Large Scale Change Detection Using Remote Sensing Data

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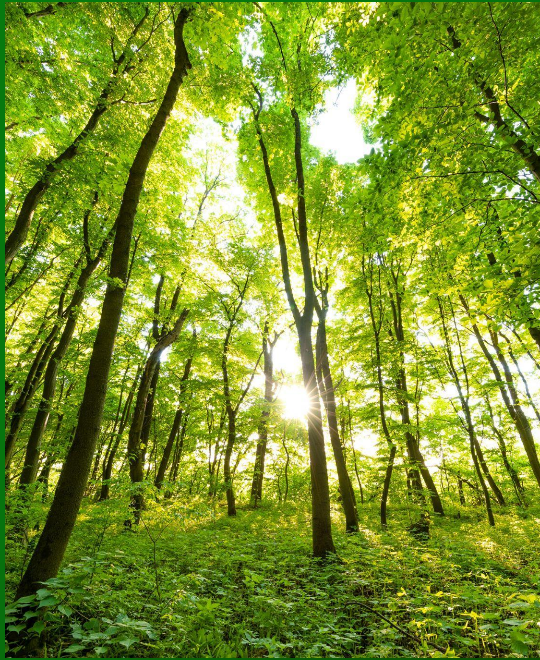
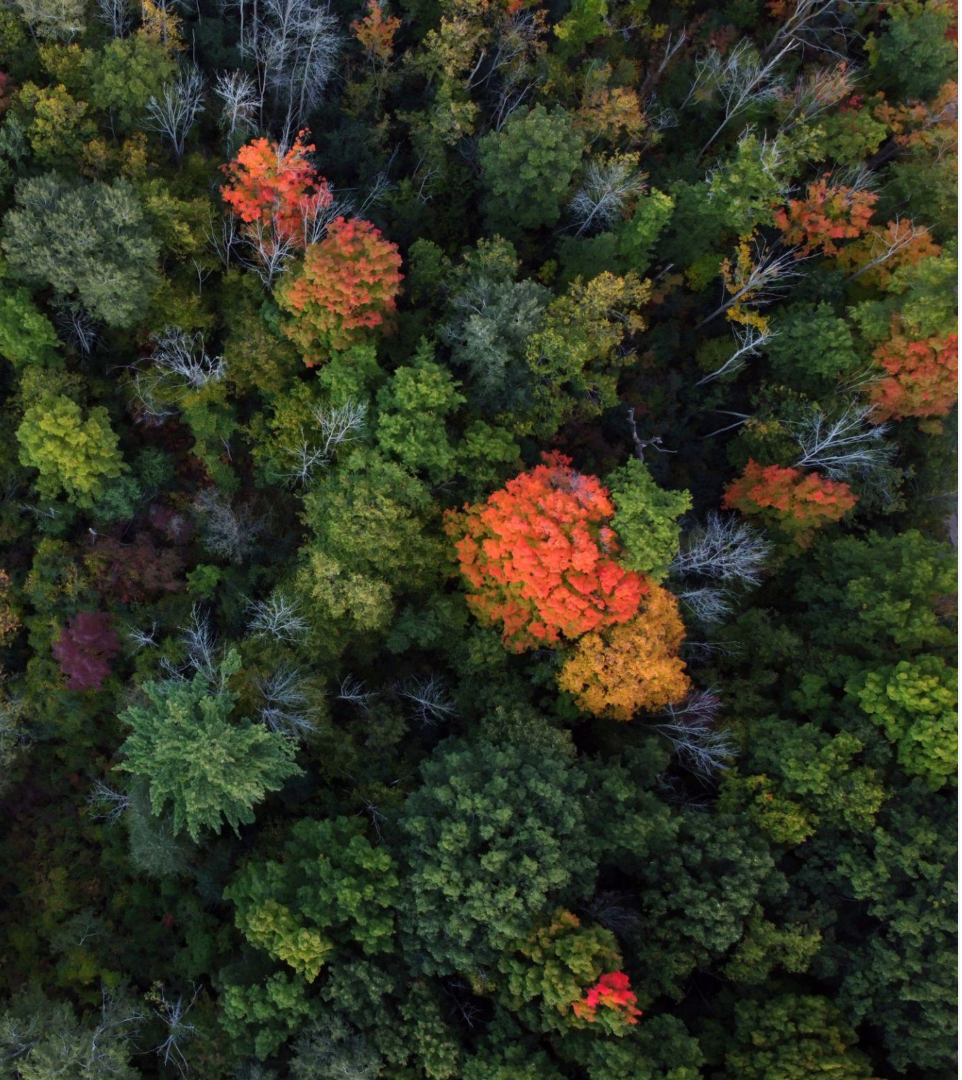
Statistical Approaches and Remote Sensing in Forest Management and Fire Analysis

