Use cases for satellite data and tools in support of climate services

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EUMETSAT’s mandate and role

• Our mandate: Contribute to the operational monitoring of the climate and the detection of global climatic changes

• Our role:
  • delivering advanced multi-satellite programmes with long-term commitment
  • Maintaining a unique archive of decades of space-based observations (ocean, atmo, land)
  • Producing consistent climate data records and providing easy access
  • Supporting climate-related capacity building initiatives
Current EUMETSAT Satellite Fleet (excl. Met-7)

**METOP -A and -B**  
(LOW-EARTH, SUN-SYNCHRONOUS ORBIT)

**EUMETSAT POLAR SYSTEM/INITIAL JOINT POLAR SYSTEM**

**Sentinel -3a**  
(LOW-EARTH, SUN-SYNCHRONOUS ORBIT)

Copernicus Global Marine and Land Environment Mission  
Operated by EUMETSAT

**JASON-2, -3**  
(LOW-EARTH, 63° INCL. NON SYNCHRONOUS ORBIT)

Ocean Surface Topography Mission

**METEOSAT SECOND GENERATION -9, -10, -11**  
(GEOSTATIC ORBIT)

Two-satellite system:  
- METEOSAT-11: in-orbit backup  
- METEOSAT-10: full disk imagery mission at 0° (15 MN)  
- METEOSAT-9: rapid scan service over Europe at 9.5°E (5 MN)

**METEOSAT -8 (2nd GENERATION)**  
(GEOSTATIC ORBIT)

Indian Ocean data coverage mission at 41.5° E
Geostationary Satellites over the years

Year


Longitude (degrees)

180  120  60  0  -60  -120  -180

GMS-1  GMS-2  GMS-3  GMS-4  GMS-5  Goes-9  MTS-1  MTS-2

Met-1  Met-2  Met-3  Met-4  Met-5  Met-6  Met-7  Met-8  Met-9


FY2-C  FY2-E
EUMETSAT Contributions to GCOS ECV Data Records

- EUMETSAT Secretariat provides Fundamental Climate Data Records (FCDR, i.e. Radiances or RO Bending Angles) for its sensors serving as input to data records on geophysical variable (Essential Climate Variables) (yellow);
- The SAF network provides single and multi-sensor ECV data records using the FCDRs (indicated in pink);
- Data record generation is performed using operational processing systems.

### Table: EUMETSAT FCDR and EUMETSAT ECV

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EUMETSAT FCDR | EUMETSAT ECV
Framing consideration 1: Product vs Data Set

Short and Intermediate Term

- Generated on a monthly basis
- First-order satellite calibration
- Algorithm and input data not homogeneous over time
- Resulting time series not applicable for all climate monitoring purposes, e.g. trend estimation

Longterm

- Generated on an irregular basis, e.g. every 2 years
- Calibrated and homogenized satellite data
- Algorithm and auxiliary input data homogeneous over time
- Resulting time series fully applicable for climate monitoring purposes, including trend estimation

Operational Products

Satellite Data

Observing system performance monitoring & automated corrections

Archived Satellite Data Records

Re-calibration & Inter-calibration,

Fundamental Climate Data Records

Thematical Climate Datasets

- Longer term climate variability & climate change analysis

Reprocessing

Schulz (2009), adapted
Framing consideration 2: Information Transfer

Use Case 1: Creating a climate atlas for my country

-Where can I get data?
-Tools to do the statistics?
-Tools to make maps and graphs?
-Information?
CM SAF Data

**Clouds**

![Clouds](image)

**Radiation**

![Radiation](image)

**Water Vapor**

![Water Vapor](image)

- **EUMETSAT Satellite Application Facility on Climate Monitoring**
  [www.cmsaf.eu](http://www.cmsaf.eu)
- Provides satellite-derived climate data of geophysical variables
- Regional, up to global coverage
- Currently, data available from Jan 1982 to September 2014
- Spatial resolution from 0.03° to approx. 1°

- Data freely available in netcdf-format
- User-friendly data access via the Web User Interface:
  [www.cmsaf.eu/wui](http://www.cmsaf.eu/wui)
- Toolkit (example data + software):
  [www.cmsaf.eu/tools](http://www.cmsaf.eu/tools)
- CM SAF Community Site available via EUMETSAT: [training.eumetsat.int](http://training.eumetsat.int)

Courtesy: Jörg Trentmann, CM SAF
Data Access

www.cmsaf.eu

Web User Interface: www.cmsaf.eu/wui

• Registration required
• Data will be delivered in 1 hr to 1 day to an ftp server in netcdf format

Courtesy: Jörg Trentmann, CM SAF
The CM SAF toolbox is available as an R package. The toolbox provides much of the functionality of the climate data operators (CDO) in R. R is platform independent.

The tools are aimed at users with little or no scripting experience and allows them to manipulate and visualise the data and generate basic statistics.

An example from the EUMETSAT African User Forum in Kigali, a meteorologist takes about 1.5 hours of one to one training in the data and the tool.

