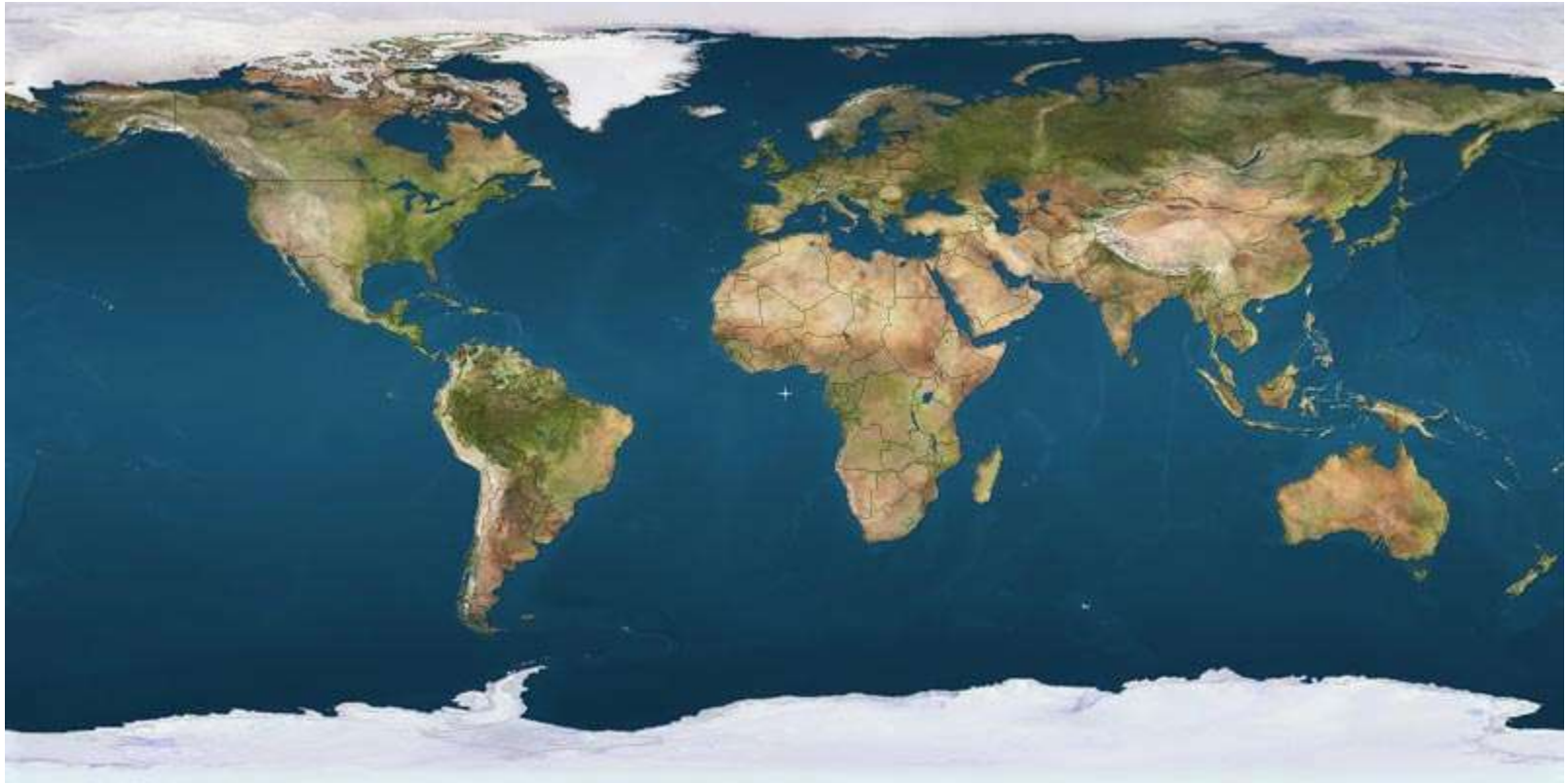
Satellite Application Facility on Climate Monitoring

CM SAF

Christine Träger-Chatterjee

Where are you now?



Outline

- **Who / What is CM SAF**
- **A few words on Climate Monitoring**
- **CM SAF Data**
  - **Climate Datasets**
  - **Operational Products**
- **CM SAF Services**
- **Summary**

EUMETSAT SAF Network

The EUMETSAT Network of Satellite Application Facilities
CM SAF
Climate Monitoring

The EUMETSAT Network of Satellite Application Facilities
NWP SAF
Numerical Weather Prediction

The EUMETSAT Network of Satellite Application Facilities
O3M SAF
Ozone and Atmospheric Chemistry Monitoring

The EUMETSAT Network of Satellite Application Facilities
H SAF
Support to Operational Hydrology and Water Management

EUMETSAT
Monitoring weather and climate from space
Surveiller le temps et le climat depuis l'espace

The EUMETSAT Network of Satellite Application Facilities
NWC SAF
Support to Nowcasting and Very Short Range Forecasting

The EUMETSAT Network of Satellite Application Facilities
LSA SAF
Land Surface Analysis

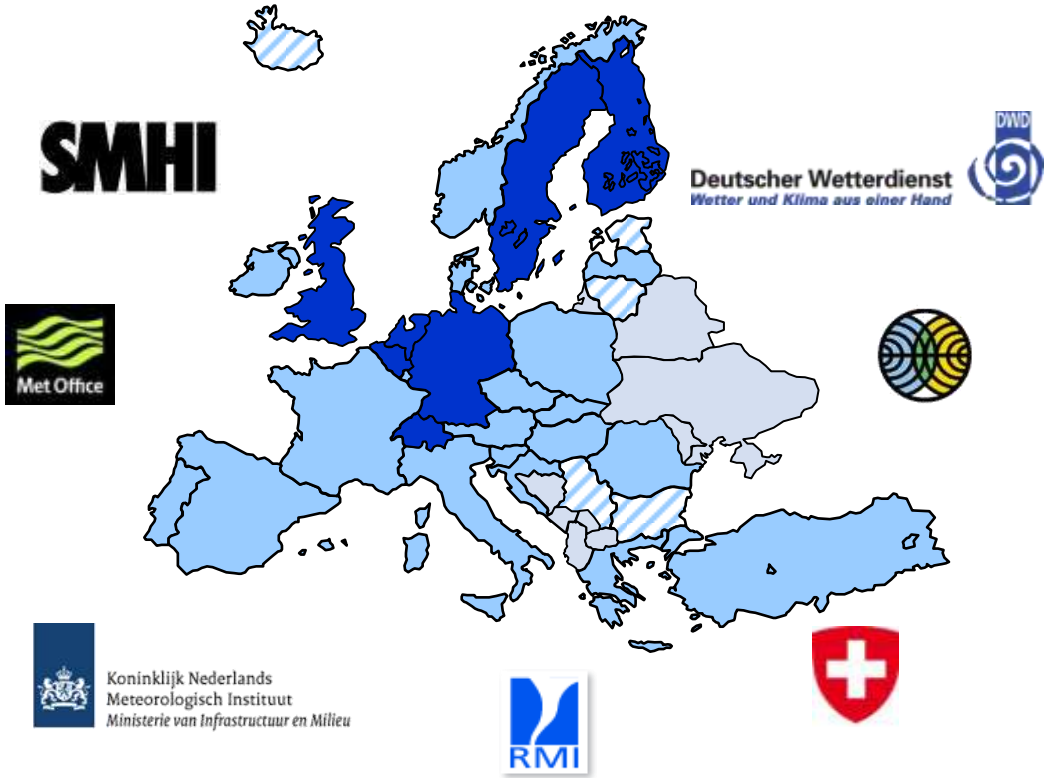
The EUMETSAT Network of Satellite Application Facilities
ROM SAF
Radio-Occultation Meteorology

The EUMETSAT Network of Satellite Application Facilities
OSI SAF
Ocean and Sea Ice

CM SAF Partners

CM SAF
Climate Monitoring

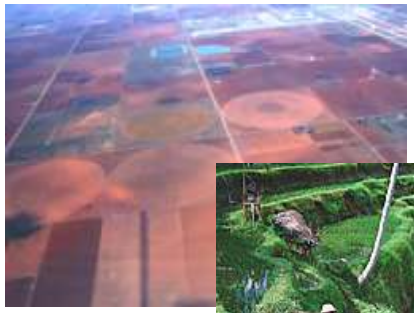
CM SAF has the mandate to generate climate data records in an operational environment. It requires calibrated and cross calibrated radiance data sets from different satellite operators.

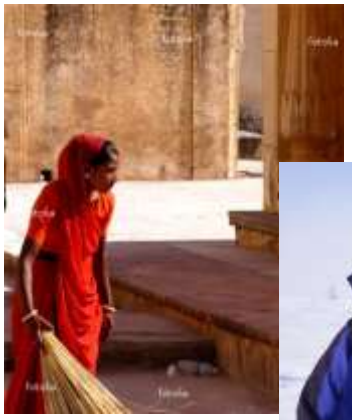


Web: **www.cmsaf.eu**

Why Climate Monitoring ?

Climate affects our every day life in various ways:





Climate vs Weather

Climate	Weather	
☐	☐	Status of the atmosphere at a certain point in time and space
☐	☐	Mean status of the atmosphere over a reasonably long period of time

Climate vs Weather

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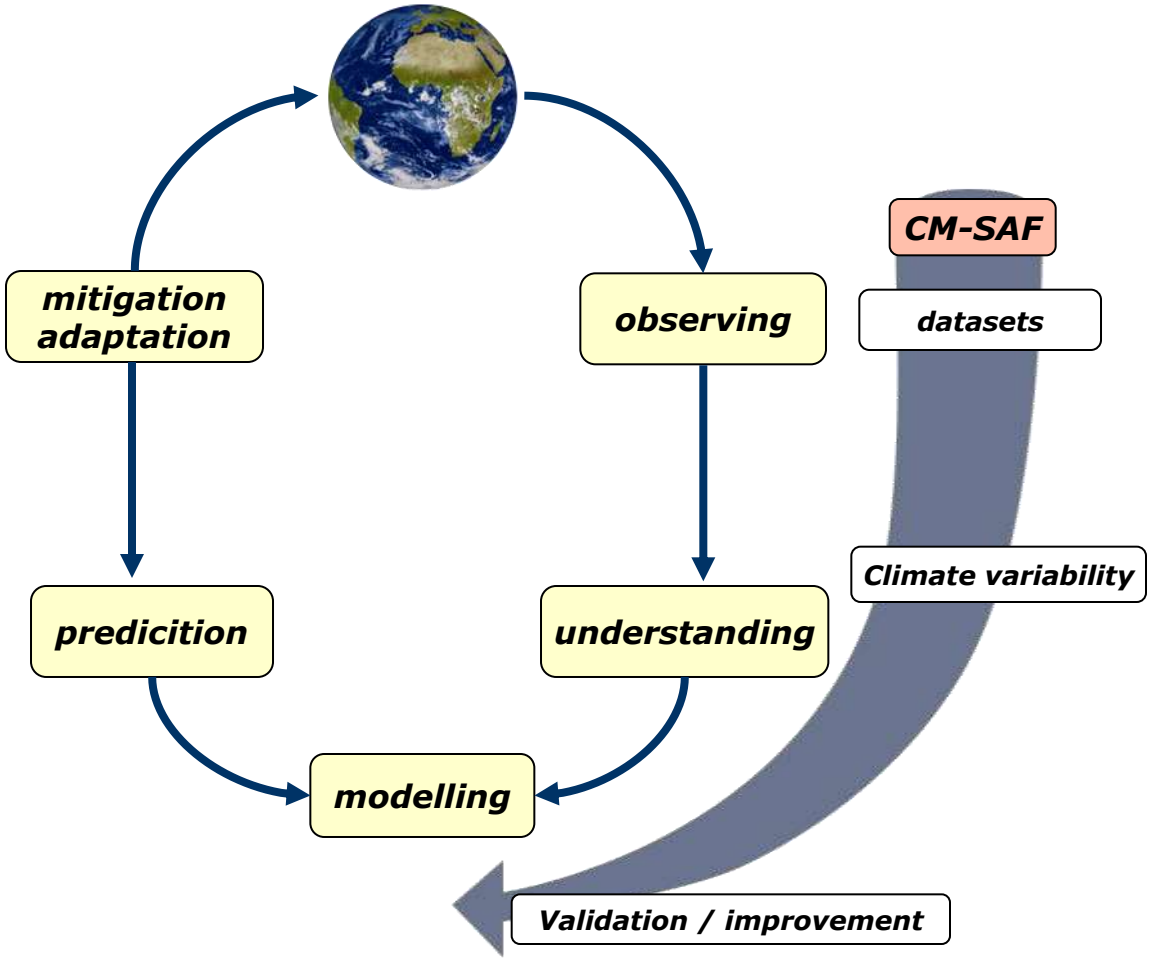
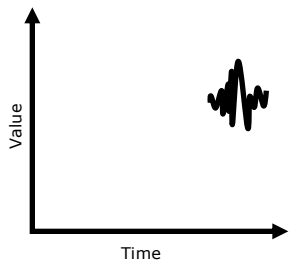
Why Climate Monitoring ?

- Assess past and current climate to
  - Understand the climate system
  - assess possible trends and changes
- Support the development of climate modells
- Assess climate impacts
- Provide a basis for political decisions and infrastructure planning



Requirements to climate Data



Sufficiently long time series

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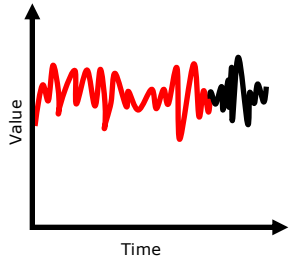

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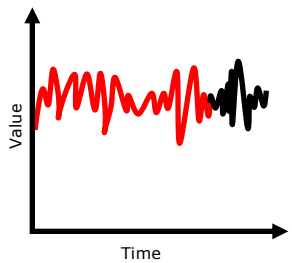

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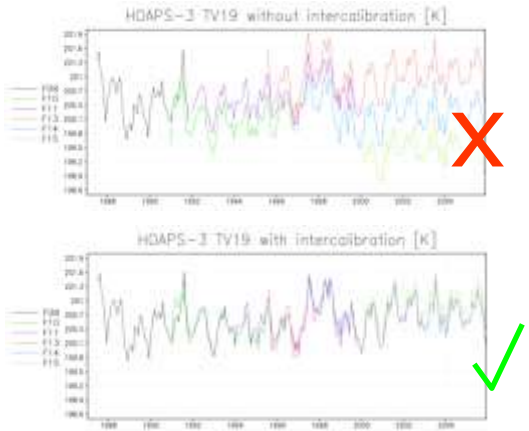
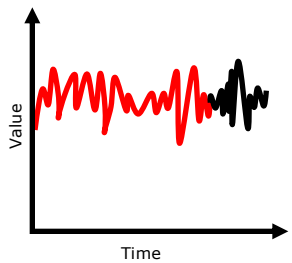


Calibrated

Requirements to climate Data



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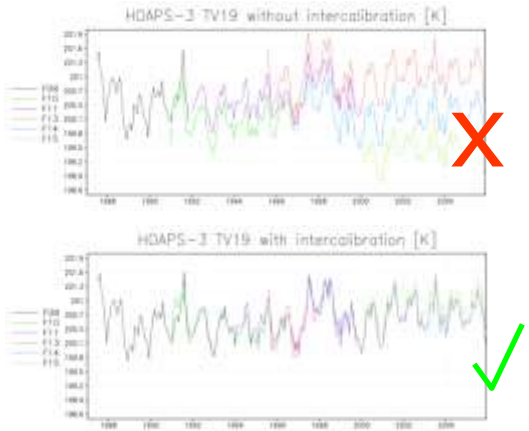

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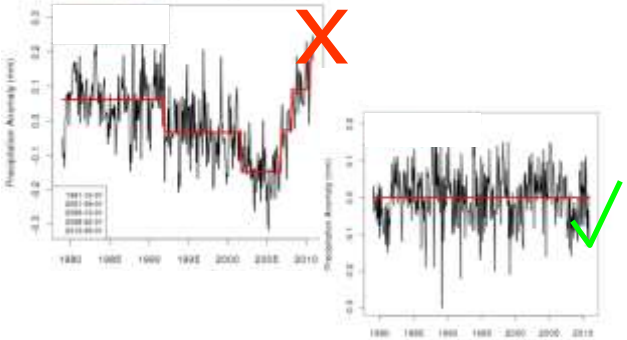
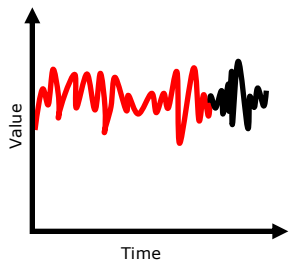


Homogeneous

Requirements to climate Data



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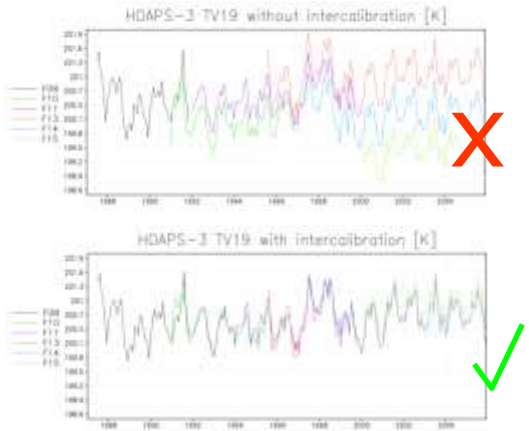

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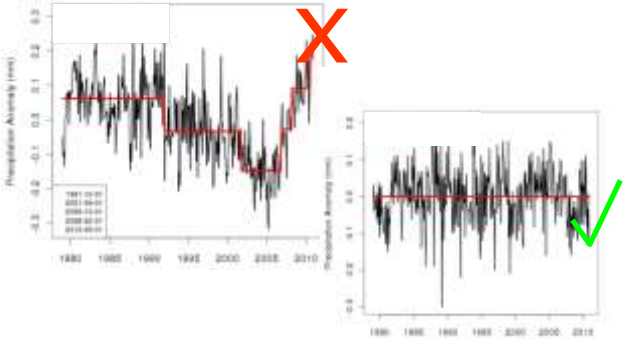

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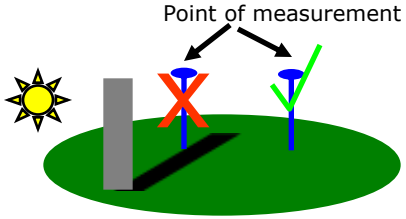
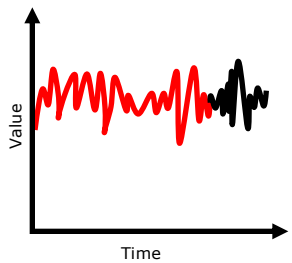


