A CASE STUDY ON HIGH RESOLUTION IMAGES TIME SERIES FOR AGRICULTURAL LAND COVER MAPPING AND EVAPOTRANSPIRATION

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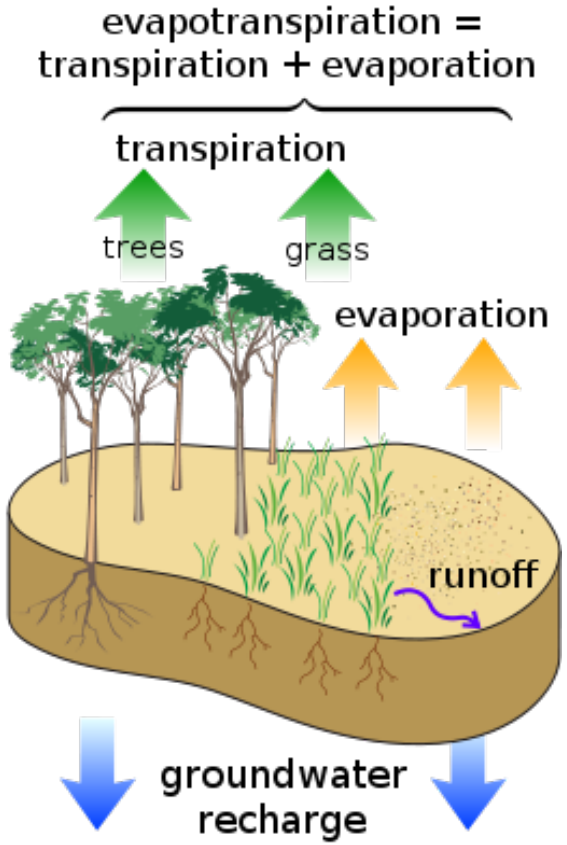
OBJECTIVE : PREPARATION OF SENTINEL-2 OPERATIONAL EXPLOITATION.

Sirhyus Project :

SIRHYUS The project aims to design, develop and implement **operational services** dedicated to the **management of inland freshwater** ressources through integration, assimilation and exploitation of earth observation satellite data.

The purpose of this project is to offer new services, relying on scientific expertise and recognized manufacturers. In this context, **CESBIO is committed to developing a processing chain for reporting hydrological dynamics at global scale of a watershed**.

Which indicator to monitor for reporting hydrological dynamics ?



-Units : mm/day

-Factors of influences :

- plant type
- stage of growth of the plant
- plant height/root depth
- air humidity and temperature
- ....

-Order of magnitude of evapotranspiration :

- most important part of the water balance
- ~ 60% of the rainfall in continental areas

➔ Information about soil water quantity (drought)
➔ Very Useful water management agency

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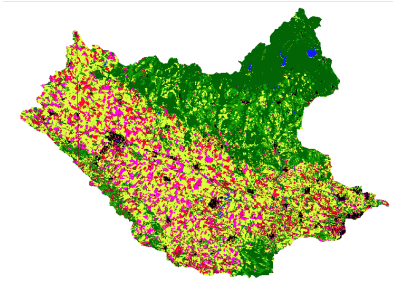
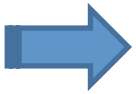
Constraints

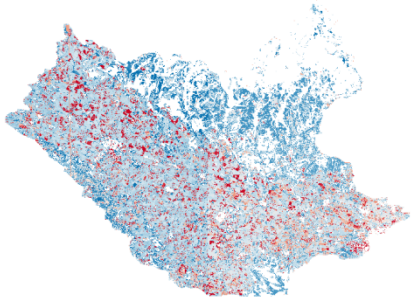
- **Automatic processing**
- **Low cost data**
- **Operational information (available for all users)**
- **Near real time**

