

Sentinel 2, 27. August 2016



Satellite-based High Resolution Climate Data Records

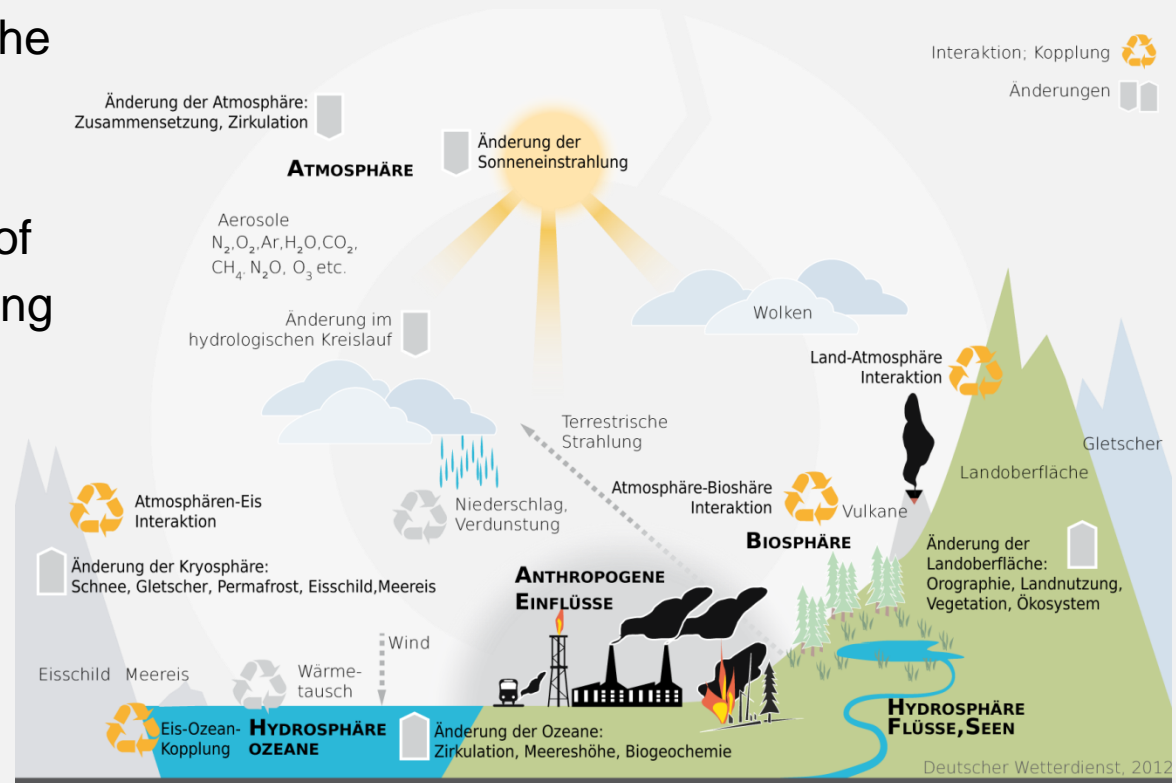
Jörg Trentmann
Deutscher Wetterdienst

Overview

- ➔ Motivation: Climate Data for Climate Monitoring
- ➔ Satellite-based climate data
 - ➔ Introduction to satellite meteorology
 - ➔ Available climate data from satellite
- ➔ Selected Applications
 - ➔ Climate Monitoring
 - ➔ Climate Modeling
 - ➔ Climate Analysis
- ➔ Summary and Outlook

Why are we collecting climate data?

- ➔ To document the status of the climate system.
- ➔ To classify the current state of the climate system in the long term climatology
- ➔ Climate Observations are coordinated by the Global Climate Observing System (GCOS).



What are the requirements for climate monitoring?

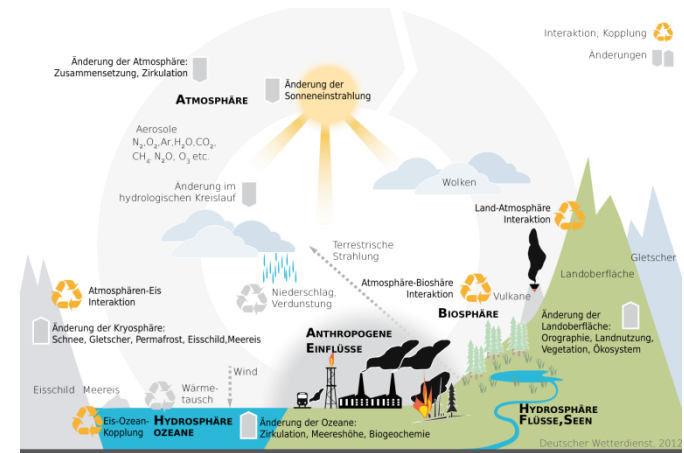
- ➔ The climate can be characterized using long-term observations (> 30 years).
- ➔ Our observing system has to be able to monitor the variability / extremes of the climate system.
- ➔ Climate Monitoring requires homogeneous, climatological reference data and consistent, current measurements

Climate Monitoring: historic climate data + consistent, current measurements



Which parameters do we need to measure?

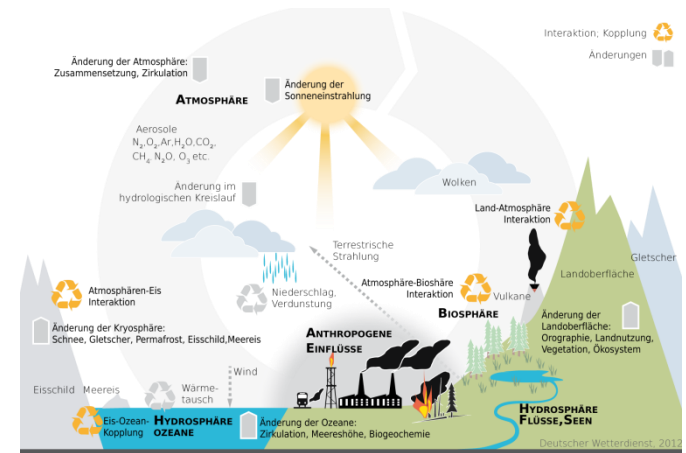
Measurement Domain	Essential Climate Variables (ECVs)
Atmospheric	<p>Surface: Air temperature, Wind speed and direction, Water vapour, Pressure, Precipitation, Surface radiation budget.</p> <p>Upper-air: Temperature, Wind speed and direction, Water vapour, Cloud properties, Earth radiation budget, Lightning.</p> <p>Composition: Carbon Dioxide (CO₂), Methane (CH₄), Other long-lived greenhouse gases (GHGs), Ozone, Aerosol, Precursors for aerosol and ozone.</p>
Oceanic	<p>Physics: Temperature, Sea Surface Temperature, Salinity, Sea Surface Salinity, Currents, Surface Currents, Sea Level, Sea State, Sea Ice, Ocean Surface Stress, Ocean Surface heat Flux</p> <p>Biogeochemistry: Inorganic Carbon, Oxygen, Nutrients, Transient Tracers, Nitrous Oxide (N₂O), Ocean Colour</p> <p>Biology/ecosystems: Plankton, Marine habitat properties</p>
Terrestrial	<p>Hydrology: River discharge, Groundwater, Lakes, Soil Moisture</p> <p>Cryosphere: Snow, Glaciers, Ice sheets and Ice shelves, Permafrost</p> <p>Biosphere: Albedo, Land cover, Fraction of absorbed photosynthetically active radiation, Leaf area index, Above-ground biomass, Soil carbon, Fire, Land Surface Temperature</p> <p>Human use of natural resources: Water use, GHG fluxes</p>



Essential Climate Variables (ECV) have been identified for the monitoring of the climate system (coordinated with GCOS).

Which parameters do we need to measure?

Measurement Domain	Essential Climate Variables (ECVs)
Atmospheric	<p>incl. Temperature, Precipitation, Radiation, Wind, Clouds, Water Vapor, CO₂, CH₄</p> <p>Composition: Carbon Dioxide (CO₂), Methane (CH₄), Other long-lived greenhouse gases (GHGs), Ozone, Aerosol, Precursors for aerosol and ozone.</p>
Oceanic	<p>incl. SST, Sea Level, Salinity, Ocean Currents, Carbon</p> <p>Physics: Temperature, Sea Surface Temperature, Salinity, Sea Surface Stress, Sea Level, Sea Ice, Icebergs, Glaciers, Icebergs, Icebergs</p> <p>Biology/ecosystems: Plankton, Marine habitat properties</p>
Terrestrial	<p>incl. Soil Moisture, River Discharge, Snow, Glaciers, Albedo, Land Cover, LST, Fire</p> <p>Human use of natural resources: water use, GHG fluxes</p>



Essential Climate Variables (ECV) have been identified for the monitoring of the climate system (coordinated with GCOS).

Which parameters can be observed from satellite?

→ Some ECVs can be derived from satellite measurements

Domain	Essential Climate Variables
Atmospheric (over land, sea and ice)	Precipitation, Earth radiation budget (including solar irradiance), Upper-air temperature, Wind speed and direction, Water vapour, Cloud properties, Carbon dioxide, Ozone, Aerosol properties.
Oceanic	Sea-surface temperature, Sea level, Sea ice, Ocean colour (for biological activity), Sea state*, Ocean salinity*.
Terrestrial	Lakes*, Snow cover, Glaciers and ice caps, Albedo, Land cover (including vegetation type), Fraction of absorbed photosynthetically active radiation (fAPAR), Leaf area index (LAI)*, Biomass*, Fire disturbance, Soil moisture*.

Which parameters can be observed from satellite?

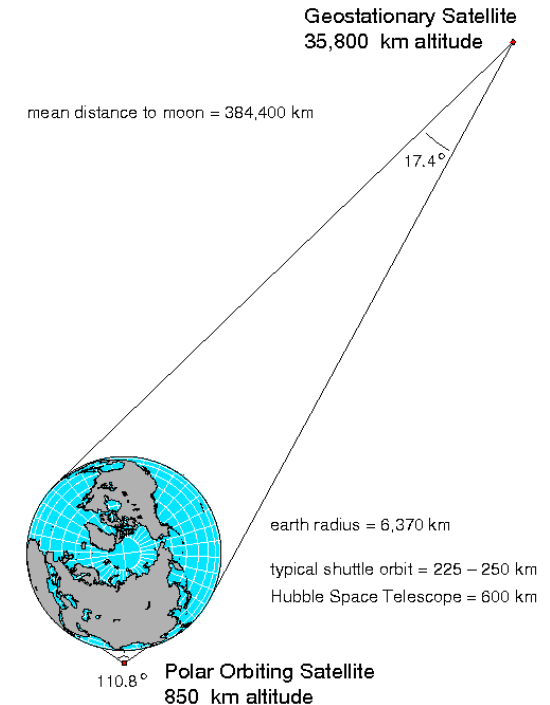
→ Some ECVs can be derived from satellite measurements

Domain	Essential Climate Variables	
Atmospheric (over land, sea and ice)	Precipitation, Wind speed, Cloud properties	incl. Temperature , (Precipitation), Radiation, (Wind), Clouds, Water Vapor CO ₂ , CH ₄ , (Ice), Upper-air temperature, Carbon dioxide, Ozone, Aerosol
Oceanic	Sea-surface temperature, Sea level, Ocean salinity*.	incl. SST, Sea Level, Salinity, Ocean activity), Sea
Terrestrial	Lakes*, Snow cover, Glaciers, Fraction of absorbed photosynthetically active radiation (fAPAR), Leaf area index (LAI)*, Biomass	Currents, Carbon (vegetation type),
		incl. Soil Moisture, River Discharge , Snow, Glaciers, Albedo, Land Cover, LST, Fire

Satellite Meteorology 101

→ Geostationary Satellites

- Orbit: 36.900 km altitude; located at the equator
- Examples: Meteosat First / Second Generation (MFG / MSG) / GOES / Himawari etc
- Instruments: MVIRI / SEVIRI / GERB
- Always observe the same part of the Earth surface (sometimes called ‚Disc‘); cannot observe polar region
- Spatial resolution in the range of 1 km to 10 km
- Sampling frequency between 5 min and 30 min

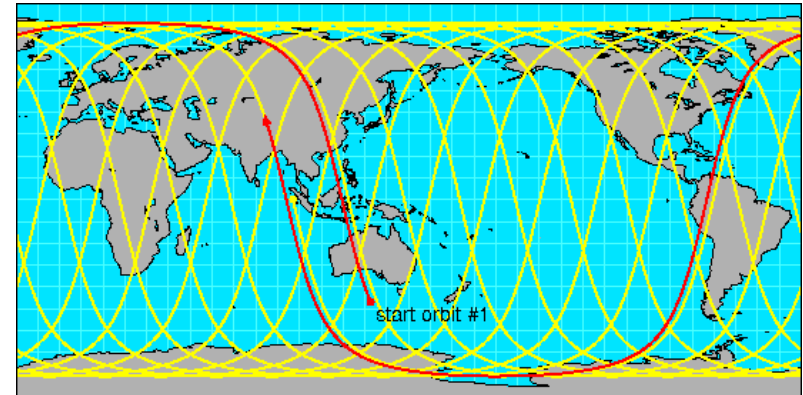


<https://www.rap.ucar.edu/~djohnson/satellite/coverage.html>

Satellite Meteorology 101

→ Polar-Orbiting Satellites

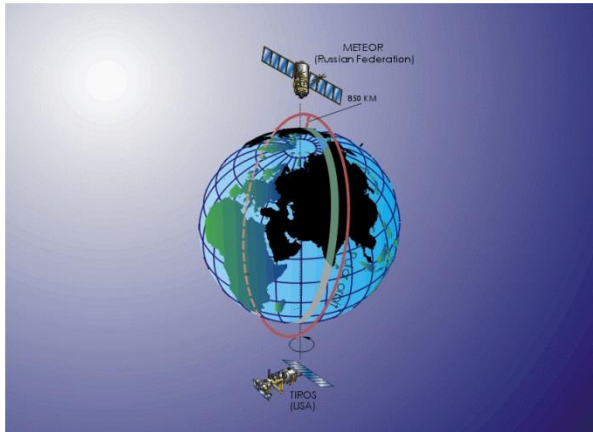
- Orbit: ca. 850 km
- Cycle the Earth in about 1 day
- Examples: Metop-A/B, NOAA-16, Terra / Aqua, DMSP, Sentinel-1/-2/-3
- Instruments: AVHRR, SSM/I, CERES, MODIS
- Spatial resolution in the range of 10 m to 50 km
- Sampling frequency: 12-h up to weekly / monthly



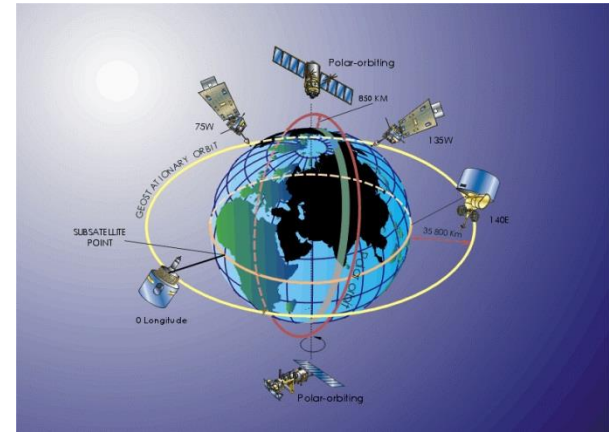
<https://www.rap.ucar.edu/~djohnson/satellite/coverage.html>

