Satellite Application Facility on Climate Monitoring-
Climate Data Records and Services -

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The EUMETSAT SAF Network

- **HSAF**
  Support to Operational Hydrology and Water Management
  Led by Italian Meteorological Institute

- **NWC SAF**
  Support to Nowcasting and Very Short Range Forecasting
  Led by Agencia Estatal de Meteorología, Spain

- **ROM SAF**
  Radio Occultation Meteorology
  Led by Danish Meteorological Institute

- **OSI SAF**
  Ocean and Sea Ice
  Led by Metocean France

- **AC SAF**
  Ozone and Atmospheric Chemistry Monitoring
  Led by Finnish Meteorological Institute

- **CM SAF**
  Climate Monitoring
  Led by Deutscher Wetterdienst, Germany

- **LSA SAF**
  Land Surface Analysis
  Led by Portuguese Meteorological Institute

- **NWP SAF**
  Numerical Weather Prediction
  Led by Met Office (UK)
CM SAF Partners

- Deutscher Wetterdienst
- Swedish Meteorological and Hydrological Institute
- Royal Meteorological Institute of Belgium
- Schweizerische Eidgenossenschaft
- Finnish Meteorological Institute
- Met Office, United Kingdom
- Centre National de la recherche scientifique
- Met Office

CM SAF Member States
Location of Partner NMHSs
Satellite Application Facility on Climate Monitoring

What we do

Satellite-derived Products of Energy & Water Cycle

Why we do it

Develop
Generate
Archive
Distribute

Monitor
Understand
Adapt
Climate Variability & Climate Change
Satellite Application Facility on Climate Monitoring

Satellite-based Climate Data Records

- Satellite measured Signal

  - Satellite measured Signal
  - Satellite measured Signal
  - Satellite measured Signal

  - Homogenization

  - FCDR
    - EDR
      - Environmental Data Record
    - FCDR
      - Fundamental Climate Data Record
    - ICDR
      - Interim
        - Climate Data Record
    - TCDR
      - Thematic
        - Climate Data Record

- Near-Real Time Production
  - Latest Algorithm
    - EDR

- Production with short Latency
  - Same Algorithm for TCDR & ICDR to retrieve geophysical property
    - ICDDR

- Regular Re-processing
  - TCDR
CM SAF Climate Data Records

- **Fundamental Climate Data Records (FCDR)** are re-calibrated and inter-calibrated long-term data records of satellite radiance information. The need for recalibration results from the changes in the sensitivity of a satellite sensor during its operational orbit time. The need for inter-calibration results from technological advancements made in satellites and remote sensing sensitivity.

- **Thematic Climate Data Records (TCDR)** are geophysical variables derived from the FCDRs. An algorithm is applied to the FCDR to estimate the geophysical variable from the satellite observation. The production of a TCDR requires a lot of time and computational resources, and it is usually updated every few years.

- **Interim Climate Data Records (ICDR)** are regularly updated TCDRs available in short-time latency with an algorithm and processing system as consistent as possible to the generation of the corresponding TCDR.
CM SAF Portfolio

Parameters describing the Global Energy and Water Cycle

Source: Wild et al., 2013, Clim Dyn
FCDR SSMIS, SSM/I and SMMR

» Variables
  » Brightness temperature

» Resolution
  » Spatial: native SSM/I
  » Temporal: native SSM/I

» Coverage
  » Spatial: global
  » Temporal: 1978 to 2013

» Satellites
  » DMSP SSM/I and SSMIS
  » Nimbus-7 SMMR
TCDR HOAPS

- **Variables**
  - Total column water vapour
  - Wind, humidity (close to surface)
  - Precipitation, evaporation
  - Latent heat flux, fresh water flux

- **Resolution**
  - Spatial: 0.5° × 0.5°
  - Temporal: 6-hourly composites, monthly means

- **Coverage**
  - Spatial: global ice-free ocean
  - Temporal: 1987 to 2014

- **Satellites**
  - DMSP SSM/I and SSMIS, Nimbus-7 SMMR from CM SAF FCDR

DOI:10.5676/EUM_SAF_CM/HOAPS/V002
TCDR CLARA-A2

→ **Variables**
  - Cloud properties
  - Surface albedo
  - Radiation

→ **Resolution**
  - Spatial: 0.25°×0.25°
  - Temporal: daily-, pentad-, monthly mean

→ **Coverage**
  - Spatial: global
  - Temporal: 1982 to 2015

→ **Satellites**
  - NOAA, Metop (AVHRR)

DOI:10.5676/EUM_SAF_CM/CLARA_AVHRR/V002
TCDR CLAAS-2

Variables
- Cloud properties
- Liquid and ice water path

Resolution
- Spatial: native, 0.05°×0.05° (0.25°×0.25°)
- Temporal: 15 min, hourly-, daily-, monthly means, mean monthly diurnal cycle

