The EUMETSAT Satellite Application Facility on Climate Monitoring

The EUMETSAT SAF Network
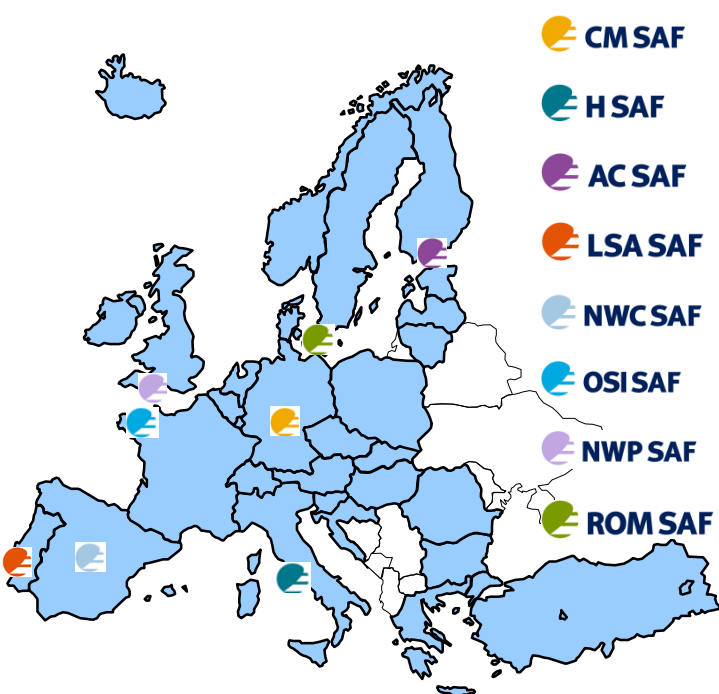
EUMETSAT Member States

Icon	SAF	Title
	CM SAF	**Climate Monitoring**
	H SAF	**Support to Operational Hydrology and Water Management**
	AC SAF	**Ozone and Atmospheric Chemistry Monitoring**
	LSA SAF	**Land Surface Analysis**
	NWC SAF	**Support to Nowcasting and Very Short Range Forecasting**
	OSI SAF	**Ocean and Sea Ice**
	NWP SAF	**Numerical Weather Prediction**
	ROM SAF	**Radio Occultation Meteorology SAF**

The Satellite Application Facility on Climate Monitoring (CM SAF)

Cnrs — *Centre National de la recherche scientifique*

Deutscher Wetterdienst — Wetter und Klima aus einer Hand — DWD

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Royal Netherlands
Meteorological Institute
Ministry of Infrastructure
and Water Management

Met Office, United Kingdom

Royal Meteorological Institute of Belgium

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Home Affairs FDHA
Federal Office of Meteorology and Climatology
MeteoSwiss

SMHI — *Swedish Meteorological and Hydrological Institute*

- **EUMETSAT Member States**
- **CM SAF Member States**
- **Location of Partner NMHSs**

The EUMETSAT Satellite Application Facility on Climate Monitoring
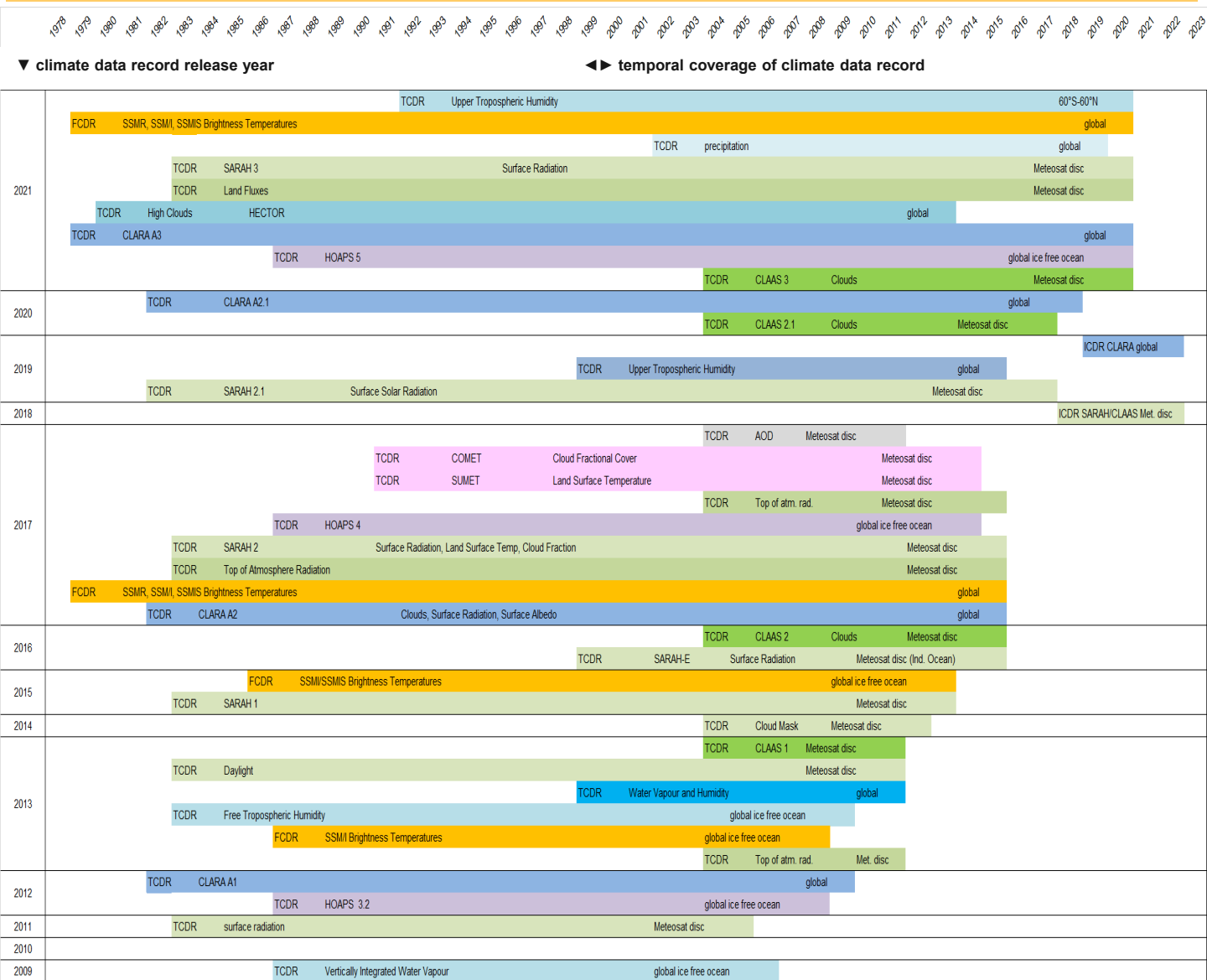
EUMETSAT CM SAF CLIMATE MONITORING

Introduction

The **Satellite Application Facility on Climate Monitoring** (CM SAF) develops, produces, archives and disseminates satellite-based products for climate monitoring. The products generally characterise the atmospheric energy & water cycles and address Essential Climate Variables (ECV) identified by GCOS:

- **Fundamental Climate Data Records (FCDRs)** are (satellite) data records with sufficient calibration for subsequent calculation of long time series of geophysical variables suitable for climate monitoring.
- **Thematic Climate Data Records (TCDRs)** contain time series of geophysical variables describing the GCOS ECVs. They are thoroughly validated, reviewed and documented.
- **Interim Climate Data Records (ICDRs)** are regularly updated products with shorter time latency that are as consistent as possible with reference TCDRs.

Overview of CM SAF Climate Data Records

Years: 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023

▼ climate data record release year   ◄► temporal coverage of climate data record

2021
- TCDR — Upper Tropospheric Humidity — 60°S-60°N
- FCDR — SSMR, SSM/I, SSMIS Brightness Temperatures — global
- TCDR — precipitation — global
- TCDR — SARAH 3 — Surface Radiation — Meteosat disc
- TCDR — Land Fluxes — Meteosat disc
- TCDR — High Clouds — HECTOR — global
- TCDR — CLARA A3 — global
- TCDR — HOAPS 5 — global ice free ocean
- TCDR — CLAAS 3 — Clouds — Meteosat disc

2020
- TCDR — CLARA A2.1 — global
- TCDR — CLAAS 2.1 — Clouds — Meteosat disc

2019
- ICDR CLARA global
- TCDR — Upper Tropospheric Humidity — global

2018
- TCDR — SARAH 2.1 — Surface Solar Radiation — Meteosat disc
- ICDR SARAH/CLAAS Met. disc

2017
- TCDR — AOD — Meteosat disc
- TCDR — COMET — Cloud Fractional Cover — Meteosat disc
- TCDR — SUMET — Land Surface Temperature — Meteosat disc
- TCDR — Top of atm. rad. — Meteosat disc
- TCDR — HOAPS 4 — global ice free ocean
- TCDR — SARAH 2 — Surface Radiation, Land Surface Temp, Cloud Fraction — Meteosat disc
- TCDR — Top of Atmosphere Radiation — Meteosat disc
- FCDR — SSMR, SSM/I, SSMIS Brightness Temperatures — global
- TCDR — CLARA A2 — Clouds, Surface Radiation, Surface Albedo — global

2016
- TCDR — CLAAS 2 — Clouds — Meteosat disc
- TCDR — SARAH-E — Surface Radiation — Meteosat disc (Ind. Ocean)

2015
- FCDR — SSMI/SSMIS Brightness Temperatures — global ice free ocean
- TCDR — SARAH 1 — Meteosat disc

2014
- TCDR — Cloud Mask — Meteosat disc

2013
- TCDR — CLAAS 1 — Meteosat disc
- TCDR — Daylight — Meteosat disc
- TCDR — Water Vapour and Humidity — global
- TCDR — Free Tropospheric Humidity — global ice free ocean
- FCDR — SSM/I Brightness Temperatures — global ice free ocean
- TCDR — Top of atm. rad. — Met. disc

2012
- TCDR — CLARA A1 — global
- TCDR — HOAPS 3.2 — global ice free ocean

2011
- TCDR — surface radiation — Meteosat disc

2010

2009
- TCDR — Vertically Integrated Water Vapour — global ice free ocean

Free Data Access & User Help Desk

www.cmsaf.eu/wui

contact.cmsaf@dwd.de

CM SAF · CM-rs · Deutscher Wetterdienst DWD · EUMETSAT · Royal Netherlands Meteorological Institute Ministry of Infrastructure and Water Management · Met Office · RMI · SMHI

RH

Product Overview

Climate Variables	Acronym	Coverage						
		Europe & Africa			global			
		EDR	ICDR	TCDR	EDR	ICDR	TCDR	FCDR
Cloud properties								
Aerosol Optical Depth	AOD	-	-	●	-	-	-	-
Cloud Fractional Cover	CFC	#	●	●	2	○	●	-
Cloud Mask	CMA	-	-	●	-	-	-	-
Cloud Optical Thickness	COT	◊	-	●	2	-	●	-
Cloud Phase	CPH	◊	-	●	2	○	●	-
Cloud Radiative Effect SW	CFS	-	-	●	-	-	●	-
Cloud Radiative Effect LW	CFL	-	-	●	-	-	●	-
Cloud Top Temperature/Height/Pressure	CTO	#	●	●	2	○	●	-
Cloud Type	CTY	◊	-	-	2	-	-	-
Cloud Water Path (ice & liquid)	CWP	◊	-	-	-		-	-
Effective Cloud Albedo	CAL	-	-	●	-	-	-	-
High Cirrus Cloud Amount	CCA	-	-	-	-	-	○	-
Ice Water Path	IWP	◊	●	●	2	○	●	-
Joint Cloud property Histograms	JCH	-	-	●	2	○	●	-
Liquid Water Path	LWP	◊	●	●	2	○	●	-
Evaporation + Precipitation								
Evaporation	EVA	-	-	-	-	-	●	-
Freshwater Flux	EMP	-	-	-	-	-	●	-
Precipitation	PRE	-	-	-	-	-	●	-
Water Vapour								
Free Tropospheric Humidity	FTH	-	-	●	-	-	-	-
Layered Water Vapour and Temperature	HLW	-	-	-	@	-	●	-
Upper Tropospheric Humidity	UTH	-	-	-	-	-	○	-
Vertically Integrated Water Vapour	HTW	-	-	-	@	-	●	-

April 2019

EDR = Environmental Data Record **TCDR** = Thematic Climate Data Record
ICDR = Interim Climate Data Record **FCDR** = Fundamental Climate Data Record

● available ◊ available until February 2012 1 including Arctic
○ planned @ available until February 2017 2 Europe (30N-80N, 60W-60E)
- not available # available until 05.03.2018

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EUMETSAT CM SAF — CLIMATE MONITORING

Climate Variables	Acronym	Coverage						
		Europe & Africa			global			
		EDR	ICDR	TCDR	EDR	ICDR	TCDR	FCDR
Radiation								
Daylight	DAL	-	○	●	-	-	-	-
Photosynthetic Active Radiation	PAR	-	○	○	-	-	-	-
Spectrally Resolved Irradiance	SRI	-	-	●	-	-	-	-
Sunshine Duration	SDU	-	●	●	-	-	-	-
Surface Direct Irradiance	SDI	-	●	●	-	-	-	-
Surface Downward Longwave	SDL	◊	-	●	-	-	●	-
Surface Incoming Shortwave	SIS	#	●	●	-	○	●	-
Surface Net Longwave	SNL	◊	-	●	-	-	●	-
Surface Net Shortwave	SNS	◊	-	●	-	-	●	-
Surface Outgoing Longwave	SOL	◊	-	●	-	-	●	-
Surface Radiation Budget	SRB	◊	-	●	-	-	●	-
Albedo								
Black Sky Surface Albedo	SAL	◊	-	●	-	○	●	-
Blue Sky Surface Albedo	SAB	-	-	-	-	○	○	-
White Sky Surface Albedo	SAW	-	-	-	-	○	○	-
Top of Atmosphere Radiation								
Land Surface Temperature	LST	-	-	●	-	-	-	-
Latent and Sensible Heat Flux	LEH/LHF	-	-	○	-	-	●	-
Microwave Radiances	FCDR-SSMI	-	-	-	-	-	-	●
Near Surface Specific Humidity	NSH	-	-	-	-	-	●	-
Near Surface Wind Speed	SWS	-	-	-	-	-	●	-
Top of Atmosphere Emitted Thermal Radiative Flux	TET/OLR	@	-	● 1	-	○	○	-
Top of Atmosphere Incoming Solar Radiation	TIS	◊	-	-	-	-	-	-
Top of Atmosphere Reflected Solar Radiative Flux	TRS/RSF	@	-	● 1	-	○	○	-

April 2019

- ● available
- ○ planned
- - not available

- ◊ available until February 2012
- @ available until February 2017
- # available until 05.03.2018

1 including Arctic
2 Europe (30N-80N, 60W-60E)

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Surface Solar Radiation Data Record - Heliosat (SARAH)-3

Surface Irradiance, Direct Radiation, Spectral Information, Sunshine Duration

Surface Irradiance Climatology (1991 - 2020), CM SAF SARAH-3
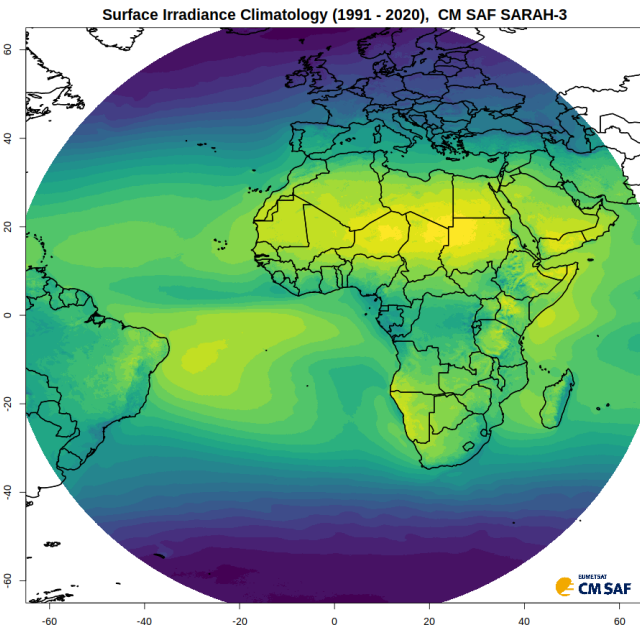
These figures show the climatological average (1991 – 2020) of the (left) solar surface irradiance (full domain) and the (bottom) annual sunshine duration (Europe) based on the SARAH-3 climate data record.

Sunshine Duration Climatology (1991 - 2020), CM SAF SARAH-3
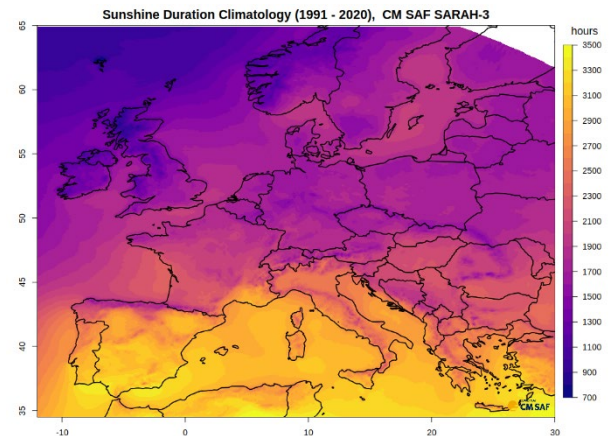
Overview

The Surface Solar Radiation Data Set - Heliosat (SARAH) Edition 3 is the latest CM SAF Surface Radiation climate data record based on the Meteosat satellites. SARAH provides climatological data of the **surface irradiance (SIS)**, the **surface direct horizontal irradiance (SID),** the **surface direct normalized irradiance (DNI),** the **photosynthetic active radiation (PAR),** the **daylight (DAL),** the **sunshine duration (SDU),** and the **effective cloud albedo (CAL)** derived from the visible channels of the MVIRI and SEVIRI instruments onboard the geostationary Meteosat satellites. The data are available from **1983 to date** as **monthly and daily averages, and on an instantaneous basis (every 30 min)** and cover the region **±65° longitude and ±65° latitude** on a **0.05° x 0.05°** regular grid. The data is operationally provided a latency of 5 days. The accuracy of the data has been determined against surface references measurements; for the monthly averages / sums the accuracy is 5 W/m² (SIS), 8 W/m² (SID), 17 W/m² (DNI), and 15 h (SDU). Further information can be found in the documentation of SARAH.

Available documentation

- Product User Manual
- Algorithm Theoretical Basis Document
- Validation Report

Pfeifroth, U., A. Sanchez-Lorenzo, V. Manara, J. Trentmann, and R. Hollmann (2018), Trends and Variability of Surface Solar Radiation in Europe based on Surface- and Satellite-based Data Records, Journal of Geophysical Research: Atmospheres, 123, 1735-1754, doi:10.1002/2017JD027418.

Kothe, S., U. Pfeifroth, R. Cremer, J. Trentmann, and R. Hollmann (2017), A Satellite-Based Sunshine Duration Climate Data Record for Europe and Africa, Remote Sensing, 9(5), 429.

Surface Solar Radiation Data Record - Heliosat (SARAH)-3

Satellite Input Data

Product

Surface incoming solar radiation	SIS also known as global irradiance
Surface incoming direct radiation	SID also known as direct horizontal irradiance
Surface incoming direct normalized radiation	DNI also known as direct normalized irradiance
Photosynthetic Active Radiation	PAR
Daylight	DAL
Sunshine Duration	SDU
Effective cloud albedo	CAL also known as cloud index

Technical Specifications

|	
Time period:	January 1983 to date
Temporal resolution:	monthly mean/sum, daily mean/sum, 30-min instantaneous
Spatial coverage:	Meteosat disk up to a scanning angle of 65 degree
Spatial resolution:	0.05° × 0.05°
Data Format:	NetCDF 4, Climate and Forecast (CF) Metadata Convention v1.6

Free Data Access & User Help Desk

www.cmsaf.eu/wui   contact.cmsaf@dwd.de

Surface Radiation, SARAH-E

Solar Surface Irradiance, Direct Irradiance, and Direct Normalized Irradiance

Global Radiation (SIS), CM SAF, SARAH-E, 1999 - 2014

These figures show the multi-year averages (1999 – 2014) of the (left) solar surface irradiance and (bottom) the direct normalized irradiance derived from the Meteosat-East satellites using the SPECMAGIC retrieval algorithm.

Direct Normalized Radiation (DNI), CM SAF, SARAH-E, 1999 - 2014
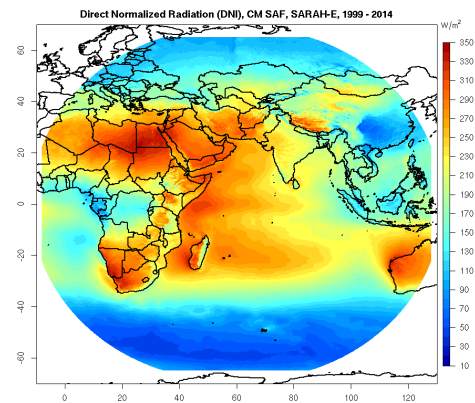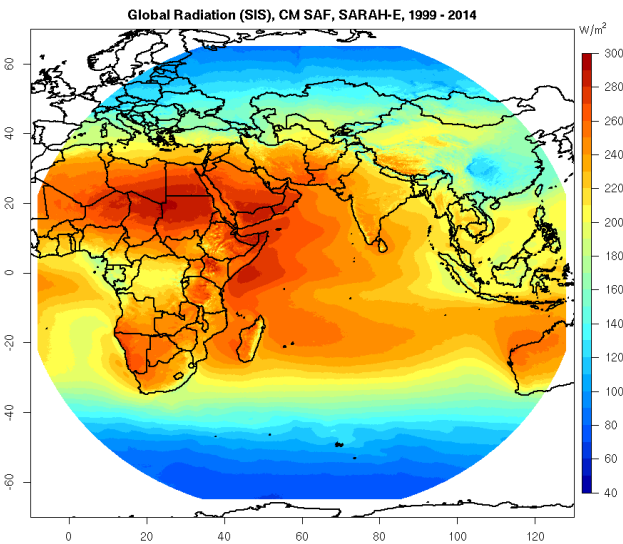
Overview

The Surface Solar Radiation Data Set - Heliosat – East (SARAH-E) is a Surface Radiation Climate Data Record based on the Meteosat satellites positioned at about 57°E. SARAH-E provides climatological data of the **surface irradiance (SIS)**, **surface direct irradiance (SID), and** the **surface direct normalized irradiance (DNI)** derived from the visible channels of the MVIRI instruments onboard the geostationary Meteosat satellites (Meteosat 5 and 7). The data are available from **1999 to 2016** as **monthly and daily averages, as well as on n hourly instantaneous basis,** and cover the region from **8 °W to 128 °E longitude and ±65° latitude** (see figures) on a **0.05° x 0.05°** regular a grid. The accuracy of the data has been determined against surface references measurements; for the monthly averages the accuracy is 10 W/m^2 (SIS), 15 W/m^2 (SID) and 27 W/m^2 (DNI). Further information can be found in the documentation of SARAH-E.

This data record has been processed and generated in cooperation with the PV GIS team from the Joint Research Centre (JRC), Ispra, Italy.

EUROPEAN COMMISSION DG JRC

Available documentation

• Product User Manual

Gracia Amillo, A., T. Huld, and R. Müller (2014), A New Database of Global and Direct Solar Radiation Using the Eastern Meteosat Satellite, Models and Validation, Remote Sensing, 6(9), 8165-8189, doi:10.3390/rs6098165.

Satellite Input Data

Meteosat-7

Meteosat-5

1995   2000   2005   2010   2015
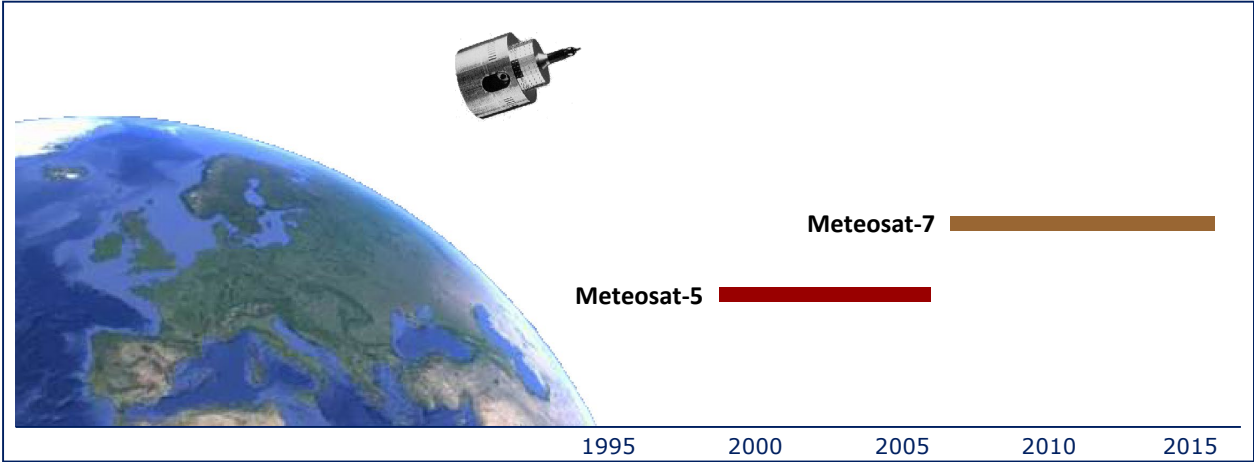
Products

Surface incoming solar radiation	SIS also known as global irradiance
Surface incoming direct radiation	SID also known as direct irradiance
Surface incoming direct normalized radiation	DNI also known as direct normalized irradiance

Technical Specifications

Time period:	01.01.1999 – 31.12.2016
Temporal resolution:	monthly mean, daily mean, hourly instantaneous
Spatial coverage:	Meteosat-IODC disk: 8 °W to 128 °E longitude and ±65° latitude
Spatial resolution:	0.05° × 0.05°
Data Format:	NetCDF 3, Climate and Forecast (CF) Metadata Convention v1.6

Free Data Access & User Help Desk

www.cmsaf.eu/wui   **contact.cmsaf@dwd.de**

Surface Solar Radiation Data Record - Heliosat (SARAH)-2.1

DOI:10.5676/EUM_SAF_CM/SARAH/V002_01

Surface Irradiance, Direct Radiation, Spectral Information, Sunshine Duration

SARAH-2.1, Surface Irradiance (SIS), 1983-2017

©EUMETSAT 2019
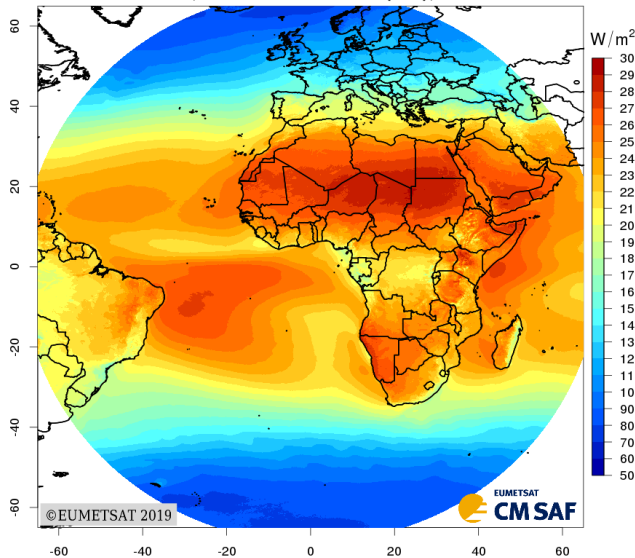
These figures show the multi-year averages (1983 – 2017) of the (left) solar surface irradiance and (bottom) the annual sunshine duration derived SARAH-2.1 climate data record.

