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CM SAF
Climate Monitoring

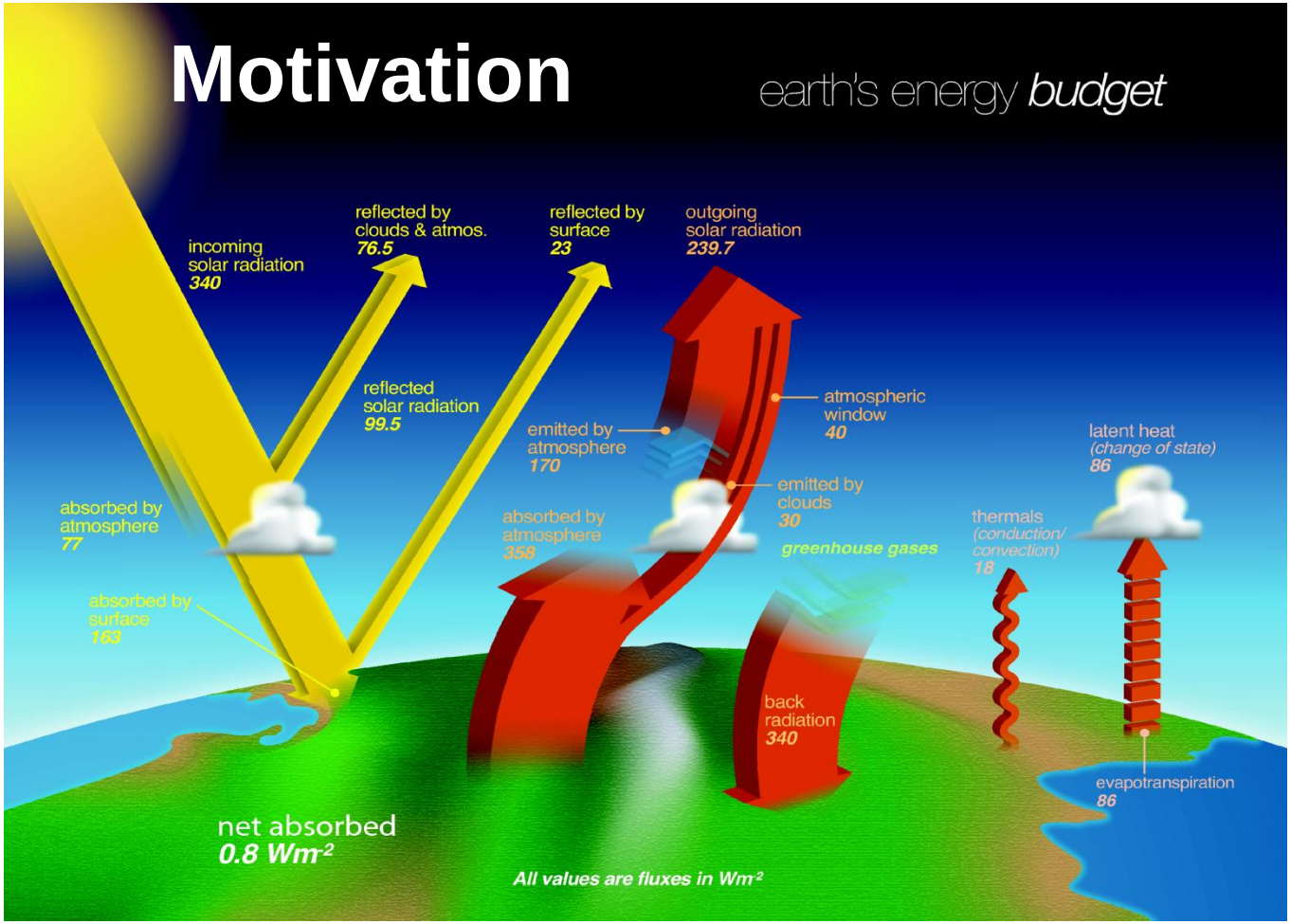
# Meteosat MVIRI surface radiation dataset

