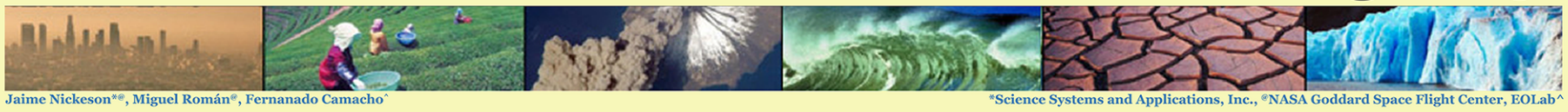
The CEOS Land Product Validation Subgroup



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Mission

To foster and coordinate quantitative validation of *higher level global land products* derived from remotely sensed data in a traceable way, and to relay results so they are relevant to users.

Web Site

https://lpvs.gsfc.nasa.gov

Now with structured information on validation stage, best practices, references, and links to products for each variable.

Organization

LPV Chair: Miguel Román
LPV Vice-Chair: Fernando Camacho
Secretariat: Jaime Nickeson

LPV Focus Area Leaders and Affiliations

Land Cover		Pontus Olofsson Sophie Bontemps	Boston University, USA Université catholique de Louvain, Belgium
Biophysical	LAI	Hongliang Fang Sylvain Leblanc	Chinese Academy of Sciences Natural Resources Canada
	Fapar	Arturo Sánchez-Azofeifa Marie Weiss	University of Alberta, Canada INRA, France
Surface Radiation		Zhuosen Wang Vacant	UMD/Goddard Space Flight Center, USA
Fire		Luigi Boschetti Gareth Roberts Andrew Edwards	University of Idaho, USA University of Southampton, United Kingdom Charles Darwin University, Australia
Soil Moisture		Michael Cosh Carsten Montzka	USDA Beltsville Agricultural Research Center, USA Jülich Research Centre, Germany
LST & Emissivity		Frank Göttsche Pierre Guillevic	Karlsruhe Institute of Technology, Germany UMD/Goddard Space Flight Center, USA
Phenology		Jadu Dash Matthew Jones	University of Southampton, United Kingdom University of Montana, USA
Snow Cover		Thomas Nagler Vacant	ENVEO, Austria
Biomass		Laura Duncansen John Armston Mathias Disney	UMD/Goddard Space Flight Center, USA University of Maryland, USA University College London, United Kingdom
Vegetation Indices		Tomoaki Miura Else Swinnen	University of Hawai'i, USA VITO, Belgium

Goals

To increase the quality and efficiency of global satellite product validation by developing and promoting international standards and protocols for:

- **Field sampling**
- **Scaling techniques**
- **Accuracy reporting**
- **Data & information exchange**

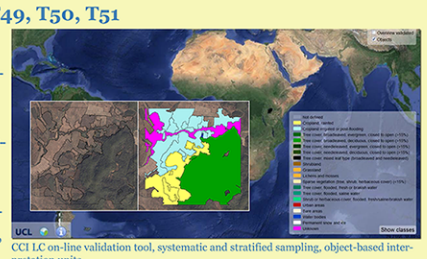
Activities within the LPV Focus Areas

The primary aim of the Focus Areas is to engage the international community in the development of data sets and protocols supporting consistent validation of remote sensing based global land products.

Land Cover

ECV: GCOS IP 2016 - T37, T47, T48, T49, T50, T51

Activities:
- Building global land cover validation dataset compatible with new high resolution land cover (LC) products.
- Providing guidance recommendations pertaining to estimation and validation.
- Harmonization of validation data, metadata, and guidelines for appropriate application of each dataset under development, with training underway.
- Implementation of a CEOS WGCV stage 4 land validation scheme is currently part of the EC Copernicus Global Land Monitoring service.



