EUMETSAT Satellite Application Facility on Climate Monitoring

Product User Manual

Land Surface Temperature (LST)

(SUMET) Edition 1

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Statistical Land Surface Temperature (LTS)	**CM-23921**
Physical Land Surface Temperature (LTP)	**CM-23931**

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Applicable Documents

Reference	Title	Code
AD 1	CM SAF Product Requirements Document	SAF/CM/DWD/PRD/2.8

Reference Documents

Reference	Title	Code
RD 1	Validation Report Meteosat Land Surface Temperature (LST) Edition 1	SAF/CM/MeteoSwiss/VAL/MET/LST
RD 2	Algorithm Theoretical Basis Document Meteosat Land Surface Temperature (LST) Edition 1	SAF/CM/MeteoSwiss/ATBD/MET/LST

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1 Executive Summary

This CM SAF Product User Manual provides information on the Meteosat Land Surface Temperature (LST) TCDRs derived from the Meteosat Visible and InfraRed Imager (MVIRI) on board the Meteosat First Generation (MFG) and the Spinning Enhanced Visible and InfraRed Imager (SEVIRI) observations onboard the Meteosat Second Generation (MSG) satellites. The covered time period of the presented Thematic Climate Data Record (TCDR) ranges from January 1991 to December of 2015, thus includes MFG 4 to 7 and MSG 1 to 3. MFG 1-3 satellites were not processed due to missing re-calbration for the thermal sensor. The presented climate data contain the following data:

Statistical Land Surface Temperature [CM-23921, LTS]
Physical Land Surface Temperature [CM-23931, LTP]

Important features of the presented Meteosat LST TCDRs are:

- Long-term climate data record for LST dating back until 1991. Those multi-decadal characteristics make the data very well suited for climate analysis.

- The high temporal (≤ 30 min) and high spatial resolution (≤ 5 km) of the MVIRI and SEVIRI instrument allow a sufficient temporal and spatial sampling of LST. Hence, the data can provide accurate estimates of monthly diurnal cycle information for a physical variable which varies strongly in time and space. The presented TCDRs are complementary to existing TCDRs from polar orbiting satellites such as ISCCP.

- The SEVIRI field of view covers a fairly large domain of the globe. For the regions covered (e.g. Europe, Africa, Atlantic Ocean) this allows the monitoring of climate variability.

The two CM SAF LST datasets, namely Statistical LST (LTS) and Physical LST (LTP), are derived from the 11 µm Meteosat infrared channel. Since the Meteosat instrument on-board Meteosat 2–7 is equipped with a single thermal channel, single-channel LST retrieval algorithms are used to ensure consistency across Meteosat satellites. The Statistical LST data are characterised by consistency with the operational Land Surface Analysis Satellite Applications Facility (LSA SAF) LST data, while the Physical LST data ensure the highest possible precision through the implicit use of radiative transfer models. Validations against in-situ ground LST measurements show that CM SAF single-channel LST retrievals reach a 1 K overall accuracy and 2 K precision, except for very moist atmospheres (total column water > 45 mm) with the added benefit that CM SAF LST models can be applied across Meteosat satellite generations.

2 The EUMETSAT SAF on Climate Monitoring (CM SAF)

The importance of climate monitoring with satellites was recognized in 2000 by EUMETSAT Member States when they amended the EUMETSAT Convention to affirm that the EUMETSAT mandate is also to “contribute to the operational monitoring of the climate and the detection of global climatic changes". Following this, EUMETSAT established within its Satellite Application Facility (SAF) network a dedicated centre, the SAF on Climate Monitoring (CM SAF, http://www.cmsaf.eu).

The consortium of CM SAF currently comprises the Deutscher Wetterdienst (DWD) as host institute, and the partners from the Royal Meteorological Institute of Belgium (RMIB), the Finnish Meteorological Institute (FMI), the Royal Meteorological Institute of the Netherlands (KNMI), the Swedish Meteorological and Hydrological Institute (SMHI), the Meteorological

Service of Switzerland (MeteoSwiss), and the Meteorological Service of the United Kingdom (UK MetOffice). Since the beginning in 1999, the EUMETSAT Satellite Application Facility on Climate Monitoring (CM SAF) has developed and will continue to develop capabilities for a sustained generation and provision of Climate Data Records (CDR's) derived from operational meteorological satellites.

In particular, the generation of long-term data sets is pursued. The ultimate aim is to make the resulting data sets suitable for the analysis of climate variability and potentially the detection of climate trends. CM SAF works in close collaboration with the EUMETSAT Central Facility and liaises with other satellite operators to advance the availability, quality and usability of Fundamental Climate Data Records (FCDRs) as defined by the Global Climate Observing System (GCOS). As a major task the CM SAF utilizes FCDRs to produce records of Essential Climate Variables (ECVs) as defined by GCOS. Thematically, the focus of CM SAF is on ECVs associated with the global energy and water cycle.

Another essential task of CM SAF is to produce data sets that can serve applications related to the Global Framework of Climate Services (GFCS) initiated by the WMO World Climate Conference-3 in 2009. CM SAF is supporting climate services at national meteorological and hydrological services (NMHSs) with long-term data records but also with data sets produced close to real time that can be used to prepare monthly/annual updates of the state of the climate. Both types of products together allow for a consistent description of mean values, anomalies, variability and potential trends for the chosen ECVs. CM SAF ECV data sets also serve the improvement of climate models both at global and regional scale.

