Centre d'Etudes Spatiales de la BIOsphère

Unité Mixte de Recherche(CNRS,UPS,CNES,IRD)

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Contribution of optical multitemporal satellite imagery for the cartography of irrigated areas

Application to South-West France

Marjorie Battude

Contributors : J. Cros, JF. Dejoux, V. Demarez, O. Hagolle, M. Huc, J. Inglada, M. Kadiri, S. Laurence, C. Marais Sicre, S. Valero

Wednesday, October 2nd, 2013

Background and Objectives

- Agriculture is an important water consumer during summer
- Give to water managers a cartography of irrigated areas over large areas, at the beginning and throughout irrigation period. Help them to better manage water needs and supplies.
- Future application of this method to watershed of the Neste river (MAISEO project, 2013-2017)

→ Use of SPOT4-Take5 (Sud MiPy) data

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  - Bare grounds cartography (March-June)→ future summer crops, irrigable areas
  - Update during irrigation campaign

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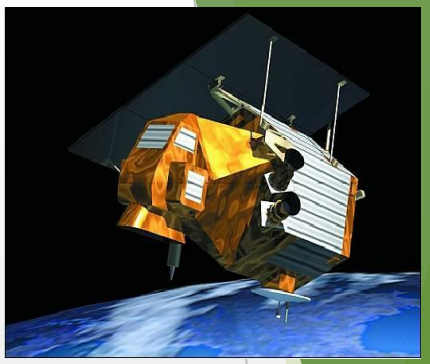
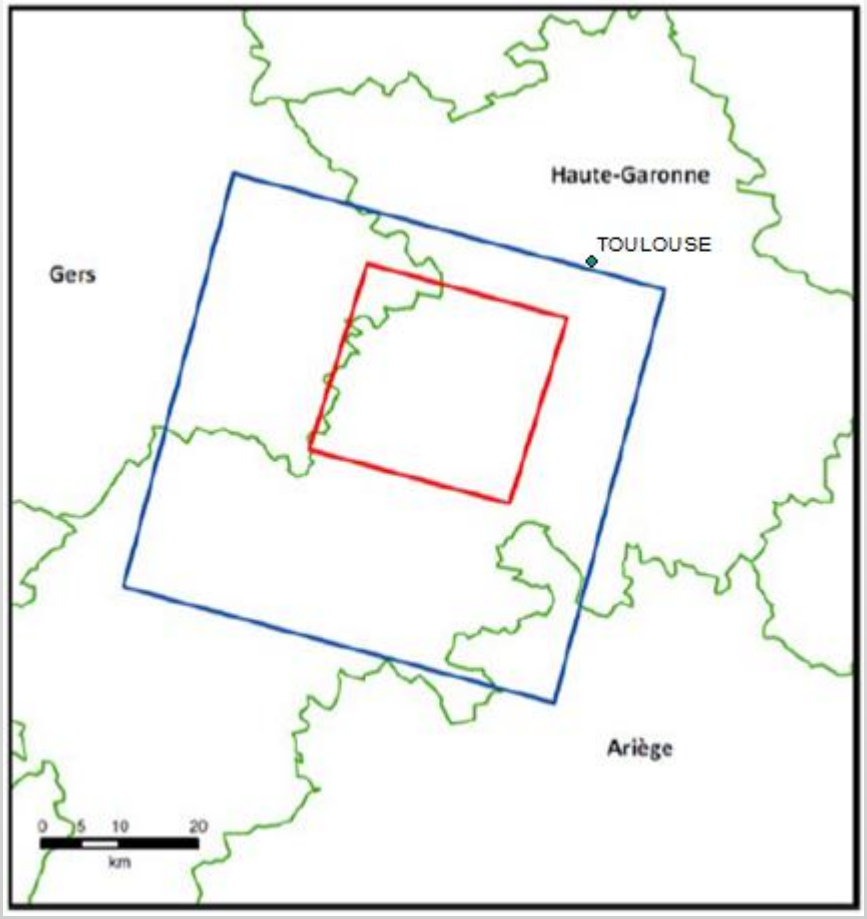
  - Bare grounds cartography (March-June)→ future summer crops, irrigable areas
  - Update during irrigation campaign
- Search phenological indicators (e.g. cycle length, emergence date, $NDVI_{max}$) to discriminate irrigated and not irrigated crops

Study area and dataset



- Study area is located in South-West of Toulouse, France

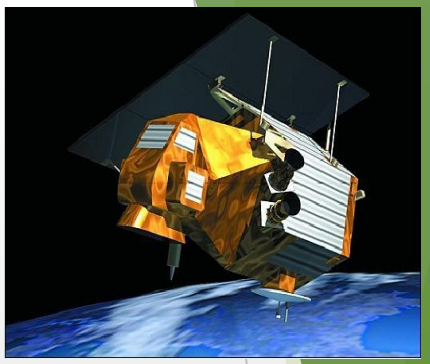


Légende

Zone SPOT
2002-2005
(50km x 50 km)

Zone FORMOSAT
2006-2009
(24km x 24km)

Study area and dataset



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  - Up to 2009 : Irrigation Information (yes/no)

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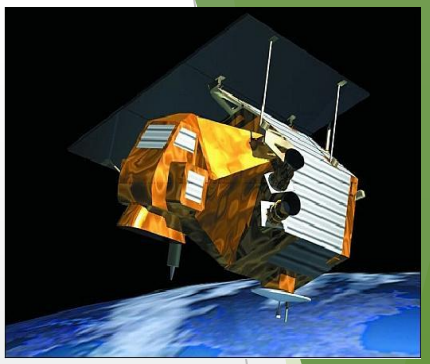

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- Cartographic field pattern registry (RPG) : GIS database that gathers the field patterns declared by farmers under the framework of the Common Agricultural Policy (CAP)
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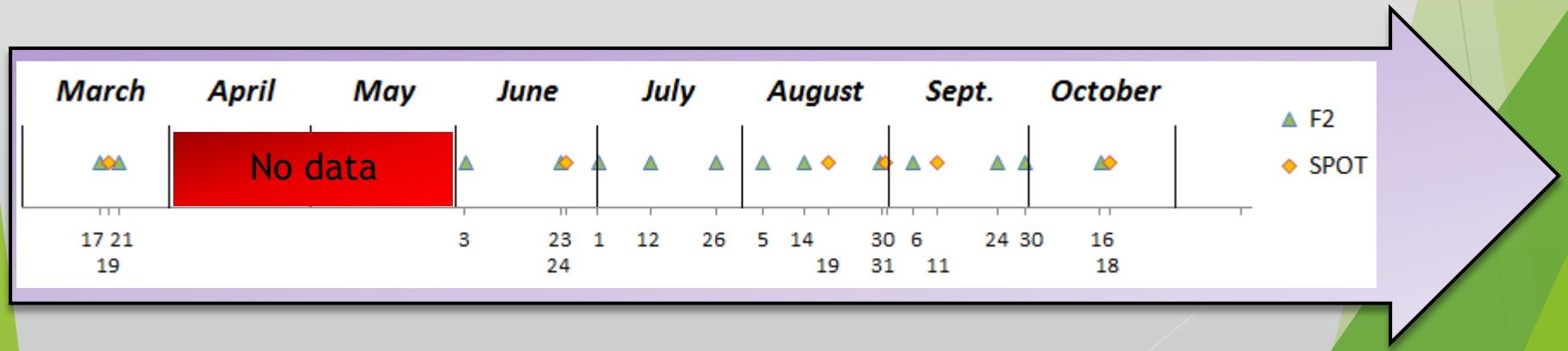
- High spatial and temporal resolution (HSTR) remote sensing data (Formosat-2, Spot 4 et Spot 5) were acquired in 2009 :



Discrimination between irrigated & not irrigated crops

Study focuses on 6 classes of land cover (only summer crops)

3 « irrigated » classes

→ grain maize
→ silage maize
→ soybean

3 « not irrigated » classes

→ grain maize
→ sorghum
→ sunflower

Part 1 : Cartography of summer crops

- Cartography of bare grounds : plots that will contain summer crops
  - Construction of a « bare ground » mask by successive NDVI thresholds (<0.2)
  - 7 dates, from March to early July
  - Pixels with NDVI <0.2 for at least one of these dates

