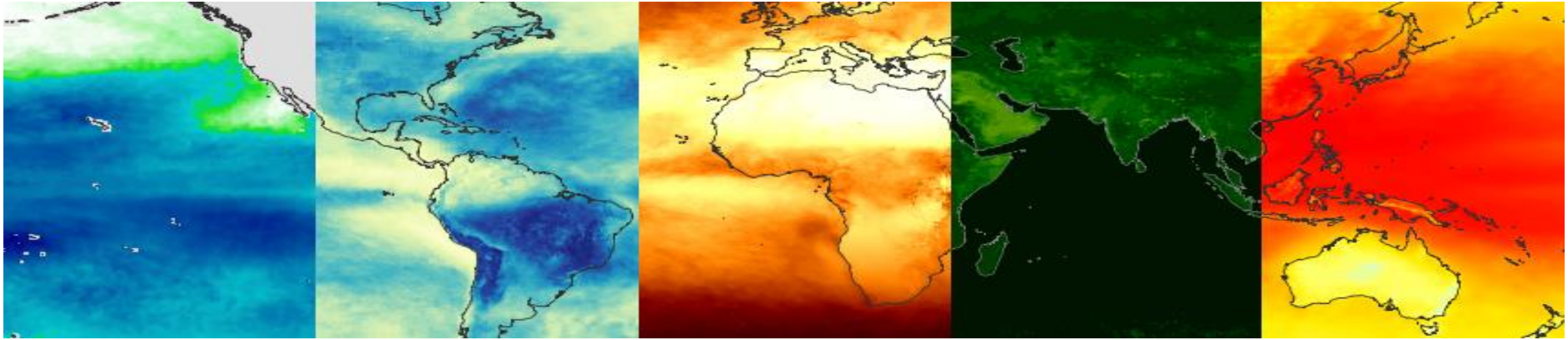
The EUMETSAT Satellite Application Facility on Climate Monitoring

M. Schröder, R. Hollmann, N. Selbach, U. Pfeifroth and the CM SAF team



Overview

- Introduction to CM SAF
- Overview of available CM SAF data records

- A few details on
  - Reprocessed versus operationally extended data
  - Recent data record releases and examples from validation
  - Example application
  - Climate normal and anomaly service from CM SAF

- Conclusions

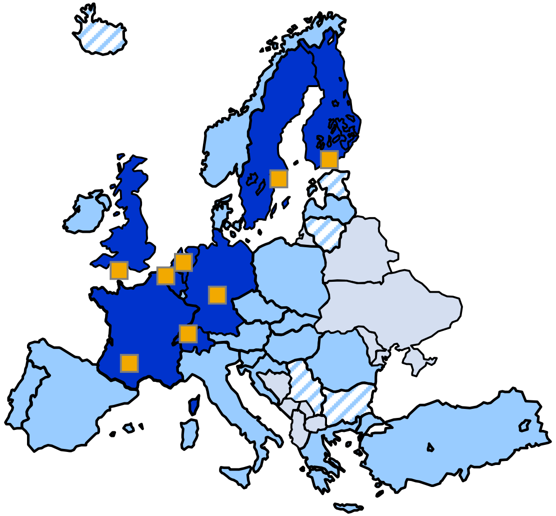
CM SAF

EUMETSAT Satellite Application Facility on Climate Monitoring (CM SAF)

https://www.cmsaf.eu

CM SAF
20
1999 - 2019

25
1999 - 2024



CM SAF Member States
Location of Partner NMHSs

Deutscher Wetterdienst

Swedish Meteorological and Hydrological Institute

Koninklijk Nederlands Meteorologisch Instituut
Ministerie van Verkeer en Waterstaat

Royal Meteorological Institute of Belgium

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Federal Office of Meteorology and Climatology MeteoSwiss