Outcome of the Sirhyus project

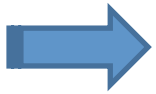


Classification product





Evapotranspiration products



Web Interface

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Multitemp_2015

Overview of the project

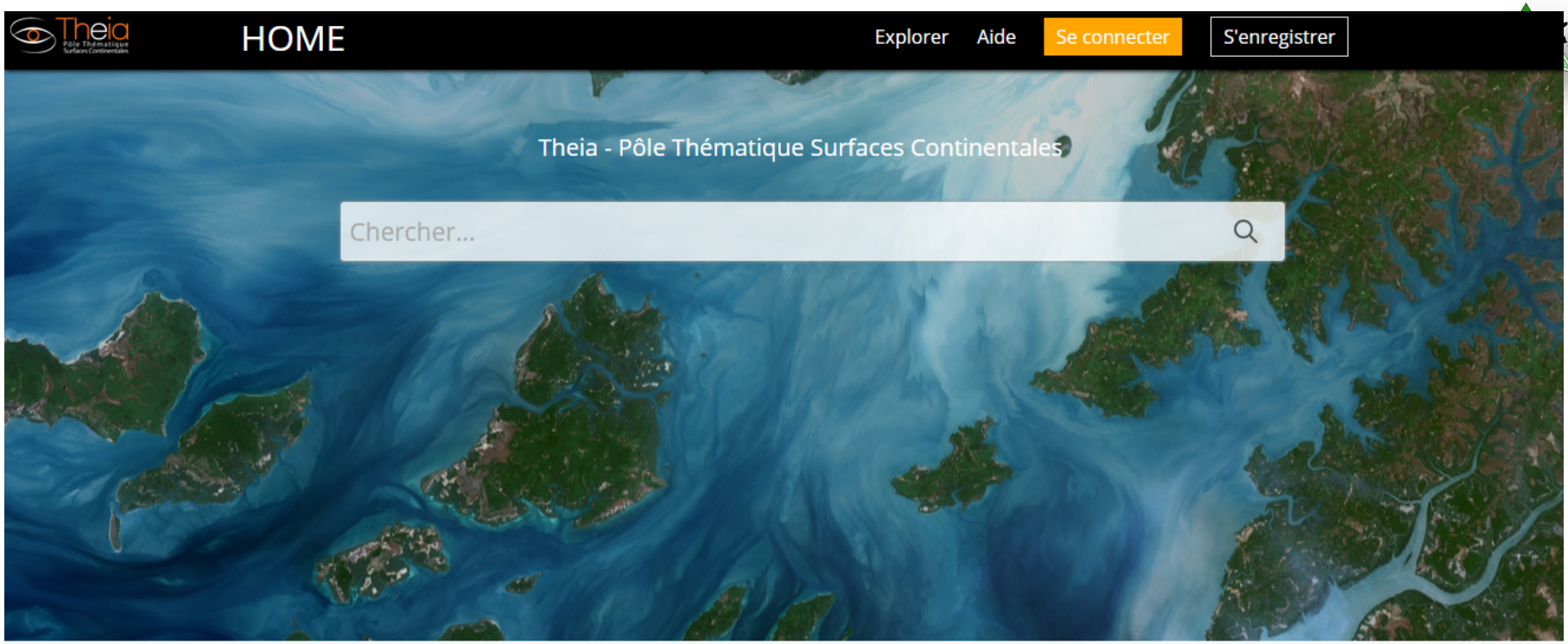
Studied Area : The Fresquel watershed

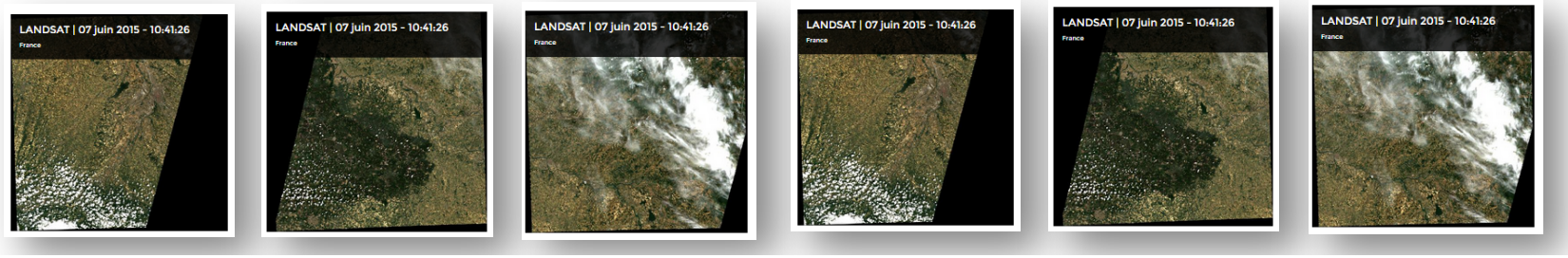
Area : 931 km²
Location : South-West of France
Water environment : fresh surface water
Agriculture Field: mainly cereals, meadow, vineyard, sunflower

Between Carcassone & Castelnaudary

A co-working project with irstea

I. **Introduction and global overview of the project**
II. Soil occupation
III. Evapotranpiration product
IV. Conclusion and future work





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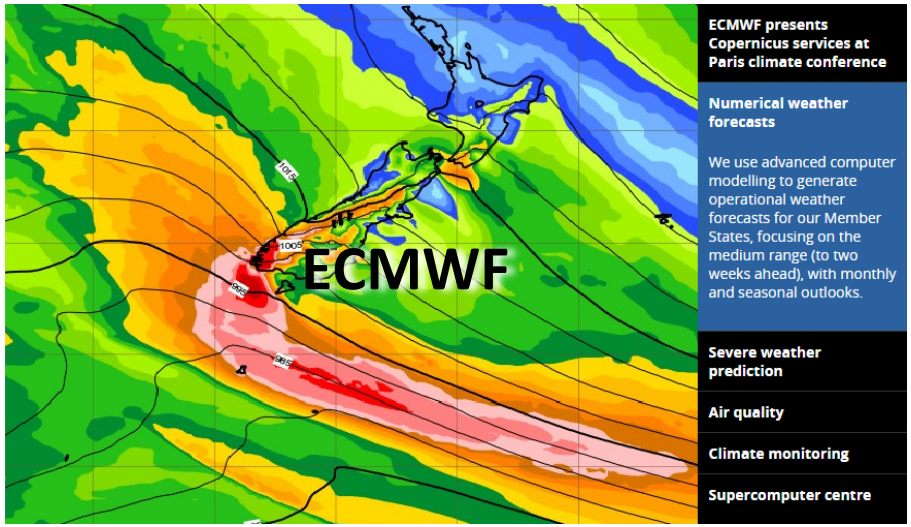

CESBIO

NATIONAL CENTERS FOR ENVIRONMENTAL PREDICTION
NCEP
WHERE AMERICA'S CLIMATE AND WEATHER SERVICES BEGIN
NCEP Products Inventory
Global Products
Updated: 10/17/2014

Combination

weather forecast daily data

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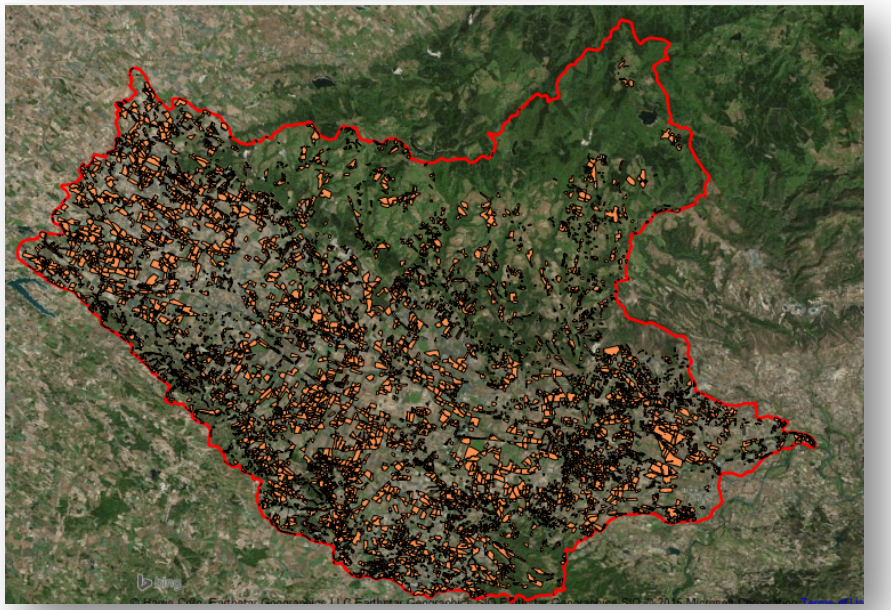
Agence de Services et de Paiement



RPG

Information on crops provided by farmers in the frame of the CAP (Common Agricultural Policy)

