



Estimating crop parameters using Sentinel-1 and 2 datasets and geospatial field data

Audrey Mercier, Julie Betbeder, Julien Denize, Jean-Luc Roger, Fabien Spicher, Jérôme Lacoux, David Roger, Jacques Baudry, Laurence Hubert-Moy

► To cite this version:

Audrey Mercier, Julie Betbeder, Julien Denize, Jean-Luc Roger, Fabien Spicher, et al.. Estimating crop parameters using Sentinel-1 and 2 datasets and geospatial field data. Data in Brief, 2021, 38, pp.107408. 10.1016/j.dib.2021.107408 . hal-03352944

HAL Id: hal-03352944

<https://hal.science/hal-03352944>

Submitted on 1 Mar 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Data Article

Estimating crop parameters using Sentinel-1 and 2 datasets and geospatial field data



Audrey Mercier^{a,*}, Julie Betbeder^{b,c}, Julien Denize^{a,d},
Jean-Luc Roger^e, Fabien Spicher^f, Jérôme Lacoux^f, David Roger^f,
Jacques Baudry^e, Laurence Hubert-Moy^a

^a LETG Rennes UMR 6554, Université Rennes 2, Place du recteur Henri Le Moal, Rennes Cedex 35043, France

^b CIRAD, Forêts et Sociétés, Montpellier 34398, France

^c Ecosystems Modelling Unity, Forests, Biodiversity and Climate Change Program, Tropical Agricultural Research and Higher Education Center (CATIE), Turrialba, Cartago, Costa Rica

^d Institute of Electronics and Telecommunications of Rennes IETR, UMR CNRS 6164, University of Rennes, Rennes 35000, France

^e Institut Agro, UMR 0980 BAGAP, ESA, Rennes 35042, France

^f Unité Ecologie et Dynamiques des Systèmes Anthropisés, UMR 7058 CNRS, Université de Picardie Jules Verne, 33 rue St-Leu, Amiens 80039, France

ARTICLE INFO

Article history:

Received 29 June 2021

Revised 16 September 2021

Accepted 20 September 2021

Available online 21 September 2021

Keywords:

LAI

Biomass

Phenological stages

Water content

Remote sensing

Optical and SAR satellite images

Wheat

Rapeseed

ABSTRACT

Crop monitoring is essential for ensuring food security in a global context of population growth and climate change. Satellite images are commonly used to estimate crop parameters over large areas, and the freely available Synthetic Aperture Radar (SAR) Sentinel-1 (S-1) and optical Sentinel-2 (S-2) images are relevant for that purpose combining high temporal resolution and high spatial resolution. For this data article, field surveys were conducted from January to July 2017 in France to sample wheat and rapeseed crop parameters during the entire crops cycle. Phenological stages were identified in 83 wheat fields and 32 rapeseed fields in Brittany and Picardy regions. Moreover, Leaf Area Index (LAI), wet biomass, dry biomass and water content were sampled in three wheat fields and three rapeseed fields in Brittany. We assigned to each field sample 10 spectral bands and 12 vegetation indices from S-2 images and two backscattering coefficients, one backscattering ratio and four

DOI of original article: [10.1016/j.isprsjprs.2020.03.009](https://doi.org/10.1016/j.isprsjprs.2020.03.009)

* Corresponding author.

E-mail address: audrey.mercier@cirad.fr (A. Mercier).

<https://doi.org/10.1016/j.dib.2021.107408>

2352-3409/© 2021 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>)

polarimetric indicators from S-1 images. This dataset can be used for crop monitoring in other regions, as well as for modelling development.

