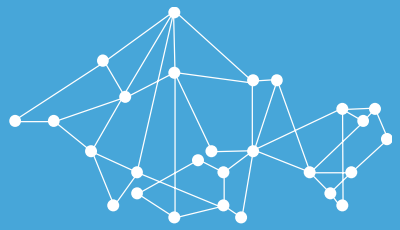
THE BELAIR 2015 PROJECT

BELAIR WORKSHOP
2016,
8 NOVEMBER,
BRUGES



Ils Reusen, Koen Meuleman, Kristin Vreys, Bart Ooms, Bart Bomans, Johan Mijnendonckx, Pieter-Jan Baeck, Marian-Daniel Iordache, Tom Verstappen,
VITO Remote Sensing

BELAIR 2015

BELAIR 2015 - Objectives

» Organize **spaceborne, APEX and UAV** acquisitions

» Simultaneously perform **in-situ measurements** at

- **“Litora”**
- **“Sonia”**
- **“Hesbania”**

in collaboration with all key users interesting in joining

Local coordinators at each of the three sites: Liesbeth De Keukelaere (VITO) @ “Litora”, Boud Verbeiren (VUB) @ “Sonia” and Stephanie Delalieux (VITO) @ “Hesbania”

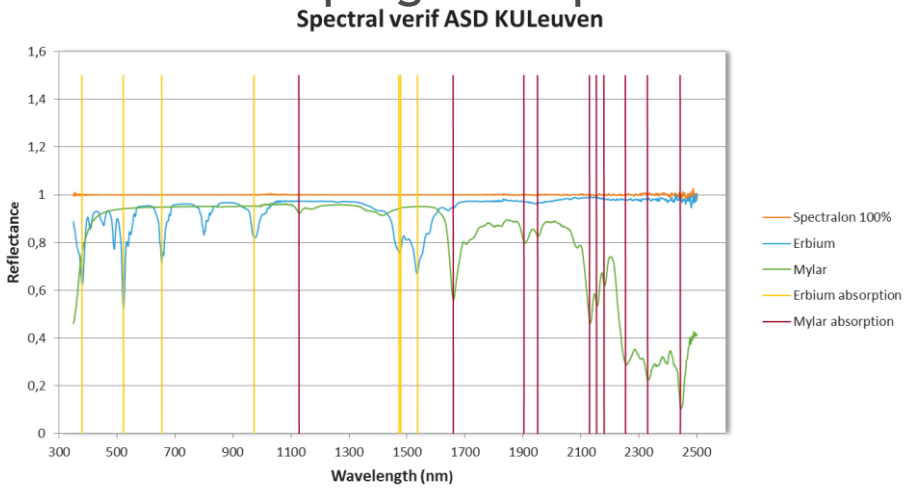
» **Process, archive and distribute** spaceborne, APEX and UAV imagery and in-situ data to be exploited in MSc and PhD theses and/or running/future (inter)national research projects

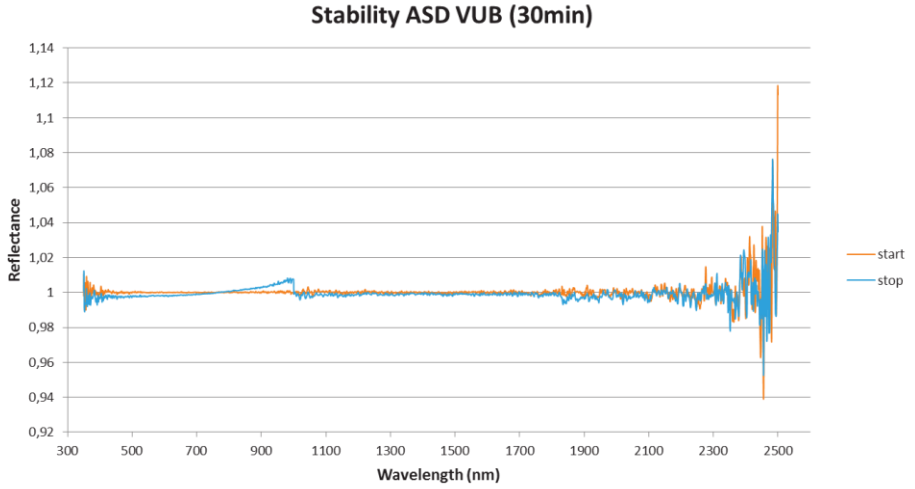
BELAIR 2015 – Kick Off meeting, 20 March 2015 @ BELSPO

- Preliminary APEX, UAV acquisition plans presented and discussed
- APEX and UAV processing presented
- Preliminary field campaign plans discussed
- BELAIR sites discussed and **“Sonia” and “Hesbania”** sites extended
- Collaboration at BELAIR sites discussed and extended

BELAIR 2015 – Performance verification

- **Uniform measurement protocol and verification of** spectral and radiometric **performance of ASD spectroradiometers** UCL, VUB and VITO: spectral (Erbium, Mylar), radiometric (synthetic panels, stability)
- A spectral and radiometric verification report including recommendation to clean the spectralon panel before the start of the campaign was provided to UCL and VUB.



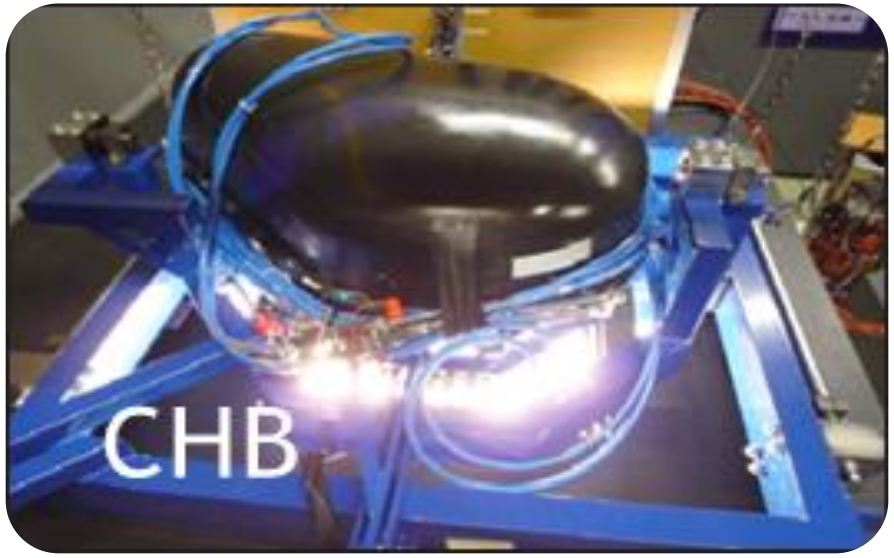


BELAIR 2015 – Auxiliary data training

- BELAIR auxiliary data training at VITO on 6 May 2015
- Recommendations/manuals/forms/sample data for pre-processing provided to teams

BELAIR 2015 – APEX calibration

» The hyperspectal APEX sensor was calibrated (spectral, radiometric and geometric) at the Calibration Home Base (CHB) hosted by DLR in April 2015.

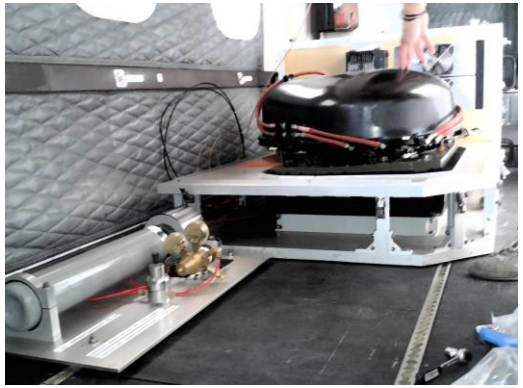


BELAIR 2015 – APEX Campaign

APEX

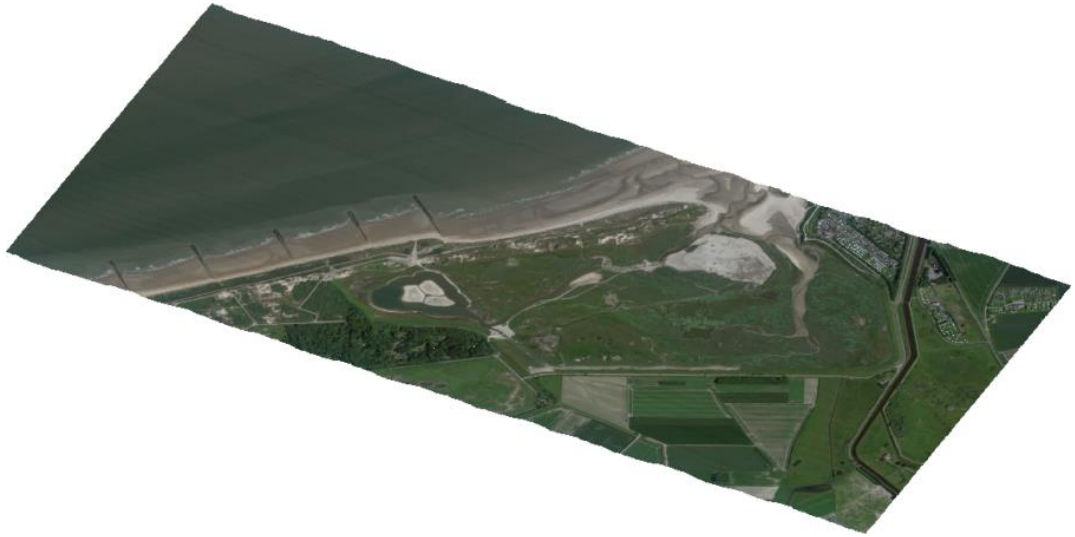
APEX data acquisition:

- Hesbania
- Sonia
- Litora



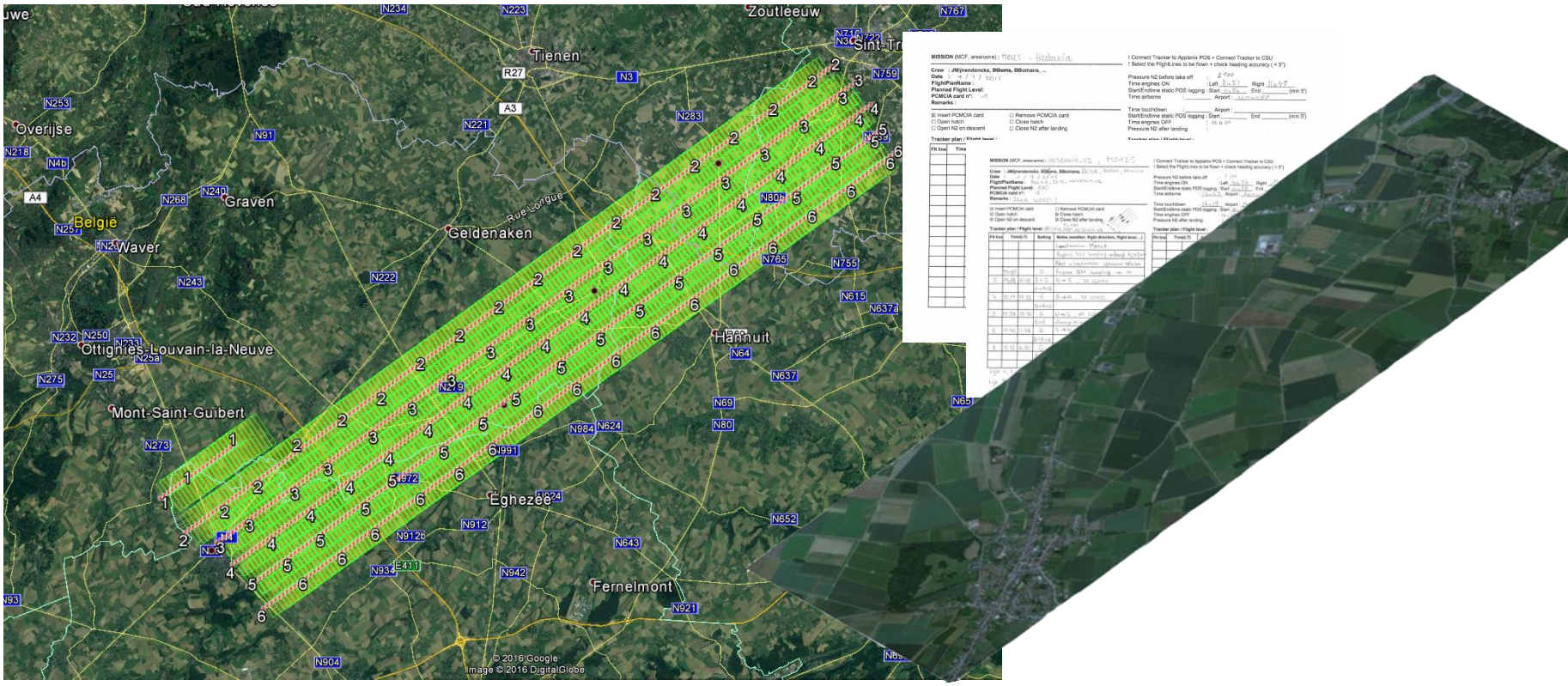
APEX data processing:

