Satellite-based surface solar radiation data records from the CM SAF – present and future

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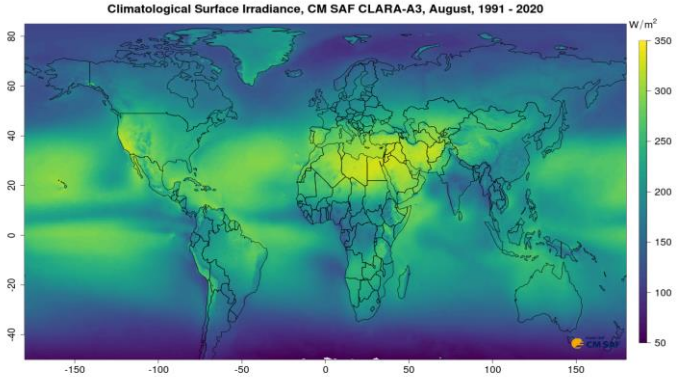
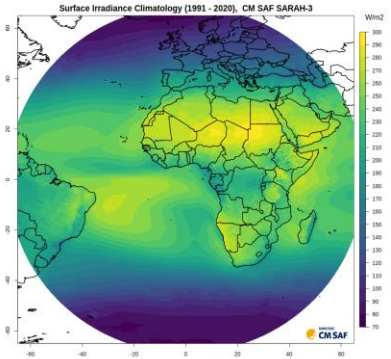
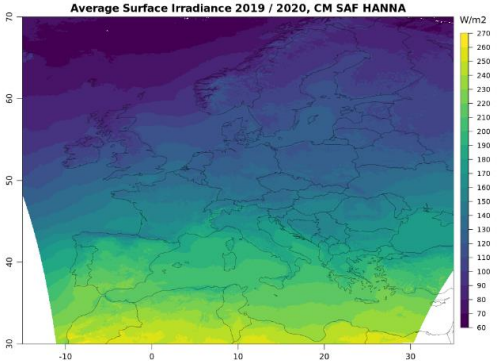
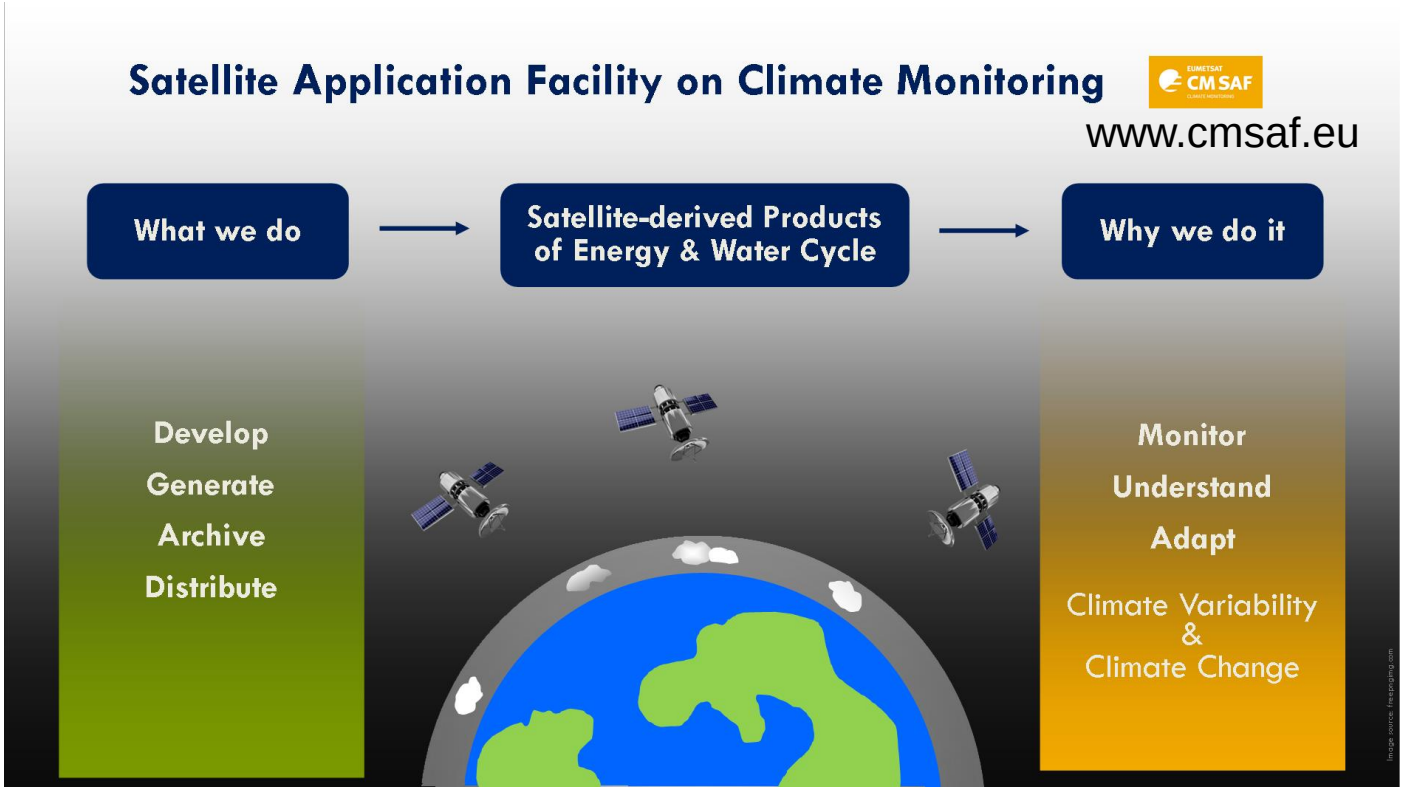


