

How do Carbon Emissions from Permafrost Melt Differ Globally Between Varying Bog Structures?

Anna Hulse, Rubenstein School of Environment and Natural Resources, University of Vermont

Background:

-Carbon within permafrost bogs comes from plants and animals which have decomposed and collected over thousands of years, holding double the amount of carbon as the atmosphere today. On top of this, the global soil carbon pool is increased by 50% when considering stores within permafrost zones, despite the area only accounting for 15% of global soil. (Schuur 2015)

-As the permafrost within peat bogs melt it morphs into three forms: collapse scars, permafrost plateaus, and unfrozen fens. (Fig. 2, Camill 2001)

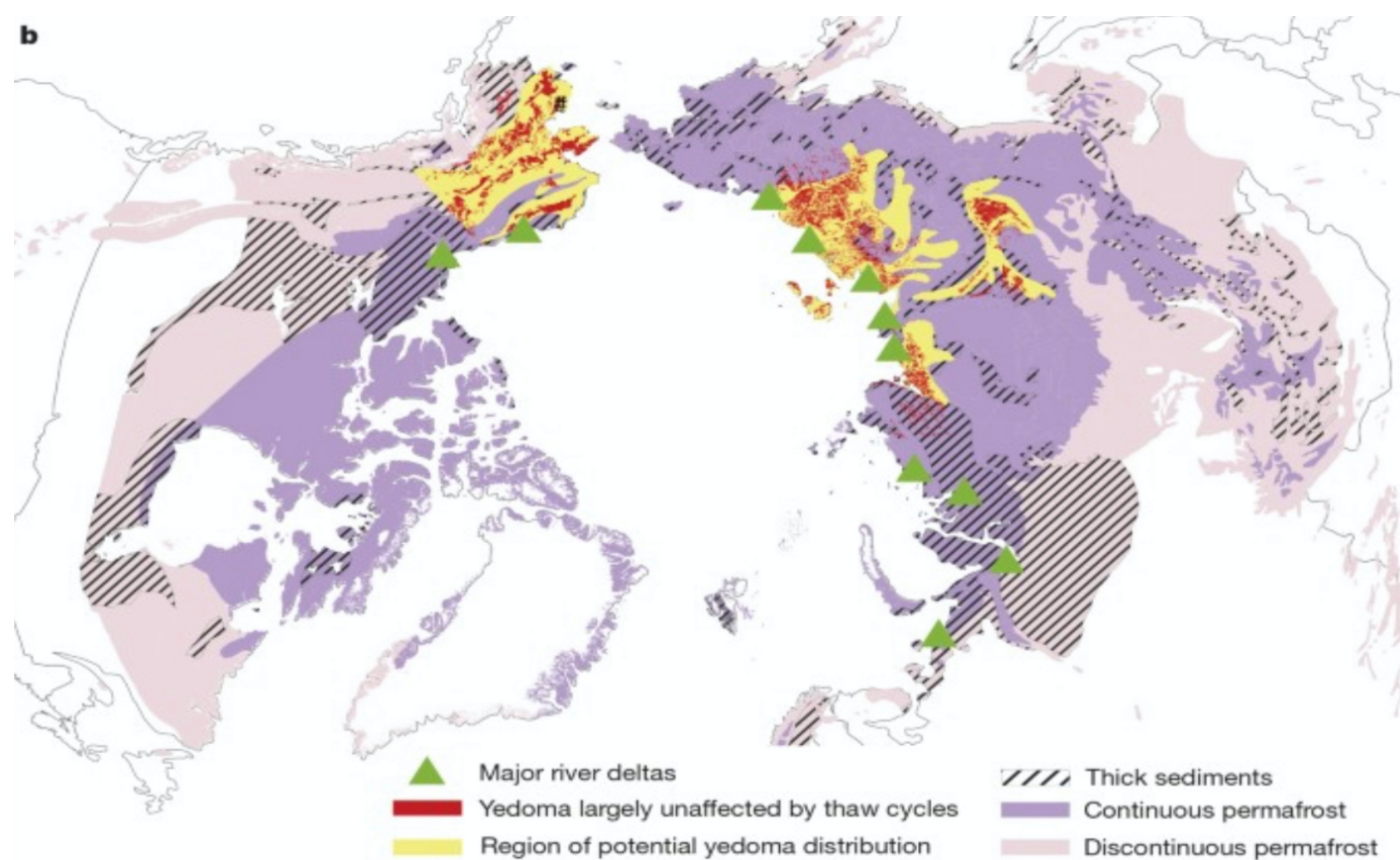


Fig 1: Permafrost Zones of Northern Hemisphere

Schurr 2015

Motivation:

Although research has been conducted on the carbon differentiation between forms of melting bogs, there hasn't been a global study to compare how carbon releases differently from these landforms between locations. This research would contribute to a global body of work studying the impacts of climate change on carbon cycles and disruption of northern ecosystems.

Camill, P., Lynch, J., Clark, J., Adams, J., & Jordan, B. (2001). Changes in Biomass, Aboveground Net Primary Production, and Peat Accumulation following permafrost thaw in the boreal peatlands of Manitoba, Canada. *Ecosystems*, 4, 461-478.
 Schaefer, K., Lantuit, H., Romanovsky, V. E., Schuur, E. A., & Witt, R. (2014). The impact of the permafrost carbon feedback on global climate. *Environmental Research Letters*, 9(8), 085003. doi:10.1088/1748-9326/9/8/085003
 Schuur, E. A., McGuire, A. D., Schadel, C., & Grosse, G. (2015). Climate Change and the permafrost carbon feedback. *Nature*, 520, 171-179.
 Turetsky, M., Wieder, R., & Vitt, D. (2002). Boreal peatland C fluxes under varying permafrost regimes. *Soil Biology and Biochemistry*, 34, 907-912.
 Zhang, H., Gallego-Sala, A., Amesbury, M., Charman, D., Phil, S., & Valiranta, M. (n.d.). Inconsistent Response of Arctic Permafrost Peatland Carbon Accumulation to Warm Climate Phases. *Global Biogeochemical Cycles*, 32, 1605-1620.

