

JECAM Science Meeting

Ottawa, Canada 21 – 23 July 2014

Belgium JECAM Site

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– in collaboration with BELAIR site (I. Piccard, VITO)



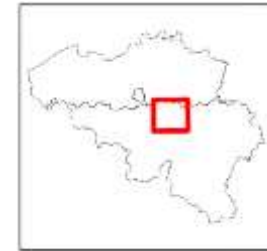
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Joint Experiment for Crop Assessment and Monitoring

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Belgium JECAM site description

- **Very intensive agricultural region with diverse and fragmented landscape dominated by agricultural lands :**
Main crop types : wheat, barley, potatoes, sugar beet, maize, alfalfa, rape seed.
- *Location* : Belgium, Centroid : 49.75° N, 3.75° E
- *Topography*: flat or slightly undulating with elevation between 20 and 200 m
- Loamy soils
- Soil moderately well-drained (no irrigation)
- *Crop calendar*:
Winter crops: wheat / barley: Sept-July;
Summer crops: Maize/sugar beet : April - Sept.
- *Field size* : **from 3 to 15 ha**
- Climate and weather: moderately humid, with annual rainfall of about 780 mm well distributed over the year
- **Cloud coverage can be frequent during the ag. season**



Belgium JECAM site : a fragmented and diverse ag. landscape



Source : DigitalGlobe, GeoEye



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Research Objectives



Overall research objectives:

methodological development for crop identification, crop area estimate and biophysical variable retrieval

Current objectives:

- Main crops identification using SAR/optical data
- Crop biophysical variable from SAR/optical time series
- Soil moisture from SAR time series
- Multi-source optical data processing

EO data received and used for 2013 ag. season



RADARSAT-2
10 m



SPOT4
20 m

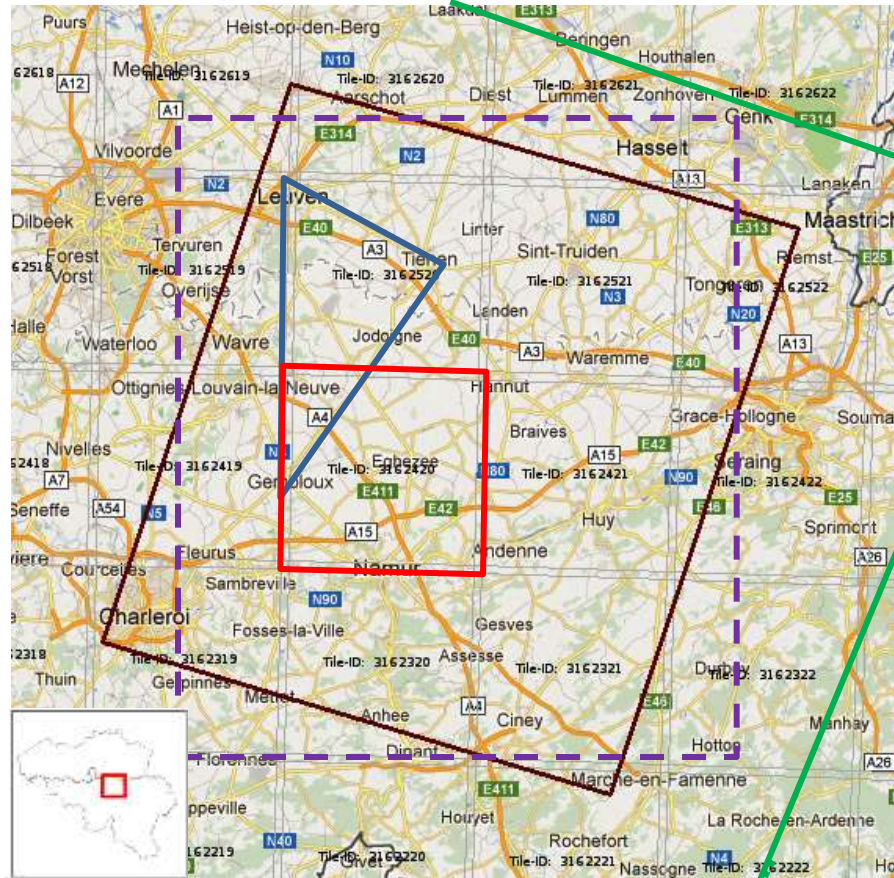


Landsat 8
30 m



RapidEye
5 m

+ daily coverage by low resolution
optical satellite sensors:
SPOT-VGT
MODIS
Proba-V 300m



