

The Regional Spatial Observatory (OSR) for a sustainable management of territories and their resources in the South-West of France

Created in 2000, supported by the CESBIO and labelled by INSU since 2007

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Objectives, data use and collection strategies

- The OSR aims at documenting on the long term the **climatic, hydrologic, and agro-ecologic evolutions** in the South-West of France.
- It is based on a **site covering an area of 50x50 km² in the South-West of Toulouse** in which **intensive, detailed and long-term monitoring** is performed on **agro-ecosystems**.
- The data collected and **internationally shared** through OSR help in :
 - Investigating** the interactions between climate and anthropic pressure on agronomical and environmental services of agro-ecosystems from plot to regional scale.
 - Demonstrating** the high potential of combining remote sensing, modeling, partnership and *in situ* data for interdisciplinary research themes covering: physics, ecology, meteorology, hydrology, agronomy.
 - Showing** the contribution of scientific innovation in the elaboration of territorial and resources management strategies.

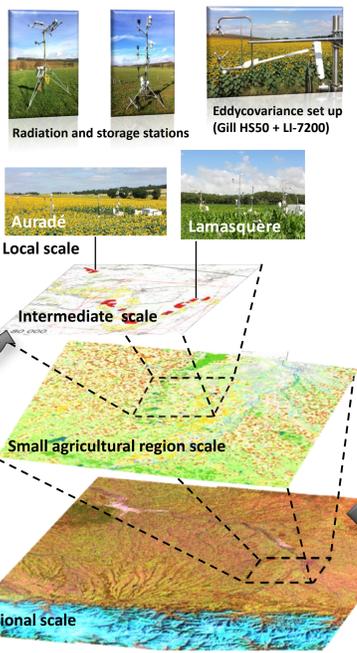
Which data? Meteorological, radiation, biometric (biomass, yield, green area index, etc.) and physico-chemical measurements on soil and vegetation, turbulent fluxes (CO₂/H₂O/N₂O, energy) following ICOS protocol, snow in the Pyrénées, Land cover and use.

A multi-scales monitoring network

- Long term continuous monitoring: **Two ICOS crop sites** (Lamasquère and Auradé, site manager : B. Zawilski) with contrasted and well documented management since 2005, a low mountain range grassland site (Lannemezan) + a high altitude site for snow monitoring since 2012. About **500 plots annually monitored** (surface state, land cover, etc.) since 2008.

- Mid-term monitoring (± 4 years) : Measurements of key variables for adjusting and spatially validating remote sensing algorithms and/or models outputs. Experiments conducted on wider scales (watershed) with reinforced observations on several crop plots.

- Special campaigns: Occasional and wider intensive measurements, covering a few days to several months (Ex: MCM'10, SPOT4-take5, S2-Agri).



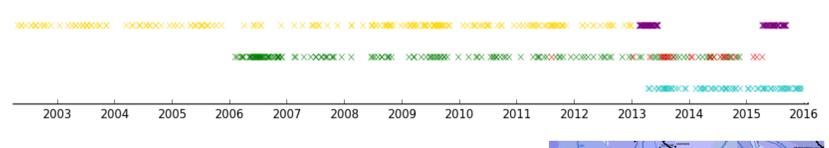
In situ observations

OSR's components and associated research activities

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:

- SPOT
- LANDSAT
- FORMOSAT
- SPOT_TAKE_5
- DEIMOS



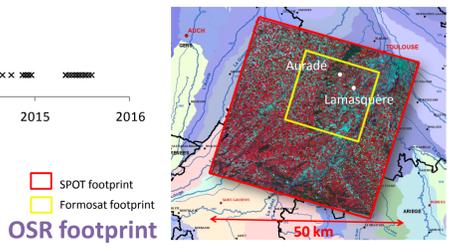
Radar images:

- RADARSAT-2
- Alos
- TerraSAR-X



Remote sensing observations

Available through Kalidéos, ESA and THEIA portals



Geodatabase & web services

- Processing chain for the integration, processing and distribution of the *in situ* data and of the modeling products
- Infrastructure management for archiving and safeguarding

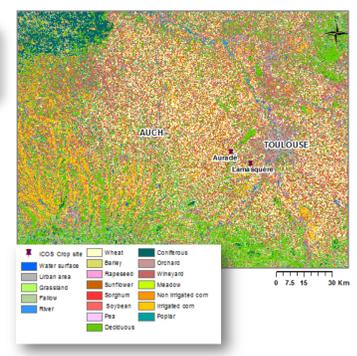
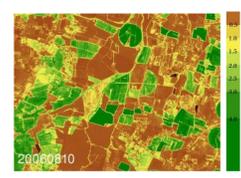
Partnership

- a key component for studies, methods and validation data sharing,
- involve a varied and rich network of partners : research laboratories, industrials, administration, farmers, technical structure, ...
- to address different agronomical and environmental aspects.

Mapping

for observatory and modeling

Biophysical products resulting from temporal synthesis, ex : Green area index map from SPOT and FORMOSAT-2 images time series.