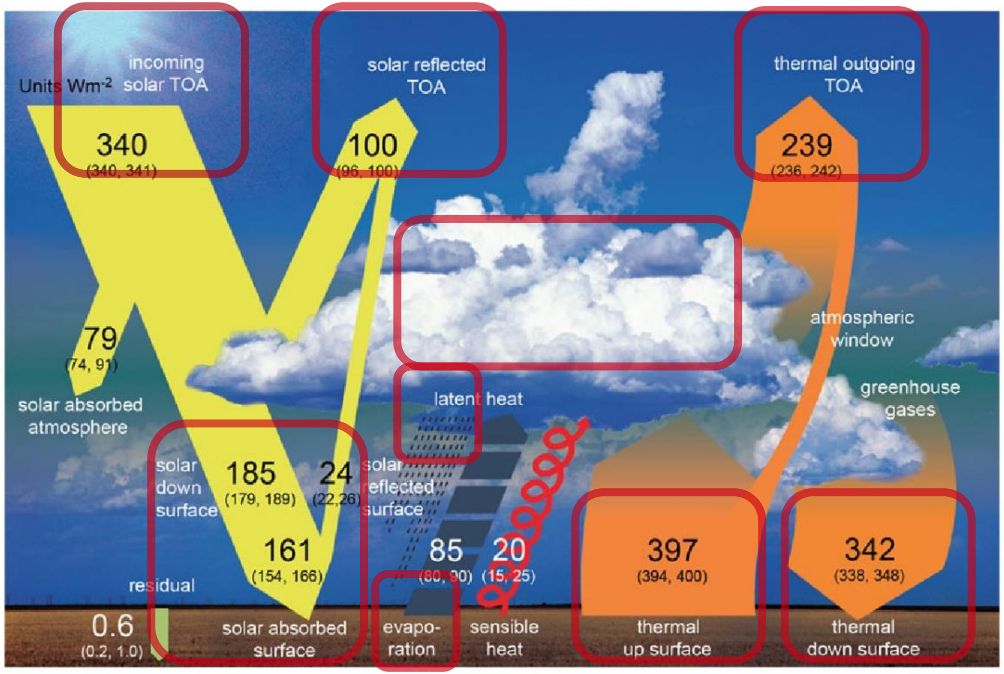
Finnish Meteorological Institute

Met Office, United Kingdom

Centre National de la recherche scientifique

What we do

CM SAF develops, generates, validates, archives and distributes high-quality satellite-derived products of the energy and water cycle suitable for climate monitoring, analysis, services and model evaluation, in a sustained operational environment, with releases after successful external review.



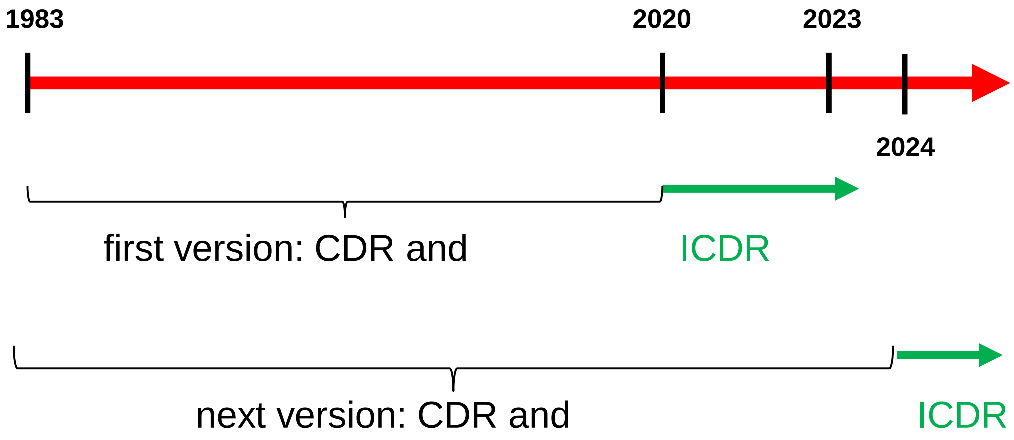
Source:
Wild et al., 2013

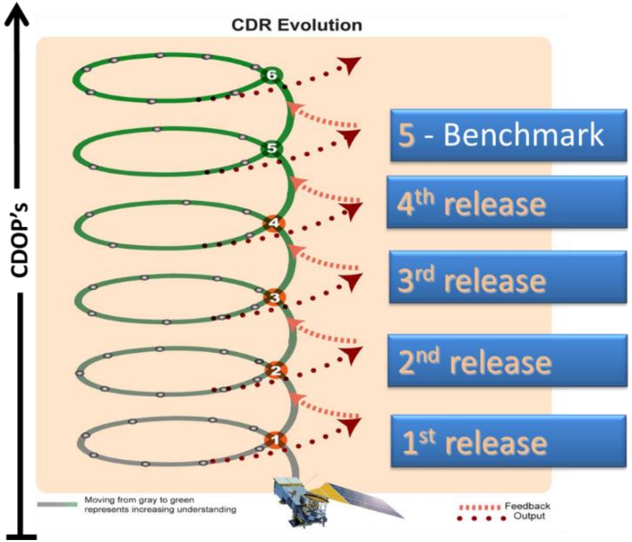
CDR vs ICDR

“Climate Data Record (CDR)”: A CDR consists of a consistently-processed time series of uncertainty-quantified retrieved values of a geophysical variable.

“Interim Climate Data record (ICDR)”: An ICDR denotes a regularly updated CDR in shorter time latency with an algorithm and processing system as consistent as possible to the generation of the CDR.

The CDR and ICDR are not be considered as two data records but as one. Consequently, a single doi is assigned to both.