Sunshine duration, mean monthly sum, SARAH-2.1, 1983 - 2017

©EUMETSAT 2019
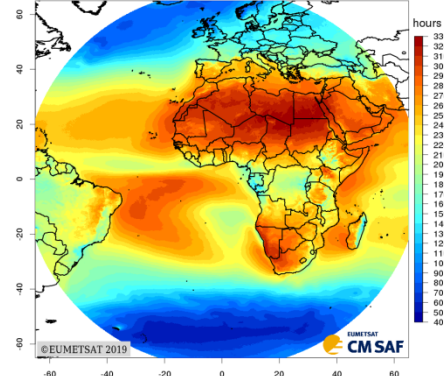
Overview

The Surface Solar Radiation Data Set - Heliosat (SARAH) Edition 2.1 is the latest CM SAF Surface Radiation climate data record based on the Meteosat satellites. SARAH provides climatological data of the **surface irradiance (SIS)**, the **surface direct horizontal irradiance (SID),** the **surface direct normalized irradiance (DNI),** the **spectral resolved irradiance (SRI),** the **sunshine duration (SDU),** and the **effective cloud albedo (CAL)** derived from the visible channels of the MVIRI and SEVIRI instruments onboard the geostationary Meteosat satellites. The data are available from **1983 to 2017** as **monthly and daily averages, and on an instantaneous basis (every 30 min)** and cover the region **±65° longitude and ±65° latitude** (see figures) on a **0.05° x 0.05°** regular grid. The accuracy of the data has been determined against surface references measurements; for the monthly averages / sums the accuracy is 5.2 W/m² (SIS), 7.7 W/m² (SID), 16.4 W/m² (DNI), and 16.6 h (SDU). Further information can be found in the documentation of SARAH.
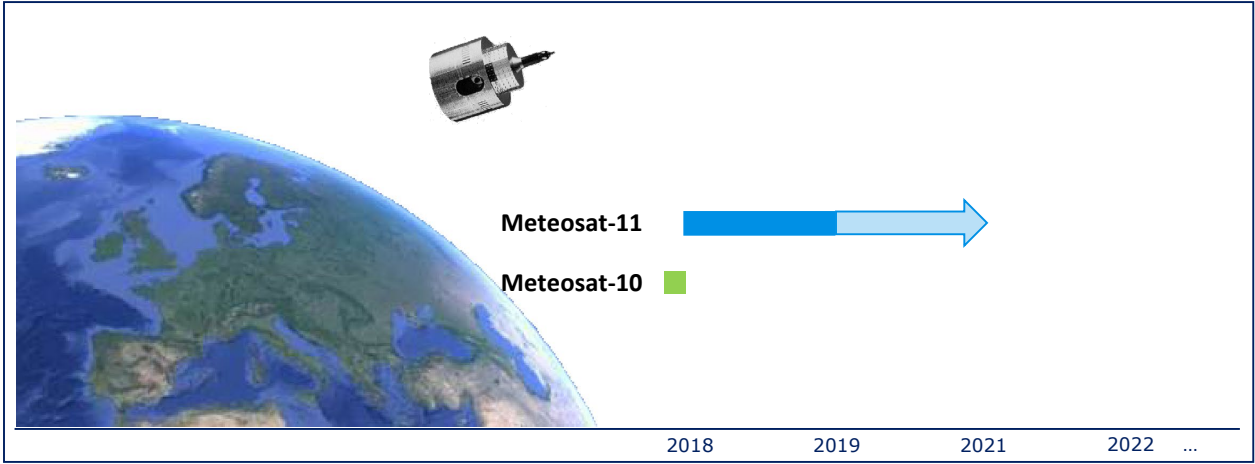
Available documentation

- Product User Manual
- Algorithm Theoretical Basis Document
- Validation Report

Pfeifroth, U., A. Sanchez-Lorenzo, V. Manara, J. Trentmann, and R. Hollmann (2018), Trends and Variability of Surface Solar Radiation in Europe based on Surface- and Satellite-based Data Records, Journal of Geophysical Research: Atmospheres, 123, 1735-1754, doi:10.1002/2017JD027418.

Kothe, S., U. Pfeifroth, R. Cremer, J. Trentmann, and R. Hollmann (2017), A Satellite-Based Sunshine Duration Climate Data Record for Europe and Africa, Remote Sensing, 9(5), 429.

Surface Solar Radiation Data Record - Heliosat (SARAH)-2.1

Satellite Input Data

Meteosat-10	(2013–2017)
Meteosat-9	
Meteosat-8	
Meteosat-7	
Meteosat-6	
Meteosat-5	
Meteosat-4	
Meteosat-3	
Meteosat-2	

1980 1985 1990 1995 2000 2005 2010 2015 2017

Product

Surface incoming solar radiation	SIS also known as global irradiance
Surface incoming direct radiation	SID also know as direct horizontal irradiance
Surface incoming direct normalized radiation	DNI also known as direct normalized irradiance
Spectral resolved irradiance	SRI
Sunshine Duration	SDU
Effective cloud albedo	CAL also known as cloud index

Technical Specifications

Time period: 01.01.1983 – 31.12.2017
Temporal resolution: monthly mean/sum, daily mean/sum, 30-min instantaneous

Spatial coverage: Meteosat disk up to a scanning angle of 65 degree
Spatial resolution: 0.05° × 0.05°

Data Format: NetCDF 4, Climate and Forecast (CF) Metadata Convention v1.6

Free Data Access & User Help Desk

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ICDR SEVIRI Radiation
based on SARAH-2 methods

Link: https://wui.cmsaf.eu/safira/action/viewICDRDetails?acronym=SARAH_V002_ICDR

Surface Irradiance, Direct Radiation, Direct Normalised Radiation, Sunshine Duration

Surface Downwelling Shortwave Radiation
ICDR SEVIRI Radiation, 2021-04

These figures show monthly means of surface irradiance (SIS, left) and direct irradiance at the surface (SID, right) for April 2021 for the ICDR SEVIRI Radiation, which is based on SARAH-2 methods
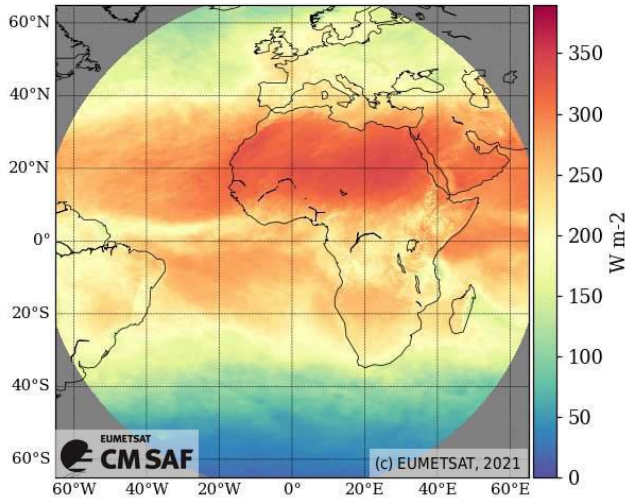
surface direct shortwave flux
ICDR SEVIRI Radiation, 2021-04
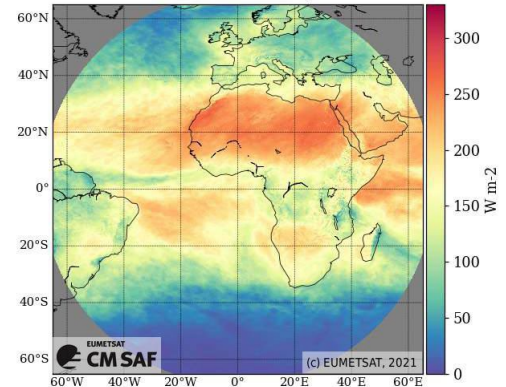
Overview

The SEVIRI-based Interim Climate Data Record of Surface Radiation products are consistent continuations of the respective parameters from the well-established Thematic Climate Data Record SARAH-2.1. It provides the parameters **surface irradiance (SIS)**, **surface direct horizontal irradiance (SID), surface direct normalized irradiance (DNI),** and **sunshine duration (SDU)** derived from the visible channels of the SEVIRI instruments onboard the geostationary Meteosat sate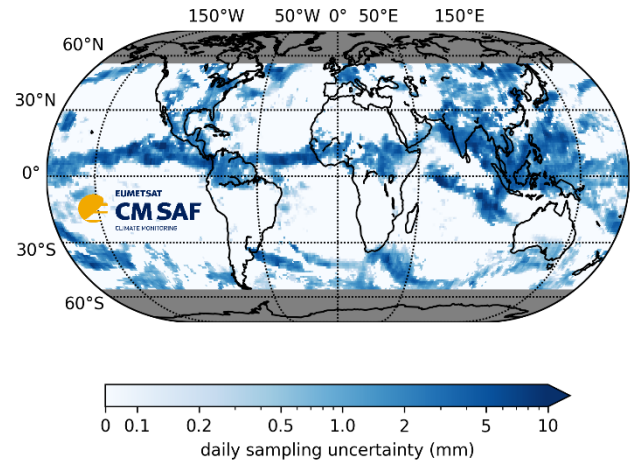llites. The data are available from **January 2018 onwards** as **monthly and daily products, and on an instantaneous basis (every 30 min)** and cover the region **±65° longitude and ±65° latitude** (see figures) on a **0.05° x 0.05°** regular grid. The accuracy of the data is regularly being determined against surface references measurements and reported in the Annual Quality Assessment Report. Further information can be found in the documentation of the ICDR SEVIRI Radiation.

Available documentation

- Product User Manual
- Algorithm Theoretical Basis Document
- Validation Report

Pfeifroth, U., A. Sanchez-Lorenzo, V. Manara, J. Trentmann, and R. Hollmann (2018), Trends and Variability of Surface Solar Radiation in Europe based on Surface- and Satellite-based Data Records, Journal of Geophysical Research: Atmospheres, 123, 1735-1754, doi:10.1002/2017JD027418.

Kothe, S., U. Pfeifroth, R. Cremer, J. Trentmann, and R. Hollmann (2017), A Satellite-Based Sunshine Duration Climate Data Record for Europe and Africa, Remote Sensing, 9(5), 429.

ICDR SEVIRI Radiation
based on SARAH-2 methods

Link: https://wui.cmsaf.eu/safira/action/viewICDRDetails?acronym=SARAH_V002_ICDR

Satellite Input Data

Meteosat-11

Meteosat-10

2018   2019   2021   2022   ...

Product

Surface incoming solar radiation	SIS also known as global irradiance
Surface incoming direct radiation	SID also known as direct horizontal irradiance
Surface incoming direct normalized radiation	DNI also known as direct normalized irradiance
Sunshine Duration	SDU

Technical Specifications

Time period: 2018/01 - ongoing
Temporal resolution: monthly mean/sum, daily mean/sum, 30-min instantaneous

Spatial coverage: Meteosat disk up to a scanning angle of 65 degree
Spatial resolution: 0.05° × 0.05°

Data Format: NetCDF 4, Climate and Forecast (CF) Metadata Convention v1.6

All products are available via the CM SAF Web User Interface (WUI).
SIS and SDU daily and monthly products are additionally available via EUMETSAT's EUMETCast service.

Free Data Access & User Help Desk

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JT

Top of Atmosphere Radiation
GERB/SEVIRI Data Record – edition 2

TOA Reflected Solar and Emitted Thermal Radiation from GERB and SEVIRI

Illustration of the Daily Mean TOA Reflected Solar Fluxes for 9th April 2007 in all sky (left) and the corresponding clear sky flux (right).
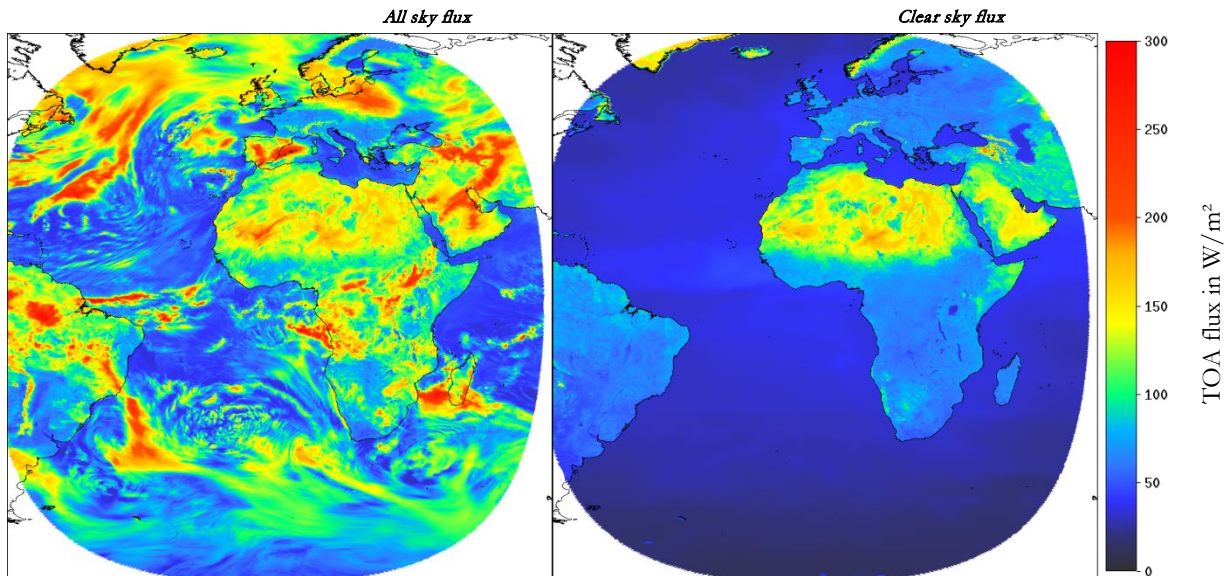
All sky flux   *Clear sky flux*

Overview

The CM SAF Top of Atmosphere Radiation GERB/SEVIRI Data Record provides an homogeneous satellite-based climatology of the TOA Reflected Solar (TRS) and Emitted Thermal (TET) radiation in all-sky and clear-sky conditions. The continuous monitoring of these components of the Earth Radiation Budget is of prime importance to study climate variability and change, and to improve the understanding of various atmospheric processes, like e.g. the cloud radiative effect. The GERB and SEVIRI instruments on board the METEOSAT Second Generation satellites are combined over a time period of time of 11 years, from 1 February 2004 to 30 April 2015. The TOA radiation products are provided as daily mean, monthly mean and monthly averages of the hourly integrated values (diurnal cycle). The data is provided on a regular grid at a spatial resolution of 0.1 degrees and covers the region between ± 70° longitude and ± 70° latitude. Compared to other Earth radiation budget products, the GERB/SEVIRI data record inherits from the excellent spatial and temporal samplings of the input sensors.

Available documentation

All products are thoroughly reviewed by international experts and a comprehensive documentation is available, comprising i.a.:

- Product User Manual
- Algorithm Theoretical Basis Document
- Validation Report

Top of Atmosphere Radiation
GERB/SEVIRI Data Record – edition 2

DOI:10.5676/EUM_SAF_CM/TOA_GERB/V002

Satellite Input Data
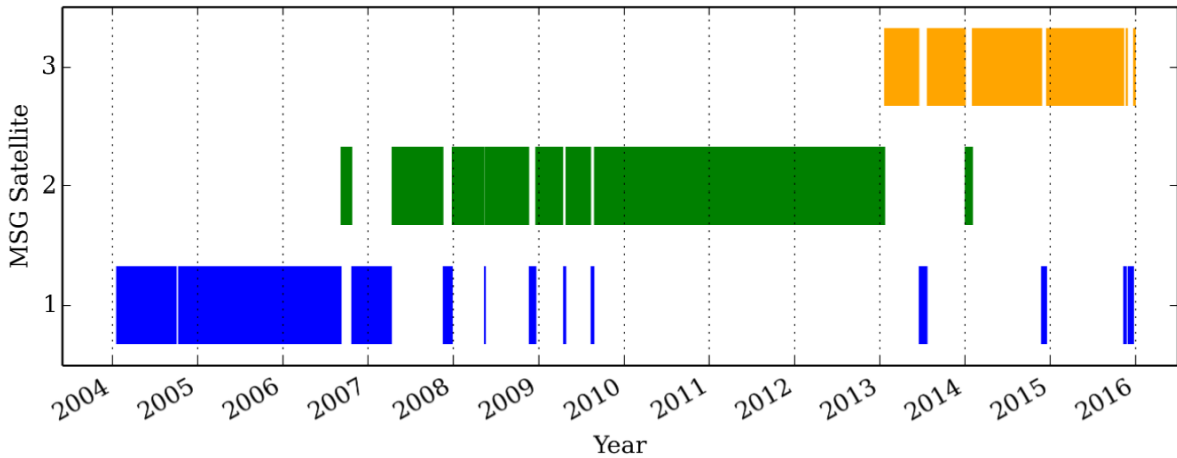
Product

TOA Reflected Solar (TRS) file	All sky solar flux (rsut)
	Clear sky solar flux (rsutcs)
	Incoming solar flux (rsdt)
TOA Emitted Thermal (TET) file	All sky thermal flux (rlut)
	Clear sky thermal flux (rlutcs)

Technical Specifications

Time period: 01.02.2004 - 30.04.2015
Temporal resolution: monthly mean, daily mean, monthly mean diurnal cycle (1-hourly)

Spatial coverage: within 70°N/S and 70°E/W (limited to a sensor viewing zenith angle of 80°)
Spatial resolution: 0.1° × 0.1°, regular longitude/latitude grid

Data Format: NetCDF 4, Climate and Forecast (CF) Metadata Convention v1.6

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GIRAFE v1

DOI:10.5676/EUM_SAF_CM/GIRAFE/V001

Global Interpolated RAinFall Estimation v1

daily accumulated precipitation (mm)

daily sampling uncertainty (mm)
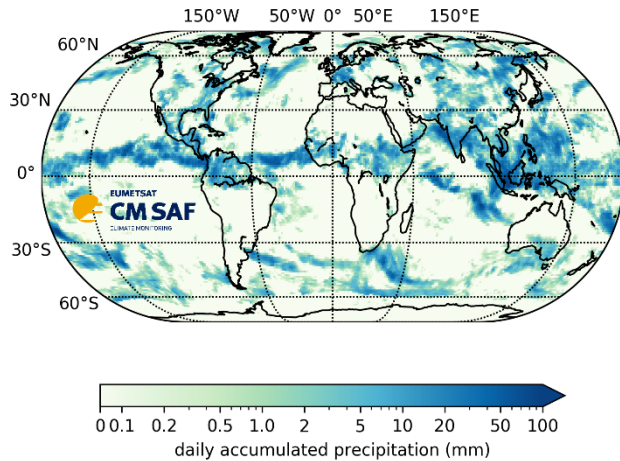
Left: Global map of GIRAFE v1 daily accumulated precipitation on 2021/07/13.
Right: Global map of the related daily GIRAFE v1 sampling uncertainty.

Overview

The GIRAFE v1 climate data record (CDR) provides precipitation estimates derived from a combination of passive microwave (PMW) observations onboard polar orbiting satellites and infrared (IR) observations onboard geostationary satellites. GIRAFE v1 covers the time period 2002/01/01 until 2022/12/31. The PMW input to GIRAFE v1 is from various microwave imager and sounder instruments. Precipitation rate estimates are retrieved from the observed PMW brightness temperatures by precipitation retrieval algorithms HOAPS, PNPR-CLIM*, and PRPS. The resulting archives of instantaneous precipitation rate estimates are homogenized using quantile mapping. The IR input to GIRAFE comes from the five geostationary positions forming the Geo-Ring, providing observations along all geographical longitudes. The spatially and temporally highly resolved IR input is trained to detect the occurrence of precipitation using the PMW-based instantaneous precipitation rate estimates. Conditional precipitation rates are computed based on PMW observations only. At latitudes higher than 55°N/S where Geo-Ring IR pixels are extremely distorted, GIRAFE v1 relies only on the PMW input. GIRAFE v1 is a gridded product which is available globally at a spatial resolution of 1° x 1°and at a temporal resolution of 24 h as accumulated precipitation computed from the (IR-based) fraction of precipitation and the conditional precipitation rate. Additionally, 1° x 1° monthly mean values of the daily accumulated precipitation are provided. The daily accumulated precipitation features a dedicated sampling uncertainty at the same 1° x1° x 24 h resolution which is based on the analysis of decorrelation scales in space and time in the IR-based precipitation fields.

Available documentation

- Product User Manuals
- Algorithm Theoretical Basis Documents
- Validation Reports

Konrad, H. et al., GIRAFE v1: a global climate data record for precipitation accompanied by a daily sampling uncertainty. *in preparation for ESSD, 2024*

*The PNPR-CLIM algorithm has been developed by CNR-ISAC in the C3S_312b_Lot1 Copernicus project.

GIRAFE v1

DOI:10.5676/EUM_SAF_CM/GIRAFE/V001

Satellite Input Data

Microwave observations from polar-orbiting satellites

DMSP-F13 SSM/I HOAPS
DMSP-F14 SSM/I HOAPS
DMSP-F15 SSM/I HOAPS
TRMM TMI HOAPS
AQUA AMSR-E HOAPS
DMSP-F16 SSMIS HOAPS
DMSP-F17 SSMIS HOAPS *
DMSP-F18 SSMIS HOAPS
GPM GMI HOAPS
NOAA-16 AMSU-B PNPR-CLIM
NOAA-17 AMSU-B PNPR-CLIM
NOAA-18 MHS PNPR-CLIM
METOP-A MHS PNPR-CLIM **
NOAA-19 MHS PNPR-CLIM
METOP-B MHS PNPR-CLIM
METOP-C MHS PNPR-CLIM
Megha-Tropiques SAPHIR PRPS
SNPP ATMS PRPS
NOAA-20 ATMS PRPS

Infrared observations from geostationary satellites

- GOES-I (4km, 10.7um)
- GOES-N (4km, 10.7um)
- GOES-R (2km, 10.3um)
- MFG (5km, 11.5um)
- MSG (3km, 10.8um)
- GMS (5km, 11.0um)
- MTSAT-01 (4km, 10.8um)
- MTSAT-02 (4km, 10.8um)
- HIMAWARI (2km, 10.4um)

140° to 145°	GMS-05, GOES-09, MTSAT-01R, MTSAT-02, HIMAWARI-08, H-09
41° to 63°	Meteosat-05, Meteosat-07, Meteosat-08, Met-09
-3.4° to 0°	Met-07, Meteosat-08, Meteosat-09, Meteosat-10, Meteosat-11
-75°	GOES-08, GOES-12, GOES-13, GOES-16
-137° to -128°	GOES-10, GOES-11, GOES-15, GOES-17

Products

Precipitation	PRE

Technical Specifications

Time period:	2002/01 – 2022/12
Temporal resolution:	daily accumulations, monthly mean of daily accumulations
Spatial coverage:	global on a regular latitude/longitude grid
Spatial resolution:	1.0° x 1.0°
Data Format:	NetCDF 4, Climate and Forecast (CF) Metadata Convention v1.7

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HOAPS 4.0

DOI:10.5676/EUM_SAF_CM/HOAPS/V002

Hamburg Ocean Atmosphere Parameters and Fluxes
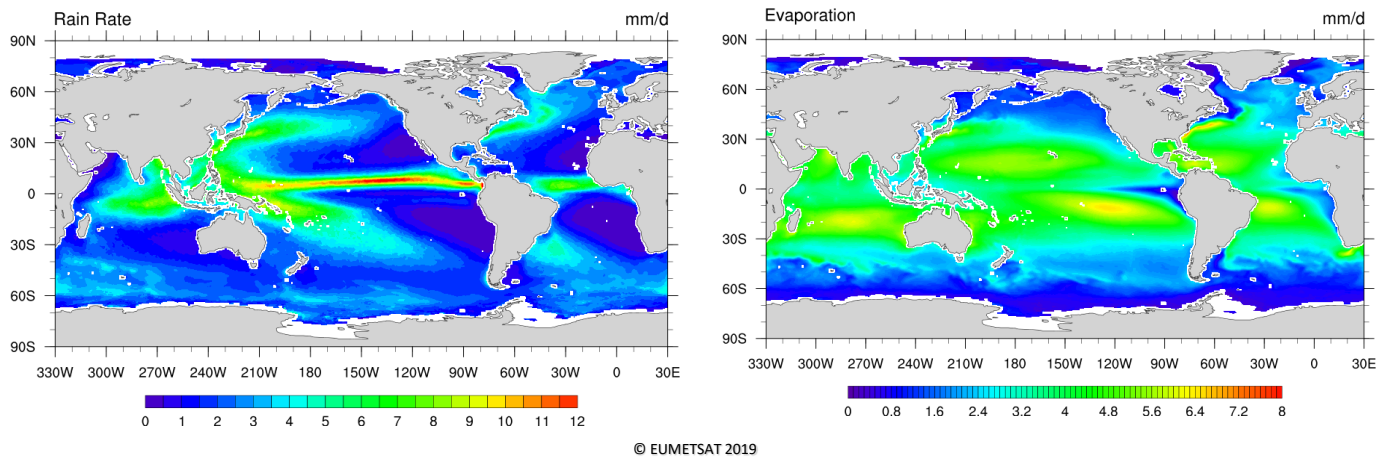
Climatological mean field of HOAPS precipitation (left) and evaporation (right) for the years 1988 – 2014.

Overview

The Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data (HOAPS) set is a completely satellite based climatology of precipitation, evaporation and freshwater budget (evaporation minus precipitation) as well as related turbulent heat fluxes and atmospheric state variables over the global ice free oceans. All variables are derived from SSM/I and SSMIS passive microwave radiometers, except for the SST, which is taken from AVHRR measurements. The data set includes multi-satellite averages, inter- sensor calibration, and an efficient sea ice detection procedure. Main changes in this version are a prolonged time series, now containing data for the time period from 1987 until end of 2014 and an updated fundamental climate data record of the level-1 SSM/I and SSMIS brightness temperatures. The physical retrieval algorithms remain unchanged compared to HOAPS 3.0. All HOAPS products have global coverage, i.e., within ±180° longitude and ±80° latitude and are only defined over the ice-free ocean surface. The products are available as monthly averages and 6-hourly composites on a regular latitude/longitude grid with a spatial resolution of 0.5° x 0.5° degrees.

Available documentation

- Product User Manual
- Algorithm Theoretical Basis Document
- Validation Report

Andersson, A., C. Klepp, K. Fennig, S. Bakan, H. Graßl, and J. Schulz, 2010a: Evaluation of HOAPS-3 ocean surface freshwater flux components. Journal of Applied Meteorology and Climatology, doi:10.1175/2010JAMC2341.1.

