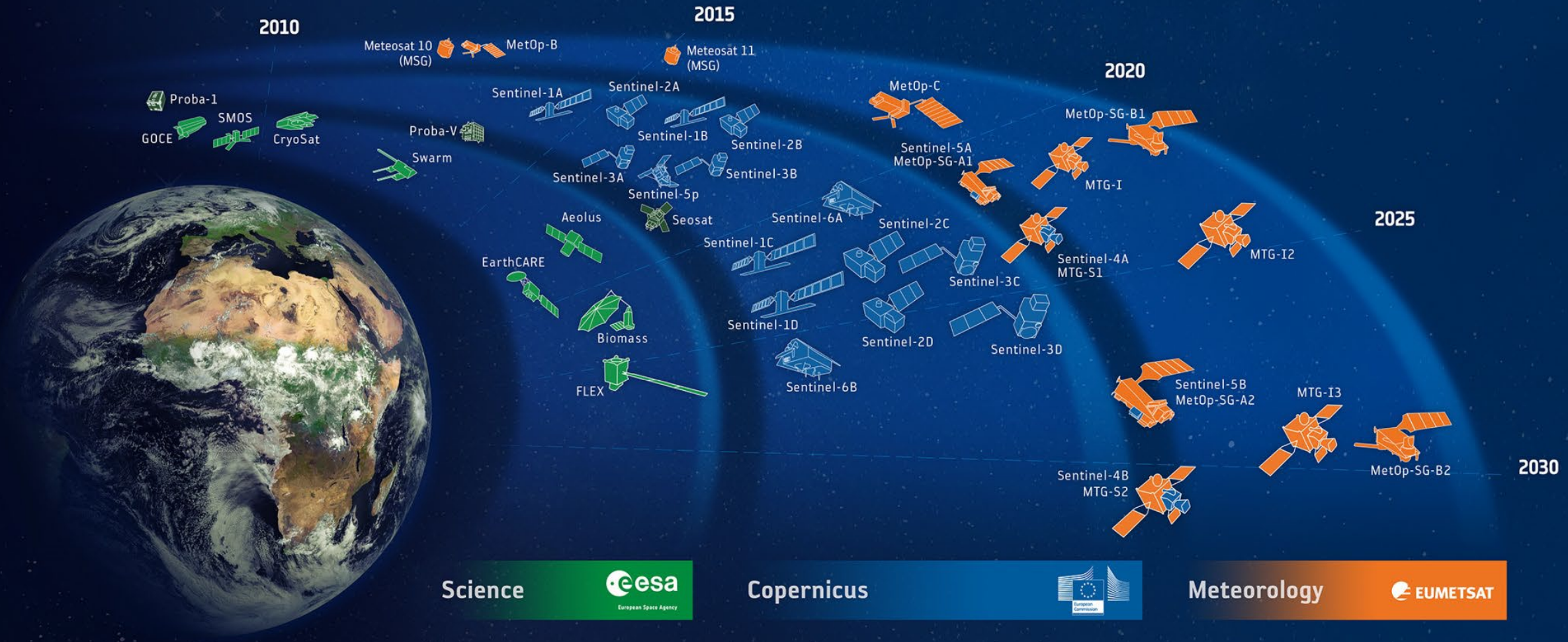
ESA Earth Explorers

for the “New EU Forest Strategy for 2030” and the urban green

Dr. Klaus Scipal

LPS 2022, Bonn, 25/05/2022

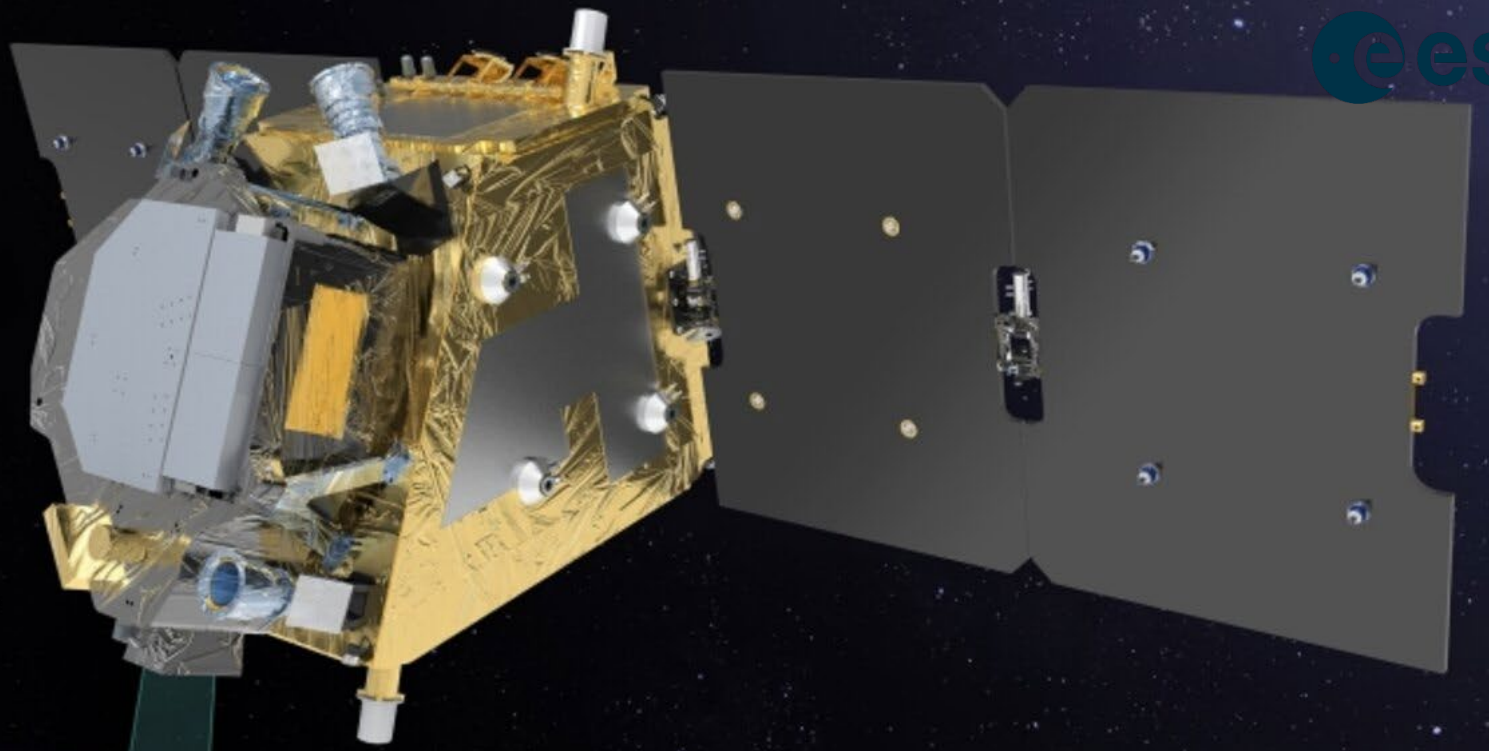
ESA–DEVELOPED EARTH OBSERVATION MISSIONS



www.esa.int

European Space Agency

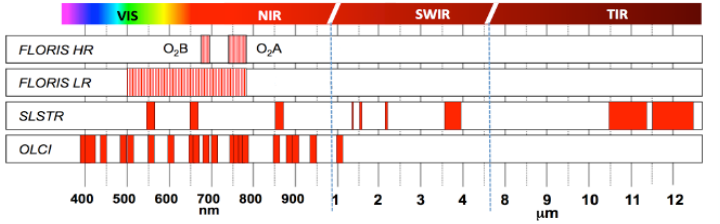
The FLEX mission



ESA's 8th Earth Explorer (FLuorescense EXplorer – FLEX) will be deployed in 2025
Will carry a high-resolution imaging spectrometer
Designed to provide global maps of vegetation fluorescence that can reflect photosynthetic activity and plant health and stress

The FLEX mission

Tandem Mission with S3



FLEX - ESA's photosynthesis mission will provide global measurements of vegetation fluorescence that will help to:

- quantify photosynthetic activity and plant stress by mapping vegetation fluorescence;
- advance our understanding of the photosynthetic machinery functioning and thus on the actual health and performance of terrestrial vegetation.