CDR vs ICDR

Key objective: identity between CDR and ICDR

In CM SAF CDR and ICDR processing systems (latencies: 5 - 15 days) are usually identical.

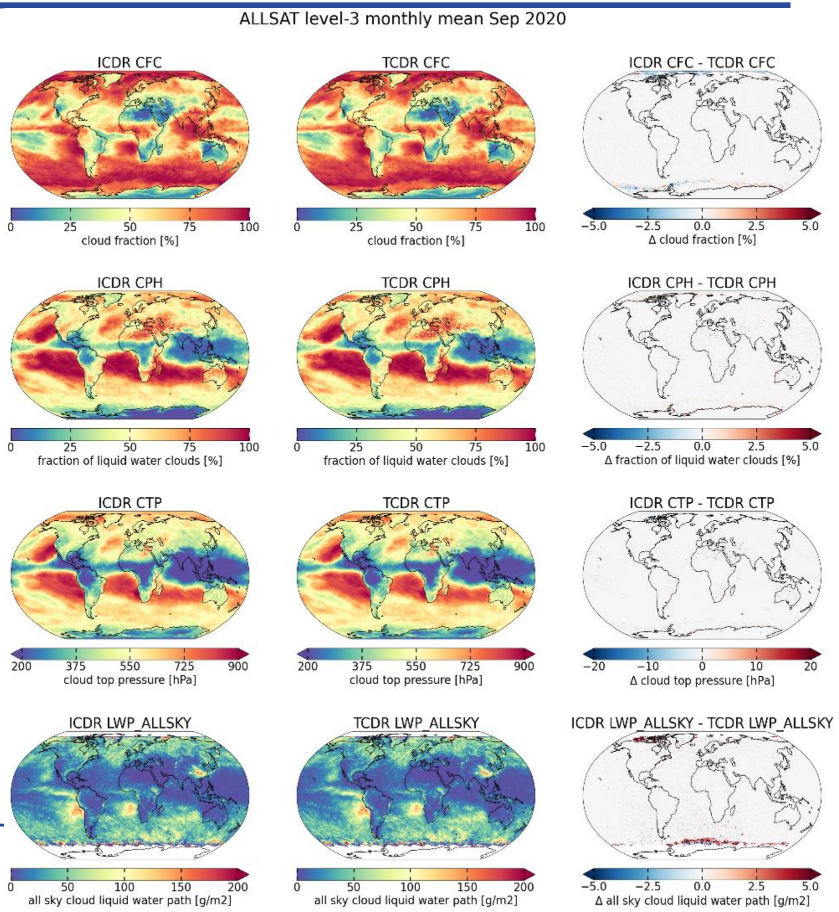
Exceptions arise from differences in input data due to constraints on availability (latency) and effort (FCDR quality).

Validation in two steps:

- Comparison to CDR using data from overlap period
- Annual validation through comparison to reference data

ICDR – CDR, CLARA-A3

Potential reasons for observed differences - sea-ice (CDR vs NRT OSI SAF product), ERA5/ERA5T, L1 FDR (EUMETSAT / CM SAF).



Available CM SAF CDRs

Documented, doi-registered, netCDF CF format, freely available via: https://wui.cmsaf.eu

EUMETSAT CM SAF CLIMATE MONITORING

Deutscher Wetterdienst DWD
Wetter und Klima aus einer Hand

Sensor, Satellite resp.	Parameter	CDR Period	Coverage
Fundamental Climate Data Record (FCDR)			
SMMR, SSM/I, SSMIS	**Microwave Radiances**	1979 – 2022	global
Climate Data Record (CDR)			
SEVIRI	**Cloud parameters (frac., height, opt. dep., phase, eff. rad., LWP, IWP), AOD (-2012) (CLAAS*)**	2004 – 2020*	Regional
GERB/SEVIRI	**Top of atmosphere radiative fluxes**	2004 – 2015	Regional
MVIRI/SEVIRI	**Cloud frac. (COMET), Land Surface Temperature (SUMET), surface radiation budget** **Latent + sensible heat flux (land)** **Free tropospheric humidity** **Surface radiation (SARAH*)**	1983 – 2020 1983 – 2020 1983 – 2009 1983 – 2020*	Regional
AVHRR GAC	**Cloud parameters, surface radiation parameters, incl. albedo, TOA radiation (CLARA*)**	1982 – 2020*	Global
SSM/I, SSMIS	**HOAPS (precip, evap, hum., wind, ...) (ice-free ocean)**	1987 – 2014	Global
ATOVS	**Water vapour and temperature profiles**	1999 – 2012	Global
MSU, AMSU, SSM/T2, MHS	**Upper troposphere humidity**	1994 – 2018	Global
Microwave+NIR imagers	**Total column water vapour with ESA WV_cci**	2002 – 2017	Global