→ First assessment of summer crops area

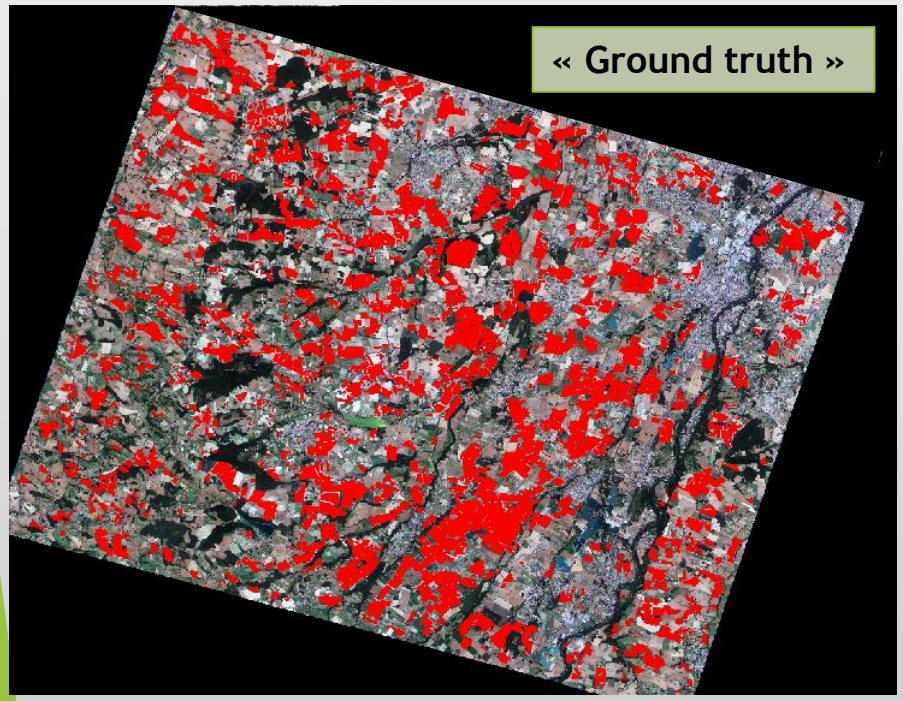
Cartography of summer crops

- Quite good estimation in terms of surface area :

  Difference estimated : ~2000 ha /15000 ha

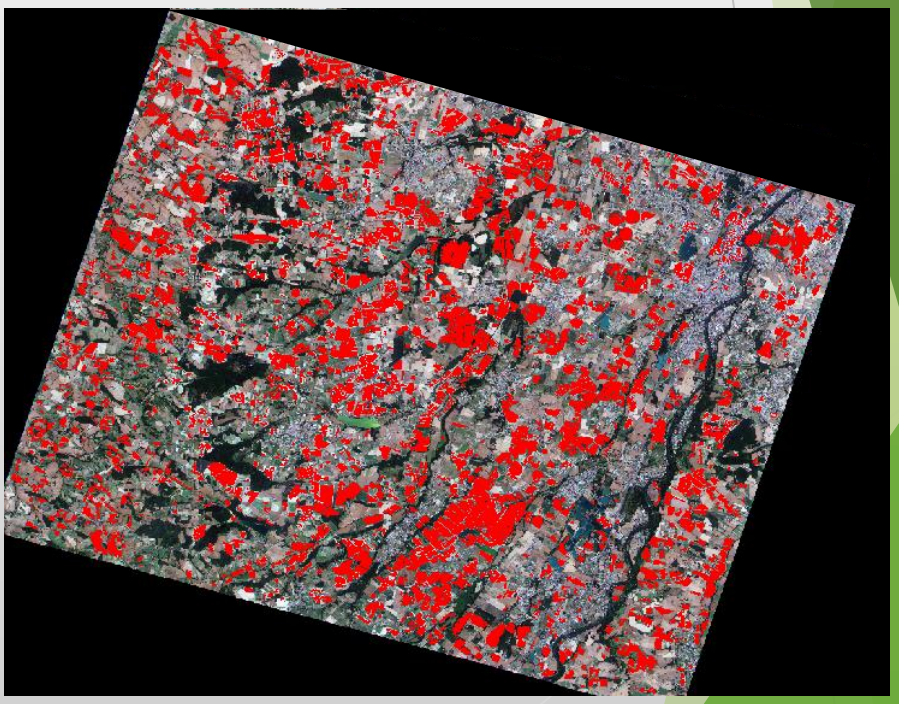
Cartography of summer crops (RPG)

15764 ha



Cartography of bare grounds

13720 ha



Summer crops : maize, sunflower, soybean, sorghum

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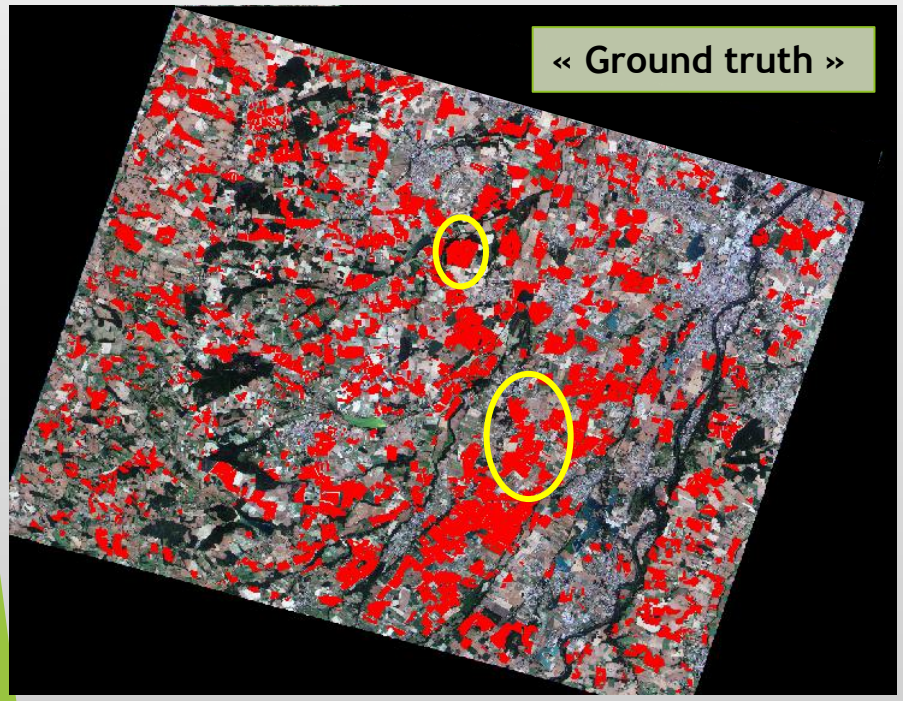

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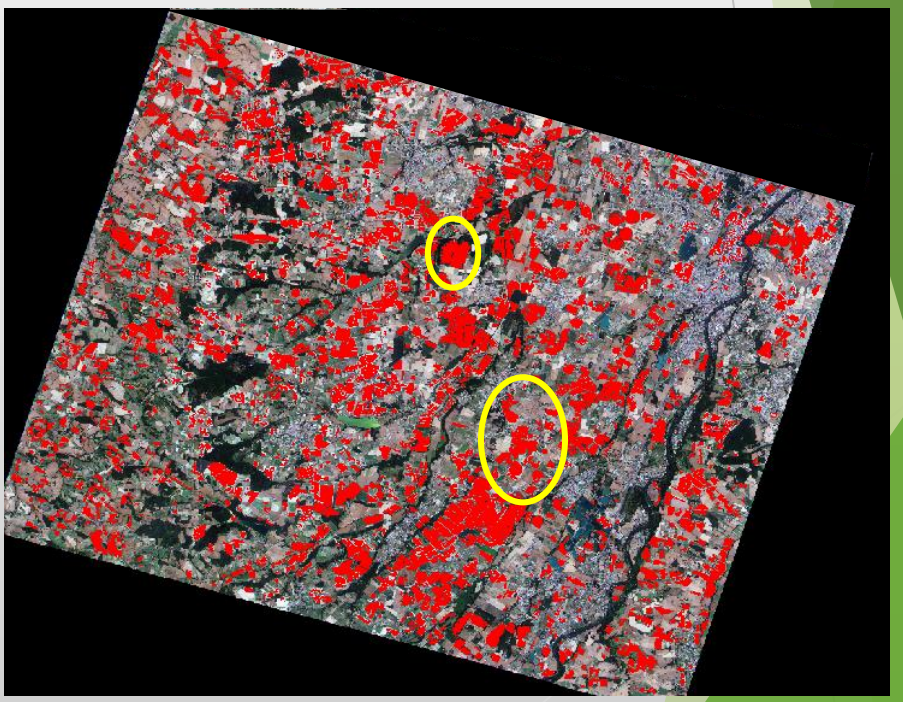

Summer crops : maize, sunflower, soybean, sorghum

Part 2 : Interpolation of NDVI time series

Normalized Difference Vegetation Index (NDVI) is correlated with plant's growth cycle

NDVI Images

Plot from RPG

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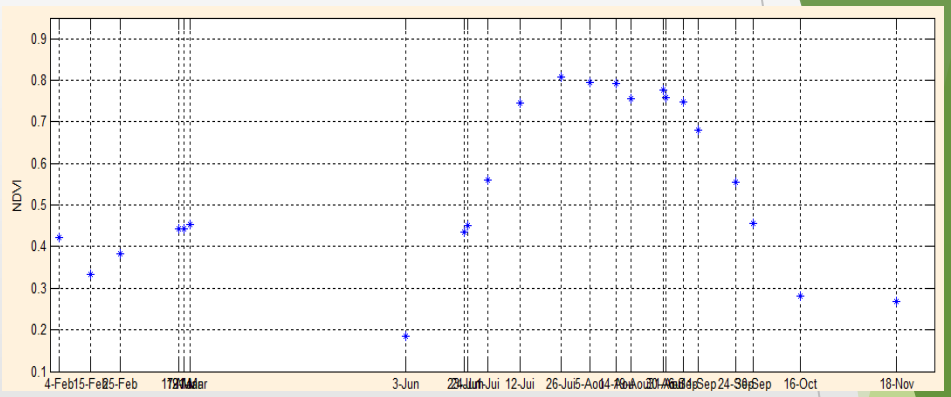
NDVI Images