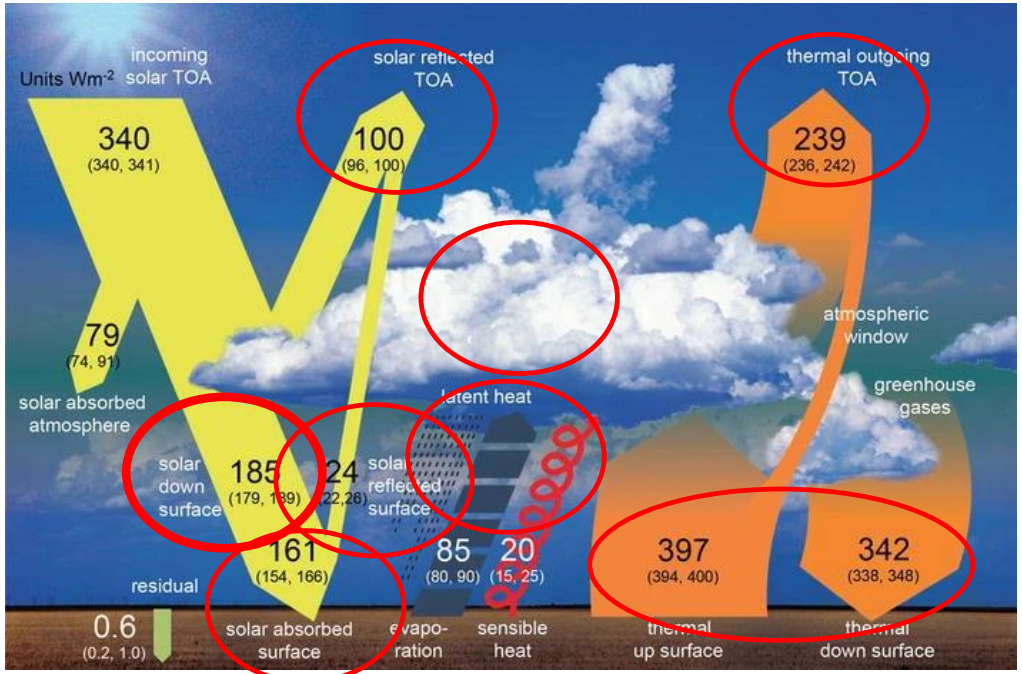





Satellite Application Facility on Climate Monitoring
EUMETSAT CM SAF
www.cmsaf.eu
What we do
Satellite-derived Products of Energy & Water Cycle
Why we do it
Develop
Generate
Archive
Distribute
Monitor
Understand
Adapt
Climate Variability
&
Climate Change

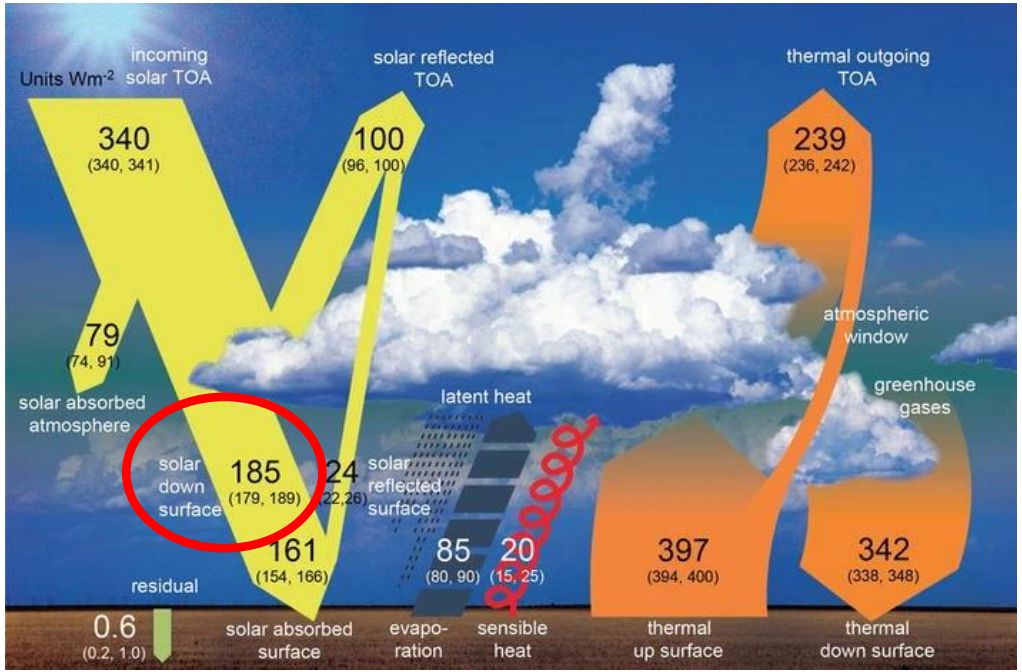
Energy Balance of the Earth-Atmosphere System

CM SAF provides data on many relevant parameters !