Representative

Requirements to climate Data



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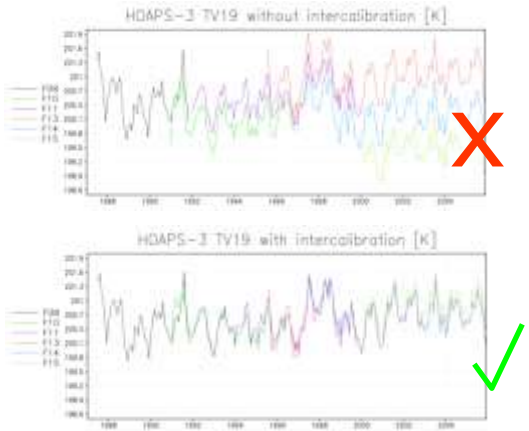

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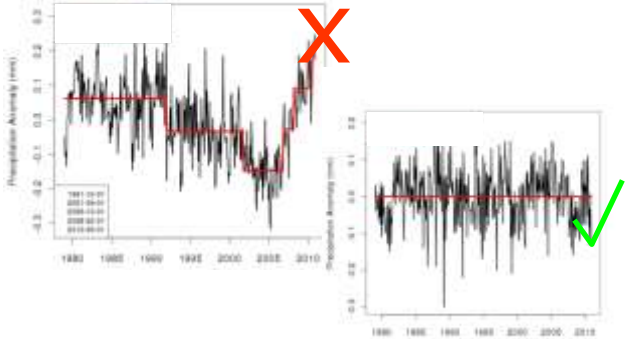

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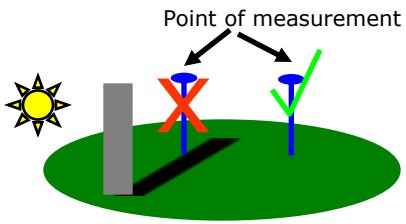

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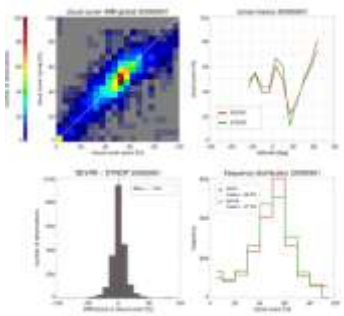
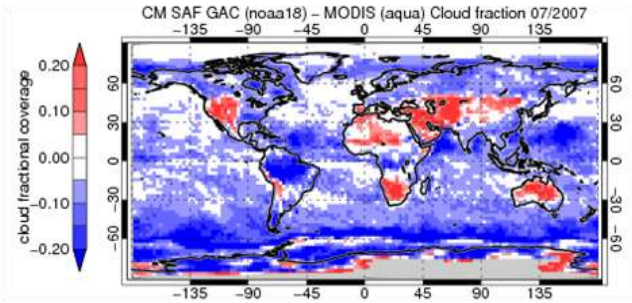




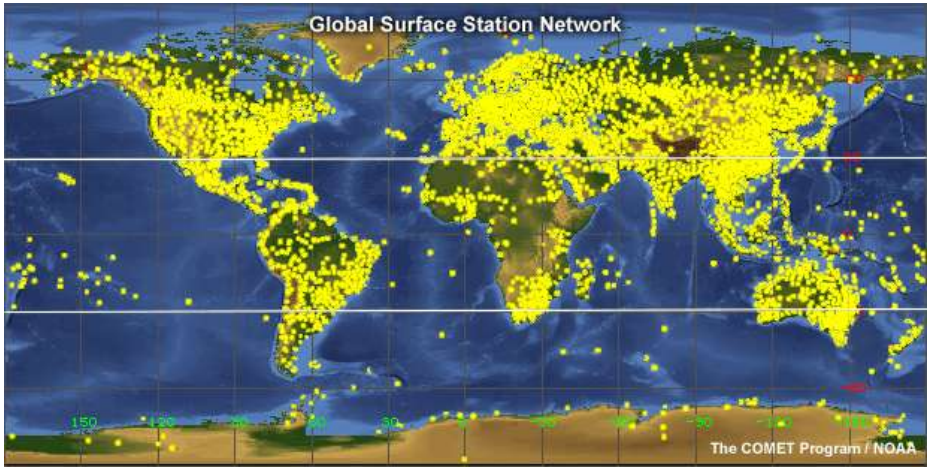
Quality controled

Ground based vs Satellite

Climate Monitoring from the Earths Surface

- patchy spatial coverage
- almost all measurement only over land

Climate Monitoring from Space (Satellites)



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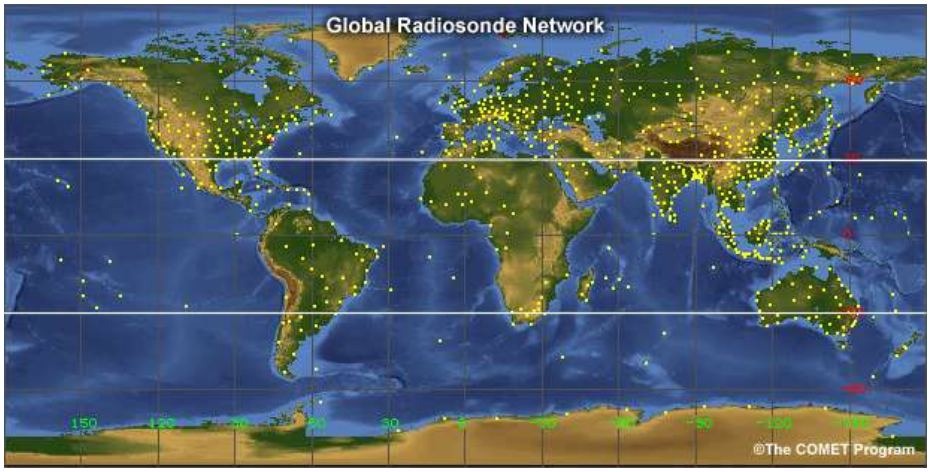
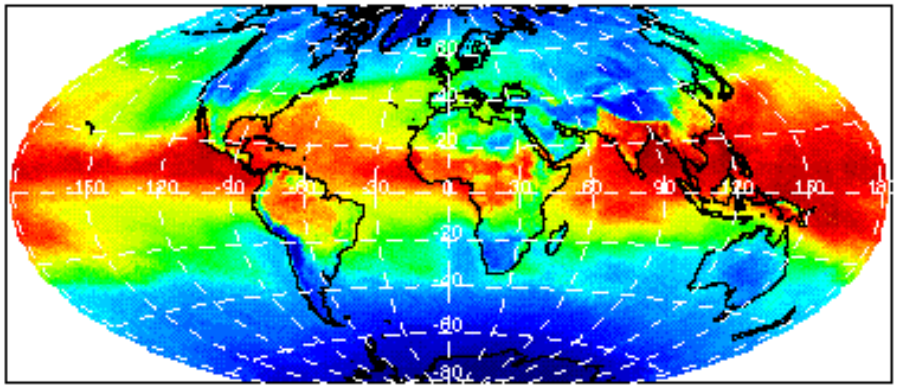
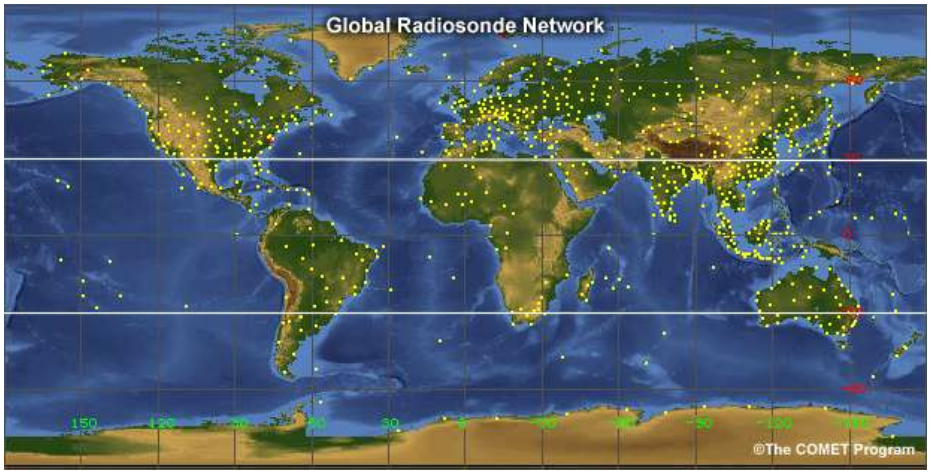




Ground based vs Satellite

Climate Monitoring from the Earths Surface

- patchy spatial coverage
- almost all measurement only over land
- high accuracy
- validation and calibration of sat-data



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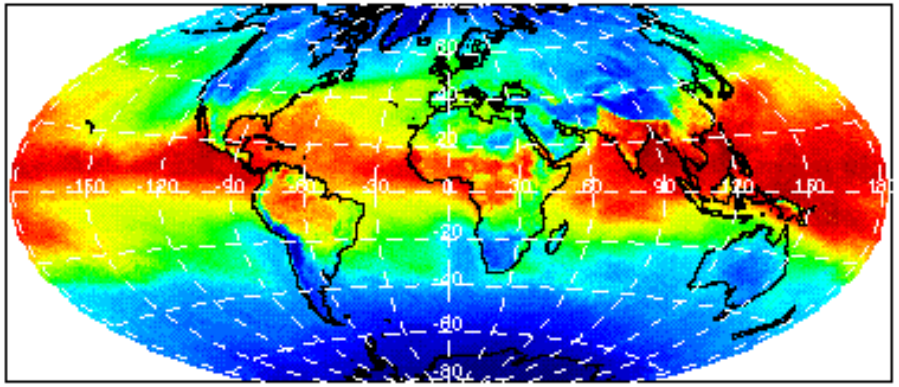
- e.g. cloud-microphysics, radiation-budget at ToA, upper atmosphere temperature and humidity



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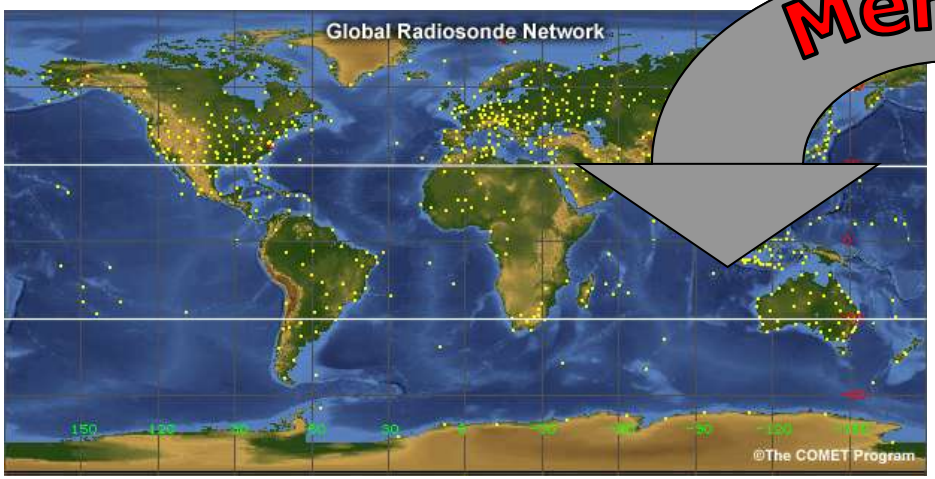
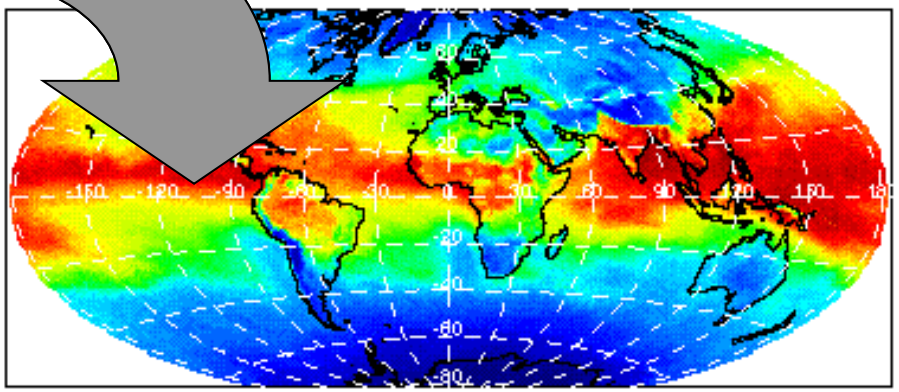
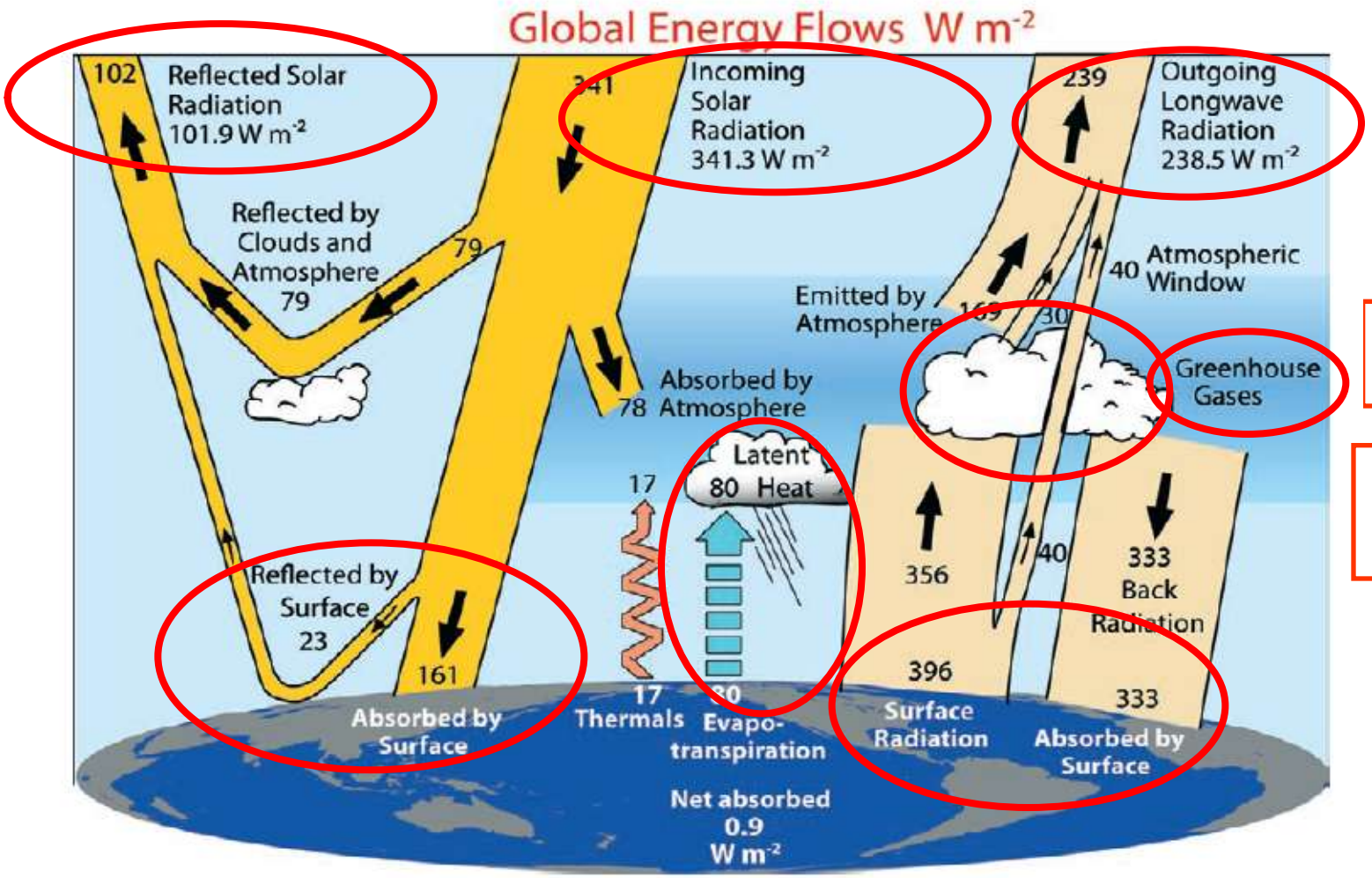


Merging



Improved quality

CM SAF Data



H_2O

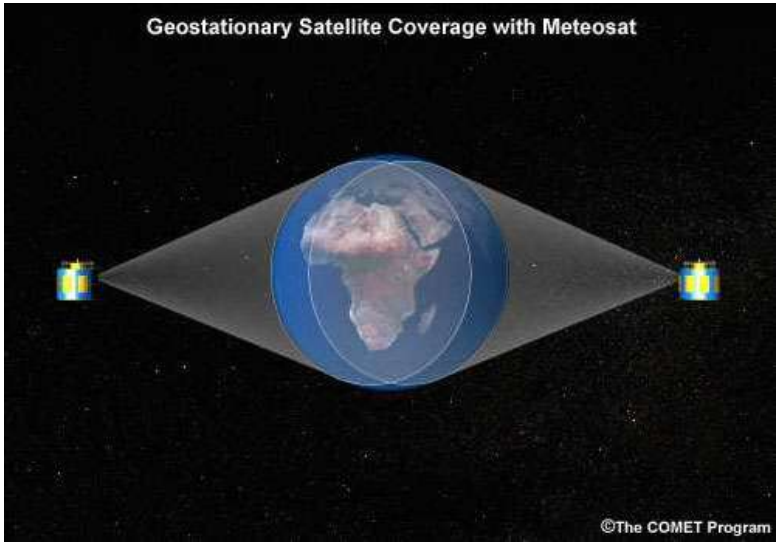
Cloud Information

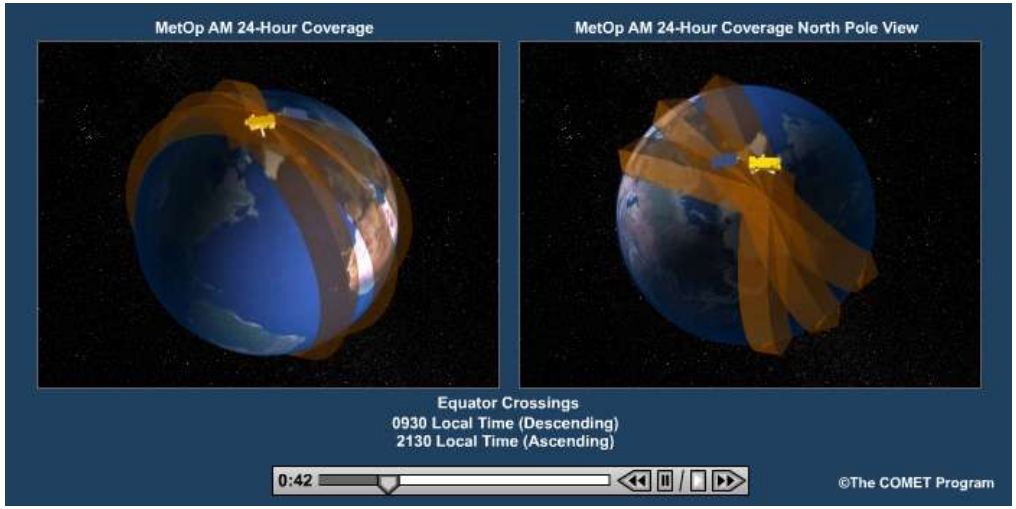
Trenberth at al., BAMS, 2009

Satellite Orbits

- GEOstationary (MSG)
- 36000 km altitude

- Low Earth Orbit or Polar Orbiting Satellites (MetOp, NOAA, …)
- Approx. 850 km altitude





Satellite Orbits

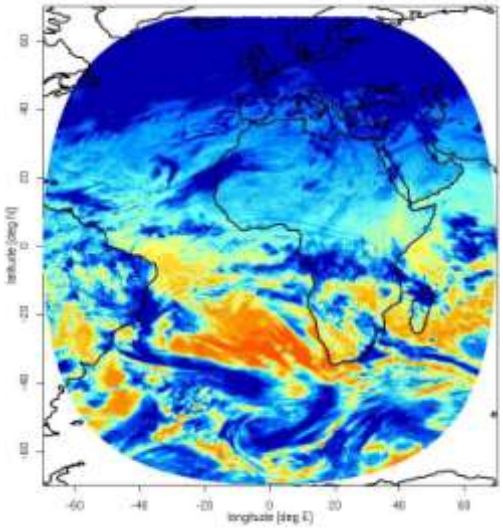
From which type of satellite are the images derived?