~8200 fields information
From 2011 to 2012

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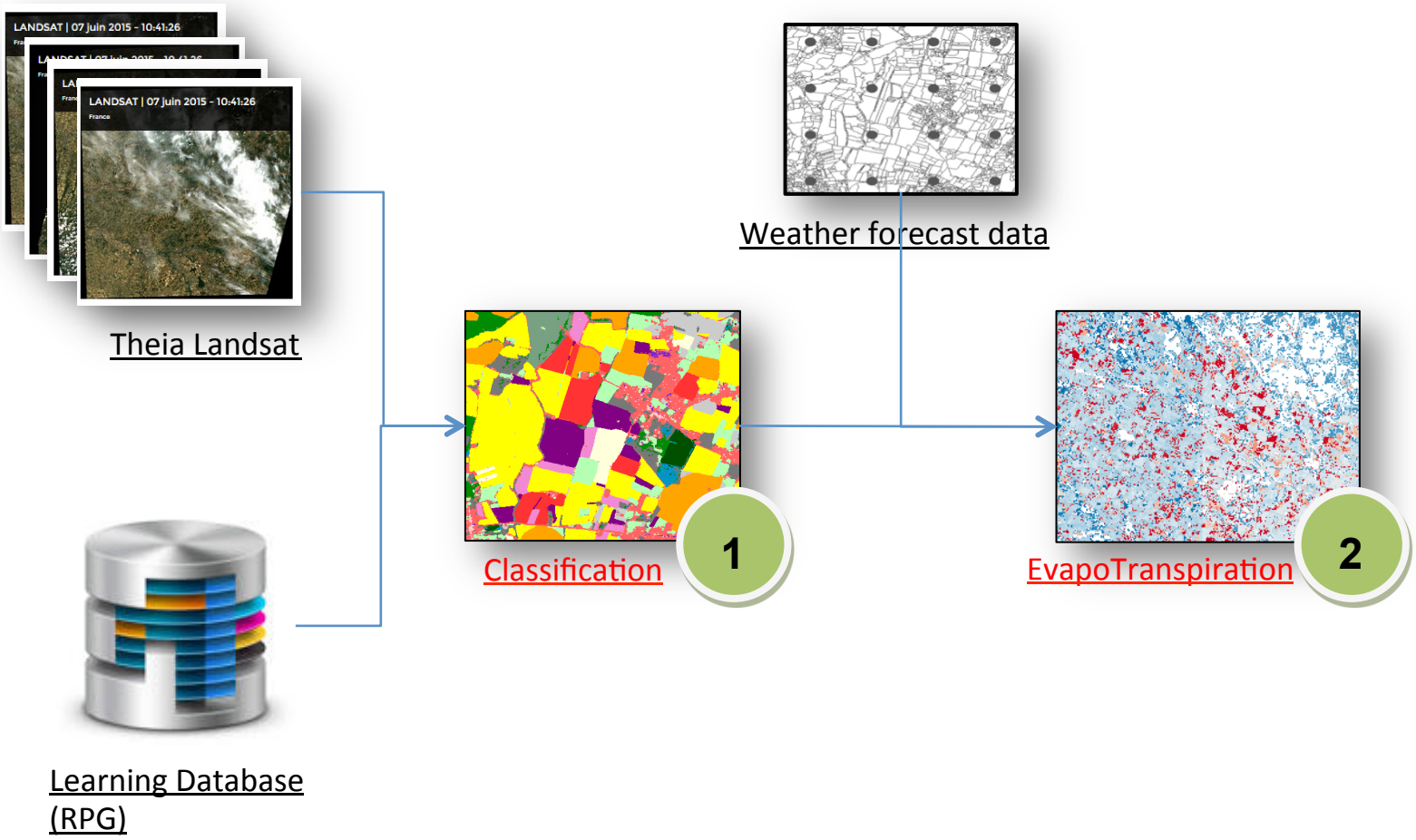
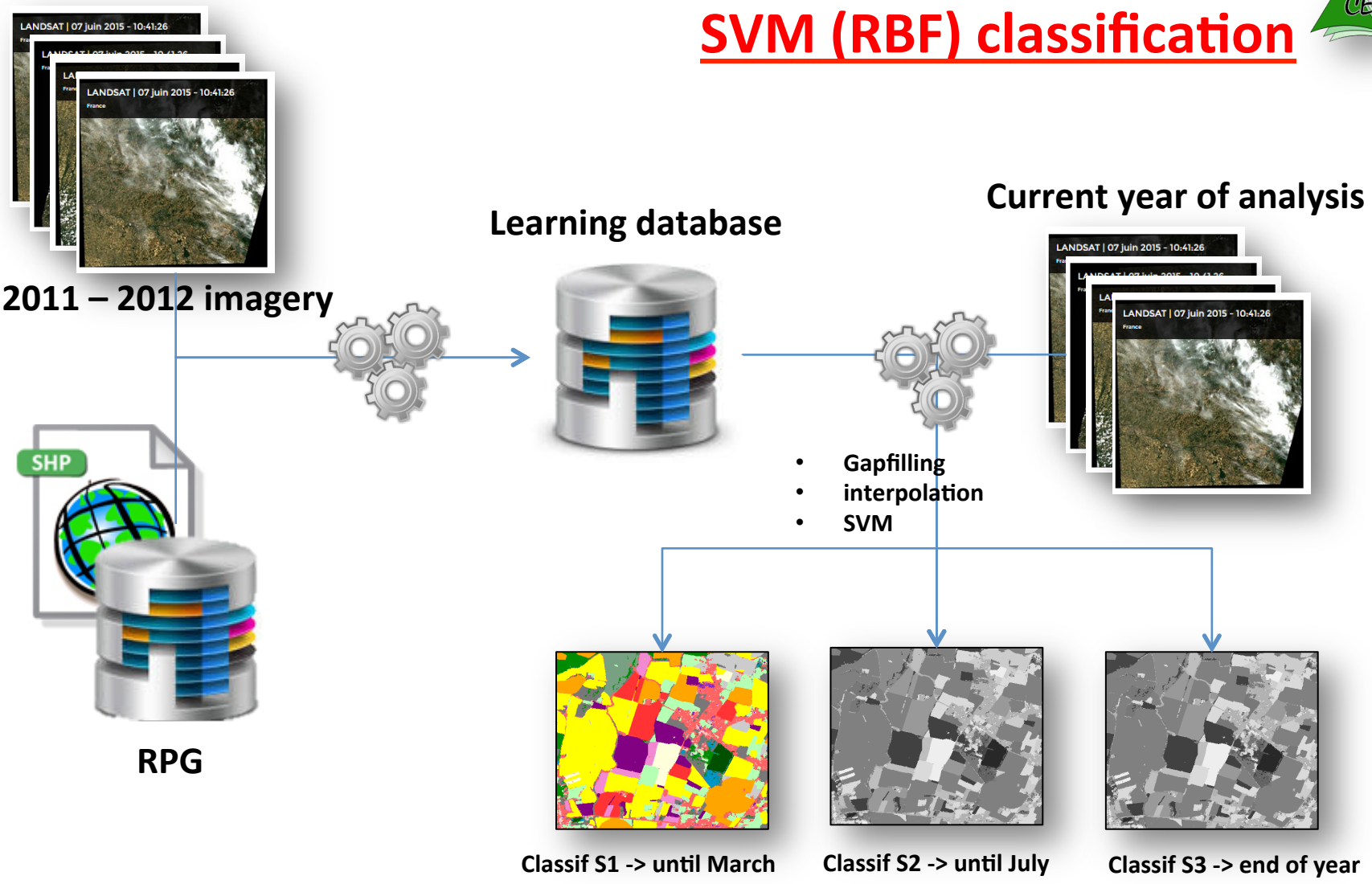
An overview of the data flow

