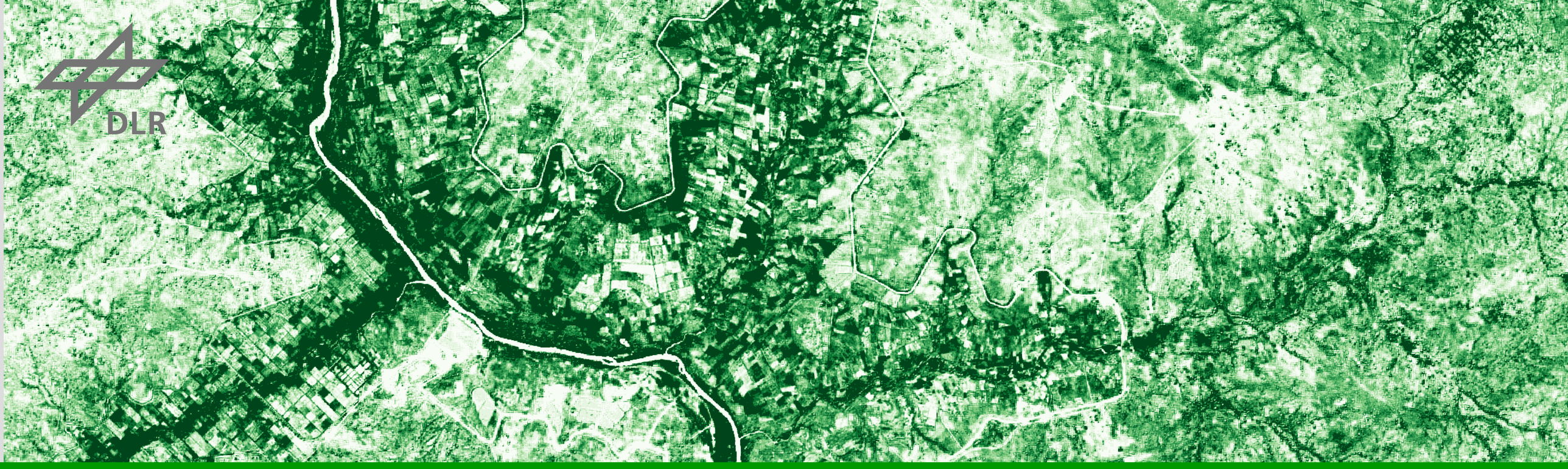

How Earth Observation closes the gap between in-situ greenhouse gas measurements and regional earth system modelling in West Africa

German Remote Sensing Data Center (DFD)
Land Surface Dynamics

Verena Huber García[1], Frank Thonfeld[1], Jonas Meier[1], Kenneth Aidoo[2], Ferdinand Tornyie[2], Souleymane Sy[3], Jan Bliefernicht[3], Harald Kunstmann[3,4], Ursula Gessner[1]

[1] German Remote Sensing Data Center, German Aerospace Center (DLR)
[2] United Nations University - Institute for Natural Resources in Africa
[3] University of Augsburg, Institute of Geography
[4] Karlsruhe Institute of Technology, Institute of Meteorology and Climate Research - Campus Alpin

BACKGROUND

The CONCERT project

… focuses on West Africa, which **contributed little to greenhouse gas (GHG) emissions,** but is **severely affected by Climate Change.**

… aims at identifying **emission mitigation options** for the major GHGs, in parallel with **improving food security** in West Africa.

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

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

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 coarse.

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

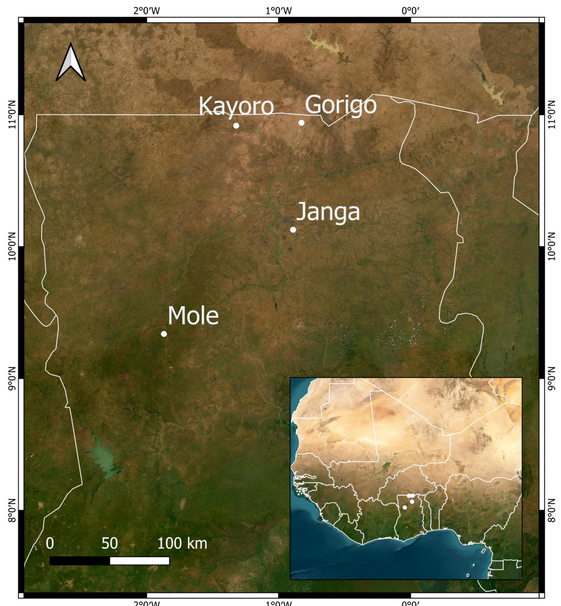

Fig.1: Location of the CONCERT study sites with EC towers in northern Ghana.

