

Innovative Optical Tools For Proximal Sensing  
Of Ecophysiological Processes

# Intro papers review “Good practice for SIF measurements”

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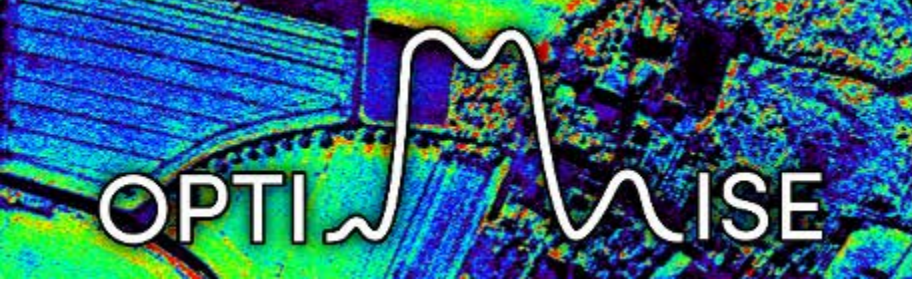


COST is supported by the EU  
Framework Programme Horizon 2020



## SUMMARY

- MOTIVATION
- AIMS OF THIS WORKSHOP
- SCOPE AND LIMITS OF THIS WORK
- PAPER 1: SENSORS
- PAPER 2: PROTOCOLS
- PAPER 3: RETRIEVAL METHODS
- SCHEDULE OF THE WORKSHOP



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## MOTIVATION

**Uprising of Sun Induced  
Fluorescence**

FLEX mission development & success

**Field spectroscopy community  
traditionally sloppy**

(instruments and protocols)  
Measuring SIF IS NOT measuring  
“reflectance”

## RISK

**Interpretation and integration of SIF with  
photosynthesis**  
Cal/Val activities of the FLEX mission

## AIMS OF THIS WORKSHOP

- Define in 3 articles that summarize what should be done to ensure adequate measurement and retrieval of SIF signal

Sensors

Protocols

Retrieval  
methods

- Be able to start writing after the workshop



## SCOPE AND LIMITS OF THIS WORK

- Provide useful information to the community
  - Balance between perfection and applicability
- Add value to the review
  - Facilitate use of complex/un-usual practices?
- Set the limits
  - Leave, within/top of the canopy, plot, pixel...
  - Single point, imagers...
  - Most usual vs. newest methods, statistical...

## SCOPE AND LIMITS OF THIS WORK

- Provide useful information to the community
  - Balance between scientific and applicability
- Add value
  - Facilitate
- Set the limits
  - Leave, within a plot, pixel...
  - Single point, imagers...
  - Most usual vs. newest methods, statistical...

### MESSAGE:

We cannot measure SIF as  
we used to measure  
“reflectance” any more

# PAPER 1: SENSORS

- PAPER STRUCTURE

1. Spectroradiometer: general characteristics
2. Sensor calibration and correction models
  1. Spectral characterization and calibration
  2. Stray light
  3. Linearity
  4. Temperature
  5. Reference standard. Reflectance, transmittance and angular dependency

## PAPER 1: SENSORS

6. Radiometric calibration
7. Tracing of uncertainty
8. Things we did not consider but might be of importance

- OPEN QUESTIONS

- Sections to add / remove? Reorganize?
- Imagers?
- Propagation of Uncertainty?
- Subsection structure (Section 2)?



## PAPER 1: SENSORS

- SUBSECTION STRUCTURE (SECTION 2)
  - Describe the issue and relevance for spectroradiometry
  - Relevance for the measurement of SIF
  - Sensor model and characterization
  - Uncertainty propagation?



## Part 2: SIF and other spectral measurements across scales

### Aim:

- Harmonize measurements across researchers
- Investigate scalability and improve transferability

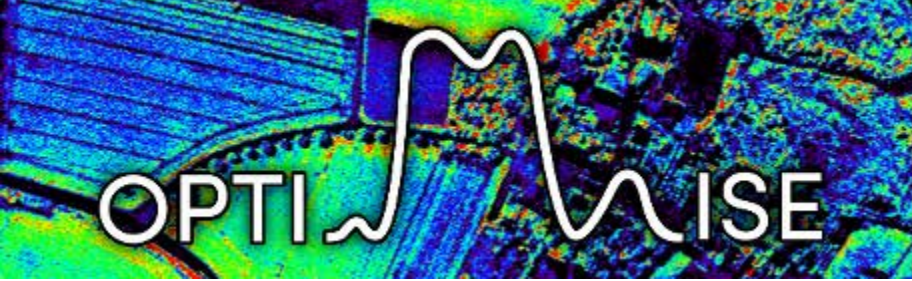
### Idea:

- Collect and discuss measurement types and protocols at different scales
  - Identify a best practice procedure
  - Define minimum auxiliary and metadata information to be provided with the data & to be published with result
- Address issues with the scalability from Leaf -> Canopy -> Field



