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24/08/15

Extending the global time series of SPOT-VGT with PROBA-V

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PROBA-V mission

MISSION OBJECTIVE:

continuity of SPOT Vegetation data

global daily coverage of land masses
(above 35°)

launched in **2013**
(lifetime 2,5 years, extension to 5 years)

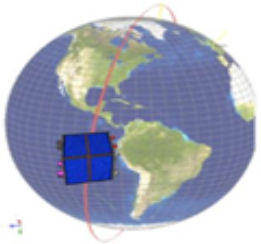
CHARACTERISTICS

like SPOT VGT:

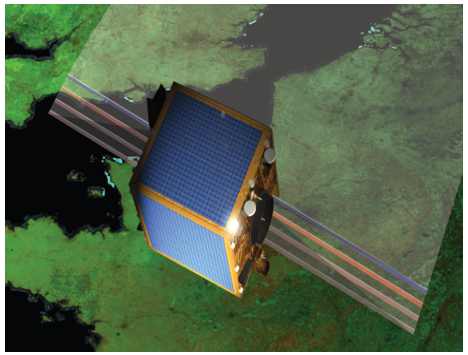
- SWATH width = 2250 km
- 14 near polar orbits per day, @820km
- 4 spectral bands (Blue, Red, NIR, SWIR)

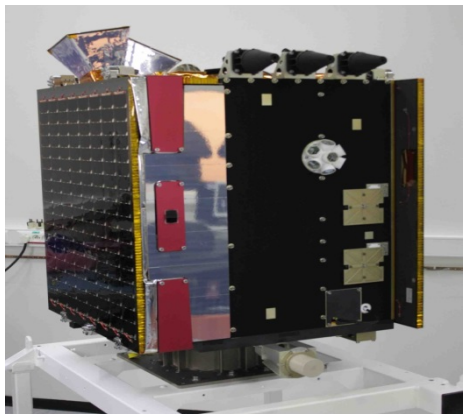
Improvements

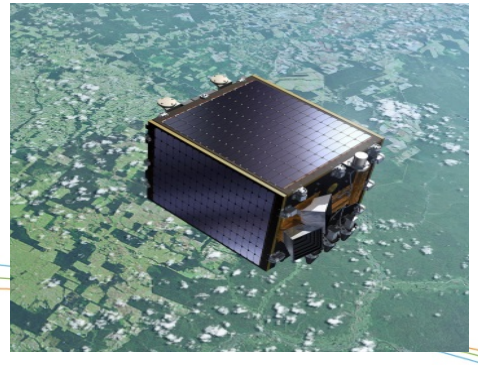
a lot lighter and smaller



spatial resolution:
products: 300m (600m for SWIR)
in addition to 1km like VGT





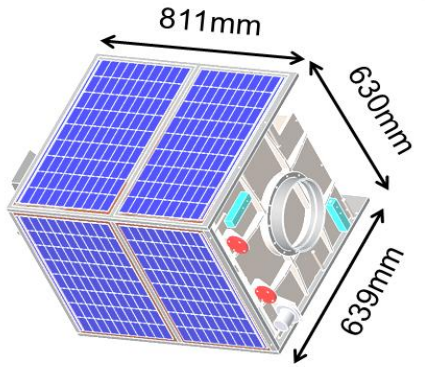


PROBA-V, mission

DIMENSIONS platform

131 kg

Power < 131 watt



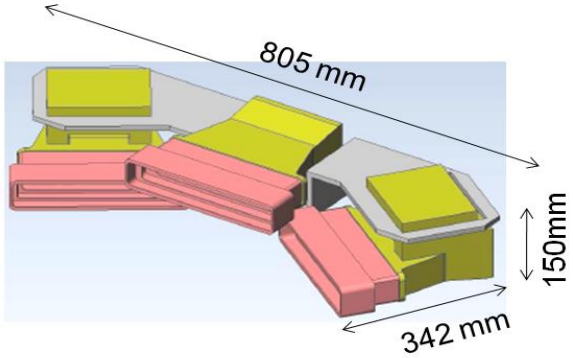
> 200x smaller

> 20x lighter than SPOT-5 (6m x 3,4 m x 3,1 m, 3000 kg)

imaging instrument

18 kg

Power < 43 watt



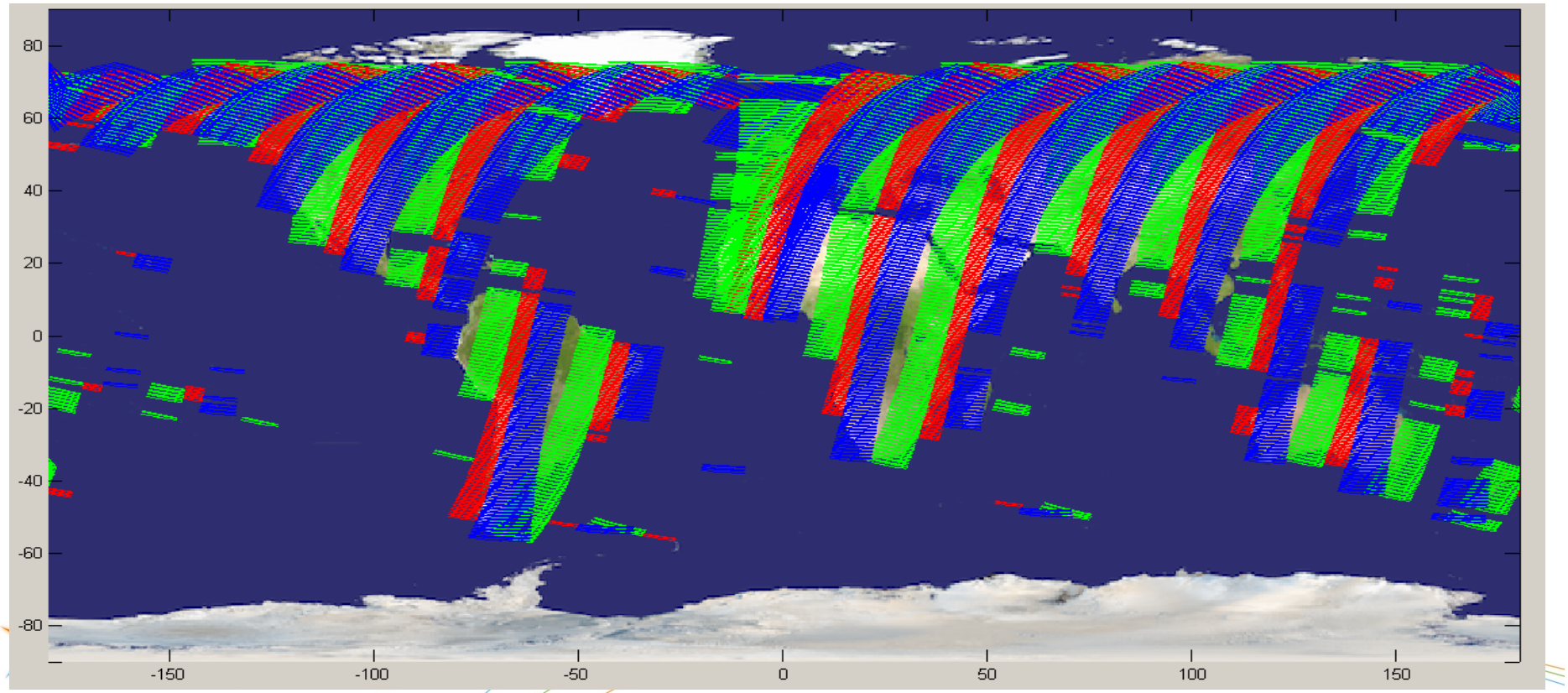
> 17x smaller

> 9 x lighter than SPOT-5 VGT (0,7m X 1 m X 1 m, 160 kg)

