EGU2020-1598
https://doi.org/10.5194/egusphere-egu2020-1598
EGU General Assembly 2020
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The storage and influencing factors of mercury in the permafrost of the Tibetan Plateau

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Soil is one of the largest reservoir of mercury in the environment. Globally, most of the mercury in the soil is stored in permafrost, such as the Arctic and the Tibetan Plateau. Mercury in the soil is mainly derived from atmospheric deposition and tightly bound to the organic carbon. The mercury level in the permafrost over the Tibetan Plateau and its influencing factors have been less studied. This study analyzes soil total mercury (STHg) concentrations and its vertical distribution in meadow soil samples collected from the Tibetan Plateau. We adopt a nested-grid high-resolution GEOS-Chem model to simulate atmospheric mercury deposition. The relationship between STHg and soil organic carbon(OCD) as well as atmospheric deposition are explored. We also extend our analysis to data in the Tibetan Plateau and other regions of China in the literature. Our results show that the STHg concentrations in the Tibetan Plateau are 19.9±12.4 ng/g. The concentrations are higher in the south/east and lower in the north/west in the Tibetan Plateau, consistent with the previous results. Our model shows that the average deposition flux of Hg is 3.3 ug m^{-2} yr^{-1} with 57% contributed by dry deposition of Hg^0, followed by dry deposition of Hg^{II} and Hg^P (19%) and wet deposition (24%). We calculate the Hg to carbon ratio (R_{HgC}) of 5.52 ± 5.11 μg Hg/g C and the estimated STHg is 67.45 Gg in alpine grasslands in the Tibetan Plateau, contributing about 2.7% globally. We find a positive correlation between OCD and STHg in the Tibetan Plateau(Log(STHg) = 0.35log(OCD) + 0.99, R^2 = 0.24) and a weak relationship between model residual (defined as the difference between model fitting values and observations) and atmospheric total Hg deposition. We conclude that soil organic carbon(SOC) and atmospheric deposition work simultaneously for STHg. Atmospheric deposition determines the potential levels of STHg in large spatial scales, while SOC and its characteristics modulate STHg locally by influencing the fate and transport of Hg.