Prediction of Boreal Peatland Fires in Canada using Spatio-Temporal Methods

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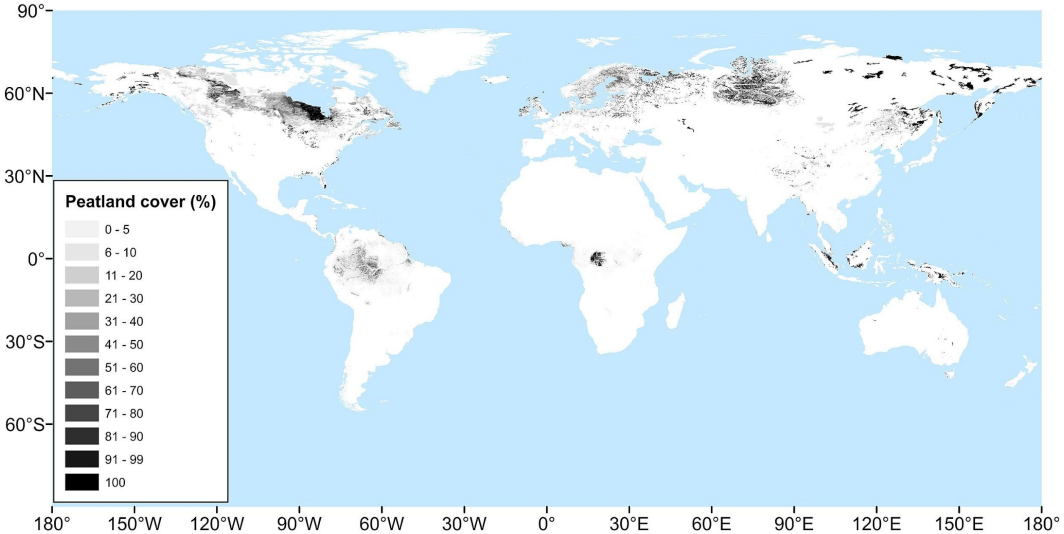
What are peatlands?

Peats are a type of **wetland** that include marshes, bogs, fens, and swamps

They sequester more than twice as much carbon as is stored in the world's forests despite covering only 3% of the Earth's land area.



Xu, Jiren, et al. "PEATMAP: Refining estimates of global peatland distribution based on a meta-analysis." *Catena* 160 (2018): 134-140.

Why do these fires require specialized techniques & attention?

Peat fires are unique:

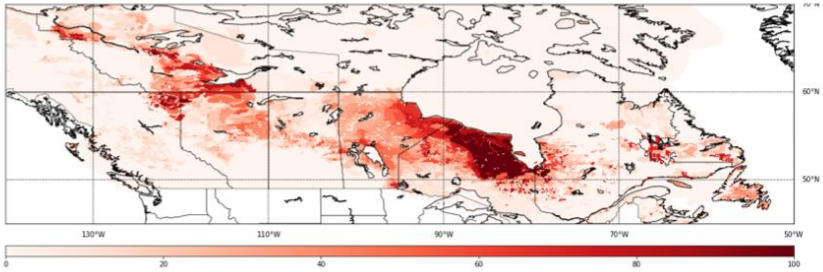
- They spread underground
- Can even exist under snow: heat masks alone aren't sufficient to identify them
- Have different emission concentrations

Peat fires are disastrous to the climate:

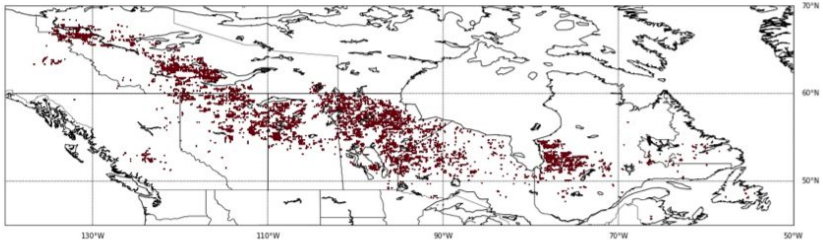
- Release much more carbon dioxide than regular fires

