SURFACE ALBEDO VALIDATION TOOL

USER GUIDE

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LIST OF ACRONYMS

AL	Albedo
API	Application Programming Interface
APU	Accuracy Precision and Uncertainty
B	Bias
BA	Bare Areas
BB	Broadband
BQ	Best Quality
BRDF	Bidirectional Reflectance Distribution Function
BH	Bi-Hemispherical
BSA	Black Sky Albedo
C3S	Climate Change Service
CEOS	Committee on Earth Observation Satellites
CGLS	Copernicus Global Land Services
CNES	Centre National D'Études Spatiales
CUL	Cultivated
DBF	Deciduous Broadleaved Forest
DH	Directional-Hemispheric
DOY	Day Of Year
EBF	Evergreen Broadleaved Forest
ECV	Essential Climate Variable
ESA	European Space Agency
ESRL	Earth System Research Laboratory
FOV	Field of view
GBOV	Ground-Based Observations for Validation
GCOS	Global Climate Observation System
GLC	Global Land Cover
GSD	Ground Sampling Distance
HER	Herbaceous
KPI	Key Performance Indicator
LANDVAL	Land Validation
LPV	Land Product Validation
MAD	Median Absolute Deviation
MAE	Median Absolute Error
MAR	Major Axis Regression
MD	Median Deviation

NARMA	Non-linear Autoregressive-Moving Average
NASA	National Aeronautics and Space Administration
NIR	Near Infra-Red
NLF	Needle-Leaf Forest
OF	Other Forest
PBV	PROBA-V
PDF	Probability Density Function
QA4ECV	Quality Assurance For Essential Climate Variable
QA4EO	Quality Assurance framework for Earth Observation
RCV	Relative Coefficient of Variation
REALS	Representativeness Evaluated Albedo Stations
RMSD	Root Mean Square Deviation
RSE	Scale Requirement Index
RST	Relative Strength of spatial correlation
RSV	Relative proportion of Structural Variation
S2	Sentinel-2
S3	Sentinel-3
SALVAL	Surface Albedo Validation
SAVS	Surface Albedo Validation Sites
SBA	Sparse and Bare Areas
SHR	Shrublands
ST	Standard Score
STD	Standard Deviation
UNFCCC	United Nations Framework Convention on Climate Change
VGT	Vegetation
VIS	Visible
WGCV	Working Group on Calibration and Validation
WMO	World Meteorological Organization
WSA	White-Sky Albedo

1. BACKGROUND OF THE DOCUMENT

1.1. EXECUTIVE SUMMARY

The surface albedo is the dimensionless ratio of the flux of solar radiation reflected by the Earth in all directions and the incoming irradiance. It is an essential climatic variable defined by the Global Climate Observing System (GCOS) and a variable with great importance in applications related to climatology and other fields as astronomy and environmental management. The validation of climatic series of albedo is, therefore, fundamental to evaluate the uncertainties of the products that offer albedo values. Surface Albedo Validation (SALVAL) is a tool that allows the validation of global surface albedo products, automating the validation process, as well as improving traceability and providing transparency in the methodology used for such purposes. The validation methodology is based on the international protocols and standards defined by the Land Product Validation working group of the Committee on Earth Observation Satellites (CEOS-LPV) and by the Quality Assurance framework for Earth Observation (QA4EO). Through the implementation of the validation methodology, the tool allows evaluating different criteria, such as product integrity, temporal and spatial consistency, statistical agreement with other similar products, precision, stability and accuracy by comparison with independent measures in situ, among others. The tool has been implemented through a web design to facilitate access to users.

1.2. CONTENT OF THE DOCUMENT

This document is structured as follows:

- Chapter 2 provides an introduction to the albedo, satellite albedo database, ground base database and validation parts and methodology.
- Chapter 3 provides information on how to configure the tool for validate albedo.
- Chapter 4 provides information on how to explore results of the validation.

2. INTRODUCTION

2.1. ALBEDO DEFINITION

Albedo is defined as “the radiation of light reflected from a particle, a planet or a satellite, with an incident light”. From the physical point of view, the surface albedo is the non-dimensional relationship between the radiation flux reflected by the Earth in all directions and the incoming irradiance. Surface albedo variations are due to many factors, among which are exogenous and endogenic variations due to continental drift and environmental variations. In addition, climatic variations due to human activities (industrial activity, use of fossil fuels, etc.) are superimposed on the last variations.

Measuring albedo changes across the Earth's surface and over time is essential to be able to track and monitor the Earth in a quantitative way. The albedo provides information of the solar radiation absorbed by the earth, environmental variations (snow, floods, fires, etc.) and the phenology of crops, among others. For example, in snowy areas such as at the poles, the albedo is very high because snow and ice reflect much of the solar radiation. On the contrary, in forests the albedo is low because the green color absorbs most of the solar radiation. Albedo also influences global warming and climate change, because as the polar ice caps melt, where most of the radiation is reflected to outer space, the absorption rate of the seas increases and therefore the earth's temperature. For all of these reasons albedo is an Essential Climate Variable (ECV) defined by the GCOS, as well as a biophysical variable of great interest in climatology, astronomy and environmental management.

2.2. ALBEDO SATELLITE PRODUCTS INCLUDED IN SALVAL TOOL

This section describes the main satellite-derived albedo products that will be included in the SALVAL validation tool. The satellite sensors provide black-sky albedo (BSA or AL-DH) and white-sky albedo (WSA or AL-BH) in the broadband or shortwave (BB), visible (VIS) and near infra-red (NIR) spectral regions, so there are a total of six different bands:

- AL-DH-BB (Albedo Directional-Hemispherical Broadband).
- AL-DH-VI (Albedo Directional-Hemispherical VISible).
- AL-DH-NI (Albedo Directional-Hemispherical Near-Infrared).
- AL-BH-BB (Albedo Bi-Hemispherical Broadband).
- AL-BH-VI (Albedo Bi-Hemispherical VISible).
- AL-BN-NI (Albedo Bi-Hemispherical Near-Infrared).

The products introduced in the SALVAL validation tool are listed in Table 1. They were previously reprojected to common spatial sampling grid (i.e., Plate Carrée projection).

Table 1: Main features of the surface albedo products included in the SALVAL validation tool. GSD stands for Ground Sampling Distance.

CODE	Product	Satellite/ Sensor	GSD	Frequency	Composite period	Coverage/ Projeciton
MCD43A3_C6	NASA / MCD43A3 C6	TERRA+AQUA /MODIS	500m	Daily	16 days	Global /Sinusoidal
MCD43A3_C61	NASA / MCD43A3 C61	TERRA+AQUA /MODIS	500m	Daily	16 days	Global /Sinusoidal
GlobAlbedo	ESA / GlobAlbedo	SPOT/ VEGETATION ENVISAT/MERIS& AATSR	1km	8 days	16 days	Global /Sinusoidal
C3S_S3_V3	C3S / Sentinel-3 V3	SENTINEL-3/ OLCI+SLSTR	300m	10 days	20 days	Global /Plate Carrée
C3S_PBV_V2	C3S / PROBA-V SA V2	PROBA / VEGETATION	1km	10 days	20 days	Global /Plate Carrée
C3S_VGT_V2	C3S / SPOT/VGT SA V2	SPOT / VEGETATION	1km	10 days	20 days	Global /Plate Carrée
C3S_PBV_V1	C3S / PROBA-V SA V1	PROBA / VEGETATION	1km	10 days	30 days	Global /Plate Carrée
C3S_VGT_V1	C3S / SPOT/VGT SA V1	SPOT / VEGETATION	1km	10 days	20 days	Global /Plate Carrée
CGLS_VGT_V1	GLS / SPOT/VGT SA V1	SPOT / VEGETATION	1km	10 days	30 days	Global /Plate Carrée
GLASS	GLASS V4	TERRA+AQUA /MODIS	1km	8 days	16 days	Global /Sinusoidal

2.2.1. Quality flags used for best quality retrievals

The following Quality Flag information was used to filter pixels flagged as low quality. For C3S PROBA-V SA v1.0 and CGLS SPOT/VGT v1.0 products, land pixels showing input status out of range or invalid or saturated in B2 and B0 channels were discarded. In case of C3S PROBA-V and SPOT/VGT SA v2.0 and C3S SPOT/VGT SA v1.0, pixels where algorithm failed were not considered in the validation exercise. Additionally, the uncertainty (ERR) and AGE ancillary layers were used, and pixels with uncertainty greater than 0.2 and AGE greater than 30 were discarded. In case of MODIS C6, pixels with best quality (i.e., magnitude inversion with number of valid observations of at least 7 days) and good quality (full inversion) were considered for the re-sampling over C3S spatial grid. For Sentinel-3 and GlobAlbedo, any quality flag information was used.

Table 2: Quality flag information used for discarding low quality retrievals.

Product	Quality Control used to discard pixels in the statistical analysis
C3S PBV V2 C3S VGT V2 C3S VGT V1	Sea and continental water (bits 0-1 of QFLAG) Algorithm Failed (bit 6 of QFLAG) ERR>0.2 AGE>30
C3S PBV V1 CGLS VGT V1	Sea (bit 1) Input status out of range or invalid (bit 6) B2 saturated (bit 10) B0 saturated (bit 11)
MCD43A3 C6	BRDF_Albedo_Band_Quality_Band1-7: Magnitude inversion (number of observations lower than 7)

2.3. LANDVAL

LANDVAL is a network of coordinates representatives of the different biome types that can be found globally distributed. It is used as sampling in the intercomparison analysis. The main objective of LANDVAL was to create a network with equitable distribution in types of biomes and locations (Fuster et al., 2020).

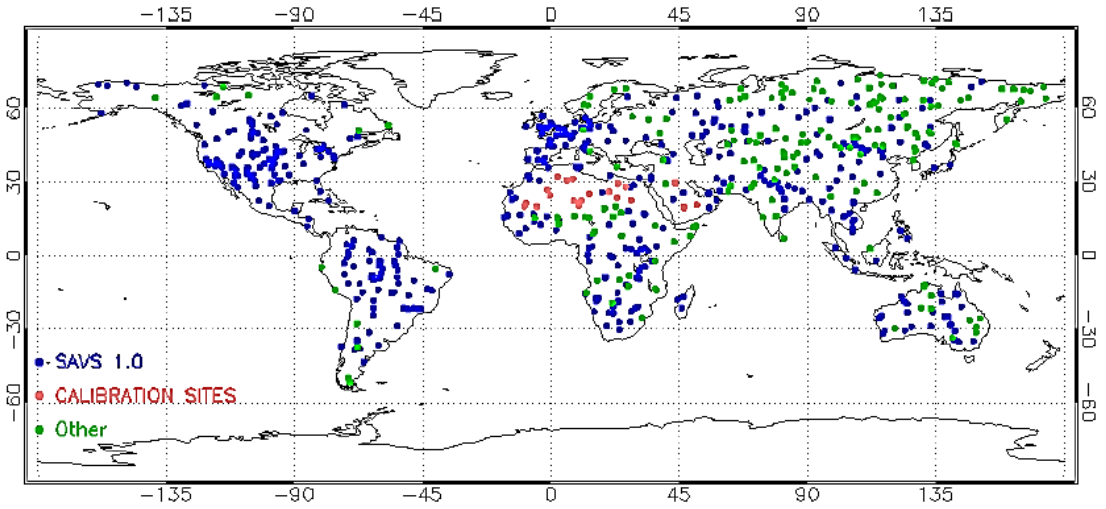


Figure 1: Global distribution of LANDVAL network.

The LANDVAL network coordinates have been classified using the Global Land Cover 2000 (GLC-2000), with a resolution of 1km. The main biomes are classified into Evergreen Broadleaf Forest (EBF), Deciduous Broadleaf Forest (DBF), Needle-Leaf Forest (NLF), Shrublands (Shrubs), Herbaceous (Herbs), Croplands, and Bare Areas. It currently has 720 places or sites:

- 521 sites come from the Surface Albedo Validation Sites (SAVS) 1.0 network (Loew, et al., 2016). This network was defined within the framework of the Quality Assurance for Essential Climate Variable (QA4ECV) project.

- 20 sites come from desert locations (Sahara and Arabia) that are known to have great temporal stability. These 20 sites are used by the Center National D'Etudes Spatiales (CNES) for the calibration of remote sensing sensors. They were added to increase the network over desert areas and in the African region, where the number of samples was less than in the rest.

- 184 sites come from other networks such as ImagineS, AsiaFlux, NARMA or OZflux) in order to cover areas (Asia, Africa and Oceania) and types of biomes (Shrub, DBF and NLF) with a lower number of samples.

The LANDVAL V1.1 deletes some repeated sites and renames others from the original version. The LANDVAL V1.1 coordinates are summarized in Annex I.

2.4. GROUND DATA

In order to perform the direct validation analysis, a representative network of in situ data is required. In order to compare in-situ data with satellite data, it is very important which in-situ measurements were homogeneous spatially or representative.

2.4.1. REALS (Representativeness Evaluated Albedo Stations)

Representativeness Evaluated Albedo Stations (REALS) is a network of sites that collect measurements in situ, defined for the direct validation of satellite-derived albedo products. The network has been defined as combination of 99 sites in the period 2000-2020 that come from other networks as can be Ground-Based Observations for Validation (GBOV) of the Copernicus GLS group, Flux Network (FLUXNET), the National Science Foundation's National Ecological Observatory Network (NEON), European Fluxes Database Cluster (EFDC), Integrated Carbon Observation System (ICOS) and Australia's Land Ecosystem Observatory or Terrestrial Ecosystem (TERN). Some of the sites (23/99) are considered SuperSites in terms of representativeness according to the CEOS LPV subgroup. Annex II summarizes the main features of the REALS network.

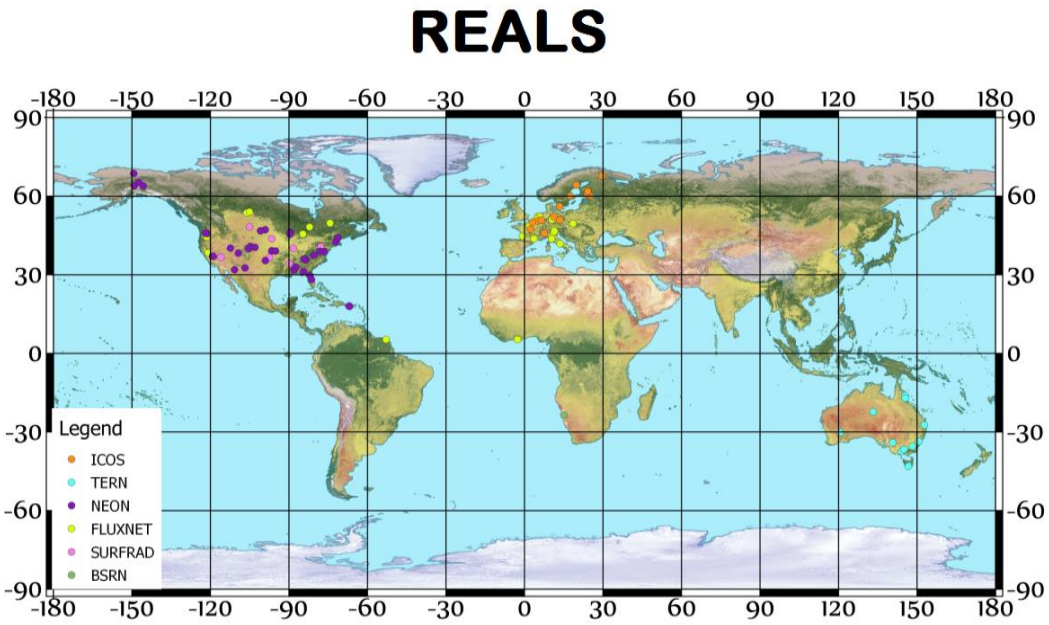


Figure 2: REALS data distribution of sites according to the networks.

2.4.2. Spatial representativeness of REALS

The albedo measured from a tower covers a circular footprint that varies according to the height of the tower. It is very difficult to match this footprint with the pixel size of a satellite derived measure. It is for this reason because it is very important that the site were homogeneous to make the in situ measurement comparable to the satellite based measurement. The representativeness of the in-situ measurements depends on the heterogeneity of the land surface. It is for this reason that the semivariogram is proposed as an estimate of the spatial representativeness of a terrestrial surface. The semivariograms must be estimated with satellite data with a spatial resolution of at least 30 m in different periods of the year. The semivariogram is defined as (Hohn, 1991; Matheron, 1963).

The methodology adopted for the evaluation of the representativeness of the sites is based on the estimation of the spherical semivariogram for different spatial resolutions (1 km^2, 1.5 km^2 and 3km^2). When the semivariogram has been estimated, geostatistical indexs are calculated in order to quantify the level of representativeness of a site. The indices used are the following (Román et al., 2009):

- Relative Coefficient of Variation (R_{CV}): Quantifies the relative dispersion in the data as estimation of the overall spatial variability regardless of the spatial scale being used.
- Scale Requirements Index (R_{SE}): Evaluates the range of the variogram using two spatial thresholds with respect to the actual spatial extent of a site.
- Relative strength of spatial correlation (R_{ST}): It is an indicator of the upward slope of the standardized semivariogram. This indicator provides information on surface albedo changes over short distances.
- Relative proportion of structural variation (R_{SV}): It is an indicator that describes the amount of spatial variability and allows finding artifacts at distances smaller than the range (Li & Reynolds, 1995).

The combination of the four geostatistical indices results in the Standar Score (ST) used as indicator of the representativeness in REALS. The RSE is used as main representativeness marker and the rest as secondary markers.

$$ST = \left(\frac{|R_{CV}|+|R_{ST}|+|R_{SV}|}{3} + R_{SE}\right)^{-1} \quad (2.1)$$

The ST score is directly proportional to the representativeness or homogeneity of a site, so higher score means that a ground site (points) is more suitable to be comparable to satellite-based measurements (pixels).

The spatial representativeness is estimated for each site of the REALS network in different temporal conditions (leaf-off season and leaf-on season) using high resolution images of Sentinel-2. The Figure 3 shows an example of variogram fitting and ST estimation over two different sites of the REALS network, Desert Rock (DRAK) and Talladega National Forest (TALL). These results show more homogeneity or spatial representativeness in case of TALL (ST=8) in the leaf-on period than in DRAK one-season (ST=0.96). Annex III describes the standard score (ST) summary of the REALS network.

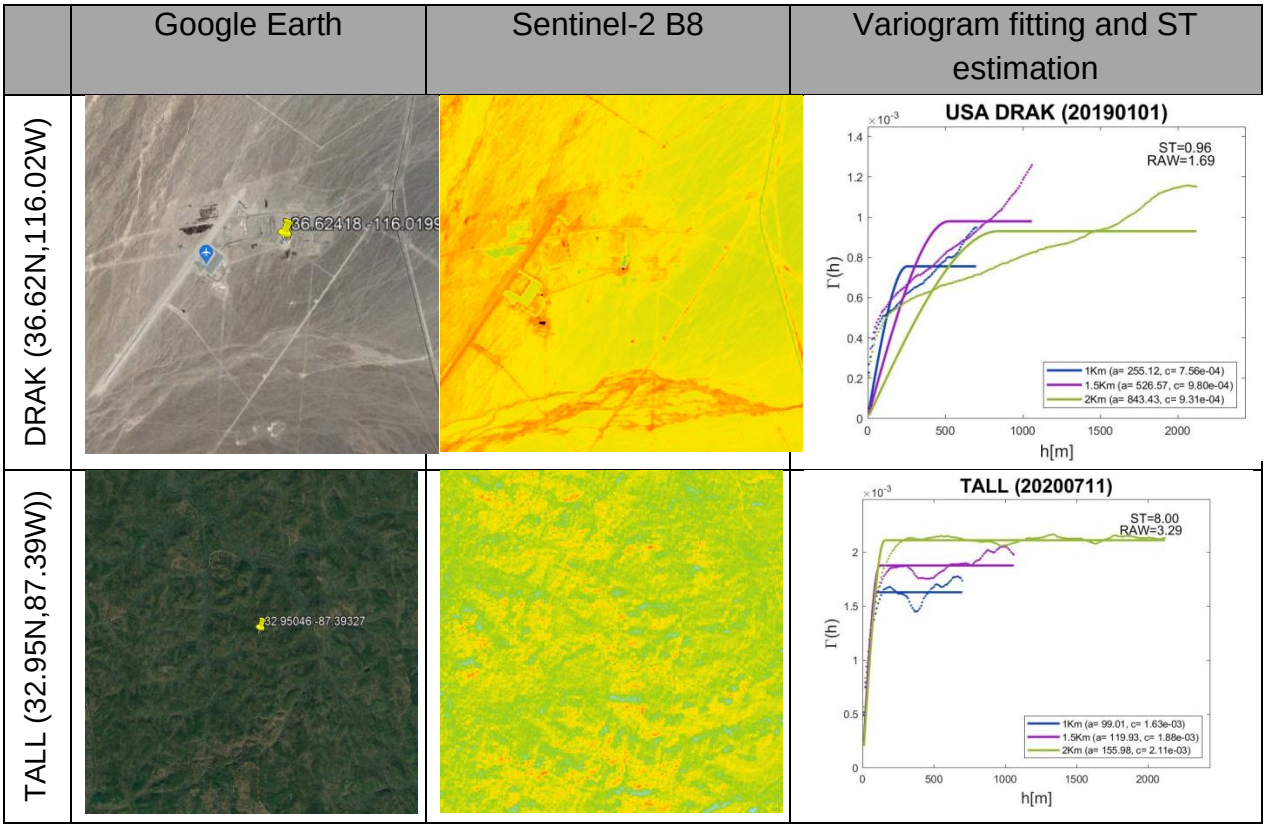


Figure 3: Example of variogram fitting and ST estimation over two different sites, Desert Rock (DRAK) and Talladega National Forest (TALL).

In order to choose a ST threshold for filtering non representatives or heterogeneous sites, an analysis of the variation of RMSD (accuracy), number of sites and number of samples between NASA MCD43A3 C6 product and REALS is performed for all available period (2000-2020). Figure 4 shows the evolution of number of sites, number of samples and RMSD as function of the ST score for the comparison between MCD43A3 C6 satellites derived product and REALS in situ measurements in the 2000-2020 period. According to the results, the RMSD tends to decrease when the ST threshold grows up, but the number of sites and samples decrease. For this reason, a threshold 1.5 for ST has been selected as filter in the REALS because the RMSD tends to be stable at this score and the number of sites and

samples discarded is reasonable. So, temporal period where ST scores were lower than 1.5 will be discarded in the Direct Validation analysis.

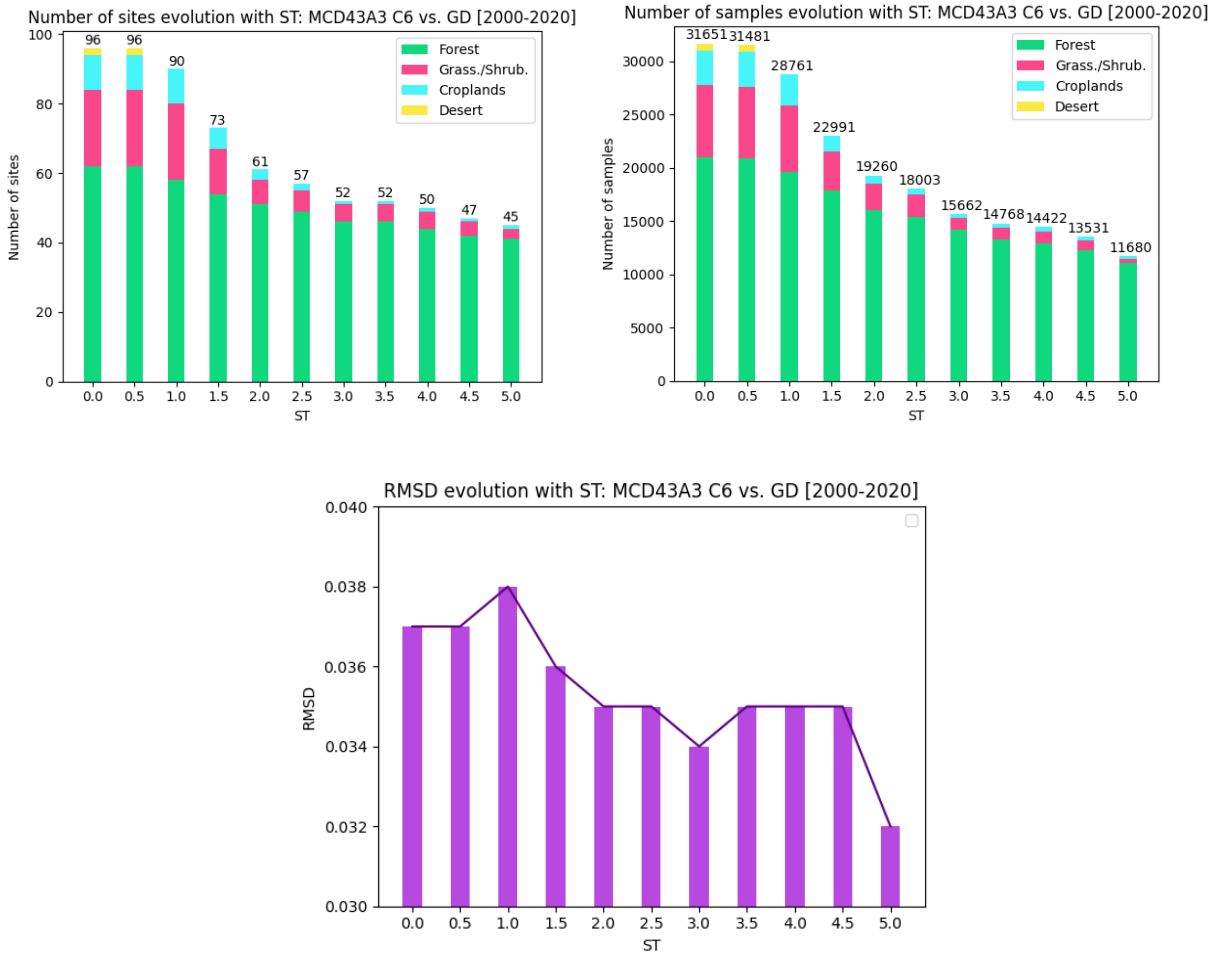


Figure 4: Evolution of Number of sites (top left), Number of samples (top right) and RMSD (bottom) of MCD43A3 C6 versus REALS network according to the ST score in the 2000-2020 period.

