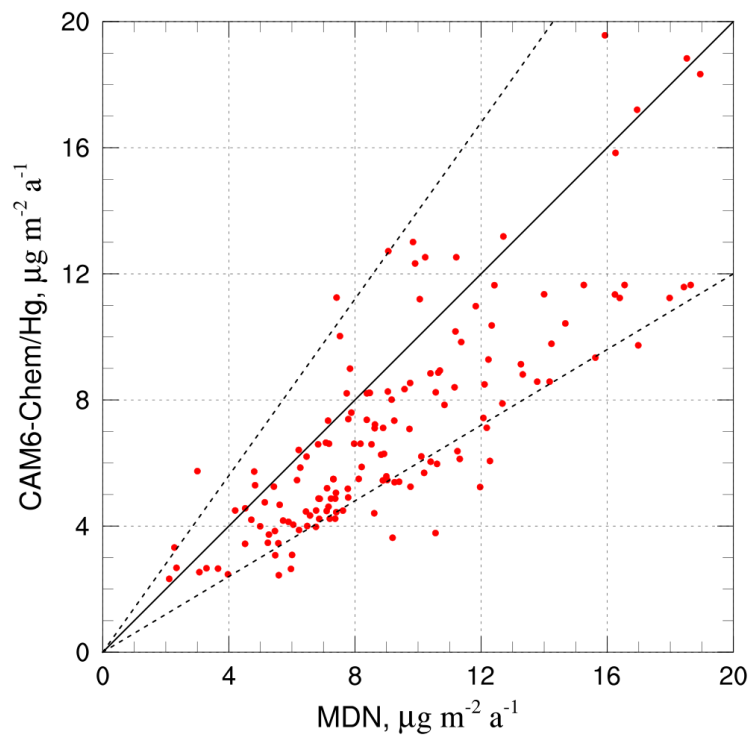


Figure S3. Annual zonal mean mixing ratios of Br and BrO in CAM6-Chem/Hg.



30

Figure S4. Scatter plot of observed and modeled annual mean Hg^{II} wet deposition flux. The solid line depicts the 1 : 1 ratio and the dashed lines correspond to $\pm 40\%$.

