

Quality Assessment and user requirements collection for Copernicus Global Land



Land Monitoring

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Global Land
Operations

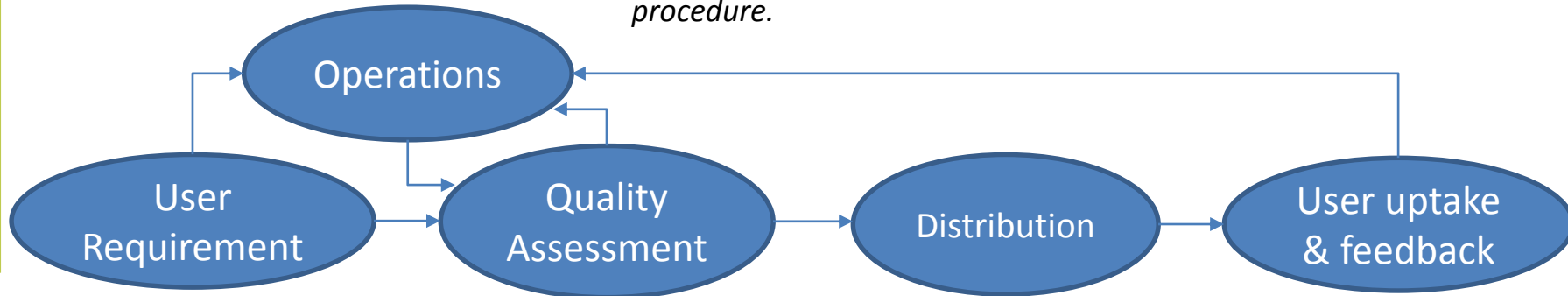
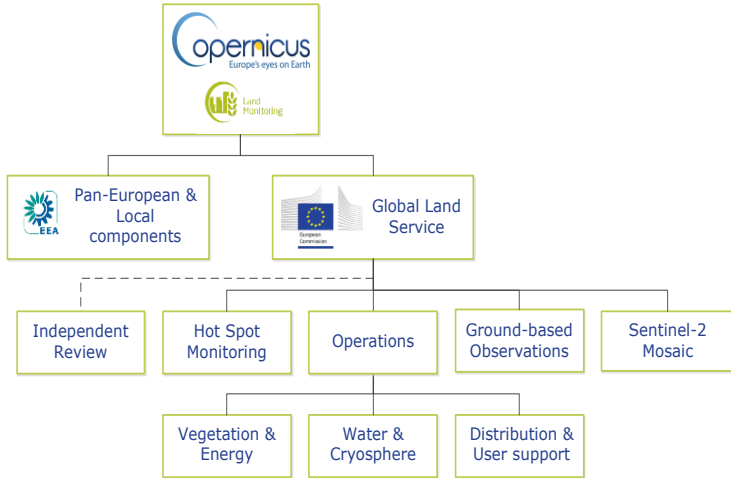
Introduction

Copernicus Global Land provides a series of bio-geophysical products describing the status and the evolution of land surfaces at global scale.

*The **Quality Assessment** is a key component of the service to assure that the products are delivered to users with known uncertainties.*

The Quality Assessment involves several levels, operational quality monitoring, scientific validation and independent review.

*A main goal of the Quality Assessment is to determine to which extent a product meets the **User Requirements**. Hence, the collection of the User Requirements can be seen as the first step of the developments and QA, and the user's feedback the last step of the validation procedure.*





Global Land
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Product Portfolio

+ *Hot Spots*, + *S2 global mosaic*, + *Ground Observations*

VEGETATION



- Leaf Area Index (LAI)
- Fraction of Absorbed Photosynthetically Active Radiation (FAPAR)
- Fraction of vegetation cover (FCOVER)
- Normalized Difference Vegetation Index (NDVI)
- Vegetation Condition Index
- Vegetation Productivity Index
- Dry Matter Productivity
- Burnt Area
- Moderate Yearly Land Cover

ENERGY



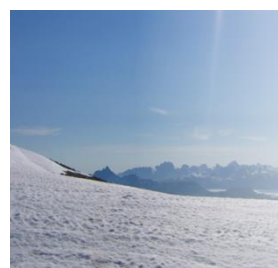
- Top-of-Canopy reflectance
- Surface Albedo
- Land Surface Temperature
- Surface soil moisture *
- Soil Water Index

WATER



- Lake surface water temperature
- Lake and river water level
- Lake water quality
- Water bodies

CRYOSPHERE



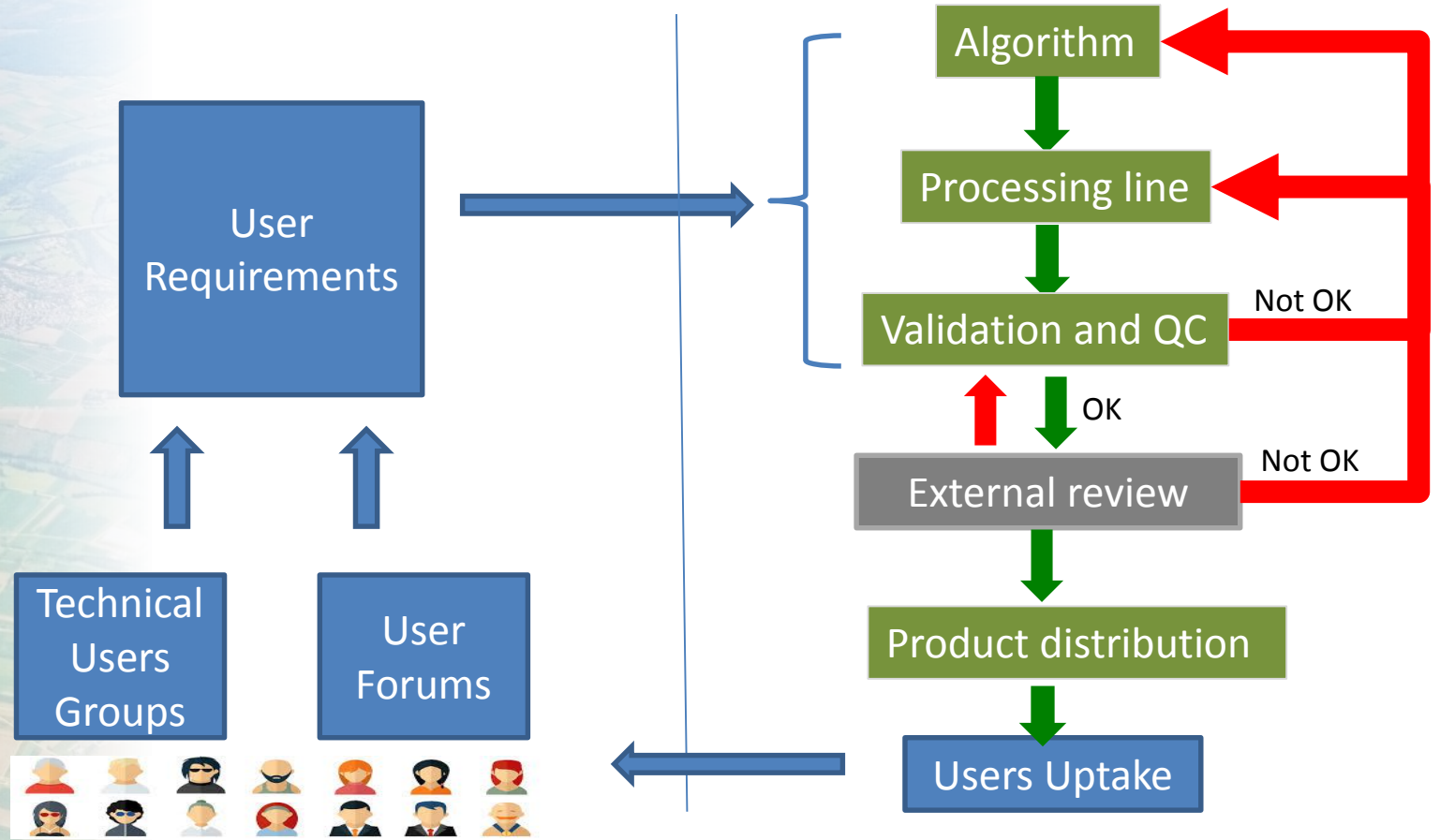
- Snow cover extent
- Snow water equivalent
- Lake Ice Extent

