THE SENSAGRI SENTINEL-2 LAI GREEN/BROWN PRODUCT: ALGORITHM DEVELOPMENT, VALIDATION AND MAPPING

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ABSTRACT

While the mapping of LAI green (LAIG) is well established, current operational products are not calibrated for LAI brown (LAIB), i.e. LAI estimation over senescent vegetation. With Sentinel-2 mission (S2), new opportunities are opened to estimate LAIB. The HORIZON 2020 Sentinels Synergy for Agriculture (SENSAGRI) project aims to develop an agricultural prototype service for the simultaneous retrieval of both LAIG and LAIB. By using LAI ground measurements data from multiple campaigns together with available S2 data, independent LAIG and LAIB models were optimized using Gaussian processes regression (LAIG: R2= 0.91, NRMSE= 6,6%; LAIB: R2= 0.76, NRMSE= 13.5%). These models can then be combined into LAIGB composite maps. The uncertainty estimates were used to map only those LAI estimated values that fall within a 40% uncertainty threshold.

INTRODUCTION

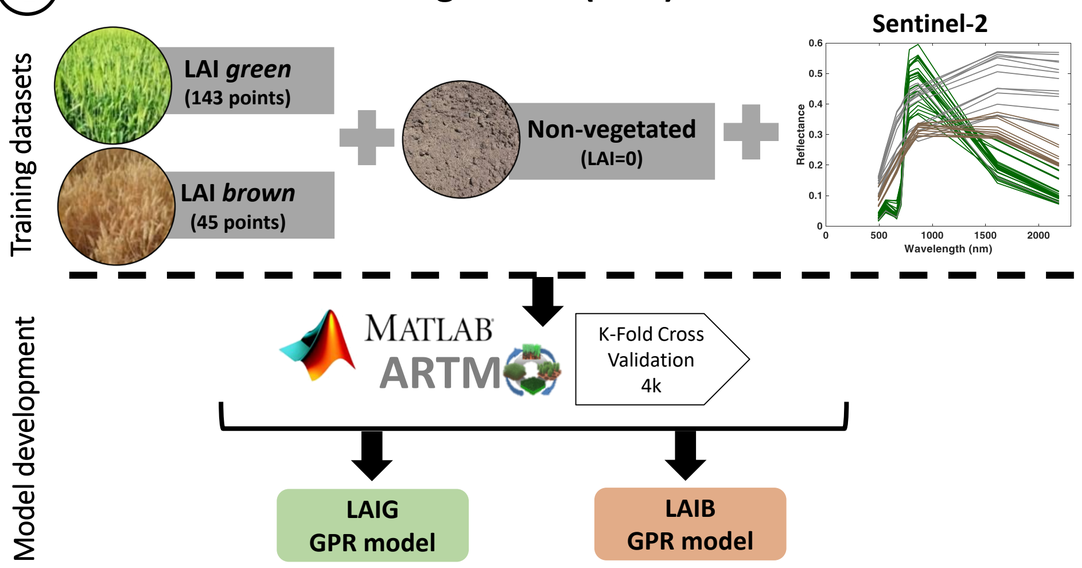
Existing operational LAI products quantify only LAI for green vegetation. However, when crop senescence, leaves remain on the plant until falling off or being harvested. Therefore, LAI stays high even when chlorophyll content degrades to zero and the plant loses its greenness. This senescent vegetation represents a significant amount of aboveground biomass and are a key factor in the carbon cycle [1]. Spatially-explicit quantification of LAIB is of interest for the farmer because it may indicate when the crop is ready for harvesting. Also, since senescent fields are more fire-prone than green fields, monitoring LAIB can contribute to fire risk assessments. Current LAI products are not optimized for estimating LAIB and the algorithms used tend to perform poorly [2], leading to confusion of senescent vegetation with bare soil. With the purpose of enabling the retrieval and monitoring of plant biophysical parameters, the HORIZON 2020 SENSAGRI project, expect to retrieve both LAIG and LAIB from S2 images. The implementation of retrieval methods into operational S2 data processing chain requires models that are fast, robust and easily applicable. This can be achieved with Gaussian processes regression (GPR), which is a powerful machine learning regression algorithm that also provides associated uncertainty estimates [3].

