Good Practices for Validation of Satellite Medium Resolution Biophysical Parameter Products

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Sentinel-2 Simplified Level 2 Prototype LAI (not fAPAR or fCOVER) is biased over forests.

Background: **LAI products are derived using multiple algorithms and sensors. Globally representative systematic product validation is required. Here, Sentinel-2 fAPAR, fCOVER & LAI products from the SSimplified Level 2 Prototype (SL2P) processor are validated over North American forests using updated good practices.**

Product	Description	Goal
LAI	Half the total foliage area per unit horizontal ground area.	max(10%, 0.05)
fAPAR	Fraction of absorbed photosynthetically active radiation by green vegetation.	5%
fCOVER	Fraction of ground covered by green vegetation.	15%

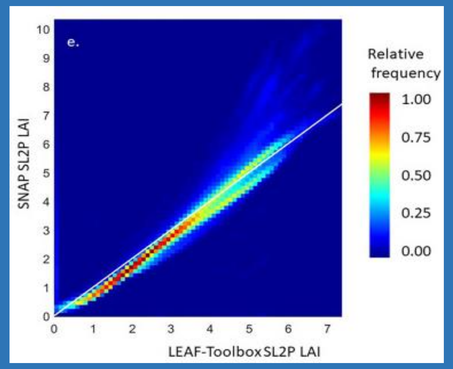
Results:

A. SNAP SL2P exhibits artifacts due to coding errors not present in LEAF-Toolbox SL2P.
B. CEOS Stage 3 validation 281 sites, 1107 reference measurements using CCRS & GBOV protocols
C. LEAF-Toolbox maps all SL2P products @20m
D. SL2P underestimates MODIS & CGLS LAI, fAPAR
E. SL2P bias <0.1 for fAPAR or fCOVER and up to −3 for LAI, empirical bias correction increases accuracy by 57% for fAPAR and 92% for LAI.

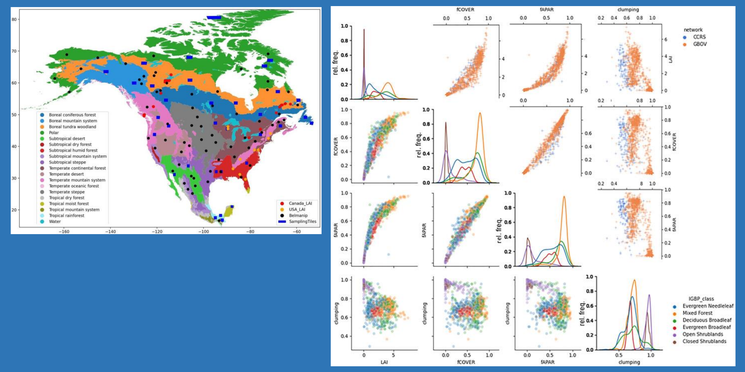
Conclusions:

- **Code verification needed in CEOS Good Practice**
- **Spatial sampling critical to quantify bias**
- **Open source flexible product generation (e.g. in Google Earth Engine) critical at continental scale**
- **Metrics vary with retrieved product value**
- **SL2P LAI has bias but this can be corrected using validation results and local verification**

