

# FLEX-Fluorescence 2026 Workshop

03 – 06 March | Bonn University, Germany



## FLEXvalGER – in situ, UAV, Airborne & Satellite Validation of FLEX L1C-L2C Products in Germany

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# Project Partners



universität freiburg



UNIVERSITÄT  
LEIPZIG



Forest in-situ+UAV

Crop in-situ+UAV

Airborne – all sites

Satellite – all sites

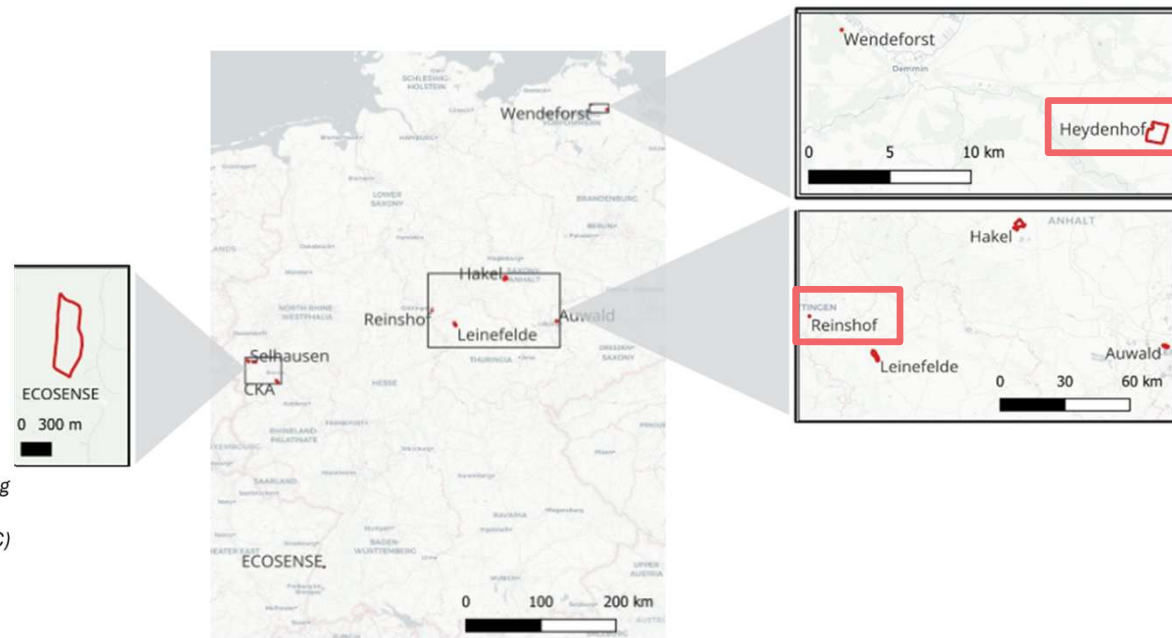
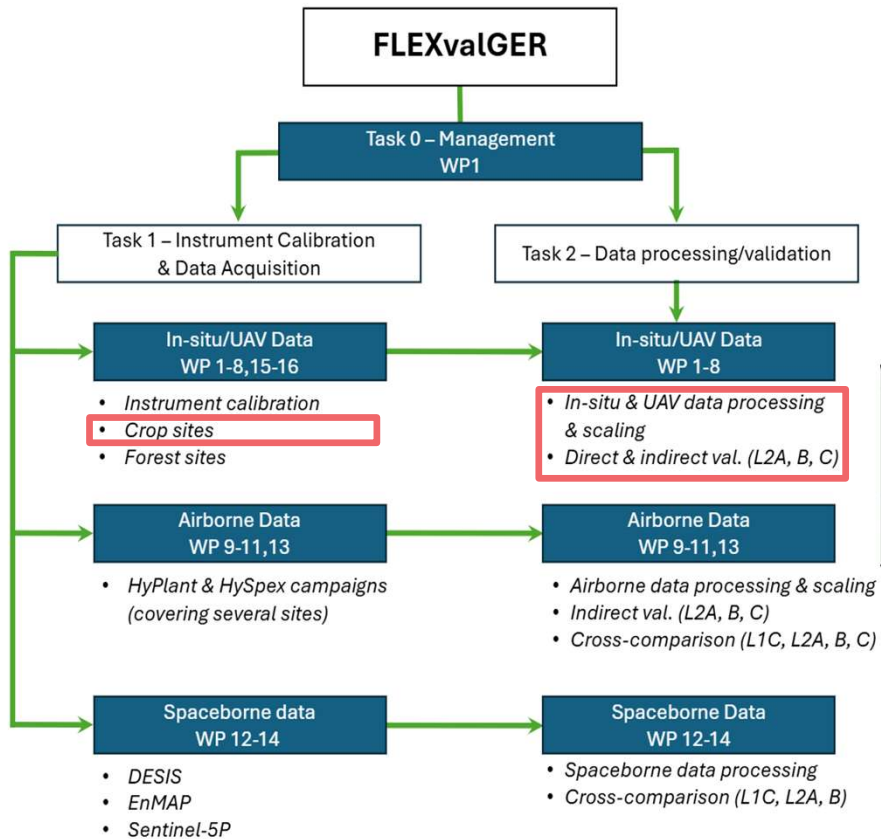
Instrument calibration

