

# Biophysical indicators derived from Sentinel-2

## Concept and methods

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Sen4CAP hands-on training, 22-23 January 2020



**sen4cap**  
common agricultural policy

**UCL**  
Université  
catholique  
de Louvain

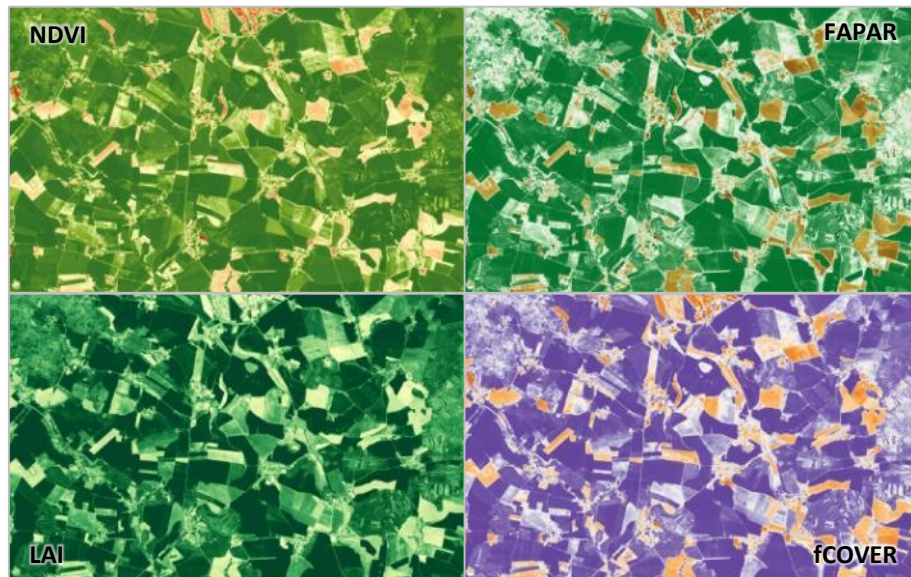
**CS**  
ROMANIA

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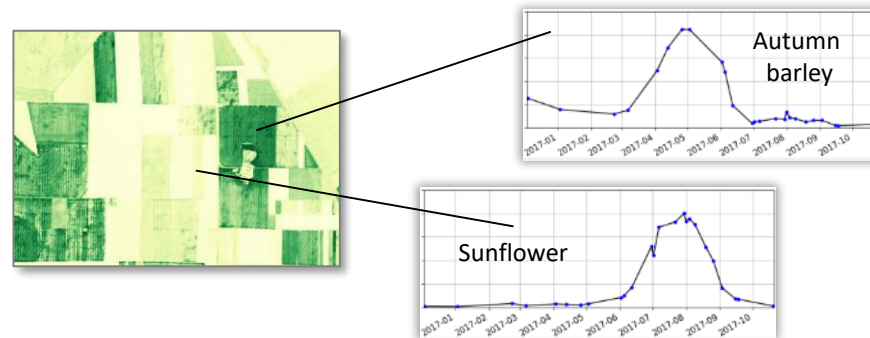
 **SINERGISE**

 **gisat**

4 indicators about the evolution of the green vegetation corresponding to the vegetative development of the crop