Source: Wild et al., 2013

Energy Balance of the Earth-Atmosphere System



Source: Wild et al., 2013

CM SAF data records of surface solar radiation

- **CLARA**-A3: CM SAF cLoud, Albedo and surface RAdiation dataset from AVHRR data – Edition 3

- **SARAH**-3**:** Surface Radiation Data Set - Heliosat - Edition 3

- **HANNA**: High-Resolution European Surface Radiation Data Record

CLARA-A3

Variables

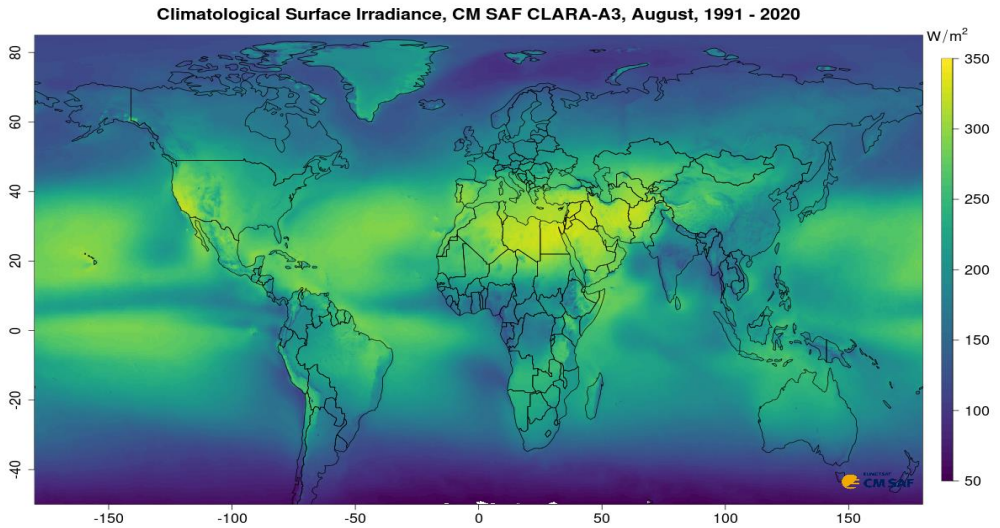
- Cloud properties (fraction, height, microphysical properties)
- Surface albedo
- Surface radiation
- TOA Radiation

Resolution

- Spatial: 0.25°×0.25° (+ polar projections 25 x 25 km)
- Temporal: daily, pentad, monthly

Coverage

- Spatial: global
- Temporal: 1979 to date



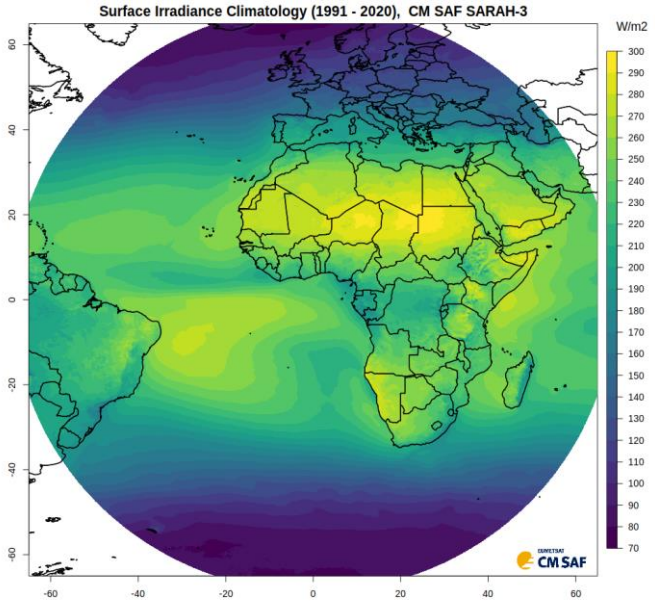
Karlsson et al. (2023): CLARA-A3: CM SAF cLoud, Albedo and surface RAdiation dataset from AVHRR data - Edition 3, Satellite Application Facility on Climate Monitoring, **DOI:10.5676/EUM_SAF_CM/CLARA_AVHRR/V003**

Karlsson, K.-G. et al., 2023: Earth Syst. Sci. Data, 15, 4901–4926, doi: 10.5194/essd-15-4901-2023