Plot from RPG

Time series of NDVI for this plot



All available dates are used to build vegetation cycle

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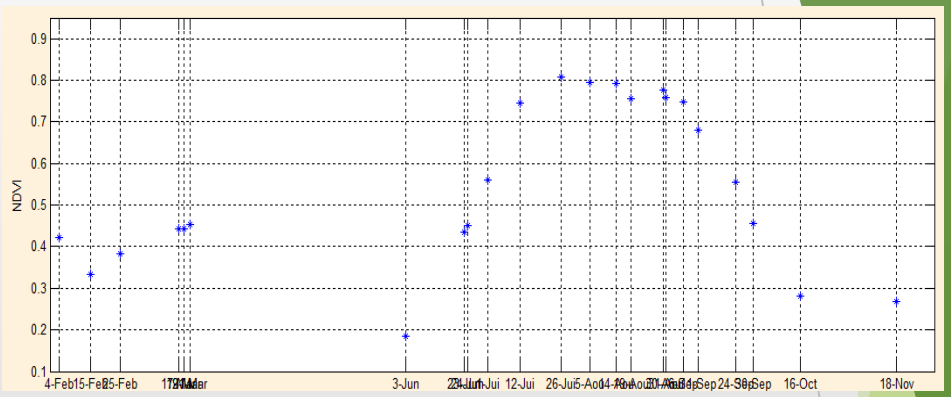

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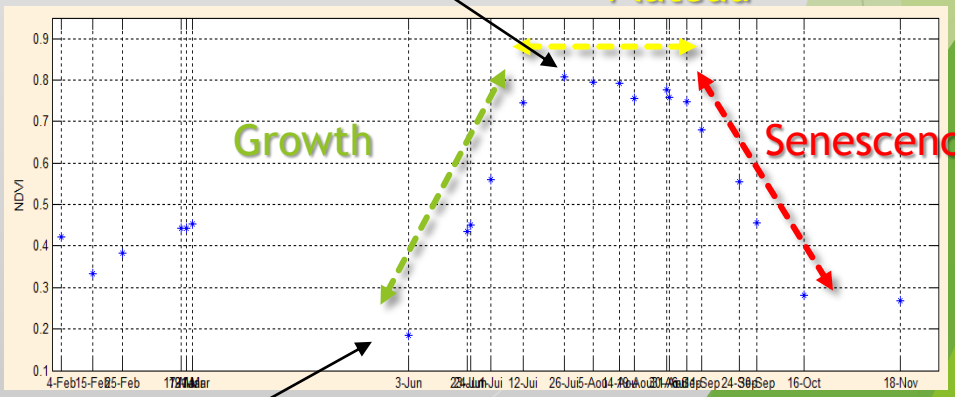
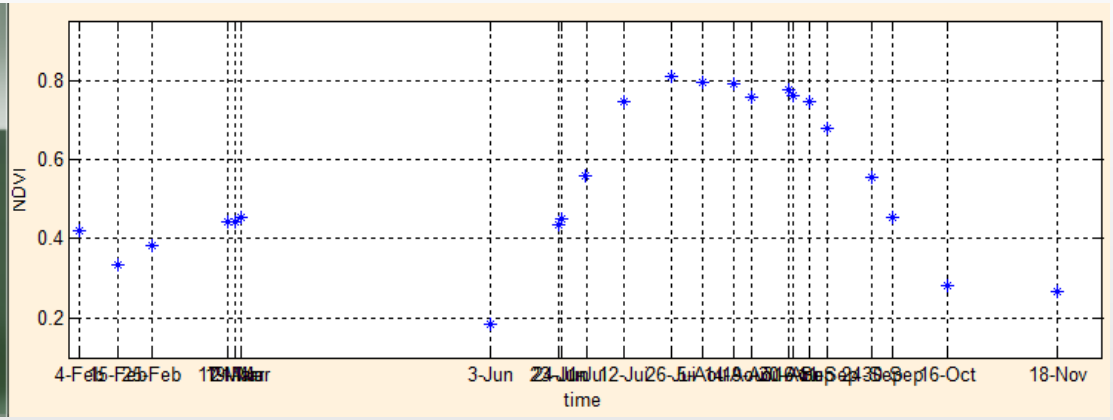


Identification of phenological stages from which indicators are calculated

Part 2 : Interpolation of NDVI time series



⟶ NDVI time series of an irrigated maize plot in 2009

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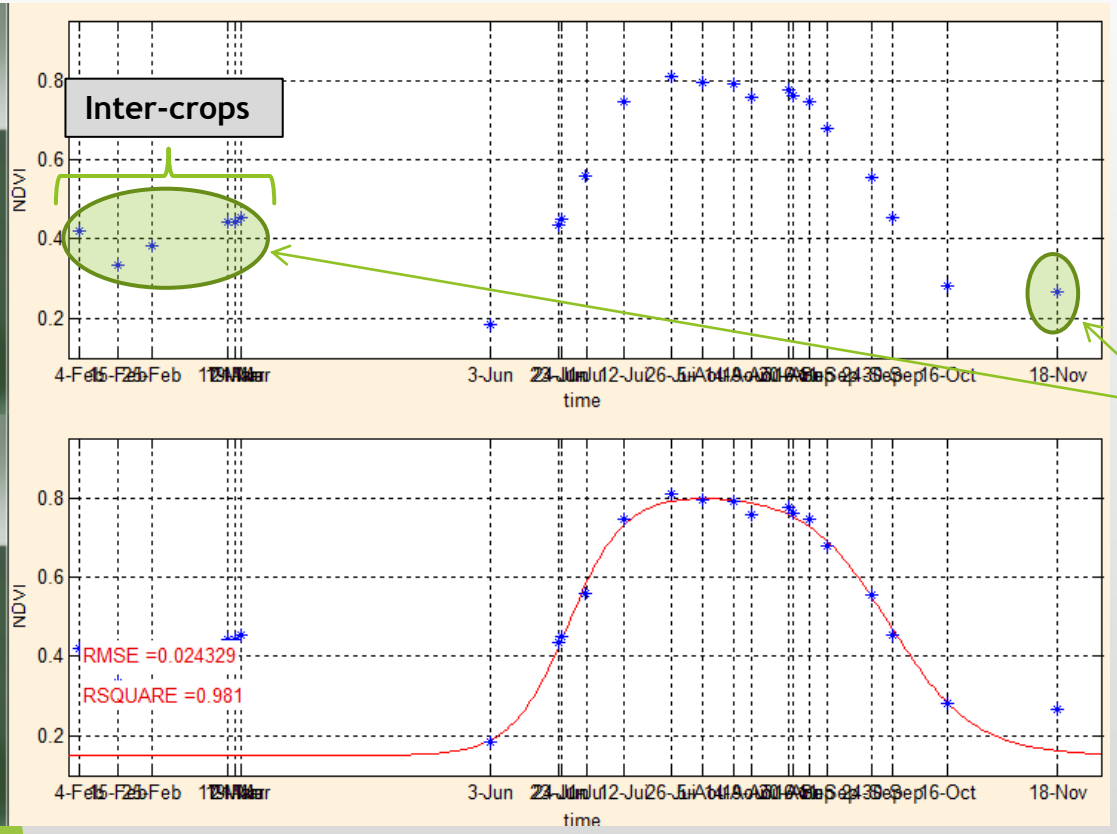
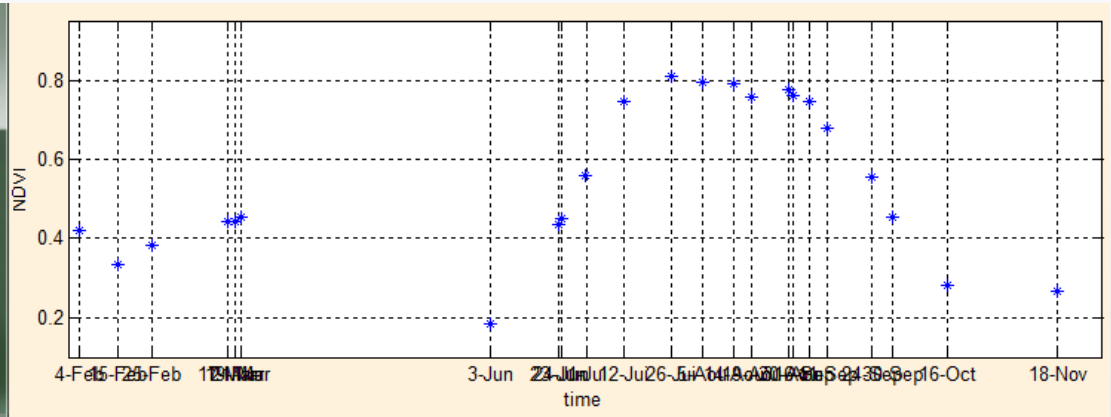