- POS data processing
- Image data processing

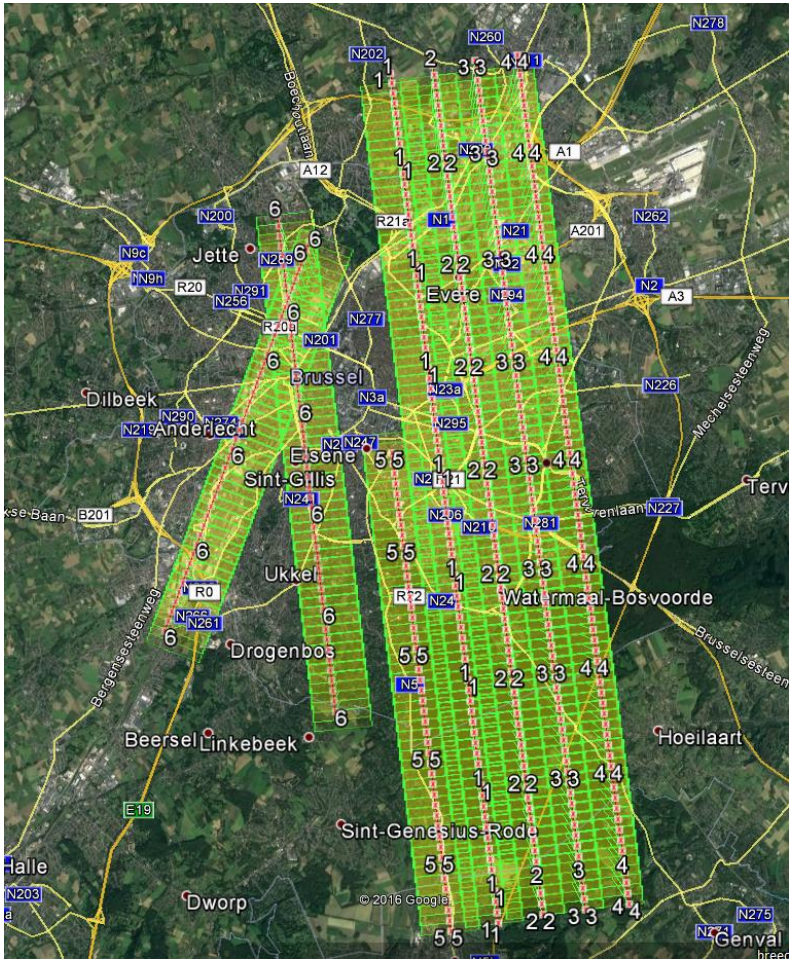


Hesbania flight

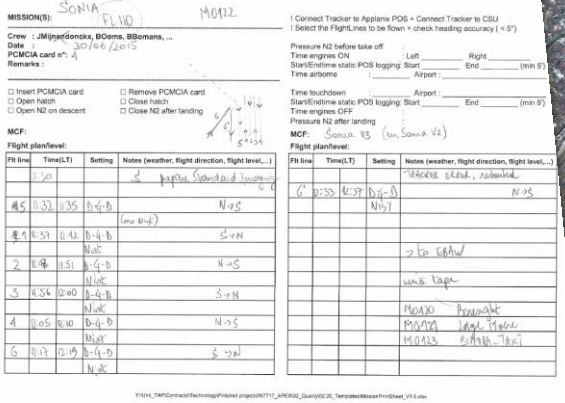
Location, area	: St. Truiden – Gembloux, 300 km²
# FLs planned	: 5 + 1
# FLs imaged, alt.	: 4 + 1, 4200m AGL (FL140)
Date Time	: 01/07/2015 1500-1600 LT
Remark	: MIL restrictions, last FL aborted
Conditions	: ++



Sonia flight



Location, area : Zoniën and Brussels City, 150 km^2
FLs planned : 6
FLs imaged, alt. : 7, 3350m AGL (FL110)
Date Time : 30/06/2015 1130-1230 LT
Remark :
Conditions : ++


MISSION(S): SONIA FLND M0122

Crew : JMjnerdonckx, BOoms, BBomans, ...
Date : 30/06/2015
PCMCIA card n°: 4
Remarks :

! Connect Tracker to Applanix POS + Connect Tracker to CSU
! Select the FlightLines to be flown + check heading accuracy (< 5°)

Pressure N2 before take off :
Time engines ON : Left _____ Right _____
Start/Endtime static POS logging: Start _____ End _____ (min 5')
Time airborne : _____ Airport : _____

☐ Insert PCMCIA card ☐ Remove PCMCIA card
☐ Open hatch ☐ Close hatch
☐ Open N2 on descent ☐ Close N2 after landing

Time touchdown : _____ Airport : _____
Start/Endtime static POS logging: Start _____ End _____ (min 5')
Time engines OFF :
Pressure N2 after landing :

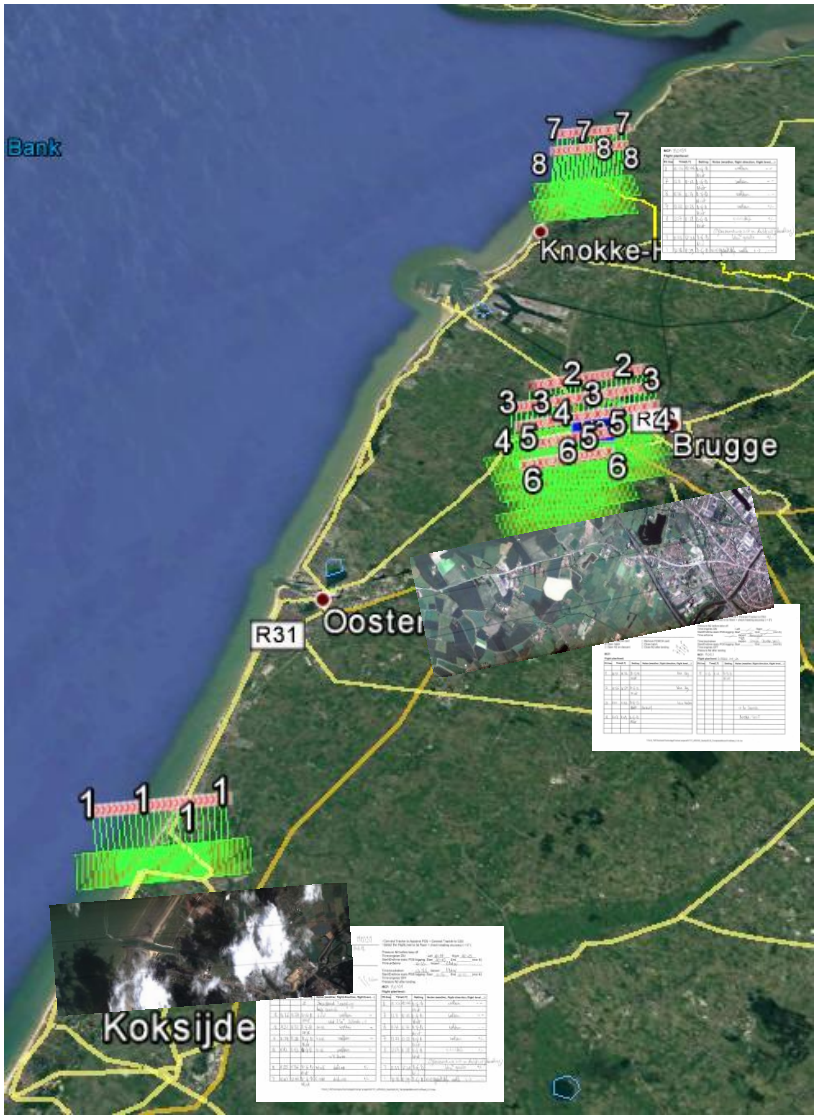
MCF: MCF: Sonia 83 (= Sonia V2)

Flight plan/level:

Flt line	Time(LT)		Setting	Notes (weather, flight direction, flight level,...)
	11:30			3 pages Standard Imagenes
#5	11:32	11:35	D-4-D	N->S
				(ens 10-4)
#1	11:39	11:42	D-4-D	S->N
			Nlat	
2	11:48	11:51	D-4-D	N->S
			Nlat	
3	11:54	12:00	D-4-D	S->N
			Nlat	
4	12:05	12:10	D-4-D	N->S
			Nlat	
5	12:17	12:19	D-4-D	S->N
			Nlat	

Flt line	Time(LT)		Setting	Notes (weather, flight direction, flight level,...)
				TRACKER CREW, Schoonhet
6'	12:33	12:37	D-4-D	N->S
			N-S-1	
				-> to CRAW
				wind tape
				M0120 Brussels
				M0121 Lange Wagen
				M0123 Ramp - Taxi

Litora flight – 2 separate days



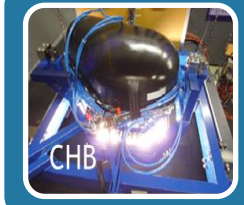
Location, area	: IJzermonding, 10 km²
# FL'ns planned	: 1
# Fl'ns imaged, alt.	: 4x 1, 3650m AGL (FL120)
Date Time	: 06/07/2015 1130-1145 LT
Remark	: extra heli's Tour de France - ATC
Conditions	: bad

Location, area	: Lage Moere, 40 km²
# FL'ns planned	: 5
# Fl'ns imaged, alt.	: 5, 3650m AGL (FL120)
Date Time	: 30/06/2015 1050-1115 LT
Remark	: flown just before Sonia
Conditions	: ++ blue sky

Location, area	: 't Zwin, 12 km²
# FL'ns planned	: 2
# Fl'ns imaged, alt.	: 4x 2, 3650m AGL (FL120)
Date Time	: 06/07/2015 1155-1245 LT
Remark, conditions	: as IJzermonding

BELAIR 2015 – APEX processing and delivery

APEX data processing



Determine:

- APEX sensor geometry
- APEX spectral characteristics

Process:

- Raw digital numbers to at-sensor radiances
- Image & system metadata

Perform:

- Differential correction of GPS (position) data
- Blending of GPS (position) and IMU (orientation) data
- Boresight calibration

HDF5 files

Central Data Processing Center (CDPC) Airborne imagery database

CDPC L2 processing chain:

Geomodelling
Atmospheric correction
Spectral resampling
Projection

Colibri:

spectral smoothing

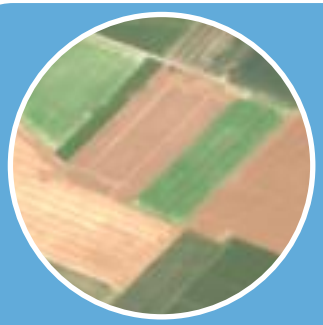
APEX data delivery

30/06/2015
Lage Moere

06/07/2015
Zwin / IJzer

Hyperspectral data cubes
of 5 flight lines
(Lage Moere only)

Available on BelAir FTP-server
ftp://cvbftp.vgt.vito.be
folder 'litora'



01/07/2015

Hyperspectral data cubes
of 5 flight lines

Available on BelAir FTP-server
ftp://cvbftp.vgt.vito.be
folder 'hesbania'

30/06/2015

Hyperspectral data cubes
of 7 flight lines
Geometrically corrected using
AGIV DHMVII DTM/DSM @ 1m

Available on BelAir FTP-server
ftp://cvbftp.vgt.vito.be
folder 'sonia'

