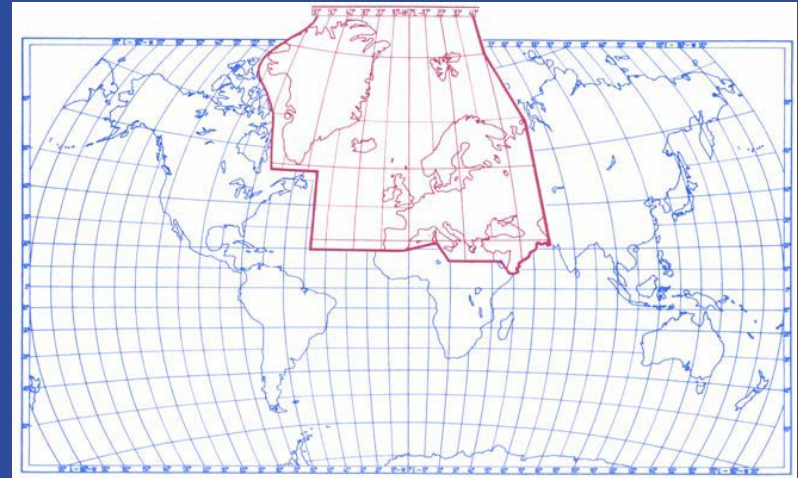


Satellite-based climate information for Europe

Klaus-Jürgen Schreiber &
André Obregón



Overview

- 1 Background & Motivation
- 2 Operational Climate Monitoring (near-real-time)
- 3 Climate Information Records (long-term)
- 4 Conclusions & Outlook

Overview

1 Background & Motivation

2 Operational Climate Monitoring (near-real-time)

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4 Conclusions & Outlook

Background & Motivation

- ~ 30 years of satellite weather observations



METEOSAT-1

FIRST IMAGE: 9 DEC 1977
COPYRIGHT ESA



METEOSAT-10

21 Jan 2013

Source: EUMETSAT

CM SAF and RCC value chain



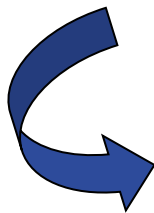
Climate data

- Near-Real-Time products
- Climate Data Records



Objective:

Development of satellite-based climate monitoring products based on datasets from EUMETSAT SAFs (in particular CM SAF)



Climate services

- Sustained climate information products and services for the Europe in the context of GFCS



Products based on GCOS ECVs

Domain	Essential Climate Variables
Atmospheric (over land, sea and ice)	Surface wind speed and direction; precipitation; upper-air temperature; upper-air wind speed and direction; water vapour; cloud properties; Earth radiation budget (including solar irradiance); carbon dioxide; methane and other long-lived greenhouse gases; ozone and aerosol properties, supported by their precursors.
Oceanic	Sea-surface temperature; sea-surface salinity; sea level; sea state; sea ice; ocean colour.
Terrestrial	Lakes; snow cover; glaciers and ice caps; ice sheets; albedo; and cover (including vegetation type); Fraction of Absorbed Photosynthetically Active Radiation (FAPAR); leaf area index (LAI); above-ground biomass; fire disturbance; soil moisture.