May 26, 2025



Tesera Systems Inc.



Project Summary

The objective of the project is to develop a solution to **automate multivariate change detection**, using time series satellite imagery.

The project will design and develop a platform that will provide rapid feedback on **land disturbances, changes in moisture content, vegetation cover, and general forest health.**

Why Change Detection?

Critical information for making informed decisions about forest management practices (**timber harvesting, reforestation, fire management**).

By detecting changes in forest cover, vegetation health, and species composition, scientists can assess the **impacts of natural disturbances** (fires, insect outbreaks) and **human activities** (land use change, pollution) on forest ecosystems.

Early warning systems for forest disturbances (pest outbreaks or increased fire risk), allowing for timely interventions to mitigate potential damage.

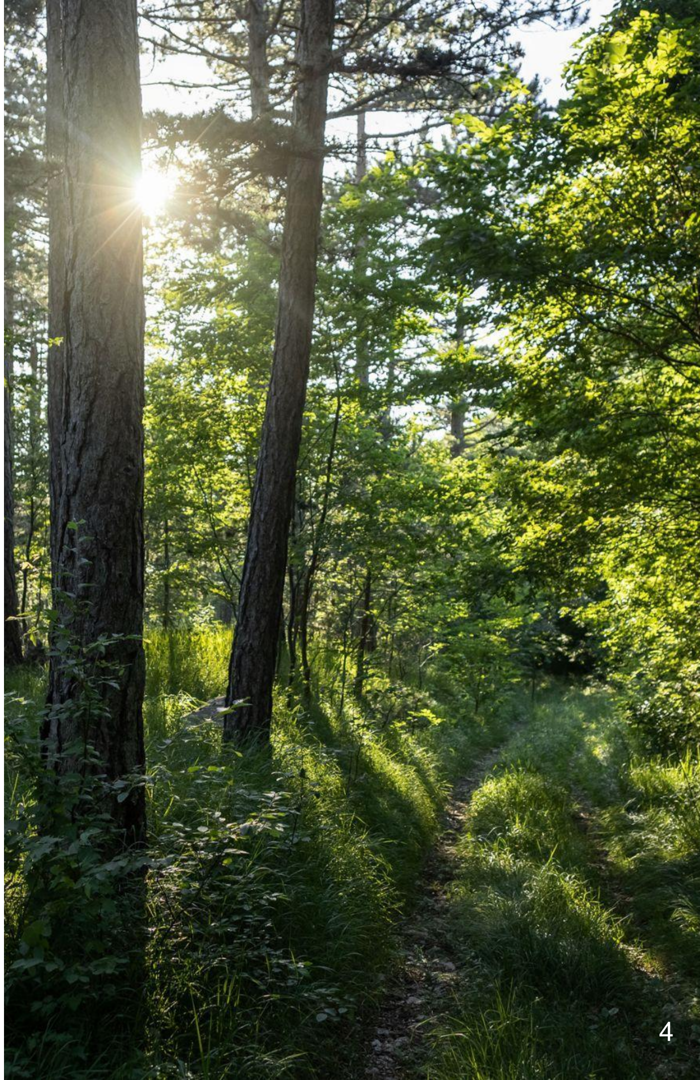
Our Project Goals

Develop a **data processing pipeline** using different types of satellite imagery that can also be deployed at scale

Test different **algorithms**

Develop **multivariate indices** to capture many possible disturbances

Provide land managers with **insights** and incorporate their **feedback** into the change detection system