Litora

Data delivery: 07/12/2015

Hesbania

Data delivery: 06/11/2015

Sonia

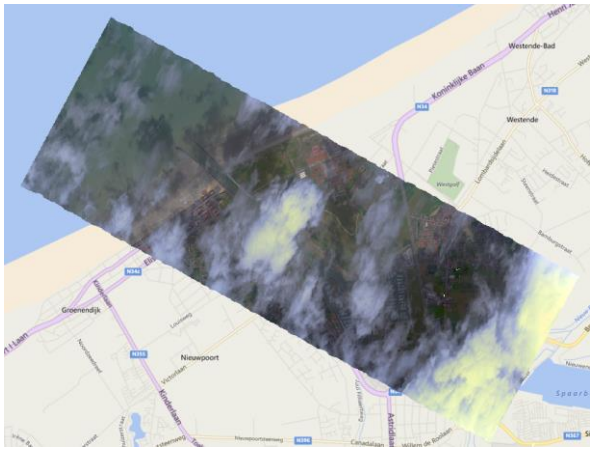
Data delivery: 02/11/2015

APEX quicklooks 2015 – Litora – Lage Moere

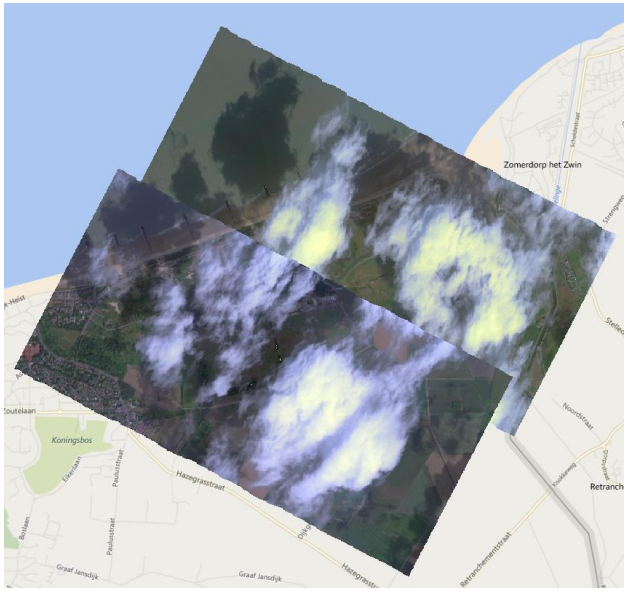
APEX quicklooks 2015 – Sonia

APEX quicklooks 2015 – Hesbania

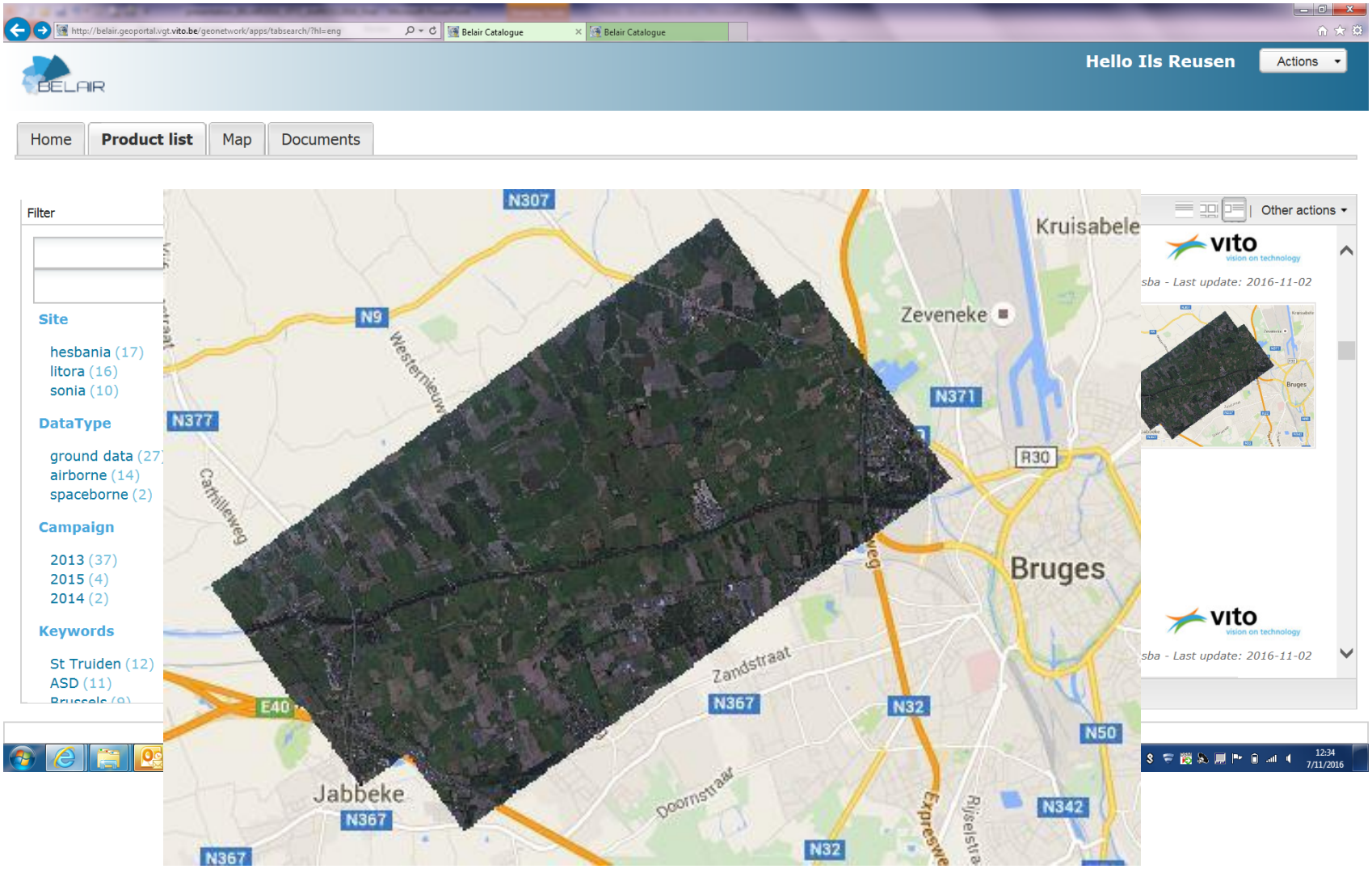
APEX quicklooks 2015 – Litora - IJzer



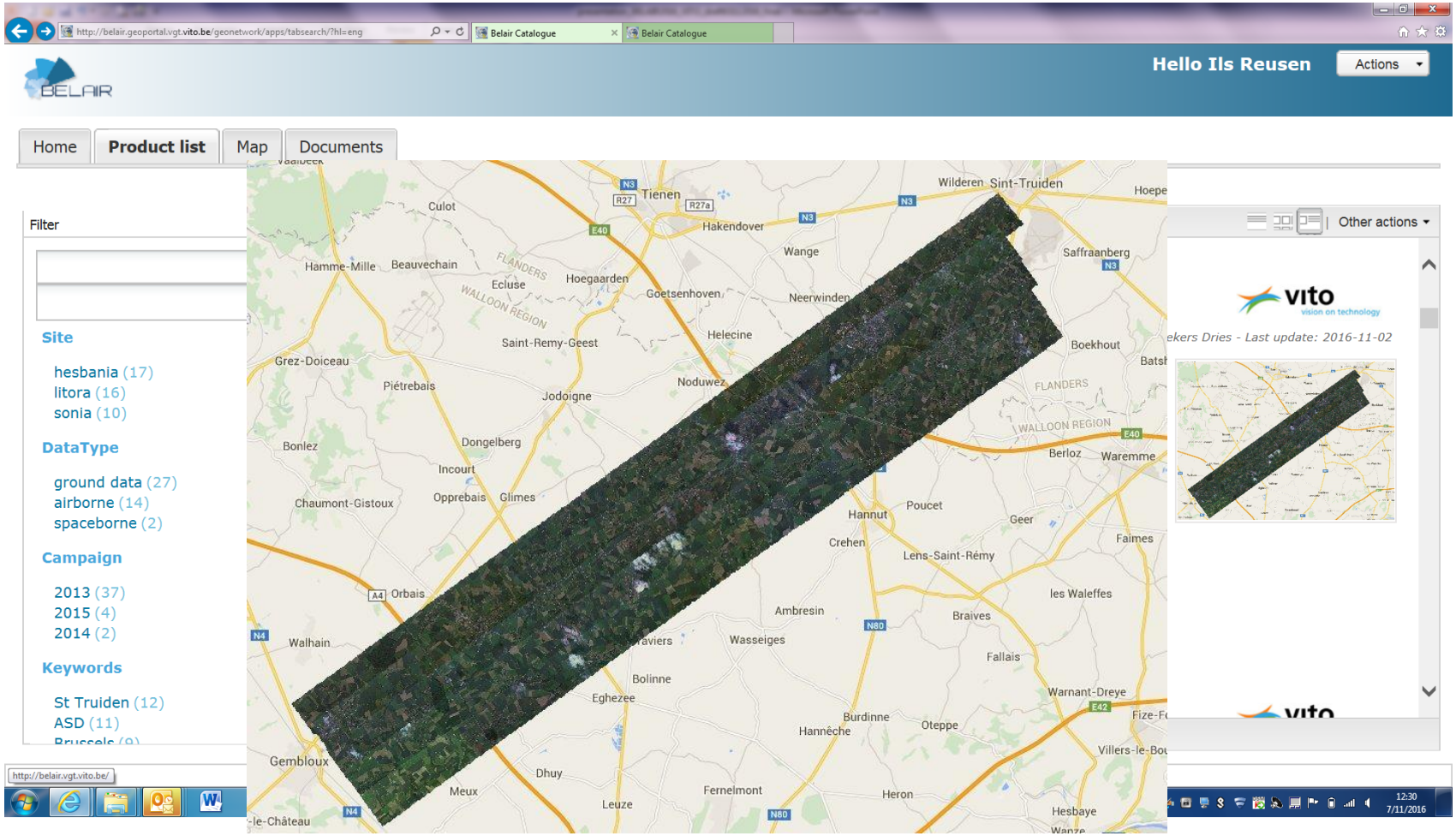
APEX quicklooks 2015 – Litora - Zwin



LITORA-Lage Moere



HESBANIA



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Other actions
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Hoegaarden
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Neerwinden
Helecine
Saint-Remy-Geest
Boekhout
Grez-Doiceau
Piétrebais
Jodoigne
Noduwez
Bonlez
Dongelberg
Incourt
Berloz
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Glimes
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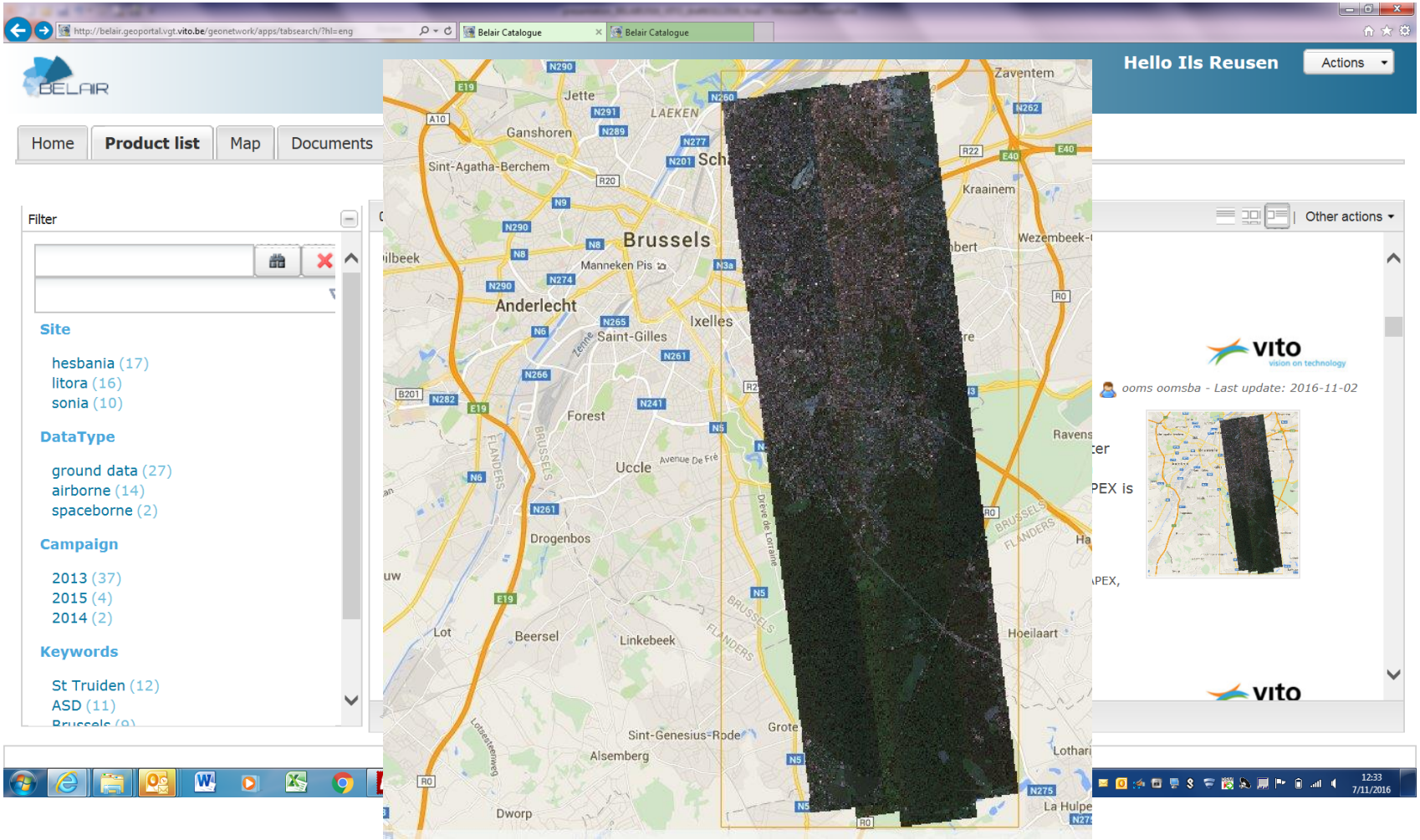
SONIA