Rebekka Posselt (MeteoSwiss)

With support from
J. Trentmann, R. Müller, R. Stöckli

Contact me at: rebekka.posselt@meteoswiss.ch

# Motivation

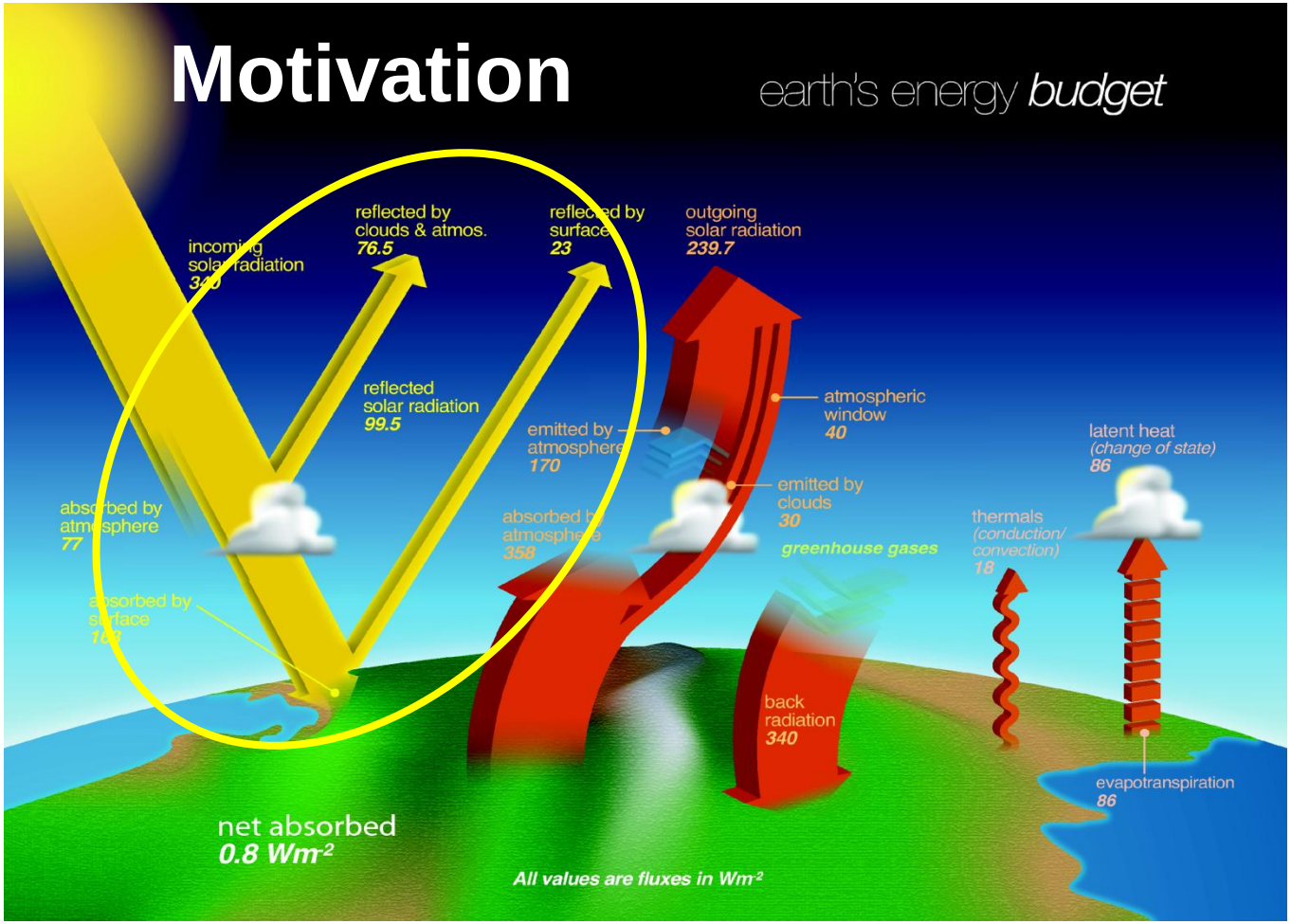



- Radiation is the driving force for all atmospheric processes.

