Product User Manual

Reference Evapotranspiration (DMETREF)

PRODUCTS: LSA-303 (DMETREF)

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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://lsa-saf.eumetsat.int/).

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., 1993; 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 (ETREF)	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.

The SEVIRI/Meteosat derived products are derived for the Full SEVIRI disk and, when applicable, distributed via EUMETCast for 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.

SEVIRI full disk products are available via ftp (off-line and/or NRT).

Metop derived parameters are currently available at level 3 full globe in sinusoidal projection, centred at (0ºN, 0ºW), with a resolution of 0.01º by 0.01º, one file for daytime and another for night-time observations.

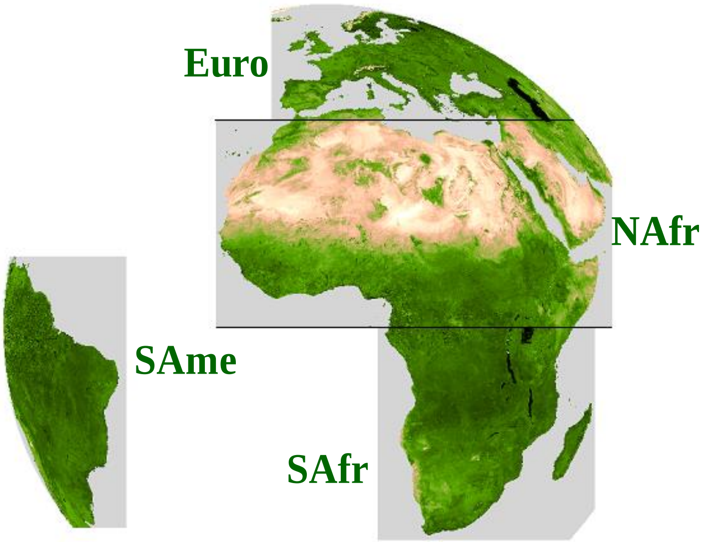

Figure 1 - The LSA SAF geographical areas.

The LSA SAF system is located at IPMA (Portugal) and VITO (Belgium) and has been designed generate, archive, and disseminate the operational products. The generation, archiving and distribution of LSA SAF reference and actual evapotranspiration products, including DMETREF (LSA-303) 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.

This document is one of the product manuals dedicated to LSA SAF users. The algorithm and the main characteristics of the Daily Reference Evapotranspiration (DMETRED) generated by the LSA SAF from SEVIRI data is described in the following sections. The product characteristics is described in Table 2. Further details on the LSA SAF product requirements may be found in the Product Requirements Document/Table (SAF_LAND_IPMA_PRD) available at the LSA SAF website http://landsaf.ipma.pt).

Table 2 - Product Requirements for reference evapotranspiration, in terms of area coverage, resolution and accuracy.

DSLF Product	Coverage	Resolution		Accuracy		
		Temporal	Spatial	Threshold	Target	Optimal
DMETREF (LSA-303)	MSG disk	Daily	MSG pixel resolution	30%	10%	5%

2 Reference Evapotranspiration

2.1 Definition and Applications

Reference evapotranspiration, denoted here as *ETo*, is the evapotranspiration rate from a clearly defined reference surface. The concept was introduced to allow the estimation of the evaporative demand of the atmosphere independently of crop type, crop development or management practices. ***ETo corresponds* to the evapotranspiration from a hypothetical extensive well-watered field covered with 12 cm height green grass having an albedo of 0.23 would experience under the given down-welling short-wave radiation** (Allen et al., 1998).

ETo provides a characterization of the "evaporative power of the atmosphere" The water requirements of a particular crop, ET_c, within a given stage in the growing season, and under the same atmospheric conditions, are assumed to be linearly related with *ETo* via a crop coefficient:

$$ET_c = K_c\, ET_o \tag{1}$$

According to the FAO56 report (see Allen et al., 1998), this crop evapotranspiration under standard conditions (ET_c) refers to the evaporating demand from crops - including both soil evaporation and plant transpiration - that are grown in large fields under optimum soil water, excellent management and environmental conditions, and achieve full production under the given climatic conditions. The crop coefficients, which depend on the crop type and growing stage, may be pre-estimated – see e.g., FAO tabulated values (e.g., Allen et al., 1998). ET_c would then correspond to the expected evapotranspiration of crop *c*, assuming disease-free plants and optimum soil conditions.

