Permafrost Thaw and Ecohydrology

Participants

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Motivations

- Permafrost soils contain C that consists of material legacies of plants, microbes, and animals and thermal legacies of ice wedges and lenses and pore ice that accumulated over thousands of years

- Warming is thawing permafrost, exposing organic C to microbial decomposition and loss via leaching of DOC to aquatic ecosystems

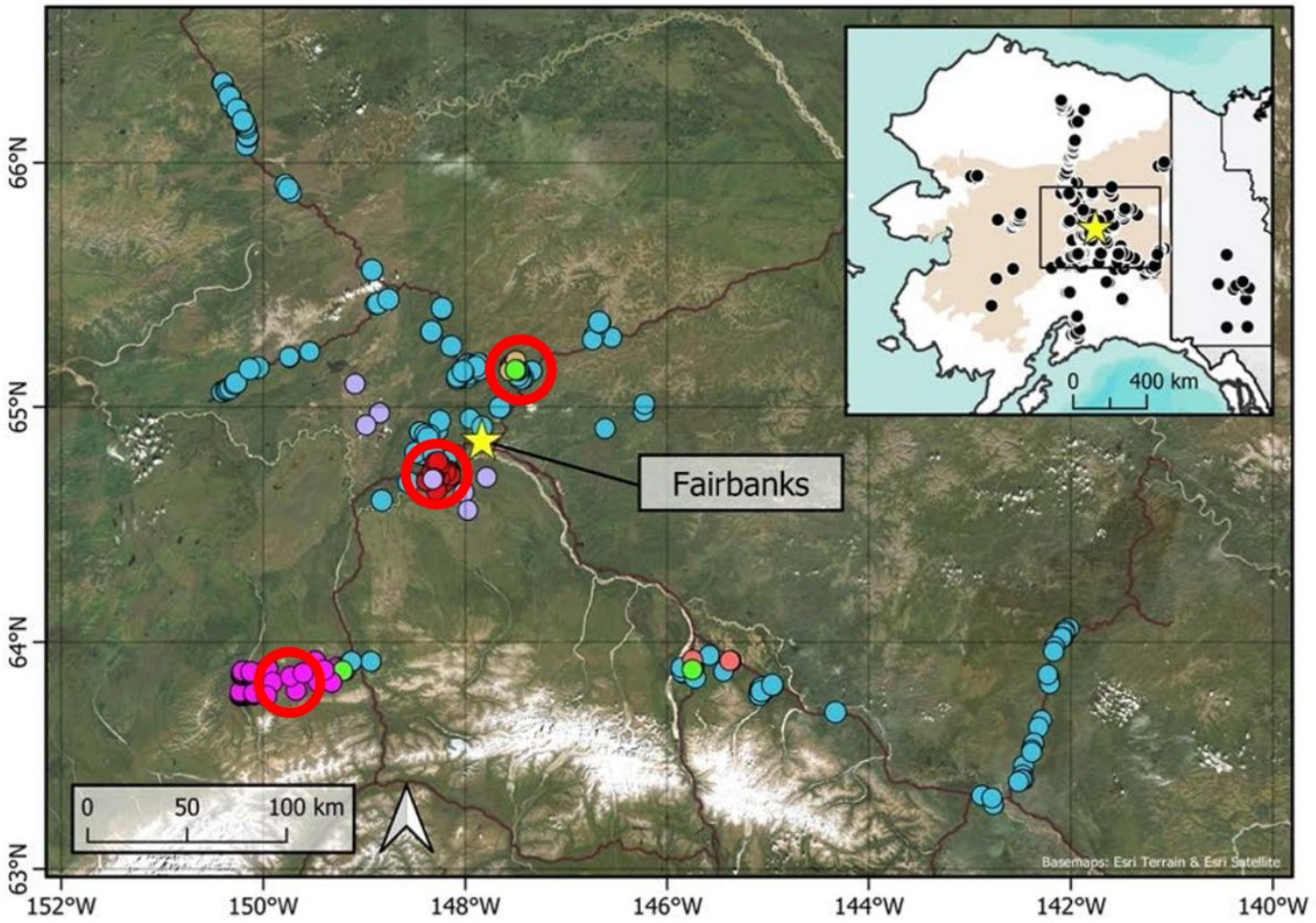
- Expansion of perennial thaw zones above the permafrost table remain unfrozen during the winter and represent the expansion of a sub-surface ecosystem

- In contrast to increasing active layer thickness and formation of taliks, abrupt thaw that melts ground ice can cause ground subsidence, altering surface hydrology and eroding soils

