Regional Space Observatory (France)

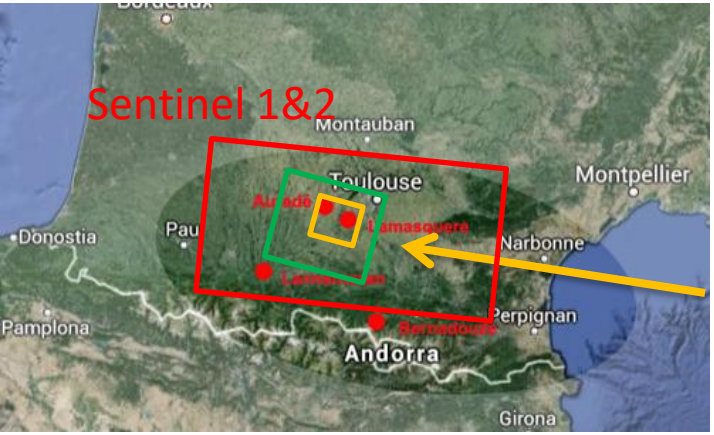
Earth Observation Technologies for Crop Monitoring: A Workshop to Promote Collaborations among GEOGLAM/JECAM/Asia-RiCE 2018

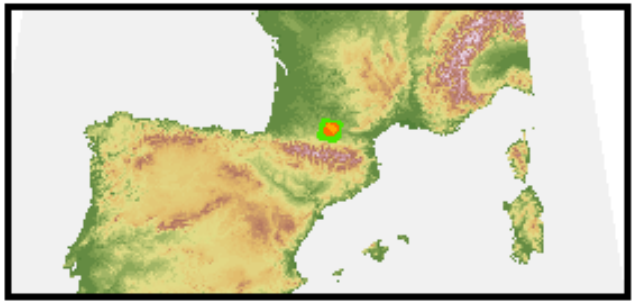
Taichung City, Taiwan

17-20 September, 2018

The Spatial Regional Observatory (OSR)

Part of the international JECAM & ICOS networks





Experimental Sites

ESU Biomass & Yield Data (2011)

Yield Data (farmers surveys)

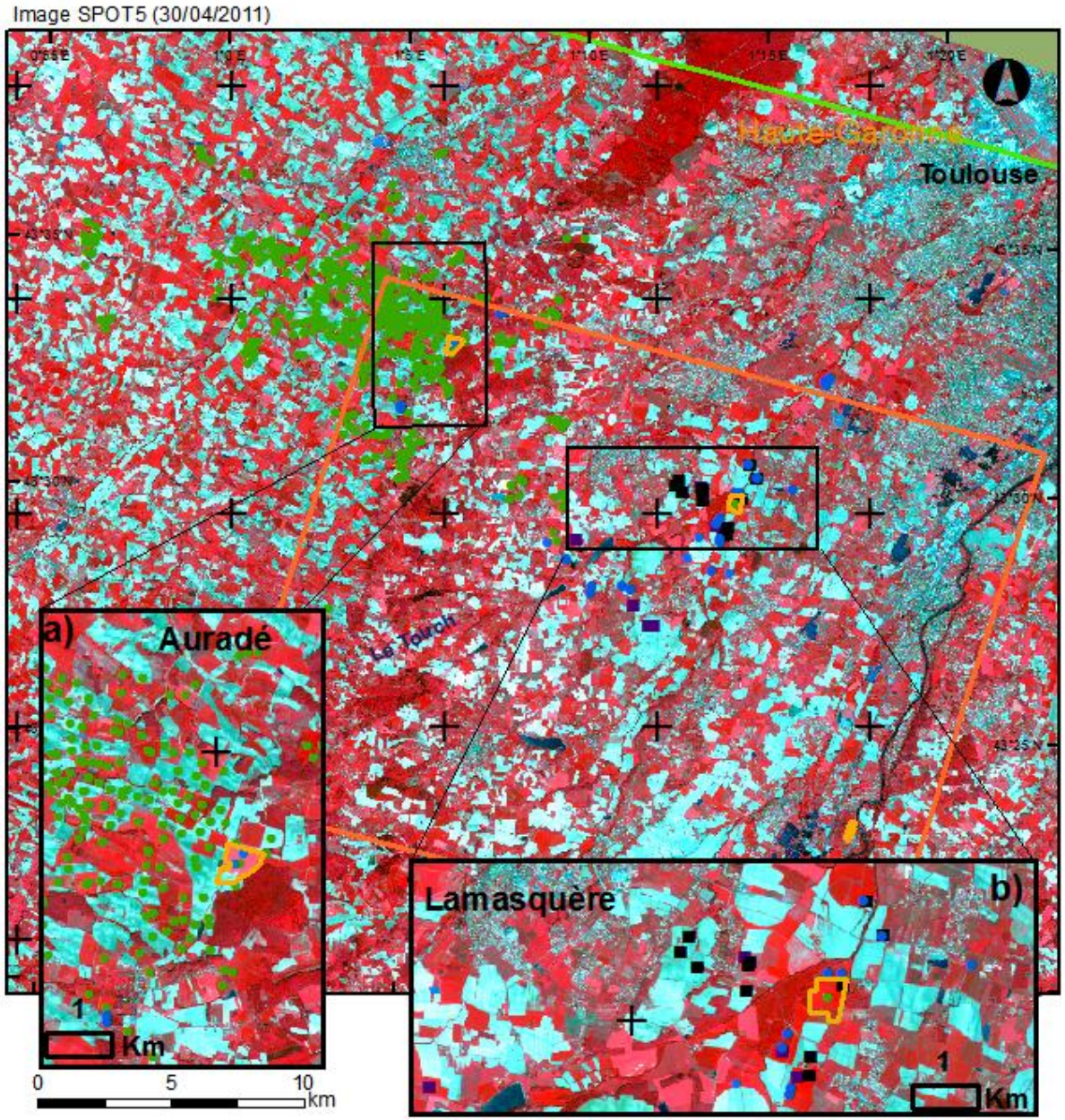
ESU LAI & Biomass Data (2008)

LAI & Biomass Data (2010)

SAFRAN grid

SPOT window (since 2002)

Formosat-2 window (since 2006)