It should be stressed that FAO tabulated crop coefficients were estimated taking into account reference evapotranspiration computed using the Penmann-Monteith equation (FAO56, Allen et al., 1998). Their application with LSA SAF ETo product should be first tested by users.

The characteristics of land surfaces impact the radiation budget and influence the atmosphere boundary layer. As such, estimations of *ETo* using the methodology proposed in the FAO56 report (Allen et al., 1998), but with observations gathered over surfaces that deviate from the reference, may lead to erroneous values. The LSA DMETRef product, however, does not use atmospheric humidity and only presents a slight dependency on near surface air temperature. The algorithm behind the LSA SAF DMETRef is based on experimental and theoretical evidence that the main driver of evapotranspiration over the extensive reference surface is global radiation. LSA SAF DMETRef is not affected by local effects, such as surface aridity or local advection (please see the product Validation Report SAF/LAND/IPMA/VR_ETREF/1.1 for further details).

The characteristics of the LSA SAF DMETRef product, and particularly the fact that it is not affected by aridity effects, make it particularly suitable for drought mapping and monitoring: the ratio of *ETo* to actual evapotranspiration has been demonstrated to be an efficient index for such purpose (e.g., Otkin et al., 2016). The availability of long time-series of the LSA SAF DMETRef product will determine its use in climate monitoring.

The LSA SAF *ETo* product (DMETREF, LSA-303) is estimated from the Daily Downward Surface Shortwave Flux (DIDSSF) product generated by the LSA SAF from SEVIRI/Meteosat. As detailed in the sections below, it is shown that *ETo* can be computed from the daily net radiation and since *ETo* refers to a well-known and well-watered reference surface, daily net radiation over such surface can be estimated from short-wave radiation. Therefore, daily short-wave radiation at the surface estimated from SEVIRI, i.e., DIDSSF (LSA-203) product is the main input for DMETREF (LSA-303). The algorithm and product characteristics of DIDSSF are described in the respective LSA SAF documents (LSA SAF DSSF ATBD and LSA SAF DSSF PUM) and its assessment presented in the respective Validation Report (LSA SAF DSSF VR), all available at the LSA SAF website http://landsaf.ipma.pt).

2.2 Mathematical Description of the Algorithm

As detailed in the LSA SAF ATBD_DMETREF and in De Bruin et al. (2016), the evapotranspiration over a saturated surface, assuming that the air near the surface is also saturated, is fully determined by available energy, $A = Q^* - G$, where Q^* is the net radiation and G is the amount of heat stored in the ground. Since we consider 24-hourly averages, G can be ignored, and therefore it is shown that:

$$\lambda ET_{0eq} = \frac{\Delta}{\Delta+\gamma} Q^* \tag{2}$$

where ET_{0eq} is evapotranspiration from a saturated surface into a saturated atmosphere, λ is the latent heat of vaporization, Δ is slope of the saturation water vapour pressure, and γ is the psychometric constant. However, the entrainment of relatively warm and dry air into the well-mixed atmospheric boundary layer (ABL) during daytime breaks the condition of a fully saturated air near the surface. As noted by Beljaars and Bosveld (1997) and DeBruin et al. (2016), evapotranspiration over a well-watered surface, or reference evapotranspiration ET_0 can be approximated by:

$$\lambda ET_0 = \frac{\Delta}{\Delta+\gamma} Q^* + \beta \tag{3}$$

Where β is a constant (20 Wm^{-2}).

