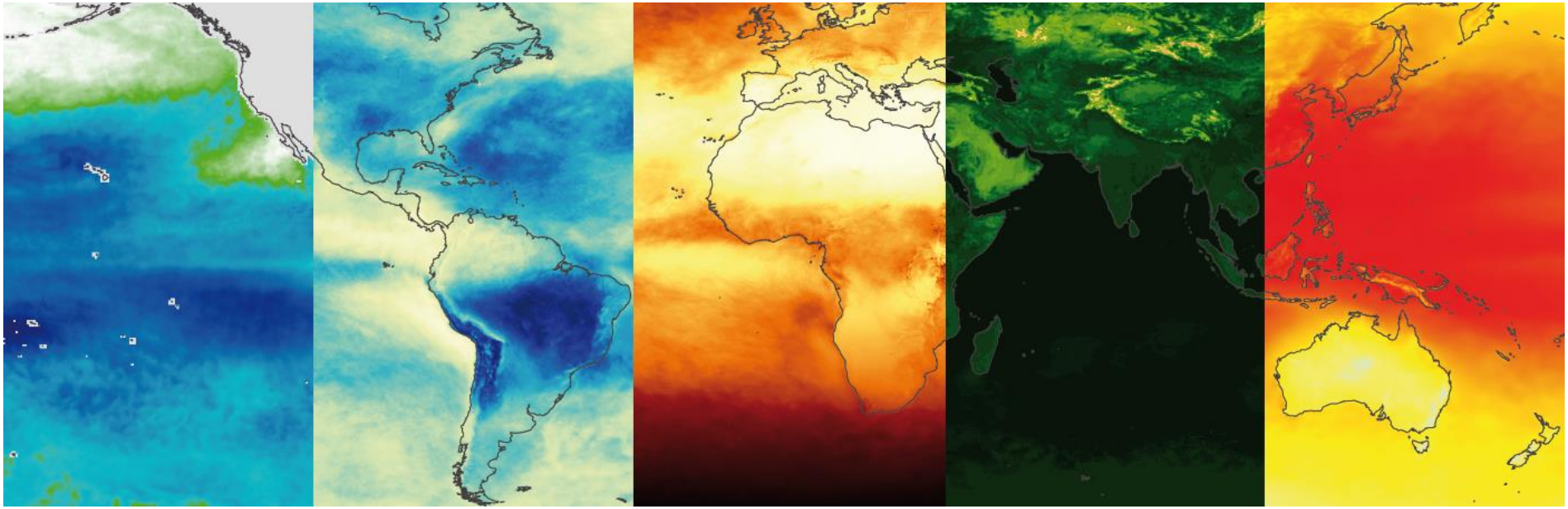
EUMETSAT CM SAF CLIMATE MONITORING

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

DWD

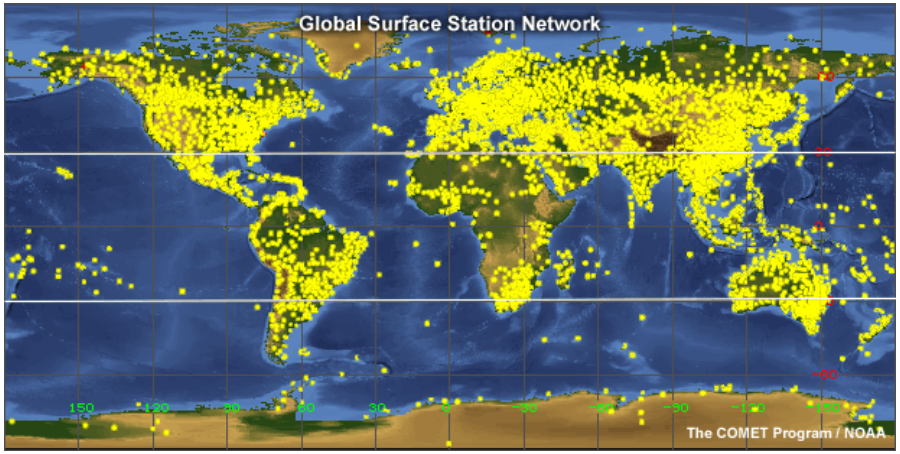
Satellite Application Facility on Climate Monitoring
Climate Data Records and Services

Steffen Kothe and CM SAF team

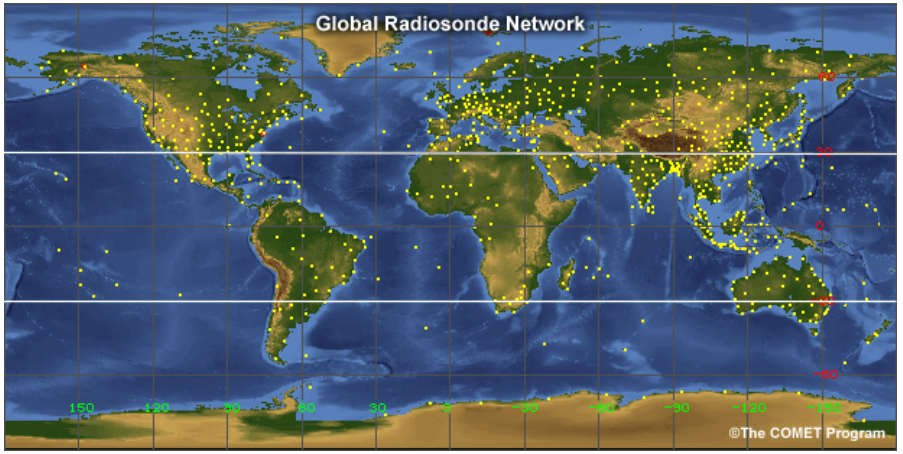


Climate Monitoring

- State of climate system
- Better understanding of climate change



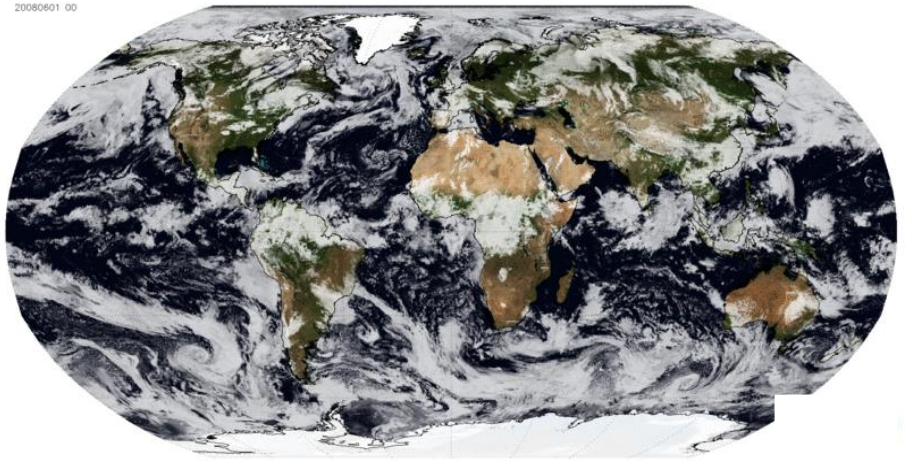
Global station network



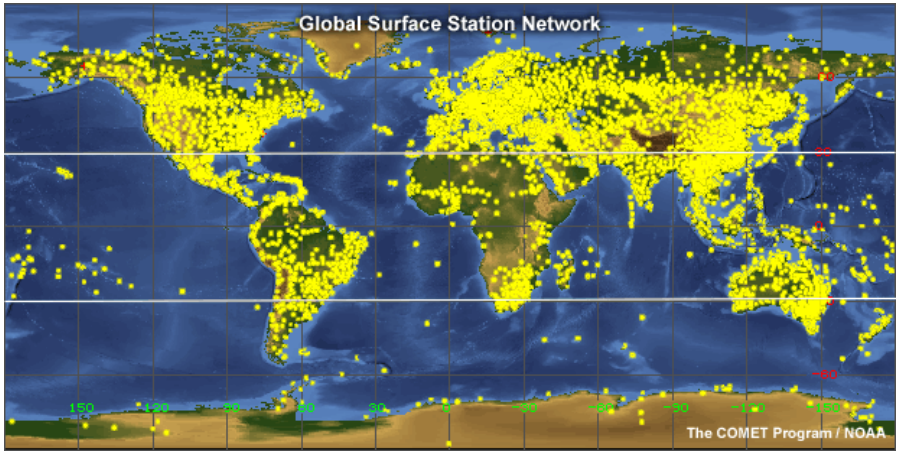
Global Radiosonde network

Climate Monitoring

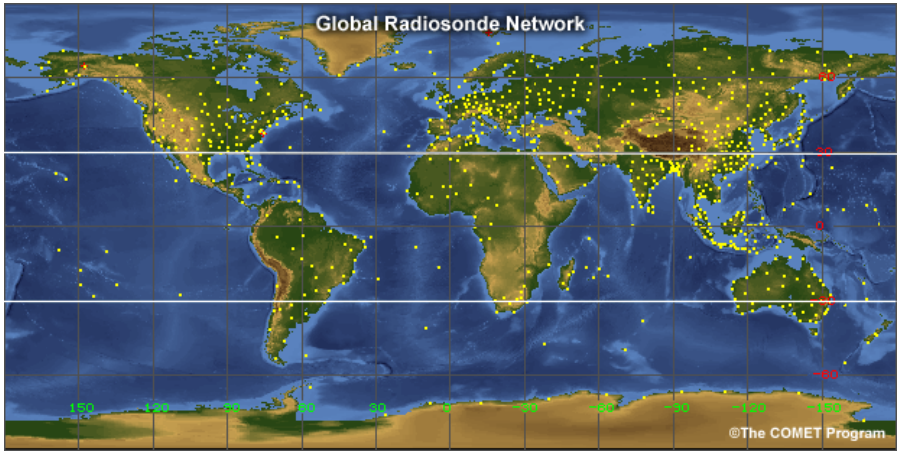
- State of climate system
- Better understanding of climate change
- Basis are in situ measurements and more and more satellite-based data



