Antsirabe (Madagascar)

JECAM/GEOGLAM Science Meeting

Brussels, Belgium

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cirad
LA RECHERCHE AGRONOMIQUE POUR LE DÉVELOPPEMENT

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FOFIFA

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Site Description

- **Location:** 60*60km in the Highlands (Lat.: 19.43° S / Long.: 47.04° E)
- **Topography:** hills / plains / shallows (1400-2000m)
- **Soils:** Clayey
- **Drainage class / irrigation:** Moderate / irrigation canals
- **Crop calendar:** October - april
- **Field size:** 0.03 ha
- **Climate and weather:** Subtropical humid (cloudy !)
- **Agricultural methods used:** Manual Tillage / Hoeing / Fertilization with manure more or less mixed with ashes (few NPK inputs due to availability and cost) / Irrigation on terraces or basins, rainfed crops on the hills

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Site Description

Project Objectives

- **Crop identification and Crop Area Estimation**
  - Using existing missions providing decametric images (simulating Sentinel-2 data), VHSR imagery (PLEIADES) and other data (DEM, field database)
  - With OBIA and data mining (Random Forest)

- **Yield Prediction and Forecasting**
  - Analyzing time series to monitor crop phenology
  - Estimating yield of rice crop (main crop of the Region, and key information for food security systems)

Collaboration

- **Koumbia (Burkina Faso – Cirad site)**
  - Similar methods used (object based image analysis and Random Forest)
  - Comparisons in overall accuracies obtained for the classifications
  - Comparisons in metrics used (which are the most informative variables?)
- **Champion user of S2-Agri project**
- **SIGMA project**

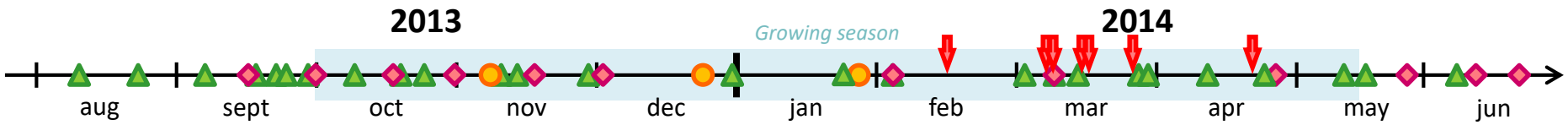
Earth Observation (EO) Data Received/Used

- 1rst growing season (2012-13): SPOT4 Take5 experiment

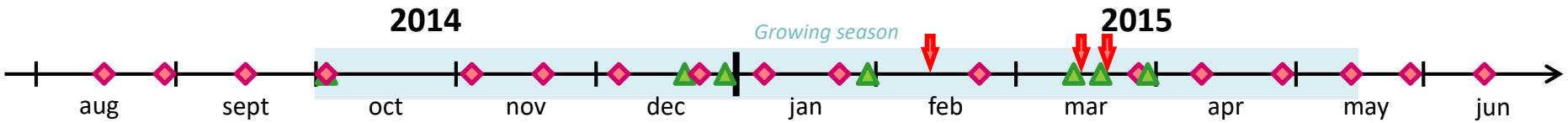
SPOT5 (10m) from SEAS-OI receiving station
DEIMOS (20m) from Deimos Imaging
LANDSAT 8 (15m) from USGS
PLEIADES (0.5m) from CNES

HSR Time series

VHSR coverage (pic of growing season)



