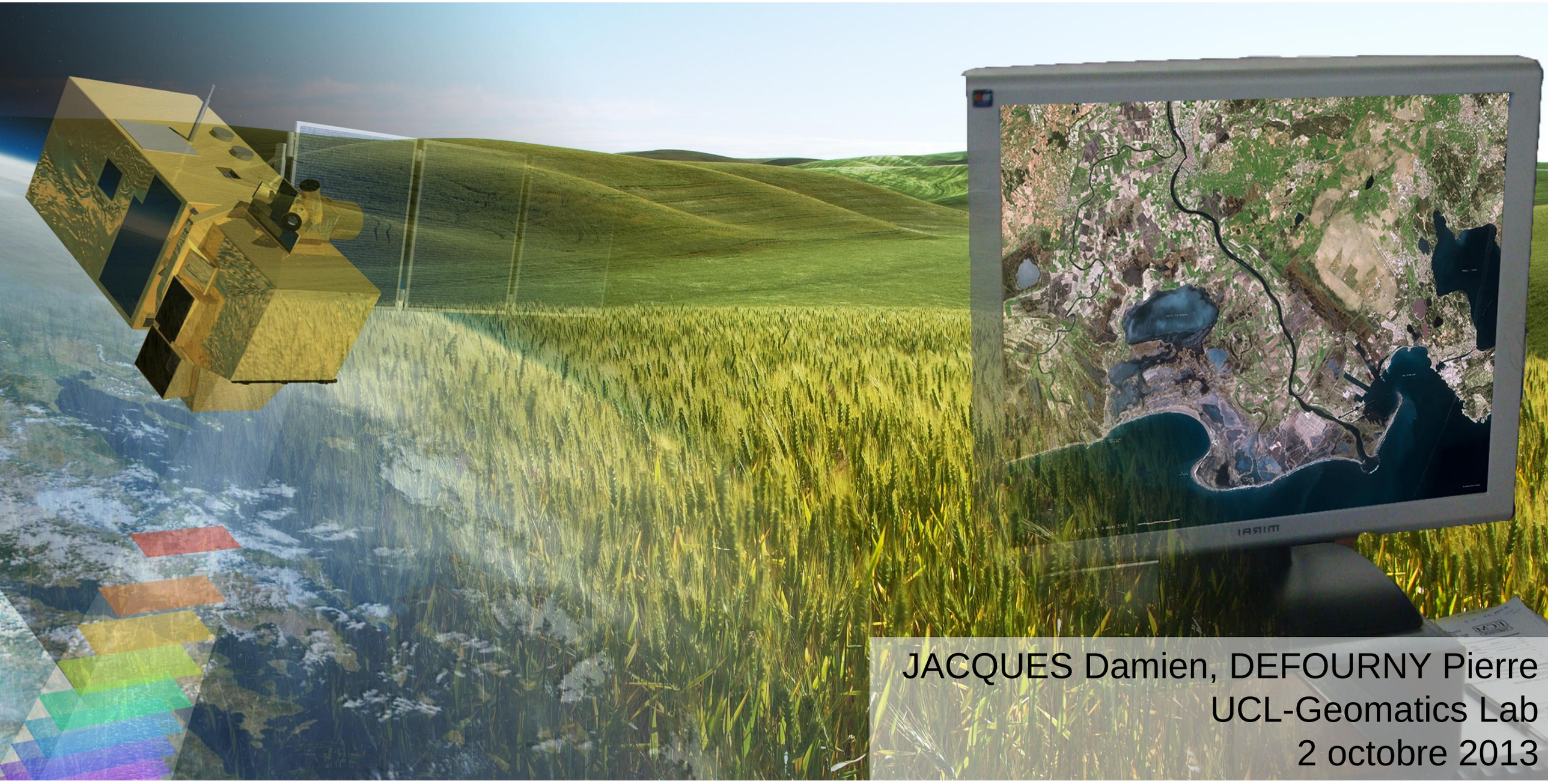
Preparing for the exploitation of Sentinel-2 data for agriculture monitoring



JACQUES Damien, DEFOURNY Pierre
UCL-Geomatics Lab
2 octobre 2013

Agriculture monitoring, why?

- Growing speculation on food market
- Climate change
⇨ *Price volatility (2008, 2012…)*

