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**GEOMATICS CANADA
OPEN FILE 78**

**Monthly vegetation essential climate variable maps of the
United Kingdom of Great Britain and Northern Ireland
from 2017 to 2023 at 20 m resolution from
Copernicus Sentinel 2 satellite imagery**

**R.A. Fernandes, L. Sun, F. Canisius, N. Djamai, K. Harvey, G. Hong,
C. MacDougall, H. Shah, and D. Janzen**

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Abstract

Vegetation essential climate variables corresponding to the black-sky albedo (albedo), the fraction of absorbed photosynthetically active radiation (fAPAR), the fraction of canopy cover (fCOVER) and the leaf area index (LAI), as defined by the Global Climate Observing System, are produced for the United Kingdom at 20m resolution on a monthly basis from 2017 to 2023. Maps correspond to variables estimated from input Copernicus Sentinel-2 satellite imagery using the Landscape Evolution and Forecasting (LEAF) Toolbox implementation of the Simplified Level 2 Prototype Processor. The day of retrieval is also provided with each monthly map. Uncertainty estimates are provided based on validation over North America. These products have not been validated over the United Kingdom and are only available for research use.

1 Introduction

The Global Climate Observing System (GCOS) has defined requirements for global mapping of essential climate variables (ECVs, 2023). These include vegetation ECVs required for environmental monitoring and modelling. A subset of these ECVs can potentially be derived in a manner that typically meets GCOS thematic performance and spatial resolution requirements using medium resolution (<100m) optical satellite imagery: to the black-sky albedo (albedo), the fraction of absorbed photosynthetically active radiation (fAPAR), the fraction of canopy cover (fCOVER) and the leaf area index (LAI). The Simplified Level 2 Prototype Processor (SL2P, Weiss and Baret 2016) estimates each of these quantities for individual pixel measurements of 20m resolution Sentinel-2 Multispectral Instrument surface reflectance imagery (S2). SL2P relies on separate regression estimators for each variable calibrated using a shared database of simulated S2 reflectance and associated canopy parameters representative of global land surface observations for the nominal S2 mission. SL2P has been implemented within the Landscape Evolution and Forecasting (LEAF) Toolbox to allow for efficient global mapping of these variables (Fernandes et al., 2021). The thematic performance of the LEAF implementation of SL2P estimates of fAPAR, fCOVER and LAI has been quantified at over 1000 North American in-situ sites across xx land cover classes (Brown et al., 2021; Fernandes et al. 2023). LEAF can also produce Level 3 products corresponding to temporal composites where one sample data of available clear sky S2 data is selected based on a weighted criteria (Sun and Fernandes, 2023).

This document corresponds to LEAF toolbox estimates of monthly albedo, fCOVER, fAPAR and LAI for the United Kingdom of Great Britain and Northern Island (UK) from 2017 to 2023 at 20m resolution together with an ancillary layer corresponding to the day of retrieval and an ancillary layer corresponding to a data quality flag as documented in Sun and Fernandes, 2023.

2 Results

Monthly products were generated for the UK from January 2017 to December 2023 using the Google Earth Engine Application Programmer Interface with varying amounts of Earth Engine Compute Resources (EECU) due to variation in input cloud free data for each month. The average EECU for 2019 to 2023, when both Sentinel 2A and 2B data were available, is ~1360000 EECU seconds per month with approximately half that prior to 2019 when only Sentinel 2A data was available. The average product volume is 4 Gbytes/year. Data is available, upon request, at

https://drive.google.com/drive/folders/1bYtZ97sve_YcuTRuBwDlcmgrQVTr1fBI?usp=sharing.

Sample July products are shown for the UK 2022 (Figure 1) and for the London Metropolitan region (Figure 2). fAPAR and fCOVER products are closely related as expected since both are proportional to the canopy gap fraction. Albedo products show sensitivity to acquisition date as well as measurement error of input Sentinel 2 data. These figures and products are not validated over the UK and are for visualization and research purposes only.

Products are formatted as described in the LEAF User Guide here

https://github.com/fqqlsun/LEAF_production?tab=readme-ov-file.