* *Distribution to start soon*



Global Land
Operations

User collection and quality assessment overview





Part of Lot 4: Product and Service Independent Evaluation

Activity lead by Spacebel and the University of Liege

- **Technical User Groups (TUG) meetings**

Aiming at discussing the different aspects of the production and dissemination

28 external experts for vegetation and radiation products

21 experts for water and cryosphere

- **Service specification and requirements**

- Documentation, Quality Control, Validation, Archiving, Distribution, Time series...

- **Global Land User Forums**

Aiming at gathering views and recommendations from users

Platform to discuss on users needs and identify future requirements

Reference:
SPB-GIO-307-TUG-SS-004

Issue:
1 - 26/05/2015

Revision:
0 - 26/05/2015

Distribution Code:
Restricted Distribution



*GIO Copernicus Global Land
Technical User Group*

*Service Specification and Product
Requirements Proposal*

Specific Contract n°2 ref CCR.IES.C389266.X2 under Framework Contract 389266



User Requirements collection

Area of Water Bodies

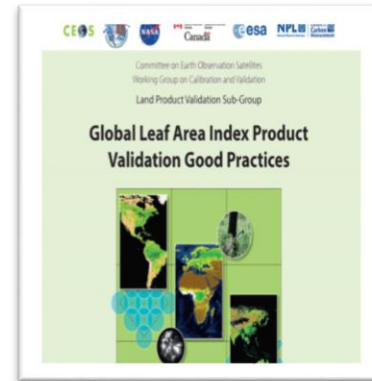
- Spatial resolution : 100m not contracted but feasible (Land Cover product Line : 100m yearly product)

Attr. Name	User requirements	Product characteristics	Gap Analysis
PR-PS-0203: Spatial Resolution	<ul style="list-style-type: none"> • 1/112° (~1km at Equator) • 1/336° (~300m) • 100m 	<ul style="list-style-type: none"> • 1/112° • 1/336° 	
PR-PS-0205: Temporal Coverage		<ul style="list-style-type: none"> • since Jan 2014 • for Africa 1km: Jan 1999 	
PR-PS-0206: Generation Interval	<ul style="list-style-type: none"> • Monthly 	<ul style="list-style-type: none"> • 1km and 300m: 10 day composites <ul style="list-style-type: none"> ○ start: 1st, 11th, 21st of month 	
PR-PS-0207: Geometric accuracy	<ul style="list-style-type: none"> • 1/3 pixel 	<ul style="list-style-type: none"> • 1/3 pixel 	
PR-PS-0304: Timeliness		<ul style="list-style-type: none"> • within 3 days after acquisition period 	
PR-PS-0401: Accuracy Threshold	<ul style="list-style-type: none"> • max. error of omission and commission: 	<ul style="list-style-type: none"> • 300m: 	
	<ul style="list-style-type: none"> ○ lake area maps: 5% ○ mapping individual classes: 15% 	<ul style="list-style-type: none"> ○ overall accuracy: 99.71%; omission error: 26.08%; commission error: 13.60% ○ omission / commission depend on seasonal effects; at some periods not complaint with requirements 	
PR-PS-0402: Accuracy Target			



Quality Assessment procedure

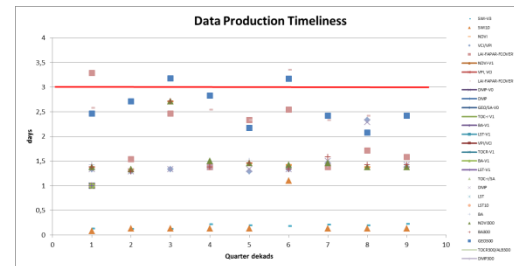
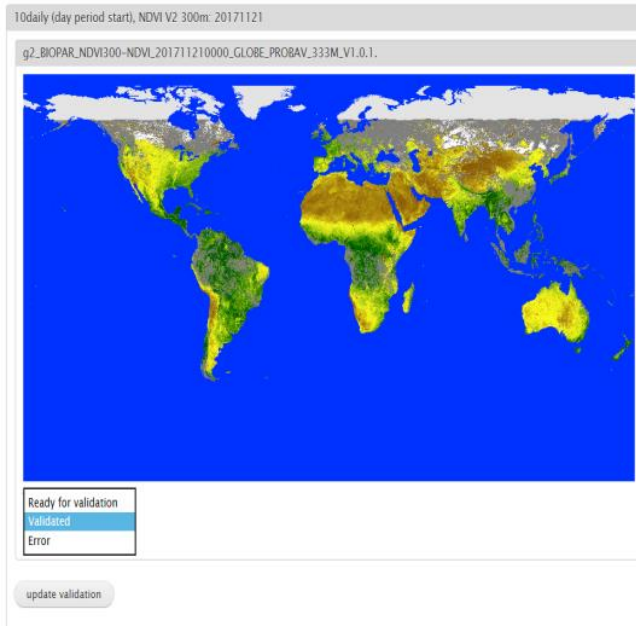
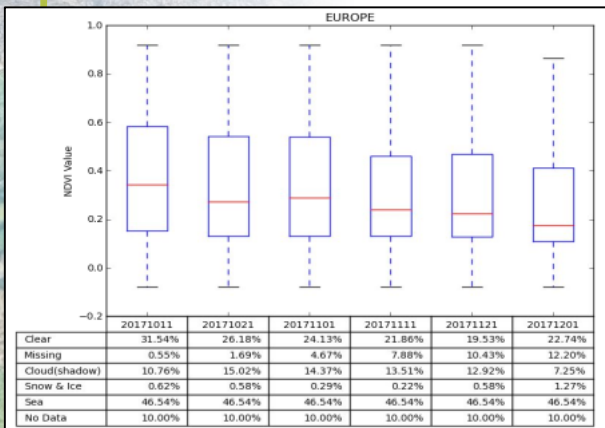
- **Operational quality monitoring (daily)**
 - *Monitoring of automated processing steps*
 - *Semi-automatic checks at production centers (e.g. QL inspection)*
 - *Check unreliable values through statistics*
- **Thematic scientific validation**
 - ***Exhaustive validation*** per variable (**each new version**)
 - Global, according to CEOS Land Product Validation (LPV) protocols
 - ***Quality evaluation*** per and across variable (**yearly**)
 - Includes regional analysis
 - Analysis on events and sites with ground truth
- **Independent Assessment**
 - *Through panel of independent experts*
 - *Each version*
 - recommendation development stage (operational, pre-operational...)