As an essential partner in the related international frameworks, in particular WMO SCOPE-CM (Sustained COordinated Processing of Environmental satellite data for Climate Monitoring), the CM SAF - together with the EUMETSAT Central Facility, assumes the role as main implementer of EUMETSAT's commitments in support to global climate monitoring. This is achieved through:

- Application of highest standards and guidelines as lined out by GCOS for the satellite data processing,
- Processing of satellite data within a true international collaboration benefiting from developments at international level and pollinating the partnership with own ideas and standards,
- Intensive validation and improvement of the CM SAF climate data records,
- Taking a major role in data set assessments performed by research organisations such as WCRP (World Climate Research Program). This role provides the CM SAF with deep contacts to research organizations that form a substantial user group for the CM SAF CDRs,
- Maintaining and providing an operational and sustained infrastructure that can serve the community within the transition of mature CDR products from the research community into operational environments.

A catalogue of all available CM SAF products is accessible via the CM SAF webpage, http:/www.cmsaf.eu/. Here, detailed information about product ordering, add-on tools, sample programs and documentation is provided.

3 Compilation of the Meteosat LST TCDRs

The CM SAF Meteosat Land Surface Temperature (LST) TCDRs are based on 25 years of Meteosat measurements.

MVIRI and SEVIRI are optical imaging radiometers mounted on the geostationary Meteosat First Generation (MFG) satellites 1 to 7 and Meteosat Second Generation (MSG) satellites 1 to 4. Meteosat imagers in operational mode are centred near 0°/0° latitude/longitude, where a full earth disk image includes Europe, Africa, the Middle East and the Atlantic Ocean. MVIRI scans the full disk of the earth every 30 minutes with spatial resolution of at least 5 x 5 km² at nadir (the visible channel has double resolution). SEVIRI images the full disk every 15 minutes with a horizontal resolution of 3 x 3 km² at nadir. Both passive imagers have spectral bands in the visible and thermal infrared. MVIRI has only three bands including a broad visible channel, a water vapour channel and an infrared channel. SEVIRI has 12 spectral channels ranging from 0.6 µm to 13.4 µm. To ensure consistency of the TCDRs only those channels for the LST retrieval which are available or can be simulated from both sensors i.e. the broad visible channel and the 10.8 µm infrared channel were used.

The presented LST TCDRs cover the time-span 1991-2015, and are based on measurements of MFG-4, MFG-5, MFG-6, MFG-7, MSG-1, MSG-2 and MSG-3 (see Figure 3-1). Gaps in the prime satellite were filled by a back-up satellite. For the derivation of the TCDRs the Level 1.5 MVIRI and SEVIRI data provided by EUMETSAT were used.

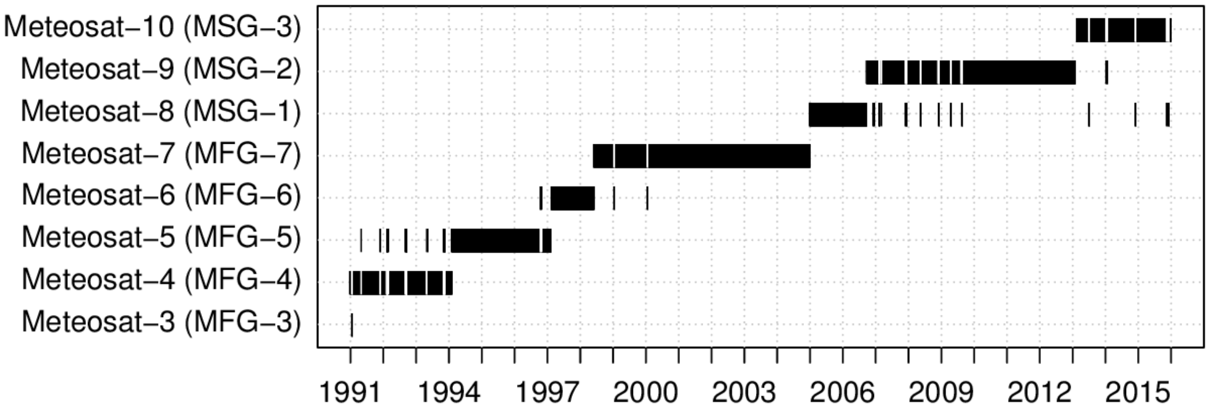

Figure 3-1: *Overview of the MFG and MSG measurements record used as basis for the Meteosat LST TCDRs.*

For SEVIRI original radiance calibration factors are used as provided as part of the Level 1.5 radiance data by EUMETSAT. The MVIRI infrared channel inter-calibration factors are provided by EUMETSAT (V. John, R. Roebeling and J. Schulz, personal communication). These inter-calibration factors are based on a daily inter-calibration of MFG MVIRI with the High Resolution Infrared Radiation Sounder (HIRS) instrument on board the National Oceanic and Atmospheric Administration (NOAA) polar orbiting platforms. The inter-calibration is carried out with the spectral response function of the respective MVIRI sensor. The MVIRI visible channel calibration factors are used as provided by EUMETSAT (Govaerts et al. 2004).

For a more detailed instrument specification and description of the calibration the reader is referred to the CM SAF LST ATBD (RD-2).

4 Product Description

In a joint effort, the LSA SAF and CM SAF team have developed single-channel LST retrieval algorithms suitable to generate LST data across Meteosat satellite generations. A consistent single-channel approach maximizes long-term and inter-satellite consistency (Scarino et al. 2013).

