sentinel-2

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JECAM/SEN2AGRI CROSS SITES BENCHMARKING FOR CROP TYPE

UCL Université catholique de Louvain
Earth and Life Institute - Geomatics

CS The power of innovation

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JECAM Annual Science Meeting

16-17 November 2015 – Brussels, Belgium

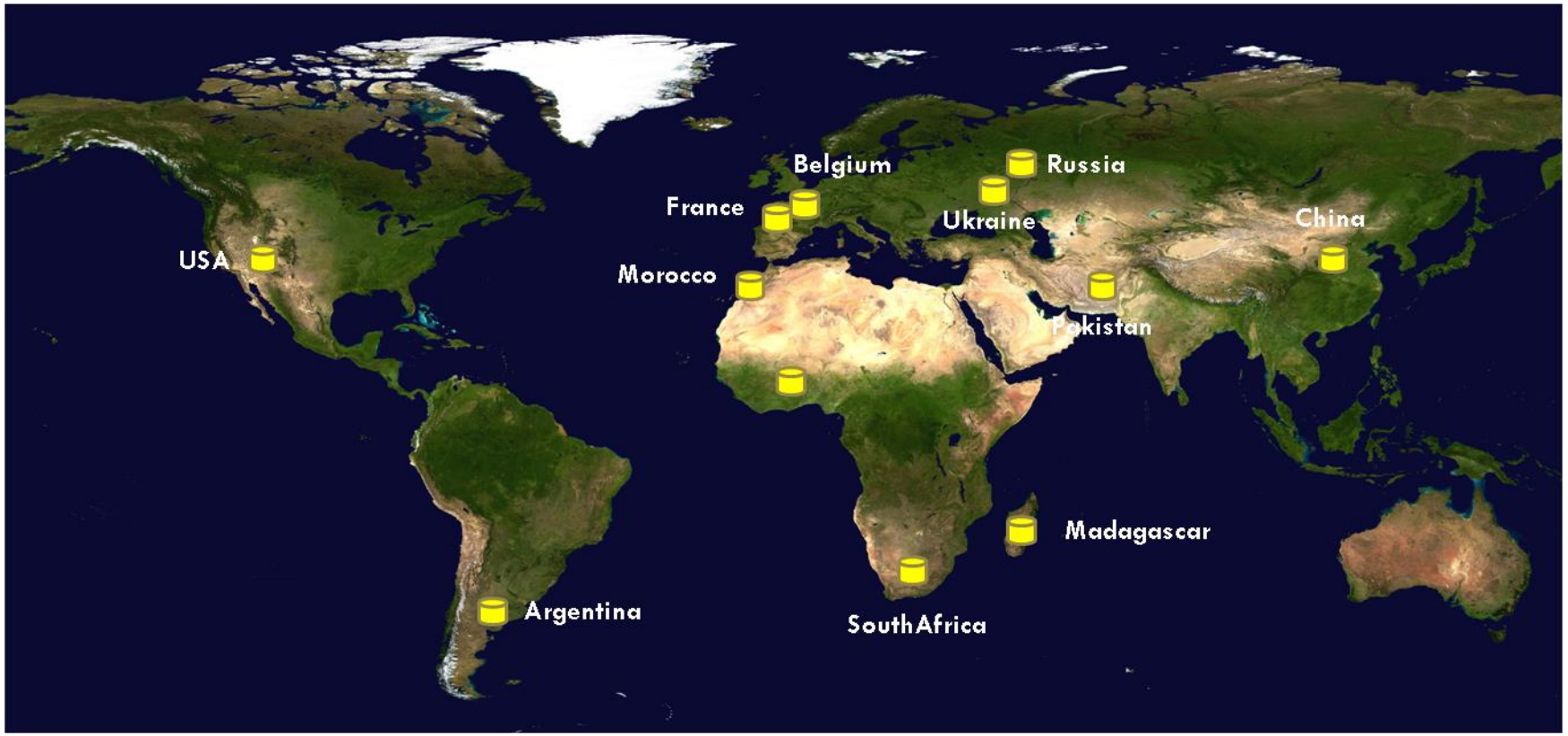
European Space Agency

CROP-TYPE PRODUCT

- Delivered as soon as possible after the end of the season
- Spatial resolution between 10 to 20 meters
- Main regional crop types or crop group mapping
- Quality metrics: Overall Accuracy and F-Score per class
- 4 key crops:
  - wheat
  - maize
  - rice
  - soybean