→ Radiation budget is an essential climate variable (GCOS)

- Planning and monitoring of solar energy systems

# Motivation




- Radiation is the driving force for all atmospheric processes.

→ Radiation budget is an essential climate variable (GCOS)

- Planning and monitoring of solar energy systems

# Outline

- Motivation and Introduction
- Algorithm repetition
- **Meteosat MVIRI surface radiation dataset**
  - Validation
  - Homogeneity
  - Known Issues
- Applications
- Extension with SEVIRI data?

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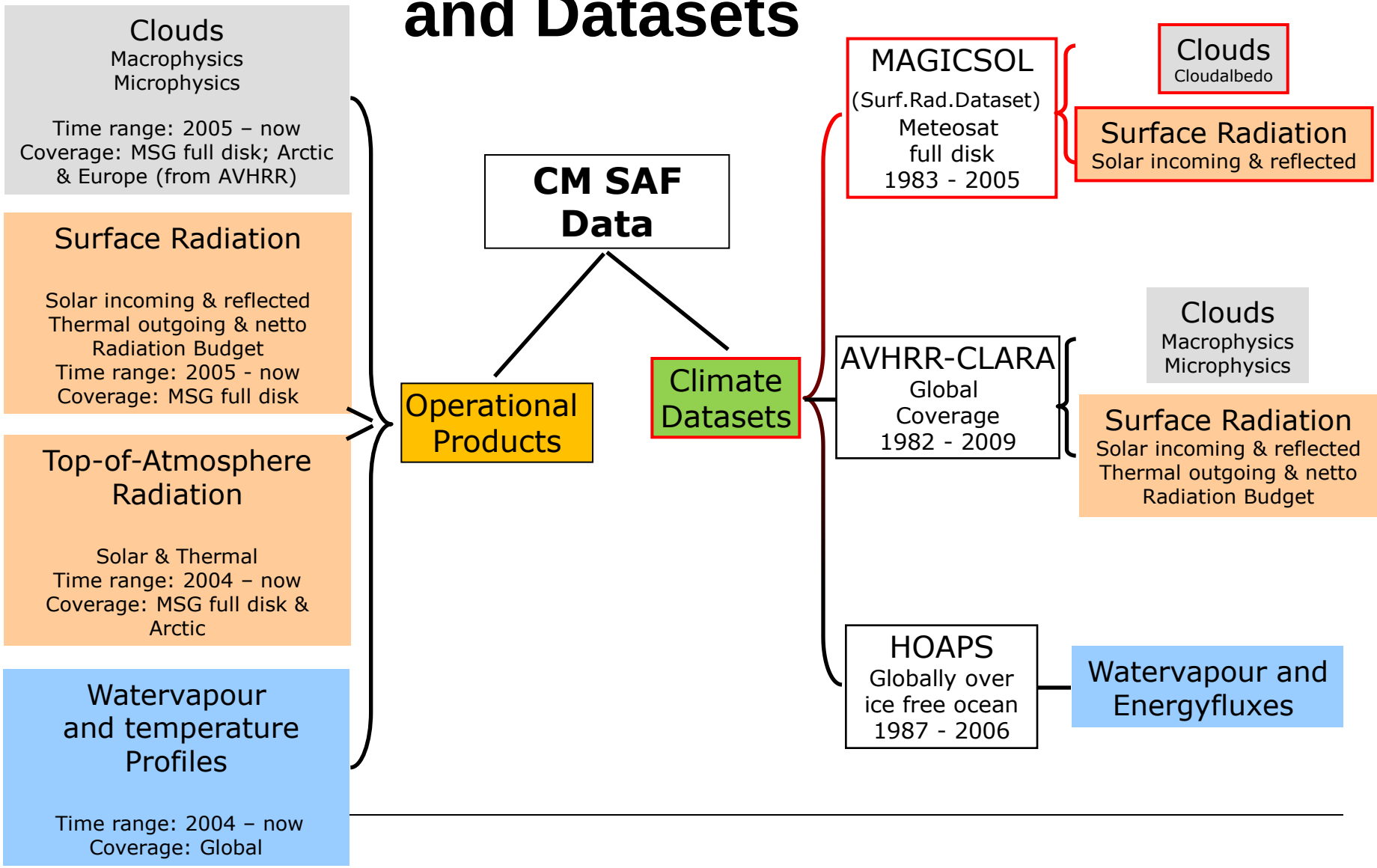
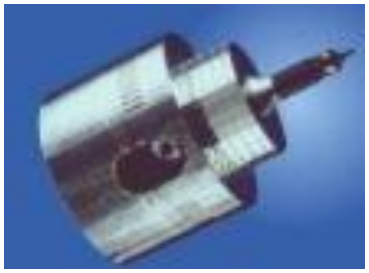
# Available operational Products and Datasets

