



Natural Resources
Canada

Ressources naturelles
Canada

Global Mapping of Vegetation Biophysical Variables at Decametric Resolution: Are we there yet?

Living Planet Symposium, 2025

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Contains: Modified Copernicus Sentinel 2 imagery, and data from the
Copernicus Global Land Monitoring Service , the US National Ecological
Observatory Network, and Natural Resources Canada.

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Why monitor vegetation from space?

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Biodiversity



Weather and Climate



Sustainable Development



Food and Agriculture



Healthy Cities

Land cover does not tell the whole story.

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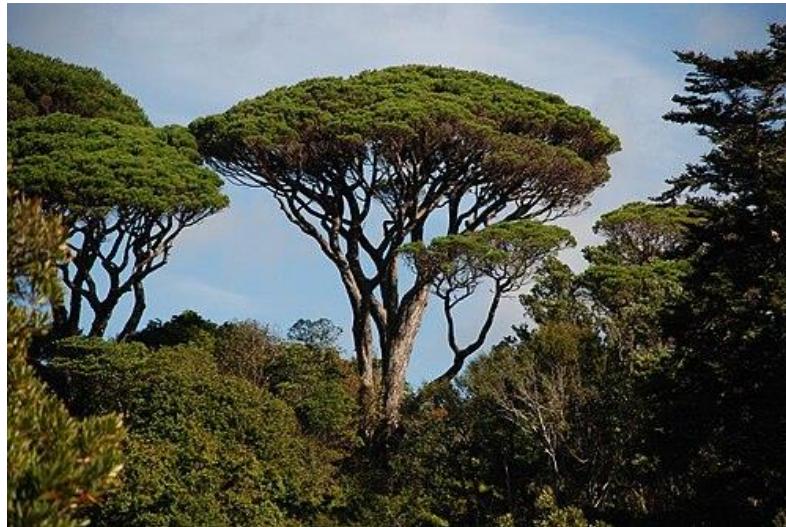
Inuvik, Canada. NRCan



Oslo, Norway. Copernicus.



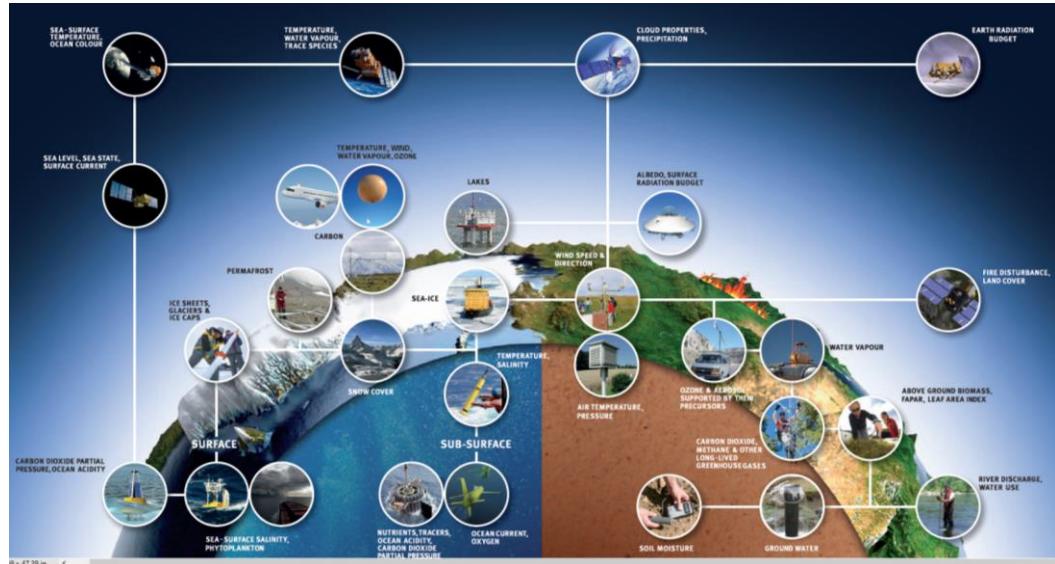
Sequoia National Forest, USA. USDA



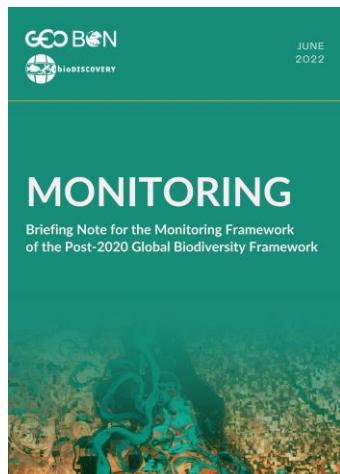
Wellington, New Zealand. Wikipedia

Biosphere Essential Climate Variables

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Variable	Definition	Spatial Res. m	Temporal Res. days	Uncertainty	Stability
fCOVER	the fraction of ground covered by green vegetation	100 (10)	365 (30)	20% (5)	15% (5%)
LAI	half total green foliage area per horizontal ground area	250 (10)	10 (1)	20% (10%)	6% (3%)
fAPAR	part of PAR that is effectively absorbed by plants	250 (10)	10 (1)	10% (5%)	3% (1.5%)