* ICDR service, data available until present time

Upcoming versions of CM SAF CDRs

Sensor, Satellite resp.	Parameter	CDR Period	Coverage
Fundamental **C**limate **D**ata **R**ecord (FCDR)			
SMMR, SSM/I, SSMIS	**Microwave Radiances**	1979 – 2024	global
Climate **D**ata **R**ecord (CDR)			
SEVIRI	**Cloud parameters (frac., height, opt. dep., phase, eff. Rad., LWP, IWP) (CLAAS*)**	2004 – 2024*	Regional
Geo-ring	**Land surface temp., latent+sensible heat flux, SRB**	CDOP 5	Global
Geo-ring	**Cloud products, TOA radiation, TBD**	***ISCCP-NG demo***	
Microwave imagers+sounders, Geo-ring	**Global precipitation (GIRAFE) ***	2002 – 2020 (2024)*	Global
AVHRR GAC	**Cloud parameters, surface radiation parameters, albedo, TOA radiation (CLARA*)**	1979 – 2024*	Global
SSM/I, SSMIS, TMI, GMI, AMSR-E, AMSR2	**HOAPS 5 (precip, evap, hum., wind, ..) Ice-free ocean**	1987 – 2020 (2022)	
Geo-ring	**Surface radiation (SARAH*-GEO)**	1983 – 2025*	
MSU, AMSU, SSM/T2, MHS	**Upper troposphere humidity**	1994 – 2023	
Microwave+NIR imagers	**Total column water vapour with ESA WV_cci**	2000 – 2022 (TBD)	

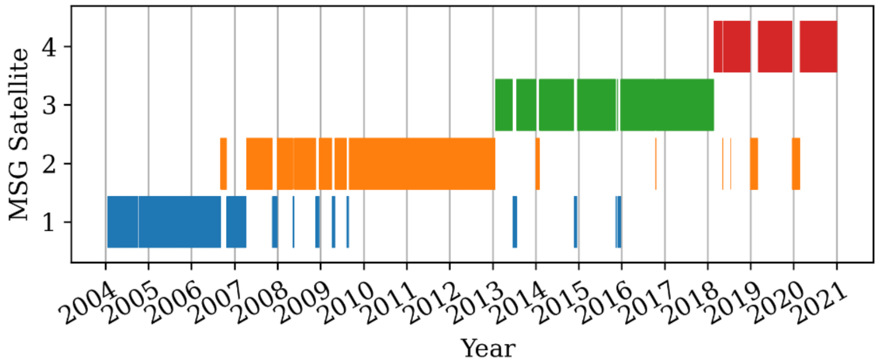
CLAAS-3 CDR and ICDR
(release: December 2022)

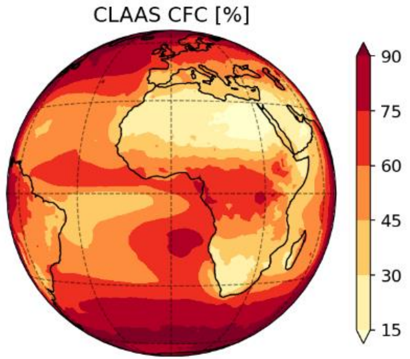
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

CLAAS-3: CM SAF CLoud property dAtAset using SEVIRI - Edition 3

- Cloud products
- CDR: 2004-2020 (4 different prime satellites)
- ICDR: January 2021 onwards, all variables
  (2 different prime satellites)
- Resolution: 0.05°, instantaneous, daily, monthly