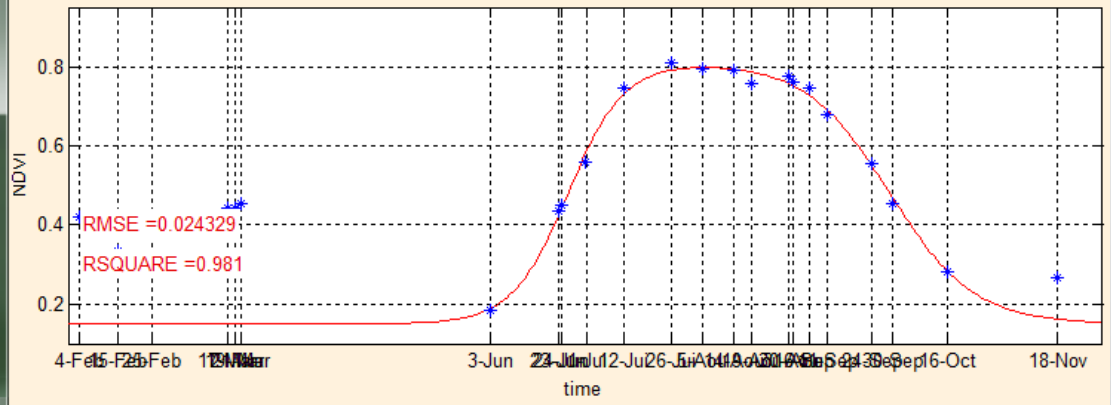
→ NDVI time series of an irrigated maize plot in 2009

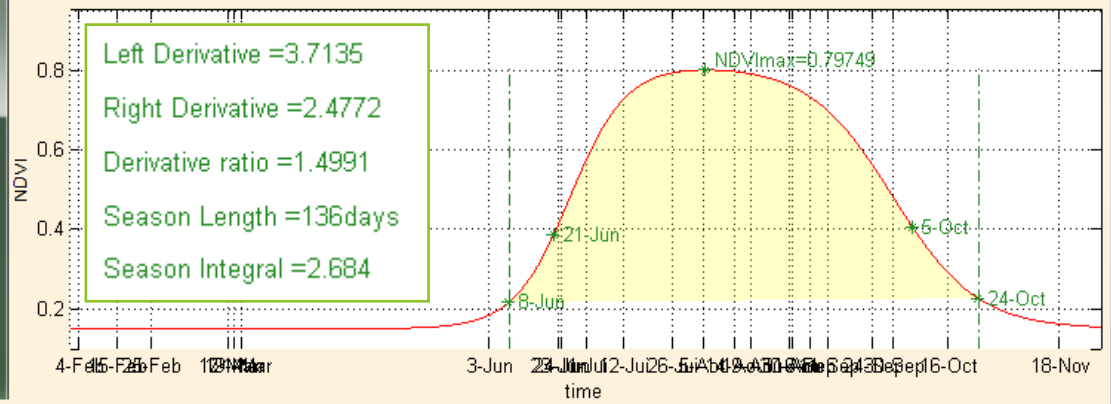
Possibility to attribute a weight to each point for the interpolation

From February to March : inter-crops

Part 3 : Calculation of indicators







⟶ NDVI time series of an irrigated maize plot in 2009

Class	Plots' number
Grain maize (irrigated)	137
Grain maize (not irrigated)	18
Silage maize	22
Soybean	30
Sorghum	110
Sunflower	121

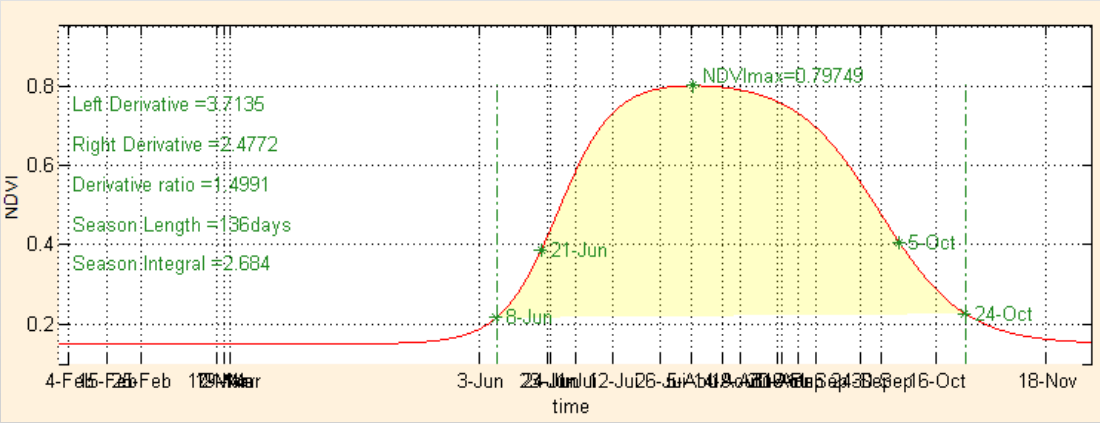
Number of samples available in 2009

Part 3 : Calculation of indicators

- Two classes of indicators are obtained by mean of the use of double sigmoid
  - Phenological indicators

    → *Emergence date, growth speed, NDVImax, cycle length*

  - Daily accumulation of interpolated NDVI



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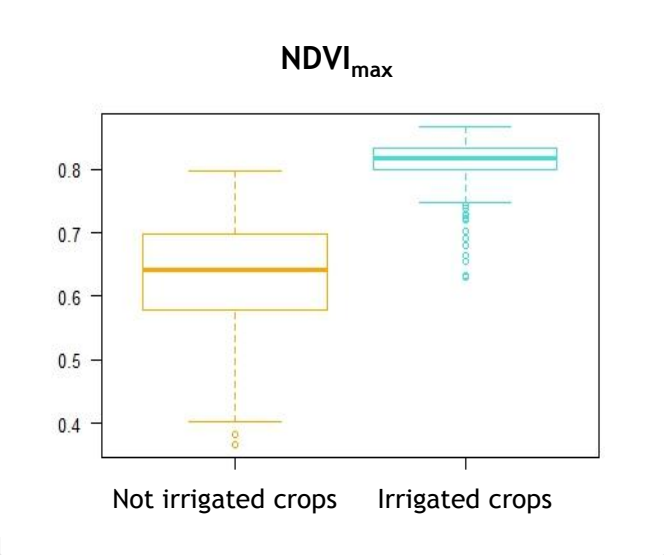
  - Daily accumulation of interpolated NDVI

- Analysis of these indicators and of their discrimination's ability (reach trends specific to each crop)
- Integration in a classification process

Phenological indicators and Irrigation



Note : Emergence date, cycle length, growth speed

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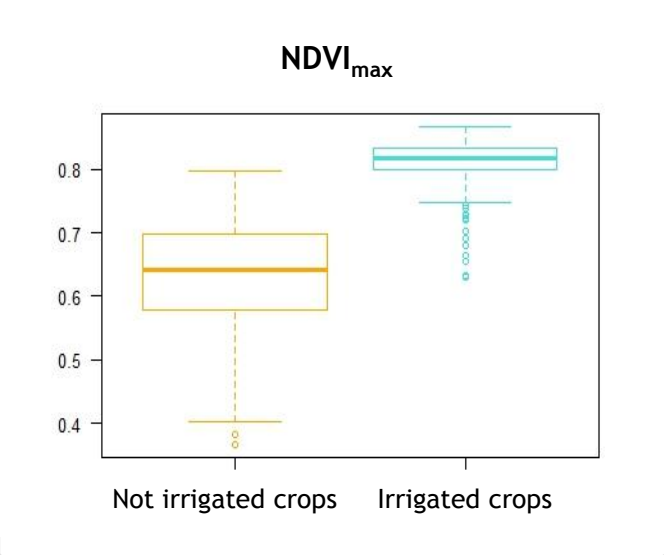