Operational Quality Monitoring

- Operational quality monitoring (daily)
 - Monitoring of automated processing steps
 - Semi-automatic checks at production centers (e.g. QL inspection)
 - Check unreliable values through statistics



- Collections in NRT
 - 13 products
 - 24 versions
- On-time NRT deliveries
 - 92% dekad < 3 days,
 - 65% dekad < 2 days
 - 95% day < 1 days
- Archive reprocessing
 - 107 Years data
- Infra uptime
 - > 99.7%

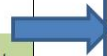
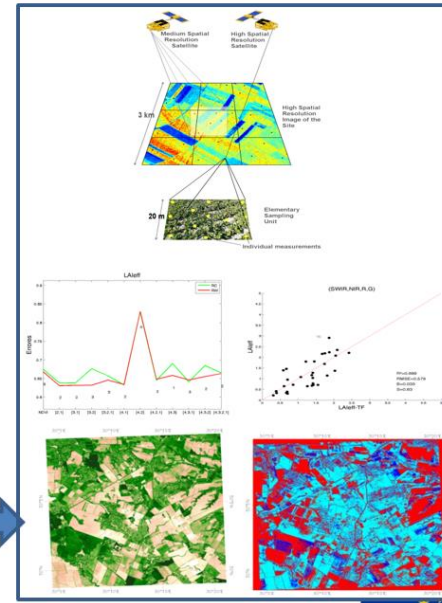


Thematic Scientific Validation: – 1) Exhaustive validation

- *An exhaustive scientific validation is performed every new product version or sensor switch*
- *Global analysis based on international standards and procedures (CEOS LPV) + additional metrics*
- *Validation against fiducial ground references and benchmarking with validated datasets*

Quality Criteria	Product evaluated	Reference Product	Coverage
Completeness	PROBA-V GEOV2	SPOT/VGT GEOV2	Global
	Global maps and temporal evolution of QFLAG Bit 3 (filling method) activation.		
Spatial Consistency	PROBA-V GEOV2 (RT6 and RT0)	SPOT/VGT GEOV2 PROBA-V GEOV1 MODIS C5	Global Sub-continental Regions
	Visual inspection of global maps and sub-continental regions Maps and histograms of residuals (global maps). Percentage of pixels within the uncertainty levels: optimal (GCOS), target and threshold. PDFs of retrievals & histograms of residuals per biome and region (BELMANIP 2.1) Moran Index		
	PROBA-V GEOV2 (all modes)	SPOT/VGT GEOV2 PROBA-V GEOV1 MODIS C5	445 BELMANIP2.1 + DIRECT sites
Temporal Consistency	Qualitative inspection of temporal variations. Histograms of Cross-correlation between GEOV2, GEOV1 and MODIS C5.		
Intra-annual Precision (smoothness)	PROBA-V GEOV2 (all modes)	SPOT/VGT GEOV2 PROBA-V GEOV1 MODIS C5	445 BELMANIP2.1
	Histograms of the smoothness.		
Statistical Analysis (Discrepancies)	PROBA-V GEOV2 (all modes)	SPOT/VGT GEOV2 PROBA-V GEOV1 MODIS C5	445 BELMANIP2.1 + Africa Region (20°X35°)
	Scatter-plots (R ² , RMSE, Bias, Scattering, Major Axis Regression, p-value) per biomes (BELMANIP2.1).		
Accuracy Assessment (Error)	PROBA-V GEOV2 (RT6, RT0) PROBA-V GEOV1 MODIS C5	Ground-based maps	In-situ sites (see section 3.3)
	Scatter-plots, Pearson's coefficient. Root Mean Square Error (RMSE), mean bias (B), major-axis regression (offset, slope), p-value test, percentage of pixels within the GCOS accuracy levels.		