Global coverage of satellites

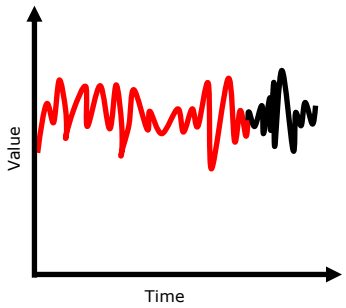


Global station network

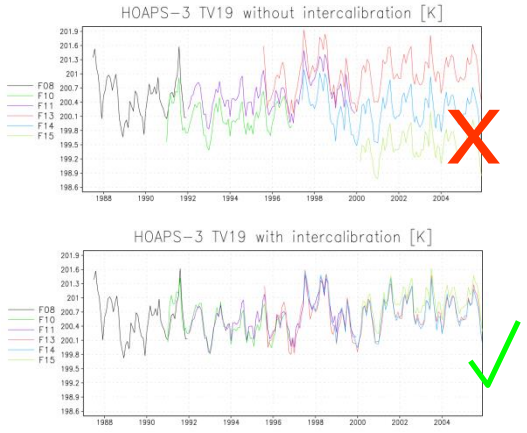


Global Radiosonde network

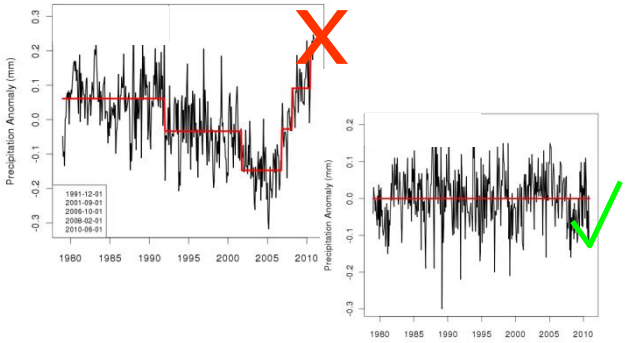
Requirements for Climate Data



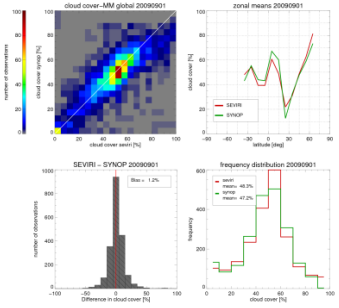
Long-term time series

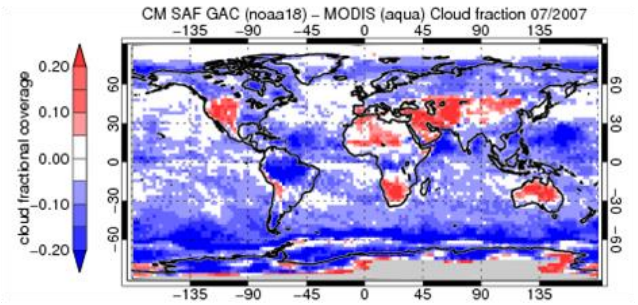


Calibration



Homogeneity

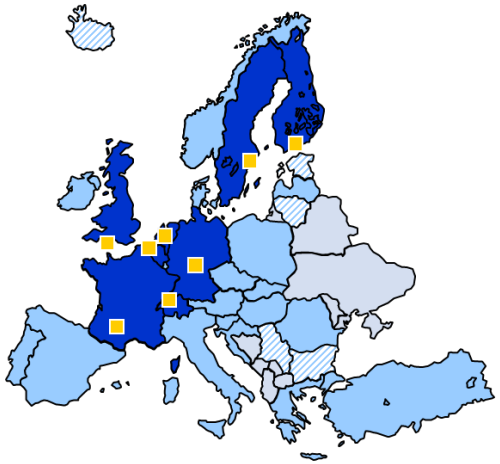




Quality control

Mandat

The EUMETSAT Satellite Application Facility on Climate Monitoring develops, generates, archives and distributes high-quality satellite-derived products of the energy & water cycle in support to monitor, understand and adapt to climate variability and climate change.



Partner:

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

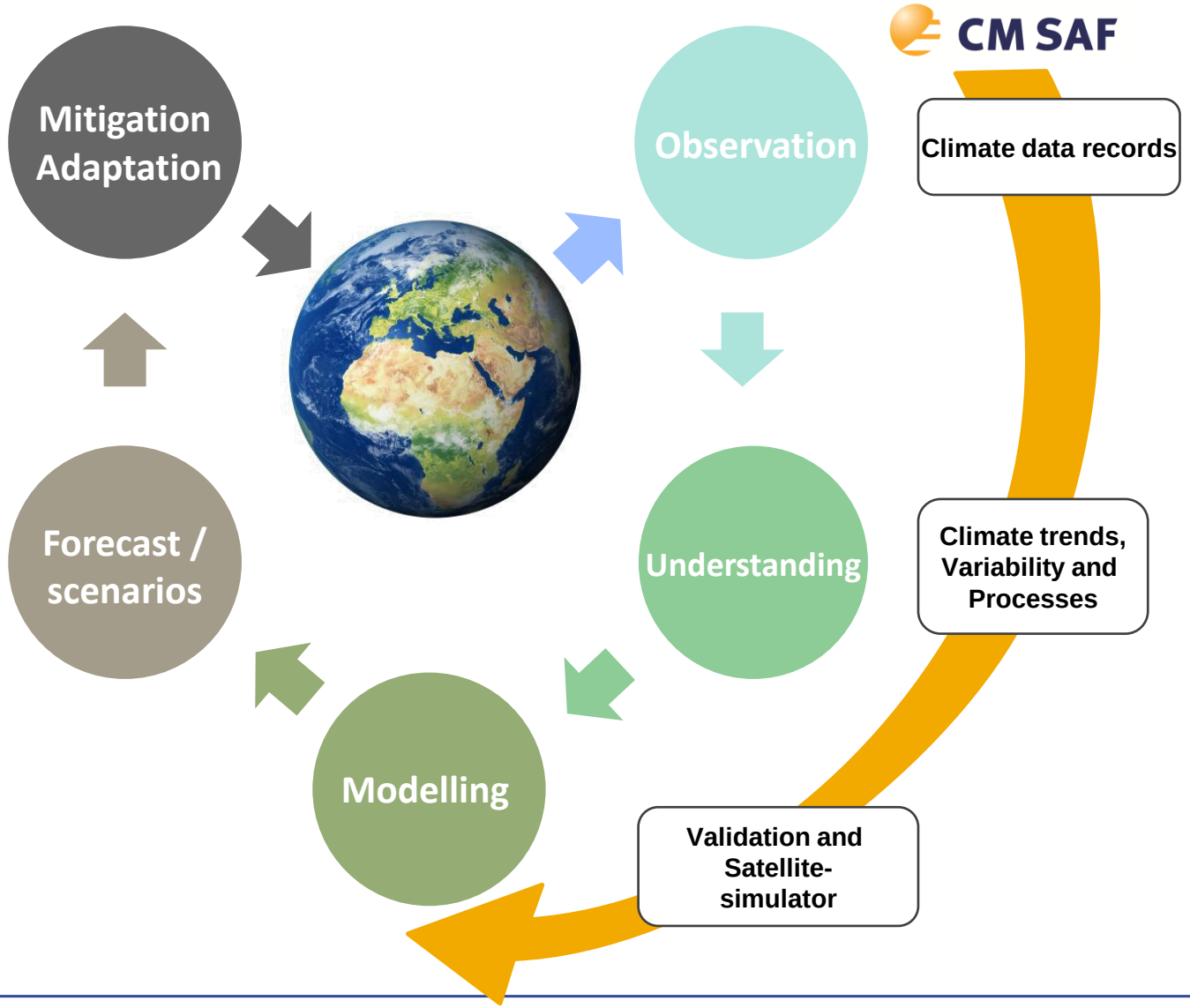
SMHI

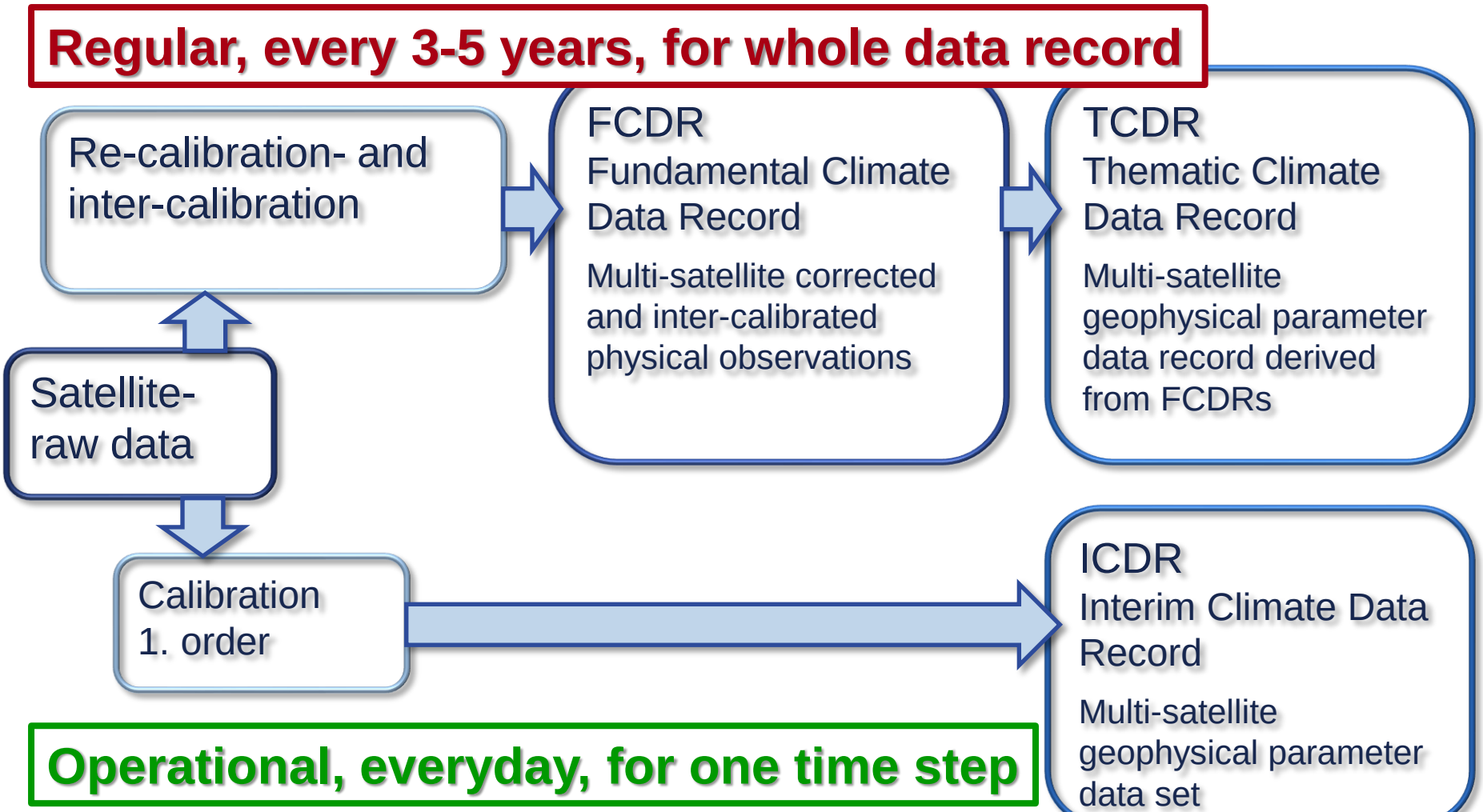
Royal Netherlands Meteorological Institute
Ministry of Transport, Public Works and Water Management