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Alsemberg
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Ganshoren
Jette
Sint-Agatha-Berchem
Manneken Pis
Zaventem
Kraainem
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Hoeilaart
Lot
Grote
La Hulpe
12:33
7/11/2016

BELAIR 2015 – UAV Campaigns

UAV data acquisition-overview

Ebee platform was used combined with multiple payloads:

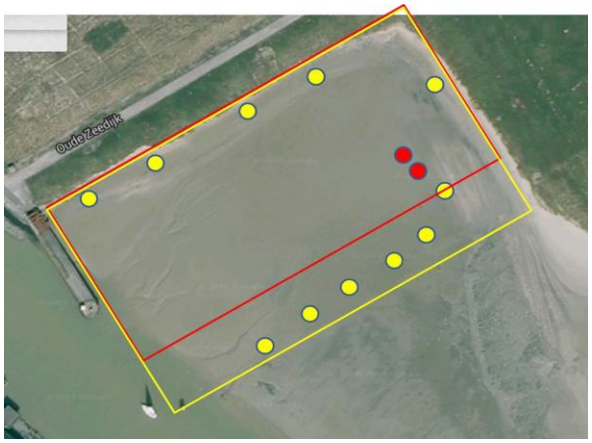
-) RGB
-) Red Edge Camera
-) Multispec 4C

» Hesbania

-) Gembloux area's (several flights, 75 datasets acquired on several dates)
-) Sint-Truiden/PC fruit (5 acquisitions between May and Sept, RGB, Re and Multispec datasets,

» Litora

-) Zwin (11/07/2015, 6 flights Re, Multispec)
-) Lage Moere (30/06/2015, 5 flights Multispec)
-) Nieuwpoort (10/07/2015, 7 flights, Multispec)



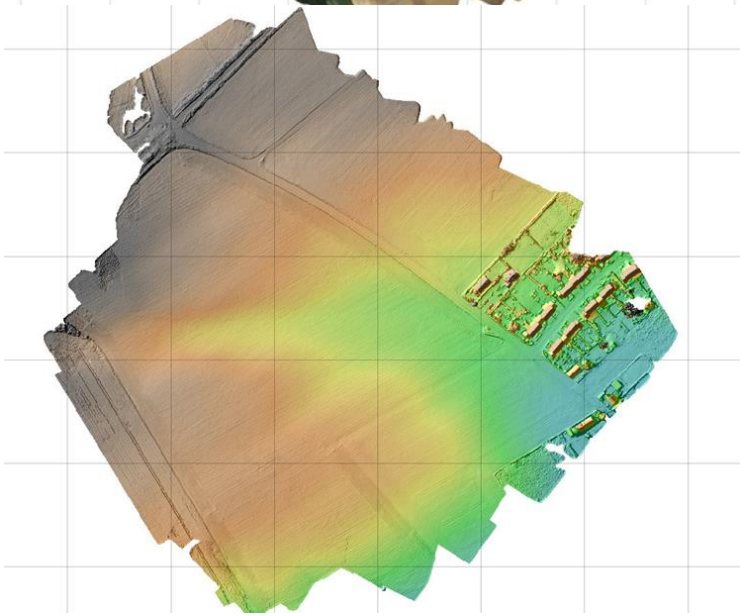
BELAIR 2015 – UAV processing and delivery

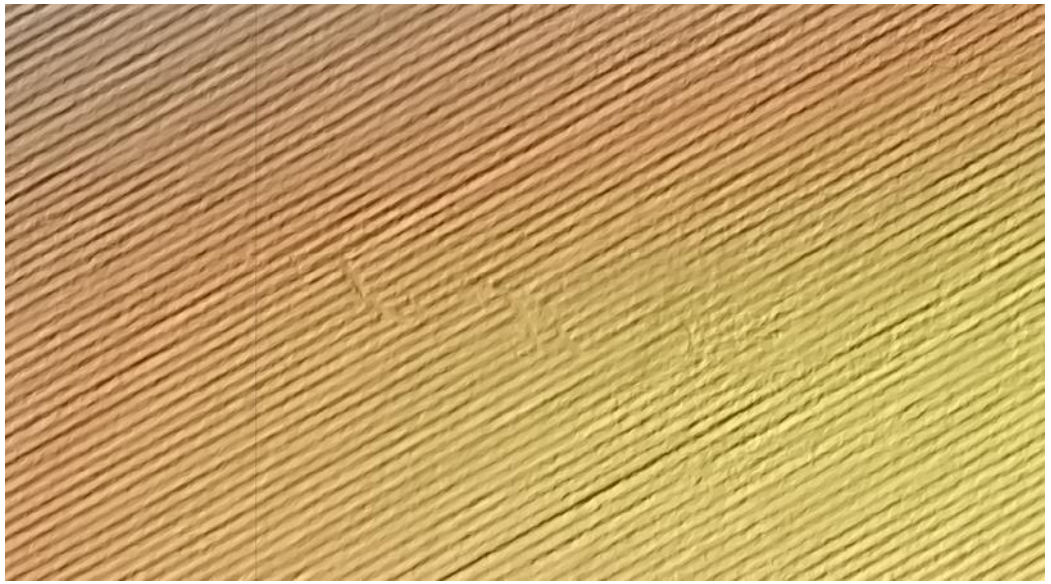
UAV data processing

- **What:**
  - datasets acquired with the Ebee platform
  - Multiple sensor datasets: RGB, Red Edge and Multispec 4C
  - End products are orthophoto mosaics per band or combined
  - Digital Surface Model
  - Metadata: camera calibration report, kml, quality report

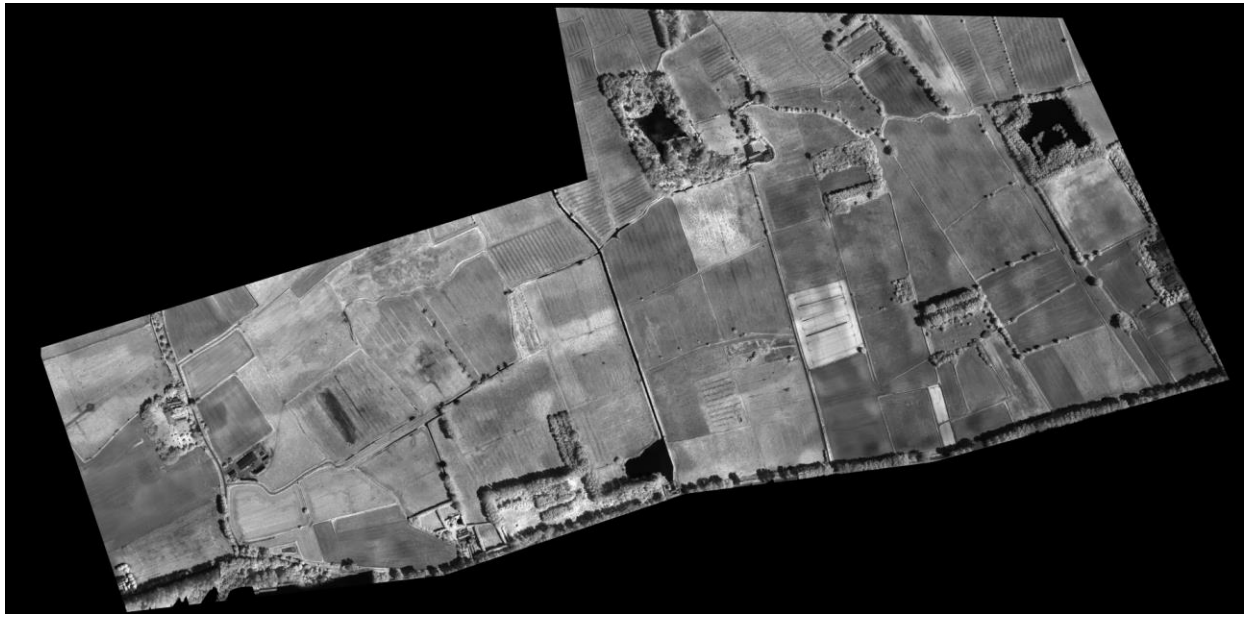
- **How**:
  - Huge amount of data which was acquired was overwhelming (also) for VITO → New approach needed!
  - Data acquisition over difficult area's e.g Nieuwpoort (lessons learned!)
  - Multispec data processed with Pix4D (PostFlight Terra 3D)
  - Re, RGB data processed through automated chain via Photoscan