PROBA-V Processing chain

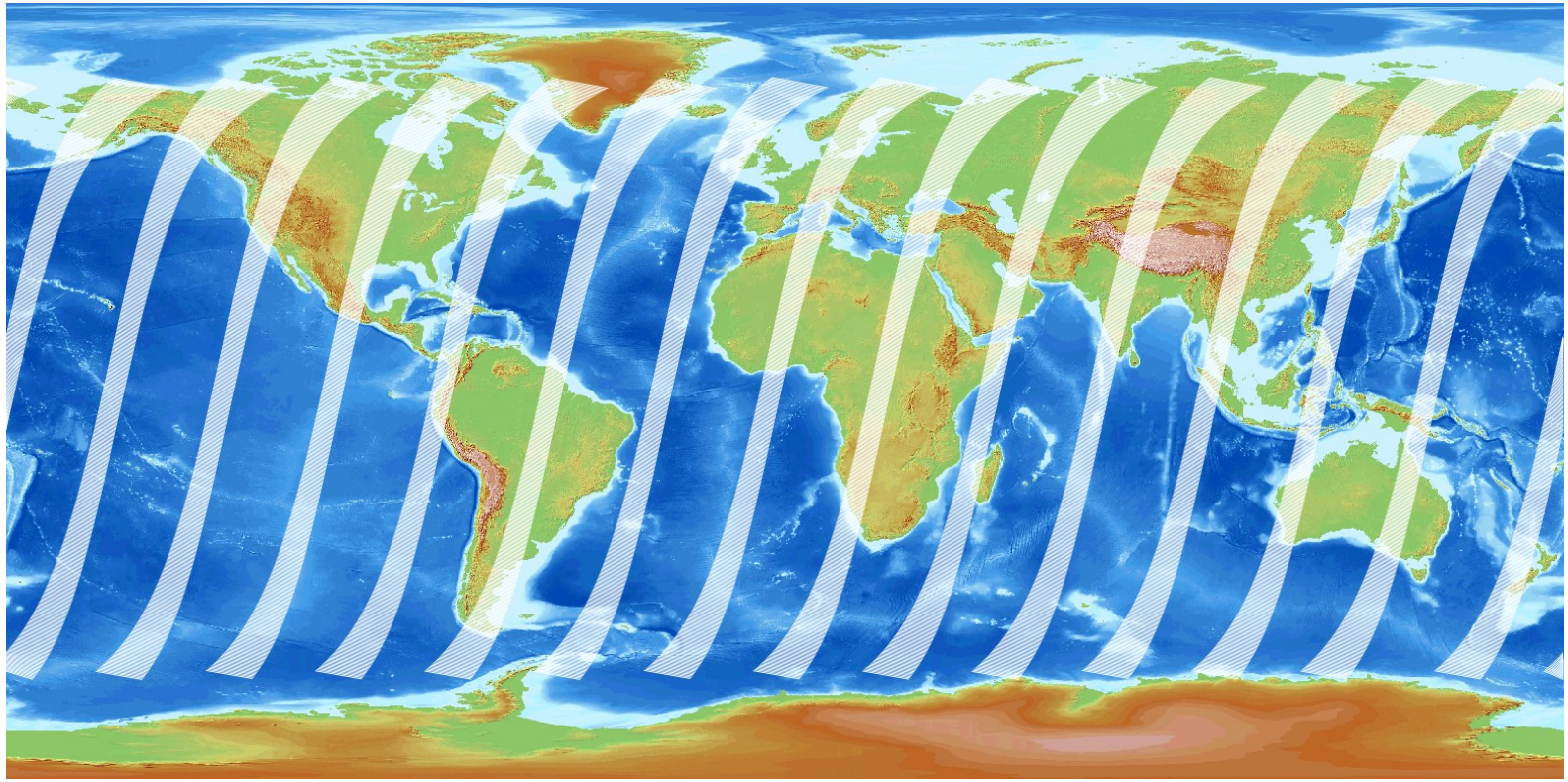
PROBA-V one day coverage (1 day orbiting)

- **GREEN** = right camera (100 – 360m GSD)
- **RED** = center camera (100m GSD)
- **BLUE** = left camera (100 – 360m GSD)



PROBA-V 100 m

1 day coverage



PROBA-V 100 m

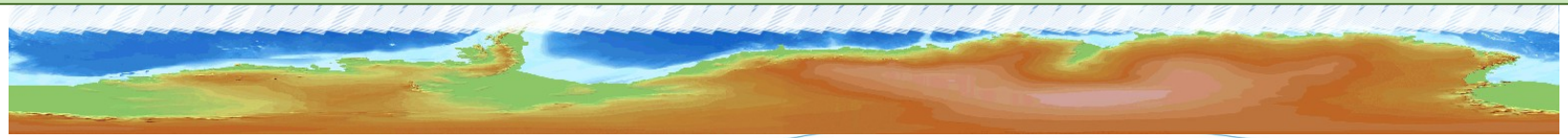
5 days coverage

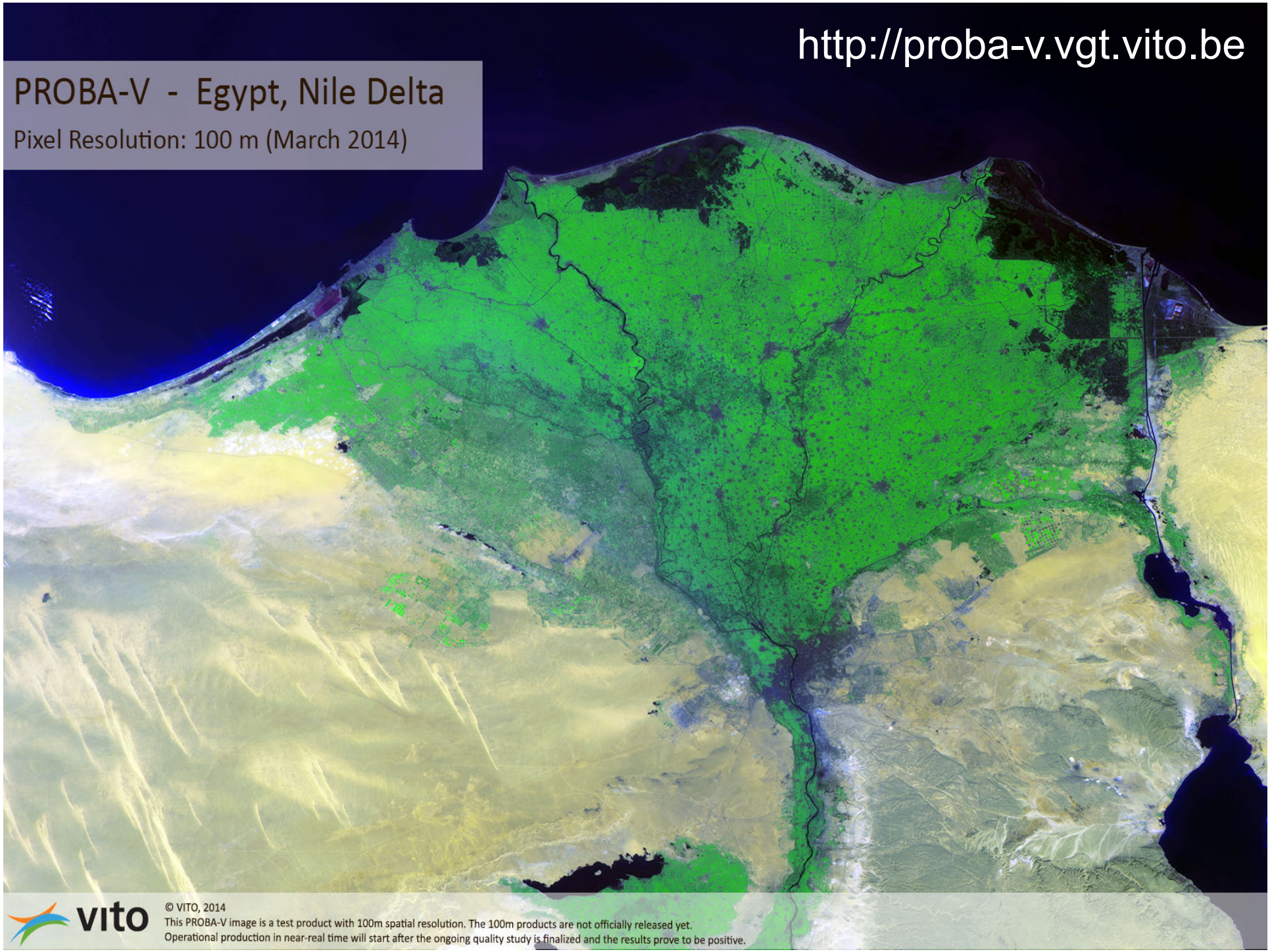
Combination of spatial resolution (100m), spatial accuracy (app. 50m!) and temporal frequency (5 days/global cov.)