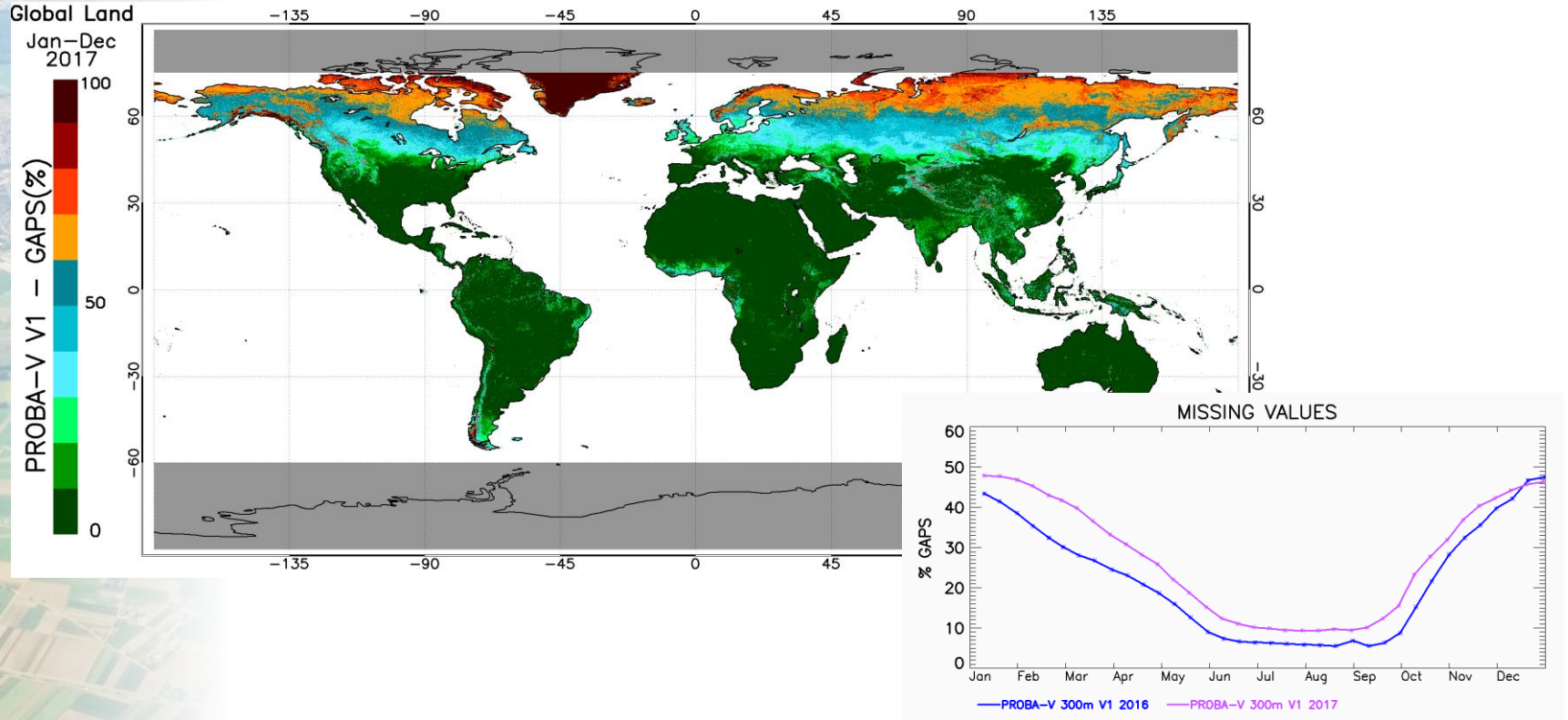
Upscaled ground data





Thematic Scientific Validation: – 1) Exhaustive validation

- *Completeness – gap size spatio-temporal distribution*

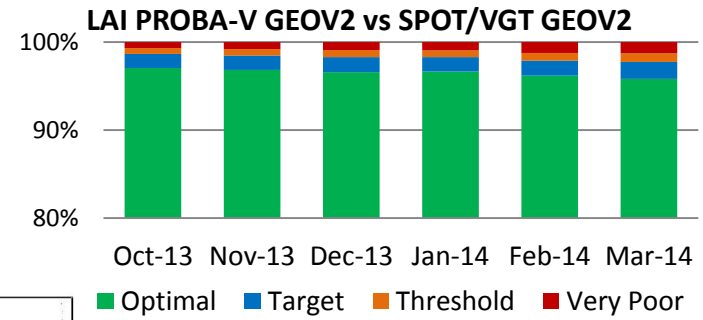
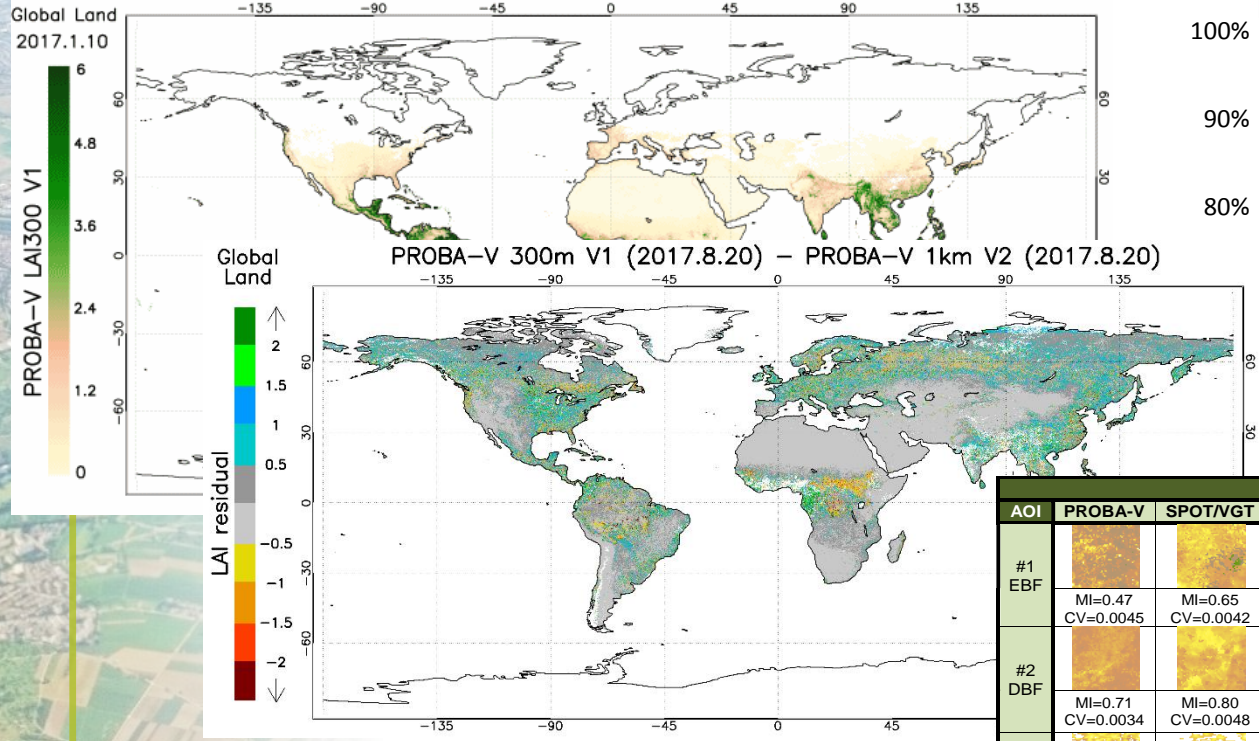




Global Land Operations

Thematic Scientific Validation: – 1) Exhaustive validation

- Spatial consistency – maps, residuals, spatial auto-correlation*



		AL-DH-VI							
		AOI	PROBA-V	SPOT/VGT	MODISC5	AOI	PROBA-V	SPOT/VGT	MODISC5
#1 EBF						#4 Shrub			
		MI=0.47 CV=0.0045	MI=0.65 CV=0.0042	MI=0.52 CV=0.0046	MI=0.76 CV=0.0078		MI=0.87 CV=0.0062	MI=0.86 CV=0.0056	
#2 DBF						#5 Herb.			
		MI=0.71 CV=0.0034	MI=0.80 CV=0.0048	MI=0.70 CV=0.0040	MI=0.57 CV=0.0035		MI=0.87 CV=0.0029	MI=0.81 CV=0.0037	
#3 NLF						#6 BA			
		MI=NaN CV=0.0264	MI=NaN CV=0.0186	MI=NaN CV=0.0306	MI=0.84 CV=0.0055		MI=0.94 CV=0.0048	MI=0.90 CV=0.0036	



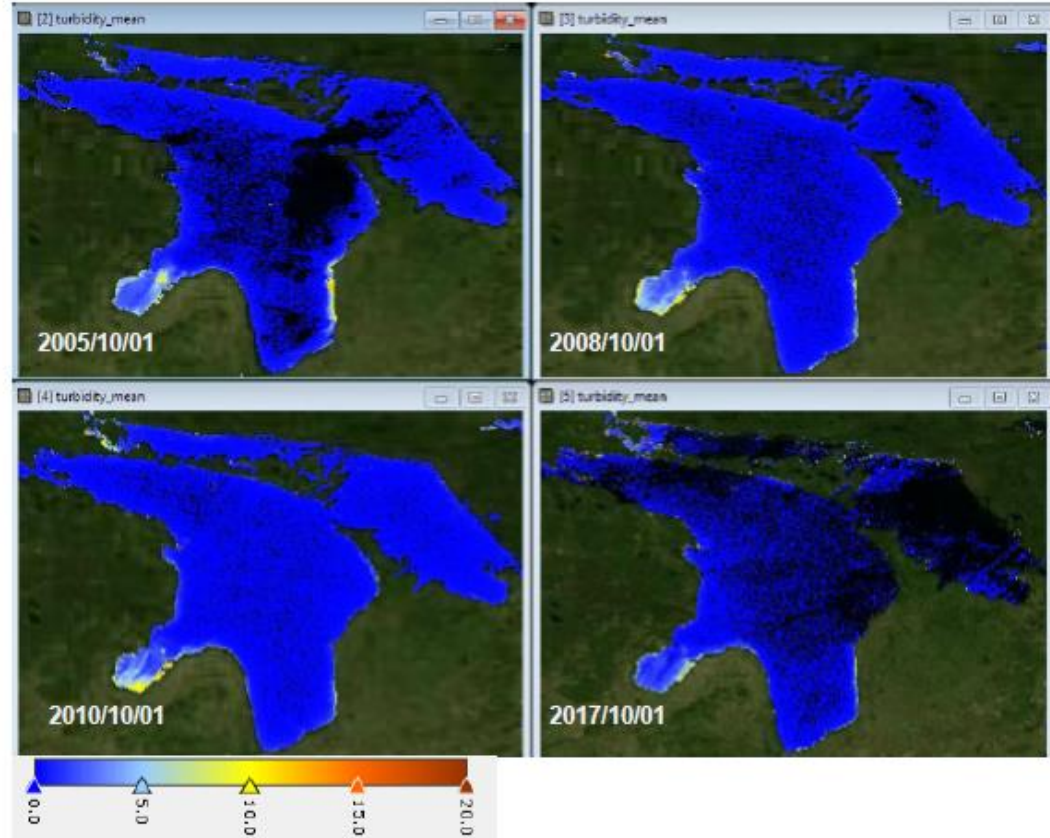
Thematic Scientific Validation: – 1) Exhaustive validation

- *Spatial consistency*

The spatial consistency with other independent datasets is also analyzed.

Here, the Lake Water Quality NRT product (turbidity variable estimated with OLCI over year 2017) is compared to the archive product (estimated with MERIS over years 2005/2008/2010).