Figure 5 shows the density of sites (maximum number of available sites) per year. In the validation analysis, the number of available sites could be lower if blue-sky albedo is selected, or the data available is not spatially representative or the available ground data does not match in time with the satellite data (e.g. temporal gaps in satellite data).

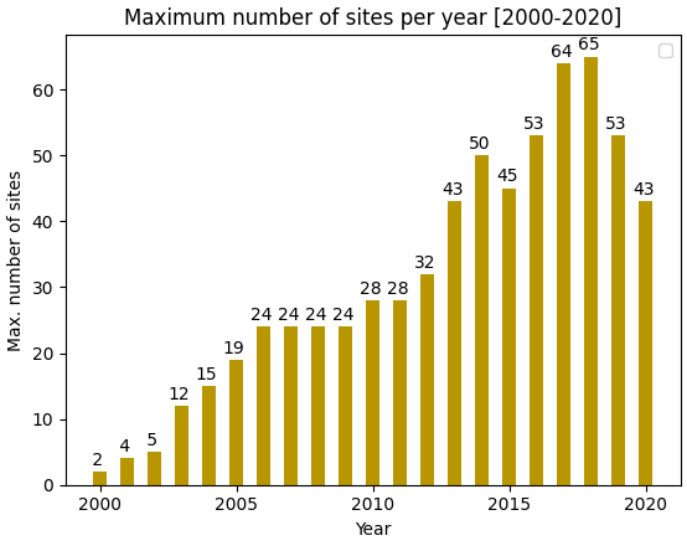


Figure 5: Density of REALS maximum available sites depending on the year.

2.5. REQUIEREMENTS

One of the most important aspects in any validation exercise is to be able to evaluate the results based on the requirements provided by the end user, with the aim of knowing if the product meets the quality criteria required for its application. The following are a series of the most representative user requirements for albedo products. For SALVAL default requirements values: WMO requirements were used as optimal level and C3S requirements for target level, but can be changed in the configuration of the SALVAL validation tool.

2.5.1. GCOS-200 requirements

GCOS published in 2016 a system of global requirements for observing the climate, based on the current applications of LCAs and responding to the needs of the United Nations Framework Convention on Climate Change (UNFCCC). An essential climate variable (LCA) is a physical, biological, chemical variable or a group of variables that contribute critically to the characterization of climate change. The GCOS-200 aims to develop a guide that establishes the necessary requirements to meet data and information needs and to improve the management of current and future climate change. It is a model to follow for scientific innovations and for the implementation of climate observation systems and networks. A summary of the GCOS-200 albedo requirements are summarized in Table 3.

Table 3: GCOS-200 requirements for albedo products.

Product	Frequency	Spatial resolution	Uncertainty	Stability
BSA	Daily	1km	Max(5%; 0.0025)	Max(1%; 0.001)
WSA	N/A	1km	Max(5%; 0.0025)	Max(1%; 0.001)

2.5.2. WMO requirements

The requirements for World Meteorological Organization (WMO) are summarized in Table 4.

Table 4: WMO requirements for albedo products.

Criteria	Requirement		
	Optimal	Target	Threshold
Uncertainty	1%	2%	5%
Horizontal Resolution	10km	30km	100km
Observation cycle	60 min	3h	12h
Opportunity	24h	5 days	10 days
Coverage	Global		

2.5.3. C3S requirements

User's requirements of the C3S program define a Key Performance Indicator (KPI) for albedo measures are summarized in Table 5.

Table 5: C3S KPI requirements for albedo products.

Product	Uncertainty	Stability
BSA	Max(2%; 0.002)	Max(10%; 0.01)
WSA	Max(2%; 0.002)	Max(10%; 0.01)

2.6. VALIDATION METHODOLOGY

To determine the uncertainties associated with the albedo product values and the overall quality of the satellite-derived estimates is mandatory. The Global Climate Observation System (GCOS) establishes three albedo validation approaches:

- **Indirect validation**: This involves an intercomparison of several satellite-derived albedo products, performing a spatial and temporal analysis.

- **Direct point-to-pixel validation**: This involves comparing satellite products with albedo measurements made in situ.

- **Expanded pixel-by-pixel validation**: This involves using satellite-derived albedo products with high spatial resolution to evaluate albedo products with lower resolutions.

The product validation strategy is the process that must be followed to verify that the estimates meet certain requirements. The recommendations contained in the protocol of good practices for the validation of global products (Wang et al., 2019) defined by the Land Product Validation (LPV) subgroup of the Working Group on Calibration and Validation (WGCV) of the Committee on Earth Observation Satellites (CEOS) will be followed.

The CEOS-LPV subgroup defines some metrics that should be used for validation. These include accuracy, precision, uncertainty, and completeness.

- **Accuracy**: The bias and the absolute bias must be specified as a minimum. For a more exhaustive analysis, the median of the error, the median and percentiles of the residual should be added, and some box-plots comparing the residuals and the albedo.

- **Precision**: The standard deviation must be specified as a minimum. For a more in-depth analysis, the median of the absolute deviation and the median of the difference between three points should be included.

- **Uncertainty**: The mean square error or Root Mean Square Deviation (RMSD) must be included as a minimum. For better practice, you should also add a scatter-plot comparing the products, median and percentiles of the absolute residuals, and a box-plot of the residuals compared to the albedo.

- **Integrity**: The distribution of the size of the gaps or invalid values, as well as their duration, must be studied.

- **Stability**: Average of the time series, standard deviation and regression slope. To analyze the stability of albedo products, specific regions of the earth are studied using a statistical approach. This analysis is not a validation, but serves to provide an indication of

the temporal reliability of the albedo data. The use of desert areas is recommended because the albedo variation in them is usually negligible.

The Accuracy and Uncertainty criteria are evaluated in both, product intercomparison and direct-validation sections. The integrity are evaluated in product intercomparison, Precision and stability are included in precision and stability analysis.

2.6.1. Indirect validation or product intercomparison

Product-to-product validation approach, referred to satellite product intercomparison or indirect validation. The intercomparison offers a means of assessing discrepancies between products and provides relative uncertainties. Indirect validation is helpful because most validation metrics cannot be computed using ground data, due to the limitations of ground measurements in terms of global conditions. In general, product intercomparison offers a means of assessing the discrepancies (systematic or random) between products. This method is particularly valuable for finding spatial disagreements between products over large areas and for a wide range of cover types. However, this approach does not yield absolute validation results, and satellite product intercomparisons alone are insufficient to validate a new product. Then, direct validation enables the assessment of uncertainties, and it may be argued that only such methods can be seen as actual validation in the field of remote sensing (Mayr et al., 2019). The LAND VALidation (LANDVAL) network of sites (Fuster et al., 2020; Sánchez-Zapero et al., 2020) is used for sampling global conditions in the intercomparison with similar satellite products. The LANDVAL V1.1 network is composed of 720 sites, of which 521 sites are from Surface Albedo Validation Sites (SAVS 1.0) (Loew et al., 2016), and complemented with additional sites in order to cover under-sampled regions and biome types. These analyses are achieved per aggregated land cover class based on the 8 generic classes derived from the Global Land Cover 100m (GLC-100m) classification (Buchhorn et al., 2020): Evergreen Broadleaf Forest (EBF, 9.6% of LANDVAL sites), Deciduous Broadleaf Forest (DBF, 7.5%), Needle-Leaf Forest (NLF, 11.3%), Other Forests (OF, 17.2%), Shrublands (SHR, 8.2%), Herbaceous (HER, 21.3%), Cultivated (CUL, 19.5%) and Sparse and Bare areas (SBA, 13.8%).

The product intercomparison includes:

- **Product Completeness**

Completeness corresponds to the absence of spatial and temporal gaps in the data. Missing data are mainly due to cloud or snow contamination, poor atmospheric conditions or technical problems during the acquisition of the images and is generally considered by users as a severe limitation of a given product. It is therefore mandatory to document the completeness of the product (i.e. the distribution in space and time of missing data).

Global maps of missing values and temporal profiles with distribution of gaps as a function of the season are analysed.

- **Spatial Consistency**

Spatial consistency refers to the realism and repeatability of the spatial distribution of retrievals over the globe. A first qualitative check of the realism and repeatability of spatial distribution of retrievals and the absence of strange pattern of artifacts (e.g., missing values, stripes, unrealistic low values, etc.) can be achieved through systematic visual analysis of all global maps based on the expert knowledge of the scientist. The methodology for visual analysis includes the visualization of animations of global maps at a reduced (1/16 pixels) resolution.

The spatial consistency can be quantitatively assessed by comparing the spatial distribution of a reference validated product with the product biophysical maps under study. Two products are considered spatially consistent when the residual are within uncertainty requirements of the variable. Global maps of residuals and differences between the product under study and reference products are included in the SALVAL validation tool in order to identify regions showing spatial inconsistencies for further analysis. Furthermore, global maps of the distribution of pixels within the pre-defined uncertainty levels are computed for both, residuals and differences. The residual (ε) is estimated assuming a linear trend between two products ($Y = a X + b + \varepsilon$), then the residual can be written as $\varepsilon = Y - a X - b$, which represent the remaining discrepancies regarding the general trend between both products. In this way, systematic trends are not considered, depicting more clearly patterns associated to the spatial distribution of retrievals.

- **Temporal Consistency**

The realism of the temporal variations and the precision of the products are assessed over the 720- site LANDVAL V1.1 network. This section includes temporal profiles and cross correlation between products.

- **Overall Analysis**

Accuracy, Precision and Uncertainty (APU) are quantified by several metrics reporting the goodness of fit between the products and the corresponding reference dataset. Accuracy is quantified by the bias and Median Deviation (MD - according to the LPV best practice). Precision represents the dispersion of product retrievals around their expected value and can be estimated by the Standard Deviation (STD) of the difference between retrieved satellite product and the corresponding reference estimates. Median Absolute Error (MAE) is also calculated to report to quantify the precision, according to the CEOS LPV best practices. Uncertainty includes systematic and random errors and can be estimated by the Root Mean Square Deviation (RMSD). In addition to these metrics, other statistics are useful to evaluate the goodness of fit between two datasets including linear

model fits. For this purpose, Major Axis Regression (MAR) is computed instead of ordinary least square regression because is specifically formulated to handle error in both of the x and y variables (Harper, 2014).

These metrics are summarized in Table 6. Products histograms, histograms of the difference, scatter-plots and validation metrics versus references and box-plots of bias and RMSD are included in this section.

Table 6: Validation metrics.

Statistics	Comment
N	Number of samples. Indicative of the power of the validation
B	Mean Bias. Difference between average values of x and y. Indicative of accuracy and offset. Bias (%) is the relative mean bias between the average of x and y.
ME	Median error between x and y. CEOS LPV best practice reporting the accuracy. ME (%) is the relative ME between the average of x and y.
STD	Standard deviation of the pair differences. Indicates precision.
MAE	Median absolute error between x and y. CEOS LPV best practice reporting the precision. MAE (%) is the relative MAE between the average of x and y.
RMSD	Root Mean Square Deviation. RMSD is the square root of the average of squared errors between x and y (see Table 5 for formulae). CEOS LPV best practice reporting uncertainty. RMSD (%) is the relative RMSD between the average of x and y.
R	Correlation coefficient. Indicates descriptive power of the linear accuracy test. Pearson coefficient is used.
MAR	Slope and offset of the Major Axis Regression linear fit. Indicates some possible bias
Conformity test	Percentage of pixels matching the optimal (GCOS), target (C3S KPI) and threshold uncertainty predefined levels (see 2.5).

2.6.2. Direct Validation

Involves comparisons of satellite products with albedo measured from in situ tower-based instruments. It is, therefore, mandatory to evaluate the spatial representativeness of ground albedo measurements (see 2.4.2), which depends on the land surface heterogeneity (Román et al., 2009, 2010; Wang et al., 2012, 2014).

In the SALVAL validation tool, two options can be used for direct validation: the comparison of satellite blue-sky albedo (Lewis, P & Barnsley, 1994) with ground-based measurements (recommended) and the comparison of black-sky or directional albedo with ground-based measurements (supposing that all components of the radiation are direct and any diffuse).

The comparison of black-sky albedo should be used when low number of stations are available (the number of stations is higher due to some stations does not provide diffuse information). In order to evaluate or narrow down the possible error introduced when comparing black-sky albedo instead blue-sky albedo, the comparison between them for C3S PBV V1 in the 2014-2019 period using all the available REALS retrievals for the blue-sky computing was performed (see). The results show a RMSD of 0.011 (6%) and Median Absolute Error (MAE – equivalent in this case to MAD) of 0.006 (3.5%) due to introduce black-sky albedo, instead of blue-sky albedo, that must be taken into account in the analysis by the user.

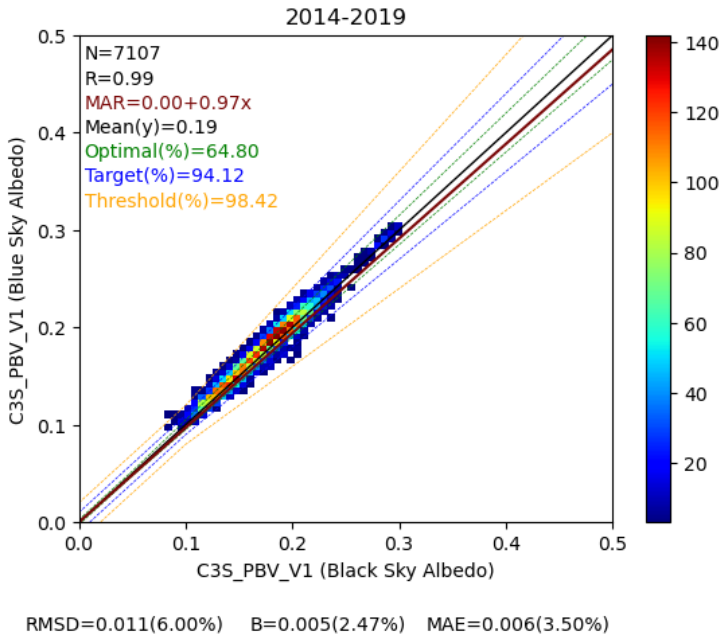


Figure 6: Comparison of blue-sky albedo versus black-sky albedo for C3S PBV V1 using all available REALS information in the 2014-2019 period.

2.6.3. Precision

Two aspects of the precision are also evaluated: inter-annual and intra-annual precision. Intra-annual precision (smoothness) corresponds to temporal noise assumed to have no serial correlation within a season. In this case, the anomaly of a variable from the linear estimate based on its neighbours can be used as an indication of intra-annual precision. For each triplet of consecutive observations, the absolute value of the difference between the center P(dn+1)

and the corresponding linear interpolation between the two extremes P(dn) and P(dn+2) is computed (Weiss et al., 2007):

$$\delta = \left| P(d_{n+1}) - P(d_n) - \frac{P(d_n) - P(d_{n+2})}{d_n - d_{n+2}} (d_n - d_{n+1}) \right| \quad \text{Eq. 1}$$

Probability Density Function (PDFs) of the intra-annual precision are analysed. CEOS LPV albedo protocol (Wang et al., 2019) recommends providing the median of 3-point difference (i.e. median δ values) as the good practice to evaluate the intra-annual precision of satellite albedo products.

Inter-annual precision (i.e., dispersion of albedo values from year to year) was assessed over 19 well-known desert calibration sites (Lacherade et al., 2013). Scatter plots between two different years are generated over calibration sites, and median absolute deviation values are used as an indicator of the inter-annual precision of the products according to CEOS LPV best practice recommendation (Wang et al., 2019).

2.6.4. Stability

Stability is the extent to which a product remains constant over a long period, usually a decade or more (Lattanzio et al., 2021). For the stability validation, the temporary profiles of the products with a validation period of at least five years evaluated on the LANDVAL calibration sites are proposed. Calibration sites are used, because they are all desert areas where a negligible change in surface albedo is expected over time. The slope of the linear regression of the temporal evolution of the albedo products on each site of the LANDVAL calibration sites is calculated, giving as stability indicator the slope per year and the slope every ten years. The slope of the mean linear regression every ten years of the twenty LANDVAL calibration sites will be used as the main stability indicator.

2.7. DATA HOMOGENEITY

In order to compare different satellite product retrievals, between them or with in situ or ground data measurements, it is necessary to homogenize the data spatially and temporally. For that, spatial resolution has been taken at 1km^2 around the center of the evaluated pixel (e.g. 1x1 pixels for C3S PBV V1, 2x2 pixels for MCD43A3 C6 or 3x3 pixels for C3S S3 V3). In addition, the temporal product composition window has to be centered respect of the synthesis time of each sensor.

3. LOGIN AND CONFIGURATION

3.1. SIGN UP

SALVAL is a free validation tool available in www.salval.eolab.es. It is mandatory to sign up, introducing name information, e-mail address and creating a password (see Figure 7). At the end, it is needed to confirm that you are not a robot and to click in get started.

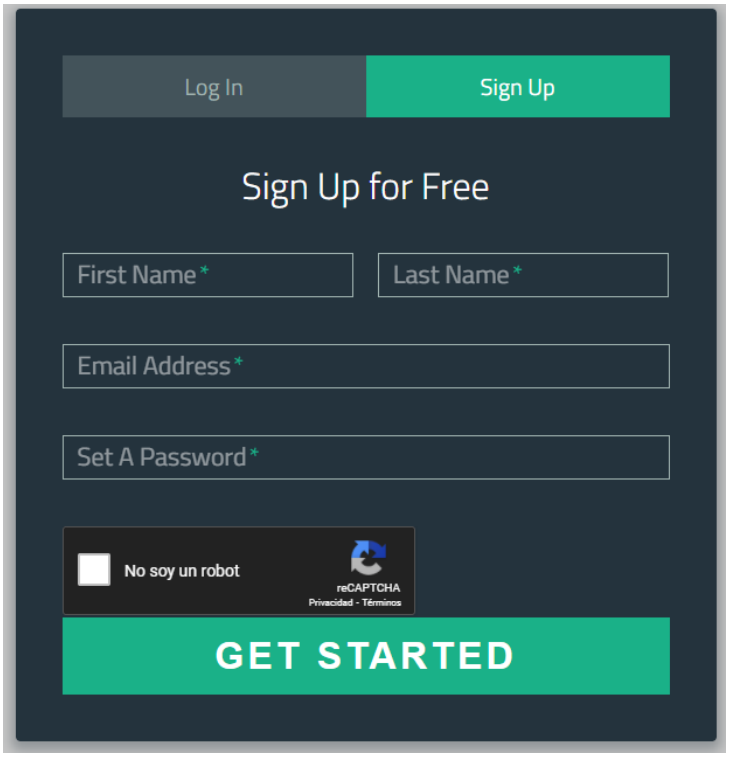


Figure 7: Sign up step on SALVAL validation tool.

When finishing the sign up process, an e-mail is sent to validate the register to the e-mail indicated in the sign-up step. Please, click in the validation link for finish the sign up process (see Figure 8). For any question you can contact to info@salval.eolab.es. Review your span folder.

Welcome to SALVAL albedo validation tool, the EOLAB team welcomes you.

Please click the following link to activate your account: salval.eolab.es/activate.php?email=enrique.martinez@eolab.es&code=6194c4dfeb157

If you have any doubt about SALVAL, feel free to contact: info@salval.eolab.es

Best regards,

EOLAB Team

Figure 8: Confirmation e-mail in the sign up step of SALVAL validation tool.

3.2. LOGIN

After sign up process, you can login introducing you e-mail address and your password in the login step of SALVAL validation tool.

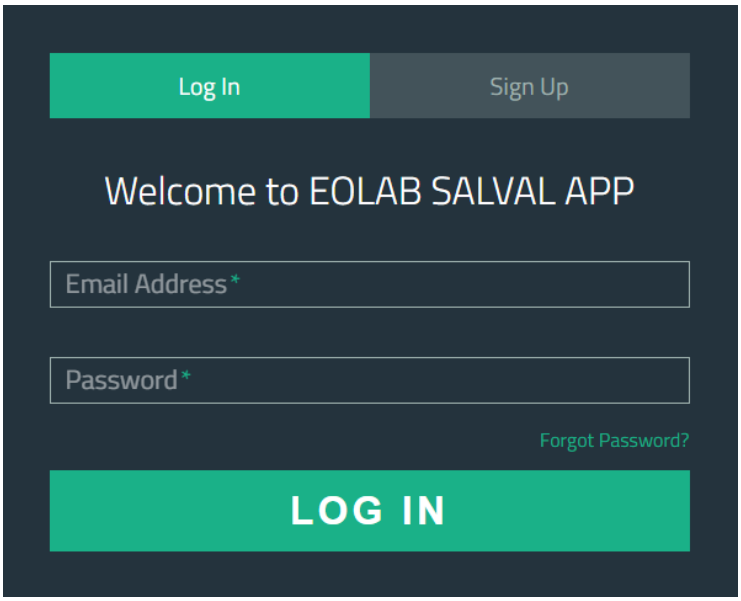
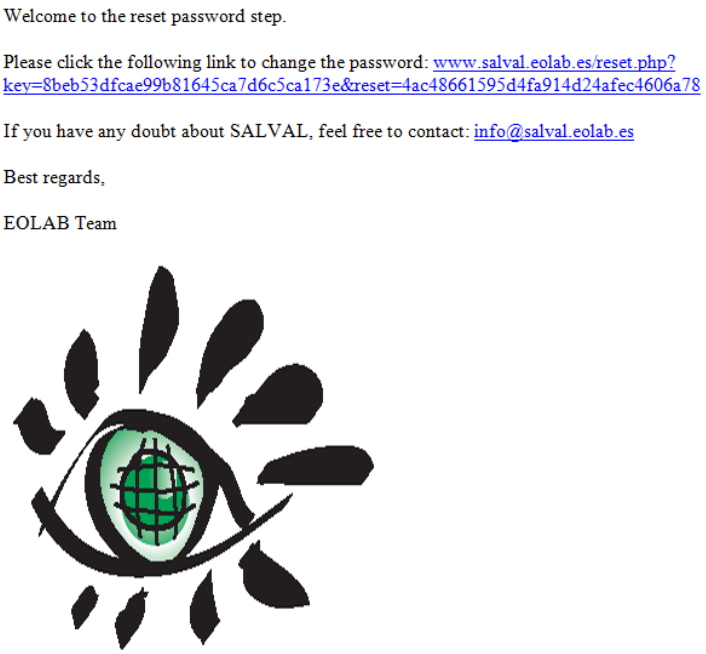


Figure 9: Log in step in the SALVAL validation tool.

If you forgot the password of profile, you have to click in “Forgot Password”. An e-mail will be sent to your e-mail with the link for restart the password (see Figure 10). Please, click in the link. Review your spam folder.


Welcome to the reset password step.

Please click the following link to change the password: www.salval.eolab.es/reset.php?key=8beb53dfcae99b81645ca7d6c5ca173e&reset=4ac48661595d4fa914d24afec4606a78

If you have any doubt about SALVAL, feel free to contact: info@salval.eolab.es

Best regards,

EOLAB Team

Figure 10: Reset password e-mail in SALVAL validation tool.

After that, you can choose your new password and click in change password. Then, this will be automatically updated.

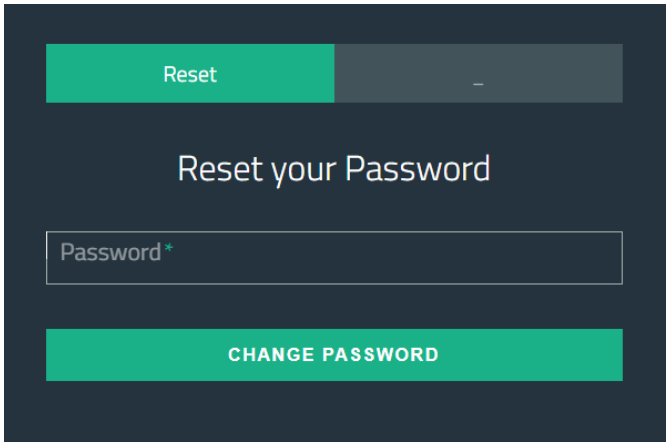


Figure 11: Reset password step in SALVAL validation tool.

3.3. SETTINGS FOR THE VALIDATION

3.3.1. General window features in the setting validation process

After login in, starts the configuration or settings of the validation process. The general window of each step of the configuration process has the next features:

1. Click in to restart the configuration of the validation process.
2. Click in to see the profile information.
3. Click in for log out.
4. Step status bar, which shows the step where you are in the moment.
5. Go back button.
6. Next button.

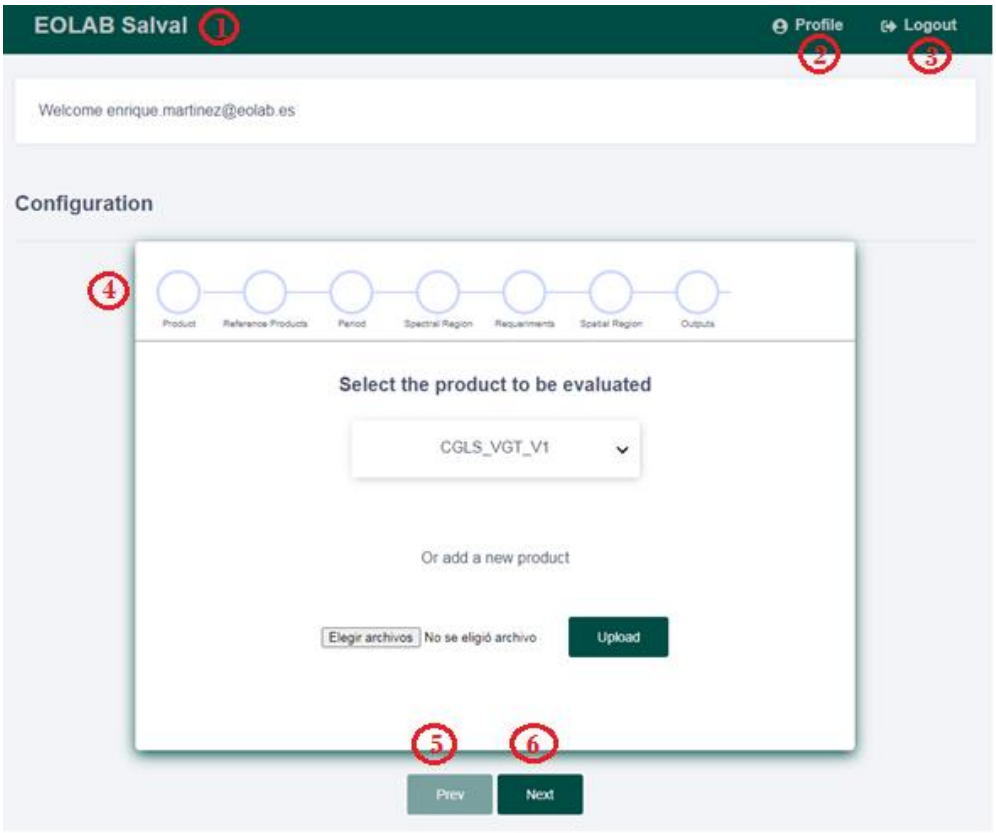


Figure 12: General window features in the setting process of SALVAL validation tool.