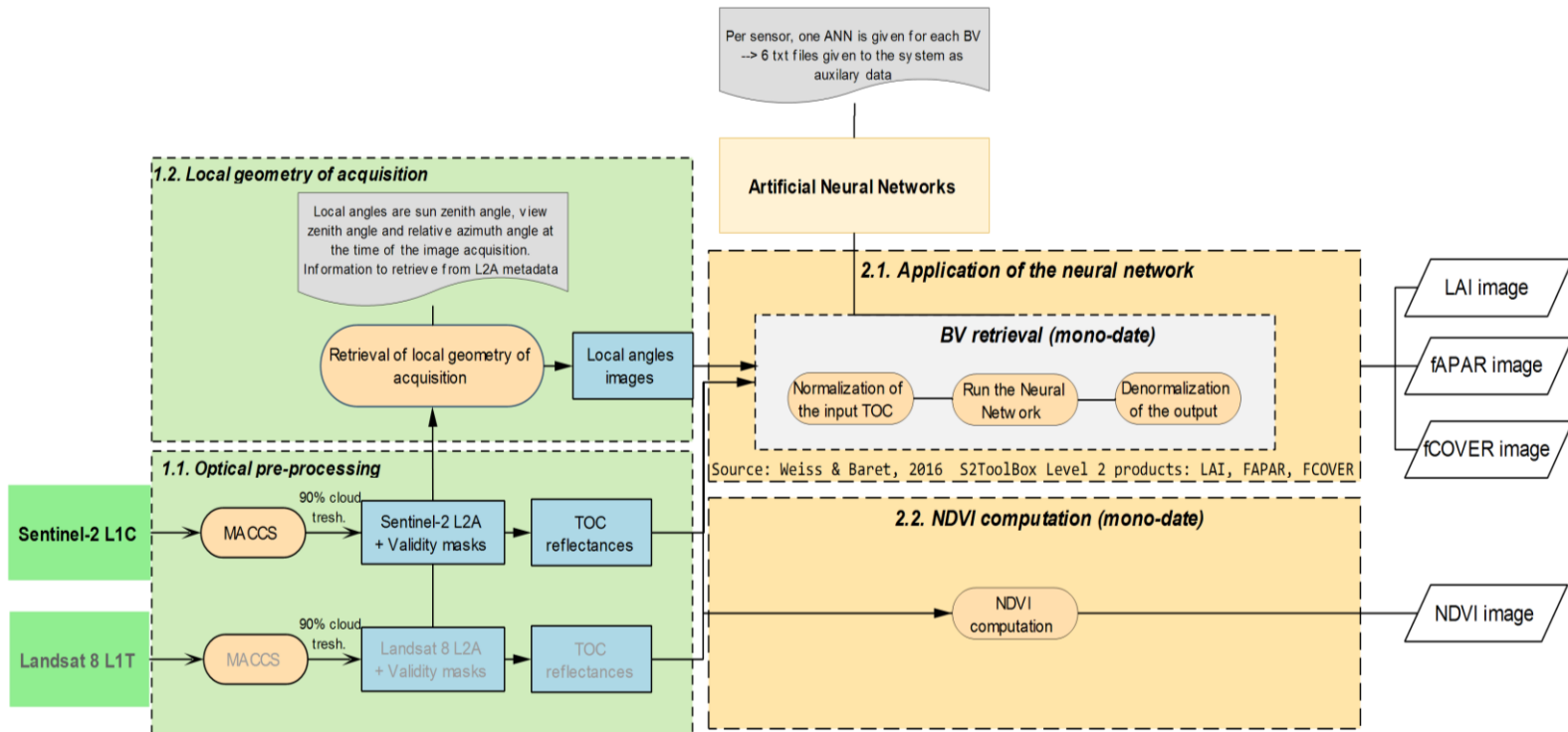
- **Normalized Difference Vegetation Index (NDVI)**, which is the most popular indicator operationally used for agriculture monitoring
- **Leaf Area Index (LAI)**, which determines the size of the interface for exchange of energy (including radiation) and mass between the canopy and the atmosphere
- **fraction of Vegetation Cover (fCover)**, corresponding to the fraction of ground covered by green vegetation
- **fraction of Absorbed Photosynthetically Active Radiation (FAPAR)** by the green and alive elements of the canopy



