CM SAF

The EUMETSAT Network of Satellite Application Facilities

CM SAF
Climate Monitoring

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Operational products on Clouds and Radiation

Anke Kniffka

Deutscher Wetterdienst

Clouds, Albedo, Top-of-Atmosphere Radiation and Surface Radiation

EUMETSAT · Deutscher Wetterdienst · KNMI · RMI · SMHI · Met Office

Contents

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2. General features of the data fields
3. Application examples
4. Some questions?

Overview

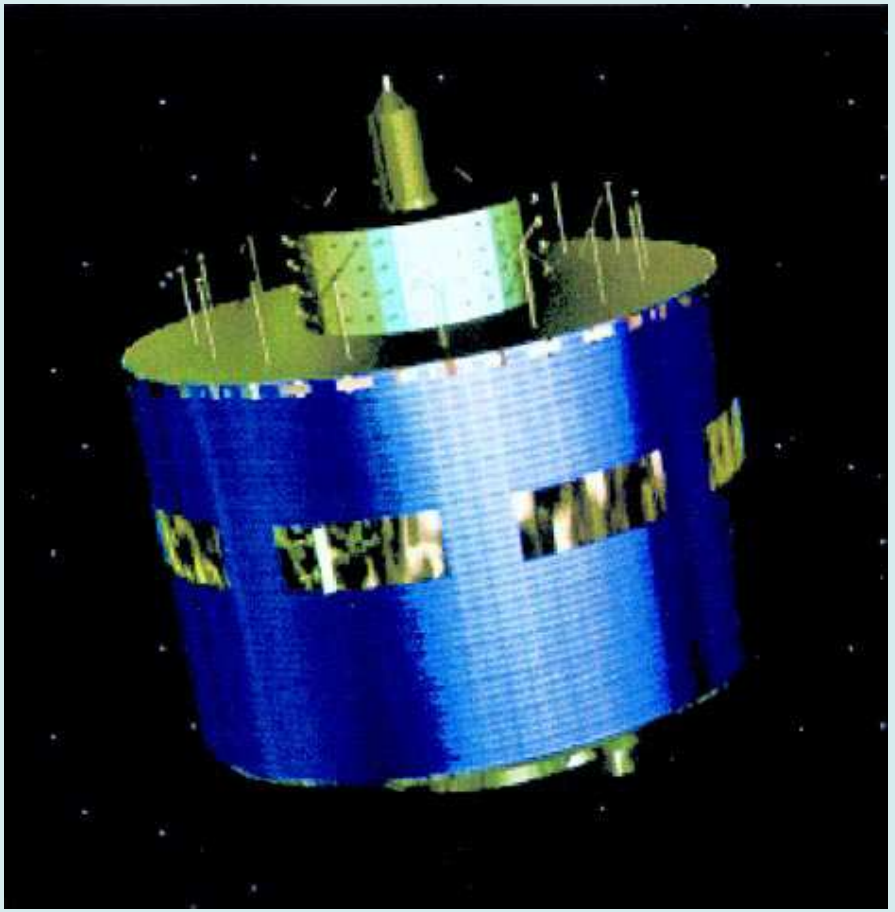
The protagonists:

1) Meteosat second generation

-geostationary → high temporal resolution

-field of view →constant with time, centered at 0°/0°

-instruments used by CM SAF: SEVIRI + GERB



from Schmetz et al. (2002)

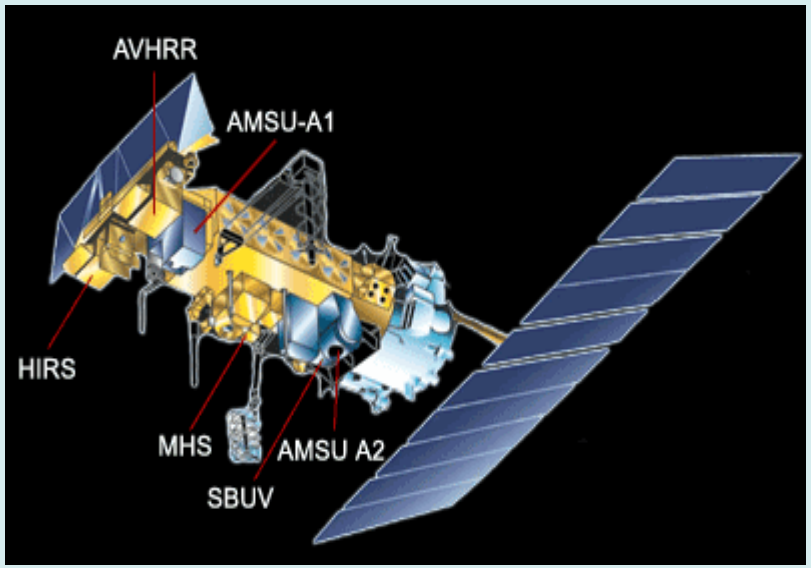
Overview

2) global players NOAA + Metop

-polar orbiting → repetition cycle is 2/day

-global view of the earth

-instrument used by CM SAF: AVHRR, ATOVS as well as CERES on AQUA



NOAA18 from NASA website

general information on satellite meteorology can be found at:
http://eumetrain.org/courses/basic_satellite_meteorology.html

General features

The CM SAF products are categorized in

- “near real time” operational products (routinely and operationally produced data sets in support to climate monitoring)
- data sets based on carefully intersensor calibrated radiances

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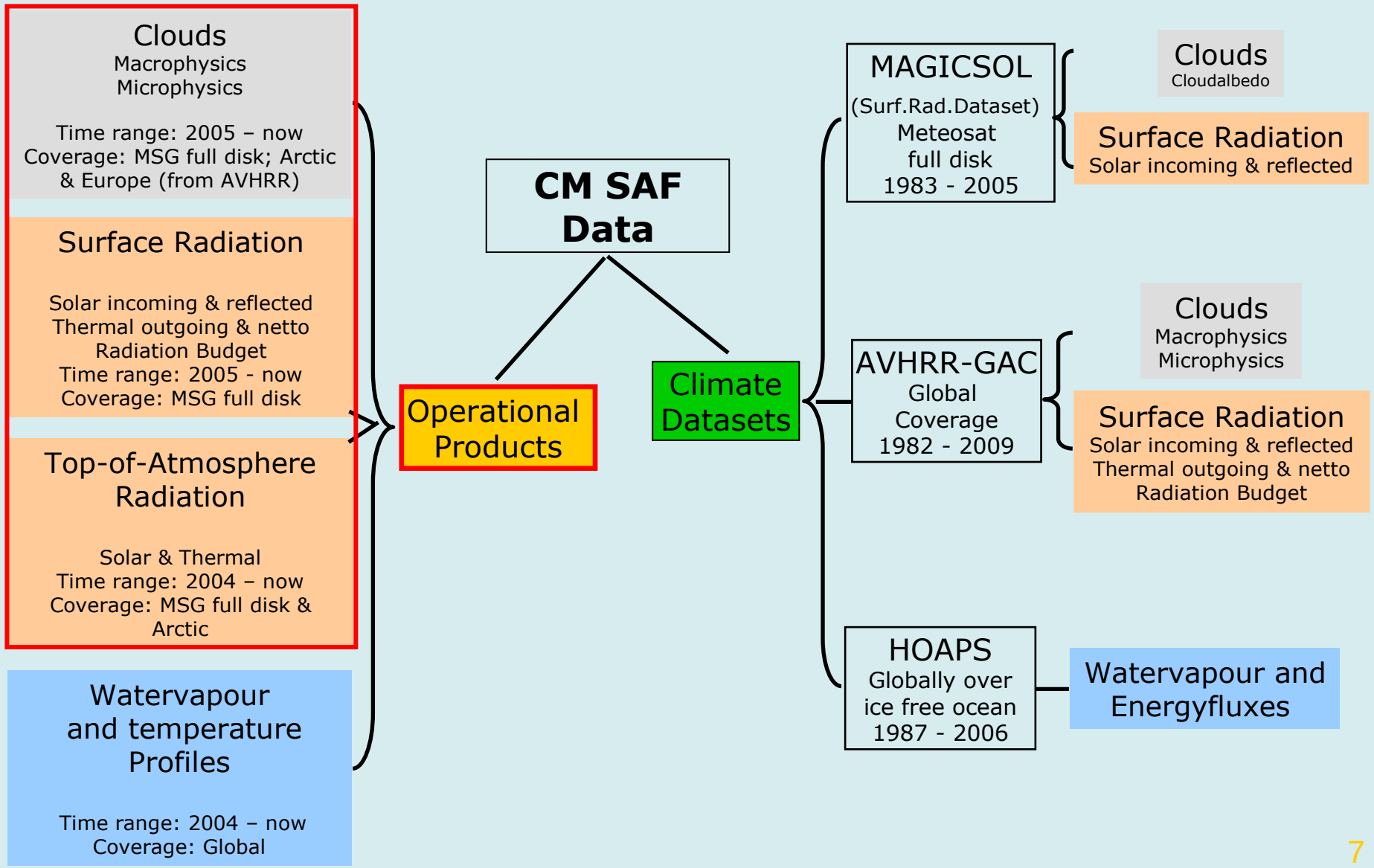
Available operational Products and Datasets



General features

Products are available in various temporal formats:

- daily mean
- monthly mean
- monthly mean diurnal cycle

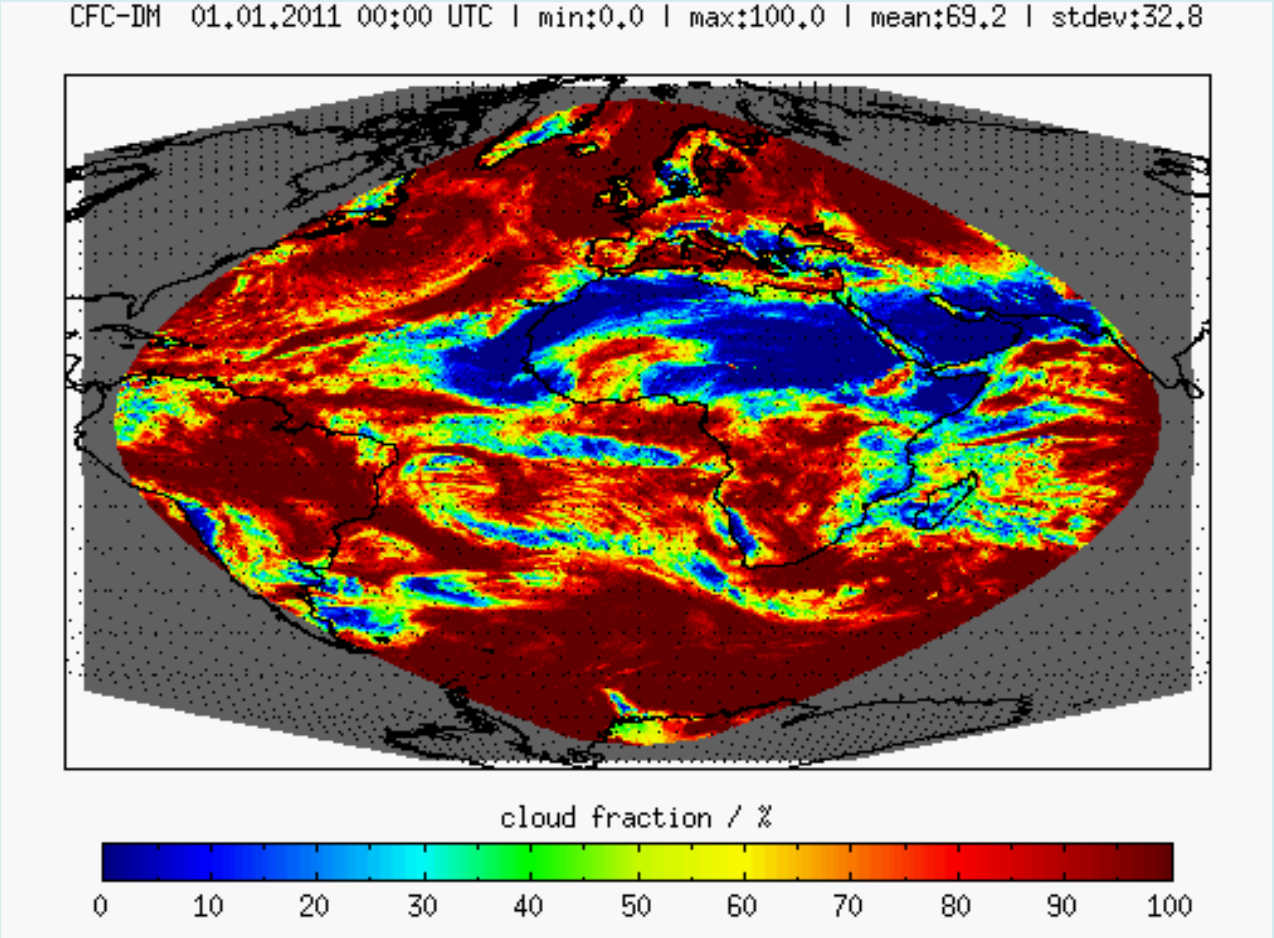
also available on special request:

- non-averaged products, so-called level 2 data like SEVIRI cloud mask in hourly resolution

General features

Product example daily mean:

cloud fractional coverage



daily average is created from cloud mask (yes/no, maybe decision for cloud), 24 timeslots/day, horizontal resolution is reduced from original SEVIRI pixel to 15x15 km² equal area grid