3.3.2. Uploading a new product to the database

SALVAL validation tool has an extent albedo database (see 2.2), but you can upload a new product temporary to the validation tool. For that, it is necessary to facilitate eight different .csv files:

- PRODUCTNAME_DATESTART_DATEEND_BH_BB_LANDVAL.csv
- PRODUCTNAME _DATESTART_DATEEND_BH_VI_LANDVAL.csv
- PRODUCTNAME _DATESTART_DATEEND_BH_NI_LANDVAL.csv
- PRODUCTNAME _DATESTART_DATEEND_DH_BB_LANDVAL.csv
- PRODUCTNAME _DATESTART_DATEEND_DH_NI_LANDVAL.csv
- PRODUCTNAME _DATESTART_DATEEND_DH_VI_LANDVAL.csv
- PRODUCTNAME _DATESTART_DATEEND_BH_BB_GD.csv
- PRODUCTNAME _DATESTART_DATEEND_DH_BB_GD.csv

Where PRODUCTNAME is the name that will be appear in the results section, DATESTART and DATEEND are the first and last day of the datasets in format (YYYYMMDD where YYYY is the year, MM the month and DD the day), BH stands for white-sky albedo or bi-directional, DH stands for black-sky albedo or directional, VI stands for Visible range, NI for Near Infra-red range, BB for shortwave or Broadband range, LANDVAL for LANDVAL V1.1 network and GD for Ground Data network. Figure 13 shows an example of files to be temporary uploaded as new dataset product. The list of LANDVAL V1.1 sites to do de extractions of the products can be found in Annex I, whereas the list for GD network are available in Annex II. Remember not use low bar ("_") in the product name, the low bars are delimiters for SALVAL validation tool.

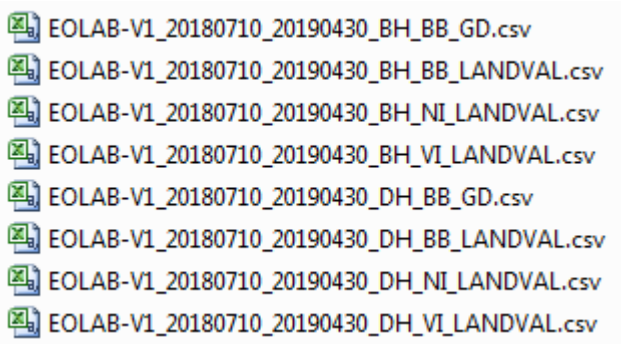


Figure 13: Example of files naming to be temporary uploaded as new dataset product in the SALVAL validation tool. EOLAB-V1 is the product name, 2018/07/10 is the start date and 2019/04/30 is the end date.

The structures of the files are the next:

- The first row is the header and the columns are YEAR, DOY (which stands for day of year) and the ID of each sites (1,2,3,4,…,725 for LANDVAL network and 1,2,3,4,…,99 for GD network).
- From second to the last row the values of if columns. The number of rows depends on the number of retrievals of the datasets.

The summary of the required files is:

- For LANDVAL network, a matrix of [numberOfRetrievals +1 (header)] x [2 (YEAR and DOY) + 725 sites]
- For GD network, a matrix of [numberOfRetrievals +1 (header)] x [2 (YEAR and DOY) + 99 sites]

Figure 14 shows an example of file structure for LANDVAL network, the first row is the header. From second to the last row are the retrievals and the values. First column contain the years, second column the days of year and the rest the retrievals for each of the 725 sites of the network.

Year	DOY	1	2	3	4	5	6	7
2018	190	0.204019	0.188251	0.162936	0.223746	0.36479	0.216119	0.232027
2018	200	0.209138	0.169941	0.157831	0.21371	0.361149	0.236553	0.215548
2018	211	0.205043	0.199362	0.185022	0.213715	0.351163	0.211249	0.225264
2018	221	0.222299	0.205252	0.193393	0.216825	0.362119	0.212521	0.224958
2018	231	0.199343	0.189635	0.181639	0.204369	0.337291	0.207081	0.214768
2018	242	0.200757	0.182852	0.178005	0.201167	0.3399	0.210004	0.203235
2018	252	0.208517	0.180321	0.178006	0.210927	0.347289	0.184678	0.19609
2018	262	0.205602	0.182178	0.176664	0.196544	0.354036	0.186862	0.214074
2018	272	0.217038	0.178857	0.176049	0.196119	0.334732	0.172723	0.205795
2018	282	0.219822	0.174706	0.175656	0.19776	0.334144	0.165633	0.221835
2018	292	0.247553	0.160875	0.169872	0.172025	0.340675	0.169644	0.213316
2018	303	0.229379	0.158862	0.161377	0.172743	0.332026	0.202144	0.233117
2018	313	0.233215	0.168141	0.174922	0.170305	0.330438	0.169581	0.214143
2018	323	0.217167	0.199638	0.167258	0.160246	0.324669	0.205779	0.225889
2018	333	0.214506	0.332835	0.157658	0.154394	0.321346	0.173043	0.233793
2018	343	0.208709	0.423306	0.168028	0.146495	0.319953	0.164521	0.237006
2018	353	0.218061	0.4758	0.167522	0.151988	0.316628	0.140038	0.217269
2018	364	0.196232	0.518862	0.190721	0.152307	0.311258	0.190281	0.219335
2019	9	0.192154	0.543315	0.178047	0.147405	0.318701	0.180231	0.225278
2019	19	0.189147	0.57229	0.151774	0.144221	0.331474	0.377995	0.22151
2019	30	0.207589	0.596874	0.17119	0.146636	0.318063	0.548449	0.236341
2019	40	0.198099	0.607688	0.174707	0.154499	0.308317	0.577689	0.231435
2019	50	0.196444	0.618259	0.167721	0.1792	0.302337	0.618849	0.243762
2019	58	0.201693	0.663327	0.173239	0.19071	0.319477	0.694604	0.224511
2019	68	0.228989	0.653821	0.18727	0.180954	0.321711	0.544447	0.203357
2019	78	0.2041	0.581669	0.194889	0.179043	0.341826	0.12629	0.244789
2019	89	0.197142	0.363923	0.186604	0.222198	0.328917	0.153994	0.245781
2019	99	0.203684	0.153462	0.191373	0.186843	0.316937	0.155	0.212332
2019	109	0.200395	0.156193	0.195288	0.206384	0.324253	0.171114	0.2663

Up to 725

Figure 14: Example of file structure to be temporary uploaded as new dataset product in the SALVAL validation tool.

To upload the files, click in “choose files button” (1) and upload all of them at the same time. Then click in “upload button” (2). After the uploading process finish, the product uploaded will appear temporary in the product list in the choosing product to be evaluated (see 3.3.3) and choosing reference products (see 3.3.4) steps.

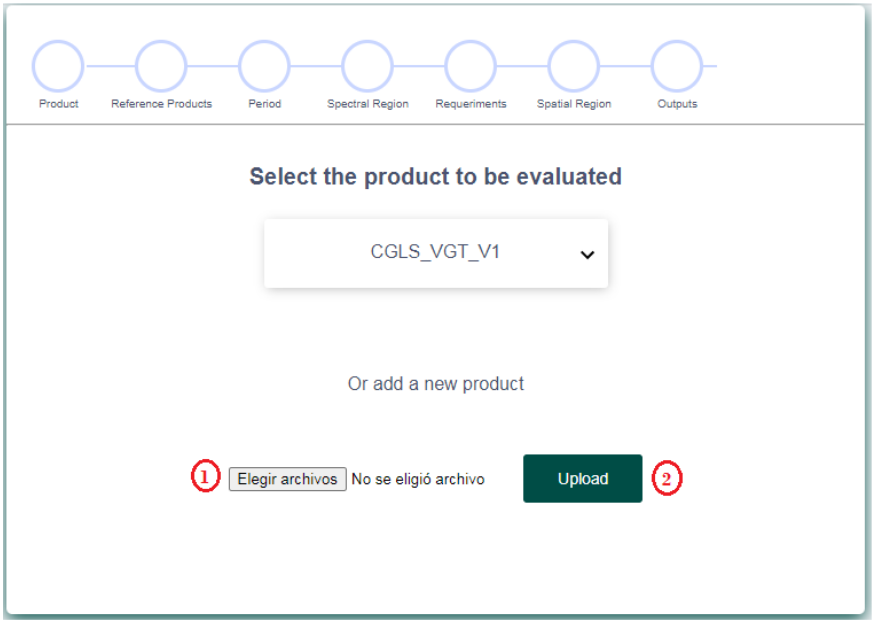


Figure 15: Upload new dataset files as new product temporary in the SALVAL validation tool.

3.3.3. Choosing a default product to be evaluated

The first step in the configuration of the validation process is to choose the product which will be evaluated. Click in the product evaluated bar to choose the product. In the list will appear the default products included in the SALVAL validation tool database (see 2.2) and the product uploaded (see 3.3.2), if it is the case.

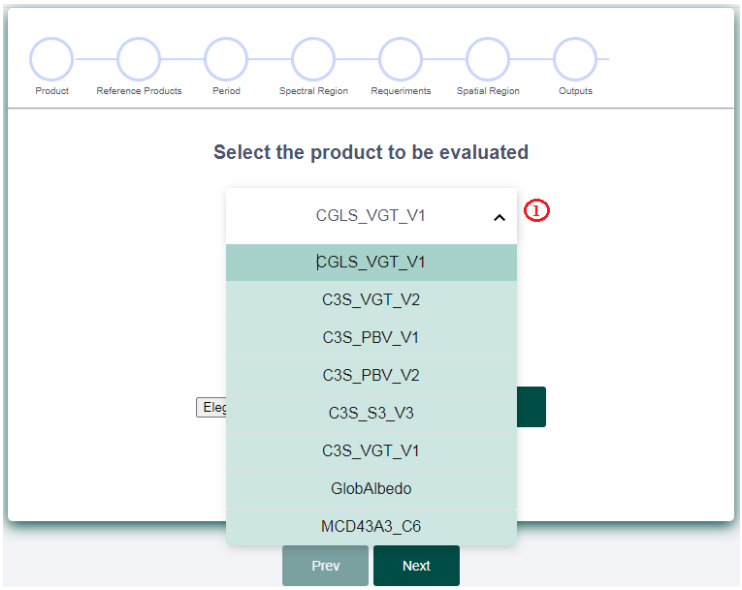


Figure 16: Choosing a product to be evaluated in the SALVAL validation tool.

3.3.4. Choosing reference products.

The second step in the configuration of the validation process is to choose the reference products (products to compare in the product. Click in the product reference list (1) to choose the product. In the list will appear the default products included in the SALVAL validation tool database (see 2.2) and the product uploaded (see 3.3.2), if it is the case. The chosen reference products will appear in the selected products list (2). You can select up to four different reference products. The SALVAL tool is limited to two reference products.

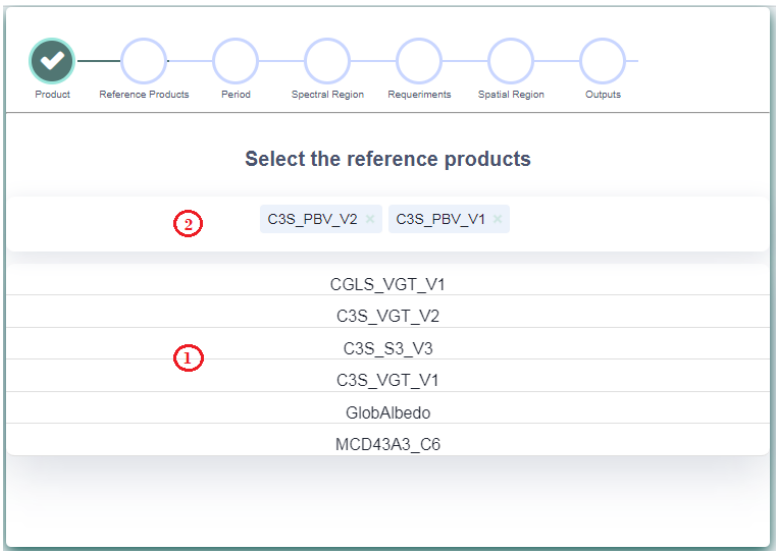


Figure 17: Choosing the reference products in the SALVAL validation tool.

3.3.5. Selecting the evaluation period

The thirst step in the configuration of the validation process is to select the validation period. The start date of the validation analysis can be changed in the Since bar (1) and the end date in the To bar (2). In (3) the available common period between the product to be evaluated and the reference products is showed. Remember that the SALVAL tool is limited to five years of period.

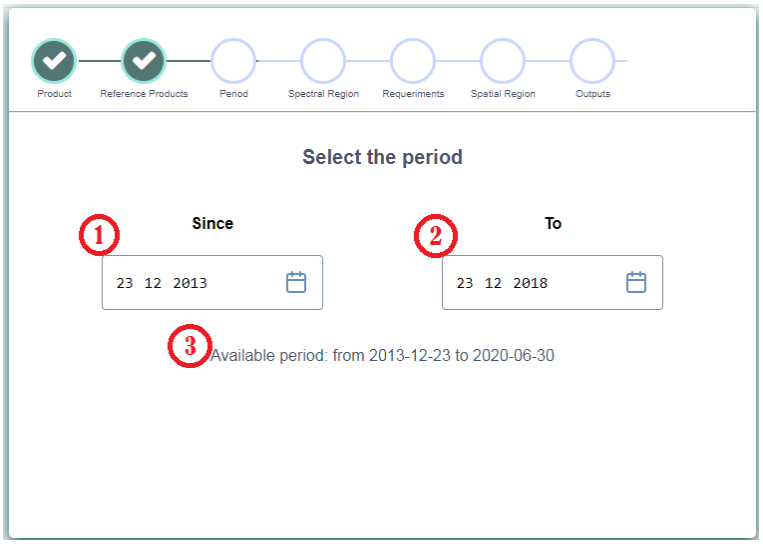


Figure 18: Selecting the validation period in the SALVAL validation tool.

3.3.6. Choosing the albedo type

The fourth step is to choose the albedo type. You can select directional (BSA) or hemispheric (WSA) albedos in the albedo type bar (1).

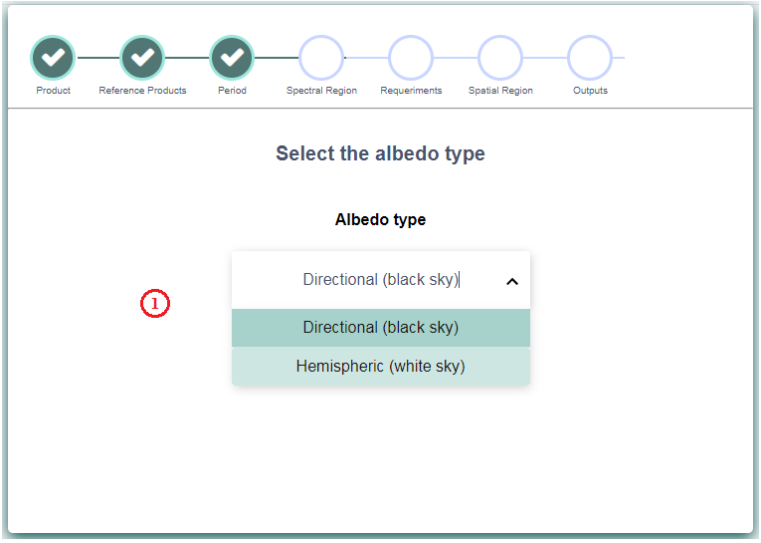


Figure 19: Choosing albedo type in the SALVAL validation tool.

3.3.7. Adjusting requirements

The fifth step is to adjust the requirements for the validation (see 2.5). The default requirements values are: WMO requirements were used as optimal level and C3S requirements for target level, but can be changed in the configuration of the SALVAL validation tool. The different requirements (stability and accuracy) can be changed in their table panel (3). Each panel can be displayed in graph form (4). To change from table to graph click in "Show Graphic" (1) and for change from graph to table click in "Show Table" (2).

Figure 20: Adjusting the requirements in the SALVAL validation tool.

3.3.8. Selecting the spatial region over LANDVAL network

The sixth step is to choose the spatial region of the analysis. The spatial region is divided into North America, South America, Europe, Africa, Asia and Oceania (see Figure 21), but it possible to choose all the regions at the same time (Global option).

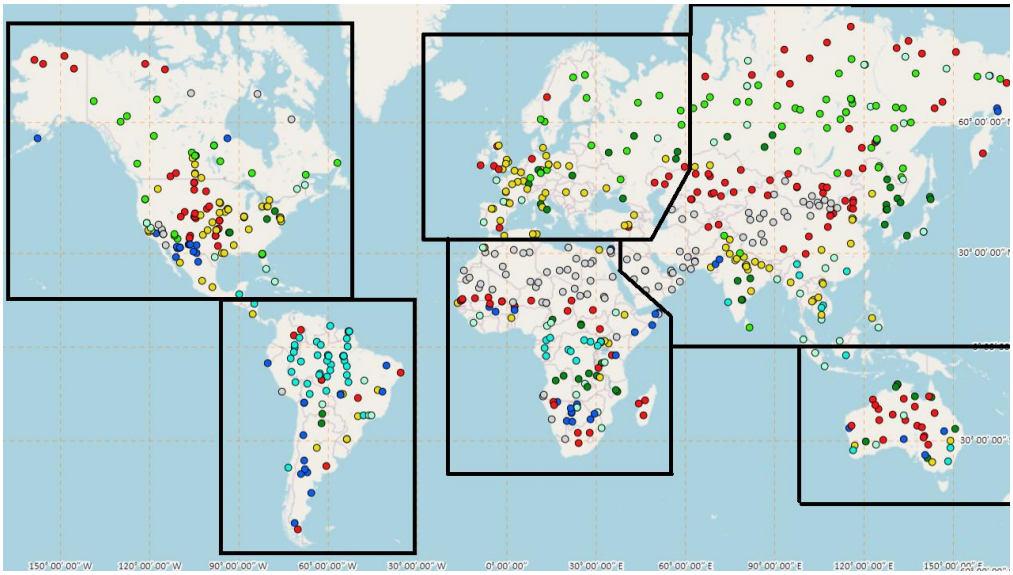


Figure 21: Spatial regions in SALVAL validation tool.

To select the spatial region for the validation process, choose the option using the spatial region buttons (1). The default option is the Global Analysis. The map show the LANDVAL V1.1 sites by biomes (EBF stands for Evergreen Broadleaved Forest, DBF for Deciduous Broadleaved Forest, NLF for Needle-leaf Forest, OF for Other Forest including Mixed Forest, CUL for Cultivated, SHR for Shrublands, HER for Herbaceous and SBA for Sparse and Bare Areas). The map will refresh when the region changes.

Figure 22: Selecting the spatial region in SALVAL validation tool.

3.3.9. Selecting the validation type and configuration summary

The last step is to select the validation type. The options are:

- Product Intercomparison (see 2.6.1).
- Direct Validation (see 2.6.2).
- Precision (see 2.6.3).
- Stability (see 2.6.4).

You can choose a validation option using the validation option buttons (1) (2) (3) and (4). When choose a validation type using the button a new page will be opened . You can generate a validation report using “Generate VR (PDF)” (5) button (see 4.9). The result is a .pdf file with a summary of the validation results of all validation types. A summary of the settings chosen is displayed in the summary panel (6).

Note: For the precision validation type, at least two years of period must be available in the product dataset. For Stability, at least 5 years must be available.

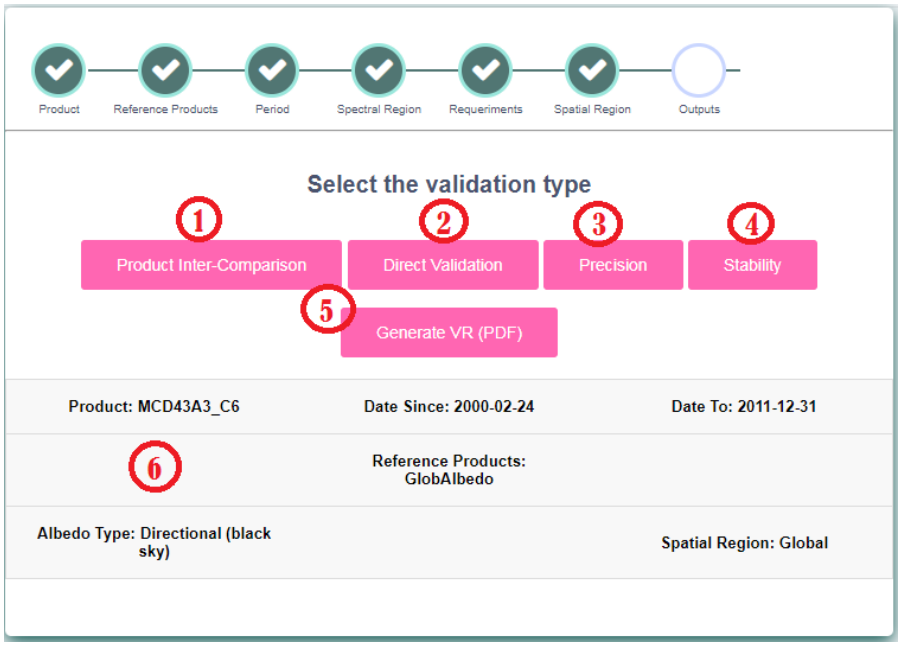


Figure 23: Selecting validation type and configuration summary in SALVAL validation tool.

4. VALIDATION RESULTS

Validation results are divided according to the validation type options: Product Intercomparison, Direct Validation, Precision and Stability (see 2.6).

4.1. GENERAL WINDOW FEATURES IN THE VALIDATION RESULTS STEP

After configure the validation and choose the type, a new page will be opened with the validation results. The general window of the results has the next features:

1. Click in to restart the configuration of the validation process.
2. Click in to download or visualize the User Guide.
3. Click in to contact with the develop apartment of EOLAB.
4. Click in to see the profile information.
5. Click in for log out.
6. Elements of the validation bar.
7. Configuration summary.
8. Click to go back to the configuration/settings step or to go from another validation analysis.
9. Results Panel.

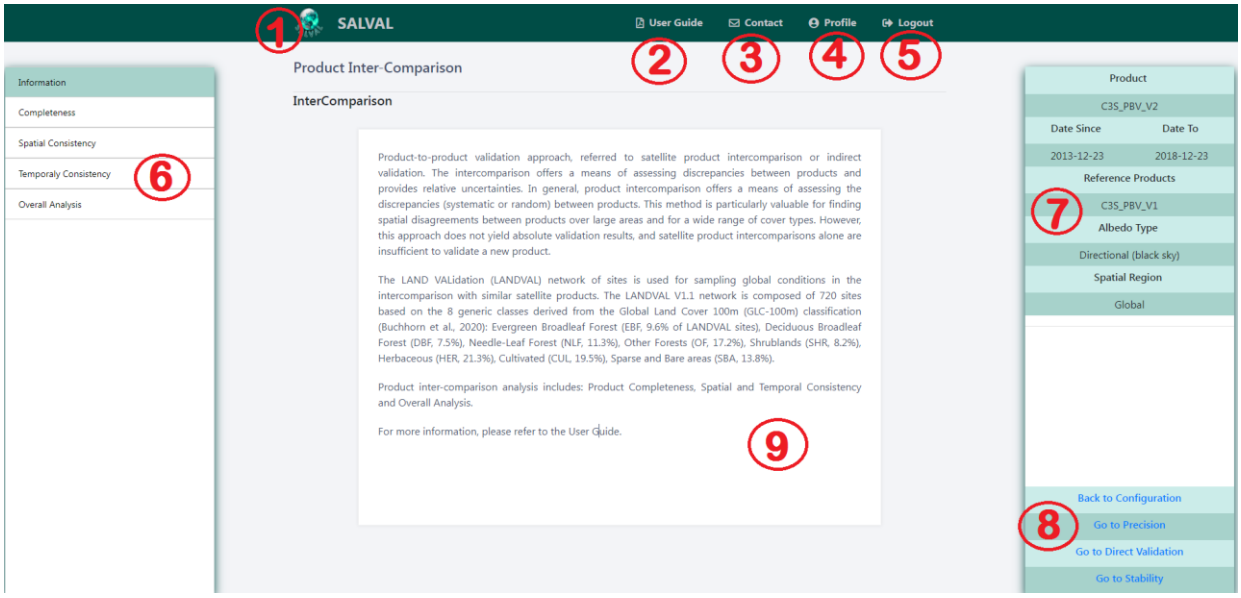


Figure 24: General window features in the validation results step in SALVAL validation tool.