Critical need of early information on

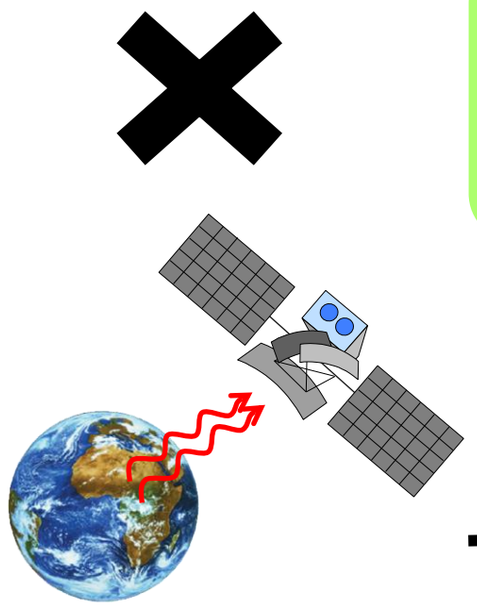
CROP PRODUCTION

AREA

LUCAS

YIELD

MARS



Crop mapping

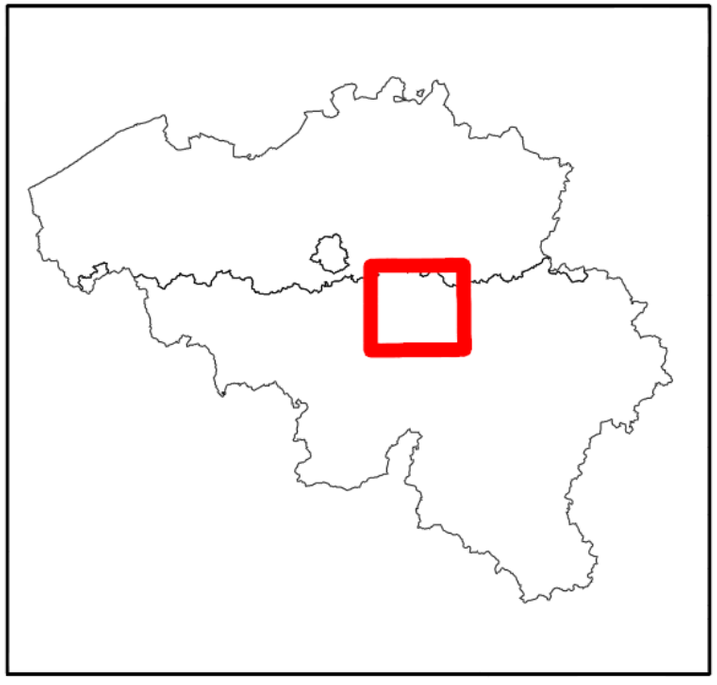
Biophysical variable retrieval

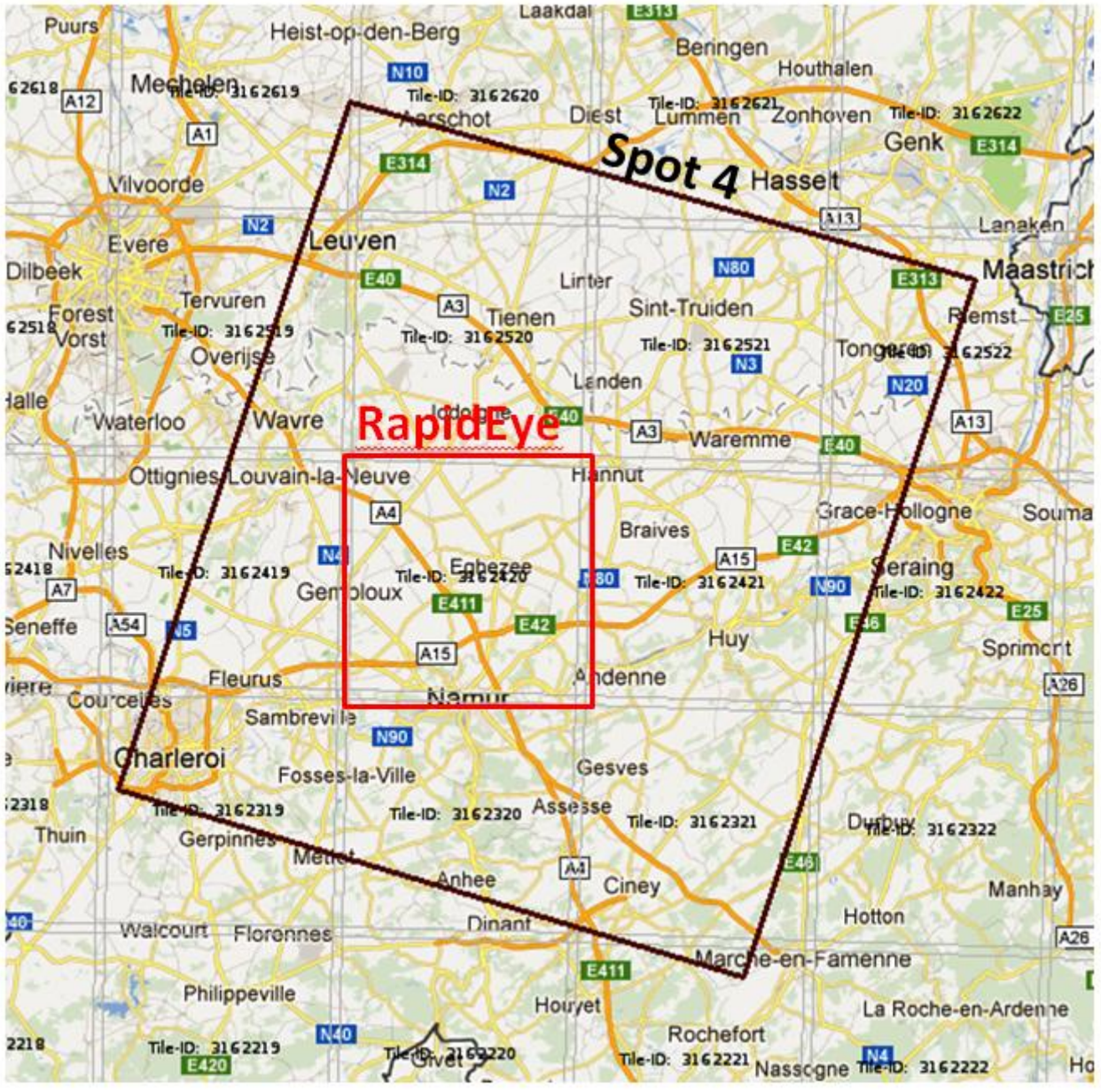
Study area in Loamy region in Belgium

Typical agriculture area

JECAM
Joint Experiment for Crop Assessment and Monitoring

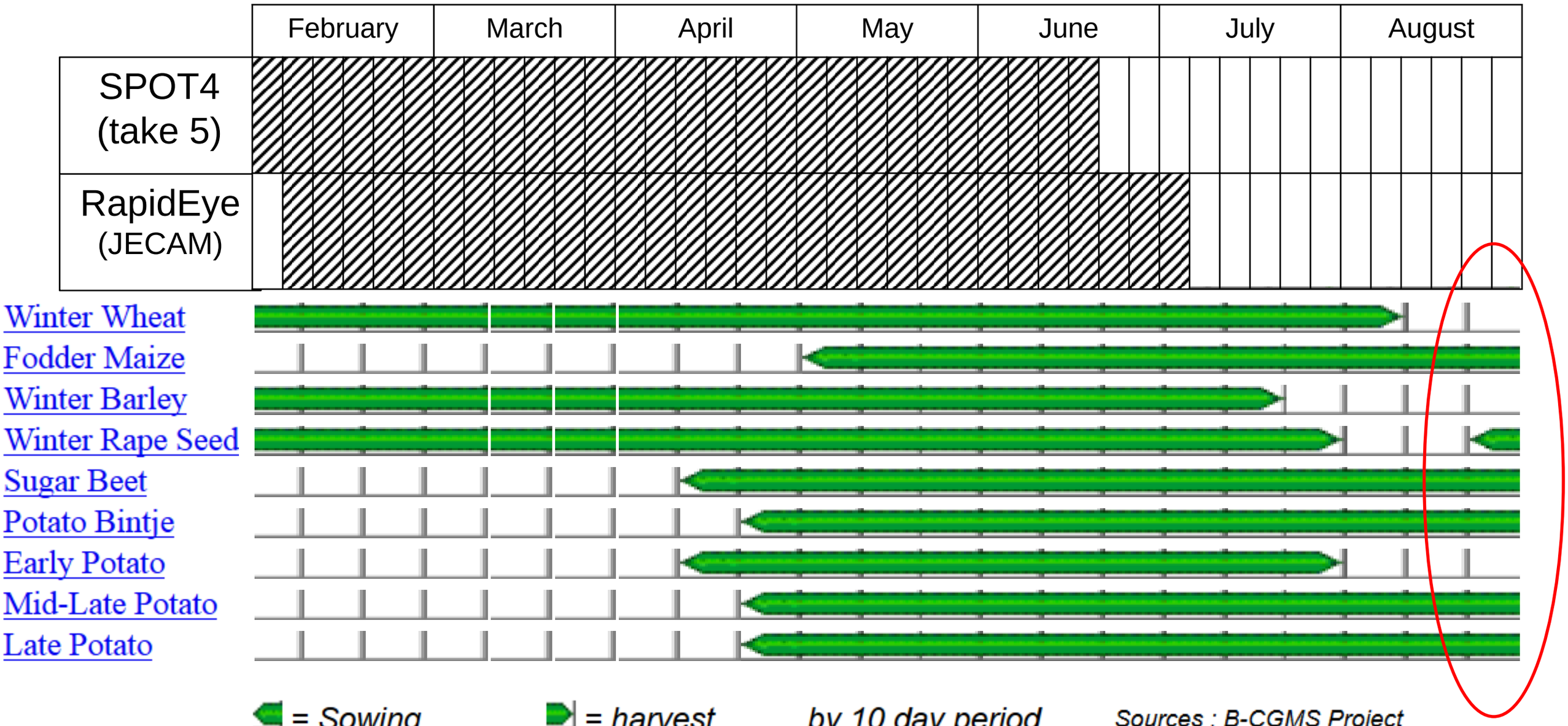
GEO GROUP ON EARTH OBSERVATIONS





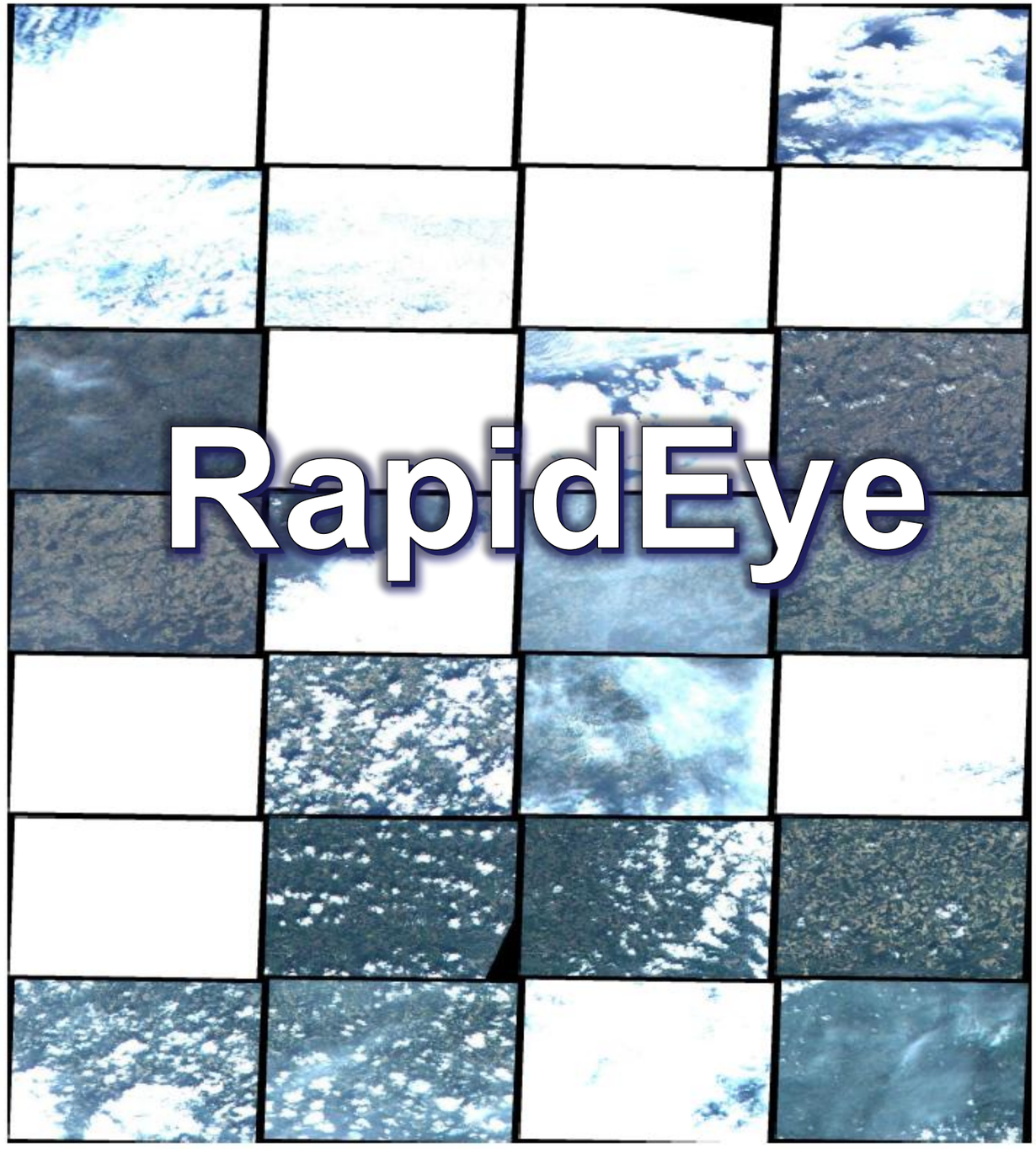
Planning of acquisition of SPOT4 and RapidEye data

~ 5 months every 5 days (~ 30 images)

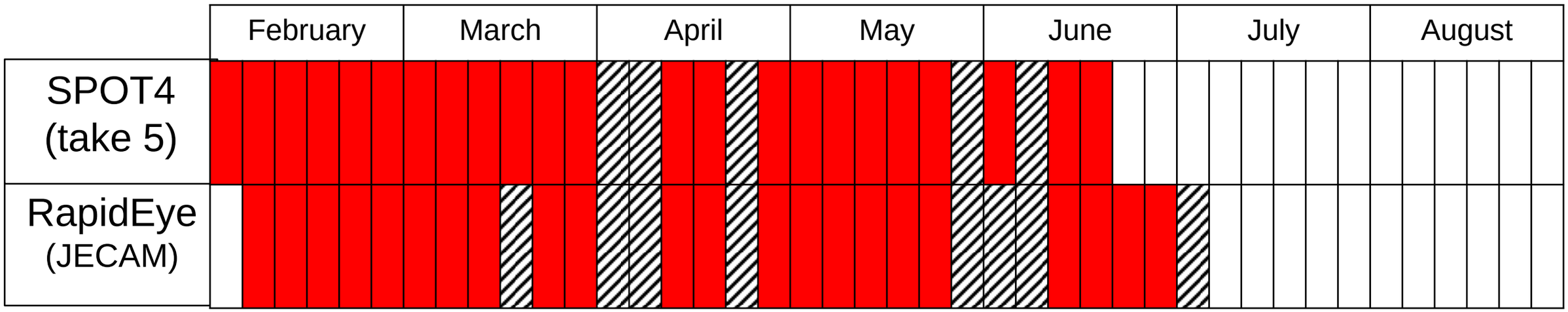


⟶ Do not fit with crop calendar

Quicklooks of SPOT4 and RE time series

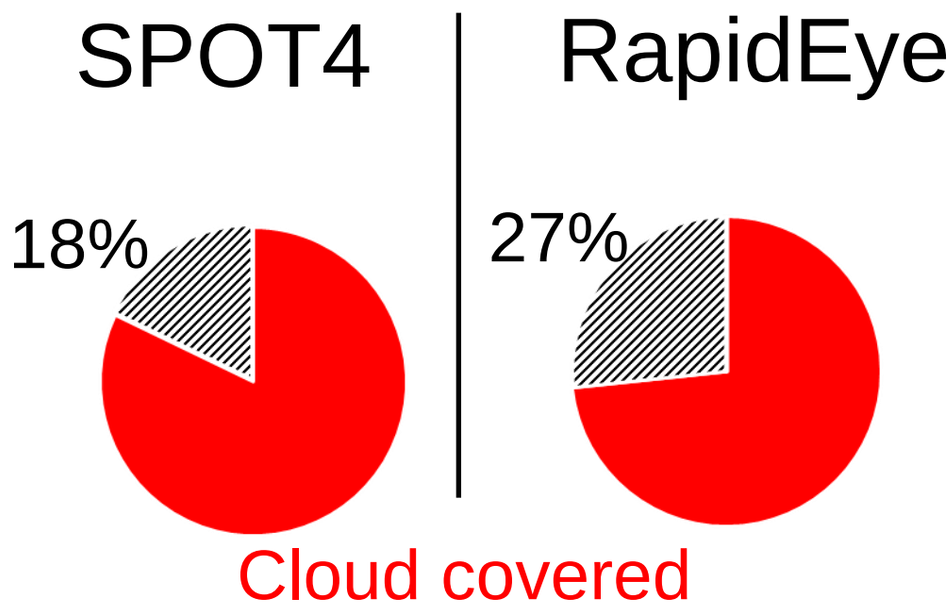


Effective temporal resolution for valid observation ≠ acquisition planning or technological capabilities

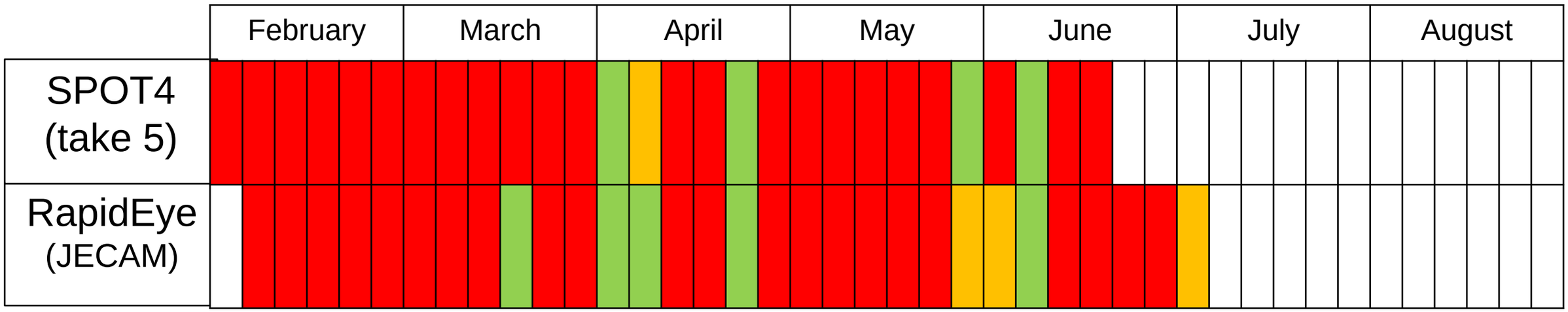


~ 5 months every 5 days (~ 30 images)

Important losses due to meteorological conditions

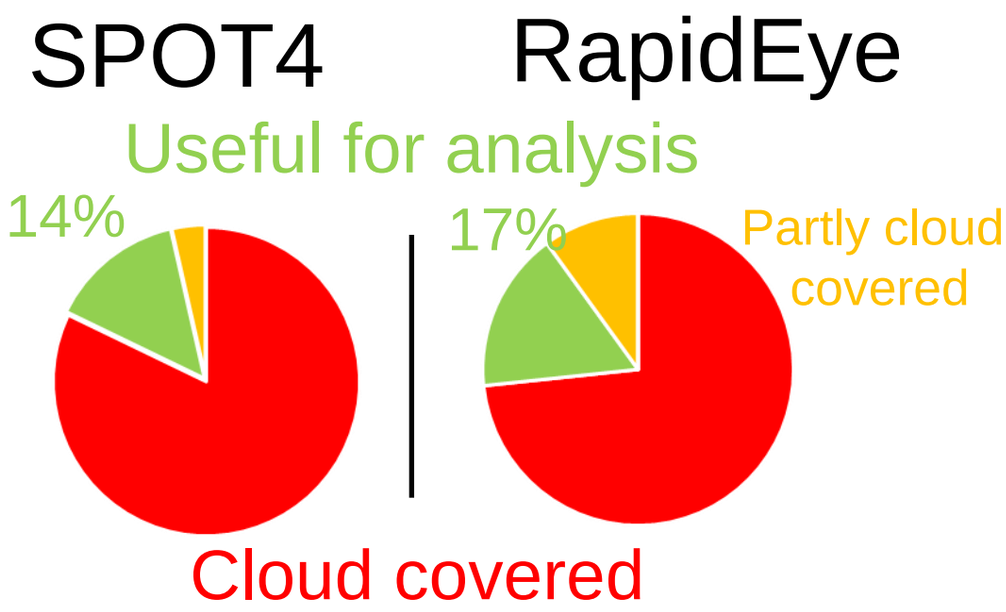


Effective temporal resolution for valid observation ≠ acquisition planning or technological capabilities