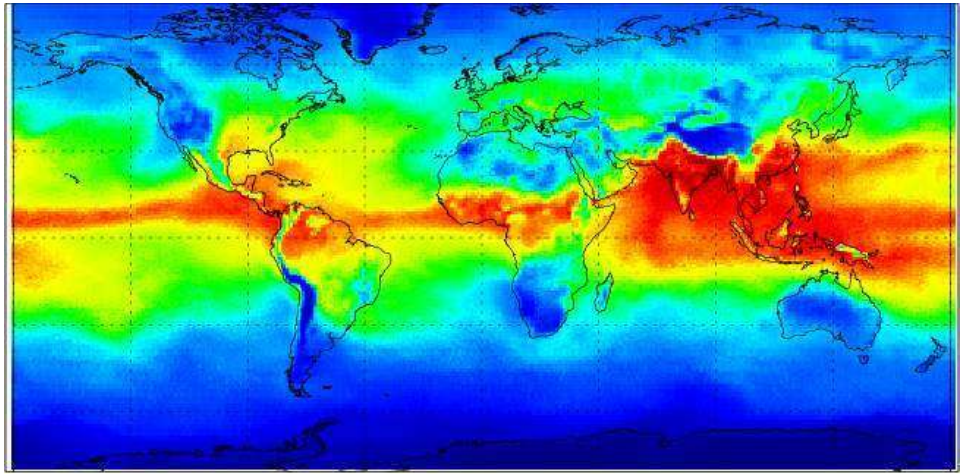
Geostationary satellite ☐

Polar orbiting satelite ☐

Geostationary satellite ☐

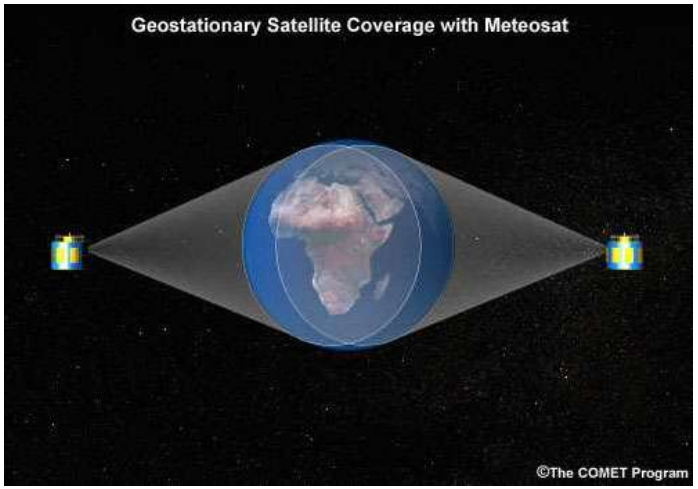
Polar orbiting satelite ☐

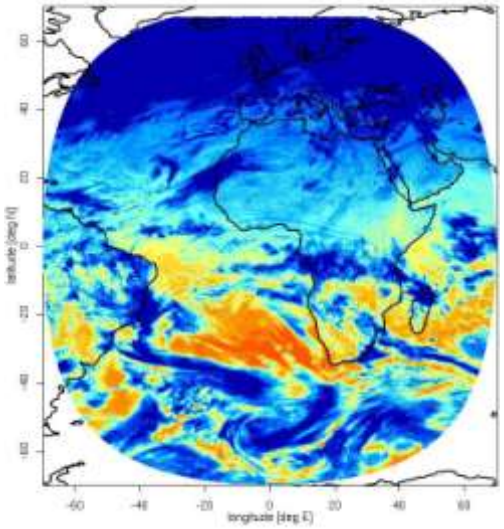




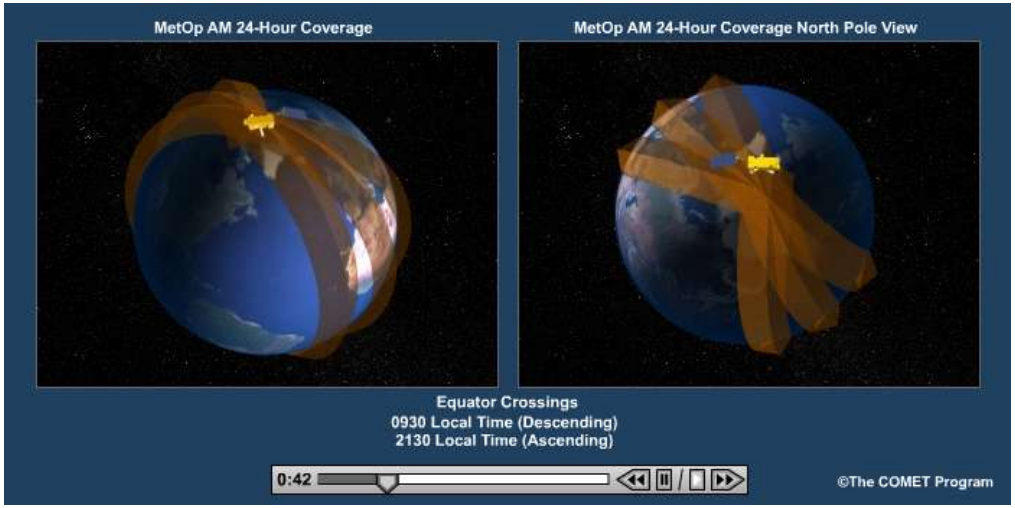
Satellite Orbits

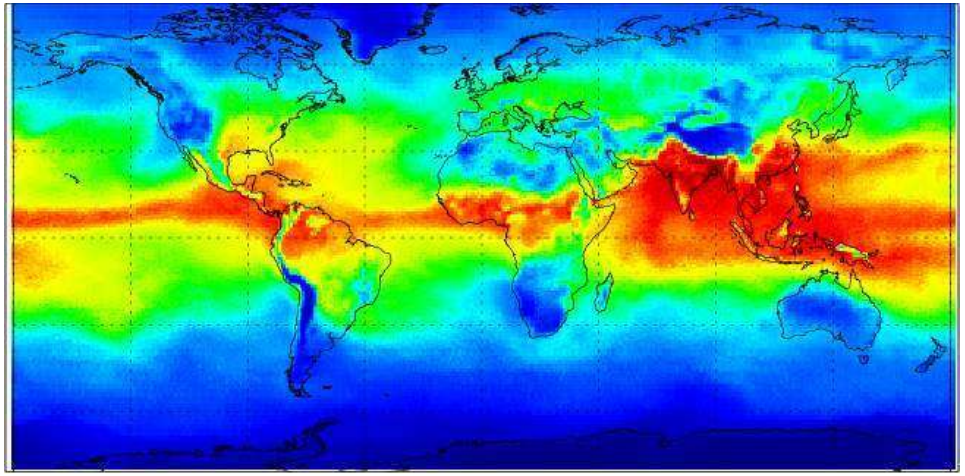
Geostationary



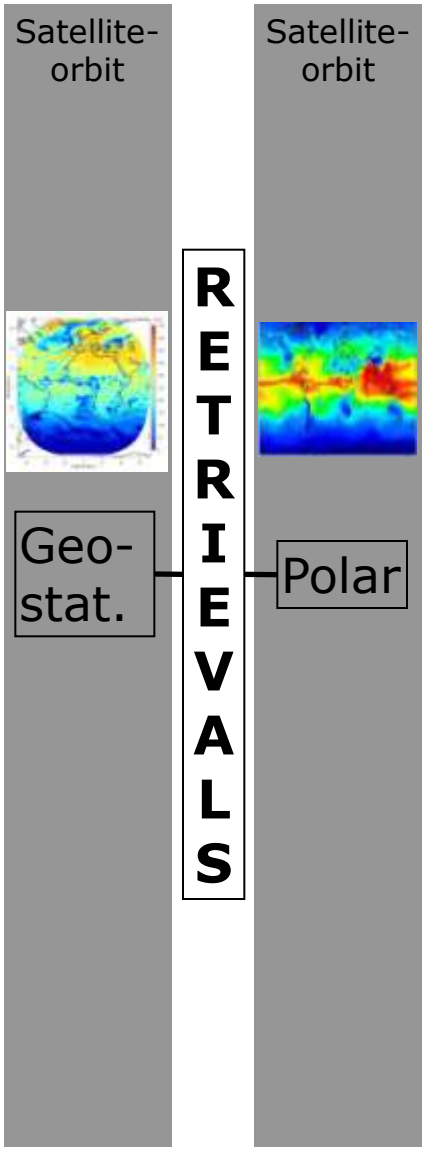


Polar orbiting





Retrieval Overview



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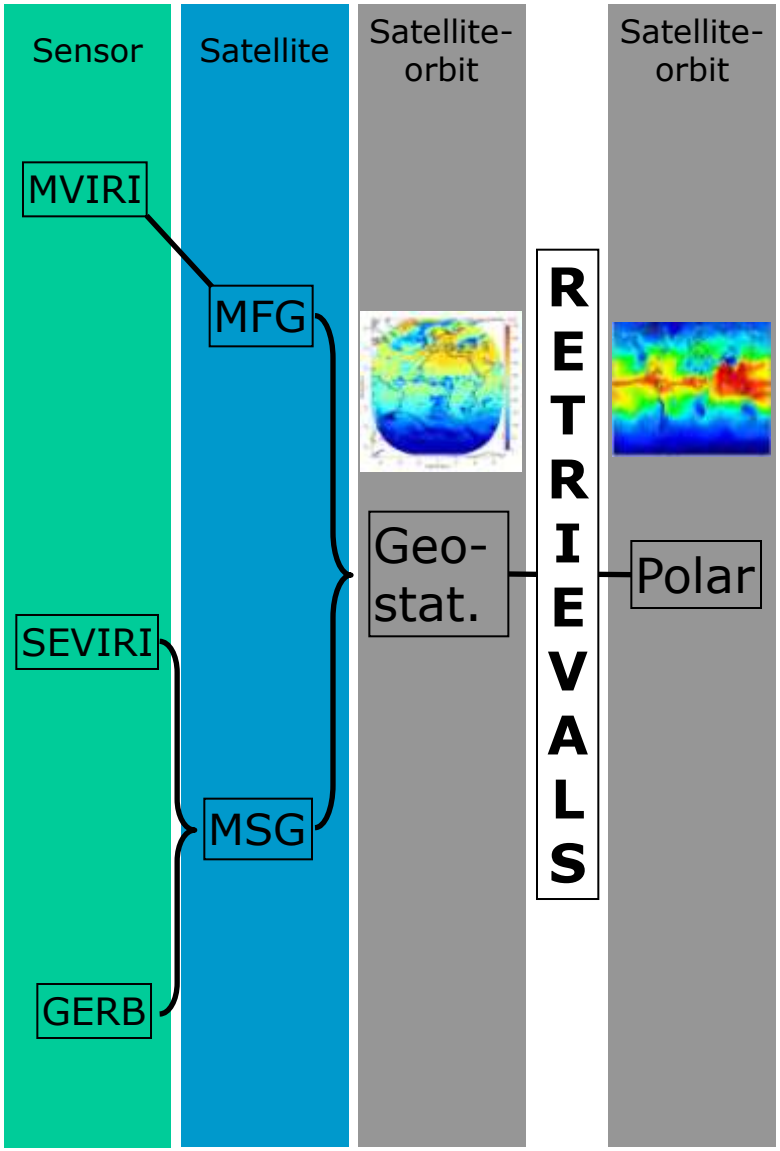

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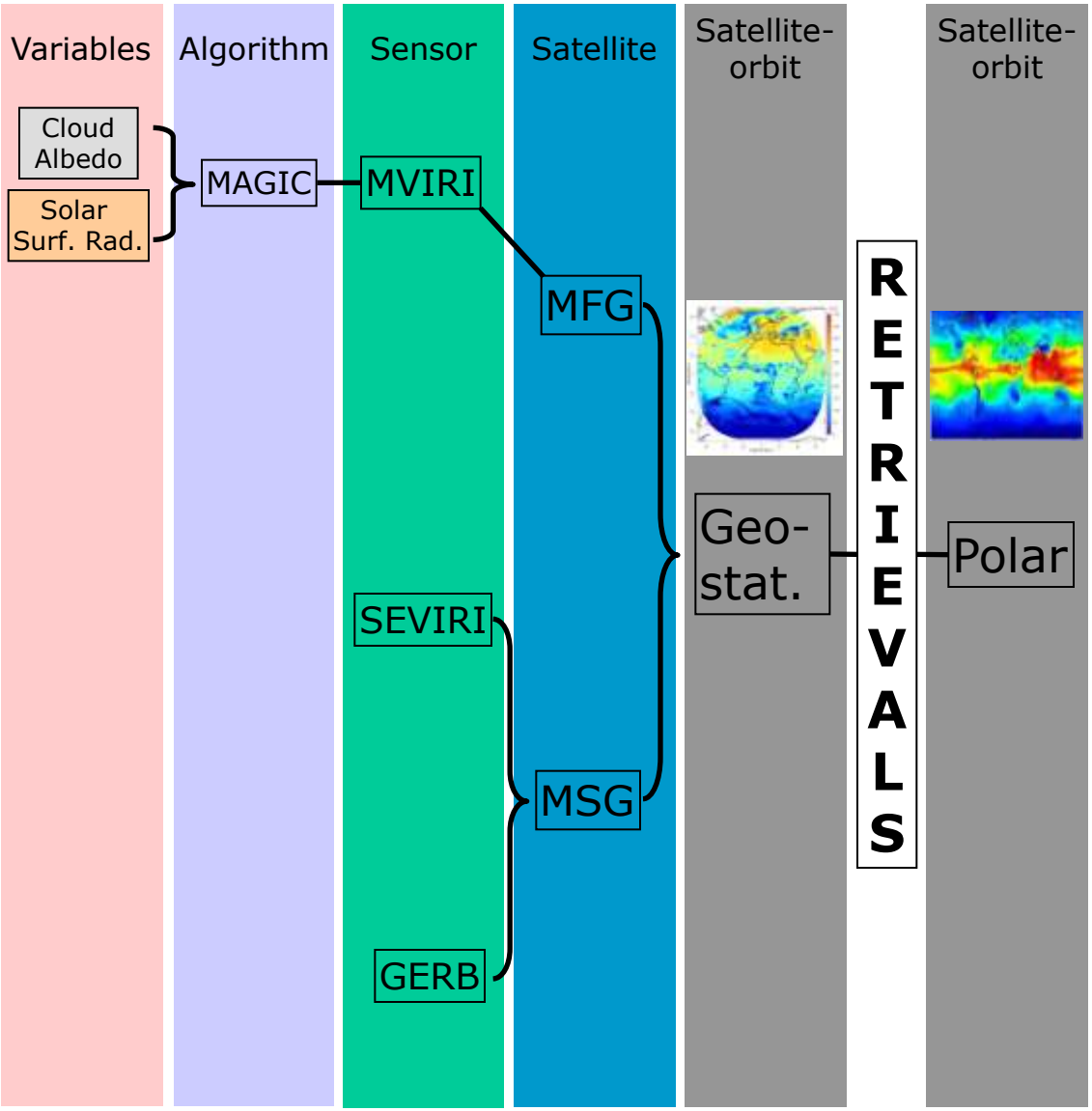

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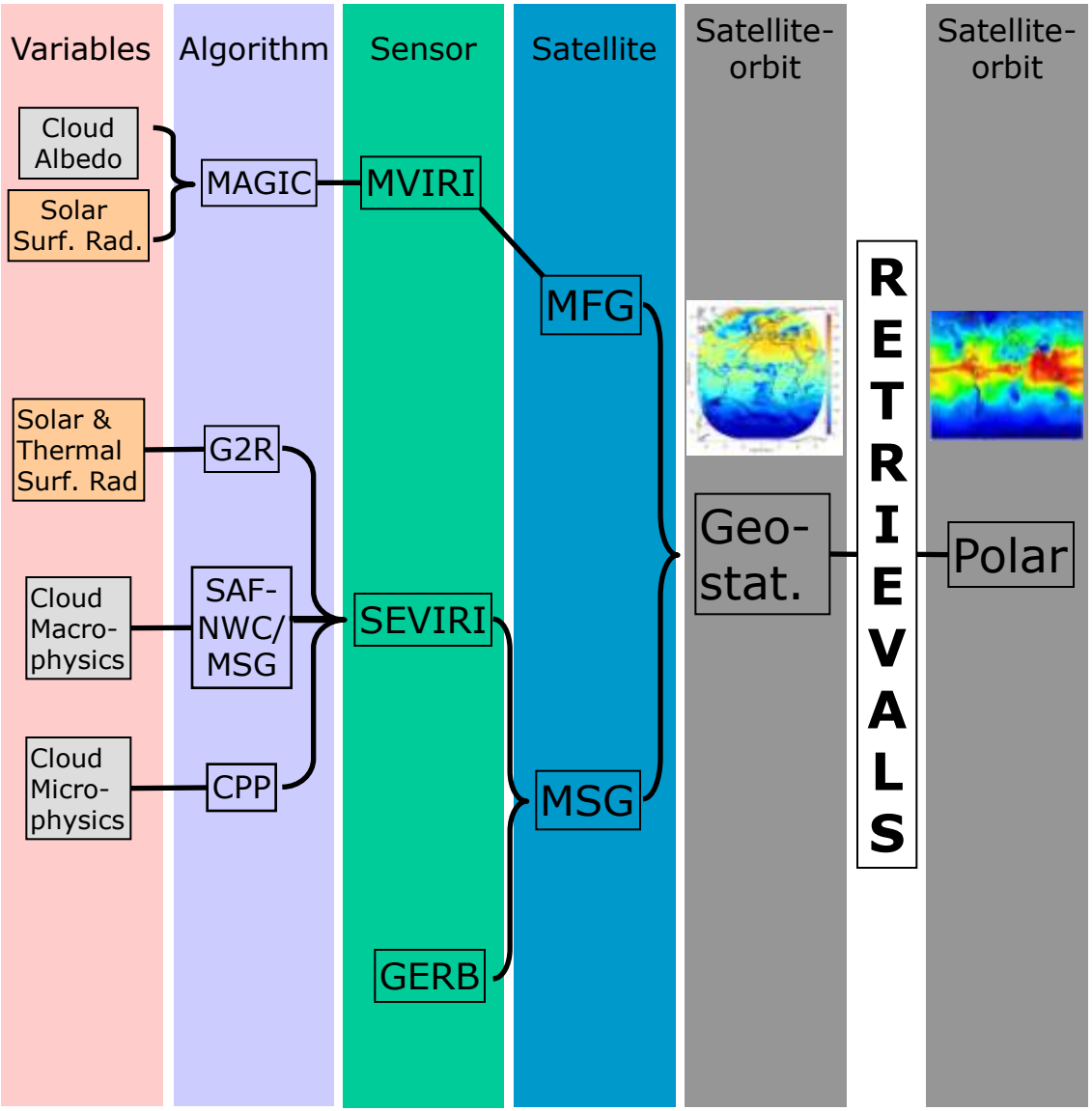