4.2. WORKING WITH OPENLAYERS MAPS

All the maps displayed in the results come from OpenLayers API. The available features in the SALVAL validation tool are the next:

1. Zoom In/Out.
2. Full window size.
3. Scroll.
4. Clicking right in any place of the map, “save image as” option.

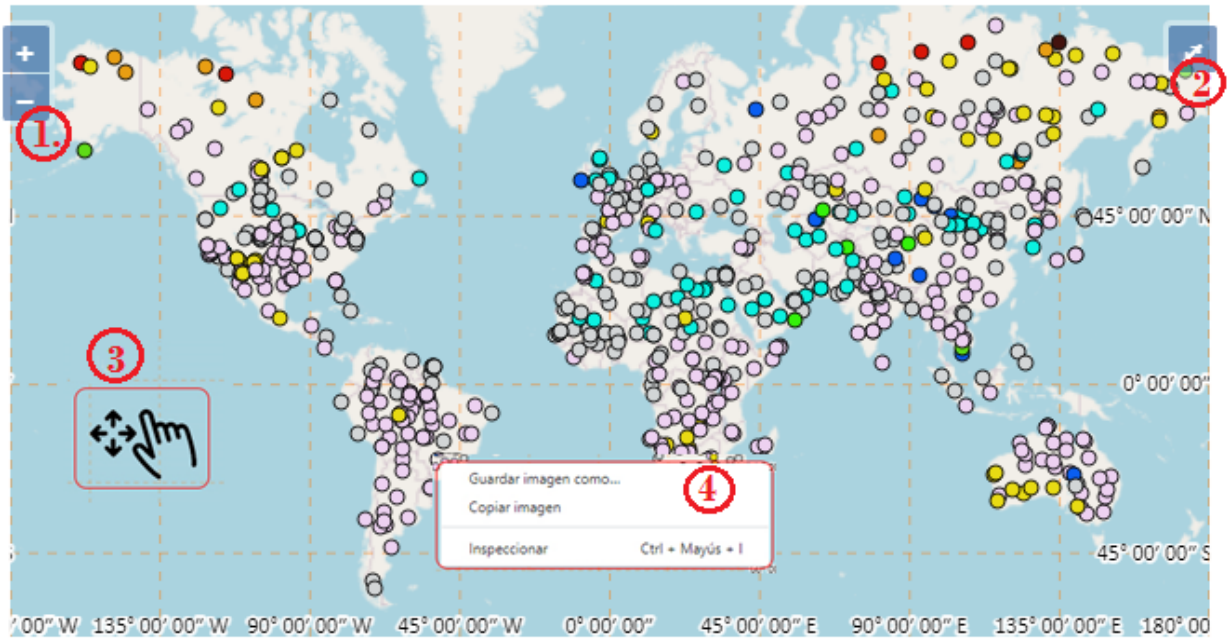


Figure 25: Main features in the OpenLayers maps in SALVAL validation tool.

4.3. WORKING WITH CANVASJS GRAPHS

All the graphs in SALVAL validation tool use the CanvasJS API, except scatter plots. The main features of the graphs are the next:

1. Show retrieval values when hover mouse.
2. Select an area with left click + scroll for zooming.
3. Legend: Click in to Show/Hide a serie of the graph.
4. Graph Menu: Contain options as print, save…

Figure 26: Main features in the CanvasJS graphs in SALVAL validation tool.

4.4. WORKING WITH PLOTLYJS GRAPH

Scatter plots in SALVAL validation tool have been developed using PlotlyJS API. The main features of PlotlyJS graphs are:

1. Validation metric results information (see Table 6).
2. Validation metrics results information II (see Table 6).
3. Legend: Click in to Show/Hide a serie in the plot.
4. Other features. From left to right: Download plot as .png, Zoom, Pan, Zoom in, Zoom out, Auto scale, Reset axes, Toogle skipe lines, Show closest data on hover, Compare data on hover.

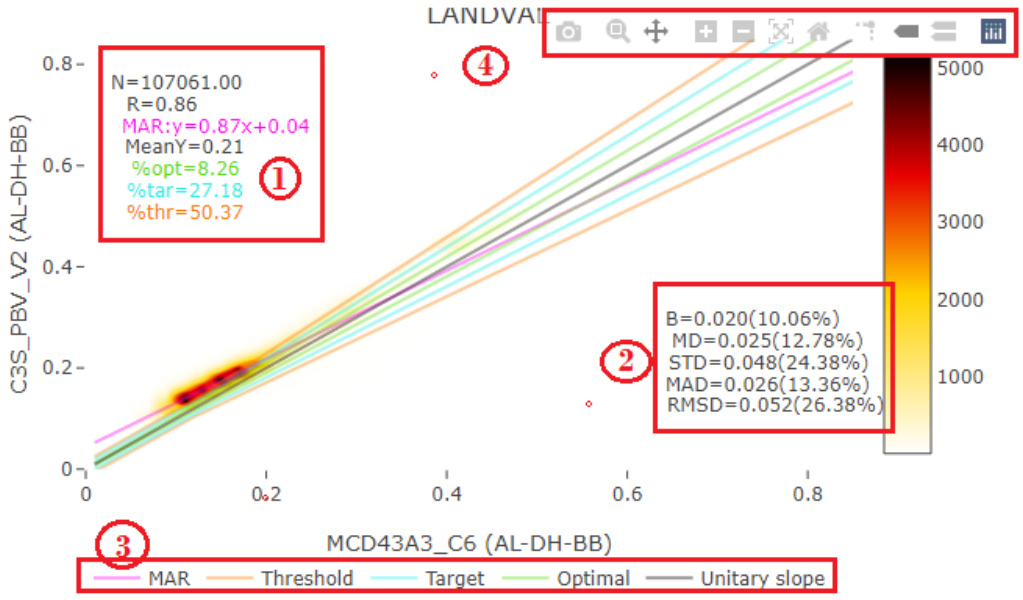


Figure 27: Main features in PlotlyJS graphs in SALVAL validation tool.

4.5. PRODUCT INTERCOMPARISON

The Product Intercomparison is divided into four sections: Completeness, Spatial Consistency, Temporal Consistency and Overall Analysis.

4.5.1. Completeness

The integrity of a product is the absence of missing values or spatial and temporal gaps in the data. Spatial gaps can be due to bad atmospheric conditions such as cloud or snow pollution or technical problems in the data acquisition. To analyze the integrity of the product it has been developed two subsections: Spatial Distribution and Temporal Variation.

4.5.1.1. Spatial Distribution

In this subsection, the spatial distribution of missing values is showed for the product to be evaluated (left) and reference products (right) over LANDVAL V1.1 network. To change the reference product to another product chosen in the configuration step, use the reference products select (1). By default, only best quality pixels (see 2.2.1) are computed. To use all pixels deselect the best quality button (2).

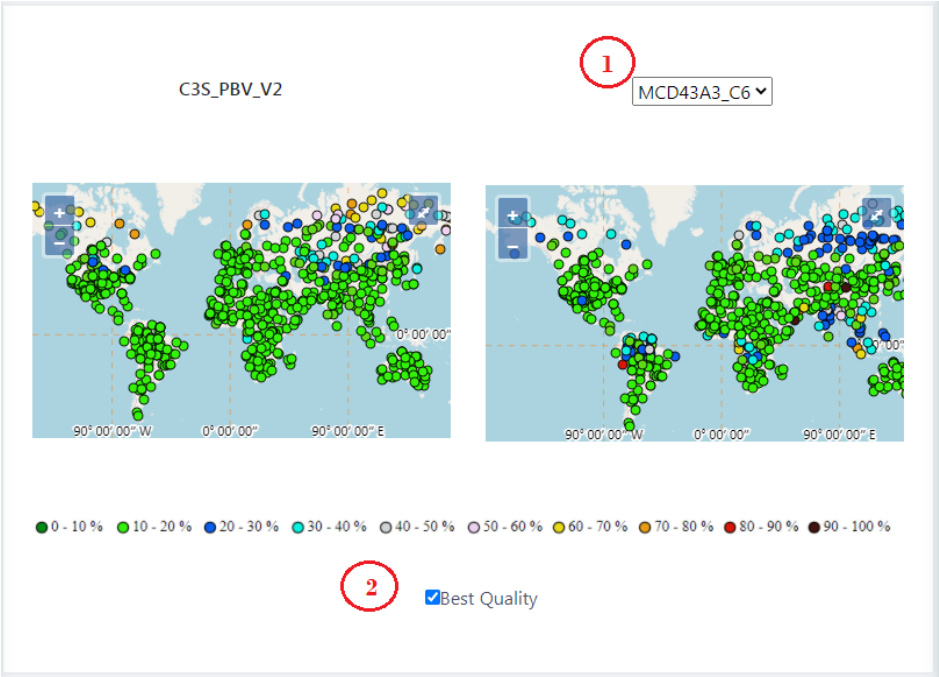


Figure 28: Product InterComparsion: Spatial distribution in Completeness in SALVAL validation tool.

4.5.1.2. Temporal Variation

Temporal variation is divided into percent of gaps (or missing values) and length of gaps. The percent of gaps shows the mean amount of missing values (in relative values) of each product (evaluated and references) computed over LANDVAL V1.1. The length of gaps shows the mean length in days of the gaps for each product computed over LANDVAL V1.1. By default, percent of gaps for shortwave or broadband band and best quality pixels are showed. To change the spectral region (see 2.2) to Visible or Near Infrared move the radio select (1). To change from best quality pixels computation to all pixels computation unselect the “Best Quality” option (1).

Figure 29: Product InterComparison: Temporal Variation in Completeness in SALVAL validation tool. Top: Percent of gaps. Bottom: Length of gaps.

4.5.2. Spatial Consistency

Spatial Consistency tries to observe the realism and repeatability of the spatial distribution of product data around the world and for different types of biomes, as well as strange patterns or artifacts (e.g., fringes, unrealistic values). The Spatial Consistency is evaluated in four parts: Residual Map, Difference Map, Residual Spatial Consistency and Difference Spatial Consistency.

4.5.2.1. Residual Map

Residual Map is a map that represents the average residue for each LANDVAL V1.1 site between the product to be evaluated and the reference product in the period of the analysis. For that, the Major Axis Regression (MAR) is computed between the product to be evaluated and the reference product, obtaining a slope and an ordinate at the origin. In order to compute the calculation, the values of the reference products that are closest to the dates of the product to be evaluated were used. In the central panel, it is possible to see a map with the residuals between the product to be evaluated and the reference product. It is possible to change the reference product for another chosen in the configuration step using the reference change bar (1). By default, spectral range shortwave or broadband band and best quality pixels are showed. To change the spectral region (see 2.2) to Visible or Near Infrared move the radio select (2). To change from best quality pixels computation to all pixels computation unselect the “Best Quality” option (2).

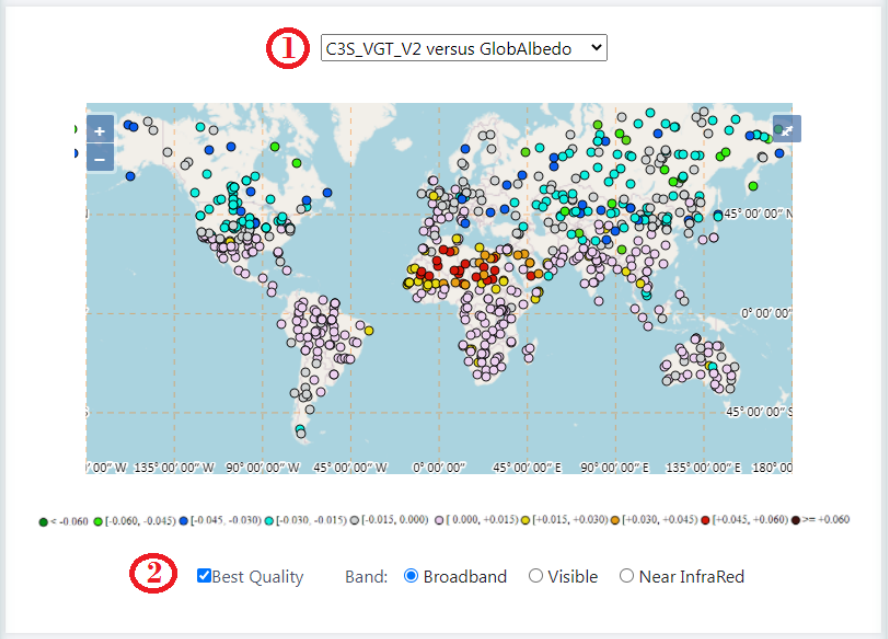


Figure 30: Product InterComparison: Residual Map in Spatial Consistency in SALVAL validation tool.

4.5.2.2. Difference Map

Difference Map is a map that represents the average difference for each LANDVAL V1.1 site between the product to be evaluated and the reference product in the period of validation. In order to compute the calculation, only the values of the dates of the reference product that are closest to the dates of the product to be evaluated are used. . In the central panel, it is possible to see a map with the differences between the product to be evaluated and the reference product. It is possible to change the reference product for another chosen in the configuration step using the reference change bar (1). By default, spectral range shortwave or broadband band and best quality pixels are showed. To change the spectral region (see 2.2) to Visible or Near Infrared move the radio select (2). To change from best quality pixels computation to all pixels computation unselect the “Best Quality” option (2).

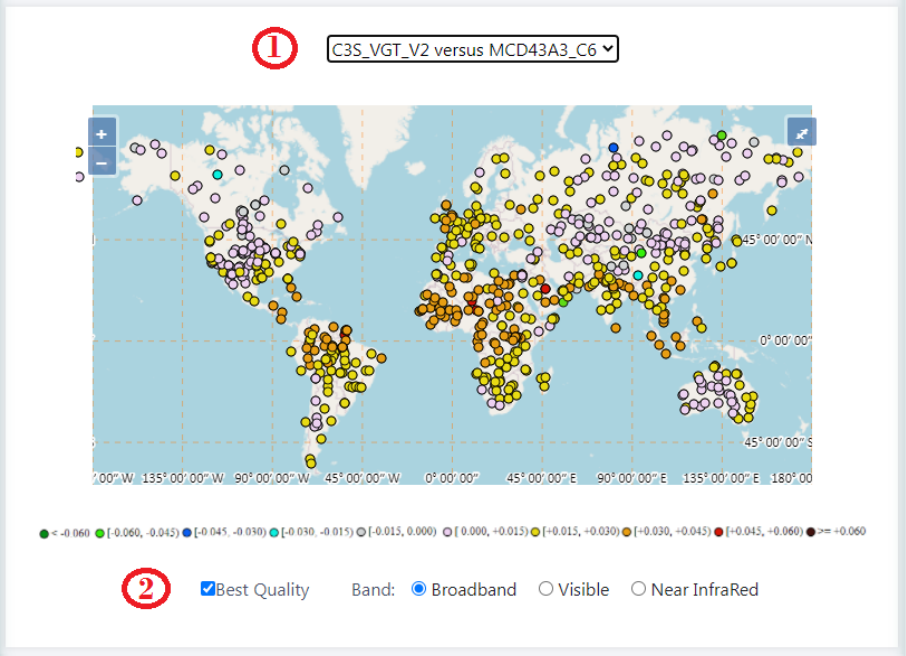


Figure 31: Product InterComparison: Difference Map in Spatial Consistency in SALVAL validation tool.

4.5.2.3. Residual Spatial Consistency

Residual Spatial Consistency is a map that represents the LANDVAL V.1.1 sites that reach the level associated with the requirements (see 2.5) for uncertainty or accuracy measurement adjusted in the configuration step for residuals. In order to compute the calculation, only the values of the dates of the reference product that are closest to the dates of the product to be evaluated are used. In the central panel, it is possible to see a map with the levels reached when compute residuals between the product to be evaluated and the reference product. Also, the percentage of LANDVAL V1.1 sites that reach each requirement (Optimal, Target,

Threshold and Non-Compliance) is showed below of the map. It is possible to change the reference product for another chosen in the configuration step using the reference change bar (1). By default, spectral range shortwave or broadband band and best quality pixels are showed. To change the spectral region (see 2.2) to Visible or Near Infrared move the radio select (2). To change from best quality pixels computation to all pixels computation unselect the “Best Quality” option (2).

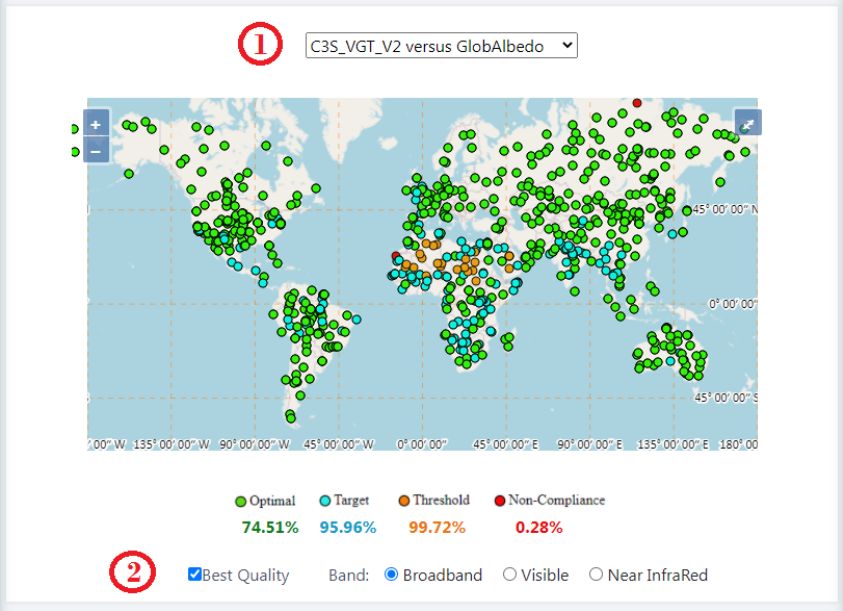


Figure 32:Product InterComparison: Residual Spatial Consistency in Spatial Consistency in SALVAL validation tool.

4.5.2.4. Difference Spatial Consistency

Difference Spatial Consistency is a map that represents the LANDVAL V.1.1 sites that reach the level associated with the requirements (see 2.5) for uncertainty or accuracy measurement adjusted in the configuration step for differences. In order to compute the calculation, only the values of the dates of the reference product that are closest to the dates of the product to be evaluated are used. In the central panel, it is possible to see a map with the levels reached when compute residuals between the product to be evaluated and the reference product. Also, the percentage of LANDVAL V1.1 sites that reach each requirement (Optimal, Target, Threshold and Non-Compliance) is showed below of the map. It is possible to change the reference product for another chosen in the configuration step using the reference change bar (1). By default, spectral range shortwave or broadband band and best quality pixels are showed. To change the spectral region (see 2.2) to Visible or Near Infrared move the radio select (2). To change from best quality pixels computation to all pixels computation unselect the “Best Quality” option (2).

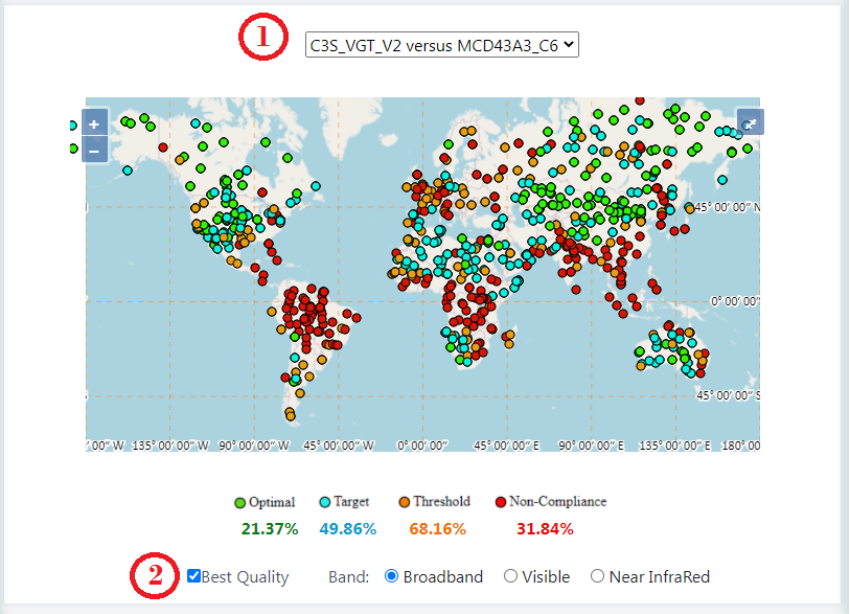


Figure 33: Product InterComparison: Difference Spatial Consistency in Spatial Consistency in SALVAL validation tool.

4.5.3. Temporal Consistency

Temporal Consistency aims to evaluate the temporal variations around the world and for different types of biomes. For that, the Temporal Consistency analysis is divided into Temporal Profiles and Cross Correlation.

4.5.3.1. Temporal profiles

Temporal profiles show the temporal evolution of the products (product to be evaluated and reference products) over LANDVAL V1.1 sites for the period selected in the configuration step. It is possible to change the LANDVAL V1.1 profile using the sites change bar (1). By default, spectral range shortwave or broadband band and best quality pixels are showed. To change the spectral region (see 2.2) to Visible or Near Infrared move the radio select (2). To change from best quality pixels computation to all pixels computation unselect the “Best Quality” option (2).

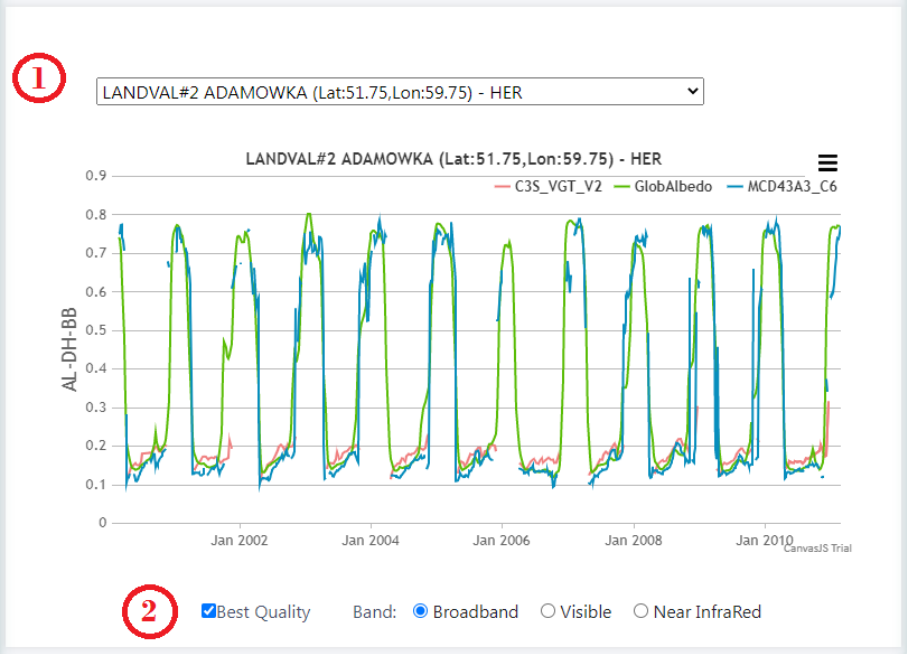


Figure 34: Product InterComparison: Temporal Profiles in Temporal Consistency in SALVAL validation tool.

4.5.3.2. Cross Correlation

Cross Correlation is a standard method for estimating the degree to which two series are correlated. The graph shows the cross correlations between the product to be evaluated and the reference products in the validation period. In the central panel, it is possible to see the distribution of correlations in relative terms, and the percentage that reach the threshold (R=0.8 in the example). By default, the correlation threshold is 0.8, but can be changed using the “Percentage Correlation” input (1). By default, spectral range shortwave or broadband band and best quality pixels are showed. To change the spectral region (see 2.2) to Visible or Near Infrared move the radio select (2). To change from best quality pixels computation to all pixels computation unselect the “Best Quality” option (2).

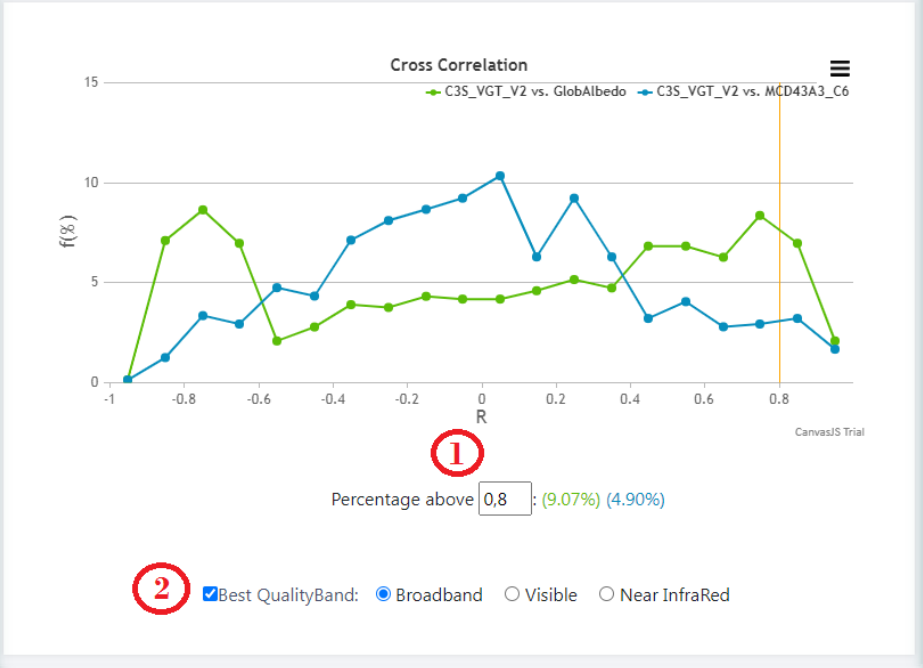


Figure 35: Product InterComparison: Cross Correlation in Temporal Consistency in SALVAL validation tool.

4.5.4. Overall Analysis

The Overall Analysis is an extension of the Product InterComparison that includes: Product Histogram, Difference Histogram, Scatter Plot and Box Plots.

4.5.4.1. Product Histogram

Product Histogram shows the frequency in relative terms in which the products (product to be evaluated and reference products) takes an albedo value within the range [0,1] in the validation period over LANDVAL V1.1. So, Product Histogram shows the distribution of the albedo values for each product. By default, spectral range shortwave or broadband band and best quality pixels are showed. To change the spectral region (see 2.2) to Visible or Near Infrared move the radio select (1). To change from best quality pixels computation to all pixels computation unselect the “Best Quality” option (1).