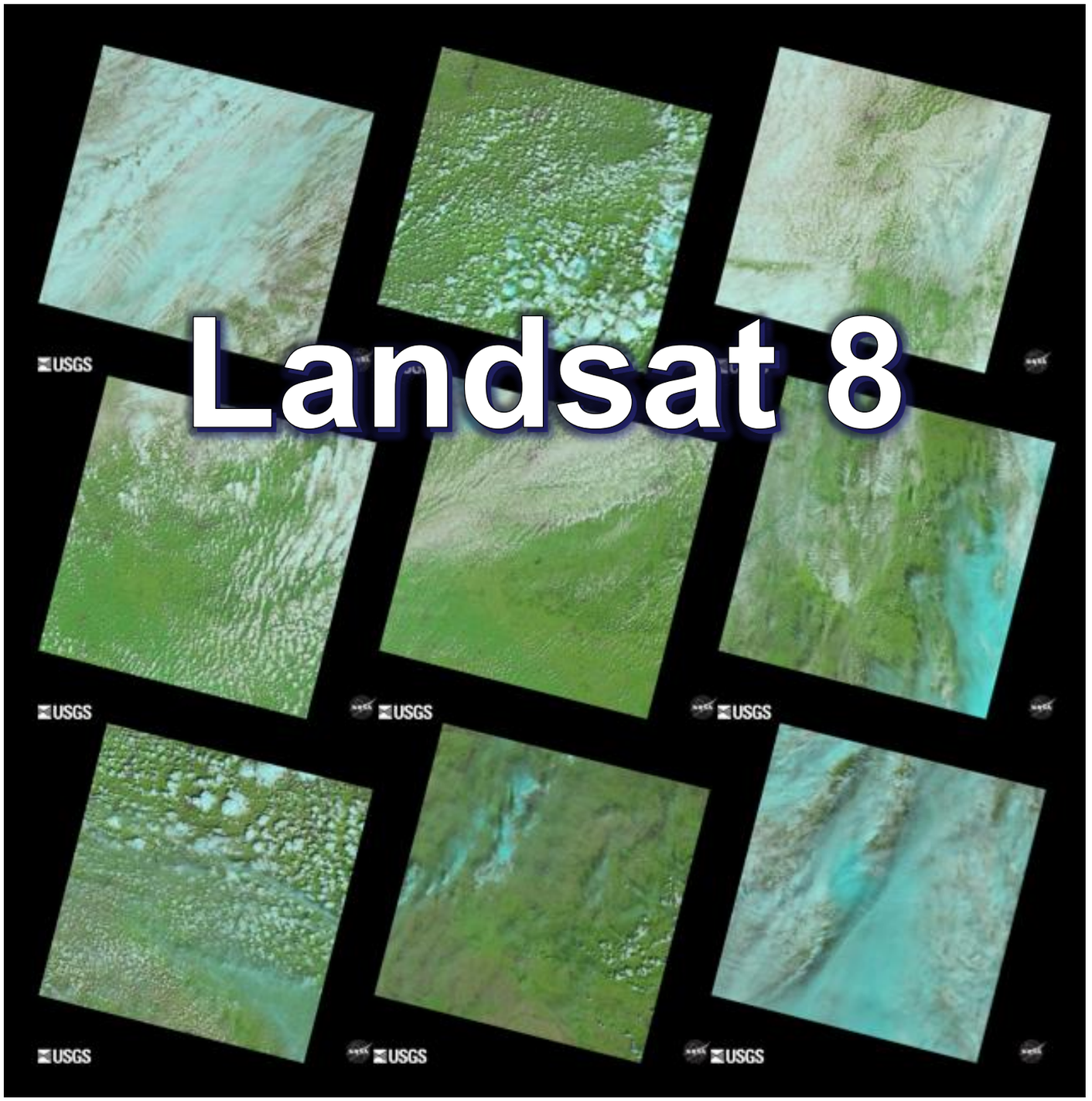


~ 5 months every 5 days (~ 30 images)

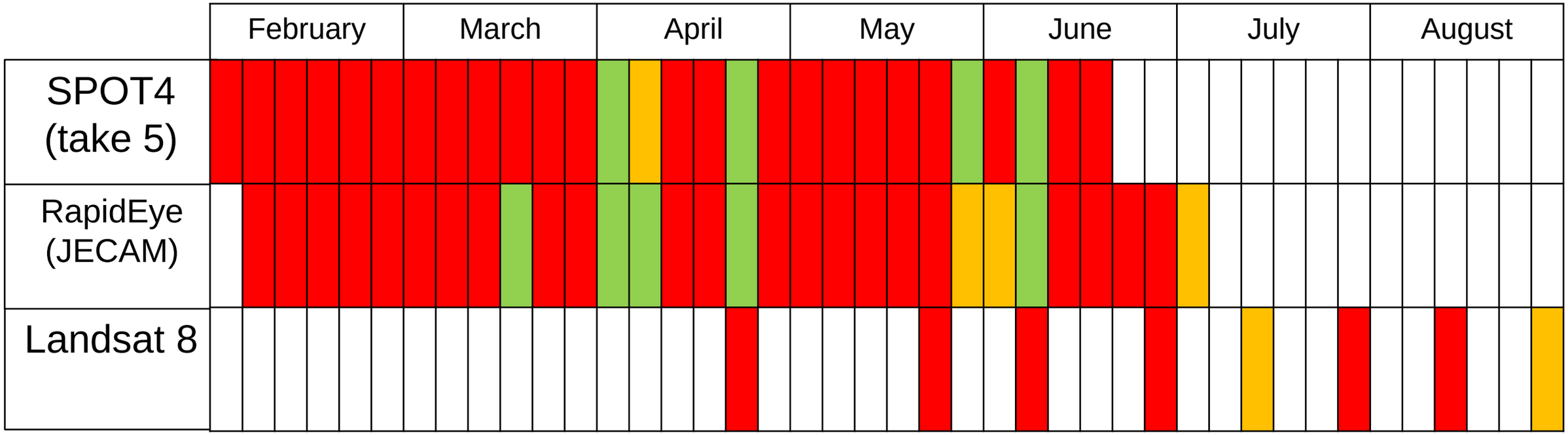
Important losses due to meteorological conditions



Combine with Landsat 8 (30 m, every 16 days)

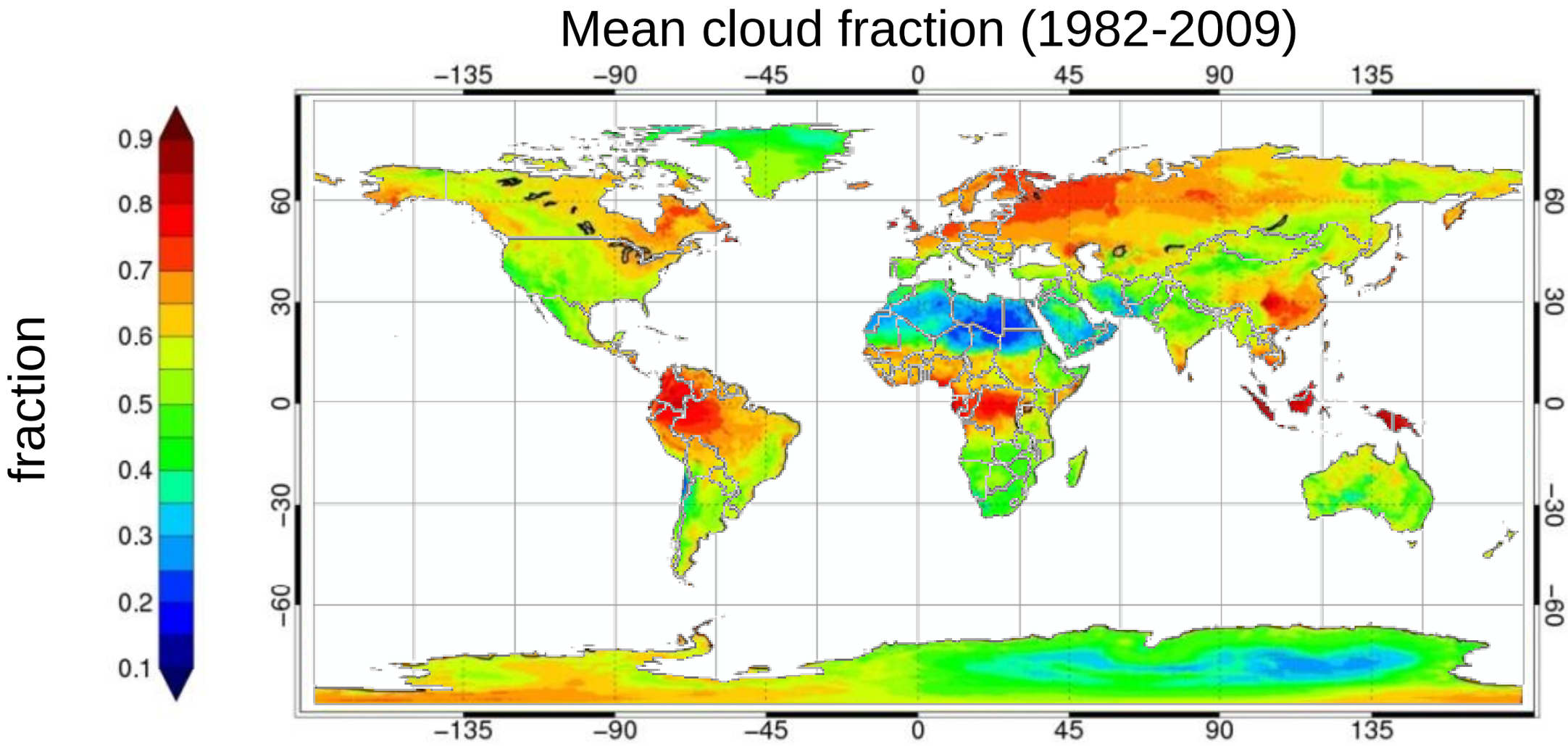


Combine with Landsat 8 (30 m, every 16 days)



Same issue…

Cloud cover: a global issue (not only in Belgium!!)

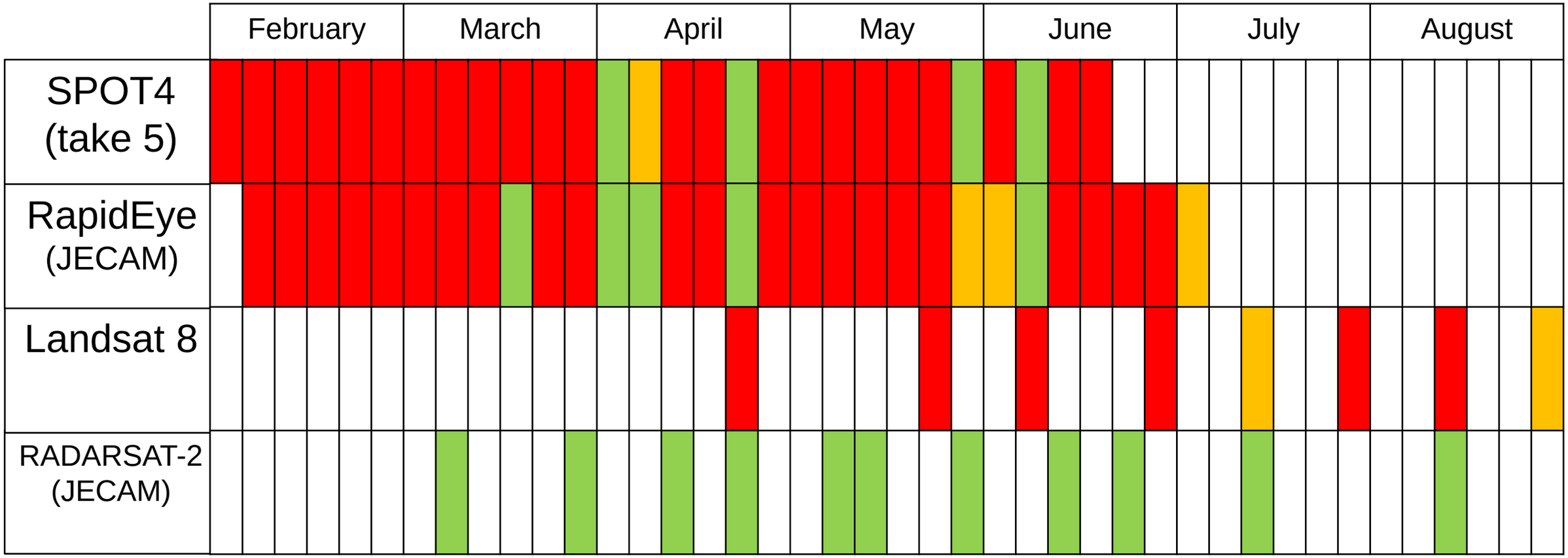


CLARA-A1 dataset is a global dataset of cloud, surface albedo and surface radiation products derived from measurements of the Advanced Very High Resolution Radiometer (AVHRR) onboard the polar orbiting NOAA and Metop satellites (EUMETSAT).