S2-AGRI – JECAM SITES

From 12 sites used for benchmarking 9 are JECAM sites:



Argentina, Belgium, China, Ukraine, South-Africa, Madagascar, France, Morocco and Russia

In each site:

1. Satellite imagery:

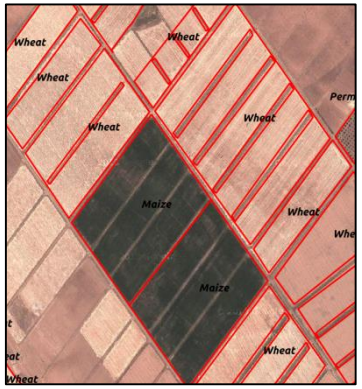
Simulation of Sentinel-2

time series based on SPOT4-Take5

and/or LANDSAT 8 imagery of 2013

2. In-situ field data:

- From field observations
- From institutional data



EXPLORATORY PHASE

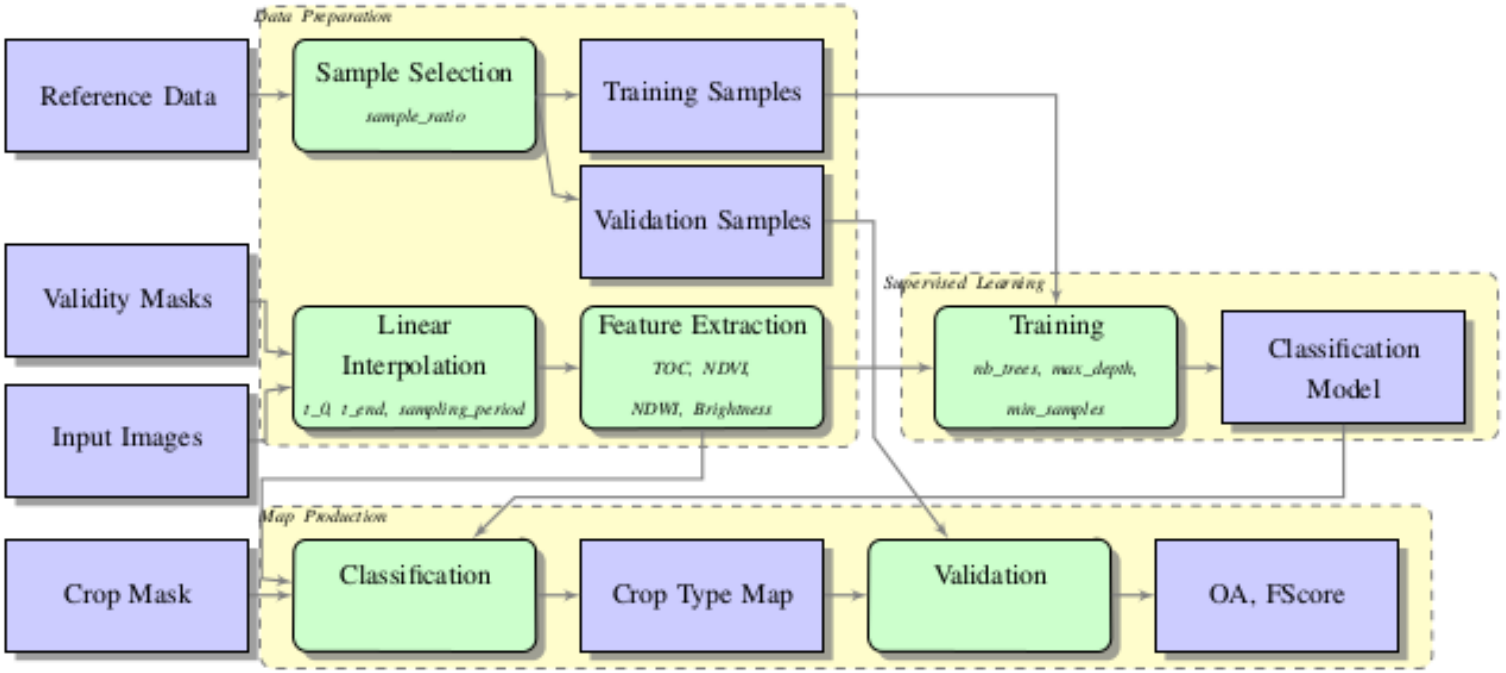
Goals:

- to set up a single processing chain that will operate with good performances on all different sites
- to evaluate a high number of combinations of the processing steps of a typical processing chain for land cover map production:

  - Feature extraction
  - Classifiers and definition of ranges for the values of the parameters of the different algorithms
  - Dealing with cloudy pixels

BENCHMARKING PHASE

Final procedure implemented for the assessment of the crop type map production chain



ARGENTINA

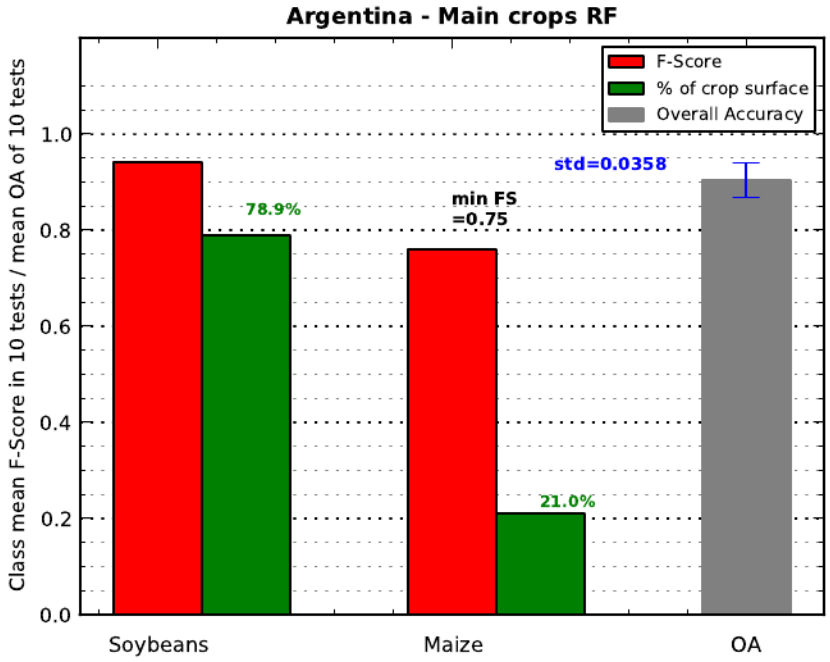


Image dataset -> Very good:
-Coverage from February to April covering the end of the summer crop season (October/November to April)
- Winter crops are not covered at all

Site	OA (95% conf. Intervalles)	F-Score of main crop	F-score minimal
Argentina	0.904 +- 0.026	0.9399	0.7586

BELGIUM

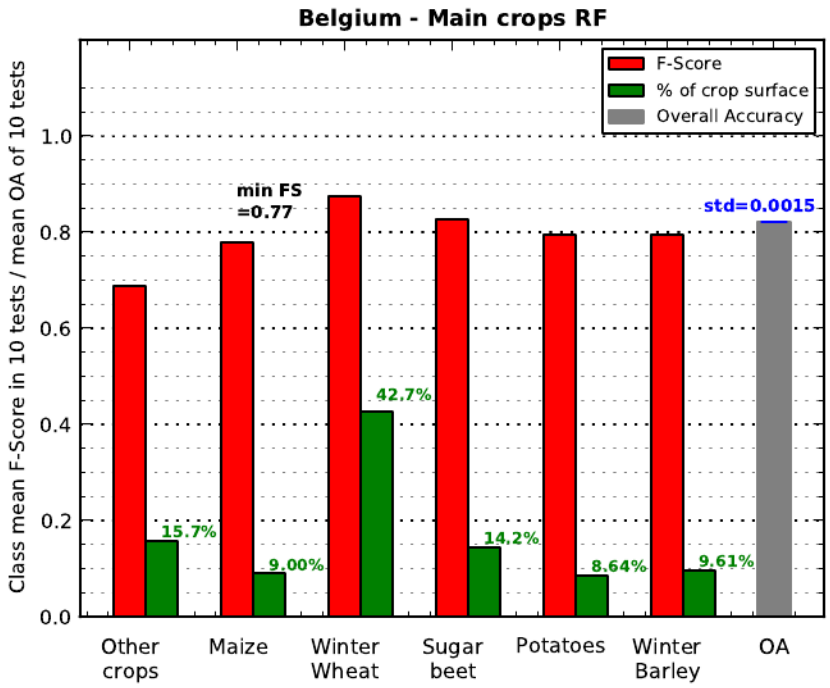


Image dataset -> Moderate:
- High cloudiness
- At least one acceptable image per month during the summer crop season (from March to September)