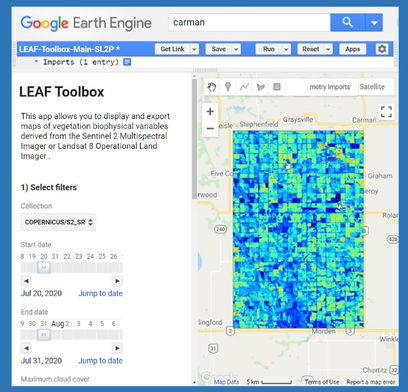
A. Code Verification

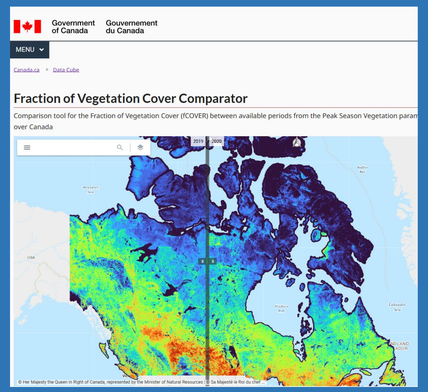


B. Reference Measurements

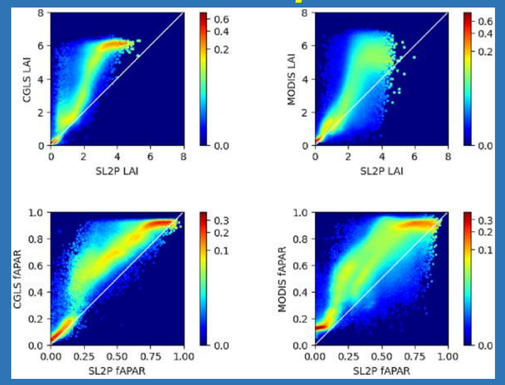


C. Production using Google Earth Engine

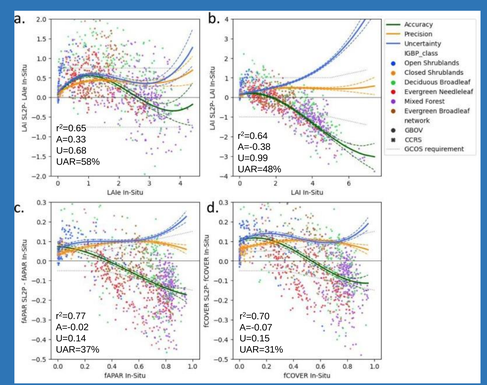




D. Intercomparison



E. In-situ Validation



References:

Fernandes, R. et al. 2014. Global leaf area index product validation good practices , Land Product Validation Subgroup (Committee on Earth Observation Satellites Working Group on Calibration and Validation) 10.5067/doc/ceoswgcv/lpv/lai.002

Brown et al., 2021. Fiducial reference measurements for vegetation bio-geophysical variables: an end-to-end uncertainty evaluation framework, Remote Sens., 13 p. 3194.

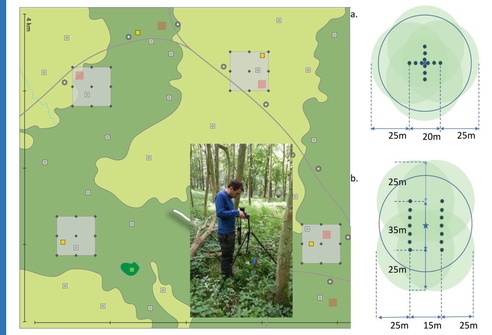
Fernandes, R., et al., 2021. LEAF Toolbox, Canada Centre for Remote Sensing accessed at https://github.com/rfernand387/LEAF-Toolbox/wiki on March 15, 2023, 202110.5281/zenodo.4321298.

Fernandes et al., 2023. Validation of Simplified Level 2 Prototype Processor Sentinel-2 fraction of canopy cover, fraction of absorbed photosynthetically active radiation and leaf area index products over North American forests, Remote Sensing of Environment Volume 293, 1 August 2023, 113600

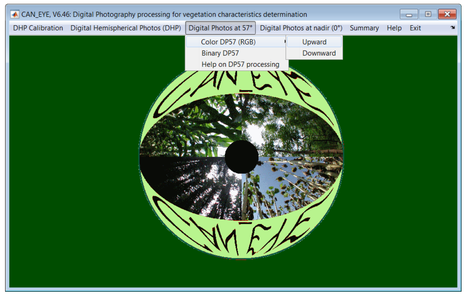
Methods:

Metric	Description
Uncertainty	Square root of the expected value of the squared difference of estimated and product values.
Accuracy	Expected value of the estimated value minus the product value.
Precision	Square root of expected value of the square of the total of the estimated value minus reference and accuracy metric.
Uncertainty Agreement	Fraction of validated samples that meet a given uncertainty requirement

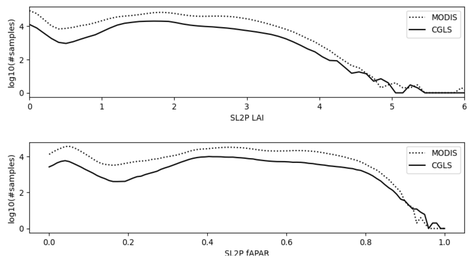
Thematic performance metrics.



NEON site with 4 DHP Elementary Sampling Units. Inset (a) NEON (b) CCRS footprints.



CANEYE (for CCRS) or GBOV (for NEON) algorithms used to derive fiducial RM.



Sampling distribution of 1.5km x 1.5km MODIS and CGLS intercomparison products.

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