OBJECTIVES

1. **To develop independent GPR models for an explicit quantification of LAIG and LAIB based on S2 data.**
2. **To implement these models in an automated processing chain.**
3. **To convert S2 images into LAIGB composite maps of various European sites.**

METHODS

1 Gaussian Processes Regression (GPR)

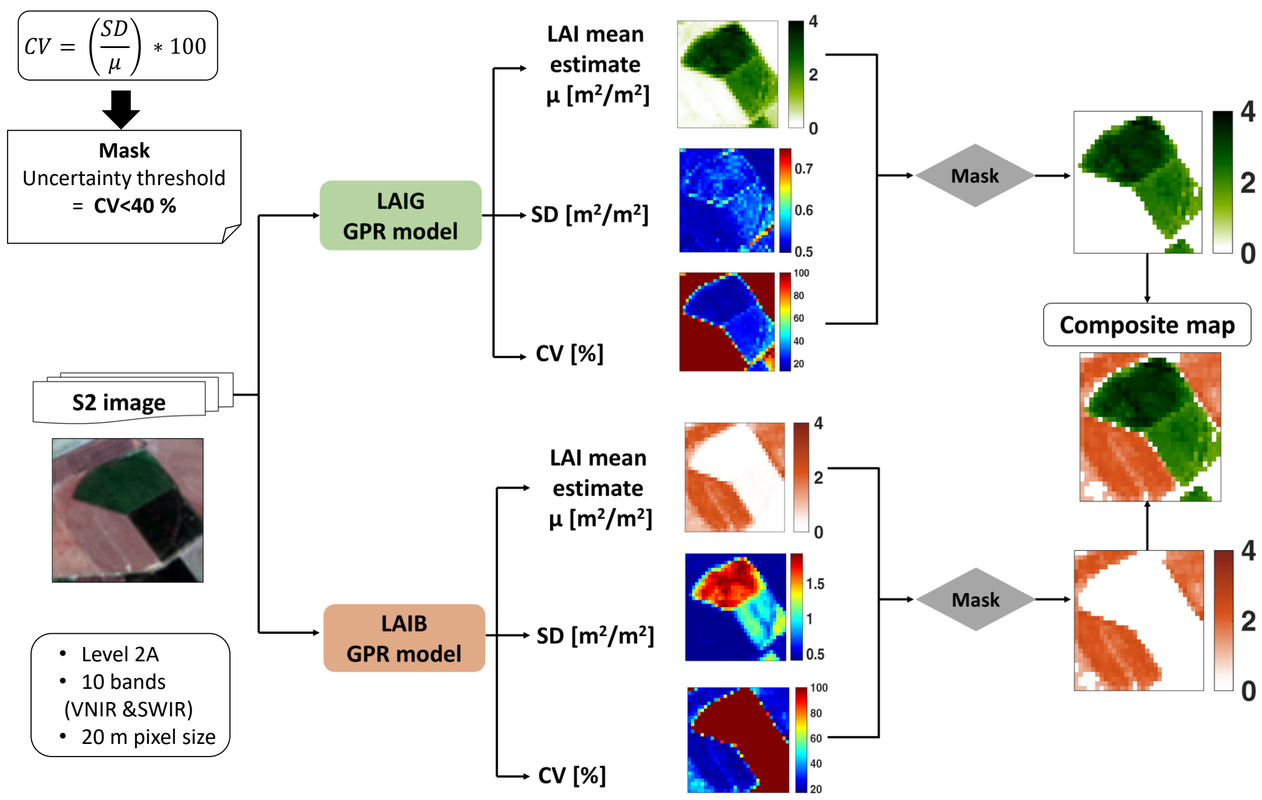


2 Validation

Cross validation (CV) statistics of GPR models LAIG and LAIB. All statistics are averaged 4-fold.

