Connecting science, people, and policy for Arctic justice and global climate

Background

The arctic and boreal regions are warming at more than twice the global rate, with temperatures already greater than 2°C above preindustrial levels. Rapid warming is intensifying wildfires and thawing permafrost, both of which are transforming northern ecosystems and creating hazardous conditions that are forcing arctic communities to make difficult and urgent adaptation decisions. These changes can also impact global climate through carbon feedbacks, and thus there is an urgent need to reduce the uncertainties that observational and modeling gaps create in understanding the current and future state of permafrost feedbacks. Despite this need, at present, not even current scientific understanding of future emissions from a warming Arctic is reflected in most climate policy planning.

Here we present our strategy to address these issues through a six-year science and policy project, Permafrost Pathways. Our scientific approach includes coordinating and expanding the network of CO2 and CH4 eddy covariance sites across the Arctic-boreal zone, remote sensing of landscapes disturbances, and developing a data assimilation ecosystem model to project carbon-climate feedbacks under various policy scenarios. We will work in partnership with local leaders and national policymakers to harness these data to support Arctic community adaptation and appropriate climate mitigation policy. We plan to work closely with members of the ABoVE community and contribute to ABoVE objectives regarding permafrost thaw, carbon cycling, disturbances, hydrology, modeling, climate feedbacks, knowledge co-production, and mitigation and adaptation solutions.

Monitoring & Modeling

Flux Networks

In collaboration with members of the international flux community, we are working towards a more comprehensive ground network of CO2 and CH4 eddy covariance sites across the Arctic-boreal zone. This includes collating and synthesizing past observations, supporting and augmenting current towers, and establishing new sites.

Remote Sensing

Using remote sensing and machine/ deep learning techniques, we will produce pan-Arctic maps of wildfire extent and carbon emissions, changing hydrology, abrupt permafrost thaw, and upscaled CO2 and CH4 fluxes. Mapping will be facilitated by ground data collected by project scientists, volunteers, and our partners including Indigenous community members.

Modeling

We are building a data assimilation version of the DVM-DOS-TEM model in order to better constrain parameters and provide accurate initial conditions. We are also further developing the model’s capacity to represent wildfires, abrupt permafrost thaw, CH4 fluxes, and aquatic transport and fluxes. The model will be run at 1-2 km resolution across the Arctic-boreal zone to provide historical assessments, near-term forecasts, and longer-term projections. We will use model outputs to inform policy scenarios using a compact Earth System model (OSCAR).

Mitigation

Translating our collective science (in partnership with ABoVE) into impact is one of our primary project goals. With updated data and models that reduce uncertainty in permafrost emissions, we will supply policymakers at varying levels of government with information to incorporate permafrost into international climate mitigation policy, and continually communicate the level of risk associated with permafrost carbon feedbacks.

Adaptation

Permafrost thaw is putting Arctic communities at risk. Working closely with climate scientists, Indigenous knowledge holders and Alaska Native tribes who live on land underlain by permafrost, we are applying our monitoring and modeling tools to assess the current and future impacts of permafrost thaw and co-create equitable adaptation plans that respect and protect the health, well-being, and human rights of Arctic residents.

Brendan Rogers, Sue Natali, John Holdren, Robin Bronen, Patricia Cochran, Jennifer Watts, Rachael Treharne, Helene Genet, Elchin Jafarov, Valeria Briones, Anna Virkala, Darcy Peter, Stefano Potter, Mathias Goedcke, Martijn Pallandt, Yili Yang, Greg Fiske, Jessica Howard