Our General Approach

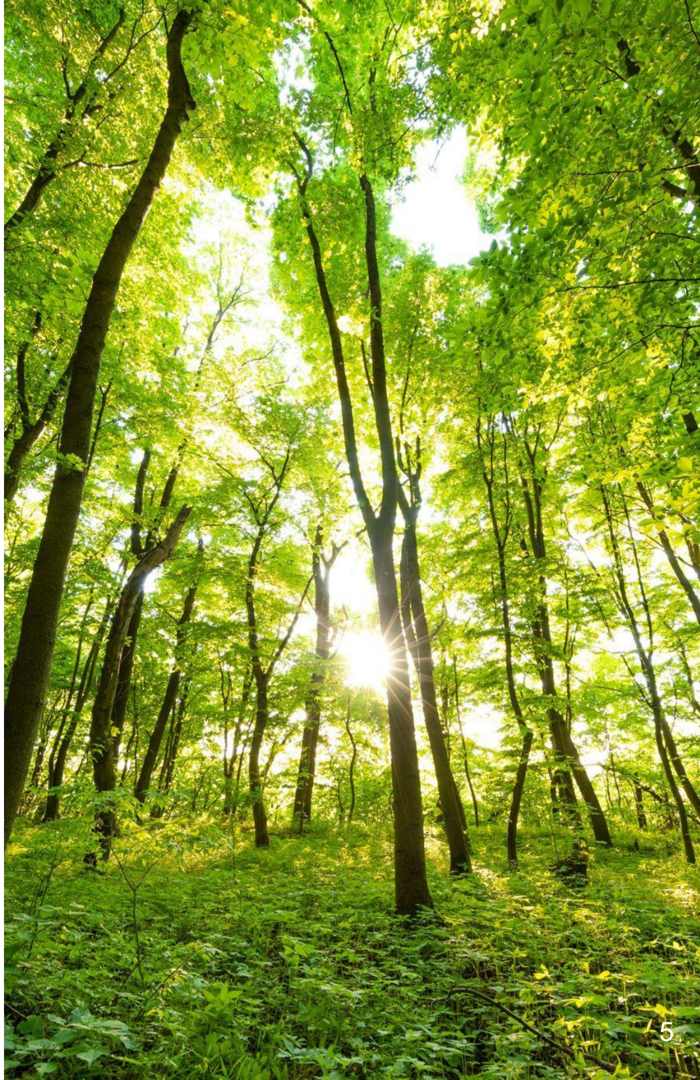
Download **satellite imagery** over the Areas of Interest (AOI ~April to October)