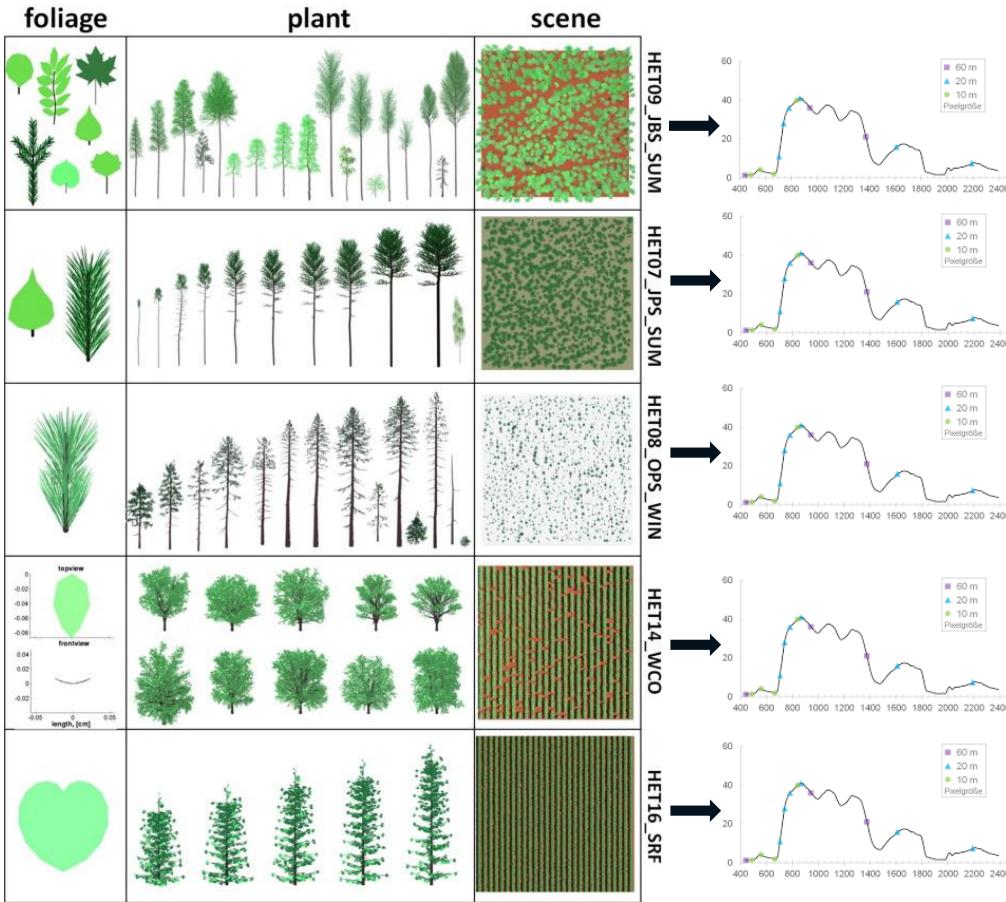


Combining spectroscopy and machine learning

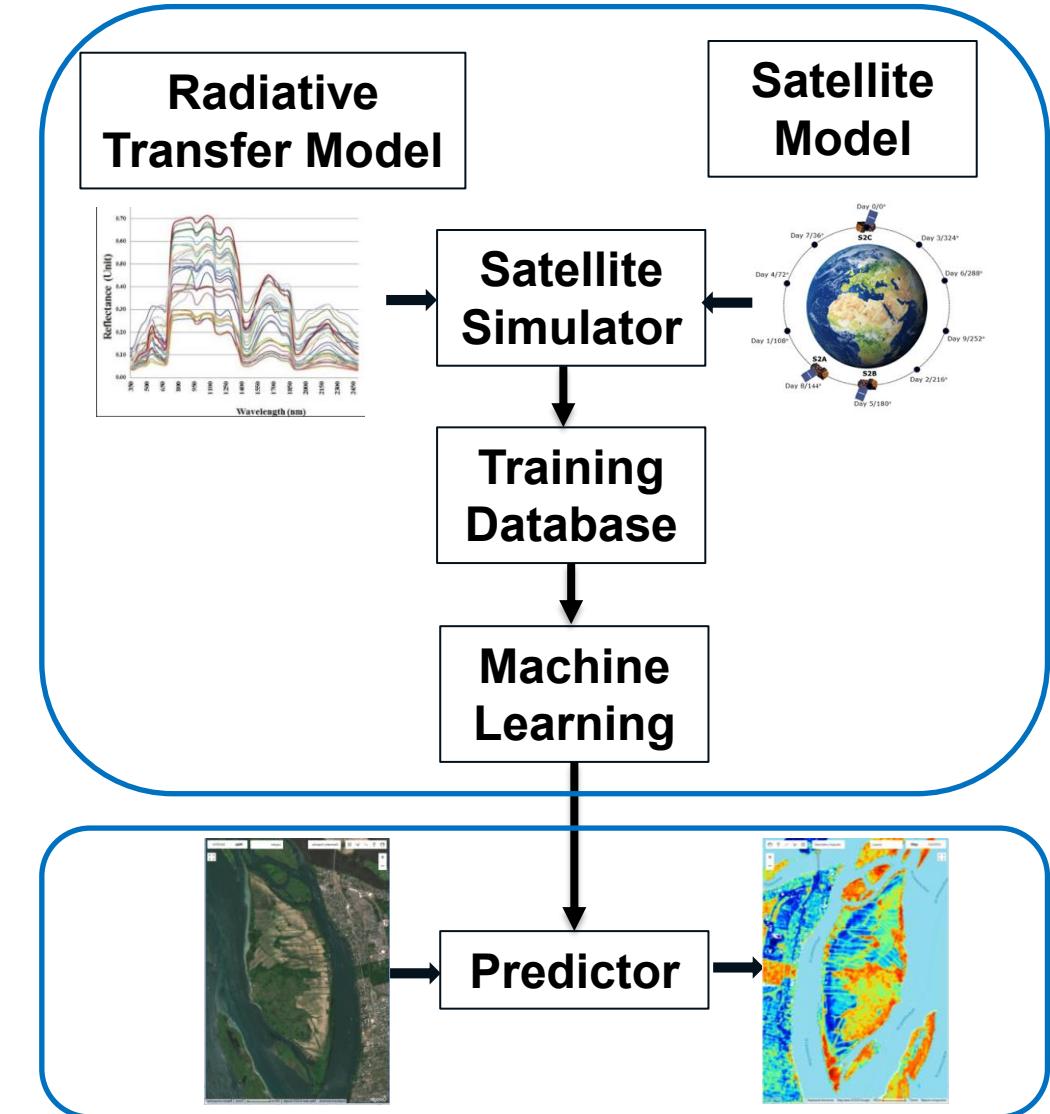
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RAMI Radiative Transfer Models (4SAIL2,Flight)



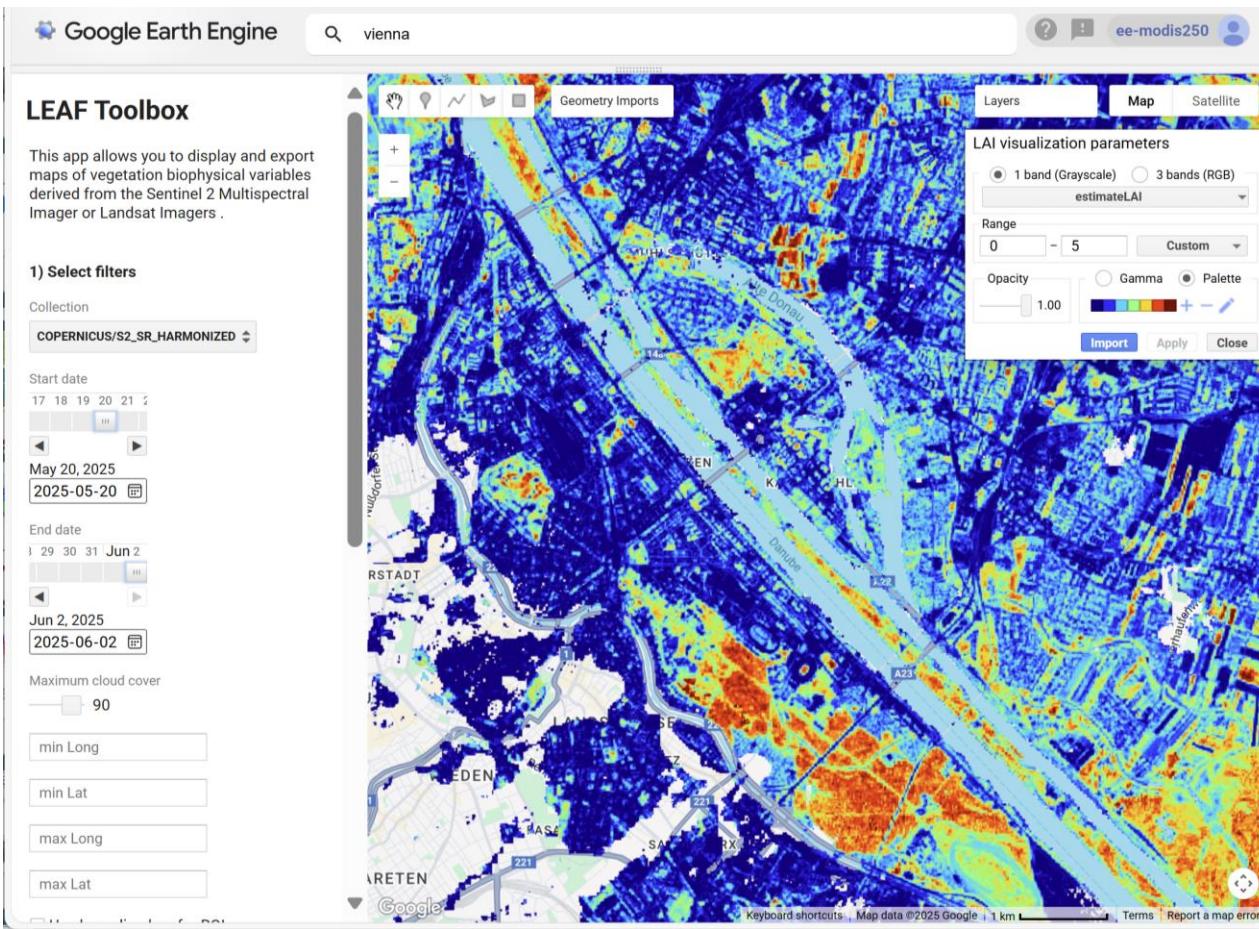
Widlowski et al., 2018. <https://doi.org/10.1029/2006JD007821>