→ 1 Sentinel-2: really not enough !!!

→ 2 Sentinel-2: the minimum threshold…if combined with Landsat 8

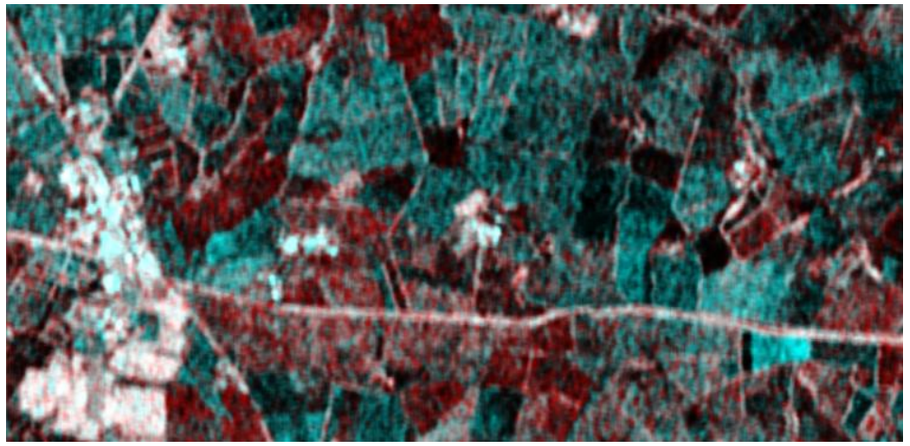
!!! Multi-sensor approach !!!



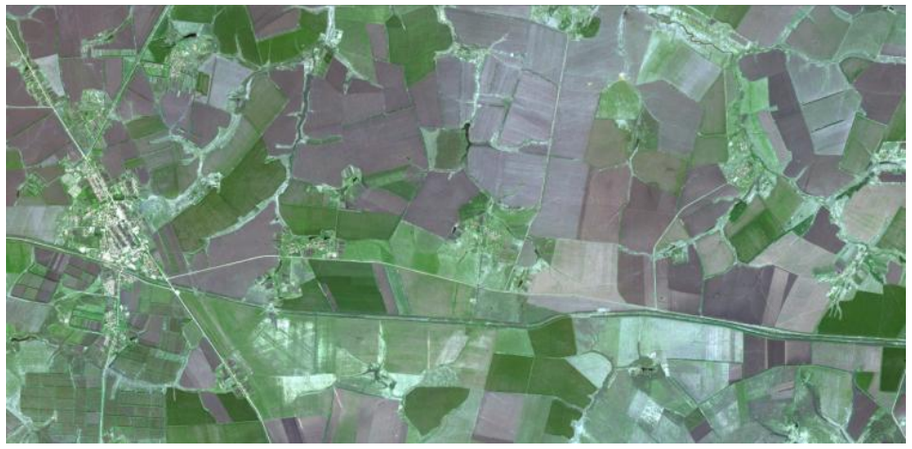
RADARSAT much more reliable but SAR (difficult to interpret)

Has to be acquired as complete time series to allow to reduce the noise

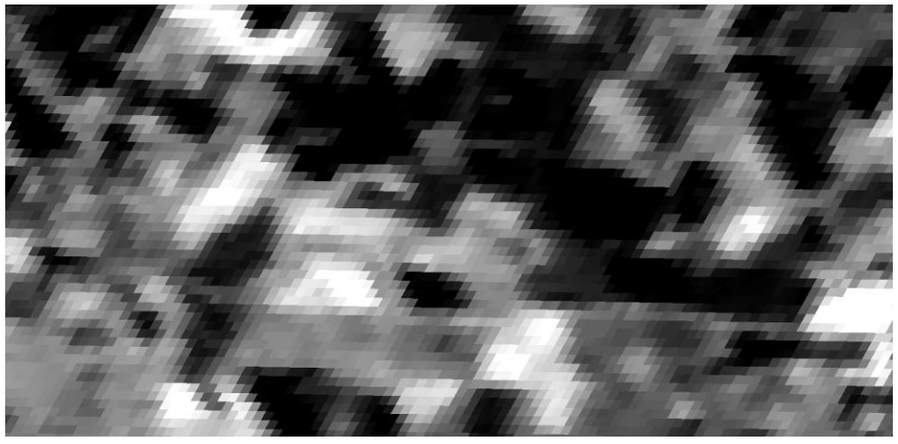
Complementarity S-1, S-2, S-3



	Sentinel-1 (SAR)
+	• **weather independent** • temporal resolution (night acquisitions)
–	• number of bands • difficult to interpret

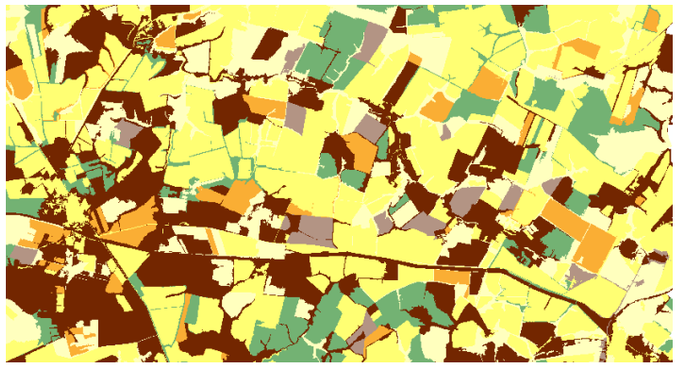


	Sentinel-2 (HRO)
+	• **spatial resolution** • number of bands
–	• cloud contamination • temporal resolution



	Sentinel-3 (MRO)
+	• **temporal frequency** • number of bands
–	• cloud contamination • spatial resolution

Efficient crop mapping



Waldner (2013)

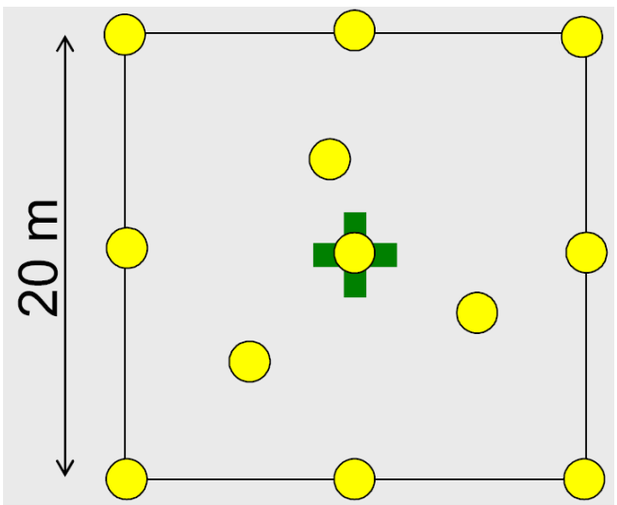
Synchroneous field campaign: LAI measurements

Leaf Area Index (LAI): the one-sided green leaf area per unit of ground surface area (m^2/m^2)

→ 15 winter wheat fields visited

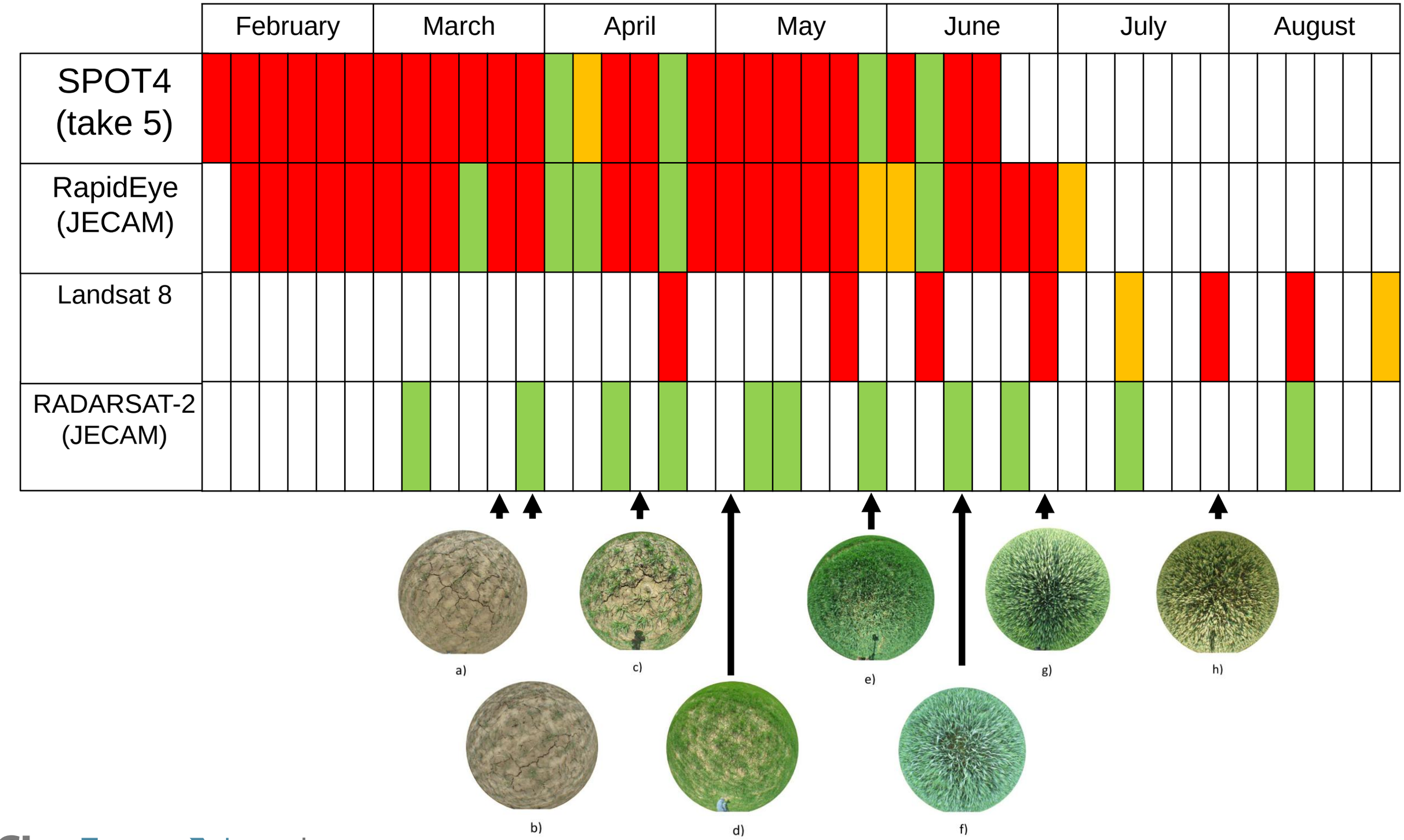
→ Hemispherical pictures taken

Fish-Eye lens



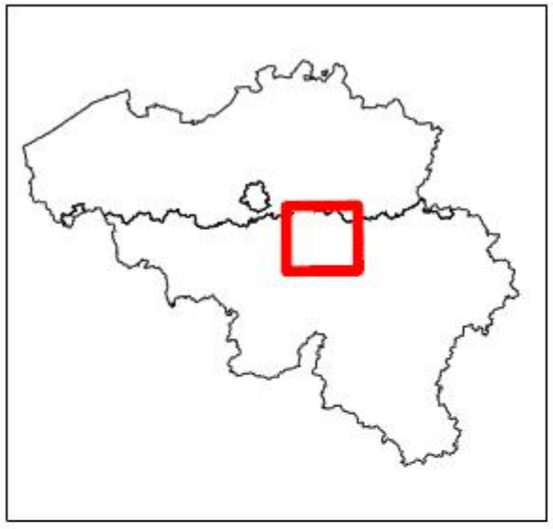
Spatial sampling example

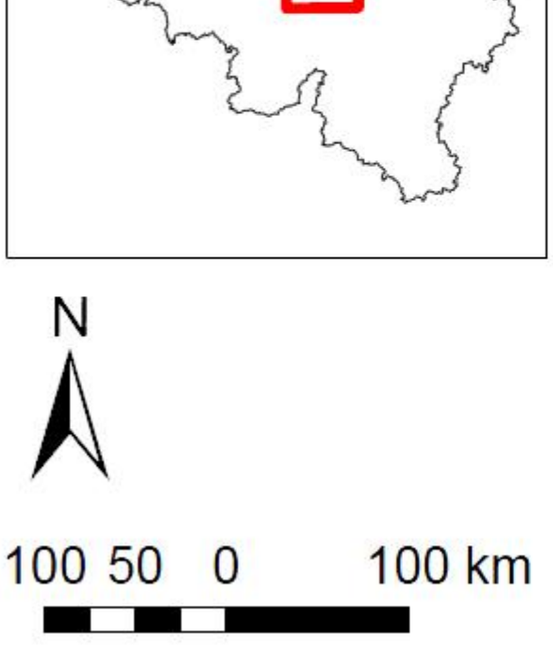
Synchroneous field campaign: LAI measurements