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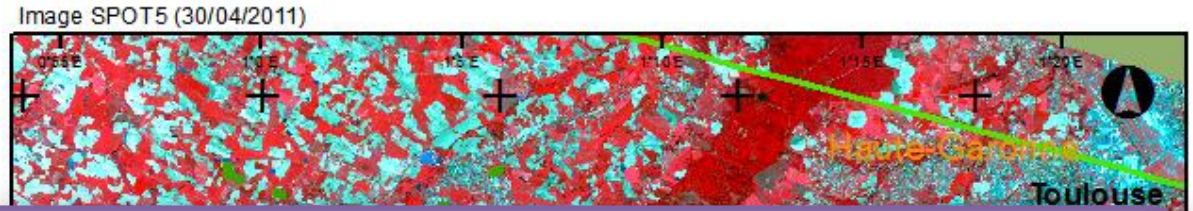
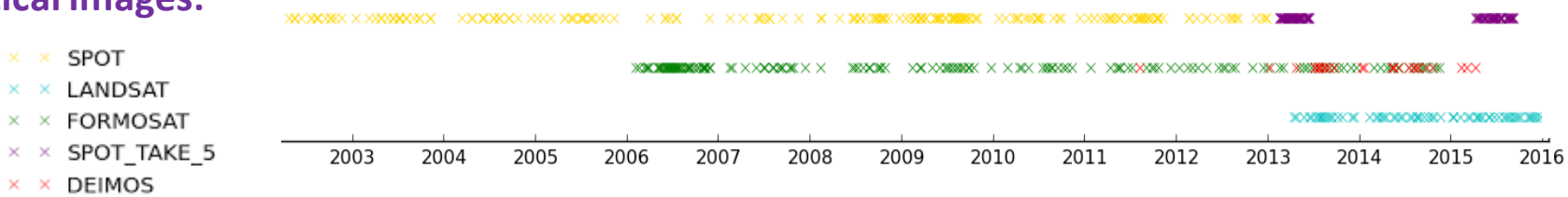


A unique remote sensing dataset covering the OSR footprint since 2002, with wide spectral ranges from optical to microwave, at moderate and high spatial & temporal resolutions (HSTR)

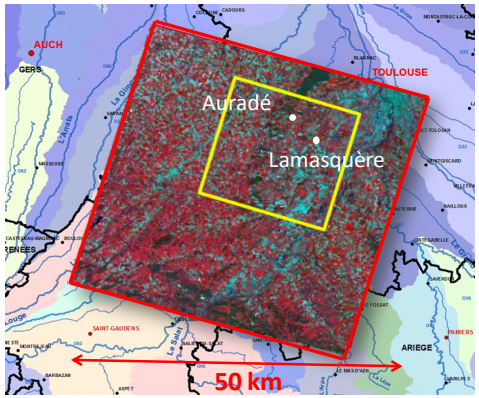
Optical images:



Radar images:

Remote sensing observations

Available through Kalidéos, ESA and THEIA portals



SPOT footprint

Formosat footprint

OSR footprint

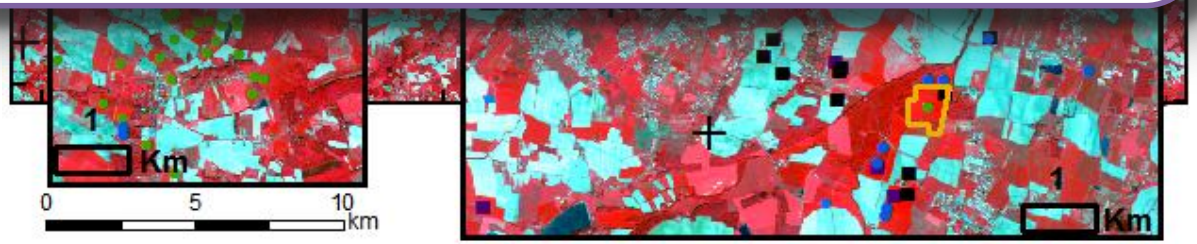
ESU

LAI & Biomass Data (2010)

SAFRAN grid

SPOT window (since 2002)

Formosat-2 window (since 2006)