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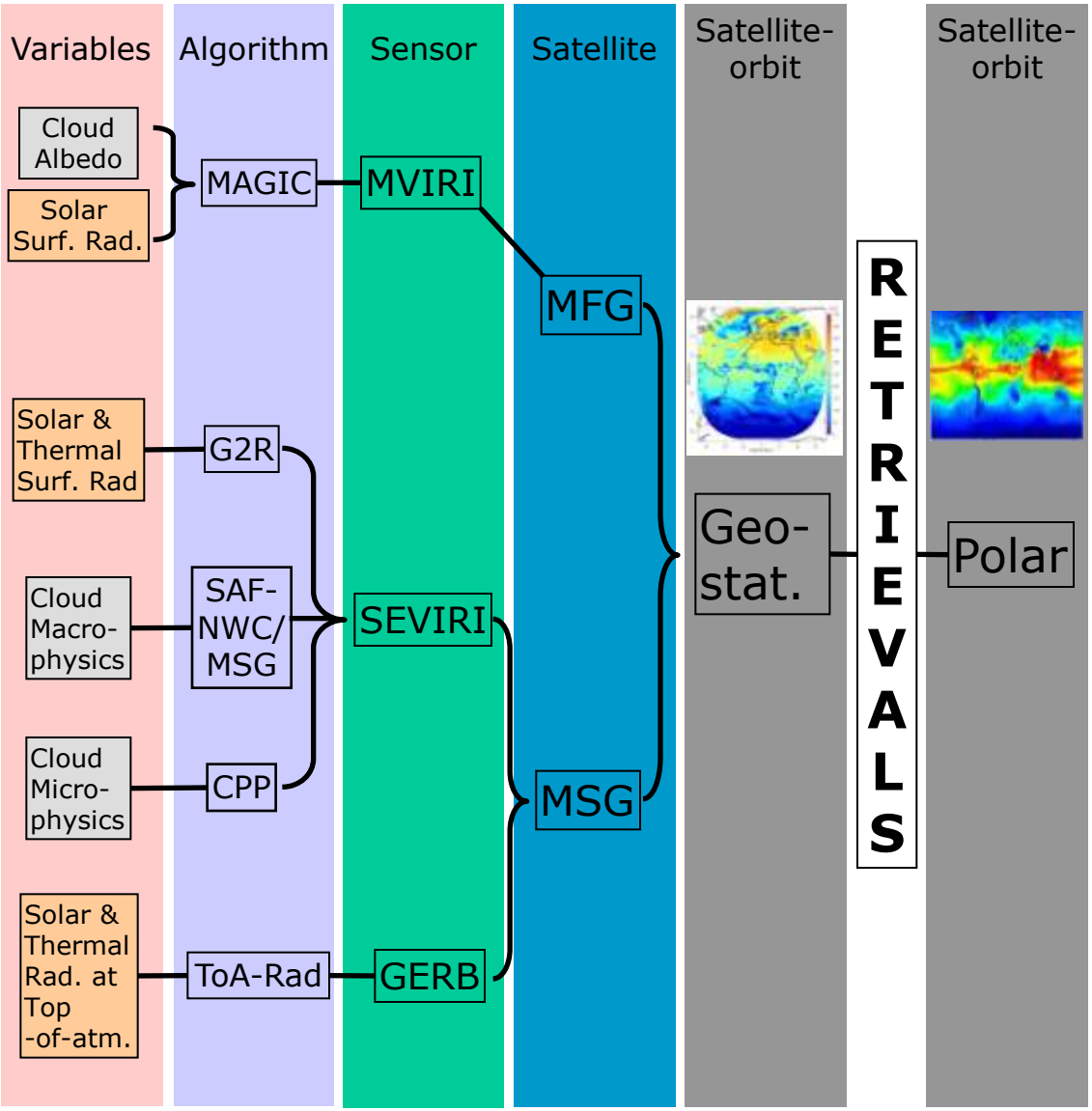

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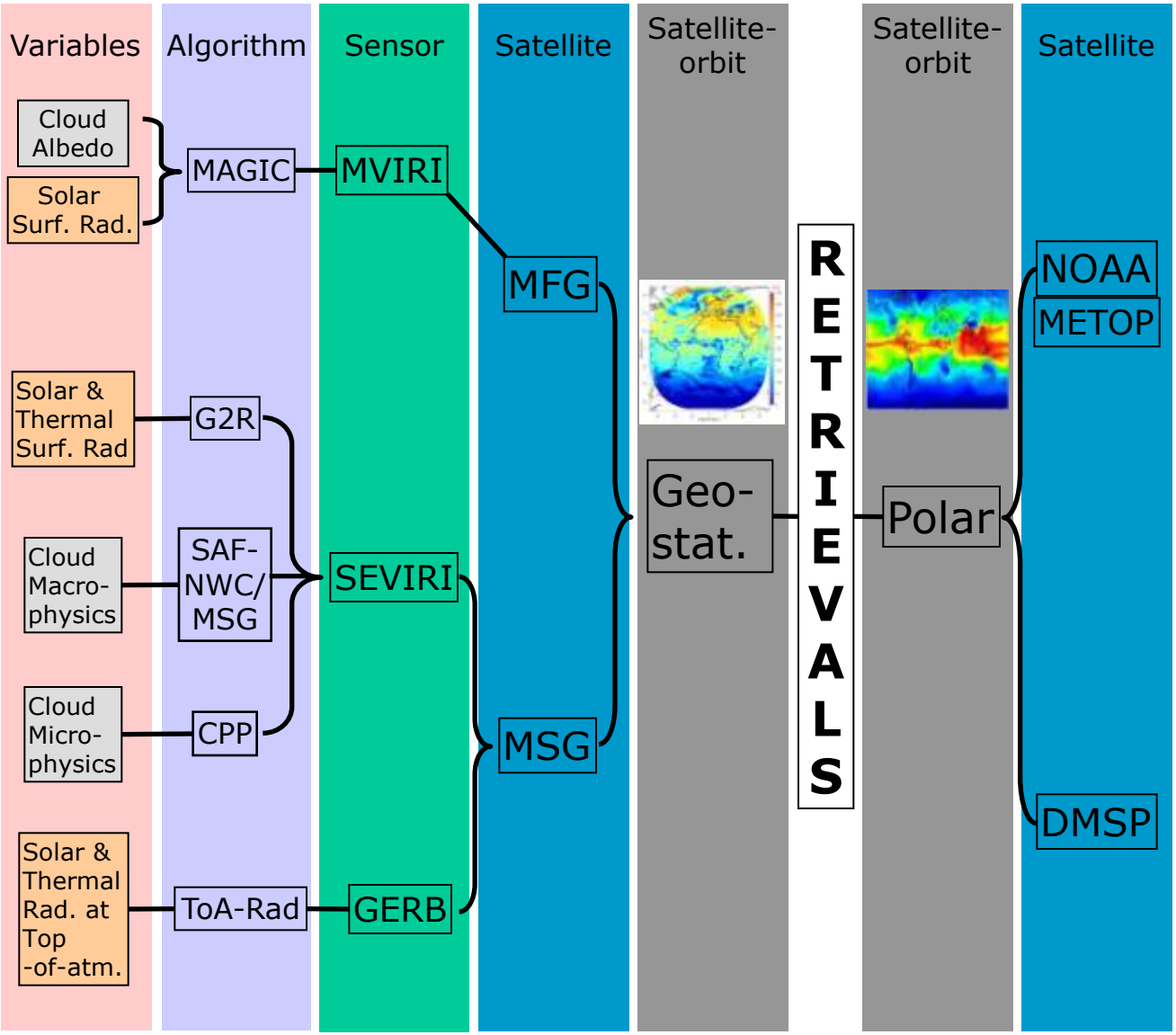

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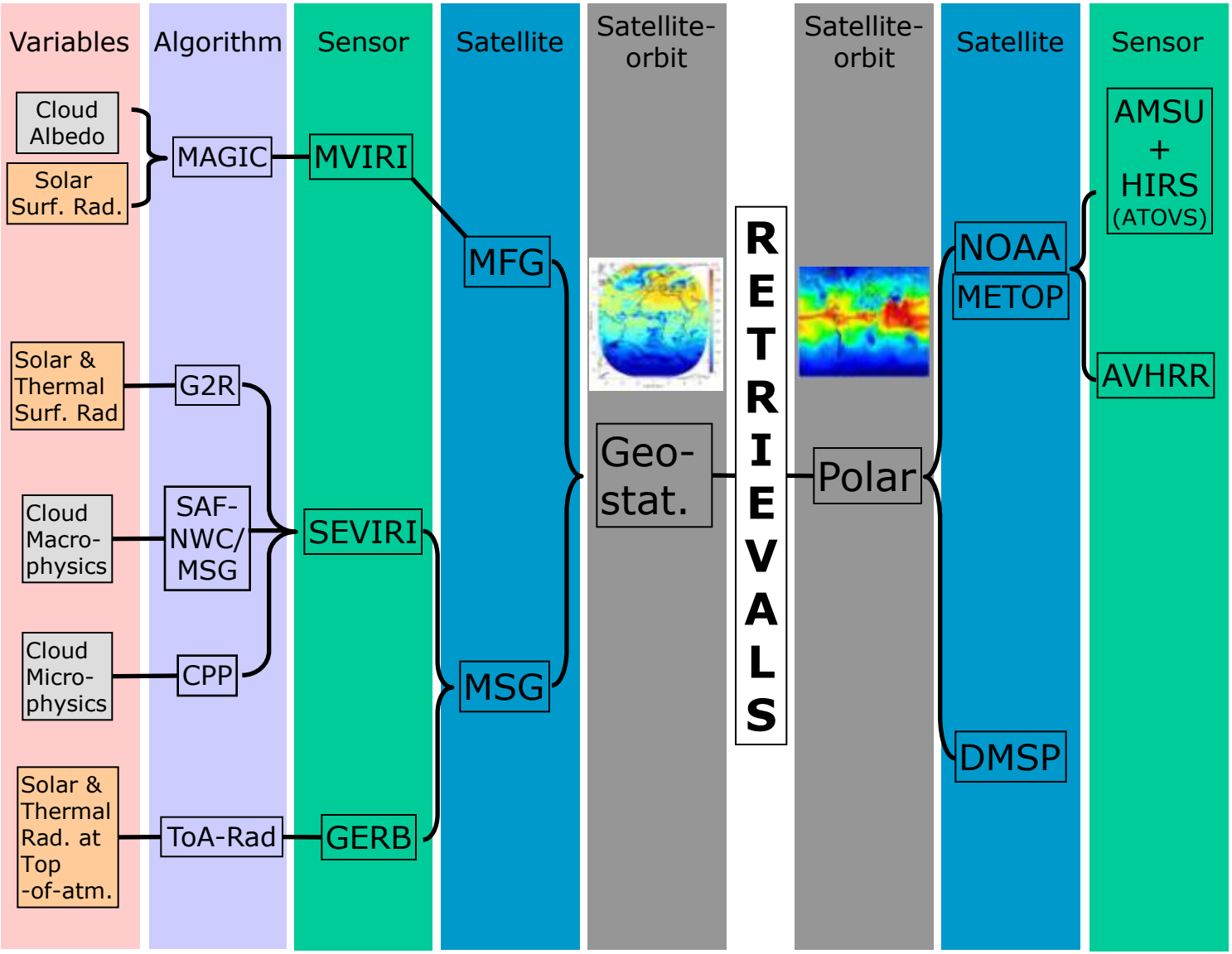

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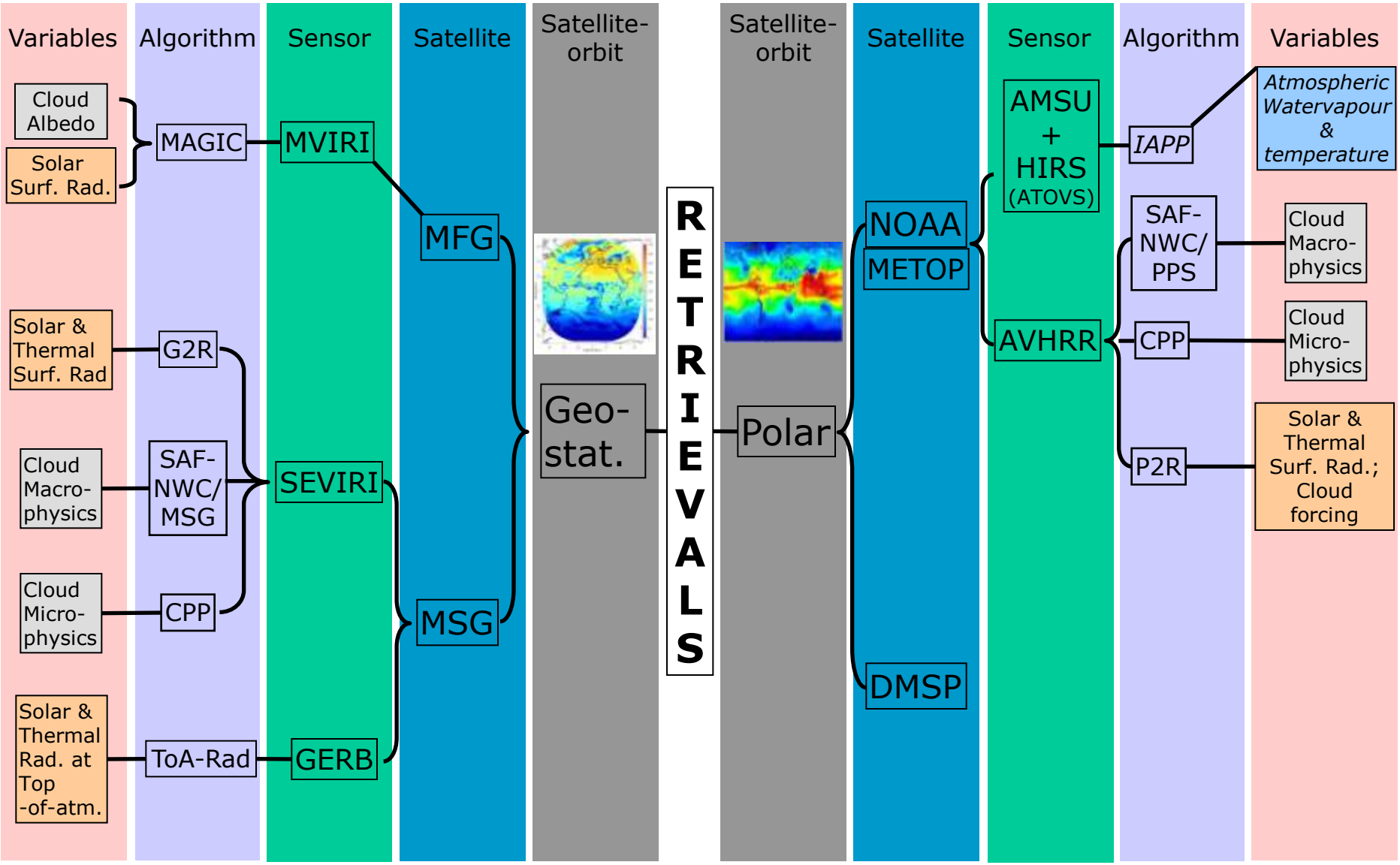

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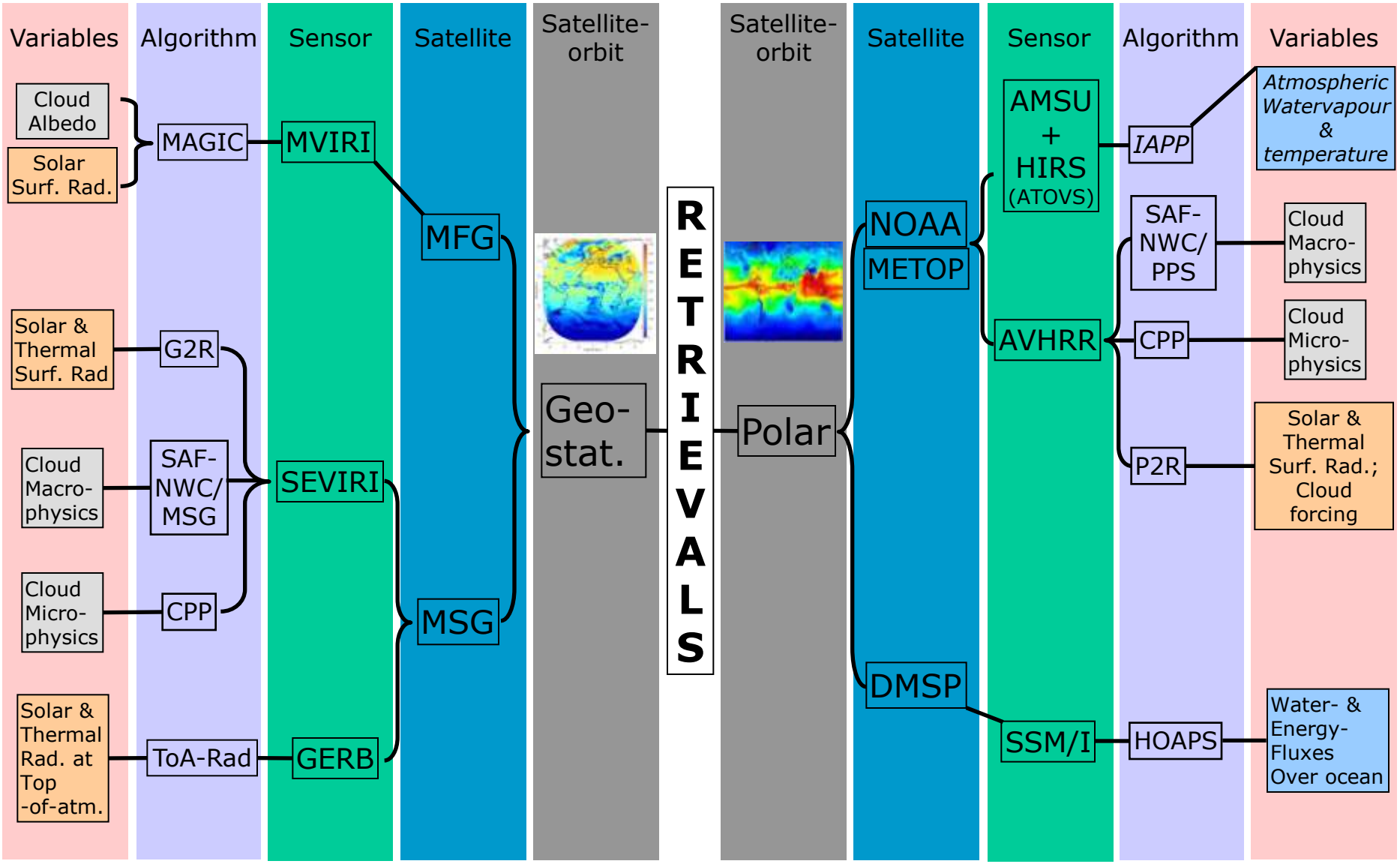