  0.25° (histograms)
- DOI: 10.5676/EUM_SAF_CM/CLAAS/V003

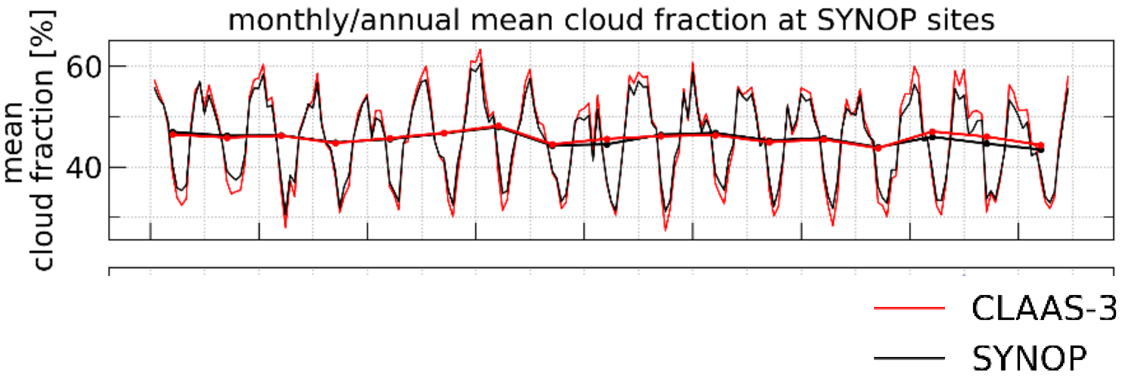


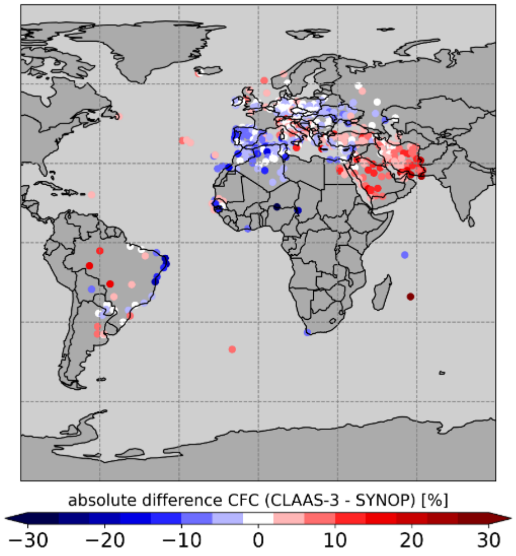


Benas, N., et al.: CLAAS-3: the third edition of the CM SAF cloud data record based on SEVIRI observations, Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2023-79, in review, 2023.

CLAAS-3 CDR and ICDR

Example result from validation





CFC vs. SYNOP

Very small mean bias and consistent seasonal cycle

But regional variations in bias

CLARA-A3 CDR and ICDR

(release April 2023)

Deutscher Wetterdienst
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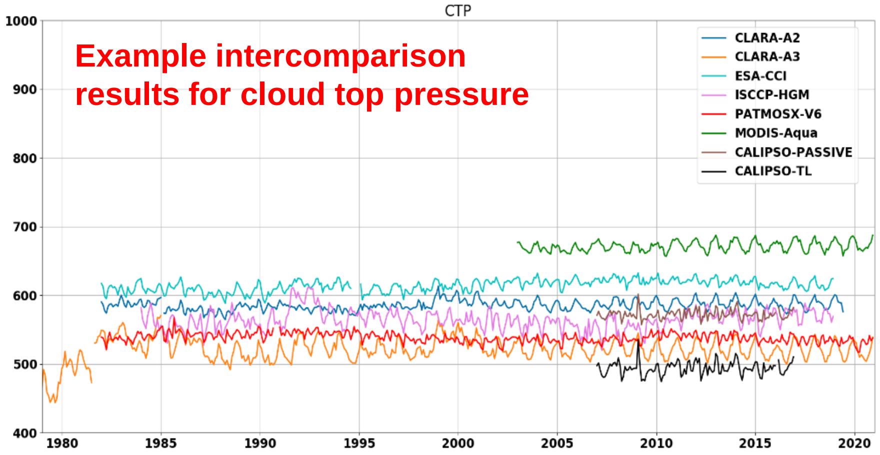
CLARA-A3: CM SAF Clouds, Albedo and Radiation dataset from AVHRR data Edition 3

- Contains a large product suite including albedo, cloud parameters, surface radiation, and TOA radiation.
- Enhanced product suite: SNS and SNL in CDR and SNS, SNL, SDL, and SRB in ICDR
- CDR: 1979-2020 (1 - 6 satellites)
- ICDR: January 2021 onwards, all parameters (currently 4 satellites), Metop-C removed from ICDR; updated calibration needed from NOAA for Metop-B and –C.
- Resolution: 0.25°, daily, monthly

  0.05° instantaneous (clouds)

  25 x 25 km^2 (polar regions, albedo and subset of clouds)
- DOI: 10.5676/EUM_SAF_CM/CLARA_AVHRR/V003



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, Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2023-133, in review, 2023.

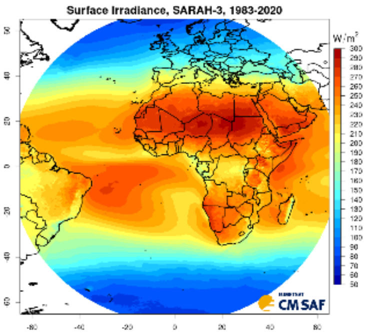
SARAH-3 CDR and ICDR

(release May 2023)