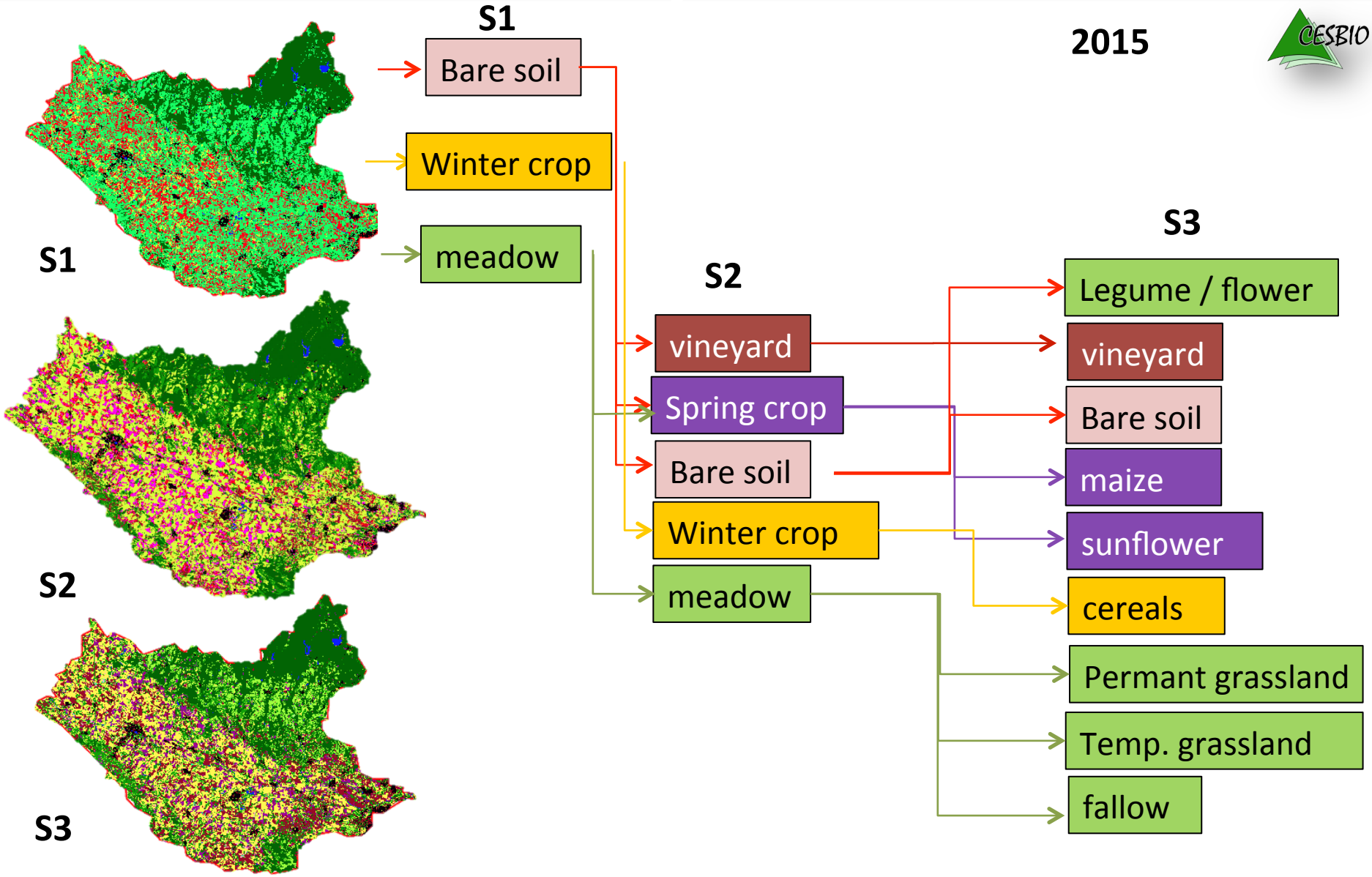


Multitemp_2015
Automatic Classification

SVM (RBF) classification



Based on preconisation on S2-agri (J.Inglada)


S1
Bare soil
Winter crop
meadow
S1
S2
S3
2015
S2
vineyard
Spring crop
Bare soil
Winter crop
meadow
S3
Legume / flower
vineyard
Bare soil
maize
sunflower
cereals
Permant grassland
Temp. grassland
fallow

Validation of classification over Midi-pyrénées Area in 2010 & 2013 [Kalideos]

	KAPPA	% wheat	%maize	%barley	%rape	%sunflowers	%meadow
2010-2011 *	**0.65**	0.793846 0.77085	0.913849 0.426427	0.111979 0.258982	0.14837 0.251099	0.83856 0.940899	0.919917 0.718067
2012-2013 **	**0.69**	0.705746 0.867507	0.915674 0.773704	0.0972041 0.0131516	0.951213 0.0142756	0.856868 0.826949	0.78074 0.891494