In this section, the two LST data, namely Statistical LST (LTS) and Physical LST (LTP), are shortly described regarding retrieval methods, information content and limitations. Validation results are also described for each presented product. A short statement on recommended applications is given at the end of each product description.

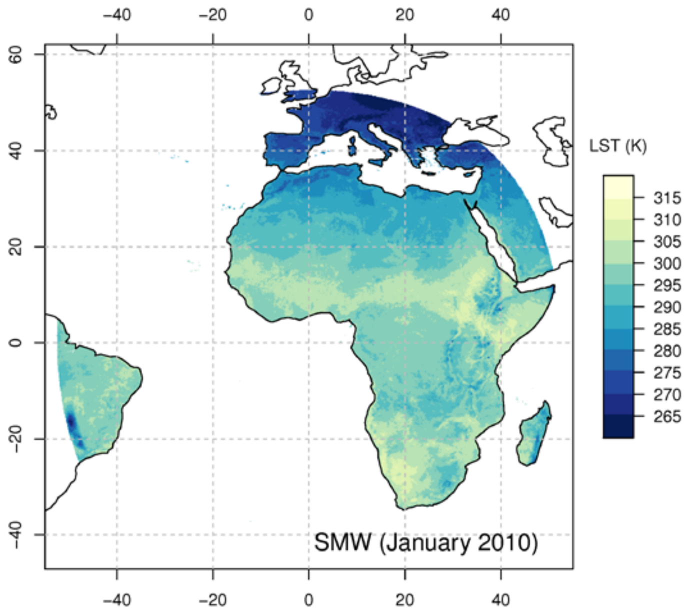

Figure 4-1: *Example CM SAF Statistical LST for January 2010.*

4.1 Statistical LST (LTS)

The Statistical LST is the clear sky LST provided in K (RD-2).

Short Algorithm Description

The Statistical LST retrieval is performed using the GeoSatClim Statistical LST Algorithm v2016 (RD-2).
The implemented Statistical Mono-Window (SMW) model is based on a single-channel model originally developed for the Geostationary Operational Environmental Satellite (GOES). The SMW model was established by the EUMETSAT LSA SAF team (Freitas et al. 2013) and was further improved and adapted to Meteosat in the framework of an EUMETSAT CM SAF/LSA SAF Federated Activity (Bento et al. 2013, Duguay-Tetzlaff et al. 2015). LST is obtained from the Meteosat 11 µm clear sky top-of-atmosphere brightness temperature (T_{ToA}) by correcting for surface emissivity and atmospheric attenuation along the satellite path as:

$$\mathrm{LST} = \mathrm{A}\frac{\mathrm{T_{ToA}}}{\varepsilon_{\mathrm{SFC}}} + \mathrm{B}\frac{1}{\varepsilon_{\mathrm{SFC}}} + \mathrm{C} \tag{1}$$

where T_{ToA} is the 11 µm clear sky ToA brightness temperature and ε_{SFC} is the surface emissivity. The SMW coefficients A, B and C were calibrated for different classes of satellite viewing zenith angle and total column water vapour. For the SMW, the LST retrieval is under-constrained and requires a-priori knowledge of the surface emissivity and the atmospheric state. The surface emissivities are taken from the University of Wisconsin Baseline Fit Emissivity Database (Seemann et al. 2008). ECMWF ERA-Interim re-analysis data are used as total column water vapour input.

Details on the SMW algorithm are published in the CM SAF LST ATBD (RD-2).

Highlights

- 25 years of LST TCDR with an hourly temporal and 5 x 5 km spatial resolution. Climatological LST observations are provided at the same time step as NWP and climate models.
- Single channel LST retrieval method across all Meteosat satellite generations to ensure climatological consistency.
- The CM SAF SMW model was tuned using the training database from the LSA SAF LST model to ensure the highest possible consistency with the near real-time LSA SAF LST data.
- Instantaneous LST estimates with pixel-wise uncertainty estimates.
- Inter-calibrated input radiances from EUMETSAT.

Limitations

- Dependency on external NWP and surface emissivities to estimate the atmospheric state and the surface properties.
- The SMW model is likely to be inaccurate in regions with heavy atmospheric water vapour loading (total column water vapour > 45 mm) and at high satellite viewing angles (beyond 50 degrees).
- Viewing angle effects due to roughness and structure of land surface are not handled in the presented algorithm.
- No coverage yet for MFG-2 and MFG-3 due to inter-calibration / stability issues (in preparation).

Validation

The Statistical LST product fulfils the 2.5 K target precision and 1.5 K target accuracy when compared to more than 50,000 in-situ LST measurements from the LSA SAF in-situ sites including a large variety of atmospheric conditions. The accuracy and precision are within or very close to the CM SAF target requirements for all atmospheric conditions at the four LSA SAF sites including desert, mediterranean and tropical surface types, except for very moist atmospheres. For very moist atmospheres (total column water vapour > 45 mm), a bias-corrected RMS difference of about 3 K and bias of about 2 K was observed. Table 4-1 and Table 4-2 show achieved accuracy and precision of the Statistical LST data as discussed in detail in the CM SAF LST Validation Report (RD-1).
The Statistical LST product fulfils the 0.8 K decadal stability requirement when compared with ECMWF skin temperatures and MODIS LST (example Figure 4-2, RD-1). Compared to ECMWF ERA-Interim skin temperatures, a decadal trend in bias of up to 0.4 K was observed, compared to MODIS a decadal trend in bias up to 0.8 K at 1° x 1° latitude and longitude data subsets including desert, mediterranean and tropical regions (RD-1).