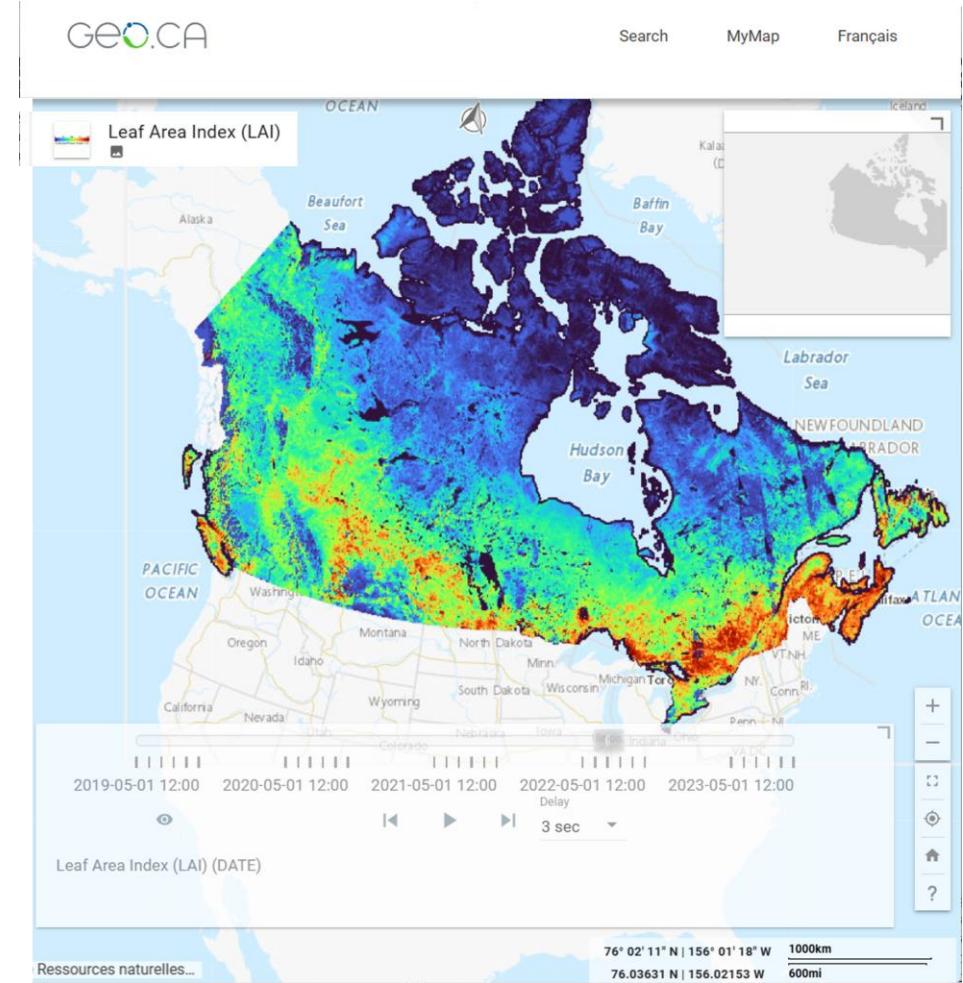
Fernandes et al., 2024, <https://doi.org/10.4095/pgf517rsk95>

Landscape Evolution and Forecasting (LEAF) Toolbox

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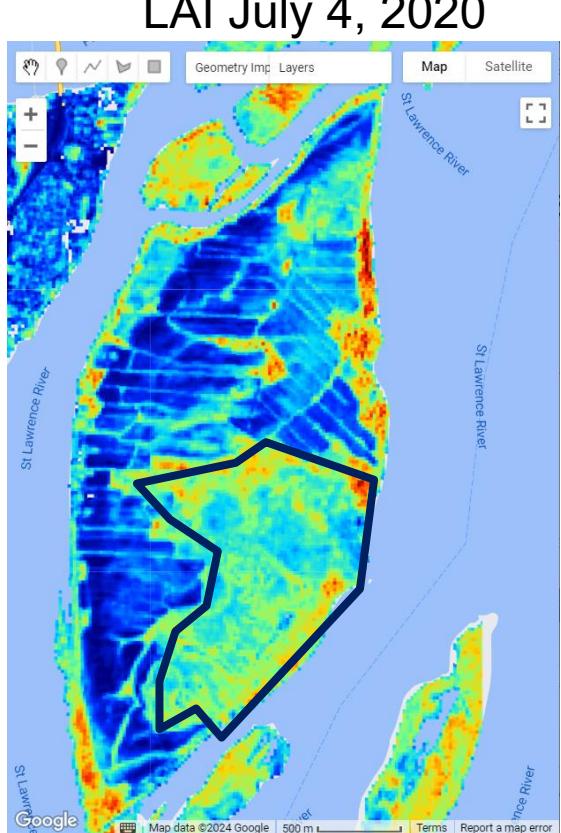
[Github.com/rfernand387/LEAF-Toolbox](https://github.com/rfernand387/LEAF-Toolbox)



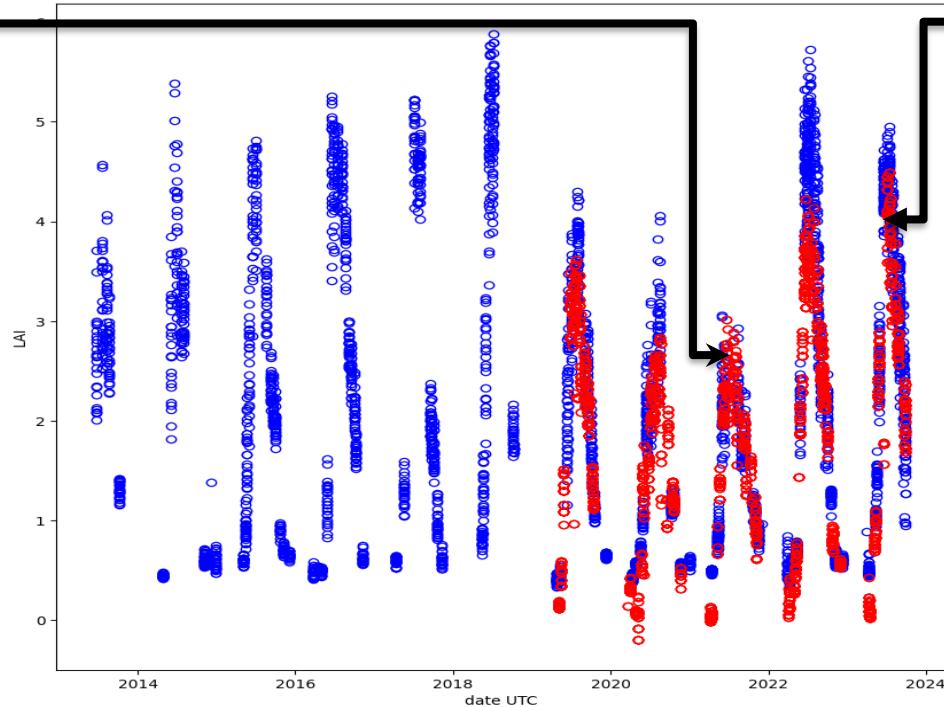
<https://datacube.services.geo.ca/en/viewer/eo4ce/vegetation/monthly-vegetation.html>

Products meet baseline resolution requirements

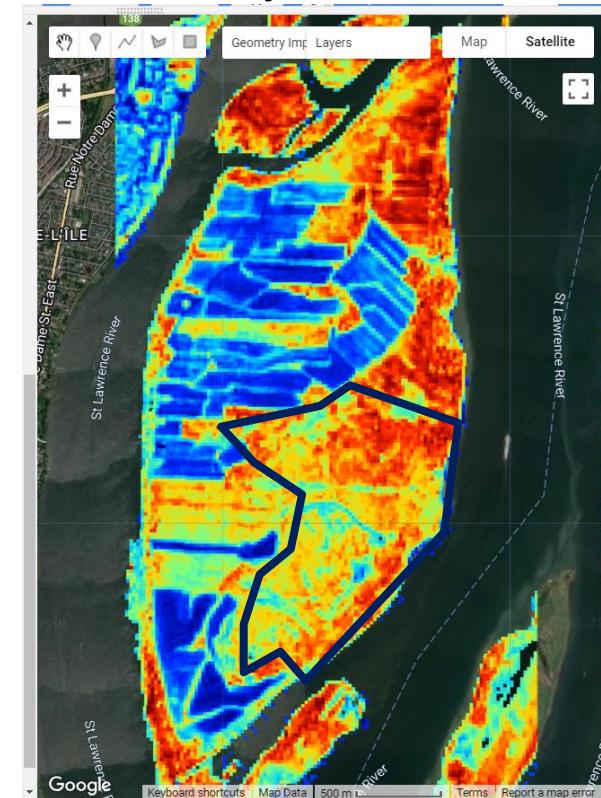
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LAI July 4, 2020