Product vs Data Set

Short and Intermediate Term

Longterm

Operational Products

Thematical Climate Datasets

Schulz (2009), adapted

Product vs Data Set

Short and Intermediate Term

Satellite Data

↓

Operational Products

↓

Operational Climate monitoring

Longterm

Thematical Climate Datasets

Schulz (2009), adapted

Product vs Data Set

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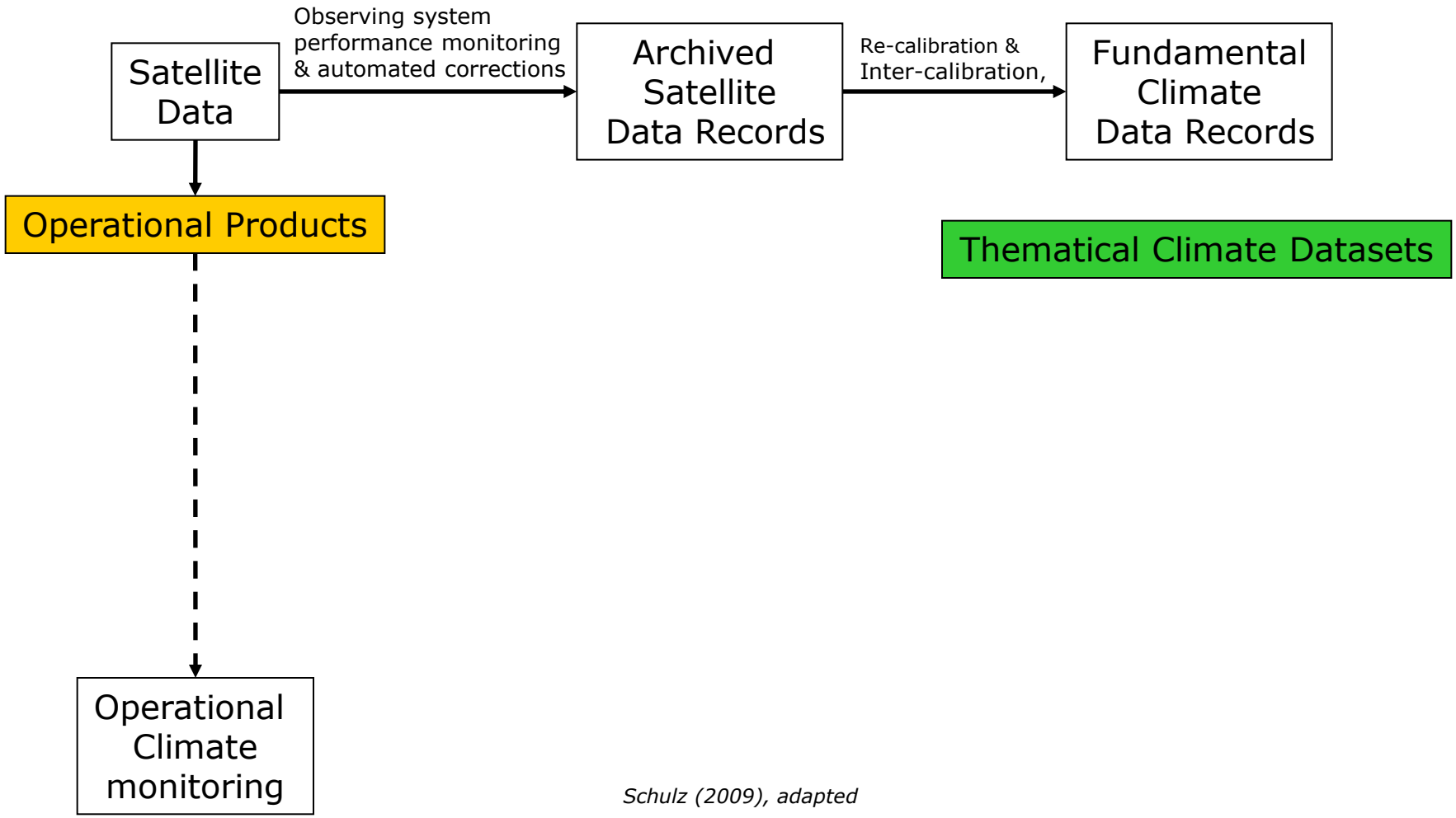

Schulz (2009), adapted

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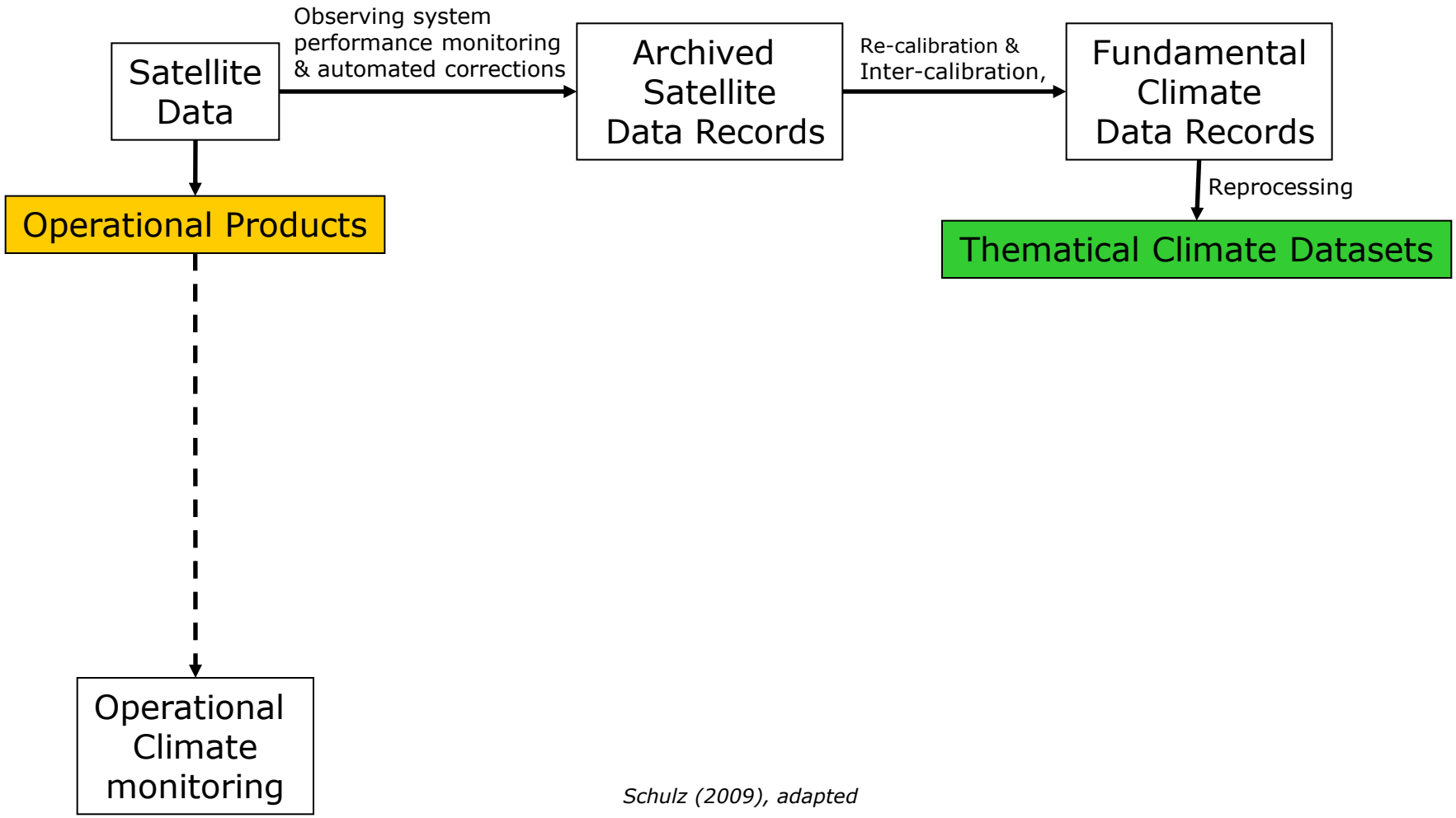

Schulz (2009), adapted

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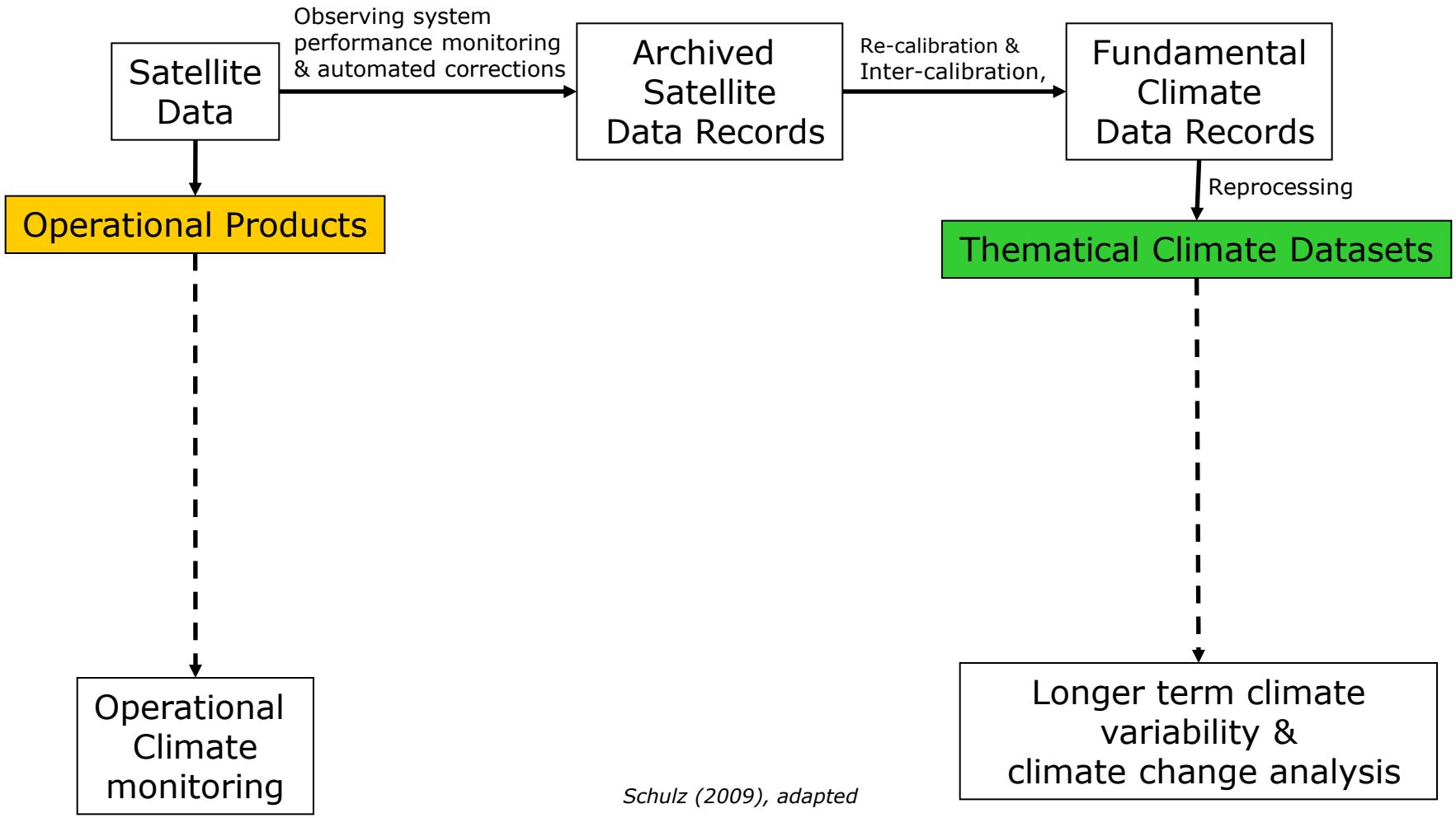


Schulz (2009), adapted

Product vs Data Set

Short and Intermediate Term

Longterm

Satellite Data

Observing system performance monitoring & automated corrections

Archived Satellite Data Records

Re-calibration & Inter-calibration,

Fundamental Climate Data Records

Reprocessing

Operational Products

- 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

Operational Climate monitoring

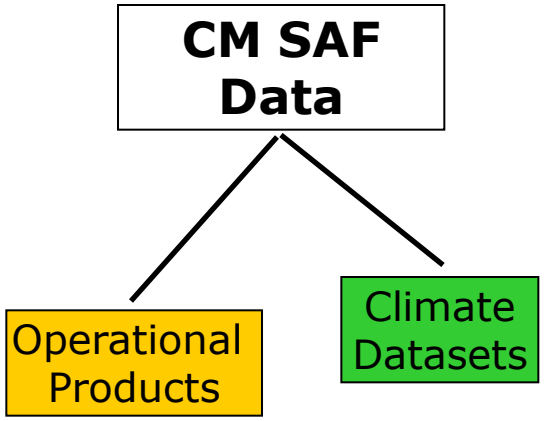
Thematical Climate Datasets

- 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

Longer term climate variability & climate change analysis

Schulz (2009), adapted

Available operational Products and Datasets



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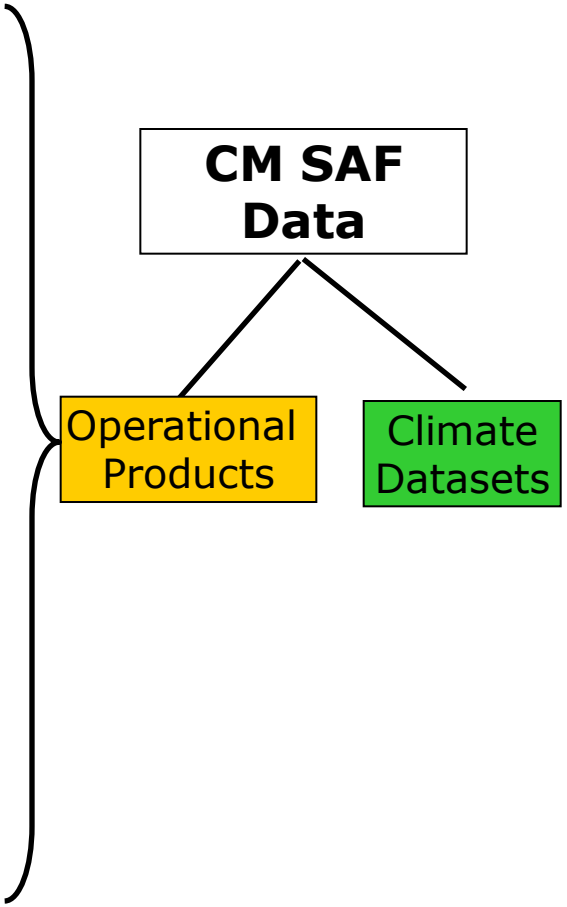

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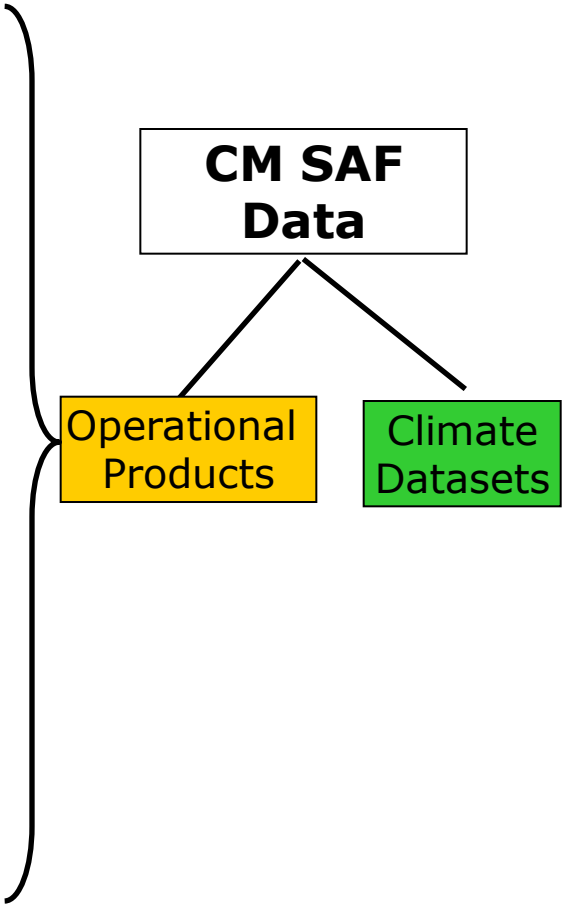