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# Work Packages – crops – in-situ/UAV



# Work Packages – crops – in-situ/UAV



- **FZJ – CKA, Selhausen, Morschenich:**

- <4 m FloX towers, next to EC tower (Selhausen – ICOS DE-RuS)
- mobile FloX, UAV AirFloX
- MONI/MICRO-PAMs, LAI, LCC, LCARC



- **UniGö - Reinshof:**

- 2 m FloX tower, next to EC flux tower
- LAI, leaf fluorescence, UAV multispectral+thermal

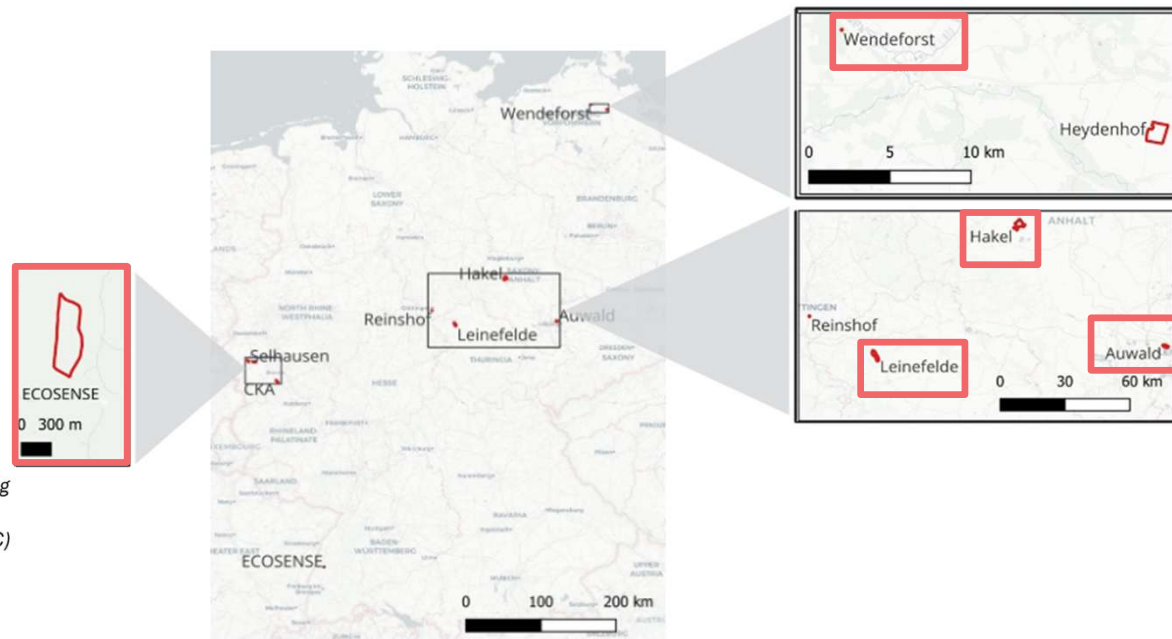
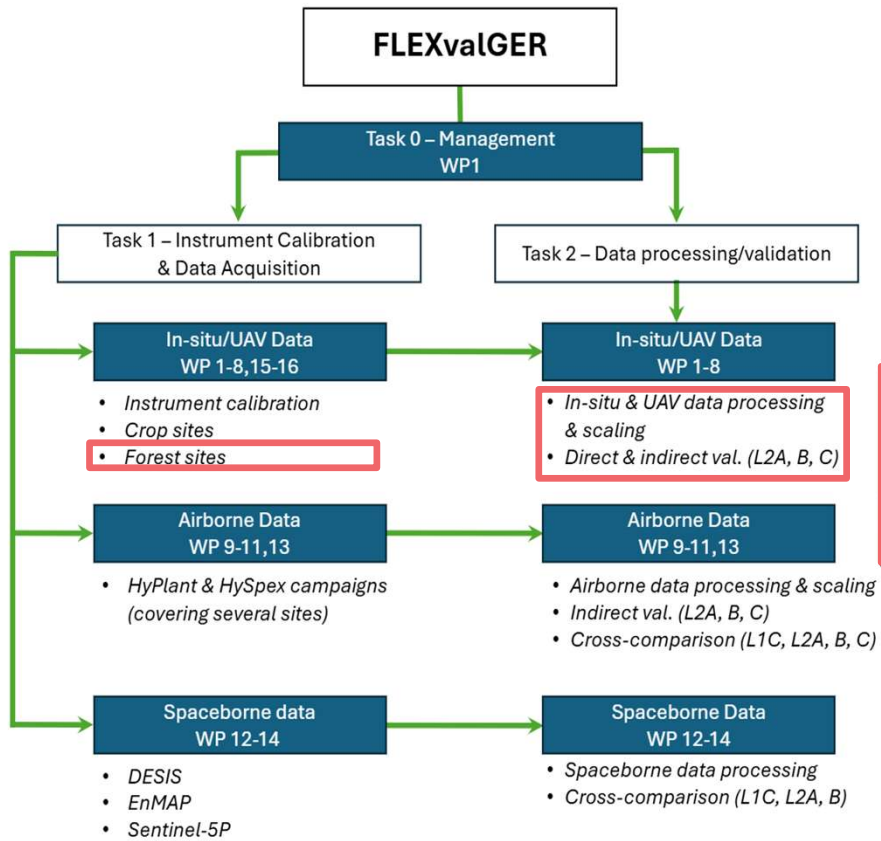


- **GFZ - Heydenhof:**