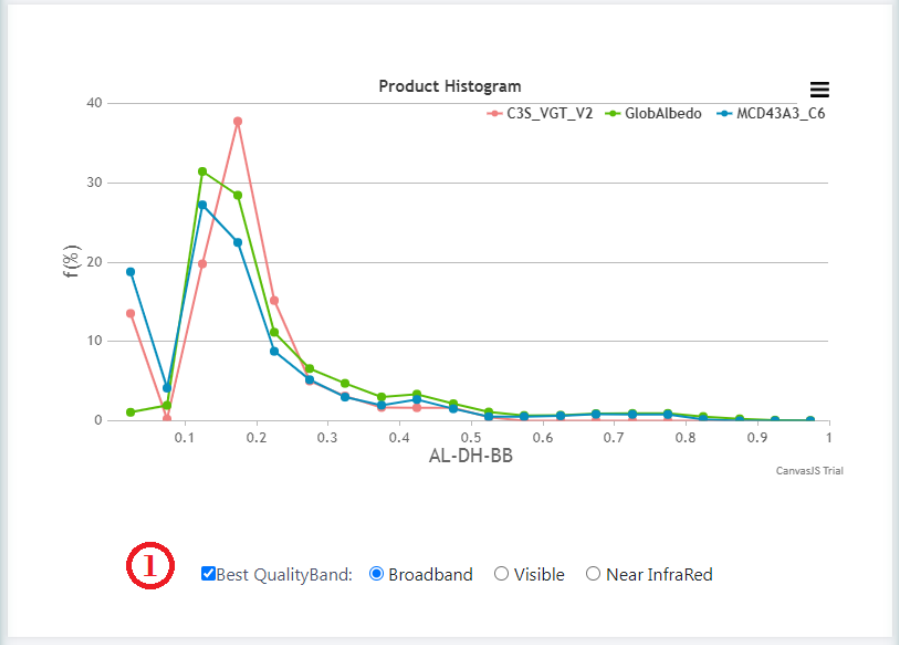


Figure 36: Product InterComparison: Product Histogram in Overall Analysis in SALVAL validation tool.

4.5.4.2. Difference Histogram

Difference Histogram shows the frequency in relative terms of the differences between the product to be evaluated and the reference products in the validation period over LANDVAL V1.1, being the differences within the range [-1,1]. Additionally, percentage within a selected range is showed. By default the percentage within ±0.1 is showed, but can be changed using the “Percentage within” input (1). By default, spectral range shortwave or broadband band and best quality pixels are showed. To change the spectral region (see 2.2) to Visible or Near Infrared move the radio select (2). To change from best quality pixels computation to all pixels computation unselect the “Best Quality” option (2).

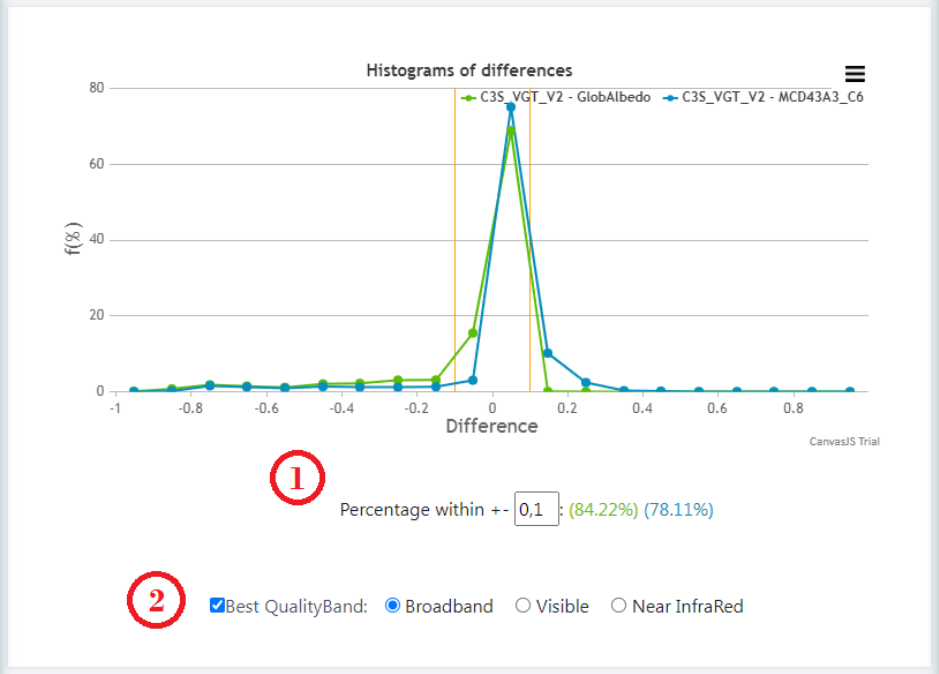


Figure 37: Product InterComparison: Difference Histogram in Overall Analysis in SALVAL validation tool.

4.5.4.3. Scatter Plot

Scatter plots between the product to be evaluated and the reference products in the validation period over LANDVAL V1.1 are computed. Additionally, the MAR, the unit slope and the lines that define the uncertainty or accuracy requirements (see 2.5) of the measurement are represented. Furthermore, some metrics are provided as number of samples, correlation, MAR, mean value of the product to be evaluated, the percentages of values that reach each requirement level, bias, median deviation, standard deviation, median absolute deviation or RMSD. The comparison can be change to another reference product using the “Reference Change” bar (1). By default, spectral range shortwave or broadband band and best quality pixels are showed. To change the spectral region (see 2.2) to Visible or Near Infrared move the radio select (2). To change from best quality pixels computation to all pixels computation unselect the “Best Quality” option (2).

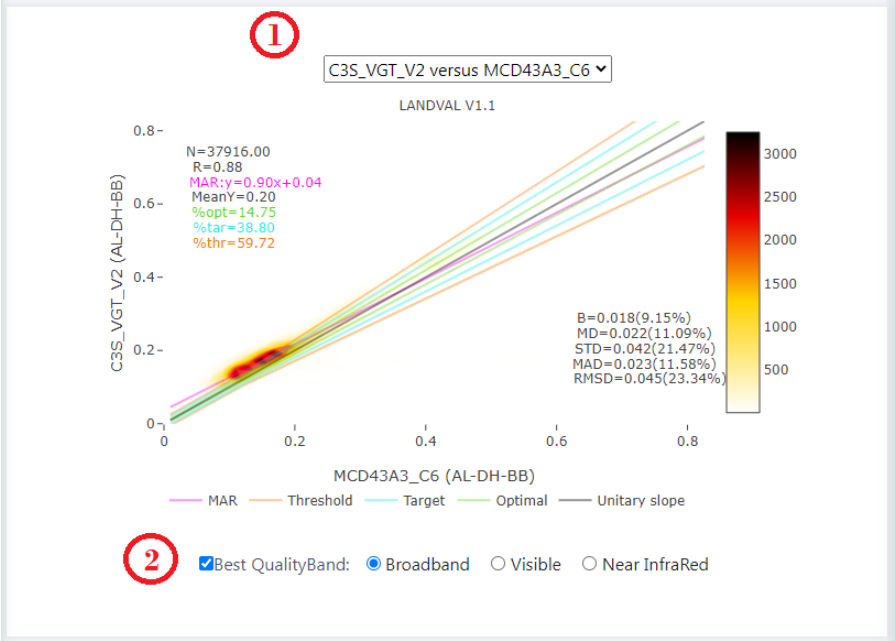
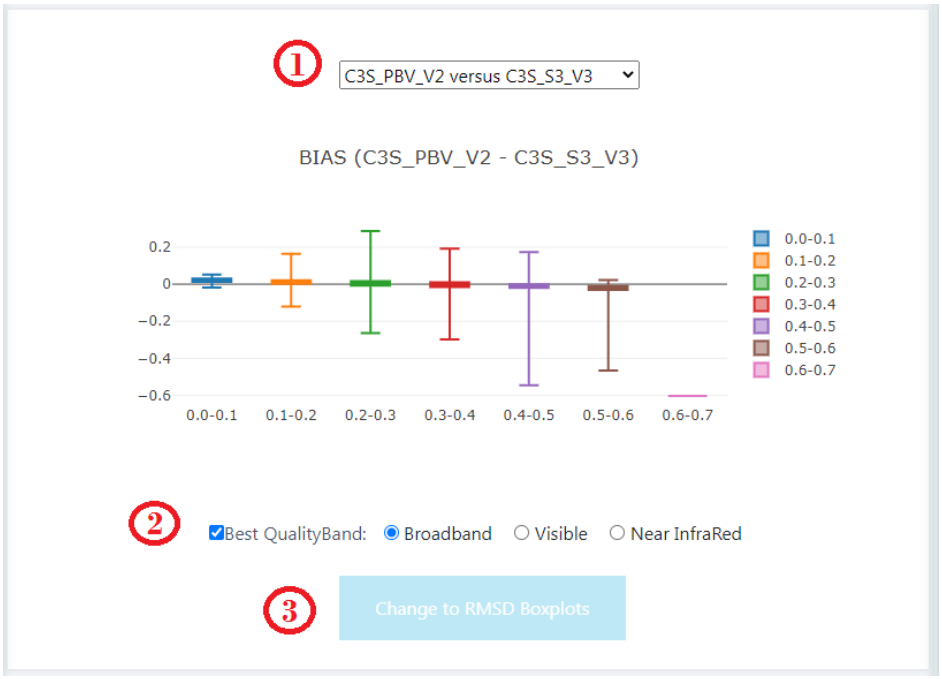


Figure 38: Product InterComparsion: Scatter Plot in Overall Analysis in SALVAL validation tool.

4.5.4.4. Box Plots

Box Plots show the Bias and RMSD between the product to be evaluated and the reference products for different albedo ranges (from albedo values of 0 to 1 with step 0.1). Hovering over each box, it is possible to see the median value, percentiles and minimum and maximum values. The comparison can be change to another reference product using the “Reference Change” bar (1). By default, spectral range shortwave or broadband band and best quality pixels are showed. To change the spectral region (see 2.2) to Visible or Near Infrared move the radio select (2). To change from best quality pixels computation to all pixels computation unselect the “Best Quality” option (2). Furthermore, it is possible to change from bias to RMSD boxplots click in “Change to RMSD Boxplots” (3) button and change from RMSD to bias click in “Change to bias Boxplots” (4) button.



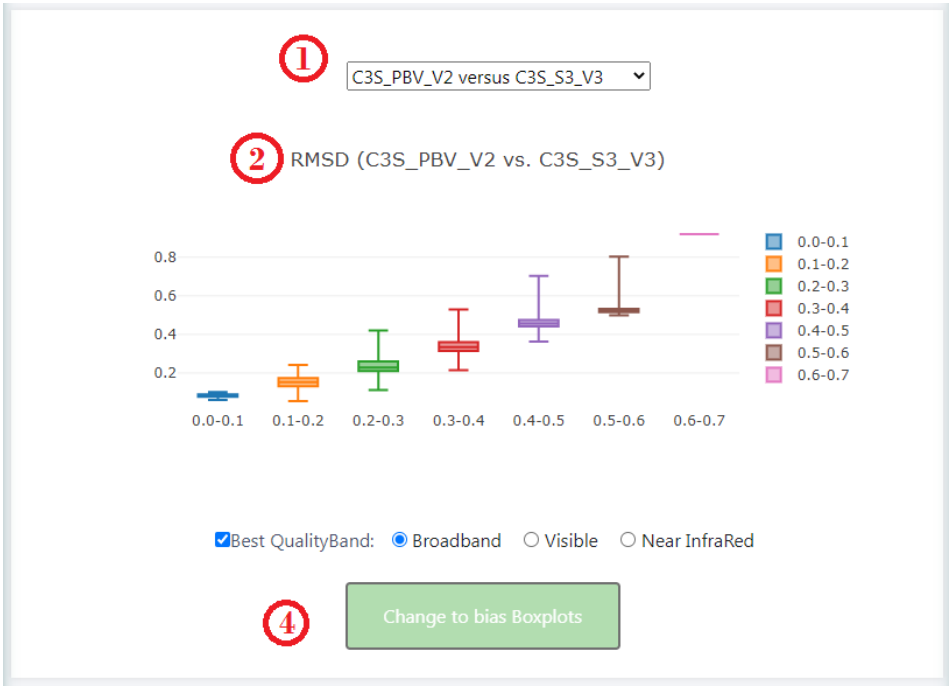


Figure 39: Product InterComparison: Box Plots in Overall Analysis in SALVAL validation tool.

4.6. DIRECT VALIDATION

Direct Validation is the most important part of the validation and aims to evaluate the accuracy of the product using metrics that report the level of fit between products and in-situ or ground data measurements. For the Direct Validation, Accuracy (scatter plots) and Temporal Profiles are included.

4.6.1. Accuracy

Accuracy shows the scatter plots between the product to be evaluated (for benchmark reference products were also included in this subsection) with the ground data or in situ measurements. Furthermore, some metrics are provided as number of samples, correlation, MAR, mean value of the product to be evaluated, the percentages of values that reach each requirement level, bias, median deviation, standard deviation, median absolute deviation or RMSD. The median absolute deviation between product and in situ data is recommended to quantify accuracy (Fernandes et al., 2014). The comparison can be change to another product using the "Product Change" bar (1). By default, blue-sky albedo and best quality pixels are showed (see 2.6.2). To change the albedo type move the radio select (2). To change from best quality pixels computation to all pixels computation unselect the "Best Quality" option (2).

Figure 40: Direct Validation: Accuracy in SALVAL validation tool.

4.6.2. Temporal profiles

Temporal profiles show the temporal evolution of the satellite-derived albedo products (product to be evaluated and reference products) and ground data or in-situ measurements (black sky albedos) for the period selected in the configuration step. It is possible to change the LANDVAL V1.1 profile using the sites change bar (1). By default, best quality pixels are showed. To change from best quality pixels computation to all pixels computation unselect the "Best Quality" option (2).

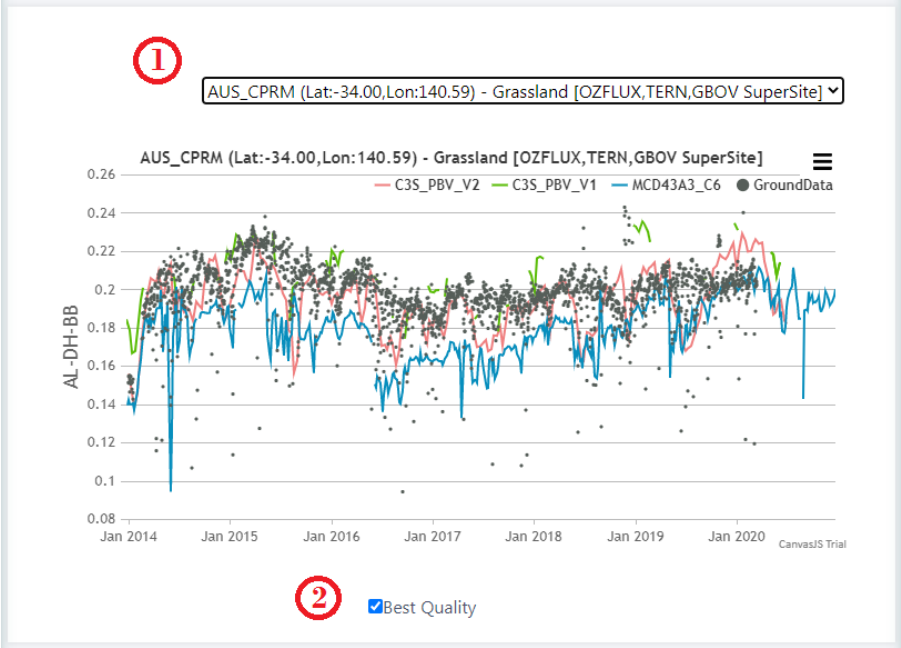


Figure 41: Direct Validation: Temporal profiles in SALVAL validation tool.

4.7. PRECISION

The precision analysis is divided into Intra-annual precision and Inter-annual precision. For that analysis, at least two years of period of the datasets must be available (if not, this options is disabled).

4.7.1. Intra-annual

Intra-annual precision, also known as smoothness (δ), corresponds to temporal noise that is assumed to be uncorrelated with the series of a season. To quantify the intra-annual precision, it is recommended the use of variable anomalies from the linear estimation base on the neighbors.

$$\delta(d_{n+1}) = \left| P(d_{n+1}) - P(d_n) - \frac{P(d_{n+2}) - P(d_n)}{d_{n+2} - d_n}(d_{n+1} - d_n) \right|$$

The smoothness (δ) corresponds to the absolute value of the difference between the central observation $P(d_{n+1})$ and the linear interpolation between two extremes $P(d_n)$ and $P(d_{n+2})$.

For the representation of intra-annual precision or smoothness, an histogram shows the frequency in relative terms of the different δ values in the validation period over LANDVAL V1.1 sites. In addition, median smoothness is showed as the main indicator of intra-annual precision. By default, spectral range shortwave or broadband band and best quality pixels are showed. To change the spectral region (see 2.2) to Visible or Near Infrared move the radio select (1). To change from best quality pixels computation to all pixels computation unselect the “Best Quality” option (1).

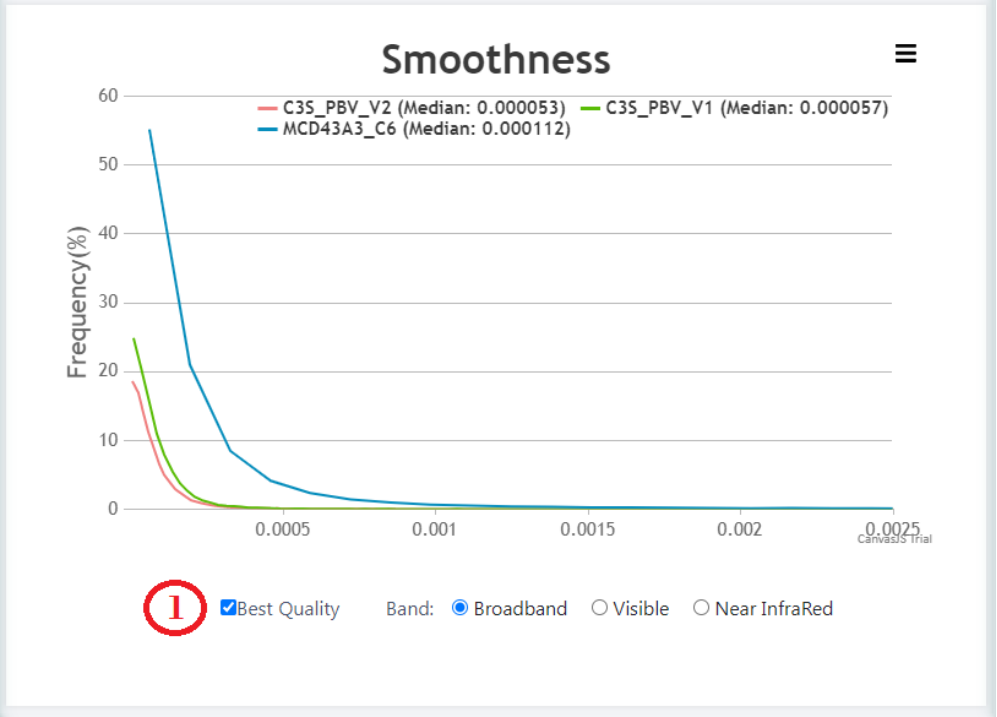


Figure 42: Precision: Intra-annual precision or smoothness in SALVAL validation tool.

4.7.2. Inter-annual

For the evaluation of inter-annual precision, the use of the upper and lower percentile of the variable (dispersion of variable values) between one year and another is recommended (Fernandes et al., 2014). For the inter-annual precision analysis, a scatter plot is represented between the series (y) and the series shifted one year (y+365days) nineteen LANDVAL V1.1 calibration sites. The calibration sites of LANDVAL are bare areas known for being highly stable in time. In order to compute the calculation, only the values of the dates of the reference product that are closest to the dates of the product to be evaluated are used.

The median of the absolute deviation between the product data for one year and another is recommended to quantify the inter-annual precision (Fernandes et al., 2014). Furthermore, some metrics are provided as number of samples, correlation, MAR, mean value of the product to be evaluated, the percentages of values that reach each requirement level, bias, median deviation, standard deviation, median absolute deviation or RMSD. The comparison can be change to another product using the “Product Change” bar (1). By default, spectral range shortwave or broadband band and best quality pixels are showed. To change the spectral region (see 2.2) to Visible or Near Infrared move the radio select (2). To change from best quality pixels computation to all pixels computation unselect the “Best Quality” option (2).

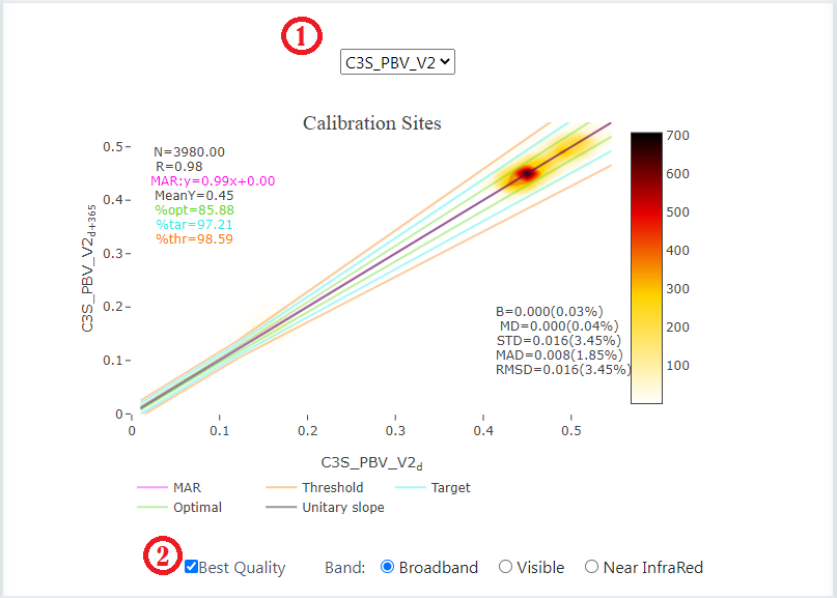


Figure 43: Precision: Inter-annual Precision in SALVAL validation tool.

4.8. STABILITY

Stability is the extent in time to which a product remains constant over a long period, usually a decade or more (Fell et al., 2012). For the stability validation, the temporary profiles of the products in the validation period over LANDVAL V1.1 calibration sites are showed. Calibration sites are used because a negligible change in surface albedo is expected over time. The slope of the linear regression of the albedo products on each site of the LANDVAL V1.1 calibration sites is calculated, giving as stability indicator the slope per ten years. The mean slope per ten years of the nineteen calibration sites is displayed too. It is possible to change the LANDVAL V1.1 profile using the sites change bar (1). By default, spectral range shortwave or broadband band and best quality pixels are showed. To change the spectral region (see 2.2) to Visible or Near Infrared move the radio select (2). To change from best quality pixels computation to all pixels computation unselect the “Best Quality” option (2).

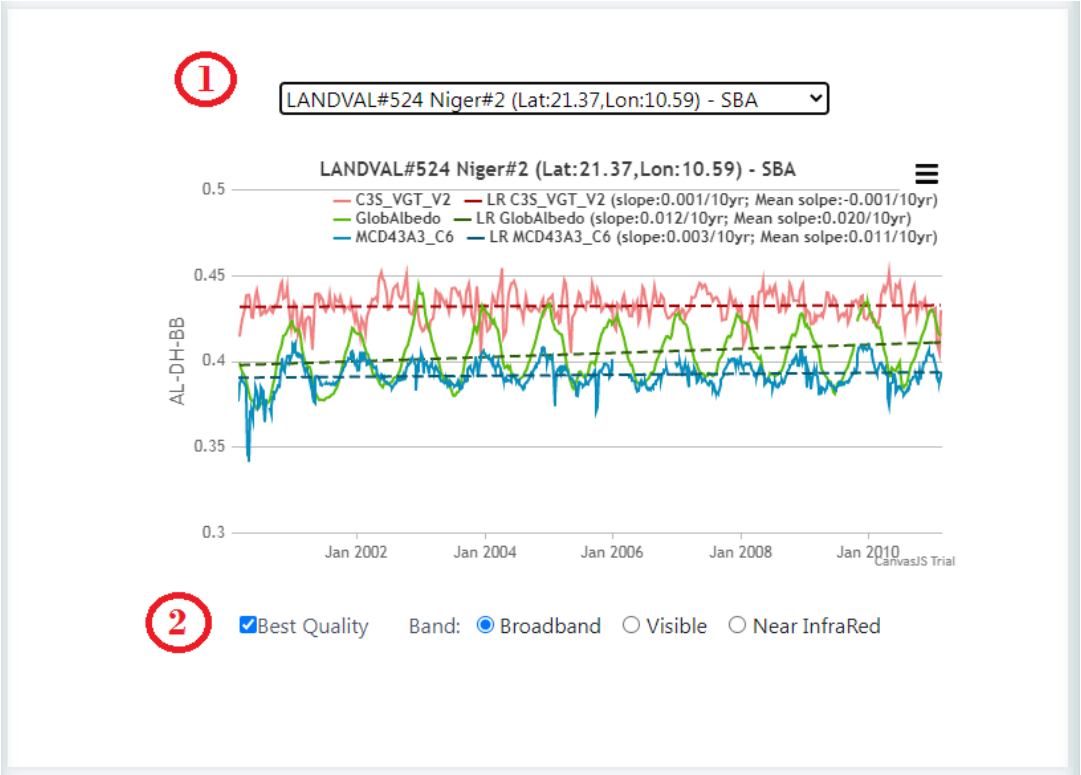


Figure 44: Stability in SALVAL validation tool.

4.9. VALIDATION REPORT (PDF)

When click in “Generate VR (PDF)” button (see 3.3.9), a new page is opened making a summary of the analysis. In this step, it is necessary to be patient, because the server has to generate all the maps and graphs to be used in the validation report (VR). In this context, only Best Quality retrievals (see 2.2.1) are taking into account. In the cover page it is located the tittle of the VR with information about the product to be evaluated, the reference products and the period chosen for the validation (see Figure 45).