Motivations

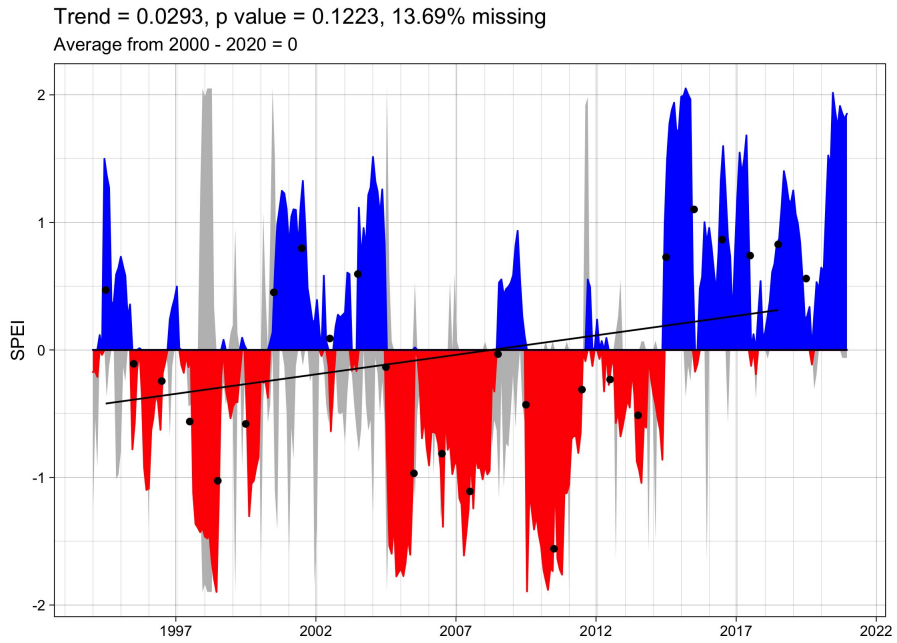
- Thaw also can be triggered by wildfire
- Thaw modulates ecosystem CO_2 and CH_4 fluxes to the atmosphere and lateral export of materials to aquatic ecosystems
- Thawing permafrost and resulting loss of old legacy C to the atmosphere is one of the largest, and still most uncertain, biogeochemical feedbacks to future climate
- Our objective is to **assess the effects of thawing permafrost on the distribution of water across the landscape, loss of C to the atmosphere, and export of C and nutrients via hydrologic fluxes into aquatic ecosystems**