=

UNIQUE!

Applications: agriculture, vegetation mapping, deforestation, desertification, climate change, …




http://proba-v.vgt.vito.be
PROBA-V - Egypt, Nile Delta
Pixel Resolution: 100 m (March 2014)
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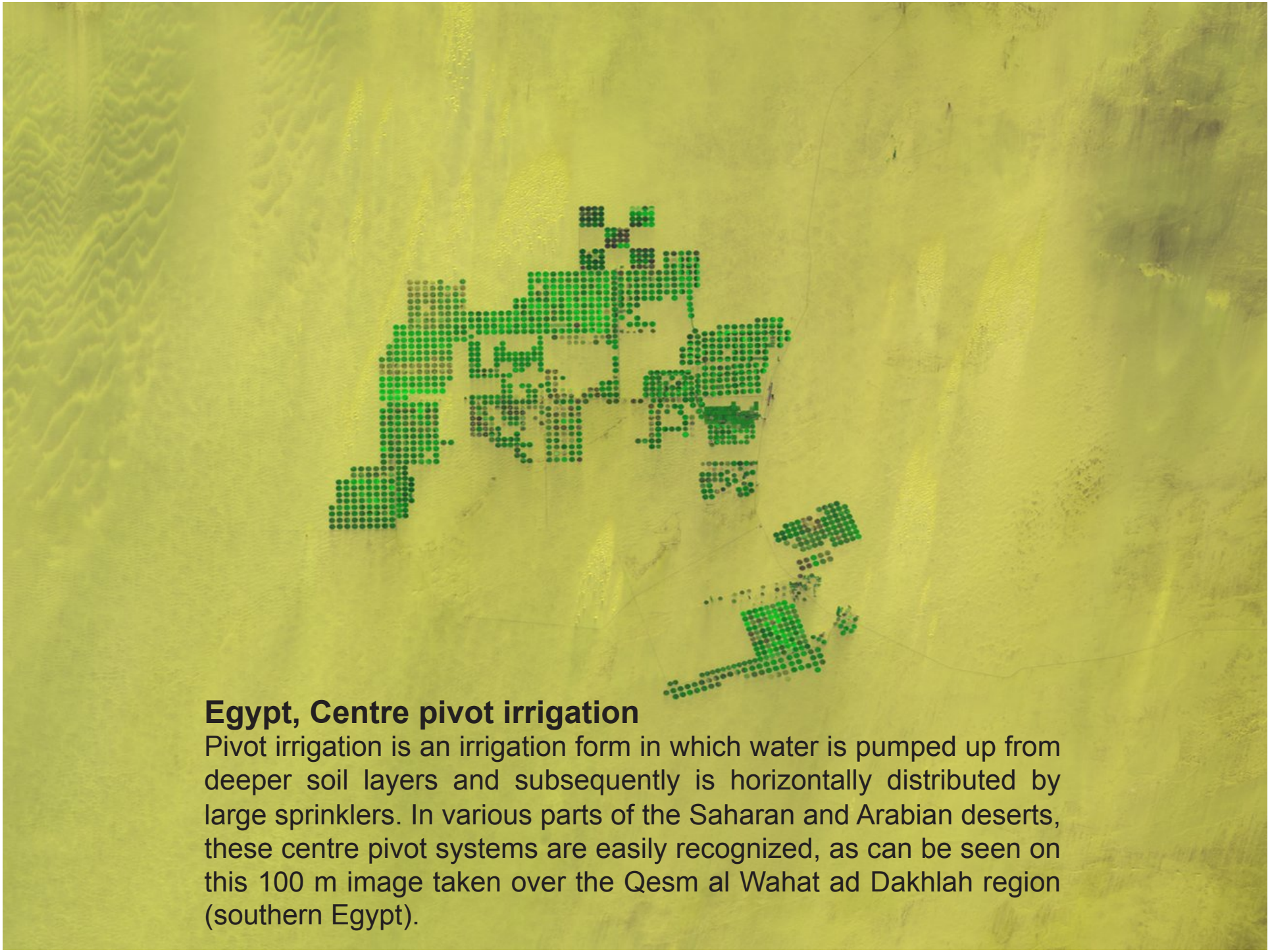
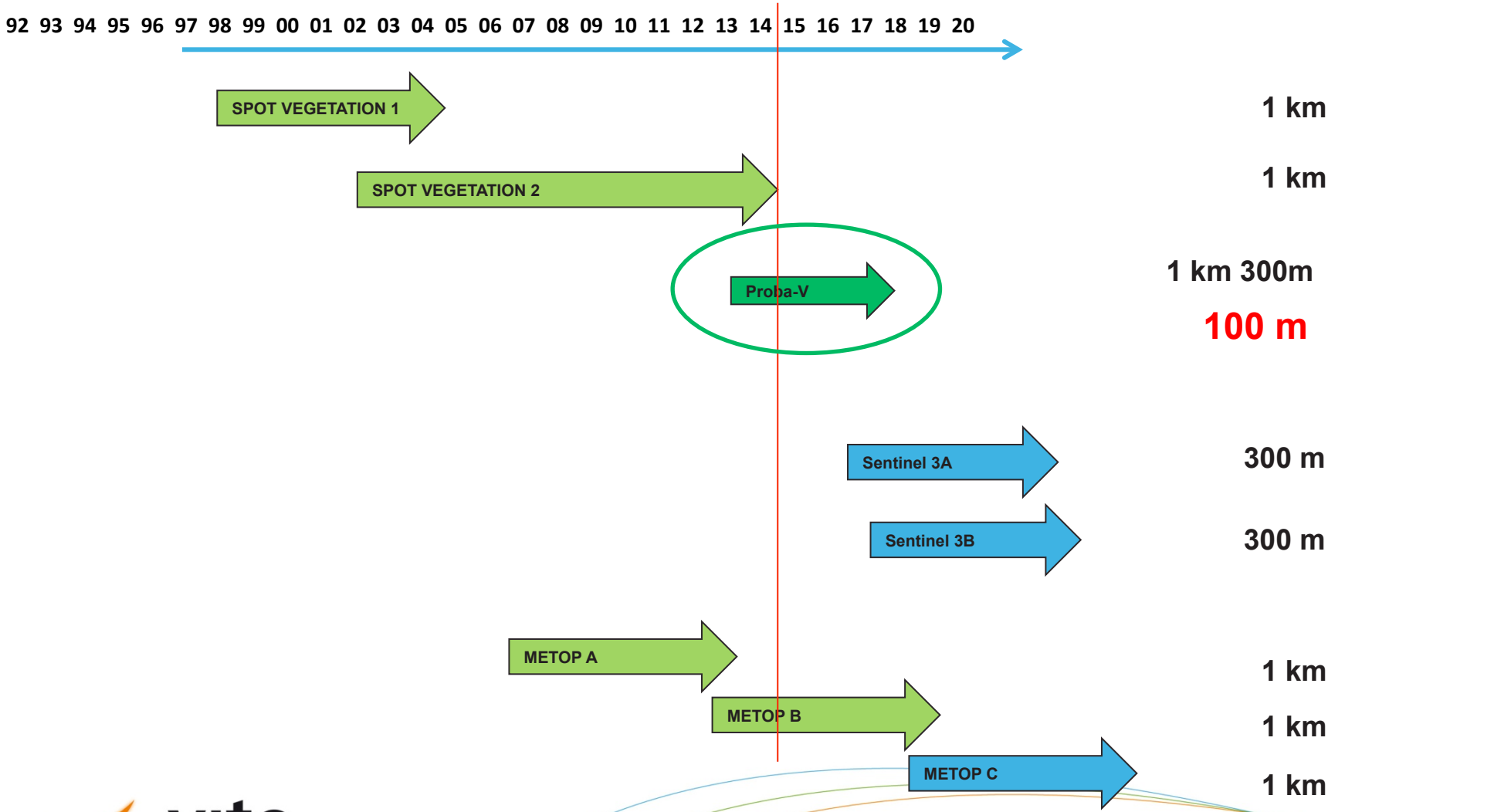
© VITO, 2014
This PROBA-V image is a test product with 100m spatial resolution. The 100m products are not officially released yet.
Operational production in near-real time will start after the ongoing quality study is finalized and the results prove to be positive.