Evolution of the Earth-observing satellite system

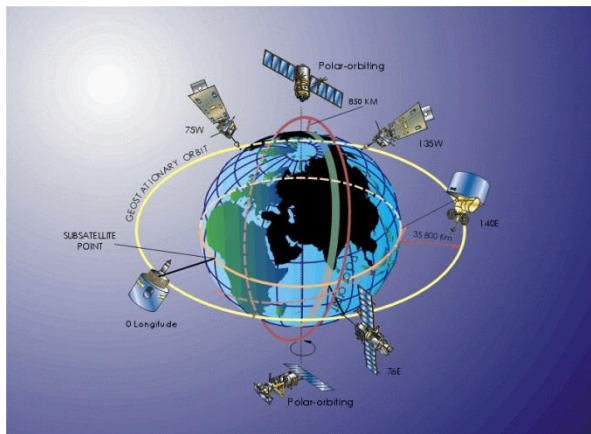
1961



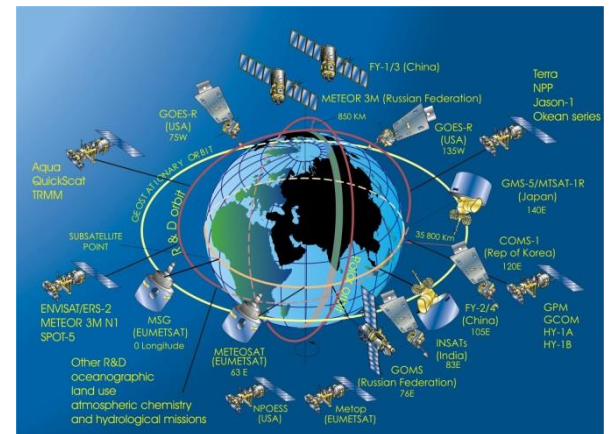
1978



1990



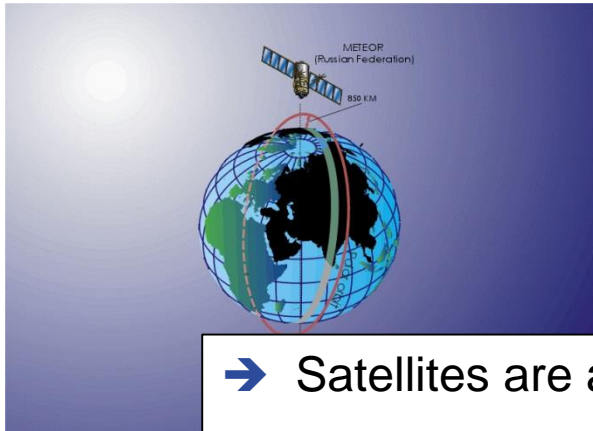
2009



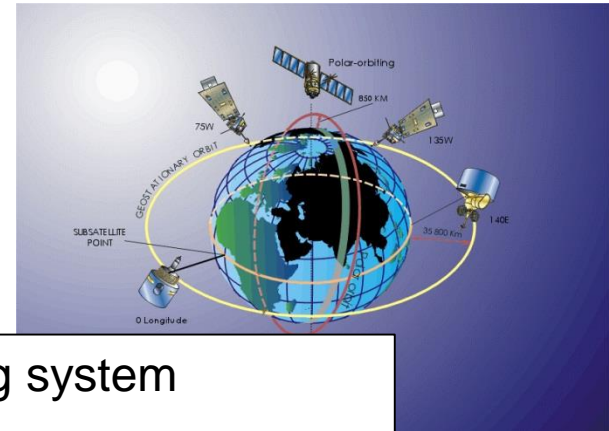
Courtesy WMO, B. Ryan

Evolution of the Earth-observing satellite system

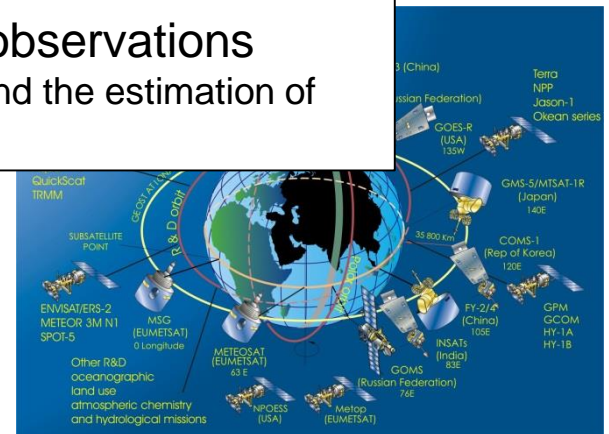
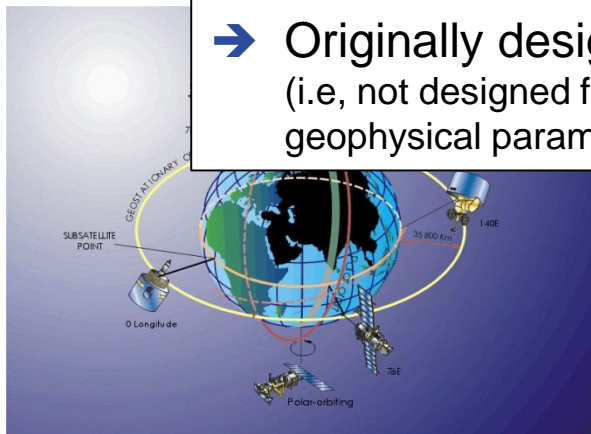
1961



1978



1990

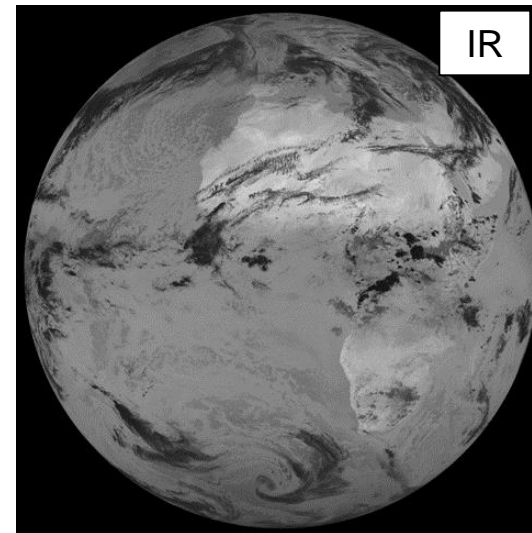
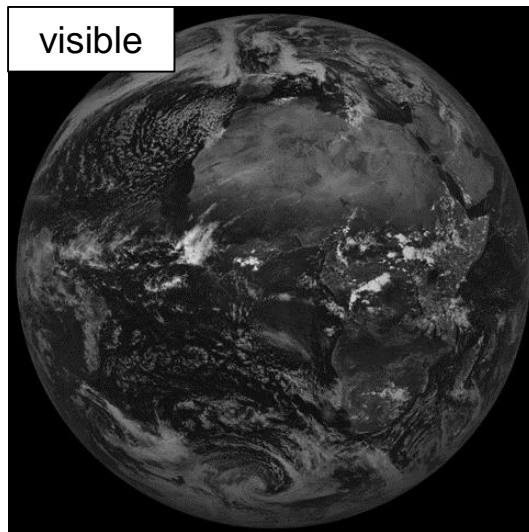


→ Satellites are a ,young‘ observing system
→ Data available since early 1980s
→ Originally designed for weather observations (i.e, not designed for climate monitoring and the estimation of geophysical parameters)

Courtesy WMO, B. Ryan

Satellite Meteorology 101

- Earth-observing satellite instruments measure the radiation reflected (solar) / emitted (thermal) from the Earth-Atmosphere System
- Typically the radiation is measured separately for certain wavelengths (spectrally resolved)
- If the measured radiation contains information on geophysical quantities, these can be derived from the satellite measurement using a „retrieval algorithm‘



Satellite Meteorology 101

Different retrieval algorithms exist for each geophysical parameter

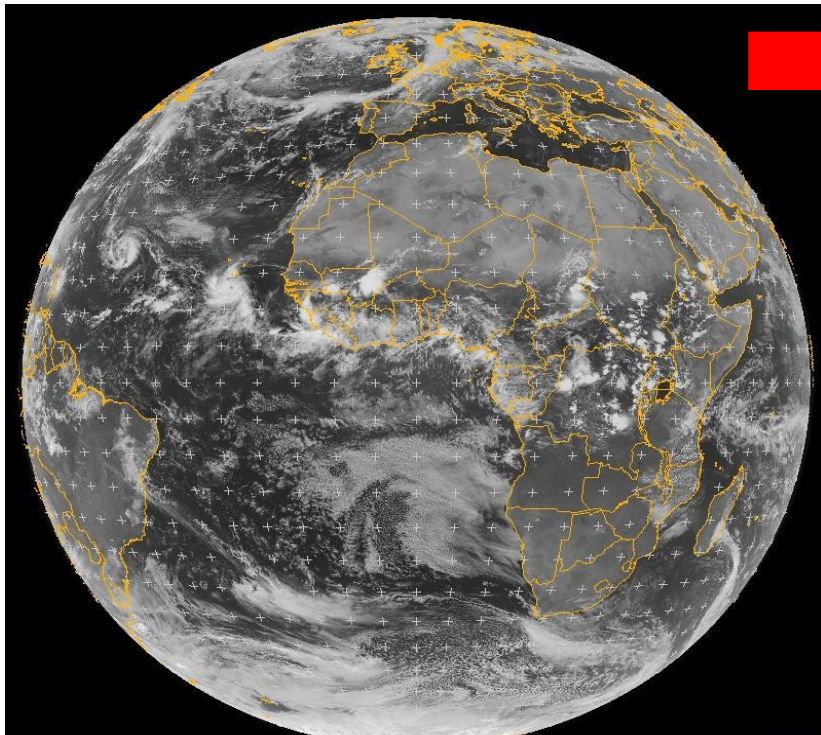
Example: **Surface Solar Incoming Radiation** (aka. global radiation, irradiance)

- ‚Physical‘:
 - Use derived cloud properties in radiative transfer model
- Statistical:
 - Relate „brightness“ of clouds to cloud optical thickness
- Look-up tables:
 - Relate measured upward fluxes to downward fluxes
- Optimal Estimation:
 - Determine the state of the atmosphere that matches best the (spectral) satellite measurement

The „Heliosat“ algorithm

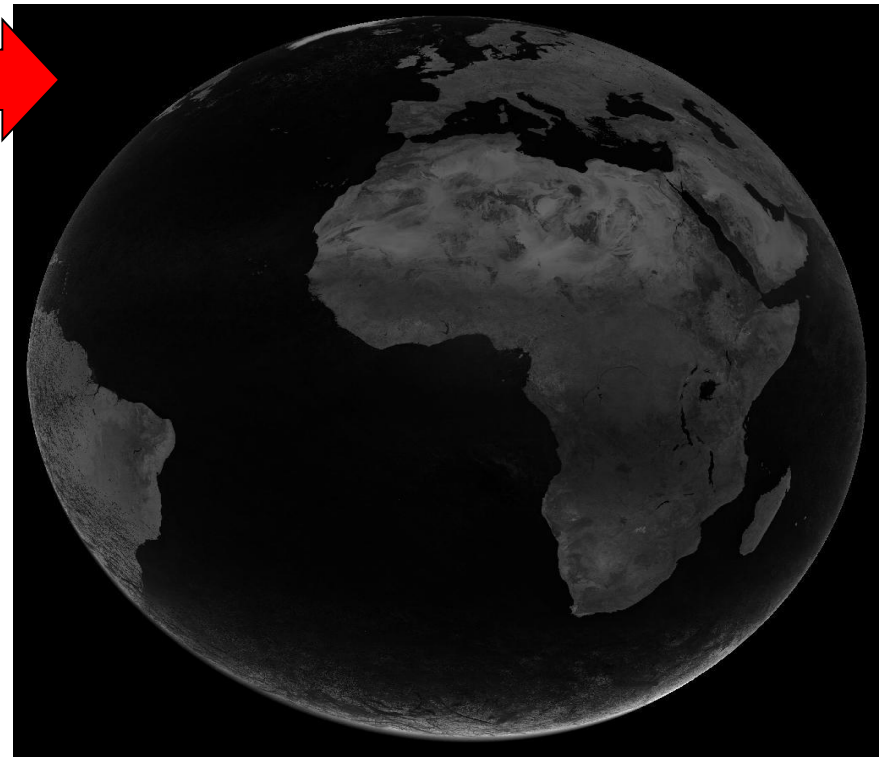
Reflectivity, 12 UTC, 2 Sept 2008

Min. Reflectivity, R_{\min} , 12 UTC, **Sept 2008**

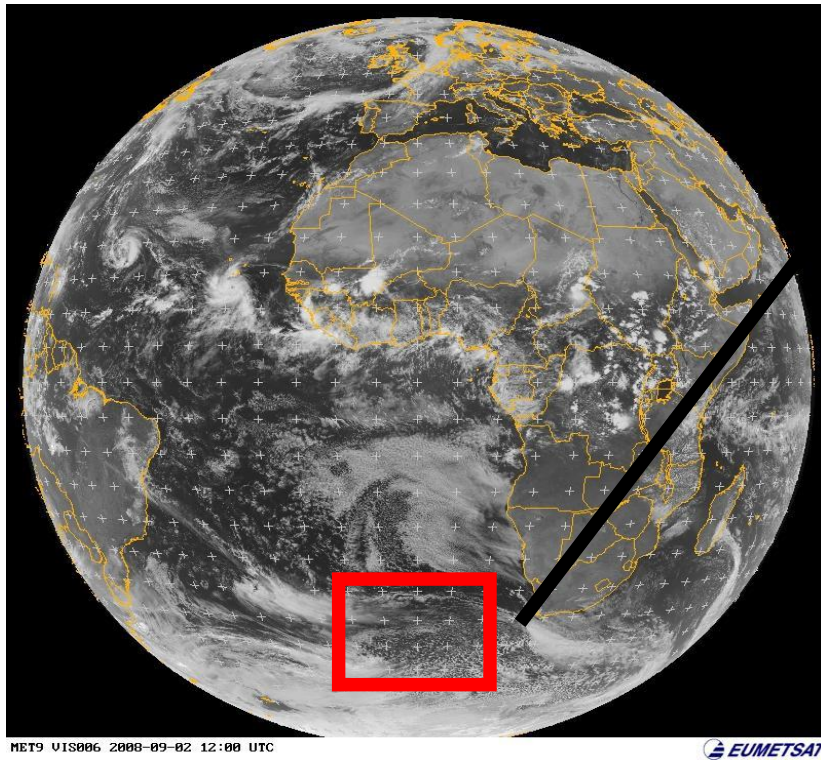


MET9 VIS006 2008-09-02 12:00 UTC

 EUMETSAT

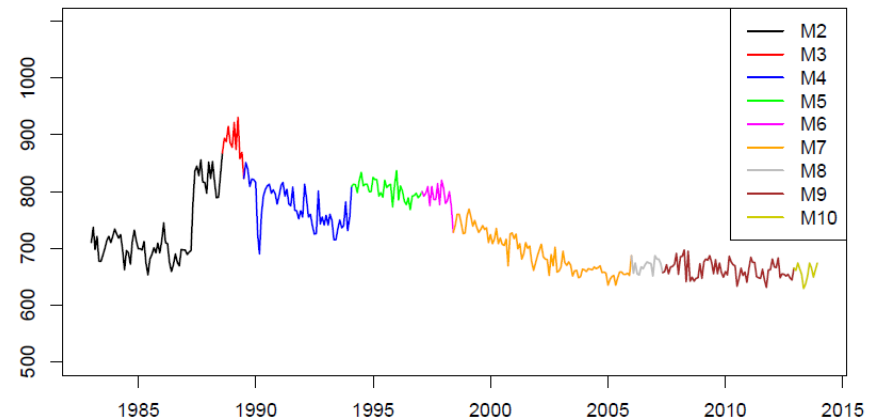


Reflectivity, 12 UTC, 2 Sept 2008



Max. reflectance, R_{max} :
95 % percentile of counts
during one month in the
reference region

Temporal evolution of R_{max}

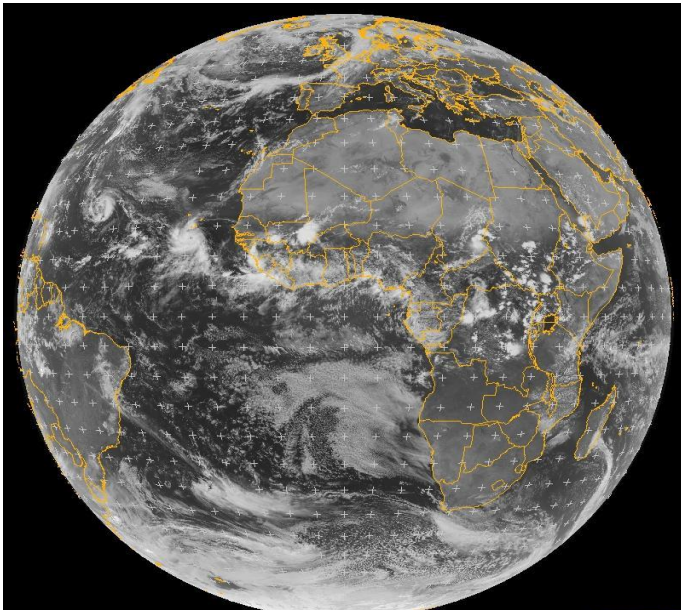


Self-calibration method, no intercalibration of different instruments required!