METHOD

Deriving Sentinel-2 Leaf Area Index (LAI)

- **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** (CDI, Frantz et al. (2018)) for comparison.
- Processing **of multi-year cloud free LAI timeseries** around the reserach sites at **20 m spatial resolution**.

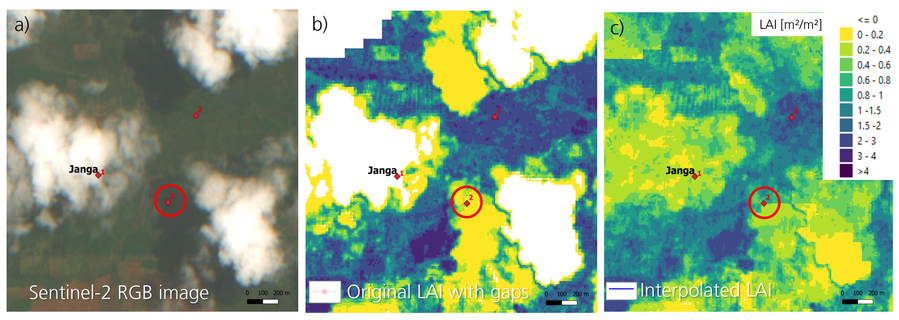

Fig. 2: a) Sentinel-2 RGB image over the Janga site the 09-08-2020, b) original (without interpolation) Sentinel-2 LAI and c) interpolated LAI applying the GPR-based approach by Pipia et al. (2021) for the same date.

Gap-filling of Copernicus Sentinel-3/PROBA-V LAI

- **Global** product available at **300 m** spatial and **10 days** temporal resolution for years 2014-2022.
- **Gaps in timeseries in study region** mainly **during vegetation** period due to **high cloud cover.**
- Gaps filled either by **average LAI values (gaps > 5 timesteps)** or by applying **Savitzky-Golay-filter (< 5 timesteps).**

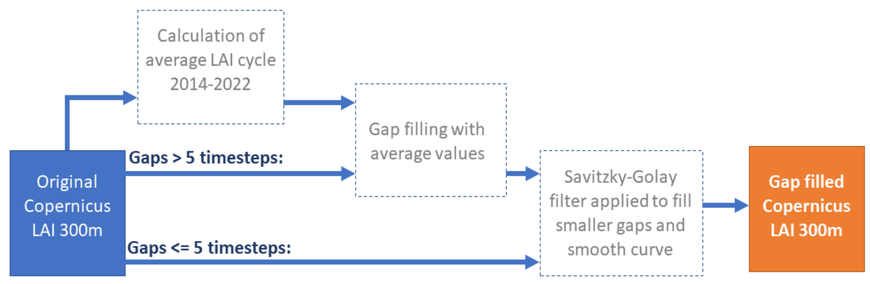

Fig.3: Workflow for gap-filling of S3/PROBA-V LAI time series.

RESULTS

Gap-filled S3/PROBA-V LAI time series

- Cloud gaps **closed properly** and timeseries smoothed (Fig. 3).
- Gap-filled product each 10 days for 2014-2022 **for West Africa covering 4 x 10^6 km²** provided to project partners **for comparison with ESM results.**