SARAH-3: Surface Solar Radiation Data Set - Heliosat

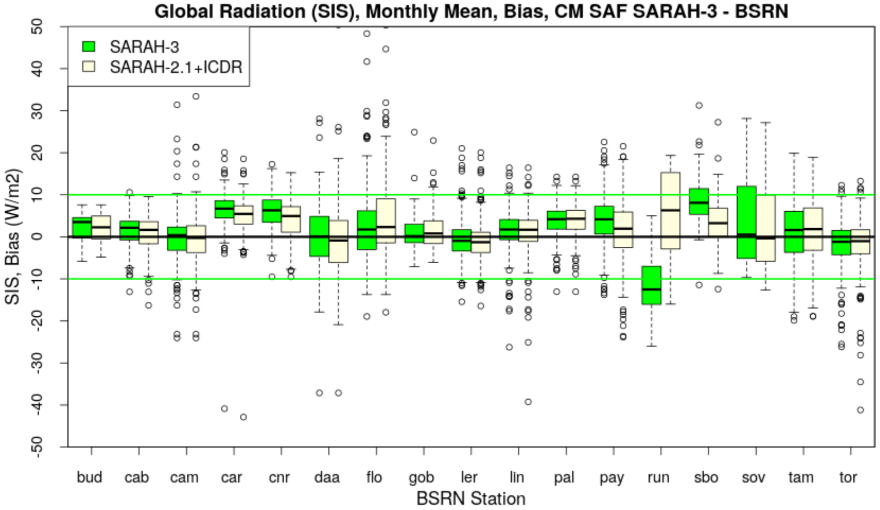
- Surface radiation parameters
- CDR: 1983-2020 (12 different prime satellites).
- ICDR: January 2021 onwards, all parameters (2 different prime satellites)
- Resolution: 0.05°, instantaneous, daily, monthly

  daily sums, monthly sums (SDU)
- DOI: 10.5676/EUM_SAF_CM/SARAH/V003



Pfeifroth et al., 2023, in preparation.

Example validation results for SIS using BSRN data as reference



SARAH-3: Snow Coverage

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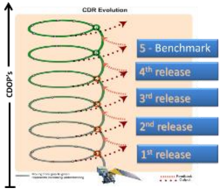
DWD

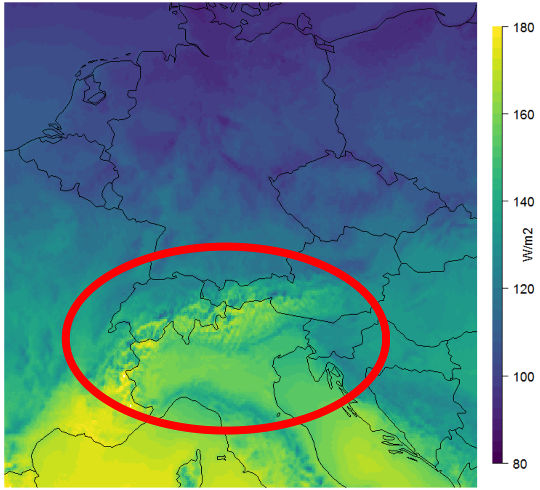


Surface Radiation, Climatology, March 1983 - 2020

Substantially enhanced (and improved) surface radiation in the Alpine region in SARAH-3