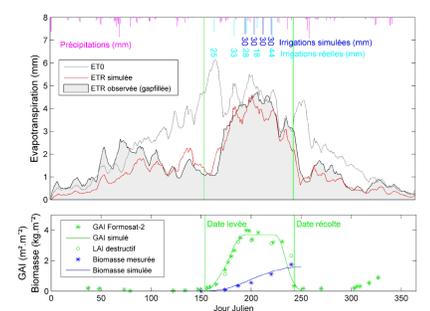


Land cover map, created from Landsat 8 for year 2015 (20 land cover classes); kappa index 0.84, overall accuracy index 0.88.

Interfacing of models and algorithms

OSR is providing added value products through the interfacing with existing models and the integration of the high end products into the database.

- Products include:
- Yield estimates
 - Early forecast of sunflower yield
 - Water use estimates
 - CO₂ fluxes/C budgets



Modeling the crop dynamics at the monitored sites. Modeled and observed evapotranspiration (above), biomass and GAI (down).

Associated Research, R&D activities

Involvement of OSR in:

Observation programmes: Theia/ Copernicus/ JECAM/ ERIC ICOS
Projects: ESA S2Agri/ H2020 SenSagri/ MAISEO/ BAG'AGE/ ESA SpaceHydroCrop/ REGARD/ RUE des sols

Plans for 2017

- Estimate maize water needs at catchment scale.
- Simulate regional CO₂ fluxes and carbon budgets at crop rotation scale.
- Deepen combined use of radar and optical images (Sentinel-1 and 2) to improve both surface state^[7] [8] & land use mapping and crops functioning modeling (yield, biomass)^[9] [10].
- Introduce HSTR GAI and land use products in a land surface model to improve river discharge modeling.
- Monitor the database functioning, continue the updating of crop sites to ICOS standard.

Main Progress in 2016

- Agronomical sciences:**
 - Enhancing yield and biomass estimates^[1] using multi-temporal optical images series over large area.
 - Early crop mapping and seasonal crop mask mapping with the joint use of optical and radar HSTR image times series^[2] [3].
 - Retrieval of soil water holding capacity parameters (depth and porosity) using GAI dynamics from HSRT optical image time series in an agro-hydrological model at plot scale^[4].
- Physical sciences:** Availability of Sentinel-2A data corrected for atmospheric effects using SCAS code.
- Hydrological sciences:** enhancing water cycle simulation using multi-temporal optical series (real GAI dynamics) to force a land surface model^[5].
- Ecological sciences :** CO₂ fluxes and carbon budget estimates on winter wheat across a large climate gradient in Europe with a generic crop model^[6], over large area combining remote sensing and a simple crop model .
- Infrastructure and data distribution:** Database with integration of the *in situ* data, land cover and GAI maps; crop model interfacing; updating of crop sites to ICOS standard.

Scientific production in 2016

[1] Battude et al., Estimating maize biomass and yield over large areas using high spatial and temporal resolution Sentinel-2 like remote sensing data, Remote Sens. Environ. 184, 668-681
 [2] Inglada et al., Improved Early Crop Type Identification By Joint Use of High Temporal Resolution SAR And Optical Image Time Series. Remote Sens., 8(5), 362; doi:10.3390/rs8050362
 [3] Marais Sicre et al., "Early Detection of Summer Crops Using High Spatial Resolution Optical Image Time Series", accepted in Remote Sensing
 [4] Ferrant et al. Extracting Soil Water Holding Capacity Parameters of a Distributed Agro-Hydrological Model from High Resolution Optical Satellite Observations Series. Remote Sens. 8(2), 154; doi:10.3390/rs8020154
 [5] Etchanchu et al., Influence of multi-temporal high resolution remote sensing products on simulated hydrometeorological variables in the south-west of France, International Congress of the Environmental Modelling and Software Society, Toulouse, France.
 [6] Vuichard et al., Simulating the net ecosystem CO₂ exchange and its components over winter wheat cultivation sites across a large climate gradient in Europe using the ORCHIDEE-STICS generic model, Agr. Ecosyst. Environ., doi: 10.1016/j.agee.2016.04.017
 [7] Baup et al., Sensitivity of X-band (s0, g) and optical (NDVI) satellite data to corn height variation, accepted in Advances in Remote Sensing,
 [8] Fieuzal et al., Estimation of leaf area index and crop height of sunflowers using multi-temporal optical and SAR satellite data, Int. J. Remote Sens., doi: 10.1080/01431161.2016.1176276
 [9] Baup et al., Assimilation of TerraSAR-X and optical data into an agro-meteorological model to estimate wheat biophysical parameters (LAI, biomass, yield). TerraSAR-X / TanDEM-X science team meeting.
 [10] Betbeder et al., Assimilation of LAI and dry biomass data from optical and SAR images into an agro-meteorological model to estimate soybean yield. Journal of Selected Topics in Applied Earth Observations and Remote Sensing, doi: 10.1109/JSTARS.2016.2541169