# Biophysical Indicator - Technical Specifications



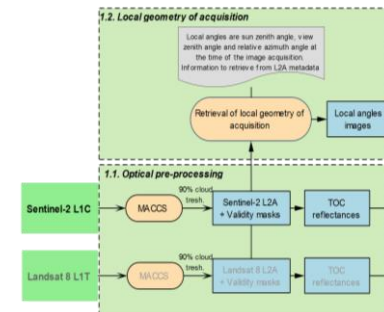
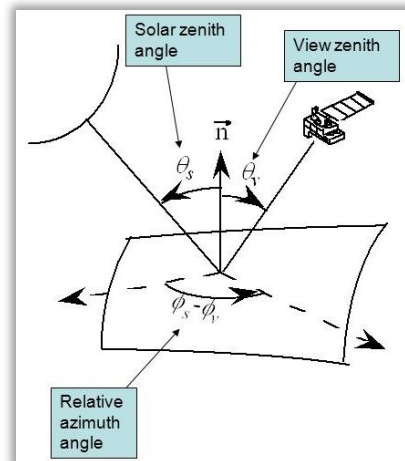
Format	Raster files in Cloud-Optimized GeoTiff
Input	<ul style="list-style-type: none"><li>• S2 (10m) and possibly L8 (30m)</li><li>• All available data of sufficient quality (cloud-free)</li></ul>
Spatial resolution	10 meters (pixel-based) + Visualization at the parcel-level through the visualization tool
Temporal resolution	Mono-date product: 1 product delivered at each acquisition
Quality flags	<ul style="list-style-type: none"><li>• 1 flag for the LAI retrieval uncertainty (pixel-based )</li><li>• 1 flag for the multi-date products about the number of available valid observations during the week</li></ul>
Metadata	.XML format
Projection	WGS84-UTM
Delivery time	1-2 days after the acquisition / week



- Optical pre-processing for S2 (and L8)
- All spectral bands are used, except the blue one

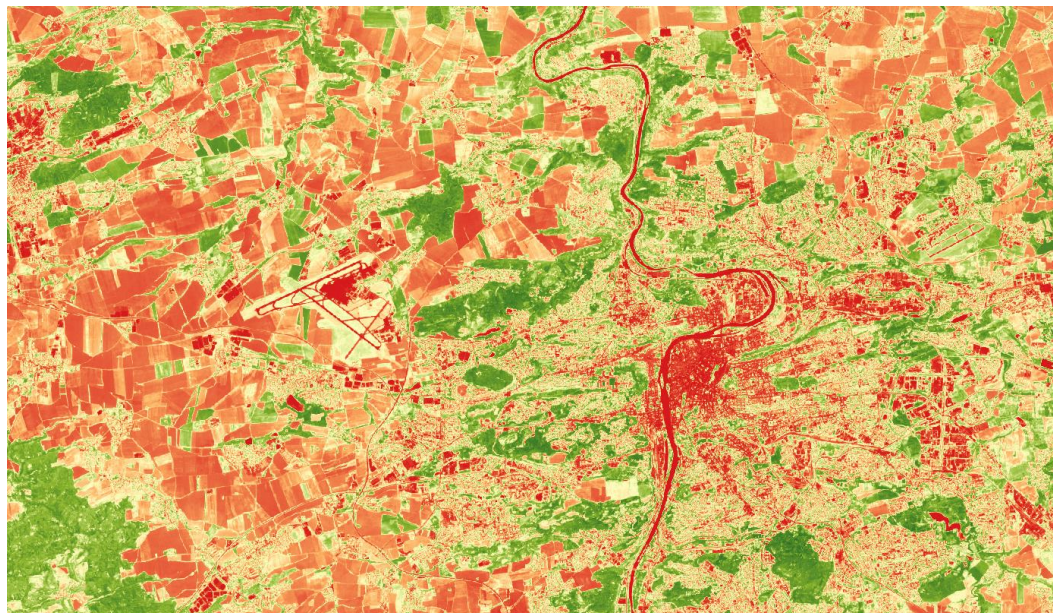
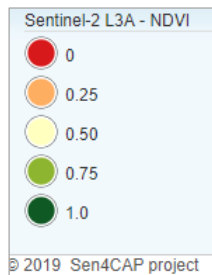
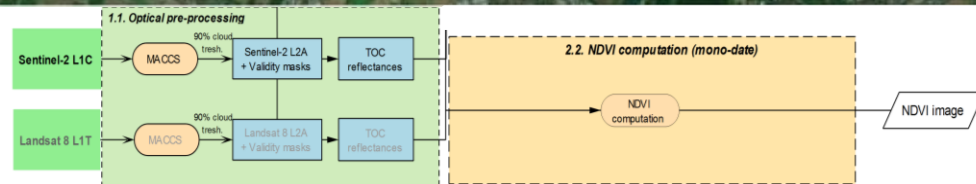
Acronym	Central wavelength (nm)	Width (nm)	Spatial resolution (m)	Band name
B3	560	35	10	Green
B4	665	30	10	Red
B5	705	15	20	Red edge 1
B6	740	15	20	Red edge 2
B7	783	20	20	Red edge 3
B8	842	115	10	NIR wide
B8a	865	20	20	NIR narrow
B11	1610	90	20	SWIR 1
B12	2190	180	20	SWIR 2