Q* is the net radiation of the hypothetical well-watered reference grass surface. "Surface dryness" will affect the actual net radiation, e.g. when the surface is dry, the surface temperature will be higher with more long-wave cooling than for a wet surface.. De Bruin (1987) found that net radiation for well-watered grass can be estimated by using the so-called Slob-de Bruin formula (hereafter SdB):

$$Q^* = (1 - 0.23)K^{\downarrow} - C_S \frac{K^{\downarrow}}{K^{\downarrow}_{ext}} \tag{4}$$

Where Q^* is the radiation over the grass reference surface with an albedo of 0.23, $K^{\downarrow}$ is the daily down-welling short-wave radiation at the surface (LSA SAF product DIDSSF),

$K_{ext}^{\downarrow}$ is the daily down-welling short-wave radiation at the top of the atmosphere, and C_S an empirical constant. De Bruin (1987) reported for unstressed grass of Cabauw C_S = 110 W m^{-2}. Combining equations (3) and (4) yields:

$$ET_0 = \frac{1}{\lambda}\left(\frac{\Delta}{\Delta + \gamma}\left[(1 - 0.23)K^{\downarrow} - C_S\,\frac{K^{\downarrow}}{K_{ext}^{\downarrow}}\right] + \beta\right) \quad (5)$$

3 Processing Scheme

3.1 SEVIRI/Meteosat ETREF Product: LSA-303 (DMETREF)

The dynamic inputs for DMETREF product are daily average 2m air temperature and the DIDSSF product. The former is provided by ECMWF as hourly forecasts; its interpolation to MSG/SEVIRI pixel (bilinear, corrected for surface orography differences between ECWMF model and pixel height) and its average over 24 hour periods (0 – to – 0 UTC) is part of the LSA SAF system pre-processing package. Major steps of the algorithm are described below:

1 outer loop for MSG line

2 Inner loop for MSG column

2.1 search for land pixels, skip and flag sea pixels

2.2 call routine to compute daily top of the atmosphere downward solar radiation (a function of Julian day and latitude of pixel)

2.3 compute latent heat of vaporization, as a function of air temperature

2.4 compute the slope of the saturation water vapour pressure, as a function of air temperature

2.5 compute DMETREF using equation (5)

2.6. set QFLAGS (with information of missing input data and/or land-sea mask) and Quality Indicators (from DIDSSF).

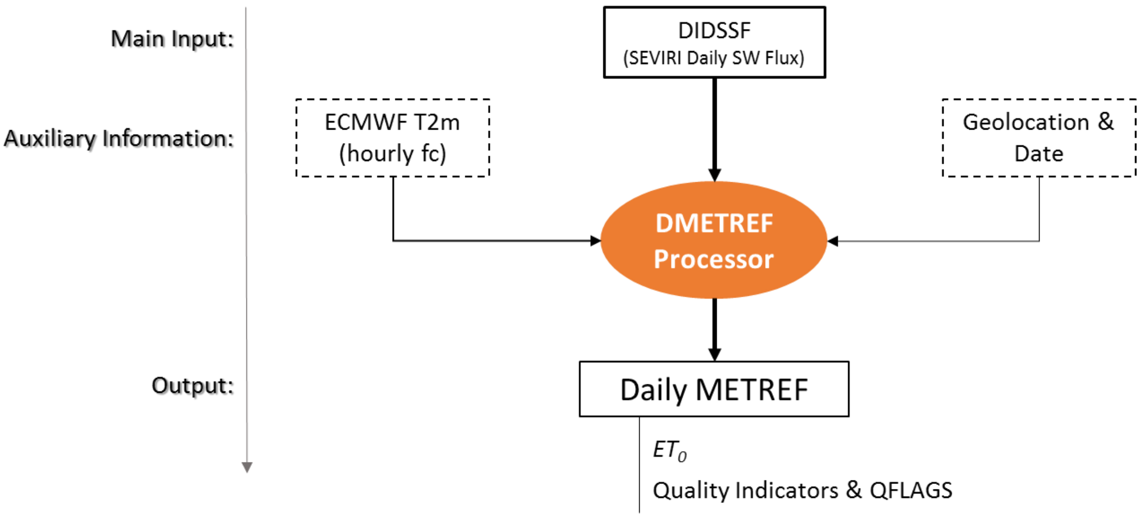

Figure 2 LSA SAF DMETREF processing chain.