- 2nd : 7 days in average between 2 acquisition of the HSR time series



- 3rd : 13 days in average between 2 acquisition of the HSR time series

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In situ Data

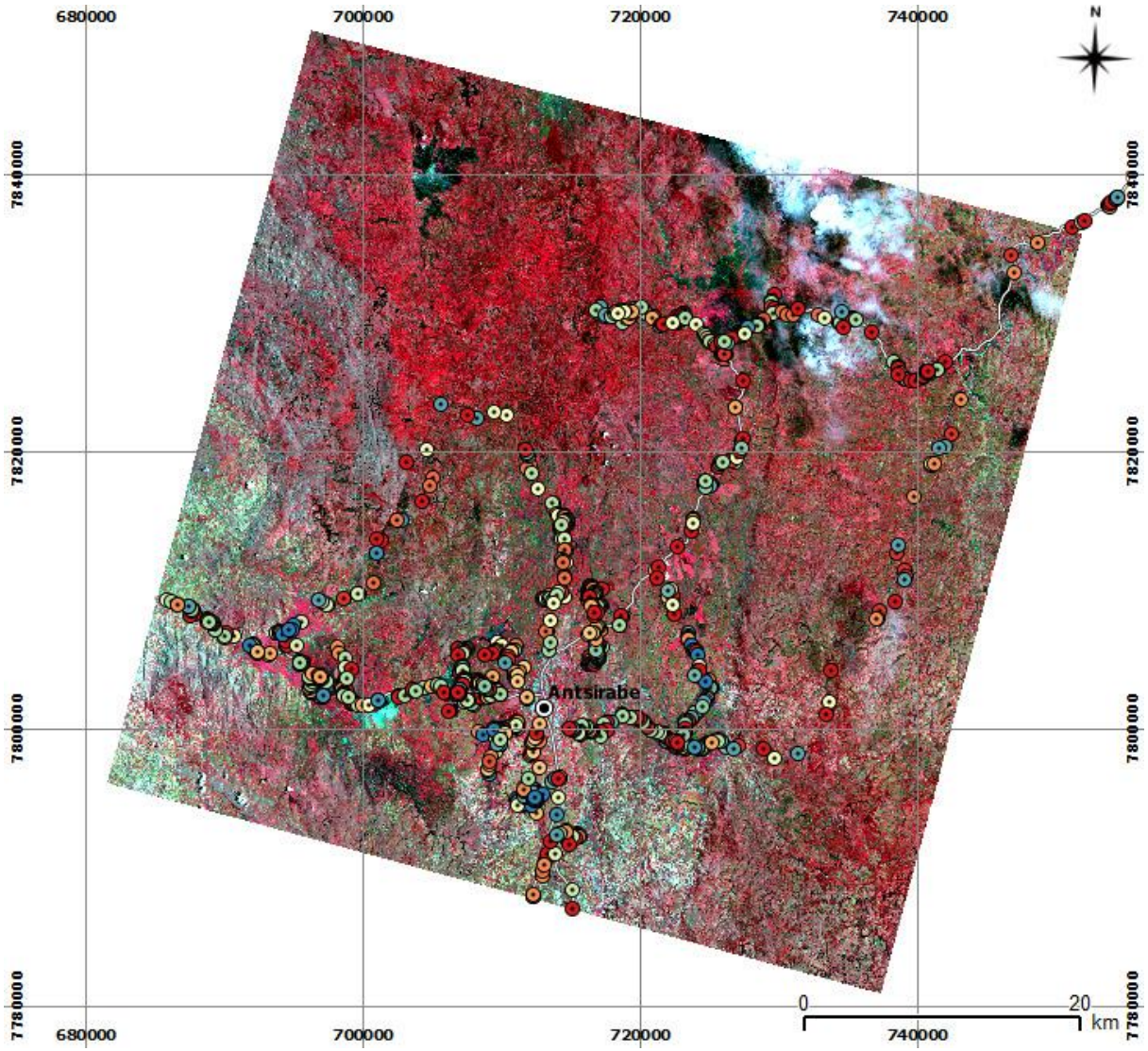
- **Land use and crop characterization 2014-2015**
  - **1020 GPS waypoints** (with contour digitized on PLEIADES imagery)
  - *Attributes:* Land use (crop or non crop), toposequence, irrigation, associated crops (if any), photo

- **Rice yield 2014-2015**
  - **124 GPS waypoints** (with contour digitized on PLEIADES imagery)
  - *Attributes*: Seeding and transplant dates, variety, fertilization (if any), toposequence, straw biomass, full grain weight, empty grain weight, photo