- Acquisition of the geometry
  - sun zenith angle ( $\theta_s$ )
  - view zenith angle ( $\theta_v$ )
  - relative azimuth angle ( $\varphi$ )



# NDVI computation

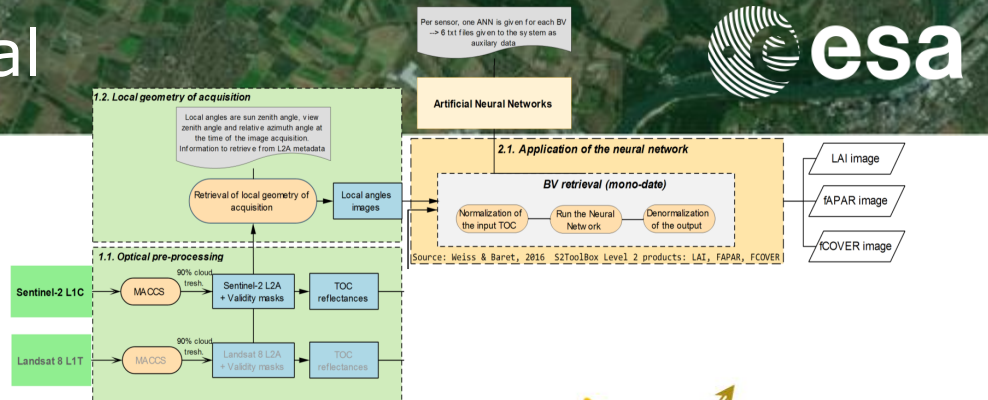
$$NDVI = \frac{\rho(NIR) - \rho(RED)}{\rho(NIR) + \rho(RED)}$$



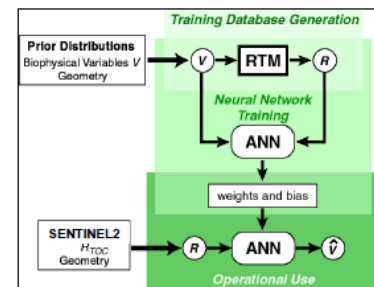
Prague (21 April 2018)

# LAI, FAPAR, FCOVER retrieval

- BV-NET approach developed by Weiss et al. (2002) from INRA

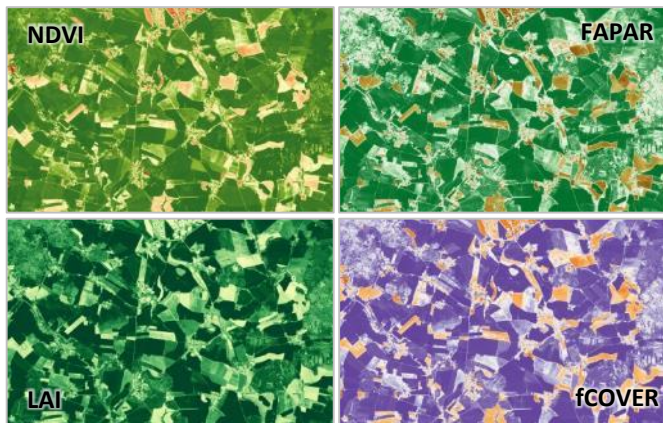


- PROSPECT&SAIL Radiative Transfer Model are used to simulate surface reflectance for a wide range of soils and vegetation
- The simulations are used to train a Artificial Neural Network for each of the 3 targeted biophysical variables
- The Neural Network is applied to real Sentinel-2 acquisitions
- It does not require in situ data for calibration