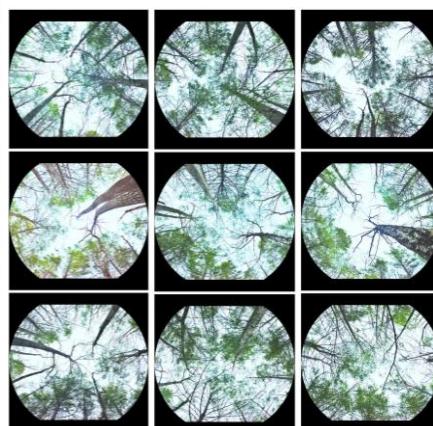
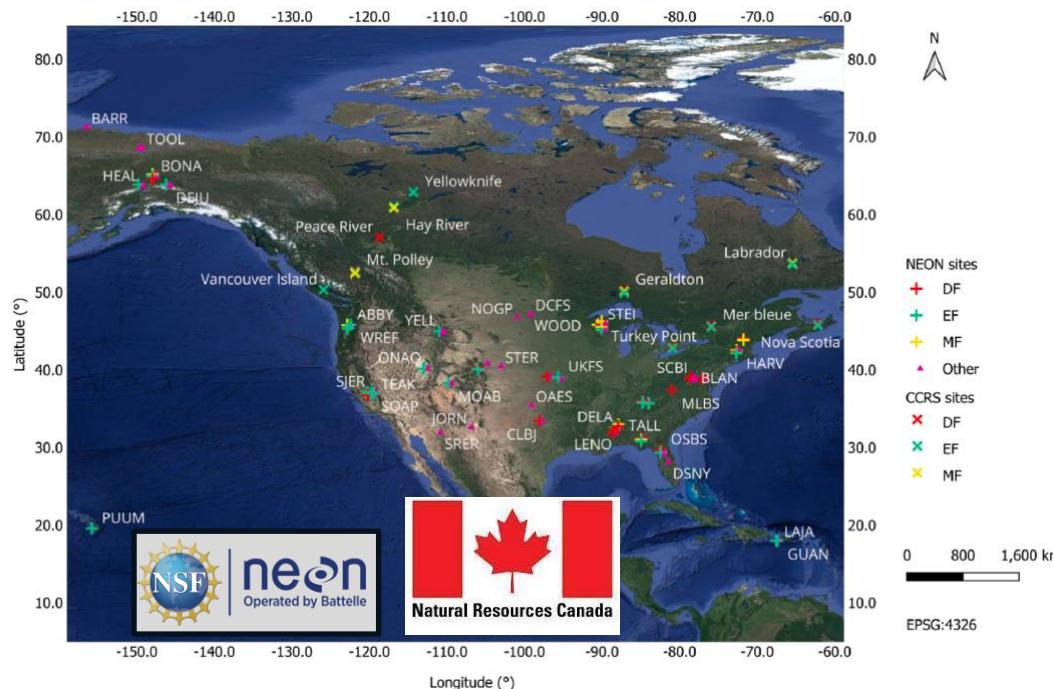
Medium resolution (20m-30m) Satellite Maps
and time series using CCMEO LEAF-Toolbox
(<https://github.com/rfernand387/LEAF-Toolbox/wiki>)



LAI July 4, 2023

Are we there yet? Validate, validate, validate!

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University of
Salford
MANCHESTER



fiducial reference
measurements
for vegetation



HOME ABOUT DOCUMENTS CAMPAIGNS AND DATA EVENTS
NEWS LINKS PUBLICATIONS SRIX4VEG

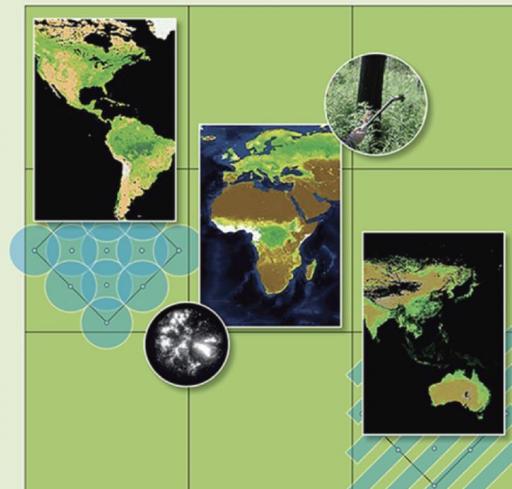
Home

Fiducial Reference Measurements for Vegetation (FRM4Veg) is a European Space Agency (ESA) managed project focused on establishing the protocols required for traceable in-situ measurements of vegetation-related parameters, to support the validation of Copernicus products from Sentinel-2, -3, and PROBA-V.



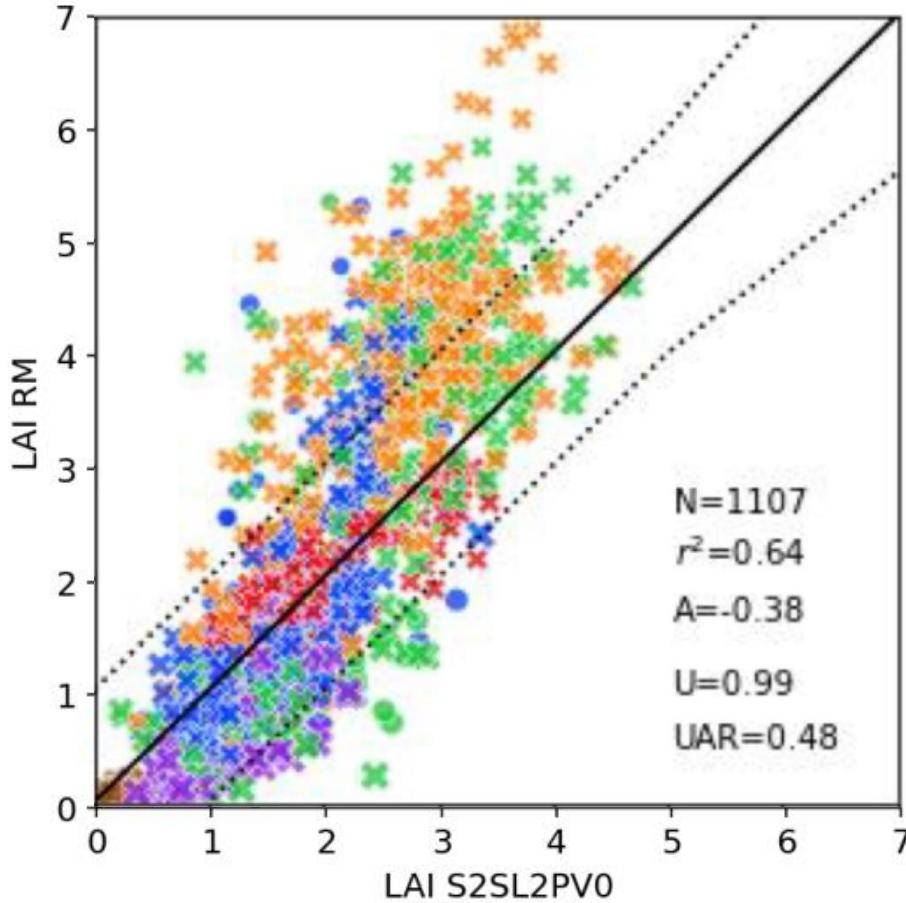
Sentinel-2.