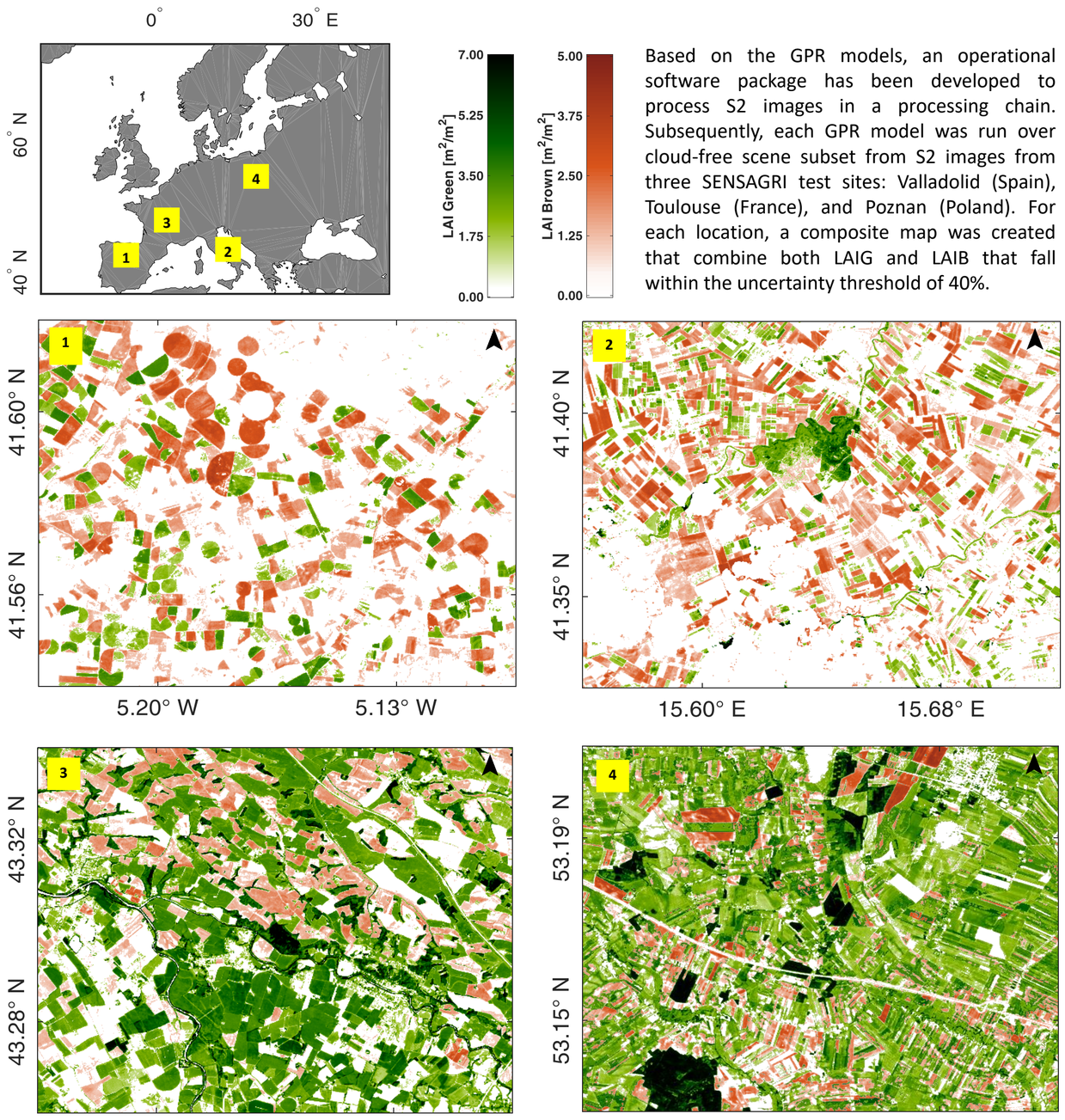
Model	$RMSE_{C-V}$ [m^2/m^2]	$NRMSE_{C-V}$ (%)	$RRMSE_{C-V}$ (%)	R^2_{C-V}
LAIG	0.62	6.63	28,42	0.91
LAIB	0.54	13.54	63,02	0.76