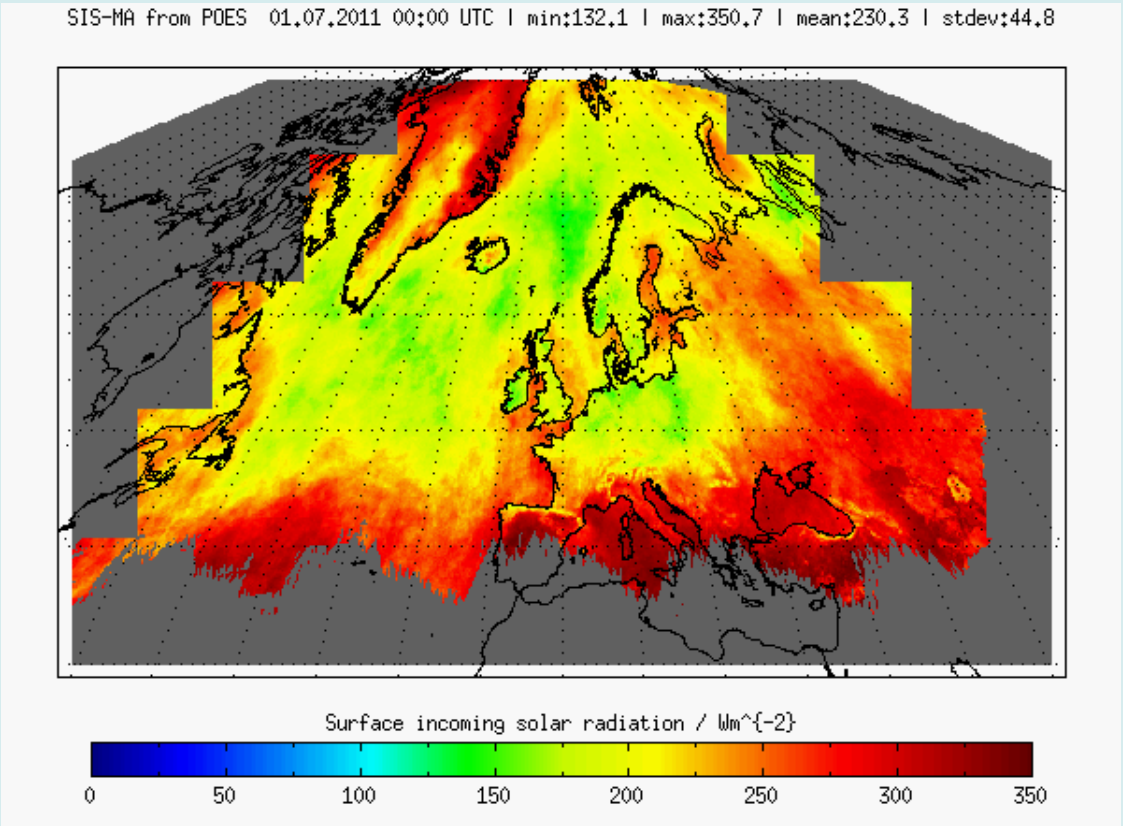
minimum requirement:

6 slots or overpasses per day (clouds)

General features

Product example monthly mean:

solar incoming surface radiation shortwave



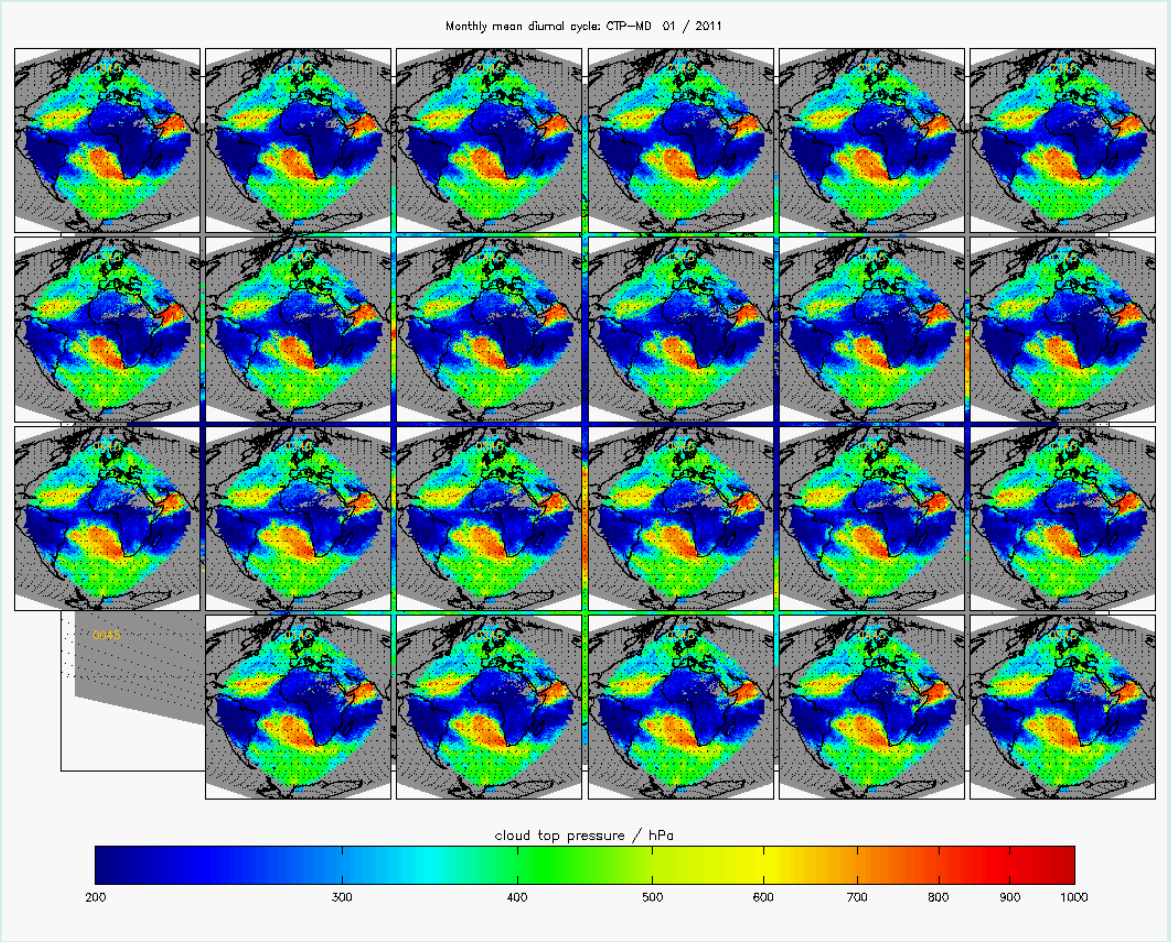
monthly averages are created by averaging the daily mean products → each day gets the same weight

minimal number of existing dm's for a mm: depends on product, 20 in case of SIS

General features

Product example monthly mean diurnal cycle:

cloud top height



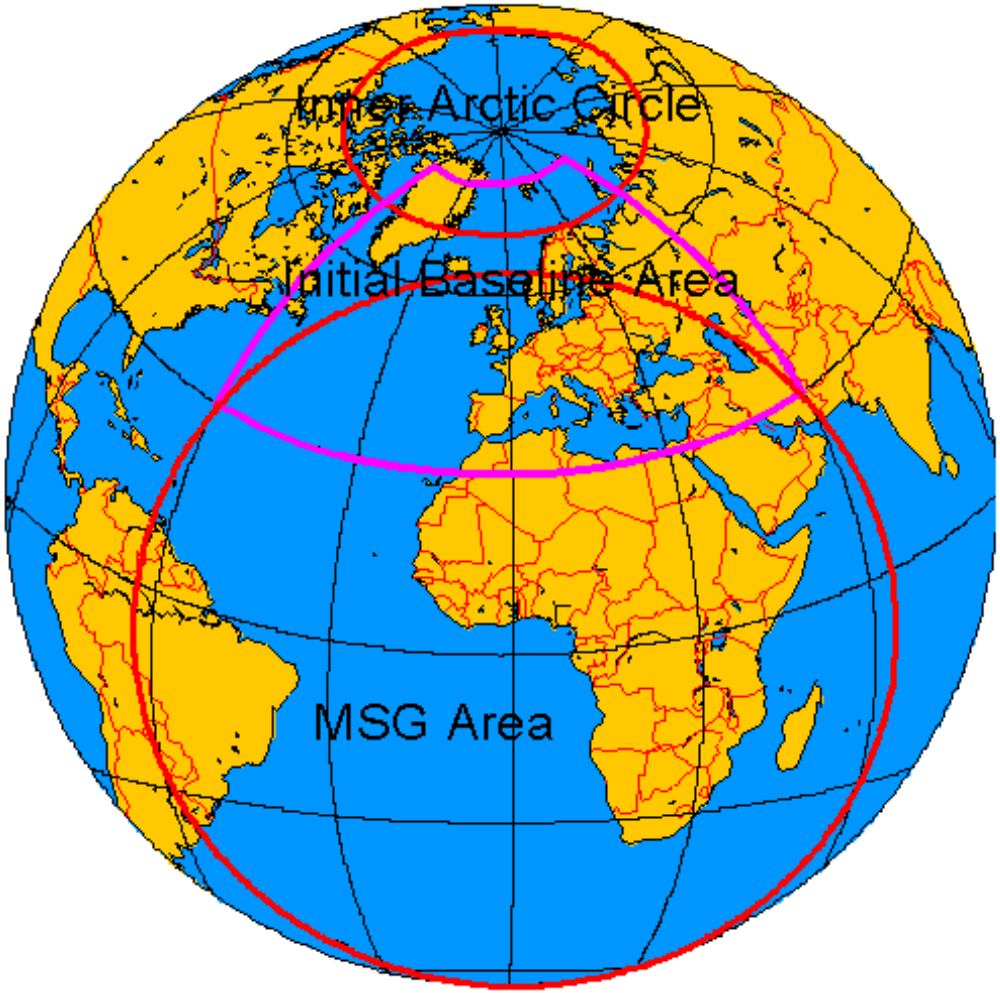
for one month all data are averaged time slot wise, result is a file with 24 fields, one/hour

minimum requirement:

20 days per slot (clouds)

General features

Products are available for different areas

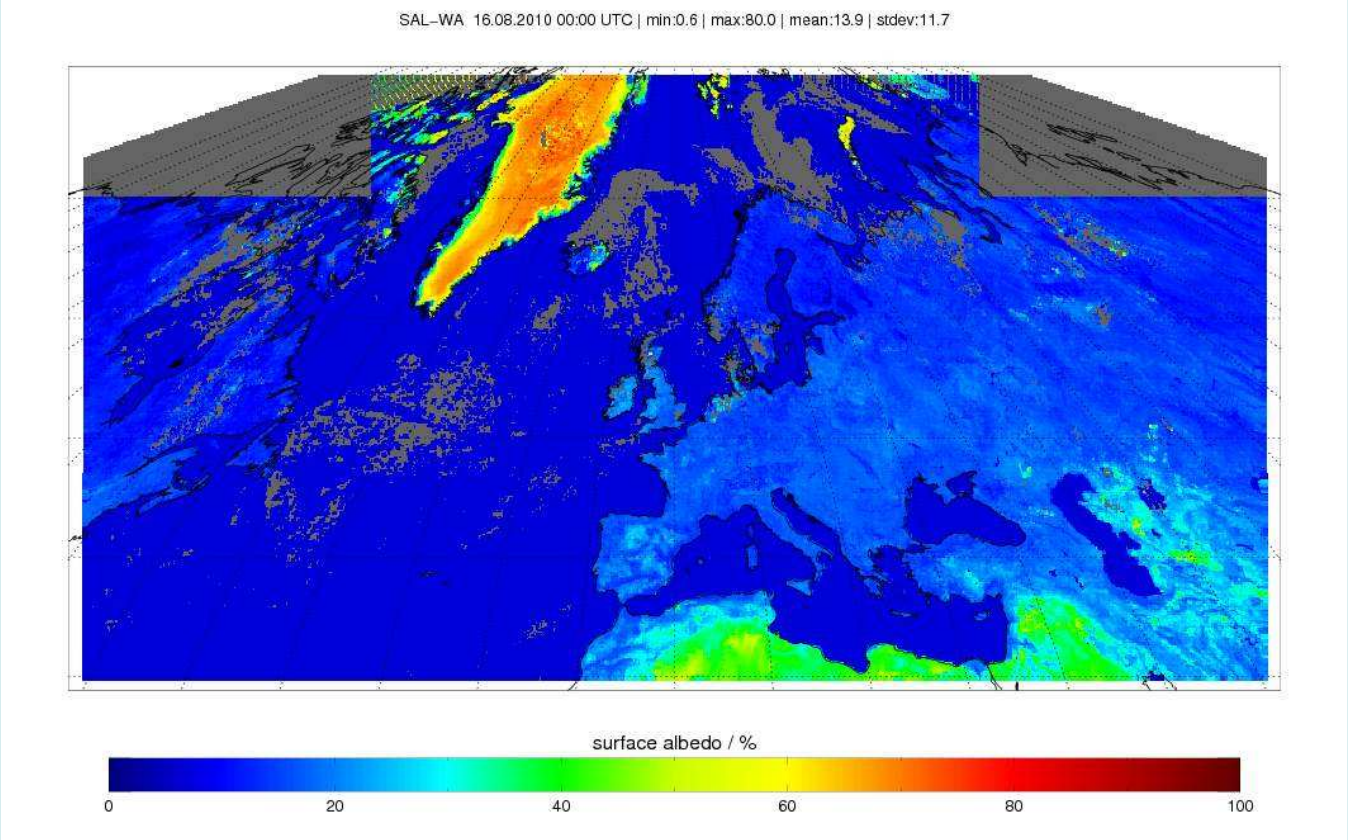


also combinations of the areas are possible, e.g. top of atmosphere radiation combines all three areas

General features

Example: Surface broadband albedo (SAL)

- Broadband albedo over the solar spectrum
- Dedicated algorithms for different land cover and snow/ice
- Weekly and monthly products for:
  - AVHRR Europe
  - AVHRR Arctic
  - SEVIRI Full Disc