Egypt, Centre pivot irrigation

Pivot irrigation is an irrigation form in which water is pumped up from deeper soil layers and subsequently is horizontally distributed by large sprinklers. In various parts of the Saharan and Arabian deserts, these centre pivot systems are easily recognized, as can be seen on this 100 m image taken over the Qesm al Wahat ad Dakhlah region (southern Egypt).

Context



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Evaluation

- Similarity & spectral correction
- Comparison against external data sets
- Focus on
  - 10-daily max value composit NDVI (1km)
  - Consistency, i.e. relative difference between data sets

NDVI data sets

Proba-V/VGT Standard products

- 10-daily NDVI from standard processing chain
- 1998-May 2014 / Oct 2013 - present
- http://www.vito-eodata.be

Copernicus Global Land Service products

- Based on 10-daily NDVI from standard products
- Spectral correction for Proba-V
- 2013 (1998 soon) - present
- http://land.copernicus.eu/global/

TERRA-MODIS

- Monthly NDVI (MOD13A3)
- 2001 - present

METOP-AVHRR

- 10-daily NDVI (LSA-SAF)
- 2008 - present

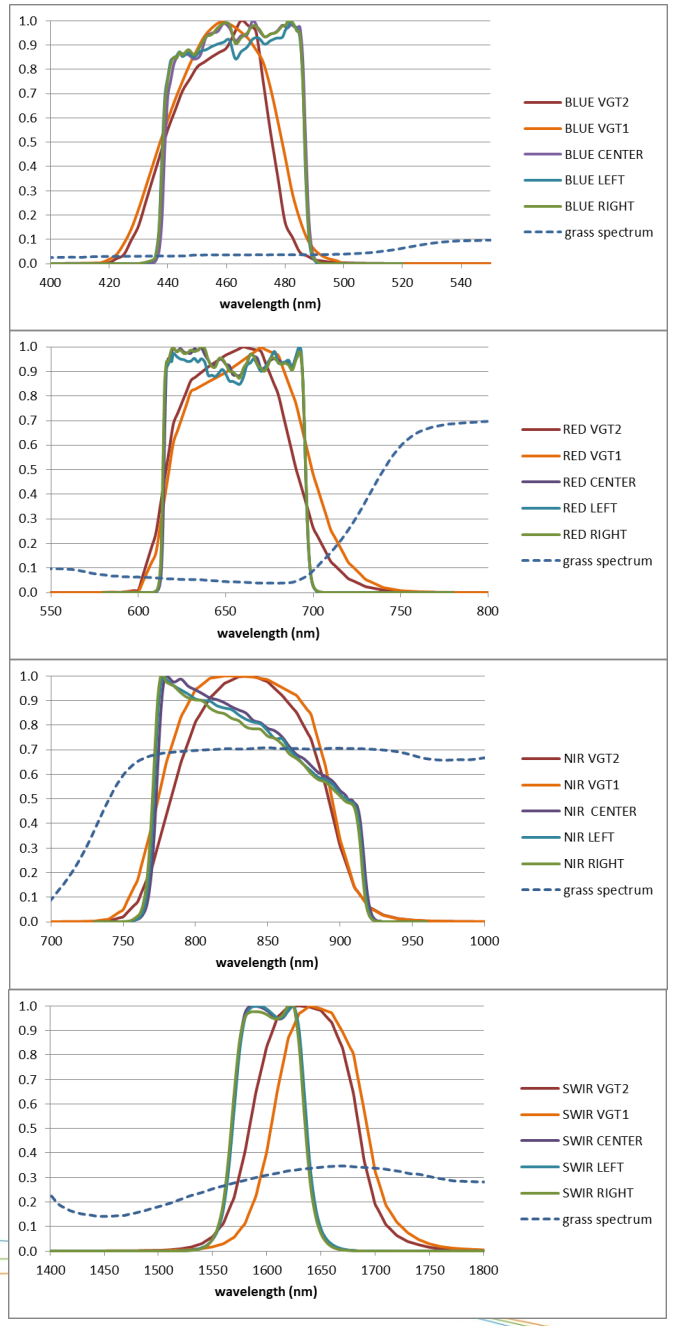
SIMILARITY AND SPECTRAL CORRECTION

Spectral correction - SRF

- Linear correction functions:
  - $VGT2_i = offset_i + slope_i \cdot ProbaV_i$
  - TOA and TOC
  - Physics based approach

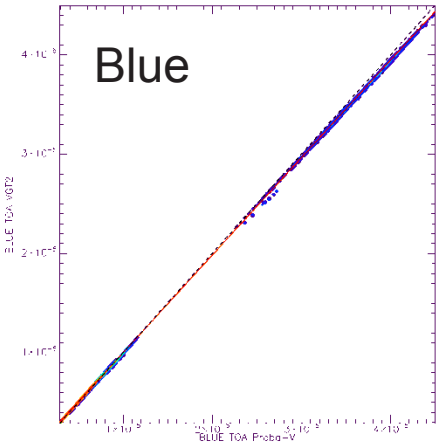
	OLS intercept	OLS slope	agreement coefficient	RMSE
TOA BLUE	0.0034	0.9971	0.999	0.0032
TOA RED	0.0029	0.9983	0.999	0.0030
TOA NIR	0.0024	1.0005	0.999	0.0031
TOA SWIR	0.0062	1.0214	0.986	0.0100
TOA NDVI	0.0005	0.9843	0.997	0.0107

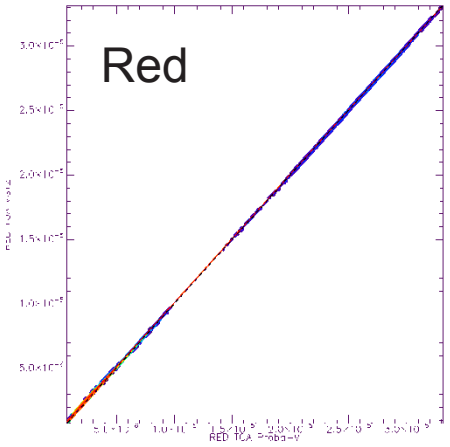
	OLS intercept	OLS slope	agreement coefficient	RMSE
TOC BLUE	0.0015	1.0056	1.000	0.0020
TOC RED	0.0024	1.0019	0.999	0.0031
TOC NIR	0.0001	0.9980	1.000	0.0020
TOC SWIR	0.0021	0.9867	0.999	0.0039
TOC NDVI	-0.0042	0.9859	0.999	0.0139