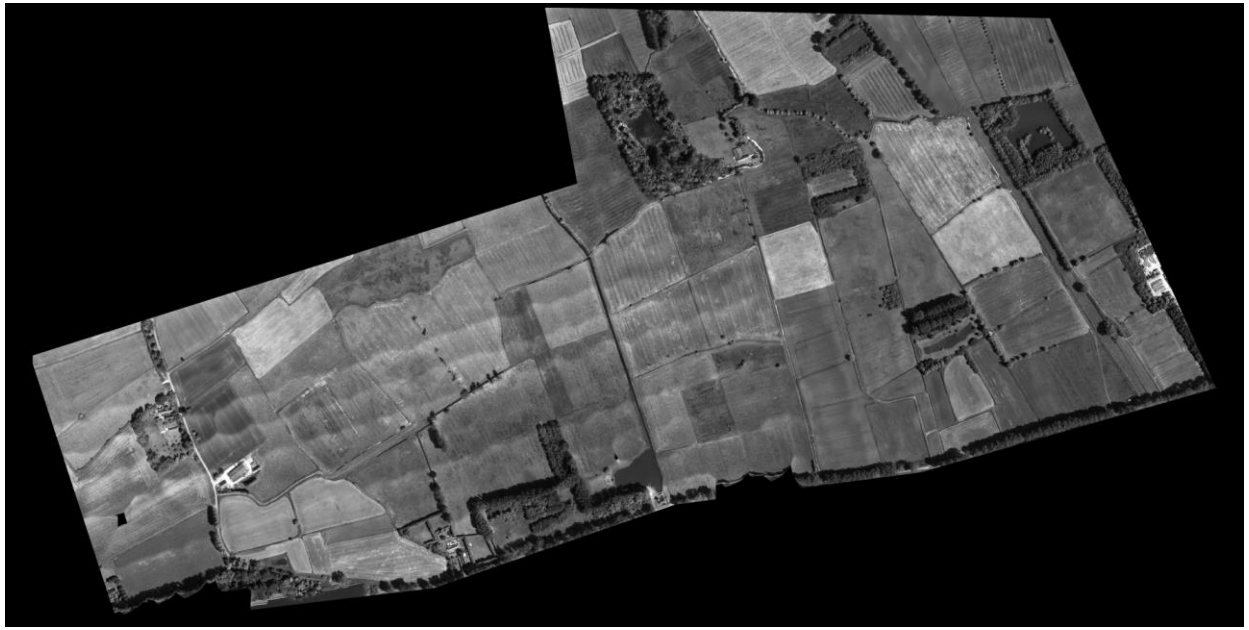
UAV data processing: Ortho and DSM





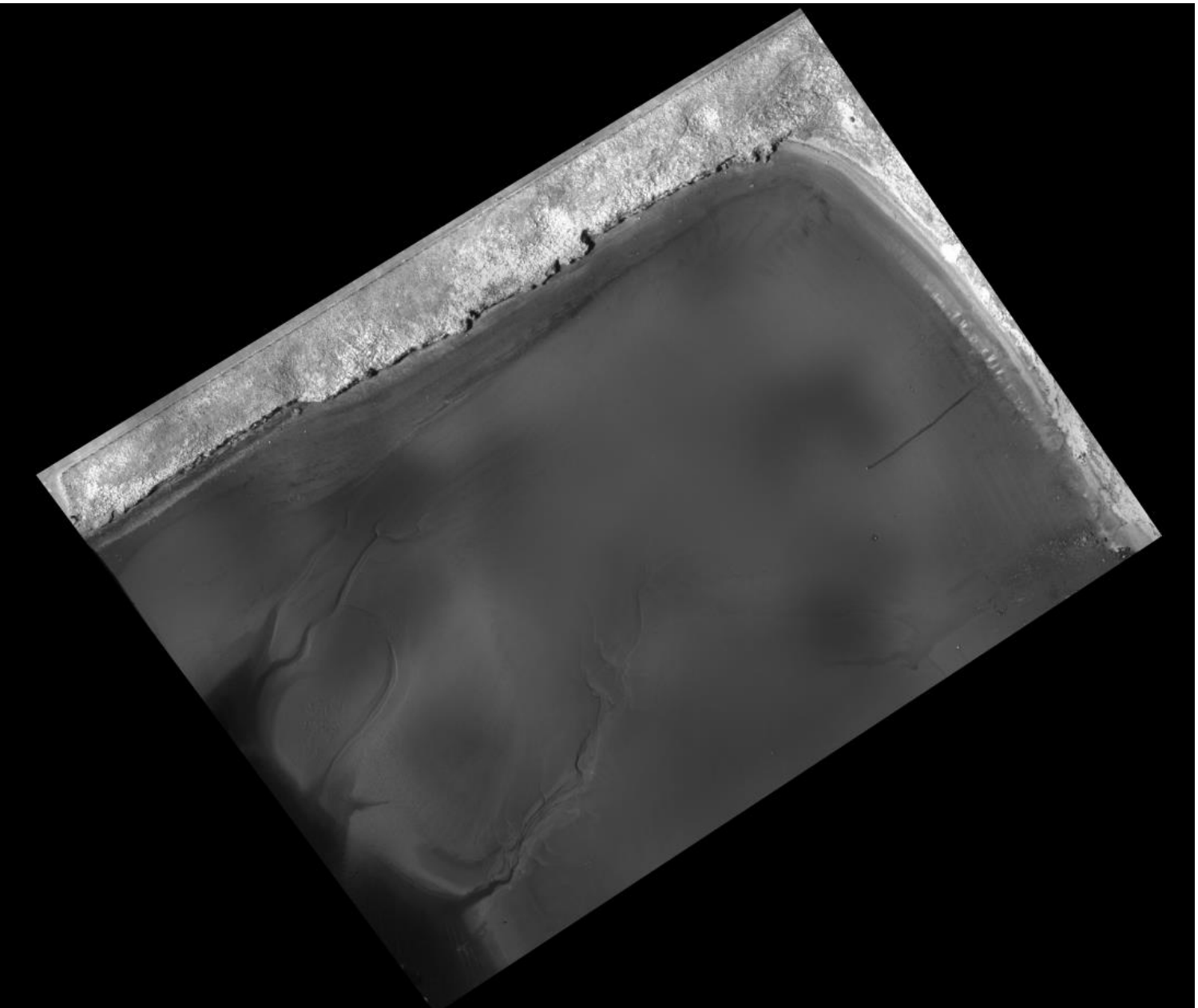
UAV data processing:





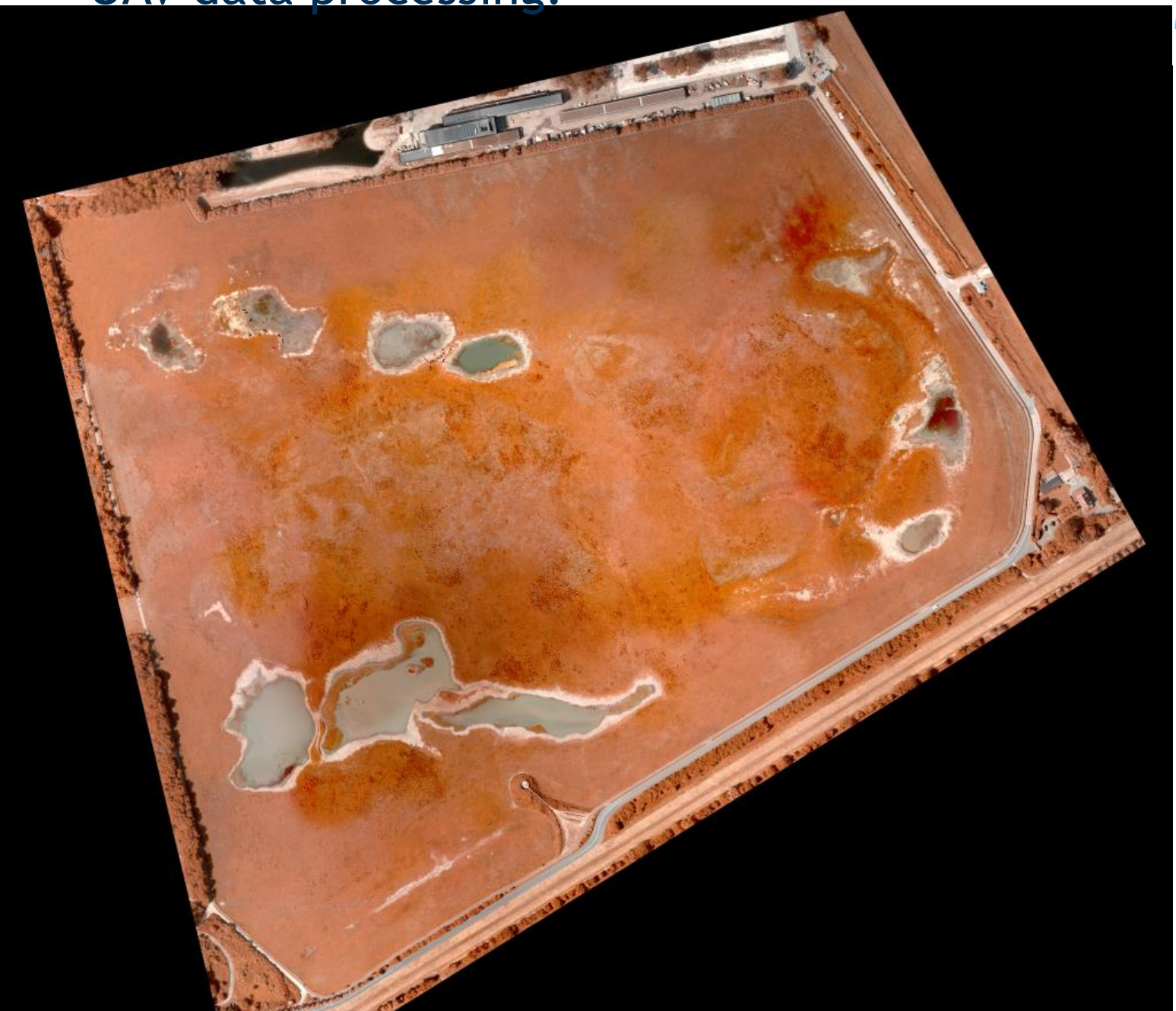
Lage Moere
Multispec bands:
NIR
Green

UAV data processing:



Nieuwpoort
Multispec bands:
NIR

UAV data processing:



Zwin bands:
Red Edge

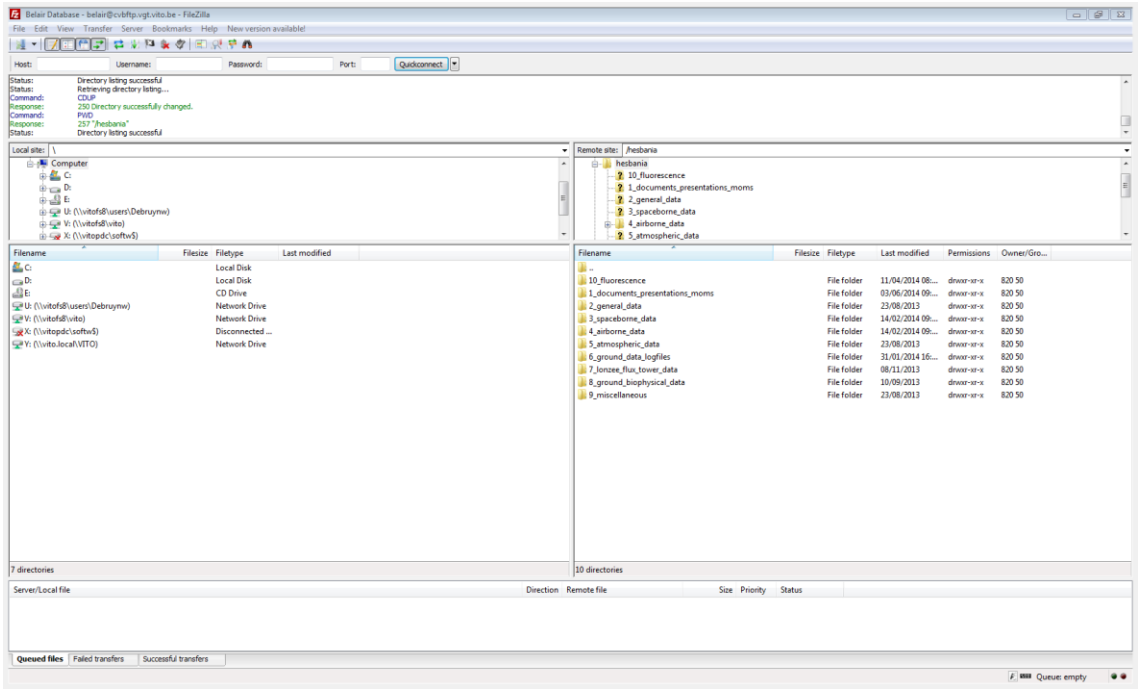
BELAIR Data distribution

BELAIR 2015 - Data policy

- **Satellite data** purchased by BELSPO (Pléiades, ASTER, DMC, ...) remain property of BELSPO
- **Airborne APEX & UAV** (RGB, Multispectral and/or Red-edge) imagery acquired over **HESBANIA, LITORA and SONIA** and **in-situ data** are released stepwise, depending on user type:
  - All Remote Sensing (RS) data immediately and free-of-charge available to all participating Users. In-situ field data available upon request to the owner of the data, i.e. to the lab which actually acquired the field data
  - Two years after delivery of the APEX data to the PI, all BELAIR data available to the entire international Scientific Community. The APEX data was delivered to the PI in November-December 2015.