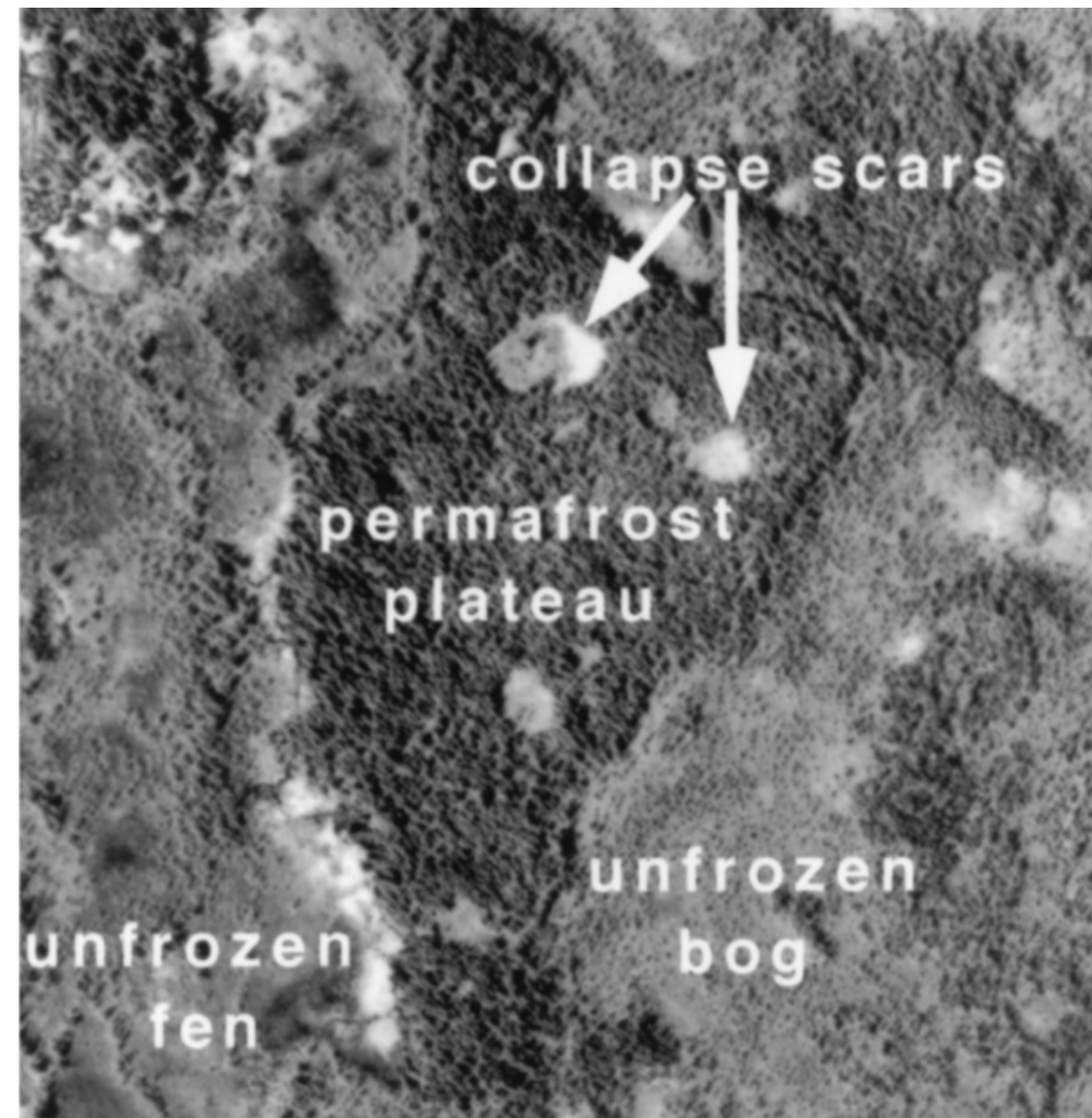


Fig 2. Ariel image of permafrost melt zones Camill 2001

Hypothesis:

We hypothesize that there is a relationship between the three categories of permafrost and the soil carbon levels but there is no global differentiation of this trend.

Prediction:

We predict that carbon levels in the soil will be lowest in the unfrozen fen, followed by collapse scars, and permafrost plateau because carbon will be released into the atmosphere as the permafrost layers melt. We also predict that there is no relationship between this trend across regions of the Northern Hemisphere.