The Cloud Index n :

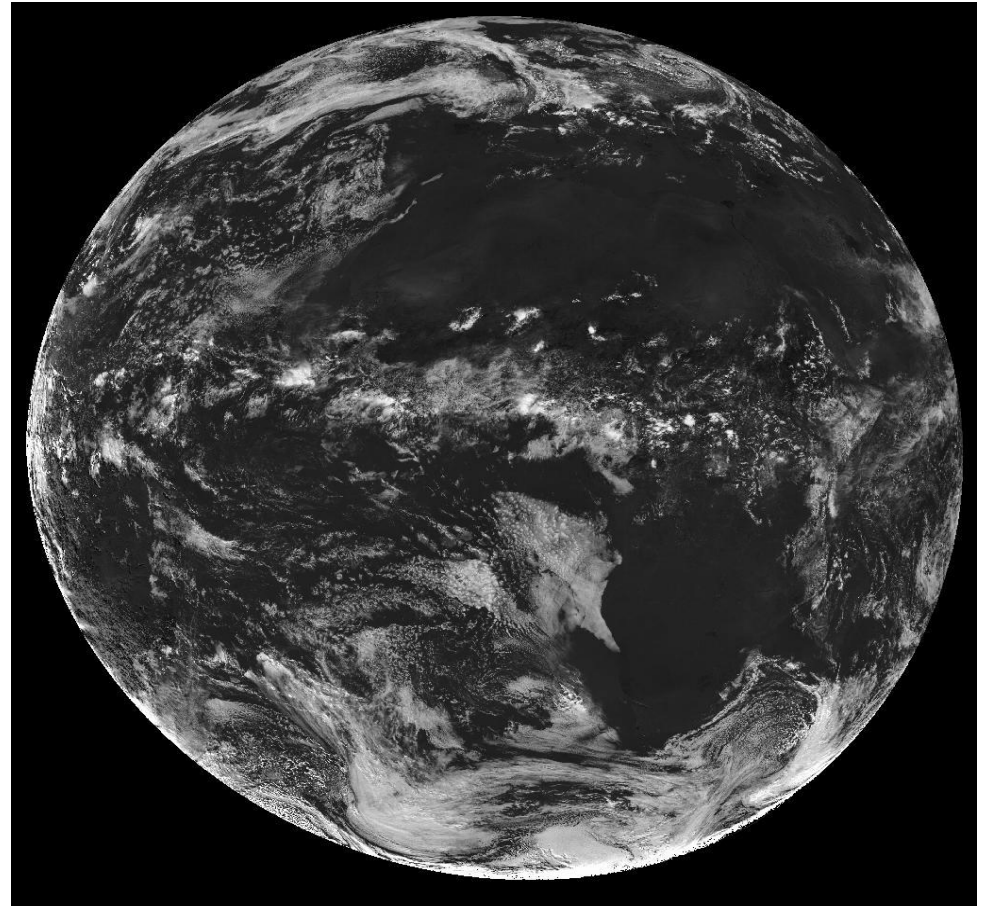
$$n = \frac{R - R_{min}}{R_{max} - R_{min}}$$

Cloud Index, 11 UTC, 1 July 2005



MET9 VIS006 2008-09-02 12:00 UTC

 EUMETSAT



- The cloud index, n , is related to the clear-sky index, k :

$$k = 1 - n$$

- The clear-sky index, k , is the ratio between the all-sky surface irradiance, G , and the clear-sky surface irradiance, G_{clear} :

$$G = k * G_{\text{clear}}$$

- G_{clear} can be calculated by radiation transfer calculations assuming water vapor column, surface albedo, aerosol information

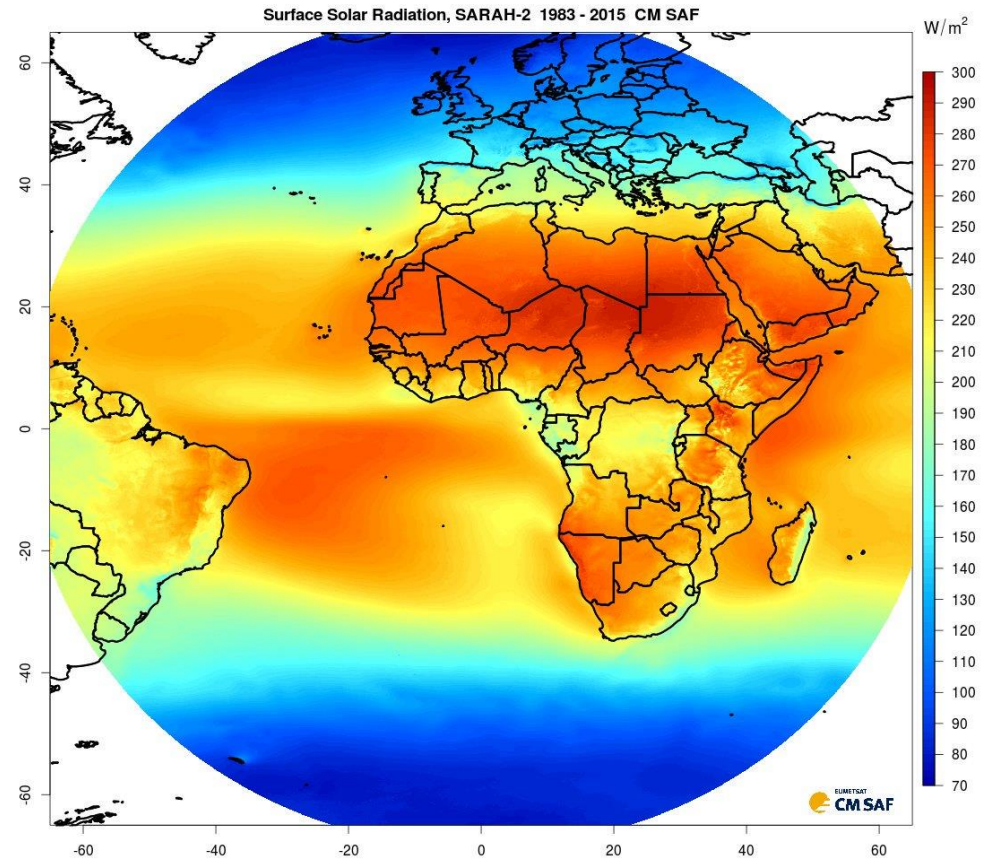
Temporal averaging

- Temporal averages (daily / monthly) are required for climatological analysis
- Additional uncertainty (in addition to the retrieval uncertainty) is introduced in the generation of the temporal average, due to the limited number of observations
- Higher uncertainty for data derived from polar-orbiting satellites; sometimes compensated by spatial averaging
- Example: **Surface Solar Incoming Radiation**
 - Clear-sky daily mean can be accurately derived from RTM calculations
 - Daily mean can be accurately estimated with:

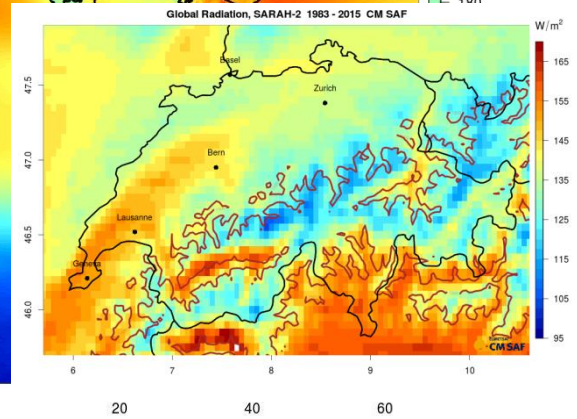
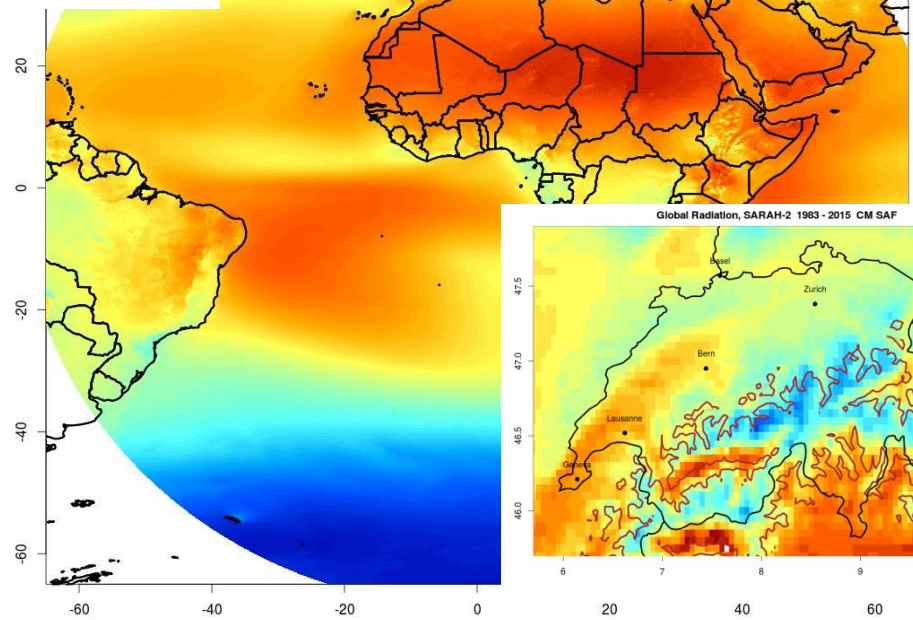
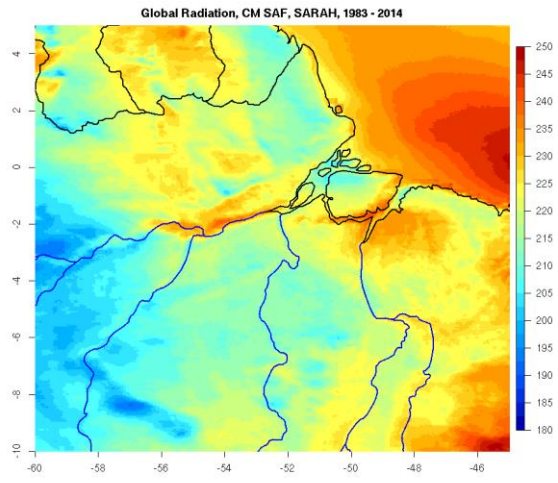
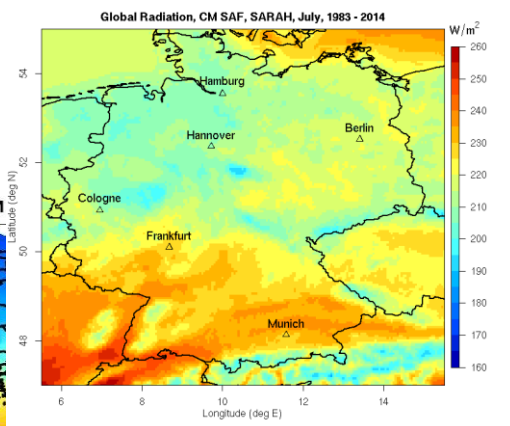
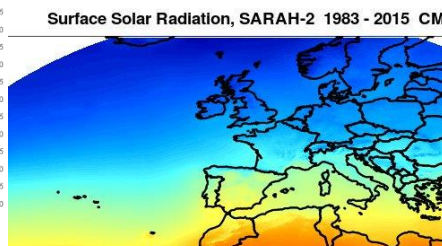
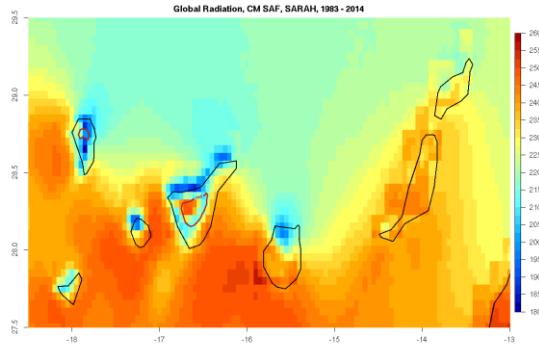
$$SIS_{DA} = SIS_{CLSDA} \frac{\sum_{i=1}^n SIS_i}{\sum_{i=1}^n SIS_{CLS_i}}$$

- Monthly means based on daily means

Climatological Irradiance: 1983 to 2015



Climatological Irradiance: 1983 to 2015



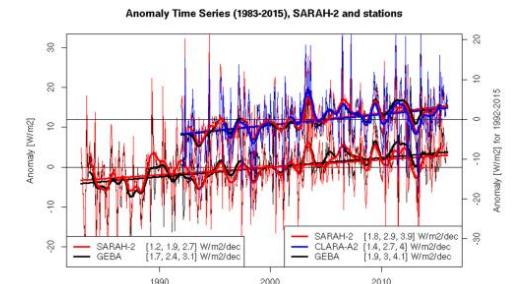
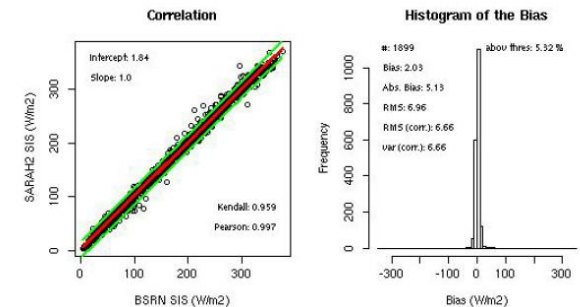
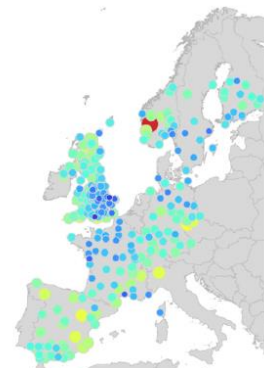
Validation of satellite-derived climate data

Reference data records required for the validation of the satellite-derived data

- ➔ Need to fulfill stronger requirements than the satellite data, i.e, in terms of accuracy, stability etc
- ➔ Should be available globally
- ➔ Often satellite data can only be compared to other satellite-based data: ‚Data evaluation‘

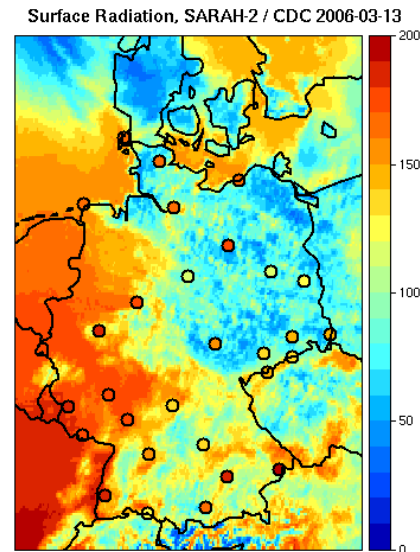
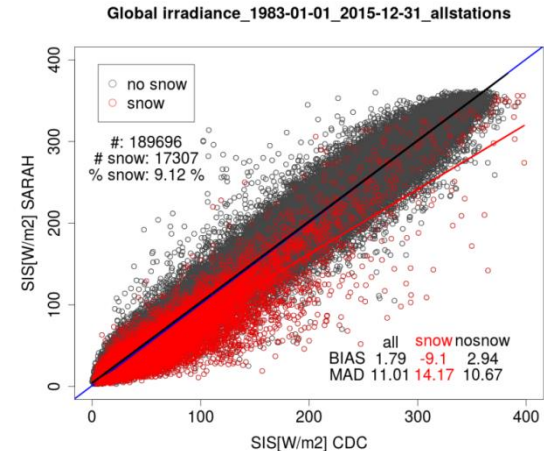
➔ Example: **Surface Solar Incoming Radiation**