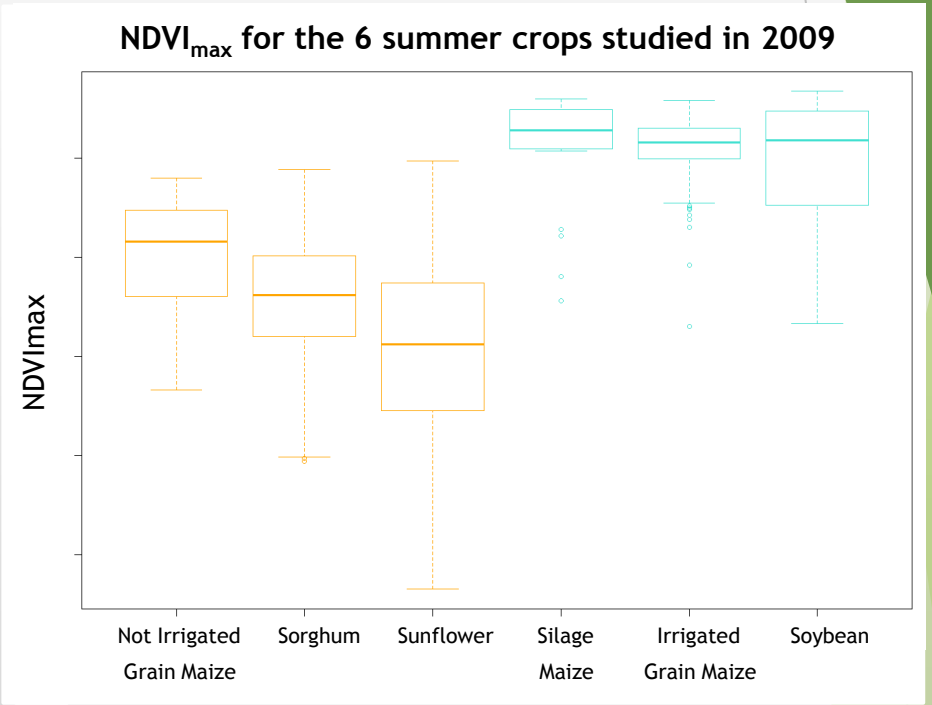

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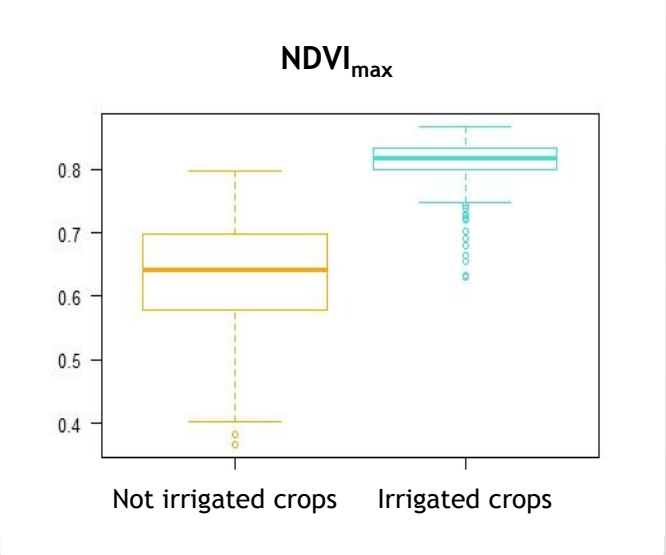