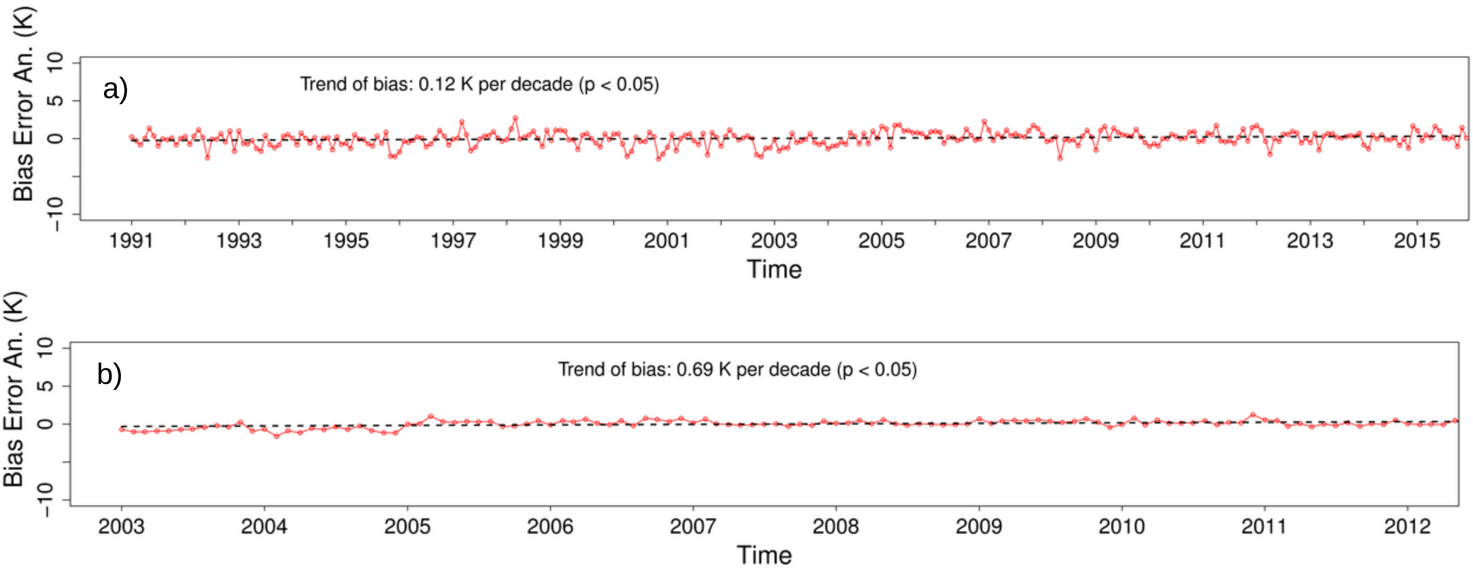

Figure 4-2: *Time series of mean bias error of CM SAF Statistical LST as compared to ECMWF skin temperatures (a) and MODIS (b) at a 1° x 1° latitude and longitude window centered at the LSA SAF validation site Evora. The black dashed line represents the Theil-Sen linear trend.*

Table 4-1: *Summary of instantaneous CM SAF Statistical LST validation results at the LSA SAF validation sites compared to target accuracy requirements. The accuracies are formulated in terms of bias*.

	Target accuracy (bias in K)	**Achieved accuracies** (bias in K)	
		Hourly	Monthly
Statistical LST	1.5	0.6	0.6

Table 4-2: *Summary of instantaneous CM SAF Statistical LST validation results at the LSA SAF validation sites compared to target precision requirements. The accuracies are formulated in terms of bias-corrected RMS*.

	Target precision (bc-RMS in K)	**Achieved precision** (bc-RMS in K)	
		Hourly	Monthly
Statistical LST	2.5	1.9	0.9

Recommended Applications

Recommended applications for the Statistical LST are specified the CM SAF Product Requirements Document (AD-1). The Statistical LST addresses users which are interested in operational climate monitoring. The statistical retrieval algorithm is trained using the training data base from the operational LSA SAF product to ensure the highest possible consistency with the LSA SAF LST product.

Specific applications and users include:

- Climate monitoring of land surface fluxes
- Climate monitoring of heat waves
- Climate monitoring of crop health

The usability of Statistical LST in subtropical to tropical climate and at very high satellite viewing angles has to be tested. Despite the high decadal stability the applicability of Statistical LST for trend analysis has to be thoroughly evaluated and cross-checked with quality-screened ground-based reference time series.