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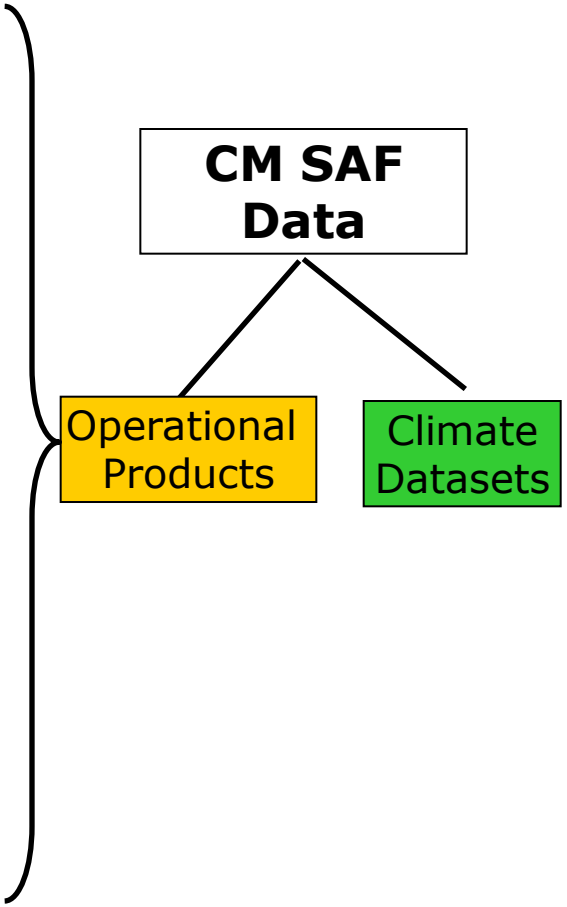

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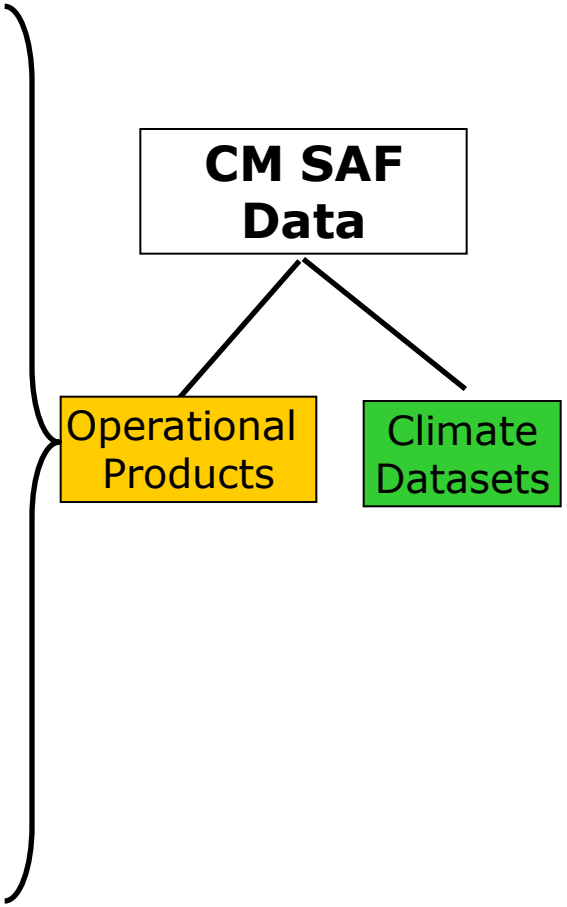

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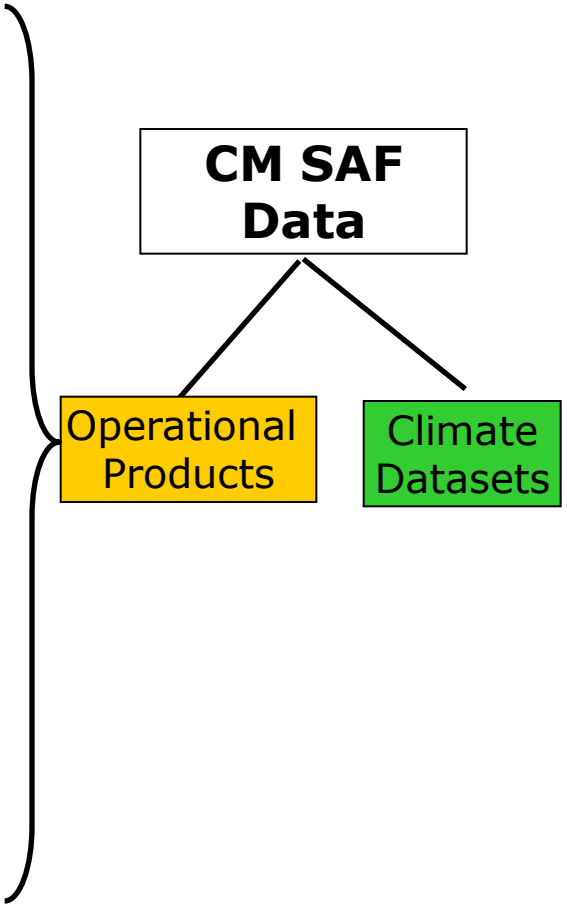

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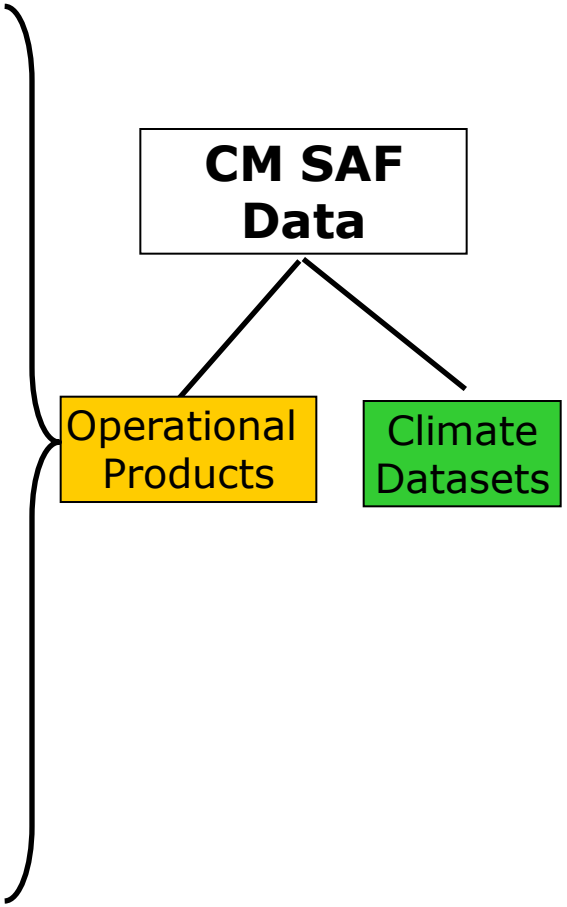
Time range: 2004 – now
Coverage: Global



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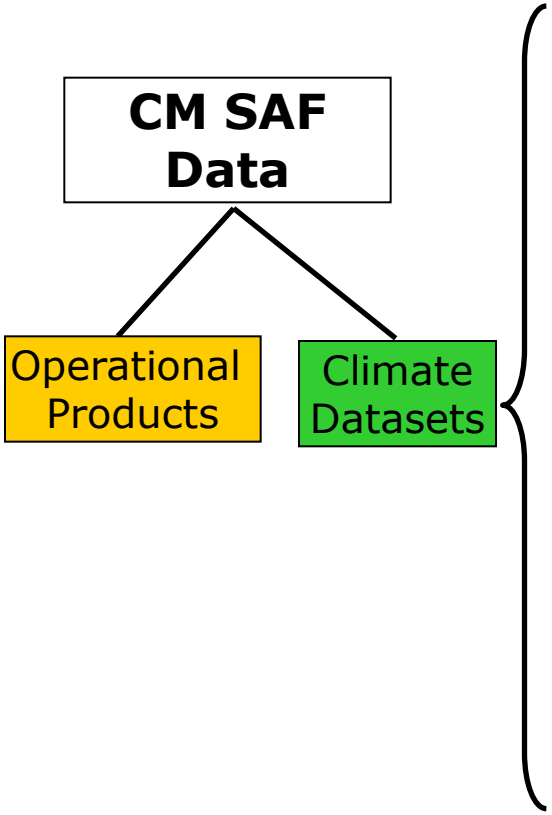

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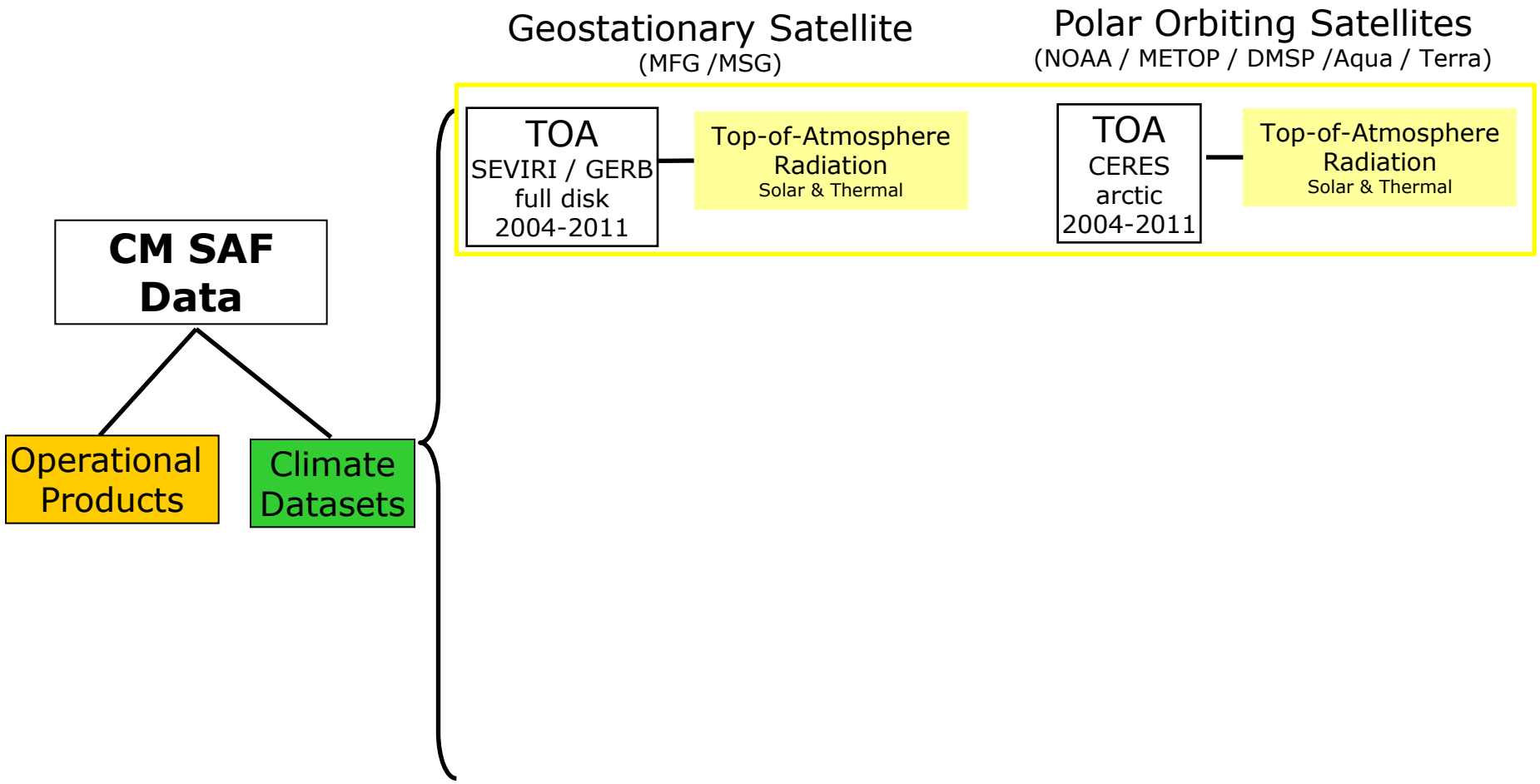

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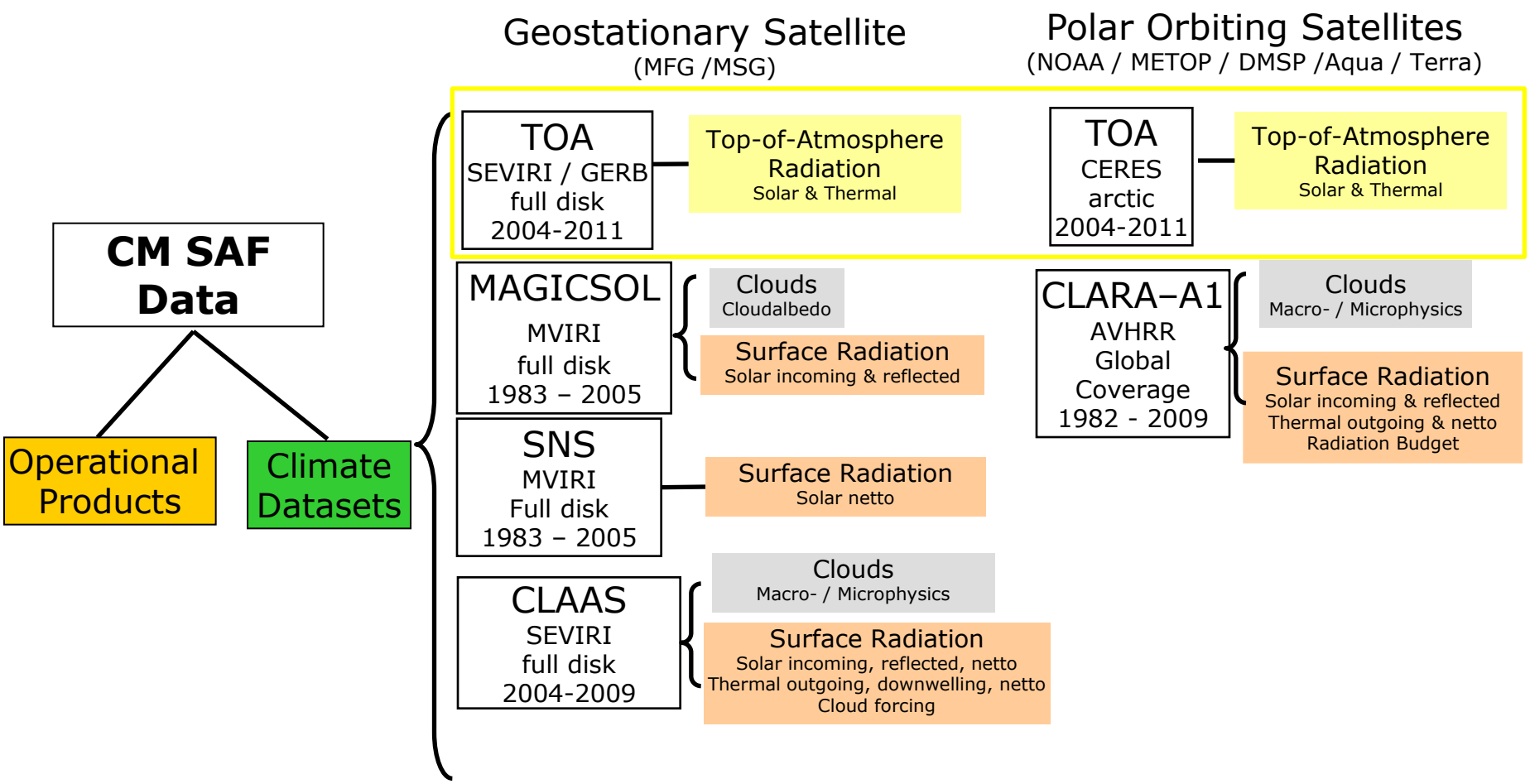

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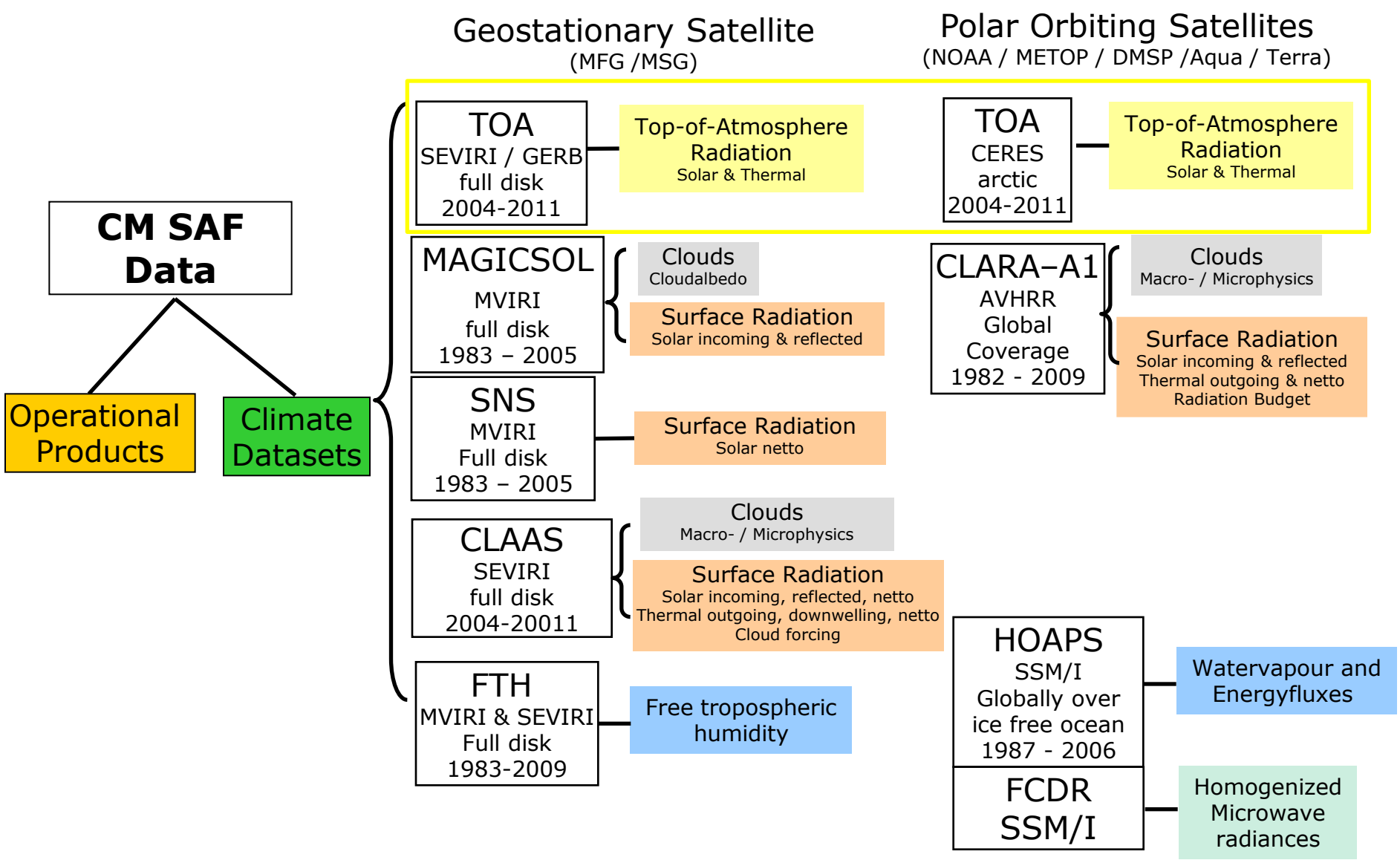