Andersson, A., K. Fennig, C. Klepp, S. Bakan, H. Graßl, and J. Schulz, 2010b: The Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data – HOAPS-3. Earth System Science Data Discussion, 3, 143-194, doi:10.5194/essdd-3-143-2010.

Schröder, M., Jonas, M., Lindau, R., Schulz, J., and Fennig, K. (2013): The CM SAF SSM/I-based total column water vapour climate data record: methods and evaluation against re-analyses and satellite. Atmos. Meas. Tech., 6, 765–775, doi:10.5194/amt-6-765-2013.

Schröder, M., Lockhoff, M., Fell, F., Forsythe, J., Trent, T., Bennartz, R., Borbas, E., Bosilovich, M. G., Castelli, E., Hersbach, H., Kachi, M., Kobayashi, S., Kursinski, E. R., Loyola, D., Mears, C., Preusker, R., Rossow, W. B., and Saha, S.: The GEWEX Water Vapor Assessment archive of water vapour products from satellite observations and reanalyses, Earth Syst. Sci. Data, 10, 1093-1117, https://doi.org/10.5194/essd-10-1093-2018, 2018.

HOAPS 4.0

DOI:10.5676/EUM_SAF_CM/HOAPS/V002

Satellite Input Data
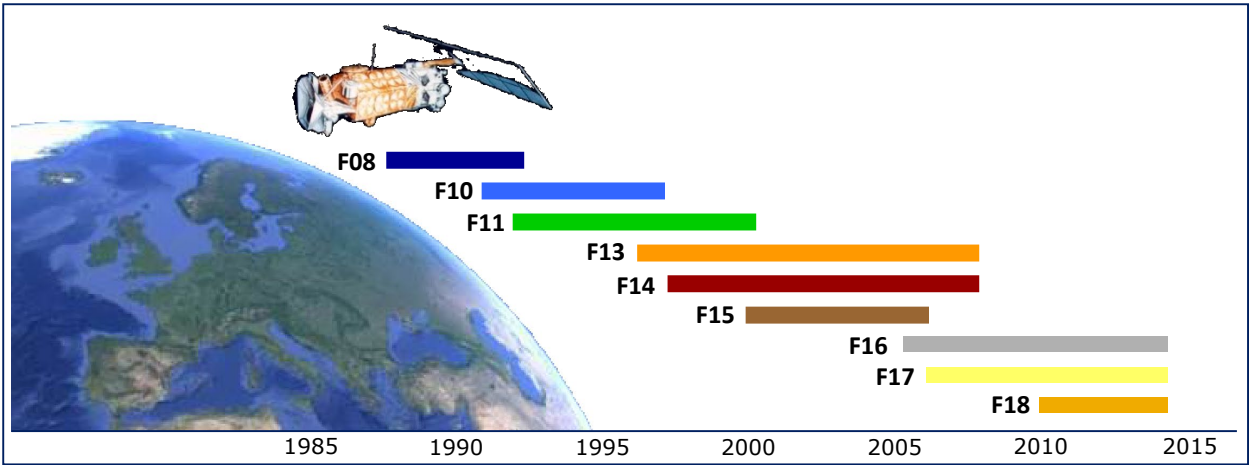
Temporal coverage of SSM/I and SSMIS instruments aboard DMSP satellites for the HOAPS processing.

Products

Near surface wind speed	SWS
Near surface specific humidity	NSH
Latent heat flux at sea surface	LHF
Evaporation	EVA
Precipitation	PRE
Freshwater flux	EMP
Total column water vapour	WVPA

Technical Specifications

Time period:	9th of July 1987 to 31st of December 2014
Temporal resolution:	6-hourly composites and monthly averages
Spatial coverage:	quasi-global coverage over the ice-free ocean surface, i.e., within ±180° longitude and ±80° latitude on regular latitude/longitude grid
Spatial resolution:	0.5° × 0.5°
	Note: instantaneous, swath based data is available on request.
Data Format:	NetCDF 4, Climate and Forecast (CF) Metadata Convention v1.6
	Note: On request, data are also available reformatted using the CMOR (https://cmor.llnl.gov/) library compliant with Obs4MIPs (https://esgf-node.llnl.gov/projects/obs4mips/) file format standard.

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MS

MW+NIR based water vapour:
CM SAF / WV_cci TCWV data record

Combined global total column water vapour product from microwave and near infrared imagers
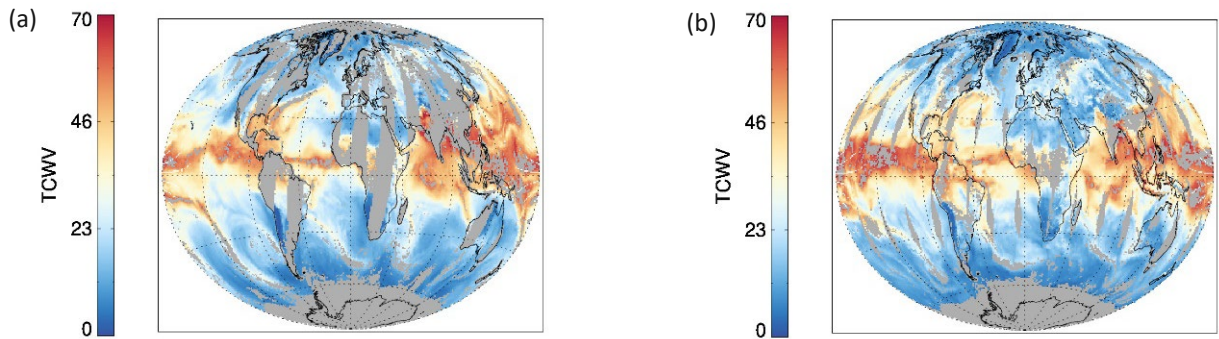
Example figures for CM SAF / WV_cci TCWV: Global maps of daily TCWV in units of kg/m²: a) 1 July 2007 and b) 1 July 2015. Grey areas mark regions that are not observed by the satellites.

Overview

The global total column water vapour (TCWV) data record combines microwave and near-infrared imager based TCWV over the ice-free ocean as well as over land, coastal ocean and sea-ice, respectively. The data record relies on microwave observations from SSM/I, SSMIS, AMSR-E and TMI, partly based on a fundamental climate data record (Fennig et al., 2020; Fennig et al., 2017) and on near-infrared observations from MERIS (3rd reprocessing), MODIS-Terra (collection 6.1) and OLCI (1st reprocessing). Details of the retrieval are described in Andersson et al. (2010) and ATBD HOAPS for the microwave imagers as well as in Lindstrot et al. (2012), Diedrich et al. (2015) and ABTD NIR Level 2 for the near-infrared imagers. The water vapour of the atmosphere is vertically integrated over the full column and given in units of kg/m². The microwave and near-infrared data streams are processed independently and combined afterwards by not changing the individual TCWV values and their uncertainties. The combined data record has a spatial resolution of 0.5°x0.5° and 0.05°x0.05°, with the near-infrared based data being averaged and the microwave-based data being oversampled to match the lower and higher spatial resolution, respectively. The product is available as daily and monthly means and covers the period July 2002 – December 2017.

Available documentation / References

- Product User Manual
- Algorithm Theoretical Basis Document
- Validation Report

Diedrich, H., et al., 2015: Retrieval of daytime total columnar water vapour from MODIS measurements over land surfaces. Atmospheric Measurement Techniques, 8:823-836.

Fennig, K. et al., 2017: Fundamental Climate Data Record of Microwave Imager Radiances, Edition 3, CM SAF, DOI:10.5676/EUM_SAF_CM/FCDR_MWI/V003,

Fennig, K. et al.: A Fundamental Climate Data Record of SMMR, SSM/I, and SSMIS brightness temperatures, Earth Syst. Sci. Data, 12, 647–681, 2020.

Fischer, J., et al.: Algorithm Theoretical Baseline Document – Part 1 (ATBD). ESA Water_Vapour_cci, version 2.1, January 2021.

Graw, K., et al.: Algorithm Theoretical Baseline Document - HOAPS version 4.0. EUMETSAT Satellite Application Facility on Climate Monitoring, Issue 2.3, 31 January 2017.

Lindstrot, R., et al., 2012: 1D-Var retrieval of daytime total columnar water vapour from MERIS measurements. Atmospheric Measurement Techniques, 5: 631–646.

MW+NIR based water vapour:
CM SAF / WV_cci TCWV data record

Satellite Input Data
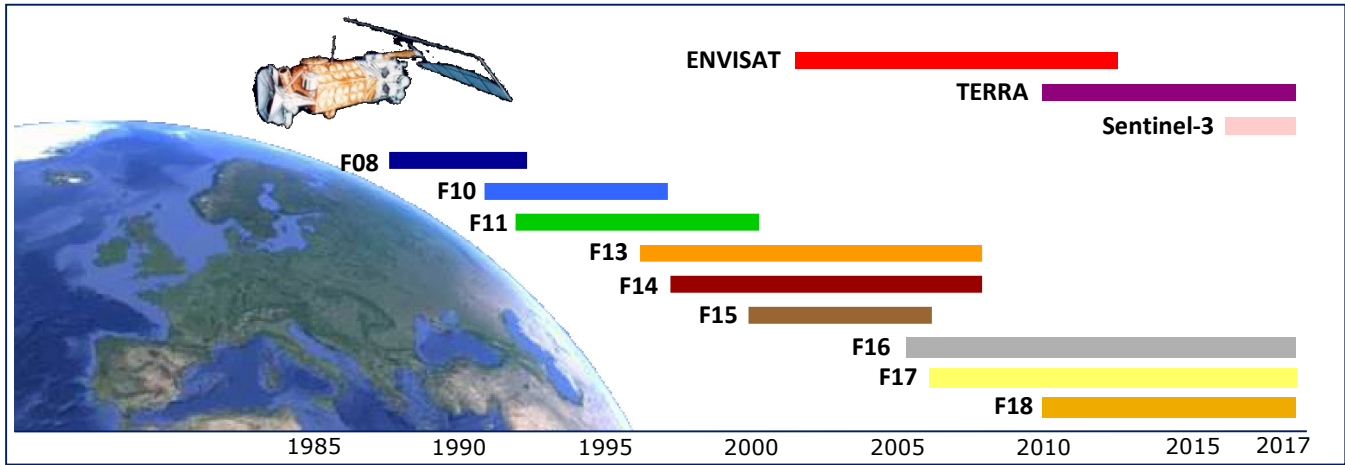
Temporal coverage of SSM/I and SSMIS instruments aboard DMSP satellites and MERIS, MODIS and OLCI aboard ENVISAT, TERRA and Sentinel-3, respectively for the CM SAF / WV_cci processing.

Products

Total column water vapour	TCWV
Average retrieval uncertainty of TCWV	TCWV_err
Propagated retrieval uncertainty of TCWV	TCWV_ran

Technical Specifications

Time period:	July 2002 to December 2017
Temporal resolution:	daily and monthly averages
Spatial coverage:	global coverage, with microwave-imager based TCWV over the ice-free ocean surface and near-infrared imager based TCWV over sea-ice, costal areas and land surfaces
Spatial resolution:	$0.5° × 0.5°$ with NIR data being averaged $0.05° × 0.05°$ with MW data being oversampled
Data Format:	NetCDF 4, Climate and Forecast (CF) Metadata Convention v1.6

Acknowledgment

The combined MW and NIR product was initiated and funded by the ESA Water_Vapour_cci project. The NIR retrieval was developed by Spectral Earth. The MW retrieval was originally developed at the University of Hamburg and the Max-Planck-Institute for Meteorology. Based on retrieval updates by CM SAF MW was processed by EUMETSAT CM SAF. The NIR data was processed and combined with the MW data by Brockmann Consult. NIR data is owned by Brockmann Consult and Spectral Earth.

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CLARA-A3

CM SAF cLoud, Albedo & RAdiation dataset, AVHRR-based, Edition 3
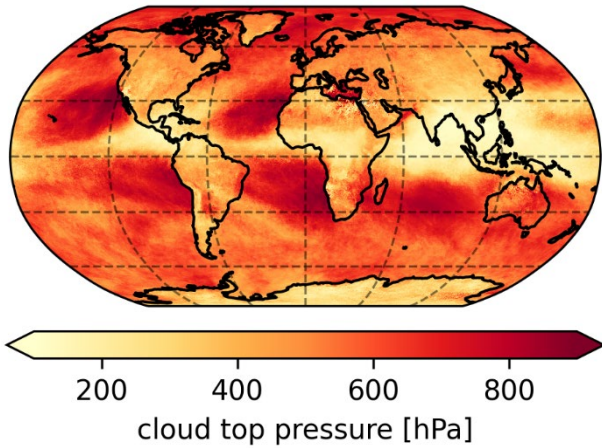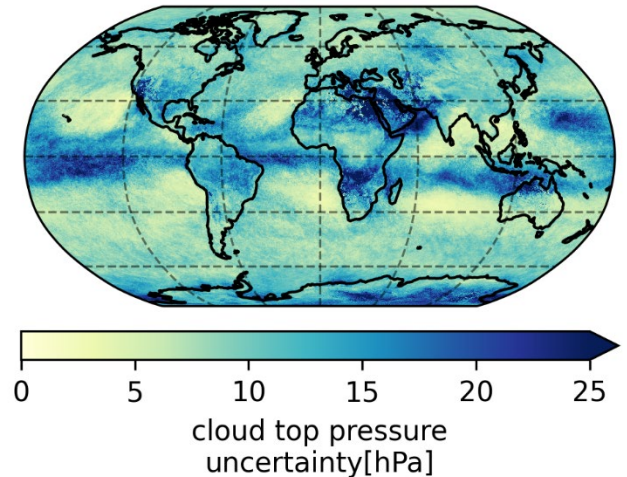
Left: Global map of CLARA-A3 monthly mean cloud top pressure for 2012/06 from NOAA-19. Right: Global map of the uncertainty of the monthly mean cloud top pressure for 2012/06 from NOAA-19.

Overview

The CLARA-A3 record provides cloud properties and radiation parameters derived from the AVHRR sensor onboard polar orbiting NOAA and METOP satellites (Karlsson et al., 2023). CLARA-A3 covers the time period 1979/01/01 until 2020/12/31 as climate data record (CDR), but is operationally extended as interim climate data record (ICDR) to the present with a latency of 10 days. CLARA-A3 features a range of cloud products: cloud mask, cloud top temperature/pressure/height, cloud thermodynamic phase, and (for liquid and ice clouds separately) cloud optical thickness, particle effective radius and cloud water path. Furthermore, a range of radiation products are included in CLARA-A3: surface black-sky, white-sky and blue-sky albedo; surface downwelling short- and longwave radiation as well as surface net radiation; top-of-atmosphere (TOA) upwelling short- and longwave radiation. Cloud products are available as monthly and daily averages and histograms, as well as daily resampled global products (Level 2b) for individual satellites. Surface albedo is presented as monthly and pentad (5 day) averages. Surface and TOA radiation products are provided as daily and monthly averages. All averages are available on a 0.25° x 0.25° global grid. Surface albedo and selected cloud products are also provided on two equal area grids with a resolution of 25 km x 25 km covering the polar regions. Daily resampled cloud products (level 2b) are provided in a global grid with a resolution of 0.05° x 0.05°. CLARA-A3 features a comprehensive set of documentation including User Manuals, Validation Reports and Algorithms Theoretical Baseline Document.

Available documentation

- Product User Manuals
- Algorithm Theoretical Basis Documents
- Validation Reports

Karlsson, K.-G., et al., CLARA-A3: The third edition of the AVHRR-based CM SAF climate data record on clouds, radiation and surface albedo covering the period 1979 to 2023 *in preparation for ESSD, 2023*

CLARA-A3

Satellite Input Data
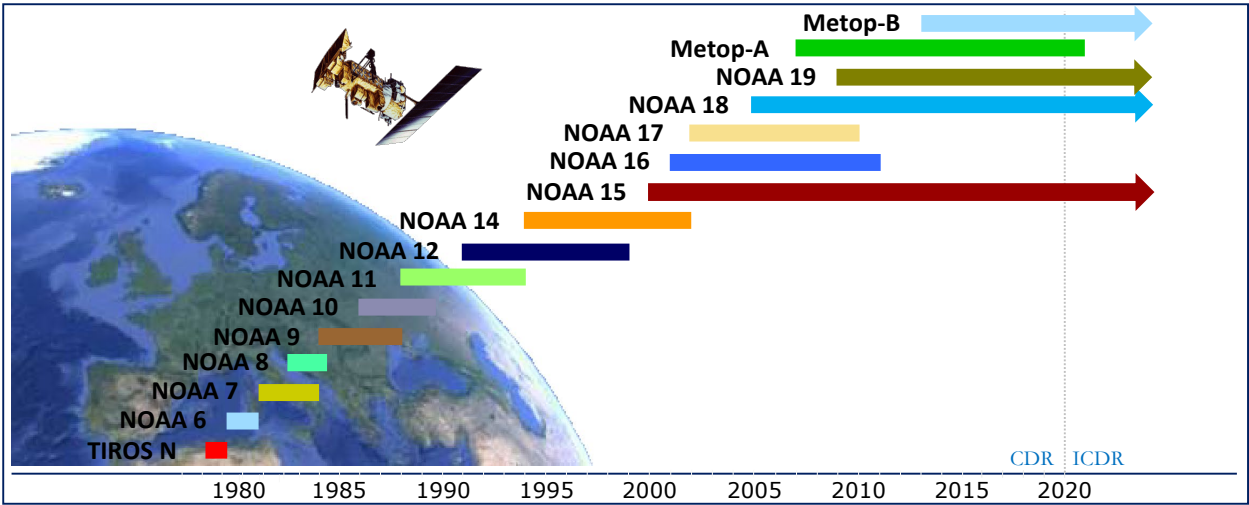
Temporal coverage of used AVHRR instruments aboard NOAA and Metop satellites.

Products

Fractional Cloud Cover	CFC	Surface Albedo (Black-,White-,Blue-sky)		SAL
Joint Cloud property Histogramm	JCH	Surface Incoming/Net Shortwave Radiation		SIS / SNS
Cloud Top Height, Temperature, Pressure	CTO	Surface Down /Net Longwave Radiation		SDL / SNL
Cloud Phase	CPH			
Liquid Wather Path[1,2]	LWP	Surface Radiation Budget		SRB
Ice Water Path[1]	IWP	ToA Reflected Shortwave Flux		SRF
		ToA Outgoing Longwave Radiation		OLR

[1] includes optical thickness, effective radius
[2] includes geometrical thickness, cloud droplet number concentration

Technical Specifications

Time period:	1979/01 – present
Temporal resolution:	daily mean, pentad mean, monthly mean, monthly histograms (depending on product) + daily subsampled global cloud products
Spatial coverage:	global on a regular latitude/longitude grid (polar areas: equal area)
Spatial resolution:	0.25° x 0.25° for monthly and daily means, 1°x1° for JCH, 0.05° x 0.05° for daily subsampled products and 25 km x 25 km for polar areas
Data Format:	NetCDF 4, Climate and Forecast (CF) Metadata Convention v1.7

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ICDR AVHRR based on CLARA-A2.1

Link: https://wui.cmsaf.eu/safira/action/viewICDRDetails?acronym=CLARA_AVHRR_V002_ICDR

CM SAF ICDR AVHRR based on CLARA-A2.1 algorithms

ICDR AVHRR Cloud Fraction
Monthly Mean June 2020
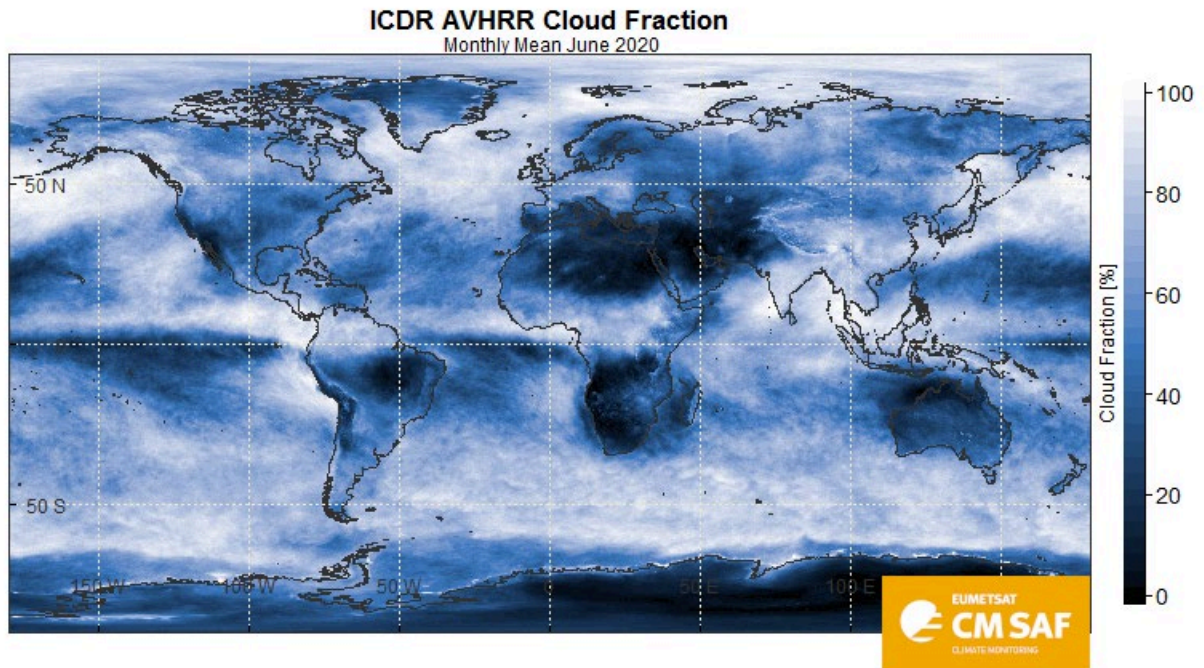
Overview

The AVHRR-based Interim Climate Data Record is a global data record of cloud, surface albedo and surface radiation products derived from measurements of the Advanced Very High Resolution Radiometer (AVHRR) onboard the polar orbiting NOAA and Metop satellites. The products are consistent continuations of the respective parameters from the well-established Thematic Climate Data Record CLARA-A2.1, which in combination are now able to support better climate monitoring applications. The products are available from January 2019 onwards with a timeliness of 5 days. The data are provided on two types of grids: one global regular latitude-longitude grid with 0.25° x 0.25° resolution and two equal-area grids covering the polar regions with (25 x 25) km² resolution (although products on the polar grids are restricted to cloud and surface albedo products). The cloud parameters and the surface incoming shortwave radiation are available as monthly and daily averages, while surface albedo is presented as monthly and pentad (5 day) averages.

Available documentation

- Product User Manuals
- Algorithm Theoretical Basis Documents
- Validation Reports

Reference documentation of underlying TCDR CLARA-A2.1

Karlsson, K.-G., Anttila, K., Trentmann, J., Stengel, M., Meirink, J. F., Devasthale, A., Hanschmann, T., Kothe, S., Jääskeläinen, E., Sedlar, J., Benas, N., van Zadelhoff, G.-J., Schlundt, C., Stein, D., Finkensieper, S., Håkansson, N., and Hollmann, R.: CLARA-A2: The second edition of the CM SAF cloud and radiation data record from 34 years of global AVHRR data, *Atmos. Chem. Phys.*, 17, 5809-5828, 2017.

ICDR AVHRR based on CLARA-A2.1

Link: https://wui.cmsaf.eu/safira/action/viewICDRDetails?acronym=CLARA_AVHRR_V002_ICDR

Satellite Input Data
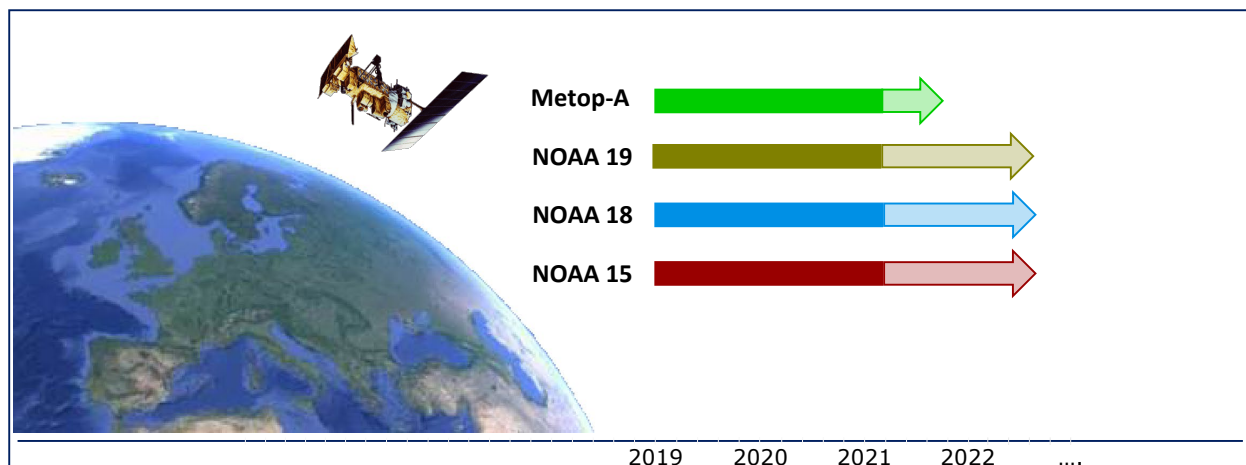
Temporal coverage of used AVHRR instruments aboard NOAA and Metop satellites.

