The EUMETSAT Satellite Application Facility on Land Surface Analysis (LSA SAF)

Product User Manual

Land Surface Albedo

PRODUCTS: LSA-101 (MDAL), LSA-102 (MTAL), LSA-103 (ETAL)

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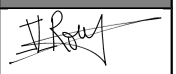
Prepared by :	Météo-France / CNRM	25/11/2016	
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1 Introduction

The Satellite Application Facility (SAF) on Land Surface Analysis (LSA) is part of the SAF Network, a set of specialised development and processing centres, serving as EUMETSAT (European organization for the Exploitation of Meteorological Satellites) distributed Applications Ground Segment. The SAF network complements the product-oriented activities at the EUMETSAT Central Facility in Darmstadt. The main purpose of the LSA SAF is to take full advantage of remotely sensed data, particularly those available from EUMETSAT sensors, to measure land surface variables, which will find primarily applications in meteorology (http://landsaf.ipma.pt/).

The spin-stabilised Meteosat Second Generation (MSG) has an imaging-repeat cycle of 15 minutes. The Spinning Enhanced Visible and Infrared Imager (SEVIRI) radiometer embarked on the MSG platform encompasses unique spectral characteristics and accuracy, with a 3 km resolution (sampling distance) at nadir (1km for the high-resolution visible channel), and 12 spectral channels (Schmetz et al., 2002).

The EUMETSAT Polar System (EPS) is Europe's first polar orbiting operational meteorological satellite and the European contribution to a joint polar system with the U.S. EUMETSAT will have the operational responsibility for the "morning orbit" with Meteorological-Operational (Metop) satellites, the first of which was successfully launched on October 19, 2006. Despite the wide range of sensors on-board Metop (http://www.eumetsat.int/), most LSA SAF parameters make use of the Advanced Very High Resolution Radiometer (AVHRR) and, to a lesser extent, of the Advanced Scatterometer (ASCAT).

Several studies have stressed the role of land surface processes on weather forecasting and climate modelling (e.g., Dickinson et al., 1983; Mitchell et al., 2004; Ferranti and Viterbo, 2006). The LSA SAF has been especially designed to serve the needs of the meteorological community, particularly Numerical Weather Prediction (NWP). However, there is no doubt that the LSA SAF addresses a much broader community, which includes users from:

- Weather forecasting and climate modelling, requiring detailed information on the nature and properties of land.
- Environmental management and land use, needing information on land cover type and land cover changes (e.g. provided by biophysical parameters or thermal characteristics).
- Agricultural and Forestry applications, requiring information on incoming/outgoing radiation and vegetation properties.
- Renewable energy resources assessment, particularly biomass, depending on biophysical parameters, and solar energy.
- Natural hazards management, requiring frequent observations of terrestrial surfaces in both the solar and thermal bands.
- Climatological applications and climate change detection, requiring long and homogeneous time-series.

Table 1 - The LSA SAF Set of Products and respective sensors and platforms. The table covers both existing and future EUMETSAT satellites, and therefore refers operational products and development activities.

Product Family	Product Group	Sensors/Platforms
Radiation	Land Surface Temperature (LST)	SEVIRI/MSG, AVHRR/Metop, FCI/MTG, VII/EPS-SG
	Land Surface Emissivity (EM)	SEVIRI/MSG, FCI/MTG (internal product for other sensors)
	Land Surface Albedo (AL)	SEVIRI/MSG, AVHRR/Metop, FCI/MTG, VII/EPS-SG, 3MI/EPS-SG
	Down-welling Short-wave Fluxes (DSSF)	SEVIRI/MSG, FCI/MTG
	Down-welling Long-wave Fluxes (DSLF)	SEVIRI/MSG, FCI/MTG
Vegetation	Normalized Difference Vegetation Index (NDVI)	AVHRR/Metop, VII/EPS-SG
	Fraction of Vegetation Cover (FVC)	SEVIRI/MSG, AVHRR/Metop, FCI/MTG, VII/EPS-SG, 3MI/EPS-SG
	Leaf Area Index (LAI)	SEVIRI/MSG, AVHRR/Metop, FCI/MTG, VII/EPS-SG, 3MI/EPS-SG
	Fraction of Absorbed Photosynthetically Active Radiation (FAPAR)	SEVIRI/MSG, AVHRR/Metop, FCI/MTG, VII/EPS-SG, 3MI/EPS-SG
	Gross Primary Production (GPP)	SEVIRI/MSG, FCI/MTG
	Canopy Water Content (CWC)	AVHRR/Metop, VII/EPS-SG
Energy Fluxes	Evapotranspiration (ET)	SEVIRI/MSG, FCI/MTG
	Reference Evapotranspiration (ET0)	SEVIRI/MSG, FCI/MTG
	Surface Energy Fluxes: Latent and Sensible (LE&H)	SEVIRI/MSG, FCI/MTG
Wild Fires	Fire Detection and Monitoring (FD&M)	SEVIRI/MSG
	Fire Radiative Power	SEVIRI/MSG, FCI/MTG, VII/EPS-SG
	Fire Radiative Energy and Emissions (FRE)	SEVIRI/MSG, FCI/MTG, VII/EPS-SG
	Fire Risk Map (FRM)	SEVIRI/MSG, FCI/MTG
	Burnt Area (BA)	AVHRR/Metop, VII/EPS-SG

The LSA SAF products (Table 1) are based on level 1.5 SEVIRI/Meteosat and/or level 1b Metop data. Forecasts provided by the European Centre for Medium-range Weather Forecasts (ECMWF) are also used as ancillary data for atmospheric correction.