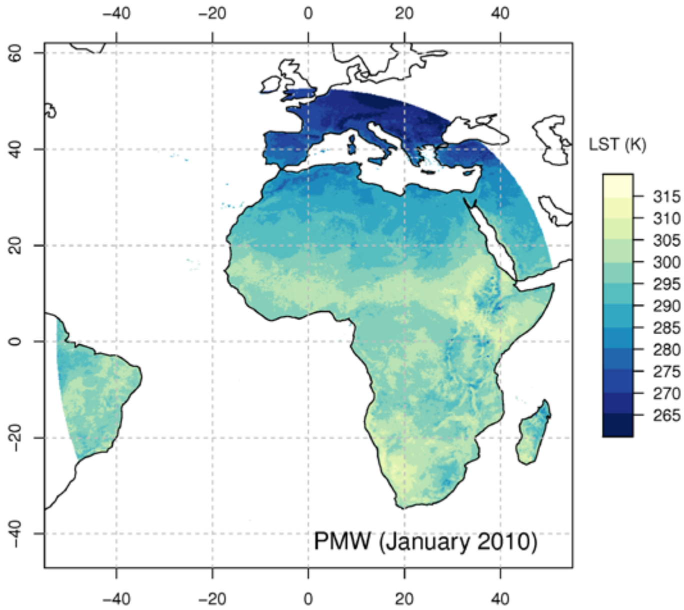

Figure 4-3: *Example CM SAF Physical LST for January 2010.*

4.2 Physical LST (LTP)

The Physical LST is the clear sky LST provided in K (RD-2).

Short Algorithm Description

The Physical LST retrieval is performed using the GeoSatClim Physical LST Algorithm v2016 (RD-2). The implemented PMW model is an adapted version of the radiative transfer-based model proposed by Heidinger et al. (2013) for climatological LST retrieval from single-channel infrared measurements. A detailed description of the implemented PMW model is provided in Duguay-Tetzlaff et al. (2015).

Radiative transfer models can be used to estimate the upward and downward atmospheric path radiance ($L^{\uparrow}_{11\,\mu m}$, $L^{\downarrow}_{11\,\mu m}$) and the atmospheric transmittance ($\tau_{11\,\mu m}$) in the thermal infrared for a specific atmospheric profile. The radiance $L_{11\,\mu m}$ recorded in Meteosat 11 µm channel can be written as:

$$L_{11\,\mu m} = \varepsilon_{11\,\mu m} B_{11\,\mu m}(LST)\tau_{11\,\mu m} + L^{\uparrow}_{11\,\mu m} + L^{\downarrow}_{11\,\mu m}(1-\varepsilon_{11\,\mu m})\tau_{11\,\mu m} \quad (2)$$

where $\varepsilon_{11\,\mu m}$ is the land surface emissivity. The calibrated Planck function $B_{11\,\mu m}(LST)$ provides the radiance emitted by blackbody at a specific LST.

The atmospheric path radiances ($L^{\uparrow}_{11\,\mu m}$ and $L^{\downarrow}_{11\,\mu m}$) and the atmospheric transmittance ($\tau_{11\,\mu m}$) in Eq. (2) was estimated using the Radiative Transfer for TOVS (RTTOV) radiative transfer model. The atmospheric temperature and moisture profiles required for the radiative transfer runs are taken from ECMWF ERA-Interim profiles. The surface emissivities are taken from the University of Wisconsin Baseline Fit Emissivity Database (Seemann et al. 2008). Details on the PMW algorithm are published in the CM SAF LST ATBD (RD-2).

Highlights

- 25 years of LST TCDR with an hourly temporal and 5 x 5 km spatial resolution. Climatological LST observations are provided at the same time step as Numerical Weather Prediction (NWP) and climate models.
- Single channel LST method across all Meteosat satellite generations to ensure climatological consistency. Sensor differences (spectral response) are handled directly within the radiative transfer-model through an accurate physical approach.
- Accurate atmospheric correction through the implicit use of radiative transfer models.
- Physical retrieval approach which is independent from a training data base.
- LST estimates with pixel wise uncertainty estimates.
- Inter-calibrated input radiances from EUMETSAT.

Limitations

- Dependency on external NWP and surface emissivities to estimate the atmospheric state and the surface properties.
- The PMW model is likely to be inaccurate in regions with heavy atmospheric water vapour loading (total column water vapour > 45 mm) and at high satellite viewing angles (beyond 50 degrees) (RD-1).
- Viewing angle effects due to roughness and structure of land surface are not handled in the presented algorithm.
- No coverage yet for MFG-2 and MFG-3 due to inter-calibration / stability issues (in preparation).
- The PMW model is highly sensitive to errors in cloud masking.

Validation

The Physical LST product fulfils the 2.0 K target precision and 1.3 K target accuracy when compared to more than 50,000 in-situ LST measurements from the LSA SAF in-situ sites including a large variety of atmospheric conditions. The accuracy and precision are within or very close to the target requirements for all atmospheric conditions at the four LSA SAF sites including desert, mediterranean and tropical surface types, except for very moist atmospheres. For very moist atmospheres, with a total column water vapour content > 45 mm (tropics), a bias-corrected RMS difference of about 3 K and bias of about 2 K was observed compared to in-situ measurements. Table 4-3 and Table 4-4 show achieved accuracy and precision of the Statistical LTS data as discussed in detail in the validation report (RD-1).
The Physical LST product fulfils the 0.8 K decadal stability requirement when compared with ECMWF skin temperatures and MODIS LST (example Figure 4-4, RD-1). Compared to ECMWF ERA-Interim skin temperatures and MODIS LST, a decadal trend in bias of up to 0.4 K was observed at 1° x 1° latitude and longitude data subsets including desert, mediterranean and tropical regions (RD-1). The Physical LST has an overall higher precision (Δ 0.3 K to 0.4 K) and a higher decadal stability (Δ up to 0.4 K) compared to the Statistical LST (RD-1).