FLEX will **generate** monthly global maps with an on-ground **spatial resolution of 300 × 300 m²** and a **swath width of 150 km**.

The tandem flight with Sentinel-3 provides auxiliary measurements from OLCI and SLSTR on the atmospheric state and land-surface characterization, necessary for the fluorescence retrieval.

B. FLEX characteristics

Mission duration

- Commissioning phase 3 months
- Lifetime 3,5 years

Mission Orbit and Satellite Attitude

Tandem Flight ca.	100 km ahead of S3
Orbit Type	LEO, sun-synchronous
Altitude	814 km
Repeat Cycle	27 days
Acquisition time	10:00
Inclination	98.645 degrees
Attitude Control	3-axis stabilized, nadir

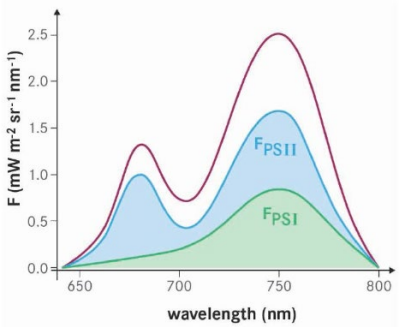
Flight Operations

ESOC via Kiruna

Expected Launch 2025

Mass

- Instrument 140 kg
- Satellite Dry Mass 450 kg
- Max Fuel Load 30 kg



Payload: FLORIS

High-resolution imaging spectrometer that will acquire data over **land, inland waters and coastal areas** in the **500-780 nm** spectral range, with a sampling of:

- **0.1 nm in the oxygen absorption bands** O2-A (759-769 nm) and O2- B (686-697 nm)
- 2.0 nm in the chlorophyll absorption band (600-677 nm) and Photochemical Reflectance Index band (500-600 nm) bands,
- 0.5-0.65 nm in the rest of the spectral range

What information we will get from FLEX

L1B – Top Of Atmosphere (TOA) radiances, from FLORIS instrument

L1C – FLEX and Sentinel3 synergy product (FLORIS+OLCI+SLSTR TOA radiances on a common grid)

L2A – data atmospherically characterized and corrected: TOC surface apparent reflectance, at-surface solar irradiance, cloud mask and retrieved atmospheric parameters (eg aerosols, water vapour).

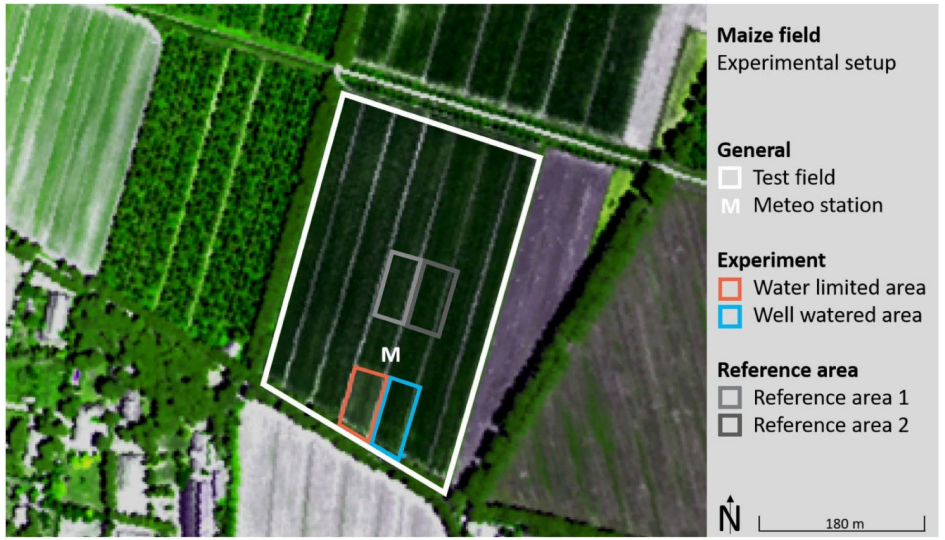
L2B – TOC real reflectances + SIF emission spectrum