Data access

wui.cmsaf.eu

- available at no costs
- in netcdf format

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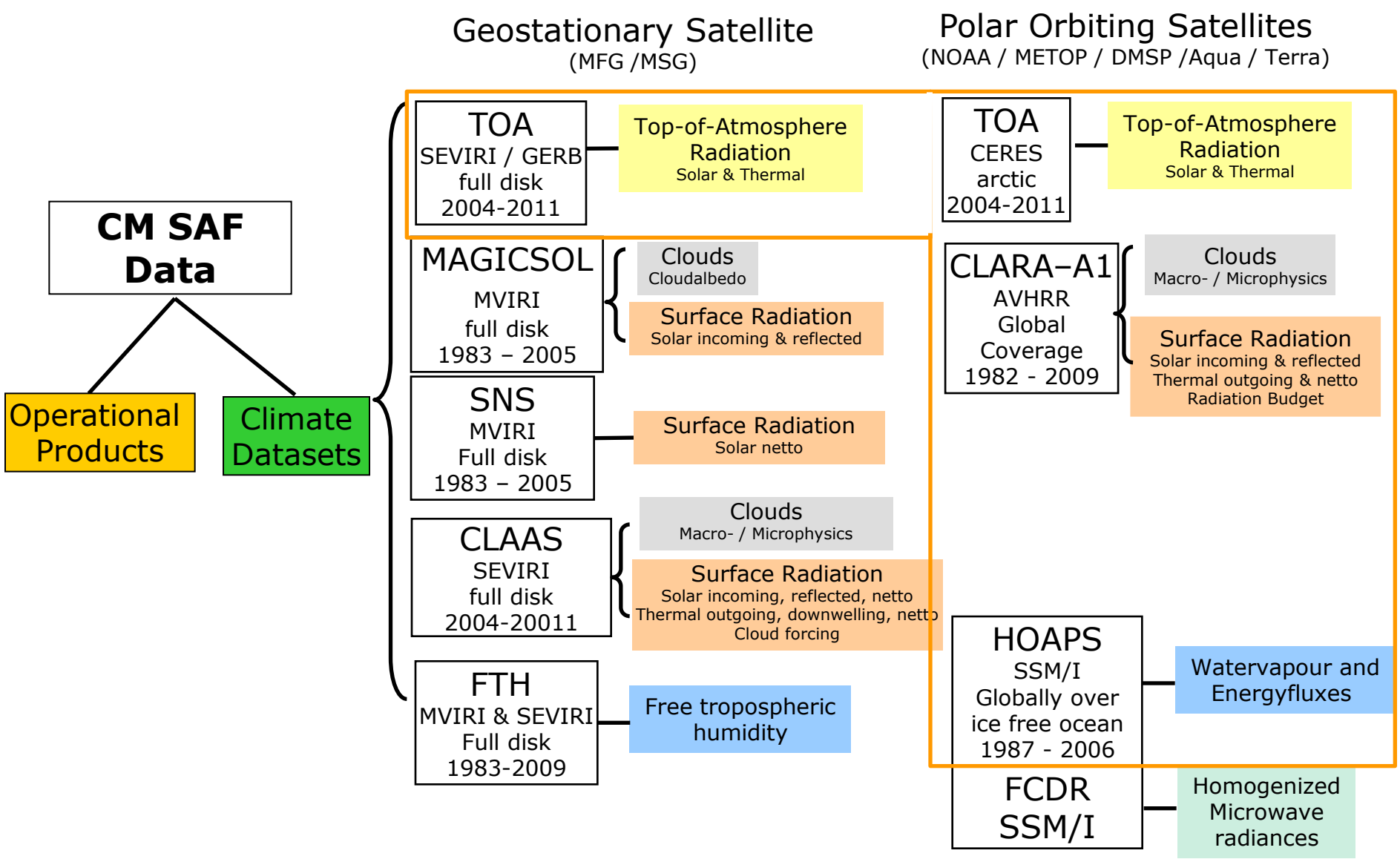
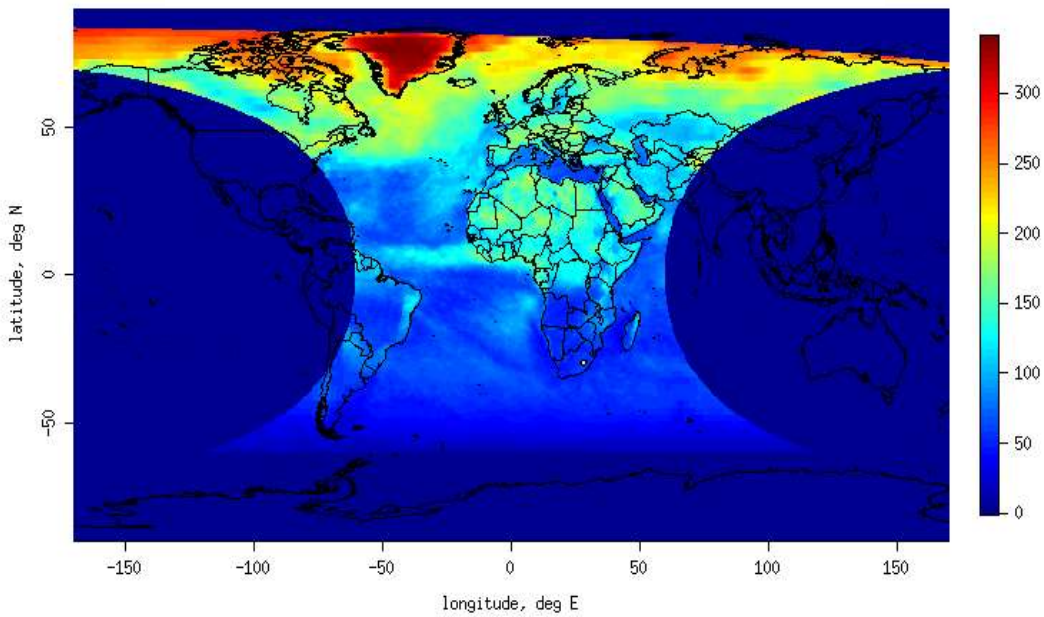


CM SAF Climate Data Sets



TOA
CERES
arctic
2004-2011

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Solar & Thermal

CLARA–A1
AVHRR
Global Coverage
1982 - 2009

Clouds
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Solar incoming & reflected
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Radiation Budget

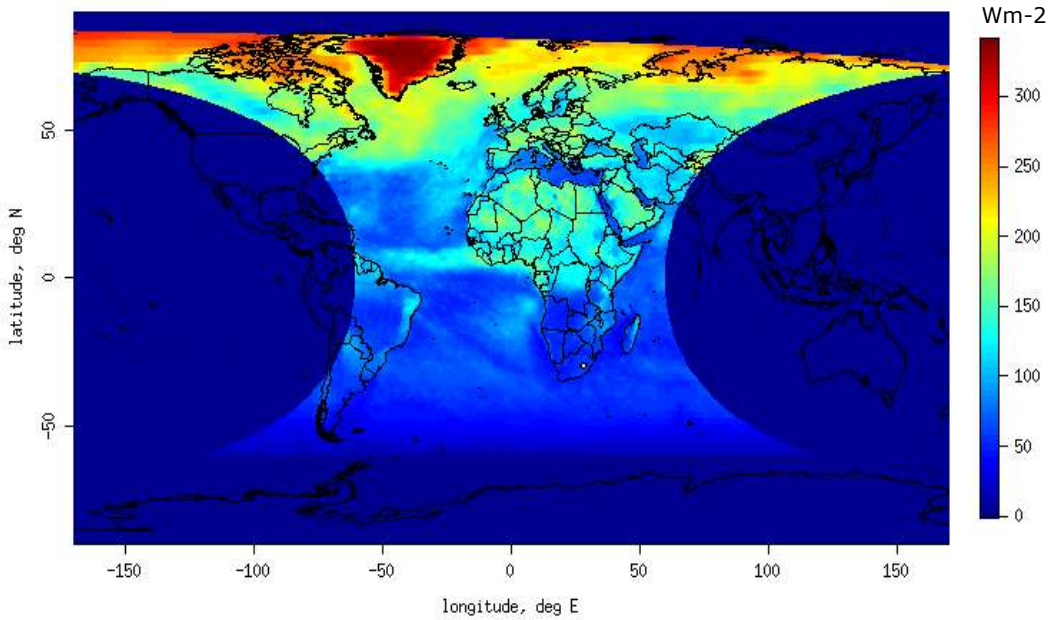
HOAPS
SSM/I
Globally over ice free ocean
1987 - 2006

Watervapour and Energyfluxes

CM SAF Climate Data Sets

Dataset of solar and thermal radiation at top of atmosphere

Reflected Solar Radiation at Top-of-Atmosphere
monthly mean June 2010



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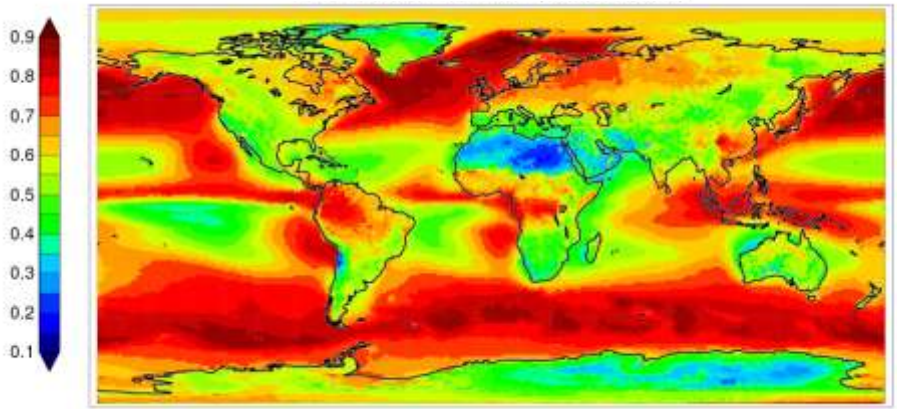

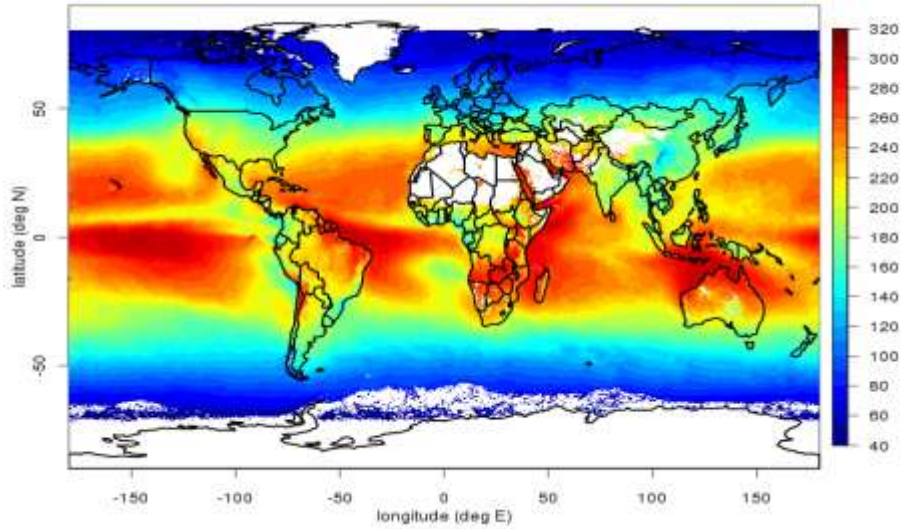

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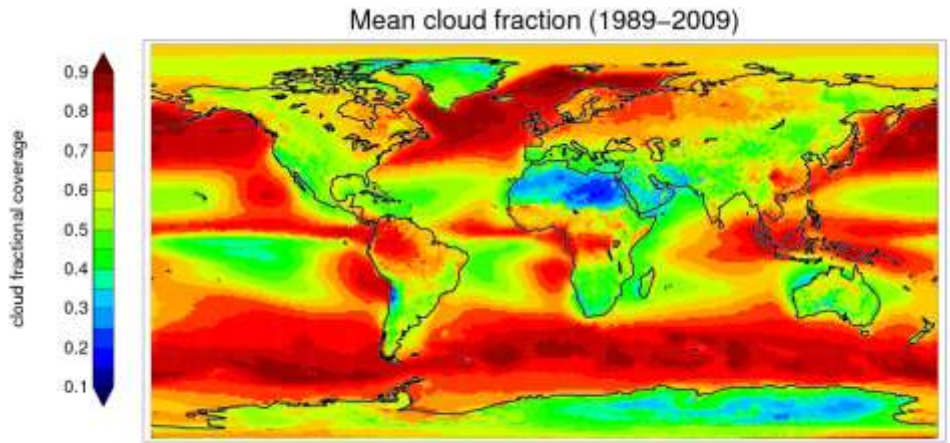
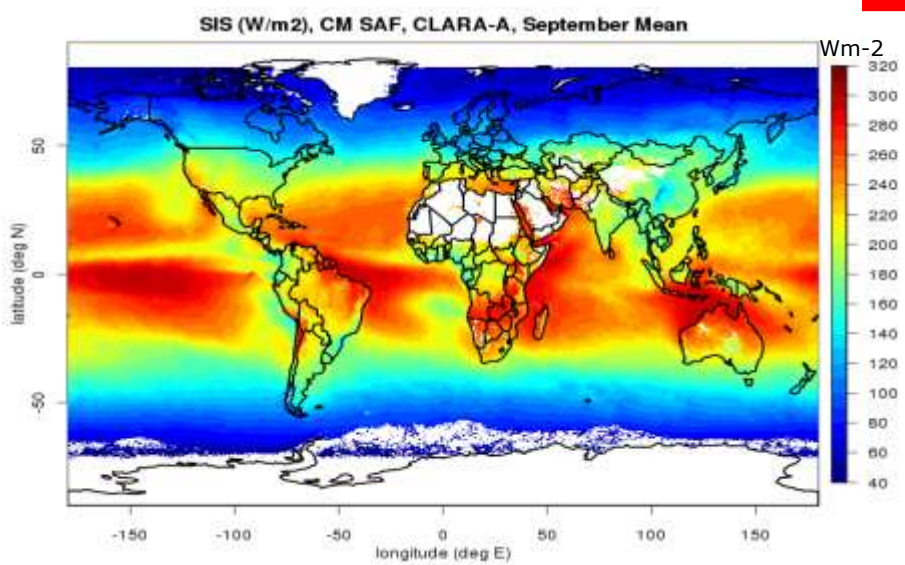
CM SAF Climate Data Sets

Global data sets of cloud coverage and solar irradiation





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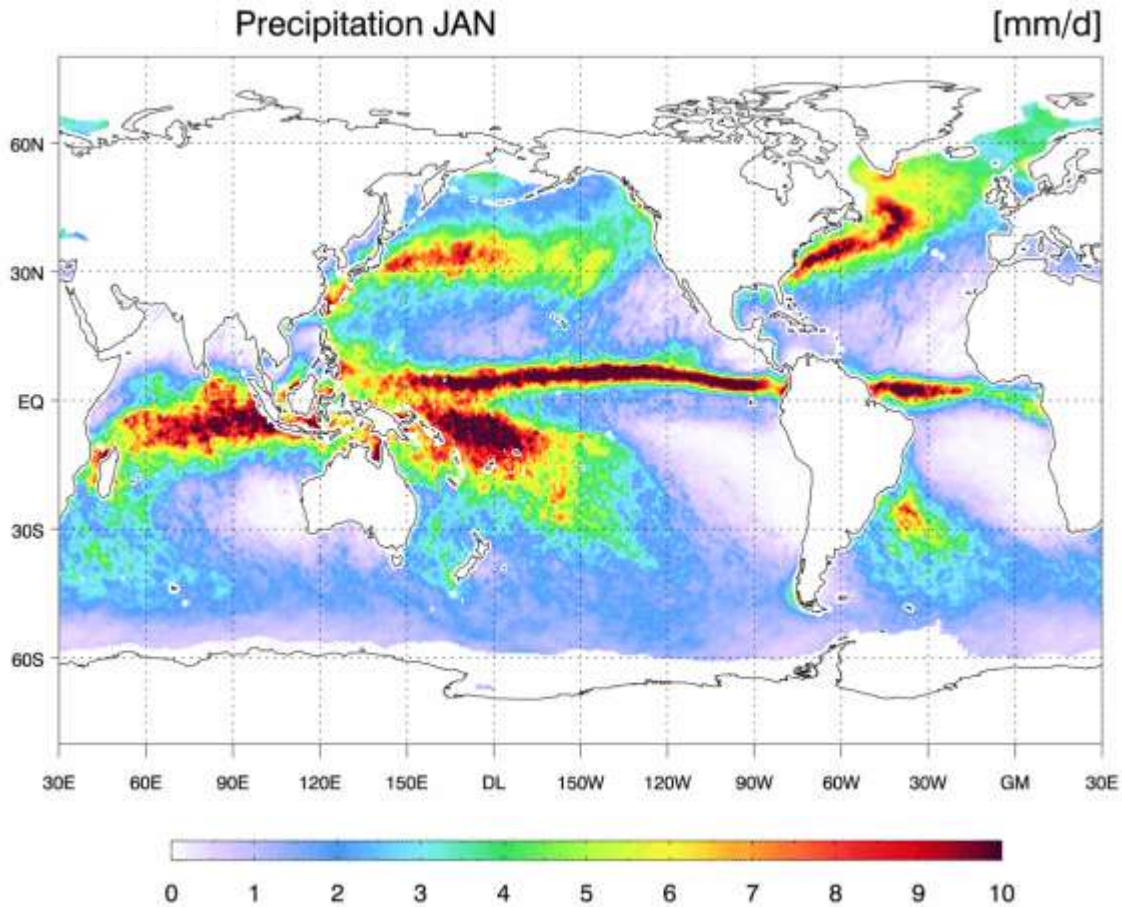