SARAH-3

Surface Solar Radiation Dataset – Heliosat

- **Variables**
  - Surface Solar Irradiance (SIS)
  - Surface Direct Irradiance (SID, DNI)
  - Sunshine Duration (SDU)
  - Photosynthetic Active Radiation (PAR)
  - Daylight (DAL)
  - Effective Cloud Albedo (CAL)
- **Resolution**
  - Spatial: 0.05° × 0.05°
  - Temporal: 30-min, daily-, monthly mean
- **Coverage**
  - Spatial: regional (±65°)
  - Temporal: 1983 to 2020 (CDR)
    2021 to date (ICDR)
  - Available at www.cmsaf.eu



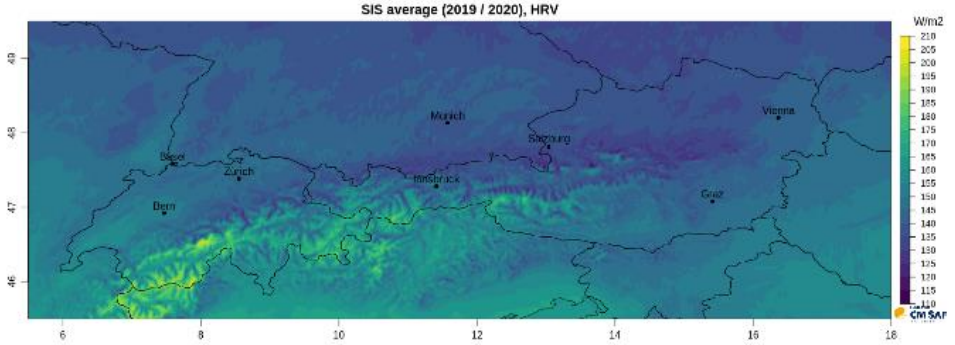
Pfeifroth, Uwe; Kothe, Steffen; Drücke, Jaqueline; Trentmann, Jörg; Schröder, Marc; Selbach, Nathalie; Hollmann, Rainer (2023): Surface Radiation Data Set - Heliosat (SARAH) - Edition 3, Satellite Application Facility on Climate Monitoring, **DOI:10.5676/EUM_SAF_CM/SARAH/V003**.

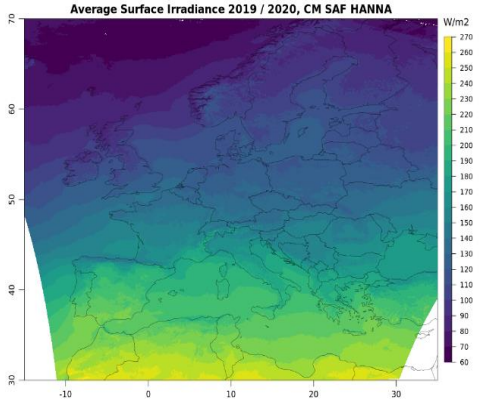
Pfeifroth et al., 2024, Earth Syst. Sci. Data, https://doi.org/10.5194/essd-16-5243-2024.

HANNA

Demonstrational data set

- **Variables**
  - Surface Solar Irradiance (SIS)
- **Resolution**
  - Spatial: 0.01° × 0.01°
  - Temporal: 15-min, daily-, monthly mean
- **Coverage**
  - Spatial: Europe
  - Temporal: 2019 + 2020





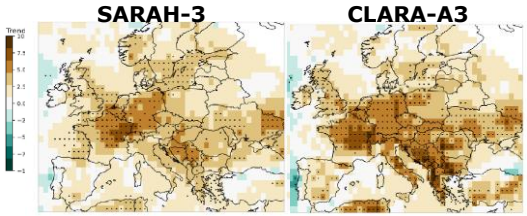
https://www.cmsaf.eu/demo_hanna

Which data to use for what ?

- **CLARA** -- for studies needing **global data and longest possible time series** (46+ years) + regular extentions (timeliness ~ 7 days), while a moderate resolution is sufficient; Data access: https://doi.org/10.5676/EUM_SAF_CM/CLARA_AVHRR/V003
- **SARAH** -- **for higher spatial and temporal resolution and additional surface radiation parameters** (e.g. direct radiation, sunshine duration) + regular extentions (timeliness ~ 2 days); Data access: https://doi.org/10.5676/EUM_SAF_CM/SARAH/V003
- **HANNA** -- currently a demo data set with **very high spatio-temporal (0.01°x0.01°, 15 min) resolution** (major benefits in rough terrain/topography);
  Data access: follow instructions on https://www.cmsaf.eu/demo_hanna

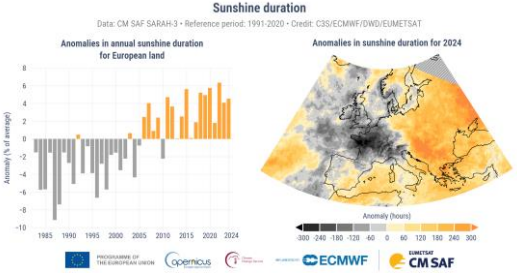
Selected Application of Surface Radiation Data