In situ Data

Land use and crop characterization

- NON CROP
- BEA
- CAB
- CAR
- CAS
- COR
- CRE
- FOD
- OAT
- ONI
- ORC
- OTHER_C
- PEA
- PN
- POT
- RIC_IRR
- RIC_RF
- SOY
- SWP
- TAR
- TOM



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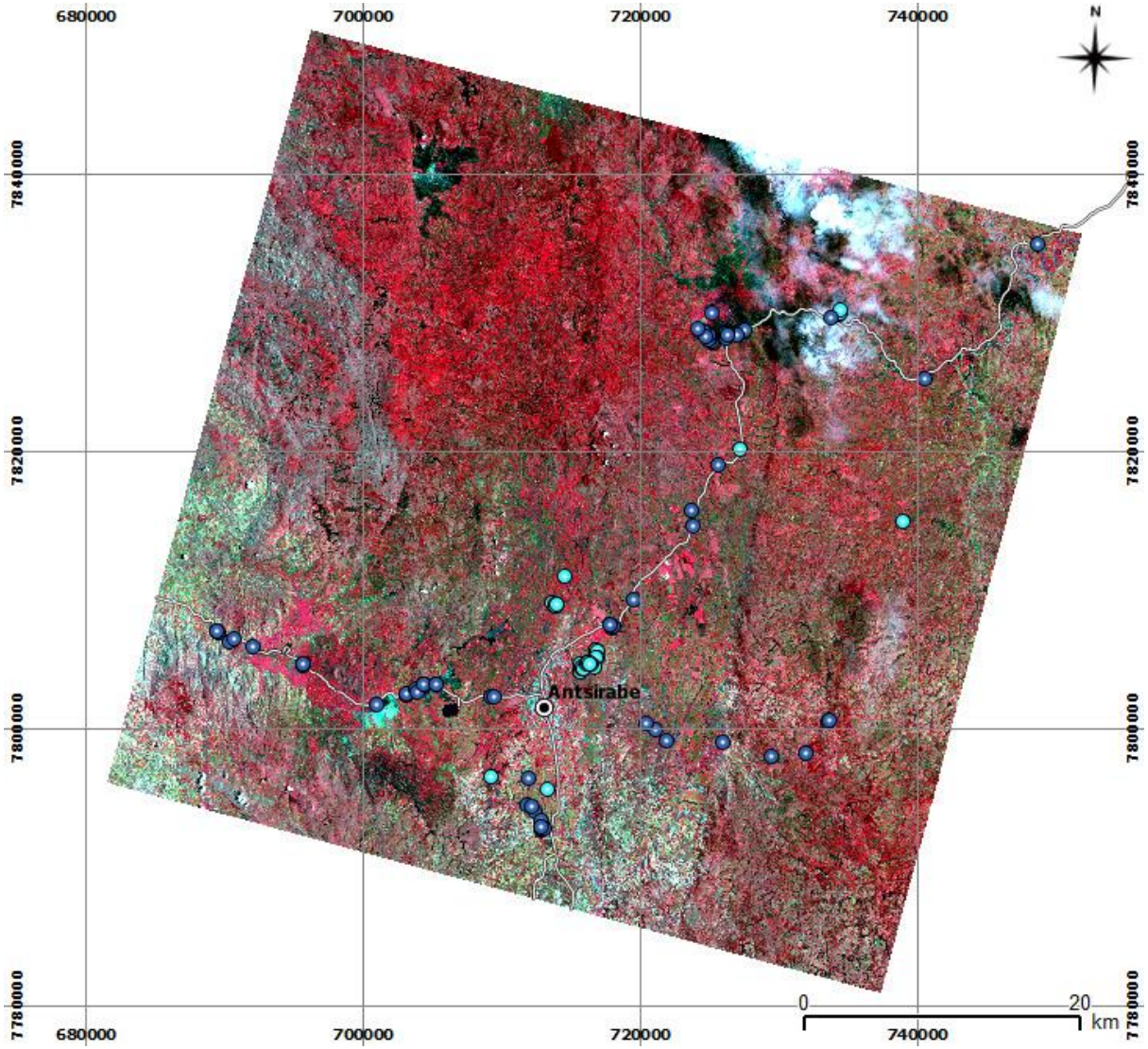
In situ Data