SEVIRI LSA SAF products are disseminated NRT in two fashions:

- via the project portal (https://landsaf.ipma.pt/) in full SEVIRI disk

- via EUMETCast by splitting the disk into 4 different geographical areas within Meteosat disk (Figure 1):

- *Euro* – Europe, covering all EUMETSAT member states;
- *NAfr* – Northern Africa encompassing the Sahara and Sahel regions, and part of equatorial Africa.
- *SAfr* – Southern Africa covering the African continent south of the Equator.
- *SAme* – South American continent within the Meteosat disk.

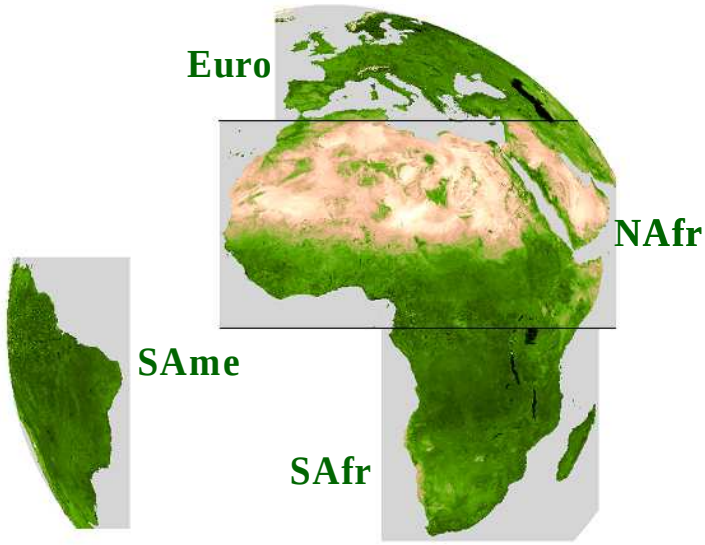

Figure 1: The LSA SAF geographical areas for SEVIRI-based products.

Metop derived parameters are currently available at Level 3 full globe in sinusoidal projection, centred at (0ºN, 0ºW), with a resolution of 1kmx1km, one file for daytime and another for nighttime observations.

The LSA SAF system is located at IPMA (Portugal) and VITO (Belgium) and has been designed generate, archive, and disseminate the operational products. LSA SAF Land Surface Temperature products are fully centralized at IPMA. The monitoring and quality control of the operational products is performed automatically by the LSA SAF software, which provides quality information to be distributed with the products.

The LSA SAF products are currently available from LSA SAF website (http://landsaf.ipma.pt) that contains real time examples of the products as well as updated information.

The Table 2 & 3 below detailed the evolution of the MSG and MetOP platforms, respectively, during the lifetime of the LSA SAF project.

Table 2– Series of MSG satellites considered for product achievement.

	MSG-1	MSG-2	MSG-3
Period	19/01/2004 23/09/2006	25/09/2006 20/01/2013 (*)	Since 22/01/2013 (**)
Operated changes	Calibration Band factors	Calibration Band factors	Calibration Band factors

(*) *During this period MSG-1 took over as the prime satellite for short periods during the outages of MSG-2.*

(**) *During this period both MSG-2 and MSG-1 took over as the prime satellites for short periods during the outages of MSG3 (e.g. for sensor decontamination).*

Satellite	Begin		End	
MSG1	2004/01/19	10:30	2006/09/23	13:45
MSG2	2006/09/25	06:45	2006/10/04	02:45
MSG1	2006/10/05	10:30	2007/04/11	12:30
MSG2	2007/04/11	12:45	2007/12/03	11:45
MSG1	2007/12/03	12:00	2007/12/12	07:45
MSG2	2007/12/12	08:15	2008/05/13	20:45
MSG1	2008/05/13	21:00	2008/05/19	10:00
MSG2	2008/05/19	10:15	2008/12/01	11:45
MSG1	2008/12/01	12:00	2008/12/08	23:45
MSG2	2008/12/09	01:00	2009/04/17	15:30
MSG1	2009/04/17	17:45	2009/04/23	08:45
MSG2	2009/04/23	09:00	2009/08/15	04:45
MSG1	2009/08/17	05:15	2009/08/21	07:45
MSG2	2009/08/21	08:00	2013/01/20	23:45
MSG3	2013/01/22	01:00	2013/07/01	07:45
MSG1	2013/07/01	08:00	2013/07/09	08:45
MSG3	2013/07/09	09:15	2014/01/14	09:00
MSG2	2014/01/14	09:15	2014/01/21	08:45
MSG3	2014/01/21	09:00	2014/12/02	08:45
MSG1	2014/12/03	07:00	2014/12/08	09:15
MSG3	2014/12/08	09:30	2015/11/15	03:15
MSG1	2015/11/15	15:15	2015/11/18	11:45
MSG3	2015/11/18	12:00	2015/12/08	07:45
MSG1	2015/12/08	08:00	2015/12/14	14:45
MSG3	2015/12/14	15:00	2016/10/15	12:15
MSG2	2016/10/15	14:30	2016/10/17	12:45
MSG3	2016/10/17	13:00		

Table 3 – Series of MetOP satellites considered for product achievement.

	MetOP-A	MetOP-B	MetOP-C
Period	Not produced yet	In production	Not produced yet
Operated changes	Calibration Band factors	Calibration Band factors	Calibration Band factors

2 Product Description

2.1 Overview

In LSA SAF operational system, the data processing exploits the full geographic coverage. This either concerns full MSG Disk for SEVIRI or the whole globe for AVHRR. The albedo product is calculated on a daily basis for SEVIRI (MDAL)) and on a 10-days basis both for SEVIRI and AVHRR (MTAL and ETAL, respectively).

The AVHRR/Metop follows two steps in its processing:

- firsrt, all Product Distribution Units (PDUs) are processed;
- secondly, PDUs are aggregated in order to produce the daily files.