© 2021 The Authors. Published by Elsevier Inc.
This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>)

Specifications Table

Subject	Agronomy and Crop Science
Specific subject area	Applied remote sensing; crop biophysical parameters
Type of data	Table
How data were acquired	Spatial data Spectral values and vegetation indices derived from S-2 images; backscattering coefficients and polarimetric indicators derived from S-1 images; LAI derived from hemispherical photographs using CAN-EYE software [5]; wet biomass, dry biomass and water content collected on the field.
Data format	Raw Analyzed
Parameters for data collection	S-1 and S-2 pixels completely included within wheat and rapeseed fields and associated crop parameters collected during the field surveys (phenological stages, LAI, wet biomass, dry biomass and water content) from January to July 2017.
Description of data collection	Field surveys were conducted from January to July 2017 to collect wheat and rapeseed crop parameters in 115 fields. Phenological stages were identified in 83 wheat fields and 32 rapeseed fields in Brittany and Picardy regions (France). LAI, wet biomass, dry biomass and water content were sampled in three wheat fields and three rapeseed fields in Brittany. As close as possible to the dates of field surveys, spectral values and vegetation indices were derived from S-2 images and backscattering coefficients and polarimetric indicators from S-1 images.
Data source location	Region: Brittany and Picardy Country: France
Data accessibility	With the article
Related research article	A. Mercier, J. Betbeder, J. Baudry, V. Le Roux, F. Spicher, J. Lacoux, D. Roger, L. Hubert-Moy, Evaluation of Sentinel-1 & 2 time series for predicting wheat and rapeseed phenological stages. ISPRS Journal of Photogrammetry and Remote Sensing. 163 (2020) 231-256. https://doi.org/10.1016/j.isprsjprs.2020.03.009

Value of the Data

- The datasets provide crop biophysical parameters (LAI, biomass and phenological stages) during the crop cycles of wheat and rapeseed and associated S-1 and S-2 features for crop monitoring.
- The datasets can be used in many fields of research (Agronomy, Climatology, Ecology...) to analyze the relationships between crop growth and agricultural practices, climatic variables, landscape structure or species distribution.
- These datasets can be used for crop monitoring in other regions, as well as for modelling development.

1. Data Description

The datasets include a vector GIS shapefile (RGF93/Lambert-93 system, EPSG 2154) containing 55 polygons located in Picardy [2,3] and 60 in Brittany regions [3,4] (France). The 115 polygons correspond to 32 rapeseed fields and 83 wheat fields sampled in 2017 during one crop cycle. Five

Table 1

List of acronyms and abbreviations.

Acronyms and abbreviations	Description	Unit
ID	Field identifier	Dimensionless
DOY	Day of year 2017	Day number
LAI	Leaf Area Index	Dimensionless
entropy_shannon_norm	Normalized shannon entropy	Dimensionless
entropy_shannon_I_norm	Normalized intensity of shannon entropy	Dimensionless
entropy_shannon_P_norm	Normalized polarization of shannon entropy	Dimensionless
span	Total scattered power	Decibel (dB)
VV	Sigma VV	Decibel (dB)
VH	Sigma VH	Decibel (dB)
VHVV	Sigma VH:Sigma VV	Decibel (dB)
Band 2	Blue band	Per ten thousand
Band 3	Green band	Per ten thousand
Band 4	Red band	Per ten thousand
Band 5	Red-edge band	Per ten thousand
Band 6	Red-edge band	Per ten thousand
Band 7	Red-edge band	Per ten thousand
Band 8	Near-infrared band	Per ten thousand
Band 8A	Near-infrared band	Per ten thousand
Band 11	Shortwave-infrared band	Per ten thousand
Band 12	Shortwave-infrared band	Per ten thousand
GNDVI	Green Normalized Vegetation Index	Dimensionless
IRECI	Inverted Red-Edge Chlorophyll Index	Dimensionless
MCARI	Modified Chlorophyll Absorption in Reflectance Index	Dimensionless
MSAVI	Modified Soil-Adjusted Vegetation Index	Dimensionless
MTCI	MERIS Terrestrial Chlorophyll Index	Dimensionless
NDI	Normalized Difference Index	Dimensionless
NDVI	Normalized Difference Vegetation Index	Dimensionless
PSSRa	Pigment Specific Simple Ratio	Dimensionless
REIP	Red-Edge Inflection Point	Dimensionless
SAVI	Soil-Adjusted Vegetation Index	Dimensionless
S2REP	Sentinel-2 Red Edge Position	Dimensionless
WDVI	Weighted Difference Vegetation Index	Dimensionless

