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Progress Toward Mapping and Modeling Arctic-Boreal Peatland Dynamics

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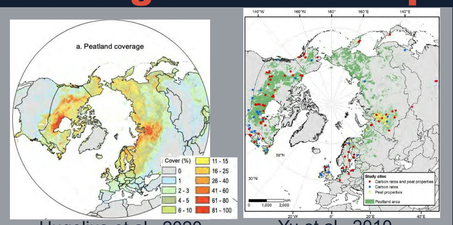
Abstract

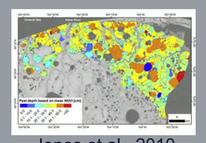
Northern peatlands contain between 300 and 600 PgC, representing a globally important pool of carbon and nutrients. Rising temperatures and changes in precipitation increase the likelihood of disturbances that threaten northern peatlands. Disturbances, such as fire, have direct implication for carbon-climate feedbacks. Therefore, it is imperative we understand the current and future carbon dynamics and the spatial distribution of these peatlands. However, our fundamental understanding of the spatial distribution has been largely limited to coarse spatial scales (≥500 m resolutions), thus representing a disconnect between typical heterogeneous patterns of burns and the heterogeneous distribution of peatlands across the Arctic Boreal Zone(ABZ)of Alaska. Here we developed a new ABZ high-resolution (10 m resolution) peatland map and parameterize the DOS-TEM model to predict changes in peatlands due to changing climatic conditions.

Existing Peatland Maps



Hugelius et al., 2020

Yu et al., 2010



Jones et al., 2010

Reyes et al., 2011, Tarnocai et al., 2002

Mapping Methods

Data-fusion of:

1. **Sentinel-1** (Dual-polarized Synthetic Aperture Radar),
2. **Sentinel-2** (Multi-Spectral Imager),
3. **Arctic Digital Elevation Model** (Arctic DEM) derivatives (e.g., slope, horizontal curvature, vertical curvature).

Supervised Support Vector Machine Algorithm was trained on:

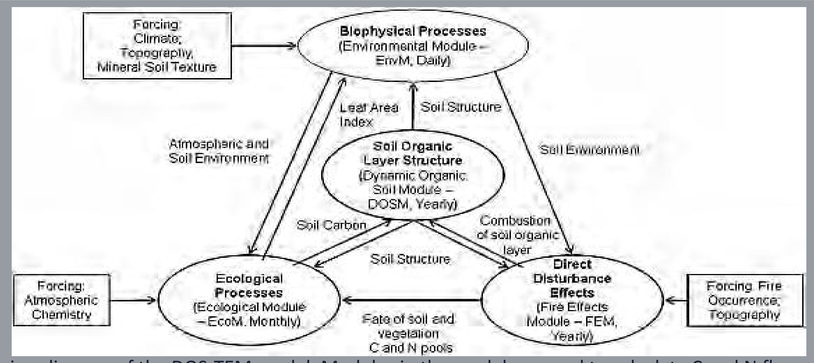
1. 300+ peatland core locations,
2. Ground observations,
3. Sub-meter resolution image interpretation.

Terrain Suitability Model spatially constrained the terrain suitable for peat accumulation; developed using a topographic cost-function using the ArcDEM.