The LSA SAF AVHRR/Metop chain processes all Product Distribution Units (PDUs) at the LSA SAF processing centre. A PDU corresponds to 3 minutes of instrument-specific observation data. The PDUs are aggregated in daily datasets. The ETAL product is available in sinusoidal projection with a resolution of 1km.
Note that scientific algorithms are essentially the same for MDAL/MTAL and ETAL, despite using input data may have some distinct characteristics.
The projection and spatial resolution of the observations correspond to the characteristics of the Level 1.5 (SEVIRI) or Level 1b (AVHRR). Information on geo-location can be found on the LSA SAF website: http://landsaf.meteo.pt. The data are disseminated through the project website and Eumetcast. As for AVHRR, a global file is disseminated for time being but distribution per tile may be envisaged. The main characteristics of these windows are listed in Table 4. Typically the algorithm is launched a little after midnight (UTC) and exploits MSG input data accumulated during the past day.

Table 4: Characteristics of the LSA SAF geographical windows.

Region Name	Description	Maximum ncol	Maximum nlin	COFF	LOFF
MSG-Disk	MSG Disk	3712	3712	1857	1857
Euro	Europe	1701	651	308	1808
NAfr	Northern Africa	2211	1151	618	1158
SAfr	Southern Africa	1211	1191	-282	8
SAme	Southern America	701	1511	1818	398
GLOB	Global AVHRR	36000	18001		

2.2 Geolocation / Rectification

Both SEVIRI-based and AVHRR-based albedo fields are generated pixel-by-pixel, maintaining the original resolution of SEVIRI level 1.5 data or AVHRR level 1b data. These correspond to rectified images to 0º longitude fro SEVIRI. Data are kept in the native geostationary projection (SEVIRI) or put on a sinusoidal grid (AVHRR).
Files containing the latitude and longitude of the centre of each pixel may be downloaded from the Land-SAF website (http://landsaf.ipma.pt under "User Tools" then MSG Toolbox):

Longitude: **HDF5_LSASAF_MSG_LON_MSG-Disk_201408100000.bz2**
Latitude: **HDF5_LSASAF_MSG_LON_MSG-Disk_201408100000.bz2**

Alternatively, since the data are in the native geostationary projection, centred at 0º longitude and with a sampling distance of 3 km at the sub-satellite point, the latitude and longitude of any pixel may be easily estimated. Given the pixel column number, *ncol* (where *ncol*=1 correspond to the westernmost column of the file), and line number, *nlin* (where *nlin*=1 correspond to the northernmost line), the coordinates of the pixel may be estimated as follows:

$$lon = arctg\left(\frac{s_2}{s_1}\right) + sub_{lon}$$ longitude (deg) of pixel centre

$$lat = arctg\left(p_2 \cdot \frac{s_3}{s_{xy}}\right);$$ latitude (deg) of pixel centre

where

sub_lon is the sub-satellite point ($sub_{lon} = 0$)

and

$$s_1 = p_1 - s_n \cdot \cos x \cdot \cos y$$
$$s_2 = s_n \cdot \sin x \cdot \cos y$$
$$s_3 = -s_n \cdot \sin y$$
$$s_{xy} = \sqrt{s_1^2 + s_2^2}$$
$$s_d = \sqrt{\left(p_1 \cdot \cos x \cdot \cos y\right)^2 - \left(\cos^2 y + p_2 \cdot \sin^2 y\right) \cdot p_3}$$
$$s_n = \frac{p_1 \cdot \cos x \cdot \cos y - s_d}{\cos^2 y + p_2 \cdot \sin^2 y}$$

where

$$x = \frac{ncol - COFF}{2^{-16} \cdot CFAC}$$ (in Degrees)

$$y = \frac{nlin - LOFF}{2^{-16} \cdot LFAC}$$ (in Degrees)

$$p_1 = 42164$$
$$p_2 = 1.006803$$
$$p_3 = 1737121856$$

CFAC = 13642337
LFAC = 13642337

The CFAC and LFAC coefficients are column and line scaling factors, which depend on the specific segmentation approach of the input SEVIRI data. Finally, COFF and LOFF are coefficients depending on the location of the each Land-SAF geographical area within the Meteosat disk. These are included in the file metadata (HDF5 attributes; Annex B). For instance, for the whole image disk sized as 3712x3712 pixels, ,one would have COFF=1857 and LOFF=1857.

2.3 File Formats

At each execution the albedo algorithm generates two types of MDAL output files.

- Spectral band albedo estimates are included in three different files with the name convention

HDF5_LSASAF_MSG_C?_MSG-Disk_YYYYMMDD0000

where **?=1,2,3** denotes the 0.6µm, 0.8µm, and 1.6µm channels, respectively,
where **YYYY**, **MM**, and **DD**, respectively, denote the year, month, and day of data acquisition.

- Broad-band albedo estimates are included in a single file with the name convention

HDF5_LSASAF_MSG_ALBEDO_MSG-Disk_YYYYMMDD0000

Similarly

HDF5_LSASAF_MSG_AL-C?-D10_MSG-Disk_YYYYMMDD0000

For distribution via EumetCast the prefix ”S-LSA_-“ is added.

To be outlined that in the distribution via EumetCast, **MSG-Disk** is replaced by **Region**, where **Region** = ‘Euro’,’NAfr’,’SAfr’ or ‘Same’.

The 10-day aggregate AVHRR files are named according to the following convention:

HDF5_LSASAF_<Satellite_name>-AVHR_ETAL_GLOBE_YYYYMMDD000003
HDF5_LSASAF_<Satellite_name>-AVHR_ETAL_AL-C?_GLOBE_YYYYMMDD000003

where **?=1,2,3** denotes the 0.6µm, 0.8µm, and 1.6µm channels, respectively,
where **<Satellite_name>** denotes satellite name (M01 or M02)
where **YYYYMMDD** denotes the year, the month, the dekad day (05, 15 or 25) corresponding to the end of the 20-days time-compositing period.