Source: GCOS Implementation Plan - Satellite Supplement



The EUMETSAT
Network of
Satellite Application
Facilities



soil moisture
cci



RCC-CM interfaces in a sustained climate information flow

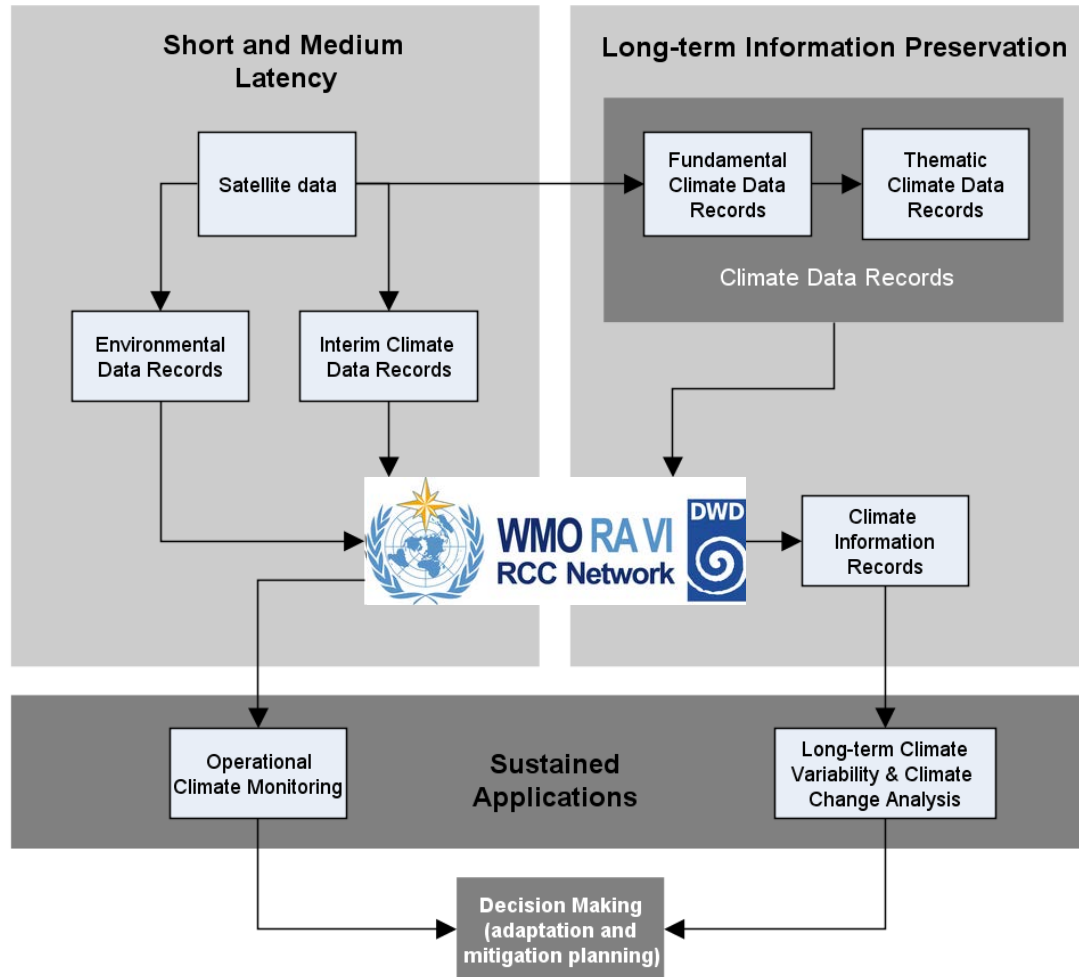


Figure modified from SCOPE-CM Phase 2 Implementation Plan

Input data

near-real-time

long-term

Group	Parameter	Environmental Data Record (EDR)	Climate Data Record (CDR)
RADIATION	Global radiation	CM SAF SIS SEVIRI 2005-	CM SAF SIS MVIRI 1983-2005
	Direct radiation	CM SAF SID SEVIRI 2005-	CM SAF SID MVIRI 1983-2005
CLOUDS	Cloud fractional cover	CM SAF CFC AVHRR-LAC 2004-	CM SAF CFC CLARA 1982-2009
	Cloudy days	CM SAF CFC AVHRR-LAC 2004-	CM SAF CFC CLARA 1982-2009
	Sunny days	CM SAF CFC AVHRR-LAC 2004-	CM SAF CFC CLARA 1982-2009
WATER VAPOUR	Total water vapour	CM SAF TPW ATOVS 2004-	CM SAF TPW ATOVS 1999-2011
ALBEDO	Surface albedo	CM SAF SAL AVHRR-LAC 2004-	CM SAF SAL CLARA 1982-2009
SUNSHINE	Sunshine duration	CM SAF SID SEVIRI 2005-	CM SAF SID MVIRI 1983-2005
SOIL MOISTURE	Surface soil moisture	H SAF ASCAT SM-OBS-1	ESA CCI 1978-2010
SNOW	Snow extent	LSA SAF SEVIRI / H SAF AVHRR	GlobSnow ATSR-2+AATSR 1995-2011



Product output

Operational Climate Monitoring	Climate Information Records
Mean	Hovmöller / Horizon plots
Anomaly (abs., rel., std.)	Time series incl. trend & running mean
Percentiles	Trend map
Annual course incl. std, mean	Reference climatology (mean, std)
Validation	

Input data

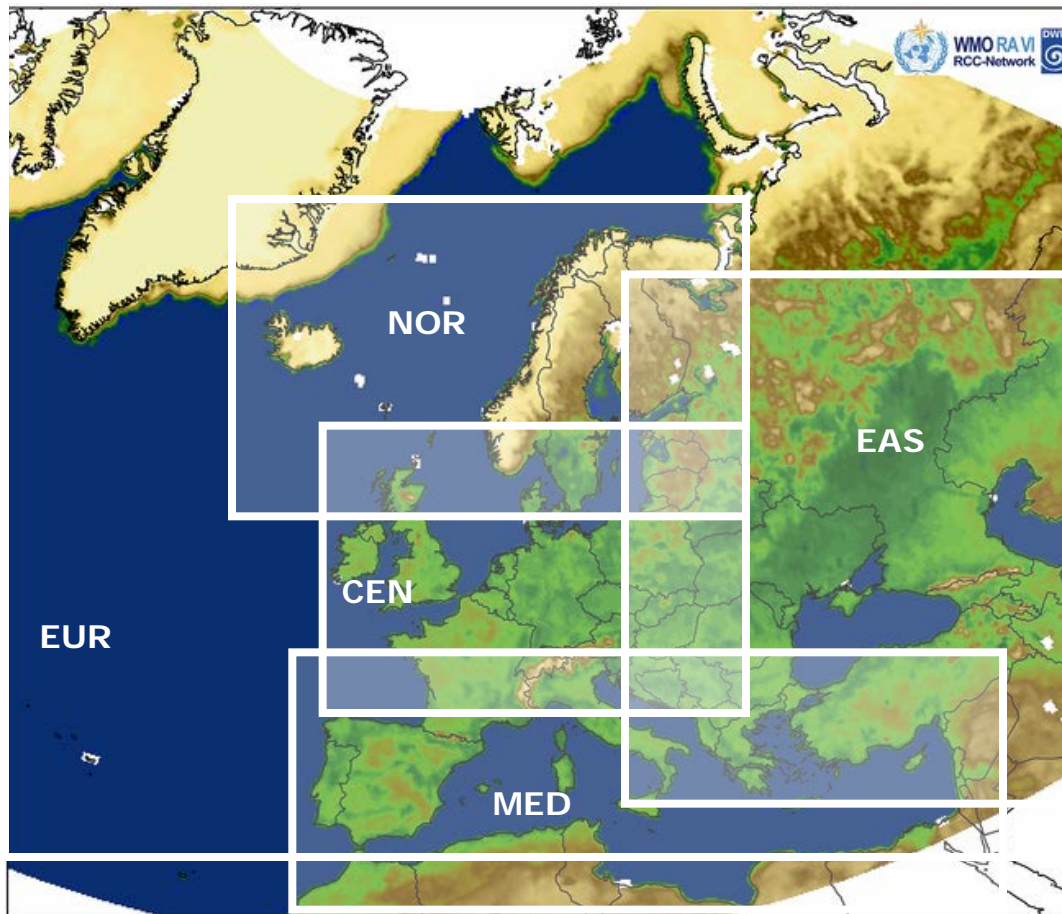
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Product output

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Validation	

Regions and time scales



Time periods:

- Months
- Seasons
- Years

Climate data records:

- CFC/SAL: 1982-2009
- SIS/SID: 1983-2005
- TPW: 2001-2011

Product types:

- Maps
- Statistical plots
- Gridded data

Overview

1 Background & Motivation

2 Operational Climate Monitoring (near-real-time)

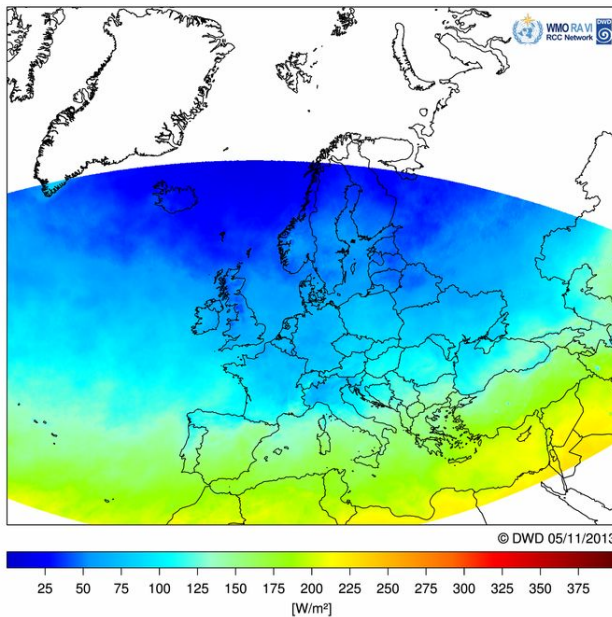
3 Climate Information Records (long-term)