Site	OA (95% conf. Intervalles)	F-Score of main crop	F-score minimal
Belgium	0.822 +- 0.001	0.8735	0.7796

CHINA

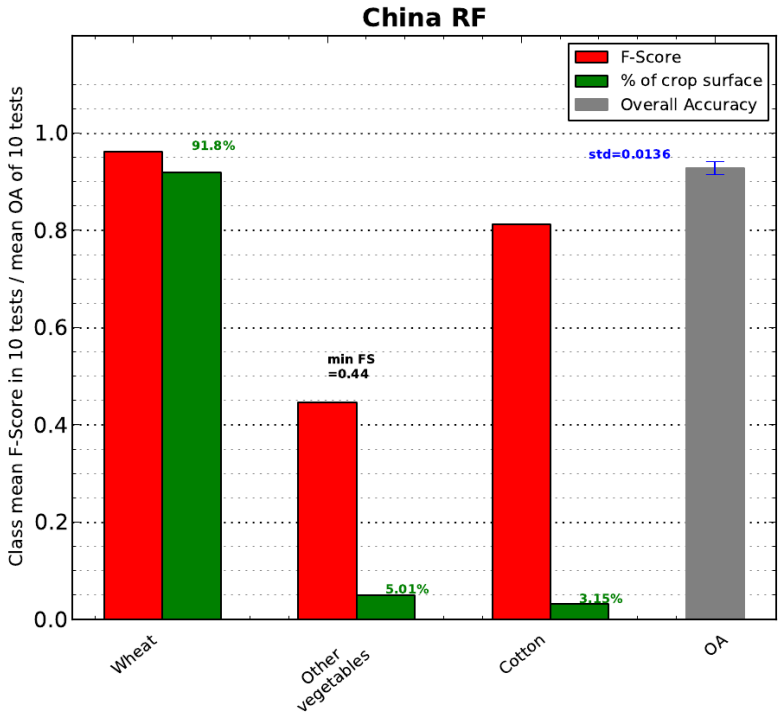


Image dataset -> Moderate:
-High presence of aerosols in February and March
- April and May are well covered, as well as the beginning of June

Site	OA (95% conf. Intervalles)	F-Score of main crop	F-score minimal
China	0.927 +- 0.010	0.9616	0.4455

FRANCE

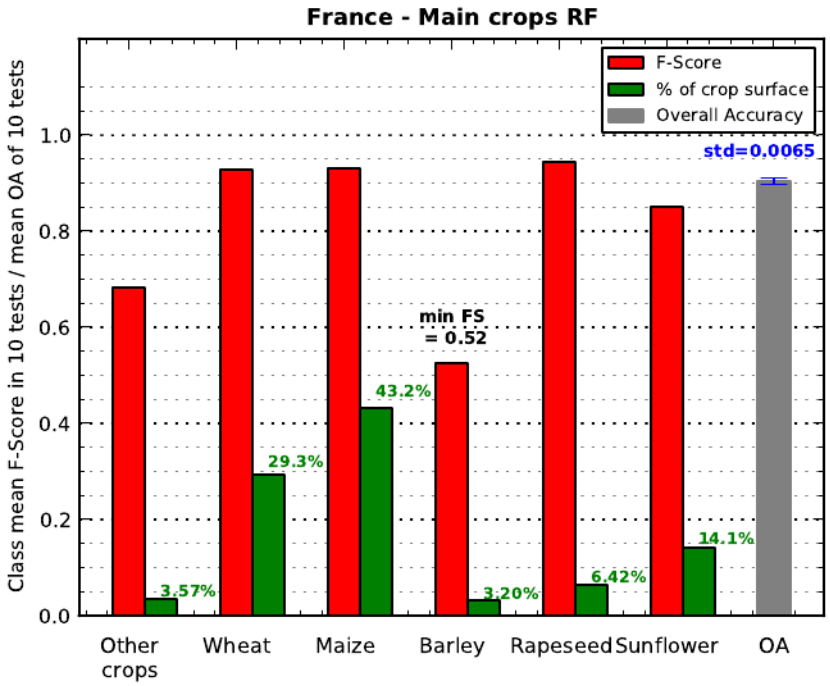


Image dataset -> Moderate:
- Covers the end of the winter crops and the complete summer crop cycles with more than one image per month
- Lacking the starting of the winter crops