The LSA SAF products are provided in the HDF5 format developed by the NCSA (National Center for Supercomputing Applications) at the University of Illinois. A comprehensive description as well as libraries for handling HDF5-files in Fortran and C are available at https://www.hdfgroup.org/HDF5/
A user friendly graphical interface to open and view HDF5-files can be downloaded from https://www.hdfgroup.org/products/java/hdfview/. The HDF5-format permits the definition of a set of attributes for providing relevant information. Each LSA SAF product file includes the general attributes listed in Table 11 of Appendix C.. Within the HDF5-files the information is organised in the form of separate datasets. For each dataset a set of additional attributes is available (Table 12 of Appendix C.).

2.4 Product Content

Broad-band albedo file contains 4 albedo quantities (BH and DH for BB, DH for NI, DH for VI), their uncertainty estimates (ERR), the quality flag (Q-Flag), and the "age" of the information (Z_age), or elapsed time since the last production. Table 5 resumes these quantities in the order of the datasets in the HDF5 structure.

Directional-hemispherical (DH) values are calculated for each of the intervals: total short-wave (BB): [0.3µm, 4µm], near infrared (NI): [0.7µm, 4µm], and visible (VI): [0.4µm, 0.7µm]. Bi-hemispherical (BH) estimates are only available for short-wave range. Reference for derivation is Eq.(39). Figure 2 shows scenes of the AL-BB-BH with respective uncertainty estimate, the quality flag, and the age of the information. Figure 2 show the global broad-band ETAL product on early February 2016.

Table 5 : Content of the broad-band surface albedo product files, which is common to MDAL, MTAL and ETAL.

Parameter	Dataset Name	Unit	Range	Variable Type	Scale Factor
$a^{bh}_{[0.3\mu m,\ 4\mu m]}$	AL-BB-BH	1	[0, 1]	2-Byte Signed Integer	10000
$\sigma[\ a^{bh}_{[0.3\mu m,\ 4\mu m]}]$	AL-BB-BH-ERR	1	[0, 1]	2-Byte Signed Integer	10000
$a^{dh}_{[0.3\mu m,\ 4\mu m]}$	AL-BB-DH	1	[0, 1]	2-Byte Signed Integer	10000
$\sigma[\ a^{dh}_{[0.3\mu m,\ 4\mu m]}]$	AL-BB-DH-ERR	1	[0, 1]	2-Byte Signed Integer	10000
$a^{dh}_{[0.7\mu m,\ 4\mu m]}$	AL-NI-DH	1	[0, 1]	2-Byte Signed Integer	10000
$\sigma[\ a^{dh}_{[0.7\mu m,\ 4\mu m]}]$	AL-NI-DH-ERR	1	[0, 1]	2-Byte Signed Integer	10000
$a^{dh}_{[0.4\mu m,\ 0.7\mu m]}$	AL-VI-DH	1	[0, 1]	2-Byte Signed Integer	10000
$\sigma[\ a^{dh}_{[0.4\mu m,\ 0.7\mu m}$	AL-VI-DH-ERR	1	[0, 1]	2-Byte Signed Integer	10000
Quality Flag	Q-Flag	na	[0, 255]	1-Byte Unsigned Integer	na
Age of Information[1]	Z_Age	days	[0, 127]	1-Byte Signed Integer	1