Met Office

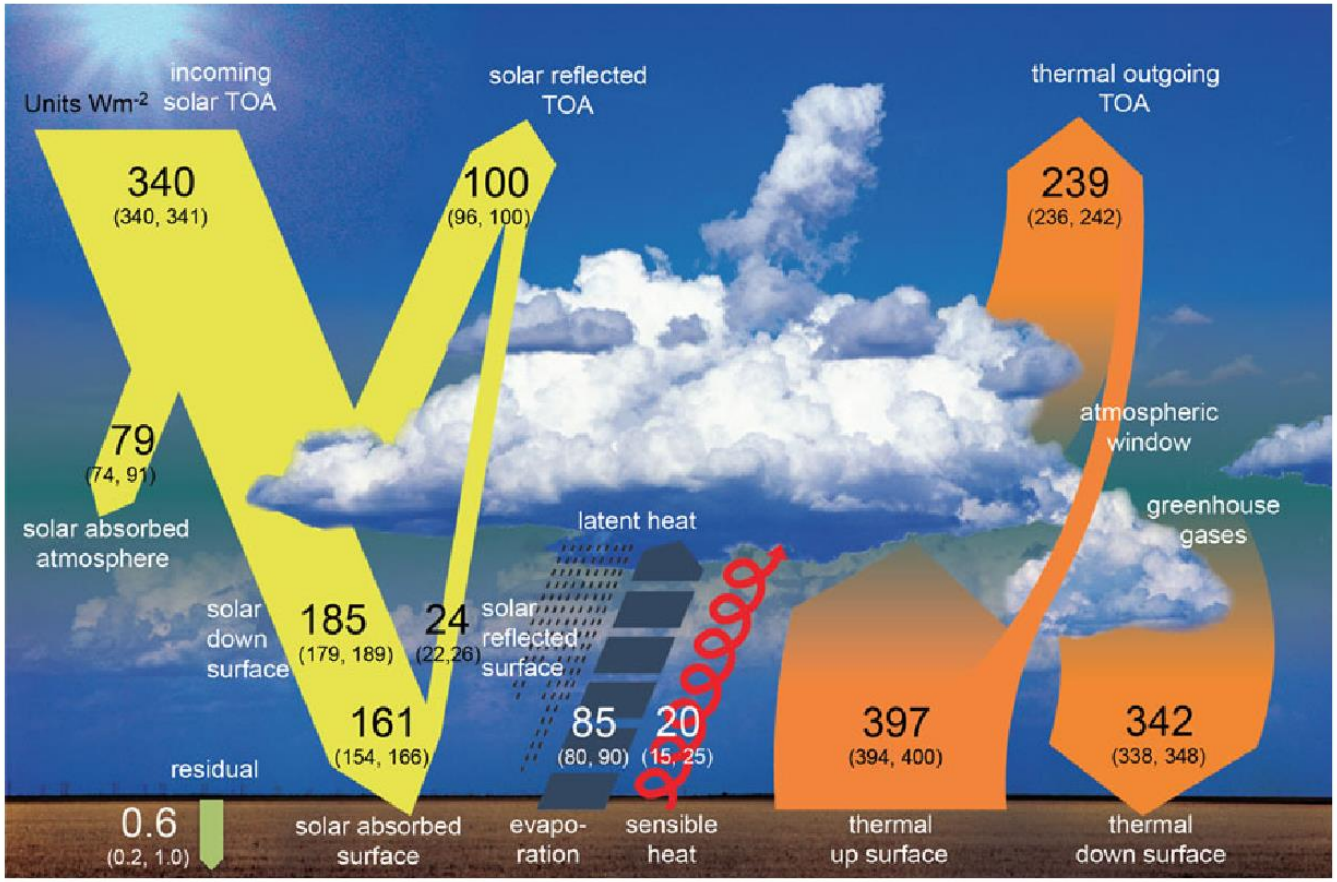
RMI

Centre National de la recherche scientifique


CM SAF
Mitigation
Adaptation
Observation
Climate data records
Forecast /
scenarios
Understanding
Climate trends,
Variability and
Processes
Modelling
Validation and
Satellite-
simulator

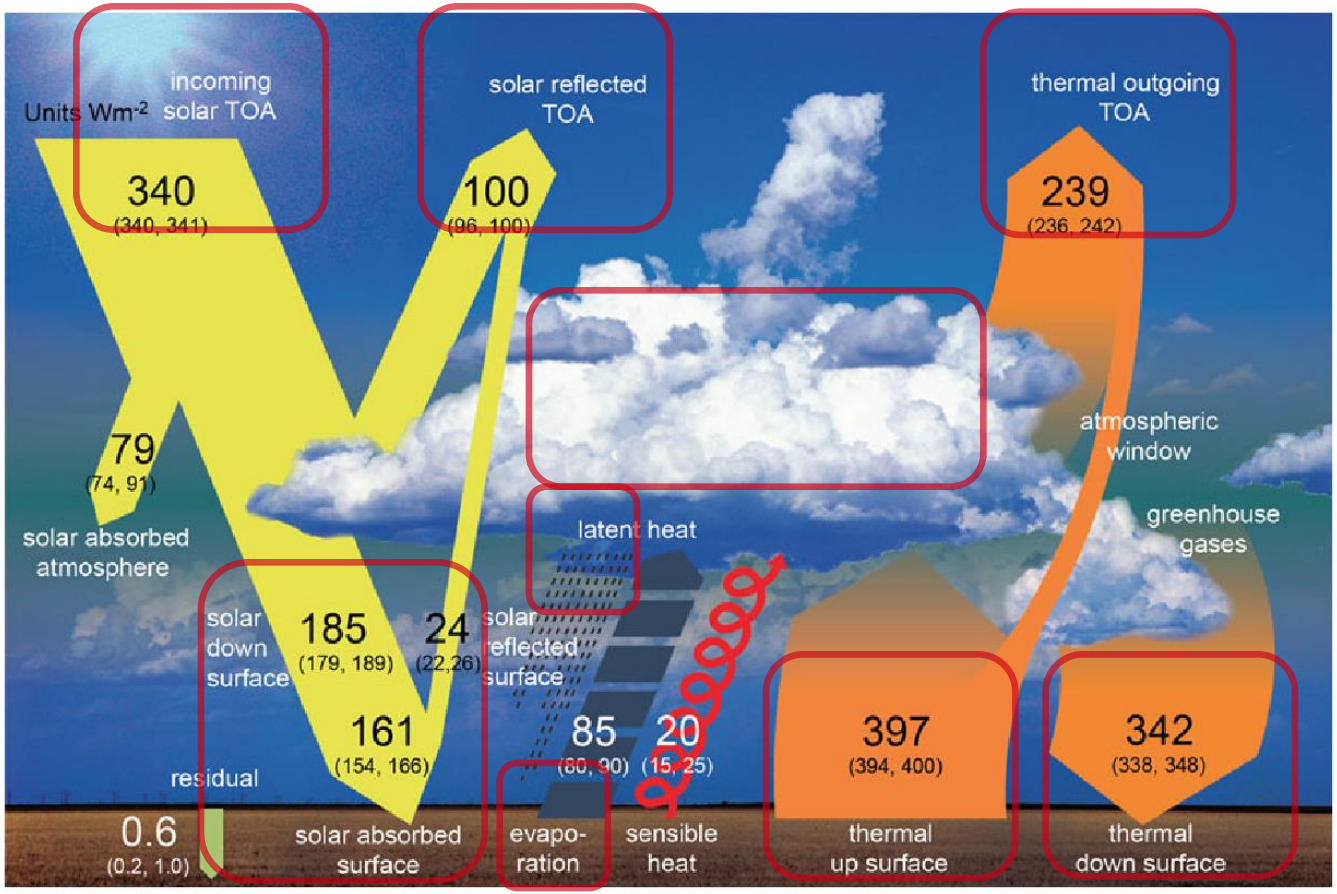

Regular, every 3-5 years, for whole data record
Re-calibration- and inter-calibration
FCDR
Fundamental Climate Data Record
Multi-satellite corrected and inter-calibrated physical observations
TCDR
Thematic Climate Data Record
Multi-satellite geophysical parameter data record derived from FCDRs
Satellite-raw data
Calibration 1. order
ICDR
Interim Climate Data Record
Multi-satellite geophysical parameter data set
Operational, everyday, for one time step