Maps show consistent levels and spatial distribution of turbidity over Lake Huron

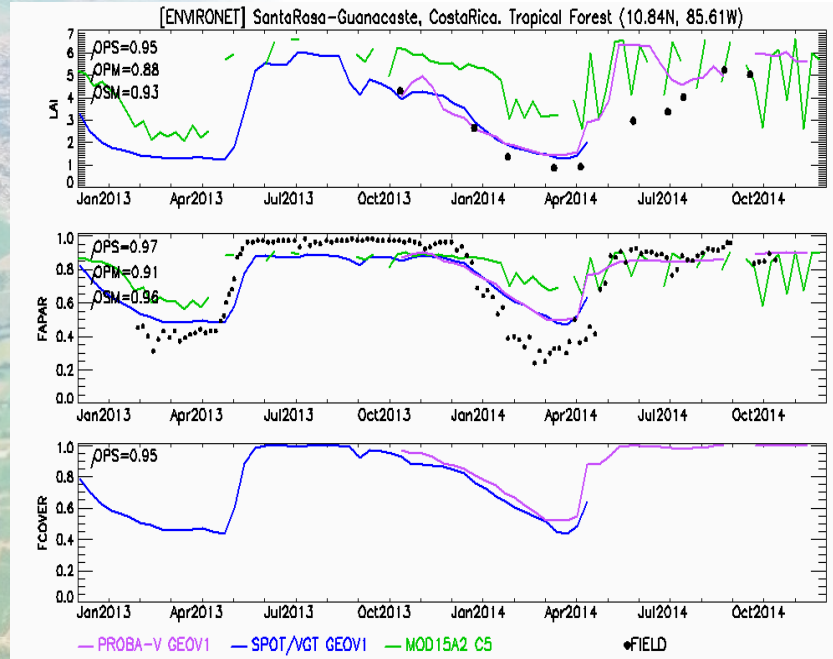




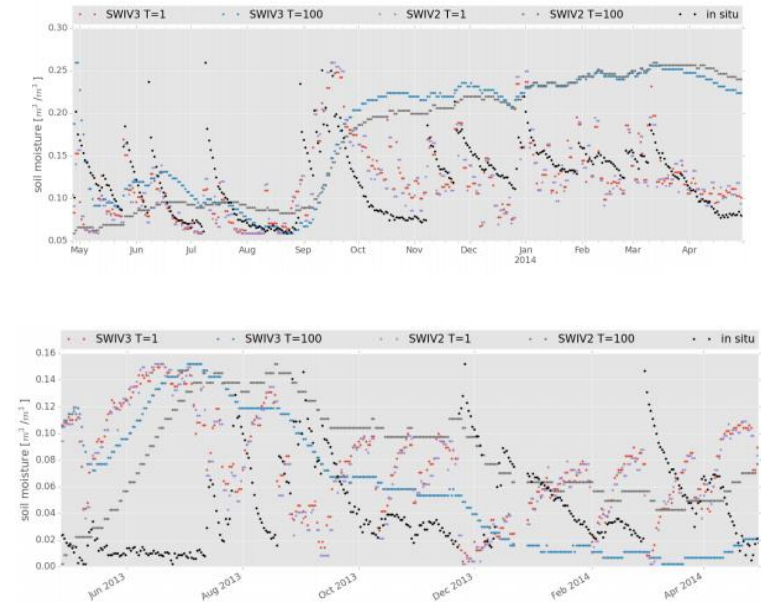
Thematic Scientific Validation: – 1) Exhaustive validation

- *Temporal consistency – analysis over different conditions*

Vegetation



Soil moisture

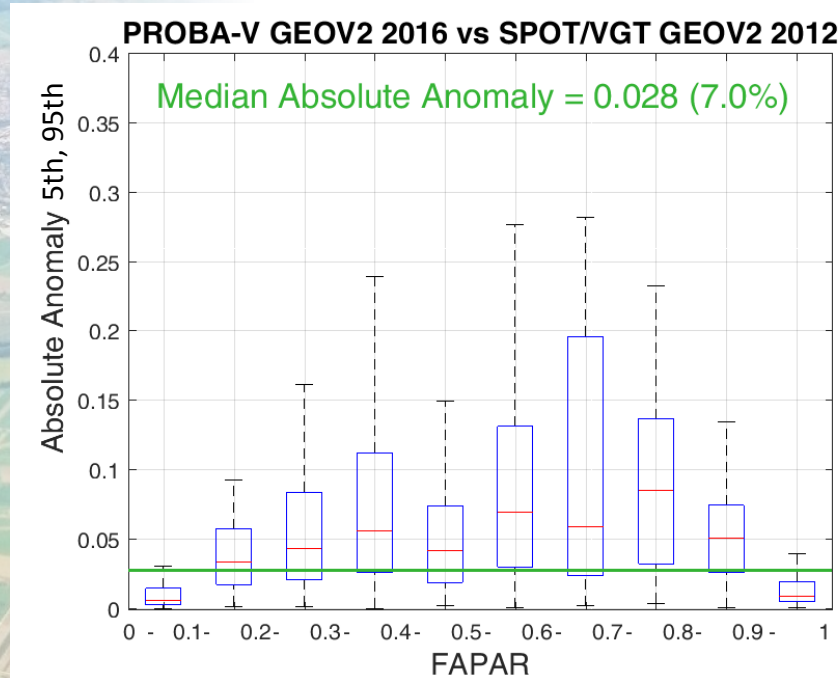




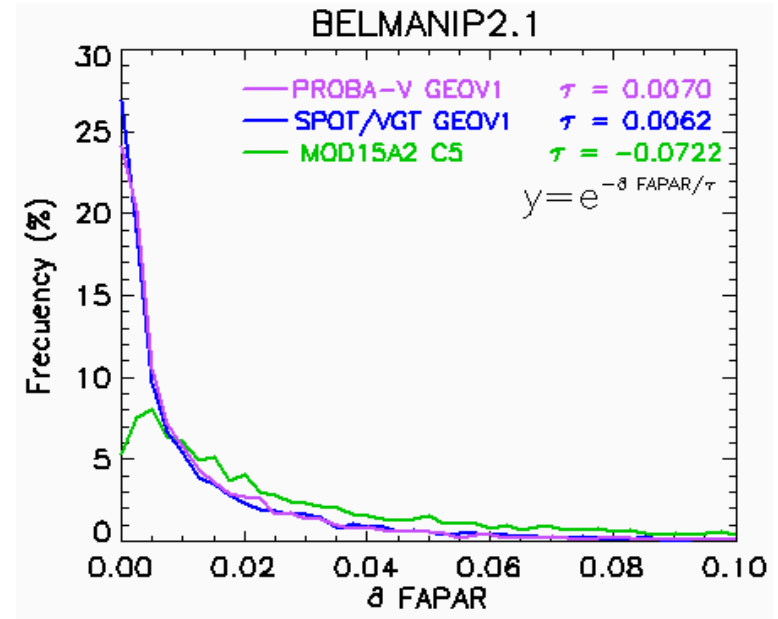
Thematic Scientific Validation: – 1) Exhaustive validation

- *Precision – evaluated over global network of sites*

Inter-annual precision



Intra-annual precision

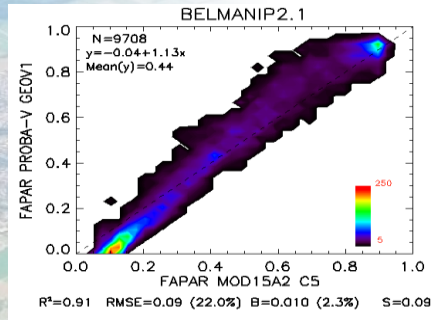




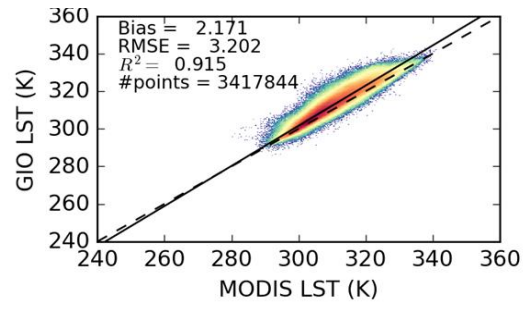
Thematic Scientific Validation: – 1) Exhaustive validation

