(5-220407-C) **Revising Global Methane Soil Sink by Considering High Affinity Methanotrophy**

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Methane oxidation by microbes is the second largest sink of the global methane budget, but its importance has been widely underestimated. Studies found the soil methane ($CH_4$) sink in more diverse terrestrial ecosystems thought to be due to high affinity methanotrophs (HAMs). A recent study that integrates the dynamics of HAMs and methanogens into a biogeochemistry model leads to the upland methane sink doubling north of 50 °N in simulations from 2000–2016 and significantly reduces the projected net methane emissions by 2100. The underestimated global soil methane sink may help explain the discrepancy of the global methane budget between biogeochemical models and atmospheric inversions by reducing the estimates from biogeochemical models. In this study, we hypothesize that HAMs significantly increase the global methane soil sink and improve the estimation of global methane budget. We test this hypothesis by using three independent methods: biogeochemical modeling and machine learning estimation of global methane soil sink, and atmospheric modeling of global methane and methane isotopes by including the revised soil sink.

We first used a biogeochemical model that includes microbial dynamics of HAMs and optimized parameters related to methane oxidation processes for regions with 8 different vegetation types. The preliminary results show that the global methane soil sink of 60 $TgCH_4yr^{-1}$, twice larger than the previous estimates, matches better with observations. We further collected in-situ methane oxidation fluxes from 182 papers to estimate global methane soil sink using a random forest model and identify important predictors for the machine learning selection. The machine learning approach also shows consistent results with biogeochemical modeling that the global methane soil sink is 50-60 $TgCH_4yr^{-1}$. Finally, we ran forward simulations of global methane and its stable carbon isotopes using atmospheric model TM5 by considering different soil sink estimations and compared the simulation results with observations from NOAA *in situ* and aircraft measurements. The revised global soil sink of 60 $TgCH_4yr^{-1}$ matches well with long-term observed $CH_4$ and $\delta^{13}C$-$CH_4$, but results varied based on fractionation factors of soil methane oxidation and global mass balance.

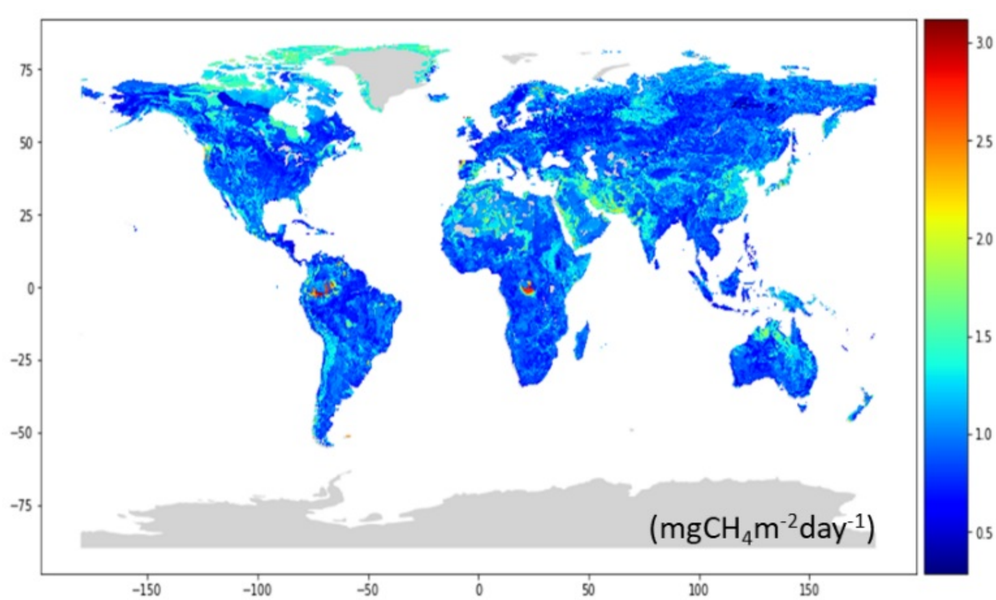


**Figure 1.** Machine learning estimation of Global methane soil sink.