4 Conclusions & Outlook

Means

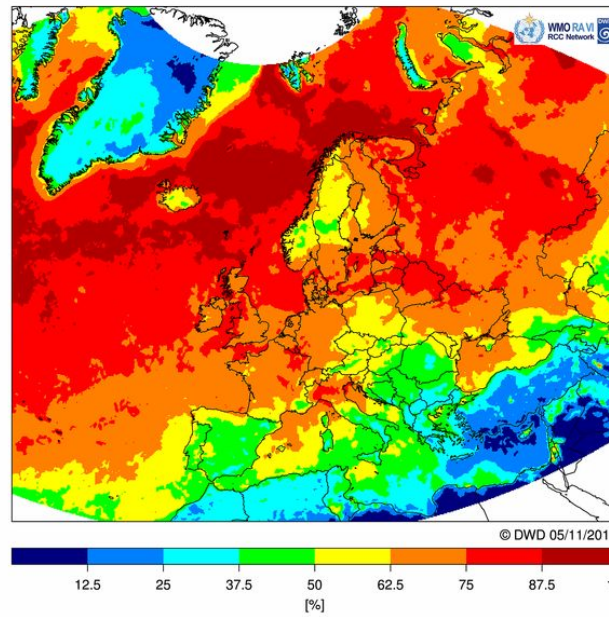
Global radiation (SIS)

Monthly mean Global Radiation October 2013



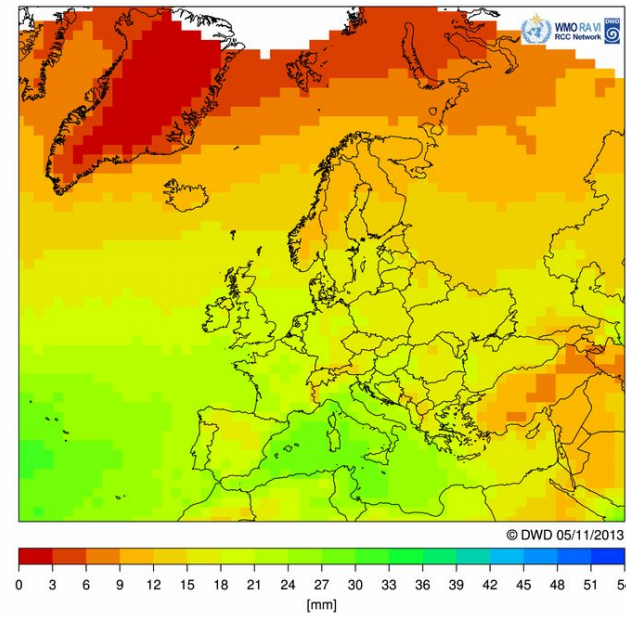
Cloud Coverage (CFC)

Monthly mean Cloud Fractional Cover October 2013



Water Vapour (TPW)

Monthly mean Total Precipitable Water October 2013



Anomalies

absolute anomalies:
absolute deviations from the long-term average

relative anomalies:
deviations as percentage

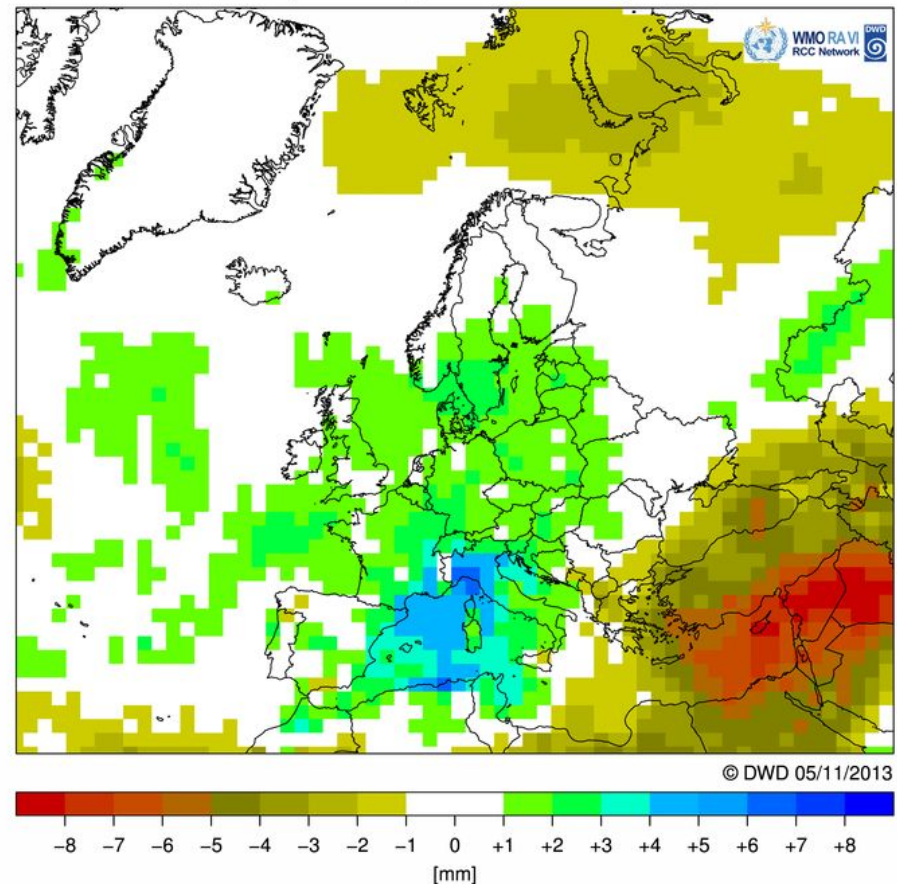
→ not taking into account the natural variability of a climate element

→ *standardized anomalies:*
absolute deviation expressed as times of standard deviation

→ considering the natural variability

Example: Water Vapour (TPW)

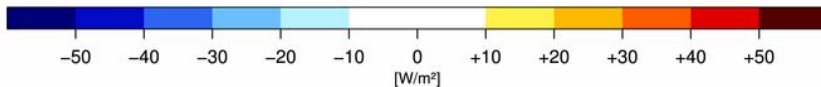
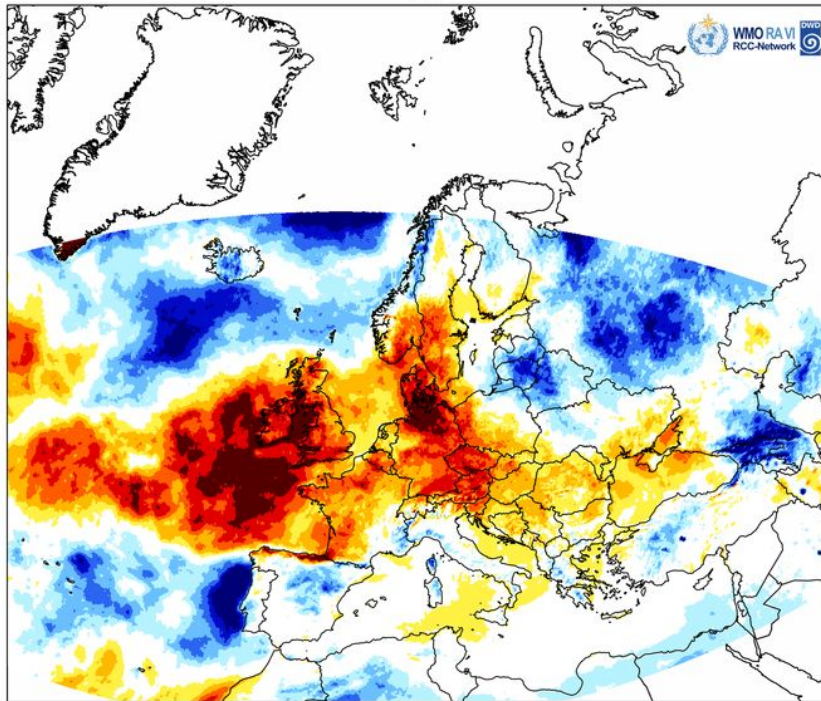
Absolute anomaly Total Precipitable Water October 2013
(reference period 2001–2011)