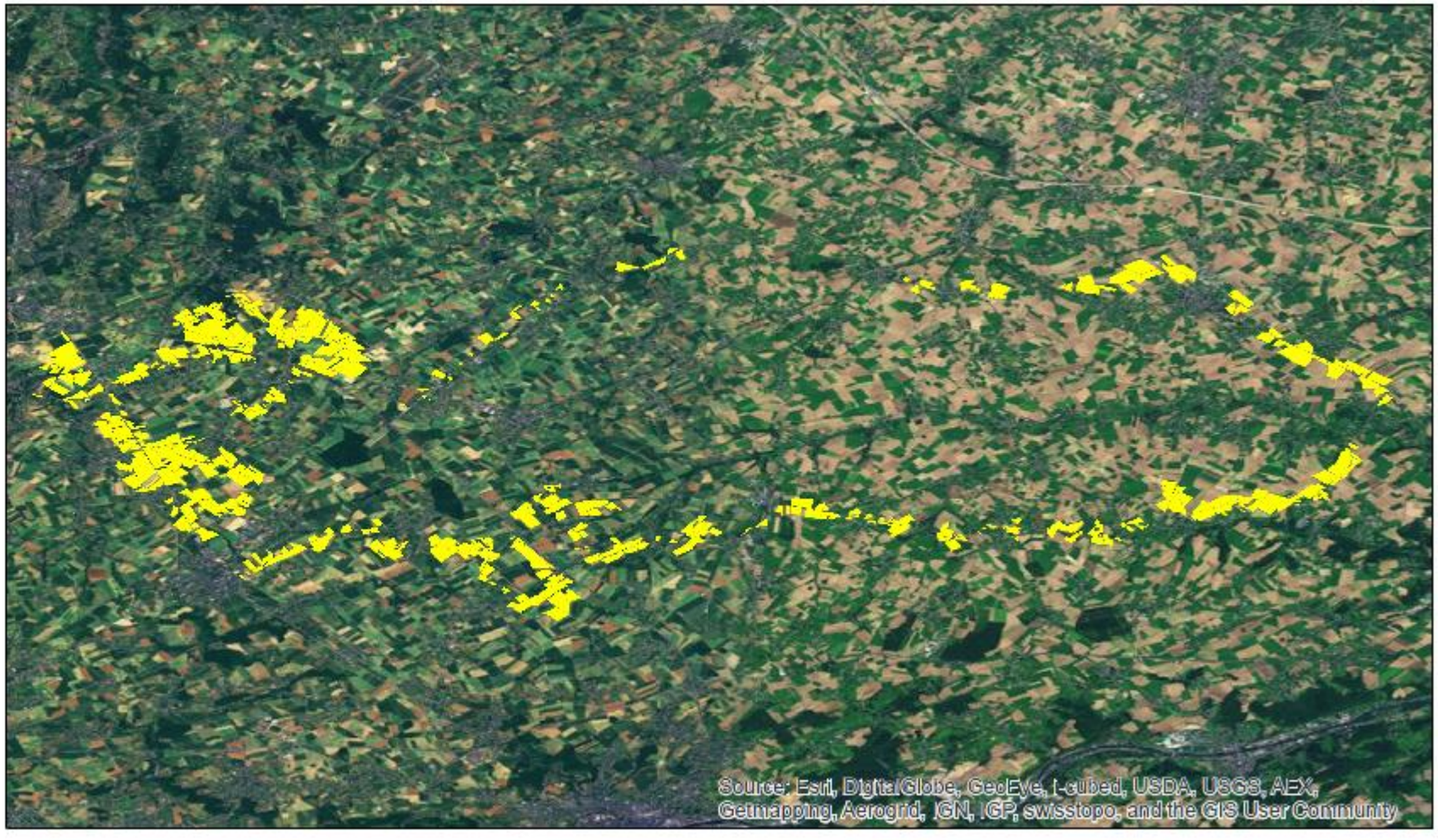


Synchroneous field campaign: crop type

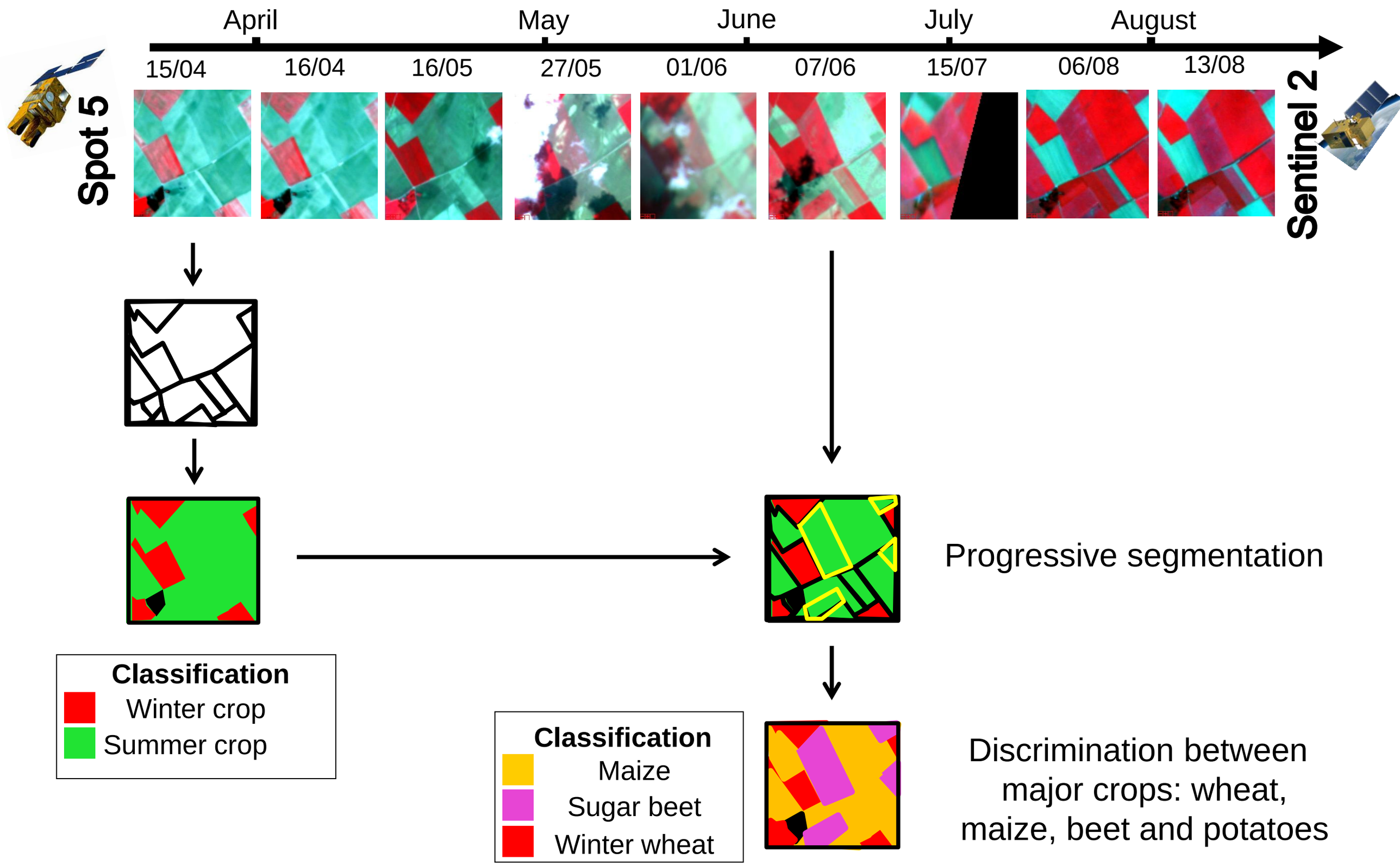
~ 1000 fields visited to build a crop type database





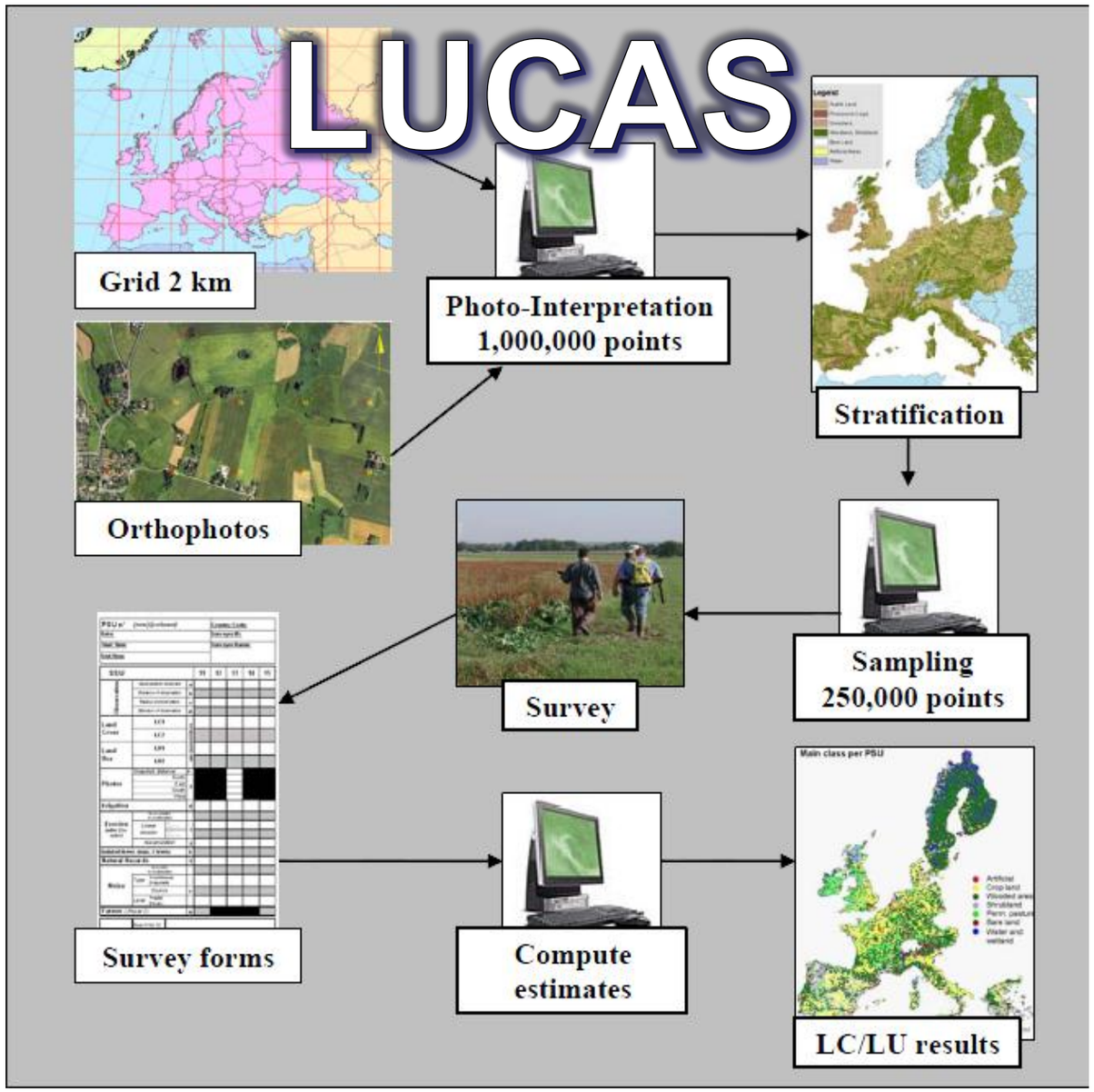


Obj.1: crop specific object-based classification method along the season



Obj.2: improve crop area statistics estimation

→ operational crop area estimate systems essentially use of field data due to time and accuracy requirements