Global Energy and Water Cycle



Source:
Wild et al., 2013

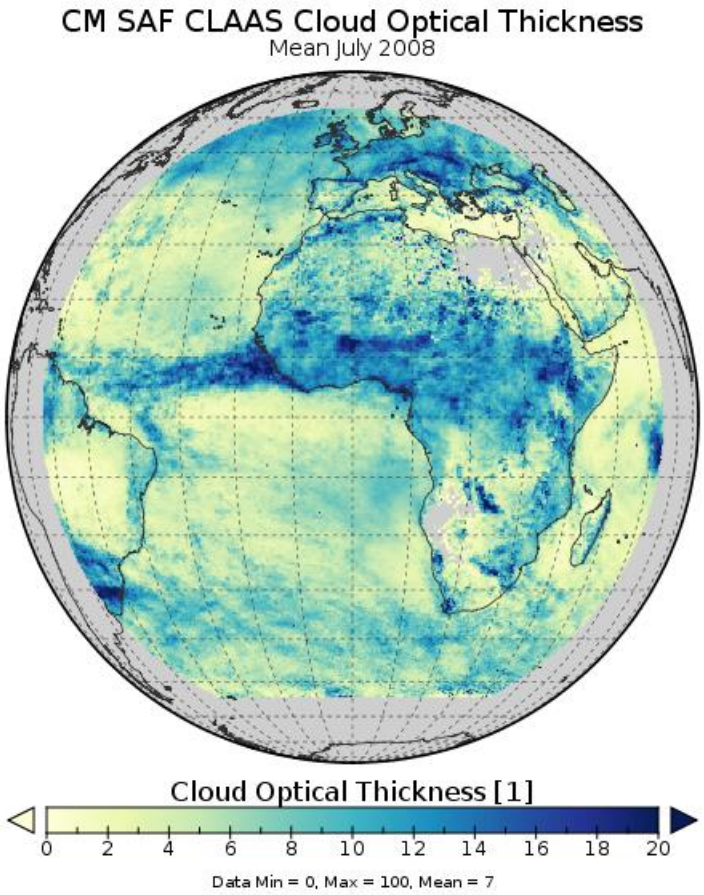
Global Energy and Water Cycle



Source:
Wild et al., 2013

CLAAS-2

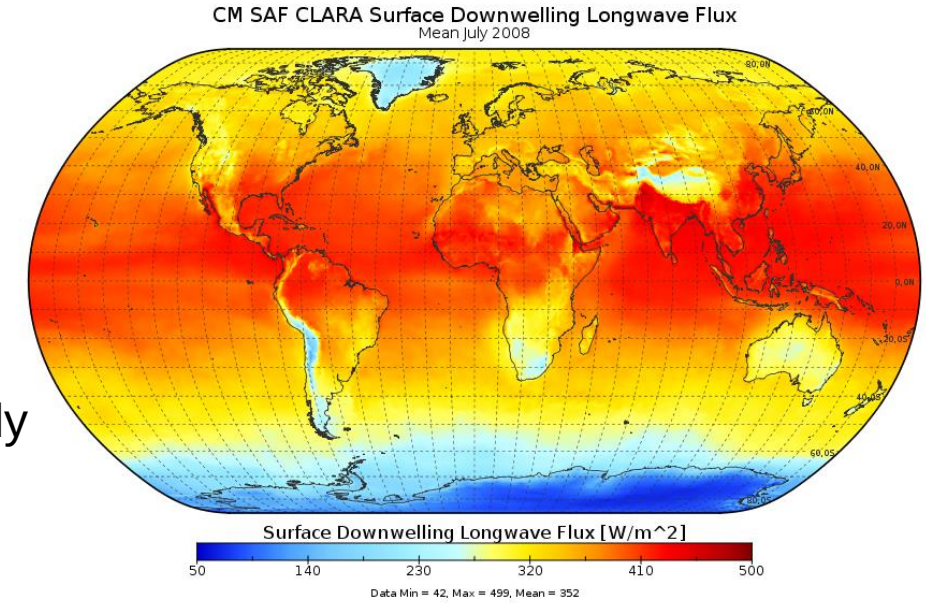
- **Variables**
  - Cloud properties
  - Liquid and ice water path
- **Resolution**
  - Spatial: native, 0.05°×0.05° (0.25°×0.25°)
  - Temporal: 15 min, hourly-, daily-, monthly means, mean monthly diurnal cycle
- **Coverage**
  - Spatial: Meteosat disk
  - Temporal: 2004 to 2015
- **Satellites**
  - Meteosat Second Generation (SEVIRI)



DOI:10.5676/EUM_SAF_CM/CLAAS/V002

CLARA-A2

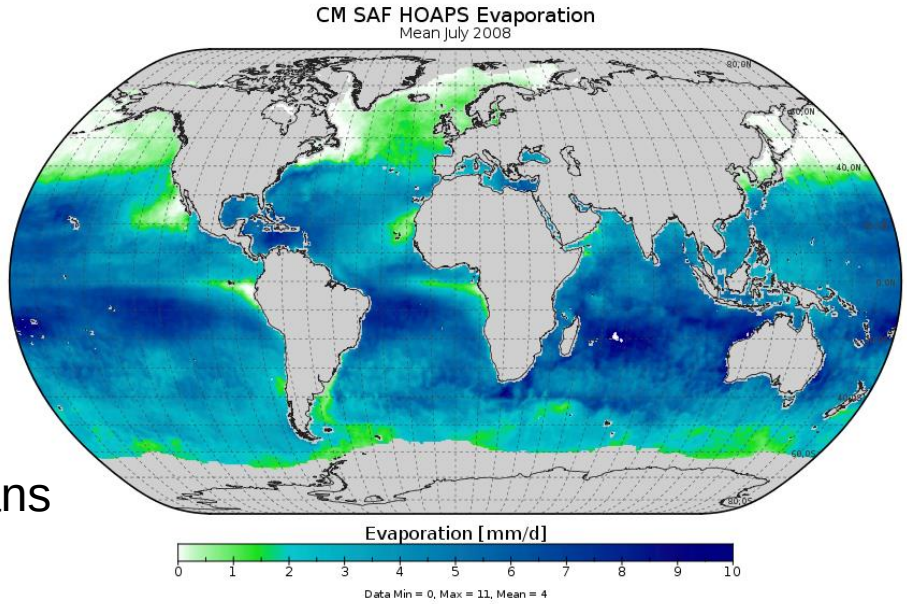
- **Variables**
  - Cloud properties
  - Surface albedo
  - Radiation
- **Resolution**
  - Spatial: 0.25°×0.25°
  - Temporal: daily-, pentad-, monthly mean
- **Coverage**
  - Spatial: global
  - Temporal: 1982 to 2015
- **Satellites**
  - NOAA, Metop (AVHRR)



DOI:10.5676/EUM_SAF_CM/CLARA_AVHRR/V002

HOAPS

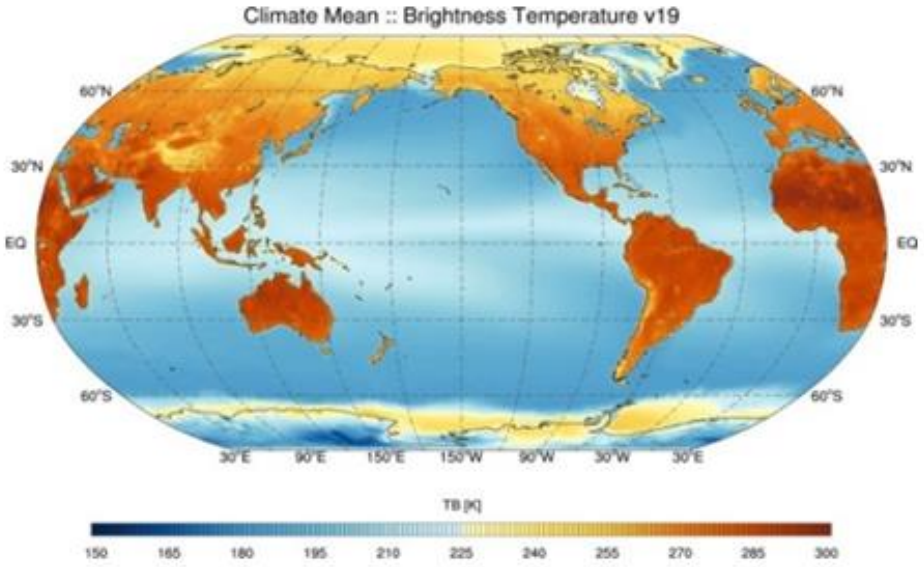
- **Variables**
  - Wind, humidity (close to surface)
  - Precipitation, evaporation
  - Latent heat flux
  - Fresh water flux
- **Resolution**
  - Spatial: 0.5° × 0.5°
  - Temporal: 6-hourly-, monthly means
- **Coverage**
  - Spatial: global ice free ocean
  - Temporal: 1987 to 2014
- **Satellites**
  - DMSP (SSM/I, SSMIS), SMMR



DOI:10.5676/EUM_SAF_CM/HOAPS/V002

FCDR SSM/I

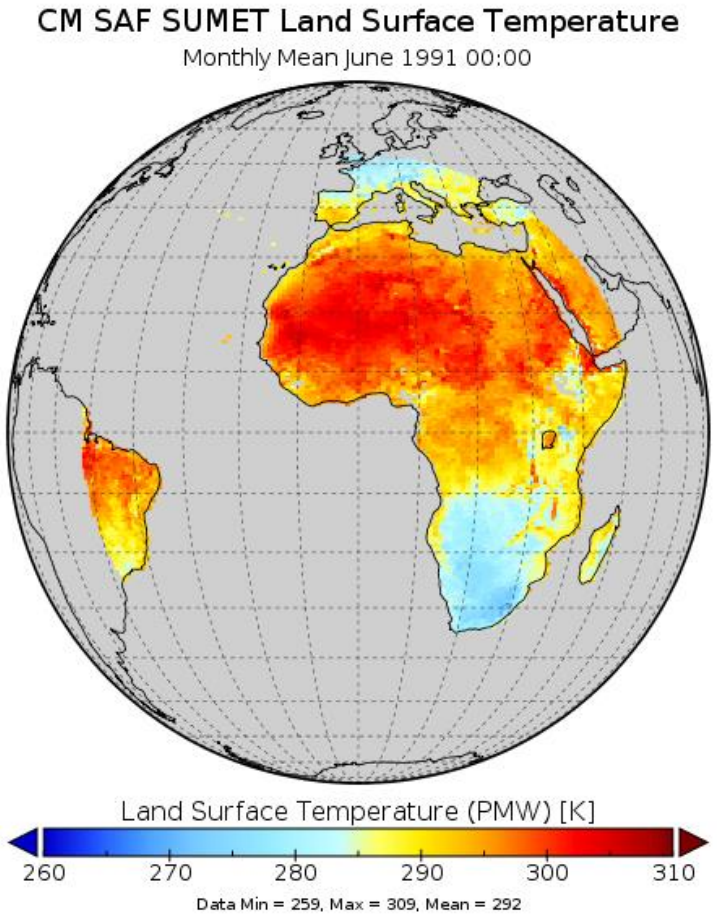
- **Variables**
  - Brightness temperature
- **Resolution**
  - Spatial: native SSM/I
  - Temporal: native SSM/I
- **Coverage**
  - Spatial: global
  - Temporal: 1978 to 2013
- **Satellites**
  - DMSP (SSM/I, SSMIS), SMMR



DOI:10.5676/EUM_SAF_CM/FCDR_MWI/V002

SUMET

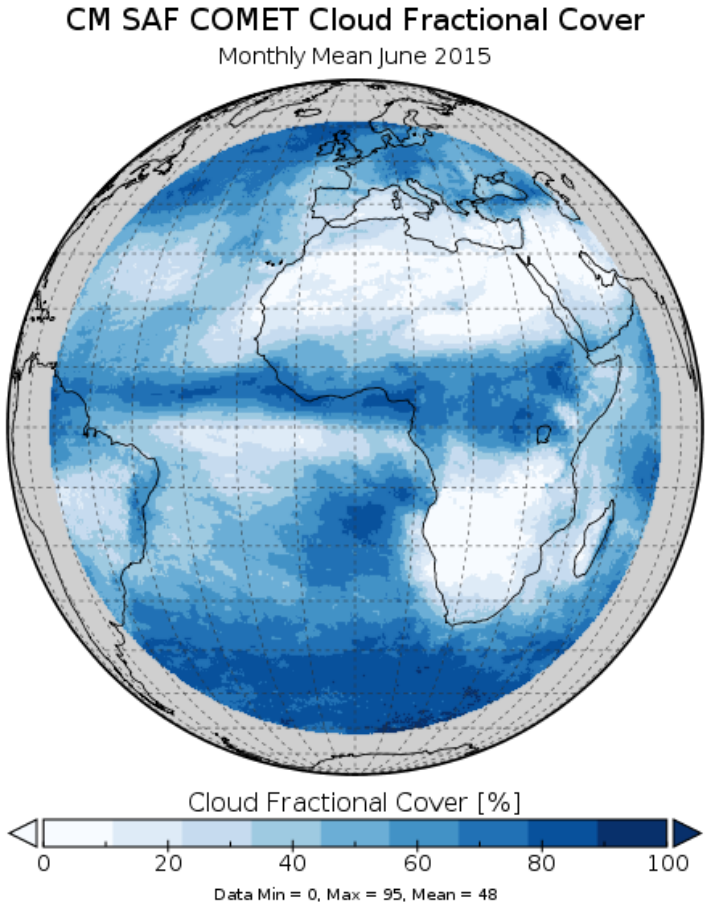
- **Variables**
  - Land surface temperature basing on physical model (LTP)
  - Land surface temperature basing on statistical model (LTS)
- **Resolution**
  - Spatial: 0.05° × 0.05°
  - Temporal: hourly instantaneous, monthly mean diurnal cycle
- **Coverage**
  - Spatial: Meteosat disk
  - Temporal: 1991 to 2015
- **Satellites**
  - Meteosat (MVIRI/SEVIRI)