BELAIR 2015 – Data distribution

- Secured FTP-directory for project partners
- Owncloud and metadata for distribution through BELAIR geoportal

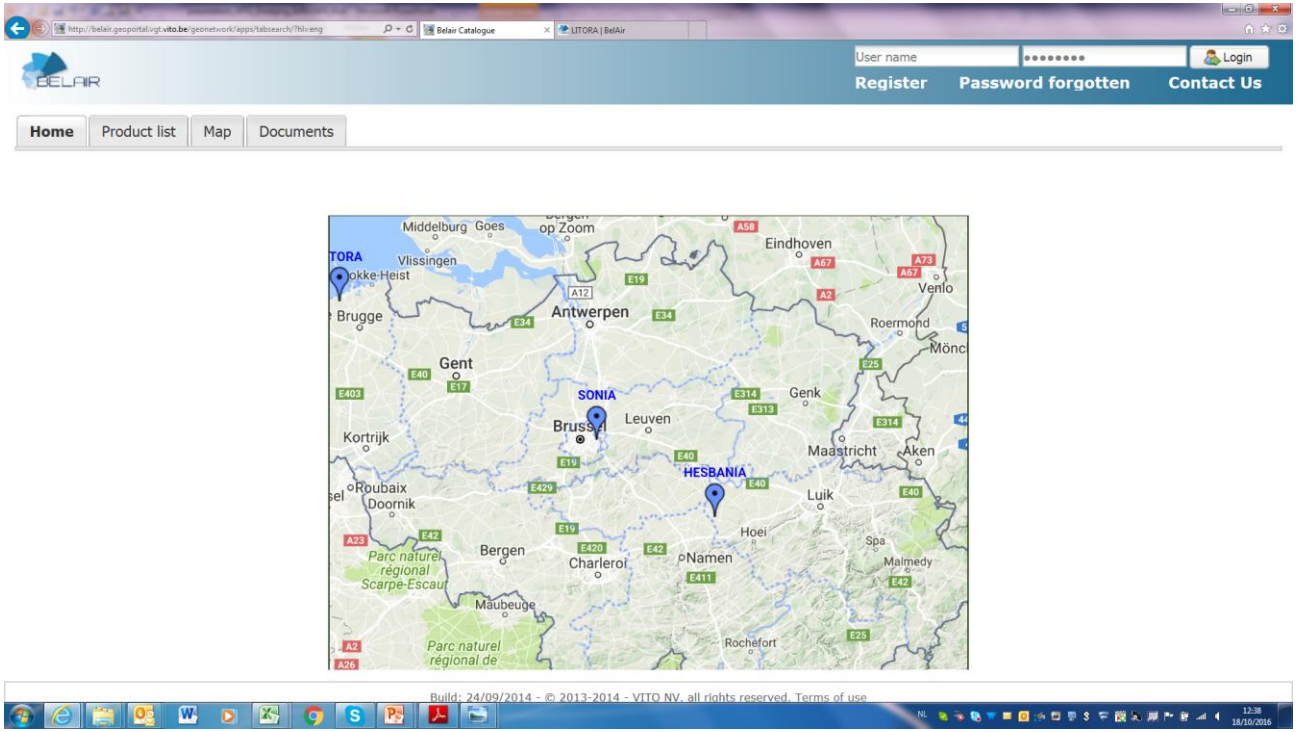


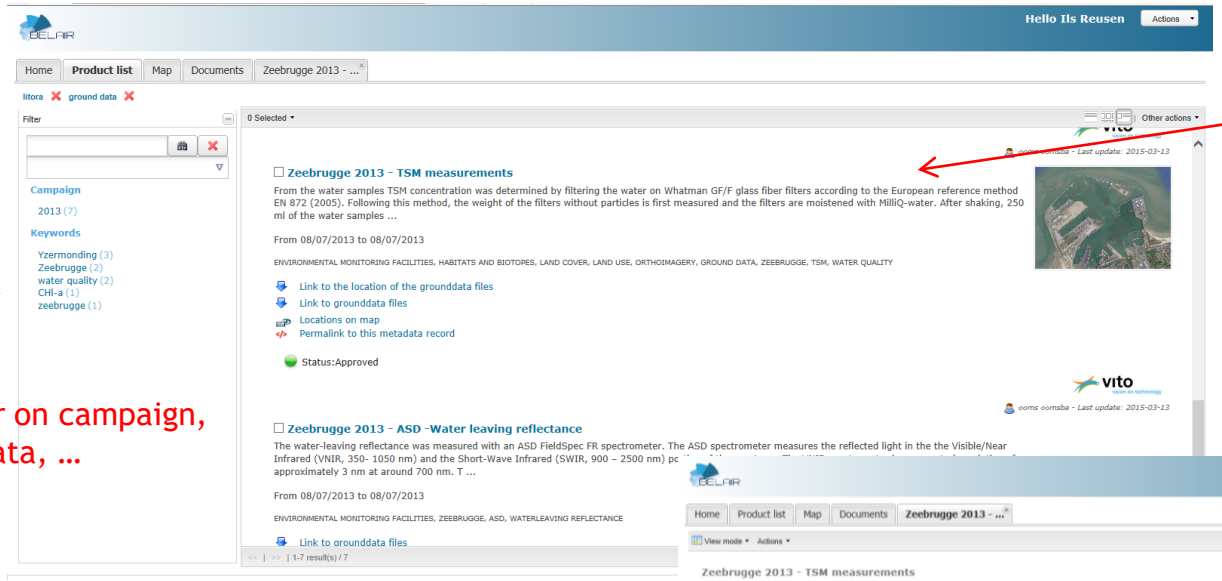
BELAIR – GEOPORTAL

» http://belair.geoportal.vgt.vito.be/geonetwork

» Web based portal to **discover** available (heterogeous) data and metadata, **view** data, **download** data via Owncloud or FTP/PDF (for APEX) when applicable

» **Manual for data providers**





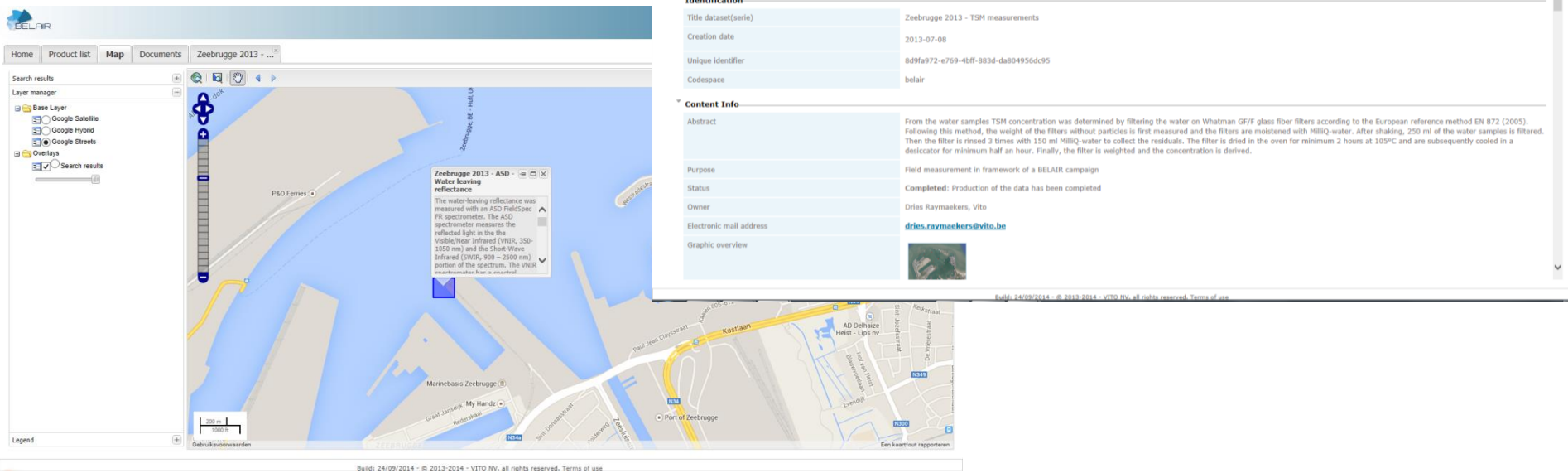
List of 'matching products' with:

- Abstract, date, …
- Link to download (incl. documents)
- Link to view data
- …

Easy filter on campaign, type of data, …

Detailed metadata

View data on map (where applicable)



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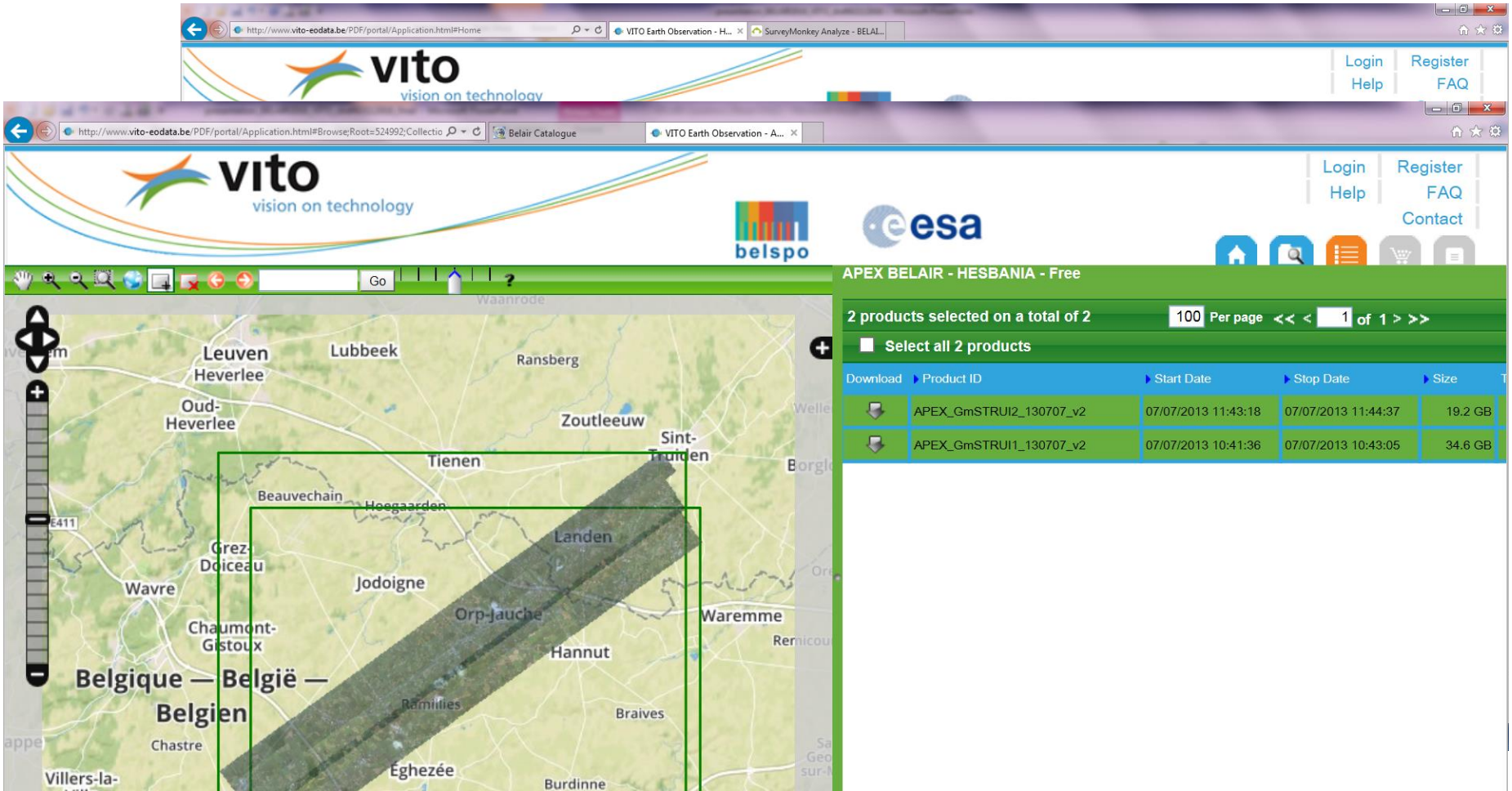
FOR APEX:
SUPPORTED BY 'PRODUCT DISTRIBUTION FACILITY (PDF)'

http://www.vito-eodata.be



METADATA AND DATA

- Providers should provide metadata and data
  - Manual for BELAIR data providers available at BELAIR GEOPORTAL

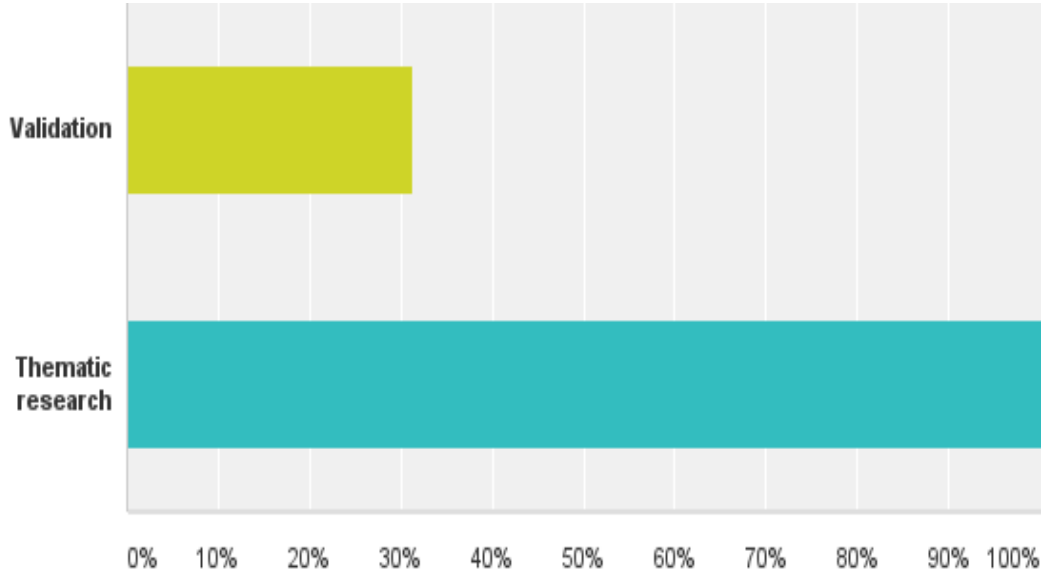
BELAIR 2015 – Survey

BELAIR 2015 – Survey and Future

- **BELAIR Survey October 2016**
  - feedback on what went right/wrong during the preparation phase, campaign and post-campaign
  - recommendations for improvements
- **Further discussion on future directions of BELAIR,** 8 Nov 2016, Bruges