Rice yield

- IRR (88 fields)
- RF (36 fields)



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Methods – Crop identification and Crop Area Estimation

- **Preprocessing**
  - **Orthorectification** and **TOA reflectance** calculation for decametric time series (simulating Sentinel-2 data) and VHSR imagery (PLEIADES)
  - DEM processing (slope, watersystem extraction)
  - **Digitizing fields contour** (based on PLEIADES imagery and GPS waypoints)

- **Building a learning database**
  - **265 radiometric variables** (mean and stdev spectral response in each band, indices, etc) from time series or PLEAIDES imagery
  - **135 textural variables** (mainly from PLEIADES imagery)
  - **5 static variables** (slope, field size, etc)

Methods – Crop identification and Crop Area Estimation

- **Random Forest**
  - **Building a classifier** (based on learning database)

    # Hierarchical method :

    1. Crop/non crop classification

    2. « Crop group » and « crop class » classification within the cropland only
  - Analyzing the importance (**informative degree**) of the different variables
  - **Optimizing the classification** (by reducing the number of variables used)

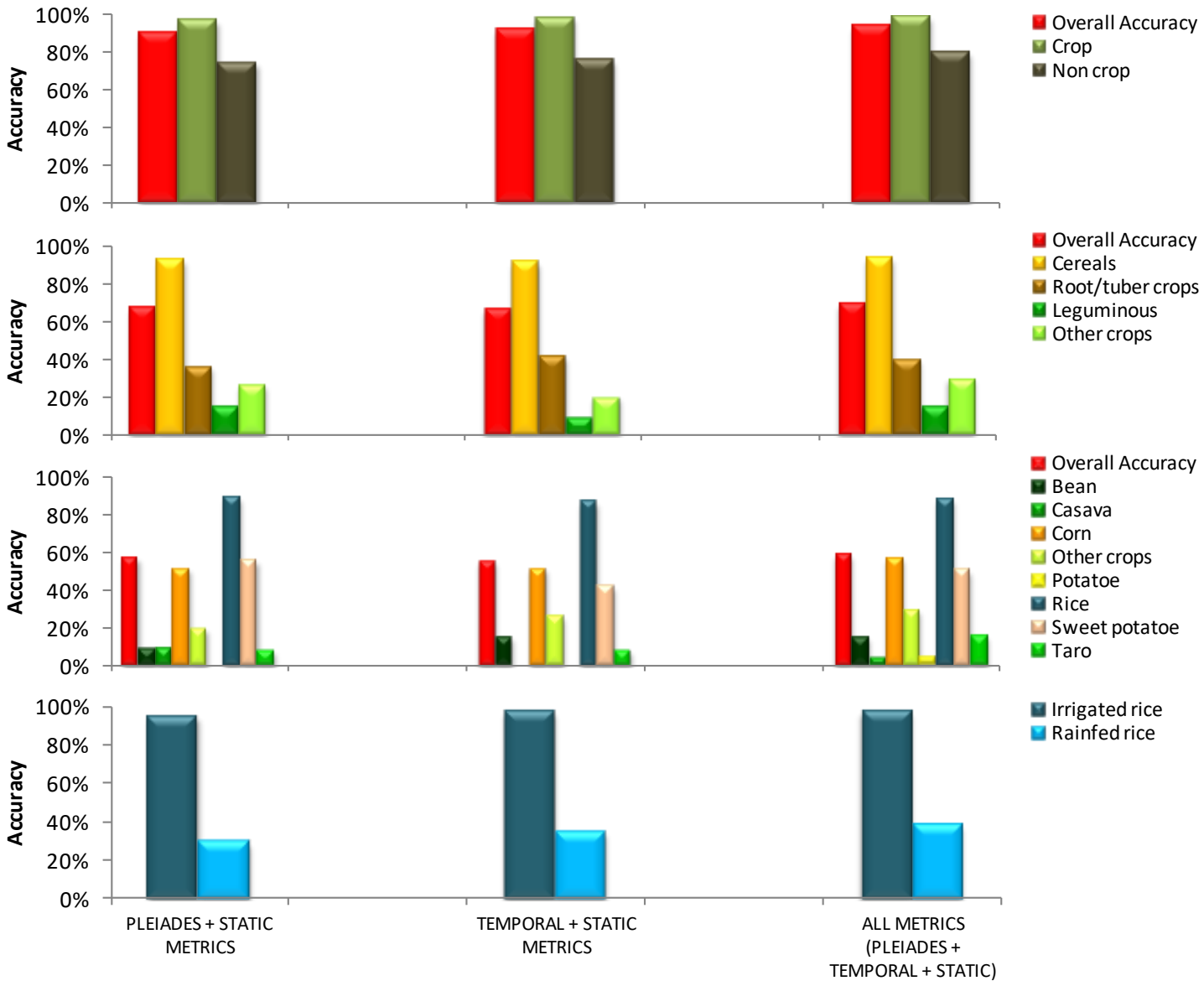
Results – Crop identification and Crop Area Estimation