DOI:10.5676/EUM_SAF_CM/LST_METEOSAT/V001

COMET

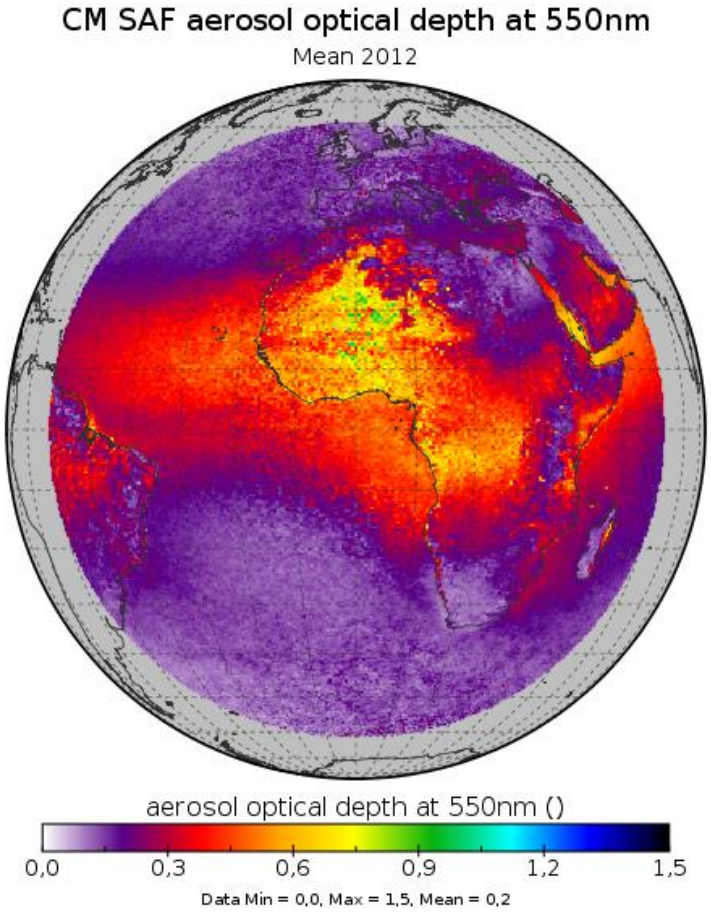
- **Variables**
  - Fractional cloud cover (CFC)
- **Resolution**
  - Spatial: 0.05° × 0.05°
  - Temporal: hourly instantaneous, daily and monthly means, monthly mean diurnal cycle
- **Coverage**
  - Spatial: Meteosat disk
  - Temporal: 1991 to 2015
- **Satellites**
  - Meteosat (MVIRI/SEVIRI)



DOI:10.5676/EUM_SAF_CM/CFC_METEOSAT/V001

CM SAF AOD

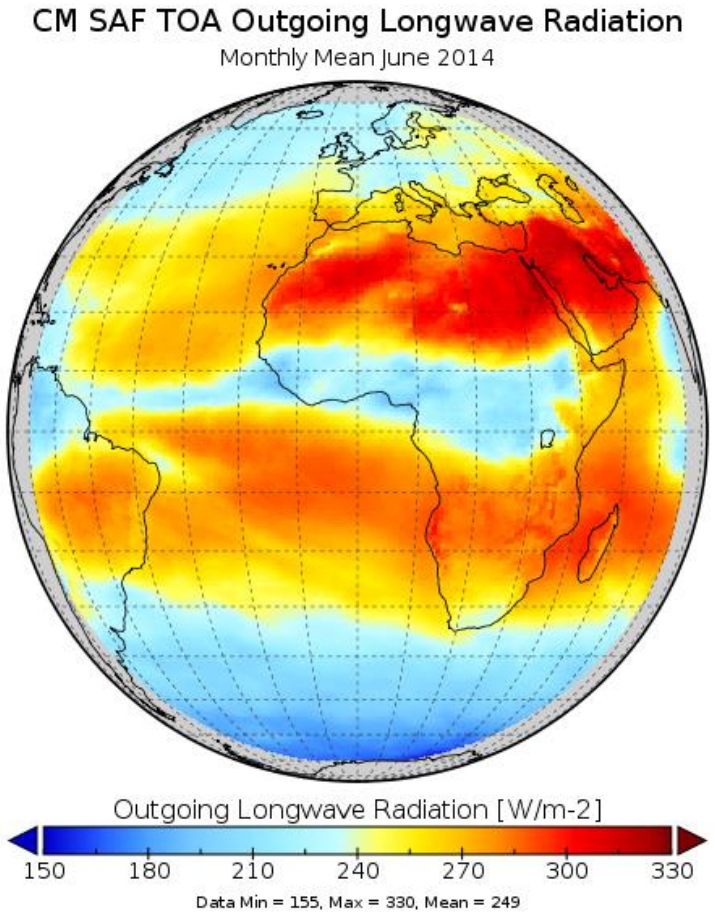
- **Variables**
  - Aerosol Optical Depth (AOD)
- **Resolution**
  - Spatial: native
  - Temporal: daily and monthly means
- **Coverage**
  - Spatial: Meteosat disk
  - Temporal: 02/2004 to 12/2012
- **Satellites**
  - Meteosat (MVIRI/SEVIRI)



DOI:10.5676/EUM_SAF_CM/MSG_AOD/V001

TOA Radiation

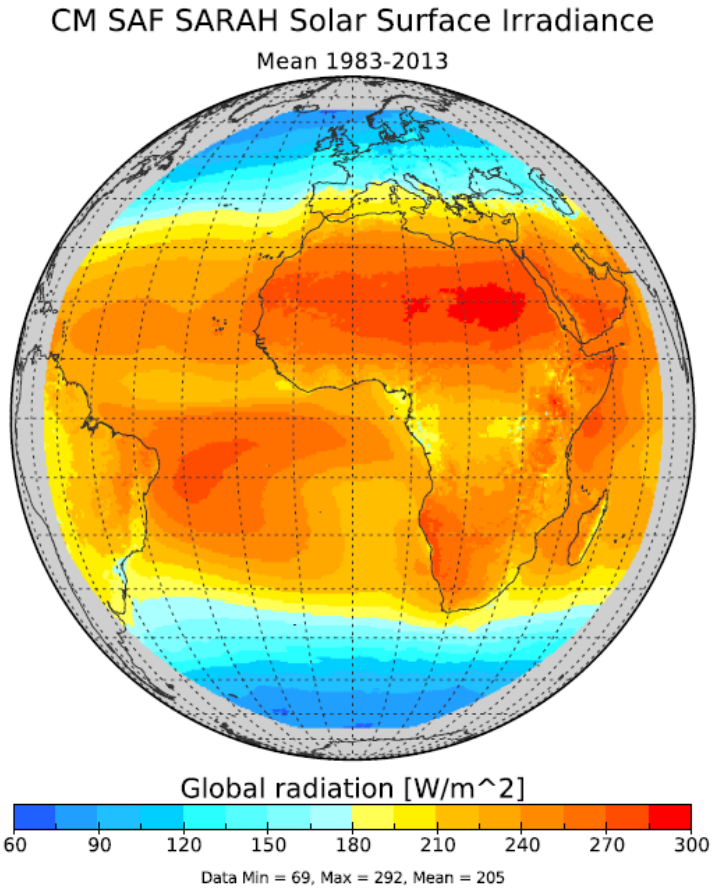
- **Variables**
  - TOA reflected solar (TRS)
  - TOA emitted thermal (TET)
- **Resolution**
  - Spatial: 0.05° × 0.05°
  - Temporal: daily and monthly means, monthly means of hourly means
- **Coverage**
  - Spatial: Meteosat disk
  - Temporal: 2004 to 2015
- **Satellites**
  - Meteosat (GERB/SEVIRI)



DOI:10.5676/EUM_SAF_CM/CFC_METEOSAT/V001

SARAH-2

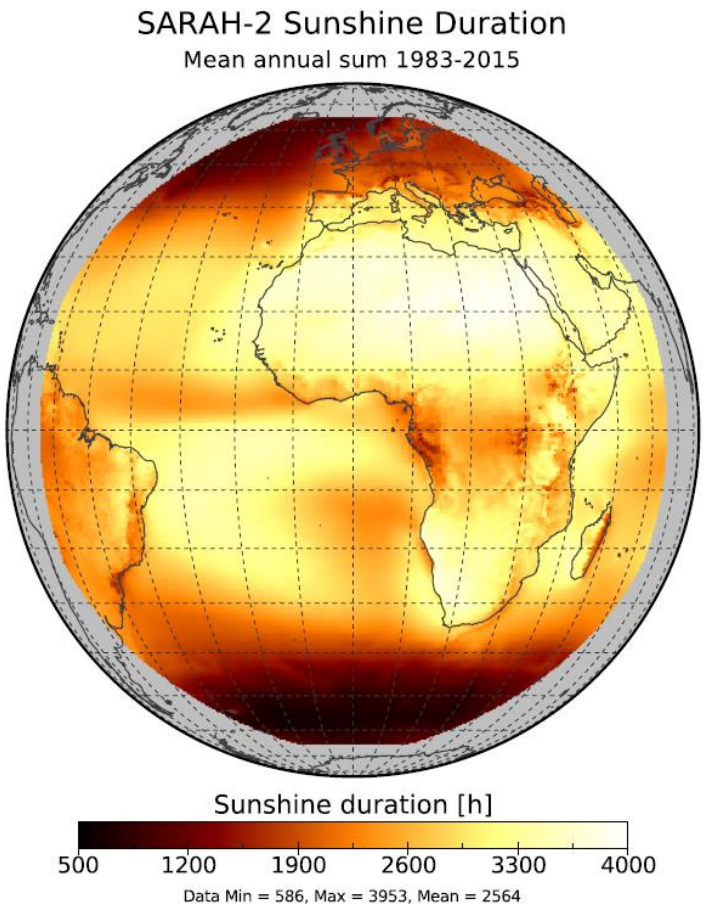
- **Variables**
  - Global radiation (SIS)
  - Surface direct irradiance (SDI)
  - Spectral resolved irradiance (SRI)
  - Effective cloud albedo (CAL)
- **Resolution**
  - Spatial: 0.05° × 0.05°
  - Temporal: 30 min instantaneous, daily-, monthly means
- **Coverage**
  - Spatial: Meteosat disk
  - Temporal: 1983 to 2015
- **Satellites**
  - Meteosat 2 to 10 (MVIRI/SEVIRI)