Climate analysis



Urraca et al., 2023

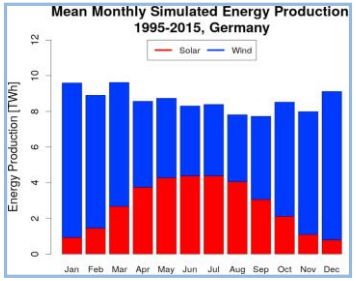
Climate monitoring



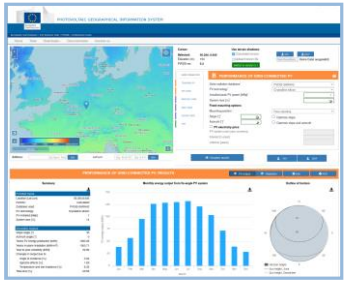
Copernicus European State of the Climate 2024

+300 scientific articles

Solar energy

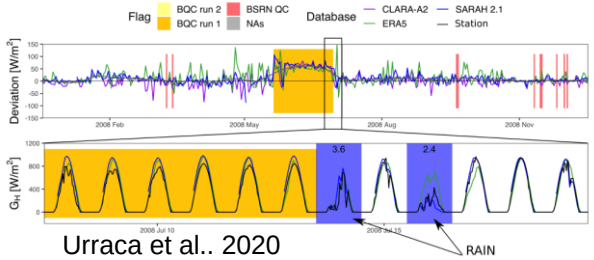


Drücke et al., 2021



PV-GIS

QC of station data



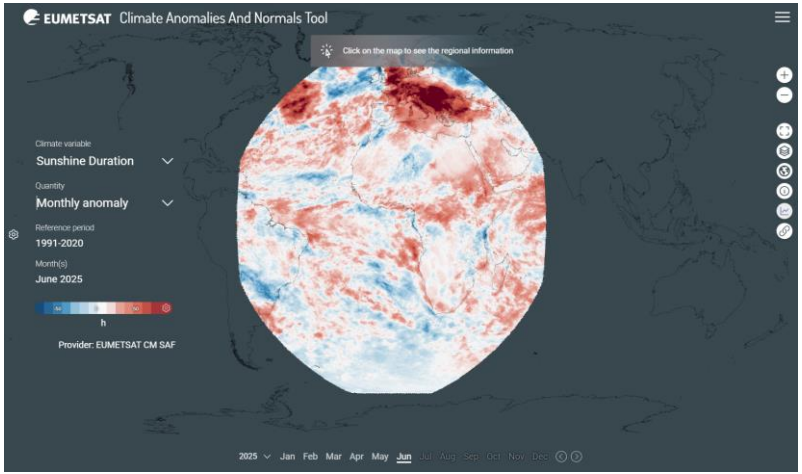
Urraca et al.. 2020

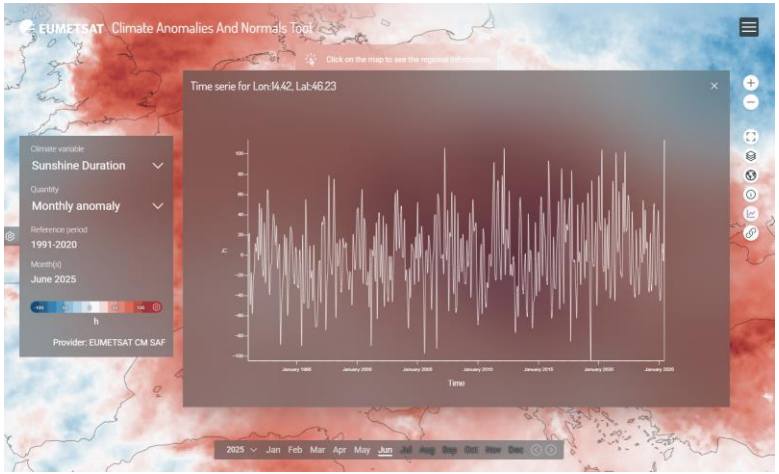
Future developments

- **CM SAF Anomaly Service** (planned release 2026) (starting with global radiation and sunshine duration)
- **CLARA-A3.5** extended data record will include „**VIIRS instruments**“ + ICDR (planned release 2027)
- **SARAH-4** will be provided for five geostationary orbits (**geo-ring**) + Meteosat ICDR (planned release 2027)
- Extend **HANNA** to become a full **climate data record** + ICDR (tbd, release 2029+)