- Statistical analysis of discrepancies – eg, benchmarking with MODIS

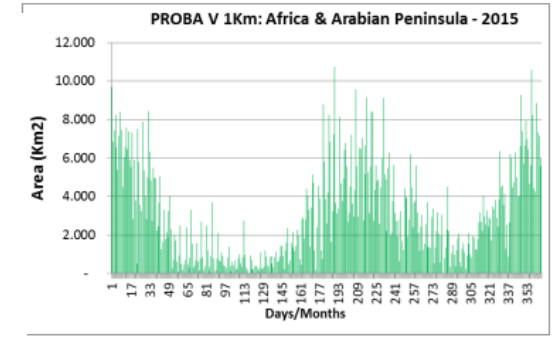
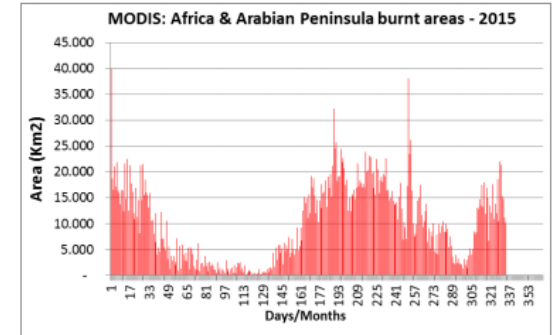
- Over global network of sites



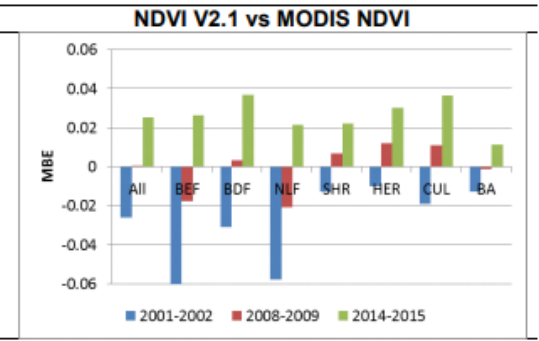
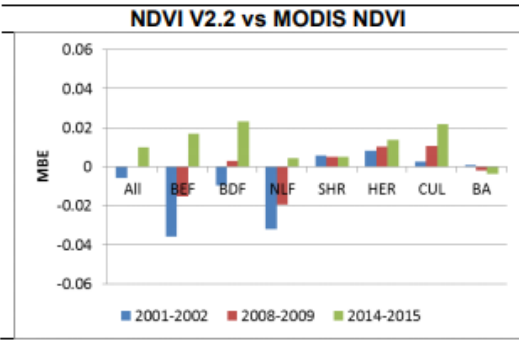
- Per regions



- Per biomes



Burned Areas (daily)

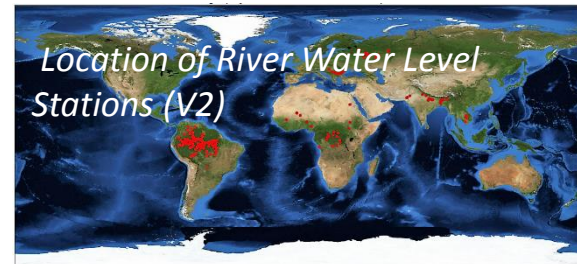
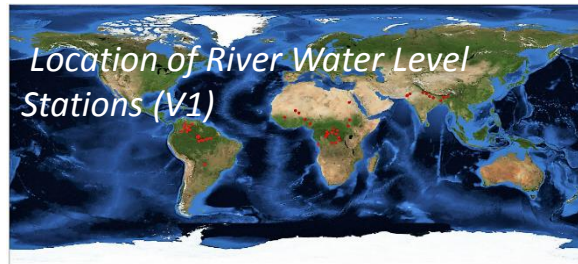
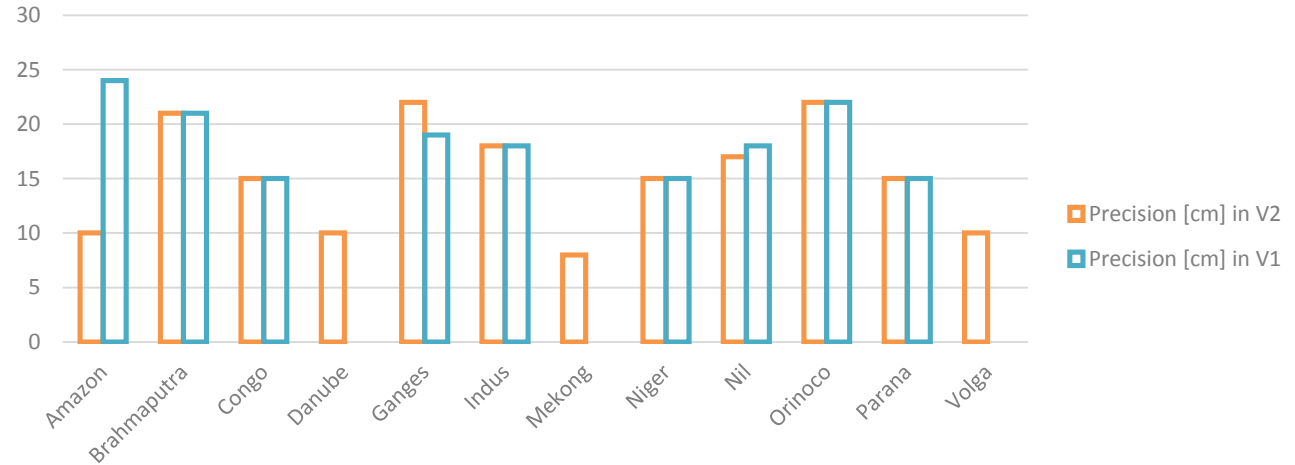




Thematic Scientific Validation: – 1) Exhaustive validation

- *Statistical analysis of discrepancies - Regression testing when a new version of the product is released*

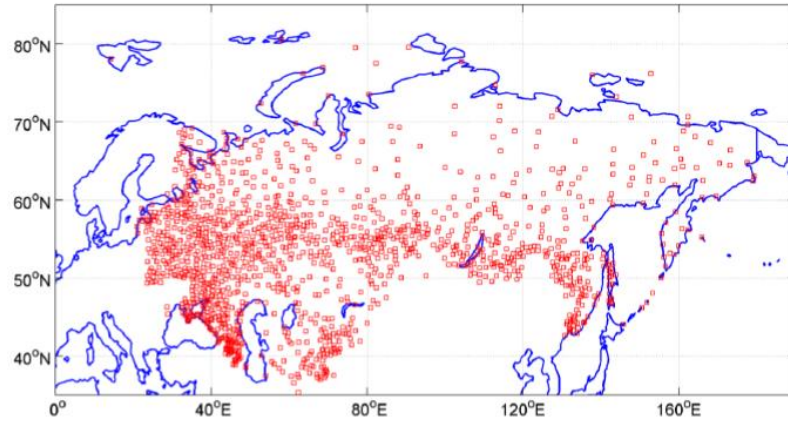
Regression test River Water Level (V1/V2)