→ commission and omission errors from classification are not counterbalanced

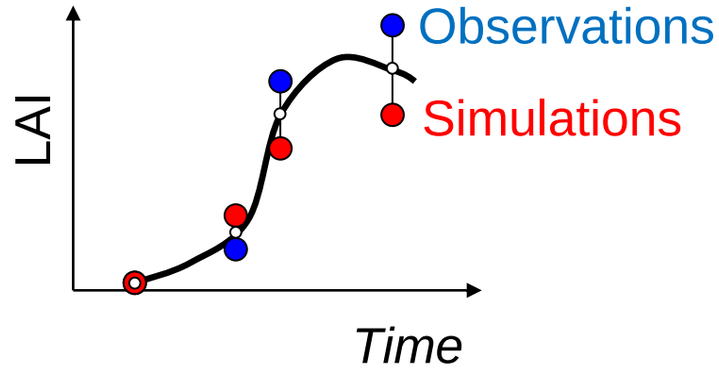
→ looking for statistical approach based on image subset

Obj. 3: improve estimate of biophysical variables retrieval for crop growth monitoring

Leaf Area Index (LAI)

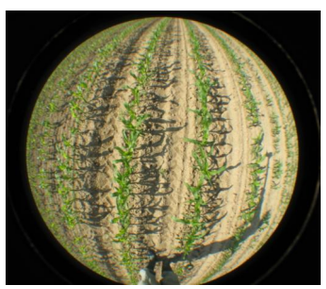
Adjustement of agrometeorological model through assimilation

Improvement of crop yield estimation

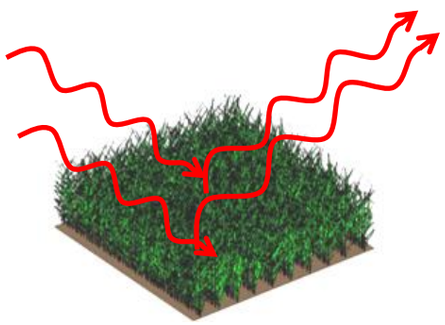


Inversion

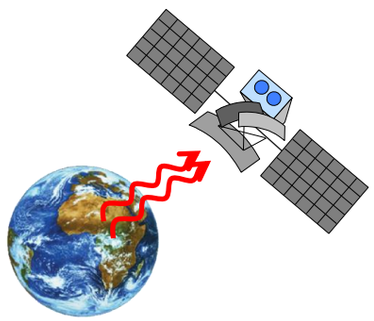
Biophysical variable (ex: LAI)



Radiative transfer model



Remote sensed spectral signal



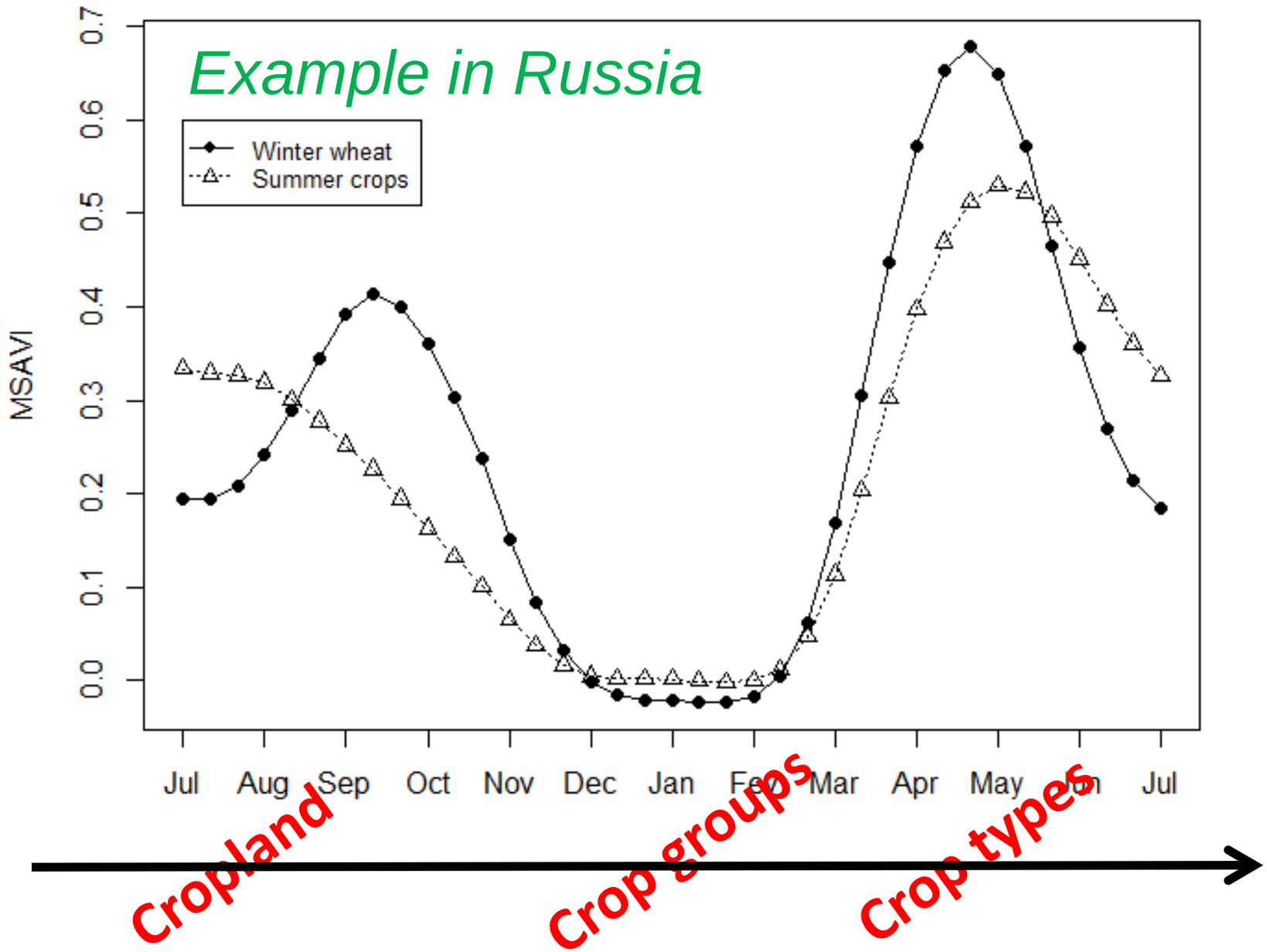
Questions ?

damien.jacques@uclouvain.be

pierre.defourny@uclouvain.be

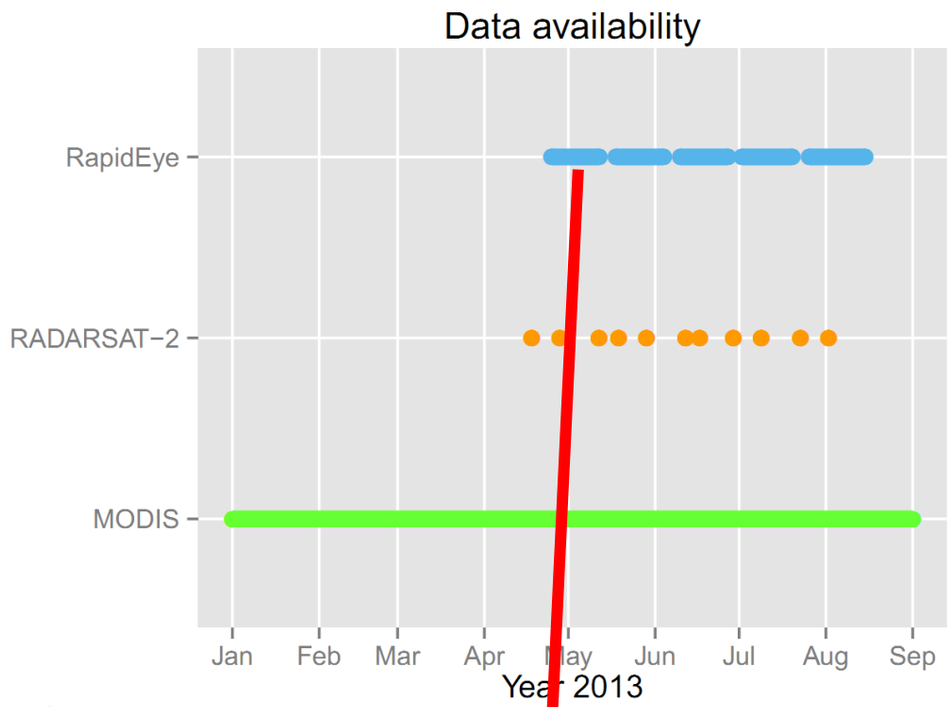
	SENTINEL-1	RADARSAT-2	SENTINEL-2	RAPIDEYE	SENTINEL-3	MODIS
Nominal Swath	80-km	300-km	290-km	77-km	1250-km	2330-km
Wavelength (μm)/frequency	C-band	C-band	blue (0.42-0.55), green (0.53-0.59), red (0.63-0.69), red-edge (0.69-0.72, 0.72-0.75, 0.76-0.8, 0.84-0.89), near-infrared (0.72-0.96) and 5 others	blue (0.40-0.51), green (0.52-0.59), red(0.63-0.685), red-edge (0.69-0.73), near-infrared (0.76-0.85)	red (0.6-0.7) , near-infrared (0.88-0.89) and 19 others	red (0.62-0.67), near-infrared (0.84-0.88) and 34 others
Polarization	HH+HV VV+VH	HH+HV VV+VH	NA	NA	NA	NA
Beam Incidence angle	20-41	20-46	NA	NA	NA	NA
Ground resolution	5-m	25-m	10-m	5-m	300-m	250-m
Repeat cycle	2 days using a constellation of satellites	programmable	5 days with a pair	daily with 5 satellites	1-2days with a pair	1-2 days

Crop type classification along the season

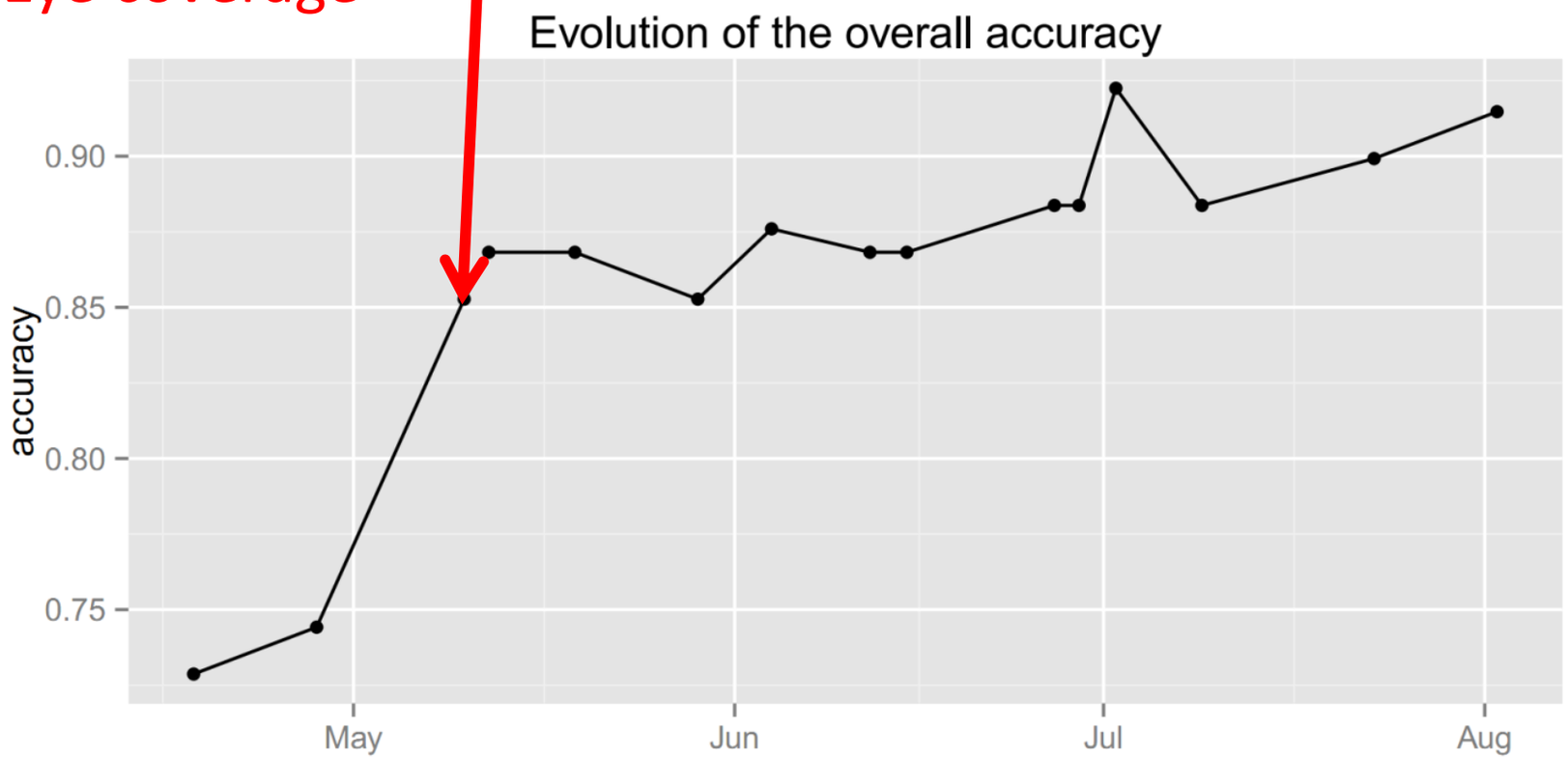


Waldner (2013)