4 Data Description - SEVIRI/Meteosat ETREF Product: LSA-303 (DMETREF)

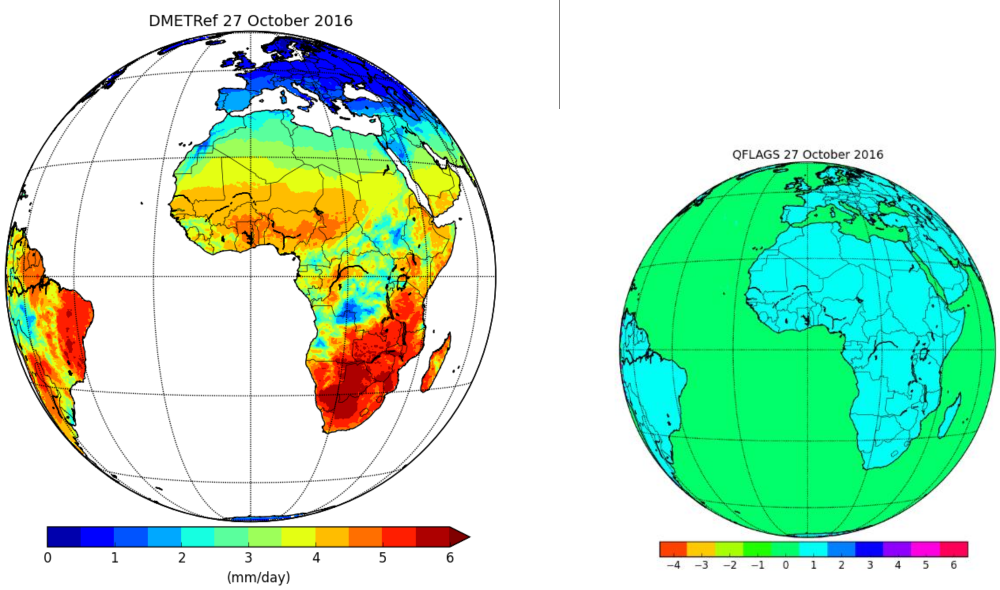

Figure 3 SEVIRI LSA SAF ETRef (DMETREF) product and respective QFLAG: please see Table 6 for the meaning of quality flag; land pixels assigned "1" indicate that DMETREF was processed within any missing input data and that DIDSSF input used was generated with the best quality possible (i.e., without any missing sub-daily SEVIRI observations).

4.1 Overview – SEVIRI ETREF (DMETREF)

The LSA SAF SEVIRI/MSG chain processes separately the full Meteosat disk (). The projection and spatial resolution correspond to the characteristics of Level 1.5 MSG/SEVIRI instrument data. Information on geo-location and data distribution is available at the LSA SAF website:

http://landsaf.ipma.pt.

Data users have access to the following data:

- Reference Evapotranspiration field;
- Quality control information field, which the users are strongly encourage to consider, as it provides information about the input data used to generate the product.

The data is coded in HDF5 format. The HDF5 files in LSA SAF system have the following structure:

- A common set of attributes for all kind of data, containing general information about the data (including metadata compliant with U-MARF requirements);
- A dataset for the parameter values;
- A dataset for error values
- Additional datasets for metadata (e.g., quality flags).

Table 3 - Characteristics of the product geographical area coverage\ defined by the corners position relative to an MSG image of 3712 columns per 3712 lines, starting from North to South and from West to East.

Region Name	**Description**	**Initial Column**	**Final Column**	**Initial Line**	**Final Line**	**Size in Columns**	**Size in Lines**	**Total Number of Pixels**
MSG-Disk	Full earth disk observed by MSG	1	3712	1	3712	3712	3712	13.788.944

4.2 Geolocation / Rectification

The **DMETREF** SEVIRI-based fields are generated pixel-by-pixel, maintaining the original resolution of SEVIRI level 1.5 data. These correspond to rectified images to 0º longitude, which present a typical geo-reference uncertainty of about 1/3 of a pixel. Data are kept in the native geostationary projection.