* Use Kalideos SPOT4-SPOT5 imagery

** Use of spot4-take5 timeseries for 2012-2013 completed with Kalideos imagery

Field campaign in progress from 2015

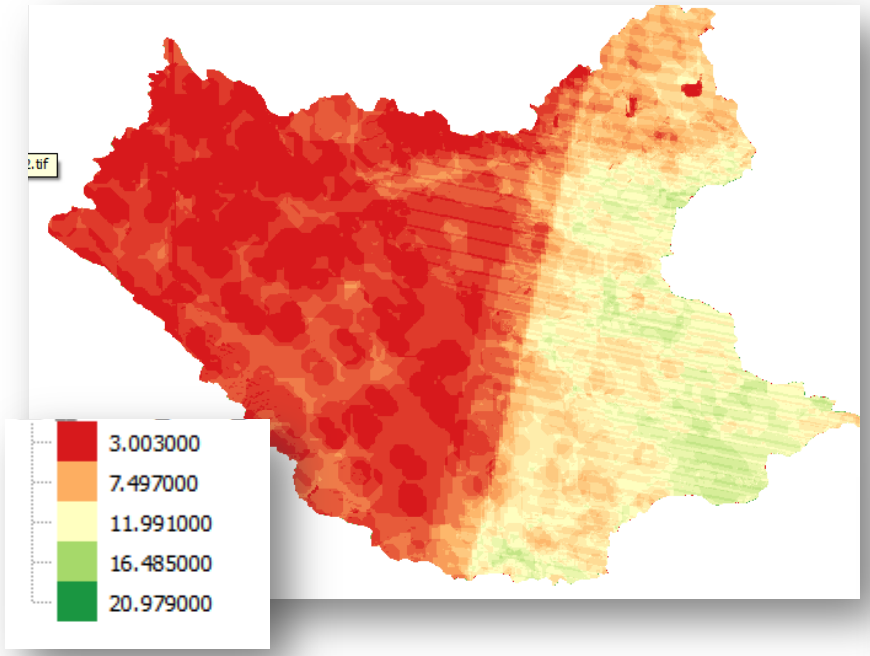
~ 250 fields analysed

Still not representative of the agronomic pattern of Fresquel watershed

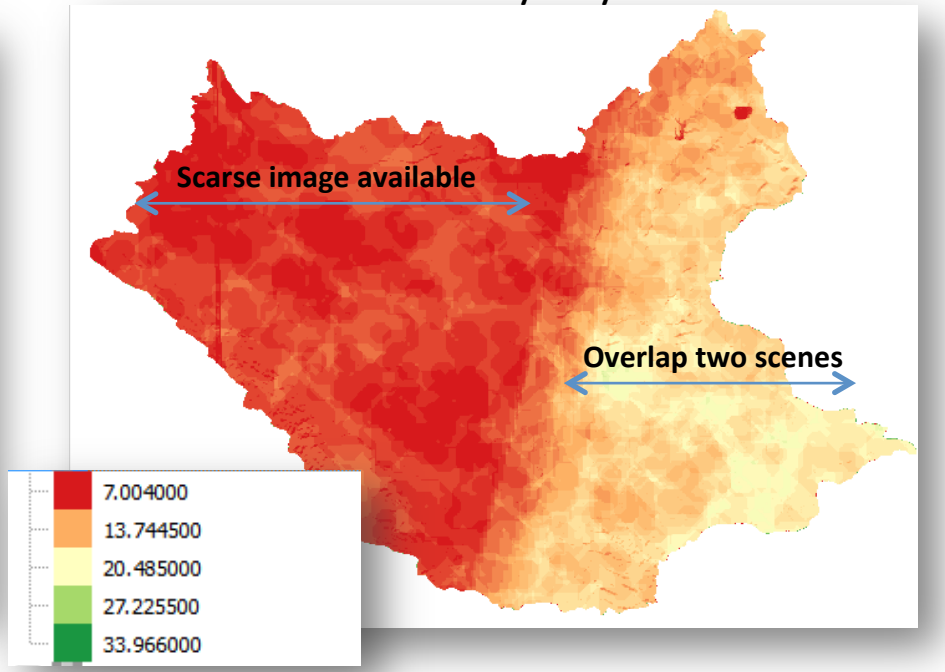
… In progress …

Limits

2013 : number of sunny day on the area



2014 : number of sunny day on the area



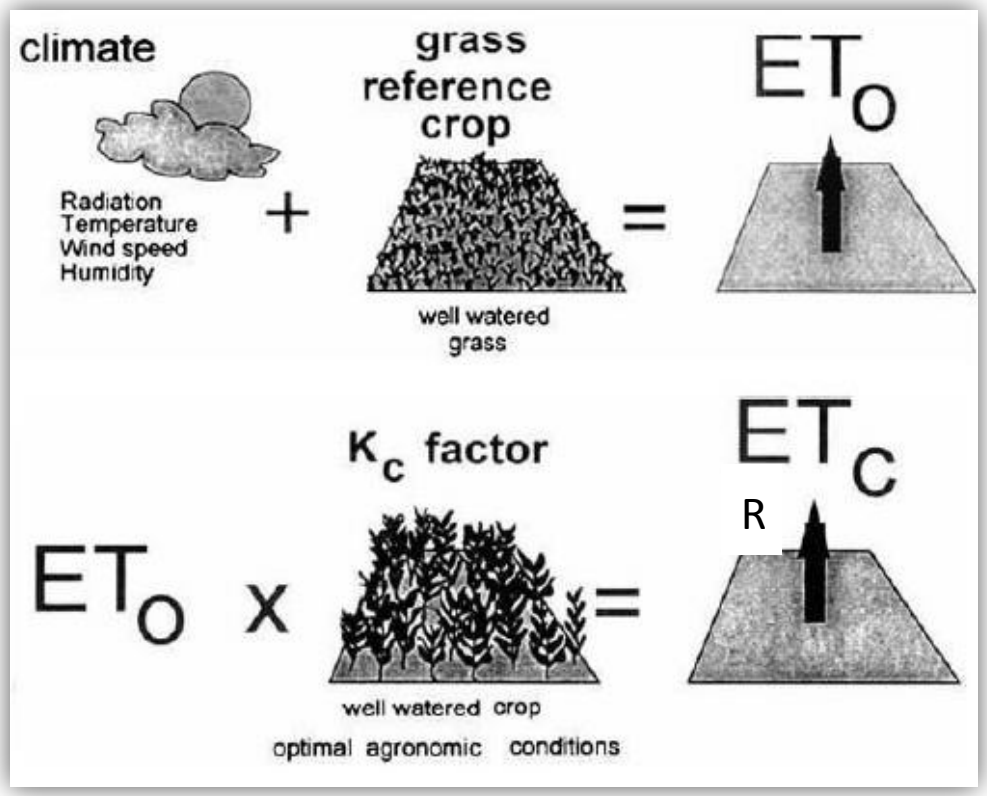
Very cloudy year are a real problem to deal with :

- only one observation until March for 2013 year
- very bad repartition of sunny day over the year

➔ An important limit for the use of Landsat Imagery

Multitemp_2015
Evapotranspiration

Computation of evapotranspirationn : Method FAO-56



$$ETR = K_c * ET_0 = (K_{cb} \times K_s + K_e) \times ET_0$$

$$ETR = (K_{cb} \times K_s) \times ET_0 + K_e \times ET_0$$

Transpiration — Plants

Evaporation — Soil

Method « **Dual Crop Coefficient** »

Allen and al. 1998 FAO n°56

Computation of ET0 : Penman Monteith equation

$$ET_o = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T+273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)}$$

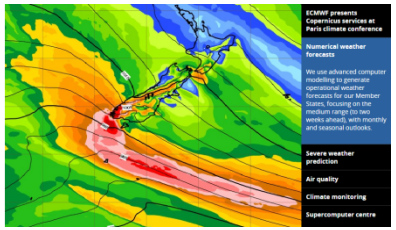
where :

ET_o reference evapotranspiration [mm day^{-1}],
R_n net radiation at the crop surface [MJ m^{-2} day^{-1}],
G soil heat flux density [MJ m^{-2} day^{-1}],
T mean daily air temperature at 2 m height [°C],
u_2 wind speed at 2 m height [m s^{-1}],
e_s saturation vapour pressure [kPa],
e_a actual vapour pressure [kPa],
$e_s - e_a$ saturation vapour pressure deficit [kPa],
D slope vapour pressure curve [kPa °C^{-1}],
g psychrometric constant [kPa °C^{-1}].

