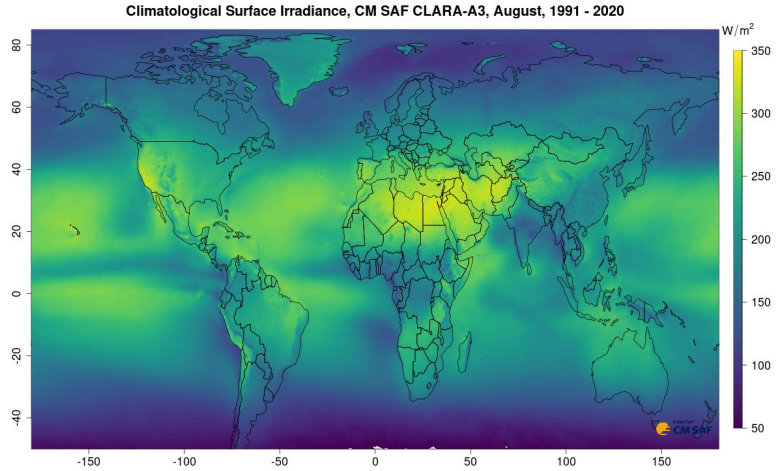
EUMETSAT CM SAF CLIMATE MONITORING

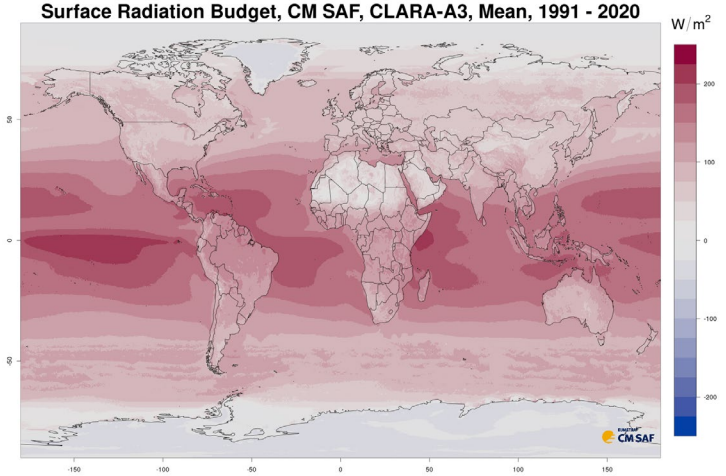
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

DWD

The CM SAF CLARA-A3 Climate Data Record
–
Surface Radiation

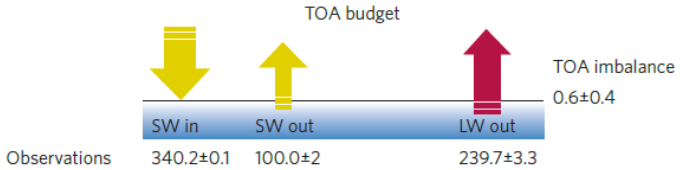
Jörg Trentmann, Uwe Pfeifroth, Karl-Göran Karlsson, and the CM SAF Team





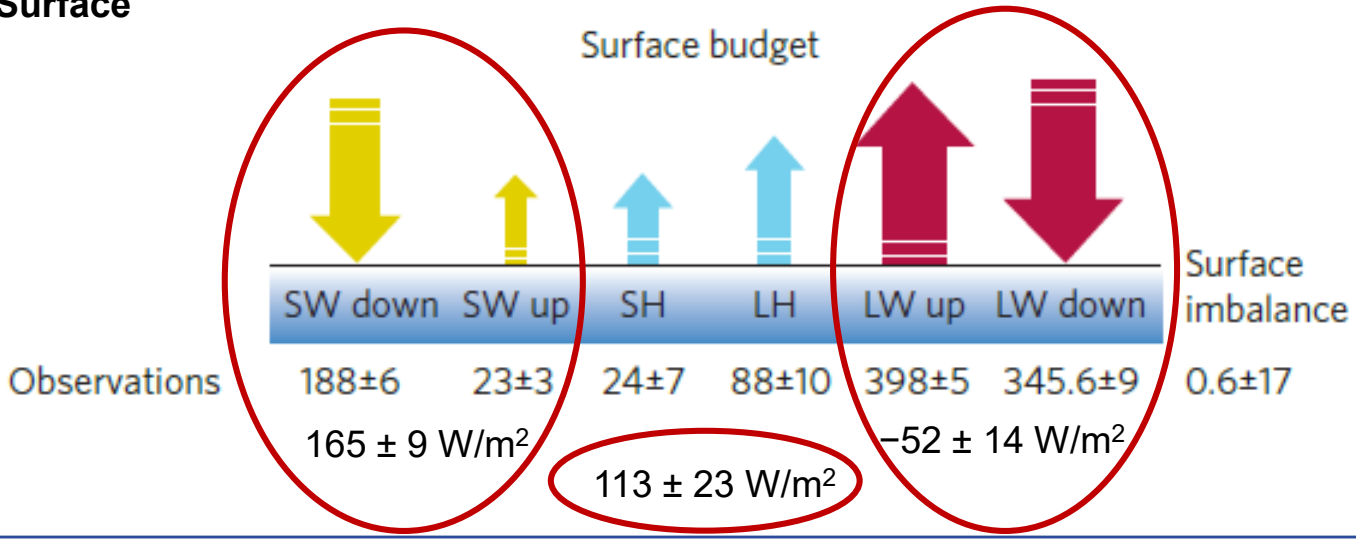
Energy Fluxes control the Earth's climate