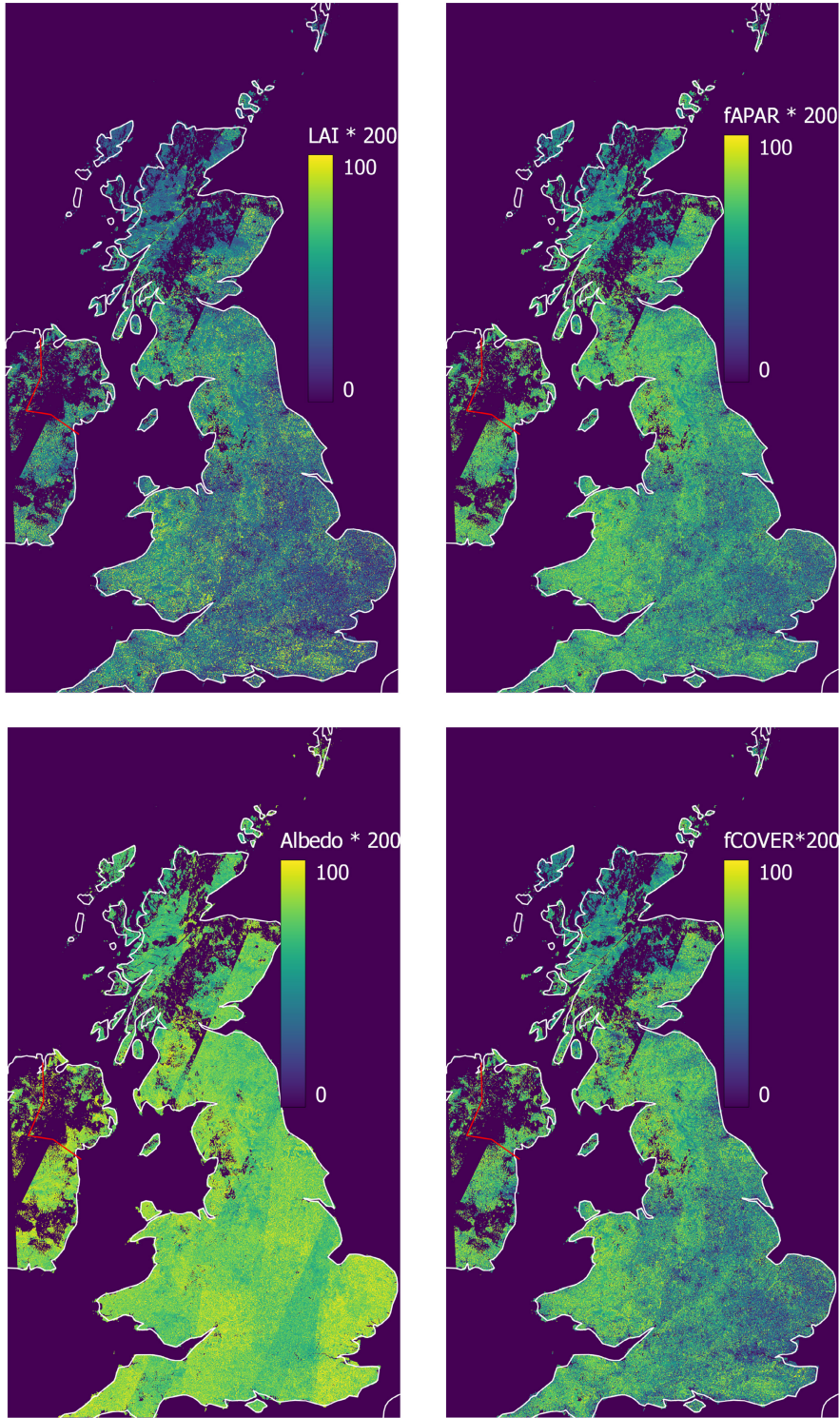


Figure 1. July 2022 ECV products for the UK and portions of Ireland derived from Sentinel 2 imagery using SL2P. Contains modified Copernicus Sentinel data 2022.