Global Leaf Area Index Product Validation Good Practices

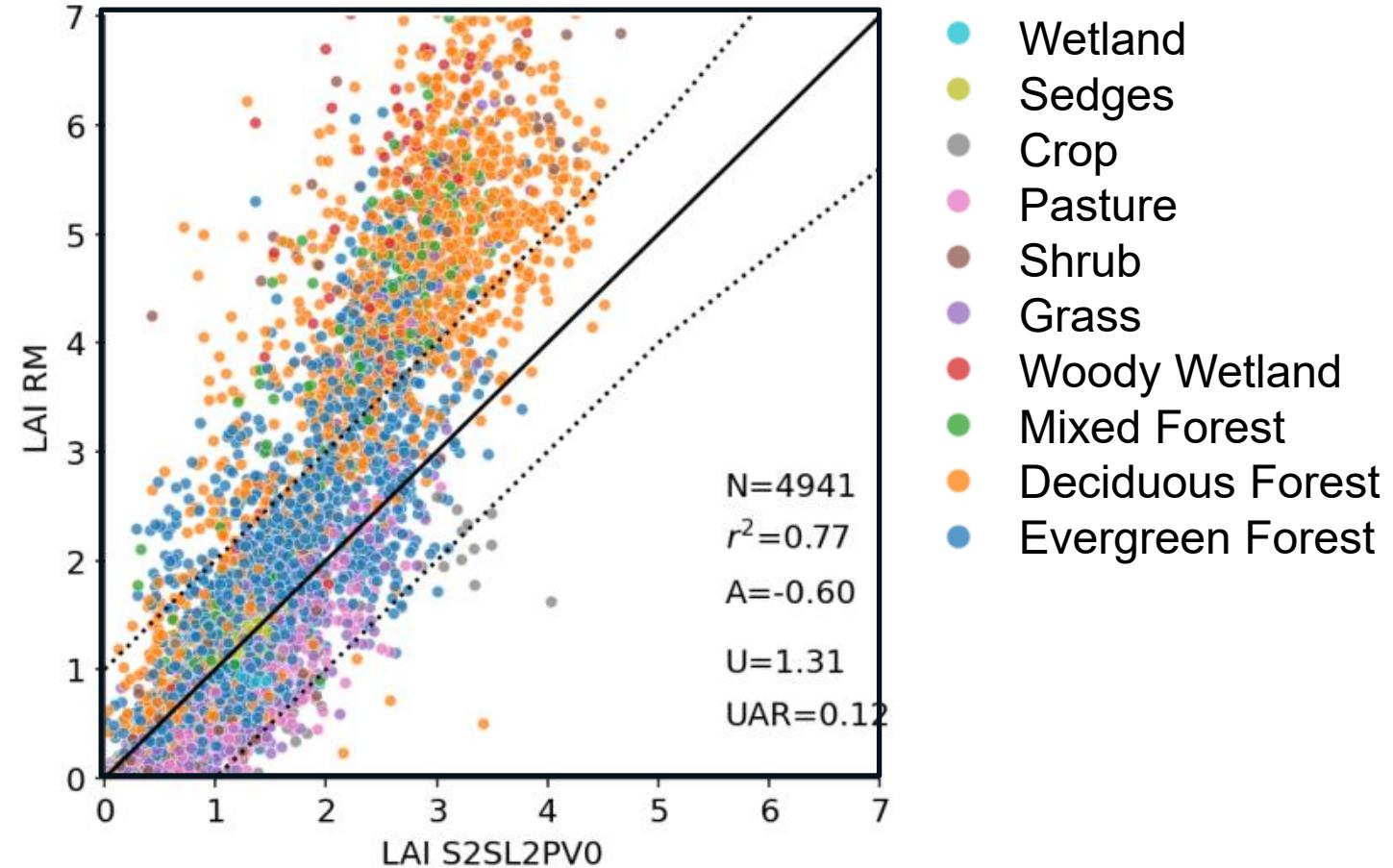


We need better validation metrics because ...

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Fernandes et al., 2023.
<https://doi.org/10.1016/j.rse.2023.113600>

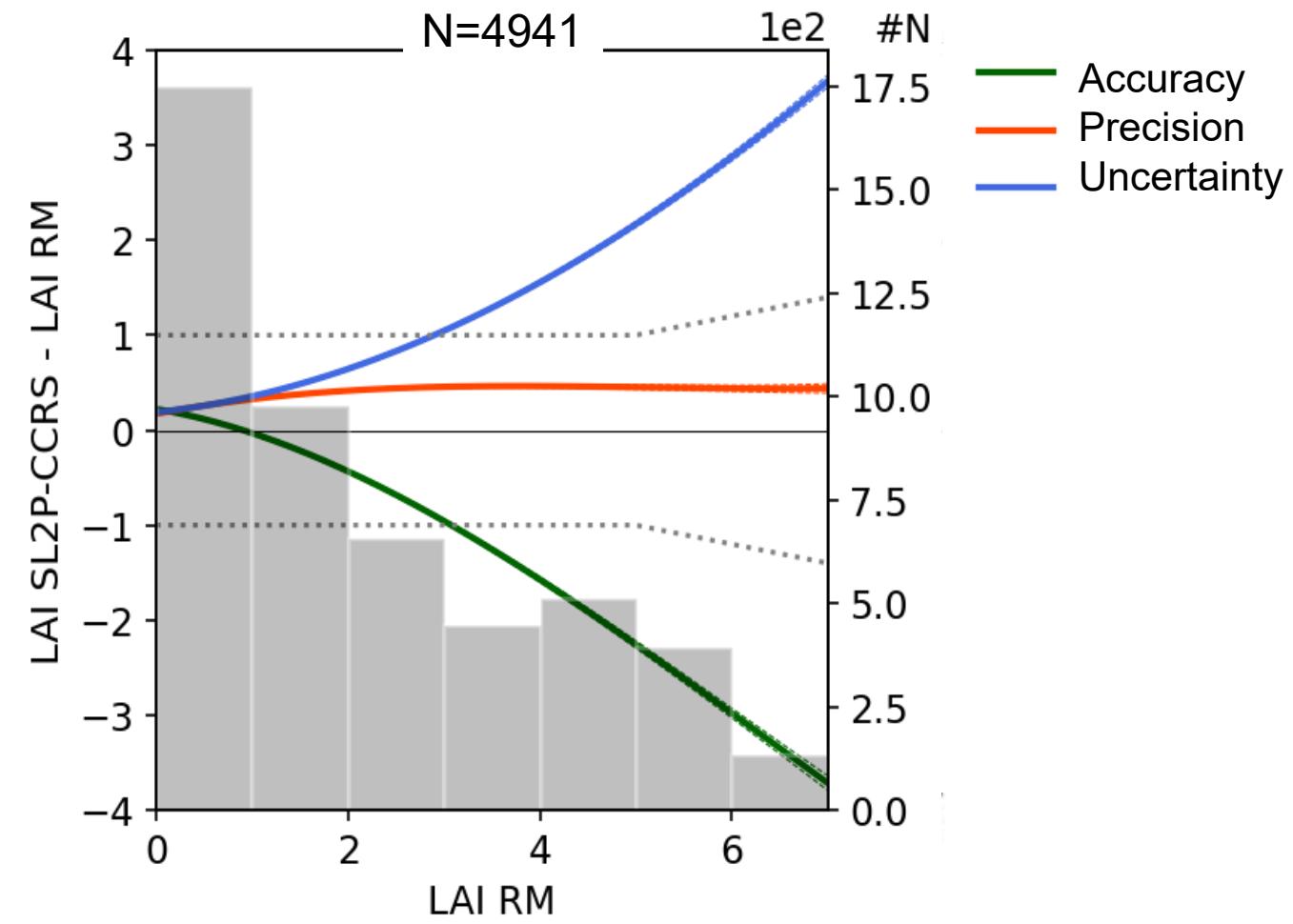
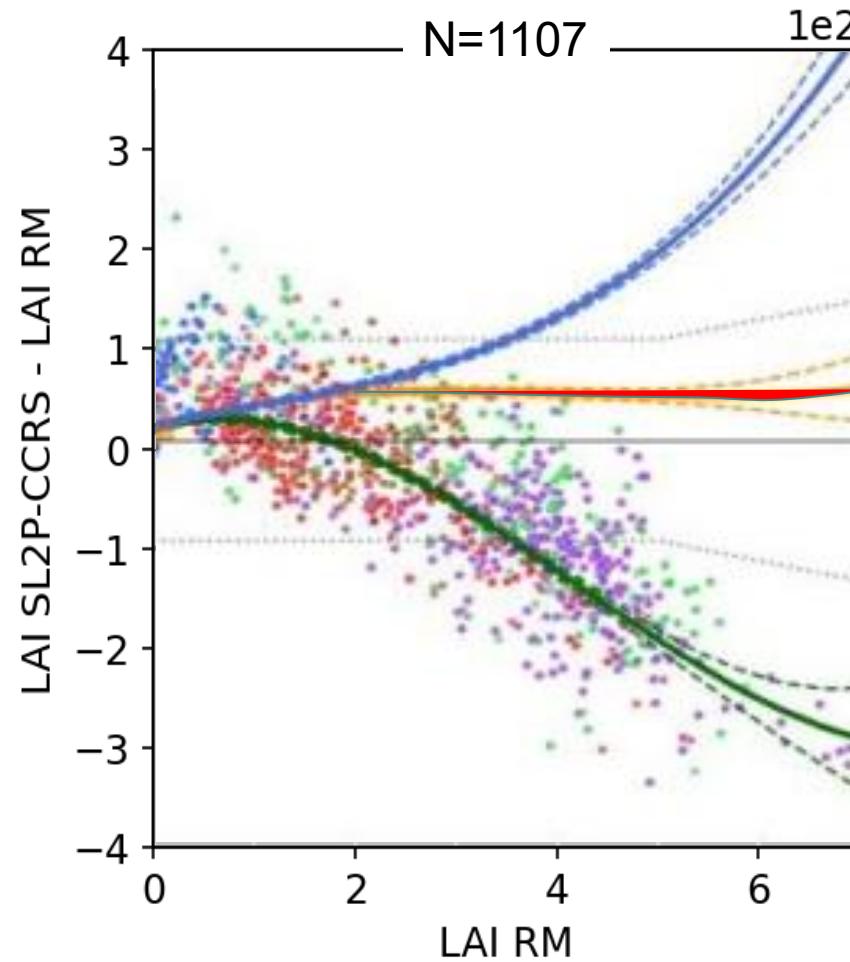