attribute tables were assigned to each sampled field, which are crop types (wheat/rapeseed), LAI and biomass (*i.e.*, LAI, wet biomass, dry biomass, water content), phenological stages, S-1 features (*i.e.*, backscattering coefficients and polarimetric indicators) and S-2 features (*i.e.*, spectral values and vegetation indices). The three last table columns that are labeled “DOY”, “Region” and “ID” correspond to the acquisition dates of satellite images or crop parameters in Day Of Year (DOY) 2017, region of France (Brittany or Picardy) and field identifier, respectively. [Table 1](#) provides a full description of the acronyms and abbreviations used in this article.

2. Experimental Design, Materials and Methods

Concerning crop parameters, phenological stages were identified over the 115 field samples based on the Biologische Bundesanstalt, Bundessortenamt and Chemical industry (BBCH) scale [5]. These data were used in Mercier et al [2,3]. LAI, wet biomass, dry biomass and water content surveys were conducted on three wheat fields and three rapeseed fields in Brittany region. For this purpose, 10 digital hemispherical photographs were taken at each sampled field on each date. These data were used in Mercier et al [4]. LAI was estimated from the hemispherical photographs using CAN-EYE software [1] and averaged per date and field sample. Biomass measurements were performed in homogeneous areas (20 × 20 m) where five samples of wheat 50 cm and five rapeseed plants were collected during the field surveys. The wet biomass was directly weighed *in situ*, and the dry biomass was measured after drying the crop (oven, 65 °C, 48 h). Water content in the plant equals wet biomass minus dry biomass.

Concerning remote sensing features, S-1 and S-2 images were downloaded from the Copernicus Open Access Hub (<https://scihub.copernicus.eu/>). Cloud-free S-2 images used correspond to Level-2A products providing top of canopy reflectances. Twelve vegetation indices were calculated from S-2 spectral bands (Table 1). S-1 images used were acquired in Interferometric Wide (IW) swath mode and correspond to Single Look Complex (SLC) products. The backscattering coefficients (sigma VH and sigma VV) extraction process was performed using the S-1 Toolbox (<http://step.esa.int/main/toolboxes/sentinel-1-toolbox/>). This process includes (1) radiometric calibration, (2) speckle filtering using a Lee Refined 7×7 filter [6], (3) geometric corrections using Shuttle Radar Topography Mission data [7], (4) calculation of the sigma VH: sigma VV ratio and (5) conversion from linear to decibel values. The polarimetric indicators extraction process was performed using PolSARpro version 5.1.3 software [8]. This process includes (1) the extraction of a 2×2 covariance matrix, (2) a speckle filtering using a Lee Refined 7×7 filter, (3) the extraction of four polarimetric indicators (the Shannon entropy, the intensity, the degree of polarization and the span), (4) the normalization of the Shannon entropy, the intensity and the degree of polarization. Finally, all S-1 and S-2 images were projected onto the RGF93/Lambert-93 system (EPSG 2154) and resampled with bilinear interpolation to the resolution of 10 m. The median value was computed at the field scale with a negative buffer of 15 m and 10 m in Picardy and Brittany, respectively, to select only pixels fully contained within each field.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships which have, or could be perceived to have, influenced the work reported in this article.

CRediT Author Statement

Audrey Mercier: Conceptualization, Methodology, Software, Validation, Data curation, Writing – original draft, Visualization; **Julie Betheder:** Conceptualization, Methodology, Software, Supervision; **Julien Denize:** Resources, Data curation; **Jean-Luc Roger:** Resources; **Fabien Spicher:** Resources, Data curation; **Jérôme Lacoux:** Resources; **David Roger:** Resources; **Jacques Baudry:** Conceptualization, Writing – review & editing, Project administration, Funding acquisition; **Laurence Hubert-Moy:** Conceptualization, Supervision, Writing – review & editing, Project administration, Funding acquisition.