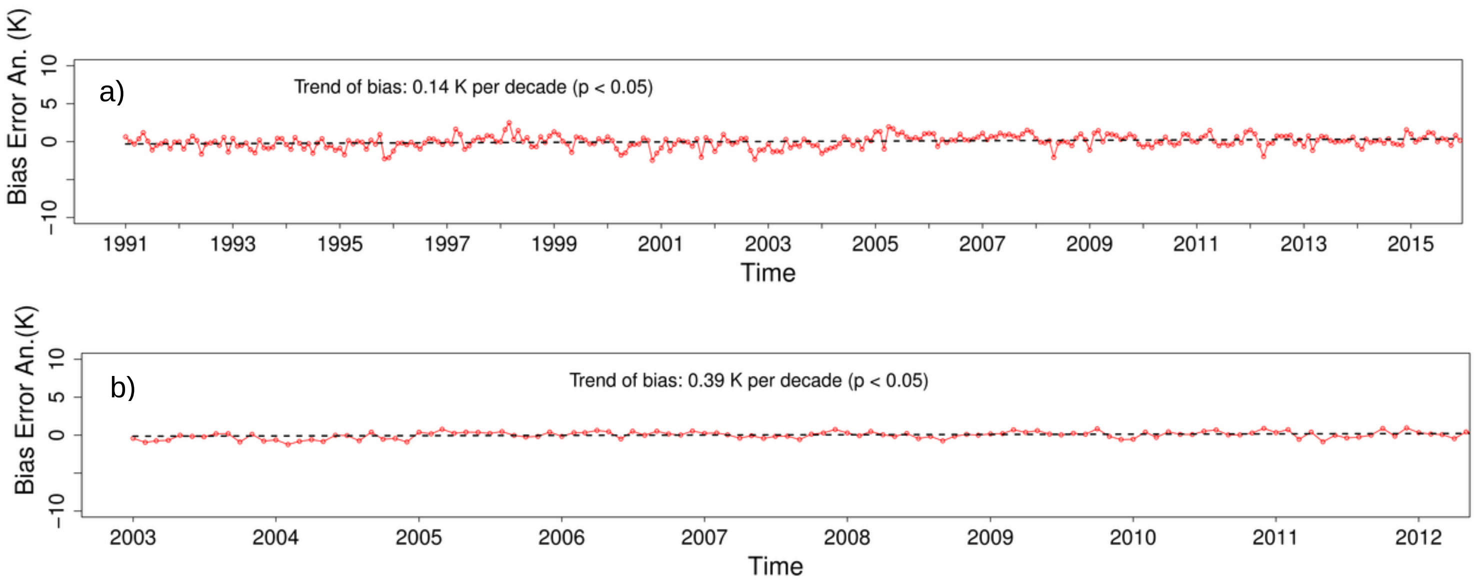

Figure 4-4: *Time series of mean bias error of CM SAF Physical LST as compared to ECMWF skin temperatures (a) and MODIS (b) at a 1° x 1° latitude and longitude window centered at the LSA SAF validation site Evora. The black dashed line represents the Theil-Sen linear trend.*

Table 4-3: *Summary of instantaneous Physical LST validation results at the LSA SAF validation sites compared to target accuracy requirements. The accuracies are formulated in terms of bias*.

	Target accuracy (bias in K)	**Achieved accuracies** (bias in K)	
		Hourly	Monthly
Physical LST	1.3	0.8	0.8

Table 4-4: *Summary of instantaneous Physical LST validation results at the LSA SAF validation sites compared to target precision requirements. The accuracies are formulated in terms of bias-corrected RMS*.

	Target precision (bc-RMS in K)	**Achieved precision** (bc-RMS in K)	
		Hourly	Monthly
Physical LST	2.0	1.6	0.5

Recommended Applications

Recommended applications for the Physical LST are specified the CM SAF Product Requirements Document (AD-1). The Physical LST addresses all users, which are interested in high precision and climatological consistent LST products and which require consistent instantaneous climate data records. As the retrieval algorithm differs fundamentally from the LSA SAF approach, the product cannot be used in conjunction with the LSA SAF LST product.

LST is a key indicator of the Earth surface energy budget, is widely required in applications of hydrology, meteorology and climatology. It is of fundamental importance to the net radiation budget at the Earth's surface and for monitoring the state of crops and vegetation, as well as an important indicator of both the greenhouse effect and the energy flux between the atmosphere and earth surface. The product is of particular interest for e.g.:

- Regional climate model validation
- Satellite-based estimates of 2m air temperatures at a high spatial resolutions
- Climate studies on elevation depending warming.
- Diurnal LST Cycle
- Surface radiation budget

The usability of the Physical LST in subtropical to tropical climate and at very high satellite viewing angles has to be tested. Despite the high decadal stability, the applicability of Physical LST in trend analyses has to be thoroughly evaluated and cross-checked with quality-screened ground-based reference time series.

5 Data Format Description

The presented CM SAF LST data are provided on a regular latitude and longitude grid. Table 5-1 gives information on the geographical coverage.

Table 5-1: *Characteristics of the presented CM SAF LST data geographical coverage.*

Lon min*	Lon max*	Lat min*	Lat max*	Spacing (lon, lat)	Projection	Datum
-65.0 °	65.0 °	-65.0 °	65.0 °	0.05	latitude - longitude	WGS 84

*pixel edges

The CM SAF LST data are Level-3 data presented as hourly and monthly mean diurnal samples as outlined in Table 5-2. The CM SAF LST hourly data are provided as hourly samples, i.e. instantaneous data at the full hour and not calculate a mean. The monthly LST diurnal cycle composites are aggregated from all available hourly means. Details on the averaging procedure can be found in the LST ATBD (RD-2).