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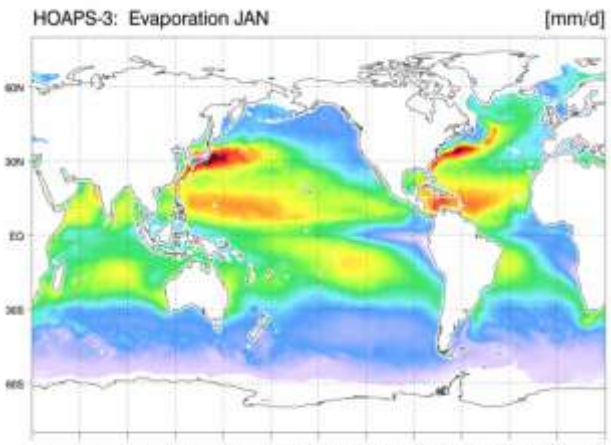
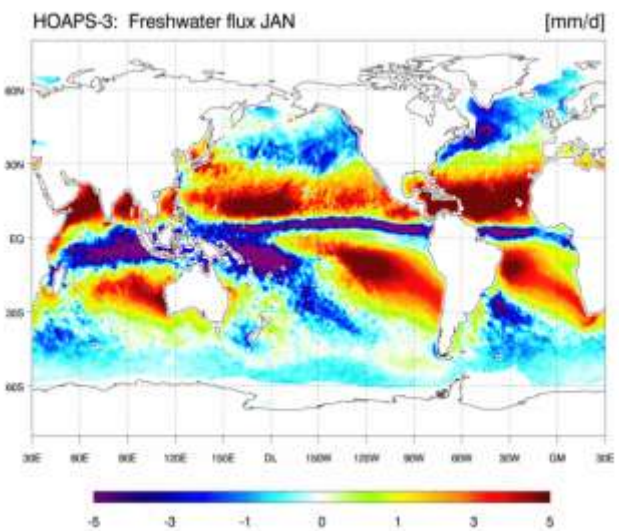
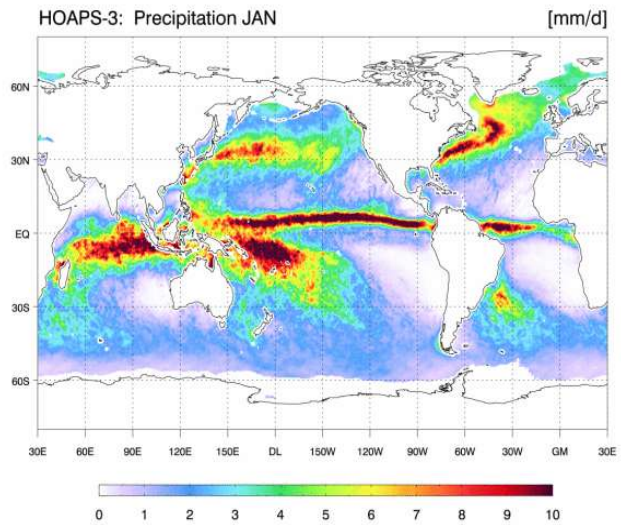
CM SAF Climate Data Sets

Choice of variables from the HOAPS dataset







Thanks to:
www.hoaps.org

A. Andersson, S. Bakan,
K. Fennig, H. Graßl, C. Klepp

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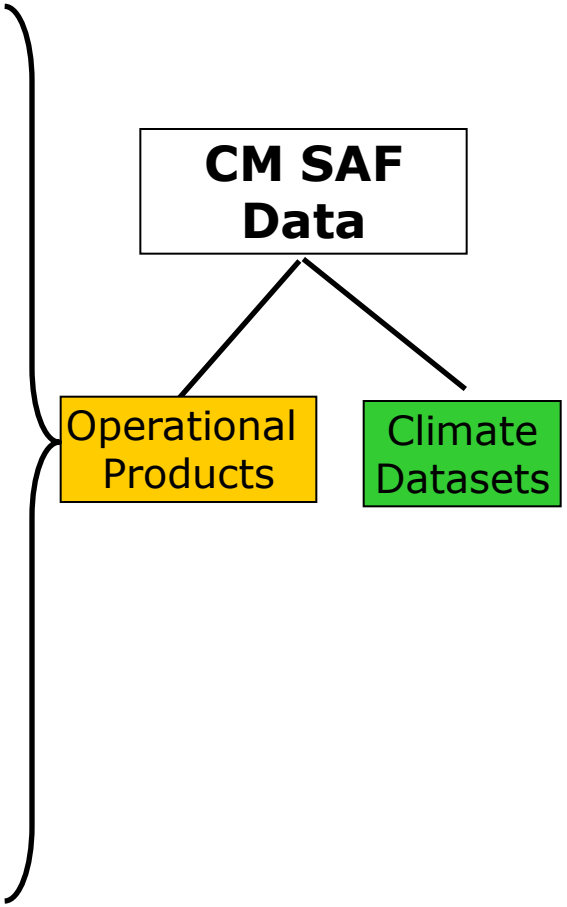


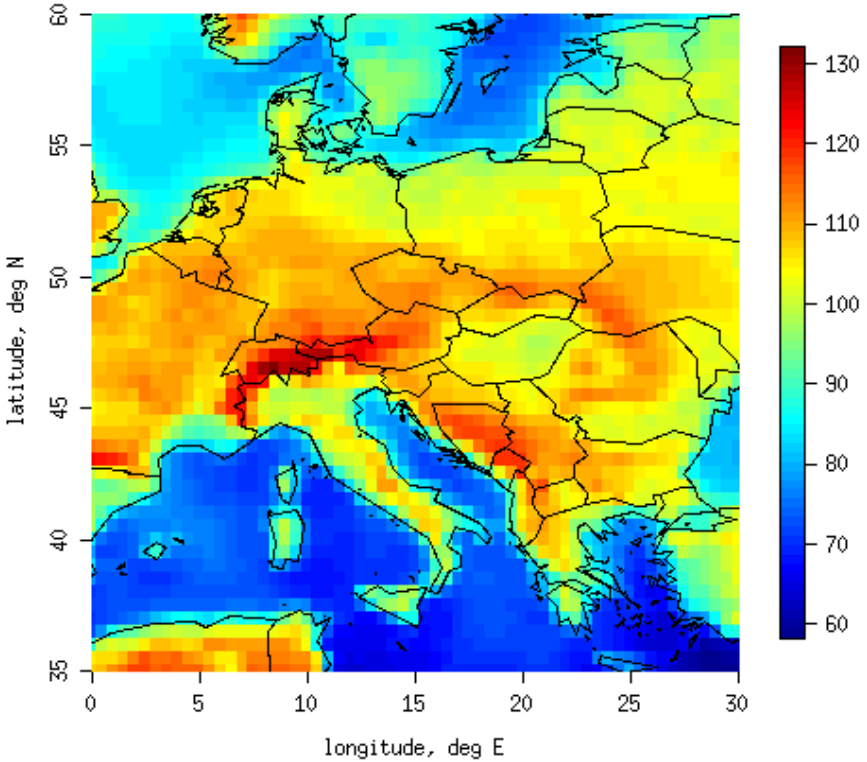
CM SAF Operational Products

Top-of-Atmosphere Radiation

- Top-of-the atmosphere radiation parameter:
  - Incoming and reflected solar
  - Emitted longwave

- available since 2004
- Coverage: Europe & Arctic
- Daily and monthly means
- spatial resolution: 45 x 45 km²

ToA reflected solar radiation Mean 2008 – 2011 [Wm-2]

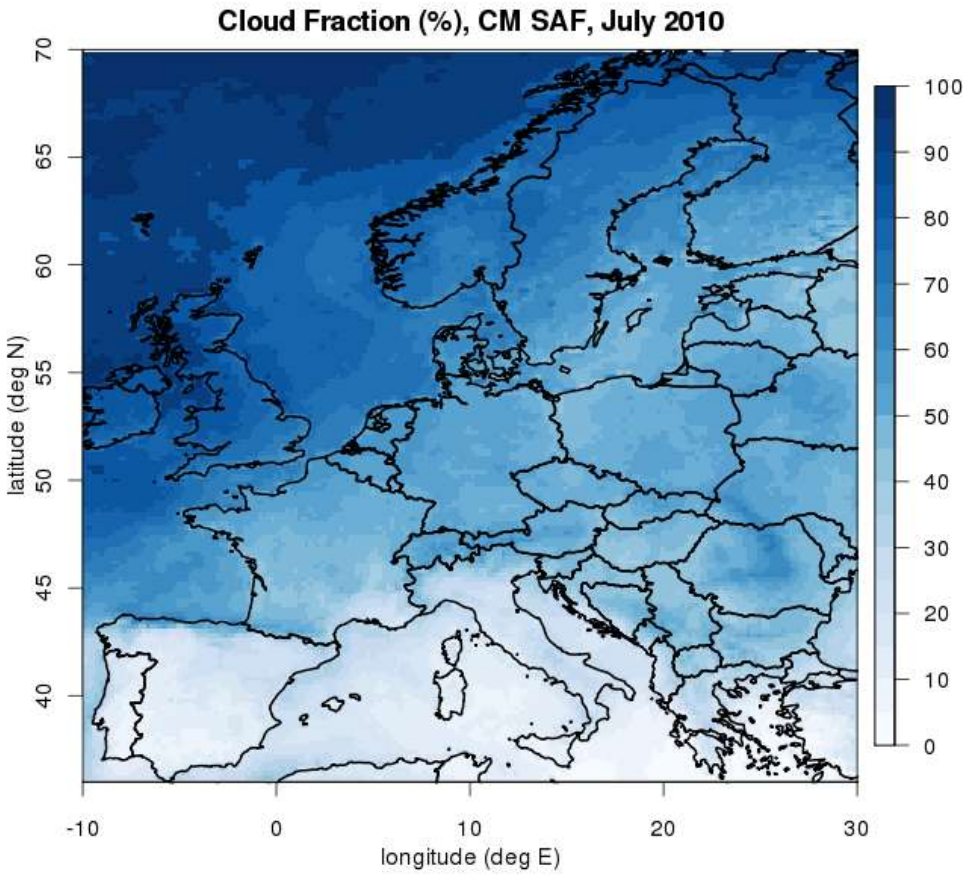


CM SAF Operational Products

Clouds

- cloud fraction
- optical depth
- phase
- top height/pressure/ temperature
- water path

- available since 2005
- Coverage: Meteosat full disk & Arctic
- Daily and monthly means
- spatial resolution 15 x 15 km



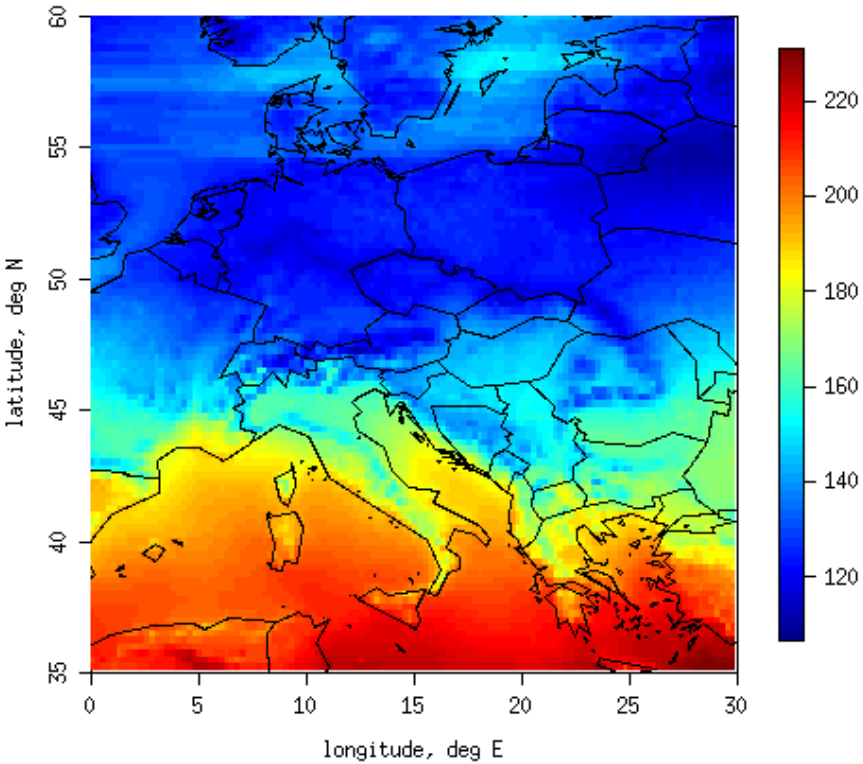
CM SAF Operational Products

Surface Radiation

- Surface radiation parameter:
  - Solar incoming and reflected
  - Outgoing and downwelling longwave
  - Radiation budget

- available since 2007
- Coverage: Meteosat full disk
- Daily and monthly means, in addition weekly means for surface albedo
- spatial resolution: 15 x 15 km²

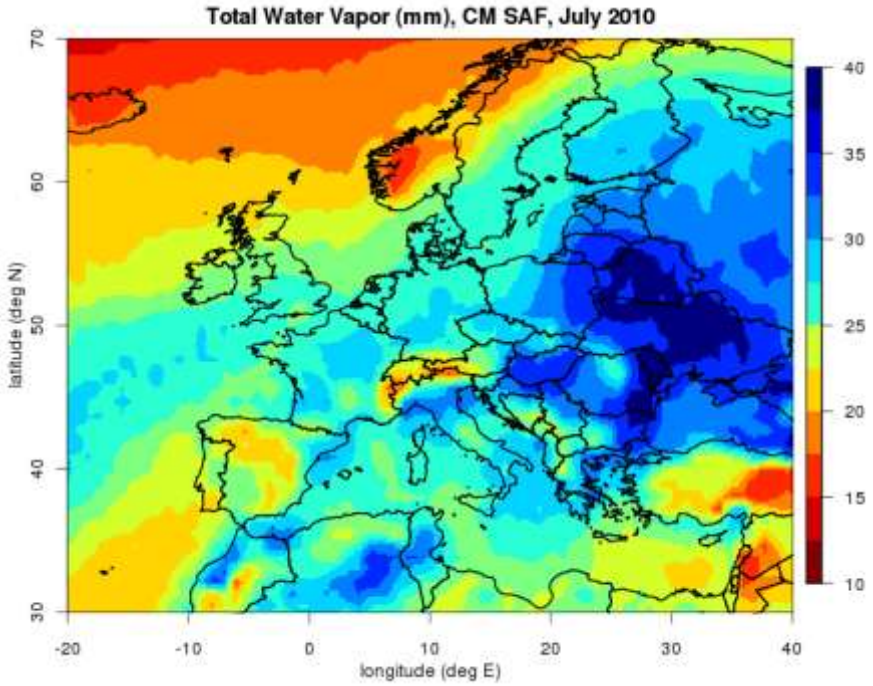
Surface incoming solar radiation Mean 2008 – 2011 [Wm-2]



CM SAF Operational Products

Water Vapor

- water vapor, temperature, relative humidity on 5 vertical levels
- Temperature, specific humidity at 6 pressure levels
- integrated water vapor



- available since 2004
- Coverage: global
- Daily and monthly means
- spatial resolution: 90 x 90 km²

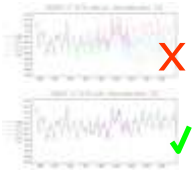
CM SAF Services

- Tools to work with CM SAF data and are provided at www.cmsaf.eu/tools
  - All software (cdo, R) freely available
  - Example scripts and example data provided
  - Presentation by Jörg Trentmann: „Introduction to Software Tools"
  - Moodle course page: Topic 2 and „Software tools" forum

Summary

- Requirements to climate data:
  - Well calibrated, homogeneous long time series

long time series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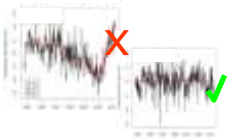
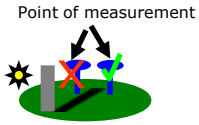
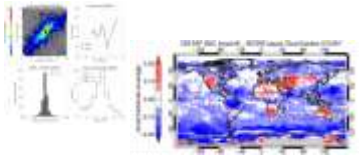

Homogeneous



Representative


Quality controled

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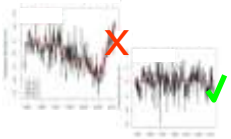

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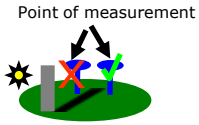

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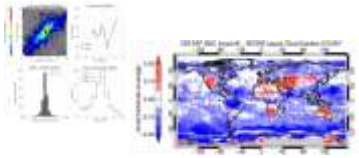
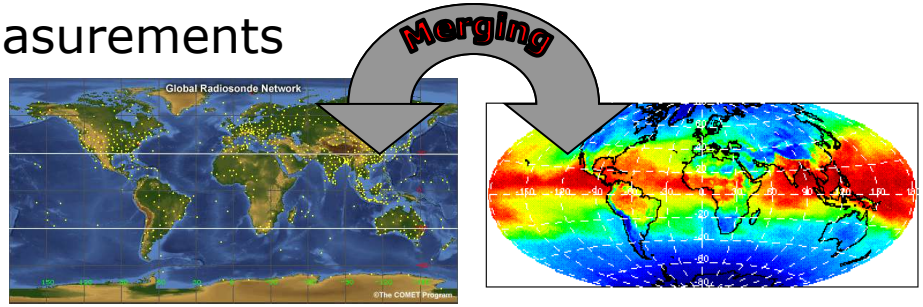


Quality controled

- Satellite data extend surface observations into new regions with less in-situ measurements



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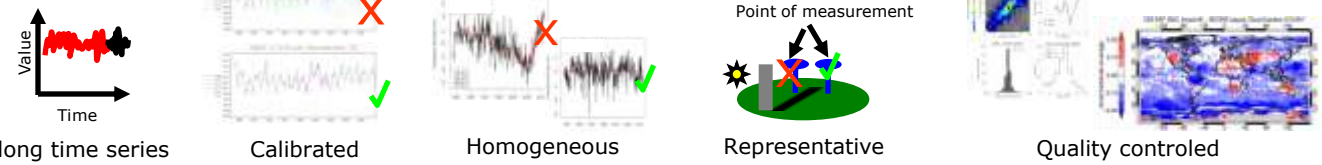

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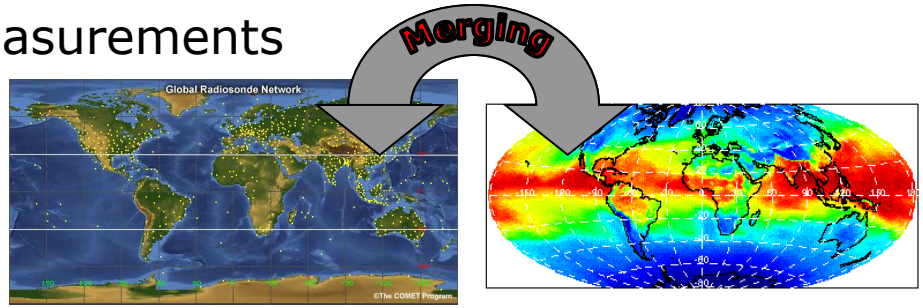

- Satellite based climate data add value to databasis of the Earth's climate system
  - Enhanced knowledge of the climate system
  - Monitor possible trends and changes
  - Development / improvement of climate modells

Summary

CM SAF provides:

Operational Products

- 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

Thematical Climate Datasets

- 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

available at:

wui.cmsaf.eu

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→ Radiation parameters

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→ Watervapor- and Temperature-Profiles

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- Training and tools to work with the data: **www.cmsaf.eu**
- Specific user support: contact.cmsaf@dwd.de

Questions? Comments?

Thank you! *Enjoy the Workshop!*