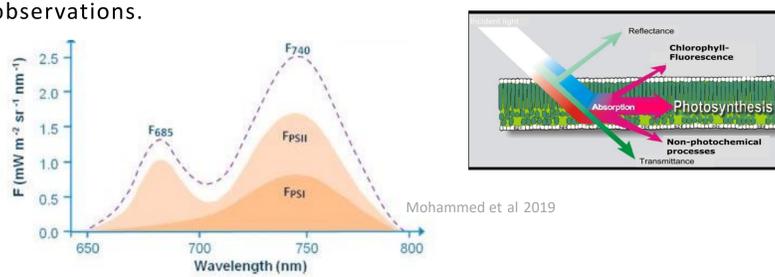


3DforestSIF - Understanding the solar-induced fluorescence signal of natural, complex tree canopies from the combined use of LiDAR and spatial high-resolution optical, and hyperspectral image data with 3D radiative transfer modelling

Introduction

- Sun-induced chlorophyll fluorescence (SIF) is an innovative remote sensing signal directly linked to the photosynthesis efficiency.
- Remote sensing of SIF enables the monitoring of vegetation photosynthetic activity and related stress across a range of scales—from in-situ measurements to satellite observations.
- The airborne imaging spectrometer HyPlant provides SIF image data of forests at meter-scale resolution, bridging the gap between ground and satellite-based SIF observations.



Challenge

SIF measured at the canopy level is different from SIF emitted by leaves or photosystems due to the confounding effects of illumination, scattering and reabsorption. Therefore, SIF cannot be directly interpreted as a physiological signal that reflects the actual photosynthetic performance of plants.

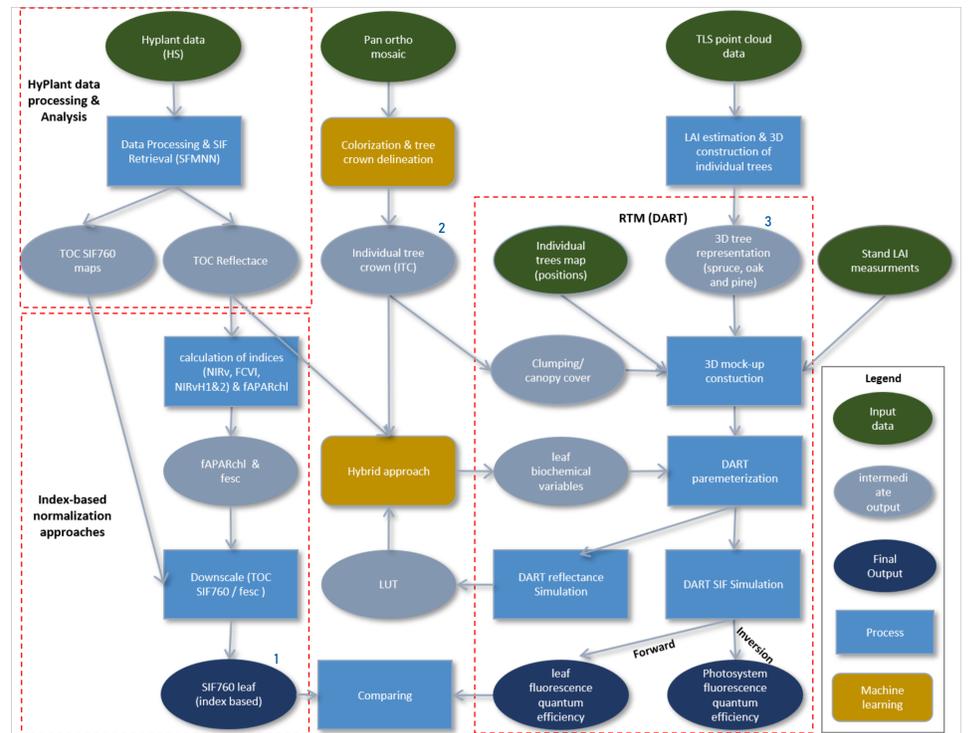
Objectives

- **3DforestSIF** aims to develop a novel SIF normalization method that scales the canopy SIF signal (SIF TOC) recorded by HyPlant down to the leaf level.
- Leaf-level SIF serves as an indicator of forest photosynthetic activity and has the potential to be used as an early warning signal of abiotic/biotic stress.

Case Study & Data Acquisition

The **3DforestSIF** dataset was collected over parts of the Kranzberg Forest, a mixed beech–spruce forest located north of Munich. High-resolution reflectance and SIF (HyPlant), full-waveform LiDAR (Riegli LMS Q-780), and panchromatic imagery (Point Grey Grasshopper) were recorded on 18th June 2023. In addition, terrestrial laser scanning (TLS) data were acquired using a Riegli TLS device at the site.

Methodology

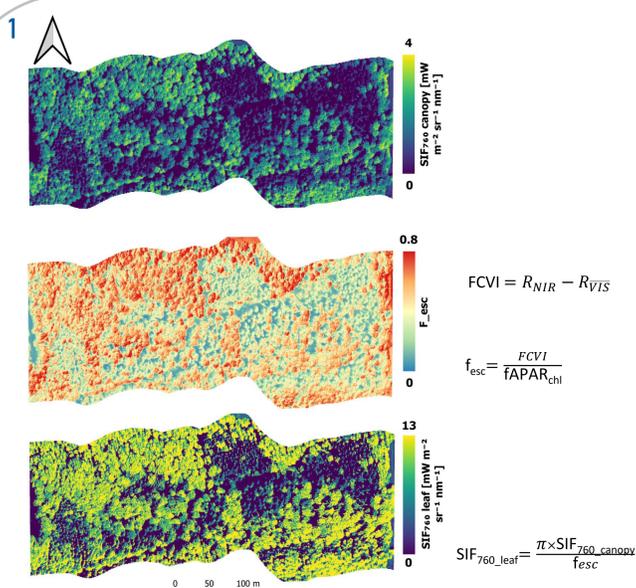


Intermediate results 1, 2, and 3 illustrate the current results using the developed methodology, as presented in the Results section. TLS: terrestrial laser scans, LUT: Look-up table, TOC: Top-of-canopy, DBH: Diameter at Breast Height

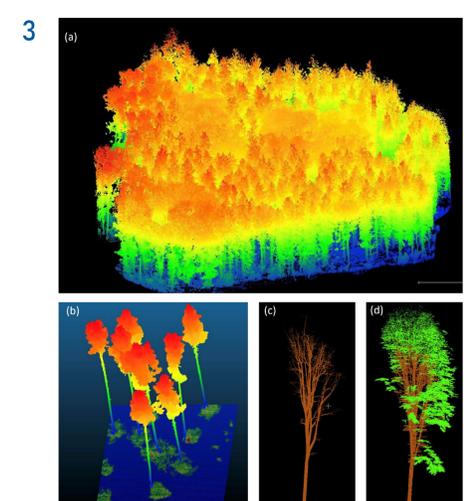


HyPlant DUAL top-of-canopy reflectance mosaic displayed as true color composite

Results



Spatial dynamics of the canopy SIF₇₆₀, SIF₇₆₀ escape fraction (f_{esc}), and leaf-level SIF₇₆₀ covering parts of the study site.



Virtual representation of a deciduous tree based on TLS data from the Kranzberg forest site: (a) pre-processed TLS point cloud, (b) TLS point cloud of separated individual trees with leaf density projected on the ground, (c) AdQSM-reconstructed woody parts, (d) The tree populated by spatially explicit leaf objects.