Acknowledgments

We thank Sébastien Rapinel for his helpful comments on database contents. This research was funded through the 2015-2016 BiodivERsA COFUND call for research proposals, with the national funders ANR, MINECO, and BELSPO, and was supported by the Kalideos project funded by the CNES, the Zone Atelier Armorique project, and a Ph.D. grant to A. Mercier from the Ministry of Research.

Supplementary Materials

Supplementary material associated with this article can be found in the online version at doi:[10.1016/j.dib.2021.107408](https://doi.org/10.1016/j.dib.2021.107408).

References

- [1] F. Baret, M. Weiss, Can-Eye: processing digital photographs for canopy structure characterization, CAN EYE tutorial document, Avignon, France, 2004.

- [2] A. Mercier, J. Betbeder, J. Baudry, V. Le Roux, F. Spicher, J. Lacoux, D. Roger, L. Hubert-Moy, Evaluation of Sentinel-1 & 2 time series for predicting wheat and rapeseed phenological stages, *ISPRS J. Photogramm. Remote Sens.* 163 (2020) 231–256, doi:[10.1016/j.isprsjprs.2020.03.009](https://doi.org/10.1016/j.isprsjprs.2020.03.009).
- [3] A. Mercier, J. Betbeder, J. Baudry, J. Denize, V. Leroux, J.L. Roger, F. Spicher, L. Hubert-Moy, Evaluation of Sentinel-1 and -2 time series to derive crop phenology and biomass of wheat and rapeseed: northern France and Brittany case studies, *Remote Sensing for Agriculture, Ecosystems, and Hydrology XXI*, International Society for Optics and Photonics, 2019, doi:[10.1117/12.2533132](https://doi.org/10.1117/12.2533132).
- [4] A. Mercier, J. Betbeder, S. Rapinel, N. Jegou, J. Baudry, L. Hubert-Moy, Evaluation of Sentinel-1 and -2 time series for estimating LAI and biomass of wheat and rapeseed crop types, *JARS* 14 (2020) 024512, doi:[10.1117/1.JRS.14.024512](https://doi.org/10.1117/1.JRS.14.024512).
- [5] H. Bleiholder, E. Weber, M. Hess, H. Wicke, T. van den Boom, P.D. Lancashire, L. Buhr, H. Hack, F.R. Klose, R. Strauss, *Growth Stages of Mono- and Dicotyledonous Plants*, BBCH Monograph, Federal Biological Research Centre for Agriculture and Forestry, Berlin/Braunschweig, Germany, 2001.
- [6] J.S. Lee, L. Jurkevich, P. Dewaele, P. Wambacq, A. Oosterlinck, Speckle filtering of synthetic aperture radar images: a review, *Remote Sens. Rev.* 8 (1994) 255–267, doi:[10.1080/02757259409532206](https://doi.org/10.1080/02757259409532206).
- [7] T.G. Farr, P.A. Rosen, E. Caro, R. Crippen, R. Duren, S. Hensley, M. Kobrick, M. Paller, E. Rodriguez, L. Roth, D. Seal, S. Shaffer, J. Shimada, J. Umland, M. Werner, M. Oskin, D. Burbank, D. Alsdorf, The shuttle radar topography mission, *Rev. Geophys.* 45 (2007), doi:[10.1029/2005RG000183](https://doi.org/10.1029/2005RG000183).
- [8] E. Pottier, L. Ferro-Famil, PolSARPro V5.0: An ESA educational toolbox used for self-education in the field of POLSAR and POL-INSAR data analysis, in: *Proceedings of the IEEE International Geoscience and Remote Sensing Symposium*, 2012, pp. 7377–7380, doi:[10.1109/IGARSS.2012.6351925](https://doi.org/10.1109/IGARSS.2012.6351925).