

PhD Thesis

Understanding the relation between photosynthesis and sun-induced chlorophyll fluorescence (SIF) of forests

Photosynthesis is unfortunately not measurable directly on scales greater than a single plant. The lack of predictability of future photosynthesis is thus one of the largest uncertainties in climate projections (IPCC, 2021).

Chlorophyll fluorescence is an afterglow of photosynthesis and hence tightly linked to **Gross Primary Productivity (GPP)**. **Sun-induced chlorophyll fluorescence (SIF)** has become the quasi-reference in studies of the carbon cycle and the response of GPP to environmental cues, on the simple basis that remotely-sensed SIF from satellites correlates well with GPP estimated on eddy covariance flux towers on a weekly to monthly scale. Several satellite missions that target SIF are to be launched in the near future such as ESA's FLEX mission scheduled for 2026. Large-scale GPP can otherwise not be measured directly and not be determined from satellite observations. However, the correlation between GPP and SIF breaks down completely for daily and diurnal observations and the simplified concepts to describe SIF from forest canopies are not valid anymore on such short timescales.

Objective: The PhD project will use **model-data fusion** to **understand mechanistically** the observed signal of **SIF above forest canopies and its link with GPP** of the ecosystem. It will **measure for the first time active and passive SIF within a forest** canopy, making it possible to describe mechanistically other loss processes in the photosynthesis apparatus. The PhD will **model photosynthesis and SIF** mechanistically **and** with a **radiative transfer within** the **canopy** with different optical properties for photosynthetically active radiation and for SIF. By **teaming up with** the research **project FLORES**, which will **codevelop** the **first drone-based SIF** instrument for proximal remote sensing, the project will be able to upscale local above-canopy SIF observations to the whole ecosystem and link it with ecosystem GPP. This will **make** the fast variations of **SIF available to study ecosystem photosynthesis** and its responses to fast environmental changes such as heat waves.

Profile: We are seeking a motivated candidate that likes to combine biology with physics, i.e. combining biochemical modelling at the leaf level with physical modelling at the canopy scale. They should have strong computer skills, an aptitude for physics, and are keen to actively participate in measurement campaigns. There should be an interest in research related to climate change and an affinity to work with international partners.

Time and Place: The thesis will take place for three years at the [UMR Silva](#) on the campus of [INRAE](#) near Nancy (54280 Champenoux) from autumn 2026 onwards.

Applications: send a cover letter, a CV, the transcript of grades of the master (or of the 3 years of engineering school), a contact information of an academic reference, as well as a résumé (300 words) of the master topic (or of the end-of-study internship).

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Detailed information: [PhD SIF long en.pdf](#)