3 LAIG and LAIB processing into a composite map



RESULTS

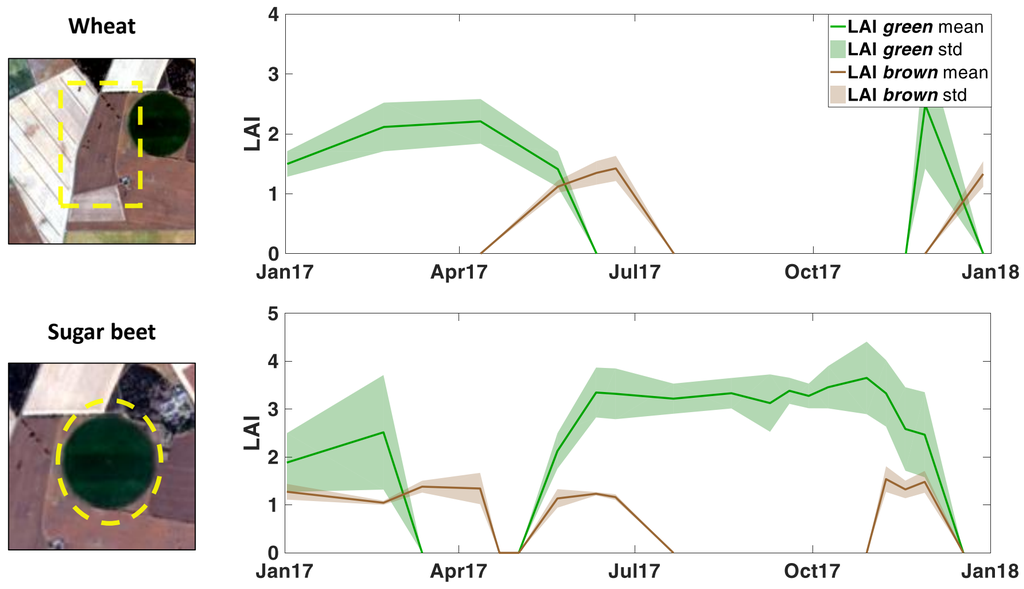
Composite LAIGB maps



Based on the GPR models, an operational software package has been developed to process S2 images in a processing chain. Subsequently, each GPR model was run over cloud-free scene subset from S2 images from three SENSAGRI test sites: Valladolid (Spain), Toulouse (France), and Poznan (Poland). For each location, a composite map was created that combine both LAIG and LAIB that fall within the uncertainty threshold of 40%.

Crop temporal evolution

A set of S2 images from the Valladolid region ranging from January to June 2017 were selected and subsequently processed into LAI maps in order to evaluate the temporal evolution of two different crop parcels described by LAIG and LAIB (mean and standard deviation).



CONCLUSIONS

- ✓ LAIG and LAIB GPR models have been successfully implemented into a processing chain for independent LAI retrieval from available S2 images. The uncertainty estimates were used as a threshold to ensure that only vegetated surfaces are quantified into LAIG and LAIB.
- ✓ The robustness and portability of the GPR models have been positively evaluated by mapping LAIGB composites over multiple European locations. All maps show a relatively good performance.
- ✓ The temporal performance of the GPR models suggests a reasonable LAI seasonal evolution with senescing that emerges from April onwards.

REFERENCES

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