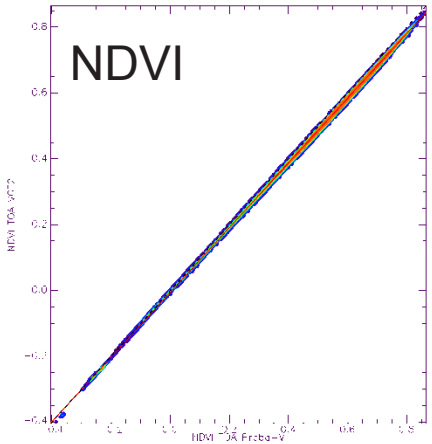


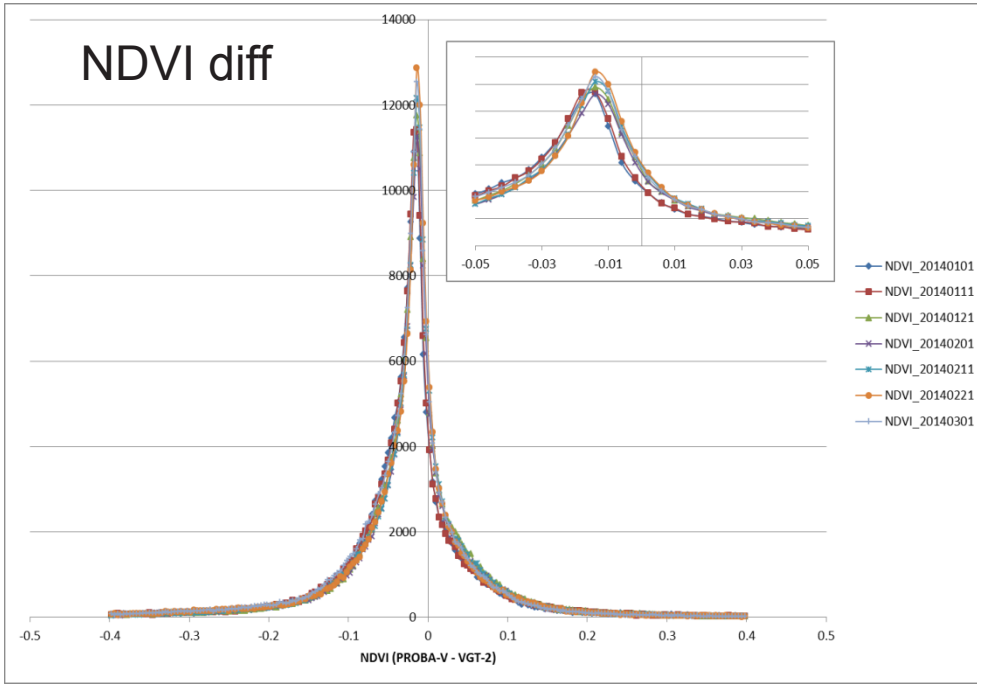
Spectral correction

» Based on simulations (PRO4SAIL + MODTRAN4) and spectral libraries (snow, bare soil, water)