Canadian Peatland Fires

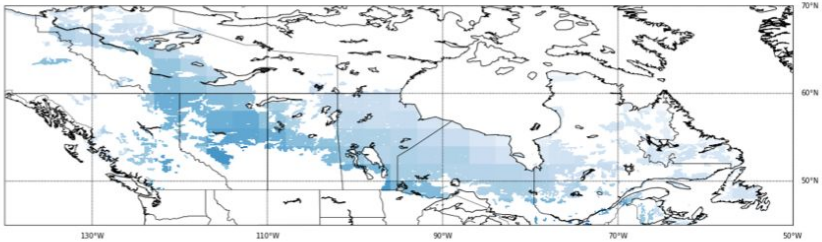
Aggregated 2012-2018



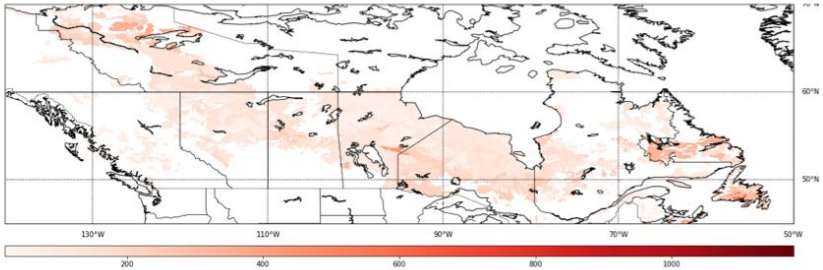
Peatland Heatmap(Tarnocai)



Burned Areas in Peatland(CWFIS)



CO_2 emissions in peatlands(Global CarbonTracker)



Total Organic Carbon Content(Tarnocai)

Our Work

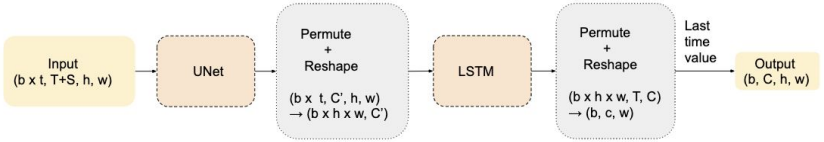
- PeatSet:
  A dataset for Peatland fires consisting of a combination of geospatial and part manually collected features (including the fire, CO_2, soil, hot spot, and weather features)

- Testing and Presenting novel algorithms used for predicting
  We use and test various spatio-temporal ML models to predict the peatland fires and present our findings. We present a novel graph neural network based architecture and a Transformer-based model in addition to previously suggested baselines.

Data Sources

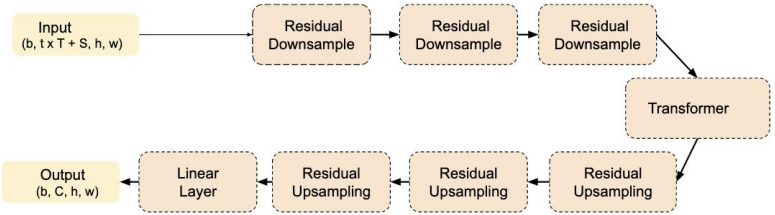
Features	Dataset	Spatial Resolution	Temporal Resolution
BURNCLASS	CWFIS	variable	daily
height_i (for i in $[0, 10)$)	CarbonTracker (Global)	3°x 2°	3-hourly
fire_flux	CarbonTracker (Flux)	1°x 1°	3-hourly
fuel_flux	CarbonTracker (Flux)	1°x 1°	3-hourly
frp	VIIRS	375m x 375m	daily
confidence	VIIRS	375m x 375m	daily
bright_ti4	VIIRS	375m x 375m	daily
TOCC	Tarnocai Peatland Map	variable	fixed
swvli (for i in $[1, 4]$)	ERA5	0.1° x 0.1°	hourly
stli (for i in $[1, 4]$)	ERA5	0.1° x 0.1°	hourly
lai_hv	ERA5	0.1° x 0.1°	hourly
lai_lv	ERA5	0.1° x 0.1°	hourly
tp	ERA5	0.1° x 0.1°	hourly
t2m	ERA5	0.1° x 0.1°	hourly
u10	ERA5	0.1° x 0.1°	hourly
v10	ERA5	0.1° x 0.1°	hourly

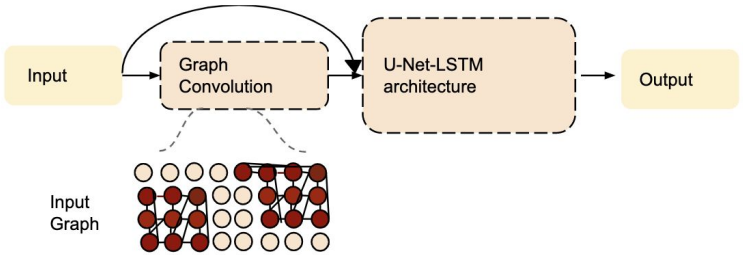
Model Architectures



UNet-LSTM

PT-Net





PeatNet

Results

	Recall	Precision	F1	Accuracy
LR	0.8186	0.0016	0.0032	0.4298
U	0.9906	0.0212	0.0419	0.9607
UL	**0.9944**	0.0294	0.0571	0.9650
PN	0.9668	0.0274	0.0532	0.9632
PT	0.9232	**0.0532**	**0.1006**	**0.9984**

The Team

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