CCI LC on-line validation tool, systematic and stratified sampling, object-based interpretation units

Protocols and documents:
- Standards for validation and accuracy assessment of regional and global land cover products exists (CEOS, Strahler 2006).
- GFOI Methods & Guidance Document (MGD) - V1 (2014) and V2 (2016) completed, and associated MGD modules in response to needs of SilvaCarbon partner countries.
- Best practices guidelines (Olofsson et al., 2014) for estimation accuracy and area of land cover change.
- Assessing global LC reference datasets for different user communities (Tsendbazar, et al. 2015), and a global crowdsourced LC and land use reference dataset (Fritz et al. 2017).

Datasets:
- Validated ESA CCI global annual 300m LC time series (1992 - 2015) and Copernicus GLS 100m LC have been delivered.

LST & Emissivity

ECV: GCOS IP 2016 - T35, T36, T42, T43, T44, T45, T46

The **CEOS Land Surface Temperature Product Validation Best Practice Protocol** has been published and is available on the LPV subgroup web site.

The **ESA GlobTemperature** project has been completed: comprehensive validation and inter-comparison reports for a broad range of LST products are now available and 16+ data sets in a harmonised data format are provided on the project's data portal. An ESA CCI+ project continuing and extending the work performed within GlobTemperature is due to start in spring 2018.

The ESA FRM4STS project prepared reports on performing fiducial reference measurements (FRM) with thermal infra-red field radiometers. Within the project several near-laboratory as well as field inter-comparison experiments were performed, e.g. an LST experiment in the Namib desert and an Ice Surface Temperature (IST) experiment on Greenland. Documentation and results are available on the project's web site

LST is now an Essential Climate Variable (ECV) and follows a definition jointly prepared by GCOS and the LPV WG on LST&E.

The **MOD21 LST&E** product retrieved with the Temperature-Emissivity Separation (TES) algorithm is now part of MODIS Collection 6. The MOD21 algorithm retrieves LST and spectral emissivity simultaneously and uses full radiative transfer simulations for atmospheric correction and an improved Water Vapor Scaling scheme. Simulation and validation results have shown consistent accuracies at the 1 K level over all land surfaces.

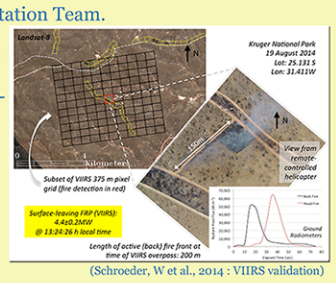
Fire/Burned Area

ECV: GCOS IP 2016 - T35, T36, T60, T61, T62, T63 and T64

'Fire disturbance', which includes burned area, active fire and fire radiative power (FRP), is one of 54 essential climate variables (ECVs) designated by the Global Climate Observing System (GCOS).

Collaboration with GOFC-GOLD Fire Implementation Team.

The standard procedure to generate reference data for Burned Area includes the use of Landsat-class imagery pairs, as described in CEOS LPV best practice guidelines (Boschetti et al. 2009). Cross-tabulation analysis is the most common validation approach, although other patch-level analyses are of interest. Validation studies indicate that moderate spatial resolution burned area products can have large commission and omission errors; particularly in areas dominated by small fires.



(Schroeder, W et al., 2014 : VIIRS validation)

A fire disturbance ECV effort – the ESA Climate Change Initiative (CCI) is now in Phase II. The validation protocol and the CCI product validation results are available.

Efforts are underway to develop a validation protocol for active fire and FRP. FRP measurements from a number of satellite sensors (e.g. MODIS, VIIRS) have been carried out in large field campaigns (e.g. RxCADRE) and in ongoing projects to validate recently launched sensors (e.g. SLSTR).

Snow Cover

ECV: GCOS IP 2016 - T28, T29

ESA's SnowPEx intercompared and validated hemispheric and global satellite snow products for accuracy assessment applying community agreed protocols. It also reveals significant differences of the various products in monthly snow extent trends.

MODIS Collection 6 shows significant improvement in snow cover in mountainous regions, VIIRS Snow Cover products are now available.

GLOBLAND - Copernicus Global Land Service of the Land Monitoring Core Service generates daily snow extent product from medium resolution optical sensors and snow water equivalent products from passive microwave data (by FMI, ENVEO, SYKE).