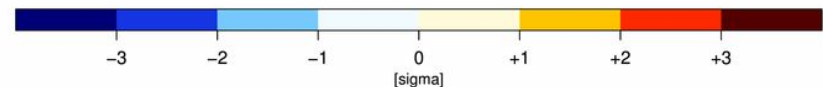
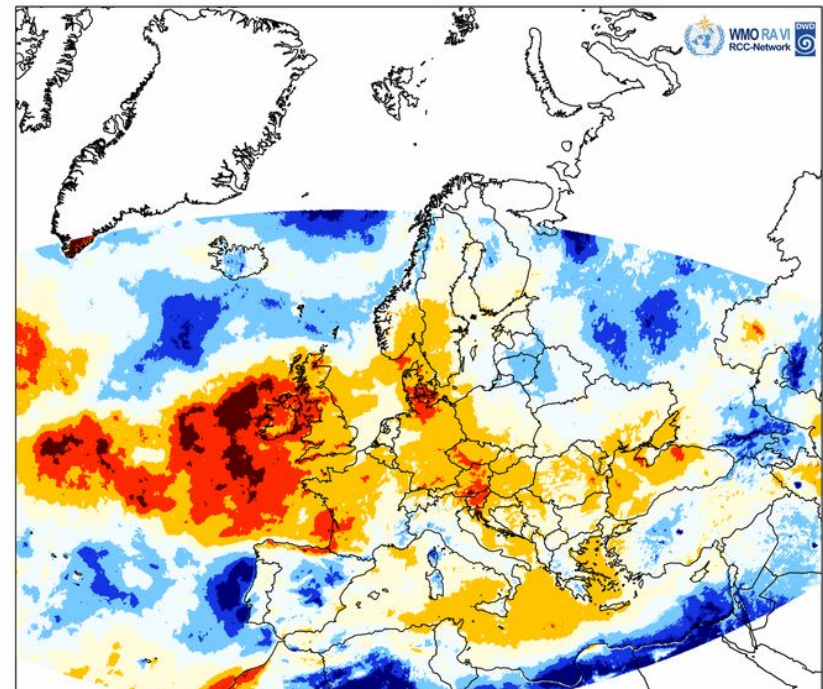
Absolute vs. standardized anomalies

Example: Global radiation (SIS)

Global Radiation July 2013
Absolute anomaly (1983–2005 base)



Global Radiation July 2013
Standardized anomaly (1983–2005 base)



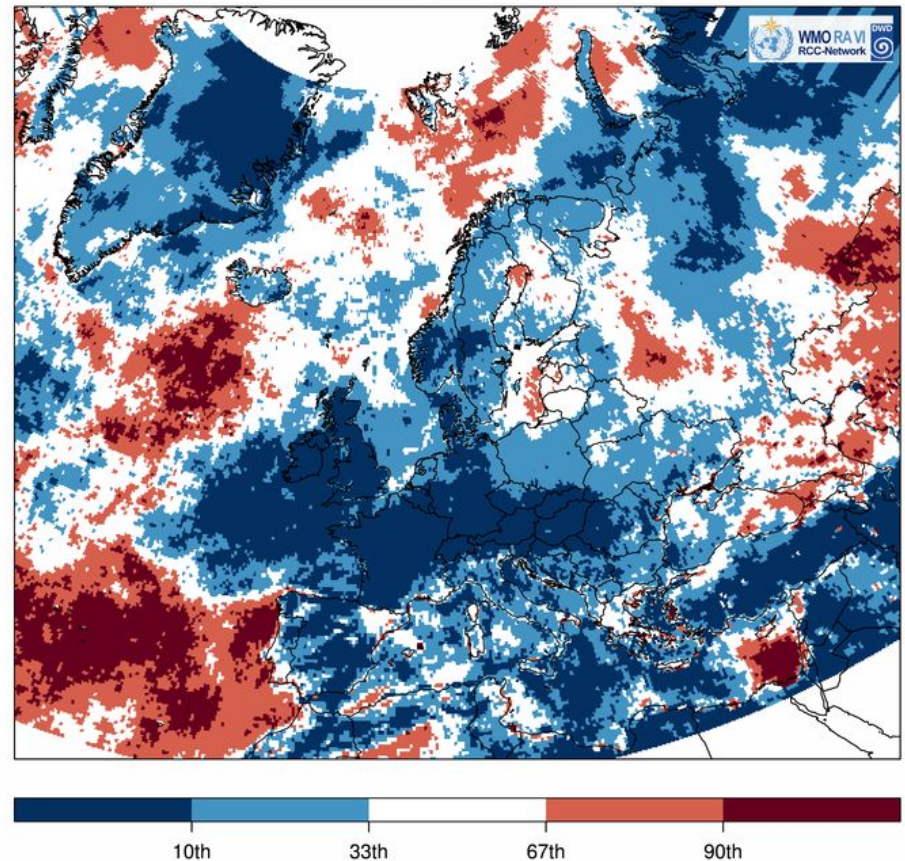
Percentiles

Example: Cloud coverage (CFC)

percentiles:
values below or above the
lower or upper tercile/decile of
the probability density function

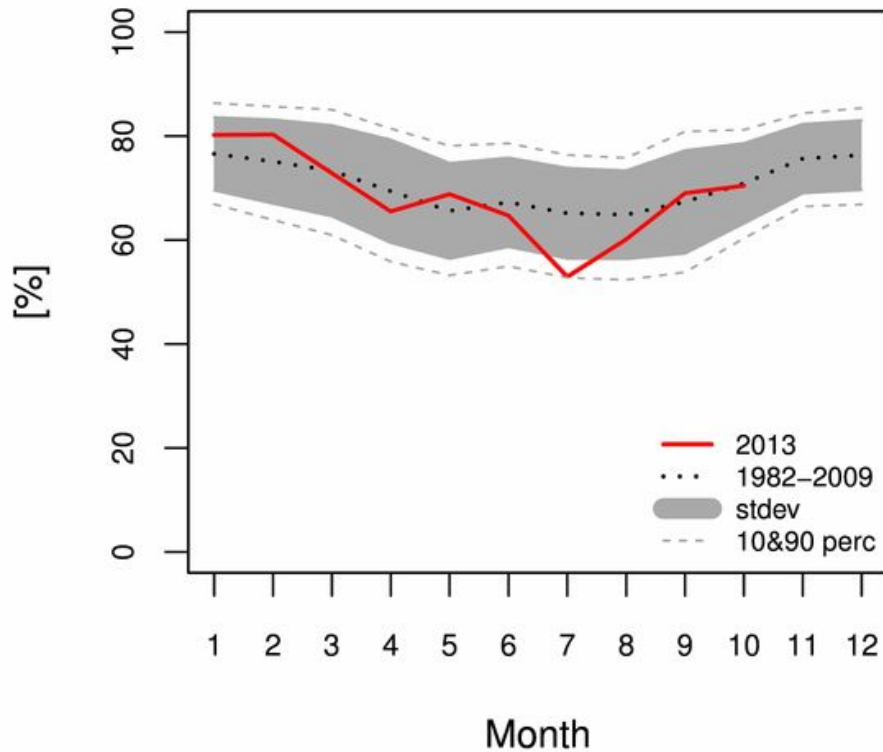
→ enable the characterization
of the rareness of events