CROP/NON-CROP
Best OA = 93.8%

CROP GROUP
Best OA = 69.2%

CROP CLASS
Best OA = 58.9%

CROP SUB-CLASS



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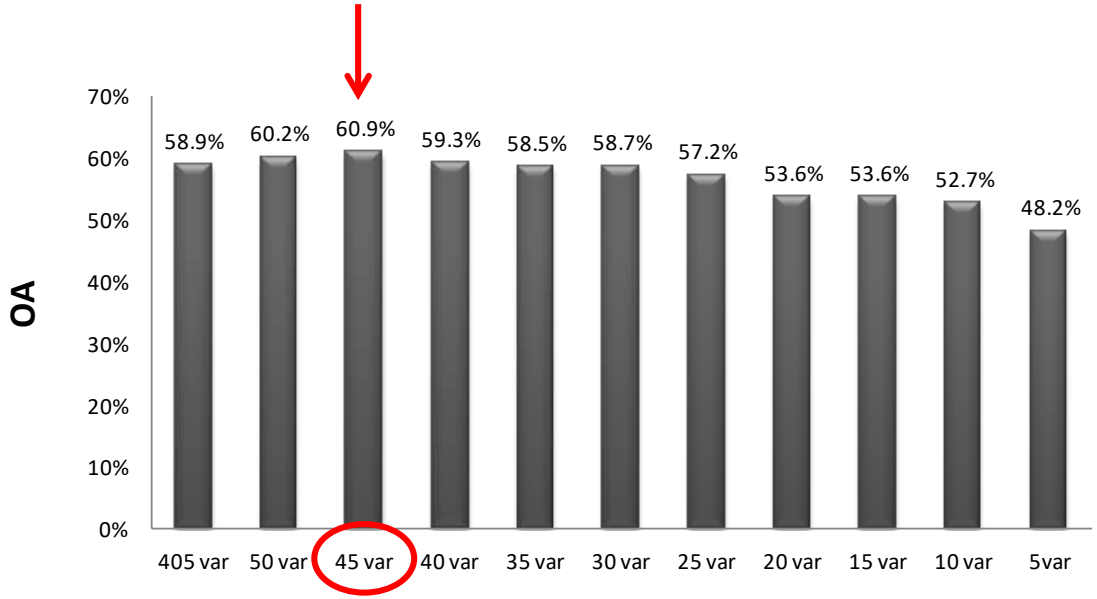
Results – Crop identification and Crop Area Estimation

- **Optimization:** how to map the whole area? (computer/volume limits)

PLEIADES 0.5 m

Results – Crop identification and Crop Area Estimation

- **Optimization:** reduce the volume of variables used
  - 5/10 metrics for CROP/NON CROP (NDVI-SWIR-Panchromatic PLEIADES)
  - 45 metrics for CROP CLASS (SWIR-NDVI-Panchromatic PLEIADES)