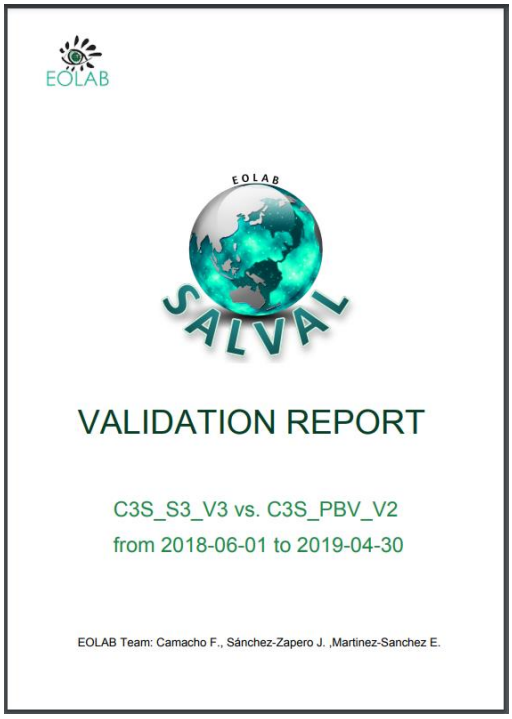


Figure 45: Validation Report Cover Page.

The validation report is divided into sections. The number of sections depends on the period extension (if five or more years are chosen, all the sections are calculated in the VR; if the period extension is between two and five years the section stability won’t displayed; if lower than two years are chosen, both stability and precision sections won’t displayed. The VR sections are the next:

1. Completeness: Includes maps showing the spatial distribution of gaps (1.1 Spatial Distribution) and graphs displaying the percentage of gaps for each date and the length of gaps in relative terms (1.2 Temporal Variation) over LANDVAL V1.1 sites.

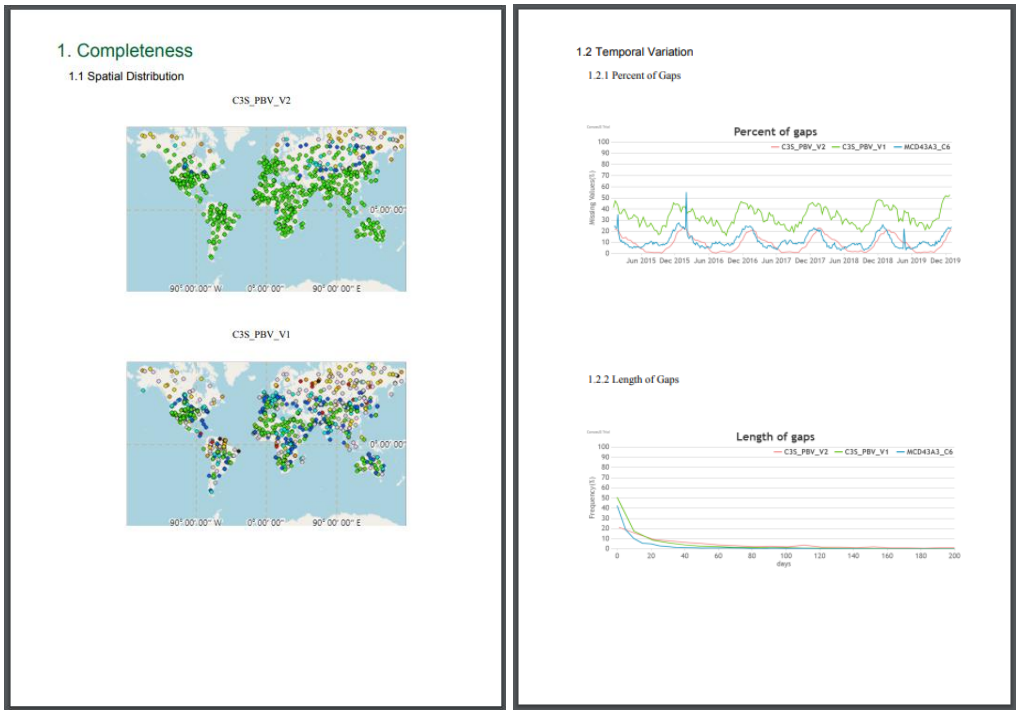


Figure 46: Validation Report: Completeness section.

2. Spatial Consistency section: Includes residual maps (2.1 Residual Maps) and residual consistency maps (2.2 Residual Spatial Consistency Maps) between the product to be evaluated and the reference products over LANDVAL V1.1 sites.

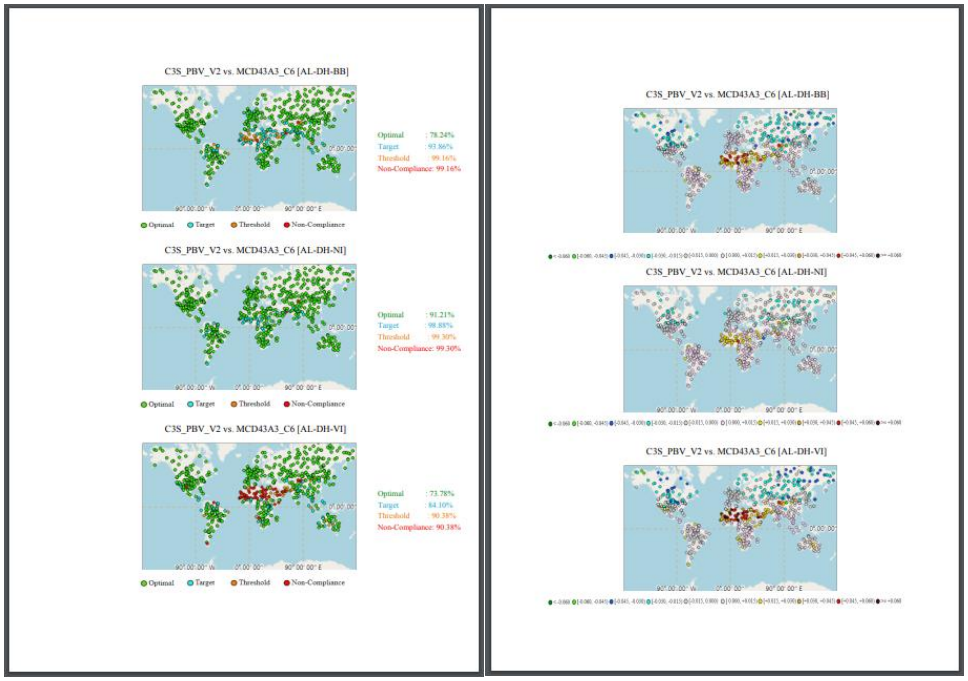


Figure 47 Validation Report: Spatial Consistency section.

In the residual spatial consistency maps, a summary of the percentage of LANDVAL V1.1 sites that reach the requirements are showed.

3. Temporal Consistency section: shows two examples of temporal profiles per main biome type (EBF, DBF, NLF, OF, CUL, HER, SHR, SBA) per each spectral region (BB, NI and VI) over LANDVAL V1.1 sites.

Figure 48: Validation Report: Temporal Consistency section.

4. Overall Analysis section: Includes histogram of differences (4.1 Histogram of differences) and scatter plots (4.2 Scatter Plots) between the product to be evaluated and the reference products for each spectral region (BB, NI and VI) computed over LANDVAL V1.1 sites. In histogram of differences, the percentage within ±0.1 of difference is showed. In case of scatter plots, a summary of the main statistics are displayed at the end of each spectral region subsection.

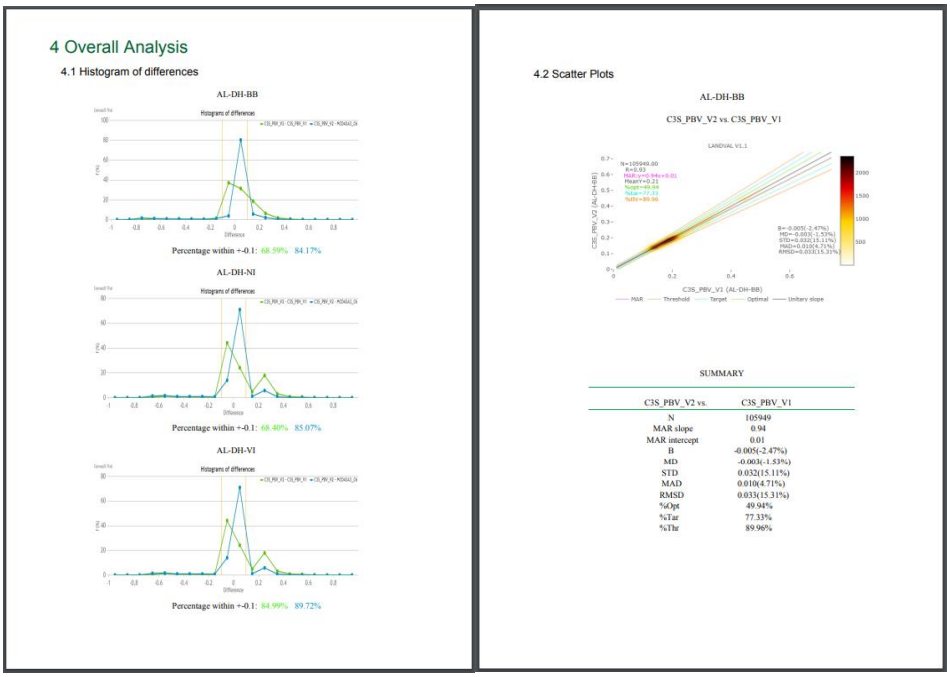


Figure 49: Validation Report: Overall Analysis section.

5. Precision section: Includes intra-annual precision or smoothness (5.1 Intra-annual precision) and inter-annual precision or scatter plots (5.2 Inter-annual precision) between a day (d) and the series shifted one year (d+365) computed over LANDVAL V1.1 sites.

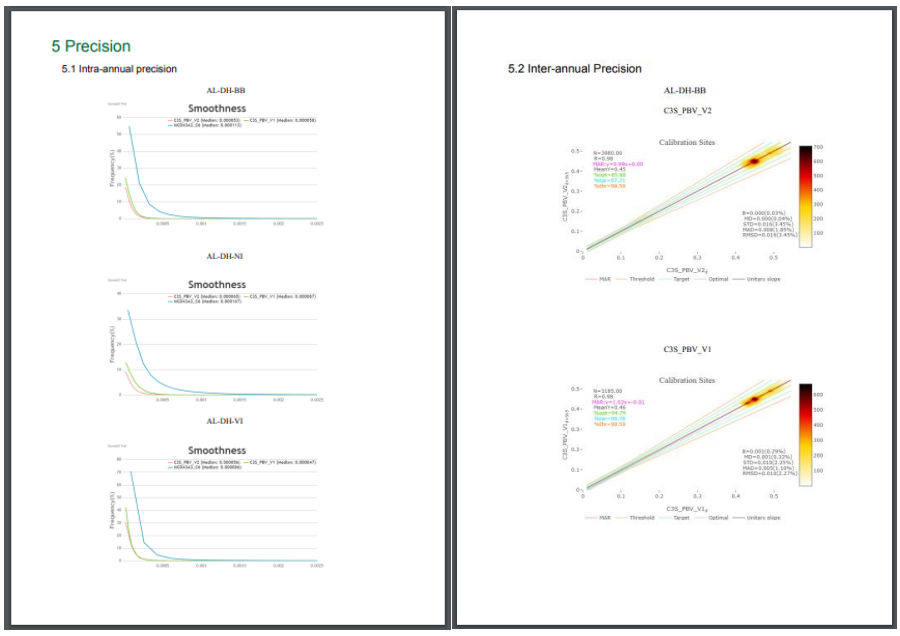


Figure 50: Validation report: Precision section.

The precision section only is computed if more than two years of period was chosen in the configuration steps. The intra-annual precision includes the delta indicator at the top right of each graph and the inter-annual precision includes a summary of the main statistics per main biome type.

6. Direct Validation section: Scatter plots between all the products and ground data based measurements (6.1 Accuracy) and temporal profiles (6.2 Temporal profiles) are included in this section. Only black-sky albedo are taking into account and a summary of the main statistics are displayed at the end of the scatter plots subsection. In temporal profiles subsection, all profiles corresponding to the available ground sites in the SALVAL GD are included in the VR.

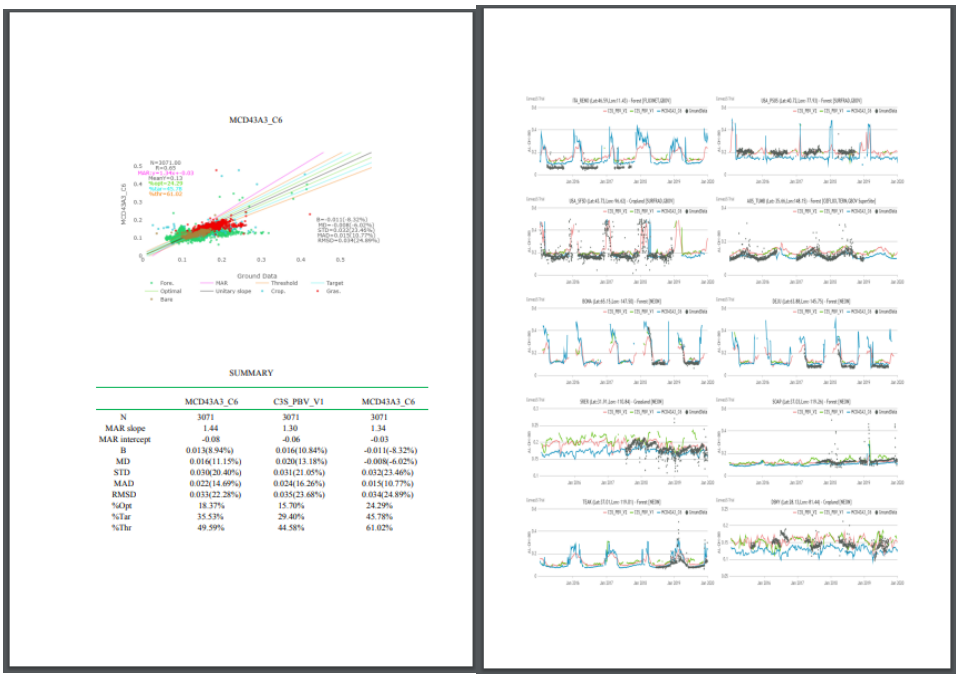


Figure 51: Validation Report: Direct Validation section.

7. Stability section: Stability section shows some examples of temporal profiles over LANDVAL V1.1 calibration sites. In each profile the linear regression is represented and the slope/10year is depicted. At the end of the section, a summary of the mean slope/10year over the 19 calibration sites is represented.

Figure 52: Validation Report: Stability section.

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ANNEX I: LANDVAL V1.1 SITES SUMMARY

ID	Name	Latitude	Longitude	Biome	Continent
1	ABRACOS_HILL	-10.76	-62.358333	6	2
2	ADAMOWKA	51.75	59.75	6	3
3	AGUASCALIENTES	21.7	-102.32	5	1
4	AIRE_ADOUR	43.7	0.25	5	3
5	AL_KHAZNAH	24.158611	55.100556	8	4
6	AMES	42.021361	-93.774778	5	1
7	AOE_BAOTOU	40.8517	109.6288	6	5
8	ARM_CART_PONCA	36.77	-97.13	5	1
9	ARM_CART_SGP	36.64	-97.5	5	1
10	ARM_CART_SHIDLER	36.93	-96.86	6	1
11	ASP	-23.798	133.888	6	6
12	AU-FOG	-12.5425	131.307	4	6
13	AU-HOW	-12.4943	131.152	2	6
14	AU-TUM	-35.6557	148.152	1	6
15	AUTILLA	41.997222	-4.603056	5	3
16	AZ_BORDER_STATION	32.487	-114.7	8	1
17	BAC_LIEU	9.28	105.73	4	5
18	BAMBEY-ISRA	14.708567	-16.476733	5	4
19	BANIZOUMBOU	13.541167	2.66475	5	4
20	BARTON_BENDISH	52.61	0.53	5	3
21	BASKIN	32.28222	-91.73866	5	1
22	BE-LON	50.5522	4.74494	5	3
23	BELMANIP_00001	-43.9024139	-65.7650985	7	2
24	BELMANIP_00003	-35.436814	-68.001143	7	2
25	BELMANIP_00004	-38.691321	-67.027077	7	2
26	BELMANIP_00006	-39.088162	-69.058273	7	2
27	BELMANIP_00007	-32.033513	-63.779423	5	2
28	BELMANIP_00009	-21.815828	-62.089606	2	2
29	BELMANIP_00010	-24.780189	-62.338143	2	2
30	BELMANIP_00013	-22.171504	-51.666539	0	2
31	BELMANIP_00014	-22.5947146	-49.9576388	5	2
32	BELMANIP_00017	-11.742246	-71.114795	1	2
33	BELMANIP_00019	-11.746512	-53.344691	1	2
34	BELMANIP_00020	-18.769628	-62.08026	4	2

35	BELMANIP_00024	-14.338407	-43.338407	5	2
36	BELMANIP_00025	-14.725375	-41.747071	7	2
37	BELMANIP_00026	-16.816896	-50.098511	6	2
38	BELMANIP_00028	-0.26432759	-71.2694818	1	2
39	BELMANIP_00029	-1.60555755	-71.5517578	1	2
40	BELMANIP_00030	-2.67854152	-63.648028	1	2
41	BELMANIP_00031	-4.473253	-54.648013	1	2
42	BELMANIP_00032	-4.928489	-69.128753	1	2
43	BELMANIP_00033	-5.881343	-58.987844	1	2
44	BELMANIP_00034	-6.511772	-53.7028	1	2
45	BELMANIP_00035	-7.600934	-59.410057	1	2
46	BELMANIP_00036	-8.348099	-72.296481	1	2
47	BELMANIP_00038	-9.745056	-60.335094	1	2
48	BELMANIP_00040	-8.403021	-35.606546	6	2
49	BELMANIP_00042	7.06997787	-59.413887	1	2
50	BELMANIP_00044	2.94569574	-53.7683657	1	2
51	BELMANIP_00045	1.77211953	-63.789166	1	2
52	BELMANIP_00046	0.720435	-71.360518	1	2
53	BELMANIP_00047	5.734292	-69.186039	6	2
54	BELMANIP_00048	3.996335	-71.684831	6	2
55	BELMANIP_00050	17.594038	-89.78266	1	1
56	BELMANIP_00051	14.31837	-84.977614	1	2
57	BELMANIP_00056	29.99962	-104.189549	7	1
58	BELMANIP_00057	27.571072	-103.607599	7	1
59	BELMANIP_00058	28.890987	-98.1605	4	1
60	BELMANIP_00060	39.541338	-80.567695	2	1
61	BELMANIP_00061	35.797081	-93.493553	2	1
62	BELMANIP_00063	34.260447	-110.508144	3	1
63	BELMANIP_00068	30.6320741	-105.283748	7	1
64	BELMANIP_00069	38.633238	-98.913151	5	1
65	BELMANIP_00070	32.1832	-97.065398	6	1

66	BELMANIP_00071	39.890621	-88.292336	5	1
67	BELMANIP_00072	36.7011396	-86.7946654	5	1
68	BELMANIP_00075	41.588198	-77.852451	2	1
69	BELMANIP_00081	47.71679	-67.793848	4	1
70	BELMANIP_00082	46.745427	-70.403859	4	1
71	BELMANIP_00083	46.592459	-105.114727	6	1
72	BELMANIP_00085	41.241915	-108.279494	6	1
73	BELMANIP_00086	46.337123	-101.066187	6	1
74	BELMANIP_00087	42.127338	-100.903664	6	1
75	BELMANIP_00088	49.271135	-102.671298	5	1
76	BELMANIP_00089	43.544548	-96.336841	5	1
77	BELMANIP_00090	42.73256	-82.205829	5	1
78	BELMANIP_00091	41.25156	-94.781119	5	1
79	BELMANIP_00094	52.382602	-124.28587	3	1
80	BELMANIP_00095	52.795269	-96.200026	3	1
81	BELMANIP_00098	50.265645	-85.780705	3	1
82	BELMANIP_00099	57.658635	-118.521428	3	1
83	BELMANIP_00100	57.280704	-93.99289	7	1
84	BELMANIP_00103	57.159575	-157.684452	7	1
85	BELMANIP_00106	52.110152	-104.750799	5	1
86	BELMANIP_00108	61.002882	-127.620524	3	1
87	BELMANIP_00113	68.922127	-158.789439	6	1
88	BELMANIP_00114	67.916808	-145.462295	6	1
89	BELMANIP_00116	68.490184	-121.441895	6	1
90	BELMANIP_00117	64.409939	-83.856196	8	1
91	BELMANIP_00118	60.501978	-72.371367	8	1

92	BELMANIP_00120	-21.420532	30.4448	4	4
93	BELMANIP_00122	-21.904271	29.470052	7	4
94	BELMANIP_00123	-27.707551	23.82799	6	4
95	BELMANIP_00124	-23.95271	20.210564	7	4
96	BELMANIP_00125	-22.1923457	45.807658	6	4
97	BELMANIP_00126	-29.4014567	19.6459848	8	4
98	BELMANIP_00127	-27.6075616	27.9533635	6	4
99	BELMANIP_00128	-23.4832795	28.195326	7	4
100	BELMANIP_00134	-17.9763999	16.8230892	7	4
101	BELMANIP_00135	-18.8817301	23.5980388	7	4
102	BELMANIP_00136	-18.4625957	44.4068125	6	4
103	BELMANIP_00138	-17.5572655	46.5038207	6	4
104	BELMANIP_00139	-17.95628	15.504162	6	4
105	BELMANIP_00140	-0.36491984	12.7903811	1	4
106	BELMANIP_00141	-2.86296064	13.1129977	1	4
107	BELMANIP_00142	-4.58979421	23.4367305	1	4
108	BELMANIP_00144	-9.51881431	19.0007516	2	4
109	BELMANIP_00146	-5.444776	31.737217	2	4
110	BELMANIP_00147	-9.56911043	30.2923342	2	4
111	BELMANIP_00148	-6.90341589	30.8569133	6	4
112	BELMANIP_00151	-2.673826	35.191517	6	4
113	BELMANIP_00152	-5.07599007	32.8732674	4	4
114	BELMANIP_00154	2.40920376	13.1936519	1	4
115	BELMANIP_00155	1.8562	28.193661	1	4

116	BELMANIP_00158	7.10350862	13.4356144	4	4
117	BELMANIP_00165	5.98022852	31.17953	6	4
118	BELMANIP_00169	3.29776861	36.9866296	8	4
119	BELMANIP_00171	1.25239292	34.0830798	5	4
120	BELMANIP_00172	8.09266571	-11.153066	4	4
121	BELMANIP_00173	2.10742702	32.8732674	5	4
122	BELMANIP_00175	10.4979511	-8.98624262	4	4
123	BELMANIP_00177	16.2652399	-10.7606342	6	4
124	BELMANIP_00179	12.3253769	28.7599051	6	4
125	BELMANIP_00180	16.4831898	-6.24400112	6	4
126	BELMANIP_00181	14.6892947	13.1129977	8	4
127	BELMANIP_00186	10.6991356	39.4062545	5	4
128	BELMANIP_00189	12.0236001	20.3718723	6	4
129	BELMANIP_00195	17.38852	27.0661677	8	4
130	BELMANIP_00201	29.8194993	-4.14699291	8	4
131	BELMANIP_00203	22.1241924	-13.7448382	8	4
132	BELMANIP_00207	27.87	28.8718	8	4
133	BELMANIP_00214	21.6044658	58.0373659	8	4
134	BELMANIP_00222	22.24155	42.7937293	8	4
135	BELMANIP_00224	25.8796363	59.08587	8	4
136	BELMANIP_00225	35.0916637	-1.0014806	5	3
137	BELMANIP_00226	37.4891122	40.9386836	6	3
138	BELMANIP_00228	30.4308896	-7.37315938	8	4
139	BELMANIP_00229	34.7228254	9.48356045	6	4
140	BELMANIP_00230	31.8056503	20.694489	8	4
141	BELMANIP_00233	30.9501	31.0539	5	4
142	BELMANIP_00234	38.0088388	40.8580294	5	3
143	BELMANIP_00241	39.5512533	58.8439075	8	3
144	BELMANIP_00243	44.5329	38.8881	2	3
145	BELMANIP_00244	43.860275	-1.098893	4	3
146	BELMANIP_00246	48.327381	49.5686789	6	3
147	BELMANIP_00247	49.6853763	54.4885828	6	3
148	BELMANIP_00248	42.1241924	-	5	3

			5.11484285		
149	BELMANIP_00250	44.8702	11.9698	5	3
150	BELMANIP_00251	46.1107	19.9447	5	3
151	BELMANIP_00253	47.0995	33.3209	5	3
152	BELMANIP_00255	47.8244197	53.0368079	6	3
153	BELMANIP_00256	41.973304	55.5370869	8	3
154	BELMANIP_00257	57.6045	42.5802	2	3
155	BELMANIP_00258	54.7395908	57.3921326	2	3
156	BELMANIP_00260	59.6518455	58.6825992	3	3
157	BELMANIP_00262	57.254397	50.617183	4	3
158	BELMANIP_00264	51.9230079	-4.313013	6	3
159	BELMANIP_00265	53.180411	-0.11428481	5	3
160	BELMANIP_00266	50.8835547	2.572113	5	3
161	BELMANIP_00267	51.0679738	11.4999145	5	3
162	BELMANIP_00270	53.2810032	53.2787703	5	3
163	BELMANIP_00271	63.17708	44.039567	3	3
164	BELMANIP_00272	64.1695681	51.1817621	3	3
165	BELMANIP_00273	61.888502	58.35987	3	3
166	BELMANIP_00274	63.8845567	26.7435511	3	3
167	BELMANIP_00276	-31.1528924	124.072684	4	6
168	BELMANIP_00277	-34.8077441	141.312127	2	6
169	BELMANIP_00280	-31.383803	116.868816	5	6
170	BELMANIP_00281	-35.8639627	143.025989	5	6
171	BELMANIP_00284	-26.2009	115.08157	7	6
172	BELMANIP_00285	-23.6509332	124.980023	6	6
173	BELMANIP_00286	-29.7199988	126.492255	6	6
174	BELMANIP_00288	-25.3610014	115.906633	6	6
175	BELMANIP_00289	-20.2978583	124.879208	6	6
176	BELMANIP_00291	-29.3846913	133.24689	7	6
177	BELMANIP_00293	-	143.832513	6	6