Generate **imagery indices** over the AOI

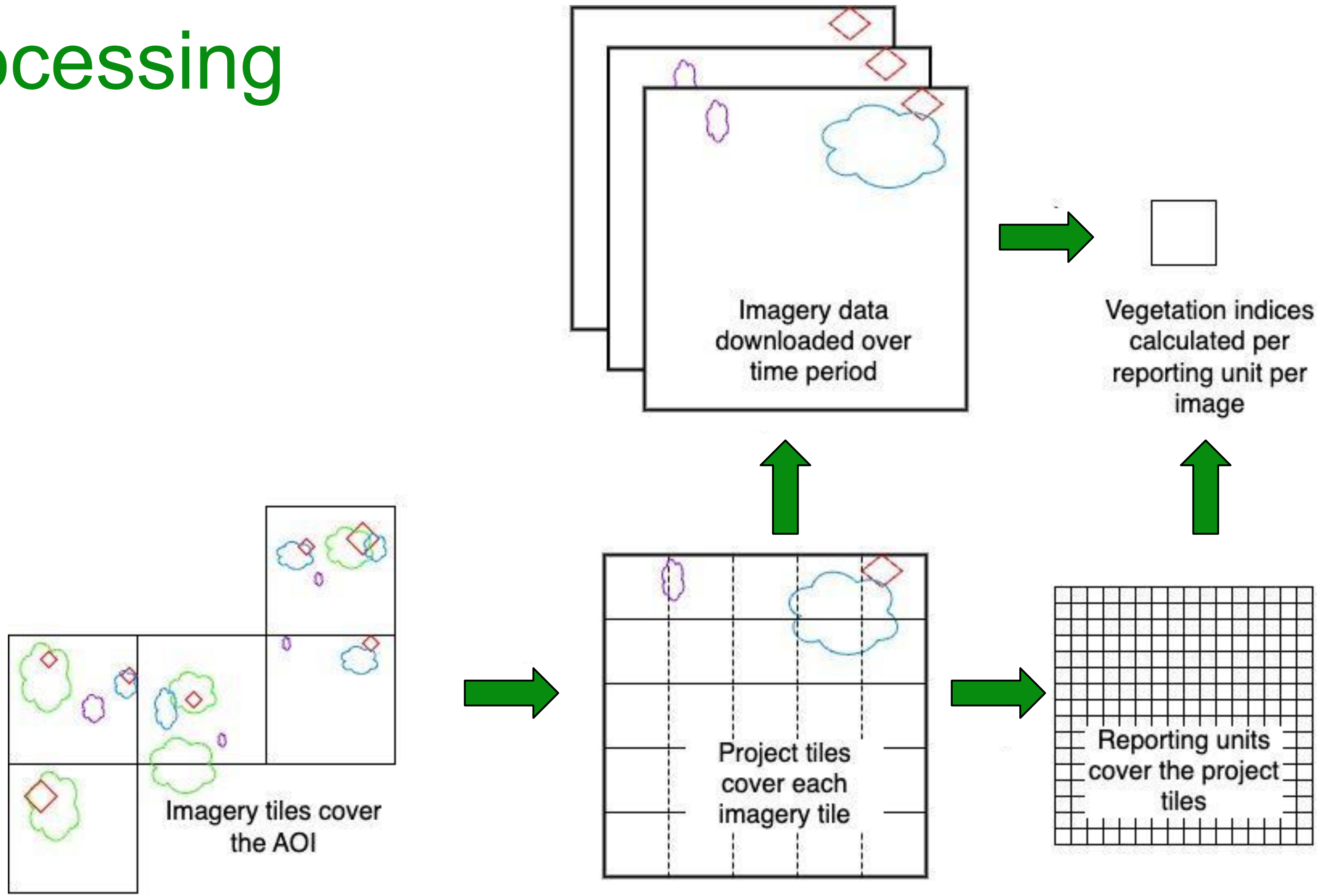
Learn **baseline changes** (phenology)

Compare **actual to expected**

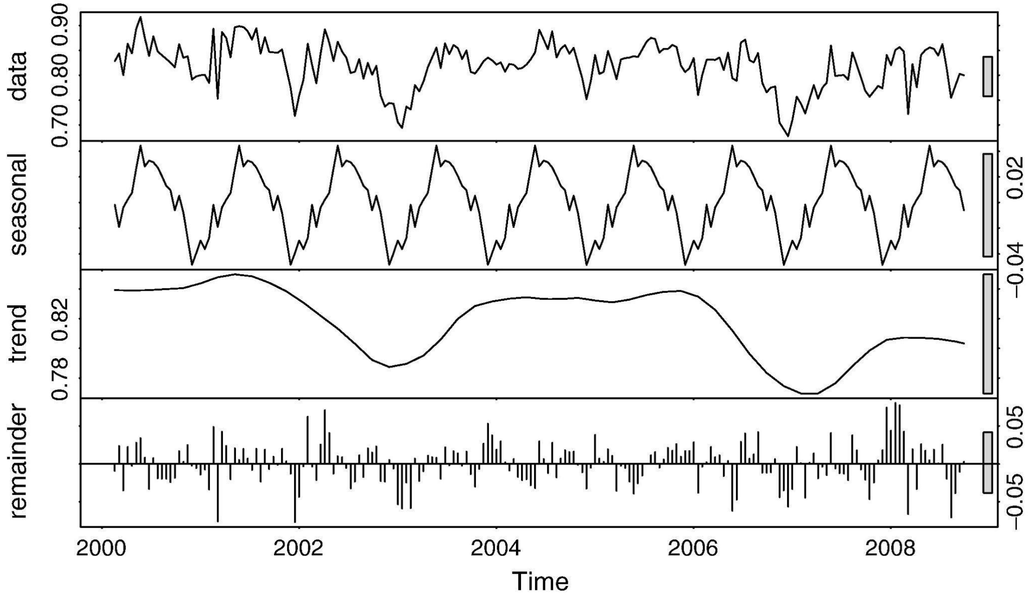
All methods we tested are available as R packages