Cloud Fractional Cover July 2013
Percentiles (1982–2009 base)

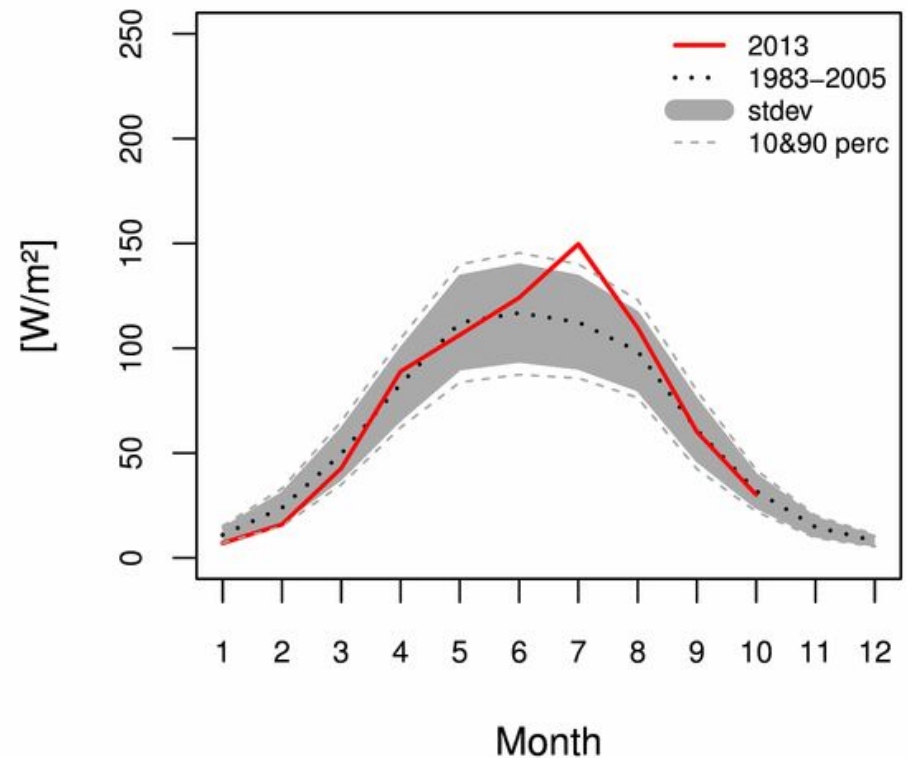


Annual cycle

Cloud Cover (Central Europe)



Direct Radiation (Central Europe)

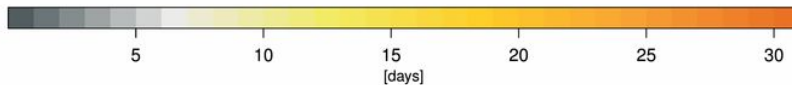
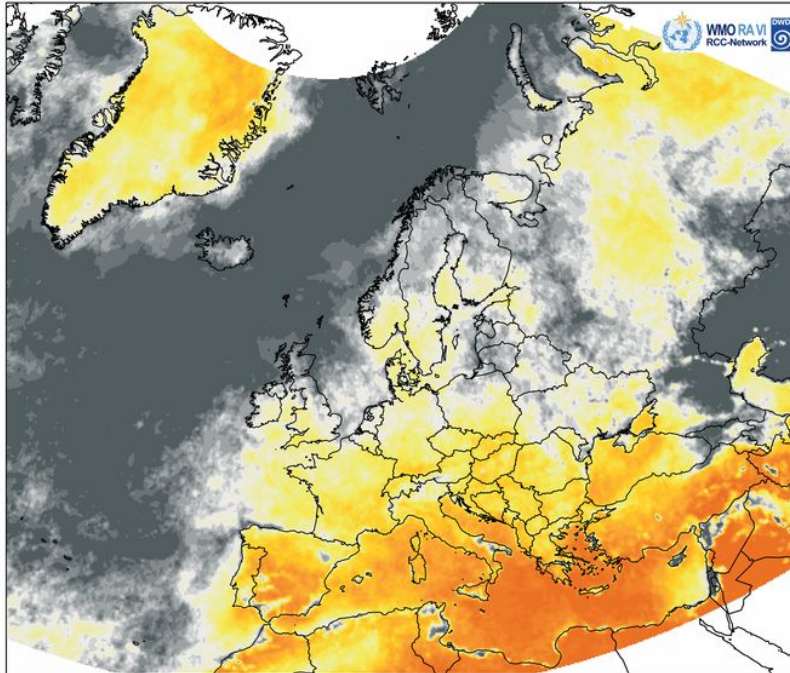


Example: Sunny days (CFC ≤ 2 octas)

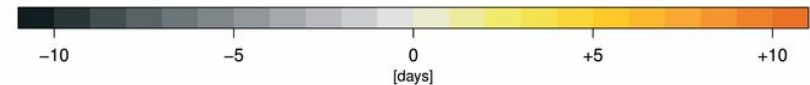
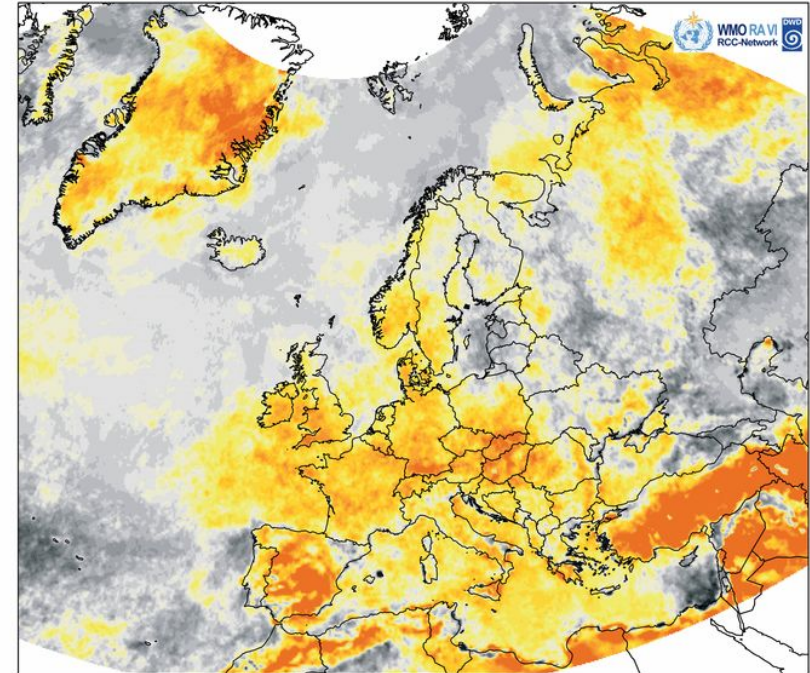
Total