Table 5-2: *Meteosat LST level 3 data.*

	Statistical LST	Physical LST
Hourly sample*	X	X
Monthly diurnal cycle	X	X

*instantaneous data at full hour (e.g. 12:00 and 13:00)

For each time step a separate output file is provided, which follows the following naming convention:

- LTS: LTStsyyyymmddhhmm001231000101MA.nc
- LTP: LTPtsyyyymmdd hh mm001231000101MA.nc

with **t** is time interval (m=monthly, i=instantaneous), **s** is time statistics (in=instanteneous, d=mean diurnal cycle), **yyyy**=year, **mm**=month, **dd**=day, **hh**=hour, **mm**=minute, 001231000101MA= fix CMSAF classifier

The CM SAF LST data are provided as NetCDF-4 (Network Common Data Format v4) files (http://www.unidata.ucar.edu/software/netcdf/). The data files are created following NetCDF Climate and Forecast (CF) Metadata Convention version 1.6 (http://cf-pcmdi.llnl.gov/) and NetCDF Attribute Convention for Dataset Discovery version 1.3.

For data processing and conversion to various graphical packages input format, CM SAF recommends the usage of the climate data operators (CDO), available under GNU Public License (GPL) from MPI-M (http://www.mpimet.mpg.de/~cdo). A common NetCDF file consists of dimensions, variables, and attributes. These components can be used together to capture the meaning of data and relations among data.

5.1 General Variables

Name	Description
time	*time of averaging/composite time period; in case of diurnal cycles, this vector has 24 elements [days counted from 1970-01-01]*
lat	*geographical latitude of grid-box centre [degree_north]*
lon	*geographical longitude of grid-box centre [degree_east]*
grid_mapping	*projection parameters*
SATID	*spacecraft ID (unique number defined by MSGGS or GSDS or NORAD or COSPAR): 19 = MFG 4, 20 = MFG 5, 21 = MFG 6, 22 = MFG 7, 321 = MSG 1, 322 = MSG 2, 323 = MSG 3*

5.2 Global Attributes

Table 5-3 contains the global attributes of the Meteosat LST final product files.

Table 5-3: *Overview of global attributes of NetCDF files and possible corresponding values.*

Name	Description
title	*GeoSatClim (processing software)*
summary	*This file contains time-space aggregated Thematic Climate Data Records (TCDR) produced by geosatclim within the Satellite Application Facility on Climate Monitoring (CM SAF)*
id	*DOI:10.5676/EUM_SAF_CM/LST_METEOSAT/V001*
product_version	*1.0.0*
creator_name	*EUMETSAT/CMSAF*
creator_email	*contact.cmsaf@dwd.de*
creator_url	*http://www.cmsaf.eu*
institution	*Federal Office of Meteorology and Climatology MeteoSwiss*
project	*Satellite Application Facility on Climate Monitoring (CM SAF)*
references	*http://dx.doi.org/10.5676/EUM_SAF_CM/LST_METEOSAT/V001*
keywords	*EARTH SCIENCE > LAND SURFACE > SURFACE THERMAL PROPERTIES > LAND SURFACE TEMPERATURE*
Conventions	*CF-1.6, ACDD-1.3*
standard_name_vocabulary	*Standard Name Table (v28, 07 January 2015)*
date_created	*creation date*
geospatial_lon_units	*degrees_east*
geospatial_lon_min	*-65 (pixel edge)*
geospatial_lon_max	*65 (pixel edge)*
geospatial_lat_units	*degrees_north*

Name	Description
geospatial_lat_min	*-65 (pixel edge)*
geospatial_lat_max	*65 (pixel edge)*
platform	*METEOSAT*
platform_vocabulary	*GCMD Platforms, Version 8.1*
instrument	*MVIRI*
instrument_vocabulary	*GCMD Instruments, Version 8.1*

5.3 Variables Statistical LST (LTS)

LST_SMW(time, lon, lat)
field containing the Statistical LST values given in K
(hourly sample for hourly files, monthly mean for each hour of the day for monthly diurnal cycle files)

LSTERROR_SMW(time, lon, lat)
field containing the estimated LST retrieval uncertainty given in K

NUMO(time, lon, lat)
total number of valid observations counted during the averaging period (not available for the hourly product)

Table 5-4: *Summary of Statistical LST product variables.*

Parameter	Unit	Valid Range	Type	Scale	Offset	Fill Value
LST_SMW	K	[193,353]	short	0.01	250	-32767
LSTERROR_SMW	K	[0,15]	byte	0.05	5.0	-127
NUMO	-	[0,31]	byte	1	0	-127

5.4 Variables Physical LST (LTP)

LST_PMW(time, lon, lat)
field containing the Physical LST values given in K
(hourly sample for hourly files, monthly mean for each hour of the day for monthly diurnal cycle files)

LSTERROR_PMW(time, lon, lat)
field containing the estimated LST retrieval uncertainty given in K
*NUMO(time, lon, lat)*total number of valid observations counted during the averaging period (not available for the hourly product)

Table 5-5: *Summary of Physical LST product variables.*

Parameter	Unit	Valid Range	Type	Scale	Offset	Fill Value
LST_PMW	K	[193,353]	short	0.01	250	-32767
LSTERROR_PMW	K	[0,15]	byte	0.05	5.0	-127
NUMO	-	[0,31]	byte	1	0	-127

6 Data ordering via the Web User Interface (WUI)

User services are provided through the CM SAF homepage www.cmsaf.eu. The user service includes information and documentation about the CM SAF and the CM SAF products, information on how to contact the user help desk and allows to search the product catalogue and to order products.

