$^{13}CH_3D$ and $^{12}CH_2D_2$ Measurements of Methane from Boreal Lakes

MOJHGAN A. HAGHNEGAHDAR[1*], EDWIN A. SCHAUBLE[1], ISSAKU KOHL[1], JABRANE LABIDI[1], KATEY WALTER ANTHONY[2], EDWARD D. YOUNG[1]

[1]Earth, Planetary, and Space Scieces, UCLA, CA, USA
(*Correspondence: mojhganhagh@ucla.edu)
[2]Water and Environmental Research Center, UAF, AK, USA

In order to begin building a realistic budget of atmospheric sources and sinks of methane that includes the abundances of multiply-substituted isotopolgues, we analyzed $\Delta^{13}CH_3D$ and $\Delta^{12}CH_2D_2$ in methane emitted from nine boreal lakes located in Alaska, Canada, and Siberia. Wetlands are one of the most important sources of atmospheric methane. Methane emissions from Arctic wetlands (>67°N) appear to have increased by 30.6 ± 0.9% during 2003 to 2007[1]. Annual emissions of methane from boreal lakes are predicted to increase by up to 54% by the end of this century[2]. Our measurements show boreal lake methane $\Delta^{12}CH_2D_2$ and $\Delta^{13}CH_3D$ ranging from −41.6 to +18.7‰, and –1.2 to +5.4‰, respectively. Most of the samples (six of nine lakes) resemble methane from laboratory cultures of microbial methanogens, with isotopic signatures that depart markedly from the equilibrium composition of $\Delta^{12}CH_2D_2 \approx +20$ and $\Delta^{13}CH_3D \approx +6$ at plausible environmental temperatures. Using these data, and taking predicted emissions growth models from the literature[2], we modeled the likely impacts of boreal lakes on the future atmospheric CH_4 isotopologue budget (up to year 2100). Our model predicts that a gradual rise of 17 Tg/yr in boreal wetland methane emission by 2100 will result an increase of ~16‰ in atmospheric $\Delta^{12}CH_2D_2$ but less than 0.2‰ change in $\Delta^{13}CH_3D$. δD also increases ~10‰ in this model, reaching a pseudo-steady state in ~50 years. The sensitivity of $\Delta^{12}CH_2D_2$ suggests a potential use for tracking changes in the atmospheric methane budget.

1-Bloom et al., 2010, *Science,*327:5963,322-325
2- Wik et al., 2016, Nature Geo.,9,99-106