Products

Product Name	Acronym
Fractional Cloud Cover	CFC
Cloud Top Height, Temperature, Pressure	CTO
Cloud Phase	CPH
Liquid Water Path	LWP
Ice Water Path	IWP

Product Name	Acronym
Surface Albedo	SAL
Surface Incoming Shortwave Radiation	SIS

Technical Specifications

Time period:	2019/01 - ongoing
Temporal resolution:	daily mean, pentad mean, monthly mean (depending on product)
Spatial coverage:	global on a regular latitude/longitude grid (polar areas: equal area)
Spatial resolution:	0.25° x 0.25° for global products
	25 km x 25 km for polar areas
Data Format:	NetCDF 4, Climate and Forecast (CF) Metadata Convention v1.6

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![EUMETSAT CM SAF CLIMATE MONITORING]

ATOVS tropospheric humidity and temperature data set

Water vapour and temperature from ATOVS
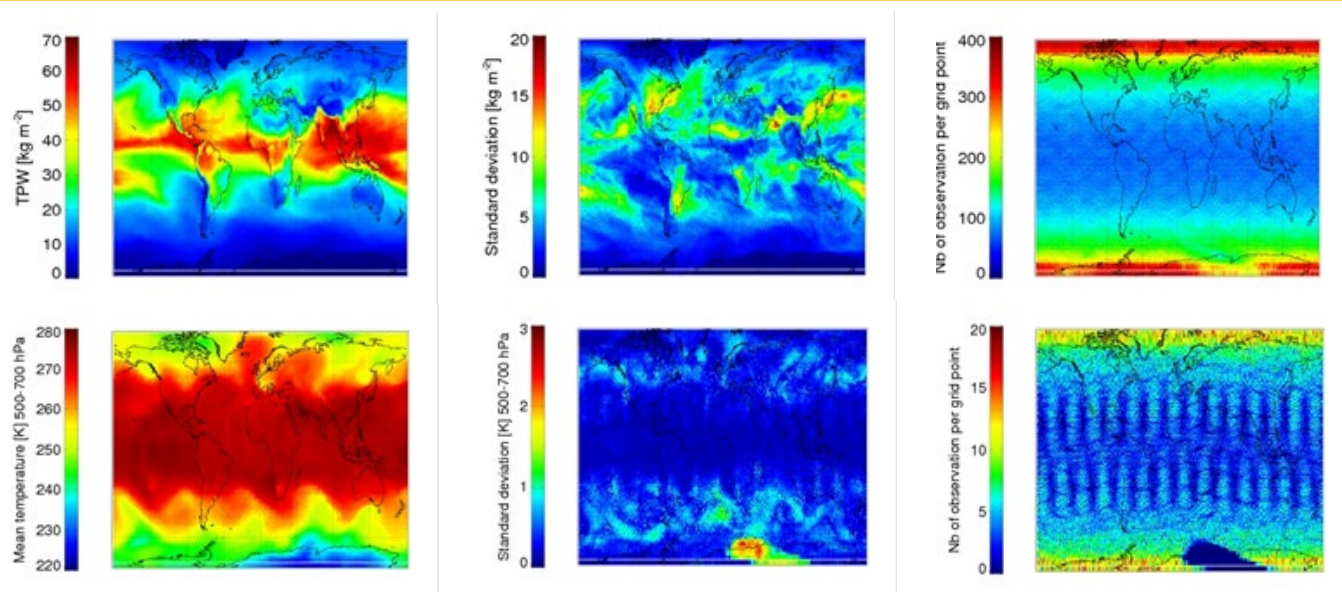
Example of ATOVS products: monthly averaged TPW for September 2007 (upper panels) and daily averaged temperature for the 27th of September 2007 (lower panels)

Overview

The CM SAF ATOVS tropospheric humidity and temperature data set provides global water vapour and kriging temperature products as well as kriging errror (for the daily means products), extra daily standard deviation (for the monthly products) and number of observation per grid point (see above). The products are available as daily and monthly means on a cylindrical equal area projection of 90km×90km. The temporal coverage of the data set ranges from 1st of January 1999 to the 31st of December 2011. The products are derived from measurements of the ATOVS instruments (HIRS, AMSU-A and -B, MHS) flying onboard the polar orbiting NOAA and Metop satellites, the International ATOVS Processing Package (IAPP, Li et.al., 2000) is used to carry out the inversion.

The products were evaluated against reference radiosonde data (GUAN (GCOS Upper-Air Network)), and other satellite observations with focus on AIRS (Atmospheric InfraRed Sounder). A comparison of the CM SAF ATOVS tropospheric humidity and temperature data set with the CM SAF ATOVS operational products was also performed.

Available documentation

- Product User Manual
- Algorithm Theoretical Basis Document
- Validation Report

Li, J., Wolf, W. W., Menzel, W. P., Zhang, W., Huang, H.-L., and Achtor, T. H.: Global soundings of the atmosphere from ATOVS measurements: the algorithm and validation, J. Appl. Meteorol., 39, 1248-1268, 2000.

Courcoux, N. and Schröder, M.: The CM SAF ATOVS tropospheric humidity and temperature data set, in preparation.

ATOVS tropospheric humidity and temperature data set

DOI:10.5676/EUM_SAF_CM/WVT_ATOVS/V001

Satellite Input Data

NOAA-15	
NOAA-16	
NOAA-17	
NOAA-18	
METOP-A	
NOAA-19	

1995   2000   2005   2010
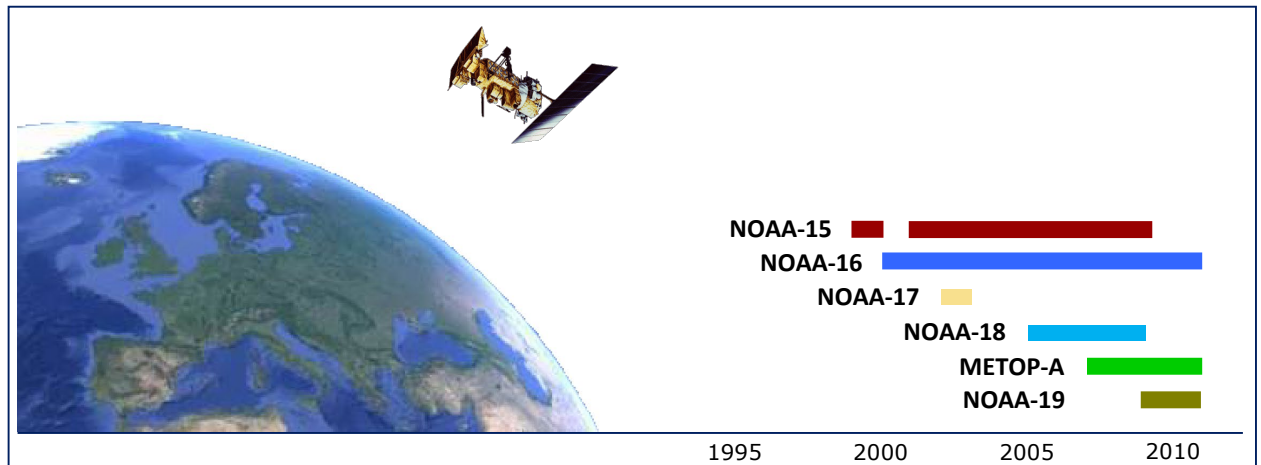
Products

Vertically integrated water vapour	HTW
Layered water vapour and temperature (5 layers)	HLW
Specific humidity and temperature at pressure levels (6 pressure levels)	HSH

HLW layer	1	2	3	4	5	-
Pressure [hPa]	300-200	500-300	700-500	850-700	Surface-850	-
HSH level	1	2	3	4	5	6
Pressure [hPa]	200	300	500	700	850	1000

Technical Specifications

Time period: 1999 – 2011
Temporal resolution: daily mean, monthly mean

Spatial coverage: global cylindrical equal area projection
Spatial resolution: 90km x 90km

Data Format: NetCDF 3, Climate and Forecast (CF) Metadata Convention v1.5

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MS

SEVIRI cloud properties:
CLAAS-3 data record

DOI:10.5676/EUM_SAF_CM/CLAAS/V003

CM SAF CLoud property dAtAset using SEVIRI (CLAAS), edition 3
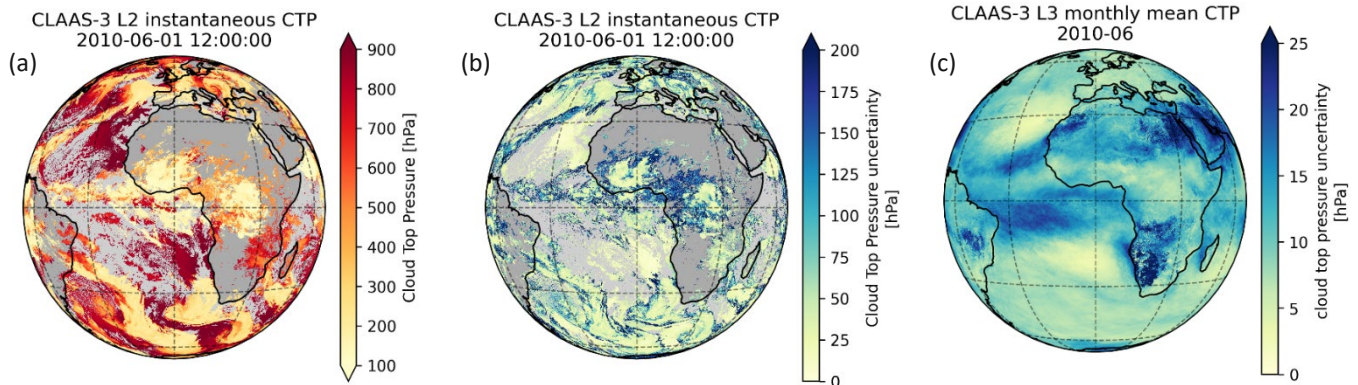
Example figures for CLAAS-3: (a) pixel-based (level-2) cloud-top pressure, (b) pixel-based cloud-top pressure uncertainty, and (c) monthly mean cloud top pressure uncertainty.

Overview

The CLAAS-3 record provides cloud properties derived from the SEVIRI sensor onboard MSG satellites. CLAAS-3 is the latest edition of CLAAS with previous editions documented in Stengel et al. (2014) and Benas et al. (2017). CLAAS-3 includes: cloud mask/type, cloud top temperature/pressure/height, cloud thermodynamic phase, cloud optical thickness, cloud particle effective radius and cloud water path. Additionally, cloud droplet number concentration and cloud geometrical thickness are provided for liquid clouds. All data are available as level-2 (native SEVIRI resolution, i.e. 15 minutes repeat cycle and 3 km (nadir) spatial resolution) and level-3 (daily averages, monthly averages and monthly histograms on a 0.05° x 0.05° grid, as well as monthly mean diurnal cycles and joint cloud optical thickness – cloud top pressure histograms on a 0.25° x 0.25° grid). CLAAS-3 covers the time period 2004/01 until 2020/12 as climate data record (CDR), but is operationally extended as interim climate data record (ICDR) to the present with a latency of 10 days. New key features of CLAAS-3 are: 1) The ICDR contains the same (full) product portfolio as the CDR, 2) Improvements for cloud detection with provision of a cloud probability, 3) Improvements for vertical placement of clouds, 4) New cloud effective radius products using the 3.9 µm in addition to the 1.6 µm channel, 5) New cloud droplet number concentration and geometrical thickness products for liquid clouds, and 6) Full uncertainty portfolio for all level-2 and level-3 products. With CLAAS-3, cloud processes at various spatial and temporal scales can be studied. Furthermore, due to its increasing record length (19 years and growing), CLAAS-3 becomes a suitable source for climate monitoring applications.
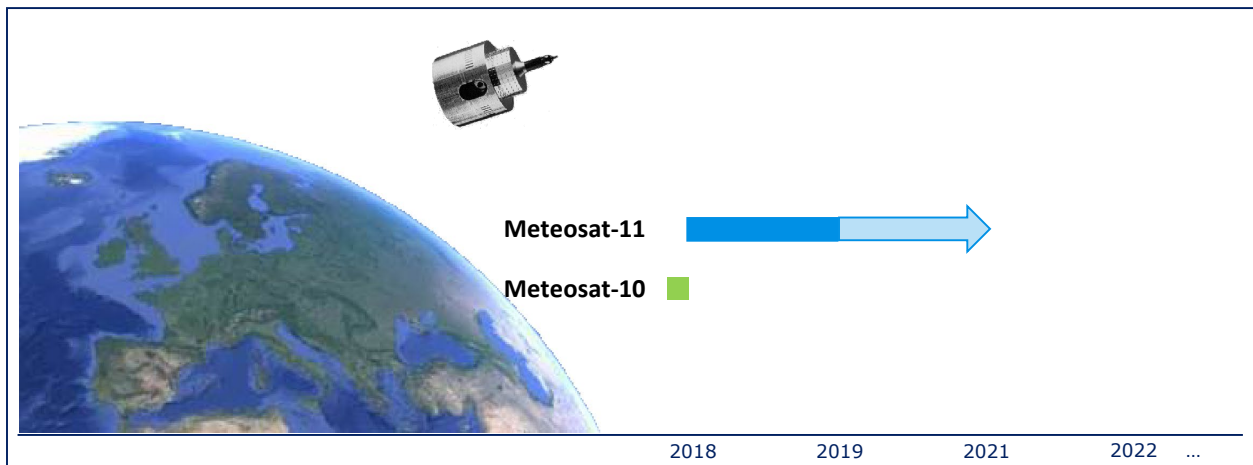
Available documentation

- Product User Manual
- Algorithm Theoretical Basis Document
- Validation Report

Benas, N., Finkensieper, S., Stengel, M., van Zadelhoff, G.-J., Hanschmann, T., Hollmann, R., and Meirink, J. F.: The MSG-SEVIRI-based cloud property data record CLAAS-2, Earth Syst. Sci. Data, 9, 415-434, https://doi.org/10.5194/essd-9-415-2017, 2017

Stengel, M., Kniffka, A., Meirink, J. F., Lockhoff, M., Tan, J., and Hollmann, R.: CLAAS: the CM SAF cloud property data set using SEVIRI, Atmos. Chem. Phys., 14, 4297-4311, doi:10.5194/acp-14-4297-2014, 2014.

SEVIRI cloud properties: CLAAS-3 data record

DOI:10.5676/EUM_SAF_CM/CLAAS/V003

Satellite Input Data

Meteosat-11
Meteosat-10
Meteosat-9
Meteosat-8

2000   2005   2010   2015   2020
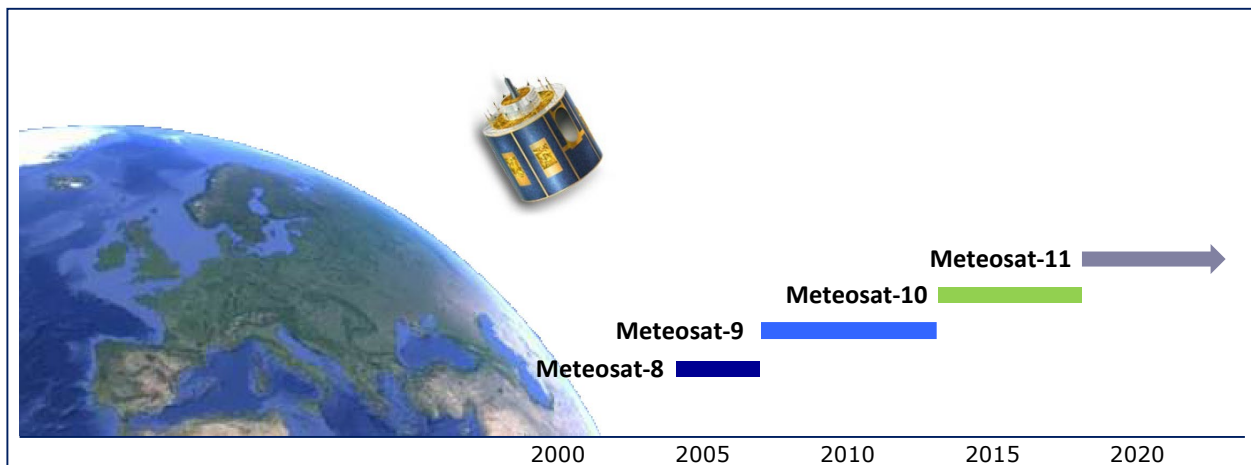
Products

	Abbreviation	Daily mean	Monthly mean	Monthly mean diurnal cycle	Monthly histograms
Cloud mask / Fractional Cloud Cover	CMA / CFC	✓ day/night high/mid/low	✓ day/night high/mid/low	✓	-
Clout Top Pressure, Height, Temperature	CTO	✓ day/night liquid/ice	✓ day/night liquid/ice	✓	✓ liquid/ice
Cloud Phase	CPH	✓ day/day+night	✓ day/day+night	✓	-
Liquid Water Path	LWP (+tau, r_e, cdnc, cgt)	✓	✓	✓	✓
Ice Water Path	IWP (+tau, r_e)	✓	✓	✓	✓
Joint Cloud property Histogram	JCH	-	-	-	✓ liquid/ice

tau: Cloud Optical Thickness, r_e: Cloud Effective Radius, cdnc: Cloud Droplet Number Concentration, cgt: Cloud Geometrical Thickness

Technical Specifications

Time period: 01.01.2004 - present
Temporal resolution: Pixel-based products (15 minutes) , daily and monthly mean (DM and MM),
                        monthly mean diurnal cycle (MMDC), monthly histograms (MH)
Spatial coverage: Meteosat disk
Spatial resolution: approx. 4km, native SEVIRI resolution (pixel-based products),
                        0.05° x 0.05° latitude-longitude grid (DM, MM, MH),
                        0.25° x 0.25° latitude-longitude grid (MMDC)
Data Format: NetCDF 4, Climate and Forecast (CF) Metadata Convention v1.7

Free Data Access & User Help Desk

www.cmsaf.eu/wui   **contact.cmsaf@dwd.de**

MSt

ICDR SEVRI Clouds based on CLAAS-2 methods

| (a) Cloud Fraction | (b) Cloud Top Pressure | (c) Cloud Top Temperature |
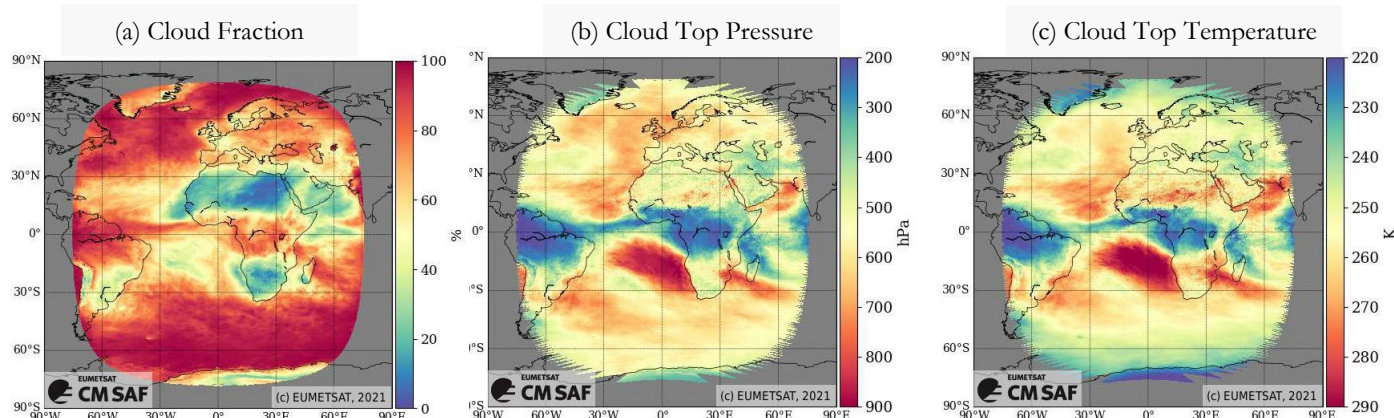
Example figures for ICDR SEVIRI clouds: monthly mean of (a) fractional cloud cover (CFC), and (b) cloud top pressure and (c) cloud top temperature, which are part of the CTO product, in April 2021

Overview

The Interim Climate Data Record (ICDR) SEVIRI Clouds provides cloud properties derived from the SEVIRI sensor onboard METEOSAT second generation (MSG) satellites. The products are based on the same algorithms as the second edition of the CM SAF CLoud property dAtAset Using SEVIRI (CLAAS-2, DOI: 10.5676/EUM_SAF_CM/CLAAS/V002; Benas et al. (2017)). It includes the products Cloud Fractional Cover (CFC) and Cloud Top Temperature/Pressure/Height (CTO). The ICDR SEVIRI Clouds features daily and monthly CFC and CTO averages aggregated on a regular 0.05° x 0.05° latitude/longitude grid. Monthly mean diurnal cycles on a 0.25° x 0.25° latitude/longitude grid are included as well. Although the algorithms used for the ICDR SEVIRI Clouds are identical to the ones used for CLAAS-2, some input data and intercalibration procedures had to be changed to facilitate a routine operation. Furthermore, a critical bug affecting monthly mean cloud top parameters in CLAAS-2 has been fixed for the ICDR SEVIRI Clouds.
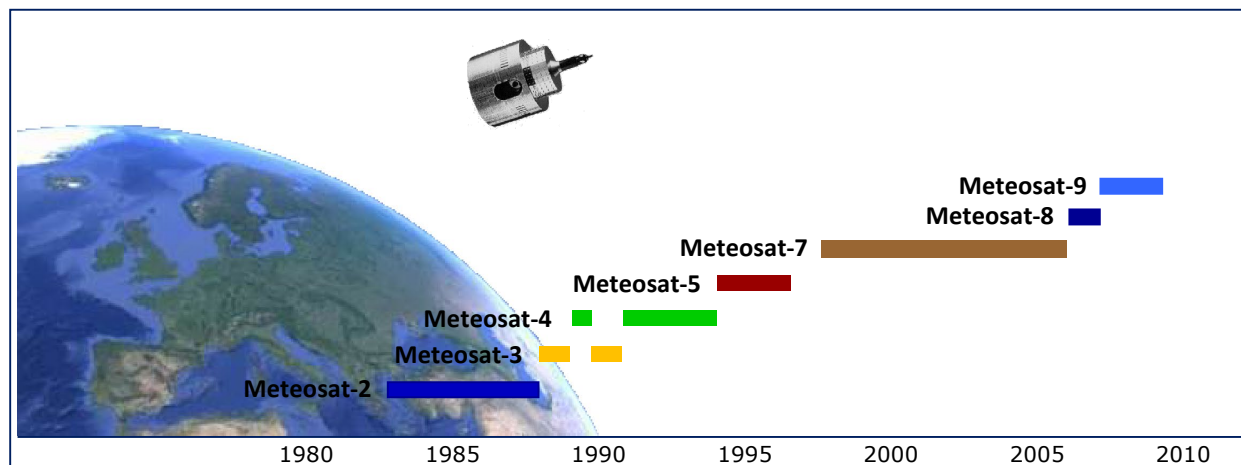
Available documentation

- Product User Manual
- Algorithm Theoretical Basis Document
- Validation Report

Benas, N., Finkensieper, S., Stengel, M., van Zadelhoff, G.-J., Hanschmann, T., Hollmann, R., and Meirink, J. F.: The MSG-SEVIRI-based cloud property data record CLAAS-2, Earth Syst. Sci. Data, 9, 415-434, https://doi.org/10.5194/essd-9-415-2017, 2017

ICDR SEVIRI Clouds
based on CLAAS-2 methods

Link: https://wui.cmsaf.eu/safira/action/viewICDRDetails?acronym=CLAAS_V002_ICDR

Satellite Input Data

Meteosat-11

Meteosat-10

2018   2019   2021   2022   ...

Products

Product name	Abbreviation	Daily mean	Monthly mean	Monthly mean diurnal cycle
Fractional Cloud Cover	CFC	✓ day/night high/mid/low	✓ day/night high/mid/low	✓
Clout Top Pressure, Height, Temperature	CTO	✓	✓	✓

Technical Specifications

Time period: 2018/01 - ongoing
Temporal resolution: daily and monthly mean (DM and MM),
Spatial coverage: Meteosat disk
Spatial resolution: 0.05° x 0.05° latitude-longitude grid (DM, MM),
                        0.25° x 0.25° latitude-longitude grid (MMDC)
Data Format: NetCDF 4, Climate and Forecast (CF) Metadata Convention v1.6

All products are available via the CM SAF Web User Interface (WUI).
The monthly mean CFC products is additionally available via EUMETSAT's EUMETCast service.

Free Data Access & User Help Desk

www.cmsaf.eu/wui   **contact.cmsaf@dwd.de**

MSt

Surface Daylight Radiation

Mean Daylight Radiation, CM SAF, 1983-2011
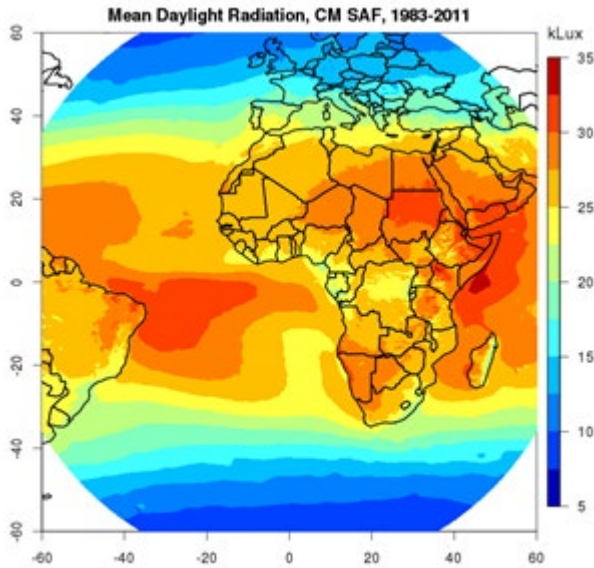
The figure shows the average (1983 – 2011) of the surface daylight derived from the geostationary Meteosat satellites.

The values are given in kLux

Overview

The CM SAF Daylight Data Set is a satellite-based climatology of the surface daylight derived from satellite-observations from the visible channel of the MVIRI and the SEVIRI instruments onboard the geostationary Meteosat satellites. The data are available from 1983 to 2011 and cover the region ±65° longitude and ±65° latitude. The products are available as monthly and daily averages on a regular latitude/longitude grid with a spatial resolution of 0.05° x 0.05° degrees.

Available documentation

- Product User Manual
- Algorithm Theoretical Basis Document
- Validation Report

R. Posselt, R. W. Müller, R. Stöckli, and J. Trentmann: Remote sensing of solar surface radiation for climate monitoring – the CM-SAF retrieval in international comparison. Remote Sens. Environ., 118:186–198, 2012. doi: 10.1016/j.rse.2011.11.016.