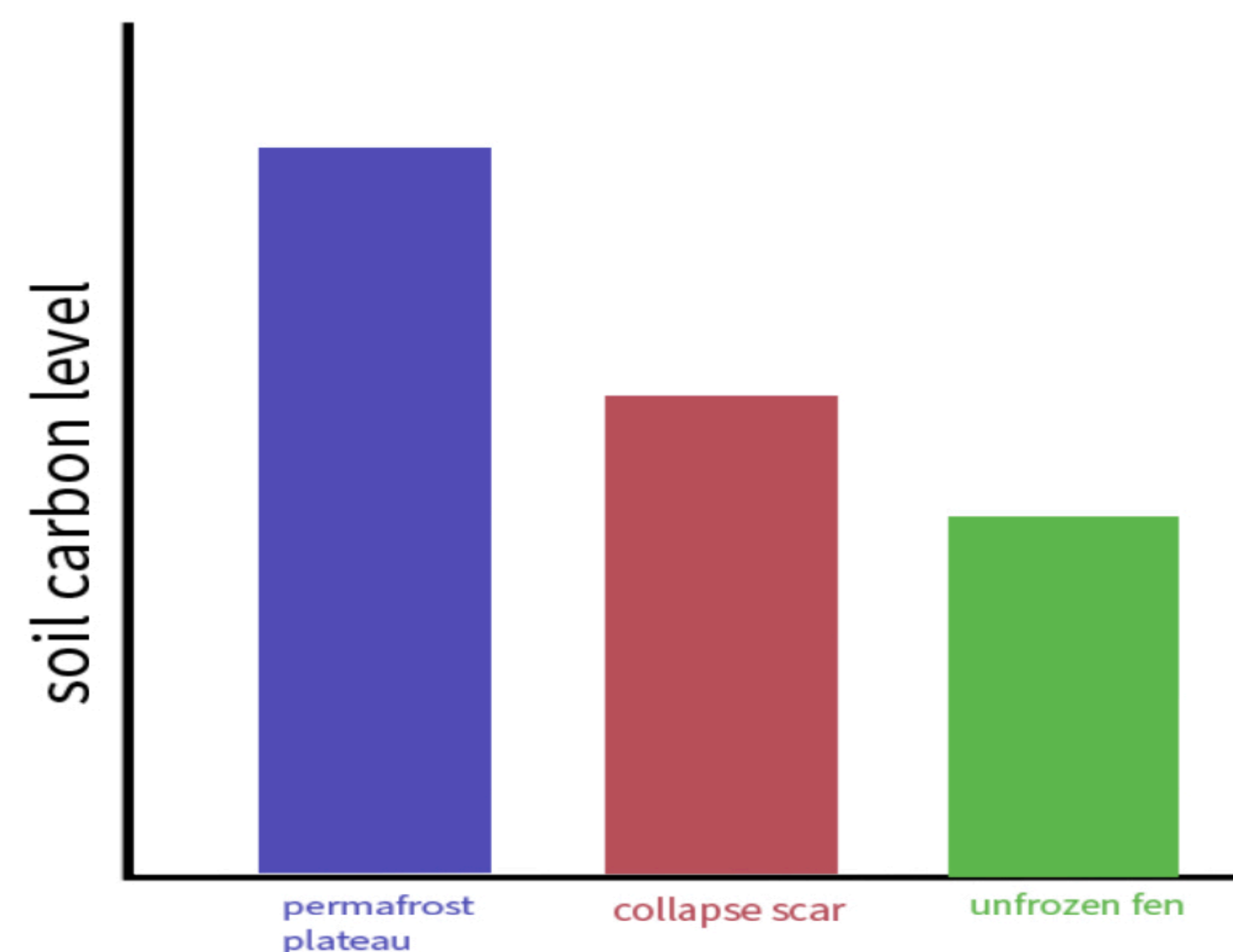


Figure 3: Predictions about carbon level in each permafrost melt zone. The highest among of carbon being where the permafrost hasn't released it and the lowest amount in the unfrozen fen.

Study Design:

-We propose three replicate study areas at each of four regions: Alaska, Quebec, Sweden, and Russia. In each location, plots will be determined at the discontinuous permafrost boundary with continuous permafrost. Each replicate study area will include permafrost plateau, unfrozen fen, and collapse scars.

-We will collect data for ten consecutive years to show longitudinal trends of soil Carbon change and collect mean annual temperature to show climate trend.

-Soil cores will be collected at each location and carbon levels will be measured at three consistent depths

Analysis:

-Since our response variable – carbon concentration- is continuous, and our independent variable -permafrost melt formation- is categorical including more than two groups, the data will be analyzed using ANOVA.

-Through this analysis we will be able to determine if there is a relationship between carbon concentration and the melting formation of a permafrost zone. From this analysis, we can compare sites regionally to determine if the trend is consistent across the Upper-Northern Hemisphere.

-Our interreference is based on our selected study sites in Alaska, Quebec, Sweden, and Russia on the discontinuous/continuous permafrost border.

Benefits of Research:

Understanding global climate trends are crucial to understanding the rate at which greenhouse gases are emitted and climate change impacts can be expected. As the climate wars, permafrost melts releasing carbon and accelerating climate change, creating a positive cycle sending us into a tremendous climate crisis. By understanding the rates of carbon expenditure we can best prepare for the ecological impacts of climate change while building on research to protect vital ecosystems. (Schaefer 2014)