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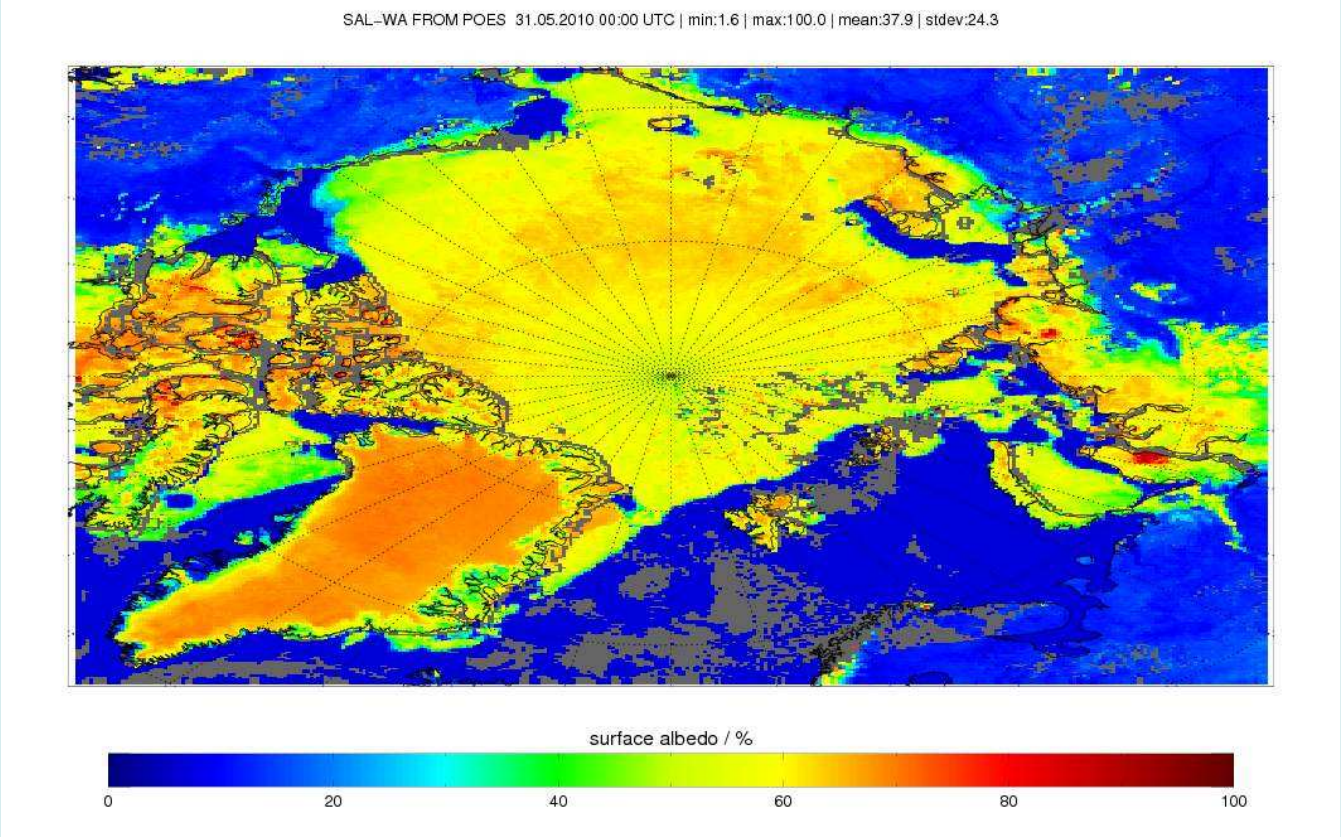

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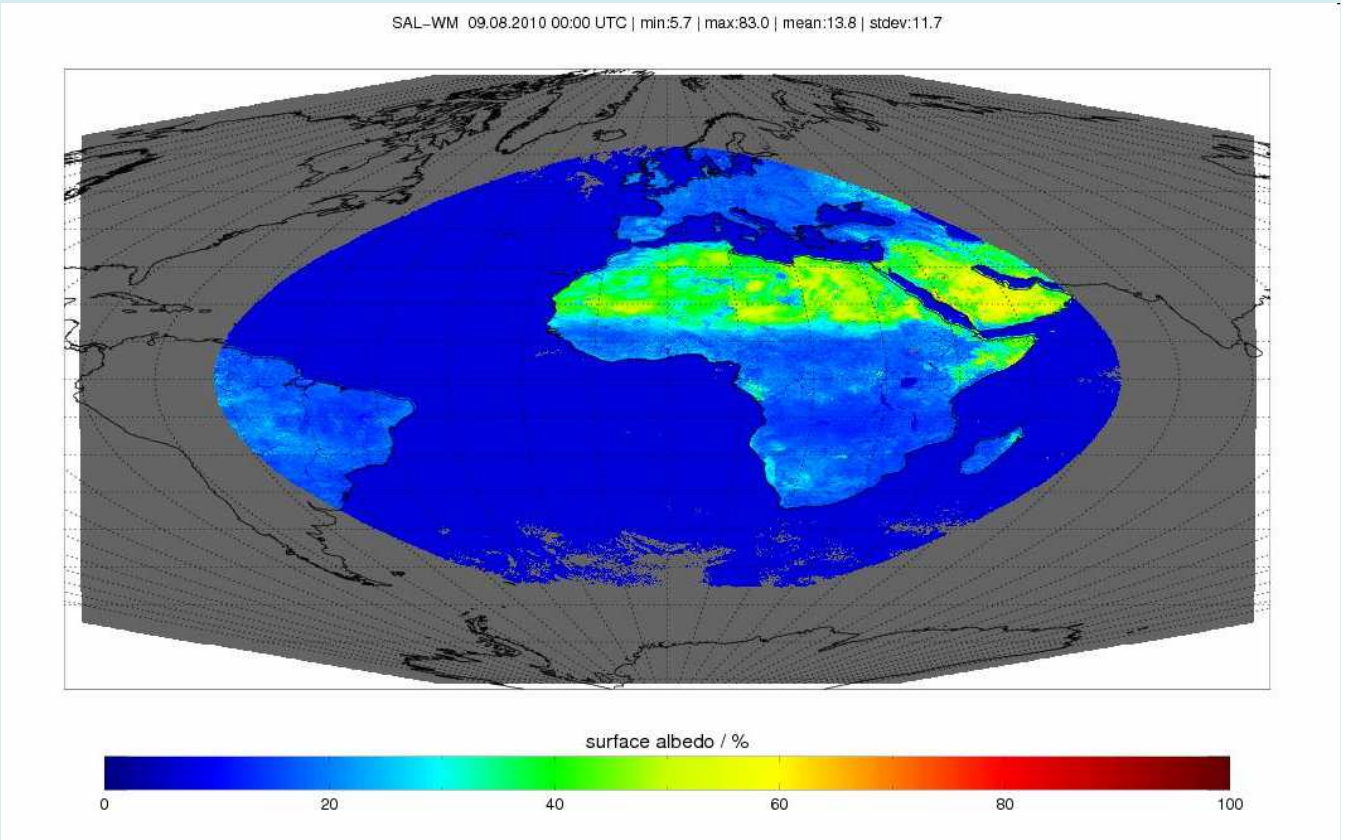


General features

not only different areas but also varying grids:

radiation and cloud products on all areas are provided in equal area grids with a horizontal resolution of 15*15 km²

→ Paris fits quite accurately into a SEVIRI pixel

top of atmosphere radiation is provided in a 45*45 km² equal area grid on the CMSAF baseline area plus MSG disk and inner arctic

→ 177 pixel needed for Germany

General features

Documentation:

can be found on our website at “CM SAF documentation”

http://www.cmsaf.eu

most necessary documents are the “PUMs” → Product user manuals (covered areas, processing details)

and the “ATBD’s” → Algorithm theoretical basis documents (description of retrieval physics)

validation reports → show quality of the products via comparison with synoptic data, ground based measurements as well as satellite measurements

General features

question for all:

Which of those products are day-time-only?

- solar incoming surface radiation
- cloud fractional cover
- cloud water path

General features

Auxiliary data and tools available on the website like viewing software or latitude/longitude gridfiles at “Data access”

software changes or missing data are notified in the “service messages”

General features

Properties of operational products

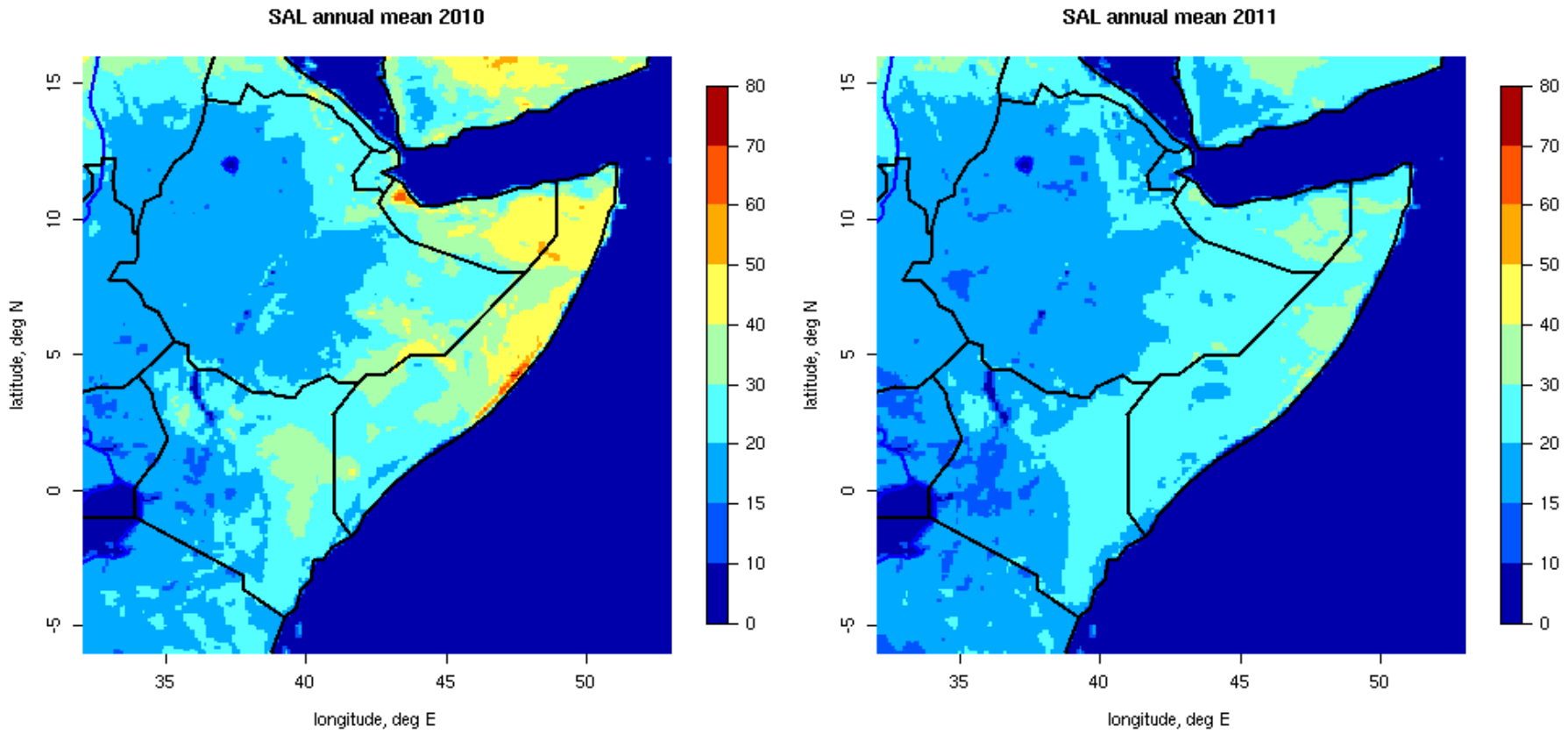
+ early and regularly available
+ regular update of the software
+ quality control via service specification

- inconsistent due to software changes
- not so carefully intercalibrated

General features

Advantages/Disadvantages compared to datasets

Example: influence of software changes:



General features

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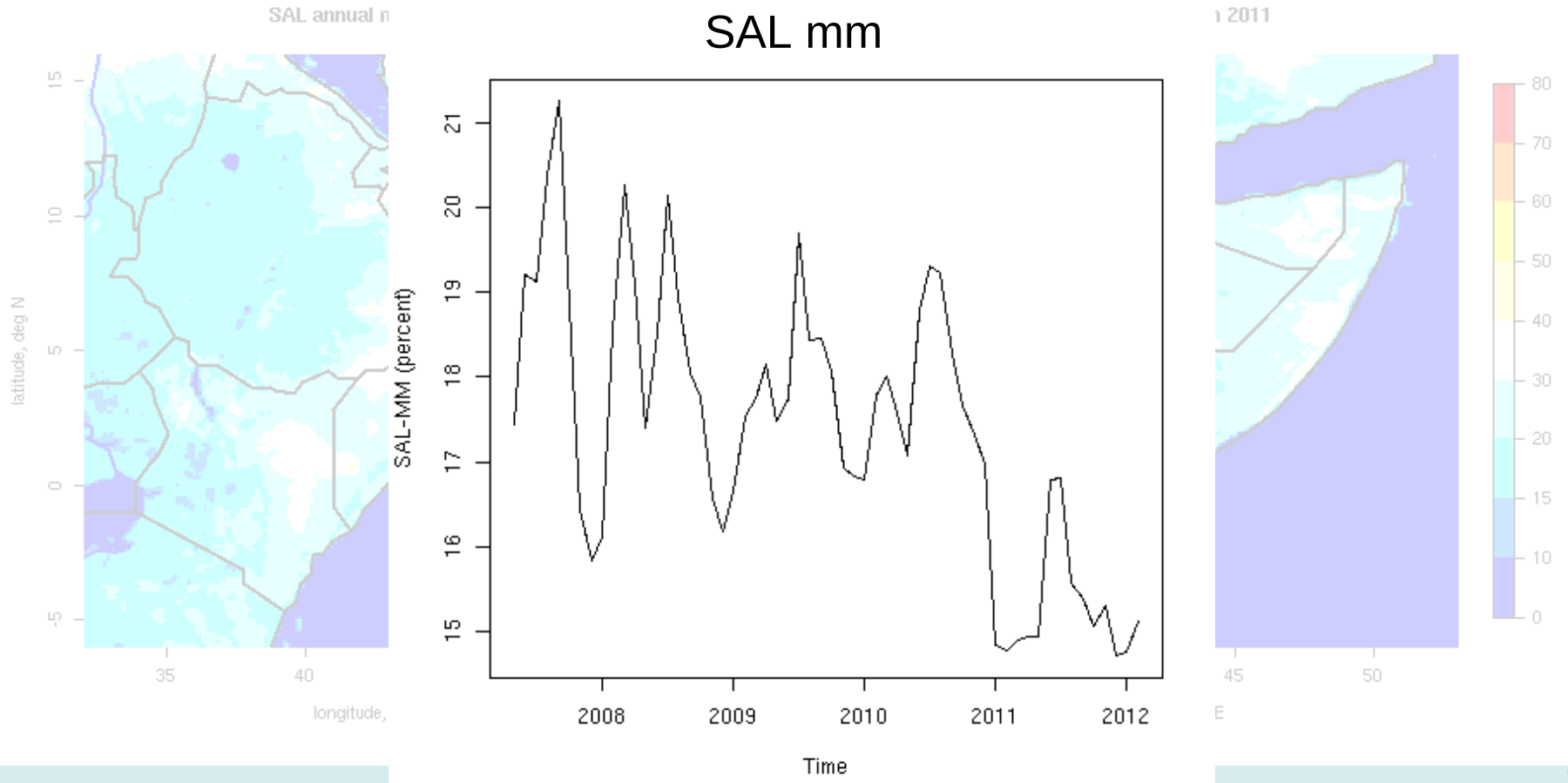
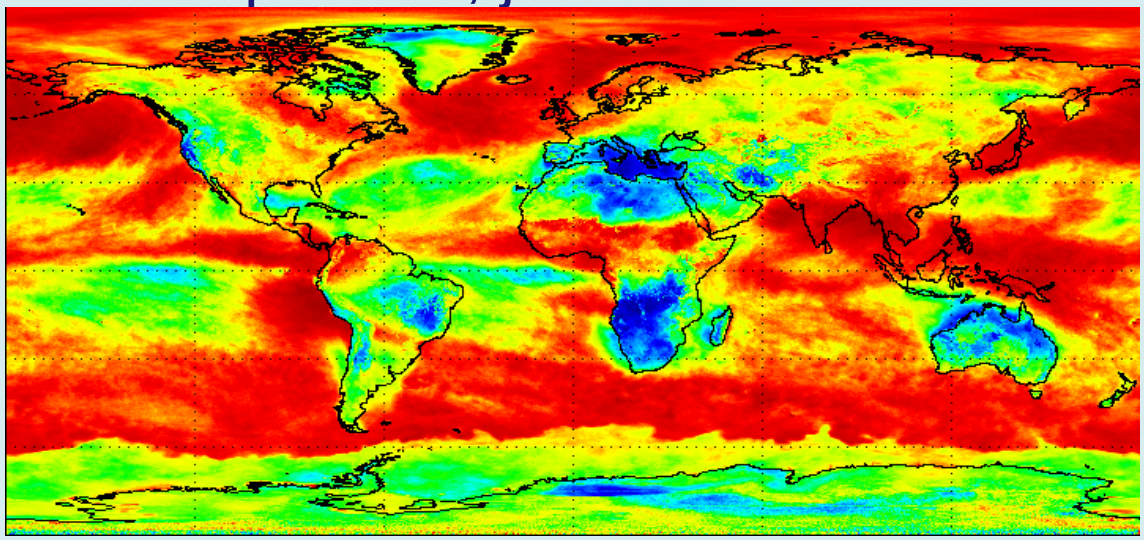
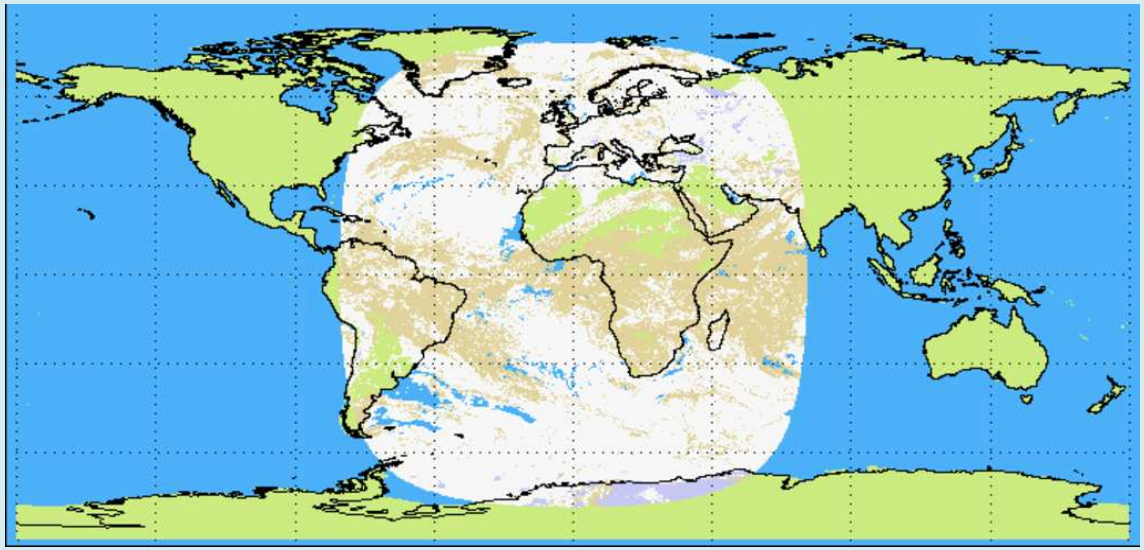


General features

small question, just 4 fun:



CFC mm from polar orbiter, morning orbit (12:00 LT)



Cloud mask at 12:00 UTC, geostationary

General features

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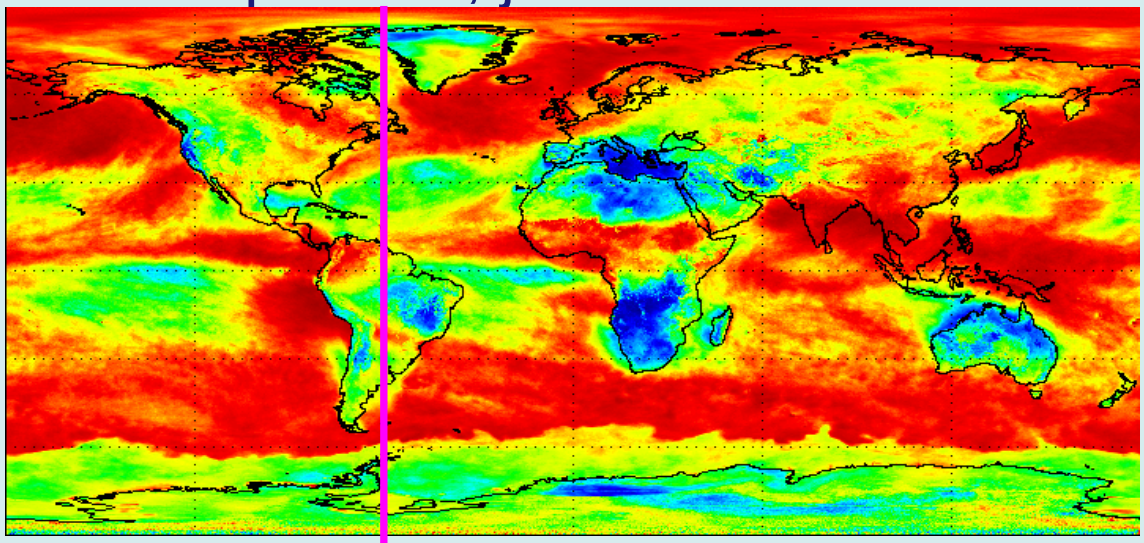

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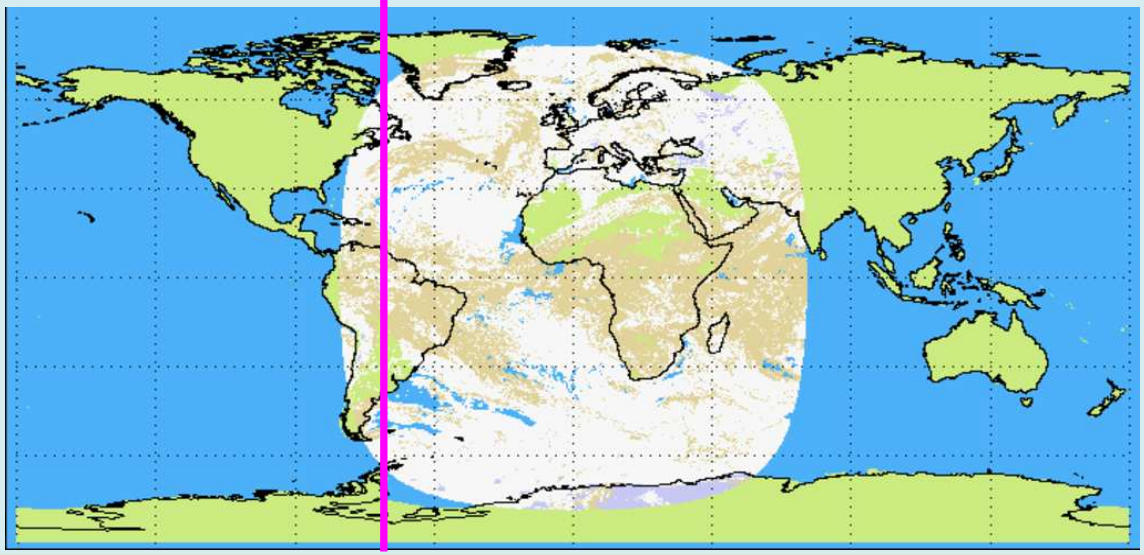

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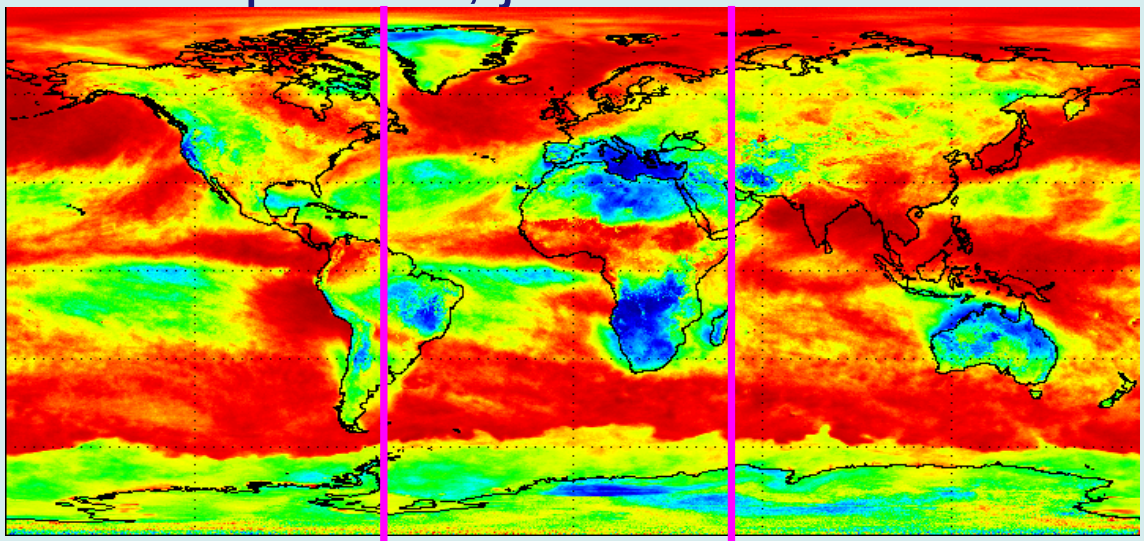

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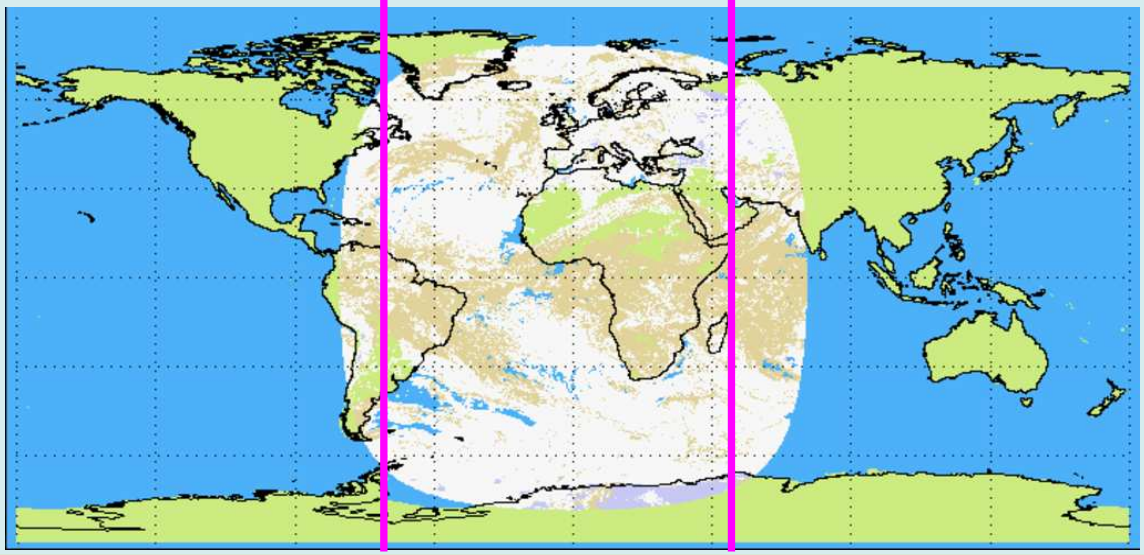