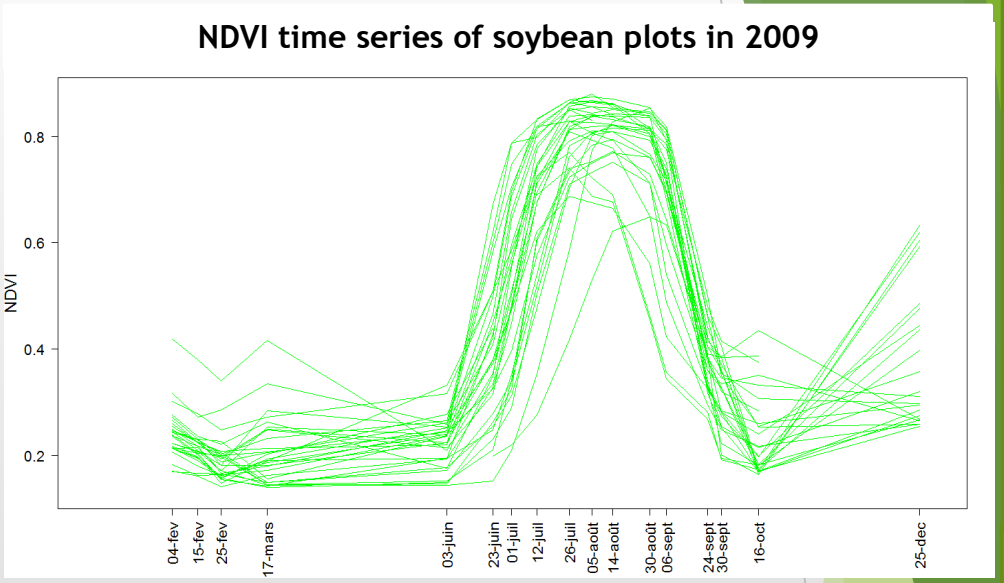

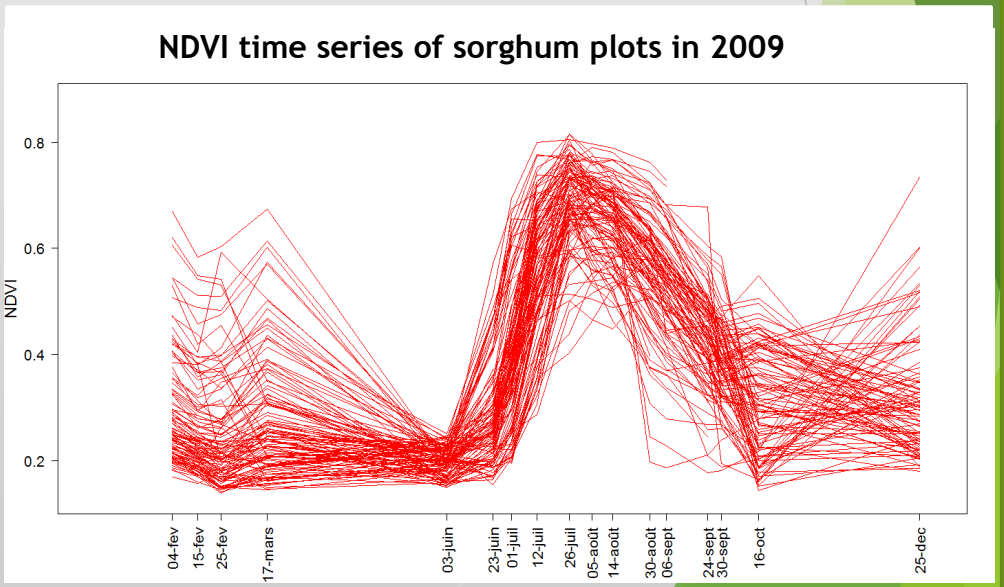

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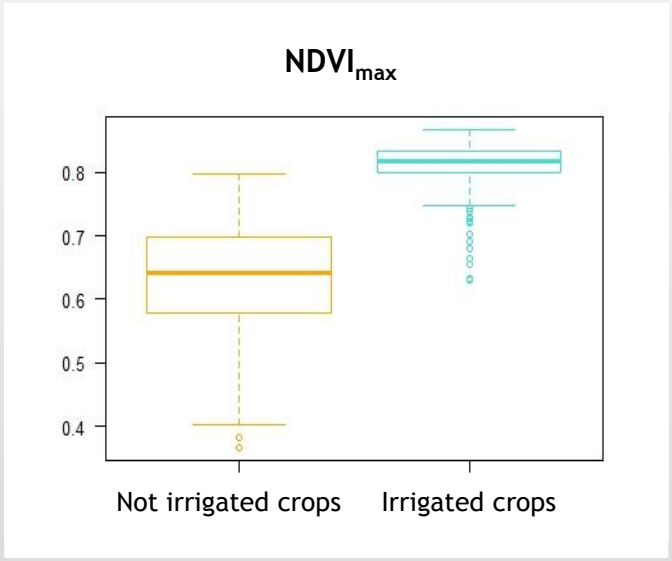
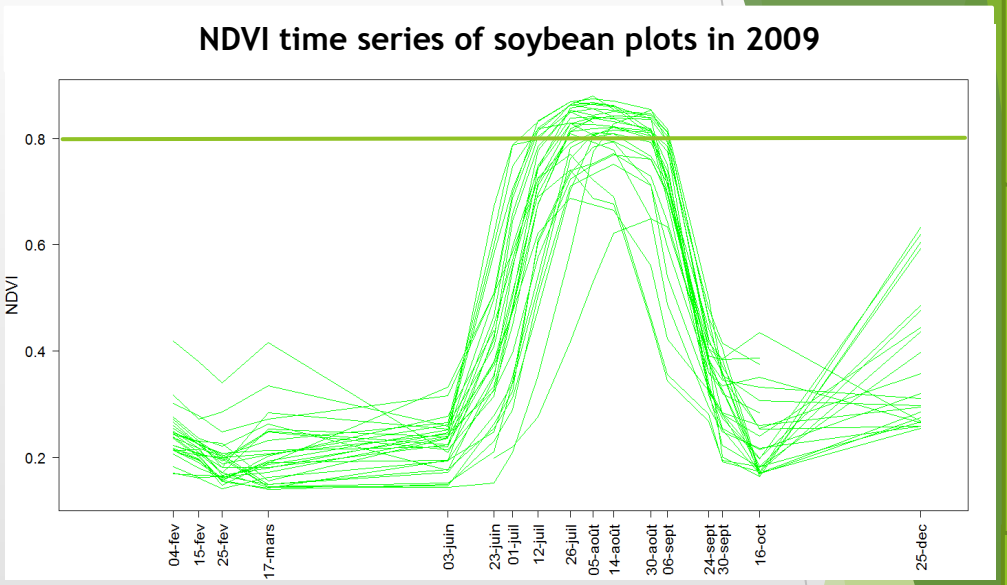
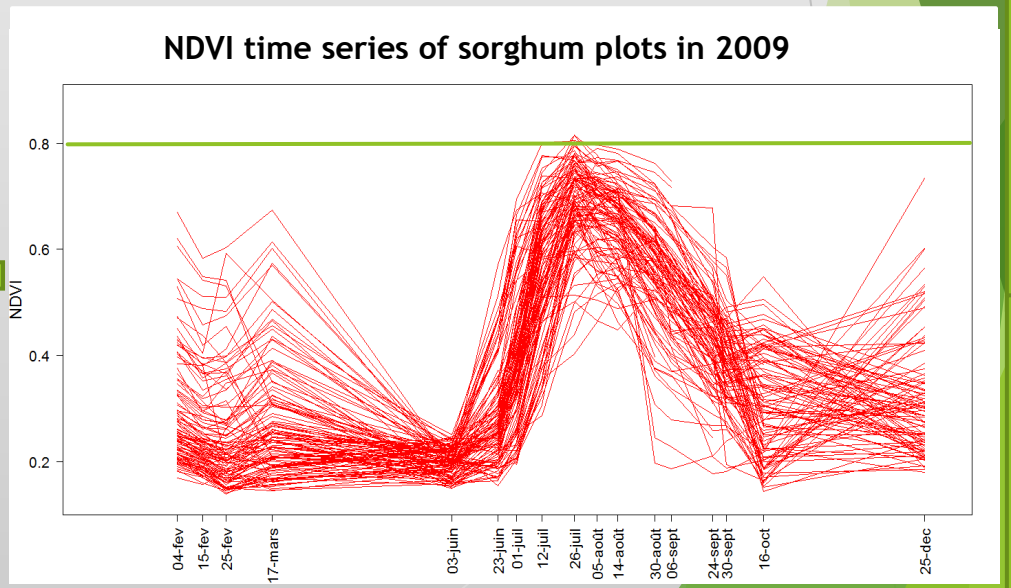
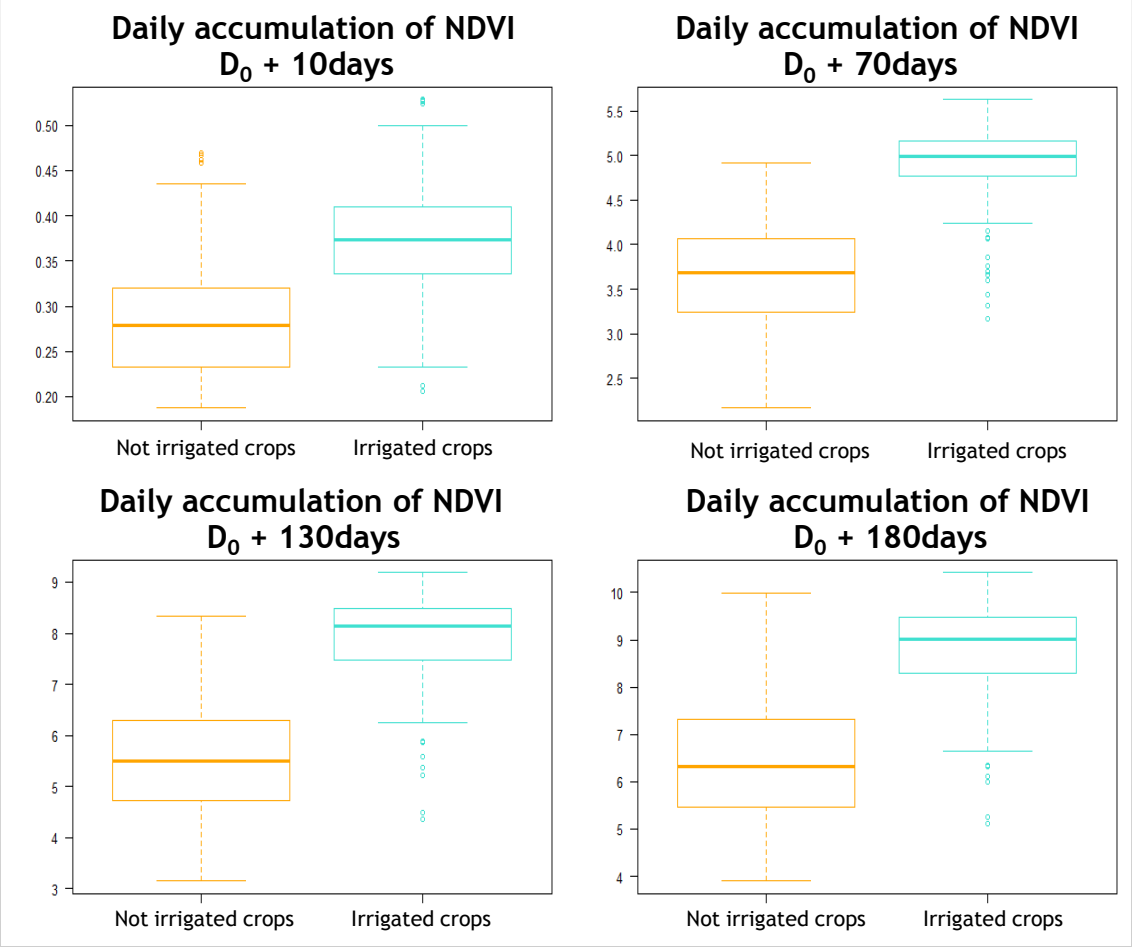






NDVI daily accumulation and Irrigation

10, 70, 130, 180 days after emergence → good discrimination



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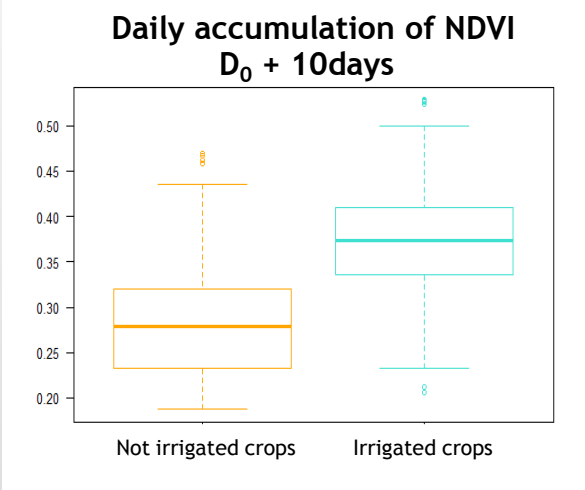

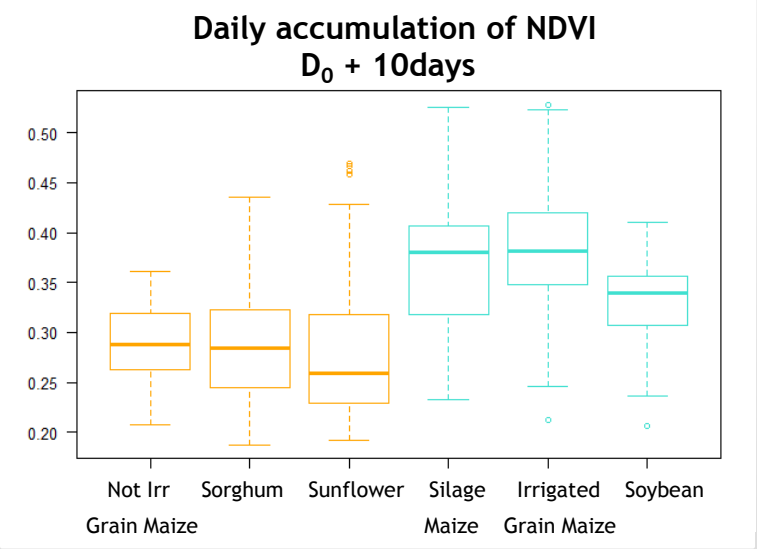

Possible estimation of irrigated areas early in the irrigation campaign

Conclusions and Future work

- **Cartography of summer crops (irrigable areas)**
  - Quite good estimation in terms of surface area in 2009

    Difference estimated : ~2000 ha / 15000 ha
  - 2013 : Results will be improved with data between March and June
    → it can be done thanks to SPOT4-Take5 dataset

Conclusions and Future work

- **Cartography of irrigated crops**
  - Use of indicators requires to have whole vegetation cycle

    (Interpolation by the double sigmoid)

    → Results are very promising for the discrimination between irrigated and not irrigated crops

    → Integration of indicators in a classification process

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  - Use of indicators requires to have whole vegetation cycle

    (Interpolation by the double sigmoid)

    → Results are very promising for the discrimination between irrigated and not irrigated crops

    → Integration of indicators in a classification process

  - Next objective : early estimation of irrigated areas (June)

    → NDVI accumulation (10 days after emergence)
    → Database of « typical » interpolated NDVI time series

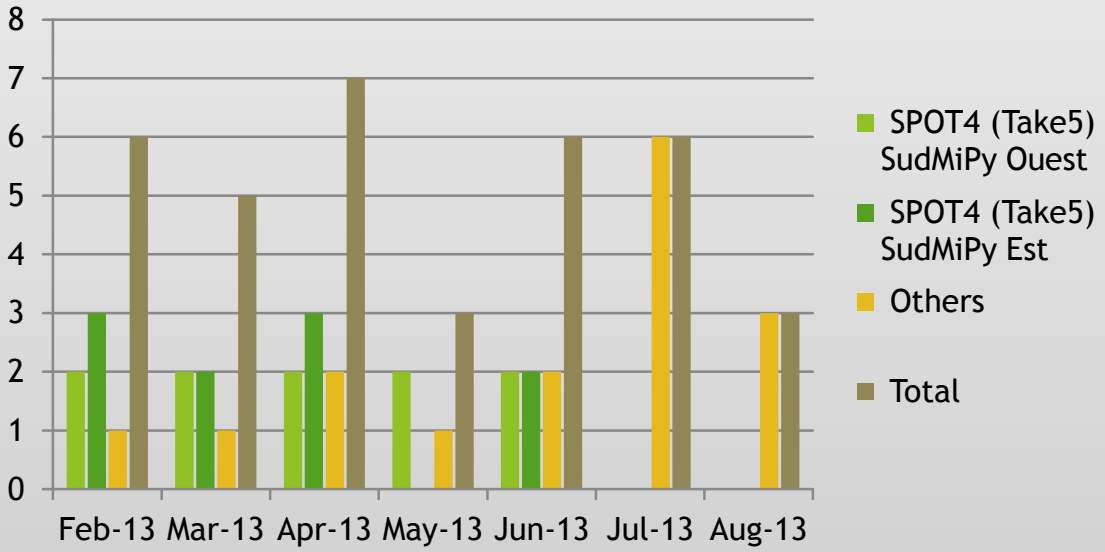
Note : Daily accumulation of NDVI requires to have a regular temporal sampling, and an accurate emergence date