Data Processing



What about BFAST? (**B**reaks **F**or **A**dditive **S**easonal and **T**rend)



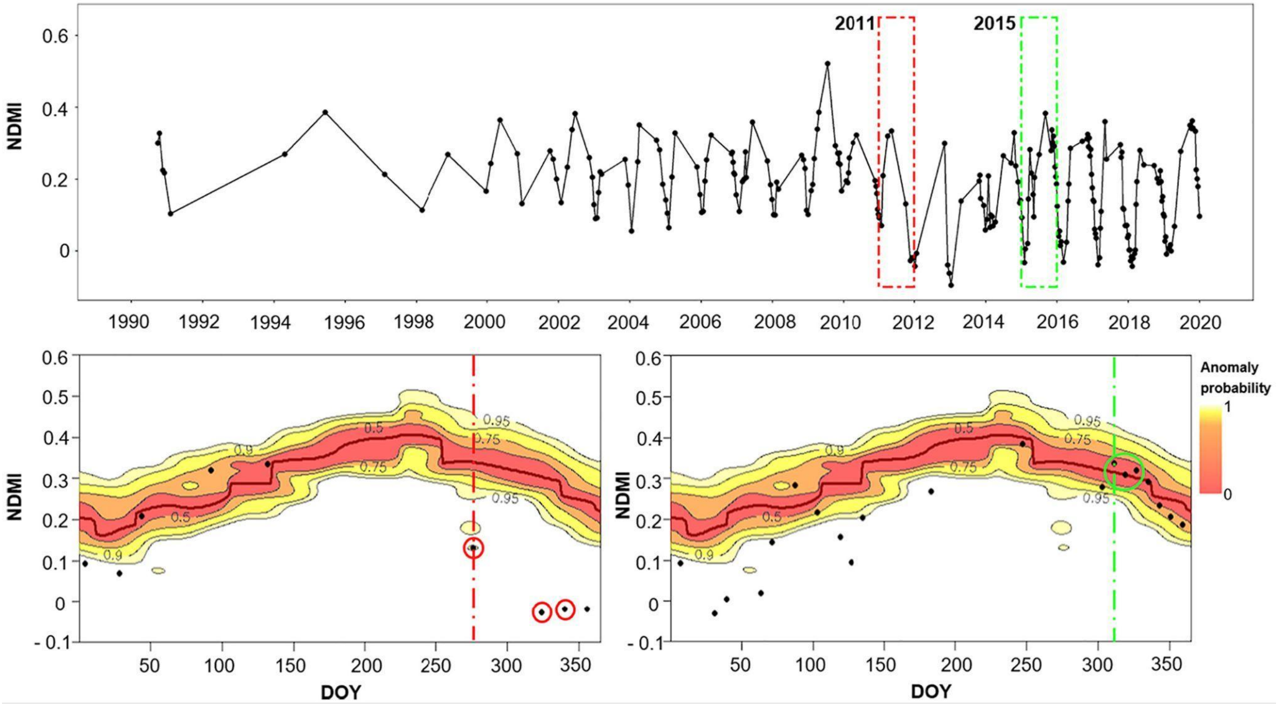
Verbesselt *et al*, 2010

$Y_t = T_t + S_t + e_t$

Trend + Seasonality + Randomness

Trend is piecewise linear
with breakpoints (abrupt changes)

What's AVOCADO? (**A**nomaly **V**egetati**O**n **C**h**A**nge **D**etecti**O**n)



Decuyper *et al*, 2022

Seasonality is estimated using a **kernel-density** approach

Each observation gets an **anomaly score**

Kejimkujik National Park

130 Sentinel2 images

(from March to December, 2018 to 2023)