Surface Daylight Radiation

Satellite Input Data

Meteosat-9
Meteosat-8
Meteosat-7
Meteosat-6
Meteosat-5
Meteosat-4
Meteosat-3
Meteosat-2

1980   1985   1990   1995   2000   2005   2010
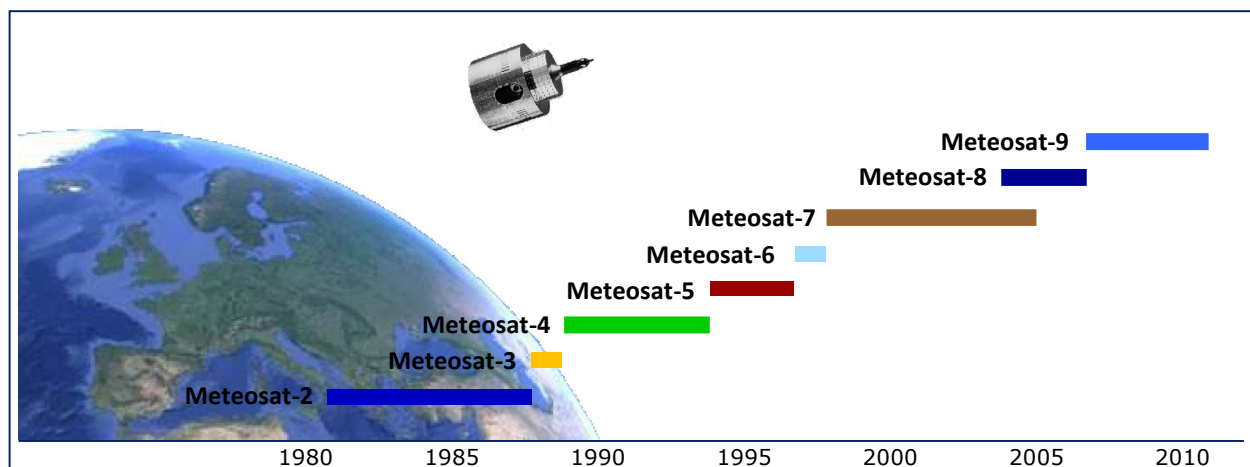
Products

Surface daylight radiation	DAL

Technical Specifications

Time period:	01.01.1983 – 31.12.2011
Temporal resolution:	monthly mean, daily mean
Spatial coverage:	Meteosat disk up to a scanning angle of 70 degree
Spatial resolution:	0.05° × 0.05°
Data Format:	NetCDF 3, Climate and Forecast (CF) Metadata Convention v1.5

Free Data Access & User Help Desk

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CM SAF MVIRI+SEVIRI free tropospheric humidity dataset, edition 1
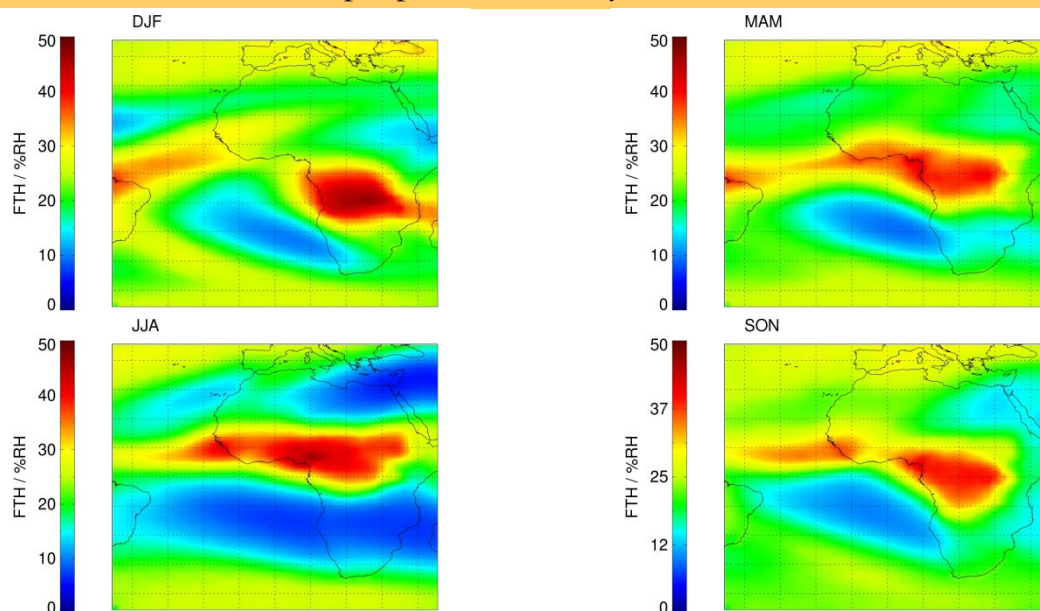
FTH seasonal averages: December-January-February (DJF, top left), March-April-May (MAM, top right), June-July-August (JJA, bottom left) and September-October-November (SON, bottom right). The period considered is 1984–2009 (adapted from Schröder et al., 2014).

Overview

The CM SAF Free Tropospheric Humidity (FTH) dataset from METEOSAT2-5 and METEOSAT7-9 provides the mean relative humidity over a deep layer of the troposphere within ±45° longitude and ±45° latitude. The retrieval was developed at Centre National de la Recherche Scientifique (CNRS) and - after transfer to CM SAF - CM SAF and CNRS jointly extended the time series into the SEVIRI era. The product is defined under clear sky and low level cloud conditions and is available at 3-hourly temporal resolution and as monthly averages (straightforward averages over all valid observations) on a regular latitude/longitude grid with a spatial resolution of 0.625° × 0.625°. The temporal coverage of the data set ranges from July 1983 to December 2009. The METEOSAT6 period, March 1997-May 1998, is not covered. The FTH layer position and thickness depends on atmospheric condition, in particular on water vapour content in the free troposphere. The clear sky radiance is provided as auxiliary information layer.

The dataset is complemented with a comprehensive documentation of the algorithms used and the generation of the dataset. Validation studies and user guidance are available as well. Its value for the analysis of variability and trends has been demonstrated in Schröder et al. (2014). Other potential application areas are (regional) climate model evaluation and (dynamical) process studies on various space and time scales.

Available documentation

- Product User Manual
- Algorithm Theoretical Basis Document
- Validation Report

Schröder, M., R. Roca, L. Picon, A. Kniffka, H. Brogniez, 2014: Climatology of free tropospheric humidity: extension into the SEVIRI era, evaluation and exemplary analysis. Atmos. Chem. Phys., 14, 11129-11148, doi:10.5194/acp-14-11129-2014.

MVIRI+SEVIRI free tropospheric humidity (FTH) dataset

DOI:10.5676/EUM_SAF_CM/FTH_METEOSAT/V001

Satellite Input Data

Meteosat-9
Meteosat-8
Meteosat-7
Meteosat-5
Meteosat-4
Meteosat-3
Meteosat-2

1980 1985 1990 1995 2000 2005 2010

Product

Free tropospheric humidity	FTH

Technical Specifications

Time period:	01.07.1983 - 31.12.2009
Temporal resolution:	3 hourly
Spatial coverage:	within 45°N/S and 45°E/W
Spatial resolution:	0.625° × 0.625°, regular longitude/latitude grid
Data Format:	netCDF3, Climate and Forecast (CF) Metadata Convention v1.5

Free Data Access & User Help Desk

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TOA Reflected Solar and Emitted Thermal Radiation from MVIRI and SEVIRI

Climate Monitoring SAF Monthly Mean TOA Fluxes for June 2005
TOA Reflected Solar — TOA Emitted Thermal
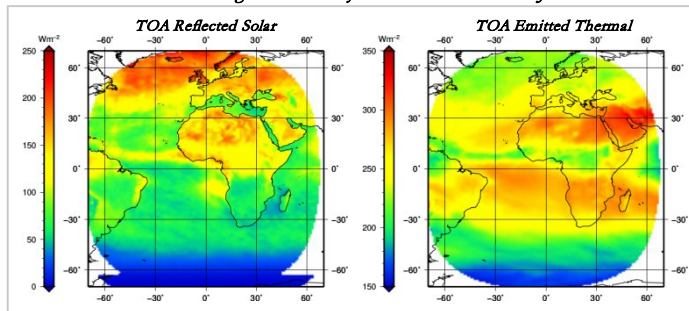
Climate Monitoring SAF Daily Mean TOA Fluxes for 1 June 2005
TOA Reflected Solar — TOA Emitted Thermal
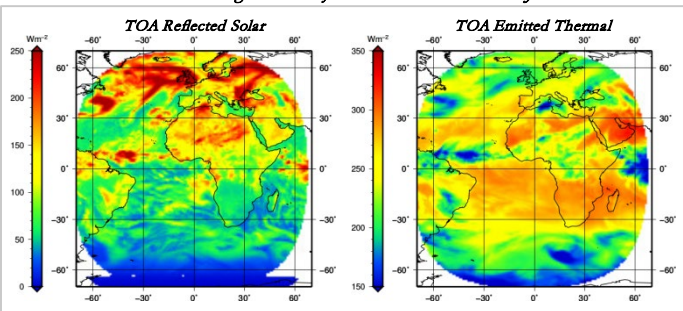
CM SAF Monthly Mean Diurnal Cycle TOA Fluxes, [12-13] UTC, for June 2005
TOA Reflected Solar — TOA Emitted Thermal
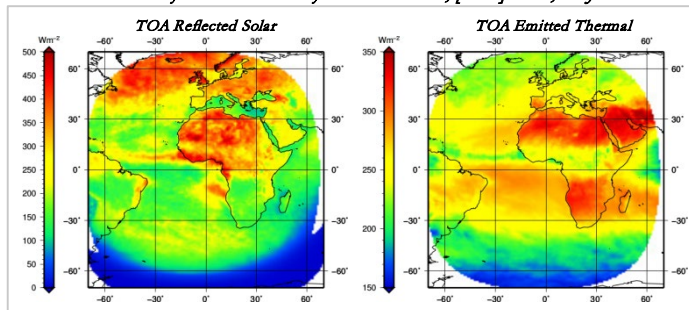
Illustrations of the monthly mean (top left), the daily mean (top right) and the monthly mean diurnal cycle (bottom left) products available in CM SAF based on the reflected solar and emitted thermal fluxes provided by the MVIRI and SEVIRI instruments on the METEOSAT First and Second Generation satellites.

Overview

The CM SAF Top of Atmosphere Radiation MVIRI/SEVIRI Data Record provides an homogeneous satellite-based climatology of the TOA Reflected Solar (TRS) and Emitted Thermal (TET) radiation in all-sky conditions. The continuous monitoring of these components of the Earth Radiation Budget is of prime importance to study climate variability and change. The MVIRI and SEVIRI instruments on board the METEOSAT First and Second Generation satellites are combined to generate a long Thematic Climate Data Record covering a period of time of 32 years, from 1 February 1983 to 30 April 2015. The TOA radiation products are provided as daily mean, monthly mean and monthly averages of the hourly integrated values (diurnal cycle). The data is provided on a regular grid at a spatial resolution of 0.05 degrees and covers the region between ± 70° longitude and ± 70° latitude. In addition to covering a long time period, the MVIRI/SEVIRI data record is also featured by excellent spatial and temporal samplings.

Available documentation

All products are thoroughly reviewed by international experts and a comprehensive documentation is available, comprising:
• Product User Manual
• Algorithm Theoretical Basis Document
• Validation Report

M. Urbain, N. Clerbaux, A. Ipe, F. Tornow, R. Hollmann, E. Baudrez, A. Velazquez Blazquez, J. Moreels (2017): The CM SAF TOA Radiation Data Record Using MVIRI and SEVIRI, *Remote Sensing*, 9, 466.

F. Tornow, N. Clerbaux, A. Ipe, U. Manon (2017): An improved method to estimate reference cloud-free images for the visible band of geostationary satellites, *International Journal of Remote Sensing*, 38(23), 7220-7241, doi:10.1080/01431161.2017.1372859.

I. Decoster, N. Clerbaux, E. Baudrez, S. Dewitte, A. Ipe, S. Nevens, A. Velazquez-Blazquez, J. Cornelis (2014): Spectral Aging Model Applied to Meteosat First Generation Visible Band, *Remote Sens.*, 6, 2534-2571.

Top of Atmosphere Radiation
MVIRI/SEVIRI Data Record

Satellite Input Data

Meteosat-10
Meteosat-9
Meteosat-8
Meteosat-7
Meteosat-6
Meteosat-5
Meteosat -4
Meteosat-3
Meteosat-2

1980   1985   1990   1995   2000   2005   2010   2015
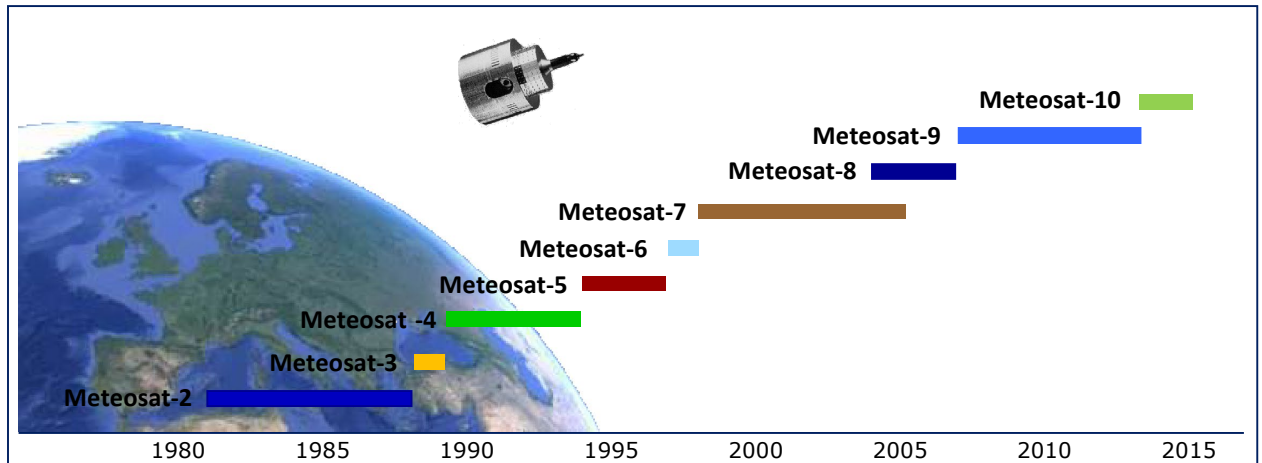
Product

TOA Reflected Solar radiation (including TOA Incoming Solar radiation)	TRS
TOA Emitted Thermal radiation	TET

Technical Specifications

|	
Time period:	01.02.1983 - 30.04.2015
Temporal resolution:	monthly mean, daily mean, monthly mean diurnal cycle (1-hourly)
Spatial coverage:	within 70°N/S and 70°E/W
Spatial resolution:	0.05° × 0.05°, regular longitude/latitude grid
Data Format:	NetCDF 4, Climate and Forecast (CF) Metadata Convention v1.6

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The CM SAF FCDR of SMMR/SSMI/SSMIS Brightness Temperatures
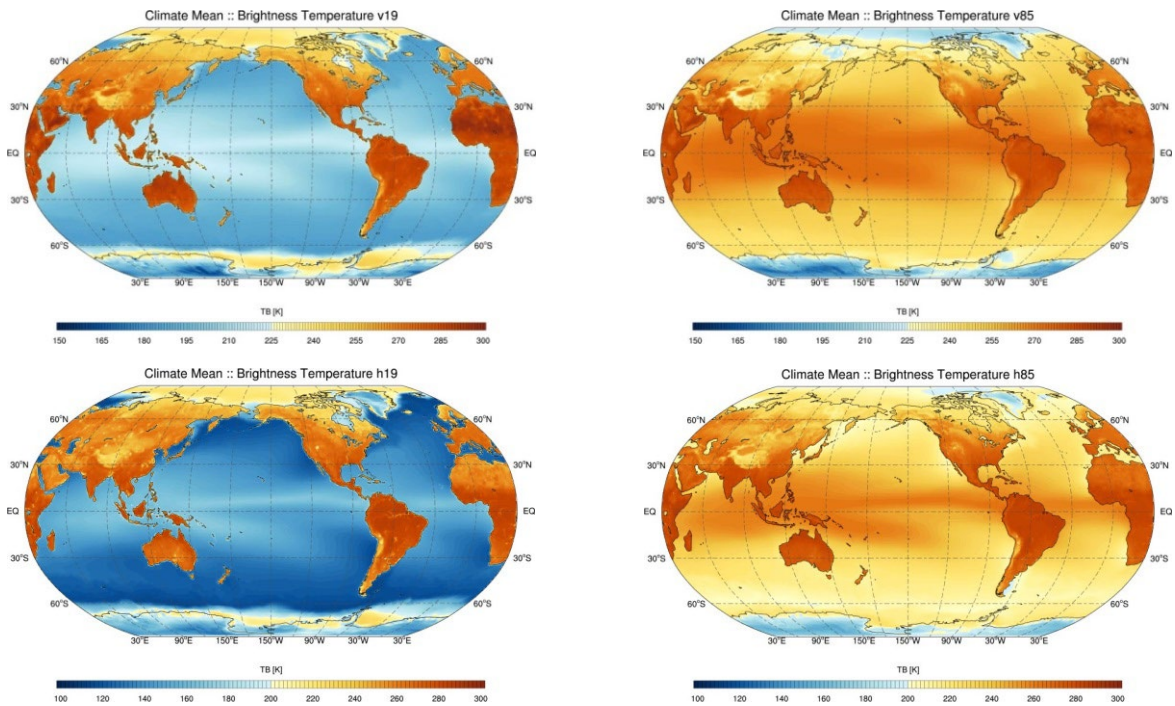
Climatological means of brightness temperatures from 19 GHz (left) and 85 GHz (right), based SSM/I and SSMIS data.

Overview

The CM SAF FCDR of SMMR, SSM/I and SSMIS brightness temperatures (BTRs) covers the time period from October 1978 to December 2023 including all available data from the SMMR radiometer aboard Nimbus-7, the SSM/I radiometers aboard F08, F10, F11, F13, F14, and F15 and the SSMIS radiometers aboard F16, F17, and F18. It provides homogenised and inter-calibrated BTRs in a user-friendly data format. SMMR, SSM/I and SSMIS data are used for a variety of applications, such as analyses of the hydrological cycle and remote sensing of sea ice. The improved homogenization and inter-calibration procedure ensure the long term stability of the FCDR for climate related applications. All available raw data records have been reprocessed to a common standard, starting with the calibration of the raw Earth counts, to ensure a completely homogenized data record. The data processing accounts for several known issues with the instruments and corrects calibration anomalies due to along-scan inhomogeneity, moonlight intrusions, sunlight intrusions, and emissive reflector. Corrections for SMMR are limited because the SMMR raw data was not available. Furthermore, the inter-calibration model incorporates a scene dependent inter satellite bias correction and a non-linearity correction to the instrument calibration. The data files contain all available original sensor data (SMMR: Pathfinder Level 1b) and metadata to provide a completely traceable climate data record. Inter-calibration and Earth incidence angle normalization offsets are available as additional layers within the data files in order to keep this information transparent to the users. The data record is complemented with radiometer sensitivities, quality flags, surface types, and Earth incidence angles.

Available documentation

- Product User Manual
- Algorithm Theoretical Basis Document
- Validation Report

Fundamental Climate Data Record (FCDR) of Microwave Imager Radiances, Edition 4

Satellite Input Data
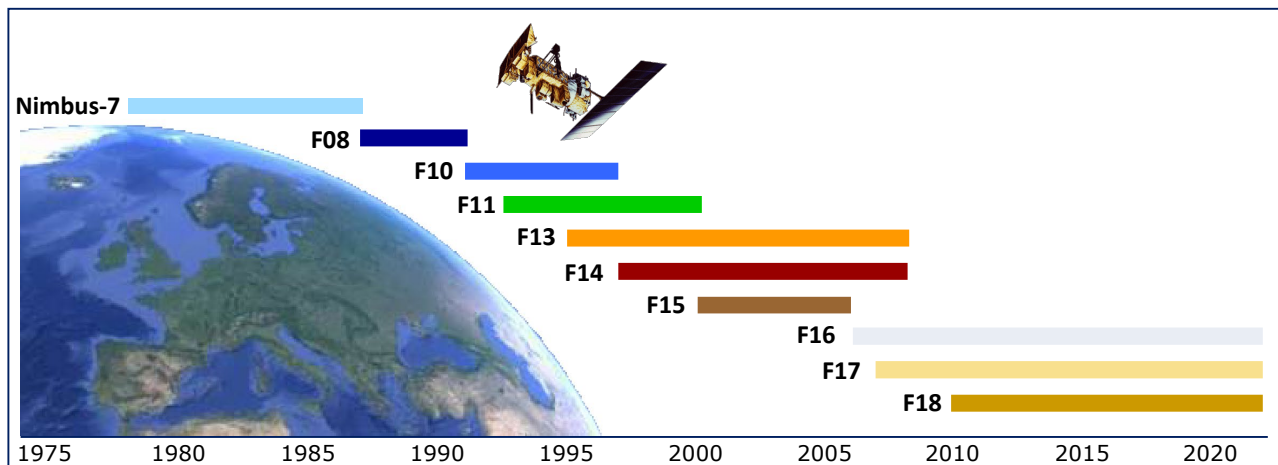
Temporal coverage of SMMR, SSM/I and SSMIS instrument aboard Nimbus-7 and DMSP satellite platforms.

Products

Brightness Temperatures	BTR

Technical Specifications

Time period:	1978-10-25 – 2022-12-31
Temporal and Spatial Resolution:	Native SMMR, SSM/I & SSMIS
Spatial coverage:	global
Data Format:	NetCDF-4
	Climate and Forecast (CF) Metadata Convention v1.7

Free Data Access & User Help Desk

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Meteosat Land Surface Temperature Data Record SUMET

Meteosat Clear Sky Land Surface Temperature

SUMET Land Surface Temperature, CM SAF,1991- 2015 (K)
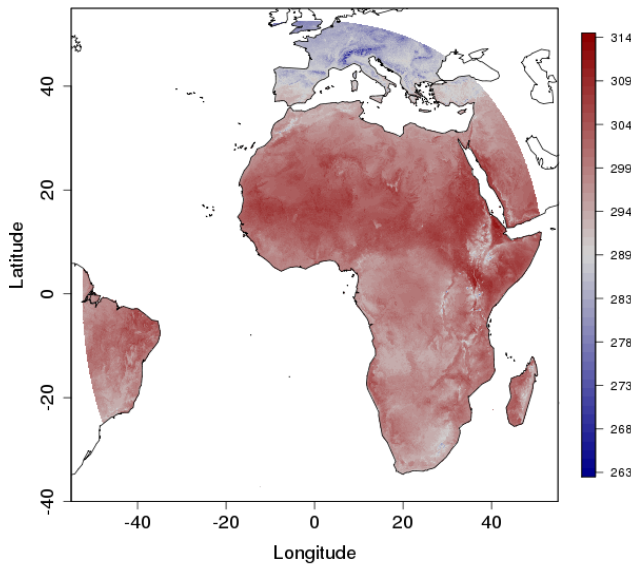
This figure shows the multi-yearly averages (1991-2015) of the clear sky land surface temperature derived from the SUMET climate data record.

Overview

The Land Surface Temperature Data Set (SUMET) is the first CM SAF Land Surface Temperature data record based on Meteosat satellites. SUMET provides climatological data of the clear sky land surface temperature derived from the thermal channel of the MVIRI and SEVIRI instruments onboard the geostationary Meteosat satellites. The data are available from 1991 to 2015 as hourly samples and as monthly diurnal cycle composites. It covers the region ±55° longitude and ±55° latitude on a 0.05° x 0.05° regular grid. This data record includes two different LST products: the Statistical Land Surface Temperature product is characterized by consistency with the operational Land Surface Analysis Satellite Applications Facility (LSA SAF) LST data, while the Physical LST product ensures the highest possible precision through the implicit use of radiative transfer models. The accuracy of the data has been determined against surface references measurements. Validations against ground measurements show that CM SAF land surface temperatures reach a 1 K overall accuracy and 2 K precision, except for very moist atmospheres, with a decadal stability < 0.5 K.

Available documentation

- Product User Manual
- Algorithm Theoretical Basis Document
- Validation Report

Duguay-Tetzlaff, A.; Bento, V.A.; Göttsche, F.M.; Stöckli, R.; Martins, J.P.A.; Trigo, I.; Olesen, F.; Bojanowski, J.S.; da Camara, C.; Kunz, H. Meteosat Land Surface Temperature Climate Data Record: Achievable Accuracy and Potential Uncertainties. Remote Sens. 2015, 7, 13139-13156.

Meteosat Land Surface Temperature Data Record SUMET

DOI: 10.5676/EUM_SAF_CM/LST_METEOSAT/V001

Satellite Input Data
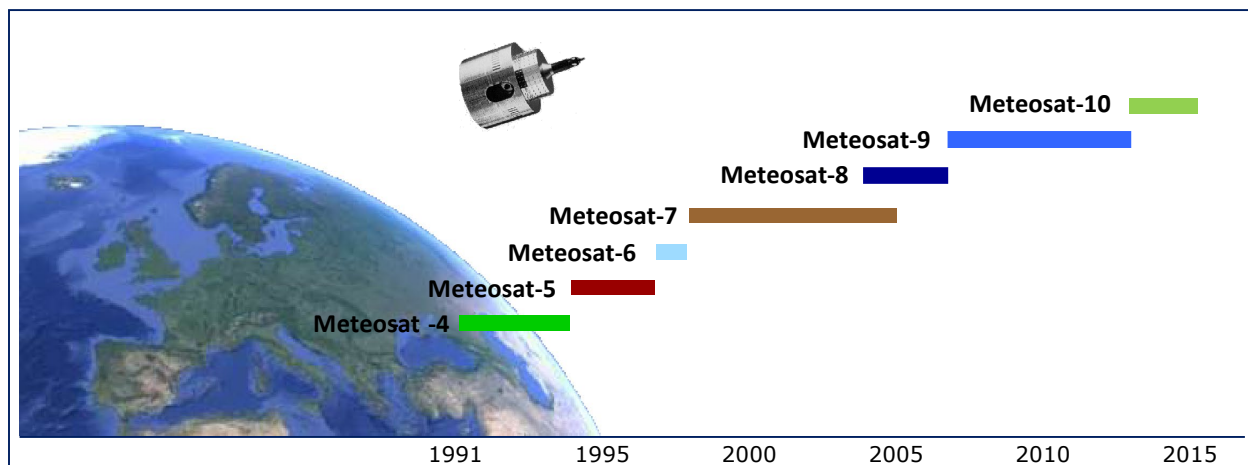
Product

Physical Land Surface Temperature - LTP	Clear sky land surface temperature retrieved from Meteosat using the physical land surface temperature retrieval scheme from the GEOSATCLIM v. 1.0 software package.
Statistical Land Surface Temperature - LTS	Clear sky land surface temperature retrieved from Meteosat using the statistical land surface temperature retrieval scheme from the GEOSATCLIM v. 1.0 software package.

Technical Specifications

Time period:	01.01.1991 – 31.12.2015
Temporal resolution:	instantaneous data every hour and monthly diurnal cycle composites
Spatial coverage:	Meteosat disk up to a scanning angle of 60 degree
Spatial resolution:	0.05° × 0.05° latitude and longitude grid
Data Format:	NetCDF 4, Climate and Forecast (CF) Metadata Convention v1.6

Free Data Access & User Help Desk

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AD-T

Meteosat Cloud Fractional Cover Data Record COMET

Meteosat Cloud Fractional Cover

COMET Cloud Fractional Cover, CM SAF, 1991-2015 (%)
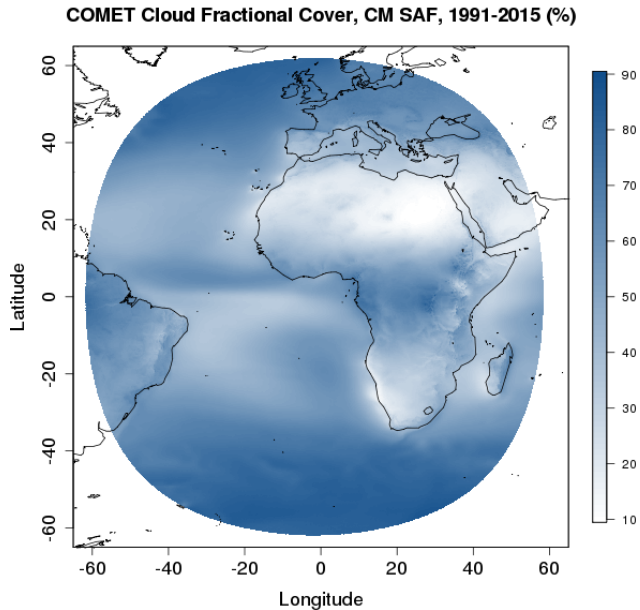
This figure shows the the multi-year averages (1991 – 2015) of the cloud fraction derived from the COMET climate data record.

Overview

The Meteosat Cloud Fractional Cover data record (COMET) provides long-term cloud fraction climate data dating back until 1991. It is derived from two Meteosat heritage channels of the MVIRI and SEVIRI instruments onboard the geostationary Meteosat satellites. The data are available from 1991 to 2015 as hourly, daily and monthly composites. It covers the region ±60° longitude and ±60° latitude on a 0.05° x 0.05° regular grid. COMET is characterized by comparability to the SYNOP-based long-term cloud fraction observations carried out at WMO ground stations. Validations against ground measurements show that COMET cloud fractions have an overall absolute bias of 5 % with an decadal stability of < 1%.