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14 SPOT-4 Take 5 and 28 ESA RapidEye acquisitions



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9 Landsat-8 available since mid-April 2013



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Example: 2013 growing season



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11 Radarsat-2 available since March 2013



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Optical EO data for the 2013 growing season

	February	March	April	May	June	July	August
SPOT4 (take 5)	Cloud covered	Cloud covered	Partly cloud covered	Cloud covered	Cloud covered	Cloud covered	
RapidEye (ESA)	Cloud covered	Cloud covered	Partly cloud covered	Cloud covered	Partly cloud covered	Cloud covered	
Landsat 8				Cloud covered	Cloud covered	Partly cloud covered	Partly cloud covered
RADARSAT-2		Useful for analysis	Useful for analysis	Useful for analysis	Useful for analysis	Useful for analysis	Useful for analysis

SPOT4

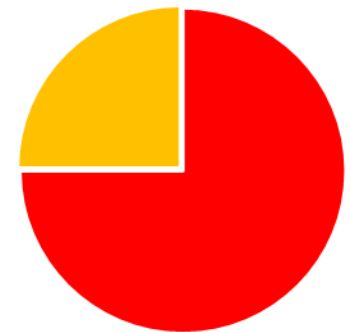
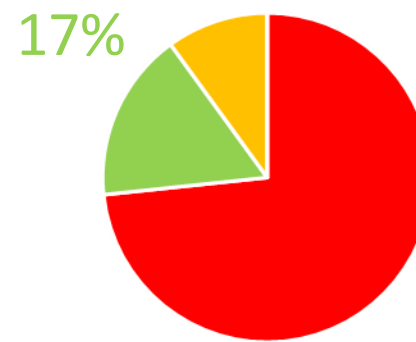
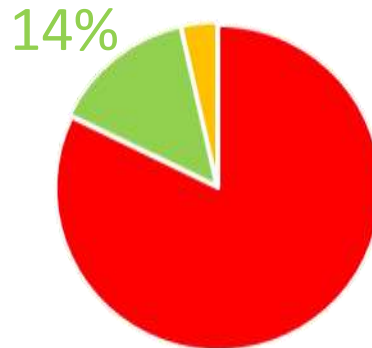
RapidEye

Landsat 8

Useful for analysis

Partly cloud covered

Cloud covered



Challenges about EO data for 2013

- *Optical EO* : cloud coverage in such a bad year !
 - all platforms much needed !
- *SAR data* : - great time series !
 - would be even better with constant incidence angle
 - paperwork to share data across JECAM sites to extend the analysis

Regular *in situ* data collection

Every year once :

Crop type

Row orientation

Plant density

4 to 7 times over a season:

Leaf Area Index (LAI)

Development stage

On ad hoc basis:

Yield

Fresh and dry biomass

Soil moisture incl. GPR



Synchronous field campaign: LAI measurements

Leaf Area Index (LAI): the one-sided green leaf area per unit of ground surface area (m^2/m^2) estimate from hemispherical photo using CAN-EYE



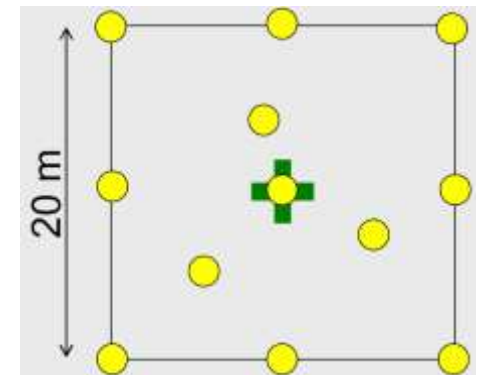
- ➔ 15 winter wheat fields visited in 2013
- ➔ 7 dates of hemispherical photographs/ field