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 "Static Data and Tools"):

Longitude

HDF5_LSASAF_MSG_LON_MSG-Disk_.bz2

Latitude

HDF5_LSASAF_MSG_LAT_MSG-Disk_.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 can easily be 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 can 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

$$s_1 = p_1 - s_n \cdot \cos x \cdot \cos y$$

$$s_2 = s_n \cdot \sin x \cdot \cos y$$

$$s_3 = - s_n \cdot \sin y$$

$$s_{xy} = \sqrt{s_1^2 + s_2^2}$$

$$s_d = \sqrt{(p_1 \cdot \cos x \cdot \cos y)^2 - (\cos^2 y + p_2 \cdot \sin^2 y) \cdot p_3}$$

$$s_n = \frac{p_1 \cdot \cos x \cdot \cos y - s_d}{\cos^2 y + p_2 \cdot \sin^2 y}$$

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), and correspond to one set of the values detailed below per SEVIRI/MSG area:

Table 4 Maximum values for number of columns (ncol) and lines (nlin), for each Land-SAF geographical area, and the respective COFF and LOFF coefficients needed to geo-locate the data.

Region Name	**Description**	**Maximum *ncol***	**Maximum *nlin***	**COFF**	**LOFF**
MSG-Disk	Full MSG Disk	3712	3712	1857	1857

4.3 File Formats – SEVIRI ETRef: LSA-303 (DMETREF)

The LSA SAF DMETREF algorithm generates an external output file on a daily basis, according to the following name convention:

HDF5_LSASAF_MSG_METREF_MSG-Disk_ YYYYMMDDHHMM

where **YYYY**, **MM**, **DD**, **HH** and **MM** respectively, denote the year, the month, the day, the hour and the minute of for which the product is valid.

The LSA SAF products are provided in HDF5 format developed by the National Center for Supercomputing Applications (NCSA) at the University of Illinois. A comprehensive description is available at http://hdf.ncsa.uiuc.edu/.

Libraries for handling HDF5-files in Fortran and C are available at ftp://ftp.ncsa.uiuc.edu/HDF/HDF5/hdf5-1.6.2/. A user friendly graphical interface to open and view HDF5-files can be downloaded from http://hdf.ncsa.uiuc.edu/hdf-java-html/hdfview/.

The HDF5-format allows defining a set of attributes that provide the relevant information. As described in the Appendix A the DMETREF product information includes the general attributes (Table A1), the dataset attributes (Table A2) and the quality flag attributes (Table A3). Within the HDF5-files the information is organised in the form of separate datasets.

4.4 Product Contents – SEVIRI ETREF

The LSA SAF DMETREF product files contain two datasets corresponding to (i) reference evapotranspiration values and; (ii) the respective quality flags. Table 6 and Table 7 show the contents of the DMETREF product file and QC information, respectively. Detailed information is given in Annex A.

The QC information (QFLAGS) contains information on processed and non-processed pixels, as detailed in Table 7. The highest possible quality of DMETREF will always correspond to QFLAGS values of 1, indicating that all required input data to generate DMETREF (and its main input DIDSSF) were available.

Table 5 - Contents of the ETREF/SEVIRI product file.

Parameter	**Dataset Name**	**Unit**	**Range**	**Variable Type**	**Scale Factor**
Reference Evapotranspiration	METREF	mm/day	>= 0	32-bit Signed Integer	100
Quality Flag	QFLAGS	-	-4, -3, …, 6	32-bit Signed Integer	1

Table 6 - Description of DMETREF Quality Flag dataset (QFLAGS).