Meteorological data : several sources

GFS (NASA)

ERAinterim (UE)



Computation of KC

Several experimental campaign in France have been conducted By CESBIO to calibrate empirical relation FOR EACH CROP :

KC = a * NDVI + b

FC = A *NDVI + B

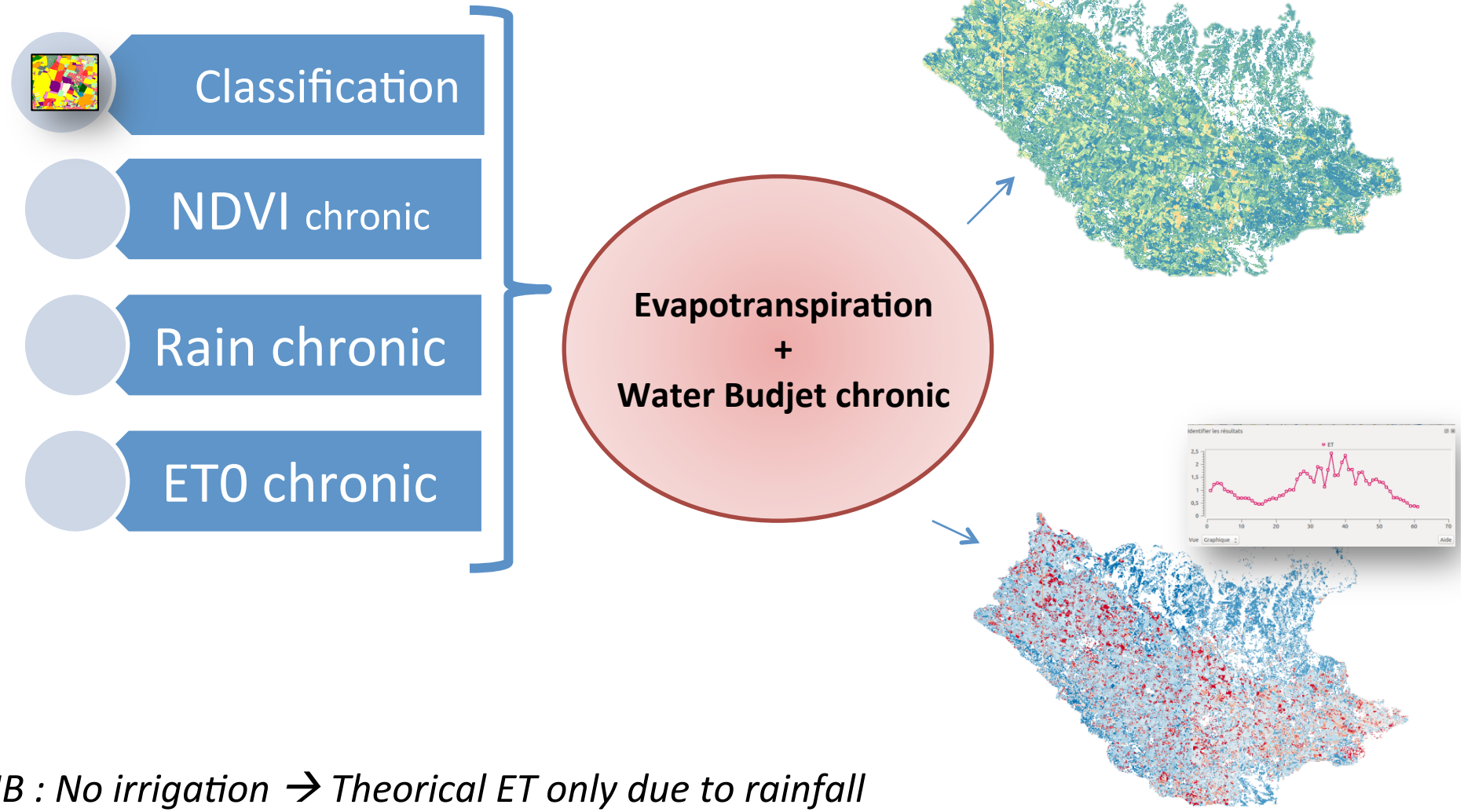
ET = ET0 * (Kc + Ke)

[…]

Field Experimentation, wheat, Lamasquère in 2010

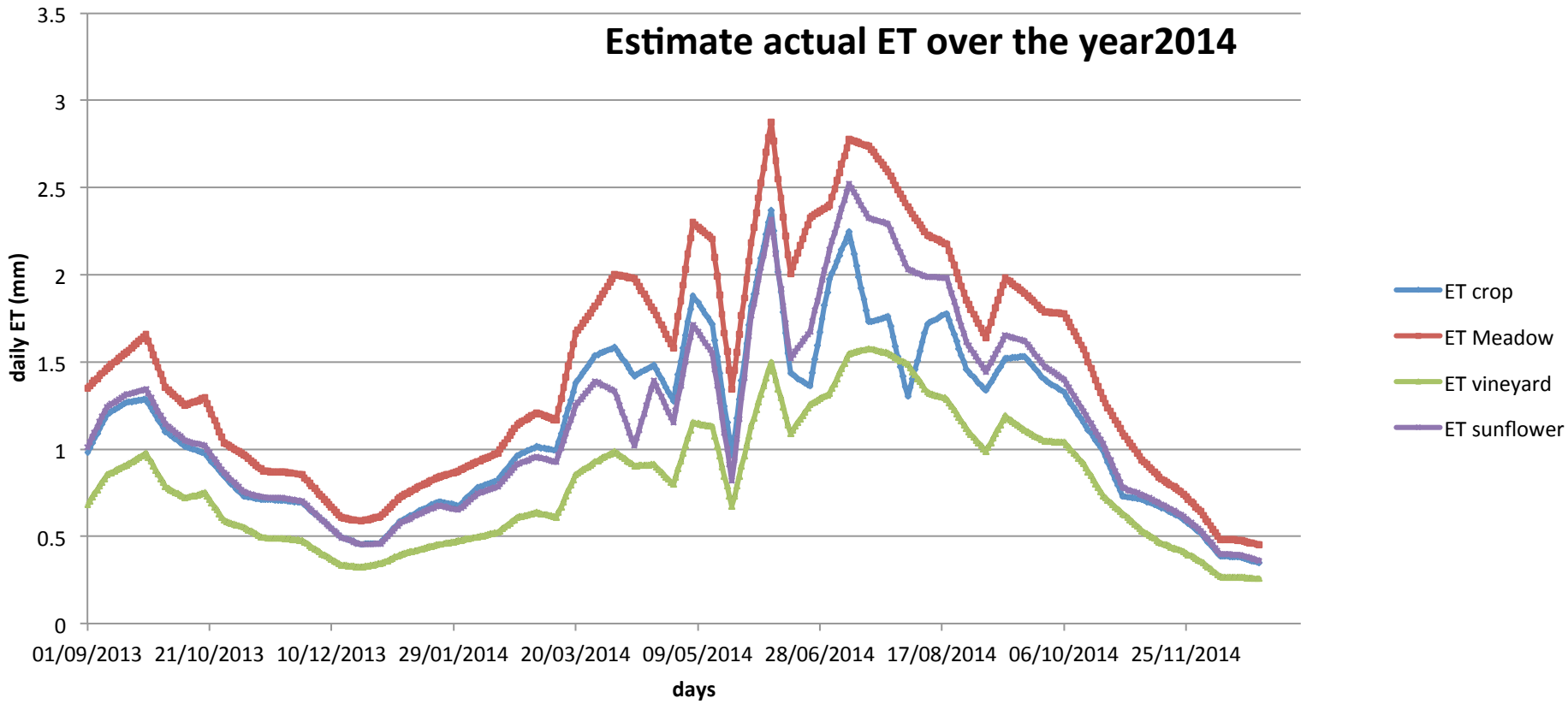
Model SAMIR : Satellite Monitoring Of Irrigation : FAO method + multi temporal time series images