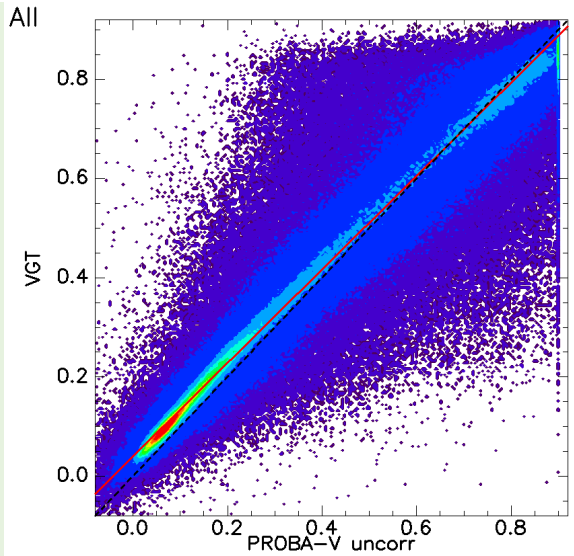


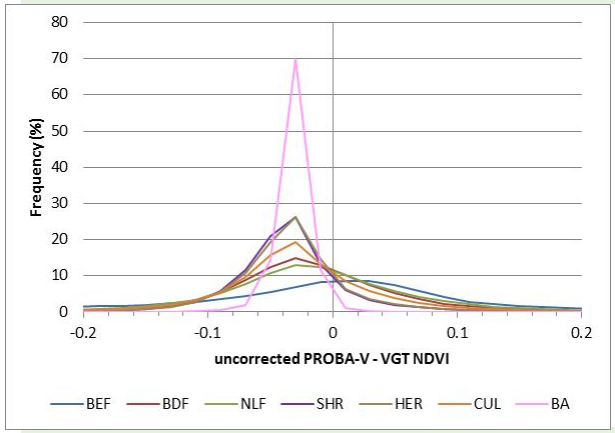


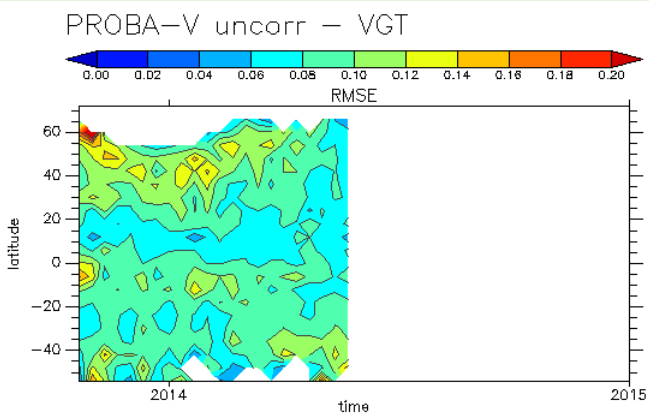
+ additional offset correction

PROBA-V – VGT overlapping period

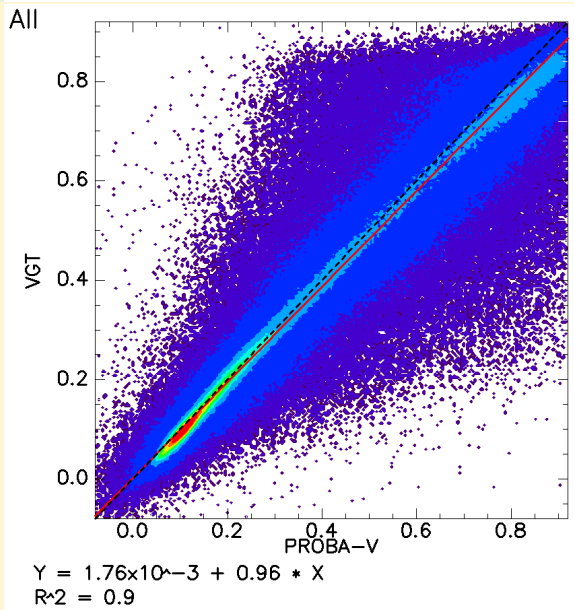
Standard Products

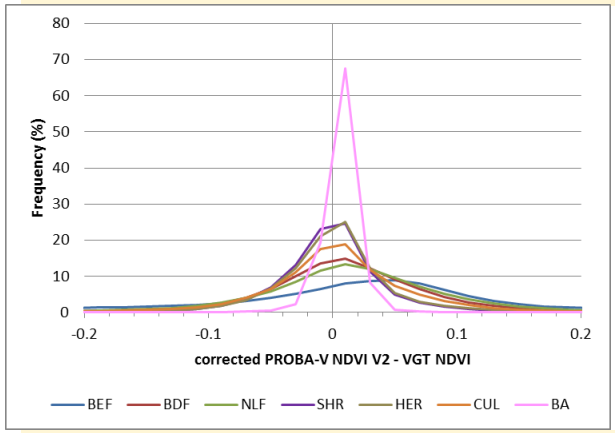


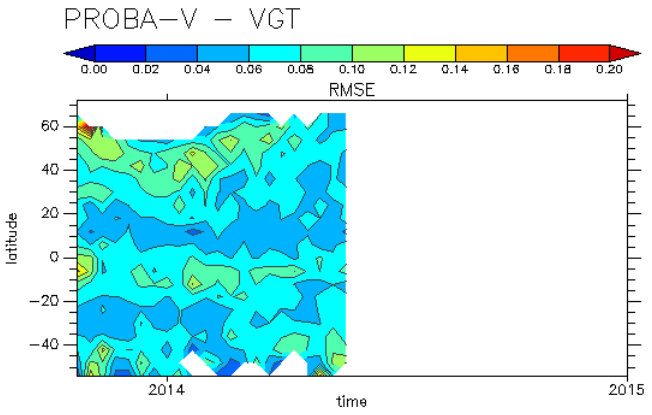




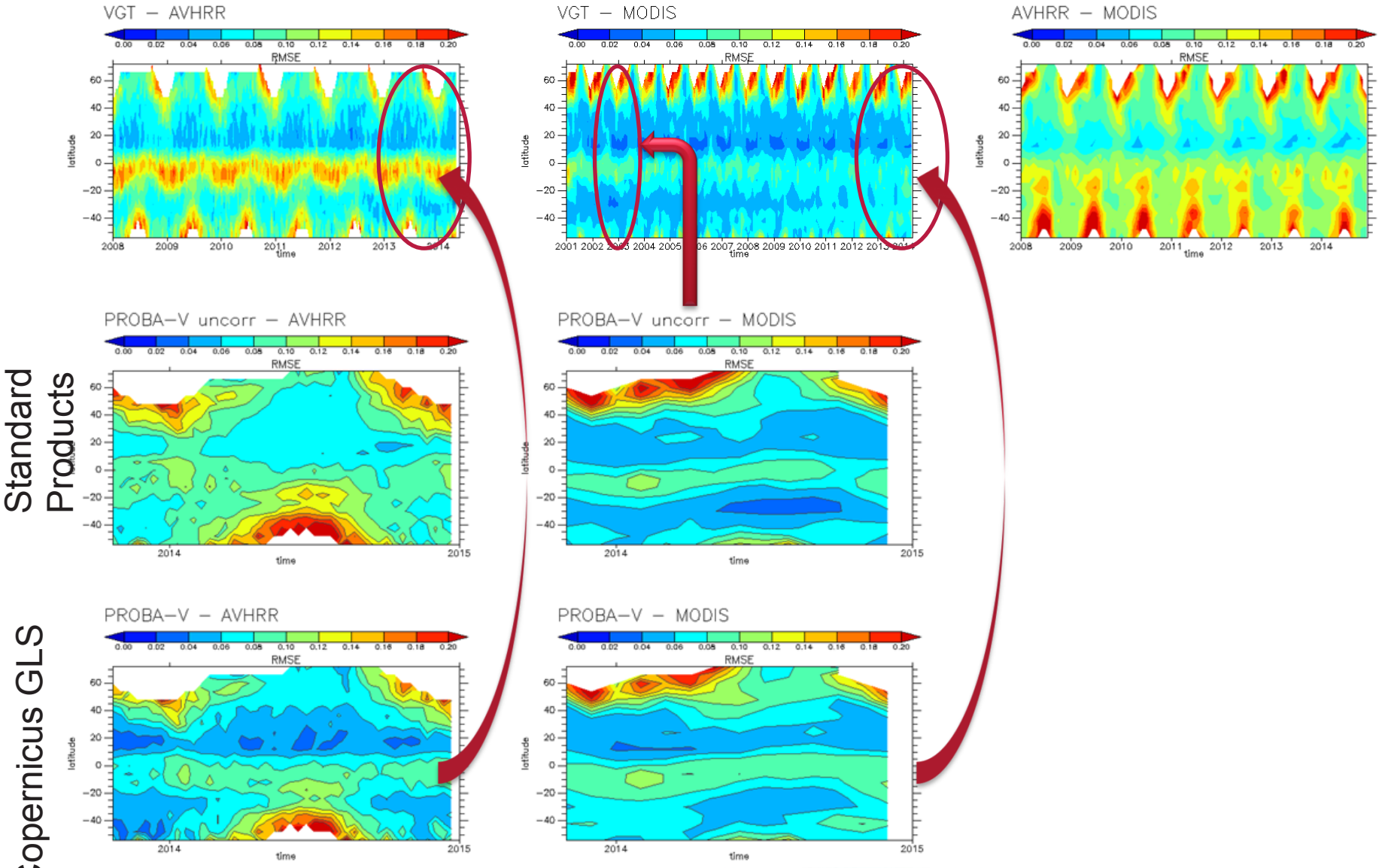
Copernicus GLS







COMPARISON TO EXTERNAL NDVI TIME SERIES



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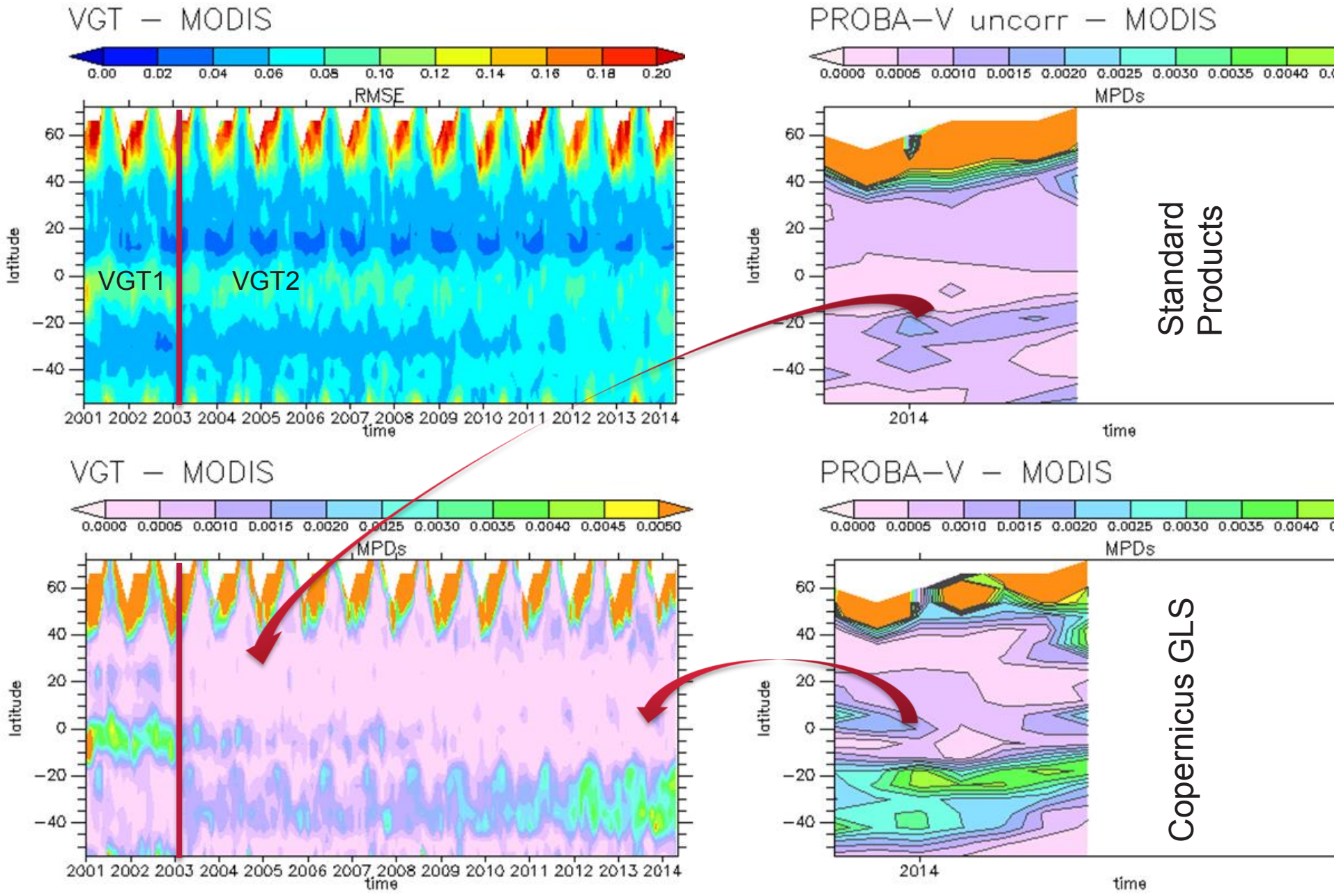
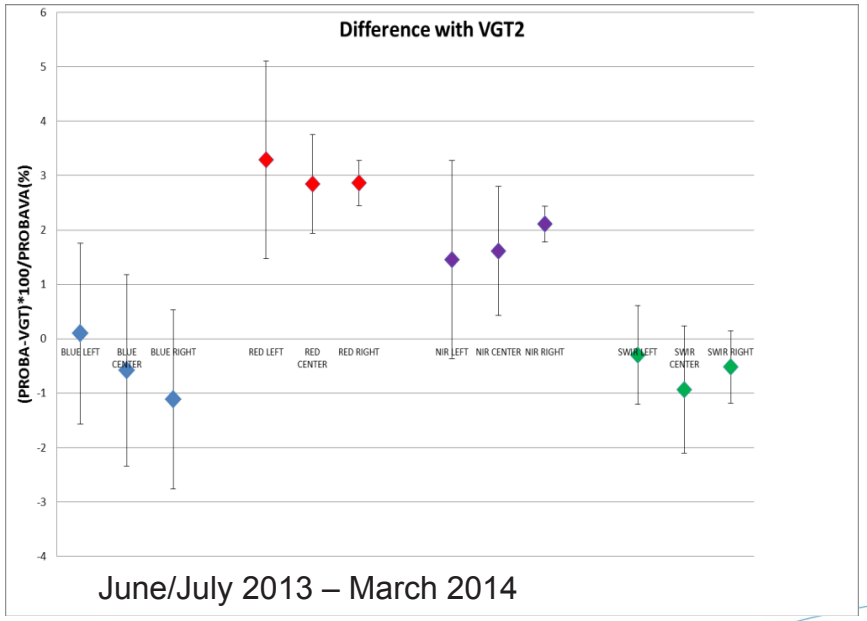
Evaluation of VGT archive



Identified sources of differences

- Overpass time
- Incorrect sun-earth distance modell
- Absolute calibration difference

Cross-comparison PROBA-V and VGT2 over Libya-4



June/July 2013 – March 2014

CEOS INTER-COMPARISON

Table 2. Mean relative difference and standard deviation between satellite TOA BRFs and SIXS-V simulations over Libya4 during the 2006–2009 period. Positive values indicate that simulations underestimate observations. The last two lines display respectively the mean and range of the $\bar{B}$ values of each different sensor. SD is the standard deviation.