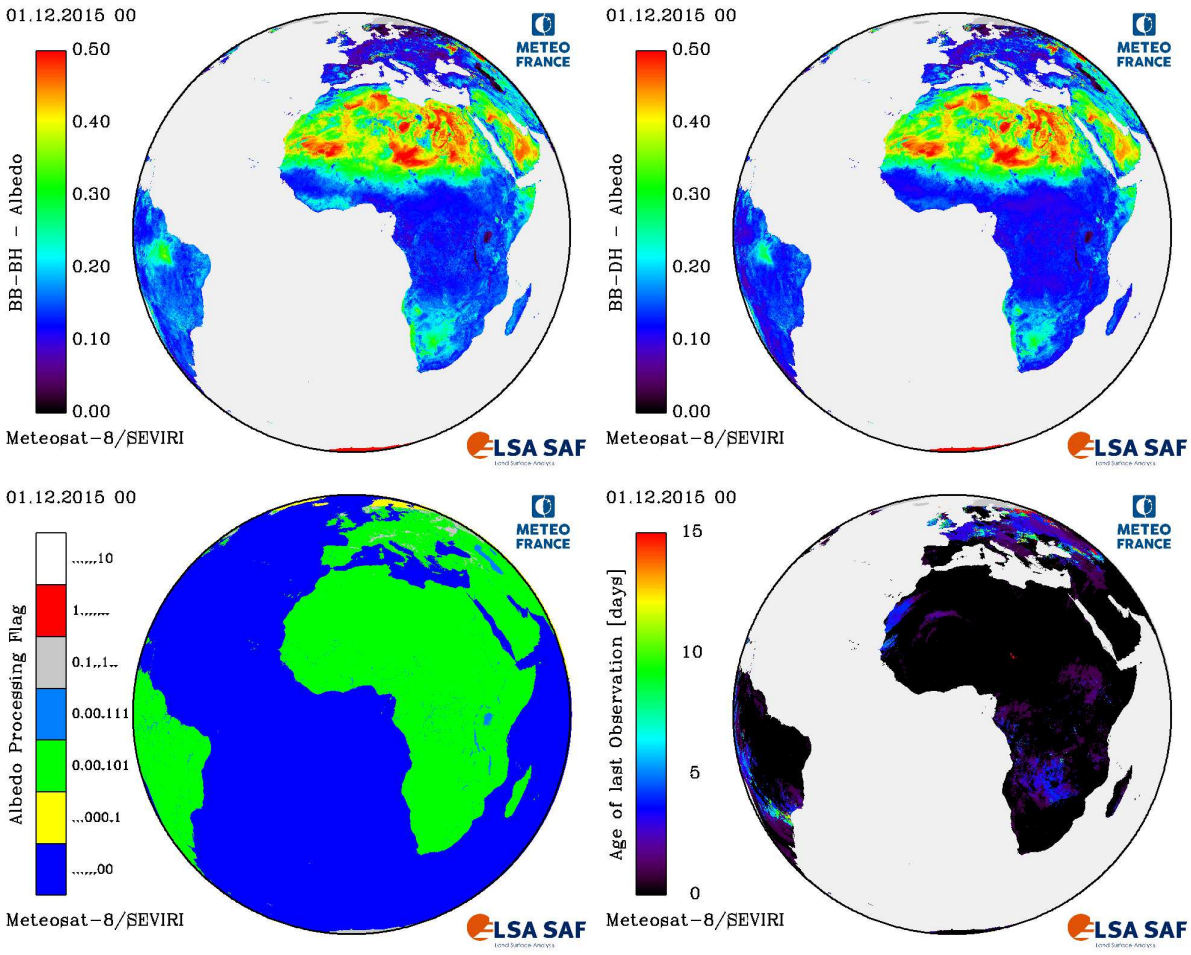

Figure 2: Examples of MDAL b-band albedo product for the 1st of December 2015.The top left panel shows the total broad-band directional-hemispherical albedo, the top right panel the corresponding uncertainty estimate, and the bottom left panel the quality flag. For the latter the legend indicates which bits were used for the visualisation, e.g. "……00" signifies that pixels with bits 0 and 1 equal to zero are depicted in dark blue colour. The bottom right panel shows the "age" of the last available observation used for each image pixel.

Figure 3 shows the global broad-band ETAL product on early February 2016 as it is disseminated in sinusoidal projection.

[1] Note that this attribute is not present for the D30 product.

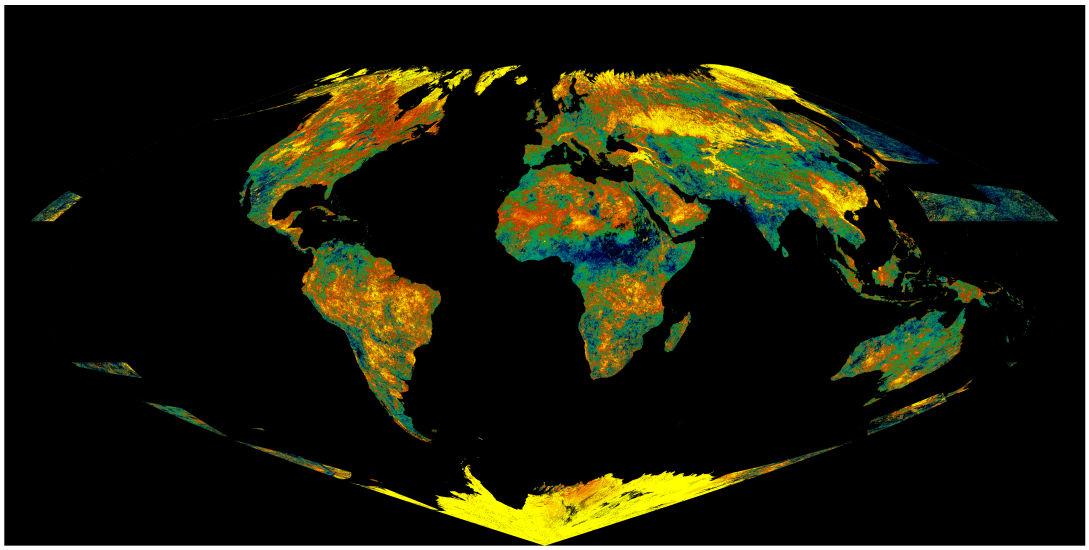

Figure 3: Example of ETAL b-band albedo product on February 15 2016.

Each of the spectral albedo (SP) files corresponding to the nominal SEVIRI bands contains 4 datasets encompassing 2 albedo quantities (BH or DH)), their respective uncertainty estimates (ERR), the quality flag (Q-Flag) and the age of the information (Z_age), or elapsed time since the last production. The technical details are given in Table 6. As illustration, a colour composite, derived by combining the spectral albedo estimates from the 3 spectral output files, is shown in Figure 4.

Table 6: Content of the spectral surface albedo product files for each channel β .

Parameter	Dataset Name	Unit	Range	Variable Type	Scale Factor
a_β^{bh}	AL-SP-BH	1	[0, 1]	2-Byte Signed Integer	10000
$\sigma[\,a_\beta^{bh}\,]$	AL-SP-BH-ERR	1	[0, 1]	2-Byte Signed Integer	10000
a_β^{dh}	AL-SP-DH	1	[0, 1]	2-Byte Signed Integer	10000
$\sigma[\,a_\beta^{dh}\,]$	AL-SP-DH-ERR	1	[0, 1]	2-Byte Signed Integer	10000
Quality Flag	Q-Flag	na	[0, 255]	1-Byte Unsigned Int.	na
Age of Information	Z_Age	days	[0, 127]	1-Byte Signed Integer	1

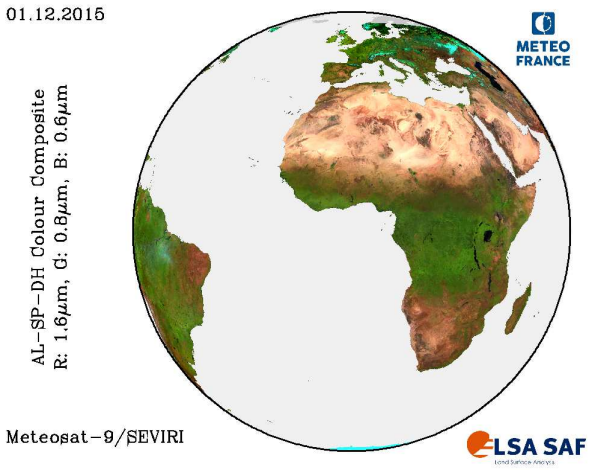

Figure 4: Colour composite derived from the three spectral directional-hemispherical albedo estimates for the 1st of December 2015**.**

Finally, Table 7 lists the signification of the numerical values of the (spectral and broad-band) albedo quality flag. Bits 0 and 1 propagate the land/sea mask information. Bits 2 to 4 indicate if MSG observations, EPS information, or additional external information, respectively, were used to produce the result. (The latter two bits are never set in the presently available product files, since up to now only MSG data have been processed.) Bit 5 indicates whether a pixel was flagged as snow covered in the NWC-CMa product for at least one slot of the daily time series.