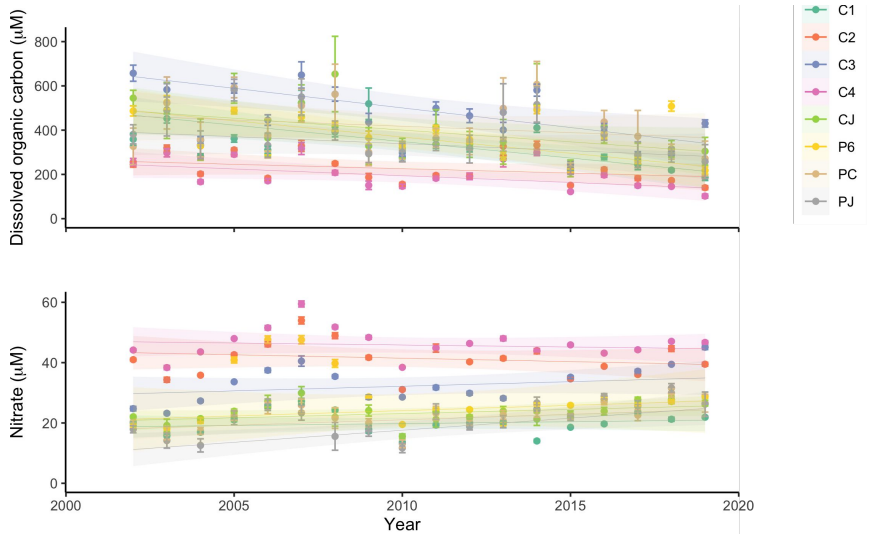
Study Sites



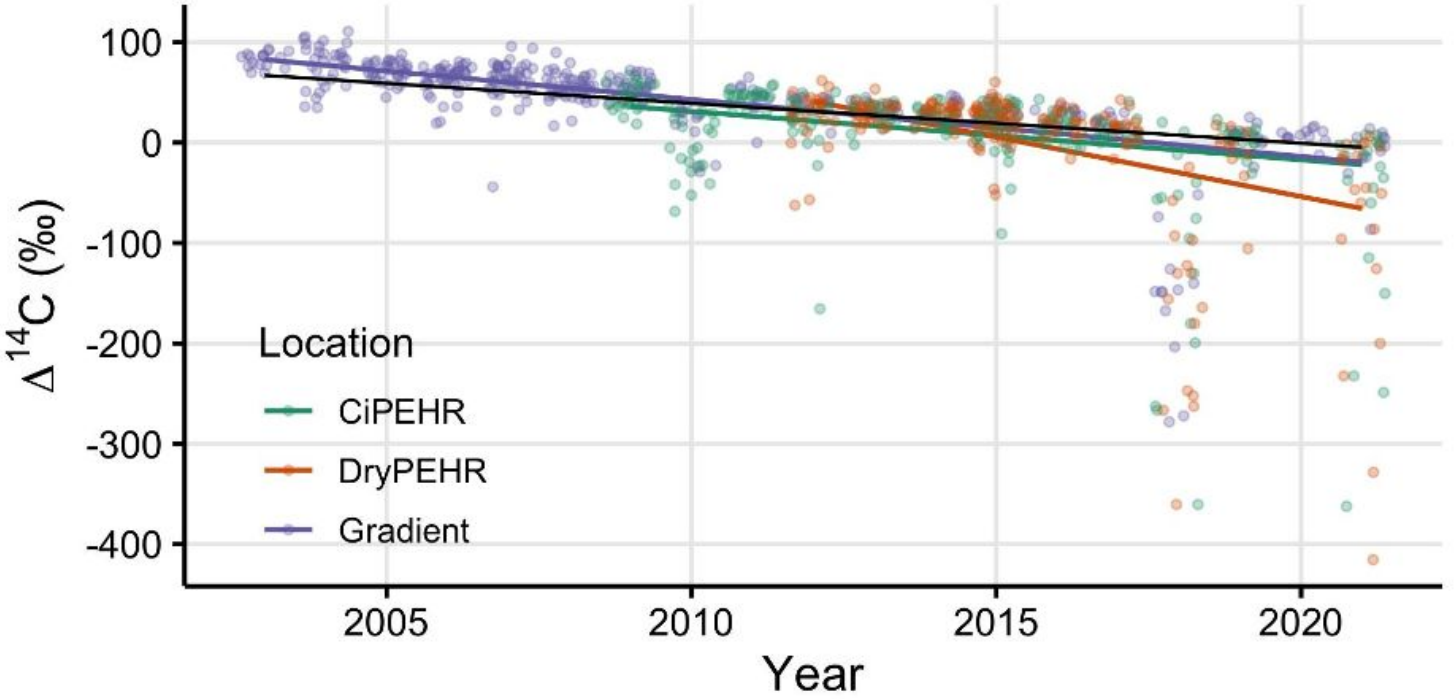
- Caribou-Poker Creeks Research Watershed
- APEX+
- Eight Mile Lake
- Sites within the Regional Site Network

Research Questions and Approaches





- **Question P1:** How will increased evapotranspiration and changing precipitation interact with thawing permafrost to affect soil moisture within terrestrial ecosystems and runoff into aquatic ecosystems?
  - Focus in later years of funding cycle with synthesis of long-term data



Research Questions and Approaches

- **Question P2:** How will the degradation of permafrost and the development of taliks in three long-term upland and lowland study sites alter the release of permafrost C to the atmosphere, and C and nutrients to aquatic ecosystems?
  - Measurements of ^{14}C-DOC across EML/Healy, APEX, and CPCRW to determine the loss of old carbon where permafrost is degrading and taliks expanding.
    - These measurements could form a time series but sampling would primarily capture spatial variation across multiple sites.
  - Measurements of porewater chemistry and microbial production/respiration rates throughout the Bonanza Creek flood plain spanning a gradient of permafrost ice conditions and hydrologic connectivity to river dynamics.
  - 16S DNA gene sequencing be conducted on cores taken from a variety of wetland sites that vary in permafrost conditions. We propose that specifically examining the activities of Geobacteraceae, Methanobacteriaceae and Methanomicrobiaceae will be informative as to shifts in methane production and oxidation potential with time since thaw.

Research Questions and Approaches

- **Question P3:** How will abrupt thaw with thermal erosion affect the mobilization of permafrost C, nutrients, and trace gases in contrast to permafrost degradation without thermal erosion?
  - Measurements of ^{14}C-DOC across a range of thermokarst/abrupt thaw features west of EML.
    - Dependent on helicopter access to pre-existing sites in Denali National Park.

Research Questions and Approaches

- **Question P4:** How does fire severity interact with ground ice to determine rates of thaw and loss of permafrost C?
  - Revisit the JFSP sites to analyze temporal trends in catchment biogeochemistry and spatial relationships between disturbance, landscapes, and biogeochemistry
  - Work across the Permafrost/Ecohydrology and Fire Working Groups

1. Questions about approaches?

2. Charge for Break-out Groups:

- Please address 2 – 3 of the items listed below in breakout groups:
    1. Missed opportunities with approaches
    2. Opportunities to integrate with consumer and fire working groups
    3. Integration with modeling
        1. Information needs/wants from the modeling group
        2. Modeling wants from the permafrost group
    4. Connections to Alaska Native Advisory Council
    5. Connections with ITOC and education
    6. Looking forward, avenues for synthesis

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