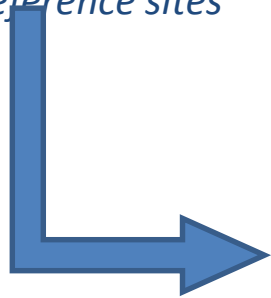


Thematic Scientific Validation: – 1) Exhaustive validation

The snow transect reference data from Russia



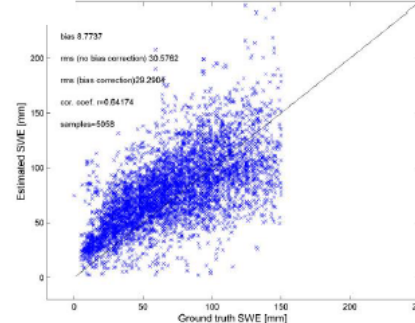
Locations of the Russians Snow transect reference sites



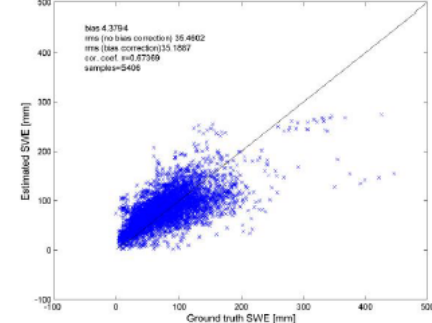
Accuracy assessment – comparison with ground data

Snow Water Equivalent retrieval accuracy for year 2012. Satellite-based SWE retrievals compared with Russian Snow transect data.

Daily SWE accuracy - FMI, all samples, year 2012



Daily SWE accuracy - FMI, all samples, year 2012

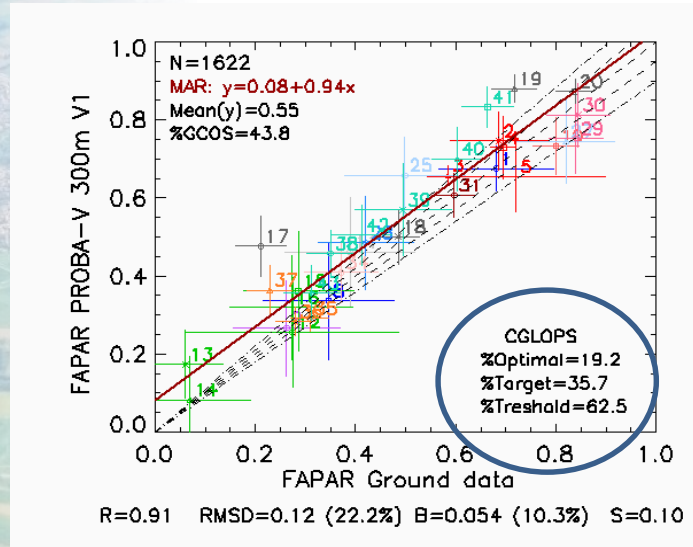


Left panel: SWE retrieval accuracy for SWE values below 150mm shown on the left. Right Panel: accuracy for all samples



Thematic Scientific Validation: – 1) Exhaustive validation

- Accuracy assessment– comparisons with ground references



SWI10 T=1 RMSD in m^3/m^3

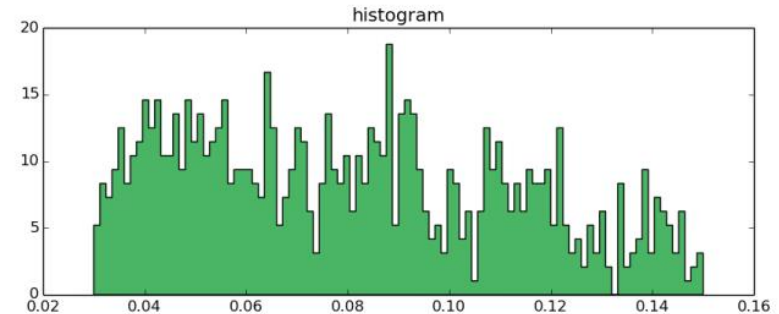
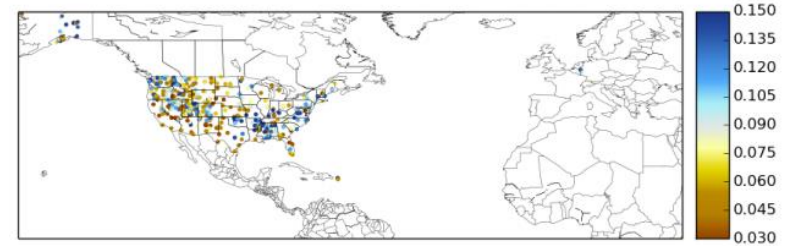


Fig. 38: Map and histogram of RMDS between in situ data and SWI10 for T=1

- Accuracy is evaluated against ground references
- % of cases within user requirements levels quantified
- Need for consistent collection and processing of ground datasets for validation



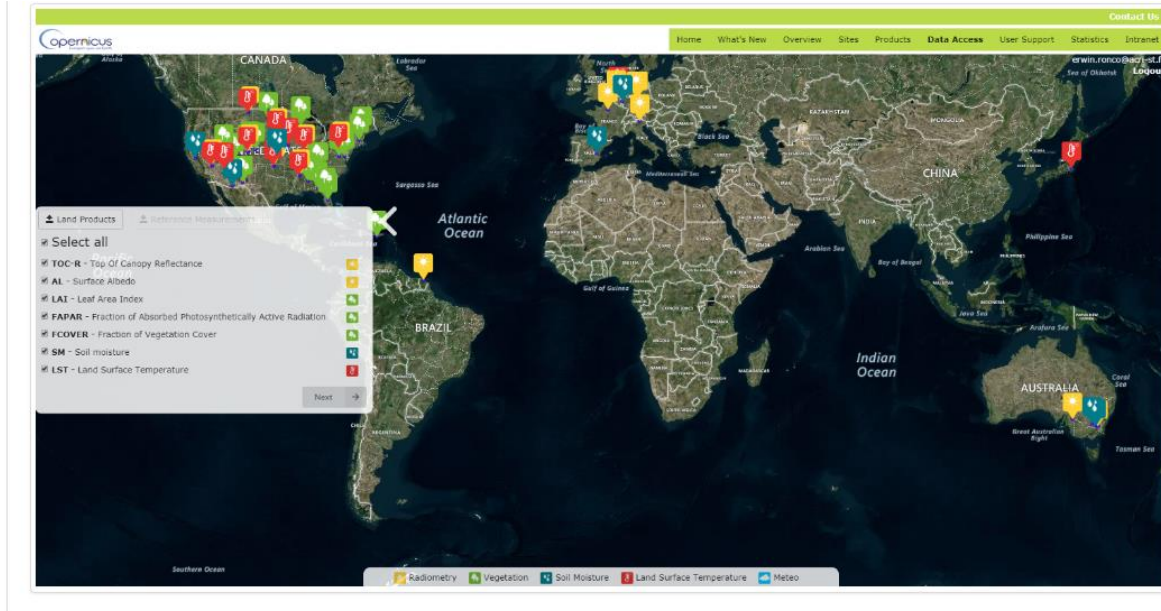


Global Land Service : Ground Based Observation for Validation (GBOV)

The GBOV service provides multiple years of high quality in-situ measurements to validate 7 core land products (Top-of-canopy reflectances, Surface albedo, fAPAR, LAI, fCover, Land Surface Temperature and Soil Moisture).

- Collection of multi-year ground-based observations of high relevance for the understanding of land surface processes from existing global networks (NEON, Fluxnet, TERN...). About 50 core sites are considered.
- Upgrade of existing sites with new instrumentation or establishing new monitoring sites to close thematic or geographic gaps.
- Implementation and maintenance of a database for the distribution of reference measurements (RMs) and the corresponding Land Products (LPs) derived by upscaling processes to match satellite resolutions.