Anomaly Service

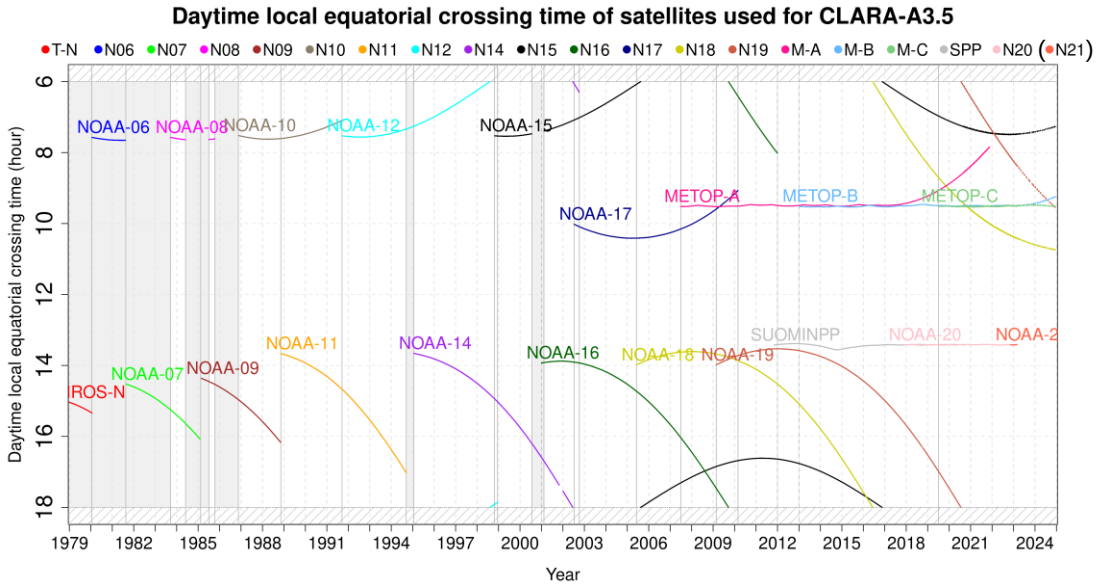
EUMETSAT will provide visualizer and underlying data from CM SAF and other SAFs





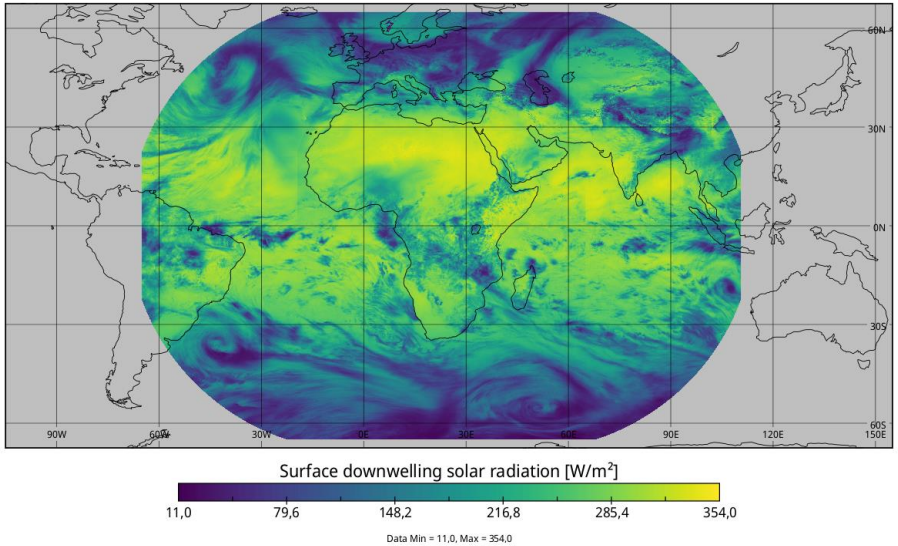
CLARA-A3.5 developements

➔ Consistently extended data record by using the VIIRS instruments (mapped on to AVHRR-channels), to regain afternoon coverage