Simonneaux et al. Estimation spatialisée de l'évapotranspiration des cultures irriguées par télédétection : application à la gestion de l'irrigation dans la plaine du Haouz, Sécheresse 2009 ; 20(1)

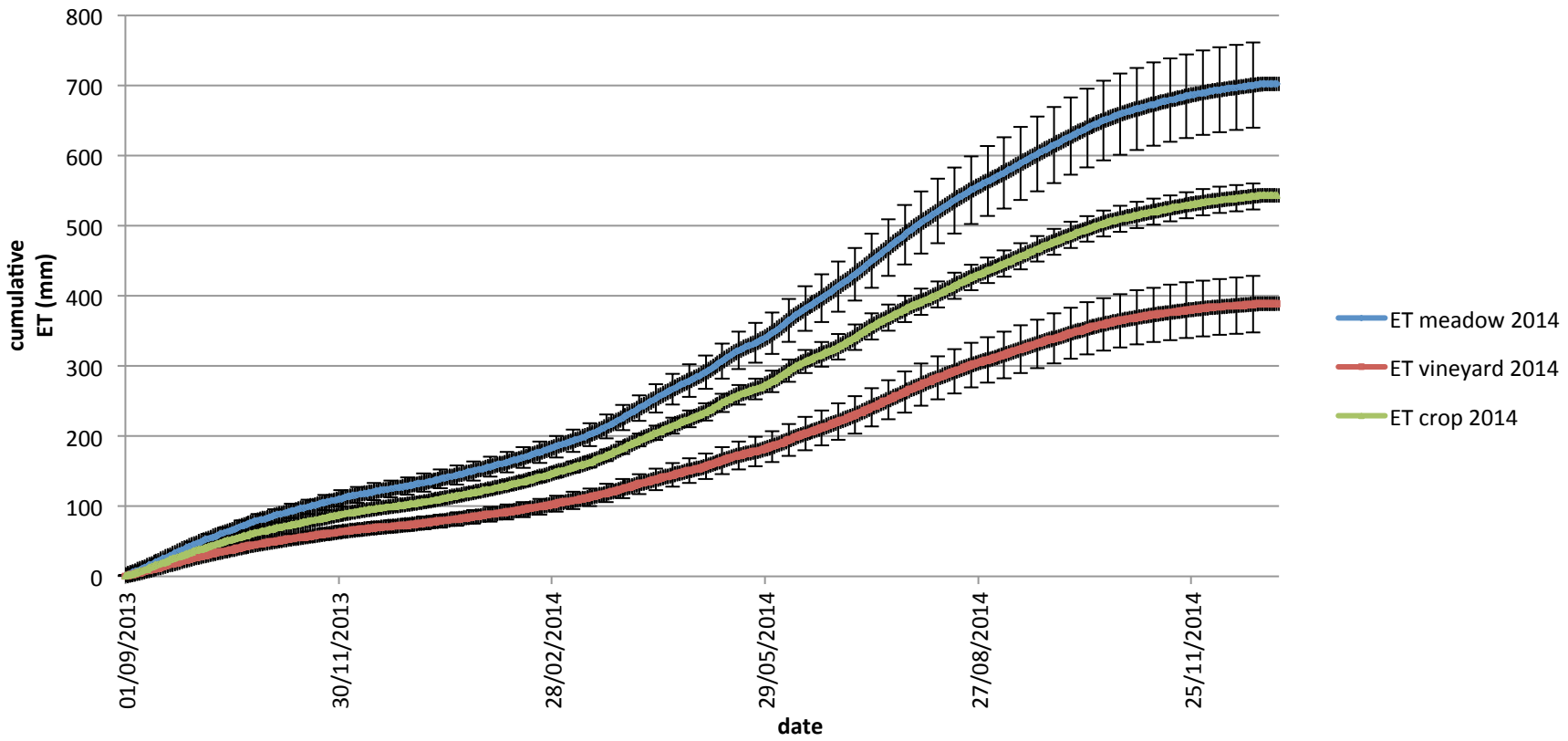


NB : No irrigation → Theorical ET only due to rainfall

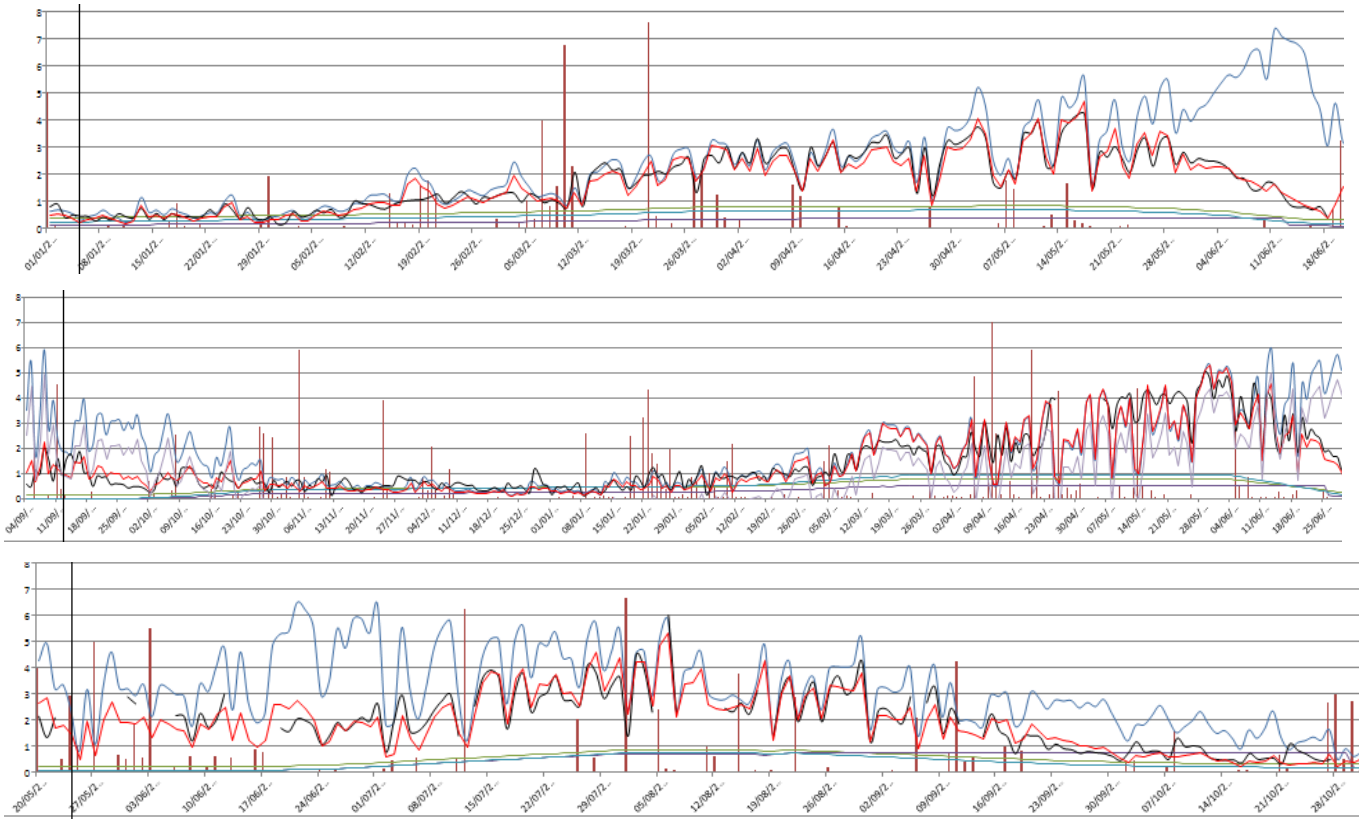
evapotranspiration of crop, meadow, vineyard and sunflower.



