



## Proba-V operational processing system, serving daily updates on global vegetation

Presented by **STEFAN LIVENS** VITO Remote Sensing









From distant satellites to buzzing drones, VITO Remote Sensing enables you to use technology you could've only dreamed of before. Starting from your needs, we develop the right sensor and choose the matching instrument to get your project underway.

#### VITO roles:

- Principal investigator
- Design & exploitation of User Segment







# User centered mission → operational processing is key

#### **User demand:**

• Long term time series





- Quality, reliability, timeliness of SPOT VEGETATION
- spatial resolution 1km  $\rightarrow$  300m
- Keep the daily revisit

#### **Extras:**

- provide a similar 100m product
  - between Landsat (30m) and MODIS (250m)
- coastal monitoring
- Antarctica
- extended to 2020













# **Geometric and Radiometric Calibration**

#### Goal:

- continuously monitor performance
- adjust calibration model parameters to counteract changes

**Radiometry & Geometry** 

**automated Cal/Val facility** → monthly updates (ICP files)

traceable and transparant to users: reports





## **Geometric calibration**

#### Platform attitude $\rightarrow$ estimate geometric parameters $\rightarrow$ adjust projection

- using Ground Control Point (GCP) dataset (Landsat GLS 2010)
- estimate and monitor regularly exterior and interior orientation
- thermally stable design still has to account for:
  - distortions within one orbit (thermal effect in/out eclipse)
  - slow varying errors (seasonal effects: sun beta angle)





# Vicarious Radiometric Calibration

- **Compare to known targets** .
- slow variations in instrument performance ۰ (sensor decay)
- radiometric model parameters (conversion  $DN \rightarrow$  reflectance)
  - absolute, inter-band & inter-pixel









## **Instrument programming**

#### Task of Mission Control Centre (@Redu ESEC):

- Define & upload instrument programming requests
  - E.g. definition of calibration campaigns

Other tasks:

- **Check performance** (3 S-band passes per day)
  - Orbit status
  - Platform status (Navigation, Power budget, Data handling)
  - Instrument status: Temperature
- Monitor "close approach notification" from ESA Space Debris Office





		IPC Deskt	op			-
Calibration Campaigns	Calibration Planni	ngʻs 📃 Nominal	Requests	instrument R	equests Follow	-Up
Filter on application period	from 2014/0	1/01 • to 201	4/03/01 -	3		
Name To	ype Ap	plication Period		Frequency	Priority	# ROPs
Rayleigh Ocean - 2 Ru	ayleigh 20	14/01/01 · 2014/03/	01	Daily	6	6
Clouds - 4 Cl	louds 20	14/02/01 · 2014/03/	01	Daily	4	3
Antartica - B Ar	ntartica 20	14/02/01 - 2014/03/	01	> 3x / day	8	1
Moon - 4 Mi	ioon 20	14/02/01 - 2014/03/	01	Monthly	1	
Add calibration campaign			Delete			ROI Catalogue
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	1.0	VEC	CT/	prob		1.2.
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# **Data ingestion Facility**

- Data Reception Stations (DRS)
  - Kiruna (Sweden), Fairbanks (Alaska), Inuvik (Canada)
    receive communication frames (L0 Transfer Frame Files)



- Ingestion of third party ancillary data
  - For atmospheric correction: ECMWF meteo and MeteoServices meteo
  - For geometric calibration:

- Polar motion
- **Data Ingestion Facility** (DIF) processes the L0 raw data to L1A
  - instrument packets, sorted by time, duplicated and wrong packets removed
  - housekeeping packets
  - ancillary packets
- L1A product: raw uncompressed DN per strip + telemetry data +line timestamp info.









# **Data processing: What needs to be done ?**

Generate "standard" products: standard, custom (reprojections) calibration segments Input: Transfer Frame Files



state	origin
collection of long image strips	18 line sensors imaging continuously
in specific viewing geometry	orbiting wide swath instrument
uncalibrated digital numbers	as recorded by detectors
affected by atmosphere	earth viewed from 820km altitude
spatially incomplete	small gaps near equator for 3 cameras large gap for center camera clouds





## Data processing: Level $0 \rightarrow$ Level 1 A, B

input	process	result
raw sensor data + metadata	reconstruct + add ancillary info	Level1A
in specific viewing geometry	calculate geolocation, solar & viewing angles	Level1B

Geolocation: determine the latitude and longitude of all observed pixels.