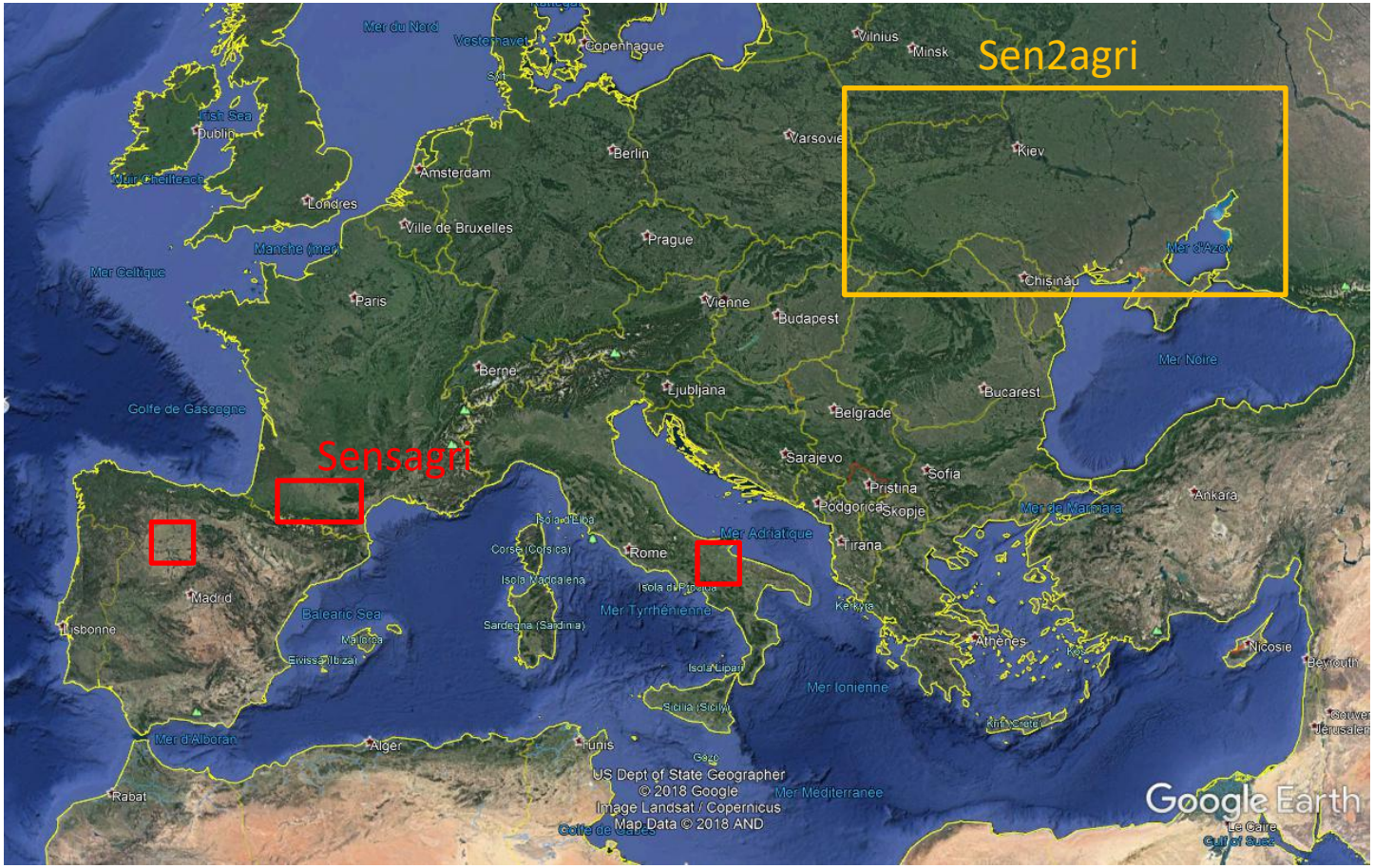


Site Description

- Purpose of project
  - Monitoring of crop production, water needs, CC mitigation strategies
  - Since 2002
- Located in South West France near Toulouse
  - Large flat valleys and hills
  - Mostly clays soils but large heterogeneity
  - Mainly between 5 and 30 Ha
  - Summer crops in valleys are irrigated
- Crop
  - Mostly wheat, sunflower, rapeseed (in the hills), maize, soya
  - Winter crops from October to July, Summer crops from late April to October
- Climate intermediate between oceanic and Mediterranean (13,3° C, 653 mm on average)
- Agricultural methods used : mostly mineral fertilisation, ploughing, and summer crops irrigated when in the valley, a few cover crops, straw are returned to the soil

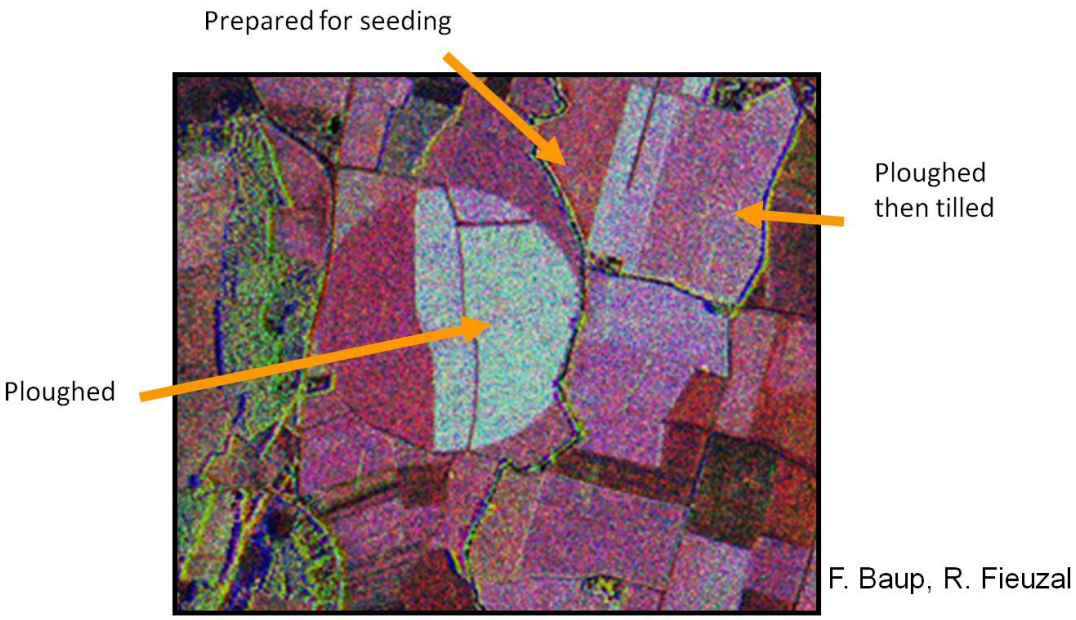
Objectives

- Crop identification and Crop Area Estimation
  ➔operational algorithms (e.g. Sen2Agri, Sensagri)



Objectives

- Crop identification and Crop Area Estimation
  ➔operational algorithms (e.g. Sen2Agri, Sensagri)
  Mapping management : crop rotations, irrigation, crop residue, tillage, cover crop

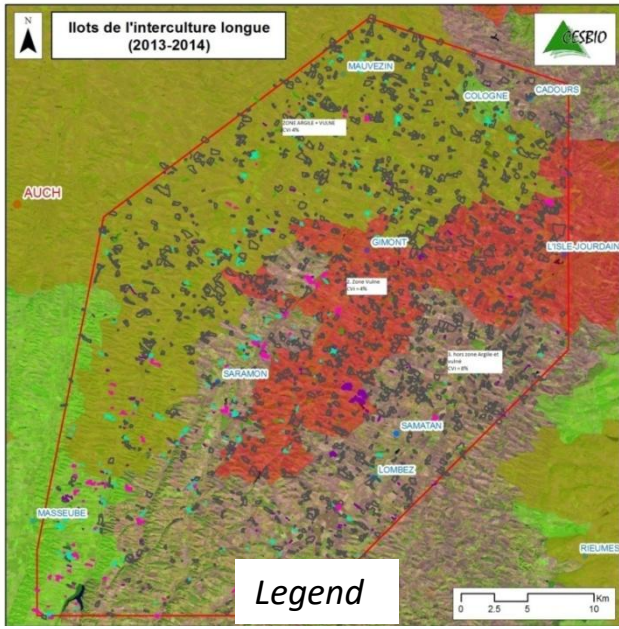


F. Baup, R. Fieuzal

Combination of several TERRASARX images (autumn 2010)