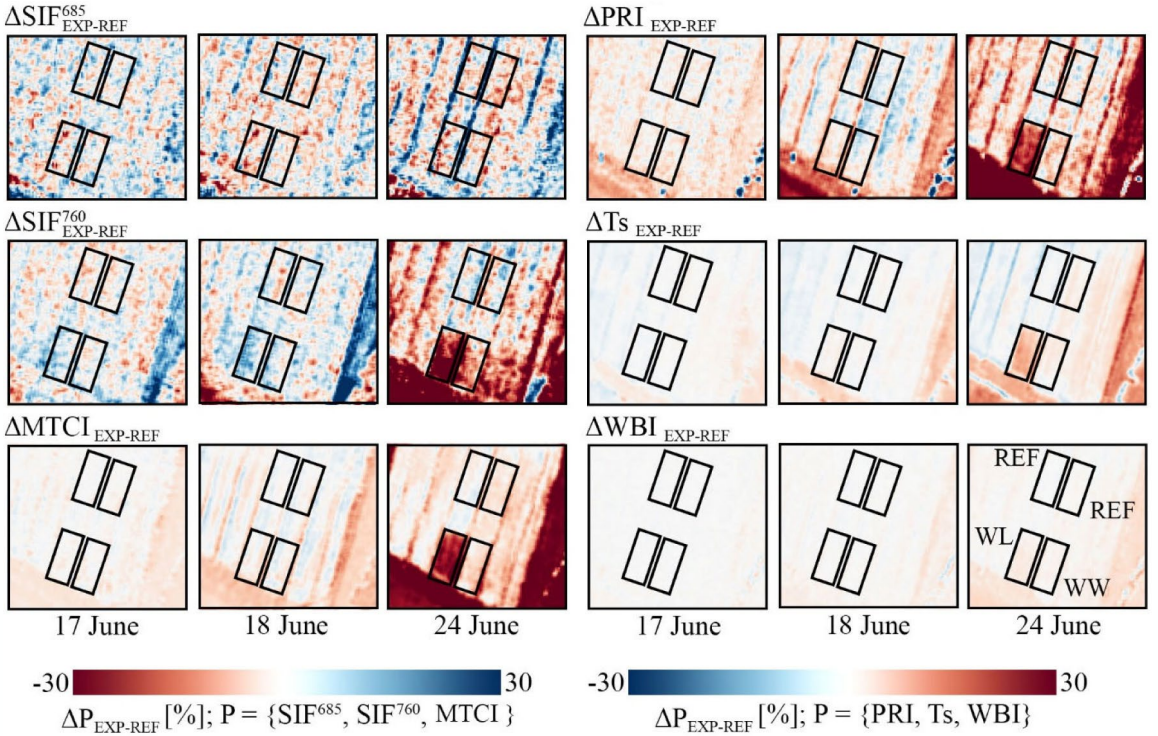
L2C – Biophysical products (e.g. Leaf Area Index, Non-Photochemical Quenching, Electron Transport Rate, …)

Water stress detection using fluorescence data

fluorescence can be used to track plant development and stress, and is considered the most direct measurement of photosynthetic activity available from remote sensing techniques

Water stress experiment during the FLEXSense 2019 FLEX preparatory campaign (corn field, Grosseto, Italy 2019