700,000 time series **/ 91M** data points

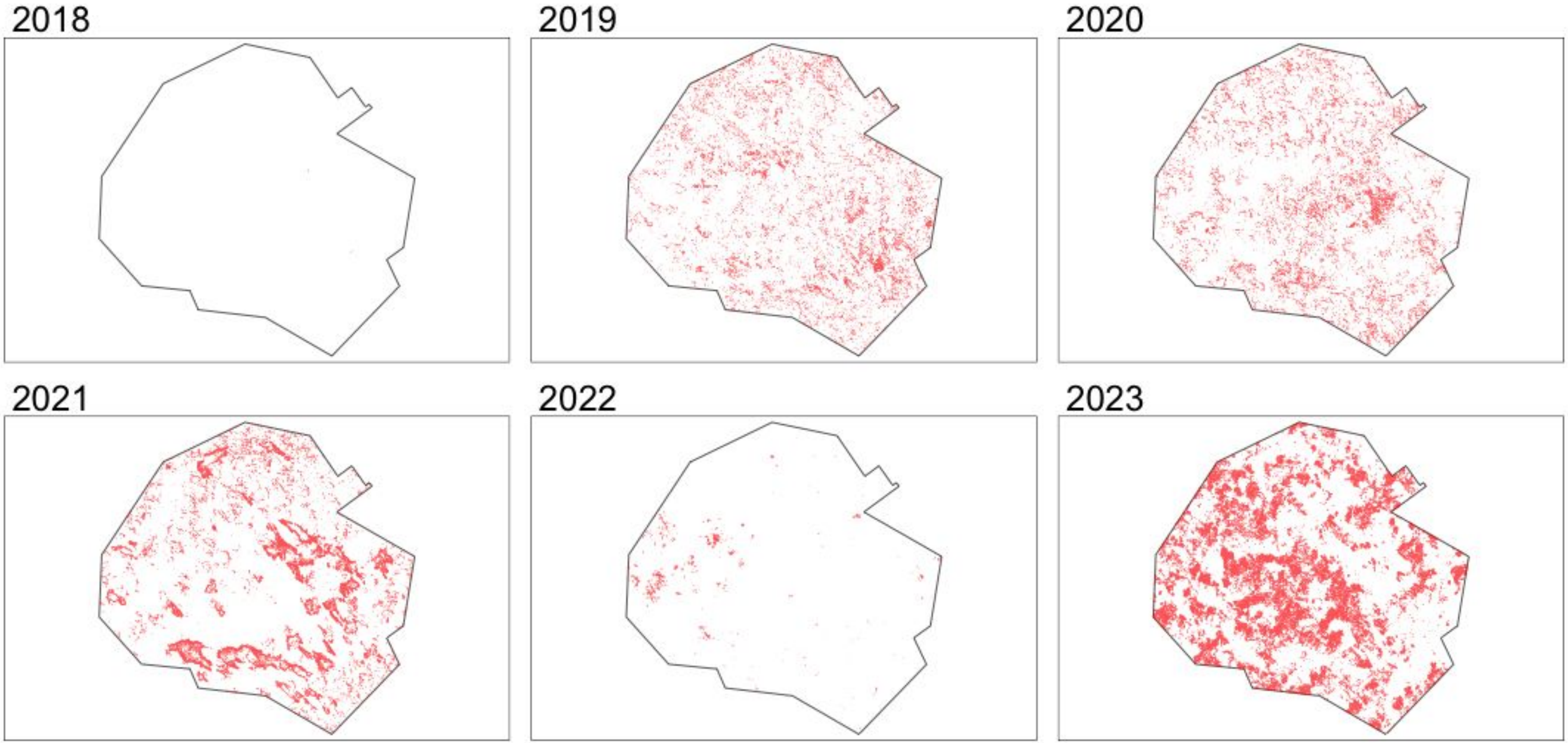
175,000 geospatial polygons

4 time series per polygon

~130 data points per series

BFAST for change detection

Kejimkujik National Park



Petawawa Research Forest

300 Planetscope images

(from April to October, 2020 to 2024)