Cover crops

CICC & Bag'ages projects

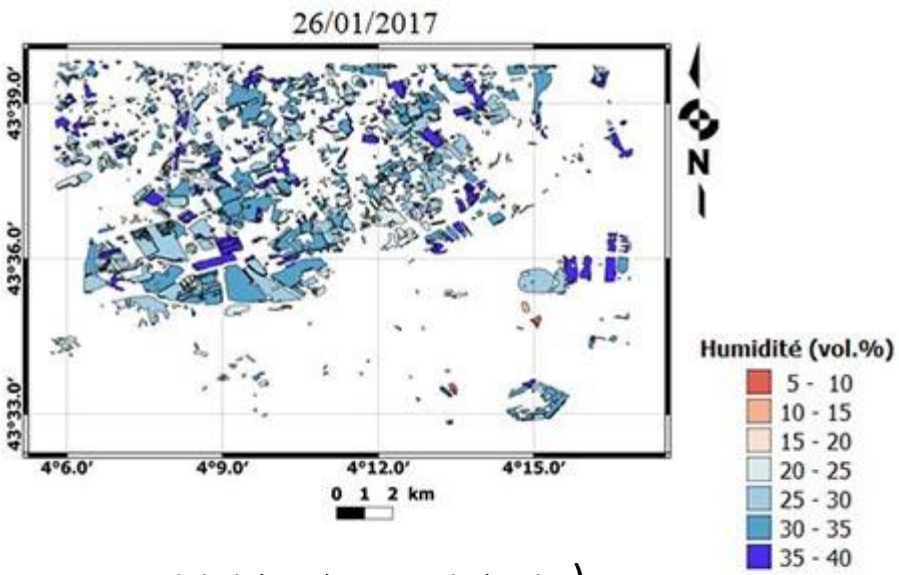


Legend

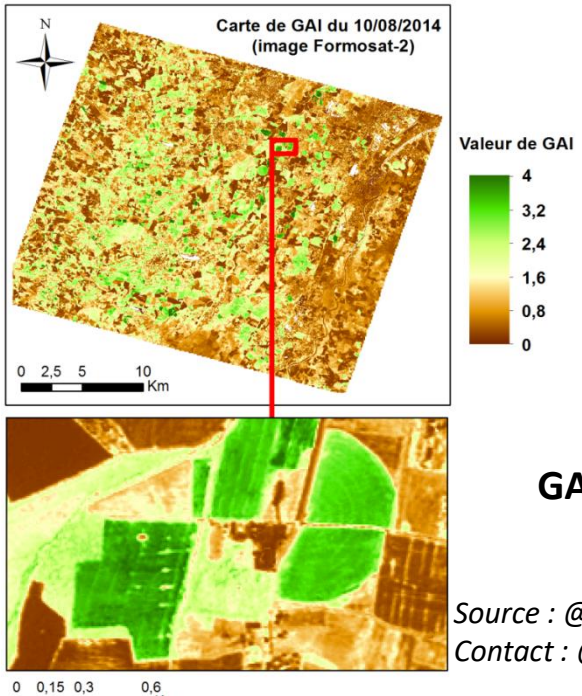
- Bare soil
- Early regrowth
- Late regrowth
- Late cover crops
- Early cover crops

Objectives

- Crop identification and Crop Area Estimation
  ➔operational algorithms (e.g. Sen2Agri, Sensagri)
  Mapping management : crop rotations, irrigation, crop residue, tillage, cover crop
- Biophysical products : soil moisture (operational THEIA product at regional scale), LAI, Fcover, Fapar



Contact: N. Baghdadi (Tetis) et M. Zribi (Cesbio)



GAI map

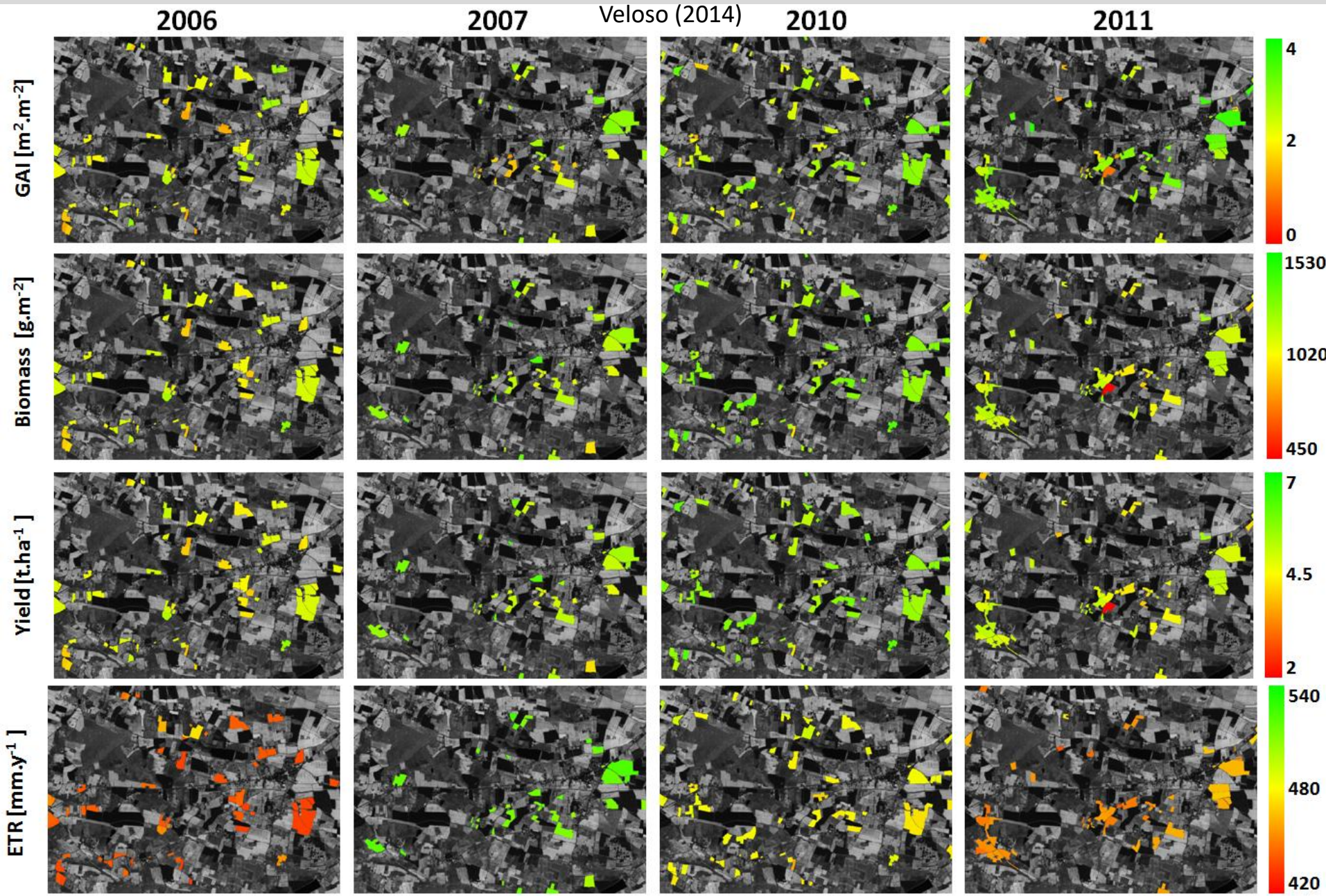
Source : @ M. Battude, 2014
Contact : @ V. Demarez