Decimal Value	Description
-4	Non-Processed: Out of Disk
-3	Non-Processed: 2m Temperature missing
-2	Non-Processed: other auxiliary input data missing
-1	Non-Processed: DIDSSF input data missing
0	Non-Processed: Sea pixel
1	DIDSSF with maximum data quality: all sub-daily slots available to estimate daily solar radiation
2	DIDSSF available with restrictions: some sub-daily slots missing corresponding to up to 20% of short-wave flux in a clear sky day
3	DIDSSF available with restrictions: some sub-daily slots missing corresponding to up to 40% of short-wave flux in a clear sky day
4	DIDSSF available with restrictions: some sub-daily slots missing corresponding to up to 60% of short-wave flux in a clear sky day
5	DIDSSF available with restrictions: some sub-daily slots missing corresponding to up to 80% of short-wave flux in a clear sky day
6	DIDSSF available with restrictions: some sub-daily slots missing corresponding to up to 100% of short-wave flux in a clear sky day

4.5 Summary of Product Characteristics – SEVIRI ETREF

Product Name:	Reference Evapotranspiration
Product Code:	DMETREF
Product Level:	Level 3
Description of Product:	Daily reference evapotranspiration

Product Parameters:

Coverage:	MSG full disk (Land pixels)
Packaging:	MSG-Disk
Units:	mm/day
Range:	>= 0
Sampling:	pixel by pixel basis
Resolution:	Temperature: hundreds of mm/day

	Spatial: MSG full resolution (~3km × 3km at nadir)
Accuracy:	< 10 – to – 30%
Format:	32- bits signed integer
Appended Data:	Quality control information (32 bits integer)
Frequency of generation:	daily
Size of Product:	

Additional Information:

Identification of bands used in algorithm: VIS, NIR, SWIR (indirect, level 3 product)
Assumptions on SEVIRI input data:
Identification of ancillary and auxiliary data:

Pixel latitude and longitude (from EUMETSAT)
Date
Land-sea mask

5 Validation and Quality Monitoring

The Validation Report (SAF_LAND_IPMA_VR_ETREF) includes the assessment of DMETREF product and algorithm. The validation of LSA SAF DMETREF is essentially based on comparison with in-situ measurements of actual evapotranspiration in conditions that may be considered similar to those of the reference surface. A thorough discussion of product strengths and weaknesses, as well as expected accuracy may be found in this DMETREF Validation Report.

Automatic Quality Monitoring (QM) is performed on DMETREF data and the quality information is provided on a pixel basis. Area statistics of the product (mean, standard deviation, median and other percentiles) can be monitored via the LSA SAF webpage on a daily basis. The QM is made available without restrictions, and is available to all operational products derived from SEVIRI/MSG data.

6 References

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8 Glossary

AVHRR:	Advanced Very High Resolution Radiometer
DMETREF:	Daily Reference Evapotranspiration from Meteosat/SEVIRI
E0:	Reference Evapotranspiration
ECMWF:	European Centre for Medium-Range Weather Forecasts
EPS:	EUMETSAT Polar System
EUMETSAT:	European Meteorological Satellite Organisation
FOV	Field of View
HDF	Hierarchical Data Format
METEOSAT:	Geostationary Meteorological Satellite
MODIS:	Moderate-Resolution Imaging Spectro-Radiometer
MSG:	Meteosat Second Generation
NIR	Near Infrared Radiation
NWC:	NoWCasting SAF
NWP:	Numerical Weather Prediction
PRD:	Product Requirements Document
QC:	Quality Control
SAF:	Satellite Application Facility
SEVIRI:	Spinning Enhanced Visible and InfraRed Imager
TIR:	Thermal Infrared
U-MARF	Unified Meteorological Archiving and Retrieval Facility

Annex A. Product Metadata – SEVIRI DMETREF

The following Tables describe the metadata distributed with each SEVIRI-based product, in the form of attributes included in the HDF5 format product files.

Table A1. General attributes of the files for the SEVIRI ETREF product.