Coverage
- Spatial: Meteosat disk
- Temporal: 2004 to 2015

Satellites
- Meteosat Second Generation (SEVIRI)

DOI:10.5676/EUM_SAF_CM/CLAAS/V002
ICDR SEVIRI Clouds

based on CLAAS-2 methods

➔ **Variables**
  ➔ Cloud fraction
  ➔ Cloud top parameters

➔ **Resolution**
  ➔ Spatial: native, 0.05°×0.05° (0.25°×0.25°)
  ➔ Temporal: daily-, monthly means

➔ **Coverage**
  ➔ Spatial: Meteosat disk
  ➔ Temporal: since January 2018

➔ **Satellites**
  ➔ Meteosat Second Generation (SEVIRI)
**TCDR SUMET**

** Variables**
- Land surface temperature basing on physical model (LTP)
- Land surface temperature basing on statistical model (LTS)

** Resolution**
- Spatial: 0.05° × 0.05°
- Temporal: hourly instantaneous, monthly mean diurnal cycle

** Coverage**
- Spatial: Meteosat disk
- Temporal: 1991 to 2015

** Satellites**
- Meteosat (MVIRI / SEVIRI)
TCDR COMET

- **Variables**
  - Fractional cloud cover (CFC)

- **Resolution**
  - Spatial: $0.05° \times 0.05°$
  - Temporal: hourly instantaneous, daily and monthly means, monthly mean diurnal cycle

- **Coverage**
  - Spatial: Meteosat disk
  - Temporal: 1991 to 2015

- **Satellites**
  - Meteosat (MVIRI / SEVIRI)

DOI:10.5676/EUM_SAF_CM/CFC_METEOSAT/V001
**TCDR AOD**

- **Variables**
  - Aerosol Optical Depth (AOD)
- **Resolution**
  - Spatial: native
  - Temporal: daily and monthly means
- **Coverage**
  - Spatial: Meteosat disk
  - Temporal: 02/2004 to 12/2012
- **Satellites**
  - Meteosat Second Generation (SEVIRI)

DOI: 10.5676/EUM_SAF_CM/MSG_AOD/V001
TCDR TOA Radiation

- **Variables**
  - TOA reflected solar (TRS)
  - TOA emitted thermal (TET)

- **Resolution**
  - Spatial: 0.05° × 0.05°
  - Temporal: daily and monthly means, monthly means of hourly means

- **Coverage**
  - Spatial: Meteosat disk
  - Temporal: 2004 to 2015

- **Satellites**
  - Meteosat Second Generation (GERB / SEVIRI)

DOI:10.5676/EUM_SAF_CM/CFC_METEOSAT/V001

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TCDR SARAH-2.1

- **Variables**
  - Surface Incoming Shortwave Radiation (SIS)
  - Surface Incoming Direct Radiation (SID)
  - Direct Normalized Irradiance (DNI)
  - Effective Cloud Albedo (CAL)
  - Spectral resolved irradiance (SRI)
  - Sunshine duration (SDU)

- **Resolution**
  - Spatial: 0.05° × 0.05°
  - Temporal: 30 min, daily-, monthly means

- **Coverage**
  - Spatial: Meteosat disk
  - Temporal: 1983 to 2017

- **Satellites**
  - Meteosat 2 to 10 (MVIRI / SEVIRI)

DOI: 10.5676/EUM_SAF_CM/SARAH/V002_01
ICDR SEVIRI Radiation
based on SARAH-2 methods

- **Variables**
  - Surface Incoming Shortwave Radiation (SIS)
  - Surface Incoming Direct Radiation (SID)
  - Direct Normalized Irradiance (DNI)
  - Sunshine Duration (SDU)

- **Resolution**
  - Spatial: 0.05° × 0.05°
  - Temporal: 30 min, daily-, monthly means