(Note that the "Age of Information" dataset is available in the broad-band and spectral albedo product files since version 6.0 implemented in September 2006. The respective graph for an earlier date shown in Figure 2 was generated from internal product files in which this information was already available before.)

Table 7: Albedo product quality flag information.

Bit		Binary Code	Description
Bits 0-1	Land Sea Mask	00	Ocean
		01	Land
		10	Space (Outside of MSG disk)
		11	Continental water
Bit 2	MSG	0	No MSG Observations
		1	Including MSG Observations
Bit 3	EPS	0	No EPS Observations
		1	Including EPS Observations
Bit 4	External Information	0	No External Information
		1	Including External Information
Bit 5	Snow	0	No Snow

		1	Snow
Bit 6	Unused	0	-
		1	-
Bit 7	Failure	0	Algorithm Failed
		1	Normally Processed

2.5 Summary of Product Characteristics

Product Name: Land Surface Albedo

Product Code: MDAL or MTAL or ETAL

Product Level: Level 3

Product Parameters:

Coverage: MSG full disk (Continental pixels)
EPS global (Continental pixels)

Packaging: MSG-Disk, Global

Sampling: pixel by pixel basis

Spatial Resolution: MSG/SEVIRI full resolution (3km×3km at nadir)
EPS/AVHRR full resolution (1kmx1km)

Projection: MSG/SEVIRI Level 1.5 data projection
EPS/AVHRR sinusoidal

Units: dimensionless

Range: 0 - 1

Accuracy: objective: 10%; (to be confirmed)

Format: 16 bits signed integer (albedo and uncertainty estimates)
8 bits (quality flag and age of information)

Frequency of Generation: daily

Size of Product Files: MDAL Broad-band Albedo: 6Mb - 28Mb
Spectral Albedo: 4Mb – 15Mb for each SEVIRI channel (depending on the window and the compression efficiency)
ETAL_Broad-band Albedo GLOBE ~ 1.2Gb
ETAL_Spectral Albedo GLOBE ~ 600Mb (each)

Additional Information:

Identification of bands used in algorithm:

MSG VIS 0.6

MSG NIR 0.8

MSG SWIR 1.6

EPS VIS 0.6

EPS NIR 0.8

EPS SWIR 1.6

Assumptions on SEVIRI & AVHRR input data:

Radiometric and Geometric Calibration

Identification of ancillary and auxiliary data:

Land/Sea Mask
Cloud Mask (CMa from NWC SAF software)
View Azimuth and Zenith Angles (from LSA SAF System)
Solar Azimuth and Zenith Angles (from LSA SAF System)
Pixel Latitude (from LSA SAF System)
Total Column Water Vapour (from ECMWF model)
Ozone Content (from ECMWF model)
Atmospheric Pressure (from ECMWF model)
Aerosol Optical Thickness at 550 nm (based on a climatology)
Digital Elevation Model (based on USGS GTOPO30)

Appendix A. Developers

The development and implementation have been carried out under the responsibility of the Centre National de Recherches Météorologiques (CNRM) de Météo-France (MF).

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Appendix B. Glossary

AL:	Land Surface Albedo Product
AVHRR:	Advanced Very High Resolution Radiometer
BRDF:	Bi-directional Reflectance Distribution Function
CNRM:	Centre National de Recherches Météorologiques
CMa:	Cloud Mask product developed by the NWC-SAF
ECMWF:	European Centre for Medium-Range Weather Forecast
EPS:	EUMETSAT Polar System
EUMETSAT:	European Meteorological Satellite Organisation
HDF:	Hierarchical Data Format
IPMA:	Instituto Português do Mar e da Atmosfera (Portugal)
NIR:	Near Infrared Radiation
LSA:	Land Surface Analysis
METEOSAT:	Geostationary Meteorological Satellite
METOP:	Meteorological Operational polar satellites of EUMETSAT
MF:	Météo-France
MSG:	Meteosat Second Generation
NOAA:	National Oceanic and Atmospheric Administration (USA)
NWC:	NowCasting
NWP:	Numerical Weather Prediction
SAF:	Satellite Application Facility
SEVIRI:	Spinning Enhanced Visible and Infrared Imager
SWIR:	Shortwave Infrared Radiation

Appendix C. HDF5-Attributes

The set of general attributes common for all LSA SAF files and their possible values are described in the table below.

Table C1: General HDF5 attributes for AL SEVIRI.