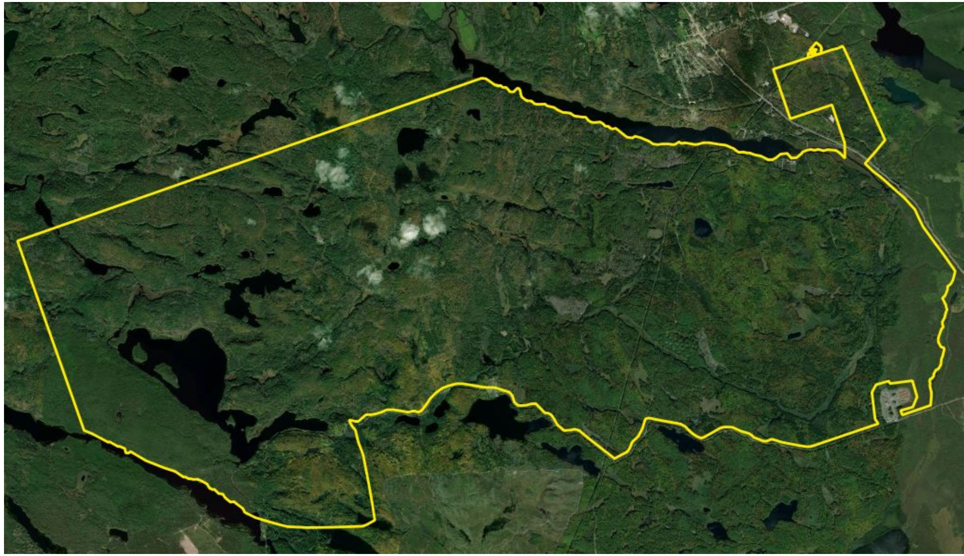
2M time series / **600M** data points

250,000 geospatial polygons

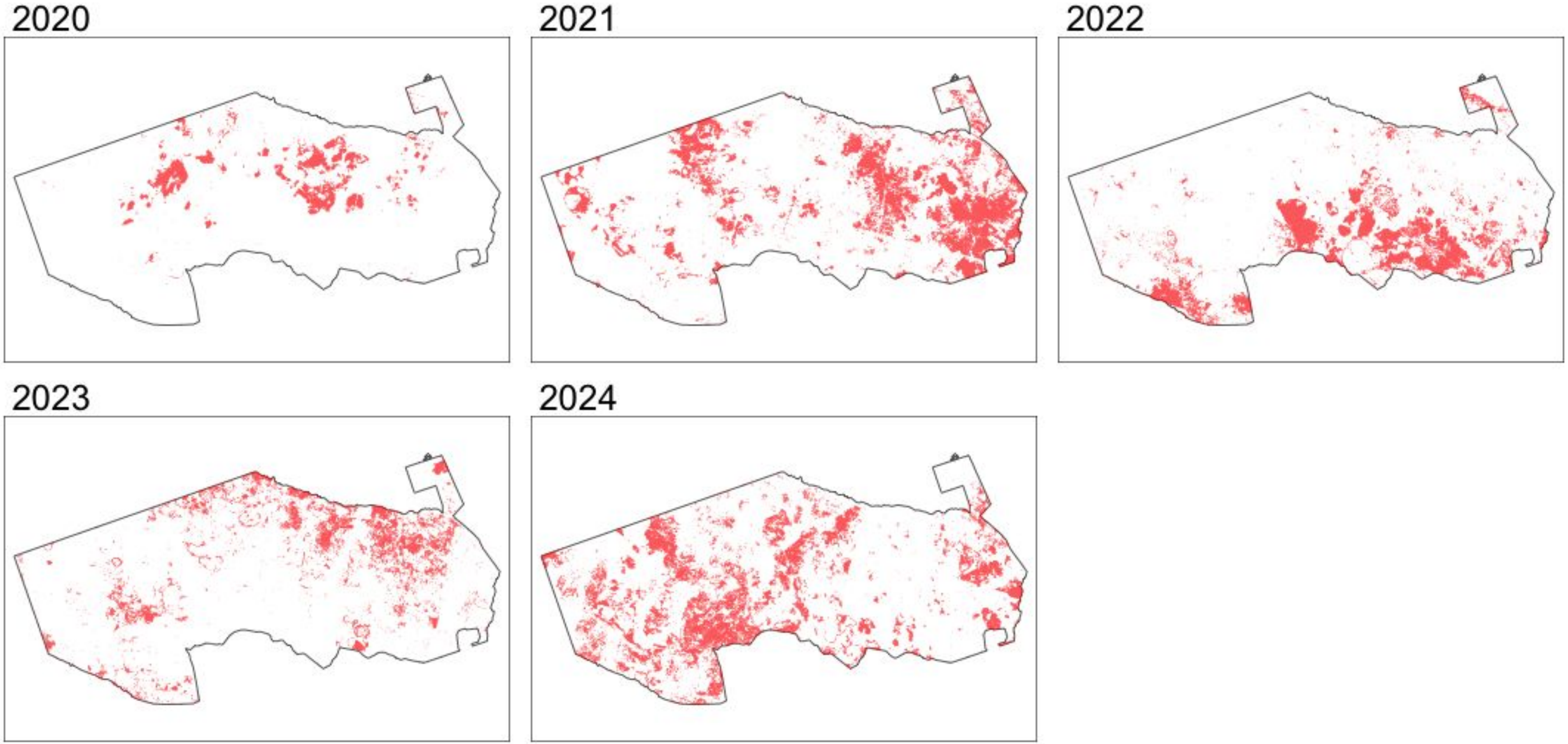
8 time series per polygon

~300 data points per series

AVOCADO for change detection



Petawawa Research Forest



Lessons Learned

Data processing

Huge amount of effort (resolution, spatial and temporal extent)

Area-based detection is essential

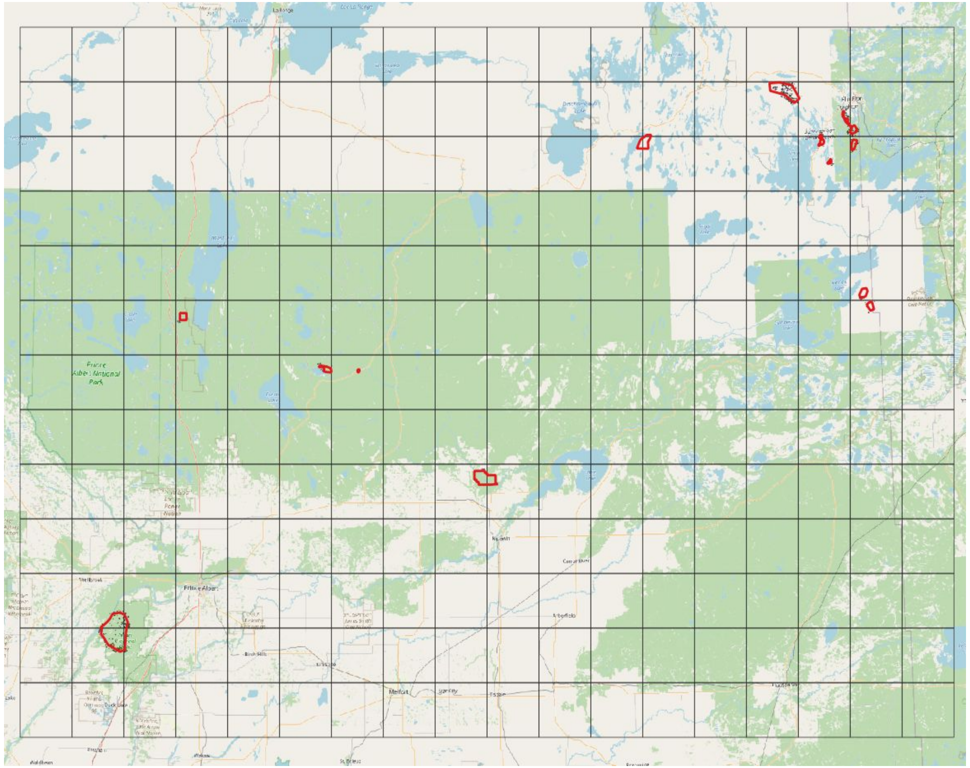
As opposed to Pixel-based

BFAST is not flexible enough

AVOCADO is better

Validation data is key

More work is required. Opportunity for feedback from clients to improve models



Disturbance detection and Change Agent Identification

General strategy

Split data into tiles

Run full analysis on random subset of polygons

Extrapolate based on similarity

Classification model conditional on detected change

Ongoing and Next Steps

Improve computational efficiency and cost

Additional QA for imagery

Continue investigating change detection model

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Thank you

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planet.

Perimeter Forest

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