References

- 35 AMAP/UNEP: Technical Background Report to the Global Mercury Assessment 2018. <https://web.unep.org/globalmercurypartnership/technical-background-report-global-mercury-assessment-2018>, 2018.
- Angot, H., Dastoor, A., De Simone, F., Gårdfeldt, K., Gencarelli, C. N., Hedgecock, I. M., Langer, S., Magand, O., Mastromonaco, M. N., Nordstrøm, C., Pfaffhuber, K. A., Pirrone, N., Ryjkov, A., Selin, N. E., Skov, H., Song, S., Sprovieri, F., Steffen, A., Toyota, K., Travnikov, O., Yang, X., and Dommergue, A.: Chemical cycling and deposition of atmospheric mercury in polar regions: review of recent measurements and comparison with models, *Atmos. Chem. Phys.*, 16, 10735-10763, 10.5194/acp-16-10735-2016, 2016.
- 40 Fu, X., Liu, C., Zhang, H., Xu, Y., Zhang, H., Li, J., Lyu, X., Zhang, G., Guo, H., Wang, X., Zhang, L., and Feng, X.: Isotopic compositions of atmospheric total gaseous mercury in 10 Chinese cities and implications for land surface emissions, *Atmos. Chem. Phys.*, 21, 6721-6734, 10.5194/acp-21-6721-2021, 2021.
- 45 Han, Y., Kim, J., Kim, P., Kim, W., Yi, S., Seo, Y., and Kim, S.: General trends of atmospheric mercury concentrations in urban and rural areas in Korea and characteristics of high-concentration events, *Atmos. Environ.*, 94, 754-764, 10.1016/j.atmosenv.2014.06.002, 2014.
- Howard, D., Nelson, P. F., Edwards, G. C., Morrison, A. L., Fisher, J. A., Ward, J., Harnwell, J., van der Schoot, M., Atkinson, B., Chambers, S. D., Griffiths, A. D., Werczynski, S., and Williams, A. G.: Atmospheric mercury in the Southern Hemisphere tropics: seasonal and diurnal variations and influence of inter-hemispheric transport, *Atmos. Chem. Phys.*, 17, 11623-11636, 10.5194/acp-17-11623-2017, 2017.
- 50 Howard, D.: Aspects of the Biogeochemical Cycling of Mercury in Australia and the Southern Hemisphere. Department of Environmental Science. PhD. Macquarie University, Sydney, Australia, p. 160, 2018
- Morrison, A. L., Nelson, P. F., and Howard, D.: Ambient atmospheric mercury in the Hunter Valley, NSW, in: 22nd International Clean Air and Environment Conference, Melbourne, Australia, 20–23 September, 2015.
- 55 Nguyen, L. S. P., Sheu, G., Fu, X., Feng, X., and Lin, N.: Isotopic composition of total gaseous mercury at a high-altitude tropical forest site influenced by air masses from the East Asia continent and the Pacific Ocean, *Atmos. Environ.*, 246, 118110, 10.1016/j.atmosenv.2020.118110, 2021.
- Sprovieri, F., Pirrone, N., Bencardino, M., D'Amore, F., Carbone, F., Cinnirella, S., Mannarino, V., Landis, M., Ebinghaus, R., Weigelt, A., Brunke, E., Labuschagne, C., Martin, L., Munthe, J., Wängberg, I., Artaxo, P., Morais, F., Barbosa, H. D. M. J., Brito, J., Cairns, W., Barbante, C., Diéguez, M. D. C., Garcia, P. E., Dommergue, A., Angot, H., Magand, O., Skov, H., Horvat, M., Kotnik, J., Read, K. A., Neves, L. M., Gawlik, B. M., Sena, F., Mashyanov, N., Obolkin, V., Wip, D., Feng, X. B., Zhang, H., Fu, X., Ramachandran, R., Cossa, D., Knoery, J., Maruszczak, N., Nerentorp, M., and Norstrom, C.: Atmospheric mercury concentrations observed at ground-based monitoring sites globally distributed in the framework of the GMOS network, *Atmos. Chem. Phys.*, 16, 11915-11935, 10.5194/acp-16-11915-2016, 2016.
- 65

- Xu, H., Sonke, J. E., Guinot, B., Fu, X., Sun, R., Lanzanova, A., Candaudap, F., Shen, Z., and Cao, J.: Seasonal and Annual Variations in Atmospheric Hg and Pb Isotopes in Xi ' an, China, *Environ. Sci. Technol.*, 51, 3759-3766, 10.1021/acs.est.6b06145, 2017.
- Xu, L., Chen, J., Yang, L., Niu, Z., Tong, L., Yin, L., and Chen, Y.: Characteristics and sources of atmospheric mercury speciation in a coastal city, Xiamen, China, *Chemosphere*, 119, 530-539, 10.1016/j.chemosphere.2014.07.024, 2015.
- 70 Yu, B., Fu, X., Yin, R., Zhang, H., Wang, X., Lin, C., Wu, C., Zhang, Y., He, N., Fu, P., Wang, Z., Shang, L., Sommar, J., Sonke, J. E., Maurice, L., Guinot, B., and Feng, X.: Isotopic Composition of Atmospheric Mercury in China: New Evidence for Sources and Transformation Processes in Air and in Vegetation, *Environ. Sci. Technol.*, 50, 9262-9269, 10.1021/acs.est.6b01782, 2016.
- 75 Zhang, H., Fu, X. W., Lin, C. J., Wang, X., and Feng, X. B.: Observation and analysis of speciated atmospheric mercury in Shangri-La, Tibetan Plateau, China, *Atmos. Chem. Phys.*, 15, 653-665, 10.5194/acp-15-653-2015, 2015.