Objectives

- Crop identification and Crop Area Estimation
  ➔operational algorithms (e.g. Sen2Agri, Sensagri)
  Mapping management : crop rotations, irrigation, crop residue, tillage, cover crop
- Biophysical products : soil moisture, LAI, Fcover, Fapar
- Crop Growth Condition/Stress
- Biomass and yield monitoring (not in near real time)
- Water requirements (irrigation), mapping of WUE
- Fluxes and budgets of energy, water &C
- Identification of strategies for CC mitigation and sustainable agriculture

Regional estimates for winter wheat

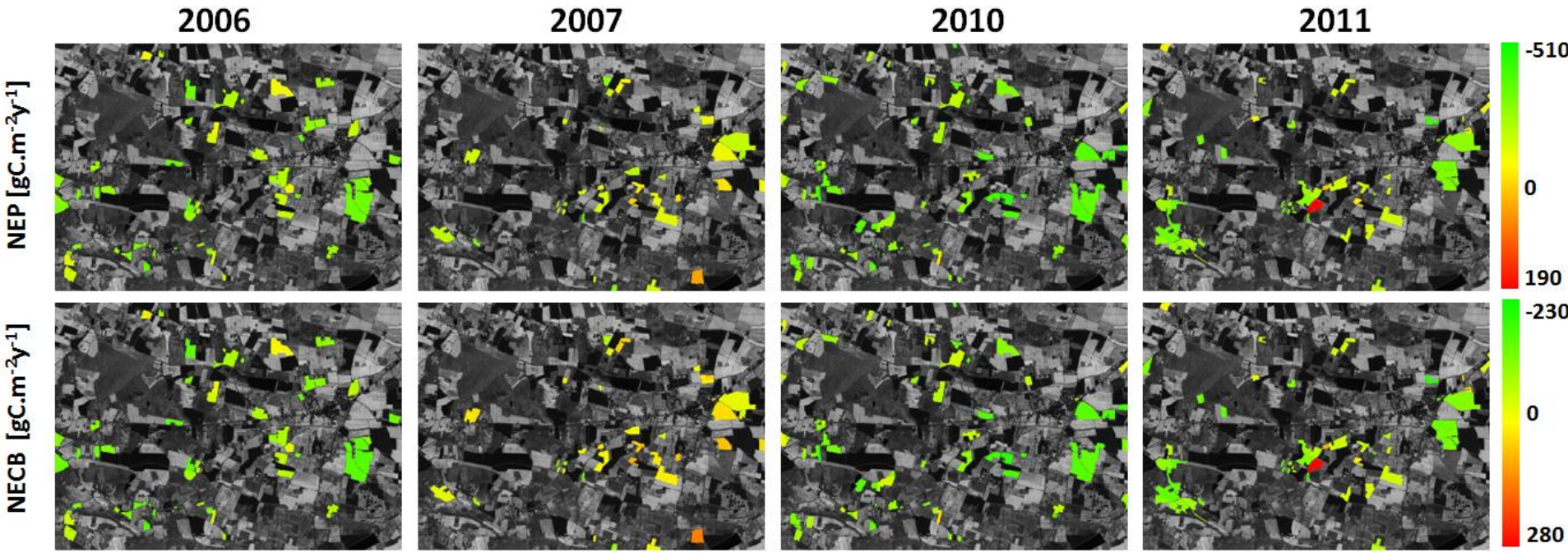
Veloso (2014)



Regional estimates for winter wheat

Veloso (2014)

Net CO_2 fluxes (NEP) & C budget (NECB)



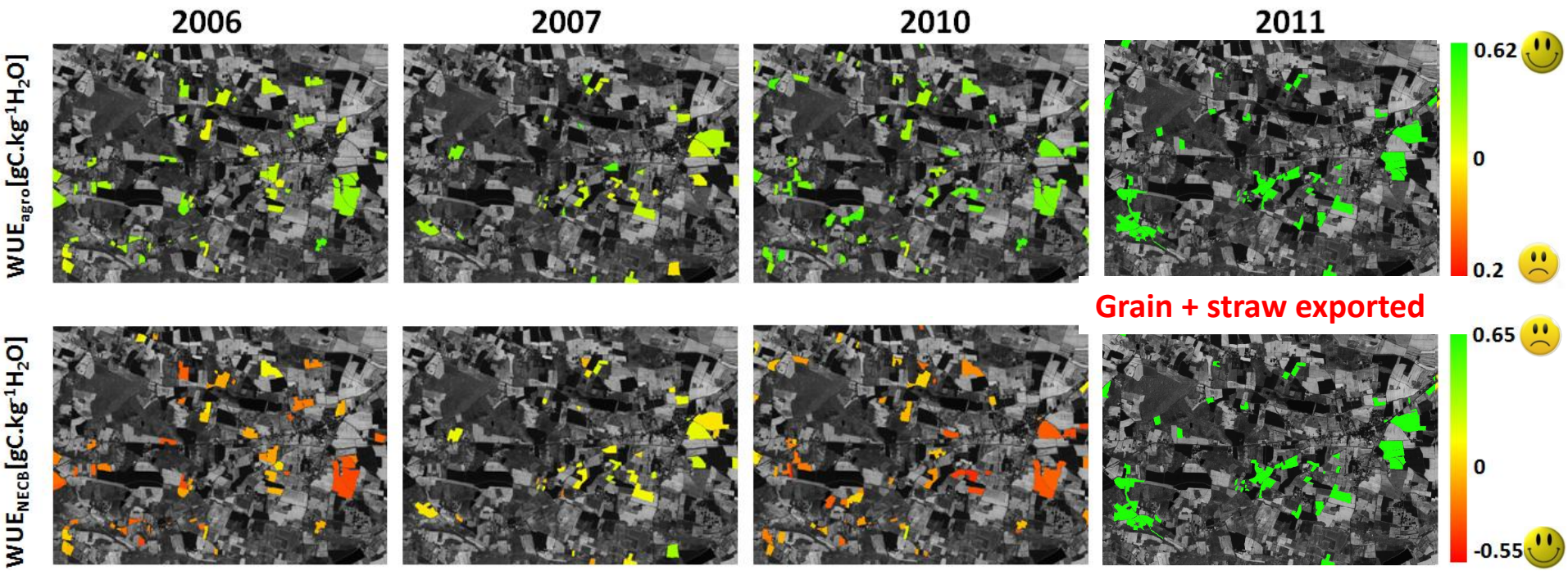
Agronomical vs environmental WUE

Veloso (2014)

$WUE_{agronomical}$ = yield or biomass exported/ETR
$WUE_{environnemental}$ = C budget /ETR