Attribute	Allowed Values	Data Type
SAF	LSA	String<3>
CENTRE	IM-PT	String<5>
ARCHIVE_FACILITY	IM-PT	String<5>
PRODUCT	METREF	String<79>
PARENT_PRODUCT_NAME	METREF,QFLAGS, -,-	Array(4) of string<79>
SPECTRAL_CHANNEL_ID	1871	Int
PRODUCT_ALGORITHM_VERSION	X.Y.Z	String<4>
CLOUD_COVERAGE	NWC-CMa,	String<20>
OVERALL_QUALITY_FLAG	OK or NOK	String<3>
ASSOCIATED_QUALITY_INFORMATION	-	String<511>
REGION_NAME	MSG-Disk	String<4>
COMPRESSION	9	Int
FIELD_TYPE	Product	String<255>
FORECAST_STEP	0	Int
NC	3712	Int
NL	3712	Int
NB_PARAMETERS	2	Int
NOMINAL PRODUCT_TIME	YYYYMMDDhhmmss	String<14>
SATELLITE	MSG*X*	Array[10] of String<9>
INSTRUMENT_ID	SEVI	Array [10] of String<6>
INSTRUMENT_MODE	STATIC_VIEW	String<511>
IMAGE_ACQUISITION_TIME	YYYYMMDDhhmmss	String<14>
ORBIT_TYPE	GEO	String<3>
PROJECTION_NAME	Geos<sub_lon>	String<15>
NOMINAL_LONG	Actual Satellite Nominal Longitude	Real
NOMINAL_LAT	Actual Satellite Nominal Latitude	Real
CFAC	13642337	Int
LFAC	13642337	Int
COFF	1857	Int
LOFF	1857	Int
START_ORBIT_NUMBER	0	Int
END_ORBIT_NUMBER	0	Int
SUB_SATELLITE_POINT_START_LAT	0.0	Real
SUB_SATELLITE_POINT_START_LON	0.0	Real
SUB_SATELLITE_POINT_END_LAT	0.0	Real
SUB_SATELLITE_POINT_END_LON	0.0	Real
SENSING_START_TIME	YYYYMMDDhhmmss	String<14>
SENSING_END_TIME	YYYYMMDDhhmmss	String<14>
PIXEL_SIZE	3.1km	String<10>
GRANULE_TYPE	DP	String<2>
PROCESSING_LEVEL	02	String<2>
PRODUCT_TYPE	LSAMETREF	String<8>
PRODUCT_ACTUAL_SIZE	Depends on the region	Integer > 0, encoded as String<11>
PROCESSING_MODE	N	String<1>
DISPOSITION_FLAG	O	String<1>
TIME_RANGE	daily	String<20>
STATISTIC_TYPE	-	String<20>
MEAN_SSLAT	0.0	Real
MEAN_SSLON	0.0	Real
PLANNED_CHAN_PROCESSING	0	Integer
FIRST_LAT	0	Real
FIRST_LON	0	Real

Table A2. Attributes of the DMETREF/SEVIRI dataset.

Attribute	Description	Data Type
CLASS	Data	String, length=4
PRODUCT	METREF	String, length=3
PRODUCT_ID	175	32-bit integer
N_ COLS	3712	32-bit integer
N_ LINES	3712	32-bit integer
NB_BYTES	4	32-bit integer
SCALING_FACTOR	100.0	64-bit floating-point
OFFSET	0.0	64-bit floating-point
MISS_VALUE	-8000	32-bit integer
UNITS	mm/day	String, length=15
CAL_SLOPE	999.0	64-bit floating-point
CAL_OFFSET	999.0	64-bit floating-point

Table A3. Attributes of the DMETREF/SEVIRI Quality Flag information dataset.

Attribute	Description	Data Type
CLASS	Data	String, length=4
PRODUCT	QFLAGS	String, length=7
PRODUCT_ID	999	32-bit integer
N_ COLS	3712	32-bit integer
N_ LINES	3712	32-bit integer
NB_BYTES	4	32-bit integer
SCALING_FACTOR	1.0	64-bit floating-point
OFFSET	0.0	64-bit floating-point
MISS_VALUE	-9999	32-bit integer
UNITS	Dimensionless	String, length=13
CAL_SLOPE	999.0	64-bit floating-point
CAL_OFFSET	999.0	64-bit floating-point