# Part 2: SIF and other spectral measurements across scales

- 2.1 Leaf level
  - 2.2.1: General measurement concept [Helge, Luis]
  - 2.1.2. Leaf clip general [Luis & ?]
  - 2.1.3. Fluorwat [Luis]
  - 2.1.4. Preprocessing (either in each sub section or in the end)
- 2.2 Canopy level
  - 2.2.1: General measurement concept
  - 2.2.2: Single and dual beam system [Andreas B, AlasdairM]
  - 2.2.3. special case of hySceen [mapi and helge]
  - 2.2.4. Field set up [Micol, Yves, Marco, Cintya, Petya, MaPi]
  - 2.2.5. Preprocessing [eventually already covered by 1]
- 2.3 Field level
  - 2.3.1 Instruments [Alex, Anke ???]
- 2.4. Scaling
  - 2.4.1. Atmospheric influences [Neus, Luis Guanter] (Vertical scaling)
  - 2.4.2. Specific field of view [Helge] (instrument scaling)
  - 2.4.3. Spatial heterogeneity [Alex Damm, Andy H., Enrico] (horizontal scaling)
  - 2.4.4. Models for scaling
    - leaf to canopy [CvT, Zbynek]
    - landscape [Jochem]
- 2.5. Soybean case study(?) [MaPi, Helge, ...]
- 2.6. Metadata (auxiliary information) requirements [all and Andy, Helge]
- 2.7. Summary and outlook - what is needed



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## PAPER 3: RETRIEVAL METHODS

- **PAPER STRUCTURE**

1. Purpose of the paper
2. Retrieval problem
3. Review state of the art of Sun Induced Fluorescence (instruments and retrievals methods)
4. Practical cases – Retrieving Sun Induced Fluorescence
5. Outlook/challenges



# PAPER 3: RETRIEVAL METHODS

- PAPER STRUCTURE

## Section 2 - Retrieval problem

1. Disentangling fluorescence from reflected radiance
2. Terminology/nomenclature
3. Accurately describe the radiative transfer in coupled atmosphere-surface systems
4. List of the effects to be considered (atmospheric absorption/scattering effects, topography, Sun position)

# PAPER 3: RETRIEVAL METHODS

## Section 3 - Review state of the art of Sun Induced Fluorescence (instruments and retrievals methods)

1. Instruments (more suited instruments – higher FWHM, SNR)
2. Retrievals methods
  - A. Summary Meroni et al 2010 paper (reflectance based method, FLD)
  - B. Consolidated method (focus on retrievals of  $F_{680}$ ,  $F_{760}$ , and full emission shape)
    - a. Empirical/statistical (singular vector decomposition) (Guanter et al. 2012, RSE)
    - b. Semi-empirical (iFLD) (Damm et al. 2014, RSE)
    - c. Physical based I (Spectral Fitting Method) (Cogliati et al. 2015 RSE)
    - d. Physical based II (Neutral Atmosphere) (Sabater et al. 2015, IGARSS)

# PAPER 3: RETRIEVAL METHODS

## Section 4 - Practical cases: Retrieving Sun Induced Fluorescence

1. FLD retrievals methods (3FLD, iFLD) – Selection of wvl inside and outside absorption bands.
2. Sensitivity to Spectral resolution
3. Sensitivity to Spectral shift
4. Sensitivity to SNR

### How to do this?

- One already existing data set – LED measurements high spectral resolution (QE-pro)
- Modify the data set (resampling, artificial shift, artificial noise)
- Retrieve fluorescence for all modifications with consolidated retrievals methods

## PAPER 3: RETRIEVAL METHODS

### Open Questions:

1. Selection of wvl inside and outside absorption band  
– **only 3FLD and iFLD?**
2. Sensitivity to: spectral resolution, spectral shift, SNR  
– **all consolidated retrievals methods (SVD, 3FLD, iFLD, SFM, SFM-Atm)**
3. **Best way to do “practical cases”?**
  - > We (Sebastian and MaPi) modify the data set
    - a. Give it to the experts of each retrieval method.
    - b. Use a unique code (R code developed by Tommi - limited to 3FLD, iFLD, SFM-Specfit).
4. **Only point sensors or imagers too?**



# SCHEDULE OF THE WORKSHOP

- **Today:** Short presentations on paper's topics
  - OVERVIEW: SHARE IDEAS/ISSUES TO BE DISCUSSED LATER
  - DINNER: Moved to 20:00
- **Tomorrow** afternoon (CETAL)
  - COMPLETE DISCUSSION ON PAPER 1 (**clear/realistic paper structure & who is doing what?**)
- **Tomorrow** afternoon (after CETAL)
  - SMALL GROUPS ORGANIZE PROPOSAL FOR PAPERS 2&3
- **Wednesday** morning
  - FINISH DISCUSSION ON PAPERS 2&3 (**clear/realistic paper structure & who is doing what?**)
  - SUMMARY