Overall accuracies for crop class level according to number of variables used

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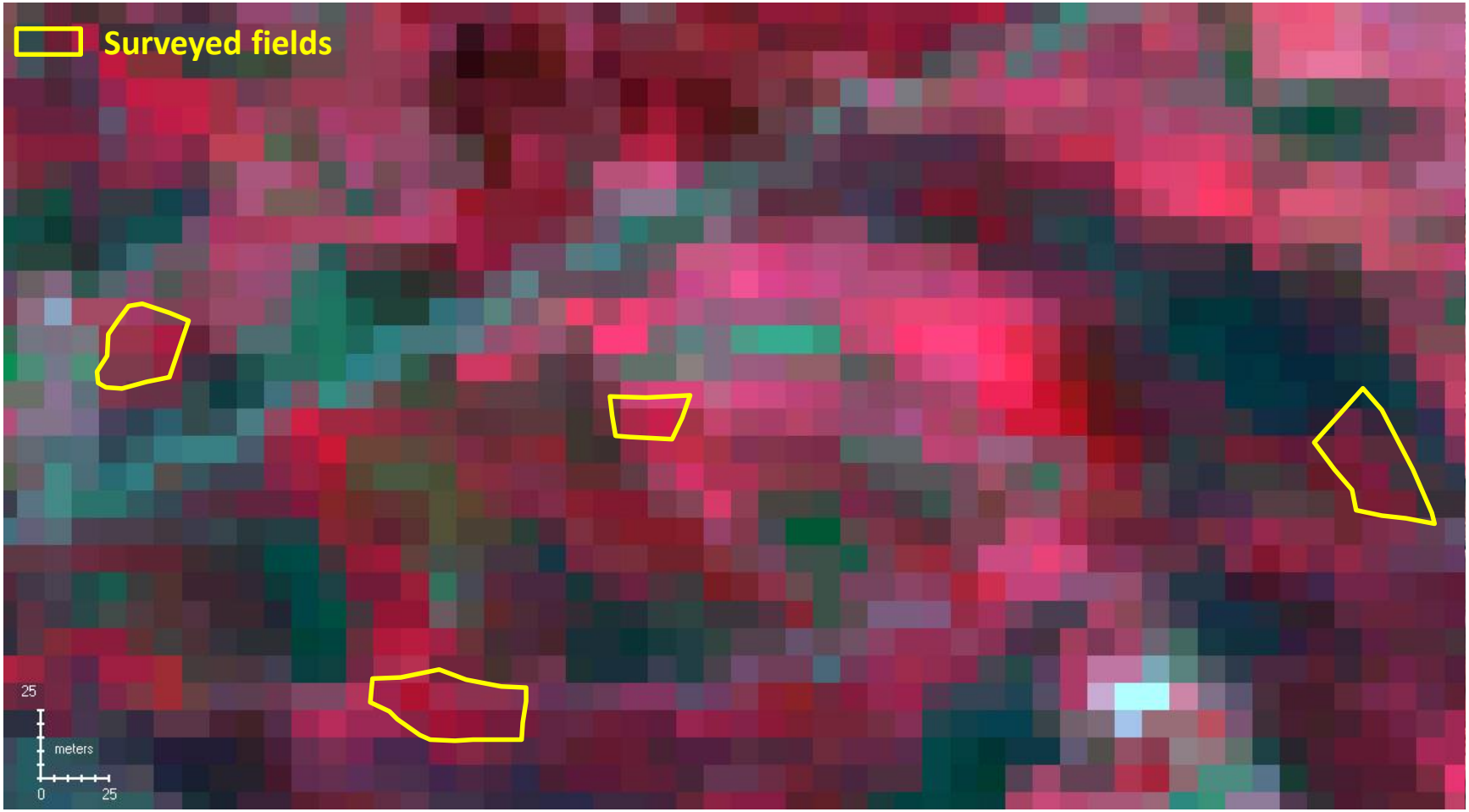
Methods – Rice crop yield estimation