- HYPSTAR, atmospheric parameters, LAI, LCC, LST
- UAV HySpex (hyperspectral) and FluorSpec (SIF)
- Leaf fluorescence (LI-6800)



# Work Packages – forest - in-situ/UAV

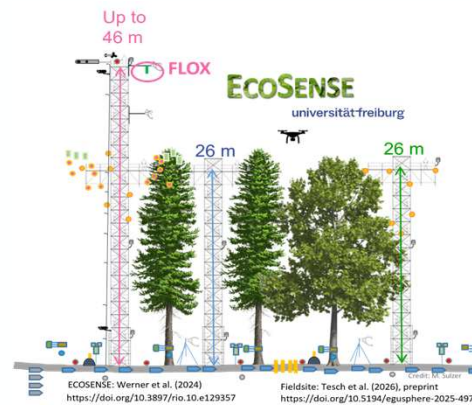


# Work Packages – forest – in-situ/UAV



## • UniFr - ECOSENSE:

- FloX on 46 m EC flux tower
- PAM, LAI, leaf pigments
- UAV LiDAR, multispec, thermal, digital site modeling
- planned atmospheric monitoring



## • UniGö - Leinefelde:

- FloX on EC tower
- PAR, fAPAR, LAI, leaf fluorescence, UAV multispectral+thermal