OSCAR Libya4	Mean relative difference (%)					SD of relative difference (%)				
Bands (μm) sensors	0.44	0.55	0.66	0.84	1.62	0.44	0.55	0.66	0.84	1.62
VGT	0.79	–	−3.14	−2.46	−1.13	2.82	–	1.05	1.26	1.52
AATSR	–	3.89	2.81	4.21	3.82	–	1.32	1.06	1.42	0.85
PARASOL	3.08	0.71	−0.23	0.00	–	5.20	2.81	2.23	1.79	–
MODISA	3.36	2.95	0.58	1.55	2.05	1.98	1.91	1.55	1.45	1.41
MERIS	2.60	2.80	1.41	1.50	–	1.57	1.43	1.07	1.25	–
Mean	2.46	2.59	0.29	0.96	1.58					
Range	2.57	3.18	5.95	6.50	4.95					

CNES :

660 nm:

Sensor	Site	N samples	Mean relative difference in % between sensor and MERIS 2nd reprocessing	Stddev of the relative difference in %	Estimated methodology uncertainty on mean relative difference in %
VGT 2	LIBYA-4	124	-4.5%	1.3%	2.5%
VGT 2	NIGER-2	180	-4.3%	1.8%	2.5%

870 nm:

Sensor	Site	N samples	Mean relative difference in % between sensor and MERIS 2nd reprocessing	Stddev of the relative difference in %	Estimated methodology uncertainty on mean relative difference in %
VGT 2	LIBYA-4	124	-5.6%	2.0%	2.5%
VGT 2	NIGER-2	180	-4.1%	2.2%	2.5%