Attribute	Description	Data Type	Allowed Values
SAF	SAF package	String	LSA
CENTRE	Institution (generating/disseminating data)	String	MF
ARCHIVE_FACILITY	Centre where the data is archived	String	IM-PT
PRODUCT	Defines the name of the product	String	AL-C?, or ALBEDO
PARENT_PRODUCT_NAME	Array of up to 4 product names, upon which the product is based	String Array(4)	AL-C?-K012, AL-C?-CK, LAT or AL-C1, AL-C2, AL-C3
SPECTRAL_CHANNEL_ID	Channel Identification (1 bit per channel, where LSB is HRV and MSB is IR13.4; values are 0 if not used, 1 if used.)	Integer	14
PRODUCT_ALGORITHM_VERSION	Version of the Algorithm that produced the product	String	5.1
CLOUD_COVERAGE	Indicator of the cloud coverage in the product	String	NWC-CMa
OVERALL_QUALITY_FLAG	Overall quality flag for the product	String	OK or NOK
ASSOCIATED_QUALITY_INFORMATION	Several miscellaneous quality indicators for the product	String	-
REGION_NAME	Processed Region Name	String	Euro, NAfr, SAfr, or SAme.
COMPRESSION	Compression Flag	Integer	0 – Uncompressed 1 – Compressed
FIELD_TYPE	Data filed type	String	Product
FORECAST_STEP	Forecast Step in Hours	Integer	0
NC	Number of columns	Integer	Depends on Region
NL	Number of lines	Integer	Depends on Region
NB_PARAMETERS	Number of datasets	Integer	5 or 9
NOMINAL_PRODUCT_TIME	Production Time	String	YYMMDDhhmmss
SATELLITE	Platform identifier (mission and spacecraft the product originated from)	String Array(10)	MSG1 or MSG2 or EPS

Attribute	Description	Data Type	Allowed Values
INSTRUMENT_ID	Instrument which acquired the product or data used by the product	String Array(10)	SEVI
INSTRUMENT_MODE	Scanning mode of the instrument at the time of the acquisition.Satellite Identification	String	STATIC_VIEW
IMAGE_ACQUISITION_TIME	Image Acquisition Time (SEVIRI 1.5 Images)	String	YYMMDD
ORBIT_TYPE	Coverage of the product (only for EPS)	String	GEO
PROJECTION_NAME	Projection name and sub-satellite point	String	GEOS(+000.0)
NOMINAL_LONG	Satellite Nominal Longitude	Real	as in Level 1.5 data
NOMINAL_LAT	Satellite Nominal Latitude	Real	as in Level 1.5 data
CFAC	Column Scaling Factor (SEVIRI 1.5 Images)	Integer	as in Level 1.5 data
LFAC	Line Scaling Factor (SEVIRI 1.5 Images)	Integer	as in Level 1.5 data
COFF	Column Offset (SEVIRI 1.5 Images)	Integer	Depends on Region
LOFF	Line Offset (SEVIRI 1.5 Images)	Integer	Depends on Region
START_ORBIT_NUMBER	First of two orbit numbers in the EPS product, valid at the starting of the sensing, i.e, at the beginning of a dump	Integer	0
END_ORBIT_NUMBER	Final of the orbit numbers in the EPS product, valid at the ascending node crossing, i.e. towards the end of a dump	Integer	0
SUB_SATELLITE_POINT_START_LAT	Latitude of sub-satellite at start of acquisition	Real	0.0
SUB_SATELLITE_POINT_START_LON	Longitude of sub-satellite at start of acquisition	Real	0.0
SUB_SATELLITE_POINT_END_LAT	Latitude of sub-satellite at end of acquisition	Real	0.0
SUB_SATELLITE_POINT_END_LON	Longitude of sub-satellite at end of acquisition	Real	0.0
SENSING_START_TIME	UTC date & time at acquisitions start of the product	String	-
SENSING_END_TIME	UTC date & time at acquisition end of the product	String	-
PIXEL_SIZE	For image products, size of pixel at nadir. For meteorological products resolution/accuracy	String	3.1km
GRANULE_TYPE	Type description of the item	String	DP

Attribute	Description	Data Type	Allowed Values
PROCESSING_LEVEL	Processing Level Applied for generation of the product	String	3
PRODUCT_TYPE	Abbreviation name for the product type rather product category	String	LSA AL-C? or LSA ALBEDO
PRODUCT_ACTUAL_SIZE	Actual size of the product	String	9966159 or 18824967
PROCESSING_MODE	Processing mode for generation of the product	String	N, B, R, or V
DISPOSITION_FLAG	Disposition status indicator of the product, as set by the UMARF operator	String	O, T, or C
TIME_RANGE	Temporal Resolution	String	frequency: daily or frequency: ?-days
STATISTIC_TYPE	Statistic Type	String	recursive, timescale: ? days or composition period: ? days

LSB – Lower Significant Bit
MSB – Most Significant Bit
YY - Year; MM-Month; DD – Day; hh – Hour; mm – Minute; ss – Second
String - Character (len=80)
Integer - Integer (kind=4)
Real - Real (kind=8)

Table C2: The attributes for each dataset of the HDF5-files for AL SEVIRI are described in the following table.

Attribute	Description	Data Type	Value for Albedo Datasets	Value for Albedo Error Datasets	Value for Q-Flag Datasets	Value for Age Datasets
CLASS	Dataset type	String	Data	Data	Data	Data
PRODUCT	Defines the name of the product	String	Name of albedo variant	“Error of” + Name of albedo variant	Q-Flag	Z_Age
PRODUCT_ID	Product identification accordingly with WMO tables	Integer	84	128	128	128
N_ COLS	Number of columns	Integer	Depends on Region	Depends on Region	Depends on Region	Depends on Region
N_ LINES	Number of lines	Integer	Depends on Region	Depends on Region	Depends on Region	Depends on Region
NB_BYTES	Number of bytes per pixel	Integer	2	2	1	1
SCALING_FACTOR	Scaling factor for the parameter	Real	10000.0	10000.0	1.0	1.0
OFFSET	Offset of the scaling factor	Real	0.0	0.0	0.0	0.0
MISS_VALUE	Missing value	Integer	-1	-1	999	-1
UNITS	Parameter Units	Integer	1	1	N/A	Days
CAL_SLOPE	Calibration Constant	Real	1.0	1.0	1.0	1.0
CAL_OFFSET	Calibration Constant	Real	0.0	0.0	0.0	0.0

Table C3: General HDF5 attributes for AL AVHRR.