## • LU - Auwald:

- movable crane-mounted FloX (40 m)
- PAM, FLUOWAT, PAR, LAI, LCC, CARC

## • GFZ - Wendeforst:

- HYPSTAR & RoX movable crane-mounted
- UAV HySpex (hyperspectral) and FluorSpec (SIF), Leaf fluorescence (LI-6800)
- Atmospheric parameters

## • JKI - Hakel:

- LAI, fAPAR sensor network, UAV LiDAR & optical imagery

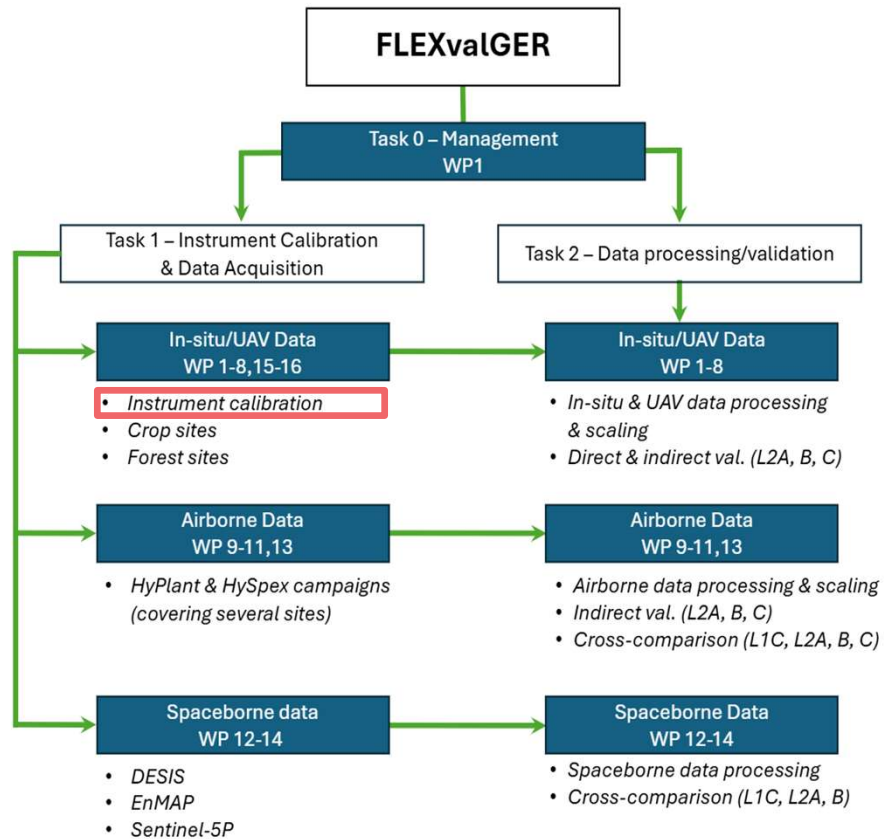


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# Work Packages – instrument calibration



## • JB Hyperspectral:

- On-site FloX calibration; MoMo real-time data links
- unified processing chain feeding INSIF network