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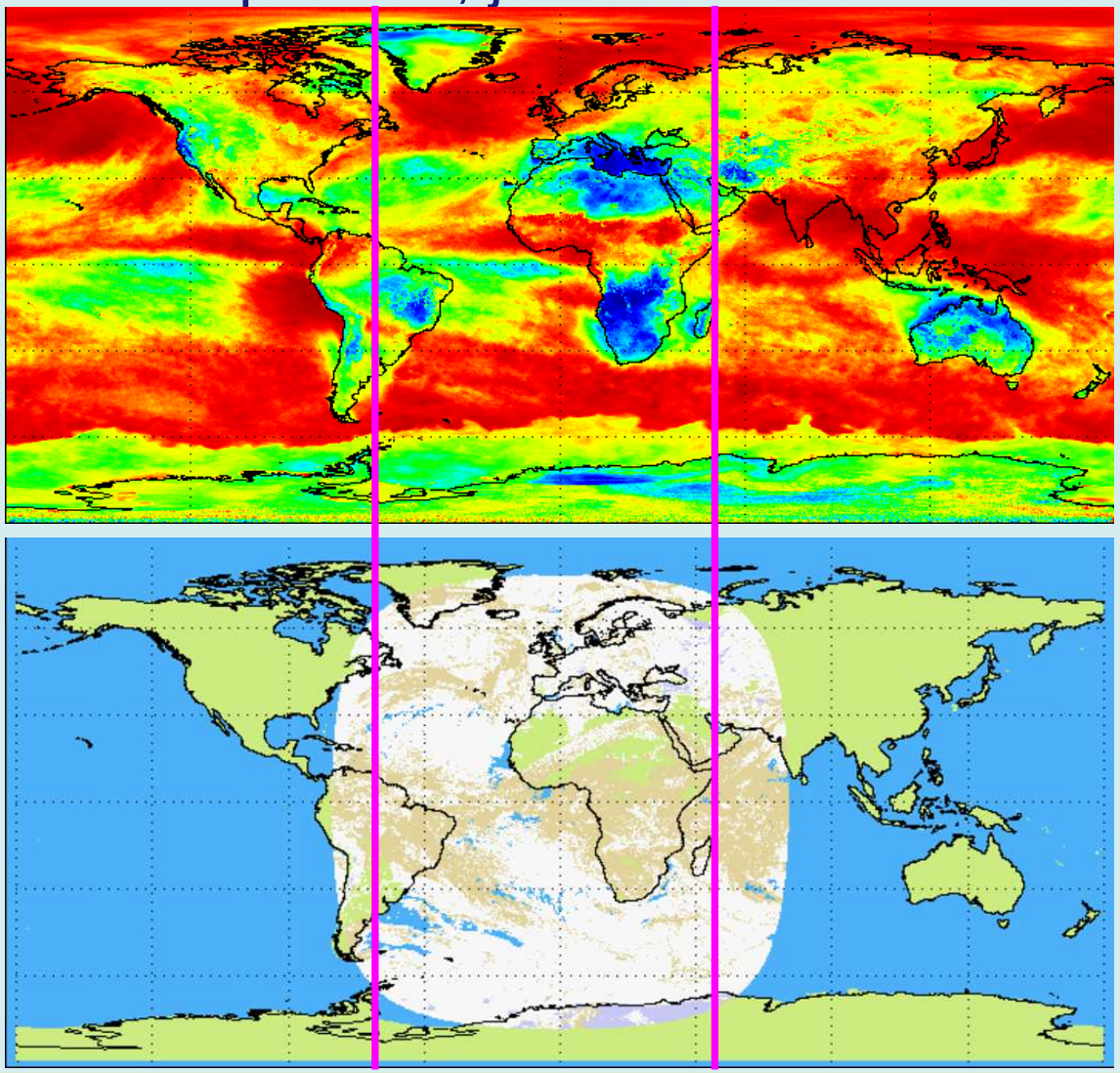


CFC mm from polar orbiter, morning orbit (12:00 LT)

Is the local measurement time still equal everywhere for a geostationary image?

- Yes
- No

Cloud mask at 12:00 UTC, geostationary

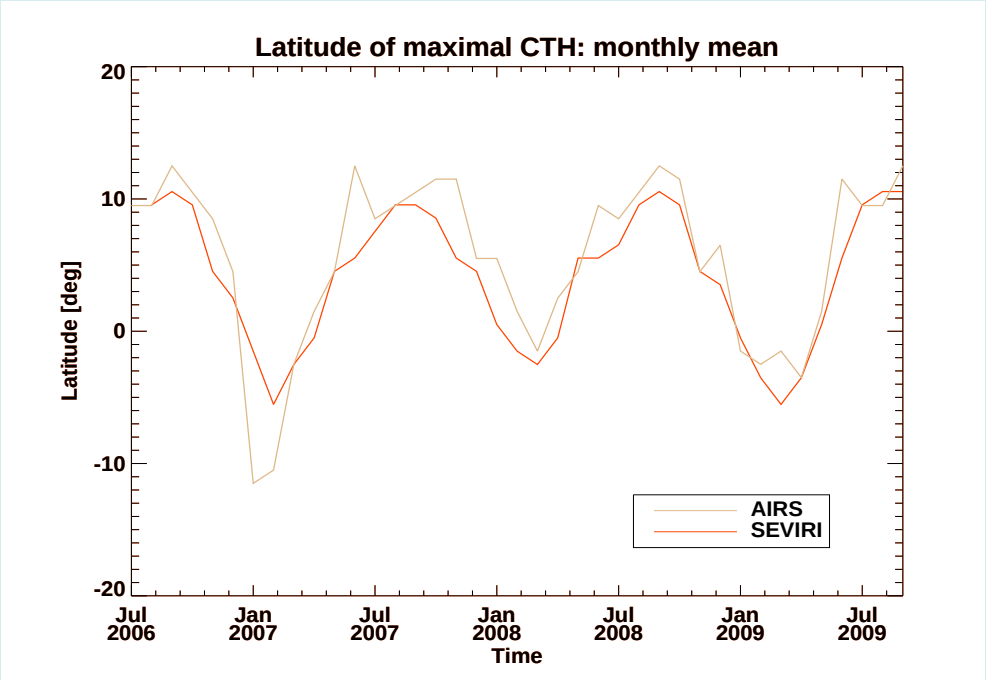
Application examples

Some examples of analysis by our users and ourselves

1) cloud products
2) radiation combined with clouds
3) surface albedo
4) top of atmosphere

Application examples

Meridional variation of CTH



Meridional position of maximal CTH → monitor variation of Inner Tropical Convergence Zone (ITCZ)

Maximal deviation (north/south) follows 1 month after maximal/minimal insolation → following theory

Application examples

Global radiation

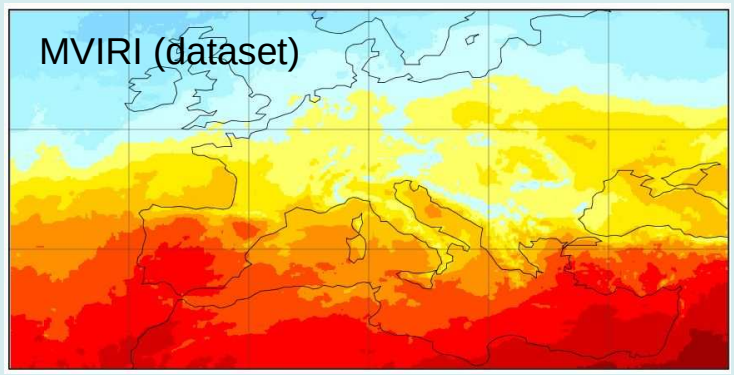
MFG: 01/1983-12/2005

Sep Oct Nov Dec

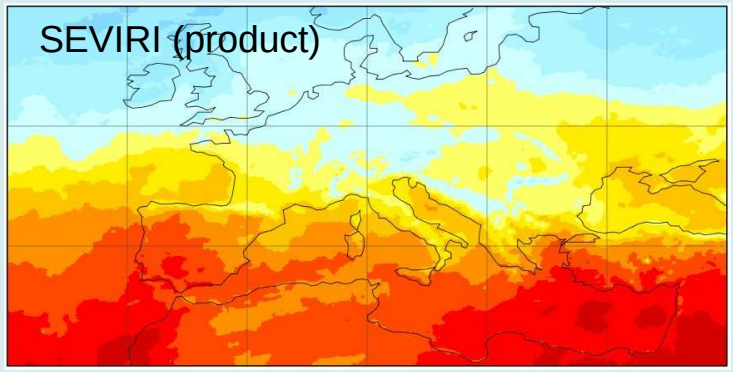
MSG: since 09/2005

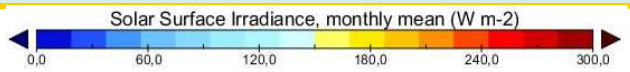
September 2005

MVIRI (dataset)

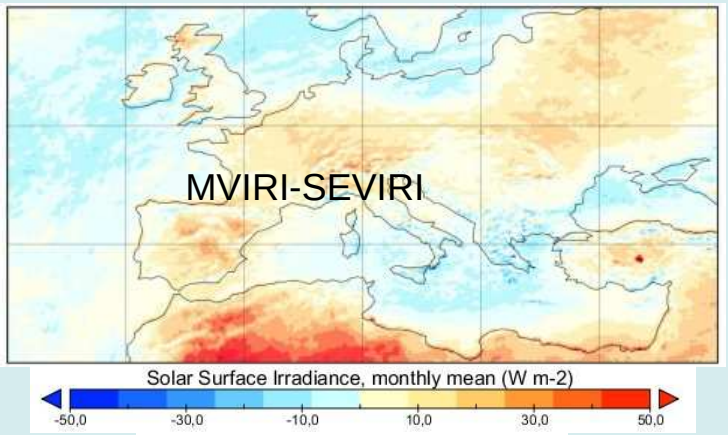


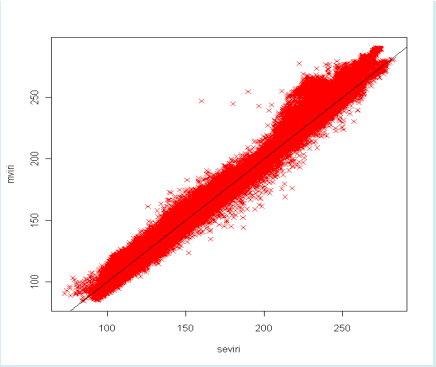
SEVIRI (product)





MVIRI-SEVIRI





Application examples

Global radiation

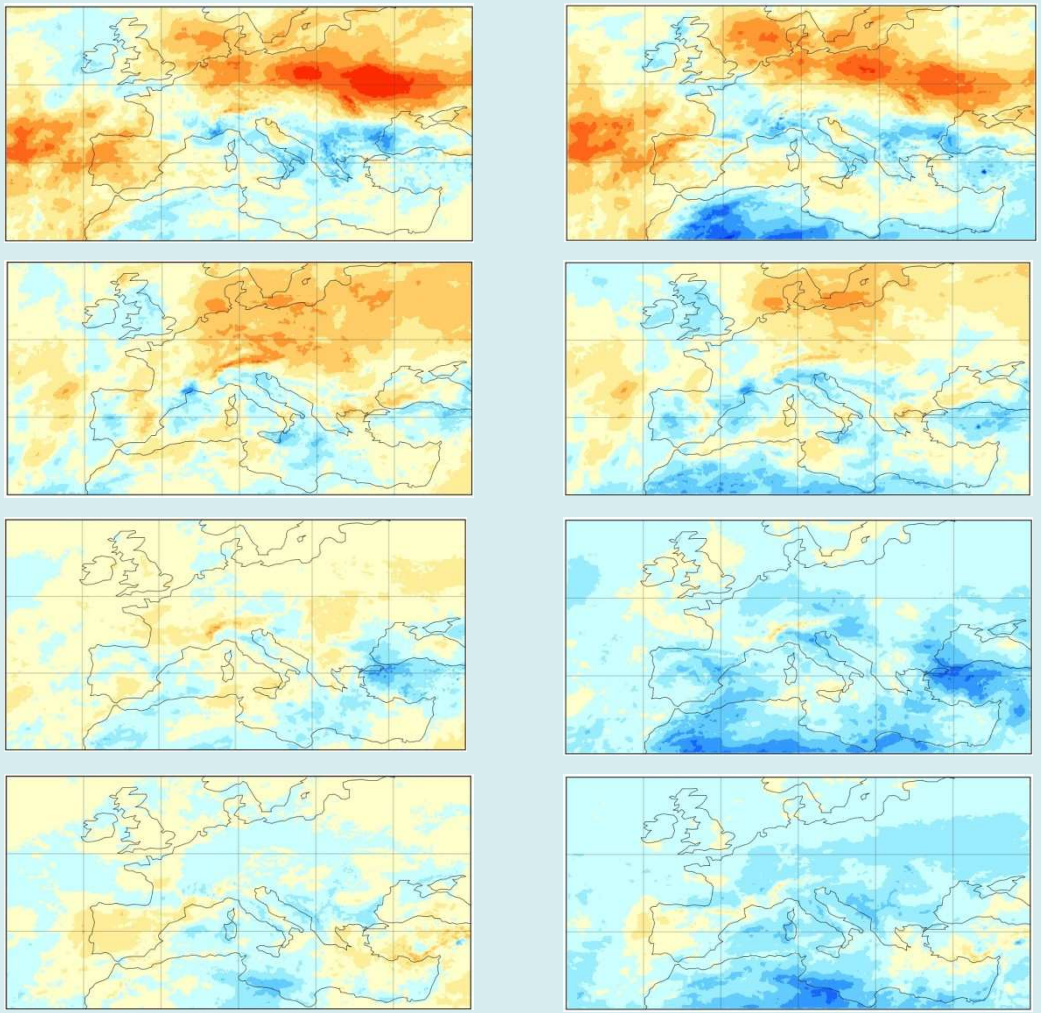
2005 MVIRI (dataset) SEVIRI (operational)

Sep

Oct

Nov

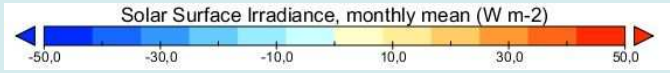
Dec



Anomalies: (Reference period 1983-2005)

Absolute Anomalies: correction of bias?