Site	OA (95% conf. Intervalles)	F-Score of main crop	F-score minimal
France	0.904 +- 0.004	0.9310	0.5250

MADAGASCAR

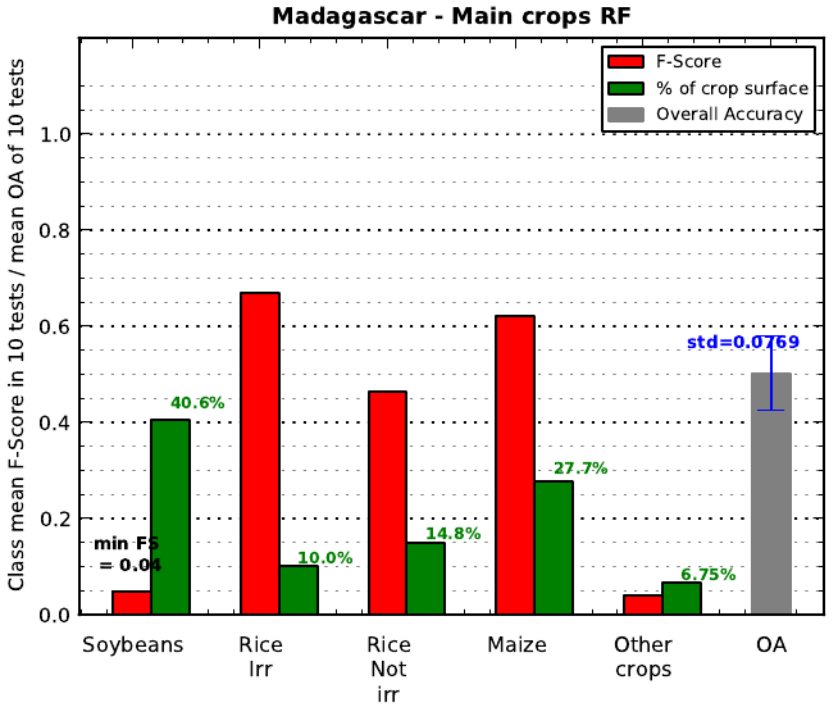


Image dataset -> Moderate/bad:
- Images were taken almost weekly from the middle to the end the growing season (from the end of February to the end of April)
- High cloudiness in the eastern half of the image, where the validation data are located

Site	OA (95% conf. Intervalles)	F-Score of main crop	F-score minimal
Madagascar	0.502 +- 0.058	0.0488	0.0488