## • Walz:

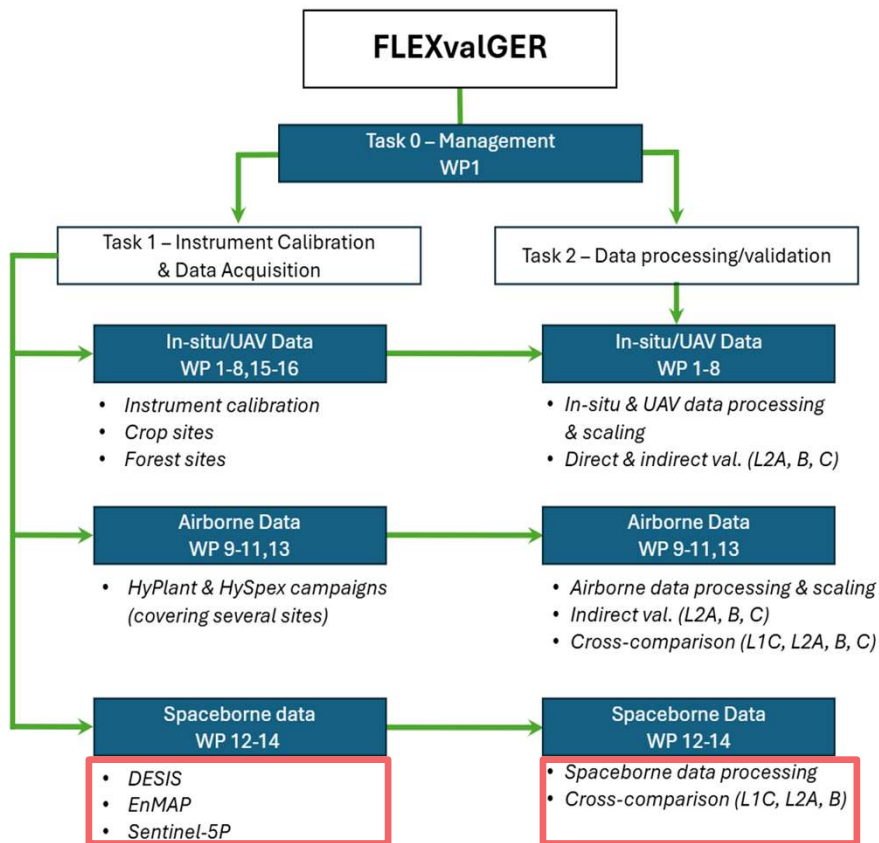
- Central PAM calibration laboratory, regular device cross-calibrations
- maintains calibrated loan units for continuous fluorescence measurements

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# Work Packages – spaceborne



## • DLR:

- DESIS & EnMAP match ups (weather, orbits, ground targets)
- FLEX spatial & spectral scaling & L1C/L2 product validation

## • DLR, Maitec, FZJ:

- O<sub>2</sub>A SIF retrieval HyPlant & DESIS (SFMNN) with uncertainties

## • MPI-BGC:

- Sentinel-5P/TROPOMI footprint-level L2 products incl. SIF, FQE & FLEX comparison
- Sentinel-2 NIRv to FLEX fesc comparison



# FLEX Products to be Validated



Data type	Core Science	Supporting Science	Experimental Science
L1	TOA reflectance	C FLORIS spec. central wavelength/FWHM	B
L2	FLORIS apparent reflectance	A,C Direct/diffuse irradiance	A
	SIF (O2A/B, peaks, peak positions, full spectrum)	A,C LCC, fAPAR fAPAR_chl, APAR_chl, LAI, LCARC	A RED, ETR, PSI/PSII A
		Land surface temperature	A FQE, fesc A, C
		Aerosol optical thickness, CWV	A Angstrom exponent, Asymmetry parameter A

Validation type (CEOS)

A: Direct validation (Satellite vs. in-situ comparison)

B: Indirect validation through numerical RTMs

C: Inter-comparison with space products

TOA: top of atmosphere, LCC: Leaf Chlorophyll Content, LAI: Leaf Area Index, fAPAR: Fraction of absorbed PAR, fAPAR\_chl: fAPAR by chlorophyll, APAR\_chl: absorbed PAR by chlorophyll, fesc: escape fraction of fluorescence, LCARC: Leaf Carotenoid Content, FQE: Fluorescence Quantum Efficiency, ETR: Electron Transport Rate (ETR), RED: Regulated Heat Dissipation (NPQ proxy), CWV: Columnar water vapor



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# Unique data from FLEXvalGER



## Multi-scale fluorescence data

- Concurrent Leaf, tower, UAV and airborne, satellite
- Complemented with spectral, structural, & in-situ reference data
- Spatial scaling to FLEX pixels

## L2 novel photosynthesis parameters

- FQE, ETR, RED, APARchl, fesc

## Cross-mission datasets tailored for FLEX validation

- Airborne & spaceborne hyperspectral data matched to FLEX spectral characteristics
- Spatial scaling from high-resolution airborne data to FLEX pixel size
- Characterized uncertainties

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