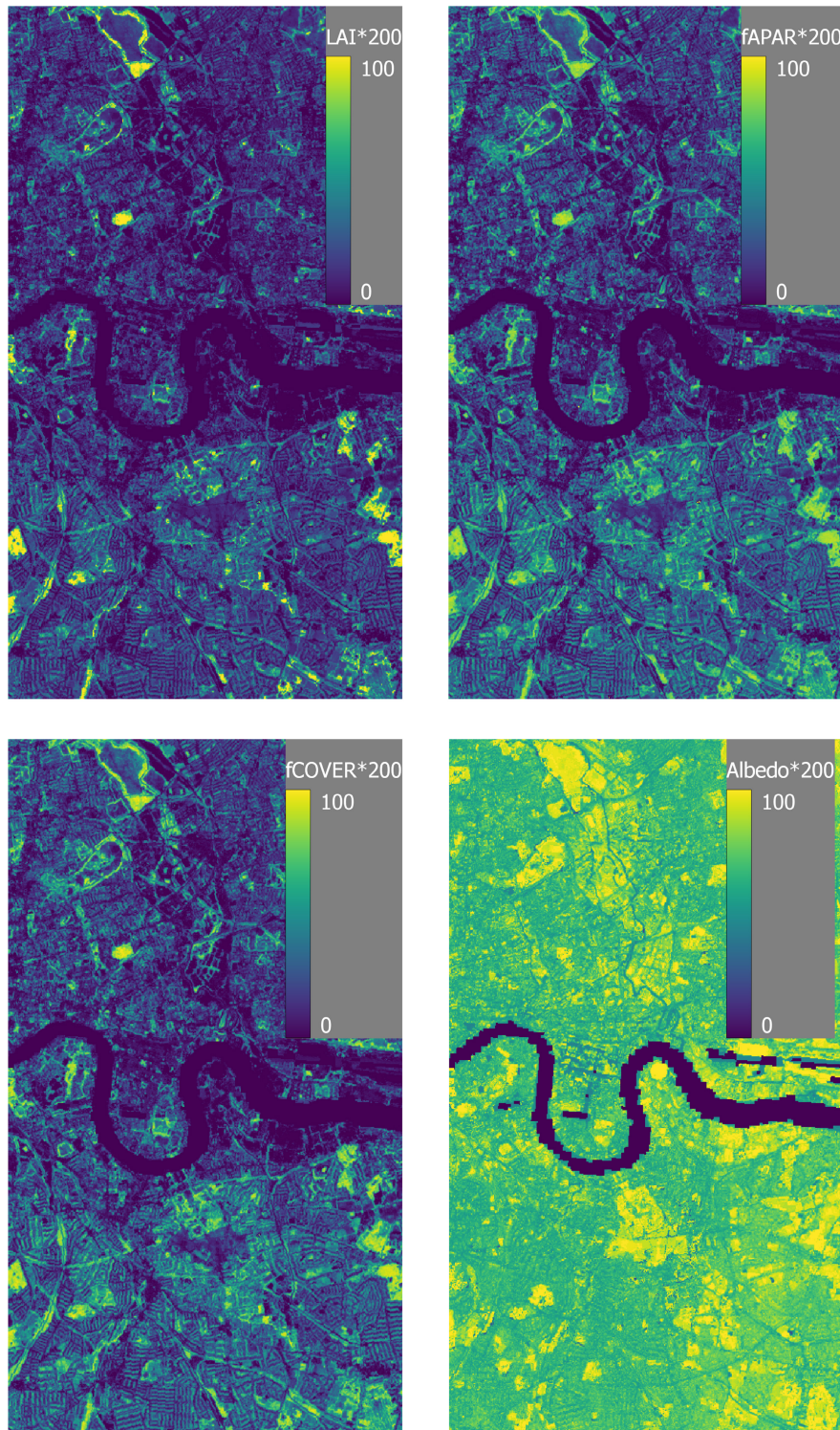


Figure 2. July 2022 ECV products for the London Metropolitan region derived from Sentinel 2 imagery using SL2P. Contains modified Copernicus Sentinel data 2022.

3 Conclusions

Maps of albedo, Lai, fAPAR and fCOVER were produced on a monthly basis at 20m resolution for the UK using available Sentinel 2 imagery and the SL2P algorithm. The products will include data gaps due to clouds.

Products are available upon request and can only be used for non-profit scientific use with permission of the authors.

4 Acknowledgements.

Products contains modified Copernicus Sentinel data 2017,2018,2019,2020,2021,2022,2023.

Dr. Marie Weiss and Dr, Fred Baret provided an initial version of the code used to produce the S2P regression algorithms later modified as described in Fernande et al., 2023. This work was based on algorithms developed within the Natural Resources Canada Earth Observation of Cumulative Effects programme of the Government of Canada.

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