The CM SAF toolbox and information on it can downloaded:
- [http://www.cmsaf.eu/EN/Products/Tools/Tools.html](http://www.cmsaf.eu/EN/Products/Tools/Tools.html)
Solar Radiation: Monitoring

March 2014 compared to Climatology

Surface Solar Radiation

March Climatology

March 2014

Cloud Coverage

Anomalies of cloud coverage and surface solar radiation, March 2014

Courtesy: Jörg Trentmann, CM SAF
Solar Radiation Climatology

Surface Solar Radiation

Global Radiation, CM SAF, 1983 - 2011, SARA

Mean Surface Irradiance, CM SAF, 1904-2005

Global Radiation (Vinz), CM SAF, Mean, 1983 - 1998

Global Radiation, CM SAF, 1983 - 2011, SARA

Courtesy: Jörg Trentmann, CM SAF
Solar Radiation Climatology

Surface Solar Radiation

Global Radiation, CM SAF, 1983 - 2011, SARAH

Global Radiation (CM SAF): Johannesburg

Average Seasonal Cycle, Johannesburg

Annual Mean Global Radiation (CM SAF): Johannesburg

Courtesy: Jörg Trentmann, CM SAF
Sunny Days

Probability of Sunny Days / Periods, Geneva

- Average: 39.9% (Summer: 55.6%)
- Max. Probability: 20. August - 69.7%
- Average: 16.3% (Summer: 28.9%)%
- Max. Probability: 25. July - 42.6%

Highest likelihood of stable, sunny conditions mid of July

Sunny Day:
Global radiation larger than 80% of the clear-sky radiation

Globally available for many cities!

 Courtesy: Jörg Trentmann, CM SAF
Use Case 2: Solar Radiation for Energy

Should I install solar panels for power or hot water for my …
  school / hospital / house?

Will it be worth it?
When will my investment start to pay for itself?
What are the risks?
Use Case 2: Solar Radiation for Energy

Factors:
• Cost of equipment
• Heating / Hot water requirements (daily and seasonal variation)
• Electricity / heating costs
• Feed in tariffs

Above data all locally available …

• Sunshine …
Solar radiation data for Namibia is available from:

- national surface network
- satellite data [CM SAF]
  - from 1983
  - Hourly mean, daily mean, monthly mean, ...
- Validated
- stable
- i.e. long-term record of climate quality
- ncdf & simple toolbox [R]
Application: PV GIS

Some further datasets essential in operational climate monitoring and ready for uptake in climate service provision
Reaching Downstream: Monitoring Arctic Sea Ice Extent (OSI-SAF)

1 October 1992

1 October 2007

Mean Value 1979-2000

Sea Ice Extent [million km$^2$]

JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

2015

2011 2012 2013 2014
Insurance of livestock against drought:

- Herders in Africa always have problems to get insurance for their livestock because insurance companies cannot verify loss for logistic reasons;
- Satellite products such as Vegetation Monitoring can help to assess if the conditions really represent drought conditions, e.g., through the establishment of a threshold value in NDVI where it becomes likely that livestock start to die;
- More advanced satellite products may even relate several geophysical variables to better describe drought condition to refine such approaches, e.g., soil moisture, precipitation, and change in surface albedo.
Sea Surface Temperature examples from the OSI SAF

sea surface temperature (Celsius)
Climate change monitoring: Mean sea level

Overall trend: 3.15 mm/yr
Altimeter data up to 66° latitude
Corrected for GIA
Annual signal removed

R. Scharoo, 2016

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Next steps – bringing together the in situ and gridded sat data worlds through R-Instat

• To support this we are exploring with the University of Reading:
  • How to integrate their R-Instat tool and the CM SAF tool (both use R)
    • R-Instat is kind of a GIS tool dedicated to the needs of climate analysis for agricultural consultation in Africa
  • What the best applications of the CM SAF data are (they are not rainfall or soil moisture). This builds on the PICSA program
    https://www.reading.ac.uk/imagine/Impact/PICSAImpact.aspx

Screenshot of R-Instat
Source: R. Stern
Next steps

  • In conjunction with CM SAF
  • Targeting meteorological services and their agricultural extension service counterparts.
Summary

www.cmsaf.eu/wui

CM SAF R-Toolbox
(or other Tools, e.g GIS, R-Instat, ...)

Training available
Information Transfer

EUMETSAT

SAF / Research Centre

MEASUREMENTS / SIMULATIONS
- satellite, airborne and ground-based observations
- climate simulations
- data assimilation (re-analyses)

CLIMATE DATA PROCESSING
- climate data records (observational and re-analyses)
- ensemble simulations/post-processing/analyses
- impact modeling

Climate Service Provider (regional/national)

CLIMATE INFORMATION
- confidence analysis
- extracting decision relevant knowledge
- co-development of prototypes

Socio-economic actors

PRODUCTS
- application of user-tailored products by decision makers, public, media

Summary / Conclusions

• The EUMETSAT Satellite Application Facility on Climate Monitoring (CM SAF, www.cmsaf.eu) generates and distributes satellite-based climate data for Africa:
  • Climate data records
  • Operational products (available within one week)

• Numerous applications in the GFCS context (e.g., climate analysis / monitoring) possible

• CM SAF provides active support through online resources, provision of software

• The next EUMETSAT climate training workshop will take place in Pretoria, South Africa, 20 to 24 November 2017!
What can we recommend?

- Pick the low hanging fruit and empower climate service providers at regional and national level that carry relevant mandates in climate service provision with available gridded climate data sets and available toolboxes.
- Investment on a larger scale in training and outreach to work with gridded climate data and available tools (integrate at the level of training, not at the level of a technical platform!)
- Output: as a minimum an online climate atlas customized for each (of the 70) countries and hosted on a local website.
- Start building on the work done by large scale regional integrators, e.g. ECMWF through C3S, ACMAD through MESA, the regional specialized centres of WMO.
Questions?

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