Research Aims

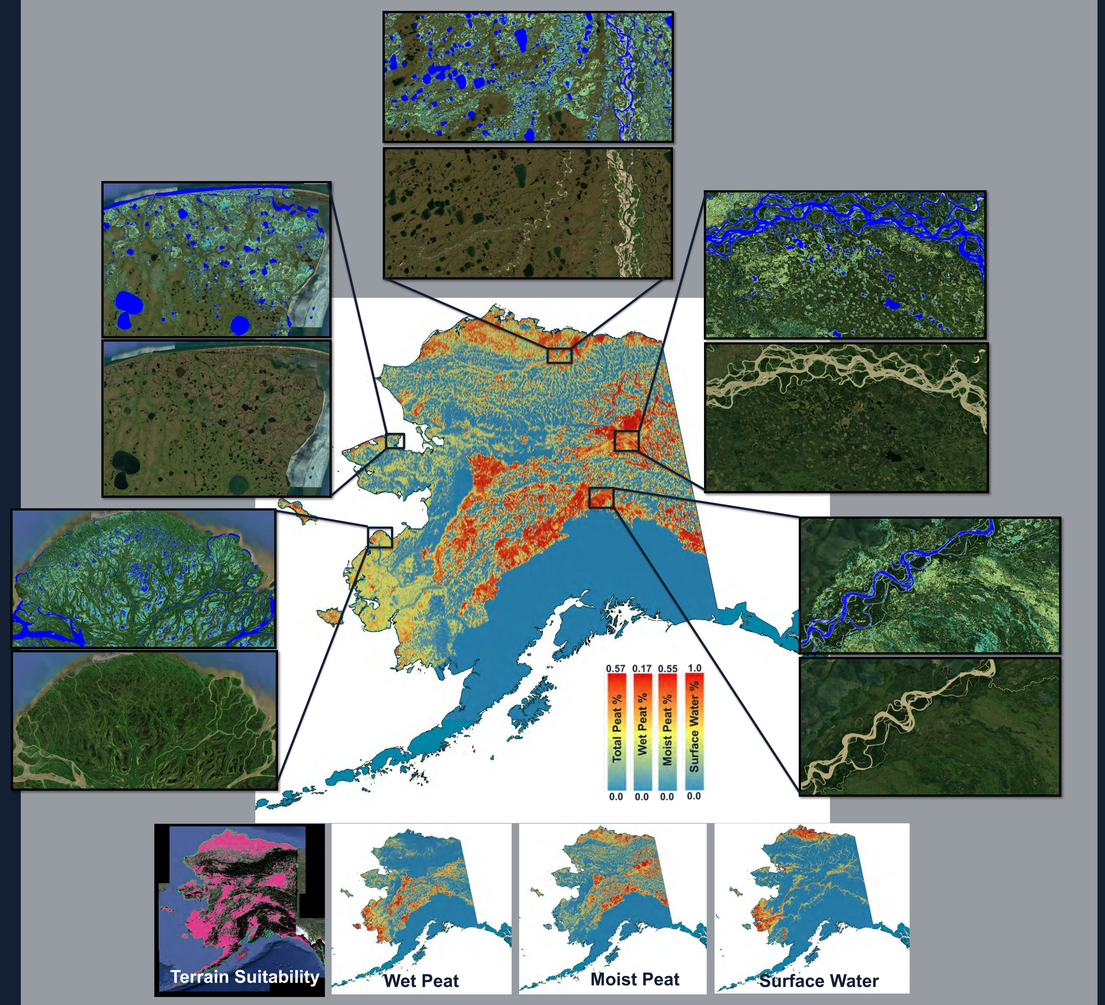
1. **Create a 10m spatial resolution peatland map of Tundra & Taiga Ecoregions in Alaska.**
2. **Model past and present peatland dynamics in response to changing climate and disturbance regimes.**

DOS-TEM

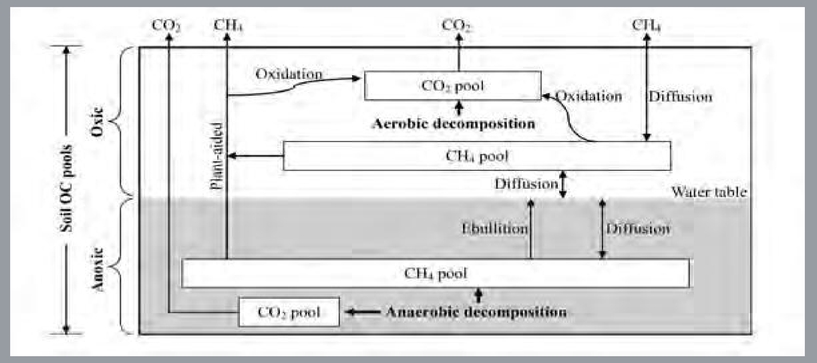


This is a diagram of the DOS-TEM model. Modules in the model are used to calculate C and N fluxes and pools on a daily, monthly, and annually timescale. The peatland module used in our model is the Dynamic Organic Soil Module. External forcing metrics drive changes in the system processes and resulting C and N concentrations. (Yi et al., 2010)

Arctic-Boreal Peatland Map



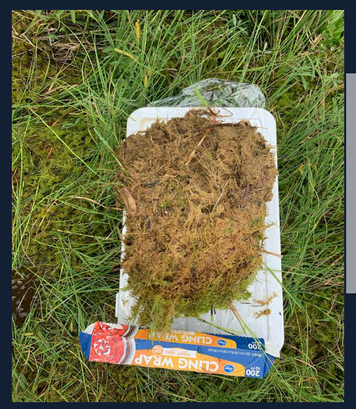
Peatland Dynamics



This diagram represents the peatland module in PEAT-DOS-TEM as described by Fan et al 2013. Products of anerobic and aerobic decomposition are CO2 and CH4 and are calculated in the model based on a function of soil temperature and SOC mass.

Current and Projected Work

1. Limitations of the current Arctic-Boreal Peatland maps include too coarse of resolution(0.5 degree grid cells). Future should include finer resolution mapping products.
2. DOS-TEM is a process-based biogeochemical model that computes the fluxes of carbon and nitrogen between pools of vegetation and soils.
3. DOS-TEM will be calibrated with measured above and belowground parameters such as soil C and N, leaf C and N, organic layer depth. rooting depth, and NPP. These variables were measured summer 2022 in the Arctic Coastal Plane in Alaska, USA.
4. Using future climate parameters, We will estimate the changes in peatland parameters: net primary productivity, soil C and N, surface/subsurface hydrology and moisture, and active layer depth, while exploring the potential impact peatland fires will have on the above parameters by the end of the century.



Boreal peat core (left) and arctic peat core (right) collected in 2022 near Fairbanks, AK and on the Arctic Coastal Plane, respectively

Acknowledgements

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