Attribute	Description	Data Type	Allowed Values
SAF	SAF package	String	LSA
CENTRE	Institution (generating/disseminating data)	String	MF
ARCHIVE_FACILITY	Centre where the data is archived	String	IM-PT
PRODUCT	Defines the name of the product	String	AL-C?, or ALBEDO
PARENT_PRODUCT_NAME	Array of up to 4 product names, upon which the product is based	String Array(4)	AL-C?-K012, AL-C?-CK, LAT or AL-C1, AL-C2, AL-C3
SPECTRAL_CHANNEL_ID	Channel Identification (1 bit per channel values are 0 if not used, 1 if used.)	Integer	24
PRODUCT_ALGORITHM_VERSION	Version of the Algorithm that produced the product 3 integer values comprised between 0 and 99 Major (X): increase only for a product change .Minor. Increase only for a new functionality Patch: increase if bug fixed	String	X.Y.Z.
CLOUD_COVERAGE	Indicator of the cloud coverage in the product	String	NWC-CMa
OVERALL_QUALITY_FLAG	Overall quality flag for the product	String	OK or NOK
ASSOCIATED_QUALITY_INFORMATION	Several miscellaneous quality indicators for the product	String	-
REGION_NAME		String	GLOBE
COMPRESSION	Compression Flag Level of compression between 0 and 9 (9 is the most efficient in terms of data volume	Integer	9
FIELD_TYPE	Data filed type	String	Product
FORECAST_STEP	Forecast Step in Hours	Integer	0
NC	Number of columns	Integer	36000
NL	Number of lines	Integer	18001
NB_PARAMETERS	Number of datasets	Integer	4
NOMINAL_PRODUCT_TIME	Production Time	String Array(14)	YYMMDDhhmmss

Attribute	Description	Data Type	Allowed Values
SATELLITE	Platform identifier (mission and spacecraft the product originated from)	String Array(10)	METOPX
INSTRUMENT_ID	Instrument which acquired the product or data used by the product	String Array(10)	AVHR
INSTRUMENT_MODE	Scanning mode of the instrument at the time of the acquisition.Satellite Identification	String	NORMAL_VIEW
IMAGE_ACQUISITION_TIME	Image Acquisition Time (SEVIRI 1.5 Images)	String Array(14)	YYMMDD
ORBIT_TYPE	Coverage of the product	String Array(3)	LEO
PROJECTION_NAME	Projection name	String Array(15)	
NOMINAL_LONG	Satellite Nominal Longitude	Real	0
NOMINAL_LAT	Satellite Nominal Latitude	Real	0
CFAC		Integer	0
LFAC		Integer	0
COFF		Integer	0
LOFF		Integer	0
START_ORBIT_NUMBER	Depend on the orbit	Integer	
END_ORBIT_NUMBER	Depend on the orbit	Integer	
SENSING_START_TIME	UTC date & time at acquisitions start of the product	String Array(14)	YYMMDDhhmmss
SENSING_END_TIME	UTC date & time at acquisition end of the product	String Array(14)	YYMMDDhhmmss
PIXEL_SIZE	For image products, size of pixel at nadir. For meteorological products resolution/accuracy	String Array(10)	0.01°
GRANULE_TYPE	Type description of the item	String Array(2)	DP
PROCESSING_LEVEL	Processing Level Applied for generation of the product	String Array(2)	02
PRODUCT_TYPE	Abbreviation name for the product type rather product category	String Array(8)	LSA AL-C? or LSA ALBEDO
PRODUCT_ACTUAL_SIZE	Actual size of the product	String Array(11)	TBD

Attribute	Description	Data Type	Allowed Values
PROCESSING_MODE	Processing mode for generation of the product	String	N
DISPOSITION_FLAG	Disposition status indicator of the product, as set by the UMARF operator	String	O
TIME_RANGE	Temporal Resolution	String	1-day
STATISTIC_TYPE	Statistic Type	String	recursive, timescale: 10days or more composition period: 30 days
MEAN_SSLAT	Latitude average	Real	0
MEAN_SSLON	Longitude average	Real	0
PLANNED_CHAIN_PROCESSING		Integer	0
FIRST_LAT	Latitude start	Real	0
FIRST_LON	Longitude start	Real	0

YY - Year; MM-Month; DD – Day; hh – Hour; mm – Minute; ss – Second
String - Character (len=80)
Integer - Integer (kind=4)
Real - Real (kind=8)

Table C4: The attributes for each dataset of the HDF5-files for AL AVHRR are described in the following table.

Attribute	Description	Data Type	Value for Albedo Datasets	Value for Albedo Error Datasets	Value for Q-Flag Datasets	Value for Age Datasets
CLASS	Dataset type	String	Data	Data	Data	Data
PRODUCT	Defines the name of the product (ETAL)	String	Name of albedo variant	“Error of” + Name of albedo variant	Q-Flag	Z_Age
PRODUCT_ID	Product identification accordingly with WMO tables	Integer	84	128	128	128
N_ COLS	Number of columns	Integer	360002048	360002048	360002048	360002048
N_ LINES	Number of lines	Integer	180001080	180001080	180001080	180001080

NB_BYTES	Number of bytes per pixel	Integer	2	2	1	1
SCALING_FACTOR	Scaling factor for the parameter	Real	10000.0	10000.0	1.0	1.0
OFFSET	Offset of the scaling factor	Real	0.0	0.0	0.0	0.0
MISS_VALUE	Missing value	Integer	-1	-1	999	-1
UNITS	Parameter Units	Integer	1	1	N/A	Days
CAL_SLOPE	Calibration Constant	Real	1.0	1.0	1.0	1.0
CAL_OFFSET	Calibration Constant	Real	0.0	0.0	0.0	0.0