Morocco

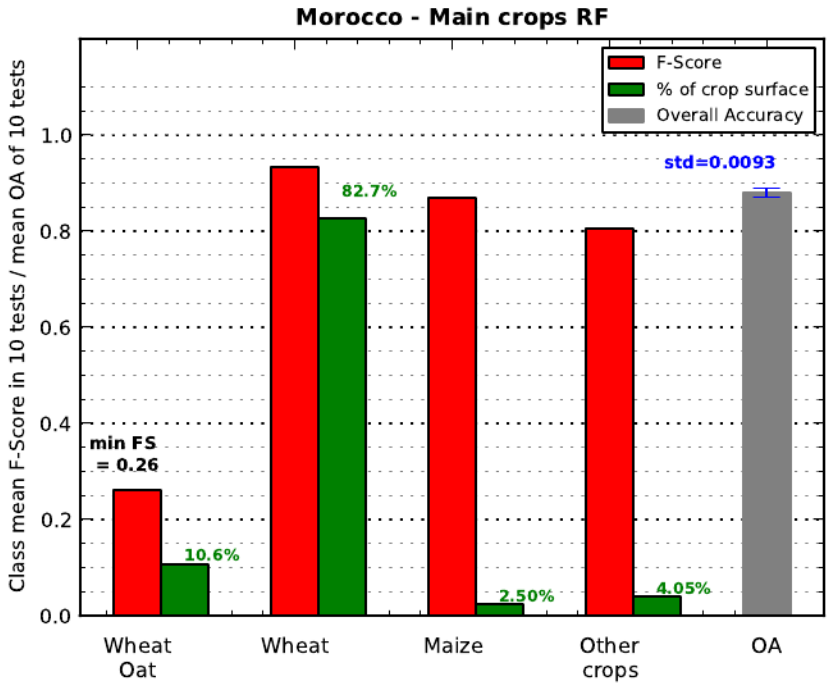


Image dataset -> Very good:
- Good coverage from January to June (one image approximately every 5 days)

Site	OA (95% conf. Intervalles)	F-Score of main crop	F-score minimal
Morocco	0.897 +- 0.005	0.9326	0.2734

RUSSIA

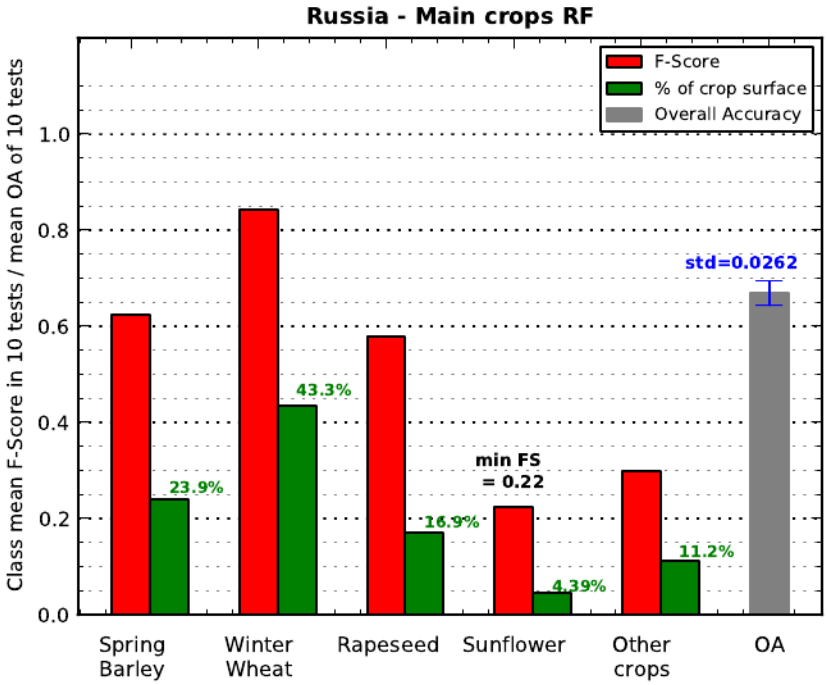


Image dataset -> Bad:
-Presence of clouds
- No SPOT4 (Take5) or Landsat images available
- RapidEye imagery was used covering the middle end of the summer crops from the end of April to July. Only 4 images were free of clouds

Site	OA (95% conf. Intervalles)	F-Score of main crop	F-score minimal
Russia	0.668 +- 0.019	0.8435	0.2237