Available documentation

- Product User Manual
- Algorithm Theoretical Basis Document
- Validation Report

Stöckli, R.; Bojanowski, J.S.; John, V.O.; Duguay-Tetzlaff, A.; Bourgeois, Q.; Schulz, J.; Hollmann, R. Cloud Detection with Historical Geostationary Satellite Sensors for Climate Applications. Remote Sens. 2019, 11, 1052.

Meteosat Cloud Fractional Cover
Data Record COMET

Satellite Input Data

Meteosat-10
Meteosat-9
Meteosat-8
Meteosat-7
Meteosat-6
Meteosat-5
Meteosat -4

1991   1995   2000   2005   2010   2015
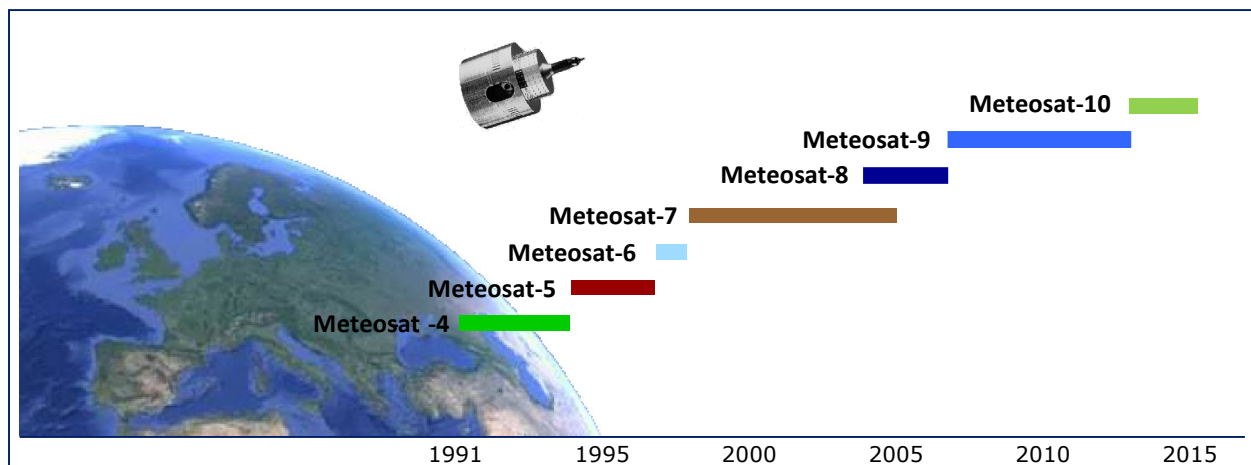
Product

Cloud Fractional Cover	Cloud fractional cover retrieved from Meteosat using the advanced Bayesian cloud fraction retrieval algorithm from the GEOSATCLIM v. 1.0 software package.

Technical Specifications

Time period:	01.01.1991 – 31.12.2015
Temporal resolution:	hourly, daily and monthly
Spatial coverage:	Meteosat disk up to a scanning angle of 65 degree
Spatial resolution:	0.05° × 0.05° latitude and longitude grid
Data Format:	NetCDF 4, Climate and Forecast (CF) Metadata Convention v1.6

Free Data Access & User Help Desk

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Aerosol Optical Depth from SEVIRI

Daily mean AOD for 22 March 2009

Monthly mean AOD for June 2004
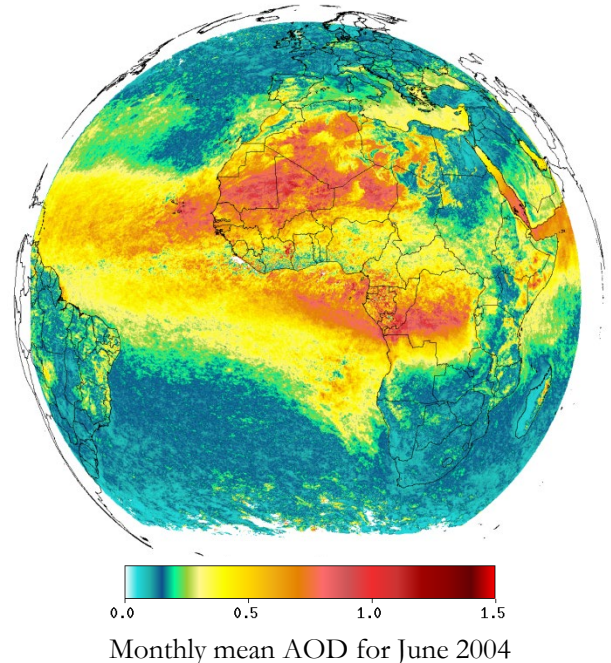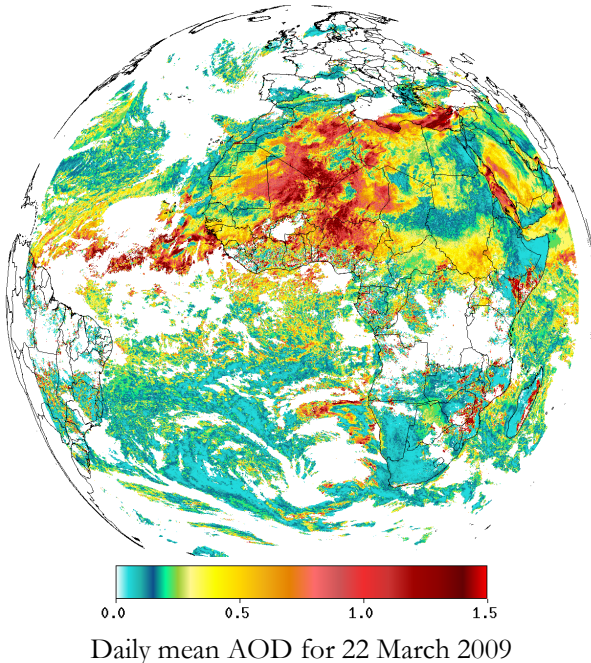
Overview

This climate data record provides daily and monthly estimates of the Aerosol Optical Depth (AOD) derived from the Spinning Enhanced Visible and InfraRed Imager (SEVIRI) sensors onboard the Meteosat Second Generation (MSG) satellites. Aerosols have many impacts on the climate on our planet: direct through the scattering and absorption of radiation, and also indirectly through the cloud nucleation and precipitation processes. Concerning the direct effect, the most relevant parameters for climate are the AOD and, to a lesser extent, the single scattering albedo. In the frame of climate monitoring, the continuous monitoring of those parameters is of prime importance to understand climate variability and change. Monitoring aerosols is also important as they have in general an adverse effect on the retrieval of many others geophysical parameters relevant for climate as, for instance, the surface albedo. The Land Daily Aerosol (LDA, Govaerts et al., 2010, Wagner et al., 2010) algorithm is used to process this Climate Data Record of AOD. The algorithm has been developed at EUMETSAT for AOD estimation, primarily for the MSG/SEVIRI instrument. The algorithm performs, on a daily basis and at full pixel scale, the inversion of the accumulated solar band observations (0.6µm, 0.8µm and 1.6µm) to estimate simultaneously the AOD (a single value at reference wavelength of 550nm) and the Rahman-Pinty-Verstraete parameters of the surface reflectance in the 3 bands. In addition, the optimization is also done over a set of different models of aerosol microphysics (single scattering albedo, phase function). The CM SAF CLAAS-2 cloud mask (DOI:10.5676/EUM_SAF_CM/CLAAS/V002) is used as additional input to perform the cloud screening.

Available documentation

All products are thoroughly reviewed by international experts and a comprehensive documentation is available, comprising i.a.:

• Product User Manual

• Algorithm Theoretical Basis Document

• Validation Report

SEVIRI Aerosol Optical Depth (AOD)
Data Record - Edition 1

Satellite Input Data
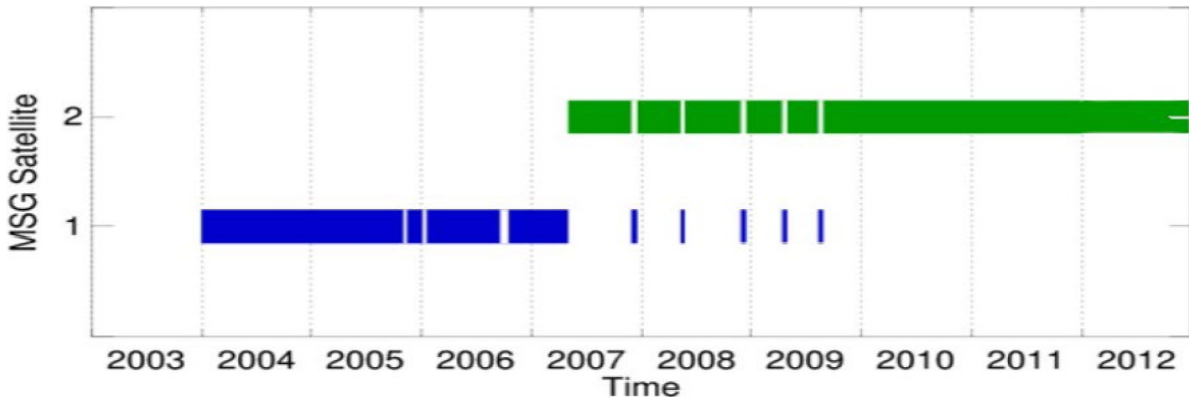
Product

AOD daily files	**aod** : the aerosol optical depth at 550nm
	aod_err : the associated uncertaincy
	class : the model of aerosol microphysic
	ancillary information on cloudiness (cloud frequency, distance to nearest clouds, …)
AOD monthly files	as in the daily files plus: **aod_stddev** : standard deviation of the daily aod during the month

Technical Specifications

Time period:	01.02.2004 - 31.12.2012
Temporal resolution:	daily mean, monthly mean
Spatial coverage:	within 60°N/S and 60°E/W (limited to a sensor viewing zenith angle of 70°)
Spatial resolution:	native SEVIRI pixels, i.e. 3km x 3km at sub-satellite point
Data Format:	NetCDF 4, Climate and Forecast (CF) Metadata Convention v1.6

References

Govaerts, Y. M., Wagner, S., Lattanzio, A., & Watts, P., 2010 : Joint retrieval of surface reflectance and aerosol optical depth from MSG/SEVIRI observations with an optimal estimation approach: 1. Theory. Jour. Geophys. Res. Atmos., 115(D2).

Wagner, S. C., Govaerts, Y. M., & Lattanzio, A., 2010: Joint retrieval of surface reflectance and aerosol optical depth from MSG/SEVIRI observations with an optimal estimation approach: 2. Implementation and evaluation. Jour. Geophys. Res. Atmos., 115(D2).

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Upper Tropospheric Humidity (UTH) data record
DOI: 10.5676/EUM_SAF_CM/UTH/V002

Upper Tropospheric Humidity from microwave sounders

Mean Upper Tropospheric Humidity — UTH (%)

Total Uncertainty — Uncertainty (%)

Mean RH — Mean RH (%)

Satellite UTH (%)
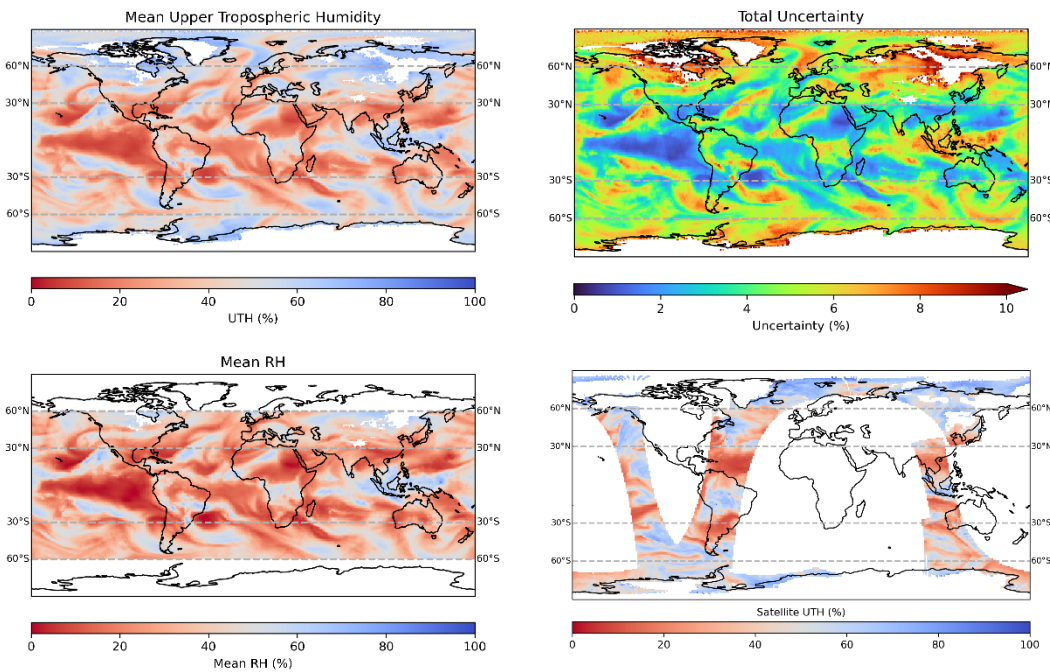
Example of the CM SAF UTH v2 product, showing the mean daily UTH (top left), mean daily mean_RH (bottom left) and the total uncertainty on the mean daily UTH (top right) for 1st December 2014.

Example of the CM SAF UTH v2 product, showing the hourly UTH for 1st January 2012 at 06:00 UTC (bottom right).

Overview

This CM SAF climate data record provides estimates of Upper Tropospheric Humidity (UTH). UTH contributes significantly to the atmospheric greenhouse effect by having a strong influence on the outgoing longwave radiation, despite the smaller concentration by mass in comparison to lower troposphere. The CM SAF UTH v2.0 data set is based on data from twelve passive MW sounders operating at 183 GHz in polar orbit that are combined into a single time series with hourly and daily time steps. Invalid observations affected by deep convective or precipitating clouds, and/or radiation emitted from the surface, together with any spurious observations from individual MW sounders, have been removed from the data set. The UTH provided typically represents a broad atmospheric layer between 500 and 200 hPa. However, the exact height of this layer depends on the atmospheric conditions at the time of the observation. An optional fixed layer approximation adjustment is supplied that users can apply to provide an estimated mean relative humidity (RH) between ±60° latitude for a fixed layer between 500 and 200 hPa (mean_RH). Uncertainty components that capture sources of independent (or random), structured (or locally correlated) and common (or systematic) errors in the data are also provided for each grid cell, together with an estimate of the spatial sampling uncertainty.

The CM SAF UTH has been validated against an equivalent UTH derived from ERA5 reanalysis.

Available documentation

- Product User Manual
- Algorithm Theoretical Basis Document
- Validation Report

Buehler, S. A. and V. O. John (2005), A Simple Method to Relate Microwave Radiances to Upper Tropospheric Humidity, J. Geophys. Res., 110, D02110, doi:10.1029/2004JD005111.

Upper Tropospheric Humidity (UTH) data record

DOI: 10.5676/EUM_SAF_CM/UTH/V002

Satellite Input Data

Schematic showing the passive microwave sounder data processed in the generation of the CM SAF UTH v2 product. „Bad" data has been excluded from the public version of the dataset as a result of data quality control processes.
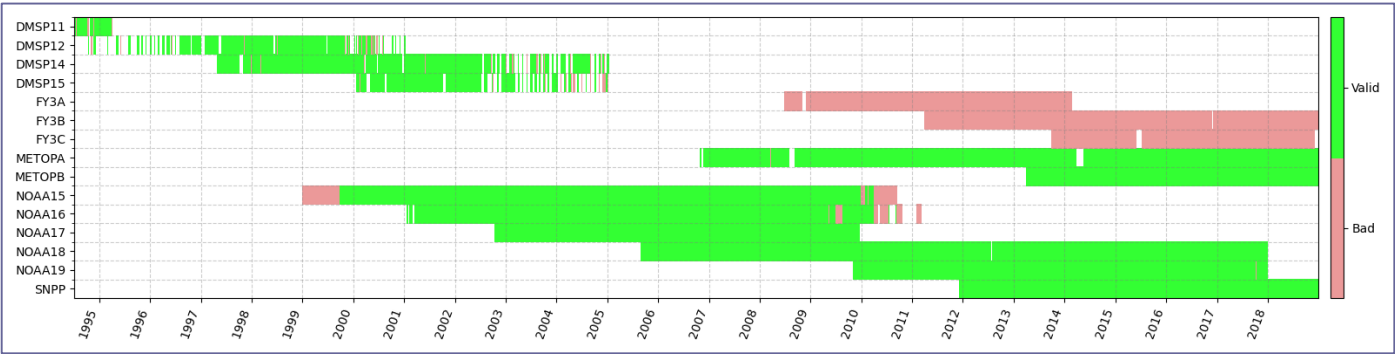
Products

Upper tropospheric humidity	UTH

Technical Specifications

Time period:	6 July 1994 to 31 December 2018
Temporal resolution:	hourly instantaneous* and daily mean observations**
Spatial coverage:	global on regular latitude/longitude grid
Spatial resolution:	1° x 1°
Data Format:	NetCDF 4, Climate and Forecast (CF) Metadata Convention version 1.9 and Attribute Convention for Dataset Discovery (ACDD) version 1.3

* The hourly product does not have observations at every hour for every grid cell and many grid cells in the time series may only have as few as one or two observations in any 24-hour period. However, for periods when multiple satellites are in operation, the majority of hourly time slots may be filled for some grid cells.

** Daily means are calculated from all available hourly observations for each grid cell with at least two filled hourly slots.

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DAPAGLOCO

Daily Precipitation Sum
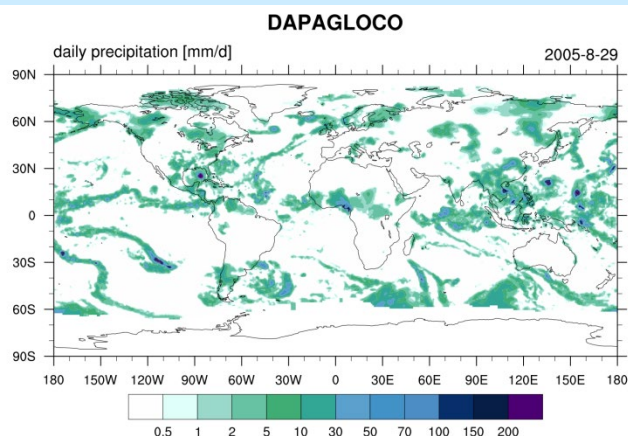
The figure shows an example for daily global precipitation sums in a spatial resolution of one degree combined from gauge data over land and accumulated rain rates over ocean retrieved from passive microwave imagers. Here, Hurricane Katrina can be seen clearly over the Gulf of Mexico.

Overview

This dataset contains global precipitation observations combined from satellite and rain gauge data over land and ocean, respectively. It spans the years 1988-2015 and has spatial resolution of 0.5°x0.5° (Europe), 1.0°×1.0° and 2.5°x2.5°. Satellite observations are based on SSM/I and SSMIS level 2 data from the HOAPS-4.0 dataset of EUMETSAT CM SAF. These data have been extended with observations from the TMI and AMSR-E microwave imagers. The basic retrieval is based on a neuronal network approach. The retrieval excludes sea-ice covered regions. Uncertainty estimations are given as standard deviation of pixel values in each grid cell. Precipitation observations over land are included from the GPCC Full Data Daily Version 2018. Relative precipitation anomalies at the stations are interpolated by means of ordinary block kriging. For these data, uncertainty information is included as well. On coastal edges, data gaps are interpolated. This dataset is recommended to be used for analyses of extreme events and related statistics at daily resolution as well as for verification and validation purposes of other precipitation products or climate models. This dataset is a successor of the HOAPS/GPCC global daily precipitation data record version 1.

This dataset has been created within the DAPAGLOCO project (Daily precipitation analysis for the validation of global medium-range climate predictions operationalized). The DAPAGLOCO project was part of the MiKlip project framework (Mittelfristige Klimaprognosen) and funded by the German Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung, BMBF).

Available documentation

- F. Dietzsch, A. Andersson, M. Ziese, M. Schröder, K. Raykova, K. Schamm, A. Becker (2017): A Global ETCCDI-Based Precipitation Climatology from Satellite and Rain Gauge Measurements. Climate, 5(1), 9. doi: 10.3390/cli5010009
- K. Graw, J. Kinzel, M. Schröder, K. Fennig, A. Andersson (2017): Algorithm Theoretical Basis Document HOAPS release 4.0. Technical Report (version 2.3). Satellite Application Facility on Climate Monitoring, 31 January 2017. doi: 10.5676/EUM_SAF_CM/HOAPS/V002
- K. Schamm, M. Ziese, A. Becker, P. Finger, A. Meyer-Christoffer, U. Schneider, M. Schröder, and P. Stender (2014): Global gridded precipitation over land: a description of the new GPCC First Guess Daily product. Earth Syst. Sci. Data, 6, 49–60. doi: 10.5194/essd-6-49-2014
- A. Andersson, K. Fennig, C. Klepp, S. Bakan, H. Grassl, and J. Schulz (2010): The Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data — HOAPS-3. Earth Syst. Sci. Data, 2, 215–234. doi: 10.5194/essd-2-215-2010.

DAPAGLOCO

Input Data

GPCC Full Data Daily Version 2018 (DOI: 10.5676/DWD_GPCC/FD_D_V2018_100).
HOAPS-4.0 based on SSM/I and SSMIS (DOI:10.5676/EUM_SAF_CM/HOAPS/V002).
TMI and AMSR-E using the HOAPS ANN retrieval.
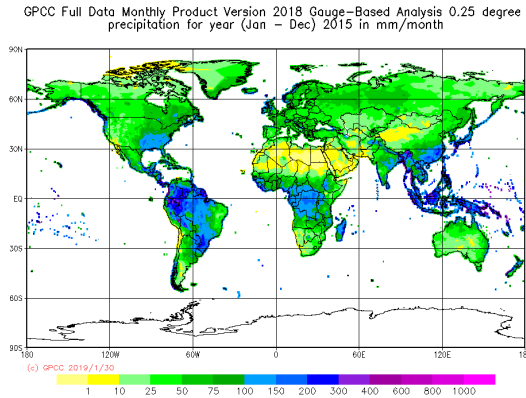
GPCC global precipitation sum 2015.
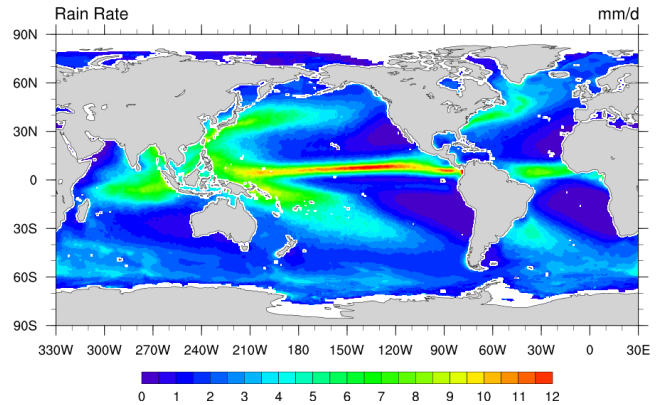
HOAPS mean precipitation 1988-2014.

Products

Daily precipitation sum	Daily accumulated precipitation in mm/d

Technical Specifications

Time period:	01.01.1988 – 31.12.2015
Temporal resolution:	daily
Spatial coverage:	global, Europe (30°N…80°N and 30°W…65°E)
Spatial resolution:	1°×1° (global), 2.5°×2.5° (global), 0.5°×0.5° (Europe)
Data Format:	NetCDF-4, Climate and Forecast (CF) Metadata Convention v1.6

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http://gpcc.dwd.de   **contact.cmsaf@dwd.de**

CM SAF
Climate Data Records

The Satellite Application Facility on Climate Monitoring (CM SAF) develops, produces, archives and disseminates satellite-data-based products in support to climate monitoring. The product suite mainly covers parameters related to the energy & water cycle and addresses many of the Essential Climate Variables as defined by GCOS (GCOS 138).

The following list provides a summary of the Climate Data Records (CDR) available and their respective Digital Object Identifiers (DOI). The QuickResponse (QR) Code allows for quick and easy access to the data.