DOI:10.5676/EUM_SAF_CM/SARAH/V002

SARAH-2 Sunshine Duration

- **Sunshine duration important parameter**
  - Tourism
  - Health Sector
  - Agriculture
  - Vegetation modelling
  - Solar energy



SARAH-2 Sunshine Duration

- **Sunshine duration important parameter**
  - Tourism
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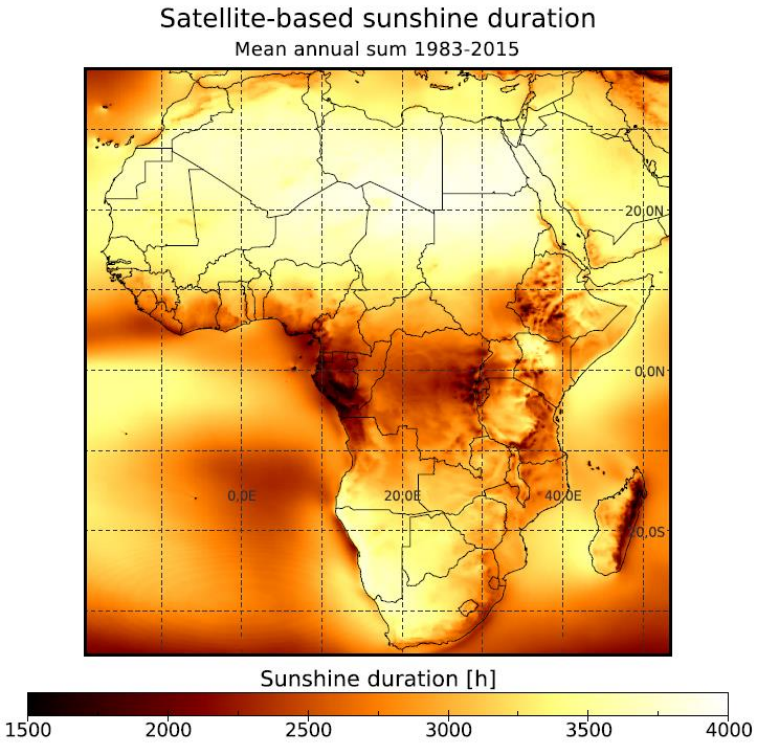
- **First satellite-based sunshine duration dataset for Europe and Africa**



SARAH-2 Sunshine Duration

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  - Tourism
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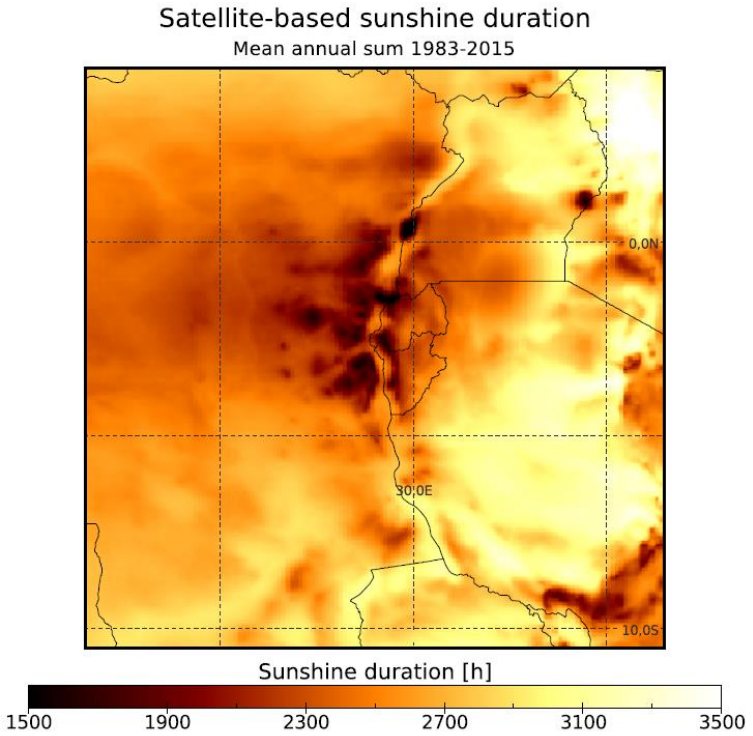
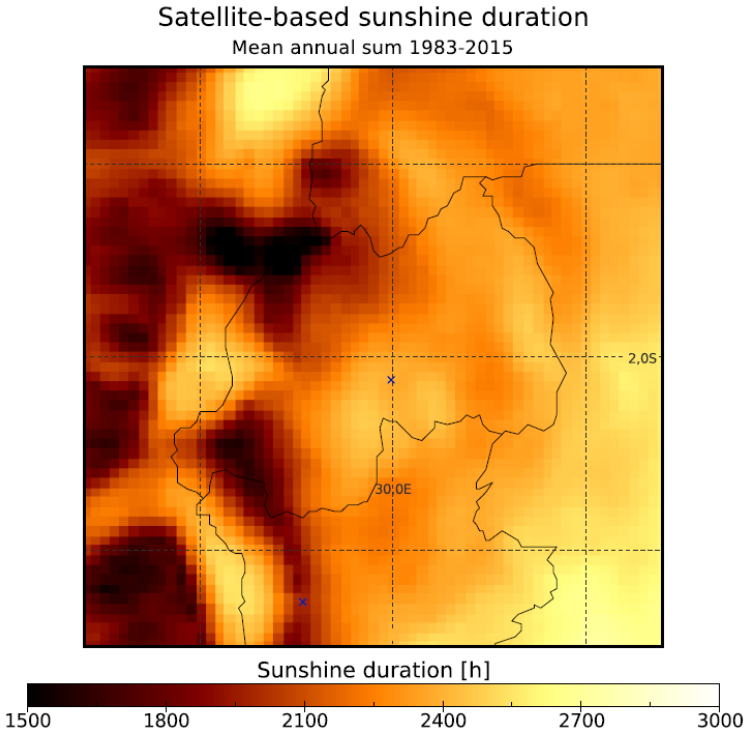
  - Agriculture
  - Vegetation modelling
  - Solar energy
- **First satellite-based sunshine duration dataset for Europe and Africa**
  - Basis SARAH-2 DNI data
  - Evaluation showed good agreement with station data (< 9 %)



SARAH-2 Sunshine Duration

- **Sunshine duration important parameter**
  - Tourism
  - Health Sector
  - Agriculture
  - Vegetation modelling
  - Solar energy
- **First satellite-based sunshine duration dataset for Europe and Africa**
  - Basis SARAH-2 DNI data
  - Evaluation showed good agreement with station data (< 9 %)
  - Suitable for many applications



Available CM SAF CDR's

Sensor, Satellite resp.	Parameter	CDR Period	Coverage
Fundamental **C**limate **D**ata **R**ecord (FCDR)			
SMMR, SSM/I, SSMIS	**Microwave Radiances**	1978 – 2013	global
Climate **D**ata **R**ecord (CDR)			
SEVIRI	**Cloud parameters (frac., height, opt. dep., phase, eff. Rad., LWP, IWP)**	2004 – 2015	Regional
GERB/SEVIRI	**Top of atmosphere radiative fluxes**	2004 – 2015	
MVIRI/SEVIRI	**TOA, surface radiation & Cloud frac.** **Land Surface Temp** **Free tropospheric humidity**	1983 – 2015 1991 – 2015 1983 – 2009	
AVHRR GAC	**Cloud parameters, surface radiation parameters, incl. albedo**	1982 – 2015	Global
SSM/I, SSMIS, SMMR	**HOAPS 4 (precip, evap, hum., wind, ..)** **Ice free ocean only**	1987 – 2014	
ATOVS	**Water vapour and Temperature profile**	1998 – 2008	
MSU, AMSU, SSM/T2, MHS	**Upper troposphere humidity**	1993 – 2013	