SOUTH AFRICA

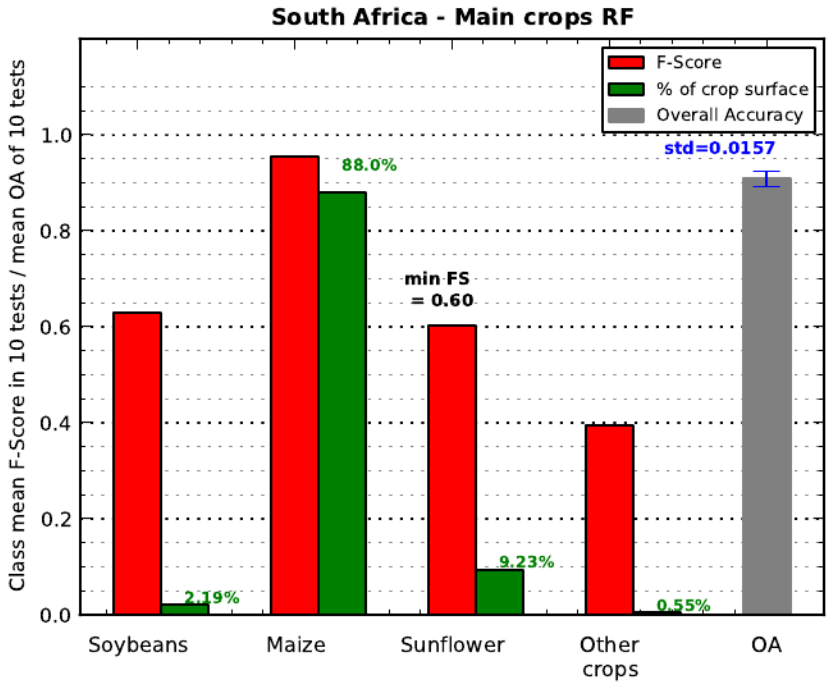


Image dataset -> Good:
- The dataset provides good coverage with a good image every week, except for the beginning of the cycle (December/January) and field data correspond to summer crops.

Site	OA (95% conf. Intervalles)	F-Score of main crop	F-score minimal
South-Africa	0.908 +- 0.011	0.9542	0.3941

UKRAINE

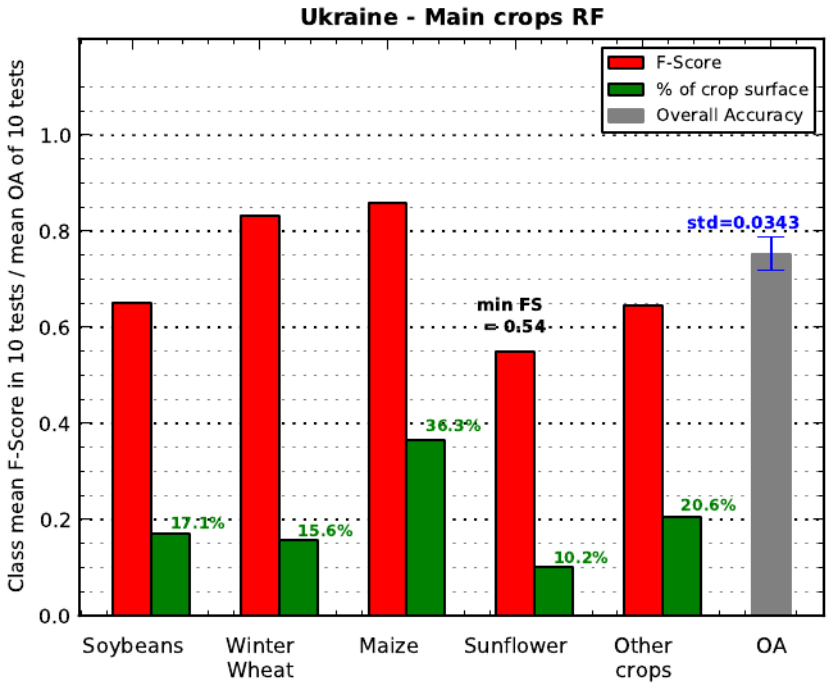
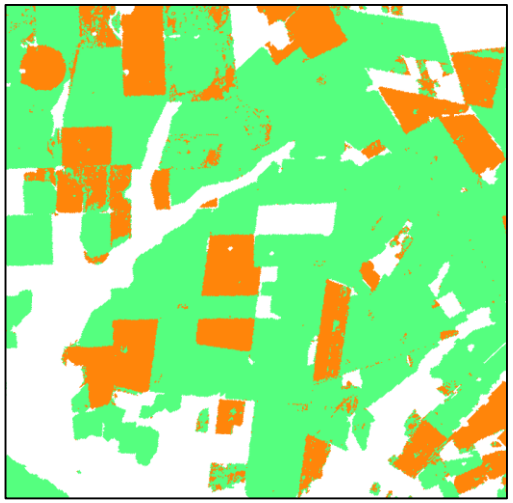


Image dataset -> Moderate:
- April, May and June are covered, which corresponds to the end of the winter crops and the beginning of the summer crops
- From December to March, there is no image due to clouds