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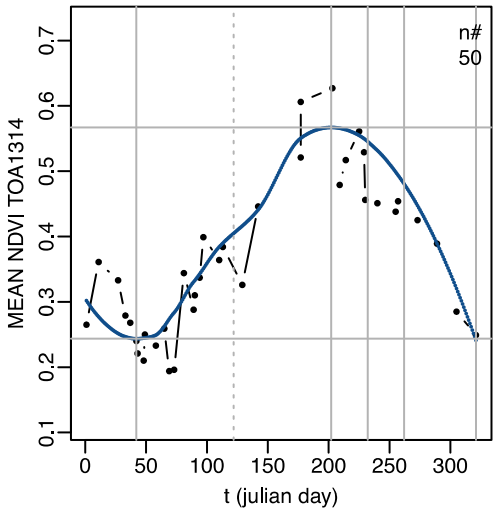
Methods – Rice crop yield estimation

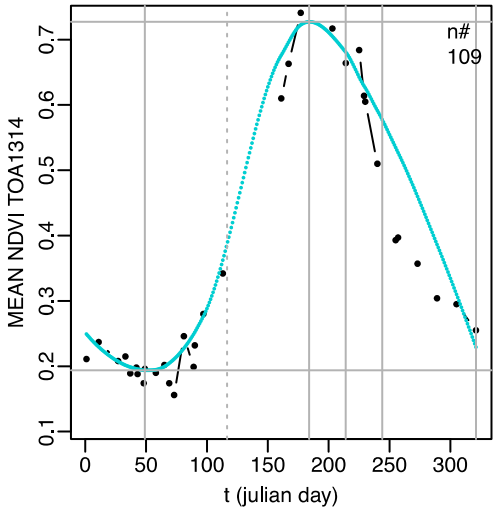
Smoothing:

- Stavitsky-Golay. Eliminate noise linked to clouds, mixed pixels, different sensors, atmospheric effects)

Different tresholds:

- Eliminate fields with incomplete temporal profil
- Eliminate fields with smoothed profil to far from raw profil





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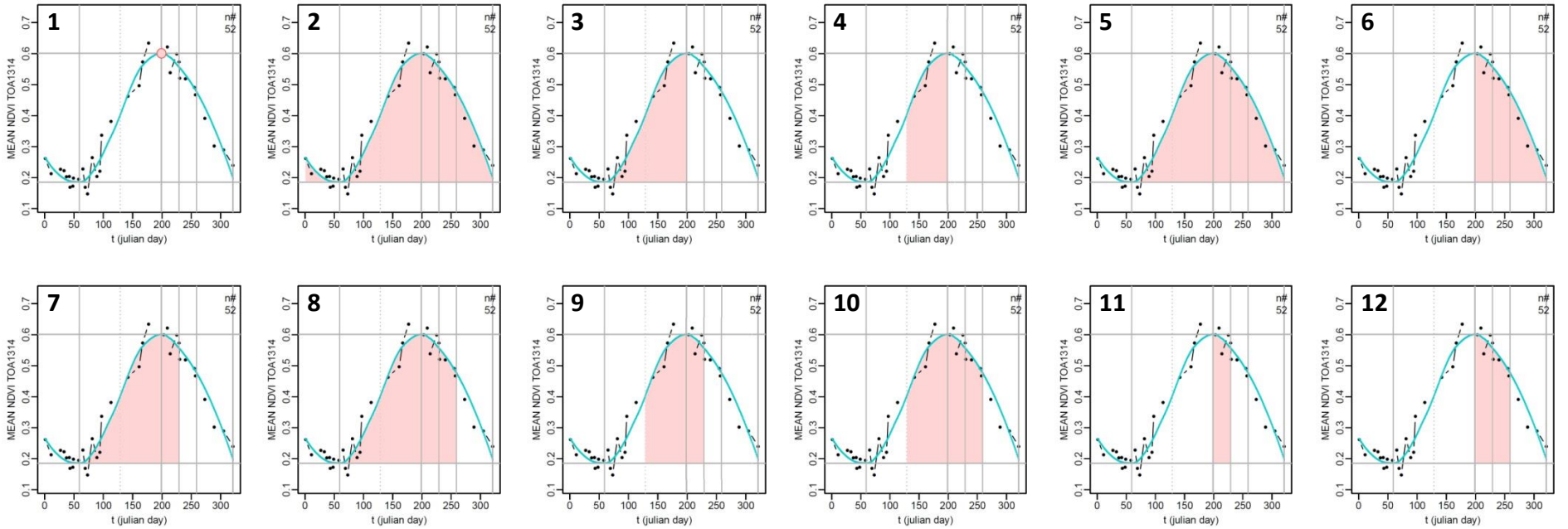
Methods – Rice crop yield estimation