Top of the Atmosphere



Surface

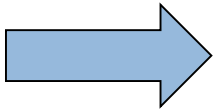
Surface Radiation Budget



Source: Stephens et al., 2012

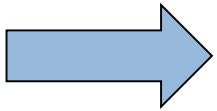
Surface radiation fluxes are driven by…

- **Shortwave / Solar**
  - Astronomy
  - Cloud Cover / Properties
  - Water vapor / Aerosol / Ozone
  - Surface Albedo



Well known / Can be derived from satellite measurements.

- **Longwave / Thermal**
  - Low-level temperature and water vapor
  - Cloud base height
  - Land / Sea Surface Temperature
  - Surface Emissivity



Not well known / Can not be derived from satellite measurements. Additional sources of information required.

Satellite retrieval of surface radiation / CLARA-A3

- **Shortwave / Solar (SIS, SNS)**
  - If no cloud is detected (CMAprob), estimate clear-sky surface irradiance ($I_{i,clr}$) with RTM
  - In case of cloudy pixel (CMAprob), the reflected solar flux (RSF) is related to transmissivity / irradiance (I_i) (using a LUT)
  - ERA-5 (incl. surface albedo!) and monthly climatological aerosol data used as auxiliary data
  - Daily clear-sky irradiance ($I_{dm,clr}$) is used to constrain daily all-sky irradiance
    SISdm: $I_{dm} = I_{dm,clr} * {}^{\sum I_i}/_{\sum I_{i,clr}}$
  - Net shortwave radiation (monthly) estimated using surface irradiance (daily) and surface albedo (pentad)

- **Longwave / Thermal (SDL, SNL)**
  - Use ERA-5 monthly surface longwave fluxes
  - (Simple) correction applied based on monthly CLARA-A3 cloud fraction
  - Downwelling (SDL) / net longwave (SNL) radiation

- **Surface Radiation Budget (SRB)**
  - Sum of monthly net shortwave and net longwave fluxes

EUMETSAT CM SAF CLIMATE MONITORING

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

CLARA-A3 Climatological Surface Radiation Data (1991 – 2020)

➔ **Shortwave / Solar**

➔ **Longwave / Thermal**

Global Irradiance, CM SAF, CLARA-A3, September Mean, 1991 - 2020

186 W/m²

Shortwave Net, CM SAF, CLARA-A3, Mean, 1991 - 2020

163 W/m²

Surface Radiation Budget, CM SAF, CLARA-A3, August Mean, 1991 - 2020

107 W/m²

Longwave Downwelling, CM SAF, CLARA-A3, Mean, 1991 - 2020

341 W/m²

Longwave Net, CM SAF, CLARA-A3, Mean, 1991 - 2020

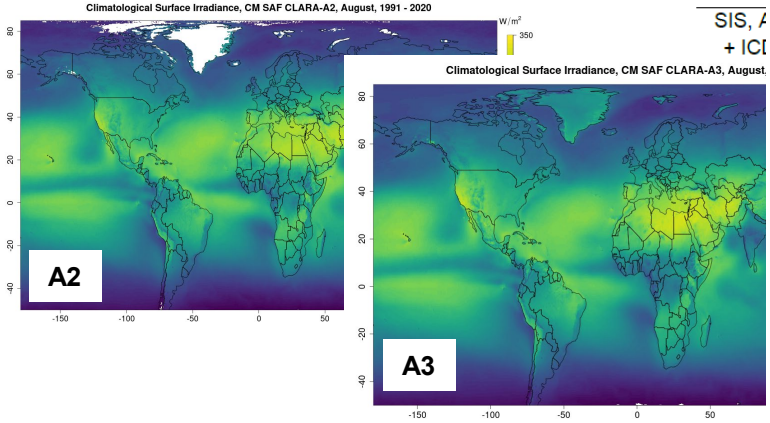
– 57 W/m²

What‘s new in CLARA–A3 (compared to CLARA-A2)?