- ➔ BSRN, GEBA data from global networks freely available
- ➔ Data from national networks also exists, but not always available, and no common standard



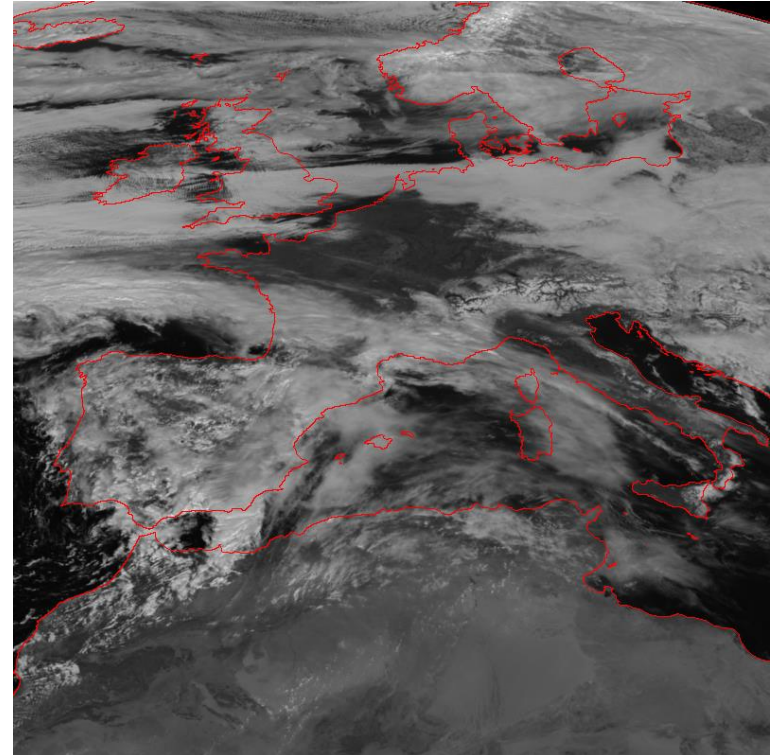
Reduced performance over snow

- ➔ Daily surface radiation:
Very good comparison with surface measurements
- ➔ Degraded performance over snow-covered surfaces
- ➔ Snow coverage appears as thick clouds, resulting in an under-estimation of surface radiation



Improved retrieval over snow

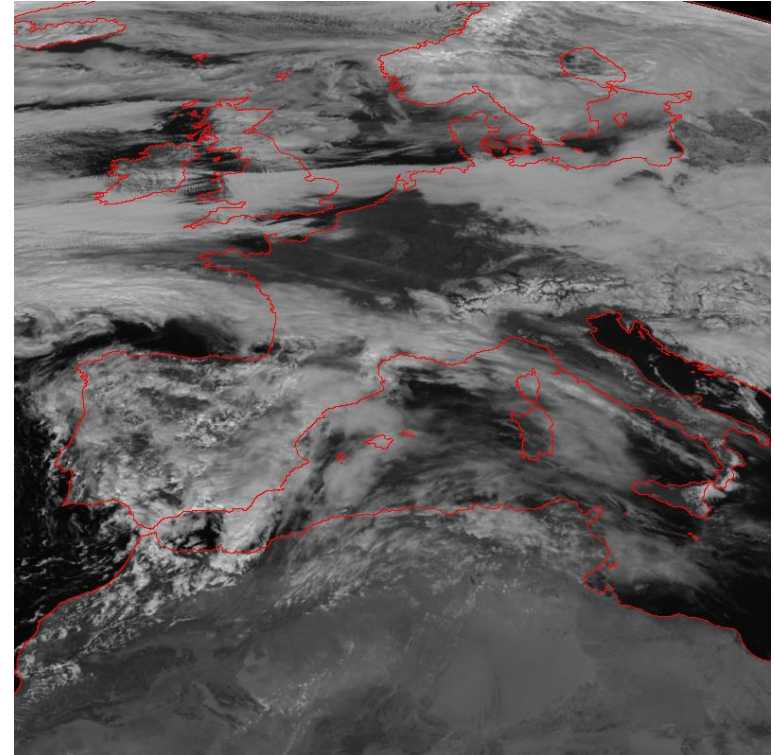
- Difficult separation between cloud and snow for the historic data: only 3 spectral channels available
- Concept:
Separation between Cloud and Snow based on ‚motion‘
- Modern programming tools (OpenCV: ‚optical flow‘) allow the processing of long time series
- Identification of snow coverage allows to adjust the cloud index



18 March 2006, 1200 UTC

Improved retrieval over snow

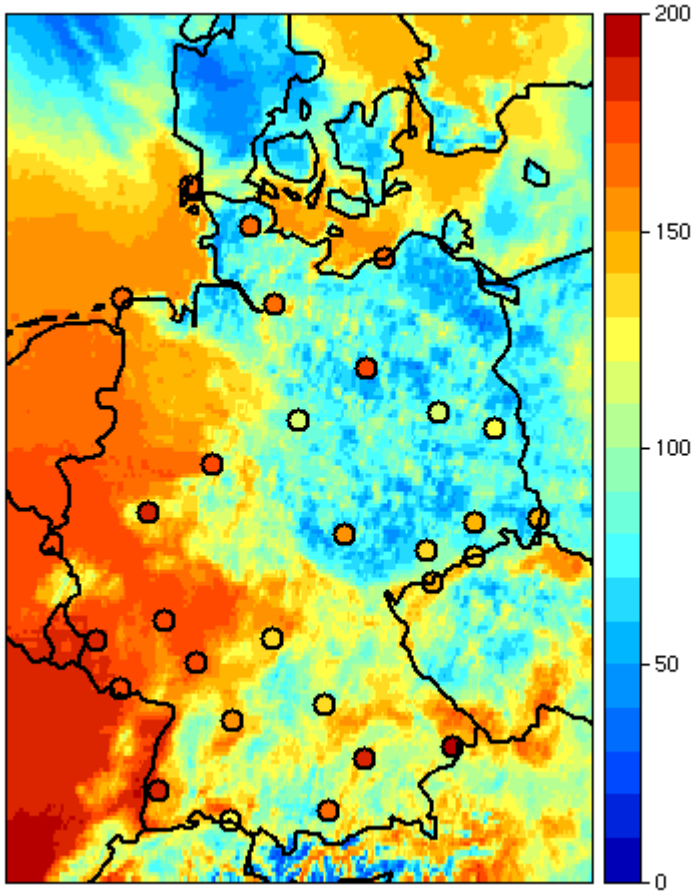
- Difficult separation between cloud and snow for the historic data: only 3 spectral channels available
- Concept:
Separation between Cloud and Snow based on ‚motion‘
- Modern programming tools (OpenCV: ‚optical flow‘) allow the processing of long time series
- Identification of snow coverage allows to adjust the cloud index



18 March 2006, 1230 UTC

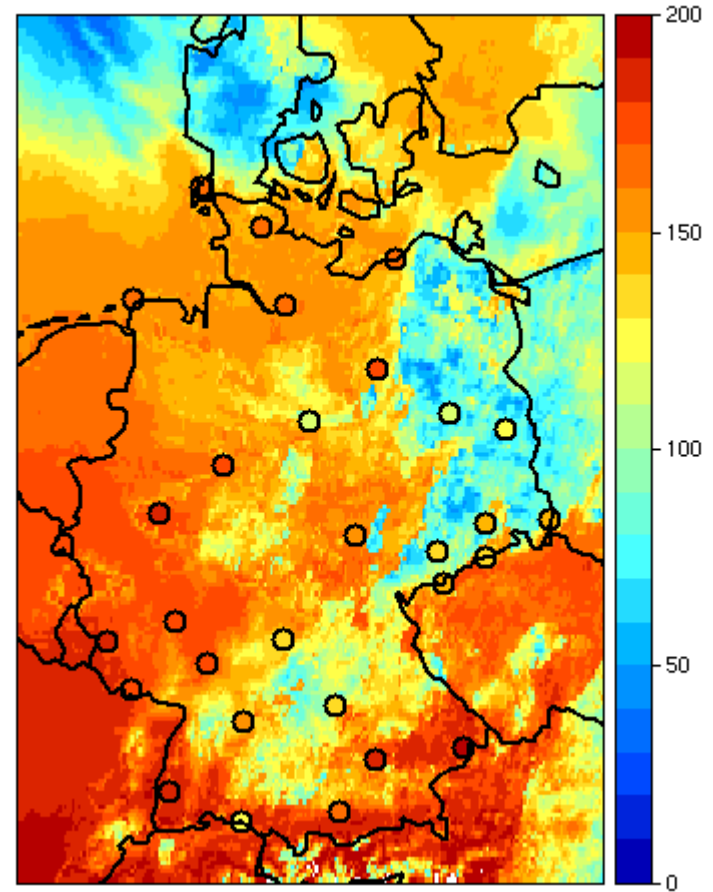
Original

Surface Radiation, SARAH-2 / CDC 2006-03-13



New

Surface Radiation, SARAH-2.5 / CDC 2006-03-13

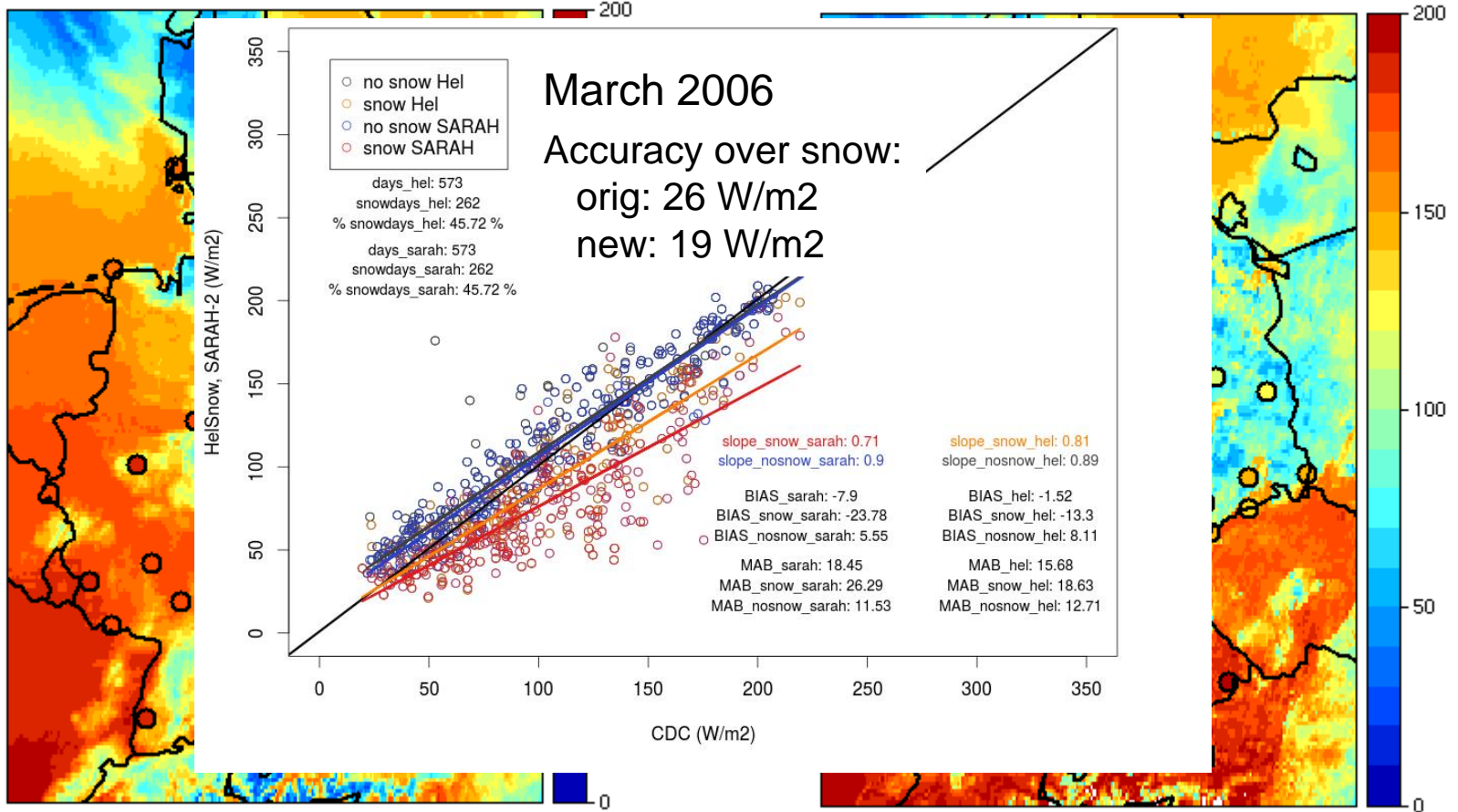


Original

New

Surface Radiation, SARAH-2 / CDC 2006-03-13

Surface Radiation, SARAH-2.5 / CDC 2006-03-13

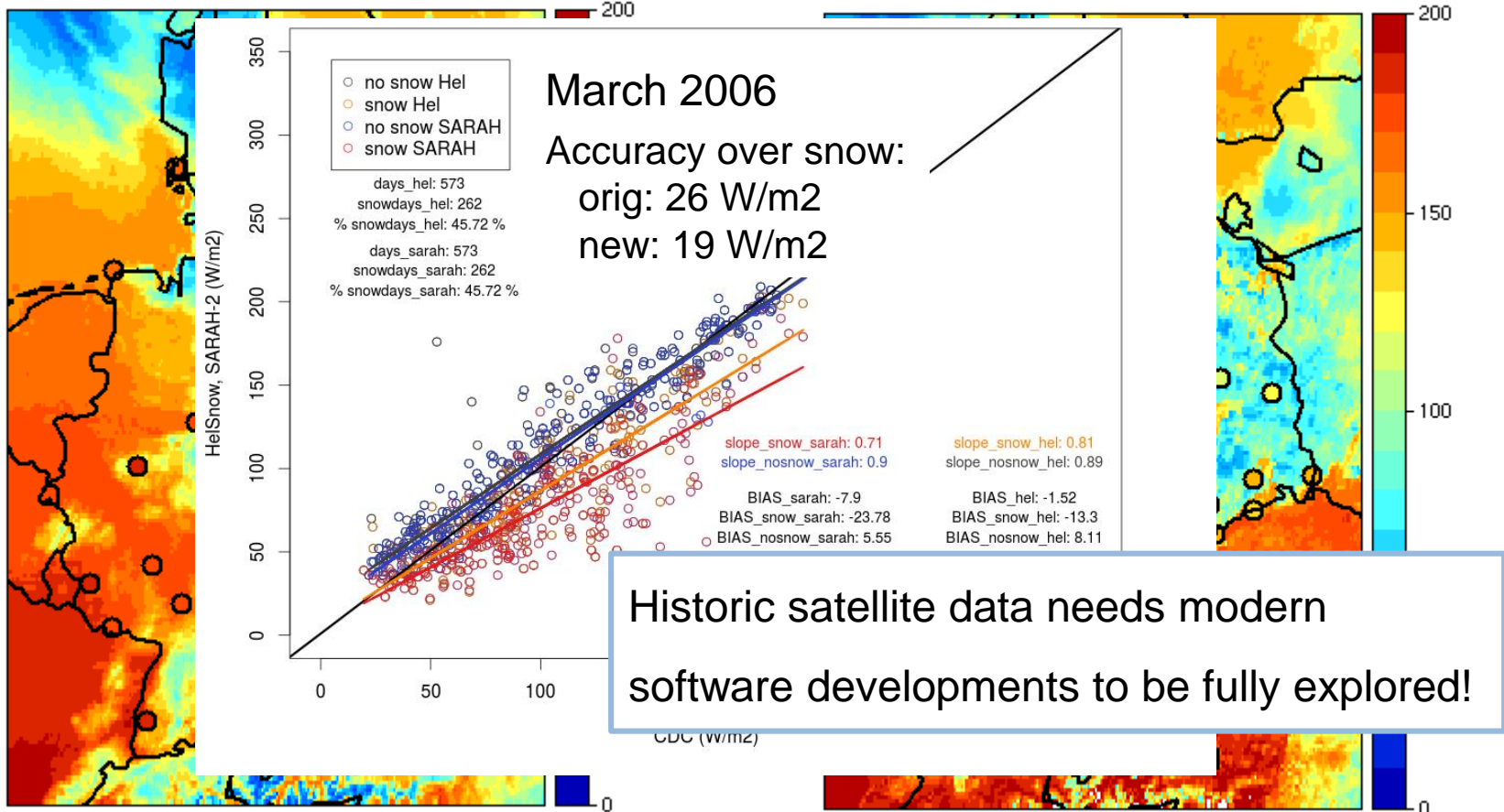


Original

New

Surface Radiation, SARAH-2 / CDC 2006-03-13

Surface Radiation, SARAH-2.5 / CDC 2006-03-13



Where can you get satellite-based climate data?