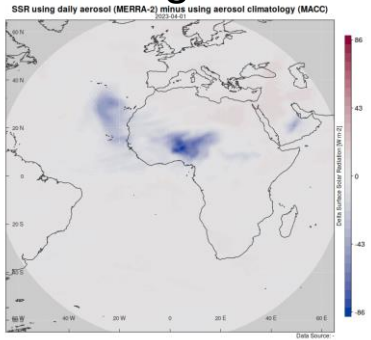
SARAH-4 developments

SARAH-4beta METEOSAT-prime and METEOSAT-IODC



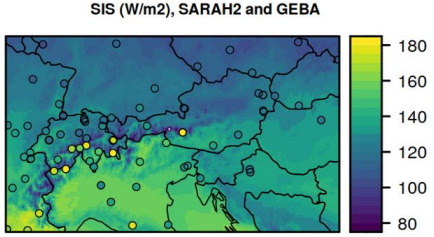
- Including Meteosat MTG FCI based ICDR

- Temporal variing aerosol input

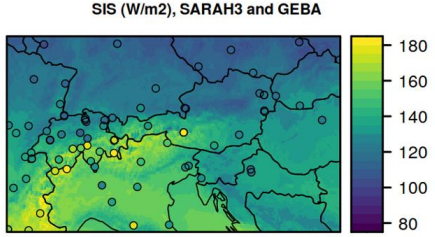


Climatology vs. daily mean aerosol input

- Further improvements in case of snow



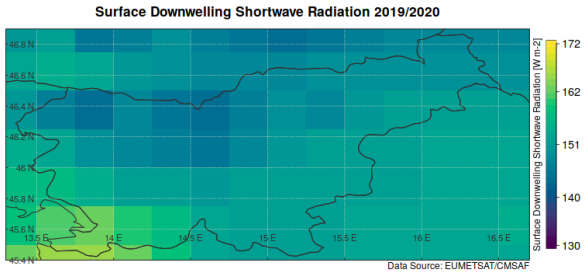
SARAH-2 in March



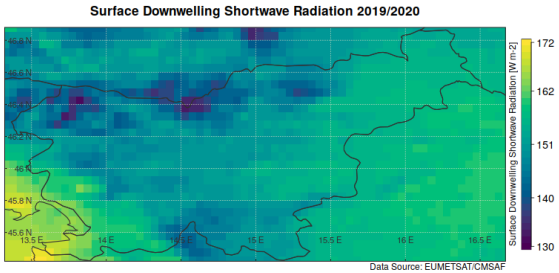
SARAH-3 in March

HANNA developements

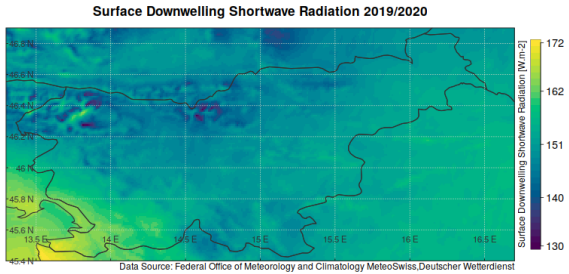
- Based on the feedback of the HANNA demonstrator data, a full climate data record (2005 onwards) including an ICDR is envisaged
- Climate data record to be based on MSG SEVIRI HRV and MTG FCI instruments on a 0.01°x0.01° grid, with a 15 min temporal resolution



CLARA (0.25°x0.25°)



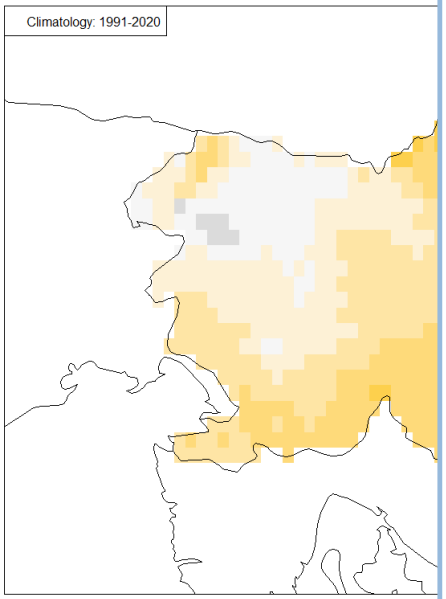
SARAH (0.05°x0.05°)



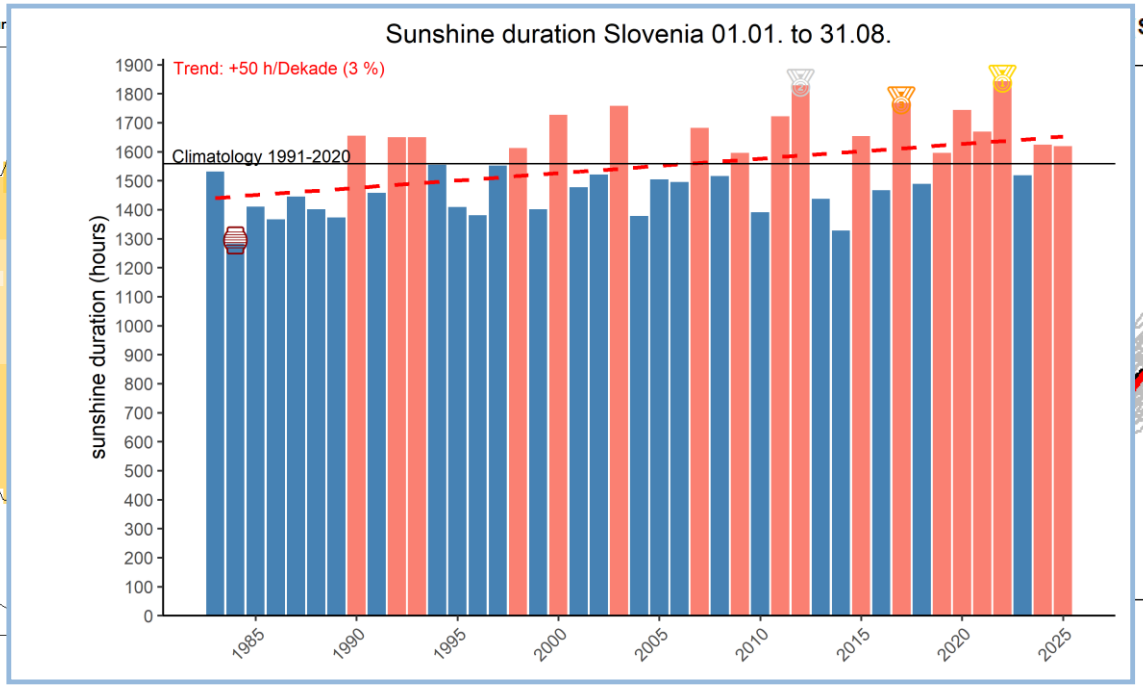
HANNA (0.01°x0.01°)