<http://land.copernicus.eu/global/gbov>





Thematic Scientific Validation: – 2) Quality Evaluation (yearly)

• When

- Quarter 1 of each year
- Use products generated during last 12 months

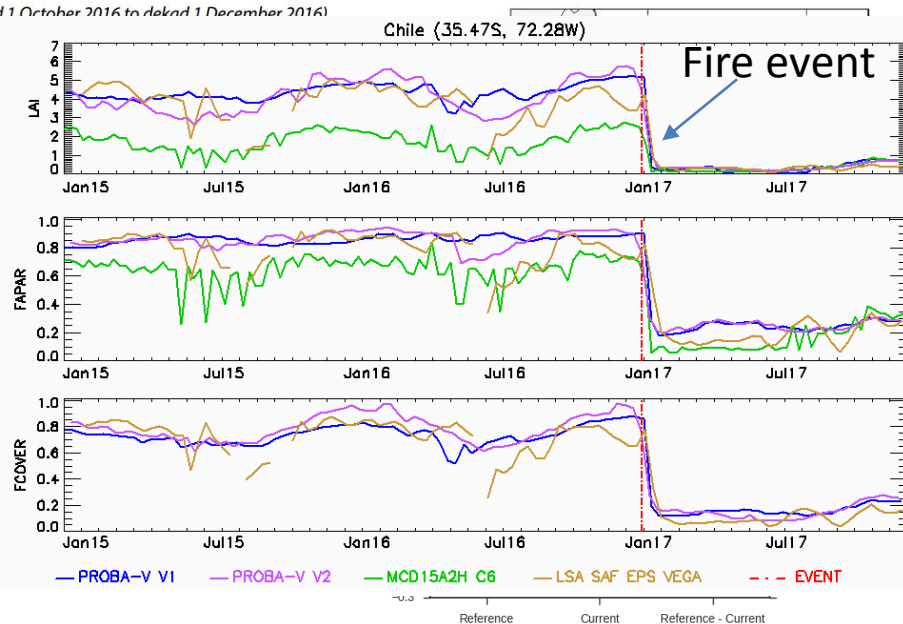
• How

- Against validated references (previous years)
- Specific regions of interest and over identified events (fires, droughts,...)
- Cross-cutting consistency analysis through assimilation

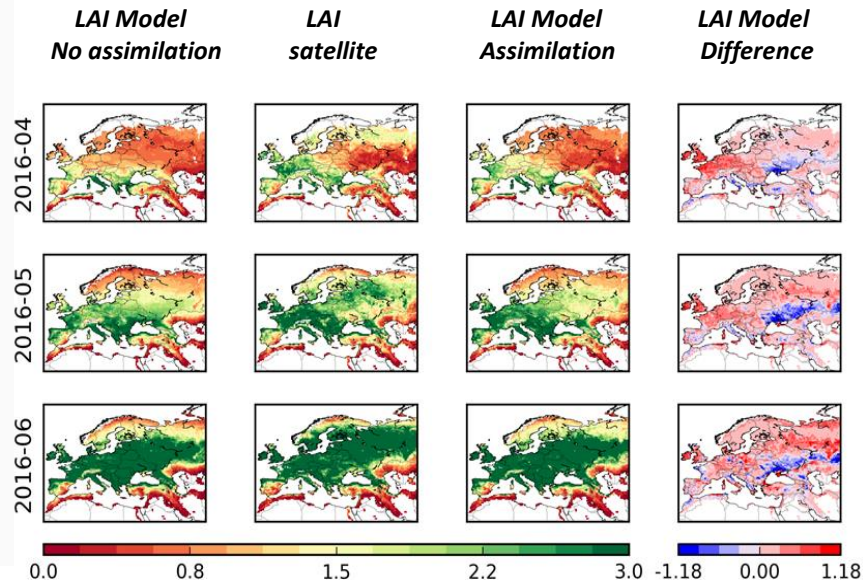
Somalia

(from dekad 1 October 2016 to dekad 1 December 2016)

Regional Analysis



Cross-cutting



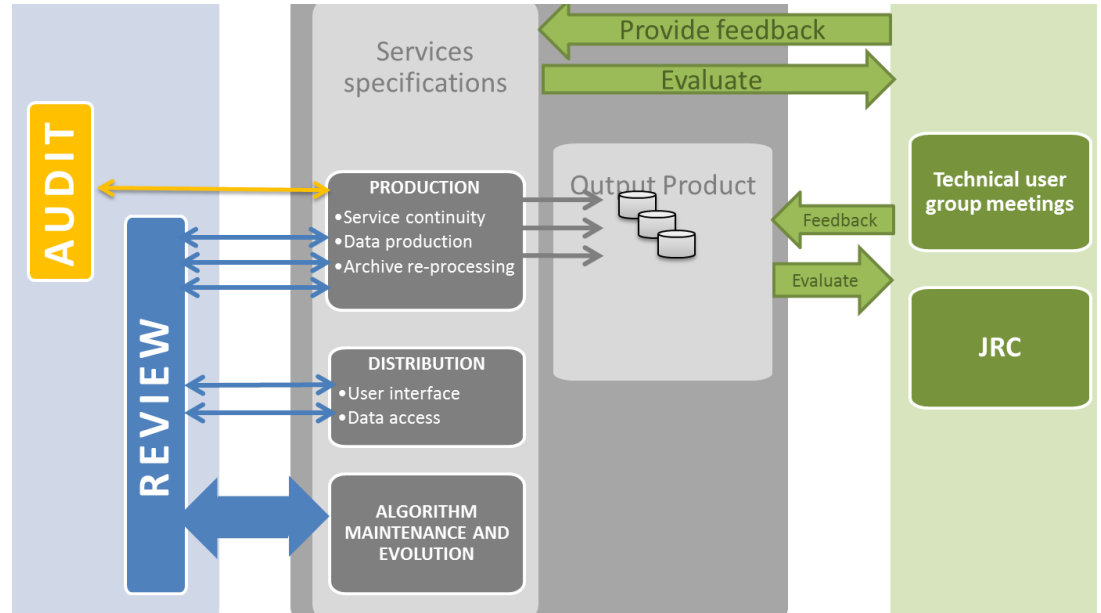


Independent Assessment: External Review

- *All the products, documents and Global Land services are reviewed by an independent panel of experts before deliver it to users.*

Objectives:

- ✓ To verify readiness for operation of the processing chains and the quality of the products.
- ✓ To make recommendation on the status of products and on their evolution.





Summary

- *Global Land Service is a user driven service, as such the collection and gathering of user requirements are crucial for the proper development of the service to satisfy users needs.*
- *Rigorous Quality Assessment procedures are followed before delivering products to Users:*
 - Operational Quality Monitoring to monitor the production system
 - Exhaustive Scientific Validation following international standards (e.g., CEOS LPV)
 - Yearly Quality Evaluation reports focused on specific regions or events.
 - Independent review by panel of experts
- *GBOV service established to provide consistently ground reference for the validation of global land products*
- *User's uptake and feedbacks are the final step of the QA, verifying the usefulness or limitations of the products for their applications.*

Validation reports can be found for each product version at the web site.

<https://land.copernicus.eu/global/documents/products>

Copernicus Global Land Operations – Lot 2
Date Issued: 03.11.2017
Issue: 11.03



Copernicus Global Land Operations
“Vegetation and Energy”
“CGLOPS-2”
Framework Service Contract N° 199496 (JRC)

QUALITY ASSESSMENT REPORT

LAKE WATER QUALITY
300M AND 1KM PRODUCTS
VERSION 1.2.0

Thank you for your attention



Land Monitoring

