German Remote Sensing Data Center (DFD)
Land Surface Dynamics

Multi-scale time series of biophysical parameters and vegetation structure in heterogeneous landscapes of West Africa

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BACKGROUND

The CONCERT project

… aims at identifying **emission mitigation options** for the major greenhouse gases (GHG), in parallel with **improving food security** in West Africa.

… will provide **estimations and predictions of GHG emission budgets** with a regional **Earth System Model** (ESM).

… allowed the installation of **Eddy Covariance Towers** for **measuring GHG fluxes** over various land covers.

Fig.1: Location of the CONCERT study sites in northern Ghana.

Vegetation dynamics

… **data at high resolution** are required together with **land cover** information to **up-scale measured GHG emissions** to the country scale.

… have to be **understood** in more detail regarding their **spatial and temporal patterns** for **reliable predictions on GHG budgets** in West Africa.

… can be **provided by earth observation**, but global datasets are often course.

… need to be **derived at a higher spatial end temporal resolution**.

METHOD

Deriving Leaf Area Index (LAI) from satellite data

- **Gaussian Process Regression (GPR)** model predicting green LAI from **Sentinel 2** data implemented in **Google Earth Engine (GEE)** by Pipia et al. (2021).
- **Filling of cloud gaps** with a GPR-based approach is already implemented.
- Testing of a second, **more sophisticated cloud mask** (s2cloudless) native to GEE for comparison.
- Processing **of multi-year cloud free LAI timeseries** around the study sites at **20 m spatial resolution**.
- LAI time series processed in GEE was **compared to existing global LAI products**, see table 1.
- **Copernicus LAI time series** cloud gaps were filled.

Tab. 1: Spatial and temporal resolutions of various LAI products.

LAI product	Spatial resolution	Temporal resolution
Copernicus Sentinel 3/ PROBA-V LAI	300 m	10 days
MODIS LPDAAC	500 m	8 days
MODIS GLASS	250 m	8 days
Sentinel 2 LAI	20 m	Daily