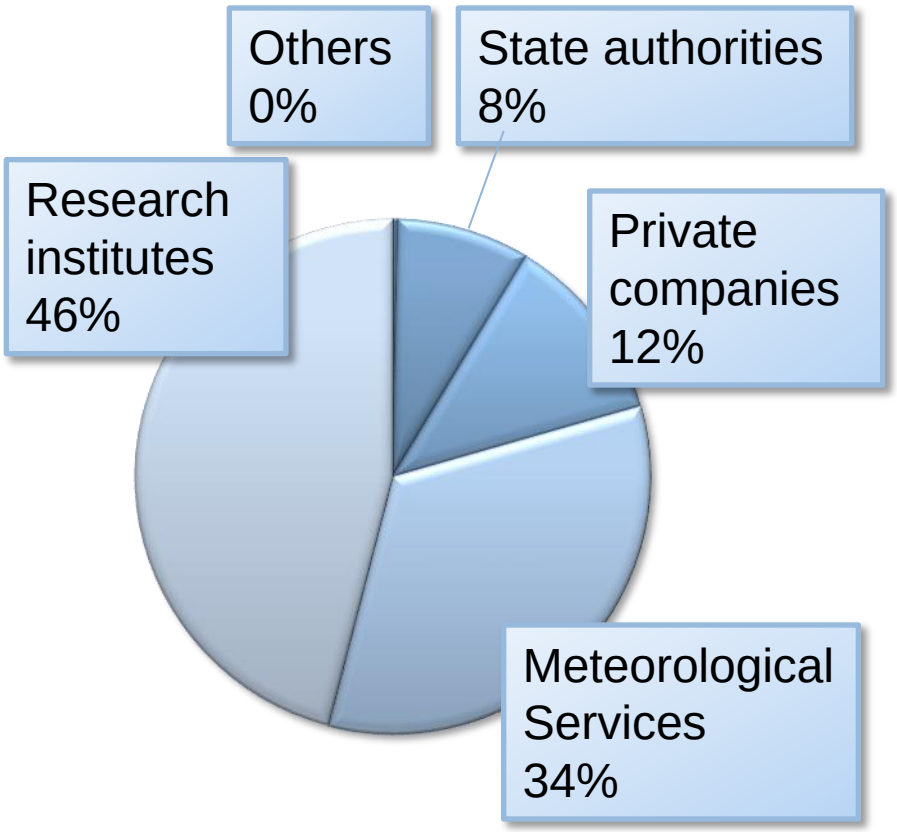
Committed CM SAF CDR's until 2022

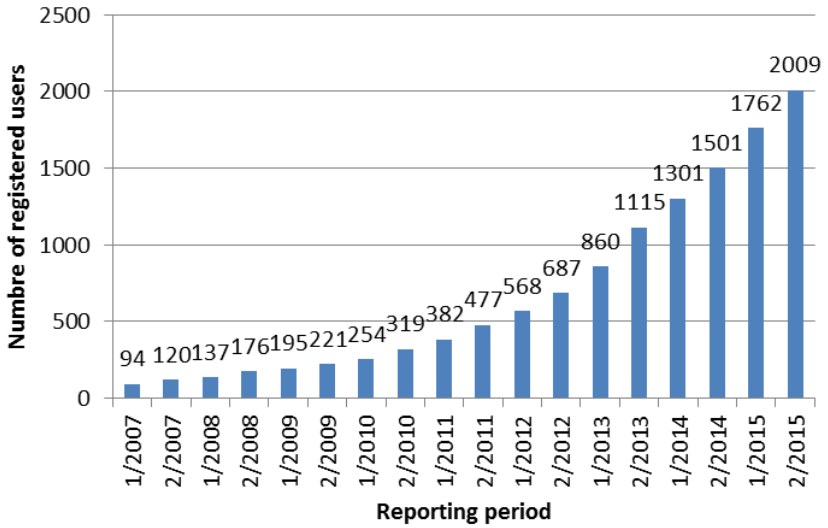
Sensor, Satellite resp.	Parameter	CDR Period	Coverage
Fundamental **C**limate **D**ata **R**ecord (FCDR)			
SMMR, SSM/I, SSMIS	**Microwave Radiances**	1978 – 2013	global
Climate **D**ata **R**ecord (CDR)			
Updated edition of SEVIRI	**Cloud parameters (frac., height, opt. dep., phase, eff. Rad., LWP, IWP)**	2004 – 2020	Regional
NEW: Global Precipitation	**Precipitation rate**	2002 – 2019	
Updated edition of MVIRI/SEVIRI	**TOA, surface radiation & Cloud frac.** **land surface temp, evapo.** **Free tropospheric humidity**	1983 – 2020 1991 – 2020 1983 – 2020	
Updated edition of AVHRR GAC	**Cloud parameters, surface radiation parameters, incl. albedo**	1982 – 2020	Global
Updated edition of SSM/I, SSMIS, TMI, GMI, AMSR-2	**HOAPS 4 (precip, evap, hum., wind, ..)** **Ice free ocean only**	1987 – 2019	
NEW: HIRS cloud properties	**Cloud fraction, cloud top pressure**	1980 – 2013	
Updated edition of MSU, AMSU, SSM/T2, MHS	**Upper troposphere humidity**	1993 – 2020	

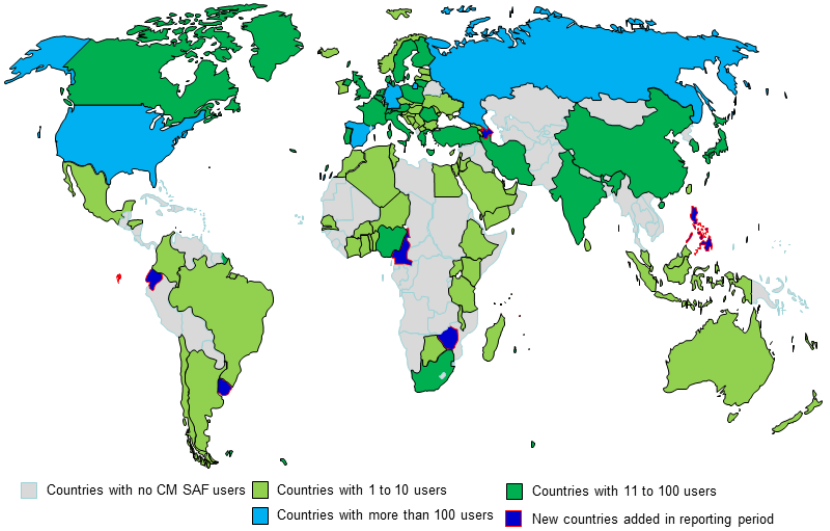
Quality assurance

- 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

CM SAF Users

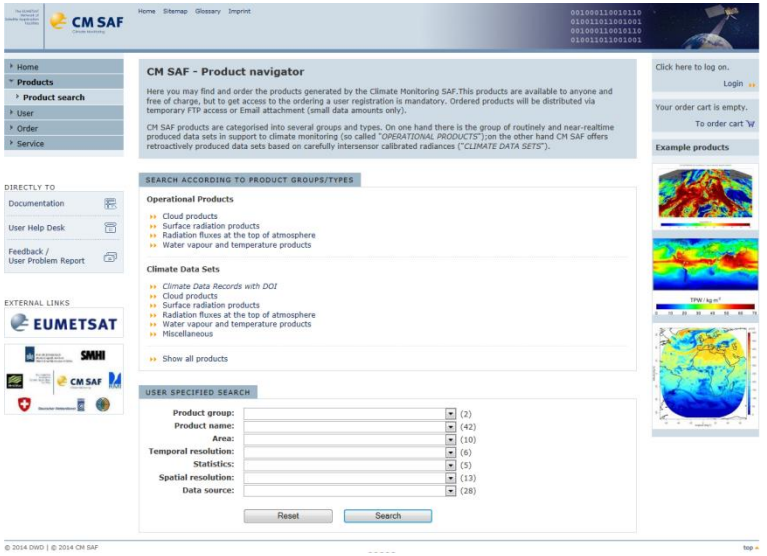

Others
0%
State authorities
8%
Research
institutes
46%
Private
companies
12%
Meteorological
Services
34%


Numbre of registered users
2500
2000
1500
1000
500
0
94
120
137
176
195
221
254
319
382
477
568
687
860
1115
1301
1501
1762
2009
1/2007
2/2007
1/2008
2/2008
1/2009
2/2009
1/2010
2/2010
1/2011
2/2011
1/2012
2/2012
1/2013
2/2013
1/2014
2/2014
1/2015
2/2015
Reporting period


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 reporting period

Data Access

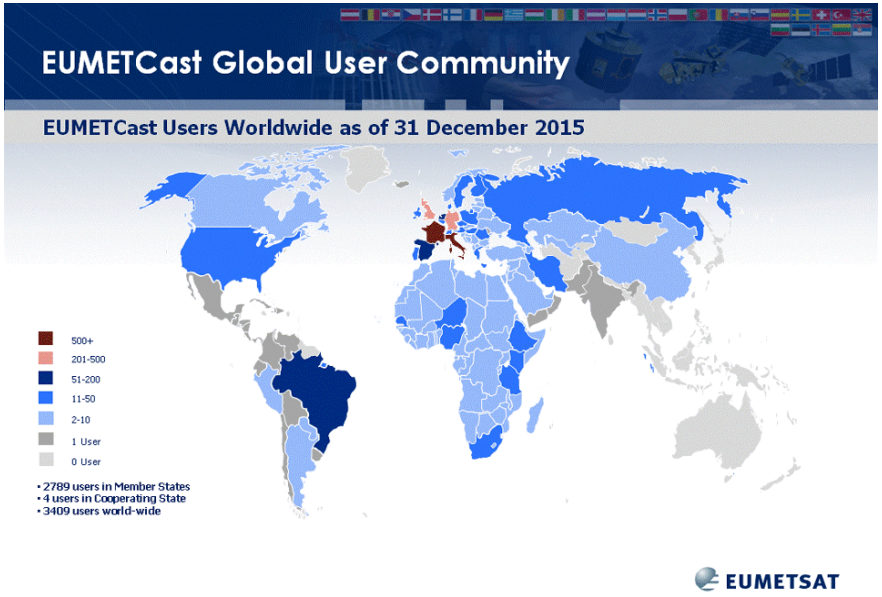
- **Web User Interface**
  - Easy selection and online ordering
  - Possibility of regular data delivery
  - Postprocessing
    - Spatial, temporal selection
  - Data format (NetCDF)
  - Ftp or e-mail
  - All data free of charge
- **User Help Desk**



https://wui.cmsaf.eu

Data Access

- **EUMETCast**
- The following CM SAF products are disseminated via EUMETCast:
  - Monthly mean fractional cloud cover
  - Monthly mean surface incoming shortwave radiation
- Product format is NetCDF
- EUMETCast Africa:
  - Channel: SAF-Africa
    PID: 301
    Multicast Address: 224.223.222.33



https://eoportal.eumetsat.int

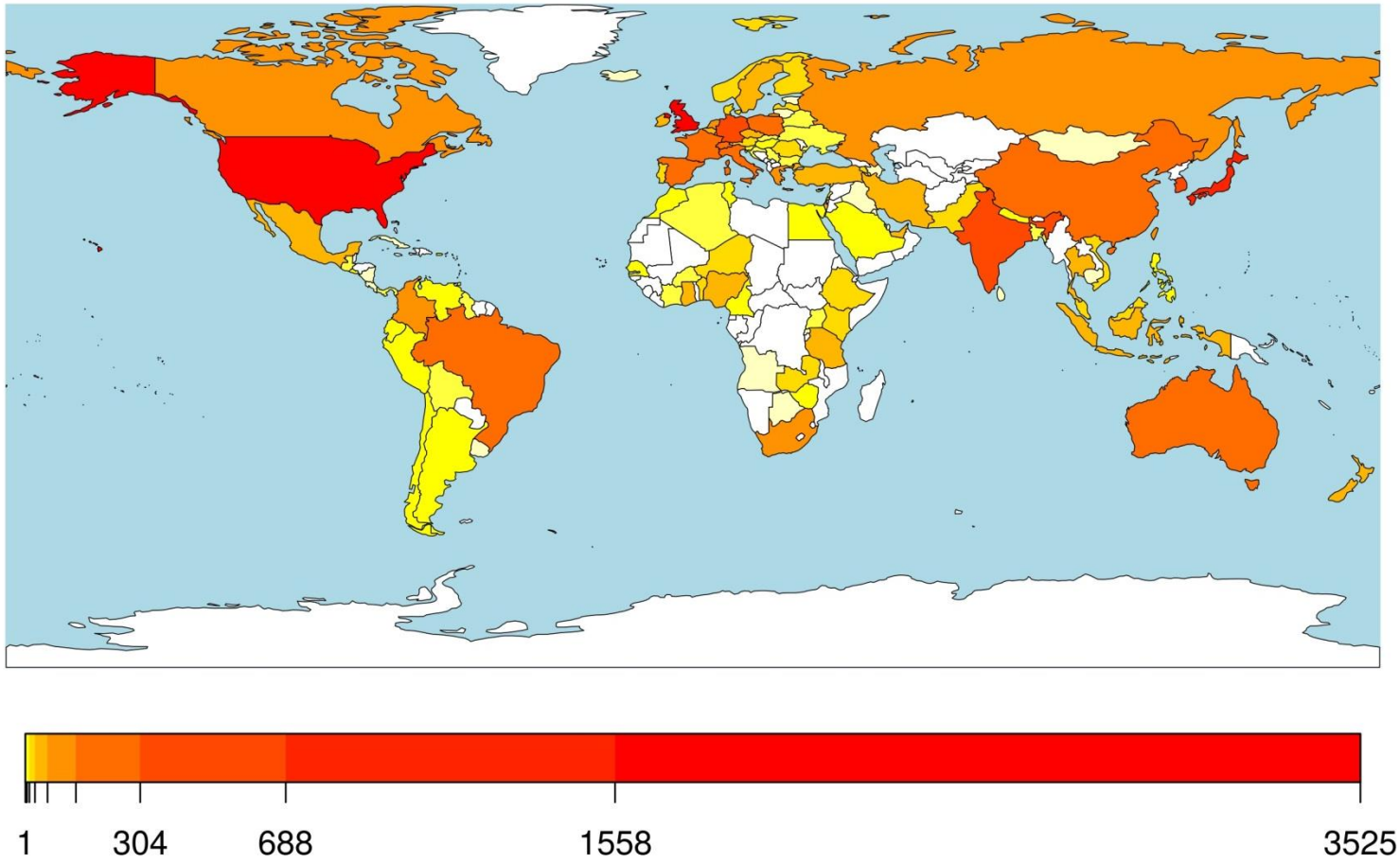
R-Toolbox

- CM SAF provides CM SAF R Toolbox for free
- **Prepare**
  - Preparation of ordered CM SAF data (extract, unzip, choose time & region)
- **Analyse**
  - 'cmsaf' R-package collection of functions for simply analysis and manipulation of CM SAF NetCDF data (see cran.r-project.org)
- **Visualize**
  - R-scripts for visualization of CM SAF data
- R-scripts, which help unexperienced R-users to apply functions of 'cmsaf' R-package (no R or scripting experiences needed)