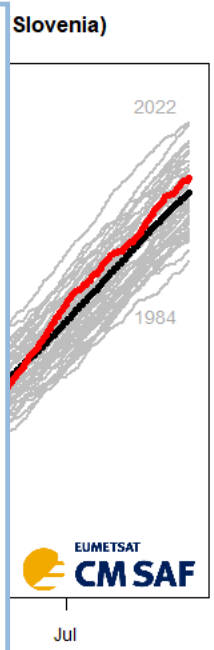
Insight into recent data (CDR + ICDR)

2025 Sunshine duration for Slovenia

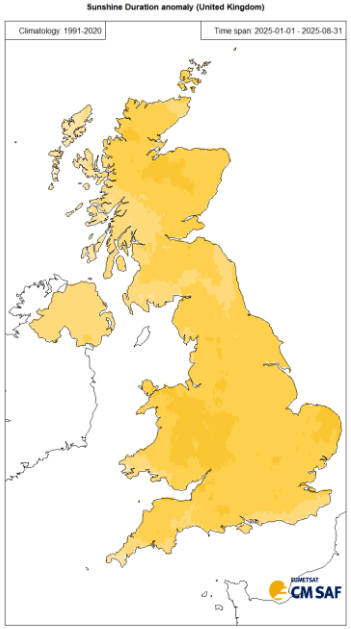


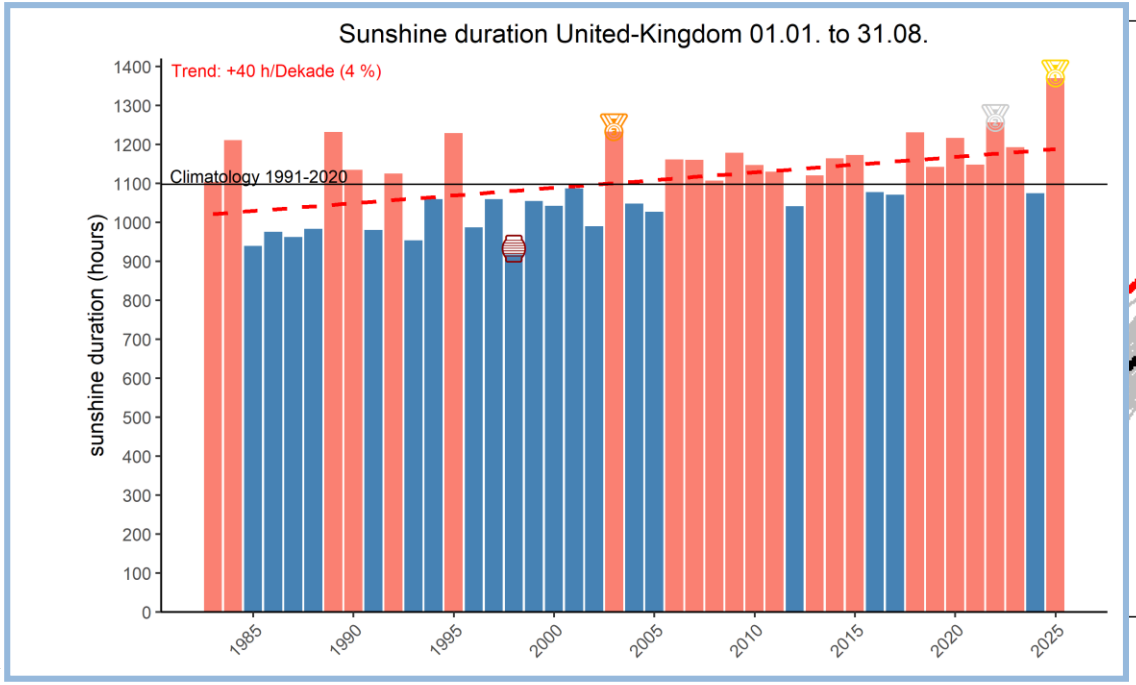
based on SARAH-3 CDR+ICDR

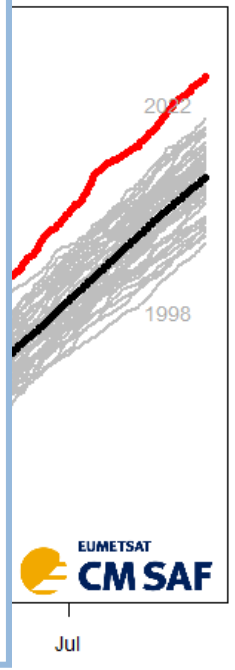




2025 Sunshine duration for UK







based on SARAH-3 CDR+ICDR

Summary

- **CM SAF** data records provide surface radiation parameters for a **wide range of applications**
- data have **high quality** and cover more than **4 decades**
- cover the current **climate normal period** (1991-2020)
- **consistent near-realtime** (ICDR) data provided
- data **freely available** via https://wui.cmsaf.eu

Outlook

- **Anomaly Service**
- **CLARA-A3.5 extented**
- **SARAH-4** for the **Geo-ring**
- **HANNA** to provide **0.01°** resolution for Europe