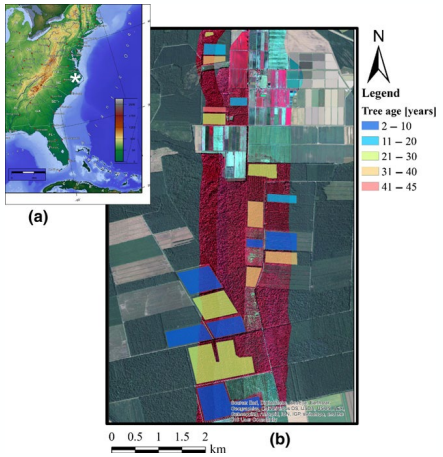


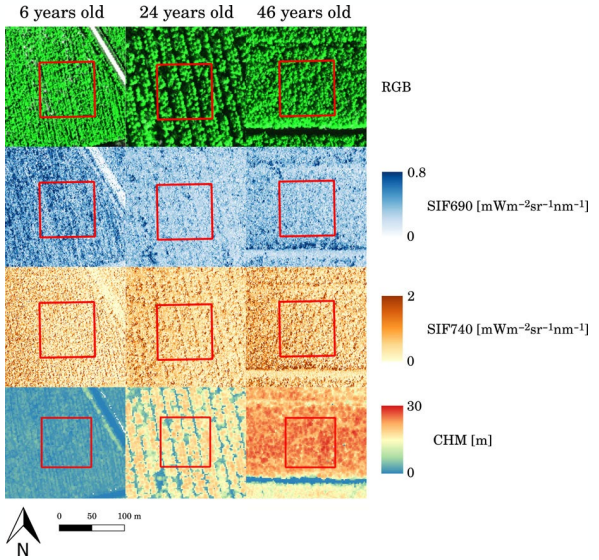
From *A. Damm, et al, Response times of remote sensing measured sun-induced chlorophyll fluorescence, surface temperature and vegetation indices to evolving soil water limitation in a crop canopy, Remote Sensing of Environment, Volume 273, 2022*

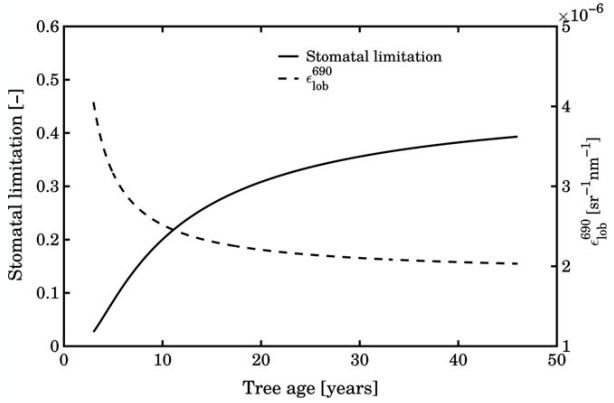
Forest related studies

Colombo R. et al, Global Change Biology 2018

SIF varies according to stand age



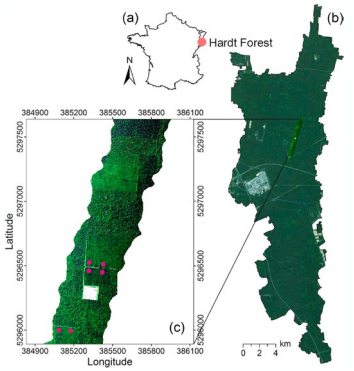


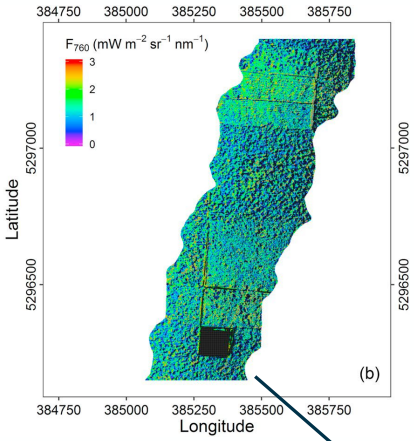


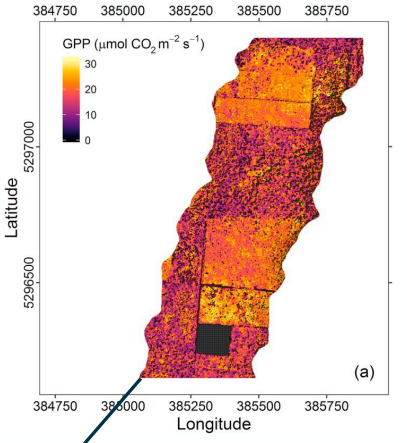
hydraulic limitation in older pines could reflect in a lower fluorescence emission compared to the younger trees, due to the reduced rates of photosynthesis

Tagliabue G. et al, Remote Sensing of Environment 2019

Far Red SIF provides insights in ecosystem variability







SIF correlates with GPP on spatial domain