Djamai et al., 2024.
<https://doi.org/10.1016/j.isprsjprs.2025.04.006>

- Wetland
- Sedges
- Crop
- Pasture
- Shrub
- Grass
- Woody Wetland
- Mixed Forest
- Deciduous Forest
- Evergreen Forest

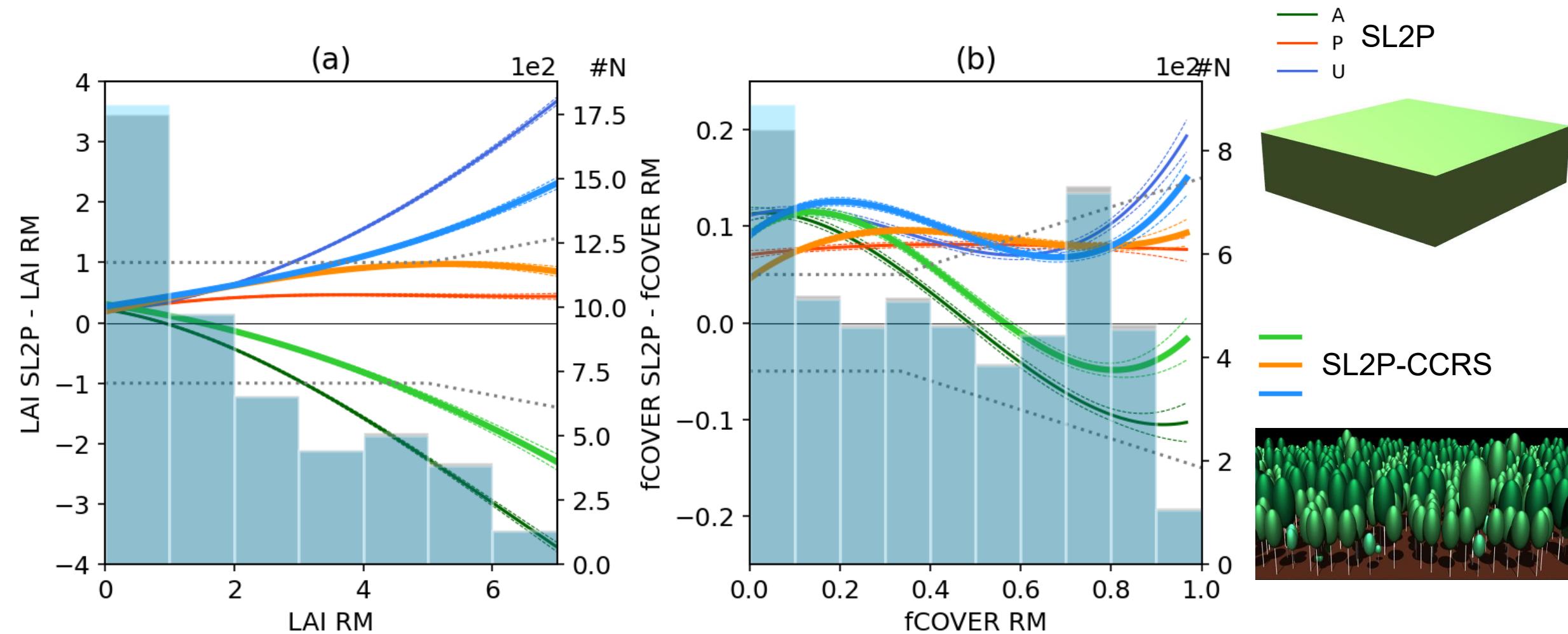
Accuracy Precision Uncertainty curves are better

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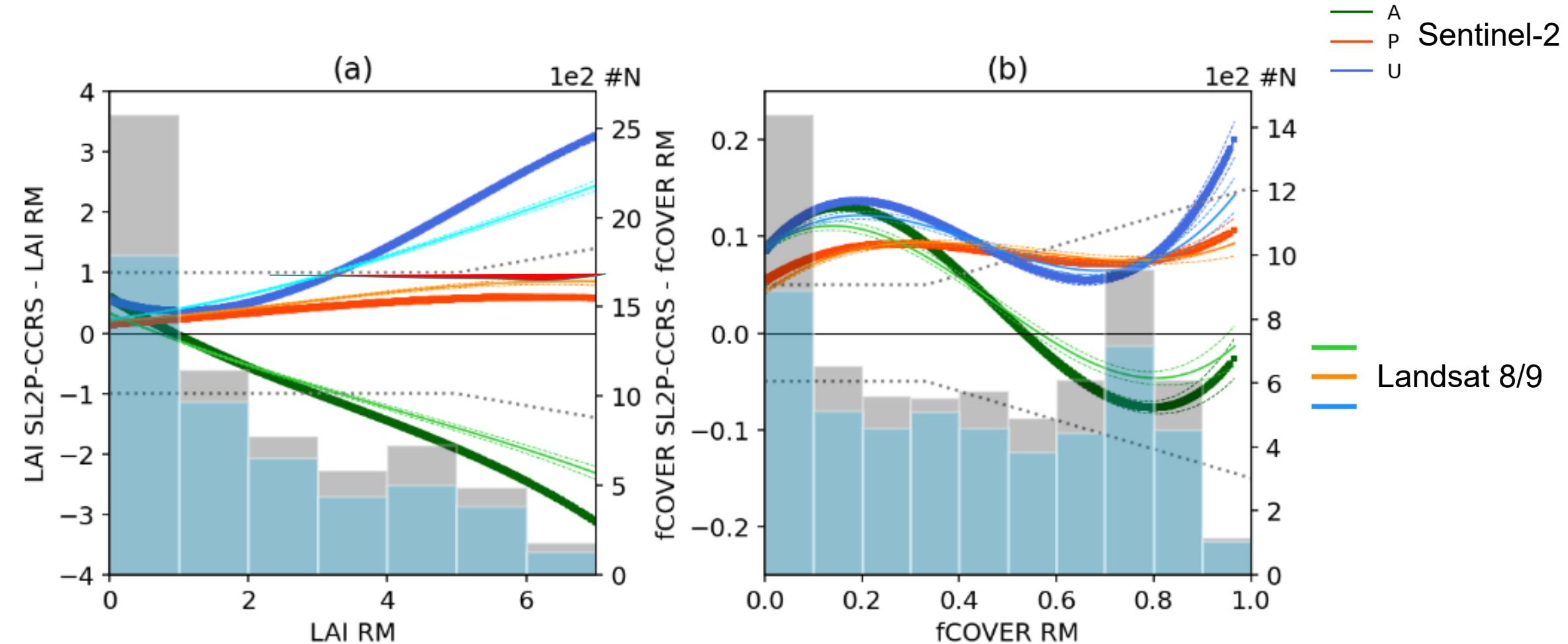
1. There is a price to pay for complex algorithms