PROBA-V COMPARED TO HISTORICAL ARCHIVE OF SPOT-VGT

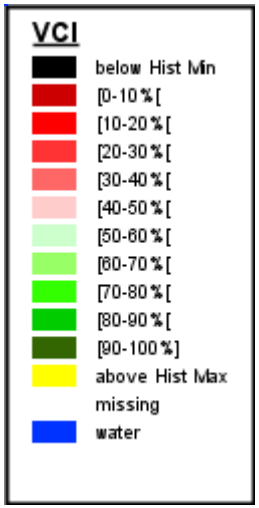
ANALYSIS OF ANOMALIES

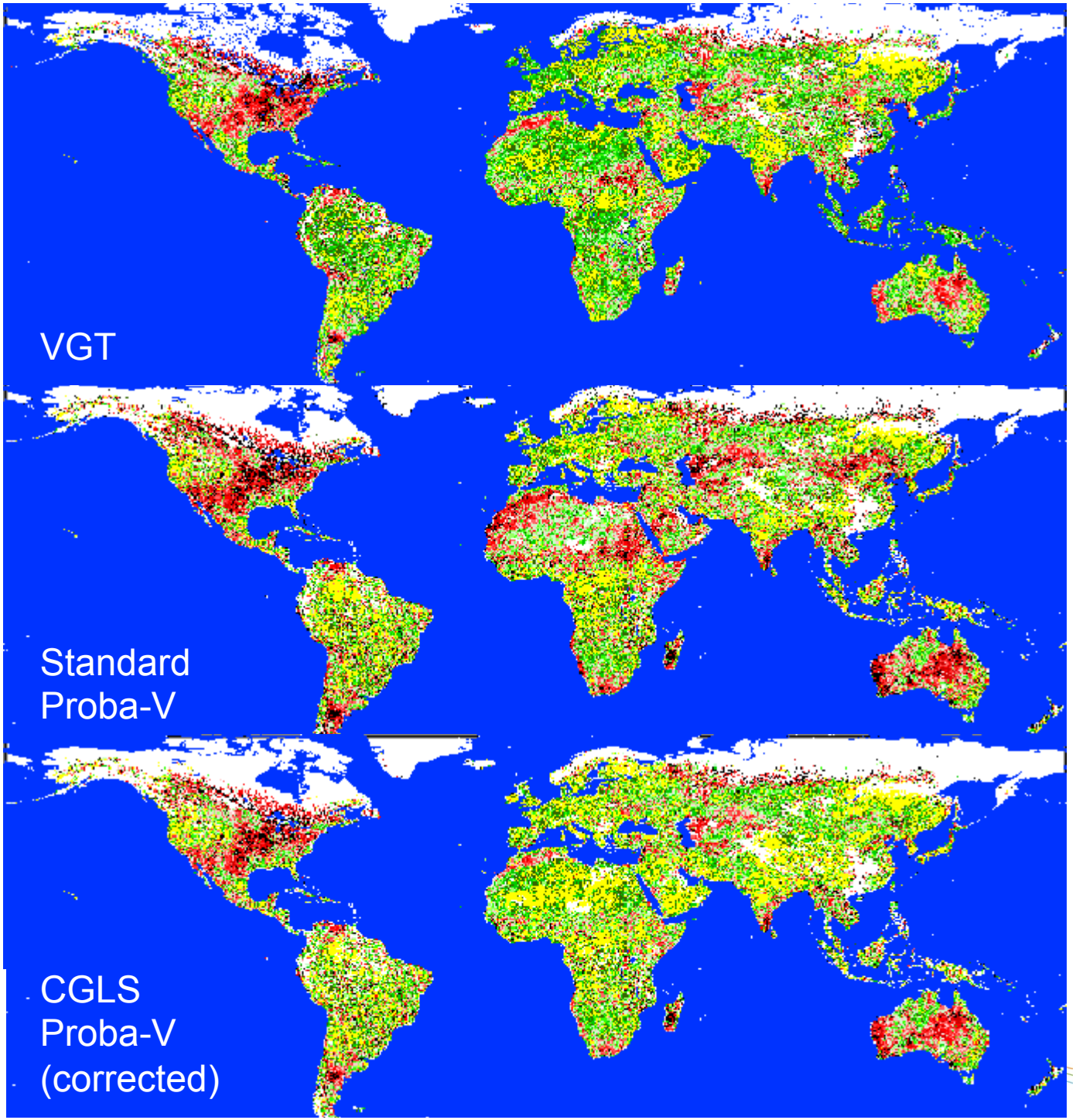
Analysis of anomalies

VCI(*)

VCI = % of actual NDVI compared to historical MIN & MAX

Historical MIN & MAX: from VGT





* Kogan, F.N.F., 1990. Remote sensing of weather impacts on vegetation in non-homogeneous areas. *Int. J. Remote Sens. 11, 1405–1419.*

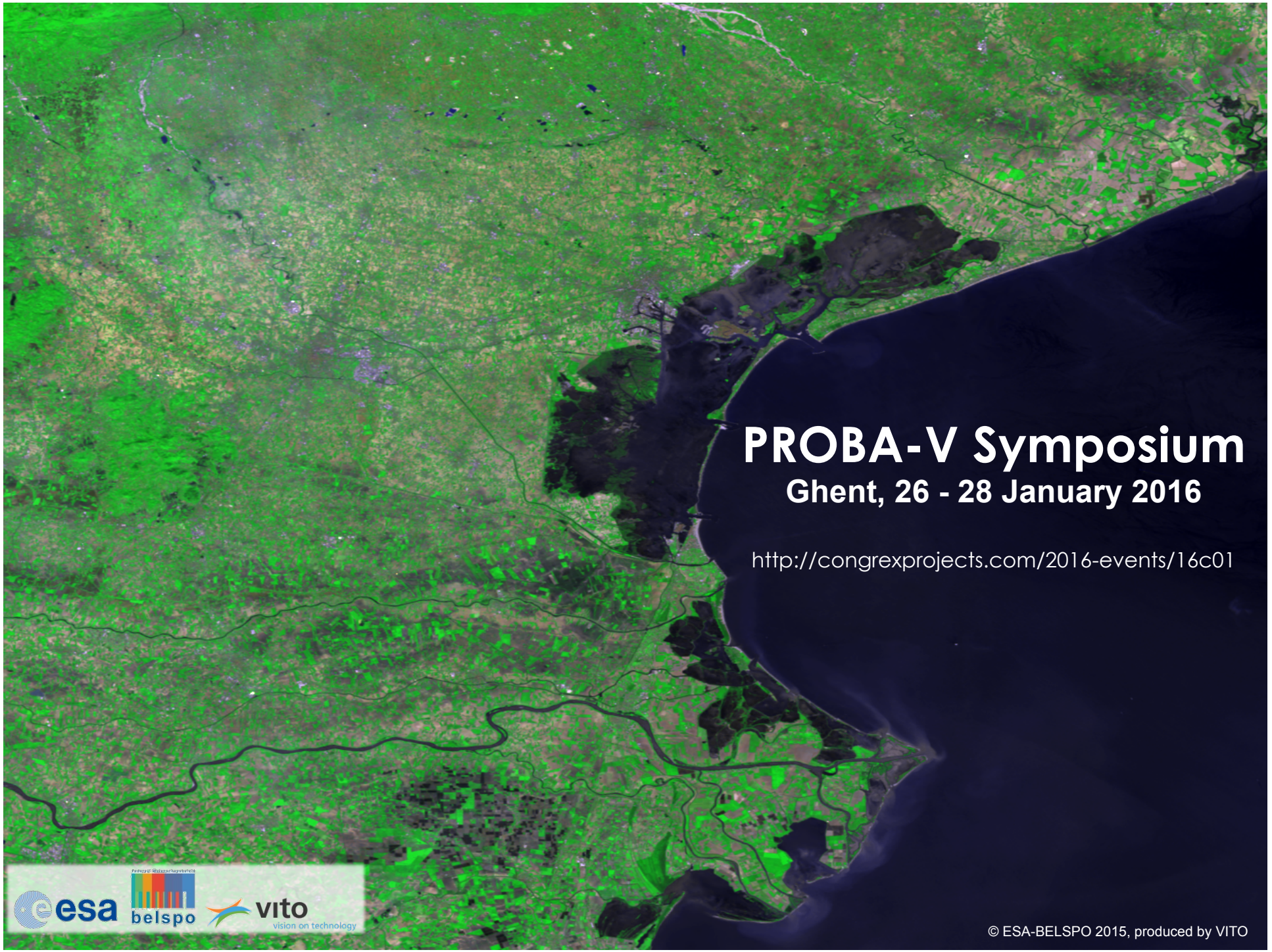
Reprocessing VGT archive

- What?
  - Improved absolute calibration
  - Smile effect
  - Correct modelling of sun-earth distance
  - Improved cloud masking

- When
  - Ongoing, finished in September
  - Full evaluation in Autumn

Discussion and Lessons learnt

- Proba-V and VGT NDVI is very similar; spectral difference is low.
- Observed difference caused by other than spectral factors:
  - Overpass time, known shortcomings in VGT data set, absolute calibration differences, …
  - Re-evaluation of consistency is necessary after reprocessing of VGT
- Sufficient long overlap between data sets of different sensors is key
  - Ideally 1 year
  - Added-value product centres: consistency can only be proven after ~1.5 Year
- Consistency with Sentinel-3 SYN VGT ?
  - Larger difference in physical properties (spectral response, tilt OLCI sensor, overpass time, …)
  - Differences in processing chain -> processing choices are important !
  - Re-processing of ALL archives should be scheduled / coordinated across ALL contributing missions


PROBA-V Symposium
Ghent, 26 - 28 January 2016
http://congrexprojects.com/2016-events/16c01
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