Cumulated evapotranspiration of crop, meadow and vineyard and STD over the year 2014



Validation with in-situ data (edy Covariance) set



AURADE 2006
Wheat
Nash = 93.7

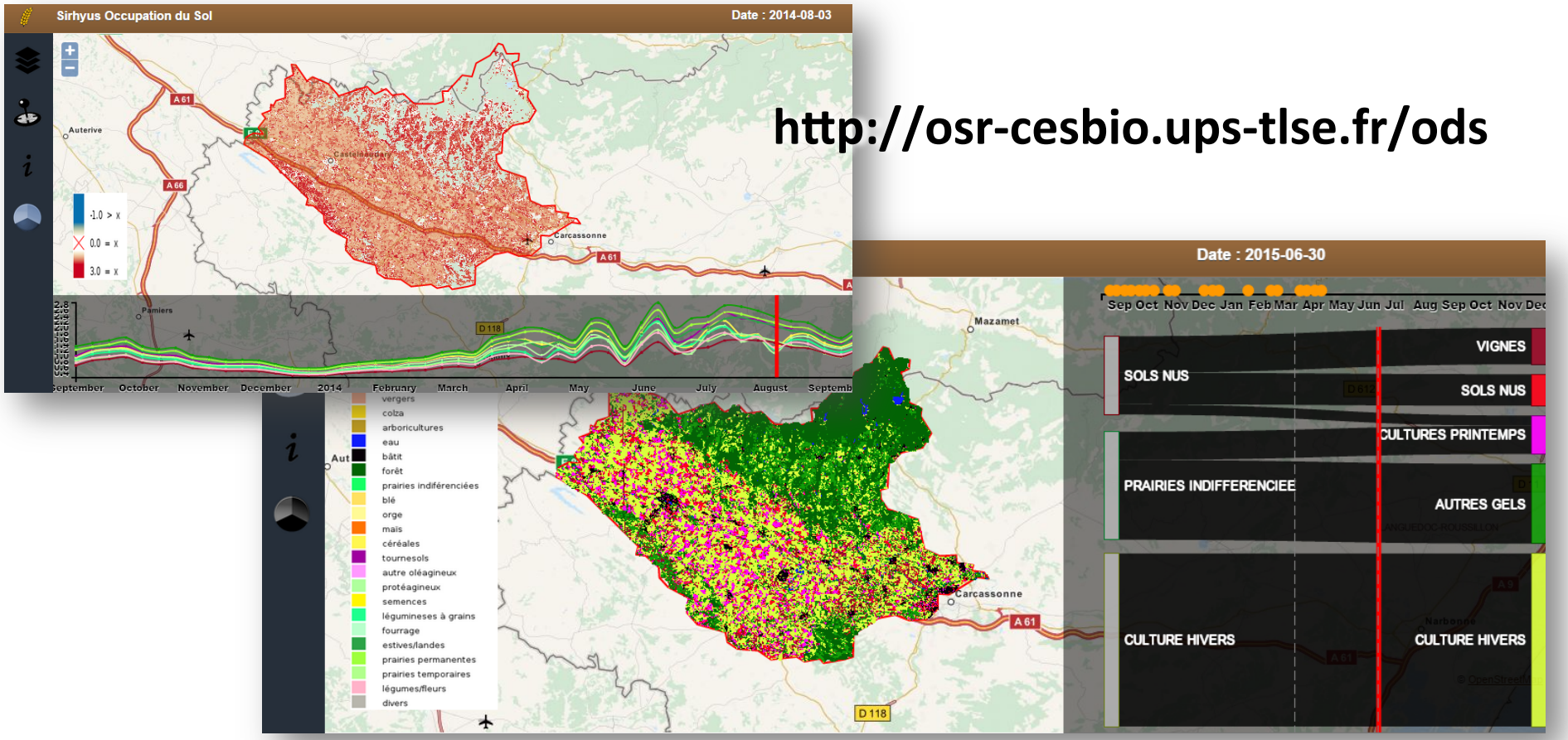
AURADE 2009
Rape
Nash = 82.3

LAMASQUERE 2008
Maize
Nash = 87.3

Over the 12 french test periods we studied with in situ validation the mean Nash criteria is 82.8

Multitemp_2015
Conclusion

We developed a web interface to demonstrate the operationnality of such approach :



Conclusion

- **The first web application using Landsat Theia in an operational process**
  - Near real time (1 month delay)
  - Automatic process

- **Large possibility of improvement of the processing chain**
  - Random forest classification algrithm
  - S2 images (multispectral, revisit, constant angle)
  - Quicker delivery of S-2 product (hopefully)

- **Analysis of result still in progress**
  - Results to evaluate in the current campaign
  - Continuous analysis of user needs

Lessons learned

- **Automatisation is a real challenge**
  - Hard to have same quality over years
  - Automatic Classification results less accurate than custom-made
- **Real time is sometime difficult to realize**
  - API modification (theia)
- **Validation hard to realized**
  - Classification (costly campaign)
  - Evapotranspiration (expensive mesure equipment)

Thank you for
your attention

Questions?