Fish-Eye lens

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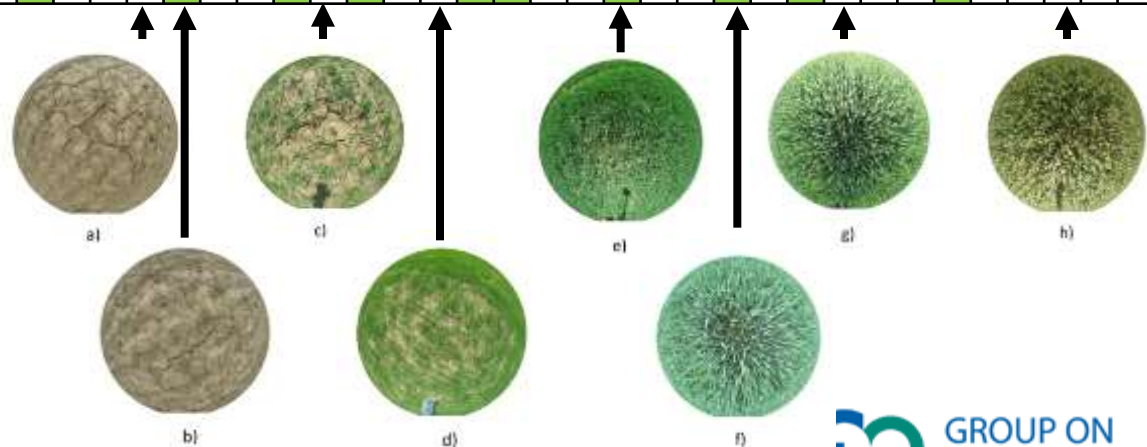
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Spatial sampling example

LAI measurements along 2013 intensive EO acquisition campaign

	February	March	April	May	June	July	August
SPOT4 (take 5)	Red	Red	Red	Red	Red	Red	Red
RapidEye (ESA)	Red	Red	Red	Red	Red	Red	Red
Landsat 8				Red	Red	Red	Red
RADARSAT-2		Green	Green	Green	Green	Green	Green



On-going collaboration with



Airborne incl. UAV data acquired starting from 2013

APEX, hyperspectral images acquired on 7 July 13 + UAV2 & 8 July 13



=>study on different N-fertilizer rates on potatoes :

- Transmittance measurements with a SPAD/HNT chlorophyllometer
- Reflectance measurements with a Cropscan radiometer
- Hemispherical photographs to estimate LAI, fCover and fAPAR
- Crop samples analyzed with a near infrared spectrometer to determine N-concentration and N-export of the different parts of the plant



On-going collaborations within JECAM

in close connexion with JECAM site managers

- Ukraine and SAfrica JECAM sites in FP-7 Imagines project
=> main crop types mapping
- Mali JECAM site in the framework of BMGF STARS project
=> fieldwork protocols and crop discrimination
- One of the 8 JECAM sites for the ESA Sen2-Agri project
=> generic methods benchmarking
- One of the 6 JECAM sites for FP7-SIGMA project
=> PROBA-V for croplands mapping

Results : making most use of already existing info to automate crop discrimination from Radarsat-2

1. Predicting the crop type before the growing season based on the annual crop type maps of the previous 6 years => **OA : 60 %**

Year of the crop sequence	Error
07-08	0.463
08-09	0.463
09-10	0.463
10-11	0.463
11-12	0.463
07-08-09	0.429
08-09-10	0.413
09-10-11	0.412
10-11-12	0.412
07-08-09-10	0.403
08-09-10-11	0.404
09-10-11-12	0.401
07-08-09-10-11	0.402
08-09-10-11-12	0.397
07-08-09-10-11-12	0.396

2. Parcel-based classification (RF) using SAR data set thanks to automatically selected training set from predicted crop types => **OA=89 %** (only 3 classes)(n=8766)

	Other Crops	Winter Wheat	Grassland	Total	Users
Other Crops	3972	646	118	4736	0.8387
Winter Wheat	202	2324	1	2527	0.9197
Grassland	11	2	1490	1503	0.9914
Total	4185	2972	1609	8766	
Producers	0.9491	0.782	0.926		0.8882

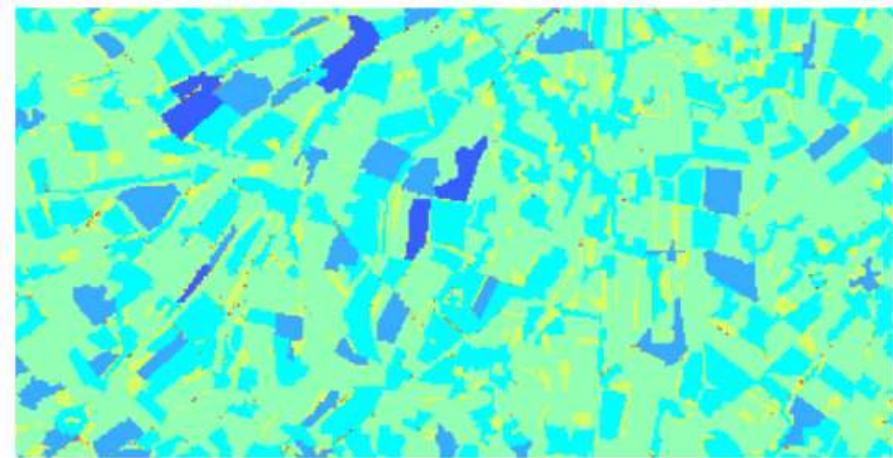
Leonard et al. IGARSS 2014

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Results : making most use of already existing info to automate training data set selection