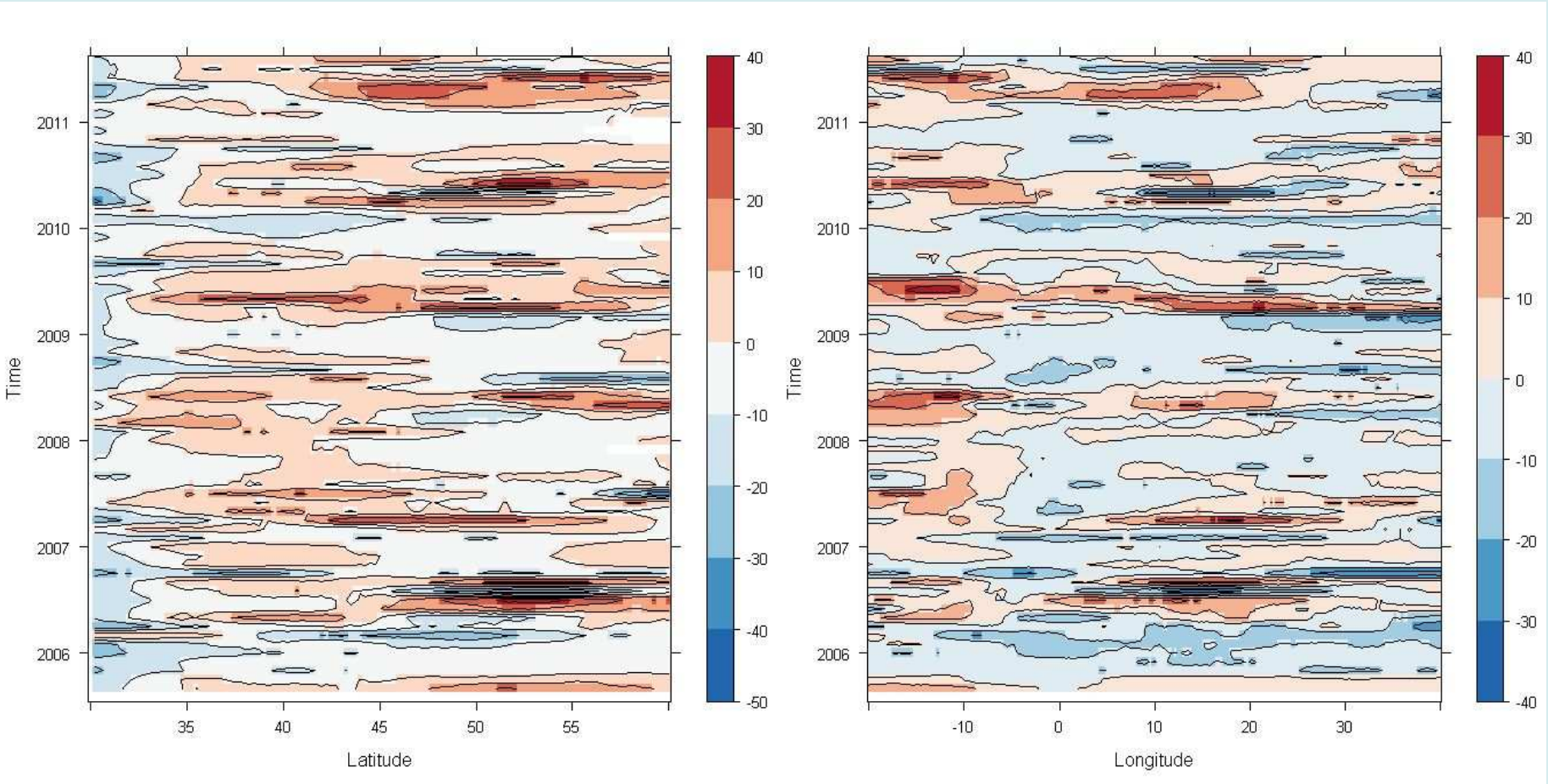
Percentile: adaption of variances?



Application examples

Global radiation

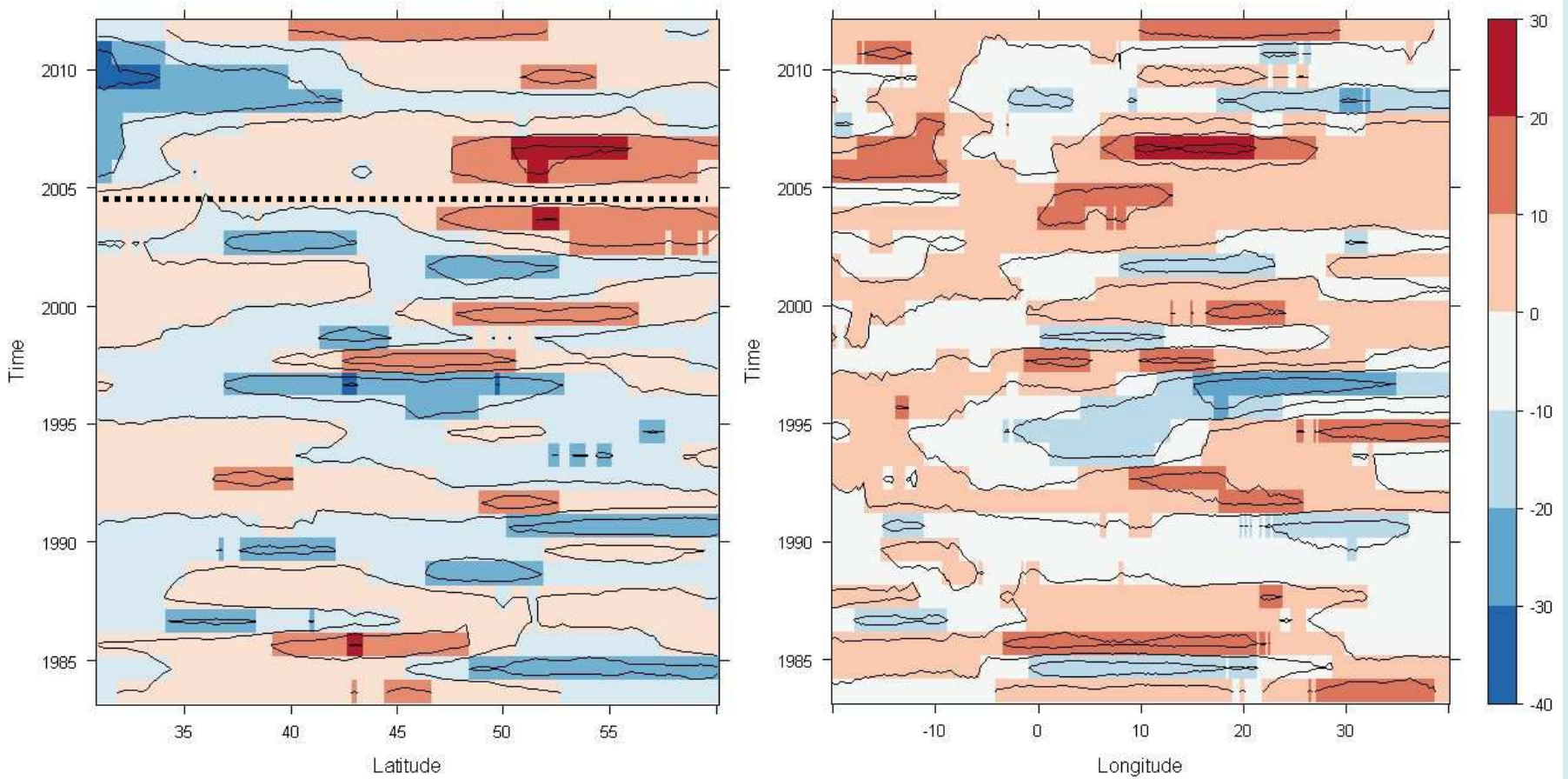
Hovmöller-plots (2005-2011 anomalies, SEVIRI only)



Application examples

Global radiation

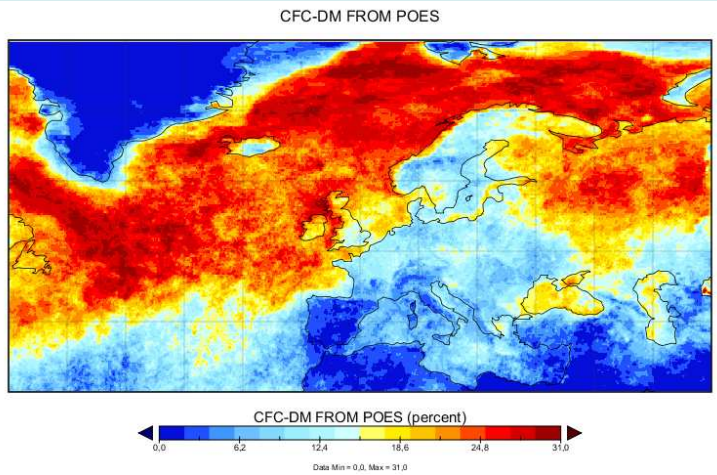
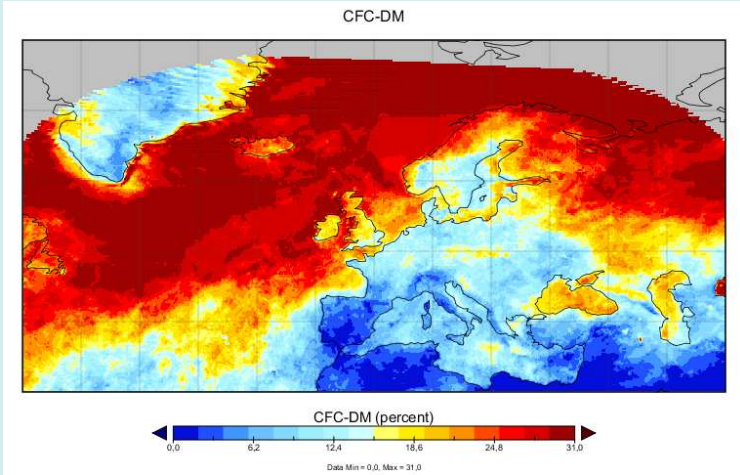
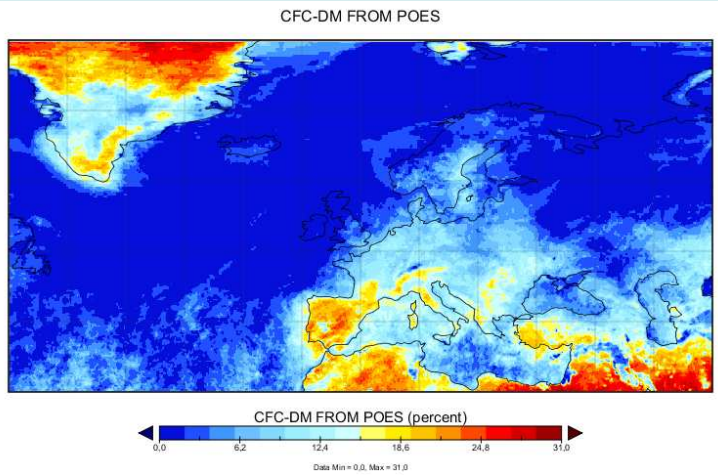
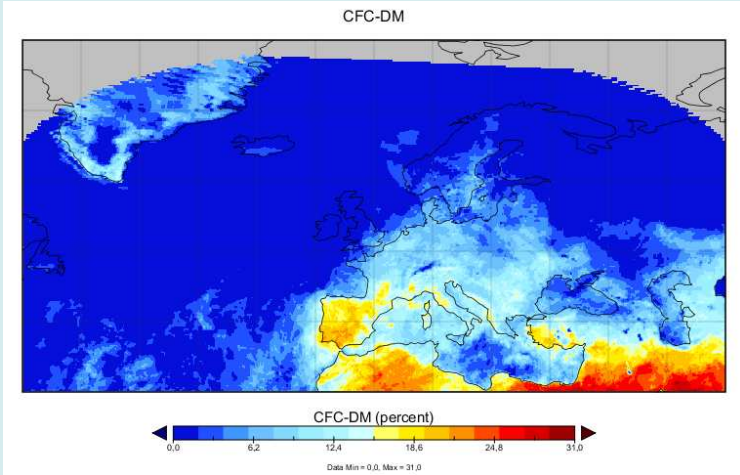
Hovmöller-plots (Sep 1983-2011 anomalies, SEVIRI and MVIRI)



Application examples

Sunshine duration

Indices (October 2010)

	AVHRR	SEVIRI
cloudy days (>=6 octas)		
sunny days (<=2 octas)		

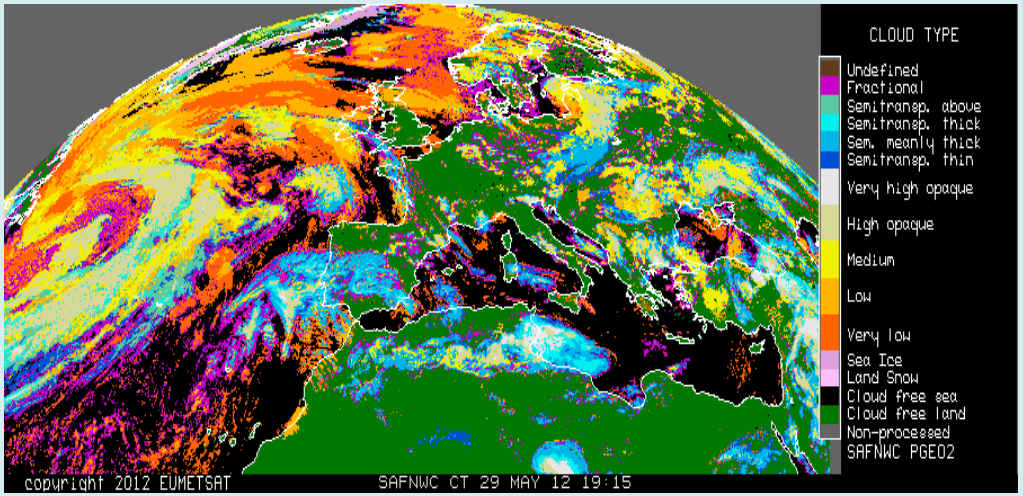
Application examples

Sunshine duration

CM SAF: Cloud Type

Method following Good (Weather 2010):