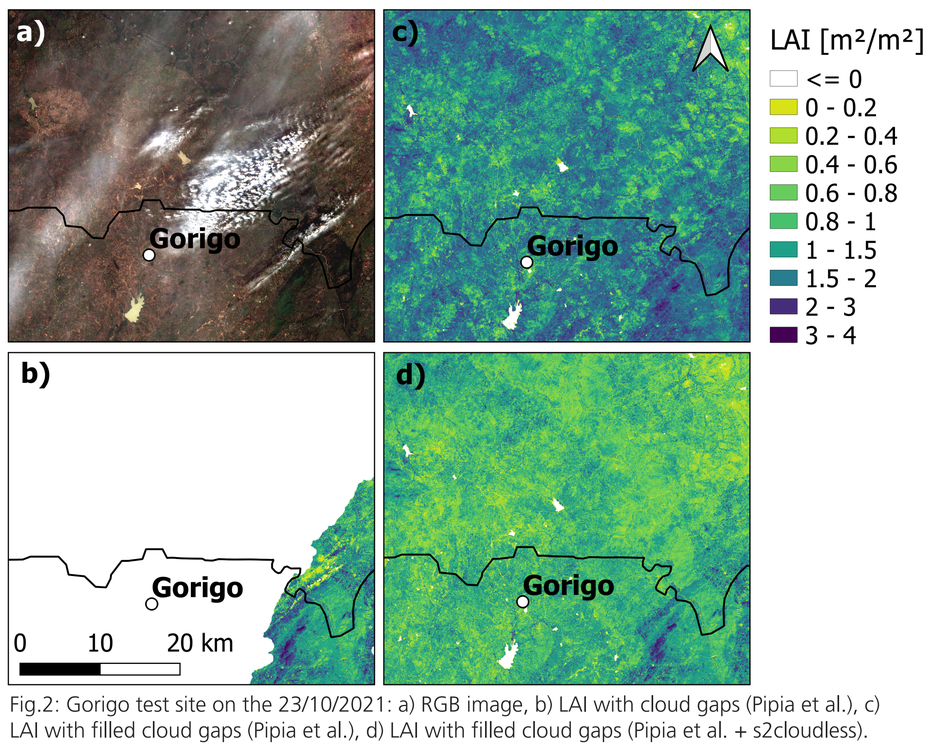

Fig.2: Gorigo test site on the 23/10/2021: a) RGB image, b) LAI with cloud gaps (Pipia et al.), c) LAI with filled cloud gaps (Pipia et al.), d) LAI with filled cloud gaps (Pipia et al. + s2cloudless).

RESULTS

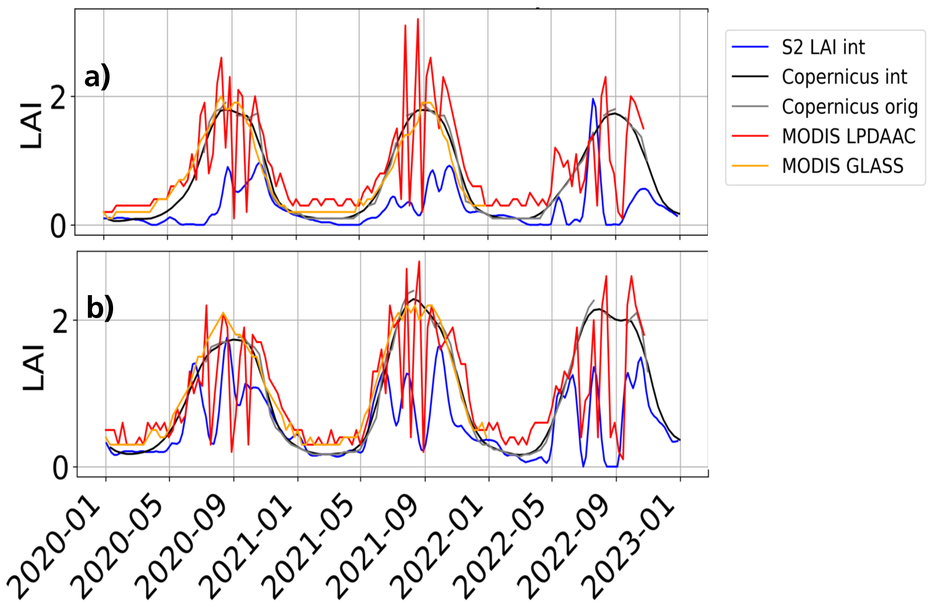

Fig.3: LAI time series for a cropland (a) and shrubland (b) close to the Janga test site. The S2 time series represents the median for a 300m x 300m area. All other time series represent a pixel of their original resolution.

Analysis of S2 LAI processing - Spatial

- Original cloud filling method by Pipia et al**. produces artefacts** in the LAI, see Fig.2 c).
- Results **improve if s2cloudless cloud mask is included** in the processing.

Comparison of LAI products

- **S2 LAI underestimates values** especially during the rain seasons when many clouds are present, values partly close to 0, see Fig. 3.
- Underestimation **independent of the land cover type** (cropland, shrubs, grassland, tree cover).
- **MODIS LPDAAC very noisy**, filtering of cloudy dates necessary.
- Copernicus LAI (original + interpolated) and MODIS GLASS, which have a similar resolution, **agree quite well**.

SPONSORED BY THE

Federal Ministry of Education and Research

This work is part of the CONCERT project funded by the German Federal Ministry of Research and Education (Förderkennzeichen 01LG2089B).

Pipia, L.; Amin, E.; Belda, S.; Salinero-Delgado, M.; Verrelst, J. (2021). "Green LAI Mapping and Cloud Gap-Filling Using Gaussian Process Regression in Google Earth Engine." Remote Sens 13(3), pp. 403.

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