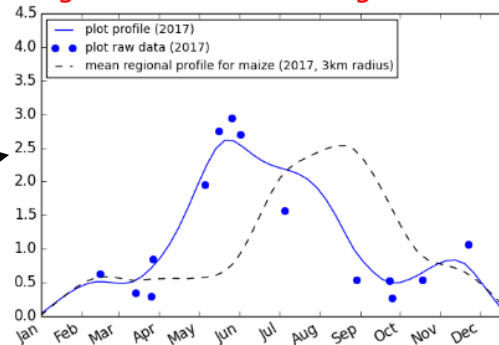
(Weiss et al., 2016)

# Biophysical indicators to further investigate the crop type labels

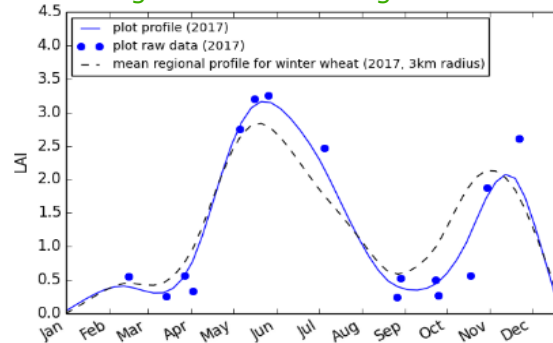


ID	NKOP_DPB	AREA	CONF_IDX	CT_DECL	CT_PRED_1	CT_CONF_1
5482	681104301/1	23275	0	Maize	Winter rapeseed	0,56
6581	665114804/1	18086	1	Winter Wheat	Grassland	0,25

