Supplemental information of

Atmosphere-terrestrial exchange of gaseous elemental mercury: parameterization improvement through direct comparison with measured ecosystem fluxes

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Figure S1 shows comparison of modeled soil re-emission fluxes of Hg^0 by Eqs. (S1-S3).

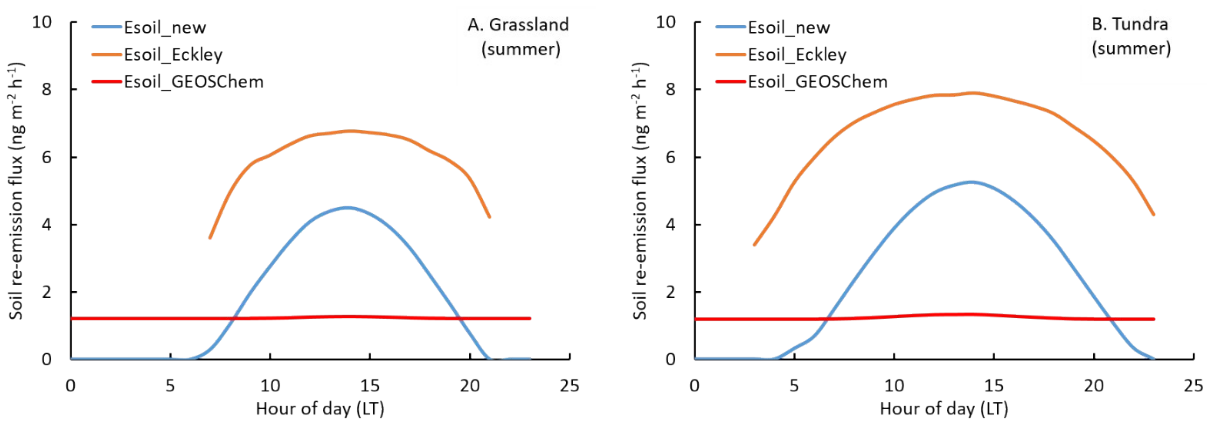

Figure S1. Comparison of modeled soil re-emission fluxes by three models in summer months (July and August) at: (A) the temperate grassland site and (B) the Arctic tundra site.

The existing soil re-emission parameterization in GEOS-Chem[1] (Eq. S1; same as Eq. 5 in the paper) implemented according to the formulation given by Zhang et al.[2] exhibited little diurnal variation in re-emission (Fig. S1).

$$E_{soil\_GESOChem} = \gamma C_{soil} \exp\left(1.1 \times 10^{-3} \times R_g\right) \tag{S1}$$

We achieved larger daytime emission and smaller nighttime emission by modifying the empirical soil Hg^0 re-emission parameterization (Eq. S2; same as Eq. 8 in the paper) given by Eckley et al.[3] in which the soil re-emission flux is a function of solar radiation and soil Hg concentration:

$$E_{soil\_Eckley} = 10^{[0.709 + 0.119 \log\left(C_{soil}\right) + 0.137 \log\left(solar\ radiation\right)]}$$

(S2)

To better account for diurnal variability in soil Hg^0 re-emission fluxes and include the effect of vegetative shading on solar radiation reaching the soil surface, we modified Eq. (S2) as follows (Eq. S3; same as Eq. 9 in the paper):

$$E_{soil\_new} = 10^{[0.709 + 0.119 \log\left(C_{soil}\right) + 0.137 \log\left(R_g^{'}\right)]} \times a^{-1} sin\frac{\pi t}{D}$$

(S3)

References:

1. S. Song, N. E. Selin, A. L. Soerensen, H. Angot, R. Artz, S. Brooks, E.-G. Brunke, G. Conley, A. Dommergue and R. Ebinghaus, Top-down constraints on atmospheric mercury emissions and implications for global biogeochemical cycling, *Atmospheric Chemistry & Physics*, 2015, **15**, 7103-7125.
2. H. Zhang, S. E. Lindberg, F. Marsik and G. J. Keeler, Mercury air/surface exchange kinetics of background soils of the Tahquamenon River watershed in the Michigan Upper Peninsula, *Water, Air, & Soil Pollution*, 2001, **126**, 151-169.
3. C. S. Eckley, M. T. Tate, C.-J. Lin, M. Gustin, S. Dent, C. Eagles-Smith, M. A. Lutz, K. P. Wickland, B. Wang and J. E. Gray, Surface-air mercury fluxes across Western North America: A synthesis of spatial trends and controlling variables, *Science of the Total Environment*, 2016, **568**, 651-665.