Surface Solar Radiation Data Record - Heliosat (SARAH)-3	January 1983 to date	
Surface Irradiance, Direct Radiation, Spectral Information, Sunshine Duration; monthly mean/sum, daily mean/sum, 30-min instantaneous; DOI:10.5676/EUM_SAF_CM/SARAH/V003	Meteosat disk NetCDF 4, CF	
Surface Radiation, SARAH-E	1999 – 2016	
Surface incoming solar radiation (SIS), Surface incoming direct radiation (SID) and Surface incoming direct normalized radiation (DNI); monthly mean, daily mean, hourly instantaneous; DOI:10.5676/DWD/JECD/SARAH_E/V001_01	Meteosat-IODC disk NetCDF 3, CF	
Surface Solar Radiation Data Record - Heliosat (SARAH)-2.1	1983 - 2017	
Surface Irradiance, Direct Radiation, Spectral Information, Sunshine Duration; monthly mean/sum, daily mean/sum, instantaneous; DOI:10.5676/EUM_SAF_CM/SARAH/V002_01	Meteosat Disk netCDF4, CF	
ICDR SEVIRI Radiation based on SARAH-2 methods	2018/01 - ongoing	
monthly mean/sum, daily mean/sum, 30-min instantaneous https://wui.cmsaf.eu/safira/action/viewICDRDetails?acronym=SARAH_V002_ICDR	daily and monthly mean (DM and MM)	
Top of Atmosphere Radiation GERB/SEVIRI Data Record – edition 2	2004 – 2015	
TOA Reflected Solar and Emitted Thermal Radiation from GERB and SEVIRI; dataset – edition2 - Monthly Means/Daily Means/Monthly mean diurnal cycle; DOI:10.5676/EUM_SAF_CM/TOA_GERB/V002	netCDF4, CF	
GIRAFE v1	2002/01 – 2022/12	
Global Interpolated RAinFall Estimation v1 daily accumulations, monthly mean of daily accumulations DOI:10.5676/EUM_SAF_CM/GIRAFE/V001	NetCDF 4, CF Metadata Convention v1.7	
HOAPS 4.0	1987 - 2014	
Hamburg Ocean Atmosphere Parameters and Fluxes; 6-hourly composites and monthly averages; DOI:10.5676/EUM_SAF_CM/HOAPS/V002	netCDF4, CF	
MW+NIR based water vapour: CM SAF / WV_cci TCWV data record	July 2002 to December 2017	
Combined global total column water vapour product from microwave and near infrared imagers daily and monthly averages; DOI:10.5676/EUM_SAF_CM/COMBI/V001	NetCDF 4, CF	
CLARA-A3	1979/01 – present	
daily mean, pentad mean, monthly mean, monthly histograms (depending on product) + daily subsampled global cloud products; DOI:10.5676/EUM_SAF_CM/CLARA_AVHRR/V003	NetCDF 4, CF Metadata Convention v1.7	
ICDR AVHRR based on CLARA-A2.1	2019/01 - ongoing	
CM SAF ICDR AVHRR based on CLARA-A2.1 algorithms daily mean, pentad mean, monthly mean (depending on product) https://wui.cmsaf.eu/safira/action/viewICDRDetails?acronym=CLARA_AVHRR_V002_ICDR	global netCDF4, CF	
ATOVS tropospheric humidity and temperature data set	1999 - 2011	
Vertically integrated water vapour, humidity and temperature at pressures levels and layers from ATOVS; Daily Means/Monthly Means; DOI:10.5676/EUM_SAF_CM/WVT_ATOVS/V001	Global netCDF3, CF	

CM SAF
Climate Data Records

SEVIRI cloud properties: CLAAS-3 data record	01.01.2004 - present	
Pixel-based products (15 minutes) , daily and monthly mean (DM and MM), monthly mean diurnal cycle (MMDC), monthly histograms (MH);	NetCDF 4, CF Metadata Convention v1.7	
ICDR SEVIRI Clouds based on CLAAS-2 methods	2018/01 - ongoing	
daily and monthly mean (DM and MM), https://wui.cmsaf.eu/safira/action/viewICDRDetails?acronym=CLAAS_V002_ICDR	daily and monthly mean (DM and MM)	
Surface Daylight Radiation	1983 - 2011	
CM SAF Surface Daylight Radiation Data Set; Monthly means / Daily means; DOI:10.5676/EUM_SAF_CM/DAL_MVIRI_SEVIRI/V001	Meteosat Disk netCDF3, CF	
MVIRI+SEVIRI free tropospheric humidity (FTH) dataset	1983 - 2009	
Free tropospheric humidity; 3-hourly; DOI:10.5676/EUM_SAF_CM/FTH_METEOSAT/V001	Meteosat Disk (45°N/S and 45°E/W) netCDF3, CF	
Top of Atmosphere Radiation MVIRI/SEVIRI Data Record	1983 - 2015	
monthly mean, daily mean, monthly mean diurnal cycle (1-hourly); DOI:10.5676/EUM_SAF_CM/TOA_MET/V001	Meteosat Disk netCDF4, CF	
Fundamental Climate Data Record (FCDR) of Microwave Imager Radiances, Edition 4	1978 – 2020	
Native SMMR, SSM/I & SSMIS DOI:10.5676/EUM_SAF_CM/FCDR_MWI/V004	Global NetCDF-4, CF	
Meteosat Land Surface Temperature Data Record SUMET	1991 - 2015	
Meteosat Clear Sky Land Surface Temperature; instantaneous data every hour and monthly diurnal cycle composites; DOI:10.5676/EUM_SAF_CM/LST_METEOSAT/V001	Meteosat Disk NetCDF4, CF	
Meteosat Cloud Fractional Cover Data Record COMET	1991 - 2015	
Meteosat Cloud Fractional Cover; hourly, daily and monthly; DOI:10.5676/EUM_SAF_CM/CFC_METEOSAT/V001	Meteosat Disk NetCDF4, CF	
SEVIRI Aerosol Optical Depth (AOD) Data Record - Edition 1	2004 - 2012	
Aerosol Optical Depth from SEVIRI; daily mean, monthly mean; DOI:10.5676/EUM_SAF_CM/MSG_AOD/V001	SEVIRI NetCDF 4, CF	
Upper Tropospheric Humidity (UTH) data record	1994 - 2018	
Upper Tropospheric Humidity from microwave sounders; hourly instantaneous and daily mean observations; DOI: 10.5676/EUM_SAF_CM/UTH/V002	Global NetCDF 4; CF, ACDD	
DAPAGLOCO	1988 - 2015	
Daily Precipitation Sum DOI: 10.5676/DWD_CDC/HOGP_050/V002 10.5676/DWD_CDC/HOGP_100/V002 10.5676/DWD_CDC/HOGP_250/V002	Global NetCDF-4, CF	

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CM SAF
Legacy Climate Data Records

These Climate Data Records have been produced by the CM SAF in the past and are now largely superseeded by more recent Climate Data Records. They are, however, still available in the CM SAF Web User Interface.

Surface Solar Radiation Data Set - Heliosat (SARAH)	1983 - 2013	
Surface irradiance (SIS), direct normalized irradiance (DNI) and effective cloud albedo (CAL); monthly man/sum, daily mean/sum, instantaneous; DOI:10.5676/EUM_SAF_CM/SARAH/V001	Meteosat Disk netCDF3, CF	
Surface Solar Radiation Data Record - Heliosat (SARAH) - 2	1983 - 2015	
Surface Irradiance, Direct Radiation, Spectral Information, Sunshine Duration; monthly mean/sum, daily mean/sum, instantaneous; DOI:10.5676/EUM_SAF_CM/SARAH/V002	Meteosat Disk netCDF4, CF	
Top of Atmosphere Radiation – edition 1	2004 – 2011	
CM SAF ToA Radiation „GERB"; dataset - edition1 - Monthly Means / Daily Means / Monthly mean diurnal cycle; DOI:10.5676/EUM_SAF_CM/TOA_GERB/V001	Meteosat Disk netCDF3, CF	
CLARA-A1	1982 - 2015	
CM SAF Clouds, Albedo and Radiation dataset from AVHRR data -Edition1; Monthly Means / Daily Means / Pentad Means / Monthly Histograms; DOI:10.5676/EUM_SAF_CM/CLARA_AVHRR/V001	global netCDF3, CF	
CLARA-A2	1982 - 2015	
CM SAF Clouds, Albedo and Radiation dataset from AVHRR data -Edition1; Monthly Means / Daily Means / Pentad Means / Monthly Histograms; DOI:10.5676/EUM_SAF_CM/CLARA_AVHRR/V002	global netCDF3, CF	
CLARA-A2.1	1982 - 2019	
CM SAF Clouds, Albedo and Radiation dataset from AVHRR data - Edition2; Daily Means/Pentad Means/Monthly Means/Monthly Histograms; DOI:10.5676/EUM_SAF_CM/CLARA_AVHRR/V002_01	global netCDF4, CF	
CLAAS dataset	2004 - 2011	
CM SAF CLoud property dAtAset using SEVIRI (CLAAS), edition 1; Hourly / Daily and Monthly Mean / Monthly Mean diurnal cycle / Monthly Histograms; DOI:10.5676/EUM_SAF_CM/CLAAS/V001	Meteosat Disk netCDF3, CF	
SEVIRI 15min cloud mask dataset	2004 - 2012	
Pixel based (~4 x 4km2); 15 minutes temporal resolution; DOI:10.5676/EUM_SAF_CM/CMA_SEVIRI/V001	Meteosat Disk HDF5	
Fundamental Climate Data Record (FCDR) of Microwave Imager Radiances, Edition 3	1978 – 2015	
Native SSM/I & SSMIS; DOI:10.5676/EUM_SAF_CM/FCDR_MWI/V003	Global NetCDF-4, CF	

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CM SAF
Legacy Climate Data Records

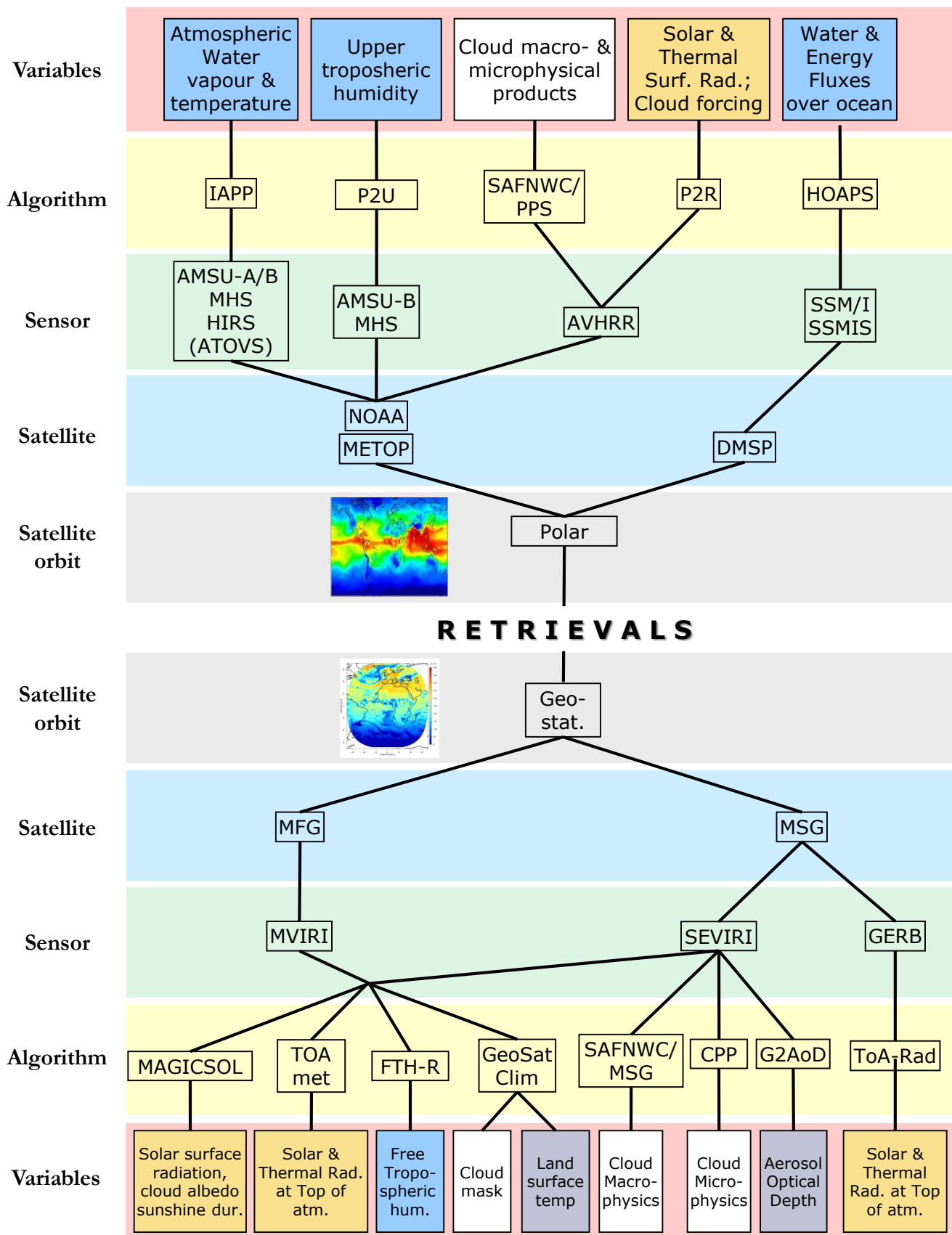|		
SEVIRI cloud properties: CLAAS-2 data record	2004 - 2015	
CM SAF CLoud property dAtAset using SEVIRI (CLAAS), edition 2; hourly (pixel-based products), daily and monthly mean (DM and MM), monthly mean diurnal cycle (MMDC), monthly histograms (MH), depending on product; DOI:10.5676/EUM_SAF_CM/CLAAS/V002	Meteosat Disk netCDF4, CF	
Surface Radiation	1983 - 2005	
CM SAF Surface Radiation MVIRI Data Set 1.0; Monthly Means / Daily Means / Hourly Means; DOI:10.5676/EUM_SAF_CM/RAD_MVIRI/V001	Meteosat Disk netCDF3, CF	
Fundamental Climate Data Record (FCDR) of SMMR/SSMI/SSMIS Brightness Temperatures	1978 – 2015	
Native SSM/I & SSMIS; DOI:10.5676/EUM_SAF_CM/FCDR_MWI/V002	Global NetCDF-4, CF	
Fundamental Climate Data Record (FCDR) of SSMI/SSMIS Brightness Temperatures	1987 - 2013	
Native SSM/I & SSMIS; DOI:10.5676/EUM_SAF_CM/FCDR_MWI/V001	Global NetCDF-4, CF	
HOAPS 3.2	1987 – 2008	
Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data HOAPS 3.2 Monthly Means / 6-Hourly Composites; DOI:10.5676/EUM_SAF_CM/HOAPS/V001	Global ice free ocean netCDF3, CF	
HTW_HOAPS 3.1	1987 - 2006	
Vertically Integrated Water Vapour from SSM/I; Daily / Monthly Means DOI:10.5676/EUM_SAF_CM/HTW_SSMI/V001	Global ice free ocean netCDF3, CF	
Upper Tropospheric Humidity (UTH) data record	1999 - 2015	
Upper Tropospheric Humidity from microwave sounders; daily mean and separate scending/descending orbits per day DOI: 10.5676/EUM_SAF_CM/UTH/V001	Global NetCDF 4, CF, ACDD	
We also recommend this related dataset:		
DAPAGLOCO	1988 – 2008	
Daily Precipitation Sum DOI: 10.5676/DWD_CDC/HOGP_050/V001 10.5676/DWD_CDC/HOGP_100/V001 10.5676/DWD_CDC/HOGP_250/V001	Global NetCDF-4, CF	

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EUMETSAT CM SAF — CLIMATE MONITORING

Retrieval Overview

This graphic exemplarily illustrates which satellite data and algorithms are used to derive the climate variables.

Variables

| Atmospheric Water vapour & temperature | Upper troposheric humidity | Cloud macro- & microphysical products | Solar & Thermal Surf. Rad.; Cloud forcing | Water & Energy Fluxes over ocean |

Algorithm

IAPP · P2U · SAFNWC/PPS · P2R · HOAPS

Sensor

AMSU-A/B MHS HIRS (ATOVS) · AMSU-B MHS · AVHRR · SSM/I SSMIS

Satellite

NOAA METOP · DMSP

Satellite orbit

Polar

R E T R I E V A L S

Satellite orbit

Geo-stat.

Satellite

MFG · MSG

Sensor

MVIRI · SEVIRI · GERB

Algorithm

MAGICSOL · TOA met · FTH-R · GeoSat Clim · SAFNWC/MSG · CPP · G2AoD · ToA-Rad

Variables

| Solar surface radiation, cloud albedo sunshine dur. | Solar & Thermal Rad. at Top of atm. | Free Tropospheric hum. | Cloud mask | Land surface temp | Cloud Macrophysics | Cloud Microphysics | Aerosol Optical Depth | Solar & Thermal Rad. at Top of atm. |

CM SAF · CNRS · Deutscher Wetterdienst · DWD · EUMETSAT · Royal Netherlands Meteorological Institute Ministry of Infrastructure and Water Management · Met Office · RMI · SMHI

CPP	Cloud Physical Products
FTH-R	Retrieval of free tropospheric humidity
G2AOD	Geostationary satellite data to Aerosol Optical Depth
GeoSatClim	Retrieval of cloud mask & land surface temperature from geostat. sat. data
HOAPS	Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data
IAPP	International ATOVS Processing Package
MAGICSOL	Retrieval of surface radiation parameters from MVIRI/SEVIRI
P2R	Polar-orbiting satellite data to Radiation
P2U	Polar-orbiting satellite data to Upper tropospheric humidity
SAF NWC / MSG	Satellite Application Facility on Nowcasting Meteosat Second Generation
SAF NWC / PPS	Satellite Application Facility on Nowcasting Polar Processing System
TOAmet	Top-of-the-Atmosphere radiation from MVIRI/SEVIRI
ToA-Rad	Top-of-the-Atmosphere Radiation from SEVIRI/GERB

AMSU	Advanced Microwave Sounding Unit
AVHRR	Advanced Very High Resolution Receiver
GERB	Geostationary Earth Radiation Budget
HIRS	High Resolution Infrared Sounder
MHS	Microwave Humidity Sounder
MVIRI	The Meteosat Visible and Infrared Imager
SEVIRI	Spinning Enhanced Visible and Infrared Imager
SSM/I	Special Sensor Microwave Imager
SSMIS	Special Sensor Microwave Imager/Sounder

DMSP	Defense Meteorological Satellite Program
METOP	Meteorological Operational Polar Satellite of EUMETSAT
MFG	Meteorological Satellite First Generation
MSG	Meteorological Satellite Second Generation
NOAA	National Oceanic & Atmospheric Administration

Data Access
Web User Interface

Access to CM SAF Data

Overview

CM SAF products are archived in a database system. To enable the users to access this archive, CM SAF provides a Java Web Application, the Web User Interface (WUI), which translates the user requests into "database language" and vice versa. So, the users will be enabled to browse through the available products or to search for the products of their interests. Furthermore, it is possible to view the details of a specific product like available domain, time range or satellite input data.

For most products quicklook images were integrated into the details page which helps the customers to visualize the selected product. To order the **free of charge** CM SAF data customers have to register. Required information for the registration are name, organisation, and country.

And, of course, we are always interested in feedback on your experiences and your application area of the data.

Available Documentation

Three introductory video messages are available at www.cmsaf.eu/ordering. They cover

1. Introduction

2. Search the database

3. Order data

Processing the Data and CM SAF Toolbox

www.cmsaf.eu/wui

CM SAF products are gridded on a product specific area. The type of gridding (i.e. the combination of geographical projection and horizontal resolution) is product specific, too. The Web User Interface offers the opportunity to re-project products to a regular latitude/longitude projection, to resample the horizontal resolution to user needs and to restrict the area to a user specific subdomain.

To process these requests CM SAF uses the "climate data operators" (CDO) to adapt the original product. CDO is a free software tool and comprises a collection of command line operators that were originally developed for processing and analysis of data produced by climate and numerical weather prediction models (e.g. for file operations, simple statistics, arithmetics, interpolation or the calculation of climate indices). Supported file formats are NetCDF, GRIB and several binary formats.

Additionally, CM SAF provides tools to access, analyse and visualize the CM SAF data (www.cmsaf.eu/tools). In particular, the CM SAF R-Toolbox provides R-based tools for preparation, analysis and visualization of the CM SAF NetCDF data records. The scripts are available for all operating systems and allow to calculate and visualise spatial and temporal averages, anomalies, trends, etc. Documentation is provided together with the toolbox and through online screencasts. The CM SAF also supports the application of the climate data operators (cdo) and QGIS for the analysis / visualization of the CM SAF climate data records.
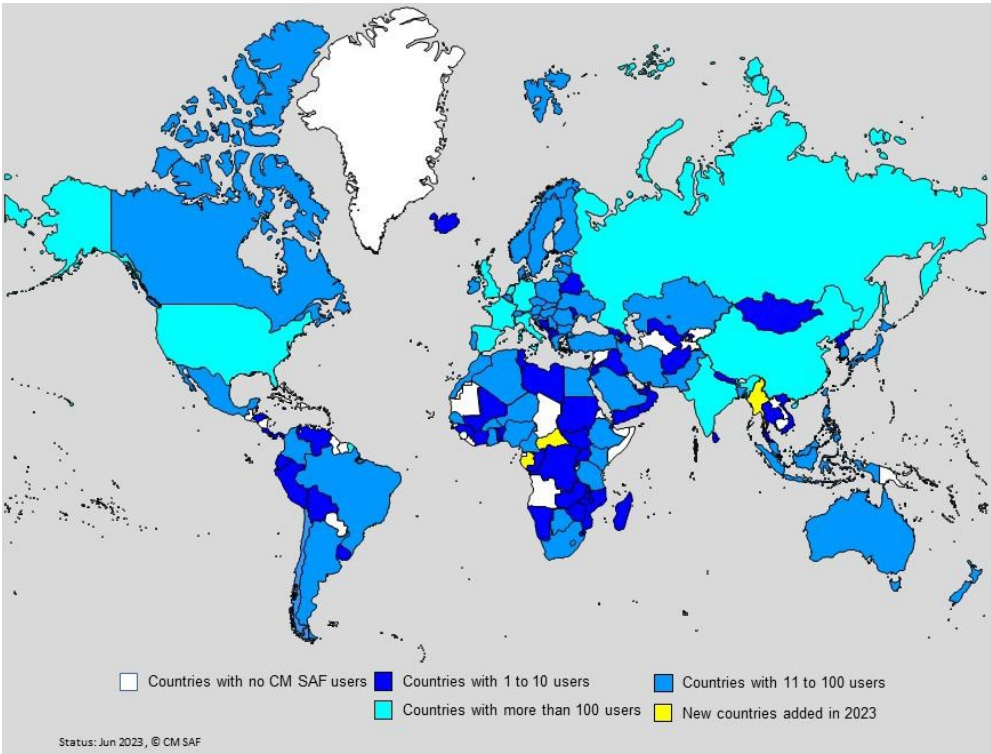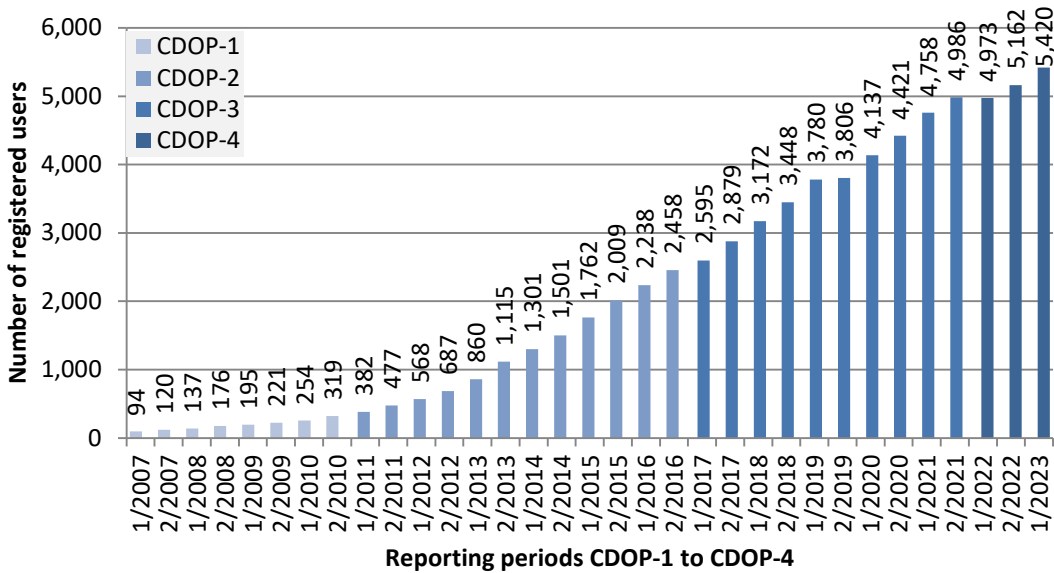
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User Community applying CM SAF Products

CM SAF is in contact with a large number of users worldwide. CM SAF products and services are applied by a diverse international user community illustrated in the map of geographical distribution of registered CM SAF users.

Status: Jun 2023, © CM SAF

Legend: Countries with no CM SAF users | Countries with 1 to 10 users | Countries with 11 to 100 users | Countries with more than 100 users | New countries added in 2023

Development of the Number of CM SAF Users

The number of registered CM SAF users increased continuously. The graph shows the half-yearly development since 2007.

Data values by reporting period:
94, 120, 137, 176, 195, 221, 254, 319, 382, 477, 568, 687, 860, 1,115, 1,301, 1,501, 1,762, 2,009, 2,238, 2,458, 2,595, 2,879, 3,172, 3,448, 3,780, 3,806, 4,137, 4,421, 4,758, 4,986, 4,973, 5,162, 5,420

Legend: CDOP-1, CDOP-2, CDOP-3, CDOP-4

Y-axis: Number of registered users
X-axis: Reporting periods CDOP-1 to CDOP-4 (1/2007 to 1/2023)

User Statistics

Data Provision

The CM SAF provides its products applying a Web User Interface (WUI), where the user can place an order. CM SAF data are used for several application areas depending on the membership of the customers. During the first half of 2023 CM SAF provided approximately 39.85 TiB of data in total to the users.
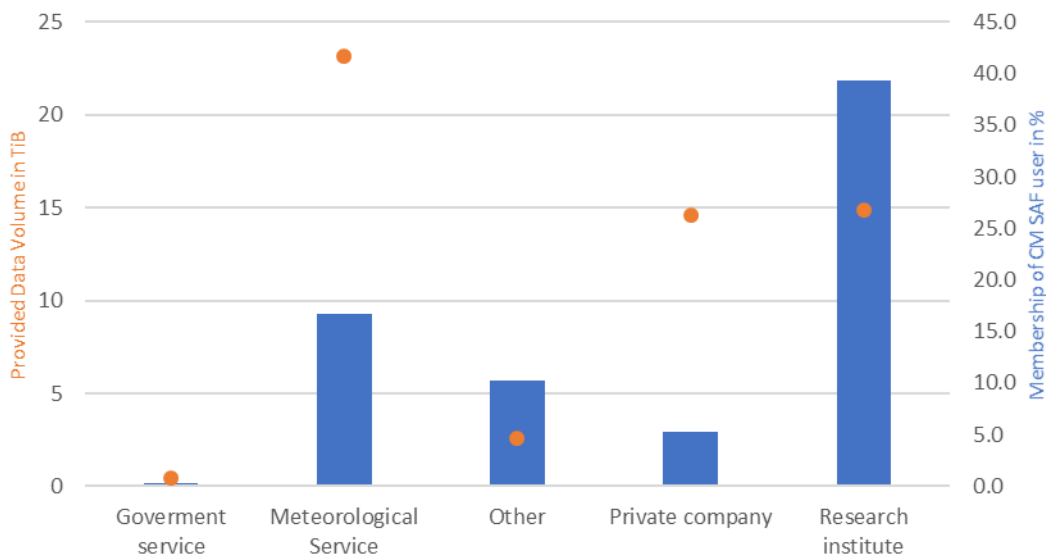
Development of the Number of Orders and provided Data Amount

The diagram shows the number of orders and provided data amount placed on a half yearly basis throughout the CDOPs. In the first half of 2023 approx. 64% of the orders were CDR (climate data records), 36% ICDR (interim climate data records; thereof 4% standing orders).
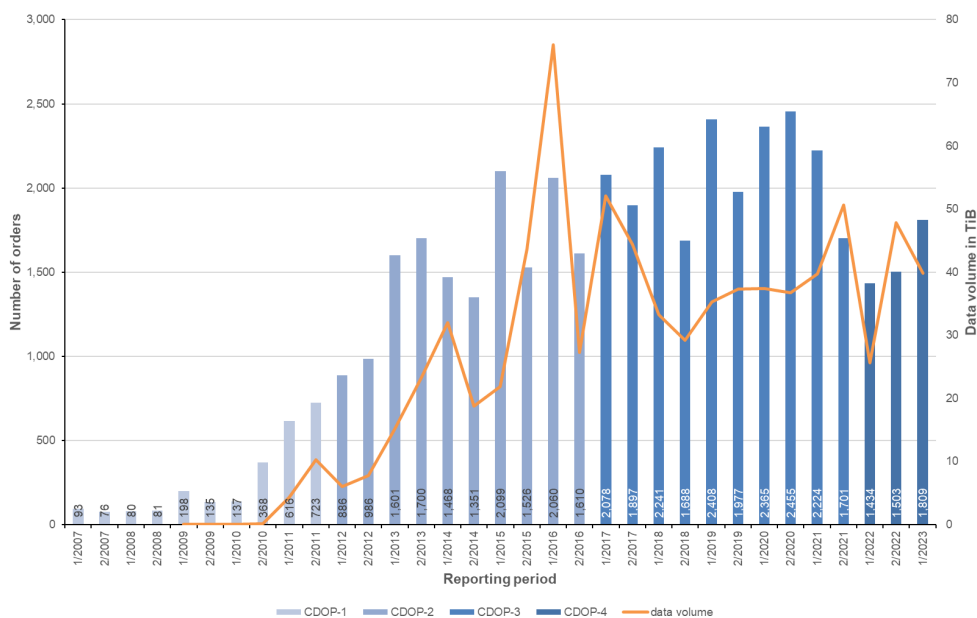
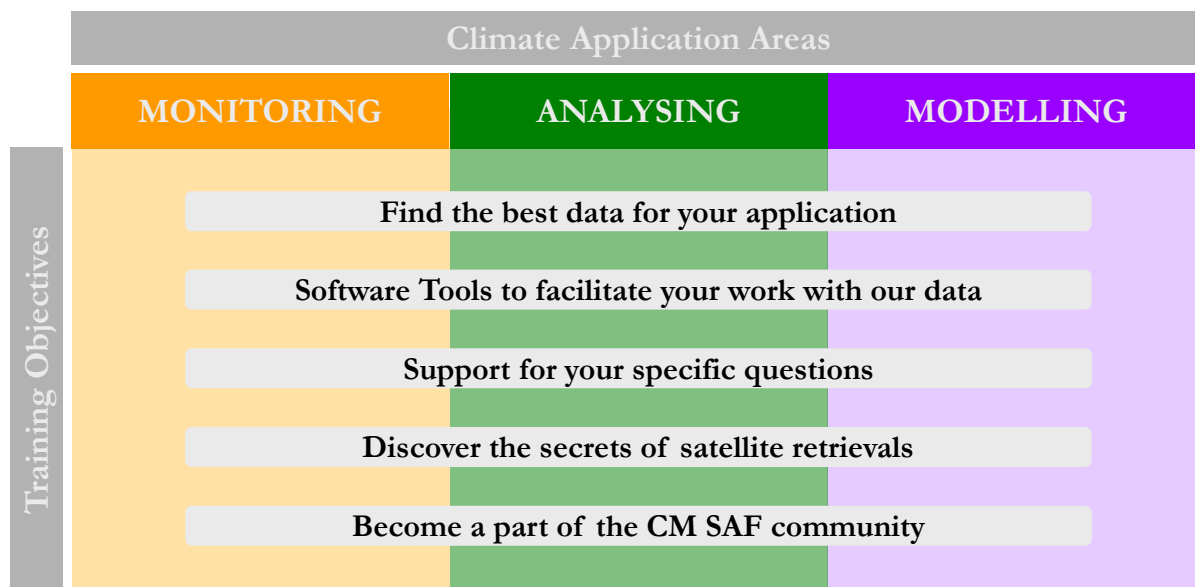
Free Data Access & User Help Desk

Overview

The **Satellite Application Facility on Climate Monitoring** (CM SAF) provides training activities to support the application of CM SAF data in climate monitoring, climate analysis, and climate modelling. The focus is on workshops, the provision of documented software tools, and the supervision of master and bachelor theses. The workshops are composed of online elements and a classroom phase of several days. The training activities are mainly designed for climatologists from National Meteorological and Hydrological Services, Regional Climate Centers and from research institutions as well as students.