High confidence in disagreement



High confidence in agreement



# System operation for crop growth monitoring : LAI, FAPAR and FCover products



Before the start of  
the monitoring period

Monitoring period

## System initialization

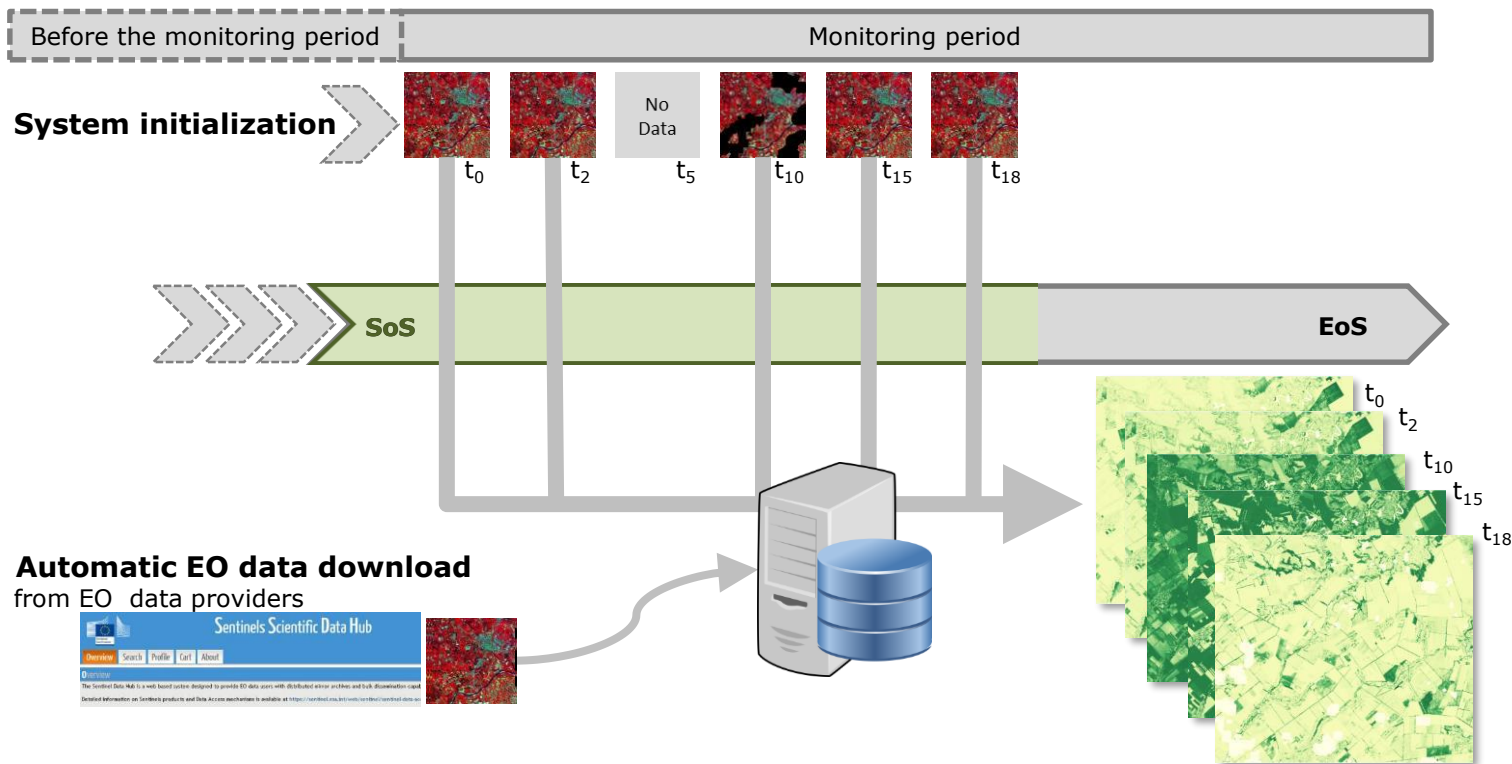


### Setting parameters

Area of Interest	Shapefile to be uploaded
Monitoring period	Start and end dates to be defined
S2 or S2+L8	To be ticked



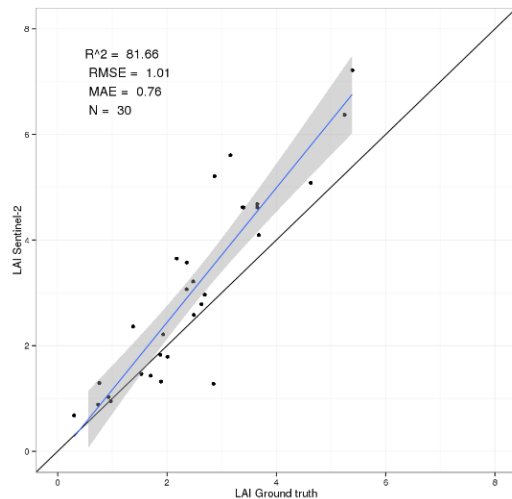
# System operation for crop growth monitoring : LAI, FAPAR and FCover products



# Examples

## Belgium

30 fields (wheat and potatoes)



6 Apr 18



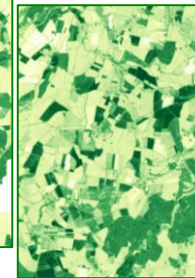
21 Apr 18



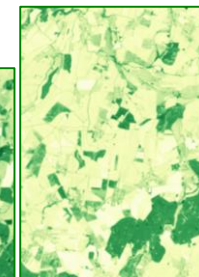
14 May 18



3 Jul 18



28 Jul 18



22 Aug 18

