Title: Mechanistic modeling of methane cycle at SPRUCE

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Summary:

This project will improve and apply a highly mechanistic microbial functional group based model to understand and predict methane (CH₄) cycling at SPRUCE. Our recently developed methane model considers four key mechanisms for CH₄ production and consumption: methanogenesis from acetate or from single-carbon compounds and CH₄ oxidation using molecular oxygen or other inorganic electron acceptors. Four microbial functional groups perform these processes: acetoclastic methanogens, hydrogenotrophic methanogens, aerobic methanotrophs, and anaerobic methanotrophs. Incorporated into Community Land Model (CLM), the module is further used to integrate measurements of CH₄ fluxes and mechanisms of CH₄ production and consumption obtained from SPRUCE project to better understand and predict soil biogeochemical processes in response to warming and elevated CO₂.

The primary tasks include, (1) understanding the dynamics of dissolved organic carbon, acetate acid, carbon dioxide and methane along soil profile; (2) understanding acetoclastic methanogenesis, hydrogenotrophic methanogenesis, aerobic methanotrophs, and anaerobic methanotrophs along soil profile; (3) examining how these biogeochemical processes along soil profile contribute to the surface CH₄ flux; (4) predicting the impacts of whole-ecosystem warming and elevated CO₂ on the below-ground soil biogeochemical processes and thus the surface CH₄ flux.

This project integrates the data from research groups of microbial genomics and soil biogeochemistry within SPRUCE and contributes to the ongoing development of CLM_SPRUCE and ACME models.