Tallec et al (2013) in AFM

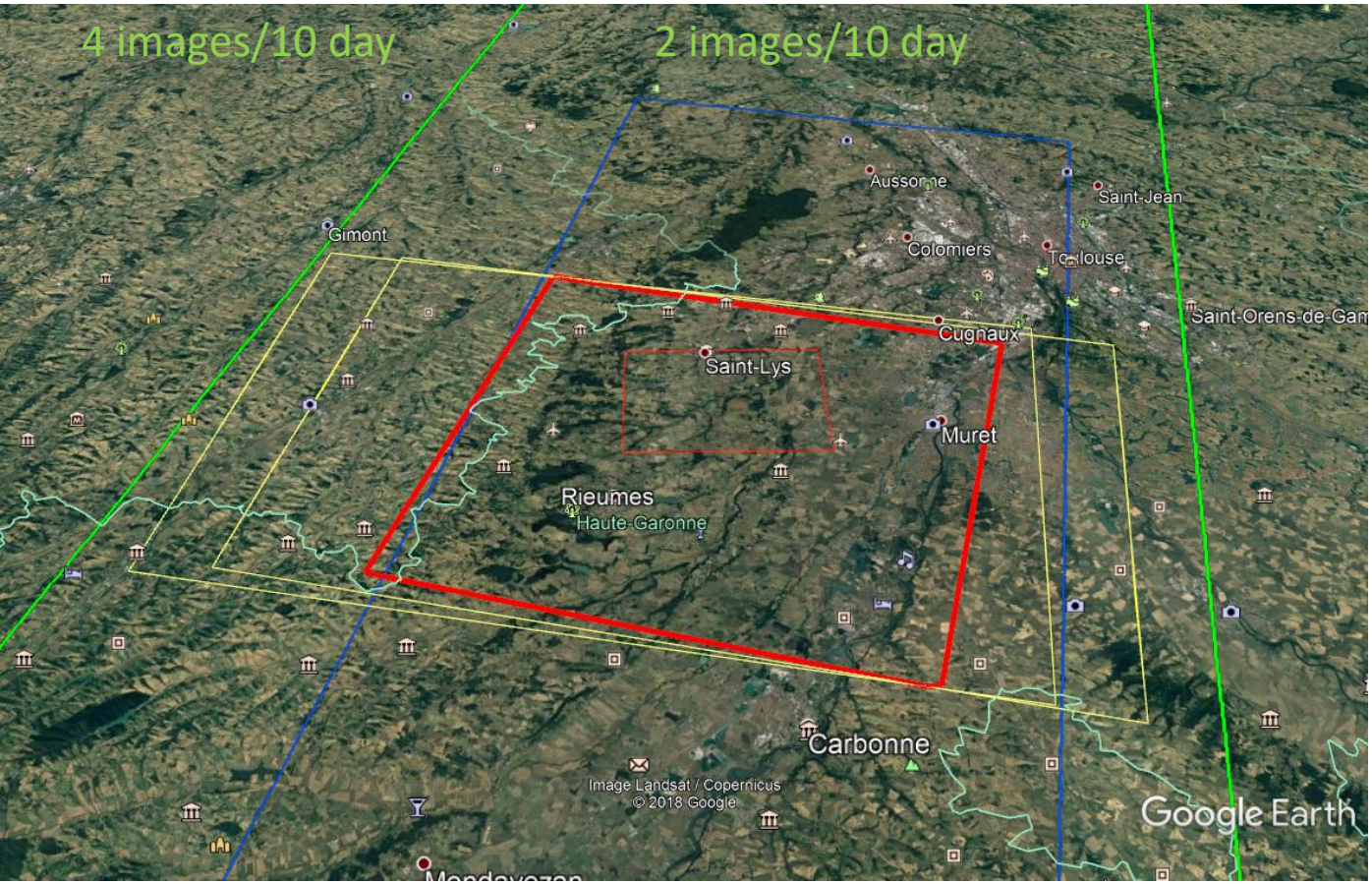
SAFYE-CO_2



Usefull approach to find compromises between productive and environmental ecosystem services.

Earth Observation Data Received/Used in 2018

- Optical : ESA Sentinel 2 (every 5 day), VenµS (every 2 day since May)
- SAR : Sentinel 1 (every 2 day), RadarSat (2-3/month) since April in WideFQ



OSR Jecam

Venµs

Sentinel 2

Radarsat2

In situ and Field survey Data in 2018

The largest field campaign ever conducted by CESBIO (H2020 Sensagri & Bag'ages projects).

On the road : over ≈ 2000 fields X 4 dates (crop type, soil work in 5 classes, irrigation, cover crop, crop residues, weeds)

In the field :

- Biomass + LAI (Digital Hemispherical Photograph, VALERI protocol) + surface SWC survey over 30 fields for winter crops X 4 dates and 30 fields for summer crops X 3 dates,
- LAI inter-comparison of destructive, DHP and Sunscan (3 dates X 2 fields),
- Cover crop : biomass sampling over ≈ 30 fields,
- Soil rugosity ≈ 30 fields X 3 dates with needle rugosimeter,
- Yield mapping by means of combine harvester yield monitor (more than 30 fields)
- 8 Soil & meteorological stations (temperature, albedo…),
- Two ICOS flux sites (Auradé & Lamasquère)

Collaborations

- H2020 SENSAGRI (Sentinel Synergy for Agricultures) :
  - Collaboration with Univ. of Valencia (IPL) & ITACyL (Spain), CNR-ISSIA & CREA (Italy, JECAM site), Institute of Plant Protection (Poland, JECAM site), Space Research Institute NAS (Ukraine, JECAM site), Agricultural Research Council (South Africa, JECAM site).
  - All those partners provide ground truth to CESBIO for the crop mask/crop type mapping (learning of the algorithm/validation), and for validation of the SAFYE-CO2 model outputs (yield, biomass…). CESBIO provides LAI data to IPL and soil humidity/roughness to CNR-ISSIA for validation of the LAI/soil humidity maps
- Collaboration with INRA-Avignon (LAI inversion with S2) : 60 field survey in 2018
- Several projects with local authorities/water council/ companies : mainly concerning the analysis of the impact of agro-ecological practices over yield and environmental indicators (C/water budgets, WUE…)

