Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.17083

Validation of a predictive model of carbon dioxide emissions from a sub-arctic boreal forest in Alaska, USA

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Subarctic and Arctic environments are sensitive to warming temperatures due to climate change. As soils warm, soil microorganisms are breaking down carbon and releasing greenhouse gases such as methane (CH_4) and carbon dioxide (CO_2). Recent studies examining CO_2 efflux note heterogeneity of microbial activity across the landscape. Additionally, soil water content and temperature have a direct influence on soil microbial activity. In an attempt to understand carbon dynamics, our team developed a predictive model, Dynamic Representation of Terrestrial Soil Predictions of Organisms' Response to the Environment (DRTSPORE), to estimate CO_2 efflux based on soil temperature and moisture estimates [1]. We expanded this model to include subarctic soils experiencing warming. The goal of this work was to validate the DRTSPORE model estimates of CO_2 efflux in cold climates by comparing them to soil respiration rates collected from a boreal forest 13 km north of the town center of Fairbanks, Alaska USA. Soil respiration was measured using a LiCOR field respirometer with automatic chambers deployed in triplicate from August 2021 to September 2022. Additionally, thaw depths as well as soil temperature and moisture from the organic and mineral horizons were measured. Our initial results show CO_2 efflux values ranging from 0 to 1410 mg C-CO_2/m^2/day. Soil activity positively correlated with soil thaw depth and water content. Furthermore, there were no significant differences in CO_2 efflux across seasons, as determined by soil temperature. These findings are important for carbon efflux modeling and estimating soil microbial activity in continuously warming Subarctic and Arctic environments.

[1] Barbato, R.A., Waldrop, L., Messan, K., Jones, R., Doherty, S.J., Foley, K., Felt, C., Morgan, M. and Han, Y., 2018. *Dynamic Representation of Terrestrial Soil Predictions of Organisms' Response to the Environment*. ERDC/CRREL TR 18-15. Hanover, NH: U.S. Army Engineer Research and Development Center.