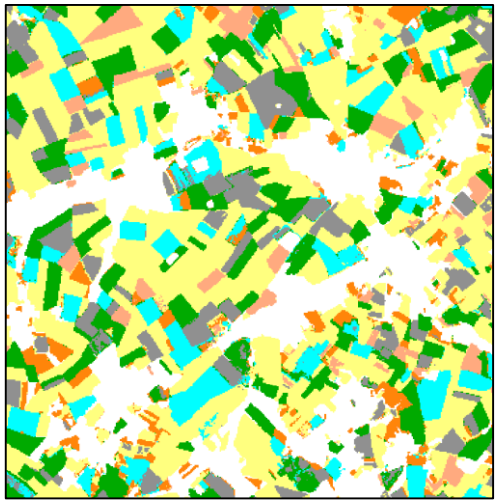
Site	OA (95% conf. Intervalles)	F-Score of main crop	F-score minimal
Ukraine	0.752 +- 0.025	0.8589	0.5493

SOME IMAGES …



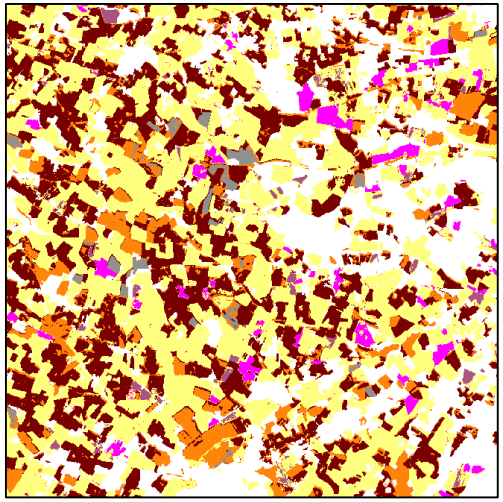
Argentina

- Maize
- Soybeans



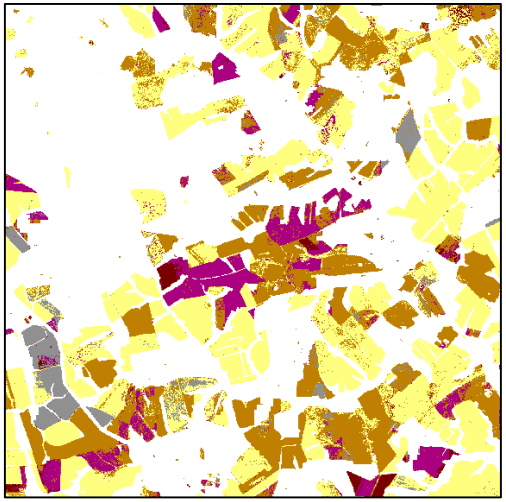
Belgium

- Maize
- Potatoes
- Sugar beet
- Winter wheat
- Winter barley
- Other annual crops



France

- Wheat
- Maize
- Barley
- Rapeseed
- Sunflower
- Other annual crops



Russia

- Winter wheat
- Spring barley
- Rapeseed
- Sunflower
- Other annual crops

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CONCLUSION

- Different kind of sites:

  -Good in-situ data and good EO data (weather)
  -Good in-situ data and bad EO data (weather, aerosols)
  -Few classes in in-situ data and growing season elapsed for the available period of EO data

- Same processing chain applied for all sites

- General better conditions with Sentinel 2 in its full configuration : more repeatability, more spectral bands, higher spatial resolution

Many thanks to the site managers for providing their in-situ data


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1.1 F-Score

The F-Score (also known as F-1 score or F-measure) is the harmonic mean of the Precision and Recall and reaches its best value at 1 and worst score at 0:

$$FScore = 2x\frac{Precison * Recall}{Precision + Recall}$$

Precision or User's Accuracy (UA) for the class *i* it is the fraction of correctly classified pixels with regard to all pixels classified as this class *i* in the classified image:

$$UA_i = \sum_{j=1}^{r} \frac{n_{ii}}{n_{ij}}$$

Recall or Producer's Accuracy (PA) for the class *i* it is the fraction of correctly classified pixels with regard to all pixels of that ground truth class *i*:

$$PA_i = \sum_{j=1}^{r} \frac{n_{ii}}{n_{ji}}$$

1.1 Overall accuracy

The Overall Accuracy (OA) is calculated as the total number of correctly classified pixels (diagonal elements of the confusion matrix) divided by the total number of test pixels:

$$OA = \frac{\sum_{i=1}^{r} n_{ii}}{\sum_{i=1}^{r} \sum_{j=1}^{r} n_{ij}}$$