Crop type classification along the season



First RapidEye coverage



Waldner (2013)

Crop type classification along the season

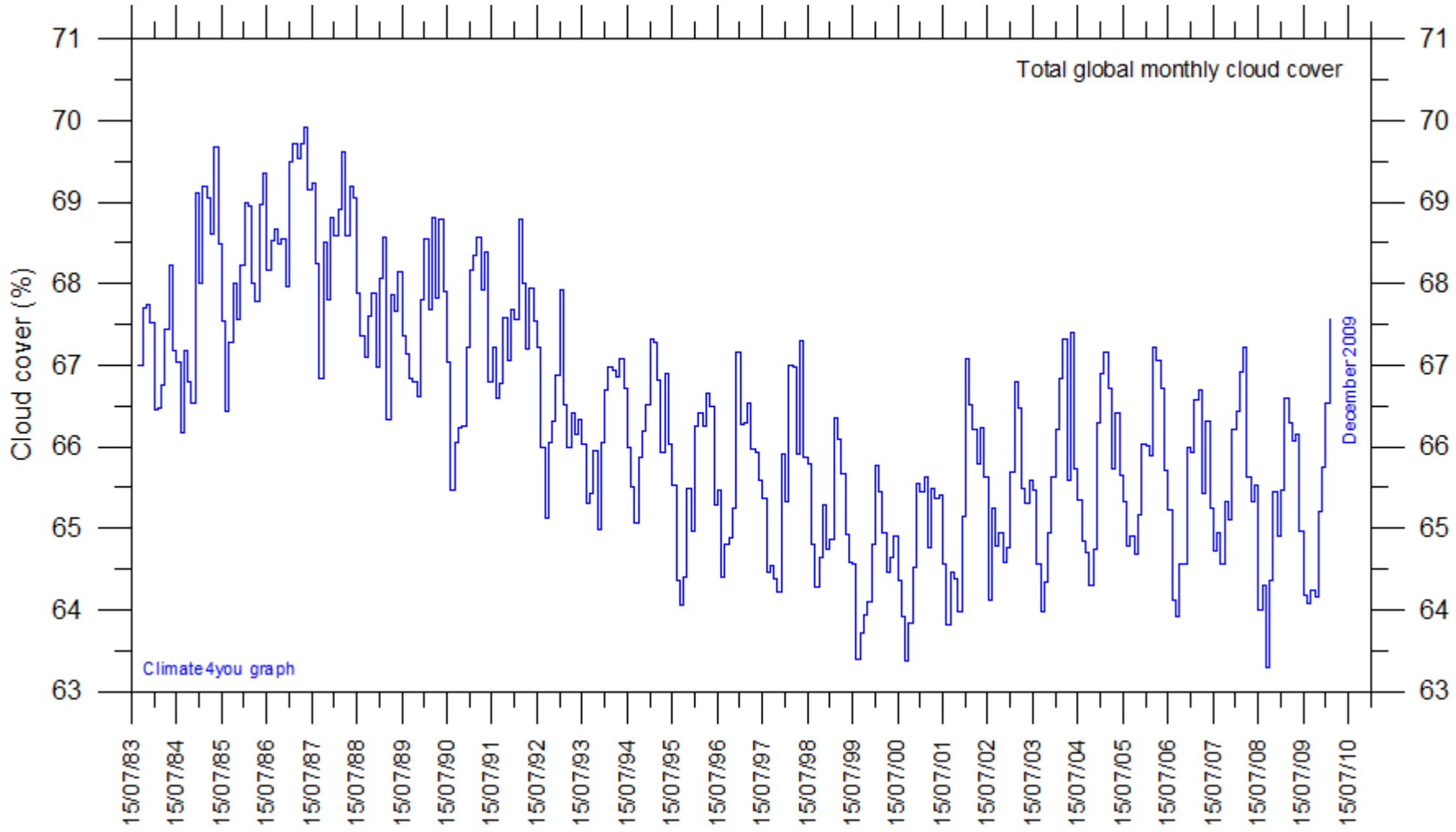
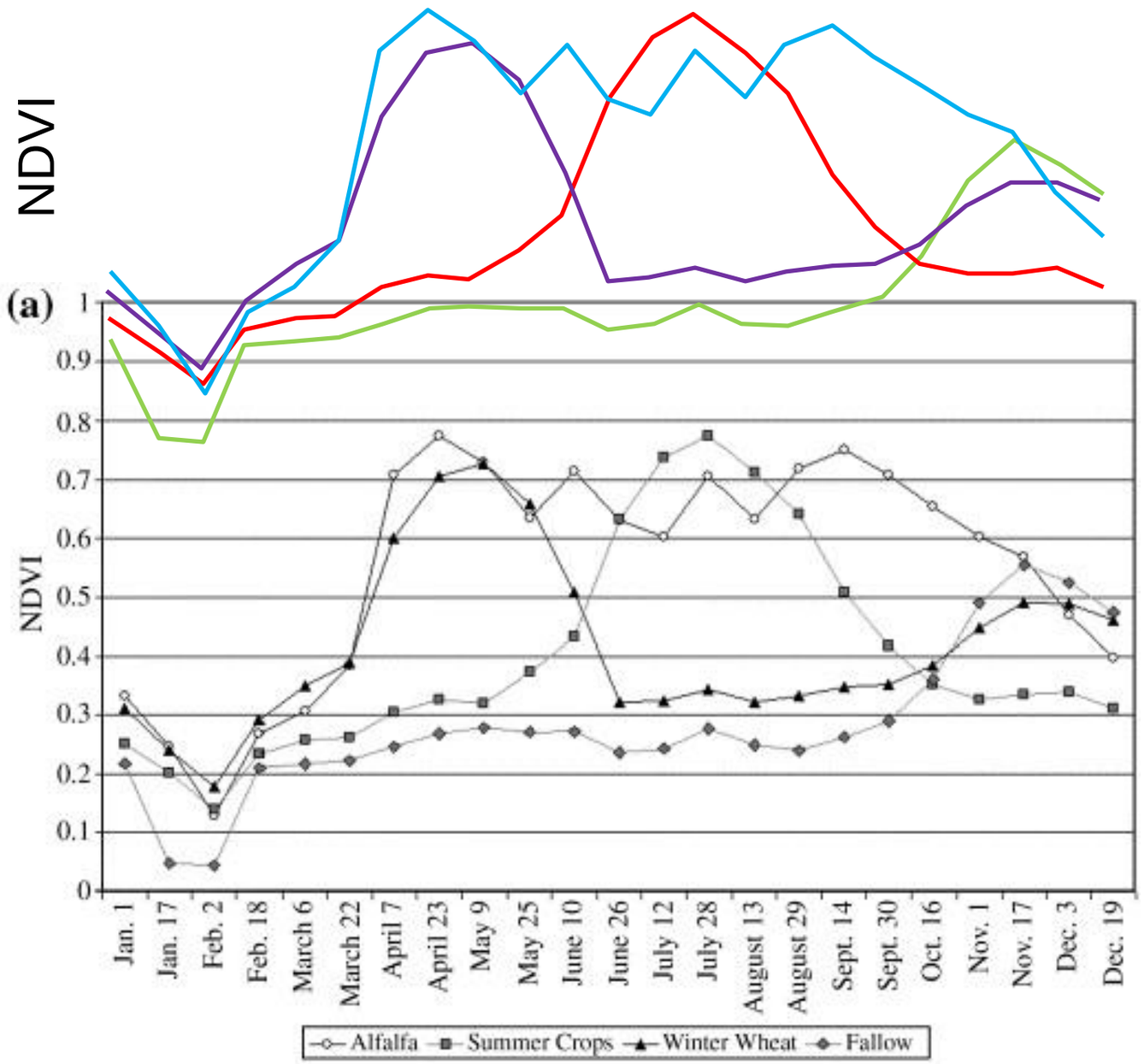
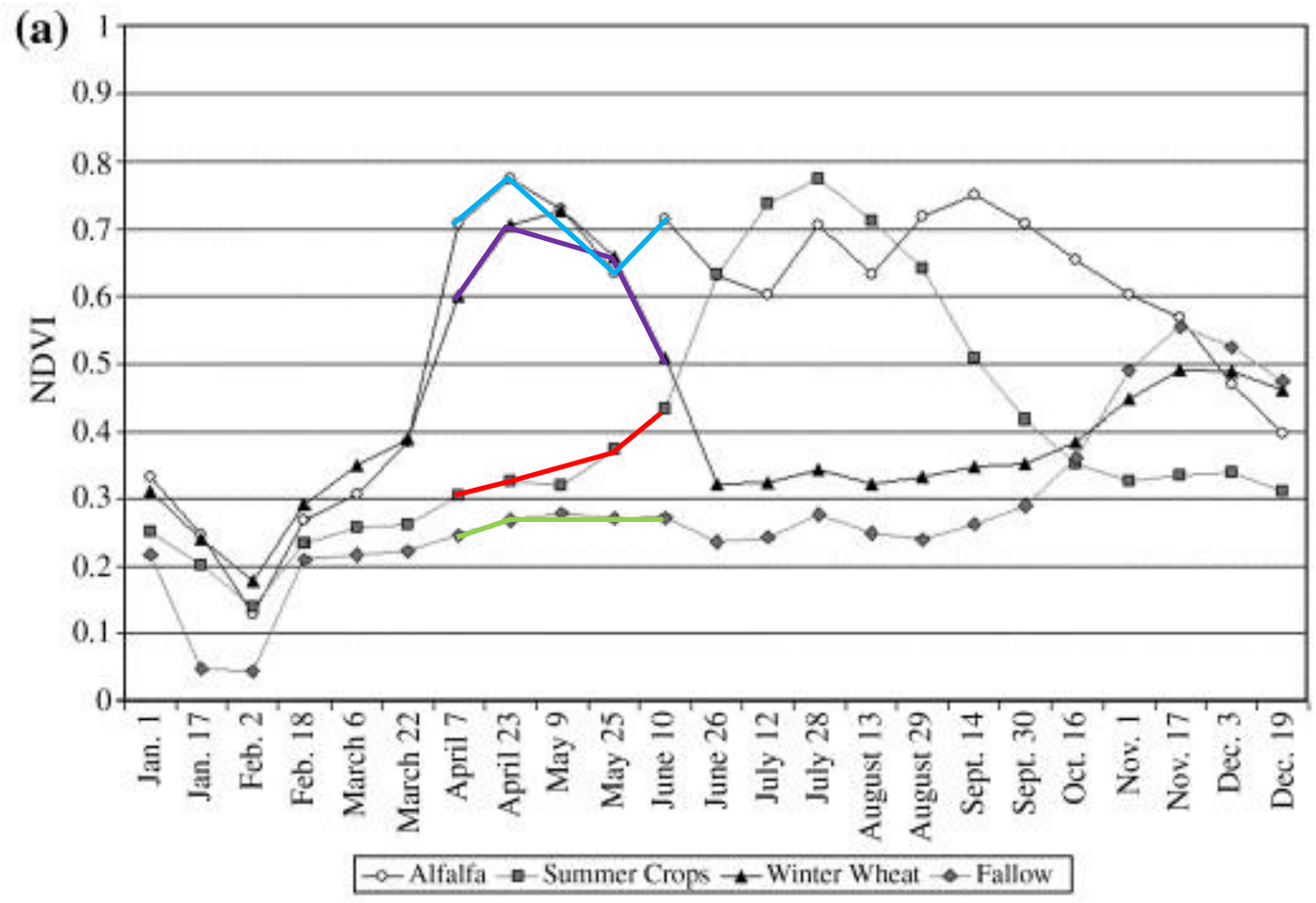
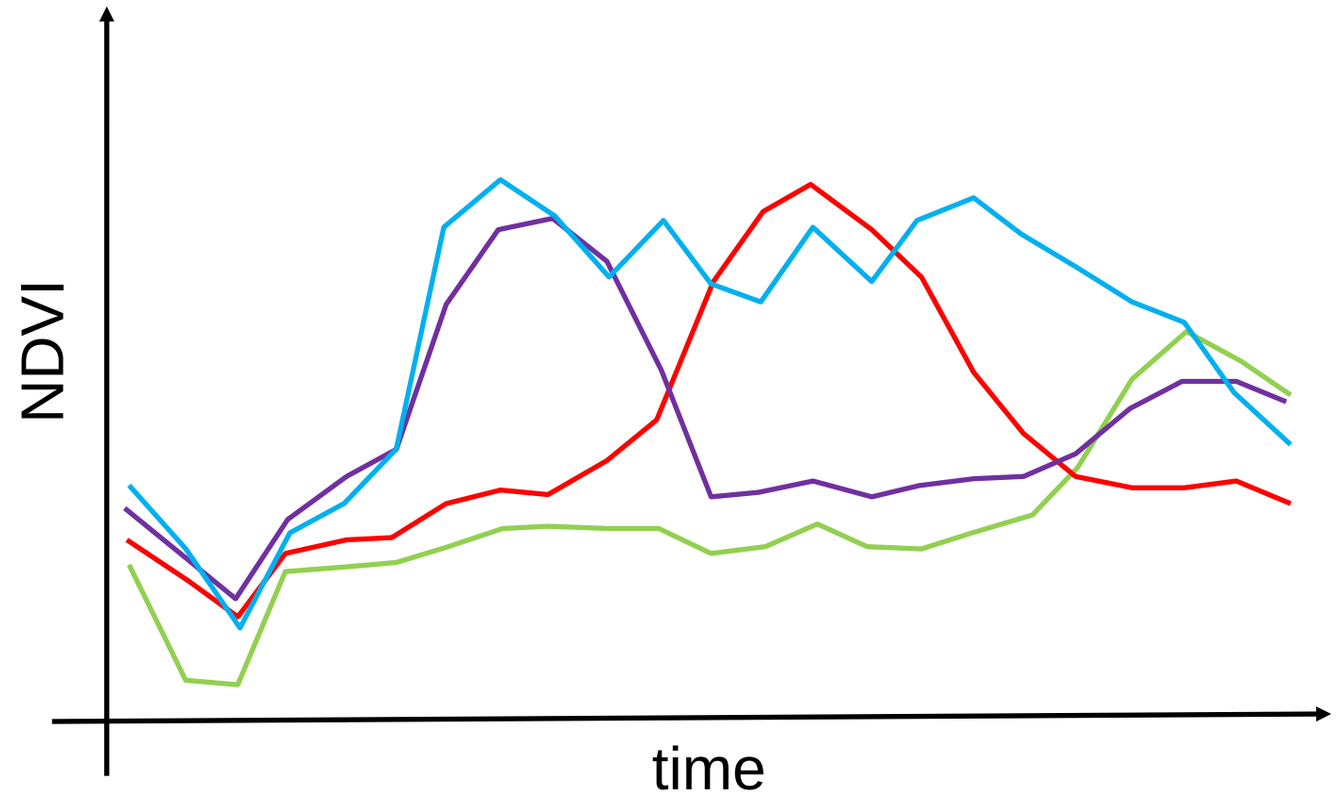
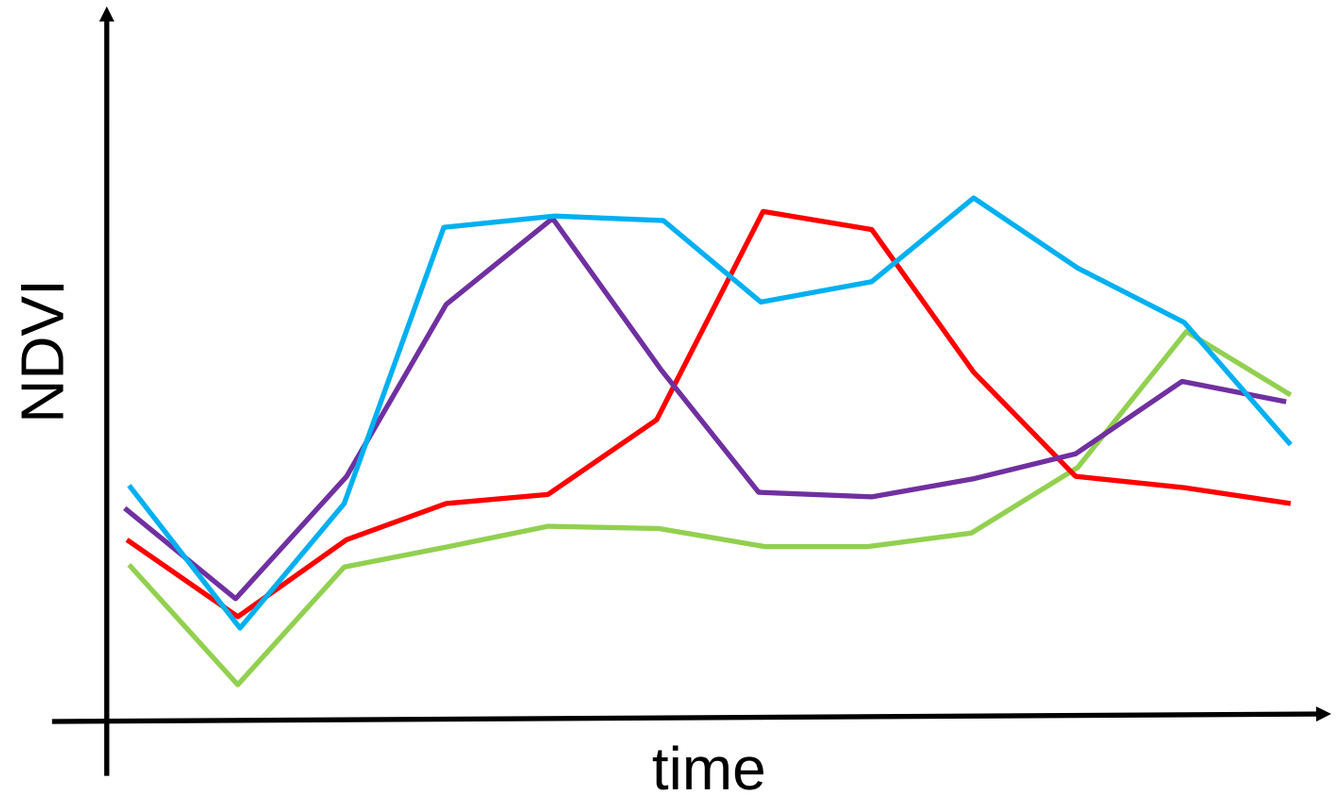