Anomaly

Number of clear days July 2013
Monthly sum



Number of clear days July 2013
Absolute anomaly (1982–2009 base)



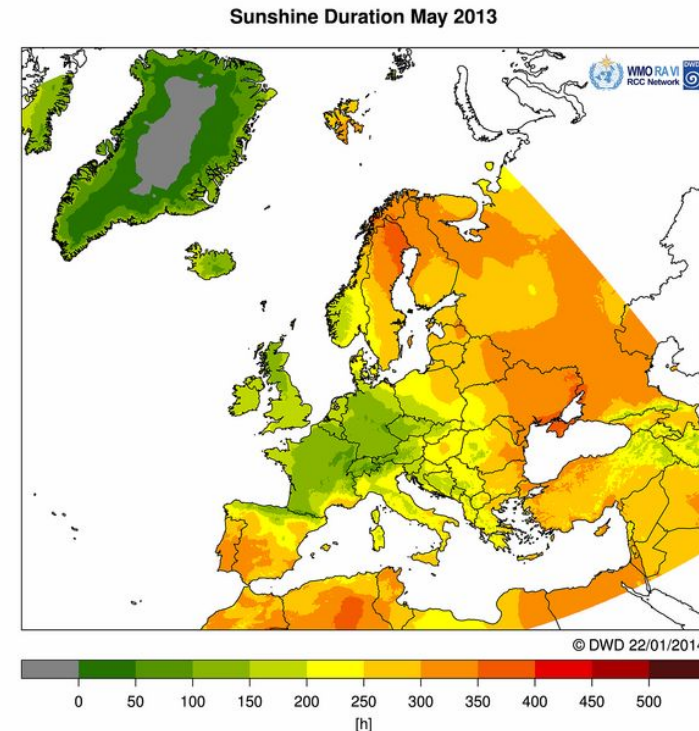
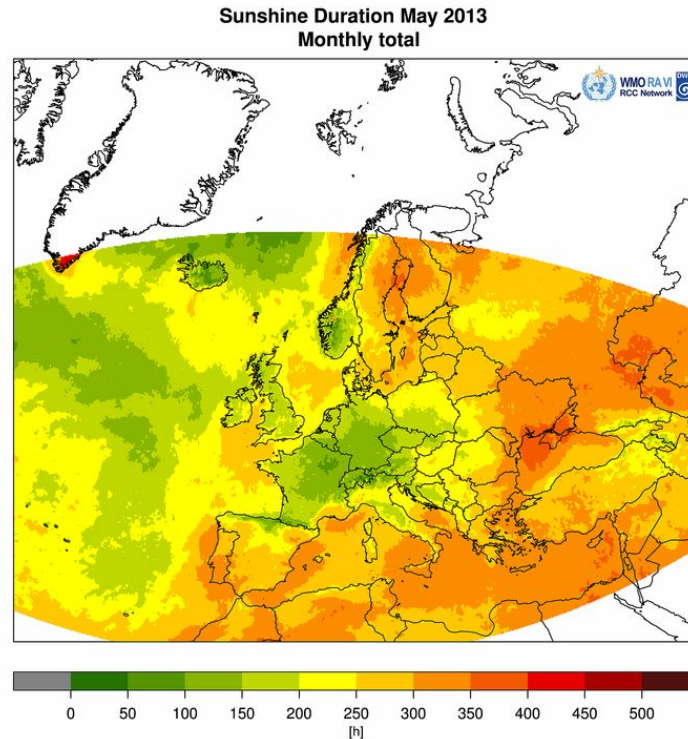
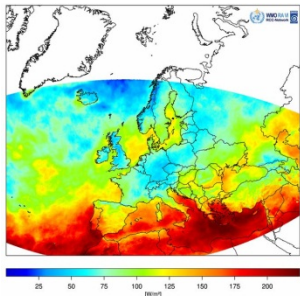
- use of daily means (CM SAF Cloud Fractional Cover)
- based on definitions by WMO Expert Team on Climate Change Detection and Indices

Derived product: sunshine duration

Satellite product

In situ product

CM SAF SID
(hourly data)



WMO definition: Bright sunshine when direct normalized irradiance (DNI) > 120 W/m²

$$DNI = \frac{SID}{\cos(SZA)}$$

Overview

1 Background & Motivation

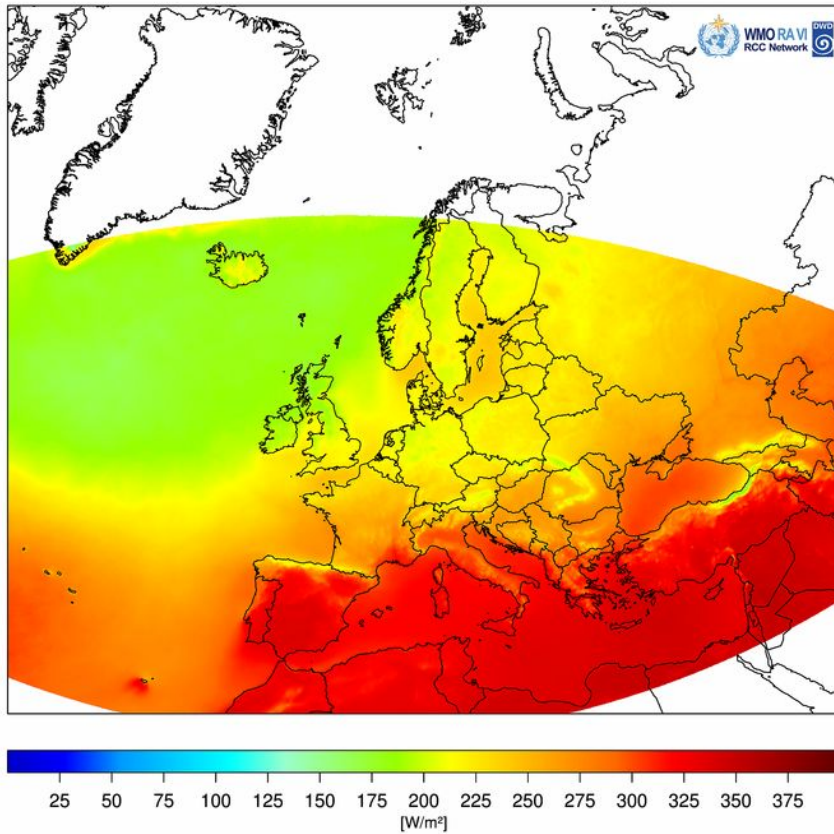
2 Operational Climate Monitoring (near-real-time)

