

## **Influences of climate warming on labile organic carbon transformation and mercury methylation in saturated tundra from Barrow, Alaska**

Ziming Yang<sup>1\*</sup>, Stan D. Wullschleger<sup>1,2</sup>, Liyuan Liang<sup>1</sup>, David E. Graham<sup>2,3</sup>, Baohua Gu<sup>1</sup>

Terrestrial Ecosystem Science Program: NGEE-Arctic Project (PI: Stan D. Wullschleger)

<sup>1</sup> Environmental Sciences Division, Oak Ridge National Laboratory

<sup>2</sup> Climate Change Science Institute, Oak Ridge National Laboratory

<sup>3</sup> Biosciences Division, Oak Ridge National Laboratory

\* Corresponding author email: [yangz1@ornl.gov](mailto:yangz1@ornl.gov)

Warming temperatures in Arctic tundra increase microbial activity and thus stimulate the degradation of stored soil organic carbon (SOC). Previous studies suggest that SOC degradation is affected by its chemical composition, but it remains unclear what fractions or pools of SOC are the most vulnerable to rapid breakdown and what mechanisms are involved. Additionally, little is known concerning the effects of permafrost thaw on microbial mercury methylation and how it is coupled to SOC degradation. Using a suite of analytical techniques, we examined the dynamic consumption and production of labile SOC compounds, including reducing sugars, alcohols, and low-molecular-weight organic acids during an 8-month anoxic incubation with a tundra soil obtained from the Barrow Environmental Observatory, Barrow, Alaska. We observe that sugars and alcohols in thawed SOC largely account for the initial rapid release of CO<sub>2</sub> and CH<sub>4</sub> through anaerobic fermentation; organic acid fermentation products are subsequently utilized as substrates for methanogenesis. Degradation of labile SOC is also found to rapidly fuel the biosynthesis of methylmercury, a potent neurotoxin in tundra soil. Mercury methylation is positively correlated to the production of CH<sub>4</sub> and ferrous ion, suggesting the linkages among microbial pathways of methanogenesis, iron reduction, and mercury methylation. These observations suggest that climate warming or permafrost thaw could greatly enhance the decomposition of labile SOC, which accelerates the release of CH<sub>4</sub> and CO<sub>2</sub> and production of methylmercury in Arctic tundra.