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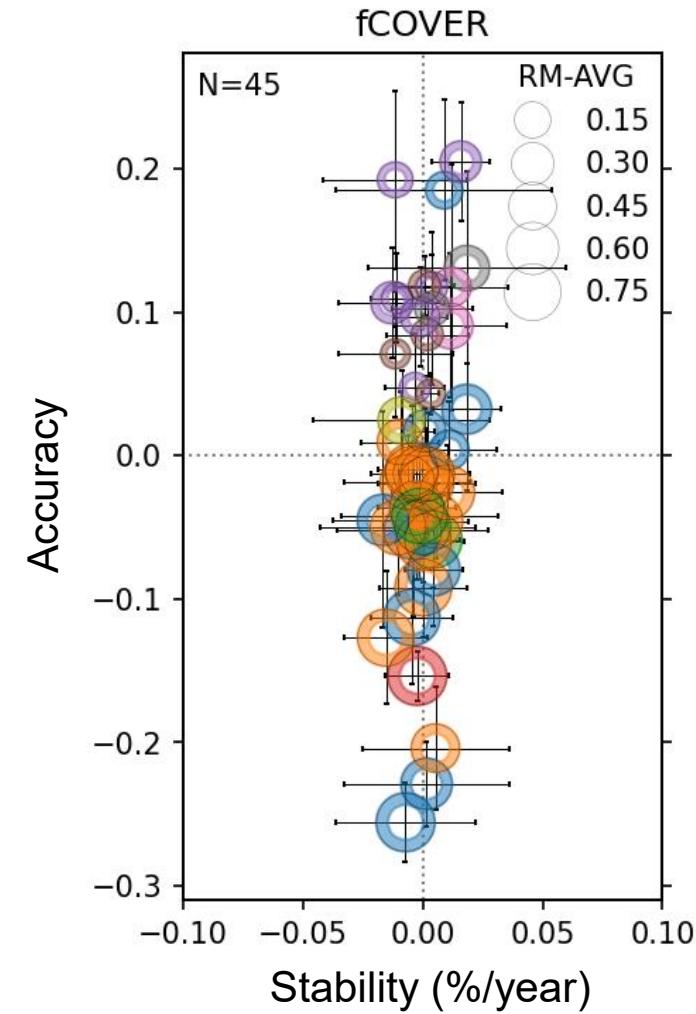
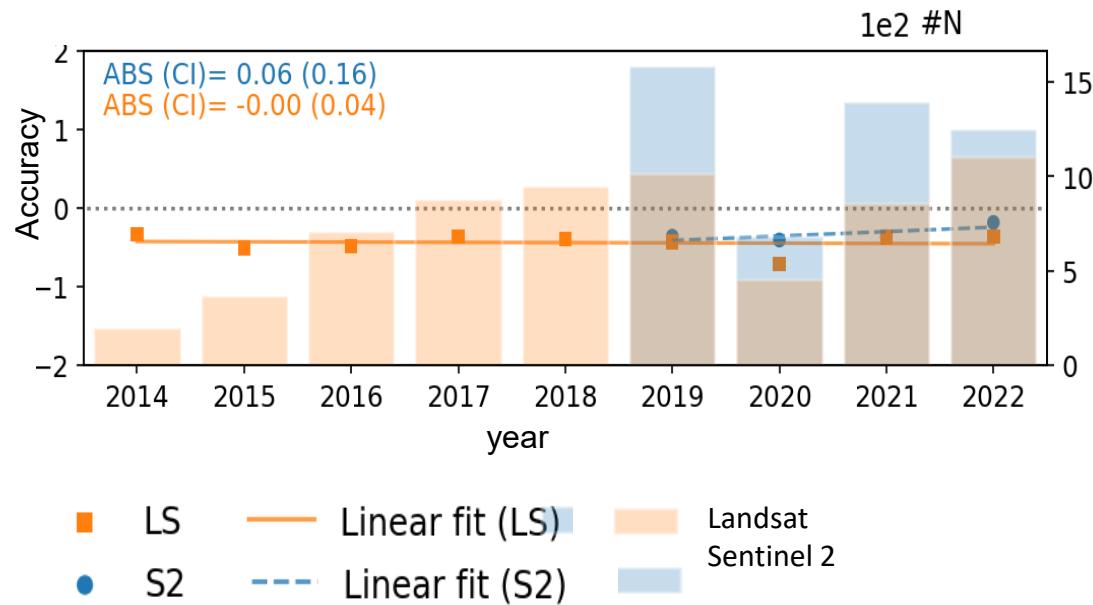
2. S2 less bias than Landsat 8/9 for dense canopies

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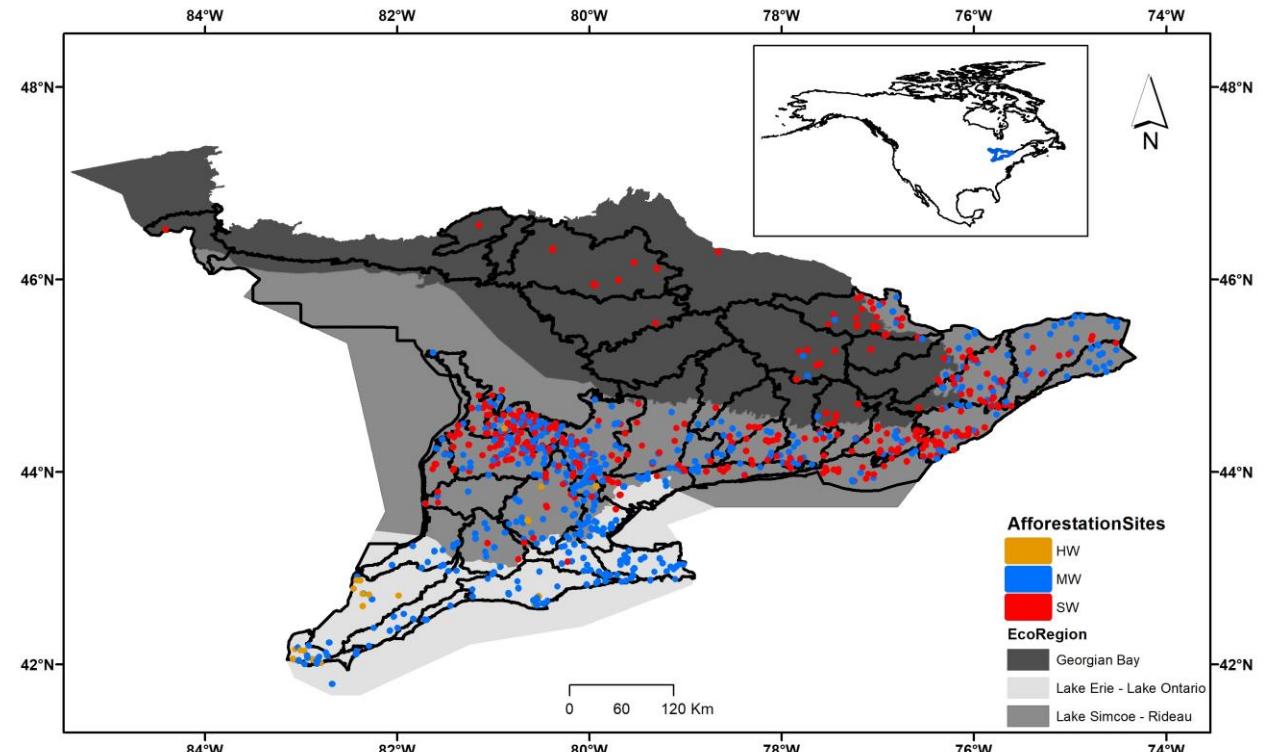
3. S2 and Landsat 8/9 satisfy baseline stability

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We are there: regional afforestation assessment

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Example: Typical site at >10 years, a woodlot