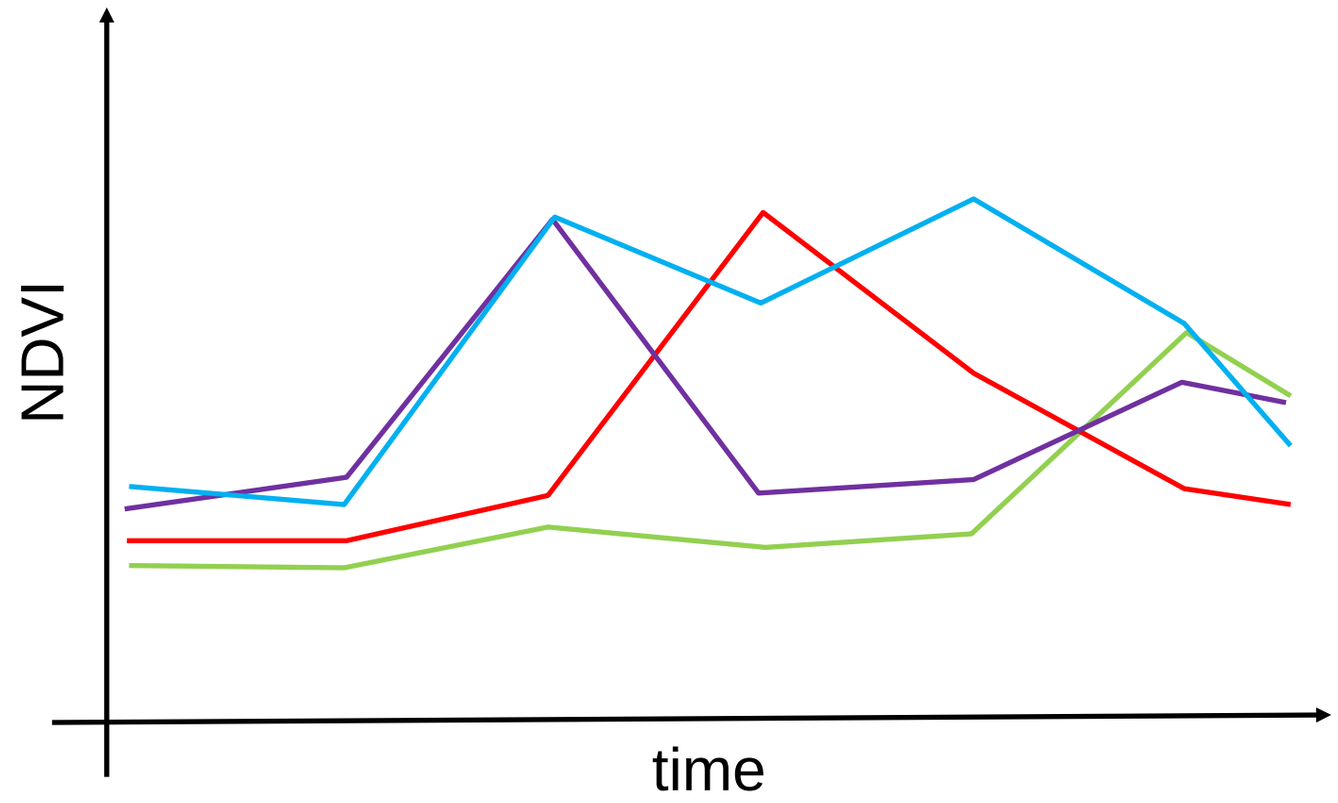
Diagram showing monthly variations in total global cloud cover since July 1983. During the period of observations, the total amount of clouds has varied from about 69 percent in 1987 to about 64 percent in 2000. The annual variation of the cloud cover follows the annual variation in atmospheric water vapour content, presumably reflecting the asymmetrical distribution of land and ocean on planet Earth. The time labels indicate day/month/year. The variation of different types of clouds can be seen in the diagram below. Data source: The International Satellite Cloud Climatology Project (ISCCP). The ISCCP datasets are obtained from passive measurements of IR radiation reflected and emitted by the clouds. Last data: December 2009. Last figure update: 4 September 2011.


NDVI
(a)
NDVI
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Jan. 1
Jan. 17
Feb. 2
Feb. 18
March 6
March 22
April 7
April 23
May 9
May 25
June 10
June 26
July 12
July 28
August 13
August 29
Sept. 14
Sept. 30
Oct. 16
Nov. 1
Nov. 17
Dec. 3
Dec. 19
Alfalfa
Summer Crops
Winter Wheat
Fallow


(a)
NDVI
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Jan. 1
Jan. 17
Feb. 2
Feb. 18
March 6
March 22
April 7
April 23
May 9
May 25
June 10
June 26
July 12
July 28
August 13
August 29
Sept. 14
Sept. 30
Oct. 16
Nov. 1
Nov. 17
Dec. 3
Dec. 19
Alfalfa
Summer Crops
Winter Wheat
Fallow


NDVI
time


NDVI
time


NDVI
time