Within ESA, the Scientific Exploitation of Operational Missions (SEOM) Sentintel-1 Snow project (PI: ENVEO) fractional snow extent and snow melt state from combined Sentinel-1 SAR and optical satellite data are in development, prototype products covering Europe are currently being evaluated.

Vegetation Indices

Essential Biodiversity Variable (GeoBON)

Vegetation Index (VI) was one of two Focus Areas established within LPV in 2016.

The VI focus area held a workshop that first year in conjunction with the Phenology focus area, in Fort Collins, CO.

The goal of this VI focus area is to establish a set of community-wide, peer-reviewed protocol recommendations for validating and inter-comparing satellite VI products.

The following components are identified as those that define VI uncertainty and, thus, that satisfy the user needs:

1) Uncertainty of VIs in their units;
2) Characterization of VI value changes with respect to changes in actual vegeta tion condition (biophysical and/or physiological);
3) Long-term stability of VI products

The focus area plans to convene a workshop in 2018 to obtain inputs and feedback on the draft framework from the wider scientific community working with VIs.

Above Ground Biomass

ECV: GCOS IP 2016 - T36, T52, T53, T54, T55, T56

Biomass was one of two new Focus Area formed in response to a CEOS Carbon Action included in their Strategy for Carbon Observations from Space. With several upcoming missions addressing carbon on the near horizon, this group is helping to coordinate the cal/val stragegy for above ground biomass.

The leads for the Biomass Focus Area have fully engaged their community and have recruited a writing team that have already begun crafting a draft of the protocol document for above ground biomass (AGB). This protocol addresses a) generation of field-based reference datasets, b) spatial and temporal linkage of field datasets to airborne or spaceborne data, c) error propagation, d) validation and reporting, e) utility for modeling, policy and non-forests communities, f) considerations for biomass change, and g) knowledge and data gaps.

The group is also working with NASA EOSDIS on building a **Multi-Mission Analysis Platform** that will foster AGB products, as well as field and airborne validation datasets.

Biophysical (LAI and fAPAR)

ECV: GCOS IP 2016 - T35, T36, T37, T40, T41

Good practices guidelines for the validation of leaf area index (LAI) products has been published and is availalbe on the LPV Web site
https://lpvs.gsfc.nasa.gov/documents.html

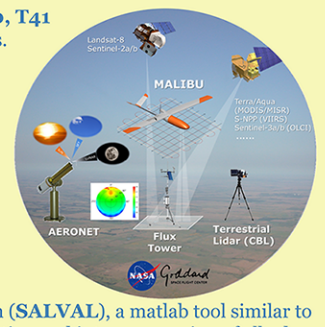
Guidelines for the validation of the Fraction of Absorbed Photosynthetically Active Radiation (fAPAR) is being written is currently being developed.

The IMAGINES database that gathers 52 LAI and fAPAR ground measurement campaigns from 2013 to 2015 is available to the community (http://fp7-imagines.eu).

ESA has established a S3VT (Sentinel 3 validation team) that has conducted multiple team meetings on validation efforts. Currently, the team is working to launch FRM4VEG (Fiducial Reference Measurements for Vegetation), an initiative aiming at developing **protocols for fiducial references** and a network of sites to ensure a comprehensive and long-term validation. The LPV fAPAR focus area will be engaged with the S3 validation team in its efforts.

Surface Radiation

ECV: GCOS IP 2016 - T35, T36, T38, T39, T40, T41
Currently focusing on Land Surface Albedo products.



Collaborating on validation efforts for:

MODIS – Collection 6 for BRDF/albedo are now available for 2000 to present

VIIRS – Albedo has reached validation Stage 3 maturity. The product will be available from early 2018

Landsat-MODIS – Production of a new merged albedo product is underway

EOLAB has developed the Surface Albedo Validation (**SALVAL**), a matlab tool similar to **OLIVE** that allows to perform a standardized validation and intercomparsion of albedo products.