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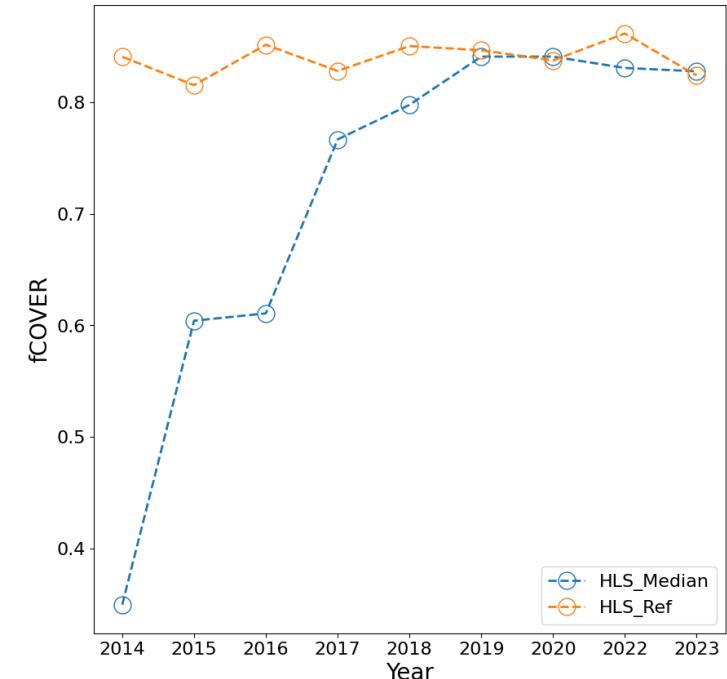
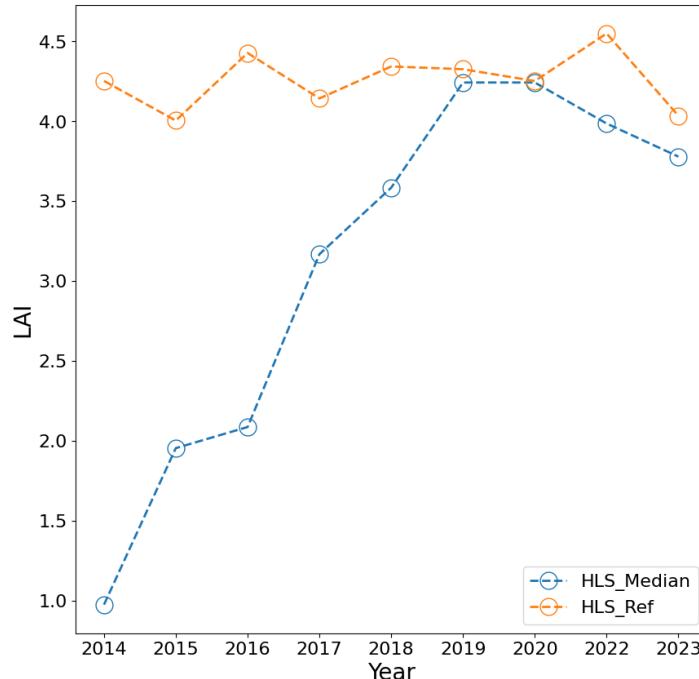


Plant date: 2013

Type: Needleaf forest

Area: 4.7ha

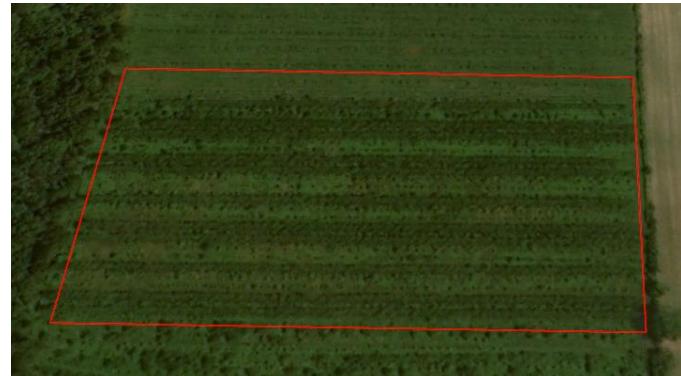
Last Survival Rate: 75.8



April 2012



April 2016



July 2019

Example: Poor site at >10years, motorcycle trails

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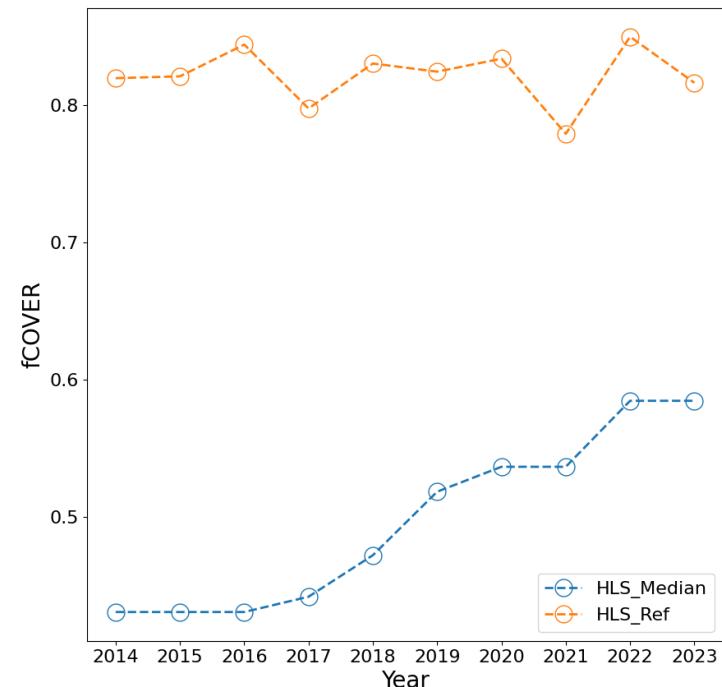
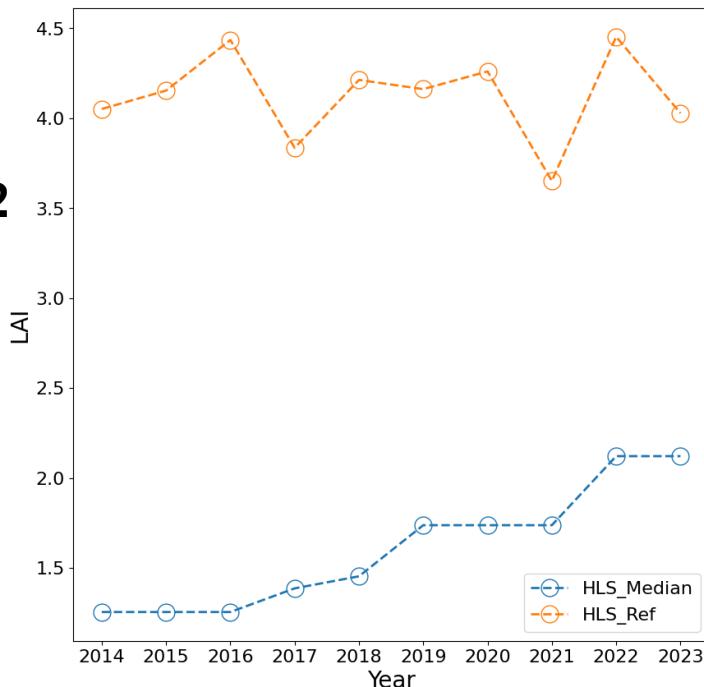


Plant date: 2013

Type: Broadleaf forest

Area: 15.9ha

Last Survival Rate: 93.2



Sept. 2013



July 2018



April 2024

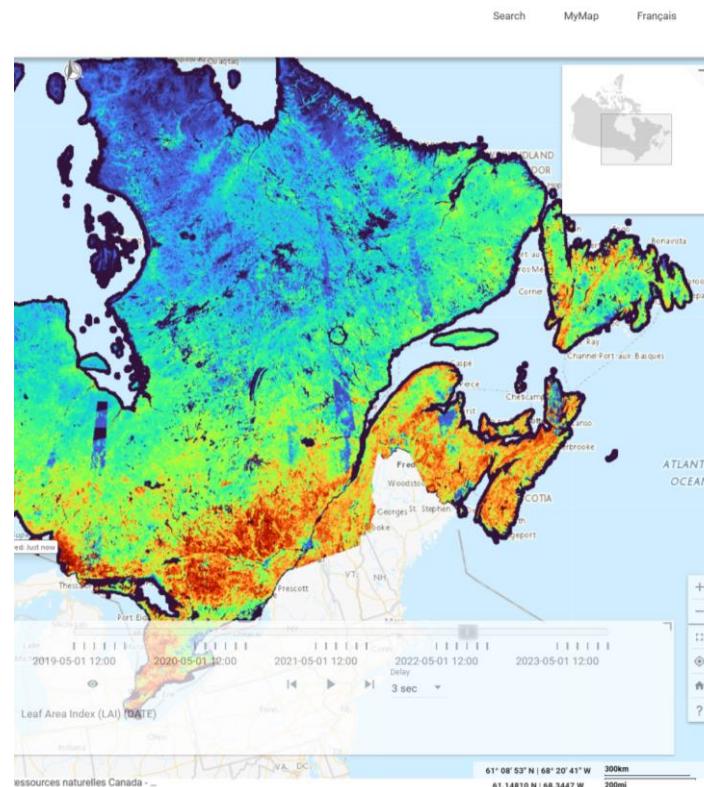
There is still much work to be done ...

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Better In-situ Measurements



Better input reflectance



High resolution mapping

