

Snapshots of the World's Cold Regions Changing Biogeochemistry

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The Earth's cold and cold-temperate regions are undergoing deep and accelerating changes due to climate change. Warming in moderate- to high-latitude terrestrial and aquatic ecosystems is accompanied by permafrost thaw, shorter winters, reduced ice cover, earlier snowmelt, more intense soil freeze-thaw cycles, drier summers, and longer fire seasons. These environmental changes in turn impact surface water and groundwater flows, water quality, greenhouse gas emissions, soil stability, primary production, and (micro)biological communities. Warming also facilitates agricultural expansion, urban growth, and natural resource development, adding growing human pressures to cold regions' water resources, soil health, and biodiversity. In this presentation, I will provide some snapshots that illustrate several of the challenges, knowledge gaps, and opportunities in cold region biogeochemical research, with an emphasis on processes and responses in both natural and anthropic environments. Many of the biogeochemical changes are closely interrelated with the changing hydrological and thermal regimes affecting cold regions' landscapes and water bodies. Compared with their temperate counterparts, these landscapes and water bodies experience shorter growing seasons, more persistent ice and snow covers, extensive permafrost, pronounced cycles of freezing and thawing, and intensifying physical and chemical weathering. Here, I will focus on some of the more unique features and response dynamics of cold regions' biogeochemistry. In addition to new unpublished work, my presentation will cover material from [1-4].

[1] Adams et al. (2022) *Earth System Science Data* **14**, 5139-5156.

[2] Byun et al. (2021) *Scientific Reports* **11**, 23219.

[3] Pi et al. (2021) *Annual Review of Environment and Resources* **46**, 111-134.

[4] Rafat et al. (2022) *Environmental Research Communications* **4**, 021003.