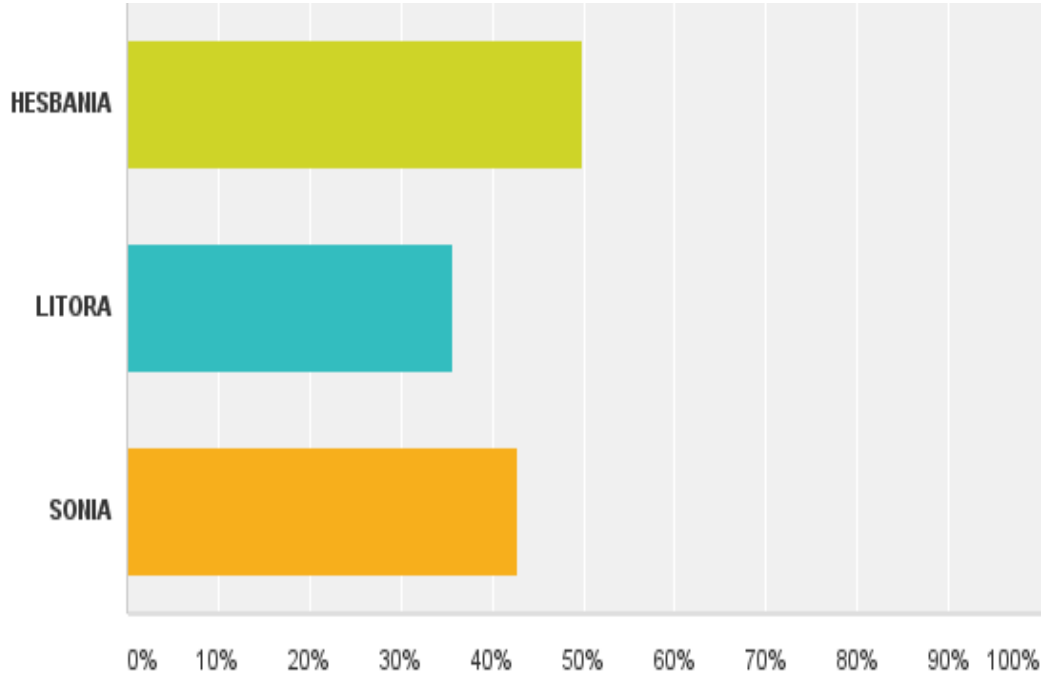
Q1: BELAIR is of interest to you for

» Answered: 16 Skipped: 0



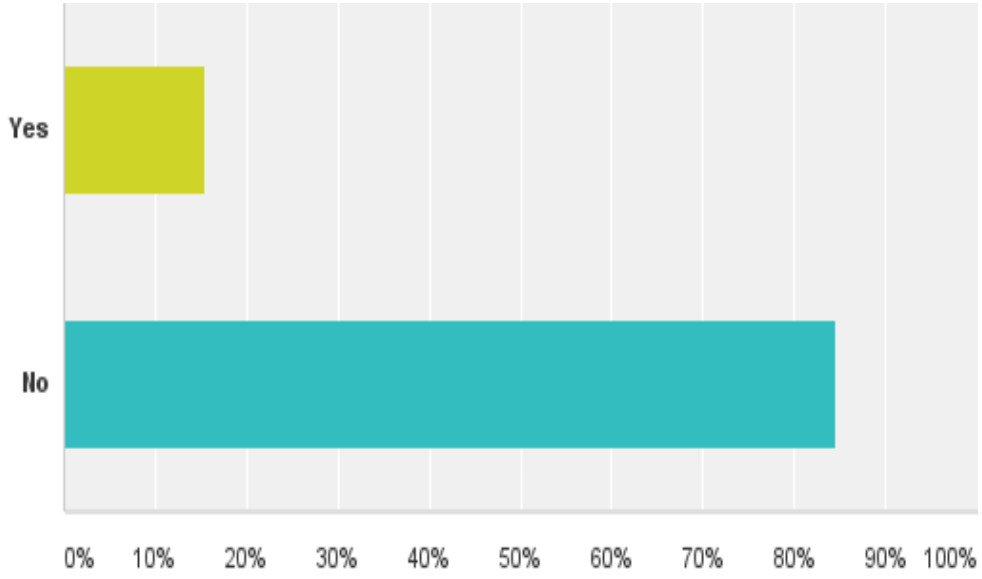
Q2: Which BELAIR site is of interest to you?

» Answered: 14 Skipped: 2



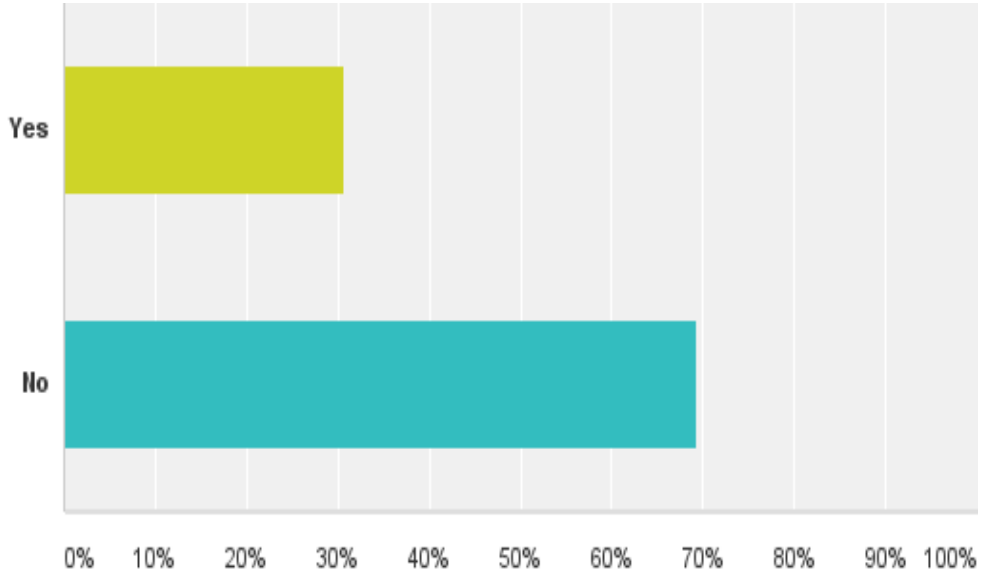
Q6: Is your spectroradiometer calibrated in the last 12 months?

» Answered: 13 Skipped: 3



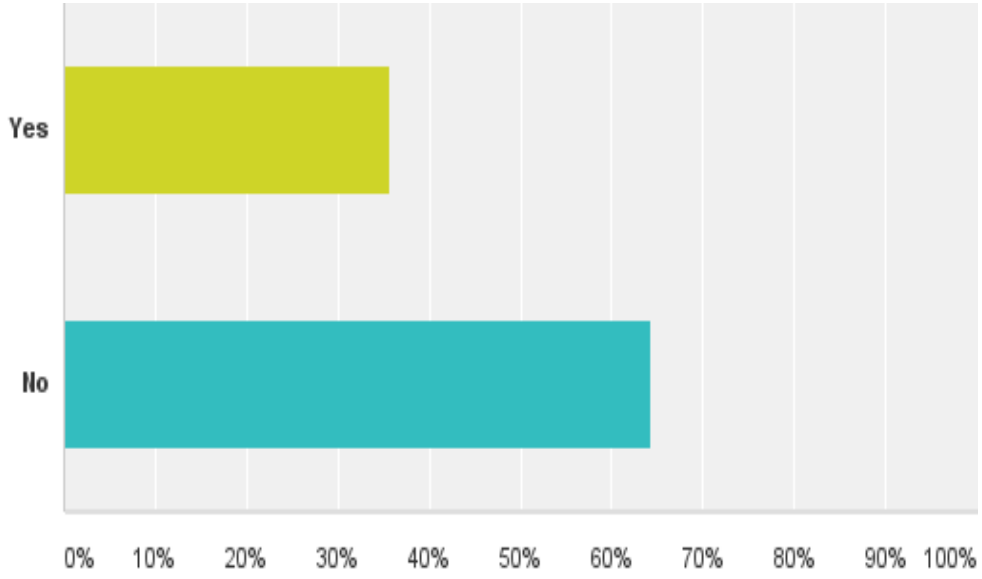
Q7: Do you have a need for spectroradiometer calibration verification by VITO?

» Answered: 13 Skipped: 3



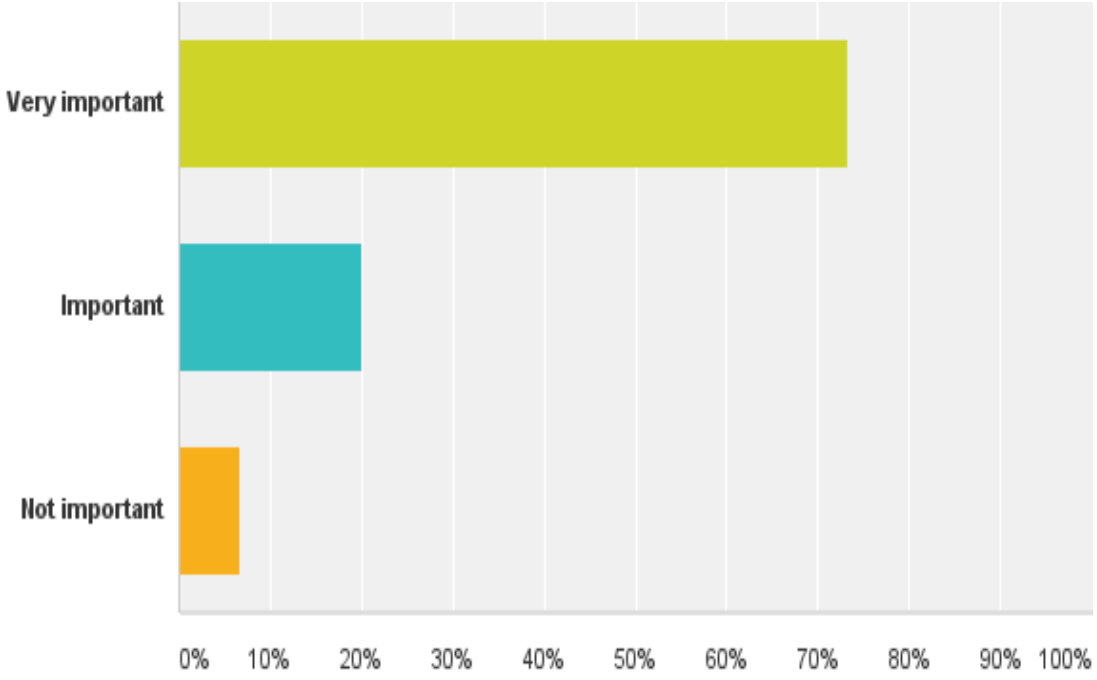
Q8: Do you have a need for training in field measurements (GPS, spectroradiometer, sun photometer) supporting the image processing

» Answered: 14 Skipped: 2



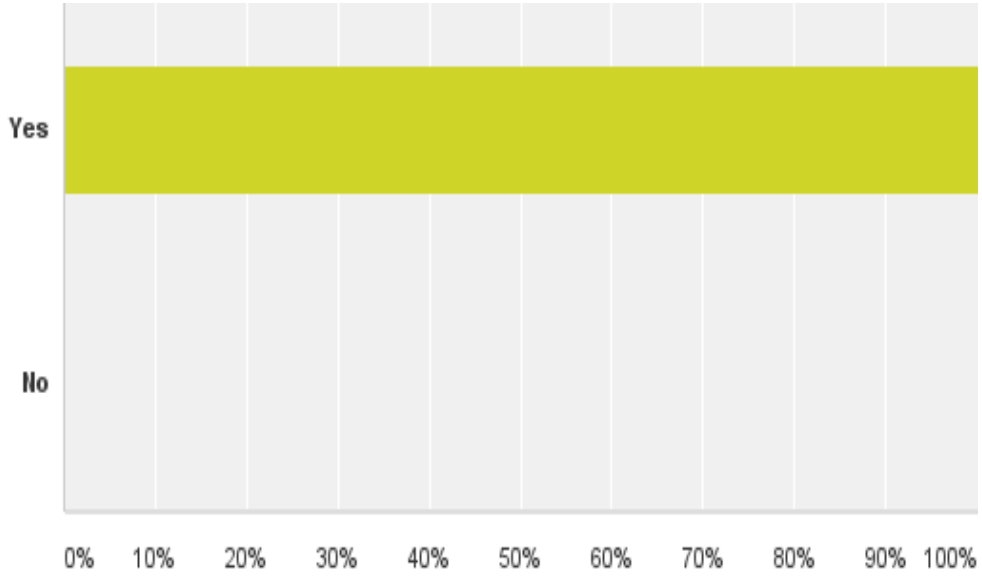
Q9: How important is a sampling strategy of field measurements for your research?