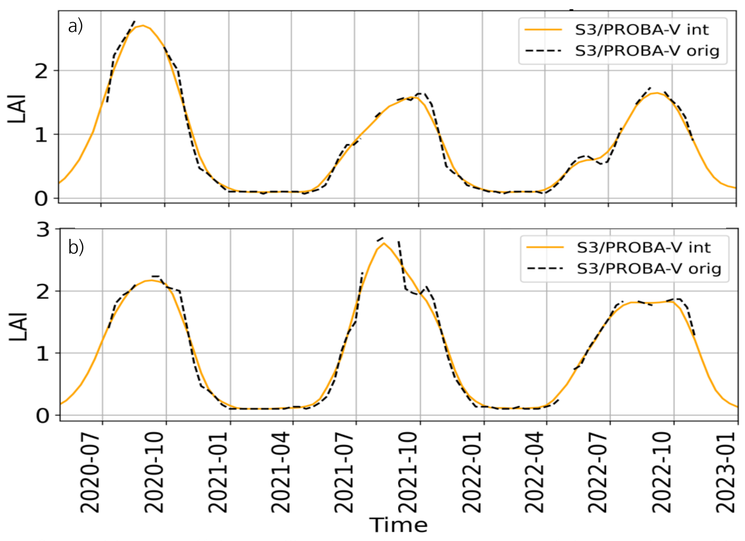

Fig. 5: Original (black) and interpolated (orange) S3/PROBA-V LAI timeseries for a) a cropland pixel and b) a grassland pixel close to the Janga research site.

Analysis of S2 LAI processing

- **Cloud masking** is **not sufficient**, LAI values erroneously calculated for original (not interpolated) LAI for **cloud boarder and shadow pixels** (Fig. 2b).
- **Clouds still visible** in spatially interpolated product (Fig. 2c) and as unexpected **drop in LAI timeseries** values during main **vegetation period** (Fig. 4).

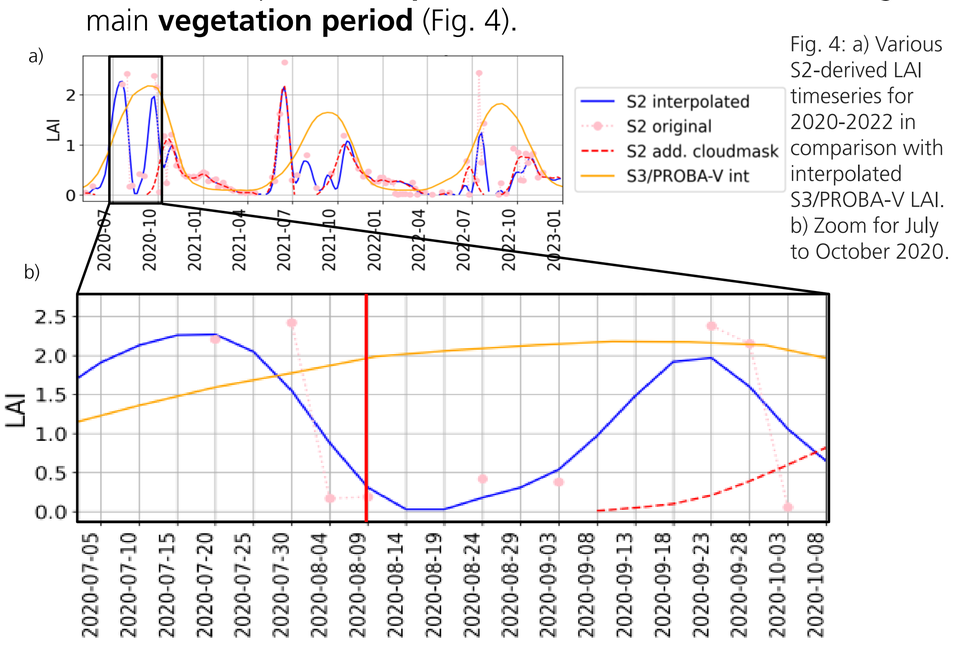

Fig. 4: a) Various S2-derived LAI timeseries for 2020-2022 in comparison with interpolated S3/PROBA-V LAI. b) Zoom for July to October 2020.

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).

Frantz, D.; Haß, E.; Uhl, A.; Stoffels, J.; Hill, J. (2018). "Improvement of the Fmask algorithm for Sentinel-2 images: Separating clouds from bright surfaces based on parallax effects". Remote Sensing of Environment 215, pp. 471-481.

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.

Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center

Contact: **Verena Huber García**
German Aerospace Center (DLR)
Earth Observation Center (EOC)
German Remote Sensing Data Center (DFD)
Oberpfaffenhofen
82234 Weßling
Tel.: +49 8153 28-3926
verena.hubergarcia@dlr.de