• orbital propagation model + geometric Instrument Calibration Parameters Calculate viewing and solar zenith angles (VZA and SZA)







## **Data processing: to Level 1C**

input	process	result
uncalibrated digital numbers	apply radiometric model	Level1C

Convert DN to radiance:

• radiometric model



• Parameters in ICP files







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# L1C image

#### Central camera, RED strip





PROBA-V segments - Level 1C [C1]						
1 products selected on a total of 22 20 Per page << < 1 of 2 > >>						
Select all 22 products						
	Download	Product Reference	► Start Date	Stop Date	Product Siz R	ed TN
<b>V</b>	- 🗣 -	PV_CENTER_L1C-20180715104020_V101	15/07/2018 10:40:20	15/07/2018 11:00:55	2.4 GB	<u> </u>
	-	PV_LEFT_L1C-20180714110700_V101	14/07/2018 11:07:00	14/07/2018 11:23:02	2 GB	
	-	PV_RIGHT_L1C-20180714092105_V101	14/07/2018 09:21:05	14/07/2018 09:42:52	2.6 GB	
	-	PV_LEFT_L1C-20180713112925_V101	13/07/2018 11:29:25	13/07/2018 11:44:49	1.8 GB	

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**KELVINS DAY:** Challenges in Space

## **Data processing: to Level 2A**



map & project: from acquisition geometry to standard projection system



mosaicking SWIR strips

input



KELVINS DAY: Challenges in Space





Projected Image

## **Interpolation for variable input GSD**

L1 GSD: varies from 100m  $\rightarrow$  300m

- Resampling: combine with low pass filtering to avoid alias
- interpolation: from **bicubic**



3. Bi-cubic filter implementations for different values of a.

to stretched bicubic:



Array of filters varying over field of view





# **Data processing: to Level 2A: Status Maps**

**Generate status maps:** flags per pixel **Detect:** Cloud, cloud shadow, snow/ice

**Difficult:** clouds have 3D geometry + are 'fuzzy'

# Cloud Cloud shadow

#### **Improvement over time:**

- Collection 0: based on SPOT-VGT algorithms
- Collection 1: more advanced: uses land cover maps
   + reference spectra & similarity checks per class





## **Data processing: to Level 2B: Atmospheric corr.**

input	process	result
affected by atmosphere	atmospheric correction	Level2B (P segments)

Atmospheric models accurate input: Aerosol Optical Thickness (AOT)

- = measure of aerosols in air column from TOC to TOA
- aerosols: e.g., urban haze, smoke particles, desert dust, sea salt, ...

#### **Improvement over time:**

latitude assumption  $\rightarrow$  CAMS prediction (Copernicus Atmosphere Monitoring Service)



## **Data processing to Level 3: compositing**

input	process	result
spatially incomplete	temporal compositing	Level3

**Result:** Synthesis products: S1, S10



#### Format: HDF5 synthesis products 1km, 333m, 100m





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VECETA

## **Product Distribution**





## Product distribution innovation from catalog to user portal



Feedbac

Uniform access user centered

- select data source .
- choose area of interest •

#### https://www.vito-eodata.be/











## **Innovation Continues:**



### INSIGHTS FROM SPACE

by providing a user-friendly platform to access satellite data and derived information to the Belgian users.

seek novel uses of EO data by providing user friendly tools

https://terrascope.be

2017

**Experts**: processing tools near data: allows massive data amounts : e.g. time series

**Non experts:** advanced viewing tools: discover opportunities





## **Conclusion:**

Use demand daily global vegetation products

→ reliable operational processing chain

**subsystems** take care of data path: from acquisition to end users

traceable & dependable data quality

#### distribution:

#### product use paradigm shift:

- mission exploitation platforms
- novel uses of data