NOAA NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION
Formerly the National Climatic Data Center (NCDC) - more about NCDC

Home Climate Information Data Access Customer Support Contact About

Operational CDRs
Atmospheric
Oceanic
Terrestrial
Fundamental

Applied CDR Projects
NASA DEVELOP

CDR Information
Guidelines
Developmental CDRs
Opportunities

CDR Announcements
BERSANN CDR Precip Application Project

Climate Data Record Program

Welcome to NOAA's CDR Program

The mission of NOAA's Climate Data Record Program is to develop and implement a robust, sustainable, and scientifically defensible approach to producing and preserving climate records from satellite data.

WHAT ARE CDRs?
The National Research Council (NRC) defines a CDR as a time series of measurements of sufficient length, consistency, and continuity to determine climate variability and change. (National Research Council, 2004-9).

For the first time, NOAA is applying modern data analysis methods, which have advanced significantly in the last decade, to these historical global satellite data. This process will unravel the underlying climate trend.

<https://www.ncdc.noaa.gov/cdr>

climate change initiative
open data portal

<http://cci.esa.int/>

esa

→ GET CCI DATA
A single point of access. Open. Free. Easy.
cci.esa.int/data

CCI Soil Moisture Featured in BAMS State of the Climate in 2016 Report
Submitted by Fay Done on Fri, 11/08/2017 - 10:35

The CCI Soil Moisture project are proud to announce that their overview of recent and historical global soil moisture conditions have been published in the *State of the Climate in 2016 Report* (released August 2017), the authoritative annual summary of the global climate that is published as a supplement to the Bulletin of the American Meteorological Society (BAMS).

The Calving of Antarctica's Larsen-C Ice Shelf
Submitted by Fay Done on Thu, 10/08/2017 - 11:58

- aerosol cci
- cloud cci
- fire cci
- ghg cci
- glaciers cci
- antarctic ice sheet cci
- ice sheets greenland cci
- land cover cci
- ocean colour cci

EUMETSAT
CM SAF The Satellite Application Facility on Climate Monitoring

Overview Products Data Access Documentation Outreach

Search

News

- 1st Operations Report 2017 available
- updated Auxiliary Data (July)
- EUMETSAT / CM SAF Workshop, Pistoia, South Africa, 2017

More

CM SAF on Twitter
@Climate_SAF

Service

- Newsletter
- Contact, User Help Desk&UIPR
- Staff
- FAQ's
- Glossary
- Links
- Disclaimer&Acknowledgement
- Sitemap

Highlights
Highlights Archiv

Updated CM SAF Surface Solar Radiation Climate Data Record available

The CM SAF is happy to announce the release of the second edition of the Surface Radiation Data Set - Heliosat (SARAH-2):
http://doi.org/10.5678/EUM_SAF_CM/SARAH/V002

SARAH-2 provides high-quality satellite-based information on surface solar radiation parameters from 1983 to 2015 covering Europe, Africa, parts of South America as well as the surrounding ocean areas. The spatial

<http://www.cmsaf.eu>

- All data are available at no charge
- Mostly in netcdf-format following the CF-standard

NOAA NCDC



The screenshot shows the NOAA National Centers for Environmental Information website. The main heading is "NOAA NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION" with the subtitle "Formerly the National Climatic Data Center (NCDC)... more about NCEI". The navigation menu includes "Home", "Climate Information", "Data Access", "Customer Support", "Contact", and "About". The current page is "Climate Data Record Program". The left sidebar lists "Operational CDRs" (Atmospheric, Oceanic, Terrestrial, Fundamental), "Applied CDR Projects" (NASA DEVELOP), "CDR Information" (Guidelines, Developmental CDRs, Opportunities), and "CDR Announcements" (PERSIANN CDR Precip Application Project, NOAA CDR Program 2015 Annual Meeting, Presentations, Posters). The main content area features a "Welcome" message and a "WHAT ARE CDRs?" section. The URL <https://www.ncdc.noaa.gov/cdr> is displayed at the bottom of the page.

- Focus on GCOS ECVs:
 - Atmospheric (e.g., ISCCP, GPCP)
 - Ocean (e.g., SST, Sea Ice)
 - Terrestrial (e.g., snow coverage)
- Different spatial / temporal resolutions + coverage (often global coverage, moderate resolution)
- Also providing FCDRs (e.g., AVHRR)

ESA Climate Change Initiative (CCI)



- Organized in 14 different projects, e.g., clouds, glaciers, land use, aerosol etc.
- Focus on historic climate data records
- New projects (ECVs) are about to be starting, no continuation of the current projects

EUMETSAT CM SAF

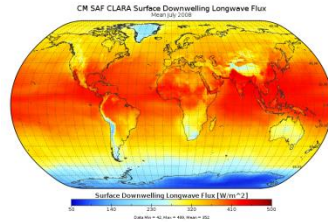


- EUMETSAT Satellite Application Facility on Climate Monitoring (CM SAF)
 - Focusing on Energy and Water cycle
 - Long-term data records > 30 years
 - Operational data (timeliness about 1 week)
 - Radiation, clouds and their properties, albedo, land surface temperature, water vapor, precipitation
 - Sustained funding via EUMETSAT satellite program



The screenshot shows the EUMETSAT CM SAF website. The header includes the EUMETSAT CM SAF logo and the tagline 'The Satellite Application Facility on Climate Monitoring'. Navigation tabs for Overview, Products, Data Access, Documentation, and Outreach are visible. A search bar is present. The main content area features a large satellite image of Earth with a weather system over the Atlantic. Below the image is a news section with links to '1st Operations Report 2017 available', 'Updated Auxiliary Data (July)', and 'EUMETSAT / CM SAF Workshop, Pretoria, South Africa, 2017'. There is also a 'CM SAF on Twitter' section with the handle @Climate_SAF. A 'Service' section lists links for Newsletter, Contact, Staff, FAQ's, Glossary, Links, Disclaimer & Acknowledgement, and Sitemap. A 'Highlights' section features a 'Highlights Archiv' and a 'Updated CM SAF Surface Solar Radiation Climate Data Record available' announcement, which includes a link to a DOI and a small map of the data coverage area.

CLARA



→ Variables

- Cloud properties
- Surface albedo
- Radiation

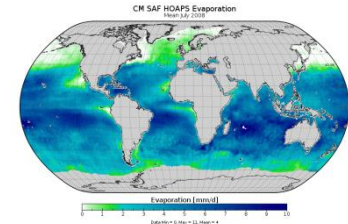
→ Resolution

- $0.25^\circ \times 0.25^\circ$
- daily-, pentad-, monthly

→ Coverage

- global
- 1982 to 2015

HOAPS



→ Variables

- Water Vapor
- Precipitation, evaporation
- Latent heat flux
- Fresh water flux

→ Resolution

- $0.5^\circ \times 0.5^\circ$
- 6-hourly-, monthly means

→ Coverage

- global ice free ocean
- 1987 to 2015

SARAH

→ Variables

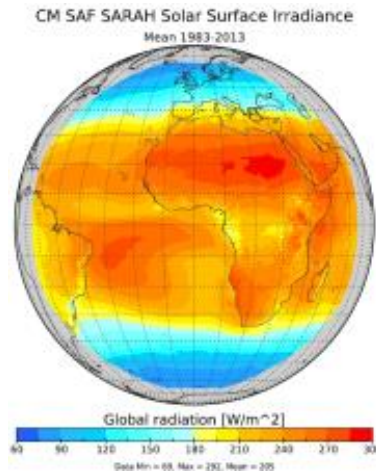
- Global radiation
- Surface direct irradiance
- Sunshine duration

→ Resolution

- $0.05^\circ \times 0.05^\circ$
- 30 min instantaneous, daily-, monthly means

→ Coverage

- Meteosat disk
- 1983 to 2015



CLAAS

→ Variables

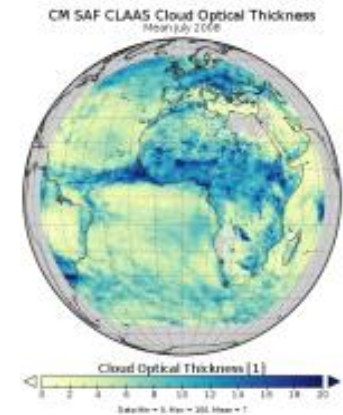
- Cloud coverage
- Cloud properties

→ Resolution

- up to $0.05^\circ \times 0.05^\circ$
- 30 min instantaneous, daily-, monthly means

→ Coverage

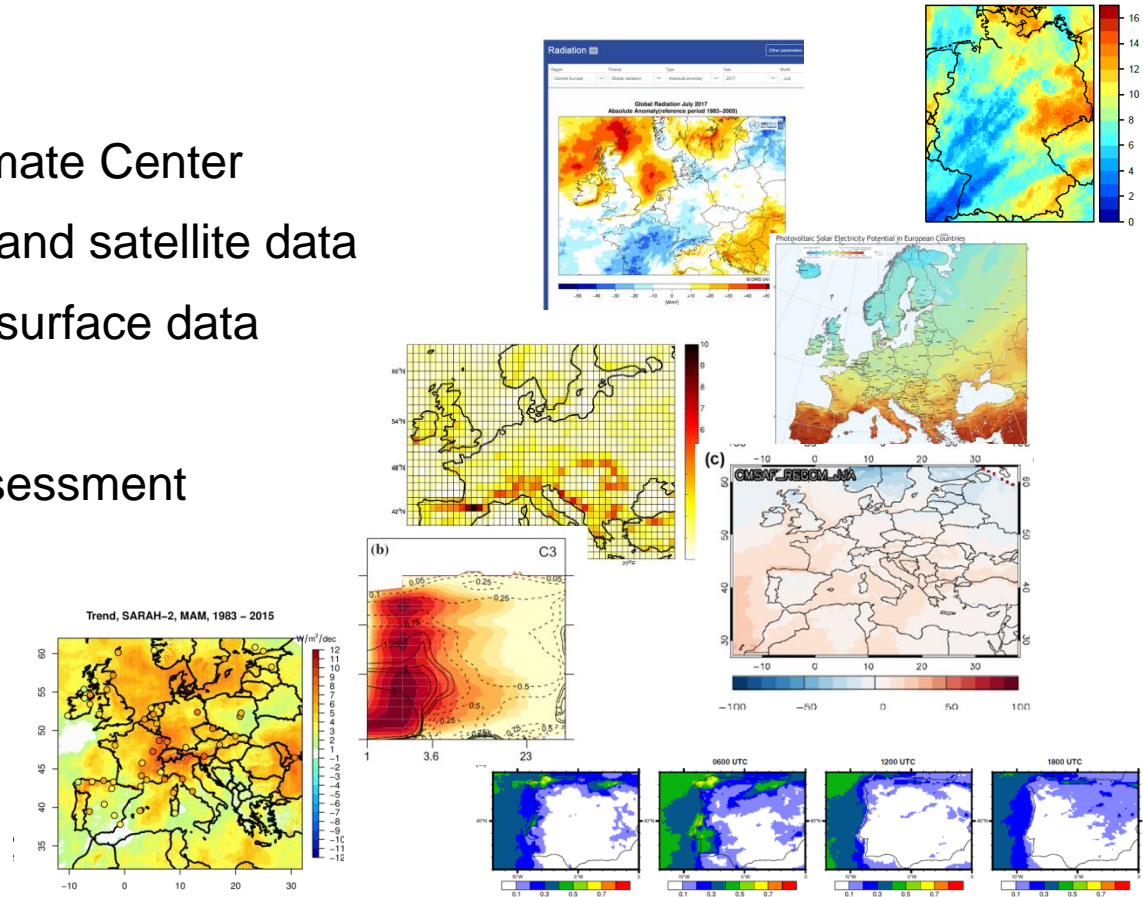
- Meteosat disk
- 2004 to 2015



Selected Applications

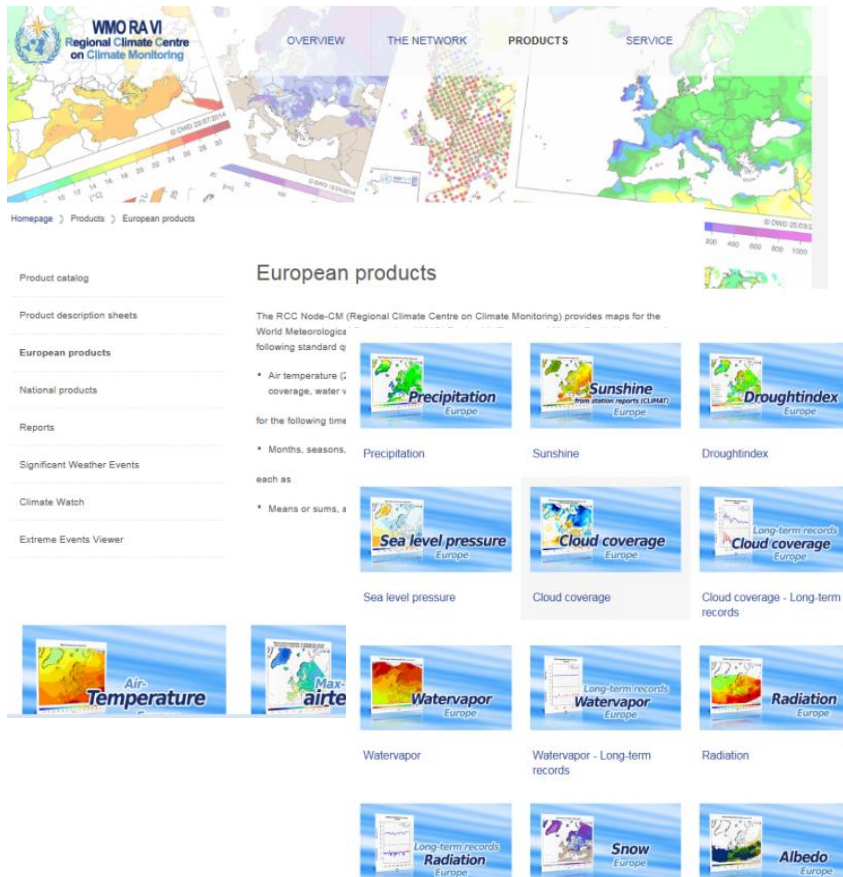
High-Resolution Satellite Climate Data

- ➔ Climate Monitoring
 - ➔ WMO Regional Climate Center
 - ➔ Merging of surface and satellite data
 - ➔ Representativity of surface data
- ➔ Model Evaluation
 - ➔ Regional Model assessment
 - ➔ Process studies
- ➔ Climate Analysis
 - ➔ Trend Analysis



WMO Regional Climate Centre (RCC)