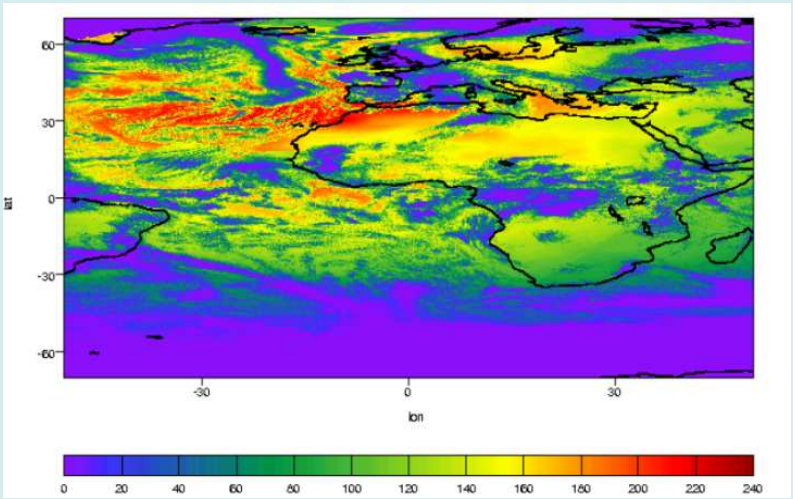
Clouds -> 0
No Clouds -> 1
Fractional Clouds -> 0.5
Semi-transparent Clouds -> Threshold SEA



CM SAF: Direct Radiation

WMO-Definition:
direct radiation >120 W m-2

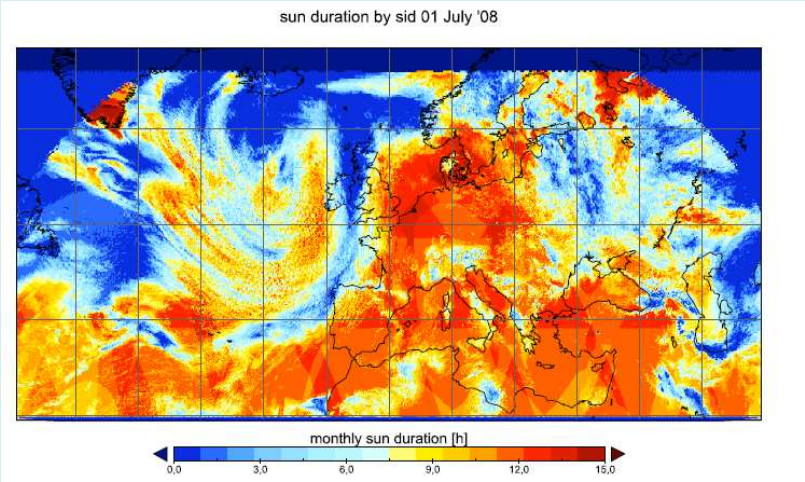
Normalization: $DNI = \frac{SID}{\cos(SZA)}$



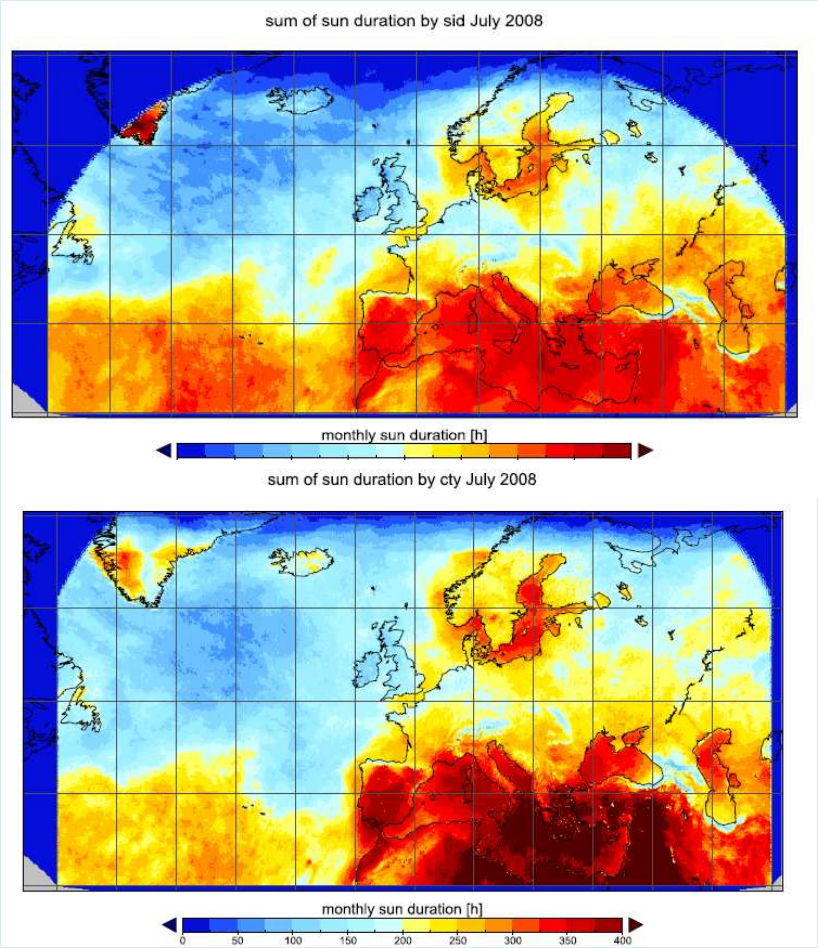
Application examples

Sunshine duration

sum per day



sum per month



SID

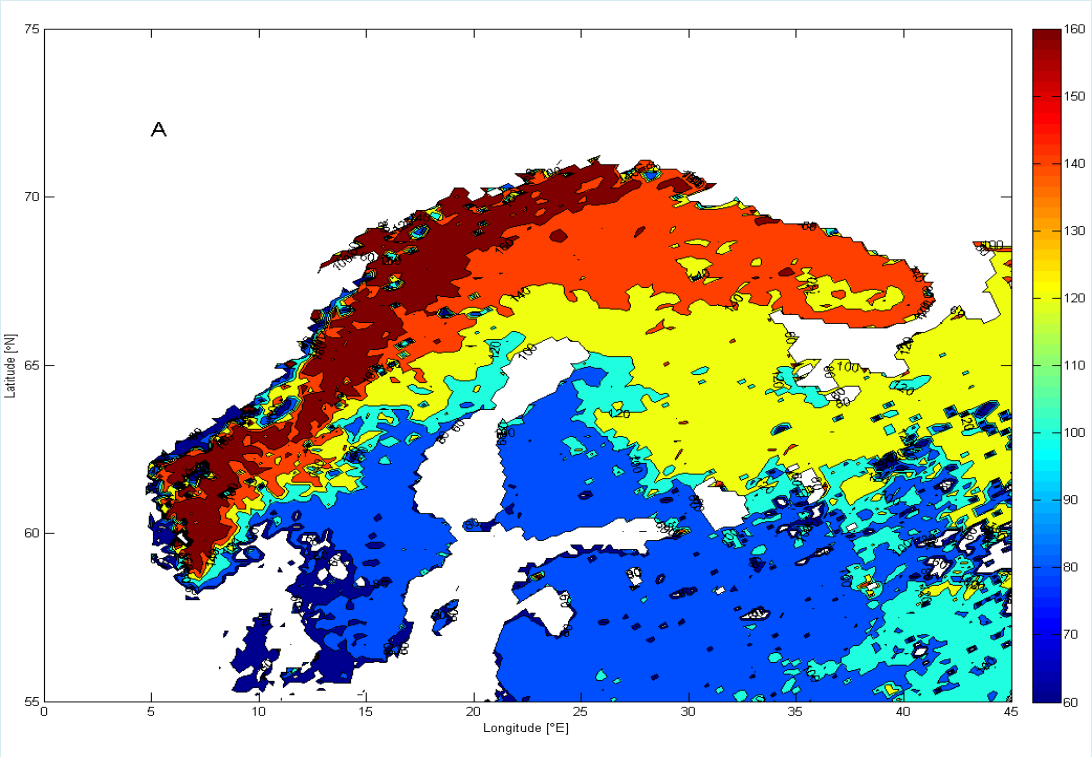
CTY

SID = surface incoming direct radiation

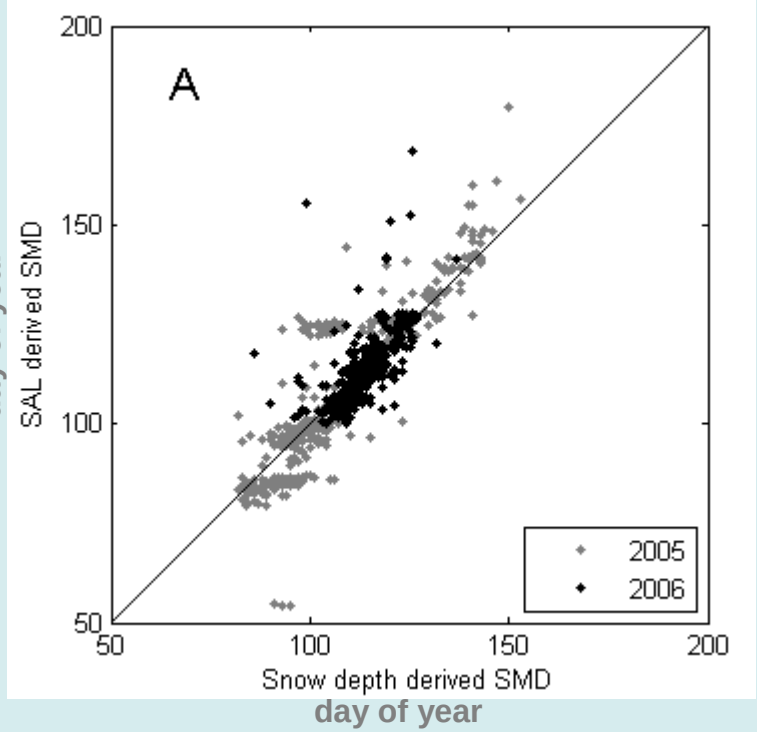
CTY = cloud type

Application examples

Surface broadband albedo: Snow melt timing in Finland



Snow melt onset day (SMD) derived from SAL products,
Based on tracking the drop in snow albedo as melt begins



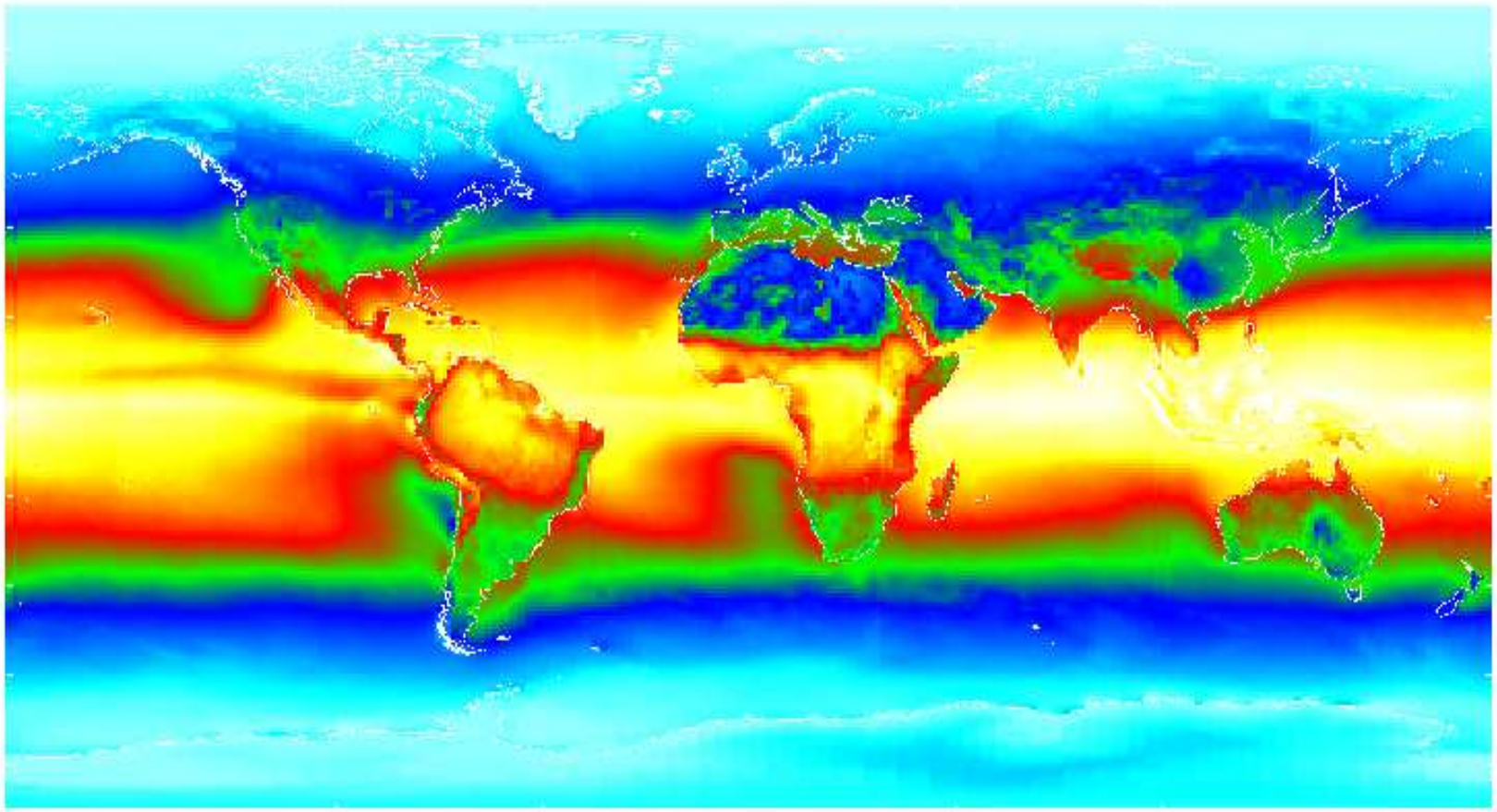
Correlation between SAL SMD and in situ-based SMD

Images from Rinne et al. (2009): **A Simple Method to Determine the Timing of Snow Melt by Remote Sensing with Application to the CO_2 Balances of Northern Mire and Heath Ecosystems,** *Remote Sens.* **2009**, *1*(4), MDPI.