3 Climate Information Records (long-term)

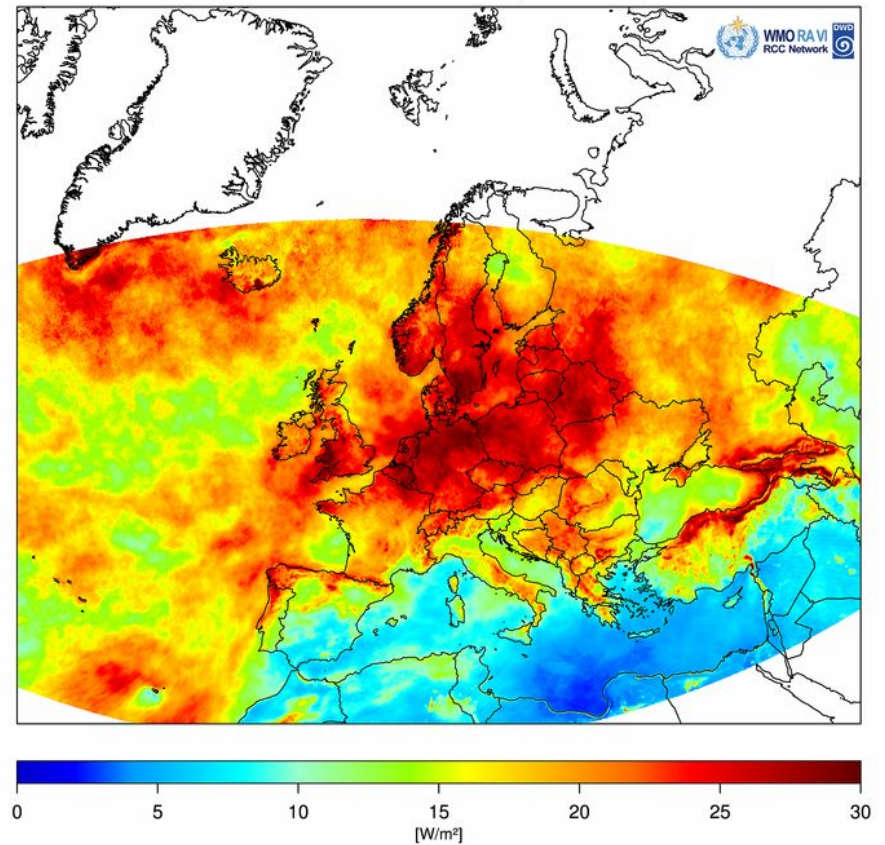
4 Conclusions & Outlook

Climatologies

Global Radiation
Reference Mean July (1983–2005)

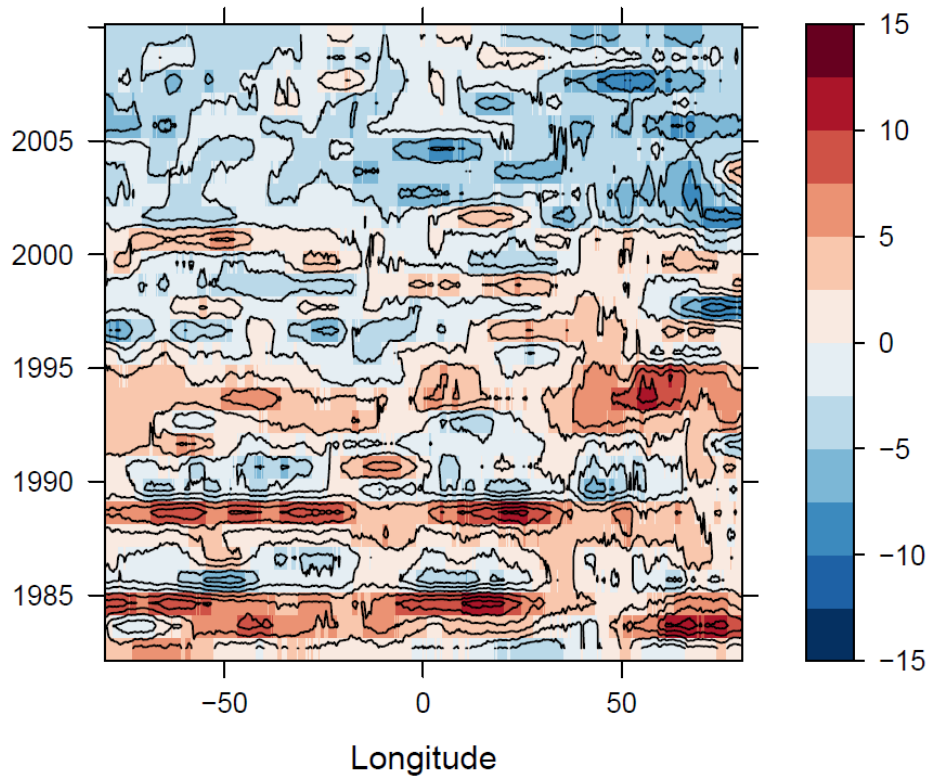


Global Radiation
Standard Deviation July (1983–2005)

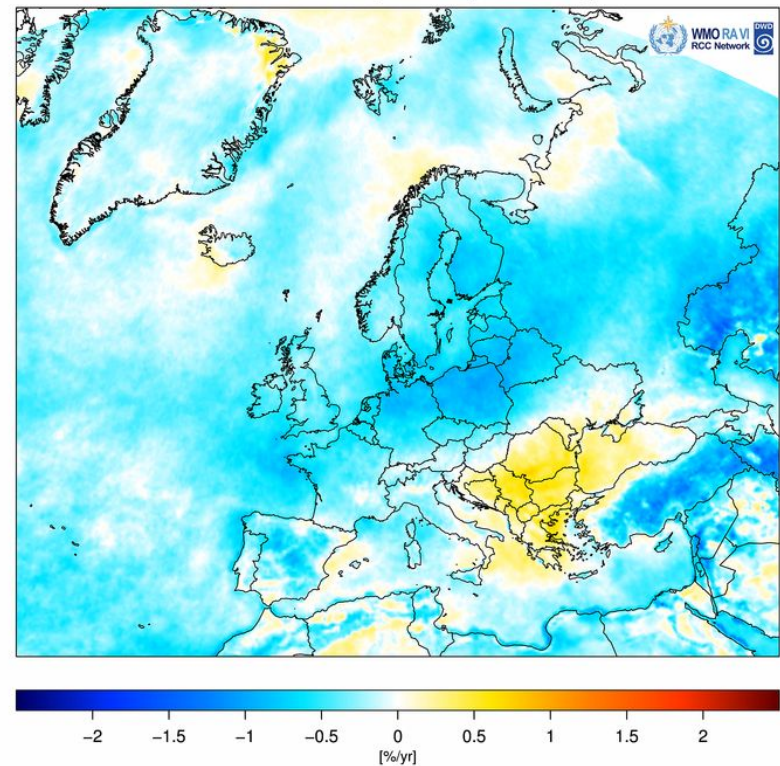


Spatiotemporal diagrams and trend maps

Cloud Cover (September)