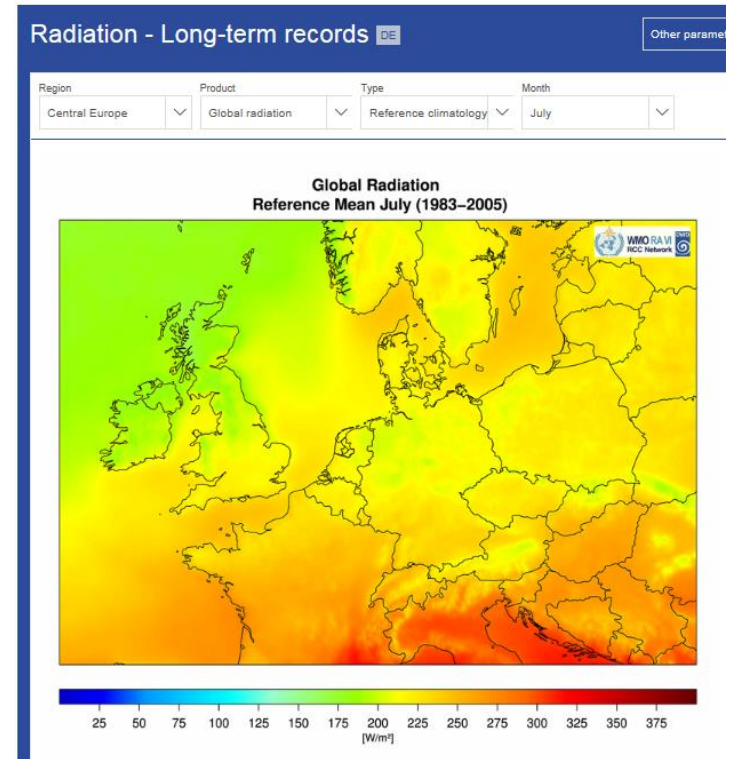
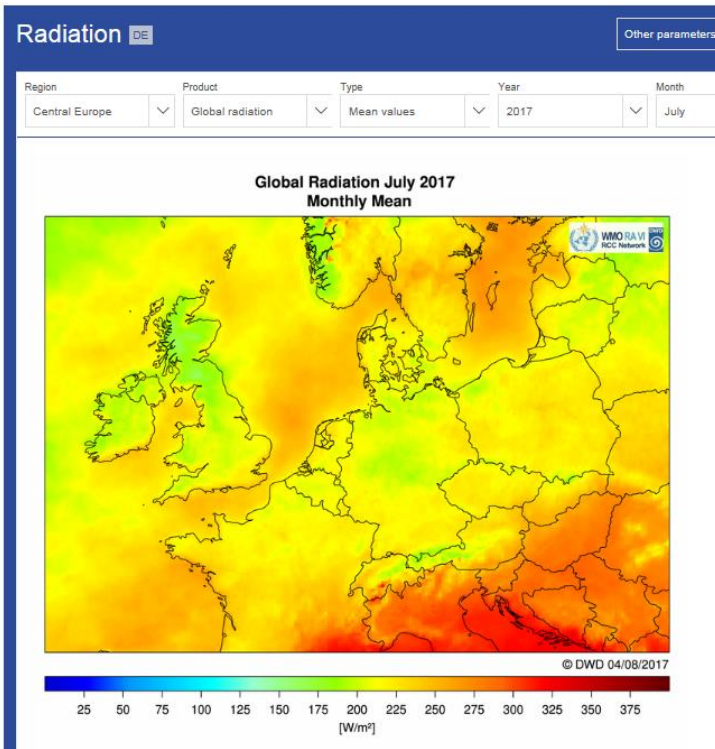
<http://rcccm.dwd.de>



- ➔ Provides maps of climatological relevant parameters for the WMO Region VI
- ➔ Many products based on surface-based records
 - ➔ Data quality / availability of surface data is different between countries
- ➔ Satellite data offer spatially consistent data

Obregón, A. et al., (2014), *Advances in Science and Research*, 11, 25-33

Example: Surface Radiation, July 2017

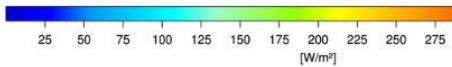
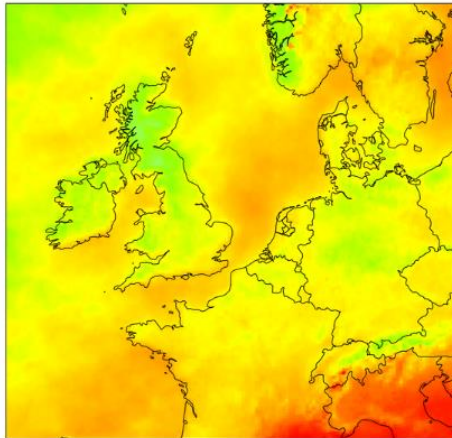


Example: Surface Radiation, July 2017

Radiation DE Other parameters

Region	Product	Type	Year	Month
Central Europe	Global radiation	Mean values	2017	July

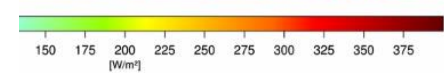
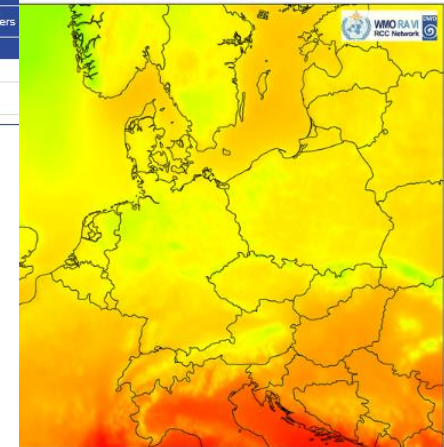
Global Radiation July 2017
Monthly Mean



Radiation - Long-term records DE Other parameters

Region	Product	Type	Month
Central Europe	Global radiation	Reference climatology	July

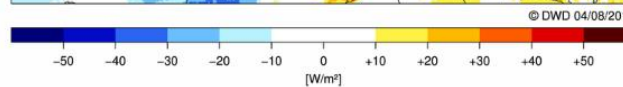
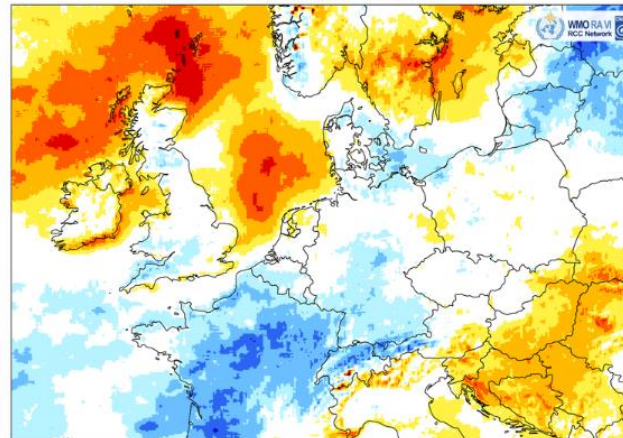
Global Radiation
Reference Mean July (1983–2005)



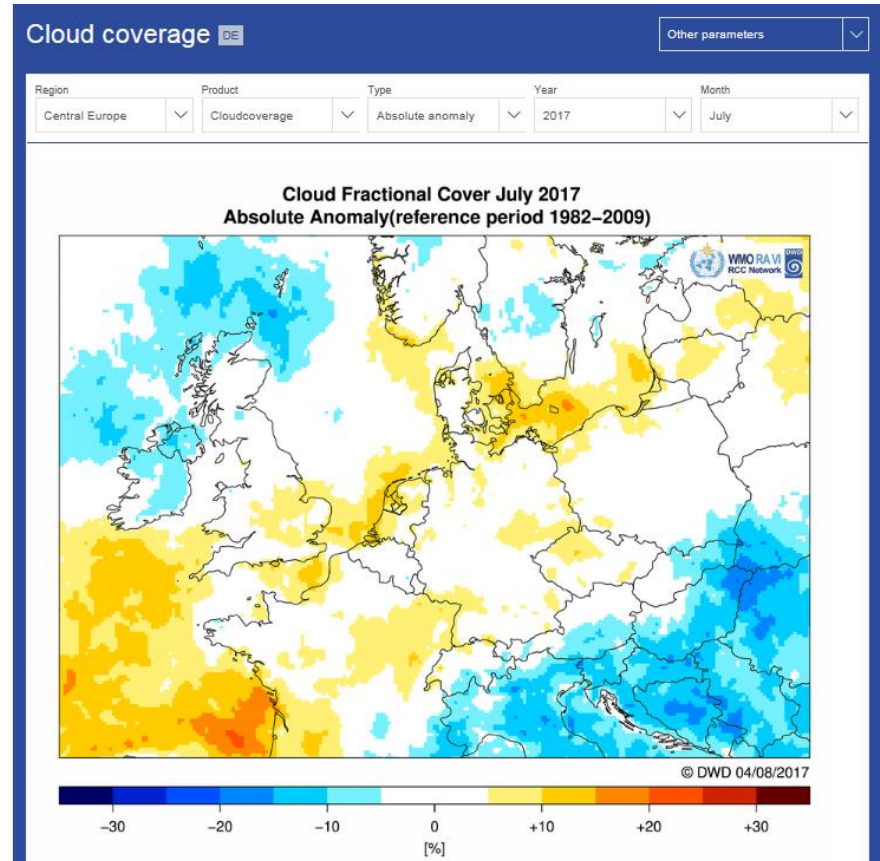
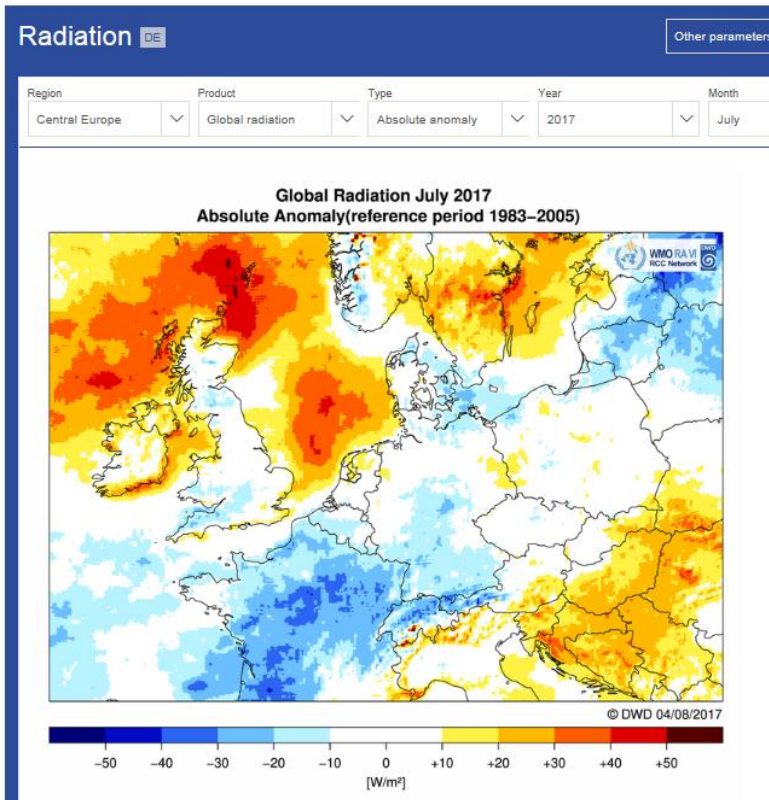
Radiation DE Other parameters

Region	Product	Type	Year	Month
Central Europe	Global radiation	Absolute anomaly	2017	July

Global Radiation July 2017
Absolute Anomaly(reference period 1983–2005)

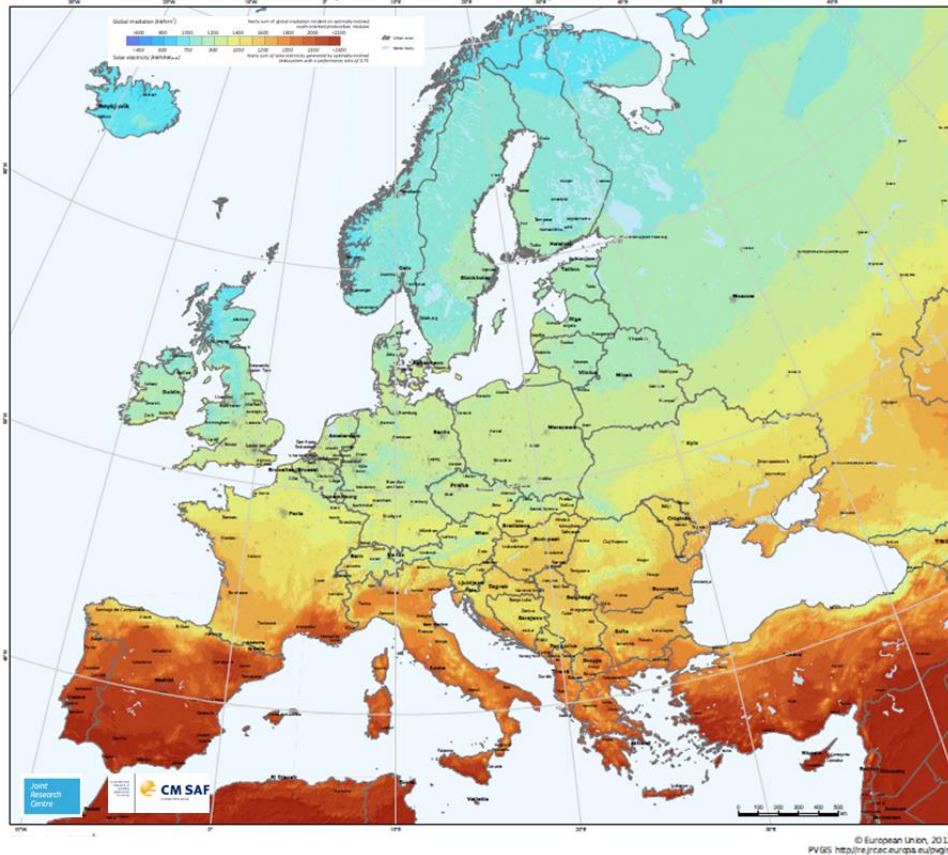


Example: July 2017



Solar Energy Potential: JRC PV GIS

Photovoltaic Solar Electricity Potential in European Countries



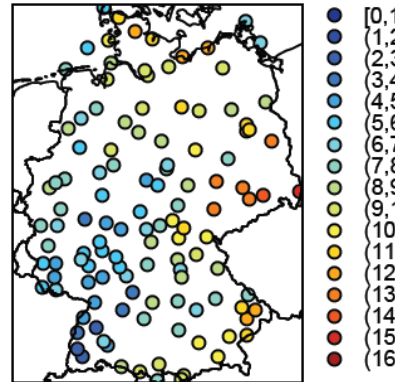
- European photovoltaic potential estimated based on hourly satellite-based climatological surface radiation.
- Similarly the current power production can be monitored.

Huld, T. et al., (2012), Solar Energy, 86(6), 1803-1815

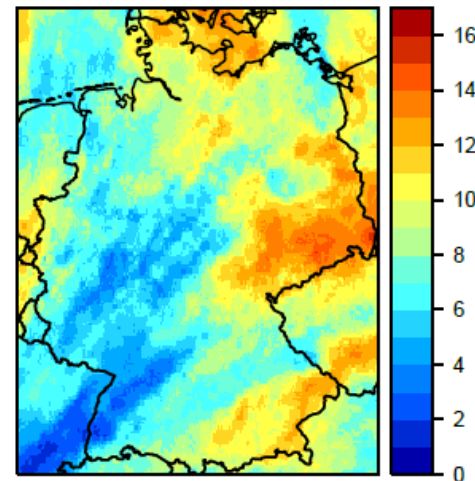
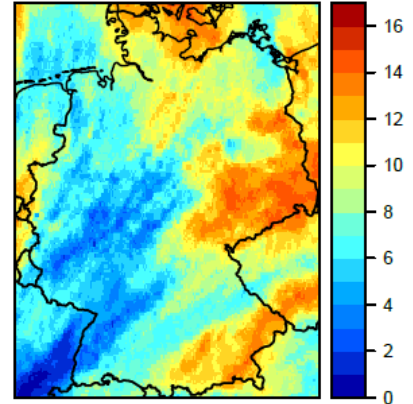
Merging of satellite- and surface-based data

- The combination of high-resolution satellite data (spatial information) and surface measurements (accuracy) provides excellent means to determine climate parameters
- Different methods for the merging have been applied / further research needed.