		21.5384961			
178	BELMANIP_00294	-25.5286552	137.985217	6	6
179	BELMANIP_00295	-28.5799533	140.203157	6	6
180	BELMANIP_00296	-16.4507508	142.622727	2	6
181	BELMANIP_00297	-17.2387234	122.963714	6	6
182	BELMANIP_00298	-16.255076	136.969616	2	6
183	BELMANIP_00299	-16.2663317	141.917019	6	6
184	BELMANIP_00300	-19.0829146	123.669422	6	6
185	BELMANIP_00301	-19.4852836	137.178693	6	6
186	BELMANIP_00306	-1.7732113	103.506332	4	6
187	BELMANIP_00310	9.737788	122.762079	5	5
188	BELMANIP_00313	18.458438	82.049413	5	5
189	BELMANIP_00317	15.8125748	103.10307	5	5
190	BELMANIP_00318	10.72192	105.67905	5	5
191	BELMANIP_00321	22.493	81.8757	2	5
192	BELMANIP_00332	29.8362647	74.8747435	5	5
193	BELMANIP_00333	28.063	76.6651	5	5
194	BELMANIP_00334	26.663052	85.488231	5	5
195	BELMANIP_00335	25.7119825	88.1823832	5	5
196	BELMANIP_00336	21.168566	95.2394648	5	5
197	BELMANIP_00337	21.146434	106.021926	5	5
198	BELMANIP_00338	25.9969939	68.52337	5	5
199	BELMANIP_00339	28.9141691	60.7605802	8	5
200	BELMANIP_00340	27.6902967	63.0793356	8	5
201	BELMANIP_00346	33.3648301	86.367705	8	5
202	BELMANIP_00348	34.8401831	101.490023	6	5
203	BELMANIP_00350	37.2879277	107.942212	6	5
204	BELMANIP_00353	33.9348528	74.8747435	5	5
205	BELMANIP_00354	31.6053	73.4522	5	5
206	BELMANIP_00355	31.1182699	105.623456	5	5
207	BELMANIP_00356	32.7817	115.5553	5	5
208	BELMANIP_00357	36.0896	140.036	4	5

209	BELMANIP_00359	30.7829624	63.4825974	8	5
210	BELMANIP_00363	44.6054678	131.331397	2	5
211	BELMANIP_00366	42.0571309	108.64792	8	5
212	BELMANIP_00367	42.2080193	115.402555	6	5
213	BELMANIP_00368	49.7356724	68.2209236	6	5
214	BELMANIP_00369	47.1705701	97.3565893	6	5
215	BELMANIP_00370	47.2208662	106.329165	6	5
216	BELMANIP_00371	42.24155	111.067491	8	5
217	BELMANIP_00373	45.6682	122.592	5	5
218	BELMANIP_00375	40.6656048	62.8777047	8	5
219	BELMANIP_00376	44.387518	62.1719965	6	5
220	BELMANIP_00377	45.7622787	68.7250009	6	5
221	BELMANIP_00378	46.04729	76.0845289	6	5
222	BELMANIP_00380	48.6248	93.4382	8	5
223	BELMANIP_00381	44.2030988	106.833242	8	5
224	BELMANIP_00382	41.2188622	93.2231558	8	5
225	BELMANIP_00383	40.2632358	101.9941	8	5
226	BELMANIP_00384	57.5561737	73.9674044	2	5
227	BELMANIP_00385	57.7573582	89.2913532	2	5
228	BELMANIP_00386	59.3165381	92.4166322	3	5
229	BELMANIP_00387	54.8401831	97.7598511	3	5
230	BELMANIP_00389	59.0482921	107.53895	3	5
231	BELMANIP_00390	55.4132	122.328	3	5
232	BELMANIP_00391	59.0650574	130.121611	3	5
233	BELMANIP_00393	51.3865159	132.944444	3	5
234	BELMANIP_00394	55.6113903	86.6701514	2	5
235	BELMANIP_00397	56.5167205	69.5315245	4	5
236	BELMANIP_00398	51.3194544	119.435173	6	5
237	BELMANIP_00399	50.1458782	67.8176618	6	5
238	BELMANIP_00401	59.5512533	80.6212243	4	5
239	BELMANIP_00402	51.6882927	63.180151	5	5
240	BELMANIP_00403	51.9397733	68.1201082	5	5
241	BELMANIP_00407	62.3589076	97.054143	3	5
242	BELMANIP_00408	63.5995454	107.337319	3	5
243	BELMANIP_00409	68.4112078	120.342512	4	5
244	BELMANIP_00410	61.7218234	113.890324	3	5
245	BELMANIP_00411	62.6103883	122.157191	4	5
246	BELMANIP_00412	62.3589076	133.045259	3	5
247	BELMANIP_00413	67.925012	147.562685	4	5

248	BELMANIP_00416	69.1656497	101.792469	6	5
249	BELMANIP_00417	69.9200915	150.99041	6	5
250	BELMANIP_00424	43.370536	108.915178	8	5
251	BELMANIP_00425	24.8705365	-14.4776795	8	4
252	BELMANIP_00429	45.1741079	102.620535	8	5
253	BELMANIP_00430	38.6919645	89.5669628	8	5
254	BELMANIP_00431	-9.404247	-53.716628	1	2
255	BELMANIP_00432	-15.493536	-66.256367	1	2
256	BELMANIP_00433	-12.058939	-67.118947	1	2
257	BELMANIP_00434	-4.606072	-60.335522	1	2
258	BELMANIP_00435	-3.807931	-72.589258	1	2
259	BELMANIP_00436	3.048456	-69.839614	1	2
260	BELMANIP_00437	0.191078	-53.387967	1	2
261	BELMANIP_00438	0.776286	-62.651056	1	2
262	BELMANIP_00440	26.789958	97.561908	1	5
263	BELMANIP_00441	13.866614	106.360339	1	5
264	BELMANIP_00442	13.081592	105.707092	1	5
265	BELMANIP_00443	-2.617722	113.878875	1	6
266	BELSK	51.836667	20.791667	5	3
267	BEN_SALEM	35.55055	9.914003	5	3
268	BERMS_BOREAS	53.65	-105.32	2	1
269	BHOLA	22.166667	90.75	4	5
270	BIL	36.605	-97.516	5	1
271	BIRDSVILLE	-25.89893	139.34596	6	6
272	BON	40.0667	-88.3667	5	1
273	BONDOUKOUI	11.85	-3.75	7	4
274	BONDVILLE	40.053333	-88.371944	5	1
275	BOU	40.05	-105.007	5	1
276	BOUMBA_BEK	3.095	14.612	1	4
277	BR-JI1	-10.7618	-62.3572	6	2
278	BR-MA2	-2.6091	-60.2093	1	2
279	BR-SA1	-2.85667	-54.9589	1	2
280	BR-SA3	-3.01803	-54.9714	1	2
281	BRAKE	53.286	8.367	6	3
282	BRATTS_LAKE	50.28	-104.7	5	1
283	BURE_OPE	48.5625	5.505	5	3
284	BUSHLAND	35.18678	-102.09384	5	1
285	BW-GHG	-21.51	21.74	7	4

286	BW-GHM	-21.2	21.75	7	4
287	BW-MA1	-19.9155	23.5605	4	4
288	CA-LET	49.7093	-112.94	6	1
289	CA-NS4	55.9117	-98.3822	3	1
290	CA-OJP	53.9163	-104.692	3	1
291	CA-SF1	54.485	-105.818	3	1
292	CA-SJ1	53.908	-104.656	3	1
293	CA-SJ3	53.8758	-104.645	3	1
294	CA-TP1	42.6609	-80.5595	5	1
295	CA-TP2	42.7744	-80.4588	5	1
296	CALIPSO_CROUSE_MILL	38.958531	-75.95163	5	1
297	CALIPSO_STRASBURG	39.934467	-76.2193	5	1
298	CALIPSO_W_STRASBURG	39.94655	-76.231117	5	1
299	CALIPSO_ZION	39.932389	-76.199	5	1
300	CAMAGUEY	21.4223	-77.8499	4	1
301	CAMPO_VERDE	-15.561667	-55.175	5	2
302	CARDENA	38.3	-4.45	0	3
303	CARLSBAD	32.368833	-104.233167	7	1
304	CART_SITE	36.60667	-97.48639	5	1
305	CHINA_LAKE	35.6741	-117.744533	7	1
306	CHITRAKOOT	25.14788	80.85518	5	5
307	CN-BED	39.5306	116.252	5	5
308	CN-DU2	42.0467	116.284	6	5
309	CN-KU1	40.5383	108.694	6	5
310	CN-KU2	40.3808	108.549	6	5
311	CN-XFS	44.13417	116.3286	6	5
312	CUIABA	-15.5	-56	4	2
313	CUIABA-MIRANDA	-15.7295	-56.0208	7	2
314	DAA	-30.6667	23.993	6	4
315	DALANZADGAD	43.577222	104.419167	8	5
316	DE-GRI	50.9495	13.5125	3	3
317	DE-HAI	51.0793	10.452	2	3
318	DE-WET	50.4535	11.4575	3	3
319	DEAD_HORSE	69.428333	-148.698333	6	1
320	DESERT_ROCK	36.6232	-116.01962	7	1
321	DIRECT_00001 - AGRO	40.006642	-88.291694	5	1

322	DIRECT_00007 - SEVI	34.350853	-106.689902	6	1
323	DIRECT_00008 - TAPA	-2.86954	-54.949467	1	2
324	DIRECT_00039 - WatsonLake1	60.10046	-129.68996	3	1
325	DIRECT_00044 - WalnutCreek	41.932208	-93.750976	5	1
326	DIRECT_00047 - LosInocentes	11.0331	-85.50281	5	2
327	DIRECT_00048 - AekLoba	2.63102	99.57626	4	5
328	DIRECT_00051 - Barrax	39.072849	-2.10395	5	3
329	DIRECT_00052 - Camerons	-32.598345	116.254226	1	6
330	DIRECT_00053 - Concepcion	-37.467097	-73.470614	1	2
331	DIRECT_00054 - Counami	5.347143	-53.237793	1	2
332	DIRECT_00055 - Counami2	5.343461	-53.23683	1	2
333	DIRECT_00056 - Demmin	53.892507	13.207185	5	3
334	DIRECT_00060 - Gourma	15.324711	-1.554639	6	4
335	DIRECT_00061 - Haouz	31.659337	-7.600293	5	4
336	DIRECT_00065 - Laprida	-36.99037	-60.552592	6	2
337	DIRECT_00069 - PlanDeDieu	44.19869	4.948133	4	3
338	DIRECT_00071 - Romilly	48.443159	3.77199	5	3
339	DIRECT_00075 - Turco	-18.235015	-68.183609	7	2
340	DIRECT_00076 - Turco2	-18.23945	-68.19333	7	2
341	DIRECT_00077 - Wankamana	13.64504	2.63534	6	4
342	DIRECT_00079 - Chimbolton	51.1640472	-1.43063682	5	3
343	DIRECT_00083 - Maun	-19.9216667	23.5908333	4	4
344	DIRECT_00085 - GuyaFlux	5.2817	-52.9122	1	2
345	DIRECT_00086 - Dahra_South	15.4119	-15.4335	6	4
346	DIRECT_00087 - Dahra_North	15.4316	-15.4034	6	4
347	DIRECT_00088 - Tessekre_South	15.8192	-15.0609	6	4
348	DIRECT_00089 - Tessekre_North	15.896	-15.0609	6	4
349	DIRECT_00092 - Bundongo_1	1.6909	31.4318	1	4
350	DIRECT_00093 - Bundongo_2	1.7532	31.4891	1	4
351	DIRECT_00094 - Bundongo_3	1.7654	31.5297	1	4
352	DIRECT_00095 - Bundongo_4	1.723	31.6372	1	4
353	DIRECT_00096 - Bundongo_5	1.7278	31.5805	1	4
354	DIRECT_00097 - Bundongo_6	1.8042	31.6047	1	4
355	DIRECT_00098 - Bundongo_7	1.7858	31.5641	1	4
356	DIRECT_00099 - Bundongo_8	1.7654	31.6146	1	4
357	DIRECT_00102 - Tshane	-	21.8928712	7	4

		24.1640693			
358	DIRECT_00104 - Harth Forest	47.821105	7.455386	2	3
359	DIRECT_00106 - Koscianski (PL)	52.03	16.83	5	3
360	DIRECT_00108 - Brotas	-22.22	-48.15	1	2
361	DIRECT_00109 - Brotas2	-22.35	-46.37	4	2
362	DIRECT_00110 - Yatir Forest	31.35	35.033333	6	4
363	DIRECT_00111 - Chize1	46.16364	-0.477083	5	3
364	DIRECT_00112 - Chize2	46.289826	-0.343625	5	3
365	DJOUGOU	9.76007	1.59901	5	4
366	DK-RIS	55.5303	12.0972	5	3
367	DRA	36.626	-116.018	7	1
368	DRAGON_ALDINO	39.563433	-76.203932	5	1
369	DRAGON_AURORA_EAST	39.63854	-104.56913	6	1
370	DRAGON_HURON	36.20615	-120.10545	5	1
371	DRAGON_NISHIHARIMA	35.026	134.336	2	5
372	DRAGON_NW_HARRIS_CO	30.039444	-95.673889	5	1
373	DRAGON_PARLIER	36.59744	-119.50369	5	1
374	DRAGON_PLATTEVILLE	40.182765	-104.7261	6	1
375	DRAGON_TRANQUILITY	36.63434	-120.38234	5	1
376	DRAGON_UH_W_LIBERTY	30.0583	-94.9781	5	1
377	DUNHUANG1	40.13	94.34	8	5
378	E13	36.605	-97.485	5	1
379	EGBERT	44.225667	-79.75	5	1
380	EL_FARAFRA	27.058	27.990167	8	4
381	ETOSHA_PAN	-19.175017	15.914383	6	4
382	EVORA	38.567833	-7.9115	4	3
383	FLORIDA_COASTAL_EVERGLADES_LTER_FCE	25.47	-80.85	4	1
384	FORT_PECK	48.30798	-105.10177	6	1
385	FOWLERS_GAP	-31.0863	141.70082	6	6
386	FPE	48.3167	-105.1	6	1
387	FR-AUR	43.5494	1.10778	5	3
388	FRENCHMAN_FLAT	36.80928	-115.93479	8	1
389	GF-GUY	5.2777	-52.9288	1	2
390	GOB	-23.5614	15.042	8	4
391	GUAL_PAHARI	28.42639	77.15	5	5
392	HAND_N_60708	26.471783	80.521825	5	5
393	HAND_S_50608	26.285554	80.492658	5	5
394	HOMBURI	15.329167	-1.546667	6	4
395	HORSEPOOL	40.144	-109.468	6	1

396	IE-DRI	51.9867	-8.75181	6	3
397	IER_CINZANA	13.278433	-5.933867	7	4
398	IHOP-HOMESTEAD	36.558333	-100.606183	5	1
399	IL-YAT	31.345	35.0515	7	4
400	IONA	-16.212	12.06	8	4
401	IT-BE2	46.0031	13.0257	5	3
402	IT-LEC	43.3046	11.2706	2	3
403	IT-RO1	42.4081	11.93	5	3
404	ITAJUBA	-22.41325	-45.452389	4	2
405	IVANPAH_PLAYA	35.57	-115.4	8	1
406	JAMARI	-8.633333	-62.75	1	2
407	JAMTOWN	-9.2	-63.099998	1	2
408	JORNADA1	32.6	-106.86	7	1
409	JORNADA_BASIN_LTER_JRN	32.62	-106.74	7	1
410	JP-MAS	36.05397	140.0269	4	5
411	KASAMA	-10.166667	31.183332	5	4
412	KIRTLAND_AFB	34.95081	-106.507403	6	1
413	KONGO_00001	2.3353	26.0675	1	4
414	KONGO_00002	-0.757	20.718	1	4
415	KONZA	39.0825	-96.559667	6	1
416	KONZAPRARIE	39.08	-96.56	6	1
417	KULGUNINO	53.3	56.9	2	3
418	LANNION	48.730833	-3.461944	4	3
419	LATOYA	-15.678133	23.299883	4	4
420	LIN	52.21	14.122	5	3
421	LITANG	29.9763	100.26185	6	5
422	LOS_FIEROS	-14.55	-60.616667	1	2
423	LUMBINI	27.49	83.28	5	5
424	LUT_DESERT_00001	30.593	58.228	8	4
425	LW-SCAN	34.96047	-97.97884	6	1
426	MANAUS	-2.59908	-60.03864	1	2
427	MANAUS_EMBRAPA	-2.890528	-59.969778	1	2
428	MANDALGOBI	45.995	106.327	6	5
429	MARTINENI	45.92	26.08	5	3
430	METOBS_LINDENBERG	52.209275	14.12087	5	3
431	METOLIUSYP	44.43	-121.56	3	1
432	MOBILE_KANPUR_W2	26.4185	80.12172	5	5

433	MOBILE_N_60708	26.530687	80.505745	5	5
434	MOBILE_S_50608	26.12513	80.53282	5	5
435	MONKS_WOOD	52.402178	-0.235211	5	3
436	MUBFS	0.566667	30.366667	1	4
437	MUKDAHAN	16.606667	104.676111	5	5
438	ND_MARBEL_UNIV	6.496011	124.842531	4	5
439	NEGEV	30.11	35.01	8	4
440	NEON-CPER	40.812444	-104.744238	6	1
441	NEON17-SJER	37.090419	-119.722136	4	1
442	NEON_IVANPAH	35.550655	-115.38178	8	1
443	NEON_STERLING	40.461903	-103.029297	5	1
444	NIABRARA	42.764833	-100.02	6	1
445	NSA_YJP_BOREAS	55.903	-98.290001	3	1
446	OK_ST_UNIV	35.04564	-97.91734	6	1
447	OMANI_DESERT	19	55.5	8	4
448	OMKOI	17.798333	98.431667	4	5
449	ORLEAN_BRICY	47.986667	1.761111	5	3
450	ORS_HERMOSILLO	29.0275	-111.145556	7	1
451	PADDOCKWOOD	53.5	-105.5	5	1
452	PANTNAGAR	29.046339	79.520889	5	5
453	PAYERNE	46.815	6.944	5	3
454	PFAELZER_WALD	49.325	7.94	3	3
455	PIMAI	15.181944	102.564167	5	5
456	PKU_PEK	39.593	116.184	5	5
457	PORTO_NACIONAL	-11	-48	4	2
458	PULLMAN	46.75	-117.191666	5	1
459	PUSPIPTEK	-6.3556	106.664383	4	6
460	QOZ_EL_HARR	16.71	32.68	8	4
461	RAS_EL_AIN	31.670278	-7.599444	5	4
462	RED_RIVER_DELTA	20.72853	106.1277	5	5
463	REGINA	50.205	-104.713	5	1
464	SAADA	31.62583	-8.15583	4	4
465	SAIH_SALAM	24.829467	55.312783	8	4
466	SALONGA	-1.462	21.518	1	4

467	SAO_MARTINHO_SONDA	-29.443333	-53.823444	5	2
468	SBO	30.8597	34.7794	8	4
469	SEDE_BOKER	30.855	34.782222	8	4
470	SELIM	40.45	42.83	5	3
471	SEVILLETA1	34.344	-106.671	6	1
472	SHORTGRASS_STEPPE_SGS	40.83	-104.72	6	1
473	SIOUX_FALLS_X	43.736283	-96.625983	5	1
474	SMART	24.249321	55.612064	8	4
475	SMEX	41.936	-93.664	5	1
476	SMS	-29.4428	-53.8231	5	2
477	SOLAR_VILLAGE	24.906933	46.397286	8	4
478	SOLWEZI	-12.170667	26.363333	4	4
479	SOV	24.91	46.41	8	4
480	SS_OJP_BOREAS	53.916	-104.69	3	1
481	STRZYZOW	49.8786	21.8613	2	3
482	SUFFIELD	50.28155	-111.130771	6	1
483	SXF	43.73	-96.62	5	1
484	T1_MAX_MEX	19.703067	-98.98195	5	1
485	TABERNAS_PSA-DLR	37.09076	-2.35818	6	3
486	TAPAJOS	-2.857	-54.959	1	2
487	THALA	35.55	8.683333	5	3
488	TINGA_TINGANA	-28.975833	139.990933	6	6
489	TOMBSTONE	31.742	-110.05	7	1
490	TONOPAH_AIRPORT	38.05044	-117.09052	8	1
491	UK-AMO	55.7917	-3.23889	6	3
492	UK-ESA	55.90694	-2.85861	5	3
493	UK-TAD	51.2071	-2.82864	6	3
494	UPPER_BUFFALO	35.8258	-93.203	2	1
495	US-ARM	36.6058	-97.4888	5	1
496	US-AUD	31.5907	-110.51	7	1
497	US-BO1	40.0062	-88.2904	5	1
498	US-FPE	48.3077	-105.1019	6	1
499	US-FUF	35.089	-111.762	3	1
500	US-FWF	35.4454	-111.7718	3	1
501	US-IVO	68.4865	-155.75	6	1
502	US-ME2	44.4523	-121.5574	3	1
503	US-NE1	41.1651	-96.4766	5	1
504	US-SP1	29.7381	-82.2188	3	1

505	US-SP2	29.7648	-82.2448	3	1
506	US-SP4	29.8028	-82.2031	3	1
507	US-SRM	31.8214	-110.866	7	1
508	US-TON	38.4316	-120.966	4	1
509	US-VAR	38.4133	-120.9507	4	1
510	US-WKG	31.7365	-109.942	7	1
511	USSURIYSK	43.7004	132.1635	2	5
512	WADI_ABU_GEIDUM	16.2	32.93	8	4
513	WALNUTGULCH	31.737	-109.942	7	1
514	WAV_AN_NAMUS	24.918	17.794	8	4
515	WHITE_SANDS_HELSTF	32.634942	-106.338072	7	1
516	YAQUI	27.280833	-109.912	5	1
517	YUFA_PEK	39.309	116.184	5	5
518	ZOUERATE-FENNEC	22.75	-12.483333	8	4
519	Arabia#1	18.88	46.76	8	4
520	Arabia#2	20.13	50.96	8	4
521	Arabia#3	28.92	43.73	8	4
522	Sudan#1	21.74	28.22	8	4
523	Niger#1	19.67	9.81	8	4
524	Niger#2	21.37	10.59	8	4
525	Niger#3	21.57	7.96	8	4
526	Egypt#1	27.12	26.1	8	4
527	Libya#1	24.42	13.35	8	4
528	Libya#2	25.05	20.48	8	4
529	Libya#3	23.15	23.1	8	4
530	Libya#4	28.55	23.39	8	4
531	Algeria#1	23.8	-0.4	8	4
532	Algeria#2	26.09	-1.38	8	4
533	Algeria#3	30.32	7.66	8	4
534	Algeria#4	30.04	5.59	8	4
535	Algeria#5	31.02	2.23	8	4
536	Mali#1	19.12	-4.85	8	4
537	Mauritania#1	19.4	-9.3	8	4
538	Mauritania#2	20.85	-8.78	8	4
539	Collelongo	41.85	13.59	2	3
540	25de Mayo_Shurb	-37.938983	-67.789014	7	2
541	Bagci Koyu	37.9062583	39.4419292	5	3
542	Chukotka	62.90625	173.45080	6	5

543	Sopka Taunshits	54.42412	159.86155	6	5
544	Krai de Krasnoyarsk	67.12947	92.00440	6	5
545	Sptin Nuur	48.76340	88.38830	6	5
546	Tagchagpu Ri	32.94197	82.70085	8	5
547	Akkacheruvu	15.74555	79.13835	7	5
548	Kukushili	35.40626	85.42406	8	5
549	Makanchi	46.67411	82.40621	6	5
550	Shiyli	50.16518	63.36157	6	5
551	Otgon	47.39733	97.44192	6	5
552	Kumana National Park	6.57591	81.56692	3	5
553	Nallamala Forest	15.60269	78.73657	2	5
554	Anshi National Park	15.02233	74.40621	1	5
555	IN-Brk	30.110682	78.20343	3	5
556	IN-Bet	21.863011	77.426019	2	5
557	JP-Tef	45.056339	142.106203	2	5
558	CN-Xg2	44.088889	113.574167	6	5
559	KR-Seo	37.93885	126.9547	2	5
560	JP-MBF	44.3842	142.3186	2	5
561	MY-Sbu	2.186667	111.84325	4	5
562	RU-Tuv	50.15	94.45	6	5
563	CN-Xi1	43.5544444	116.279722	6	5
564	Baikyt	62.1116116	98.4419197	3	5
565	Muhar	26.9151887	70.0579957	7	5
566	Mirni	61.7187545	113.897274	3	5
567	Irkutsk	58.9151835	114.995489	6	5
568	Zabaikalie	55.5223269	119.191916	6	5
569	Jabarovsk	49.4151851	132.477629	3	5
570	Birobidzhan	49.022328	133.138343	4	5
571	Chebailing	24.7009033	114.23656	1	5
572	Kamchatka	62.2544687	164.647266	7	5
573	Mayskoye	50.9508991	78.5937086	6	5
574	Kayrakty	48.3348281	73.3079952	6	5
575	Saja_1	56.5669696	123.772273	6	5
576	Saja_2	56.7633982	124.200844	7	5
577	Saja_3	57.1294695	124.272273	3	5
578	Saja_4	62.3080402	143.602627	6	5
579	Saja_5	63.2812543	146.316912	6	5
580	Kamchatka_2	61.8437545	164.959766	7	5
581	Man Na-hkai	23.5401892	98.2990626	1	5