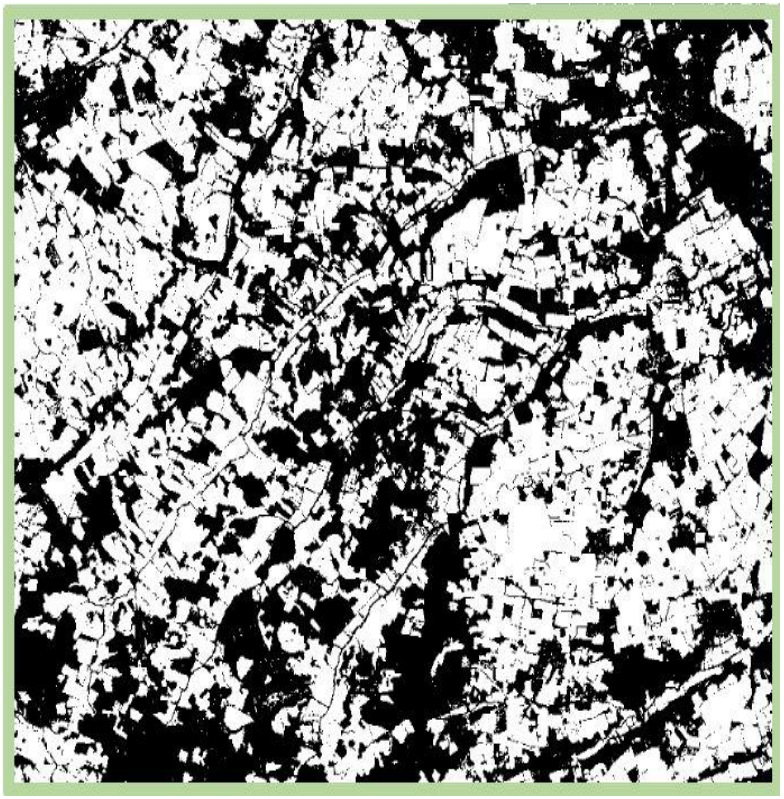
Main achievements in 2018

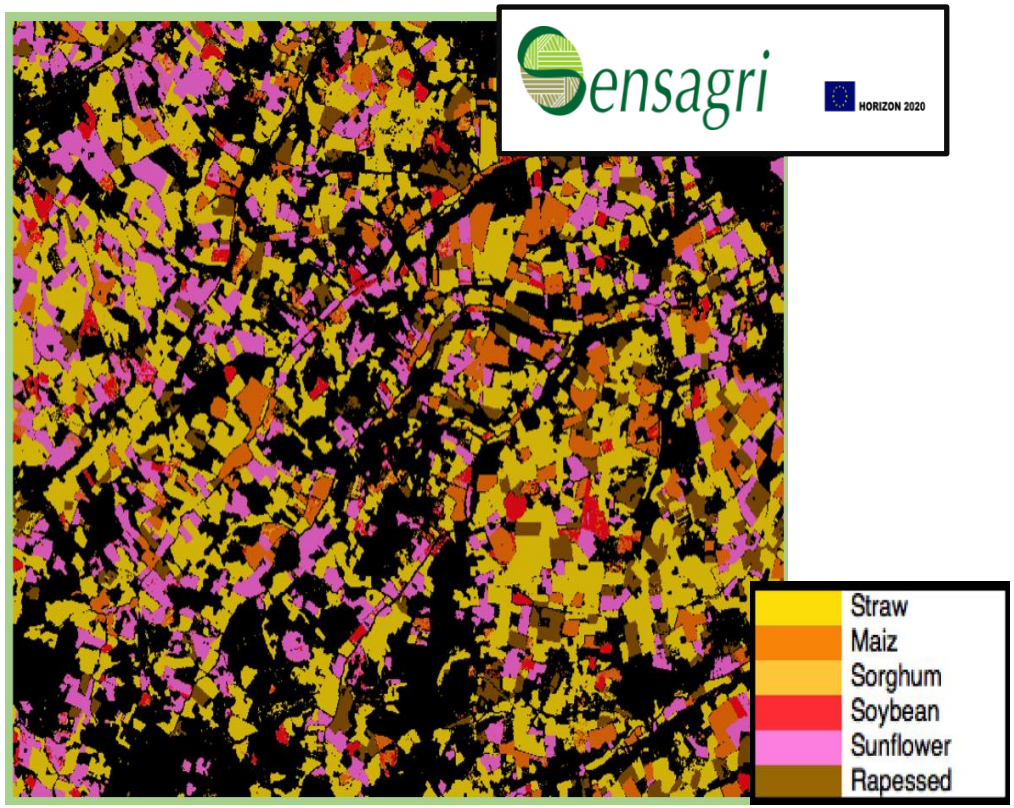
- Processing of satellite images for 2016 and 2017:
  - Sentinel-2, Landsat-8, Venµs: with atmospheric correction and cloud detection by MAJA software, images distributed by THEIA (www.theia-land.fr)
  - Sentinel-1: orthorectified and tiled to S2 on PEPS website (peps.cnes.fr), speckle filtered by a python script (http://tully.ups-tlse.fr/koleckt/s1tiling) using Orfeo Toolbox library

- Study of the synergy radar/optical images for crop classification, but still many questions to answer:
  - Use of new features to improve classification accuracies ? use of new spectral red-edge indices ? Which pre-processing for radar images? How to combine radar and optical information ? Which kind of complementary information? How to deal with the large data volume? What about the quality of the « reference data » ?

Main results in 2018

10 m resolution crop mask and crop type map on a 200km x 200 km zone in 2016 and 2017, using Sentinel-1 and Sentinel-2 (same in Spain and Italy). Products of H2020 Sensagri (Sentinels Synergie for Agriculture) project