On the main webpage, a detailed description how to use the web interface for product search and ordering is given. We refer the user to this description since it is the central and most up to date documentation. However, some of the key features and services are briefly described in the following sections.

6.1 Product Ordering Process

You need to be registered and logged in to order products. A login is provided upon registration, all products are delivered free of charge. After the selection of the product, the desired way of data transfer can be chosen. This is either via a temporary ftp account (the default setting), or by CD/DVD or email. Each order will be confirmed via email, and the user will get another email once the data have been prepared. If the ftp data transfer was selected, this second email will provide the information on how to access the ftp server.

6.2 Contact User Help Desk Staff

In case of questions the contact information of the User Help Desk (e-mail address contact.cmsaf@dwd.de, telephone and fax number) are available via the CM SAF main webpage (http://www.cmsaf.eu) or the main page of the Web User Interface.

6.3 Feedback/User Problem Report

Users of CM SAF products and services are encouraged to provide feedback on the CM SAF product and services to the CM SAF team. Users can either contact the User Help Desk (see chapter 6.2) or use the “User Problem Report” page. A link to the “User Problem Report” is available either from the CM SAF main page (www.cmsaf.eu) or the Web User Interface main page.

6.4 Service Messages / Log of Changes

Service messages and a log of changes are also accessible from the CM SAF main webpage (www.cmsaf.eu) and provide useful information on product status, versioning and known deficiencies.

7 Copyright and Disclaimer

The user of CM SAF data agrees to respect the following regulations:

Copyright

All intellectual property rights of the CM SAF products belong to EUMETSAT. The use of these products is granted to every interested user, free of charge. If you wish to use these products in publications, presentations, web pages etc., EUMETSAT’s copyright credit must be shown by displaying the words “copyright (year) EUMETSAT” on each of the products used.

Acknowledgement and Identification

When exploiting EUMETSAT/CM SAF data you are kindly requested to acknowledge this contribution accordingly and make reference to the CM SAF, e.g. by stating “The work performed was done (i.a.) by using data from EUMETSAT’s Satellite Application Facility on Climate Monitoring (CM SAF)”. It is highly recommended to clearly identify the product version used. An effective way to do this is the citation of CM SAF data records via the digital object identifier (doi). The doi of the data sets can be retrieved through (http://www.cmsaf.eu/DOI).

Re-distribution of CM SAF data

Please do not re-distribute CM SAF data to 3rd parties. The use of the CM SAF products is granted free of charge to every interested user, but we have an essential interest to know how many and what users the CM SAF has. This helps to ensure of the CM SAF operational services as well as its evolution according to user needs and requirements. Each new user shall register at CM SAF in order to retrieve the data.

Feedback

We are keen to learn of what use the CM SAF data are. So please feedback your experiences and your application area of the CM SAF data. EUMETSAT CM SAF is user driven service and is committed to consider the needs and requirements of its users in the planning for product improvements and additions. Users are invited to provide their specific requirements on future products for their applications.

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9 Glossary

ATBD	Algorithm Theoretical Baseline Document
AVHRR	Advanced Very High Resolution Radiometer
BC-RMS	Bias-Corrected RMS
CDO	Climate Data Operators
CDR	Climate Data Records
CM SAF	Satellite Application Facility on Climate Monitoring
DRR	Delivery Readiness Review
DWD	Deutscher Wetterdienst (German MetService)
ECMWF	European Centre for Medium Range Forecast
ECV	Essential Climate Variable
ERA-Interim	Second ECMWF Re-Analysis dataset
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FCDR	Fundamental Climate Data Record
FMI	Finnish Meteorological Institute
GCOS	Global Climate Observing System
GFCS	Global Framework of Climate Services
GOES	Geostationary Operational Environmental Satellite
HIRS	High Resolution Infrared Radiation Sounder
KNMI	Royal Meteorological Institute of the Netherlands
LSA SAF	Land Surface Analysis Satellite Applications Facility
LST	Land Surface Temperature
LTP	Physical Land Surface Temperature
LTS	Statistical Land Surface Temperature
MVIRI	Meteosat Visible and InfraRed Imager
MeteoSwiss	Meteorological Service of Switzerland
MSG	Meteosat Second Generation
MFG	Meteosat First Generation
NMHS	climate services at national meteorological and hydrological services
NOAA	National Oceanic and Atmospheric Administration
NWP	Numerical Weather Prediction
PMW	Physical Mono-Window Model
PRD	Product Requirement Document

PUM	Product User Manual
RMIB	Royal Meteorological Institute of Belgium
RMS	Root mean square difference
RTTOV	Radiative Transfer for TOVS
SEVIRI	Spinning Enhanced Visible and InfraRed Imager
SMHI	Swedish Meteorological and Hydrological Institute
SMW	Statistical Mono-Window Model
SZA	Solar Zenith Angle
UK MetOffice	Meteorological Service of the United Kingdom
VZA	Viewing Zenith Angle
WCRP	World Climate Research Program
WMO SCOPE CM	Sustained COordinated Processing of Environmental satellite data for Climate Monitoring