CM SAF provides support to everyone interested in working with CM SAF data. The training contents are tailored to your needs.
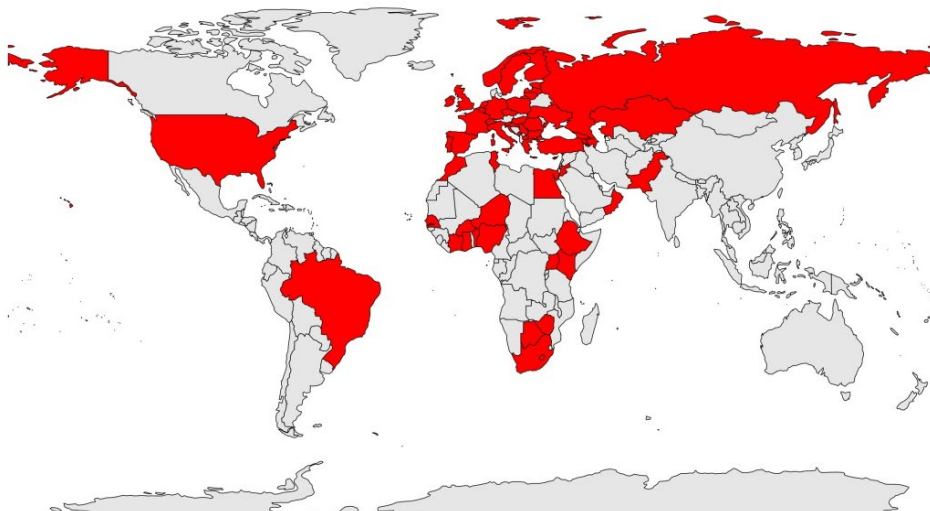
Participants from all parts of the world have already participated in CM SAF training activities.

Concept

Climate Application Areas		
MONITORING	**ANALYSING**	**MODELLING**

Training Objectives

- Find the best data for your application
- Software Tools to facilitate your work with our data
- Support for your specific questions
- Discover the secrets of satellite retrievals
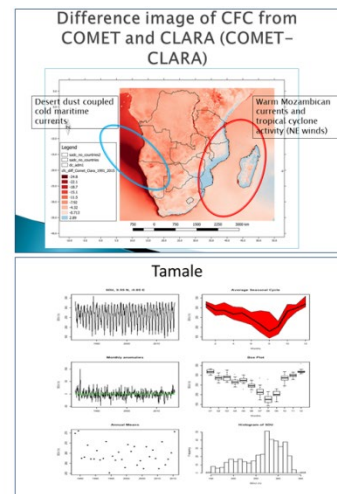- Become a part of the CM SAF community

Workshops

More than 10 CM SAF / EUMETSAT training workshops with almost 200 participants have been conducted in Europe and Africa since 2006. In joint activities and practical exercises the participants learn to apply CM SAF data to their needs and share their experiences.

CM SAF Community Site

A key concept of CM SAF training workshops is the work on self-selected mini projects. The projects can be done individually or in teams. Goals for mini projects can vary between comparisons of CM SAF satellite data and station measurements, the estimation of the solar energy potential or just plotting a map.

Free Data Access & User Help Desk

www.cmsaf.eu/wui

contact.cmsaf@dwd.de

CM SAF · CM·rs · Deutscher Wetterdienst DWD · EUMETSAT · Royal Netherlands Meteorological Institute Ministry of Infrastructure and Water Management · Met Office · RMI · SMHI

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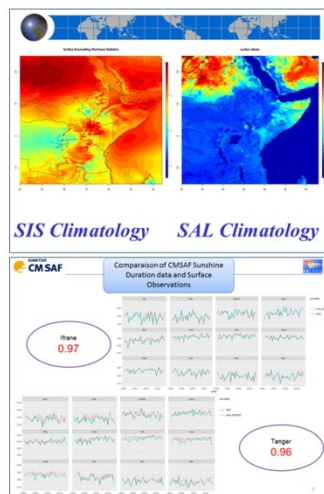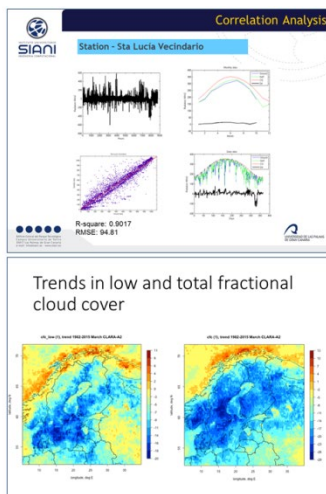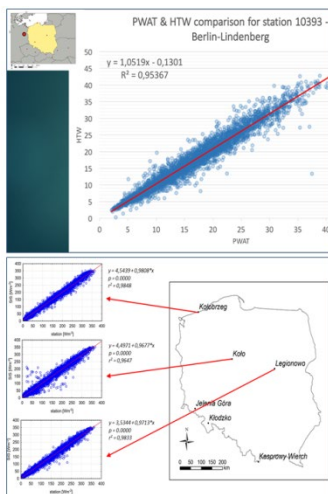
CM SAF R TOOLBOX

R-based tools for an easy usage of CM SAF NetCDF data

Sunshine Duration
Mean Monthly SDU 1983 - 2015

The CM SAF R TOOLBOX can be used to prepare, analyse and visualize CM SAF NetCDF data.
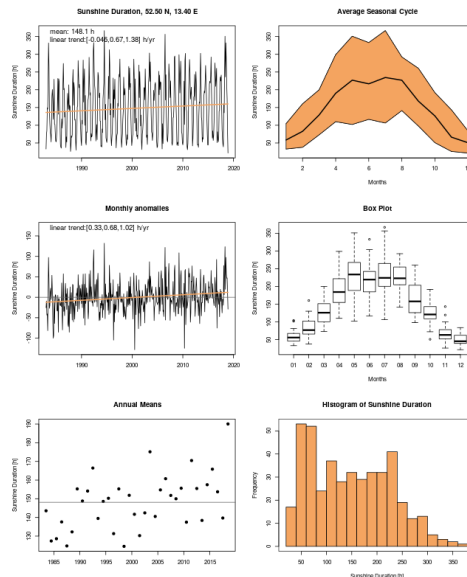
Overview

In the framework of the CM SAF product and service portfolio, the CM SAF R TOOLBOX and the 'cmsaf' R-package were developed as tools for an easy usage of CM SAF NetCD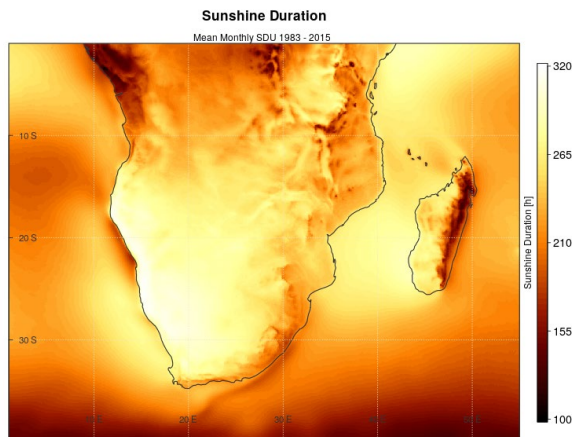F data. The 'cmsaf' R-package contains a collection of more than 60 functions for basic analysis and manipulation of CM SAF NetCDF formatted data. The package is part of the CM SAF R TOOLBOX, which also contains prepared R-scripts that are helpful to work with CM SAF NetCDF data. There are R-scripts, which can be used to prepare, analyse and visualize CM SAF NetCDF data, and it includes R-scripts, which help unexperienced R-users to apply easily the functions of the 'cmsaf' R-package.

Quick start manual

1. Install R
2. Install R-Studio (recommended)
3. Get CM SAF R TOOLBOX
   www.cmsaf.eu/tools
4. Start R or R-Studio and source the script
   Install.Packages4Toolbox.R
5. Start the script *CMSAF-R-TOOLBOX.R*
6. Have fun
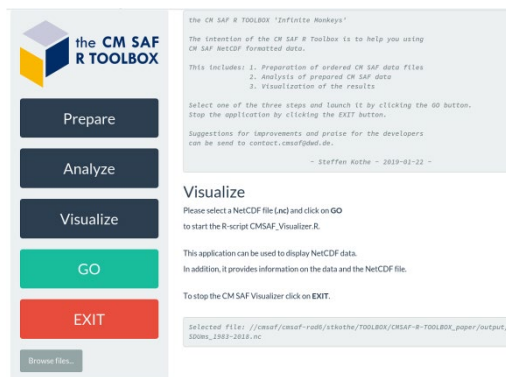
Free Data Access & Contact

In case that a question or problem can not be solved by help of the README or the cmsaf R-package manual contact the CM SAF User Help Desk.

www.cmsaf.eu/wui
User help desk: contact.cmsaf@dwd.de

SK

CM SAF R TOOLBOX

Prepare

CM SAF data records can be ordered free of charge via www.cmsaf.eu/wui. The data are provided via ftp as tarball. Use the *Prep.Data.R* script to:

- Extract
- Select time range
- Select region
- Merge

CM SAF R TOOLBOX scripts

The CM SAF R TOOLBOX consists of several prepared R-scripts, which require no R or scripting experience. After starting the script the user is guided trough all options.

Analyse

The *Apply.Function.R* scripts serve as an interface to the diversity of functions of the 'cmsaf' R-package.

cmsaf R-package

The cmsaf R-package is a collection of functions for basic analysis and manipulation of CM SAF NetCDF data. It contains more than 60 useful functions, such as:

- dayrange – diurnal range
- fldmean – spatial mean
- mon.anomaly – monthly anomalies
- monmean – monthly means
- monsum – monthly sums
- monsd – monthly standard deviation
- ncinfo – content of a netcdf file
- remapbil – bilinear interpolation
- seas.anomaly – seasonal anomalies
- seasmean – seasonal means

- sellonlatbox – select a region
- selpoint – extract a point or time series
- timmean – temporal mean
- timmax – temporal maximum
- trend – linear trend
- wfldmean – weighted 2d field mean
- year.anomaly – annual anomalies
- yearmean – annual means
- yearsum – annual sums
- ymonmean – long-term monthly means

Visualize

The script *CMSAF_Visualizer.R* is a GUI-based tool for the visualization of CM SAF data. The Visualizer can be used for plotting of 2d maps, 1d line plots or to plot statistical figures. The tool offers several options for customization.

GCOS Requirements for the Generation of Datasets and Products
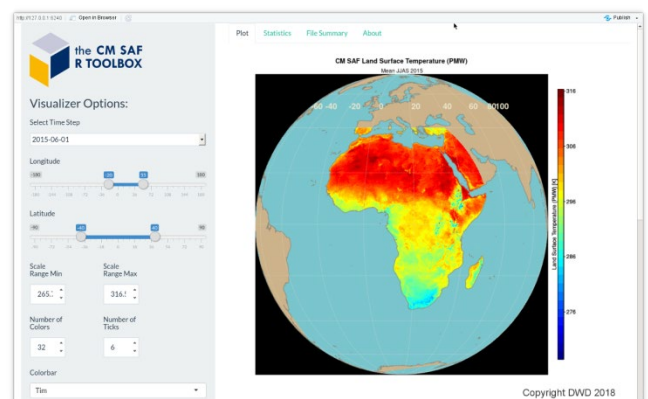
The CM SAF Climate Data Records compliance with the GCOS recommendation on data set generation

#	Climate Data Record	Description	Publications	Specification	Access	Versioning	Stability	Cal / Val	Global	Timeliness	Feedback	Maturity index	Reference
		01	02	03	04	05	06	07	08	09	10	11	12
1	CM SAF ToA Radiation „GERB" dataset - Edition1 DOI:10.5676/EUM_SAF_CM/TOA_GERB/V001	x	(x)	x	x	x	n/a	x	n/a	x	x	x	x
2	Top of Atmosphere Radiation GERB/SEVIRI Data Record – edition 2 DOI:10.5676/EUM_SAF_CM/TOA_GERB/V002	x	x	x	x	x	n/a	x	n/a	x	x	x	x
3	CM SAF Surface Daylight Radiation Data Set DOI:10.5676/EUM_SAF_CM/DAL_MVIRI_SEVIRI/V001	x	-	x	x	x	x	x	n/a	-	x	-	x
4	CM SAF cLoud, Albedo & RAdiation dataset, AVHRR-based, Edition 2 DOI:10.5676/EUM_SAF_CM/CLARA_AVHRR/V002	x	x	x	x	x	x	x	x	(x)	x	x	x
5	Vertically integrated water vapour, humidity and temperature at pressures levels and layers from ATOVS DOI:10.5676/EUM_SAF_CM/WVT_ATOVS/V001	x	(x)	x	x	x	(x)	x	x	x	x	-	x
6	CM SAF CLoud property dAtAset using SEVIRI (CLAAS), edition 2 DOI:10.5676/EUM_SAF_CM/CLAAS/V002	x	x	x	x	x	n/a	x	n/a	x	x	-	x
7	MVIRI+SEVIRI free tropospheric humidity (FTH) dataset DOI:10.5676/EUM_SAF_CM/FTH_METEOSAT/V001	x	x	x	x	x	x	x	n/a	-	x	x	x
8	Surface Radiation, SARAH-E DOI:10.5676/DWD/JECD/SARAH_E/V001	x	x	x	x	x	x	x	n/a	-	x	-	x
9	Surface Solar Radiation Data Record - Heliosat (SARAH) -2 DOI:10.5676/EUM_SAF_CM/SARAH/V002	x	x	x	x	x	x	x	n/a	-	x	x	x
10	Surface Solar Radiation Data Record - Heliosat (SARAH)-2.1 DOI:10.5676/EUM_SAF_CM/SARAH/V002_01	x	x	x	x	x	x	x	n/a	x	x	x	x
11	Fundamental Climate Data Record (FCDR) of Microwave Imager Radiances, Edition 3 DOI:10.5676/EUM_SAF/FCDR_MWI/V003	x	-	x	x	x	x	x	x	-	x	-	x
12	Meteosat Land Surface Temperature Data Record SUMET DOI:10.5676/EUM_SAF_CM/LST_METEOSAT/V001	x	-	x	x	x	x	x	n/a		x	-	x
13	Meteosat Cloud Fractional Cover Data Record COMET DOI:10.5676/EUM_SAF_CM/CFC_METEOSAT/V001	x	-	x	x	x	x	x	n/a		x	-	x
14	Upper Tropospheric Humidity (UTH) data record DOI:10.5676/EUM_SAF_CM/UTH/V001	x	-	x	x	x	x	x	x	-	x	x	x
15	SEVIRI Aerosol Optical Depth (AOD) Data Record – Edition 1 DOI:10.5676/EUM_SAF_CM/MSG_AOD/V001	x	x	x	x	x	x	x	n/a	x	x	x	x
16	Top of Atmosphere Radiation MVIRI/SEVIRI Data Record DOI:10.5676/EUM_SAF_CM/TOA_MET/V001	x	-	x	x	x	x	x	n/a	-	x	x	x
17	HOAPS 4.0 DOI:10.5676/EUM_SAF_CM/HOAPS/V002	x	x	x	x	x	x	x	x	-	x	x	x

X	fulfilled	(X)	partly fulfilled
-	Not fulfilled	n/a	not applicable

Self-assessment by SAF on Climate Monitoring

GCOS Requirements for the Generation of Datasets and Products

The 12 GCOS[1] Requirements[2] for the Generation of Datasets and Products

#	
1	Full description of all steps in the generation of data sets and products, including algorithms used, specific FCDRs used, and characteristics and outcomes of validation activities
2	Information on publications in peer-reviewed journals, covering both the description and the application of data sets and products
3	Statement of expected accuracy, stability and resolution (time, space) of the product, including, where possible, a comparison with the requirements stated in the Satellite Supplement (or any subsequent revision)
4	Arrangements for access to the data sets, products and all documentation
5	Version management of data sets and products, particularly in connection with improved algorithms and reprocessing
6	Long-term stability and homogeneity of the product
7	Full application of all appropriate calibration/validation activities that would enhance product quality
8	Global coverage where appropriate
9	Timeliness of data release to the user community to enable monitoring activities
10	Facility for user feedback
11	Application of a quantitative maturity index if possible
12	Publication of a summary (preferably on-line) documenting point-by-point the extent to which this guideline has been followed

[1] Global Climate Observing System (http://gcos.wmo.int)

[2] Guideline for the Generation of Datasets and Products Meeting GCOS Requirements;

GCOS-143 (WMO/TD No. 1530); May 2010

System Maturity Matrix

The table below summarizes System Maturity for some of the Climate Data records of the SAF on Climate Monitoring

#	Climate Data Record	Software Readiness	Metadata	User documentation	Uncertainty characterization	Public access, feedback and update	usage
1	**Fundamental Climate Data Record of SSM/I Brightness Temperatures** DOI:10.5676/EUM_SAF_CM/FCDR_SSMI/V001	1 – 4	5 – 6	2 – 5	3 – 5	4 - 5	1 - 2
2	**MVIRI+SEVIRI free tropospheric humidity (FTH) dataset** DOI:10.5676/EUM_SAF_CM/FTH_METEOSAT/V001	1 – 3	5 - 6	3 - 5	3 - 4	4 - 5	2 – 3
3	**Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data HOAPS 3.2** DOI:10.5676/EUM_SAF_CM/HOAPS/V001	1 - 5	5	4 - 5	2 - 4	4 - 5	2 - 4
4	**HOAPS 4.0** DOI:10.5676/EUM_SAF_CM/HOAPS/V002	2 - 4	5	4 - 6	2 - 5	4 - 5	3 - 4
5	**CM SAF Surface Radiation MVIRI Data Set 1.0** DOI:10.5676/EUM_SAF_CM/RAD_MVIRI/V001	2 - 4	4 – 6	5 – 6	3 – 4	5 – 6	4 - 5
6	**CM SAF Clouds, Albedo and Radiation dataset from AVHRR data** DOI:10.5676/EUM_SAF_CM/CLARA_A/V001	3 – 5	4 – 5	4 – 5	3 – 4	5	2 - 4
7	**CLARA-A2** DOI:10.5676/EUM_SAF_CM/CLARA_AVHRR/V002	2 - 5	4 - 6	4 - 6	3 - 5	5	3 – 4
8	**CM SAF ToA Radiation „GERB" dataset - Edition1** DOI:10.5676/EUM_SAF_CM/TOA_GERB/V001	2 - 5	4 - 5	3 - 4	3 - 4	5	2 - 3
9	**Top of Atmosphere Radiation GERB/SEVIRI Data Record – edition 2** DOI:10.5676/EUM_SAF_CM/TOA_GERB/V002	1 - 4	4 - 5	4 - 5	3 - 4	5	1 – 2
10	**CM SAF CLoud property dAtAset using SEVIRI (CLAAS), edition 1** DOI:10.5676/EUM_SAF_CM/CLAAS/V001	2-4	3 - 4	4 - 5	4	5	1 – 4
11	**MVIRI+SEVIRI free tropospheric humidity (FTH) dataset** DOI:10.5676/EUM_SAF_CM/FTH_METEOSAT/V001	1 - 4	3 - 4	3 - 5	3 - 4	3 - 5	2 – 4
12	**Surface Solar Radiation Data Set - Heliosat (SARAH) -2** DOI:10.5676/EUM_SAF_CM/SARAH/V002	4 - 5	4 - 5	5 - 6	3 - 4	6	5 – 6
13	**Fundamental Climate Data Redord of SMMR/SSMI/SSMIS Brightness Temperatures** DOI:10.5676/EUM_SAF/FCDR_MWI/V002	1 - 4	5 – 6	2 – 5	3 – 5	4 - 5	1 – 2
14	**Top of Atmosphere Radiation MVIRI/SEVIRI Data Record** DOI:10.5676/EUM_SAF_CM/TOA_MET/V001	1 - 4	4 - 5	4 - 5	3 - 4	5	1 – 2
15	**Meteosat Land Surface Temperature Data Record SUMET** DOI:10.5676/EUM_SAF_CM/LST_METEOSAT/V001	3 - 5		5	3 - 4	5	4
16	**Meteosat Cloud Fractional Cover Data Record COMET** DOI:10.5676/EUM_SAF_CM/CFC_METEOSAT/V001	3 - 5	5 - 6	5	3 - 4	5	4
17	**SEVIRI Aerosol Optical Depth (AOD) Data Record - Edition 1** DOI:10.5676/EUM_SAF_CM/MSG_AOD/V001	1 - 4	4 - 5	4 - 5	3 - 5	5	1 - 2
18	**CM SAF CLoud property dAtAset using SEVIRI (CLAAS), edition 2** DOI:10.5676/EUM_SAF_CM/CLAAS/V002	2 - 5	6	5 - 6	4 - 5	4 - 5	4
19	**Upper Tropospheric Humidity (UTH) data record** DOI:10.5676/EUM_SAF_CM/UTH/V001	1 - 2	4 - 5	2 - 4	2 - 4	4 - 5	2
20	**Surface Solar Radiation Data Record - Heliosat (SARAH)-2.1** DOI:10.5676/EUM_SAF_CM/SARAH/V002_01	1 - 4	4 - 5	4 - 6	2 - 4	4 - 6	6

#6 thru 10: self-assessment by SAF on Climate Monitoring
See also: " CORE-CLIMAX System Maturity Matrix Instruction Manual"
DocNo.: CC/EUM/MAN/13/002 EUMETSAT, May 2014

System Maturity Matrix

The System Maturity Matrix (SMM) shall give an overview on the "maturity" of a Climate Data Record, addressing the following aspects

Software Readiness
Are the codes compliant with standards, stable, portable and reproducible?

Metadata
Do the metadata meet international standards, and allow provenance tracking?

User documentation
Are the formal documents and peer-reviewed papers up-to-date and public?

Uncertainty characterization
Are the uncertainties assessed systematically in a standard manner?

Public access, feedback and update
Are the data, source code, and documents publicly available and regularly updated?

Usage
Are the data widely used in the scientific, and decision, and policy making communities?

Quality Assuarance

General

The CM SAF has implemented a variety of measures
to provide its products and services in high, reliable
and traceable quality.

Direct feedback from the users is established, e.g. through
dedicated user & training workshops, user help desk
and the option to issue User Problem Reports via the
web (www.cmsaf.eu/UPR).

The products and services are subject to a rigorous review process:
The Climate Data Records are passing a three step review process from the definition of the specifications,
over the assessment of the maturity of the underlying algorithm and finally checking the readiness of release
of the data set.
The Enviromental Data Records are regularly quality-checked inannual Operations Reviews.

In the resp. Review Boards international experts as well as EUMETSAT specialists scrutinize the products
and services of the CM SAF.

Operations Review

On an annual basis, the **Operations Review** assesses the performance and adequacy of operations,
including the compliance of the delivered products and services against the service specifications, as
documented in the **Service Specification Document** (SeSp).

The Service Specification Document defines i.a. the product characteristics and the services available to
the users; the document is available to public (www.cmsaf.eu -> Documentation).

Inputs to the Operations Review are:

* **Bi-annual Operations Reports**
  summarizing the operations activities within the CM SAF, including product and service provision status,
  user interaction and training activities.

* **Annual Product Quality Assessment Report (AQA)**
  providing actual validation results for the Environmental Data Records from the previous year.

All documents are available via the CM SAF web site.

Climate Data Record life-cycle

The definition, generation and the release of a CM SAF

Climate Data Record are subject to a three-step, rigorous review process:

Requirement Review (RR)

The main objective of this review is to assess the adequatness and feasibility of the product requirements as defined in the Product Requirements Document (PRD).

Product Consolidation Review (PCR)

The two major objectives of this review are to:

- assess the maturity of the algorithm selected/developed for product generation, based on the Algorithm Theoretical Baseline Document; ATBD (available via CM SAF web site).
- assess the infrastructure capability to generate the data set, based on the Data Set Generation Capability Description Document (DSGCDD).

Delivery Readiness Review (DRR)

The objective of this review is to assess the validation results aganst the defined product reuqirements and the readiness to deliver the data record, based on the Scientific Validation Report and the Product User Manual (PUM), both available via the CM SAF web site.

Free Data Access & Contact

www.cmsaf.eu/wui
User help desk: contact.cmsaf@dwd.de