JECAM Science Meeting
Ottawa, Canada  21 – 23 July 2014

Belgium JECAM Site
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– in collaboration with BELAIR site (I. Piccard, VITO)
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
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
14 SPOT-4 Take 5 and 28 ESA TPM acquisitions
9 Landsat-8 available since mid-April 2013

Example: 2013 growing season
11 Radarsat-2 available since March 2013
## Optical EO data for the 2013 growing season

<table>
<thead>
<tr>
<th></th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
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<tbody>
<tr>
<td><strong>SPOT4</strong></td>
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<td>(take 5)</td>
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<td><strong>RapidEye</strong></td>
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<td><strong>Landsat 8</strong></td>
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<td><strong>RADARSAT-2</strong></td>
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</tbody>
</table>

### Pie Charts

- **SPOT4**: 14% useful, 17% partly cloud covered, 79% cloud covered
- **RapidEye**: 17% useful, 17% partly cloud covered, 76% cloud covered
- **Landsat 8**: 17% useful, 17% partly cloud covered, 76% cloud covered

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**Useful for analysis**

**Partly cloud covered**

**Cloud covered**

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**JECAM**

Joint Experiment for Crop Assessment and Monitoring

**GEO**

GROUP ON EARTH OBSERVATIONS
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

**JECAM**

*Joint Experiment for Crop Assessment and Monitoring*
Synchroneous 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

Spatial sampling example
LAI measurements along 2013 intensive EO acquisition campaign

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<tr>
<td>SPOT4 (take 5)</td>
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<tr>
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The chart shows the frequency of measurements for each satellite during the months of February to August 2013. The images below the chart illustrate the progression of LAI measurements.
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%

<table>
<thead>
<tr>
<th>Year of the crop sequence</th>
<th>Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>07-08</td>
<td>0.463</td>
</tr>
<tr>
<td>08-09</td>
<td>0.463</td>
</tr>
<tr>
<td>09-10</td>
<td>0.463</td>
</tr>
<tr>
<td>10-11</td>
<td>0.463</td>
</tr>
<tr>
<td>11-12</td>
<td>0.463</td>
</tr>
<tr>
<td>07-08-09</td>
<td>0.429</td>
</tr>
<tr>
<td>08-09-10</td>
<td>0.413</td>
</tr>
<tr>
<td>09-10-11</td>
<td>0.412</td>
</tr>
<tr>
<td>10-11-12</td>
<td>0.412</td>
</tr>
<tr>
<td>07-08-09-10</td>
<td>0.403</td>
</tr>
<tr>
<td>08-09-10-11</td>
<td>0.404</td>
</tr>
<tr>
<td>09-10-11-12</td>
<td>0.401</td>
</tr>
<tr>
<td>07-08-09-10-11</td>
<td>0.402</td>
</tr>
<tr>
<td>08-09-10-11-12</td>
<td>0.397</td>
</tr>
<tr>
<td>07-08-09-10-11-12</td>
<td>0.396</td>
</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th></th>
<th>Other Crops</th>
<th>Winter Wheat</th>
<th>Grassland</th>
<th>Total</th>
<th>Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other Crops</td>
<td>3972</td>
<td>646</td>
<td>118</td>
<td>4736</td>
<td>0.8387</td>
</tr>
<tr>
<td>Winter Wheat</td>
<td>202</td>
<td>2324</td>
<td>1</td>
<td>2527</td>
<td>0.9197</td>
</tr>
<tr>
<td>Grassland</td>
<td>11</td>
<td>2</td>
<td>1490</td>
<td>1503</td>
<td>0.9914</td>
</tr>
<tr>
<td>Total</td>
<td>4185</td>
<td>2972</td>
<td>1609</td>
<td>8766</td>
<td>0.8882</td>
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<tr>
<td>Producers</td>
<td>0.9491</td>
<td>0.782</td>
<td>0.926</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Leonard et al. IGARSS 2014
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

Jacques et al. G2M 2014

Can this approach be called ‘best practice’? The principle should be part of the best practices but methods to benchmark

JECAM
Joint Experiment for Crop Assessment and Monitoring
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!

<table>
<thead>
<tr>
<th>Data set</th>
<th>Polarization</th>
<th>RMSE on LAI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetative phase - 4 acquisitions</td>
<td>VV</td>
<td>0.67</td>
</tr>
<tr>
<td></td>
<td>HH</td>
<td>1.24</td>
</tr>
<tr>
<td></td>
<td>HV</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td>Pond</td>
<td>0.53</td>
</tr>
</tbody>
</table>

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 JECAM sites before becoming BP
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 towards NRT crop status delivery at field level based on optical and SAR data
Thank you for attention