- **Coverage**
  - Spatial: Meteosat disk
  - Temporal: since January 2018

- **Satellites**
  - Meteosat (SEVIRI)
# Available CM SAF CDRs

<table>
<thead>
<tr>
<th>Sensor, Satellite resp.</th>
<th>Parameter</th>
<th>CDR Period</th>
<th>Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fundamental Climate Data Record (FCDR)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMMR, SSM/I, SSMIS</td>
<td>Microwave Radiances</td>
<td>1978 – 2015</td>
<td>global</td>
</tr>
<tr>
<td><strong>Climate Data Record (CDR)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEVIRI</td>
<td>Cloud parameters (frac., height, opt. dep., phase, eff. rad., LWP, IWP), AOD</td>
<td>2004 – 2015</td>
<td></td>
</tr>
<tr>
<td>GERB/SEVIRI</td>
<td>Top of atmosphere radiative fluxes</td>
<td>2004 – 2015</td>
<td></td>
</tr>
<tr>
<td>AVHRR GAC</td>
<td>Cloud parameters, surface radiation parameters, incl. albedo</td>
<td>1982 – 2015</td>
<td></td>
</tr>
<tr>
<td>SSM/I, SSMIS, SMMR</td>
<td>HOAPS 4 (precip, evap, hum., wind, ...)&lt;br&gt;ice-free ocean )</td>
<td>1987 – 2014</td>
<td>Global</td>
</tr>
<tr>
<td>ATOVS</td>
<td>Water vapour and temperature profiles</td>
<td>1999 – 2012</td>
<td></td>
</tr>
<tr>
<td>MSU, AMSU, SSM/T2, MHS</td>
<td>Upper troposphere humidity</td>
<td>1992 – 2015</td>
<td></td>
</tr>
</tbody>
</table>
## Committed CM SAF CDRs until 2022

<table>
<thead>
<tr>
<th>Sensor, Satellite resp.</th>
<th>Parameter</th>
<th>CDR Period</th>
<th>Coverage</th>
</tr>
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<tr>
<td><strong>Fundamental Climate Data Record (FCDR)</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>SMMR, SSM/I, SSMIS</td>
<td>Microwave Radiances</td>
<td>1978 – 2020</td>
<td>global</td>
</tr>
<tr>
<td><strong>Climate Data Record (CDR)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEVIRI</td>
<td>Cloud parameters (frac., height, opt. dep., phase, eff. Rad., LWP, IWP)</td>
<td>2004 – 2020</td>
<td>Regional</td>
</tr>
<tr>
<td><strong>Microwave imagers+sounders, georing</strong></td>
<td>Global precipitation</td>
<td>2002 – 2019</td>
<td></td>
</tr>
<tr>
<td>AVHRR GAC</td>
<td>Cloud parameters, surface radiation parameters, incl. albedo</td>
<td>1978 – 2020</td>
<td></td>
</tr>
<tr>
<td>SSM/I, SSMIS, TMI, GMI, AMSR-2</td>
<td>HOAPS 5 (precip, evap, hum., wind, ..) Ice-free ocean</td>
<td>1987 – 2020</td>
<td>Global</td>
</tr>
<tr>
<td>HIRS</td>
<td>Cirrus cloud fraction, cloud top pressure</td>
<td>1980 – 2016</td>
<td></td>
</tr>
<tr>
<td>MSU, AMSU, SSM/T2, MHS</td>
<td>Upper troposphere humidity</td>
<td>1993 – 2020</td>
<td></td>
</tr>
</tbody>
</table>
Quality assurance

- Rigorous review cycle is applied before publishing CDRs
- DOI is assigned
- CDR comes with comprehensive documentation and publications
- CDR with uncertainty estimates
- Participation in international assessments and retrieval evaluations
Participation in international assessments

- GEWEX Water Vapor Assessment (G-VAP)
  Information, also data, at:

- International Precipitation Working Group (IPWG)
  Information, also on data, at:
  [http://www.isac.cnr.it/~ipwg/](http://www.isac.cnr.it/~ipwg/)

- International Clouds Working Group (ICWG)
  More information at:

*TCWV, difference to ensemble mean of G-VAP data archive*
*Source: Schröder et al. (2018), ESSD*
CM SAF Users

- Research institutes: 52%
- Private companies: 11%
- Meteorological Services: 28%
- State authorities: 9%
- Others: 0%

3806 registered User in December 2019
Data Access

- Web User Interface
  - Easy selection and online ordering
  - Possibility of regular data delivery
  - Postprocessing
    - Spatial, temporal selection
  - Data format (NetCDF)
  - Download via https or sftp
  - All data free of charge

- User Help Desk

https://wui.cmsaf.eu
Data Access

→ EUMETCast

→ The following CM SAF products are disseminated via EUMETCast:
  ➔ Monthly mean fractional cloud cover
  ➔ Daily and monthly mean surface incoming shortwave radiation
  ➔ Daily and monthly sum sunshine duration

→ Product format is NetCDF

→ EUMETCast Africa:
  ➔ Channel: E1B-SAF-4

https://eoportal.eumetsat.int
CM SAF R Toolbox

- CM SAF provides CM SAF R Toolbox for free
- No R or scripting experiences needed

www.cmsaf.eu/R_toolbox
Training

- Training workshops in cooperation with EUMETSAT
- Practical exercises with CM SAF data
- To learn more about EUMETSAT training workshops see:

  https://training.eumetsat.int
Summary

- Products and services in connection with global energy and water cycle
- Thoroughly quality assurance and control mechanisms
- Extensive exchange and support with / of users
- Free and uncomplicated data access
- Peer-reviewed publications using CM SAF data are available here:

Contact data:

www.cmsaf.eu
Contact.cmsaf@dwd.de