www.cmsaf.eu/tools

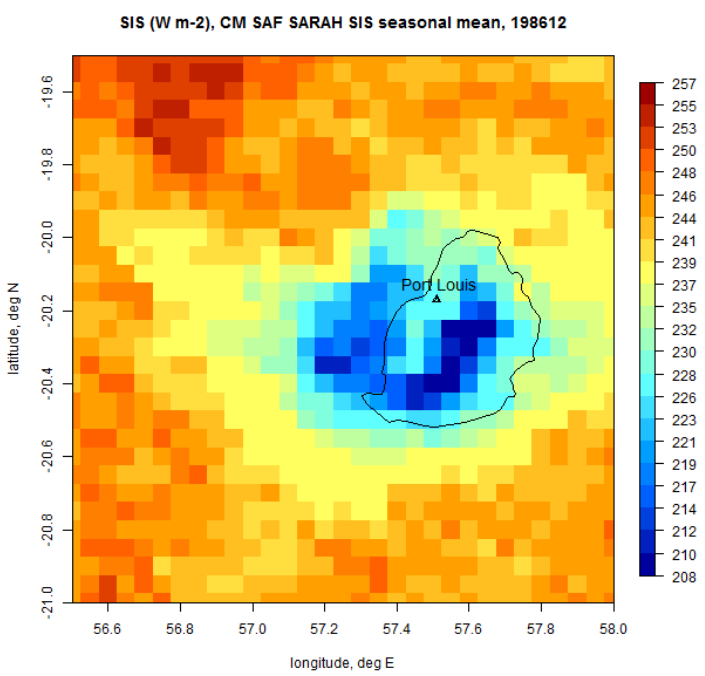
'cmsaf' R-package downloads since 26-06-2015

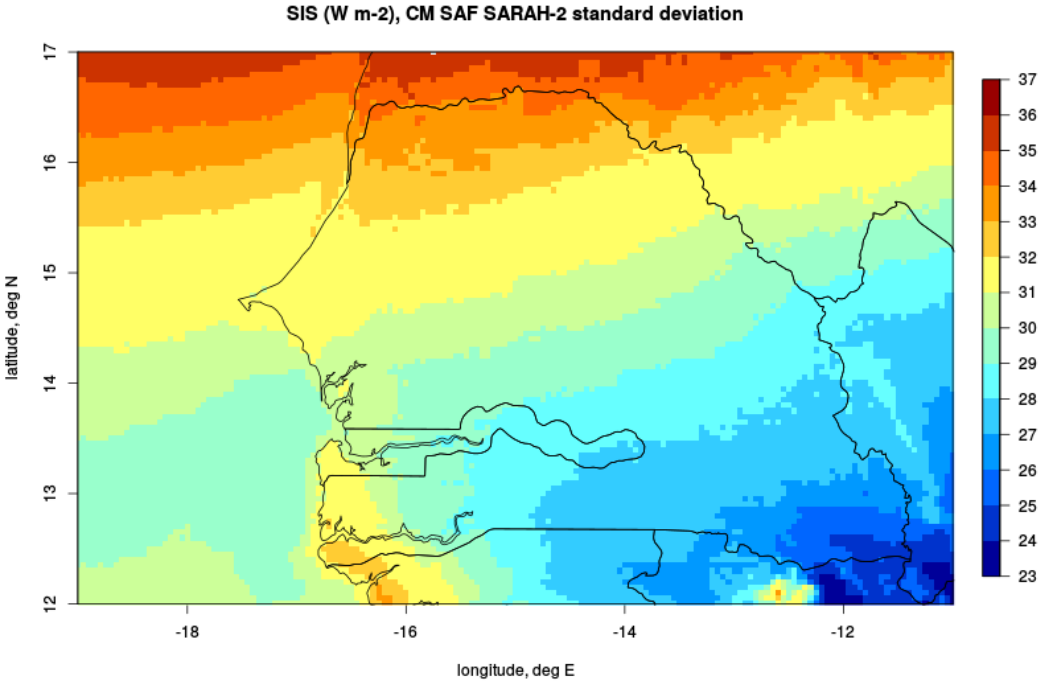
Total downloads: 11121 (03.03.2018)



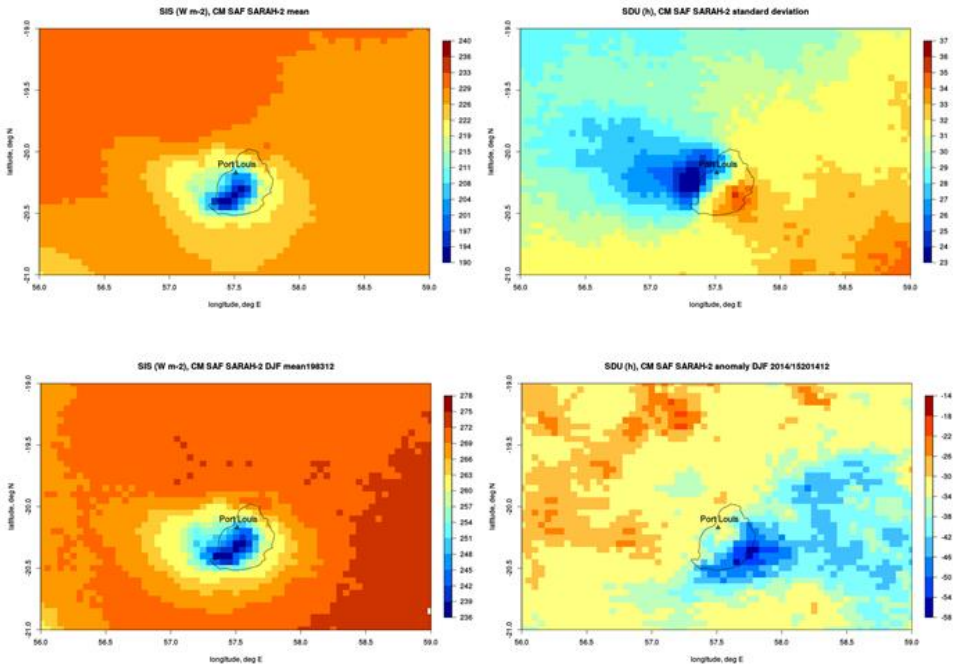
R-Toolbox

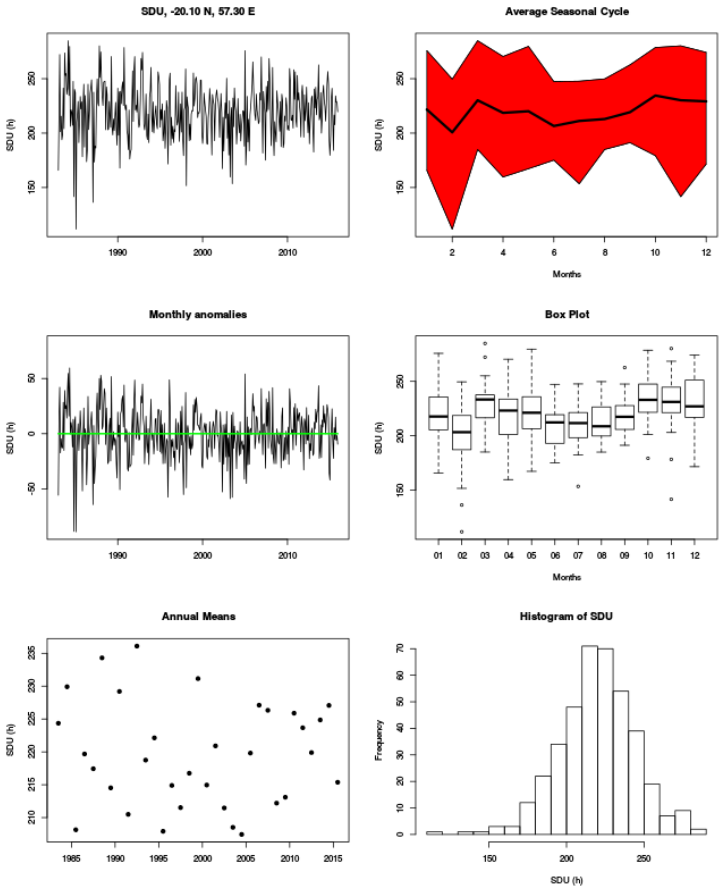
- Examples by UFA participants
- Interesting seasonal patterns over Mauritius
- Solar energy potential in Senegal





R-Toolbox


SIS (W m-2), CM SAF SARAH-2 mean
SDU (h), CM SAF SARAH-2 standard deviation
SIS (W m-2), CM SAF SARAH-2 DJF mean198312
SDU (h), CM SAF SARAH-2 anomaly DJF 2014/15201412
Port Louis
latitude, deg N
longitude, deg E


SDU, -20.10 N, 57.30 E
Average Seasonal Cycle
Monthly anomalies
Box Plot
Annual Means
Histogram of SDU
SDU (h)
Months
Frequency

Training

- Training workshops in cooperation with EUMETSAT
- Practical exercises with CM SAF data
- For content of previous courses see the community site

http://training.eumetsat.org

Summary

- Products and services in connection with global energy and water cycle
- Especially geostationary products excellent suitable for Africa
- Thoroughly quality assurance and control mechanisms
- Extensive exchange and support with / of users
- Free and uncomplicated data access
- So far more than 140 peer-reviewed publications using CM SAF data

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