Application examples

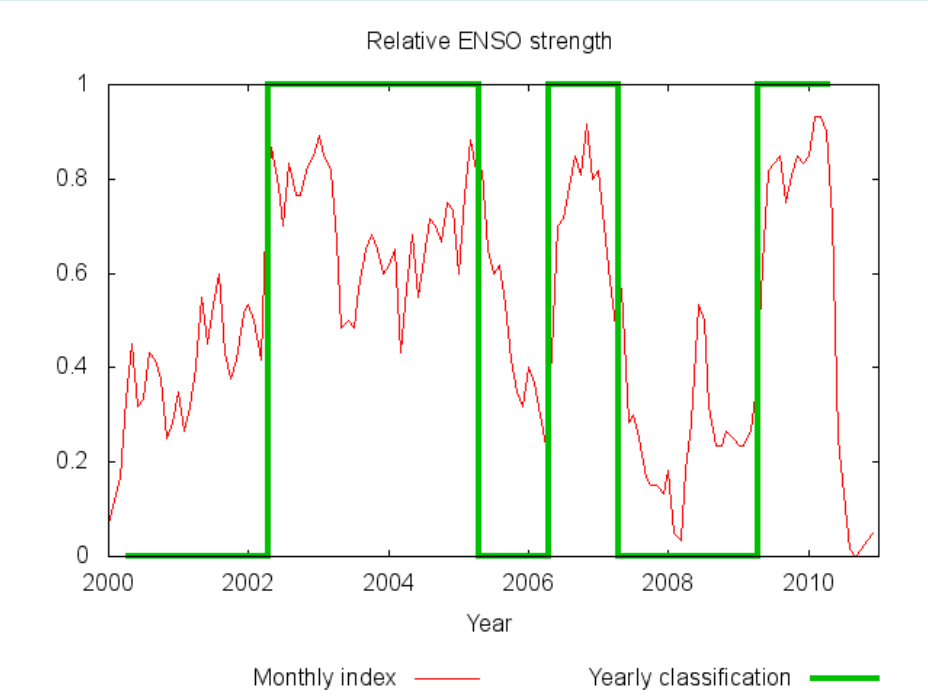
Top of atmosphere albedo

10 year annual mean Ceres EBAF net incoming radiation



Top of atmosphere albedo

El Nino / La Nina characterisation



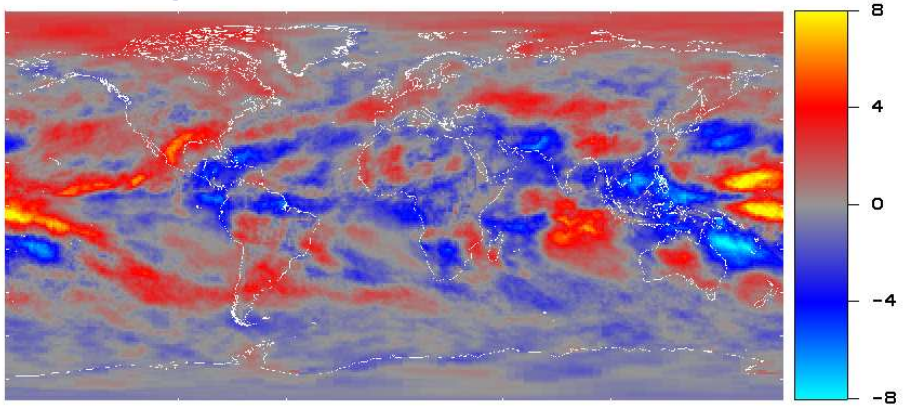
- Mulitvariate El nino index [Wolters,2011]
- La Nina – El Nino change = average over 5 strongest La Nina years - average over 5 strongest El Nino years
- Long term change = average over last 5 years - average over first 5 years

Application examples

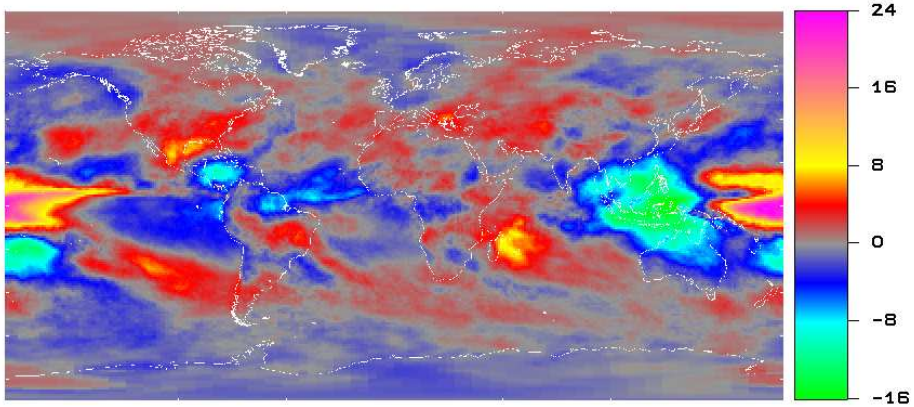
Top of atmosphere albedo

Long term change compared to La Nina – El Nino

Long term



La Nina –El Nino

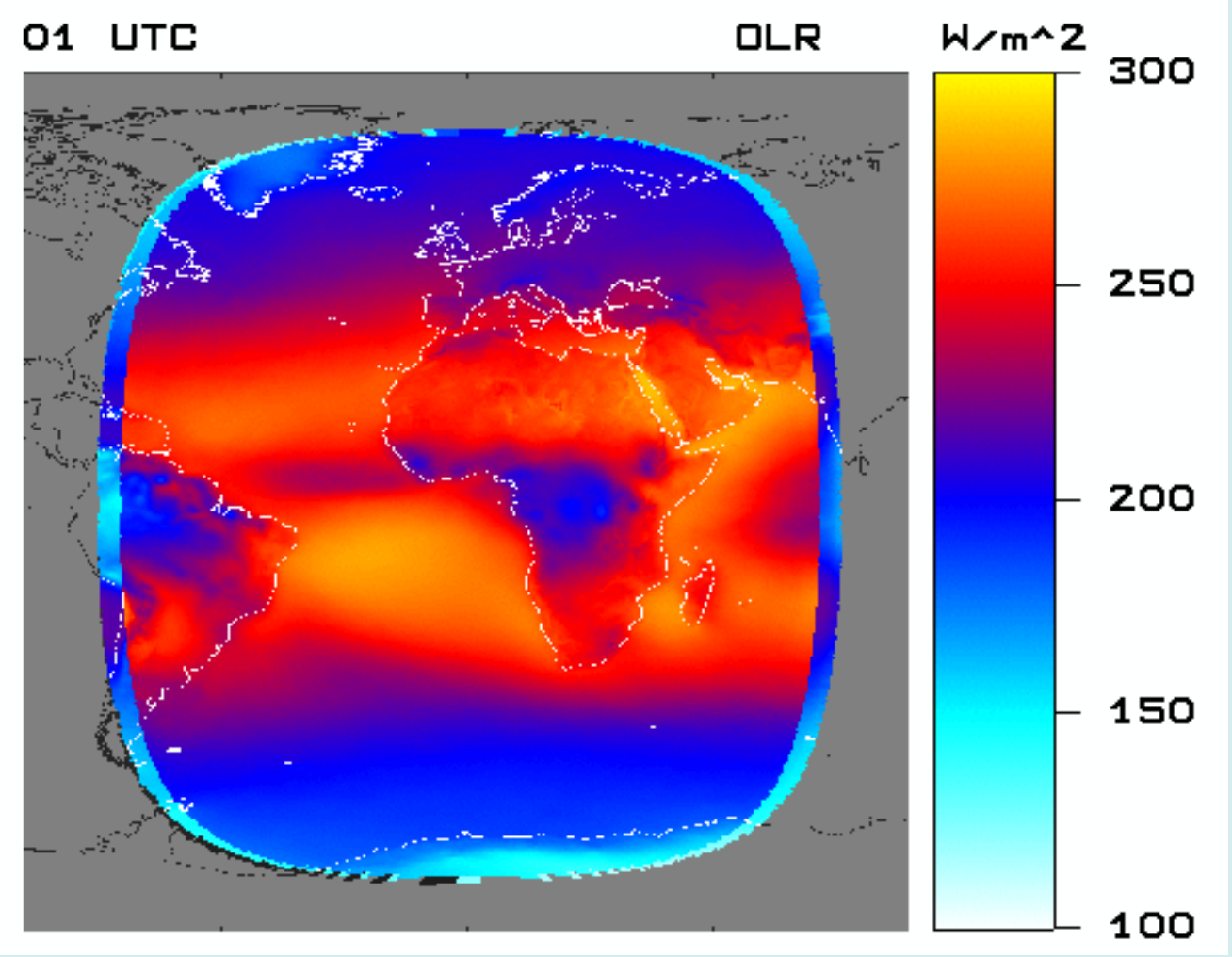


- Main change: strengthening of La Nina
  - Consistent with 'break' in global warming.
- Faint warming in the Arctic, related to ice melting ?

Application examples

Top of atmosphere albedo

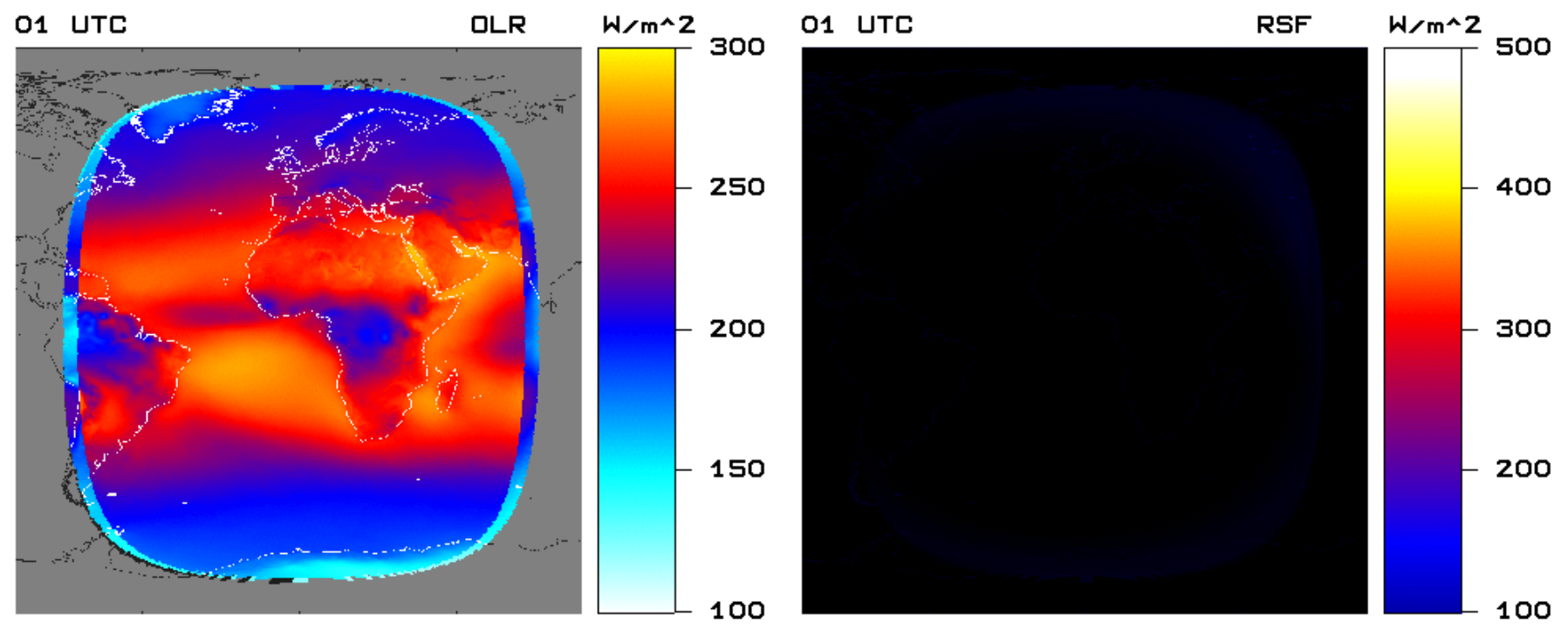
7 year GERB mean diurnal cycle



Application examples

Top of atmosphere albedo

7 year GERB mean diurnal cycle



To sum up

This is CM SAF's product suite at a glance:

available via the web-user-interface at our website

http://wui.cmsaf.eu

Product group	Specific products	Sensor, area and available since	Resolution
cloud parameter	cloud fractional cover	AVHRR: Baseline 01.11.2004	15x15 km²
	Cloud Type	AVHRR: Arctic 01.01.2009	
	Cloud Top Pressure, Height + Temp.	SEVIRI: Meteosat disc 01.09.2005	
	Cloud Phase		
	Cloud Optical Thickness		
	Cloud Water Path		
Humidity Products	see ATOVS session on Thursday		
Surface Radiation	Incoming Shortwave Radiation	AVHRR: Baseline 01.11.2004	15x15 km²
	Surface Albedo	AVHRR: Arctic (SAL only) 01.01.2009	
	Net Shortwave Radiation	SEVIRI: Meteosat disc 01.09.2005	
	Net Longwave Radiation		
	Downward longwave radiation		
	Outgoing longwave radiation		
	Surface radiation budget		
Top-of-Atmosphere	Incoming solar radiative flux	GERB and CERES (merged dataset):	45x45 km²
	Reflected solar radiative flux	Baseline, MSG disc 01.02.2004	
	Emitted thermal radiative flux		

Questions?

Thank you for you attention!