1 : Max NDVI of the growing season

2 à 12 : Integrals on different periods of the growing cycle

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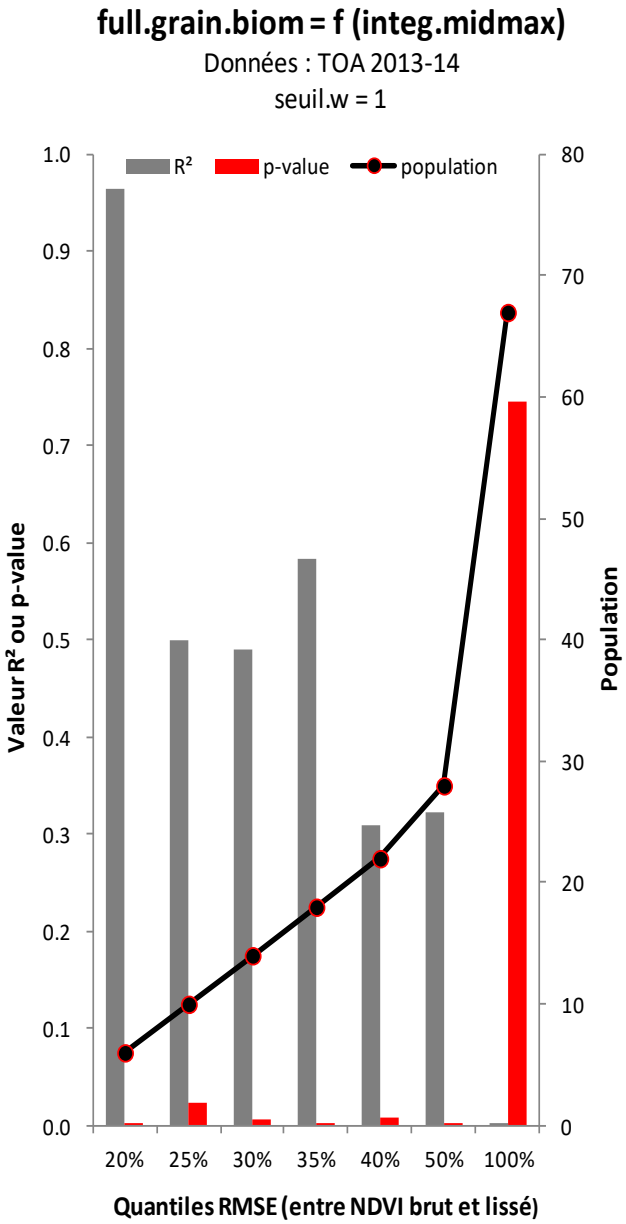
Results – Rice crop yield estimation

- The more the sorting is drastic, the more the correlations are good (but with less population!)
- Good linear correlations between some integrals and total biomass, straw biomass, acceptable for grain yield
- Currently not applicable to the whole production area but can give tendencies for food security systems



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Research Plans for Next Growing Season

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

  Multisource data analysis + Sentinel-2 data processing with a mixed image/signal processing and spatial modeling approach in order to be able to include expert knowledge on cropping systems/landscape organisation

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

  YES