3. Method development to predict the **probability of correct classification using ancillary data** in order to select most appropriate training data set for crop type discrimination



Probability of correct classification (April 22, 2013)



0.00 - 0.07
0.08 - 0.14
0.15 - 0.20
0.21 - 0.27
0.28 - 0.34
0.35 - 0.41
0.42 - 0.48
0.49 - 0.54
0.55 - 0.61
0.62 - 0.68

Jacques et al. G2M 2014

fnrs
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- *Can this approach be called 'best practice'?*

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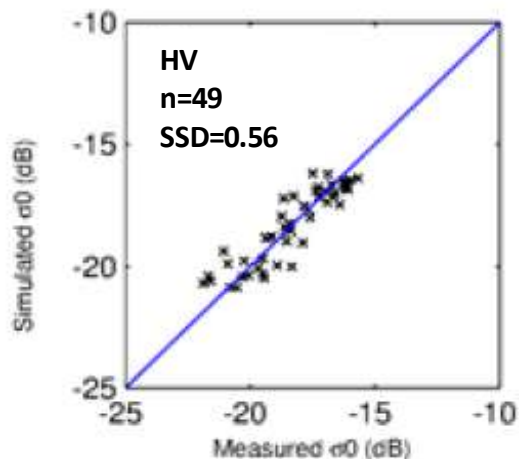
The principle should be part of the best practices
but methods to benchmark



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Results : winter wheat LAI retrieval from Radarsat-2

1. SWAP model sufficient to deal with variable soil moisture
2. Water Cloud model performing very well if only **vegetative phase** !

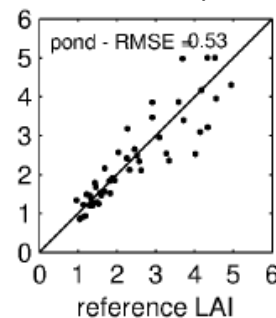
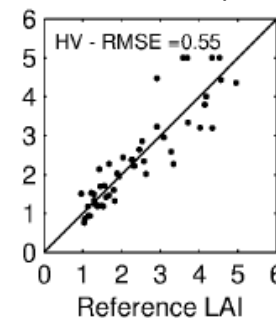
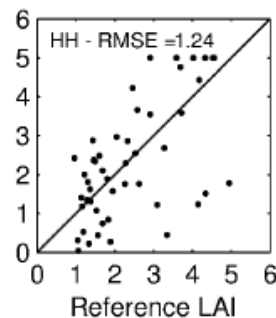
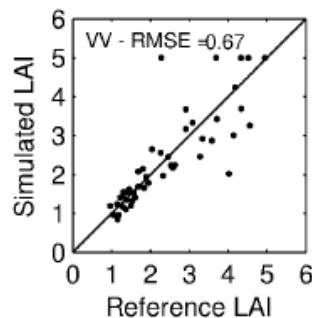


Data set	Polarization	RMSE on LAI
Vegetative phase - 4 acquisitions	VV	0.67
	HH	1.24
	HV	0.55
	Pond	0.53

SPOT ww : RMSE= 0.63 (Duveiller et al. 2011)

ASAR maize: RMSE= 0,89 (Bériaux et al. 2013)

3. VV for heading detection



Leonard et al. ESA LV 2014
Leonard et al. IGARSS 2014

- *Can this approach be called 'best practice'?*

Water Cloud and SWAP models should be tested on other

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JECAM sites before becoming BP



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Research Plan for Next Growing Season

Multi-year data set is key for robust demonstration:

- *Will you hold the course of the approach ? YES !*
- *Do you anticipate ordering the same type/quantity of EO data next year?*

YES + Sentinel-1 and TerraSAR X time series

Forthcoming **BELCAM** project supported by  belspo

towards NRT crop status delivery at field level
based on optical and SAR data

A circular, top-down view of a cornfield. The corn plants are vibrant green and arranged in rows. The soil between the rows is a dark brown color. On the right side of the circle, a person's arm and hand are visible, reaching towards the corn. A red and white striped pole or marker is also visible on the right side, extending horizontally across the image.

Thank you for attention