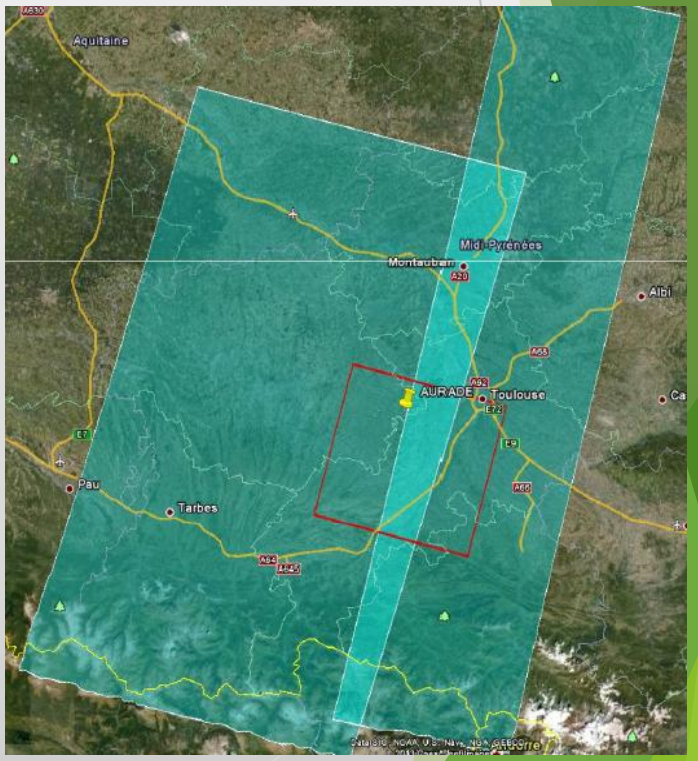
Future work

- **Application of this method to watershed of the Neste river in the framework of MAISEO project (2013-2017)**

→ Use of SPOT4-Take5 (Sud MiPy) data

- Main advantage : regular temporal sampling





Future work

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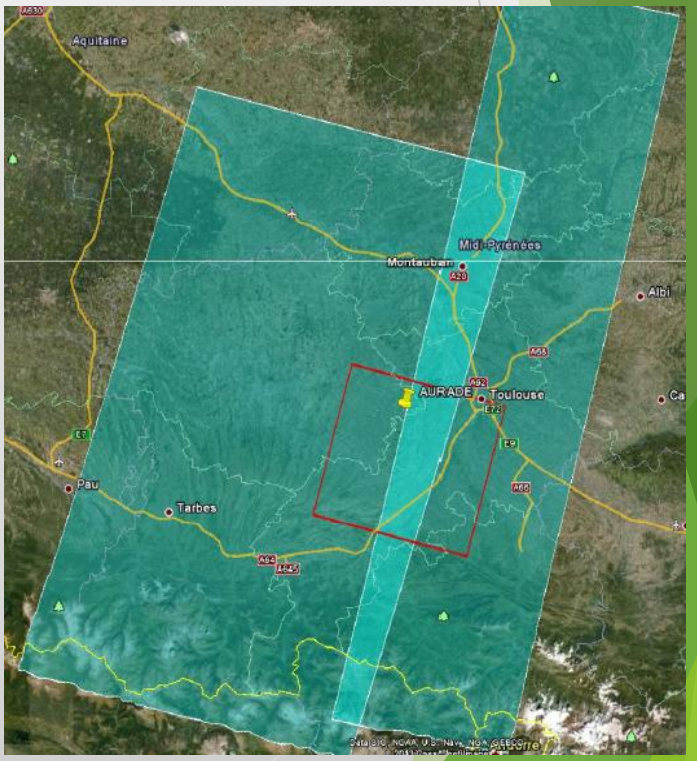
- Main advantage : regular temporal sampling
- No irrigation information in RPG since 2009

→ 2013 : Ground campaigns carried out to follow land cover and irrigation (about 1600 plots in 2 sites)

→ Take5 dates used to plan the field campaign



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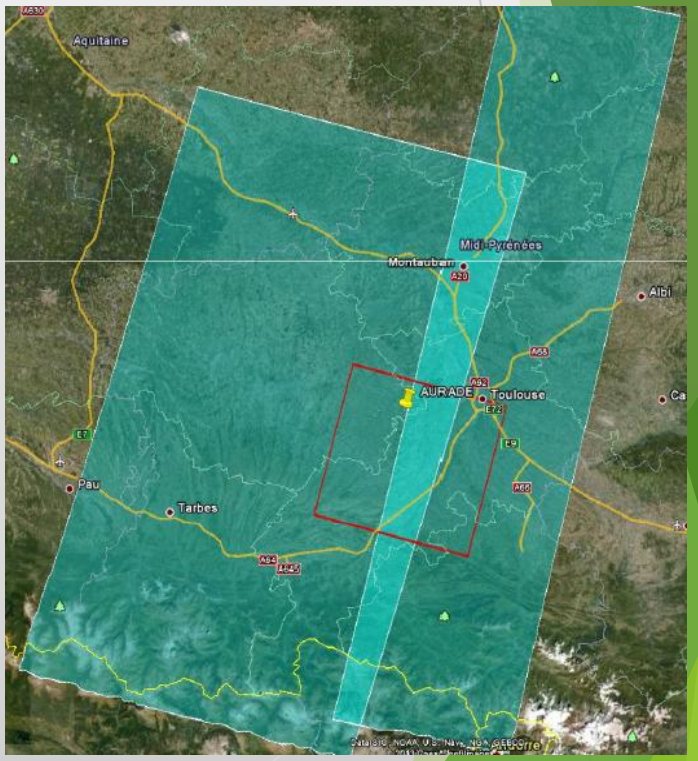
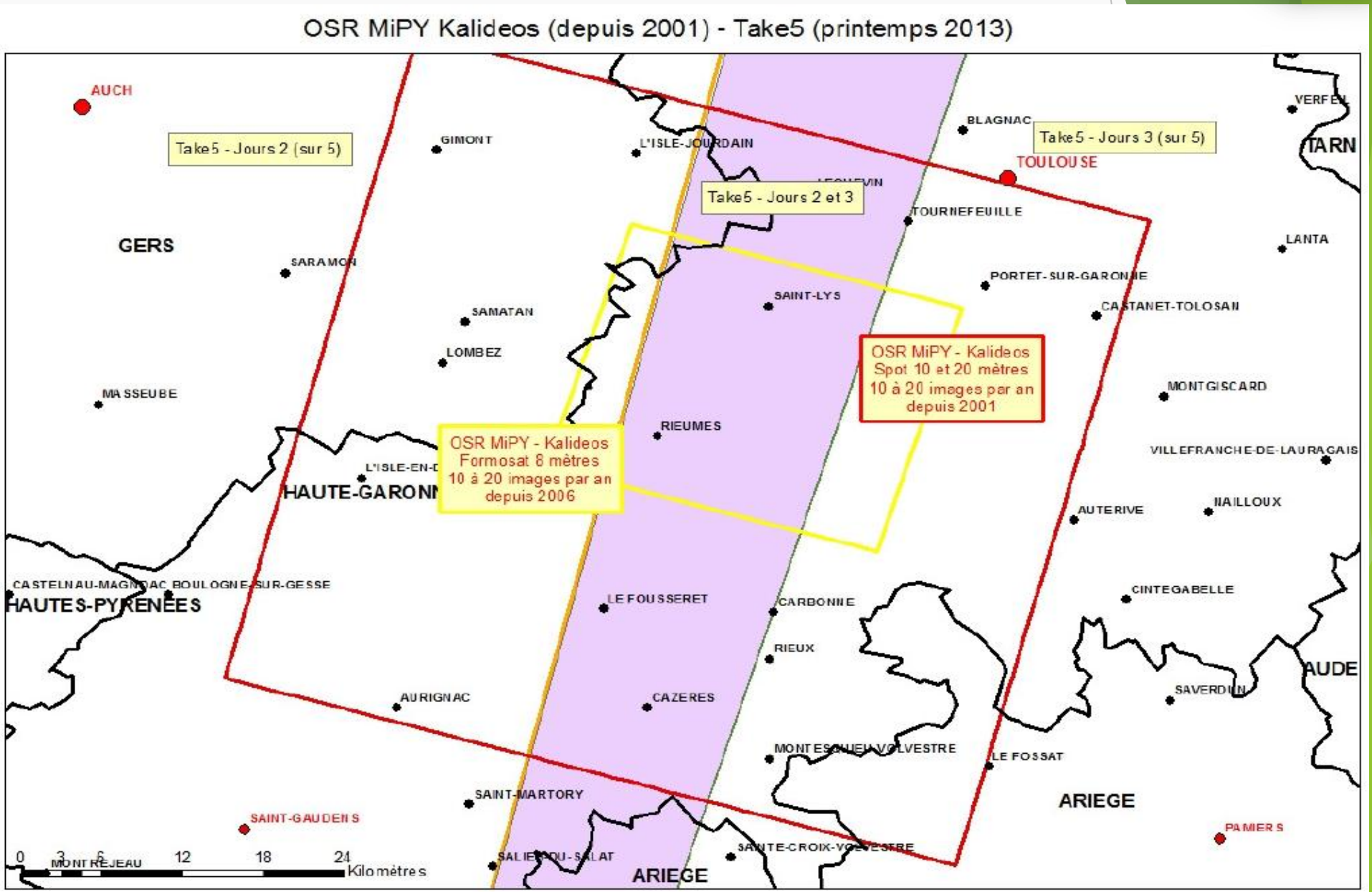
- Application in the long term :
  - Availability of Sentinel-2 data