» Answered: 15 Skipped: 1



Q10: Have you developed a sampling strategy for your field measurements?

» Answered: 14 Skipped: 2

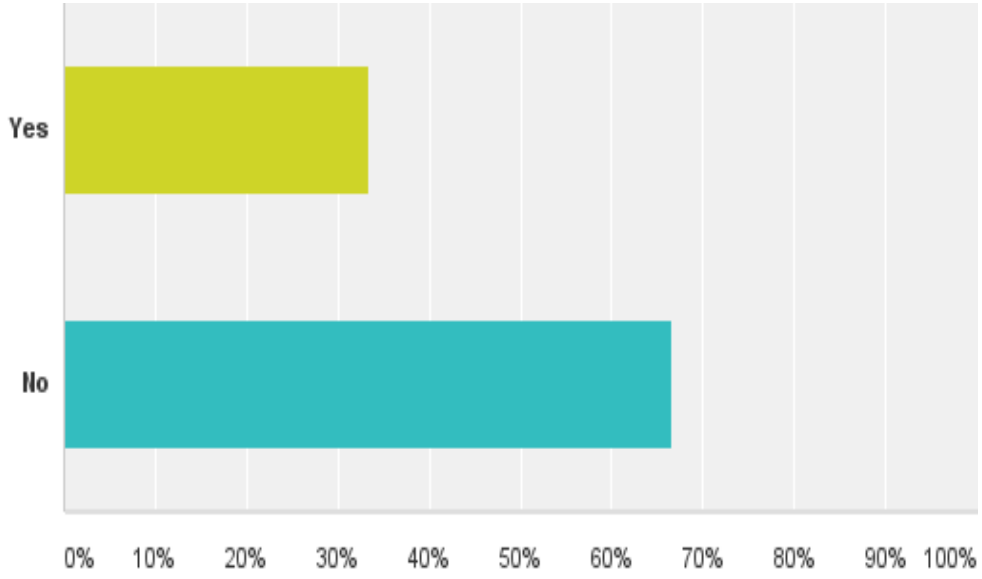


Q11 Describe briefly your sampling strategy. Did you follow an existing protocol? Which one?

- Stratified random sampling approach
- Validation of fcover, fAPAR, LAI for 3 fields based on UAV and field measurements (DHP): DHP every 20 rows and 40 steps within selected row
- Protocol to measure bright and dark targets for APEX processing
- 2-3 replicas for soil samples
- For each plot (8x8m) we consider 16 sub-pixels (2x2m) for which we perform measurements (spectra, LAI, soil moisture, etc.) which can be aggregated to have a representative measurement for the plot.
- 2 protocols for taking hemispherical pictures for fCover, fAPAR,... validation: standard sampling (INRA guidelines) for BELCAM, more dense sampling for iPot (focus on intra-field variability)

Q12: If you answered "no", would you need expert support for developing a sampling strategy?

» Answered: 3 Skipped: 13



Q14: How satisfied are you with the preparation of the

» Answered: 13 Skipped: 3

	0%	20%	40%	60%	80%	100%	N/A	Total
Reference field measurements	0.00% 0	0.00% 0	0.00% 0	0.00% 0	33.33% 4	33.33% 4	33.33% 4	12
Thematic field measurements	0.00% 0	0.00% 0	0.00% 0	0.00% 0	33.33% 4	25.00% 3	41.67% 5	12
APEX campaign	0.00% 0	0.00% 0	0.00% 0	15.38% 2	53.85% 7	7.69% 1	23.08% 3	13
UAV campaign	0.00% 0	0.00% 0	0.00% 0	16.67% 2	25.00% 3	16.67% 2	41.67% 5	12

Q17: How satisfied are you with the

» Answered: 12 Skipped: 4

	0%	20%	40%	60%	80%	100%	N/A	Total	Weighted Average
Reference field measurements	9.09% 1	0.00% 0	0.00% 0	0.00% 0	18.18% 2	36.36% 4	36.36% 4	11	5.73
Thematic field measurements	8.33% 1	0.00% 0	0.00% 0	0.00% 0	25.00% 3	25.00% 3	41.67% 5	12	5.75
UAV measurements	8.33% 1	0.00% 0	0.00% 0	0.00% 0	41.67% 5	16.67% 2	33.33% 4	12	5.50
APEX measurements	25.00% 3	0.00% 0	0.00% 0	16.67% 2	25.00% 3	16.67% 2	16.67% 2	12	4.33

Q20: How satisfied are you with the

» Answered: 12 Skipped: 4

	0%	20%	40%	60%	80%	100%	N/A	Total
BELAIR FTP site	0.00% 0	0.00% 0	0.00% 0	20.00% 2	40.00% 4	20.00% 2	20.00% 2	10
BELAIR Owncloud	0.00% 0	0.00% 0	0.00% 0	0.00% 0	30.00% 3	0.00% 0	70.00% 7	10
BELAIR Geoportal	0.00% 0	0.00% 0	0.00% 0	0.00% 0	45.45% 5	9.09% 1	45.45% 5	11
BELAIR Website	0.00% 0	0.00% 0	0.00% 0	25.00% 3	41.67% 5	8.33% 1	25.00% 3	12
BELAIR Newsletter	0.00% 0	0.00% 0	8.33% 1	8.33% 1	50.00% 6	8.33% 1	25.00% 3	12

Q24 Add all your projects using BELAIR data and add from which BELAIR site

- UrbanEARS (SONIA)
- BELCAM (HESBANIA)
- BelSAR (HESBANIA)
- iPOT (HESBANIA)
- BIO-TIDE (LITORA)
- HYPERTEMP (HESBANIA)

Q25: **Did you share your BELAIR data with external users (Belgian or international)? If yes, please specify the user**

- Humboldt Universitaet zu Berlin
- ESA, MetaSensing
- Univ. of Notre Dame, Libanon
- Nantes University (BIO-TIDE)

6 PhD, 12 MSc (Nov. 2016)

BELAIR

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BELAIR 2013 Final Report

News
BELAIR 2016 Workshop, 8 November 2016, Bruges

BELAIR 2015 APEX data of LITORA-Lage Moere delivered to LITORA users
BELAIR 2015 APEX data of SONIA and HESBANIA sites delivered to BELAIR

BELAIR MSc/PhD

HESBANIA

» MSc KULeuven: Yasmin Vanbrabant, "Crop load monitoring in apple orchards through UAVs: a feasibility study", September 2016, promotor Laurent Tits, co-promotor Ben Somers

» MSc UCL: Marie Mestdagh, MSc thesis: "Estimation du contenu en chlorophylle chez la pomme de terre par télédétection hyperspectrale aéroportée", September 2016, promotors: Defourny Pierre and Curnel Yannick

» MSc KULeuven: Pieters Catheline, "De integratie van drone, vliegtuig- en satellietobservaties voor het opvolgen van fruitboomgaarden", expected June 2017, promotor Ben Somers, co-promotor Laurent Tits

» PhD ULg: F. Ben Abdallah, "Etude des potentialités des indices basés sur la concentration en composés phénologiques des feuilles pour l'évaluation du status azoté de la culture de pomme de terre", promotor Jean Pierre Goffart

» PhD UCL: Cindy Delloye, "BELCAM", promotor Pierre Defourny

SONIA

» MSc VUB: Khanh, "Vegetation Parameterization in Urban Catchments Using Remote Sensing", 2014, promotor: Boud Verbeiren & Ann van Griensven

» MSc VUB: Nahad Helmi, "Impact of resolution on urban hydrological response simulation", 2015, promotor: Boud Verbeiren and Ann van Griensven

» MSc VUB: Wouter Vermeyen, "Hyperspectral analysis of surface materials for water balance estimation in urbanized areas. A case study on the Brussels Capital Region", September 2015, promotor: Frank Canters, co-promotor: Boud Verbeiren, Department of Geography, Vrije Universiteit

» PhD VUB: Luca Demarchi, "Mapping impervious surface cover from hyperspectral imagery using per-pixel and sub-pixel classification approaches: impact on water balance estimation", March 2015, promotors: Frank Canters and Jonathan Cheung-Wai Chan, co-promotor: Okke Batelaan, Cartography and GIS Research Group, Vrije Universiteit Brussel

» MSc KULeuven: William Oulette, "Characterizing urban green and its functional properties using hyperspectral airborne sensors", June 2015, promotor Ben Somers, co-promotor Martin Hermy

» MSc KULeuven: Adrien Compère, "Mapping urban green through the combined use of LiDAR and hyperspectral airborne sensors", expected February 2017, promotor Ben Somers, co-promotor Martin Hermy

» MSc KULeuven: Enyo Vanmontfort, "Characterizing urban trees through hyperspectral and LIDAR data", expected February 2017, promotor Jos Van Orshoven, co-promotor Frank Canters (VUB) and Ben Somers

» PhD VUB: Charlotte Wirion, "Hydrological Urban Ecosystem Analysis supported by Remote Sensing", expected 2018, promotor Boud Verbeiren and Willy Bauwens

» PhD VUB: Frederik Priem, "Assessing the impact of urbanization on heat and water regulation through integration of remote sensing, hydrological-climatological modelling and agent-based simulation of urban growth", expected end 2018, promotor: Frank Canters, Cartography and GIS Research Group, Vrije Universiteit Brussel

» MSc VUB: Eline Smets, "Urban land-cover fraction estimation using machine learning based unmixing approaches and synthetic mixing of training data: a case study on Brussels", expected January 2018, promotor: Frank Canters, Department of Geography, Vrije Universiteit Brussel

» PhD KULeuven: Vincent Smets, "Modelling the hydrological response of urban vegetation", expected 2019, promotor Ben Somers, co-promotor Boud Verbeiren

LITORA

» MSc KULeuven: Camille Christiansen, "Exploring spectroscopy as a method for the quantification", September 2015, promotor Ben Somers, co-promotor Jeroen Vandenborre (INBO)

» MSc KULeuven: Medart Sam, "Ontwikkelen van een Remote Sensing gebaseerd monitoringsysteem voor beschermde grasland- en heidegebieden in Vlaanderen", expected June 2017, promotor Ben Somers, co-promotor Stien Heremans (INBO)

Survey feedback and recommendations – for further discussion

- Preparation of campaign
  - Earlier announcement and kick-off of overall campaign for better overall preparation and also involvement of other/new teams
  - Include radar
  - Include thermal observations
  - Expert support for sampling design needed: For the multi-scale validation > how design sampling scheme?
  - UAV: availability of cameras with more bands (hyperspectral?)

- Campaign
  - UAV: Move campaigns to zones with less flight constraints?
  - APEX: Communication (by telephone?) of exact time of overpass for near simultaneous sampling
  - APEX: Feedback from VITO on how good or bad our previous calibration measurements were

- Post-campaign

  - APEX+UAV: Preprocessing of data takes a lot of time
  - Data are available from different sources (ftp, Owncloud, geoportal) (discard FTP ?)
  - Website is rather static. Include also include info on thematic work done on the different sites and scientific output
  - Newsletter looks great, but links should be provided for those looking for more info on work put in focus

BELAIR – Info & contacts

- More info at **http://belair.vgt.vito.be/**

- BELAIR: Ils Reusen (ils.reusen@vito.be)
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- BELAIR LITORA: Liesbeth De Keukelaere (liesbeth.dekeukelaere@vito.be)
- BELAIR SONIA: Boud Verbeiren (bverbeir@vub.ac.be)
- BELAIR geoportal: Bart Ooms (bart.ooms@vito.be)

THANK
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TINGKI
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TASHAKKUR ATU
SUKSAMA
EKHMET
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