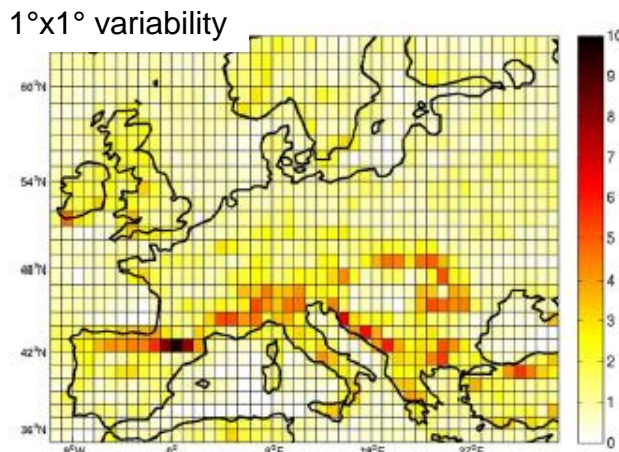
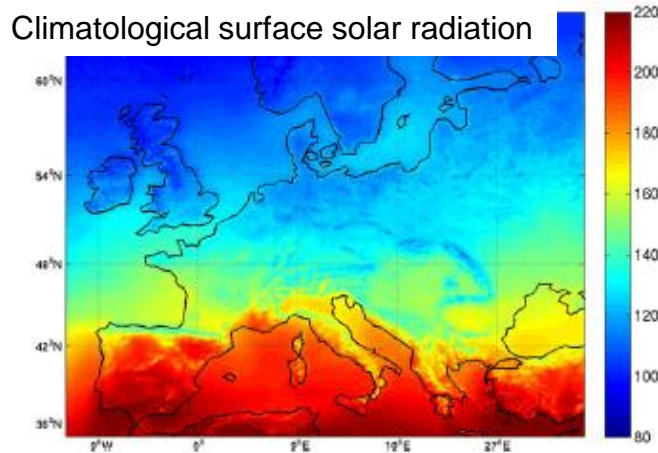
Surface data



Satellite data



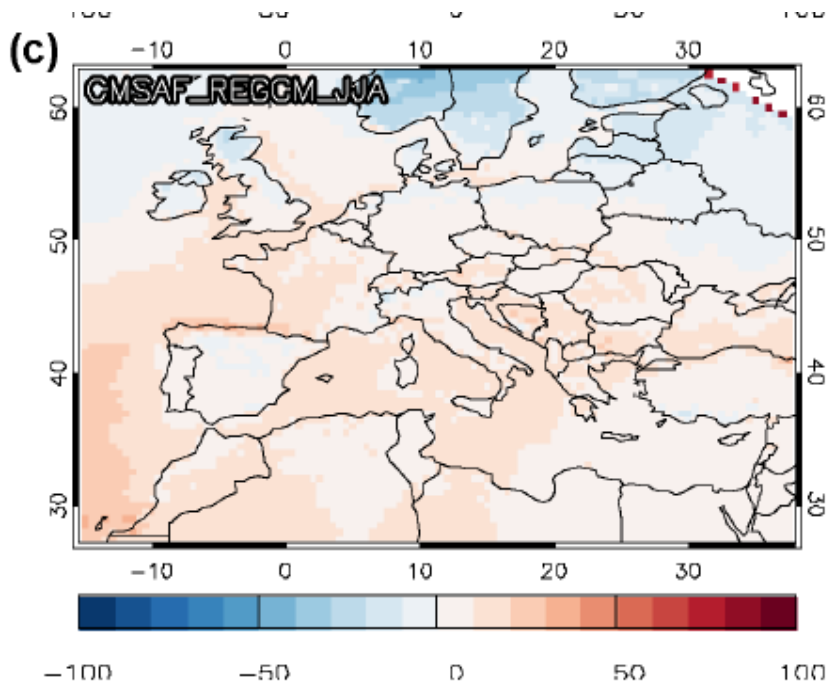
Representativity of locations / surface data



- High resolution satellite-based climate data can be used to estimate the spatial variability on the coarser scale
- Information relevant for station deployment, model evaluation etc.
- Also useful for quality control of surface data

Hakuba, M. Z. et al., (2013), *Journal of Geophysical Research*, 118(15), 8585-8597

Regional Climate Model Evaluation



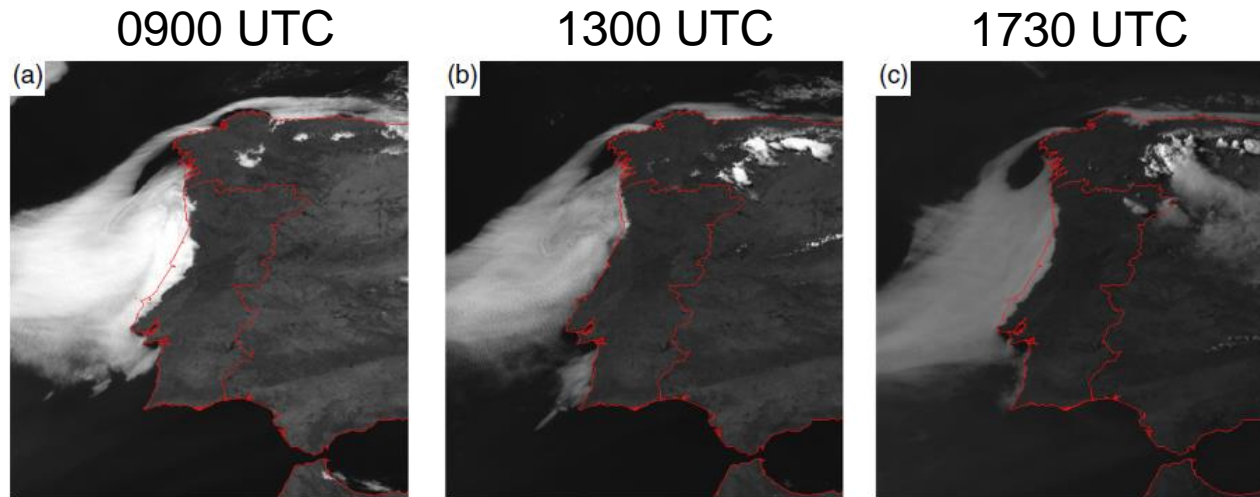
- Difference between climatological values from model vs satellite
- Classical' evaluation of high-resolution climate model simulation, e.g., from CORDEX

Alexandri, G., et al., (2015), *Atmospheric Chemistry and Physics*, 15(22), 13195-13216

Regional Climate Model Evaluation

- High resolution (time and space) satellite climate data allow process-based evaluation of climate models

a) Diurnal cycle of low clouds



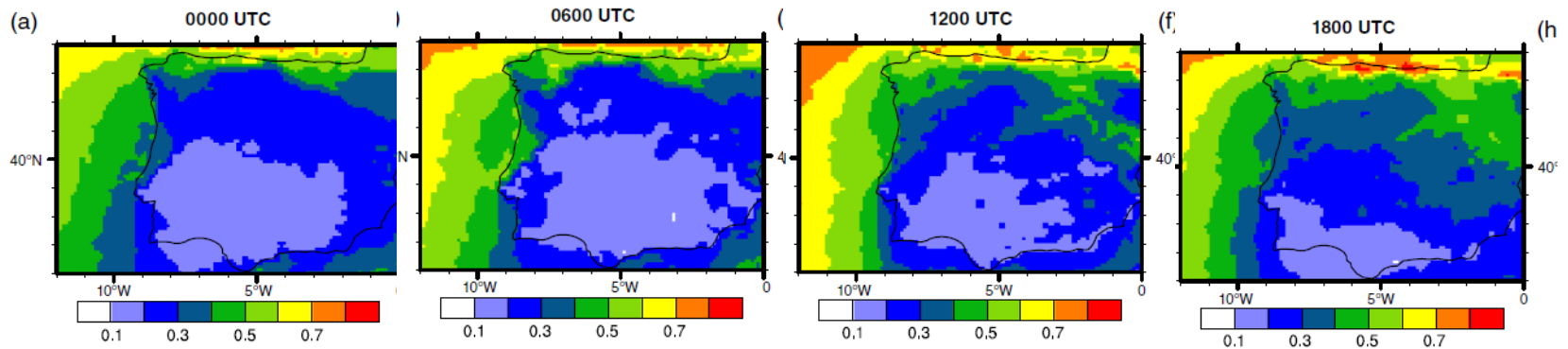
A typical summer day in the Iberia west coast cloudiness, as seen from MSG-SEVIRI high resolution visible channel (HRV). Images were taken on 10 July 2013. (a) 0900 UTC, (b) 1300 UTC, (c) 1730 UTC.

Martins, J. P. A., et al., (2016), *International Journal of Climatology*, 36(4), 1755-1772