582	Tov_1	47.3258997	106.093704	6	5
583	Tov_2	47.1294711	107.566918	6	5
584	NARMA Niger_1	15.00000	2.00000	8	4
585	NARMA Niger_2	15.00000	12.00000	8	4
586	NARMA Mali_1	14.50000	-5.75000	6	4
587	NARMA Niger_4	12.44196	2.61161	7	4
588	NARMA Botswana_1	-20.02933	21.49469	7	4
589	NARMA Tanzania_1	-2.68750	36.54464	7	4
590	NARMA Chad	9.28124	15.27233	2	4
591	Siifan	4.92412	43.05800	7	4
592	Jariiban	7.49555	48.88836	7	4
593	Hail	28.3437599	40.2276433	8	4
594	Bargaal	11.54912	50.92407	7	4
595	Zinder	15.4419762	8.15621989	6	4
596	Diffa	14.6741192	13.2812191	8	4
597	Amhara	11.6651911	36.5580011	4	4
598	Niassa_1	-14.6562333	37.0222867	2	4
599	Niassa_2	-14.1294476	36.6205011	2	4
600	Somalia_1	10.9776912	50.9419273	8	4
601	Somalia_2	50.2722846	11.4330483	3	3
602	Somalia_3	11.0044769	49.8169275	7	4
603	Mackay	-21.95980	129.74549	6	6
604	Alice Springs	-22.28261	133.24922	4	6
605	Calperum Chowilla	-34.00206	140.58911	7	6
606	Great Western	-30.1914	120.65416	2	6
607	Howard Springs	-12.4952	131.15005	2	6
608	Litchfield	-13.179	130.79455	2	6
609	Sturt Plains	-17.15124	133.35081	6	6
610	Canada_North1	63.62054	-117.44197	3	1
611	Canada_North2	63.35268	-138.68304	3	1
612	Canada_North3	64.51340	-106.15626	8	1
613	Canada_North4	67.74554	-115.00448	6	1
614	Canada_North5	65.93304	95.19192	6	5
615	Canada_North6	50.04911	-67.46877	3	1
616	Canada_North7	52.44197	-57.04913	3	1
617	Piura	-5.39731	-80.41519	7	2
618	Cienaga	-28.38837	-68.29020	7	2

619	SalinerasLasPiletas	-14.65623	-75.48662	8	2
620	Missao	-6.14731	-40.45984	7	2
621	West Three	-13.21873	26.95086	2	4
622	Namibe	-15.79909	12.40622	8	4
623	Elba NP	22.95090	35.44193	8	3
624	Hame	15.37055	21.83479	6	4
625	Darfur	16.90626	24.52229	8	4
626	Alto Mbomou	7.56698	24.79015	2	4
627	Sodralekvattnet	60.14733	12.69193	3	3
628	Jamtland	63.99554	13.44193	6	3
629	Tangen	60.58483	11.45979	3	3
630	Norrbotten	66.76340	22.20979	3	3
631	Laponia	67.03125	26.21872	3	3
632	Vitebsk	55.95983	28.47765	3	3
633	Zakaznik Kremennoye	48.98661	38.18300	3	3
634	Riazan	54.92411	40.29907	3	3
635	Oblast de Smolensk	54.60268	34.29014	2	3
636	Rahim Yar Khan	28.30805	71.40621	7	5
637	Khargai	35.02233	73.04907	3	5
638	Aksai Chin	34.60269	79.48657	8	5
639	Khizaw	37.93304	71.24550	6	5
640	Surjandain	37.46876	67.70085	6	5
641	China_Desert1	39.69197	84.93299	8	5
642	China_Desert2	39.36162	81.74549	8	5
643	Yamalia-Memetsia1	63.31697	77.37942	3	5
644	Krai de Krasnoyarsk2	62.65625	90.71871	3	5
645	Krai de Krasnoyarsk3	70.16518	93.27228	6	5
646	Yamalia-Memetsia2	68.87054	80.85264	4	5
647	Oblast de Irkutsk	61.37947	105.26335	3	5
648	Republica_Saja_1	60.54018	112.07585	3	5
649	Republica_Saja_2	62.00447	113.25442	0	5
650	Republica_Saja_3	63.05804	116.09370	3	5
651	Republica_Saja_4	68.38840	119.92406	4	5
652	Republica_Saja_5	62.72768	124.15620	3	5
653	Krai_de_Krasnoyarsk_1	65.62947	84.55799	3	5
654	Yamalia-Nenetsia_1	63.23661	81.34371	3	5
655	Yamalia-Nenetsia_2	65.55804	80.64728	4	5
656	Yamalia-Nenetsia_3	67.06697	82.26335	6	5
657	Yamalia-Nenetsia_4	65.54911	80.62942	4	5

658	Janty-Mansi_1	63.98661	68.10264	3	5
659	Janty-Mansi_2	62.95983	66.37942	3	5
660	Yamalia-Nenetsia_5	66.88840	66.63835	6	5
661	Janty-Mansi_3	62.24554	62.75443	3	5
662	Aksu	41.17411	81.35264	8	5
663	China_Desert3	40.91519	86.42406	8	5
664	Nagqu	31.15626	92.95978	6	5
665	Wuxizuo	28.80805	109.87049	4	5
666	Shanjiao	25.54912	107.08478	4	5
667	Chita_1	50.42411	111.13835	3	5
668	Chita_2	50.34376	114.60263	6	5
669	Yamalia-Nenetsia_6	69.04018	115.70977	3	5
670	Republica_Saja_6	72.63840	115.52227	6	5
671	Republica_Saja_7	67.27233	111.62049	3	5
672	Krai_de_Krasnoyarsk_2	70.99554	107.53120	6	5
673	Republica_Saja_8	71.09375	134.97763	6	5
674	Republica_Saja_9	69.31697	133.78120	4	5
675	Republica_Saja_10	70.29911	130.85263	6	5
676	Republica_Saja_11	67.26340	137.21870	3	5
677	Republica_Saja_12	69.72768	139.54013	6	5
678	Chukotka_2	66.92411	162.37941	4	5
679	Chukotka_3	66.04018	168.01334	6	5
680	Chukotka_4	68.08482	172.86155	8	5
681	Chukotka_5	66.51340	165.71869	3	5
682	Chukotka_6	66.91518	162.04905	4	5
683	Chukotka_7	66.84375	158.17405	3	5
684	Daxing angling_1	51.76340	125.03120	3	5
685	Jilin_1	43.06697	127.45977	2	5
686	Jilin_2	41.89733	127.55799	2	5
687	Yichun_1	47.22769	128.70977	2	5
688	Yichun_2	49.01340	127.73656	2	5
689	Daxing angling_2	51.58483	124.81692	3	5
690	Santa Cruz	-50.64730	-71.17412	7	2
691	Magallanes	-52.12051	-70.37055	6	2
692	Goonoo State Forest	-31.97766	148.95977	1	6
693	Barakuyla	-26.37052	150.54013	2	6
694	Nowley	-29.96873	149.12941	5	6
695	Boatmat	-27.04909	146.87941	7	6
696	Omnogobi_1	42.95090	104.87049	8	5

697	Omnogobi_2	43.13840	101.62942	8	5
698	Omnogobi_3	43.89733	99.60263	8	5
699	Sinkiang_1	45.61161	89.74549	8	5
700	Sinkiang_2	45.44197	87.72764	6	5
701	Zhambyl_1	45.25447	72.02228	6	5
702	Zhambyl_2	45.96876	69.57585	6	5
703	Kyzylorda_1	44.33483	61.74550	6	5
704	Kyzylorda_2	46.13840	64.08478	6	5
705	Jilin_3	41.85269	127.68299	2	5
706	Pakistan_1	27.54019	63.07585	8	5
707	Pakistan_2	25.29912	61.97764	8	5
708	Chad_1	19.35269	22.84372	8	4
709	Chad_2	18.37948	18.71872	8	4
710	Mbomou	7.37055	25.03122	2	4
711	Bouba Ndjida NP	8.17412	14.72765	4	4
712	Bie	-11.00445	16.29015	2	4
713	Katanga_1	-8.63838	27.53122	2	4
714	Katanga_2	-10.62945	23.97765	2	4
715	Hlane NP	-26.28479	31.88474	4	4
716	Republica_Saja_16	63.58483	115.70977	3	5
717	Republica_Saja_13	63.79018	115.47763	3	5
718	Yakutsk	62.43304	130.63834	3	5
719	Republica_Saja_14	59.84375	133.22763	4	5
720	Republica_Saja_15	60.02233	135.79906	3	5

Biomes:

- 1: Evergreen Broadleaf Forest (EBF).
- 2: Deciduous Broadleaf Forest (DBF).
- 3: Needle-leaf Forest (NLF).
- 4: Other forests, including Mixed Forest (OF).
- 5: Cultivated (CUL).
- 6: Herbaceous (HER).
- 7: Shrublands (SHR).
- 8: Sparse and Bare Areas (BA).

Continents:

- 1: North America.
- 2: South America.
- 3: Europe.
- 4: Africa.
- 5: Asia.
- 6: Oceania.

ANNEX II: REALS SITES SUMMARY

ID	Code	Latitude	Longitude	Name	Network	Class
1	USA_BOND	40.05192	-88.37309	Bondville	SURFRAD, GBOV	Croplands
2	USA_BAOR	40.05005	-105.00387	Boulder	BSRN, GBOV	Croplands
3	BEL_BRAS	51.30761	4.51984	Brasschaat	FLUXNET, GBOV(LPV SuperSite)	Forest
4	NET_CABA	51.97100	4.92700	Cabauw	BSRN, GBOV	Grass/shrub
5	AUS_CPRM	-34.00270	140.58771	Calperum	OZFLUX,TERN,GBOV(LPV SuperSite)	Grass/shrub
6	USA_DRAK	36.62418	-116.01990	Desert Rock	SURFRAD, GBOV	Desert
7	USA_FPEK	48.30783	-105.10170	Fort Peck	SURFRAD, GBOV	Grass/shrub
8	GER_GEBE	51.10010	10.91430	Gebesee	FLUXNET, GBOV	Croplands
9	NAM_GOBA	-23.56184	15.04131	Gobabeb	BSRN, GBOV(LPV SuperSite)	Desert
10	USA_GCMK	34.25505	-89.87360	Goodwin Creek	SURFRAD, GBOV	Forest
11	FRA_GRIG	48.84420	1.95191	Grignon	FLUXNET, GBOV	Croplands
12	FRA_GUYA	5.27877	-52.92486	Guyaflux	FLUXNET, GBOV(LPV SuperSite)	Forest
13	GER_HAIN	51.07920	10.45220	Hainich	FLUXNET, GBOV(LPV SuperSite)	Forest
14	USA_NRFT	40.03287	-105.54690	Niwot Ridge Forest	FLUXNET, GBOV	Forest
15	ITA_RENO	46.58690	11.43370	Renon	FLUXNET, GBOV	Forest
16	USA_PSUS	40.72012	-77.93085	Rock Springs	SURFRAD, GBOV	Forest
17	USA_SFSD	43.73403	-96.62331	Sioux Falls SurfRad	SURFRAD, GBOV	Croplands
18	USA_SGP	36.60575	-97.48876	Southern Great Plains	SURFRAD, GBOV	Croplands
19	USA_TBLN	40.12498	-105.23680	Table Mountain	SURFRAD, GBOV	Desert
20	AUS_TUMB	-35.65652	148.15163	Tumbarumba	OZFLUX,TERN,GBOV (LPV SuperSite)	Forest
21	LENO	31.85388	-88.16122	Lenoir Landing	NEON	Forest
22	TALL	32.95046	-87.39327	Talladega National Forest	NEON(LPV SuperSite)	Forest

23	BONA	65.15401	-147.50258	Caribou-Poker	NEON	Forest
24	DEJU	63.88112	-145.75136	Delta Junction	NEON	Forest
25	HEAL	63.87569	-149.21334	Healy	NEON	Grass/shrub
26	TOOL	68.66109	-149.37047	Toolik	NEON	Grass/shrub
27	SRER	31.91068	-110.83549	Santa Rita Experimental Range	NEON	Grass/shrub.
28	SOAP	37.03337	-119.26219	Soaproot Saddle	NEON	Forest
29	TEAK	37.00583	-119.00602	Lower Teakettle	NEON	Forest
30	CPER	40.81550	-104.7456	Central Plains Experimental Range	NEON (LPV SuperSite)	Grass/shrub
31	NIWO	40.05425	-105.58237	Niwot Ridge Mountain Research Station	NEON	Forest
32	STER	40.46190	-103.02930	Sterling	NEON	Croplands
33	DSNY	28.12504	-81.43620	Disney Wilderness Preserve	NEON	Croplands
34	OSBS	29.68927	-81.99343	Ordway-Swisher Biological Station	NEON(LPV SuperSite)	Forest
35	JERC	31.19484	-84.46861	Jones Ecological Research Center	NEON	Forest
36	KONA	39.11044	-96.61295	Konza Prairie Biological Station - Relocatable	NEON	Grass/shrub
37	KONZ	39.10077	-96.56309	Konza Prairie Biological Station	NEON	Grass/shrub
38	UKFS	39.04043	-95.19215	The	NEON	Forest

				University of Kansas Field Station		
39	SERC	38.89008	-76.56001	Smithsonian Environmental Research Center	NEON	Forest
40	HARV	42.53690	-72.17266	Harvard Forest	NEON(LPV SuperSite)	Forest
41	UNDE	46.23388	-89.53725	UNDERC	NEON	Forest
42	BART	44.06388	-71.28731	Bartlett Experimental Forest	NEON(LPV SuperSite)	Forest
43	JORN	32.59068	-106.84254	Jornada LTER	NEON	Grass/shrub
44	DCFS	47.16165	-99.10656	Dakota Coteau Field School	NEON	Grass/shrub
45	NOGP	46.76972	-100.91535	Northern Great Plains Research Laboratory	NEON	Grass/shrub
46	OAES	35.41059	-99.05879	Klemme Range Research Station	NEON	Grass/shrub
47	GUAN	17.96955	-66.86870	Guanica Forest	NEON(LPV SuperSite)	Forest
48	LAJA	18.02125	-67.07690	Lajas Experimental Station	NEON	Grass/shrub
49	GRSM	35.68896	-83.50195	Great Smoky Mountains National Park	NEON	Forest
50	ORNL	35.96412	-84.28260	Oak Ridge	NEON(LPV SuperSite)	Forest
51	MOAB	38.24833	-109.38827	Moab	NEON(LPV SuperSite)	Grass/shrub
52	ONAQ	40.17759	-112.45244	Onaqui	NEON	Grass/shrub
53	MLBS	37.37828	-80.52484	Mountain Lake Biological Station	NEON(LPV SuperSite)	Forest

54	SCBI	38.89292	-78.1395	Smithsonian Conservation Biology Institute	NEON (LPV SuperSite)	Forest
55	ABBY	45.76243	-121.24700	Abby Road	NEON	Forest
56	WREF	45.82049	-121.95191	Wind River Experimental Forest	NEON	Forest
57	STEI	45.50894	-89.58637	Steigerwaldt Land Services	NEON(LPV SuperSite)	Forest
58	TREE	45.49369	-89.58571	Treehaven	NEON	Forest
59	AT-Neu	47.11667	11.3175	Neustift	FLUXNET	Grass/shrub
60	CA-Gro	48.2167	-82.1556	Ontario - Groundhog River, Boreal Mixedwood Forest	FLUXNET	Forest
61	CA-Oas	53.62889	-106.19779	Saskatchewan - Western Boreal, Mature Aspen	FLUXNET	Forest
62	CA-Obs	53.98717	-105.11779	Saskatchewan - Western Boreal, Mature Black Spruce	FLUXNET	Forest
63	CA-Qfo	49.6925	-74.34206	Quebec - Eastern Boreal, Mature Black Spruce	FLUXNET	Forest
64	CZ-BK1	49.50208	18.53688	Bily Kriz forest	FLUXNET(LPV SuperSite)	Forest
65	DE-Lnf	51.32822	10.3678	Leinefelde	FLUXNET	Forest
66	DE-Tha	50.96256	13.56515	Tharandt	FLUXNET(LPV SuperSite)	Forest
67	FR-Gri	48.84422	1.95191	Grignon	FLUXNET	Croplands
68	FR-LBr	44.71711	-0.7693	Le Bray	FLUXNET	Forest
69	FR-Pue	43.7413	3.5957	Puechabon	FLUXNET(LPV SuperSite)	Forest
70	GH-Ank	5.26854	-2.69421	Ankasa	FLUXNET	Forest

71	IT-Col	41.84936	13.58814	Collelongo	FLUXNET(LPV SuperSite)	Forest
72	IT-MBo	46.01468	11.04583	Monte Bondone	FLUXNET	Grass/shrub
73	IT-SR2	43.73202	10.29091	San Rossore 2	FLUXNET	Forest
74	NL-Hor	52.24035	5.0713	Horstermeer	FLUXNET	Grass/shrub
75	NL-Loo	52.16658	5.74356	Loobos	FLUXNET(LPV SuperSite)	Forest
76	RU-Fyo	56.46153	32.92208	Fyodorovskoye	FLUXNET(LPV SuperSite)	Forest
77	SN-Dhr	15.40278	-15.43222	Dahra	FLUXNET(LPV SuperSite)	Grass/shrub
78	US-Me2	44.4523	-121.5574	Metolius mature ponderosa pine	FLUXNET	Forest
79	US-UMd	45.5625	-84.6975	UMBS Disturbance	FLUXNET	Forest
80	US-Var	38.4133	-120.9507	Vaira Ranch-Ione	FLUXNET	Grass/shrub
81	ES-Cpa	39.22417	-0.90305	Cortes de Pallas	EFDC	Grass/shrub
82	ES-ES2	39.27556	-0.31528	El Saler-Sueca	EFDC	Croplands
83	ES-LMa	39.9415	-5.77336	Las Majadas del Tietar	EFDC	Grass/Shrub
84	DE-HoH	52.08656	11.22235	Hohes Holz	ICOS (LPV SuperSite)	Forest
85	SE-Svb	64.25611	19.7745	Svartberget	ICOS (LPV SuperSite)	Forest
86	FI-Hyy	61.84741	24.29477	Hyytiala	FLUXNET (LPV SuperSite)	Forest
87	DE-RuS	50.86591	6.44714	Selhausen Juelich	FLUXNET, ICOS (LPV SuperSite)	Croplands
88	AU_ASM	-22.2828	133.2493	Alice Springs Meller	TERN (LPV SuperSite)	Forest
89	AU_Boy	-32.477093	116.93856	Boyaginj Wandoo Woodland	TERN (SuperSite)	Forest
90	AU_Cum	-33.61528	150.72361	Cumberland Plain	TERN (LPV SuperSite)	Forest
91	AU_DRF	-16.23819	145.42715	Daintree Rainforest	TERN (SuperSite)	Forest
92	AU_Gin	-31.37635	115.71377	Gingin	TERN (SuperSite)	Forest

				Banksia Woodland		
93	AU_GWW	-30.1914	120.65416	Great Western Woodlands	TERN (LPV SuperSite)	Forest
94	AU_LiS	-13.17904	130.79455	Litchfield Savanna	TERN (LPV SuperSite)	Forest
95	AU_RCR	-17.11747	145.63014	Robson Creek Rainforest	TERN (LPV SuperSite)	Forest
96	AU_SPU	-27.38806	152.87778	Samford Peri-Urban	TERN (SuperSite)	Forest
97	AU_Wrr	-43.09502	146.65452	Warra Tall Eucalypt	TERN (LPV SuperSite)	Forest
98	AU_WSE	-37.4222	144.0944	Wombat Stringybark Eucalypt	TERN (LPV SuperSite)	Forest
99	AU_WDE	-36.6732	145.0294	Whroo Dry Eucalypt	TERN (SuperSite)	Forest

ANNEX III: REALS STANDARD SCORES

ID	Code	ST leaf-off	ST leaf-on	Name	Class
1	USA_BOND	1.52	1.58	Bondville	Croplands
2	USA_BAOR	1.29	2.98	Boulder	Croplands
3	BEL_BRAS	19.36	10.42	Brasschaat	Forest
4	NET_CABA	13.86	6.65	Cabauw	Grass/shrub
5	AUS_CPRM	2.72	2.83	Calperum	Grass/shrub
6	USA_DRAK	0.96	0.96	Desert Rock	Desert
7	USA_FPEK	1.85	1.60	Fort Peck	Grass/shrub
8	GER_GEBE	1.08	1.22	Gebesee	Croplands
9	NAM_GOBA	0.95	0.87	Gobabeb	Desert
10	USA_GCMK	2.92	1.96	Goodwin Creek	Forest
11	FRA_GRIG	1.04	1.05	Grignon	Croplands
12	FRA_GUYA	5.47	5.47	Guyaflux	Forest
13	GER_HAIN	6.84	18.17	Hainich	Forest
14	USA_NRFT	4.06	-	Niwot Ridge Forest	Forest
15	ITA_RENO	1.45	1.79	Renon	Forest
16	USA_PSUS	1.04	2.96	Rock Springs	Forest
17	USA_SFSD	1.85	2.11	Sioux Falls SurfRad	Croplands
18	USA_SGP	1.02	0.80	Southern Great Plains	Croplands
19	USA_TBLN	-	-	Table Mountain	Desert
20	AUS_TUMB	11.65	11.65	Tumbarumba	Forest
21	LENO	2.33	4.96	Lenoir Landing	Forest
22	TALL	103.65	8.00	Talladega National Forest	Forest
23	BONA	-	2.78	Caribou-Poker	Forest
24	DEJU	-	3.77	Delta Junction	Forest
25	HEAL	-	1.42	Healy	Grass/shrub
26	TOOL	-	1.28	Toolik	Grass/shrub
27	SRER	5.92	4.29	Santa Rita Experimental Range	Grass/shrub.
28	SOAP	19.48	10.58	Soaproot Saddle	Forest
29	TEAK	25.17	8.46	Lower Teakettle	Forest
30	CPER	1.12	0.98	Central Plains Experimental Range	Grass/shrub
31	NIWO	0.71	0.88	Niwot Ridge Mountain Research Station	Forest
32	STER	1.05	0.92	Sterling	Croplands
33	DSNY	1.34	1.51	Disney Wilderness Preserve	Croplands
34	OSBS	0.65	0.61	Ordway-Swisher Biological Station	Forest
35	JERC	12.99	4.83	Jones Ecological Research Center	Forest

36	KONA	1.60	1.26	Konza Prairie Biological Station - Relocatable	Grass/shrub
37	KONZ	4.37	1.26	Konza Prairie Biological Station	Grass/shrub
38	UKFS	0.55	10.60	The University of Kansas Field Station	Forest
39	SERC	2.64	4.13	Smithsonian Environmental Research Center	Forest
40	HARV	40.01	6.32	Harvard Forest	Forest
41	UNDE	2.29	2.08	UNDERC	Forest
42	BART	6.50	3.04	Bartlett Experimental Forest	Forest
43	JORN	0.83	1.04	Jornada LTER	Grass/shrub
44	DCFS	0.87	1.18	Dakota Coteau Field School	Grass/shrub
45	NOGP	1.74	1.43	Northern Great Plains Research Laboratory	Grass/shrub
46	OAES	1.04	1.41	Klemme Range Research Station	Grass/shrub
47	GUAN	9.75	9.75	Guanica Forest	Forest
48	LAJA	1.35	1.23	Lajas Experimental Station	Grass/shrub
49	GRSM	7.39	4.27	Great Smoky Mountains National Park	Forest
50	ORNL	13.12	1.46	Oak Ridge	Forest
51	MOAB	0.43	1.19	Moab	Grass/shrub
52	ONAQ	1.30	1.59	Onaqui	Grass/shrub
53	MLBS	7.41	1.55	Mountain Lake Biological Station	Forest
54	SCBI	2.51	13.86	Smithsonian Conservation Biology Institute	Forest
55	ABBY	2.42	7.30	Abby Road	Forest
56	WREF	6.17	5.76	Wind River Experimental Forest	Forest
57	STEI	6.44	1.84	Steigerwaldt Land Services	Forest
58	TREE	8.10	6.44	Treehaven	Forest
59	AT-Neu	1.14	1.86	Neustift	Grass/shrub
60	CA-Gro	6.32	4.91	Ontario - Groundhog River, Boreal Mixedwood Forest	Forest
61	CA-Oas	27.82	9.18	Saskatchewan - Western Boreal, Mature Aspen	Forest
62	CA-Obs	7.98	3.23	Saskatchewan - Western Boreal, Mature Black Spruce	Forest
63	CA-Qfo	1.40	1.47	Quebec - Eastern Boreal, Mature Black Spruce	Forest
64	CZ-BK1	4.63	7.44	Bily Kriz forest	Forest
65	DE-Lnf	13.88	3.06	Leinefelde	Forest
66	DE-Tha	5.51	2.86	Tharandt	Forest
67	FR-Gri	-	-	Grignon	Croplands
68	FR-LBr	10.82	1.59	Le Bray	Forest

69	FR-Pue	1.22	1.22	Puechabon	Forest
70	GH-Ank	17.71	17.71	Ankasa	Forest
71	IT-Col	1.63	1.44	Collelongo	Forest
72	IT-MBo	2.03	1.26	Monte Bondone	Grass/shrub
73	IT-SR2	13.04	12.66	San Rossore 2	Forest
74	NL-Hor	0.60	0.60	Horstermeer	Grass/shrub
75	NL-Loo	29.14	1.55	Loobos	Forest
76	RU-Fyo	17.98	119.73	Fyodorovskoye	Forest
77	SN-Dhr	1.03	0.83	Dahra	Grass/shrub
78	US-Me2	0.79	2.18	Metolius mature ponderosa pine	Forest
79	US-UMd	0.69	0.80	UMBS Disturbance	Forest
80	US-Var	4.84	2.58	Vaira Ranch- Ione	Grass/shrub
81	ES-Cpa	6.88	4.70	Cortes de Pallas	Grass/shrub
82	ES-ES2	5.36	4.68	El Saler-Sueca	Croplands
83	ES-LMa	1.66	1.24	Las Majadas del Tietar	Grass/Shrub
84	DE-HoH	6.95	5.28	Hohes Holz	Forest
85	SE-Svb	1.11	1.11	Svartberget	Forest
86	FI-Hyy	1.37	1.37	Hyytiala	Forest
87	DE-RuS	1.82	1.40	Selhausen Juelich	Croplands
88	AU_ASM	8.88	6.78	Alice Springs Meller	Forest
89	AU_Boy	0.72	0.33	Boyaginj Wandoo Woodland	Forest
90	AU_Cum	6.18	1.04	Cumberland Plain	Forest
91	AU_DRF	13.17	4.53	Daintree Rainforest	Forest
92	AU_Gin	1.74	0.97	Gingin Banksia Woodland	Forest
93	AU_GWW	23.87	1.79	Great Western Woodlands	Forest
94	AU_LiS	34.74	7.66	Litchfield Savanna	Forest
95	AU_RCR	17.90	28.67	Robson Creek Rainforest	Forest
96	AU_SPU	14.49	4.71	Samford Peri-Urban	Forest
97	AU_Wrr	3.76	3.30	Warra Tall Eucalypt	Forest
98	AU_WSE	8.34	13.02	Wombat Stringybark Eucalypt	Forest
99	AU_WDE	4.15	91.64	Whroo Dry Eucalypt	Forest