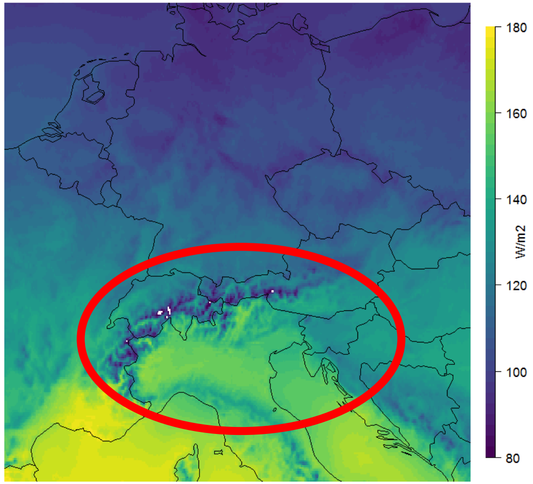
SARAH-3

Surface Irradiance (W/m2), SARAH-3, beta09.1, March

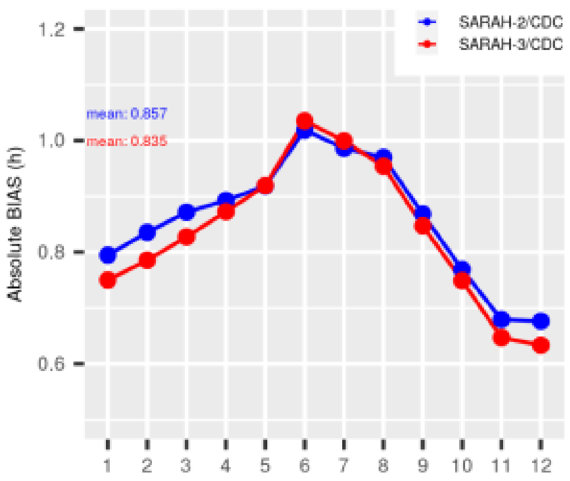


SARAH-2

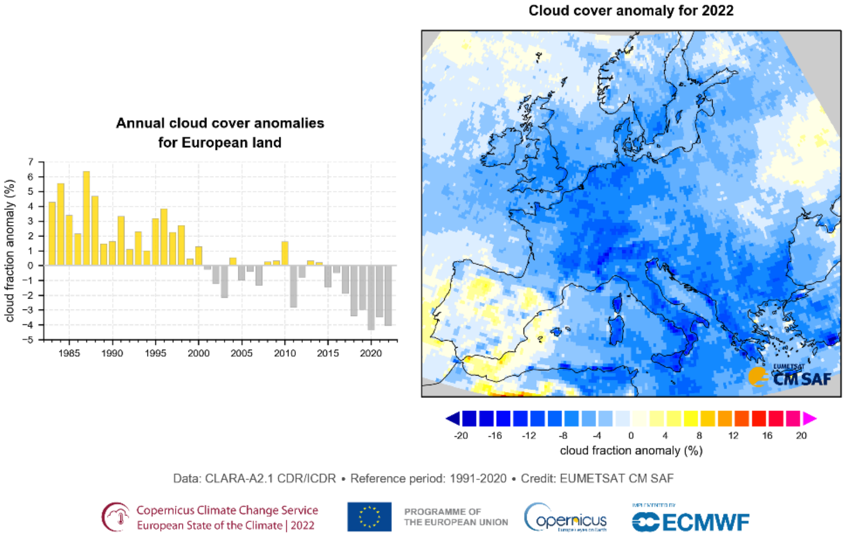
Surface Irradiance (W/m2), SARAH-2.1 / ICDR, March

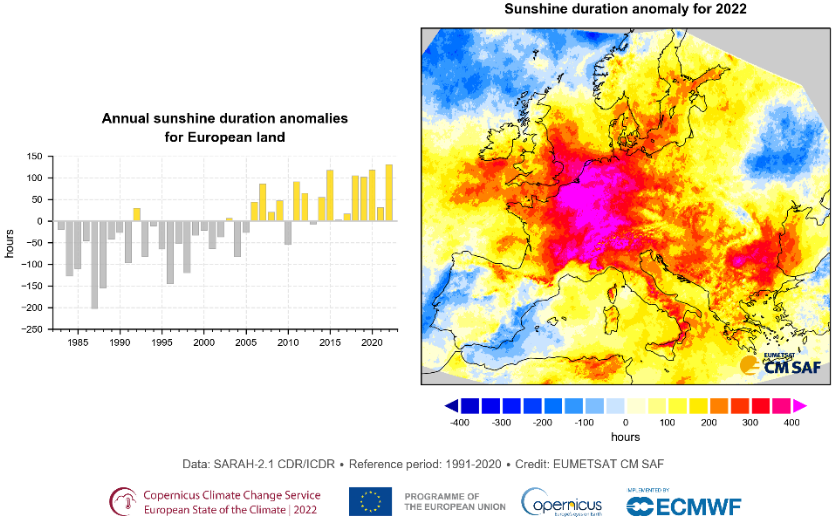


Absolute BIAS, SDU (1991-2020), Monthly Mean



Example application





➔ European State of Climate 2022, https://climate.copernicus.eu/esotc/2022/clouds-and-sunshine-duration

➔ In 2022, Europe experienced its highest sunshine duration and second-lowest cloud cover on record.

Climate normals and anomalies

CM SAF supports climate services by providing climate normals and climate anomalies as the recent WMO reference period spans 1991 – 2020. The normals and anomalies will rely on CM SAF CDR and ICDR data.

Basis: existing CM SAF monthly means.

Details:

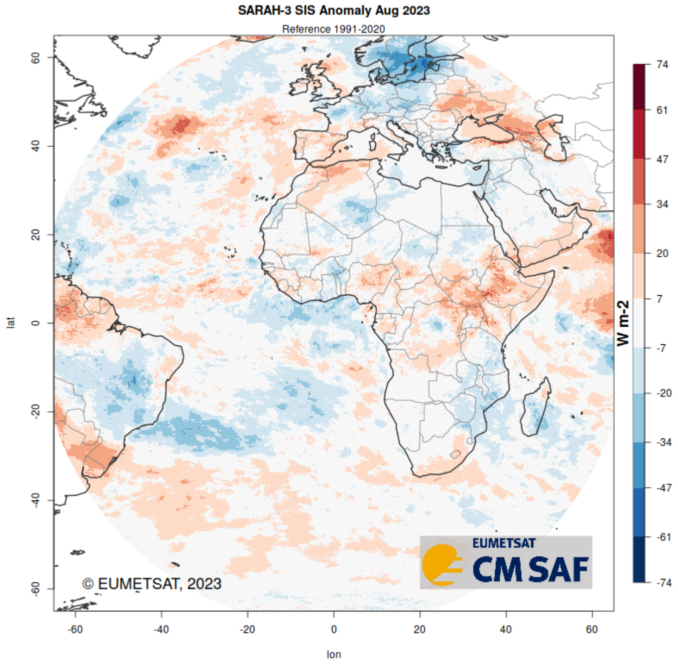
1. Calculate once climate normal and associated statistics as well as anomalies for CDR
    - Anomalies for full CDR period
    - Reference period 1991-2020
        - 12 monthly climate normals and average based on all 30*12 months
        - additional statistics (Min + year , Max + year, Median, Standard deviation, N) for all 12 months
2. Operational retrieval of anomalies using ICDR and climate normal
    - Difference between ICDR and climate normal
3. Operational quality control by utilizing CDR variability on monthly basis

Example
(SIS and SDU from SARAH-3)

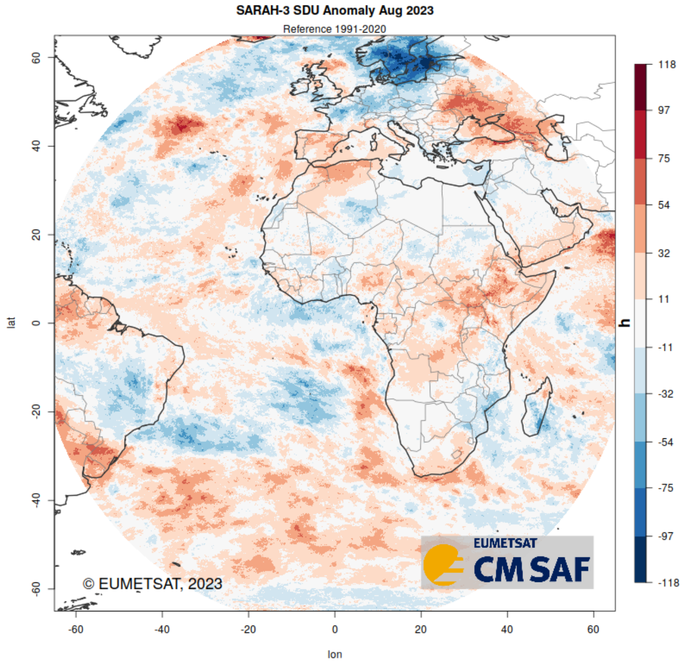
Monthly anomaly

August 2023

SIS



SDU



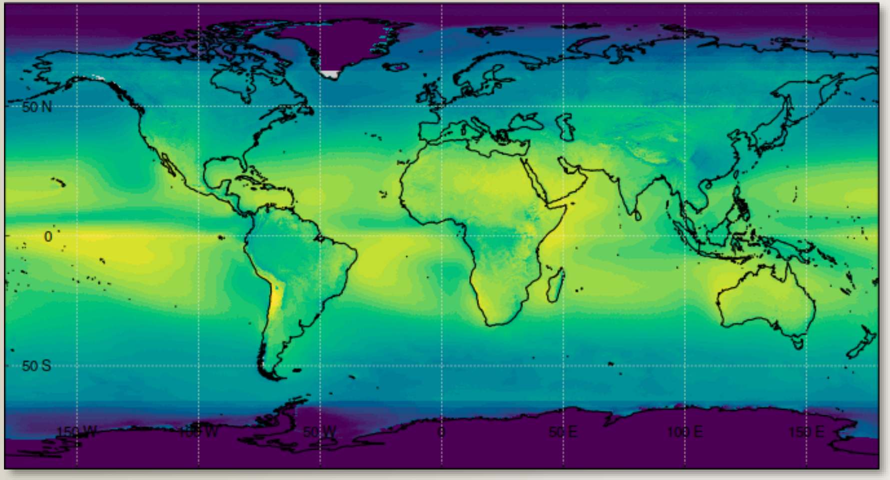
CLARA – A new Climate Data Record on Earth Radiation Budget

20 September 2023 | Online Short Course

EUMETSAT

EUMETSAT CM SAF CLIMATE MONITORING

- Learn from experts
- Discover the features
- Explore the data



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bit.ly/45blHCe

Conclusions

- Large variety of freely available, satellite-based CDRs with operational extension
- Continuous reprocessing and adaptation of service based on evolution of user requirements and opportunities
- New developments include, among others,
  - Towards global evapotranspiration
  - Global precipitation
  - Geo-ring based products, in particular ISCCP-NG
  - Climate normals and anomalies

Thank you very much for your attention. Questions?

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