- New parameters: net solar / thermal fluxes, surface radiation budget
- Improved satellite input data (e.g., extended temporal coverage / better calibration)
- Use of improved input parameters (for solar radiation)
  - (probabilistic) cloud mask, CMAprob
  - reflected solar flux, RSF
- Use of ERA-5 surface albedo (climatology was used in CLARA-A2)

Advantages of CLARA-A3 (compared to CLARA-A2)

- High and improved quality
- Better spatial data coverage
- CDR + ICDR allow global climate monitoring



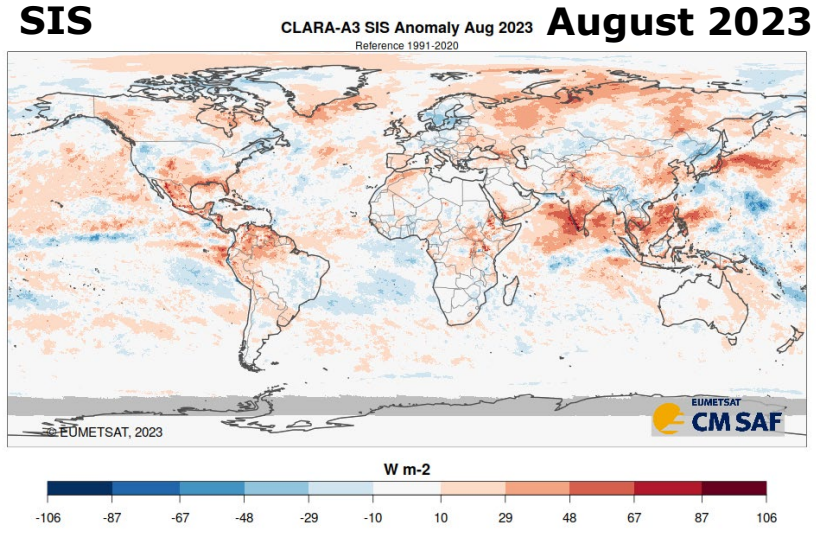
Daily Surface Irradiance

Data set	Analyzed Days /	Bias	Abs. bias
SIS,			
SIS, A + ICI			

Monthly Surface Longwave

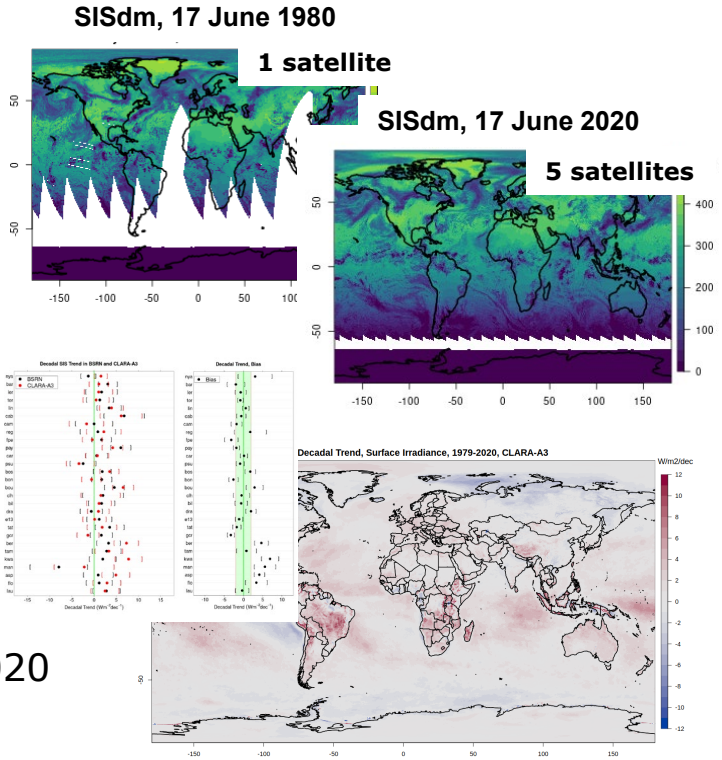
Data set	Analyzed Months /	Bias	Abs. bias

SIS



Some known limitations

- Solar Radiation data records are spatially not complete:
  - Individual daily means may contain (many) miss data (due to reduced satellite coverage)
  - Missing data values also in monthly SIS / SNS / SRB data records
- Longwave data heavily depends on ERA-5
- Temporal variability of aerosol optical depth not considered -> long term trends should be carefully evaluated
- Temporal stability affected by degraded calibration (starting approx. 2018) -> estimated trends after 2020 are not reliable!



Summary

- CM SAF CLARA-A3 provides global high quality data of Shortwave and Longwave Surface Radiation Fluxes and the Surface Radiation Budget
- Data quality (and availability) much improved compared to previous CLARA editions / competitive with alternative international data records
- Available climate data (1979 – 2020) and near-realtime data provision (timeliness 10 days) allow climate monitoring.
- The presence of missing data needs to be considered when analyzing the data