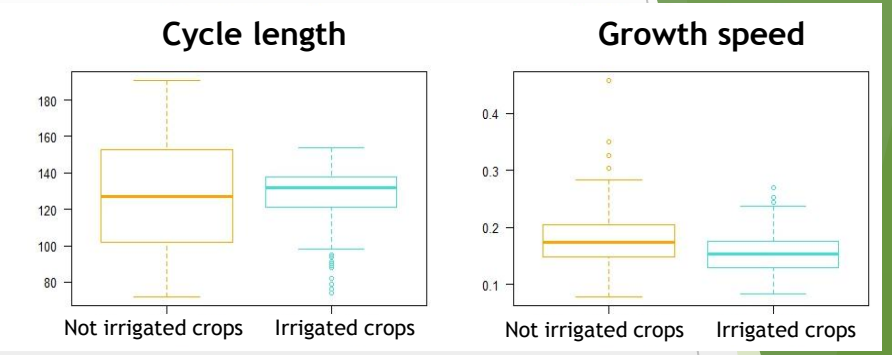


Thank you for your attention

Remote sensors footprint



Phenological indicators



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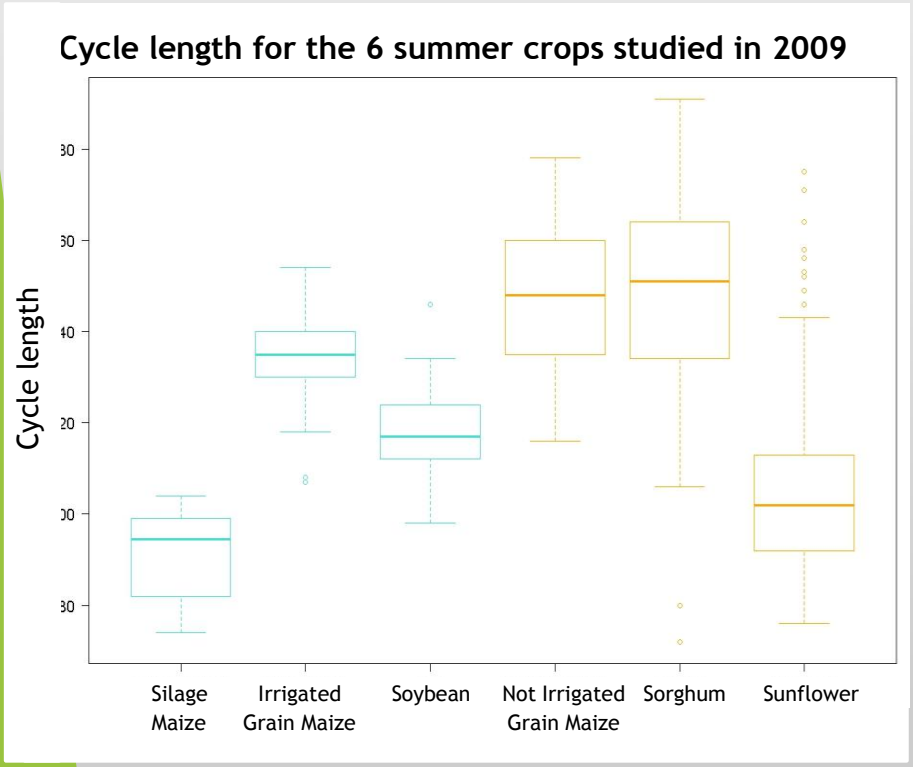
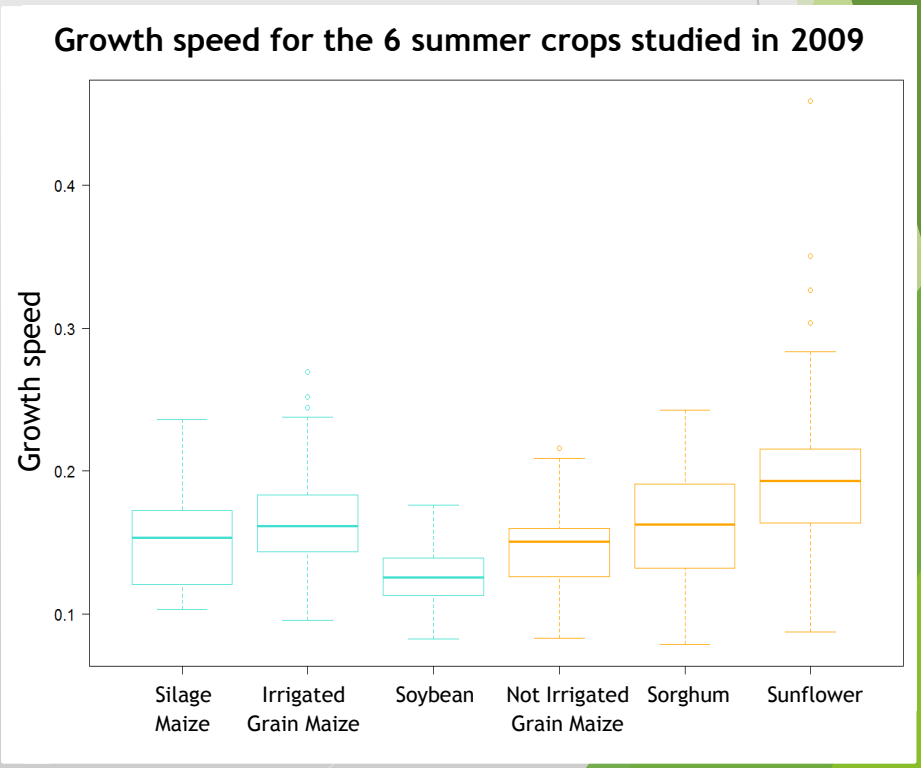
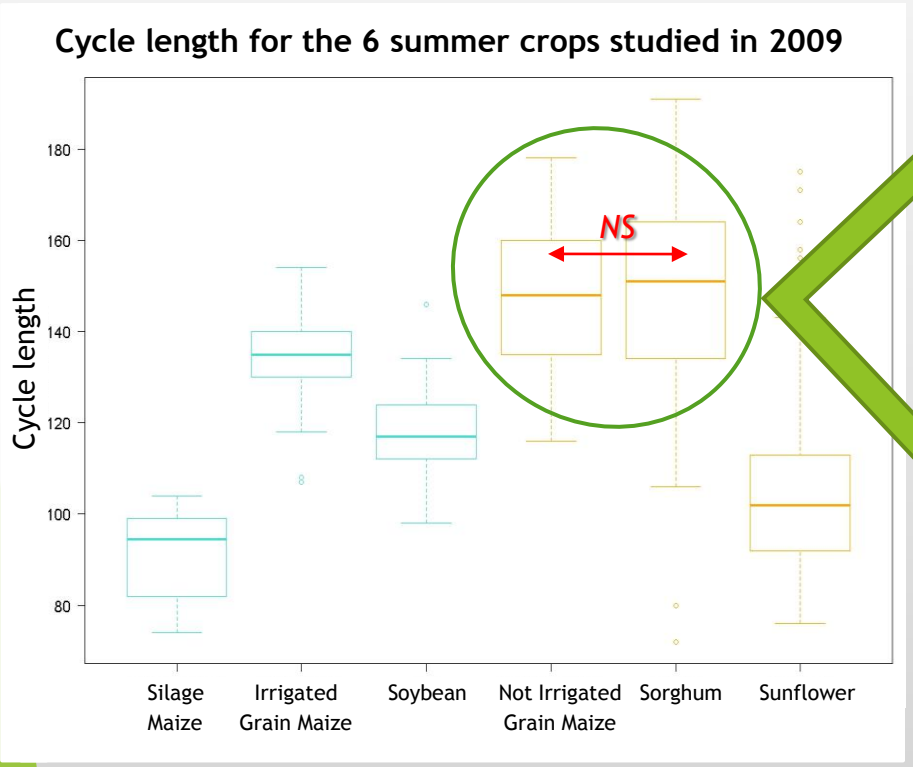




Phenological indicators and Land cover



Grain maize field

Sorghum field

Grain maize field

Sorghum field