Best Practices
The Multi AngLe Imaging Bidirectional Reflectance Distribution Function small-UAS (MALIBU) platform acquires extremely high resolution sub-meter measures of surface anisotropy and surface albedo, and is an important resource for generating reference data to improve land surface reflectance and albedo product validation efforts, and resolve the uncertainties in the various existing products. We are working to support and standardize validation procedures for existing and emerging products..

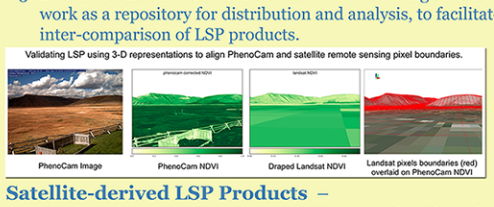
Land Surface Phenology (LSP)

Essential Biodiversity Variable (GeoBON)

Developing methods to quantify uncertainty in satellite, near-surface, and ground phenology measurements.

Held the 4th International Phenology Validation Workshop, in late 2016, at the USGS in Fort Collins, CO, USA, where we developed action items to advance the validation of satellite land surface phenology (LSP) metrics.

1. Analyze sites that contain both flux tower and phenology camera data, and identify or rank the sites that contain representative phenology ground observations (e.g., camera footprint data and observations in close proximity with common plant functional types).
2. Conduct a full analysis of these potential sites. Publish in peer-reviewed literature. The result will identify 15-30 sites for direct comparison of ground, phenology camera, and satellite phenology metrics.
3. Establish a LSP Validation Database of the resulting sites for validation, using LPV frame work as a repository for distribution and analysis, to facilitate a dedicated effort for global inter-comparison of LSP products.



The graphics were provided by Colin Talbert, Geneva Chong, Eric Cole, Brian Miller, Jeff Morisette, and Andrew Richardson; USGS and North Central Climate Science Center.

Satellite-derived LSP Products –
- MODIS (MCD12Q2, VIP, USGS RSP, Australia Phenology, NASA GSFC), AVHRR (VIP)

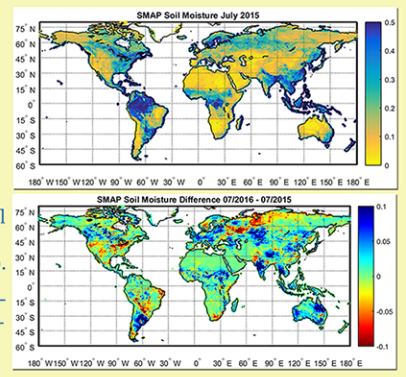
Near Surface Remote Sensing Networks –
- Phenological Eyes Network (Asia), PhenoCam & NEON (USA), SPECNET (Lund Univ)

In situ Phenology Observation Networks –
- See the Global Alliance of Phenological Observation Networks (GAPON) at **www.usanpn.org/partner/gapon**

Soil Moisture

ECV: GCOS IP 2016 - T15, T16, T17, T18

Four current satellites instruments (ASCAT, ASMR2, SMAP, SMOS) produce global near daily soil moisture estimates and two more missions (W-COM, SAOCOM) are planned for the near future.



After the failure of the NASA SMAP radar, dual frequency L-/C-band combination of SMAP radiometer data with ESA Sentinel-1 SAR data provides high resolution (3km) soil moisture retrievals. Data are available at the National Snow and Ice Data Center (NSIDC).

The **ESA Climate Change Initiative** combines microwave remote sensing data to provide a global soil moisture time series from 1978 to 2016.

ESA extended funding for the **International Soil Moisture Network (ISMN)**, which hosts over 2000 monitoring stations within more than 55 different networks worldwide.

The Committee on Earth Observation Satellites coordinates civil space-borne observations of the Earth. Participating agencies strive to enhance international coordination and data exchange and to optimize societal benefit. Currently 28 space agencies along with 20 other national and international organizations participate in CEOS planning and activities.

EOLAB
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