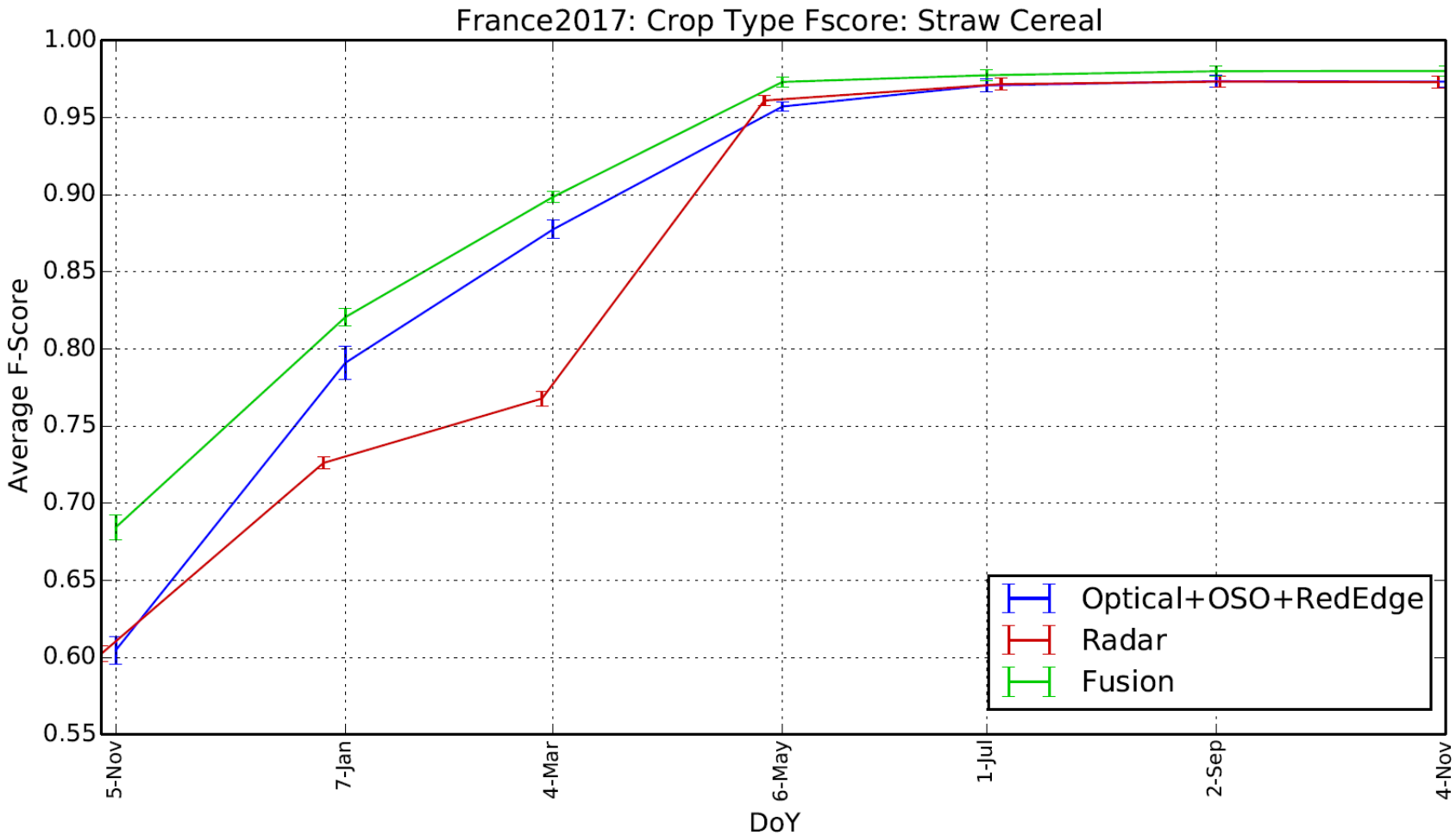




Binary Crop mask (W: crop B: no crop)

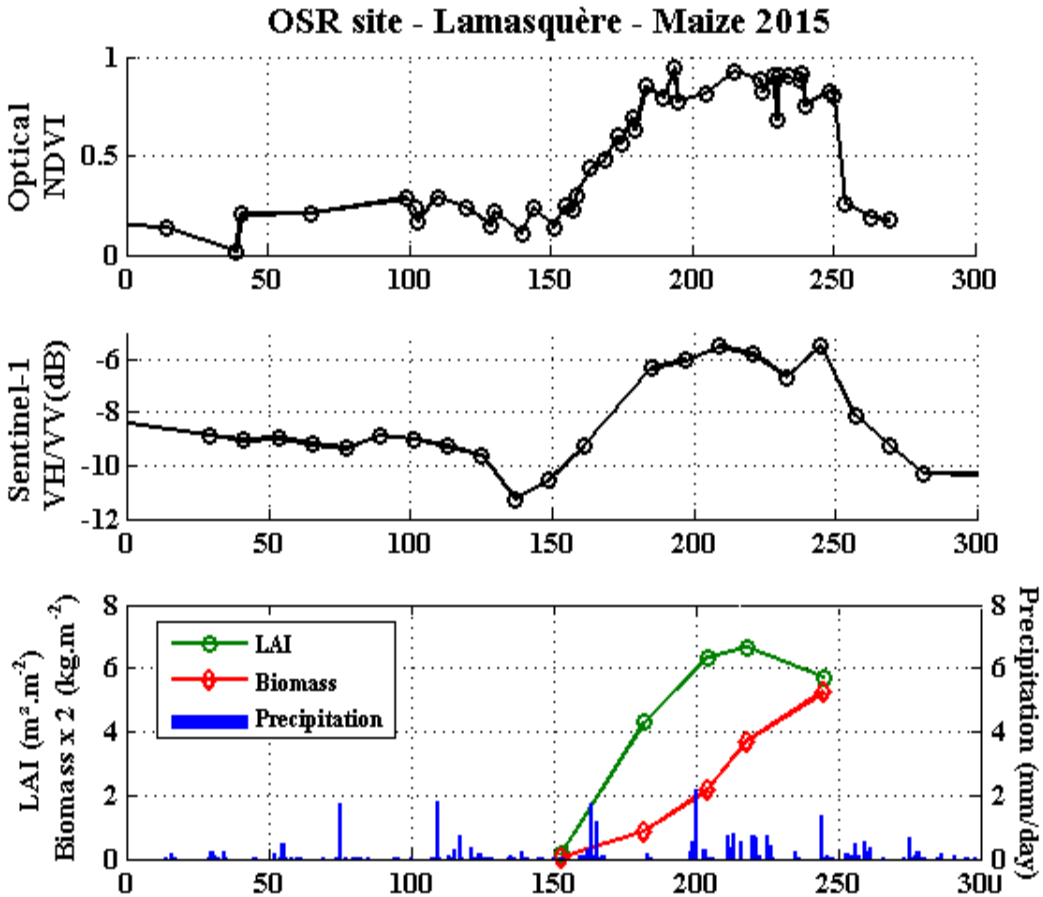
Main results in 2018

Fusion of S1 and S2 classifications provide the best results and earlier identification than optical or SAR alone (for all crop species)



Main results in 2018

Time series analysis: Sentinel-1, Spot+ Formosat, in situ data for different crop types



2017

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Understanding the temporal behavior of crops using Sentinel-1 and Sentinel-2-like data for agricultural applications

Amanda Veloso *,1, Stéphane Mermoz, Alexandre Bouvet, Thuy Le Toan, Milena Planells, Jean-François Dejoux, Eric Ceschia

CESBIO, Université de Toulouse, CNES/CNRS/IRD/UPS, Toulouse, France

Plans for Next Growing Season

- Will you hold the course, or modify the approach?

No field survey in 2019 !! (we need some rest)

- Do you anticipate using the same type/quantity of EO data next year?

Definitely NO !! (not in a near future)

- If no, how have your needs changed?

We have plenty of data to analyse/process, algorithms/models we want to test/implement and papers to write ! (ex. We plan to study the complementary in modes and time acquisitions of Radarsat2/S1)