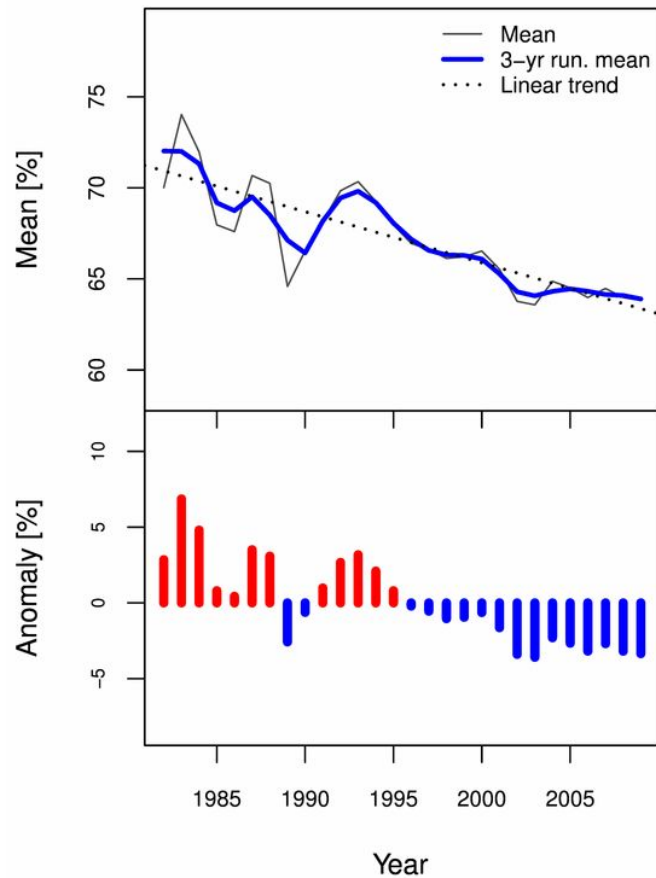


Cloud Fractional Cover Annual Trend September (1982–2009)

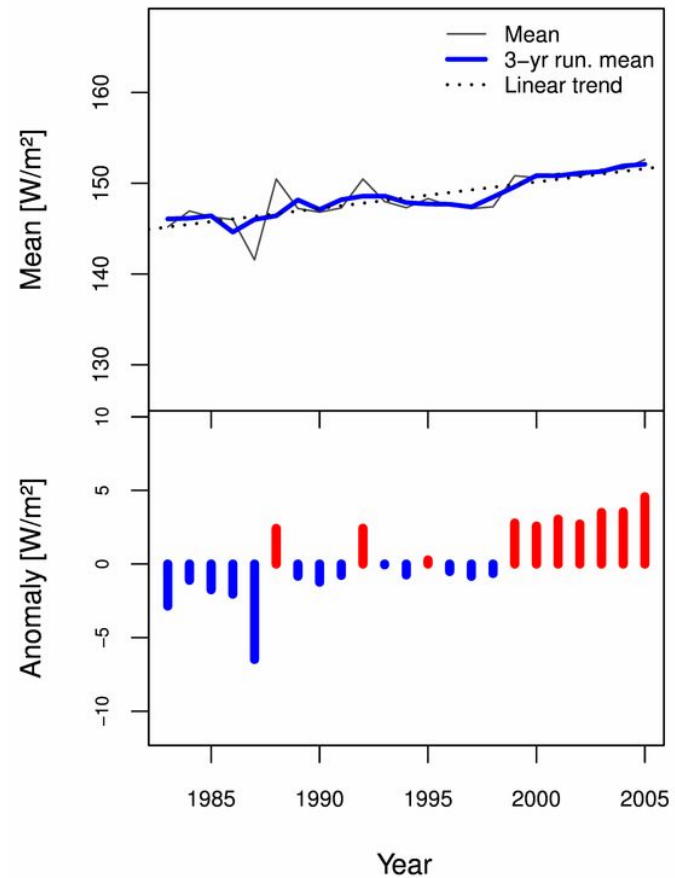


Time series

**Cloud Fractional Cover (Europe)
Annual**




**Global Radiation (Europe)
Annual**



Documentation

- „Product Description Sheets“ for each climate element



RCC-CM Product Description Sheet Version 1.3 (Jul 2012)

CLOUD COVER

Clouds play a crucial role in the climate system by altering earth radiation and water balance. They reflect incoming shortwave (solar) radiation and cool the earth's surface but at the same time warm the earth's surface by absorbing outgoing long wave (thermal) radiation and radiating it back to the earth's surface (greenhouse effect). Further, clouds supply water to the earth by producing precipitation.

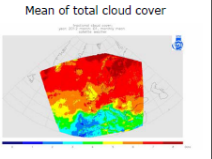
Clouds have a large influence on the climate but in turn, a changing climate will also affect the formation of clouds. However, it is poorly known whether cloud changes would diminish or enhance warming. Therefore, detailed knowledge on clouds is crucial for the understanding of climate change.

Traditionally, cloud coverage is derived by ground-based observations either by eye observations or by automatic detection systems. These data generally suffer from poor station coverage in many regions. Due to the ability of space-based instruments to detect clouds, satellite data can account for these shortcomings by providing high-resolution data over large areas.

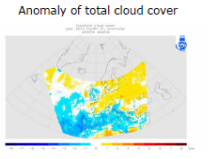
Within RCC-CM, gridded data and maps are produced regularly for monthly cloud cover and its anomalies from a reference state (1971-2000) to display the main areas of reduced or enhanced cloudiness in the RA VI Region. Monthly cloud cover can be used for various applications, e.g. energy, tourism, human health and all issues concerning climate variability and climate change.

Products

Mean of total cloud cover



Anomaly of total cloud cover



- 1 -

Specifications

- Geographic region
- Spatial/temporal resolution
- Projection
- Availability
- Timeliness
- Format
- Units
- Input data
- Reference data

Website:
www.dwd.de/rcc-cm

Methodology

Quality/Usage

Applications

Overview

- 1 Background & Motivation
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Conclusions

1. Products span the atmospheric (radiation, clouds, water vapour) and terrestrial domain (snow cover, soil moisture)

2. Near-real-time data are used for operational climate monitoring purposes

4. Maps, statistical plots and gridded data are made available through the RCC-CM website
www.dwd.de/rcc-cm

3. Long-term Climate Data Records with adequate stability, accuracy and homogeneity are used for the generation of Climate Information Records



Outlook

- Updates of long-term products (on the release of new versions of Climate Data Records)
- Use of daily data for the monitoring of extreme events
- Development of further user-tailored indices
- Including satellite-based products in monthly climate bulletins

Thank you very much for your attention.



Meteosat-10 (MSG-3) Launch, 5 July 2012, Kourou, French Guiana (Credits: ESA/CNES/Arianespace)