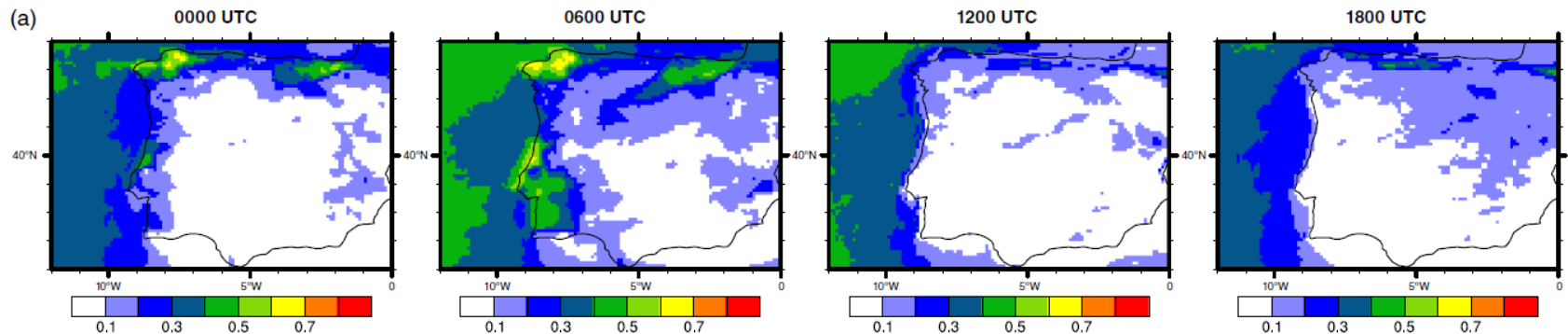
Regional Climate Model Evaluation

Climatological diurnal cycle of cloud coverage, JJA

CM SAF CLAAS



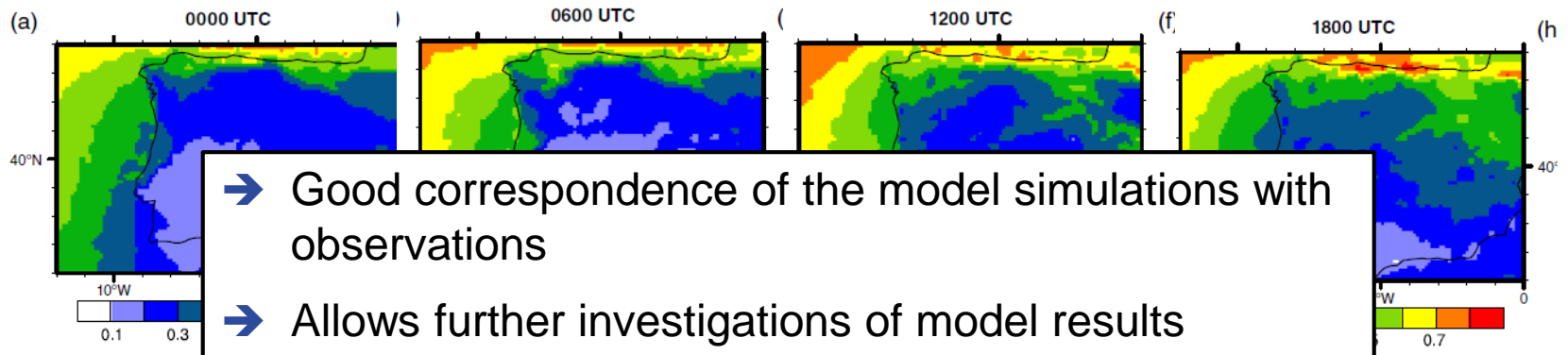
WRF Model simulations



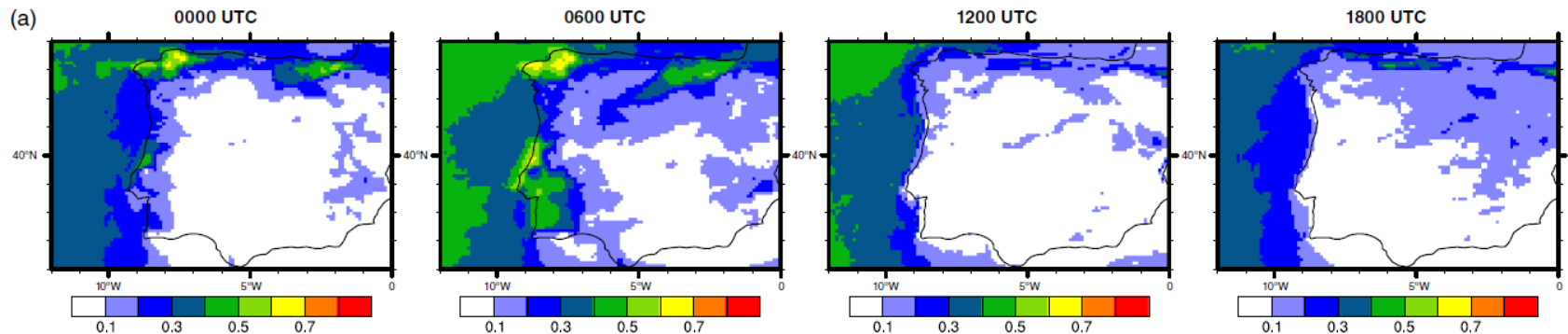
Regional Climate Model Evaluation

Climatological diurnal cycle of cloud coverage, JJA

CM SAF CLAAS



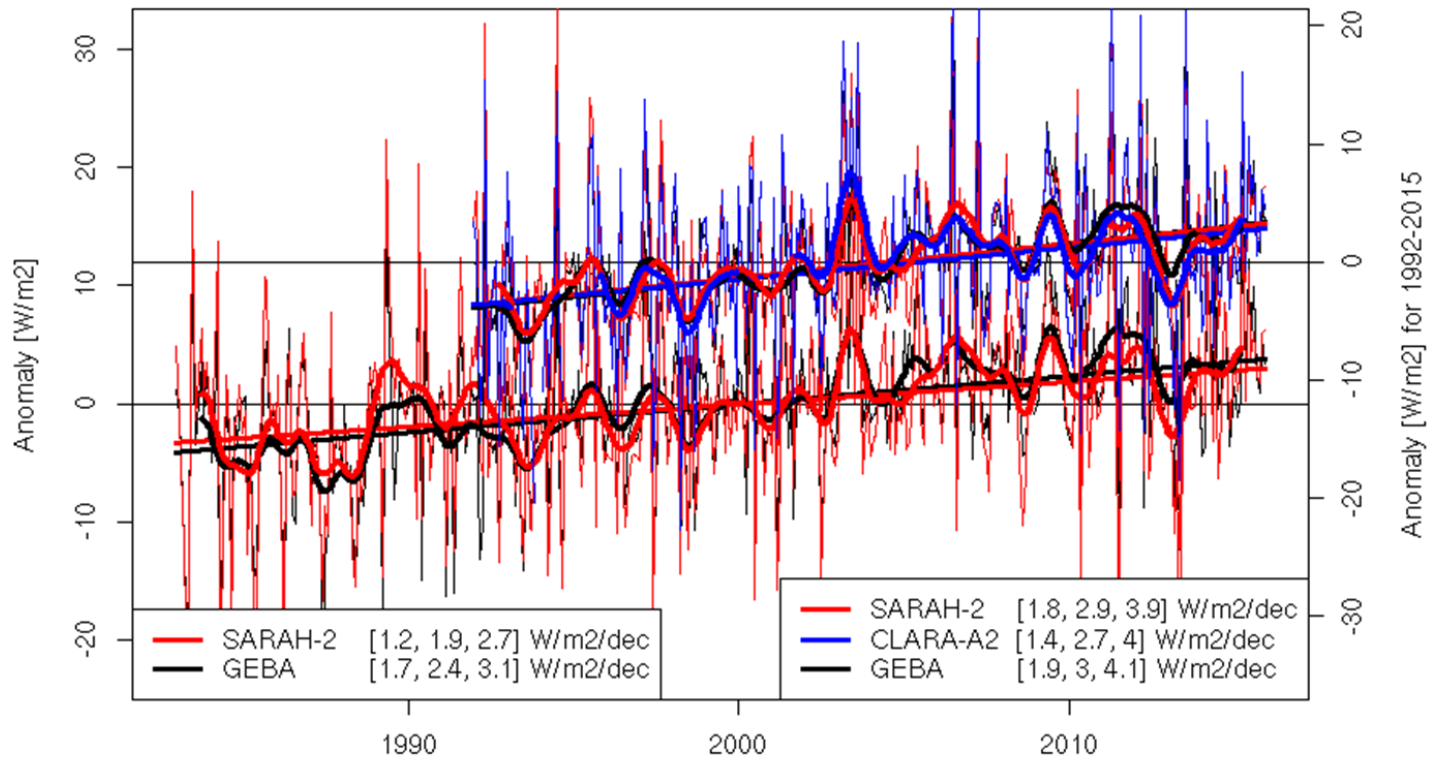
WRF Model simulations



Climate Analysis: Trend in Surface Solar Radiation

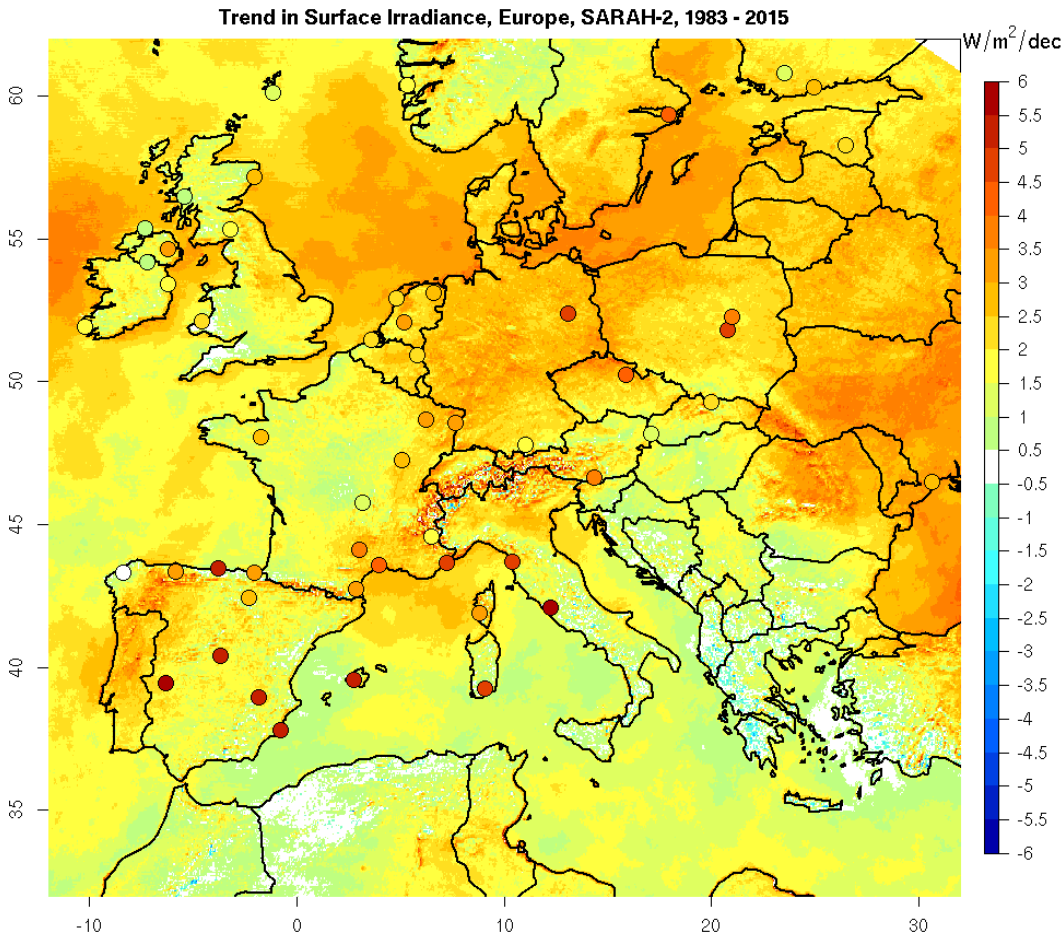
Validation of satellite data

Anomaly Time Series (1983-2015), SARAH-2 and stations



Trend: SARA / Surface

SARA: 1983 - 2015

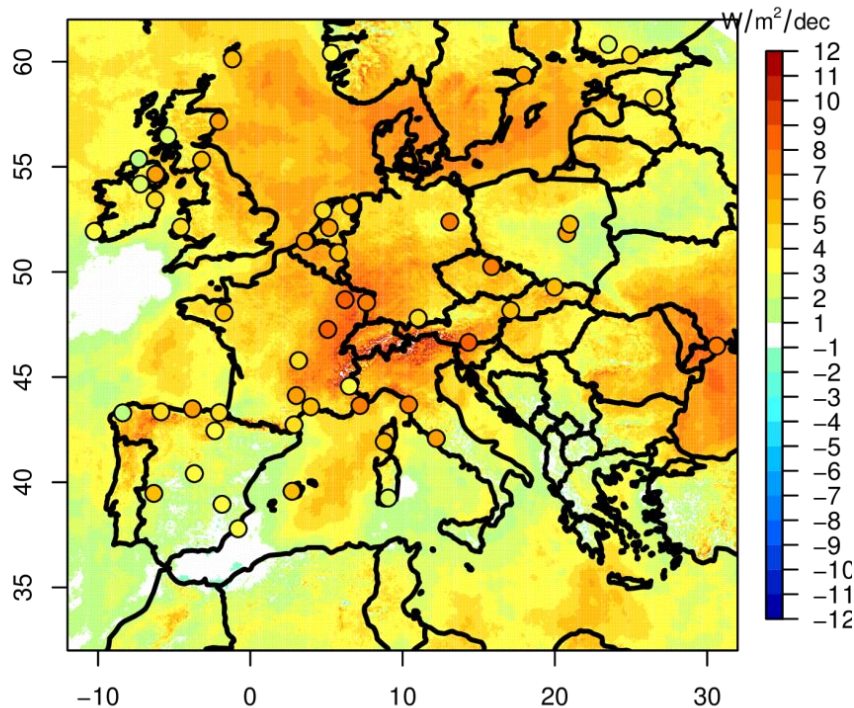


- Spatial variability of the trend in surface radiation
- Good correspondence of the spatial variability of the trends between satellite and surface data.

Seasonal Trends: Surface / SARA

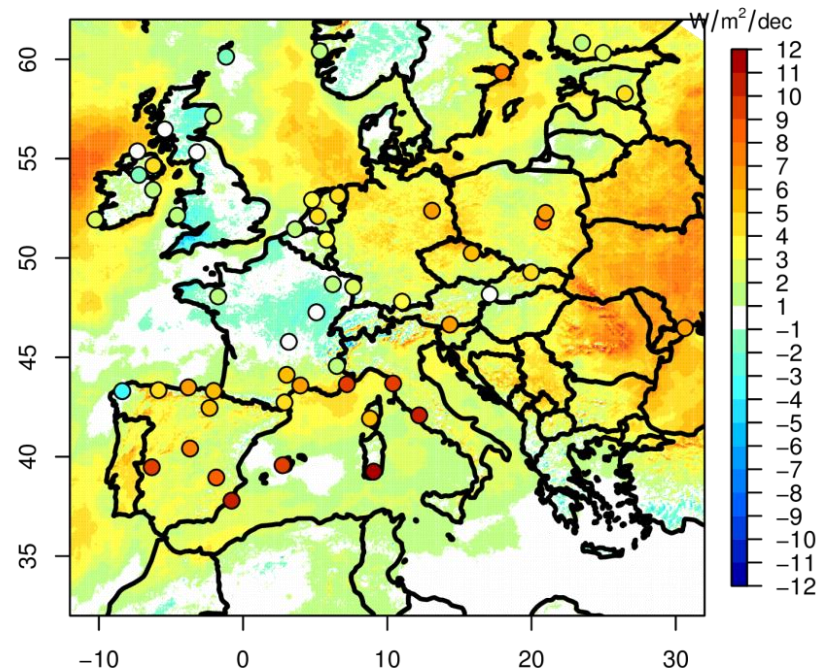
Spring

Trend, SARA-2, MAM, 1983 - 2015



Summer

Trend, SARA-2, JJA, 1983 - 2015

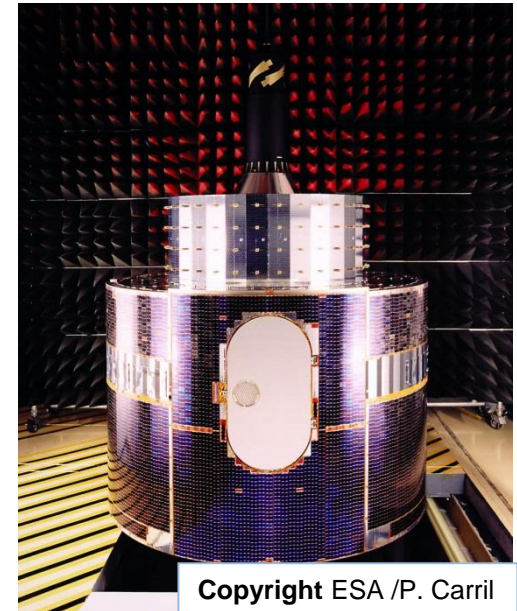


- Large scale 'brightening' in spring
- Spatially diverse trends in summer

Status and Outlook: EUMETSAT Meteosat Satelliten

1. Generation (MVIRI) (1982 - 2006)

- 3 spektrale Kanäle
- Zeit: 30 min
- Raum: 5 km



Status and Outlook: EUMETSAT Meteosat Satelliten

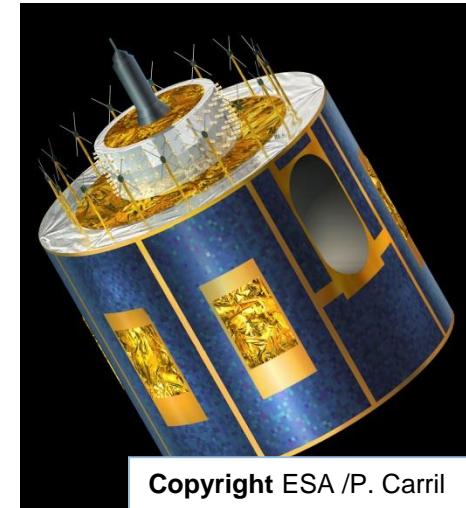
1. Generation (MVISI) (1982 - 2006)

- 3 spektrale Kanäle
- Zeit: 30 min
- Raum: 5 km



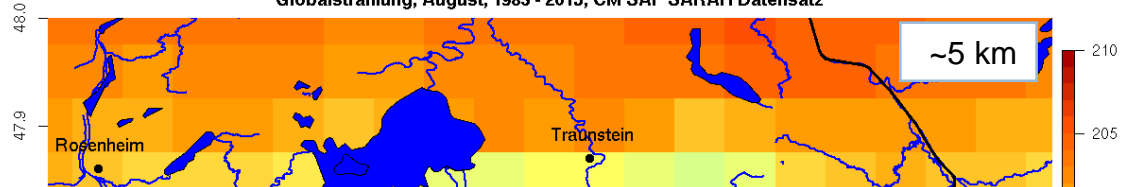
2. Generation (SEVIRI) (2004 - ~2020)

- 11 spektrale Kanäle
- 5 min bis 15 min
- 5 km / 1 km (HRV)

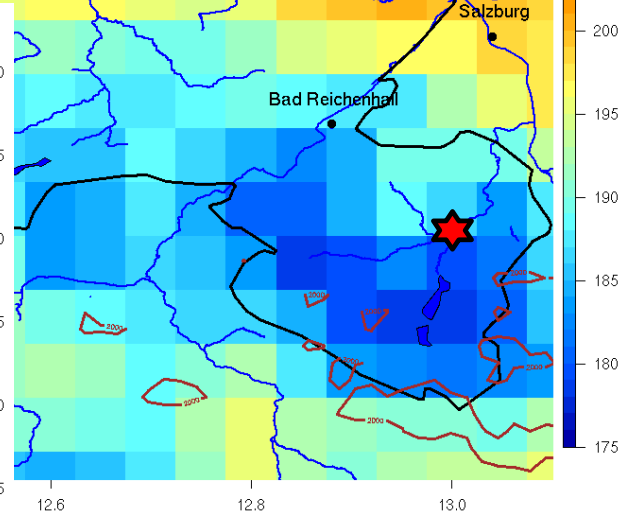
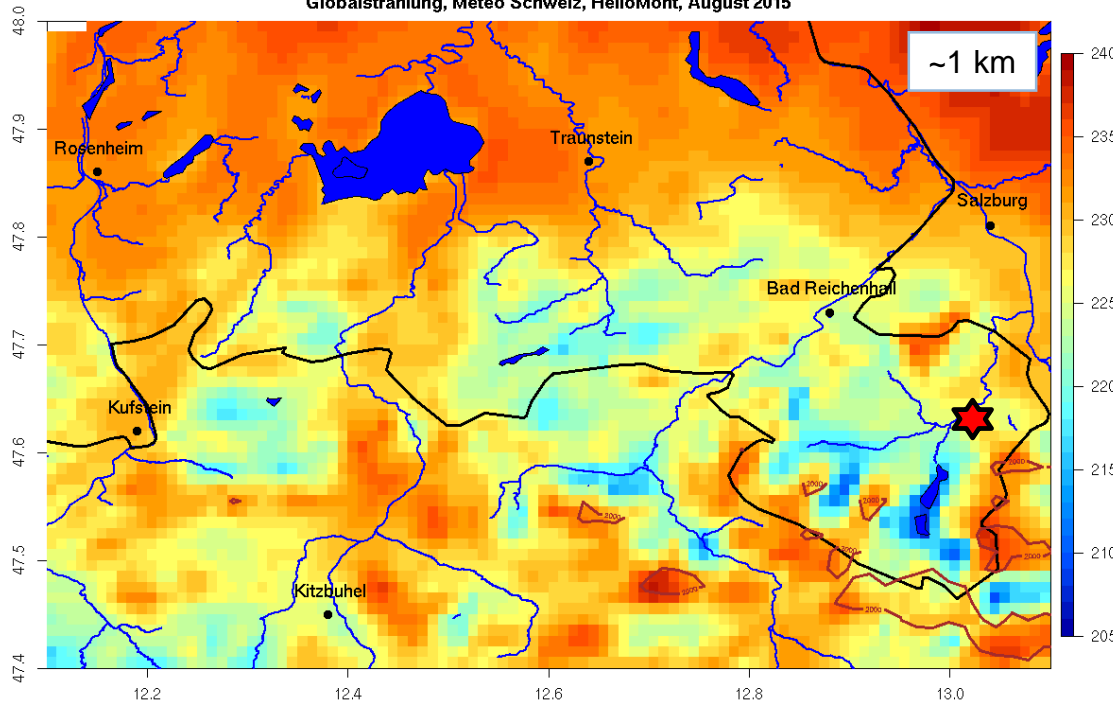


Example: Surface Radiation, August 2015

Globalstrahlung, August, 1983 - 2015, CM SAF SARAH Datensatz



Globalstrahlung, Meteo Schweiz, HeliMont, August 2015



Surface Radiation August 2015

R. Stöckli, Meteo Schweiz

Status and Outlook: EUMETSAT Meteosat Satelliten

1. Generation (MVIRI) (1982- 2006)

- 3 spektrale Kanäle
- Zeit: 30 min
- Raum: 5 km



2. Generation (SEVIRI) (2004 - ~ 2020)

- 11 spektrale Kanäle
- 5 min bis 15 min
- 5 km / 1 km



3. Generation (FCI) (ab ~ 2020)

- 16 spektrale Kanäle
- 2.5 min bis 10 min
- 500 m / 1 km / 2 km



Summary

- ➔ Collecting climate data is a core element to monitor climate
- ➔ Satellite-based high resolution climate data are readily available
- ➔ Data availability / quality depends on the parameter + maturity of retrieval algorithm
- ➔ High-resolution satellite-based climate data is extending the information available from surface observations
- ➔ High-resolution satellite data provide new possibilities to address the quality of regional climate models