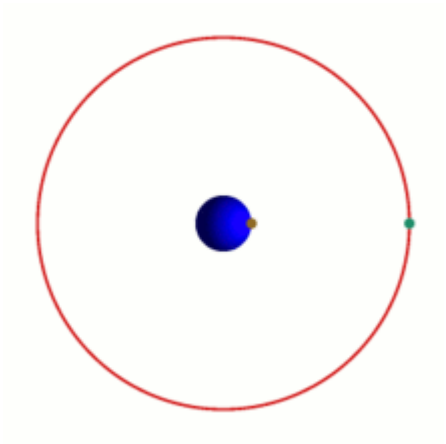


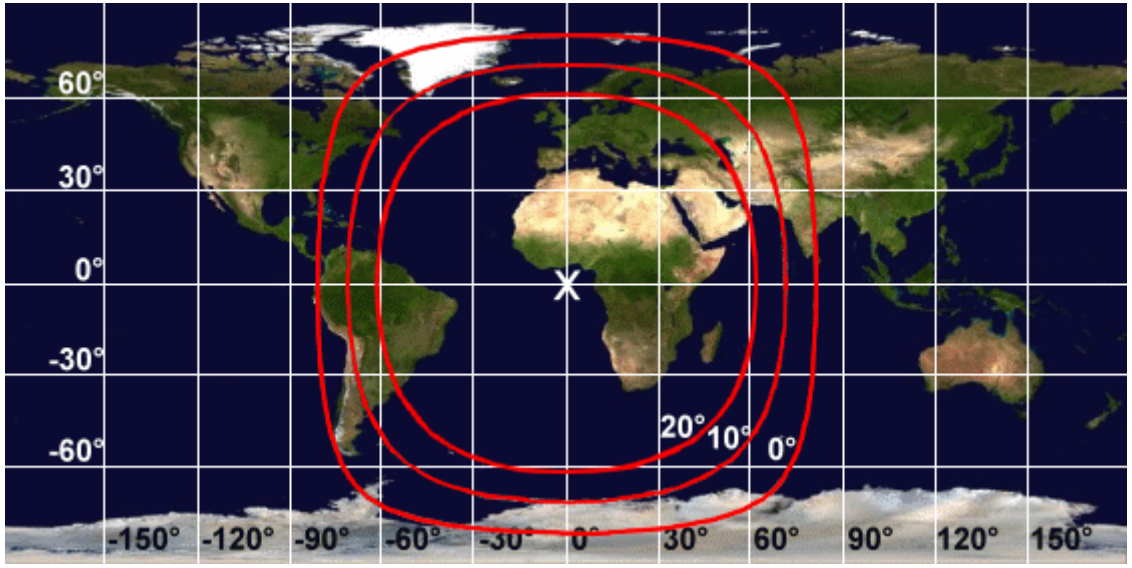
# Meteosat MVIRI

- MVIRI = Meteosat Visible and Infrared Imager
- Instrument on Meteosat First Generation (or Meteosat Transition Period) Satellites
  - 1977-2005 = Meteosat 1-7
- Covers Africa and Europe (positioned at 0°)



© http://www.eumetsat.int

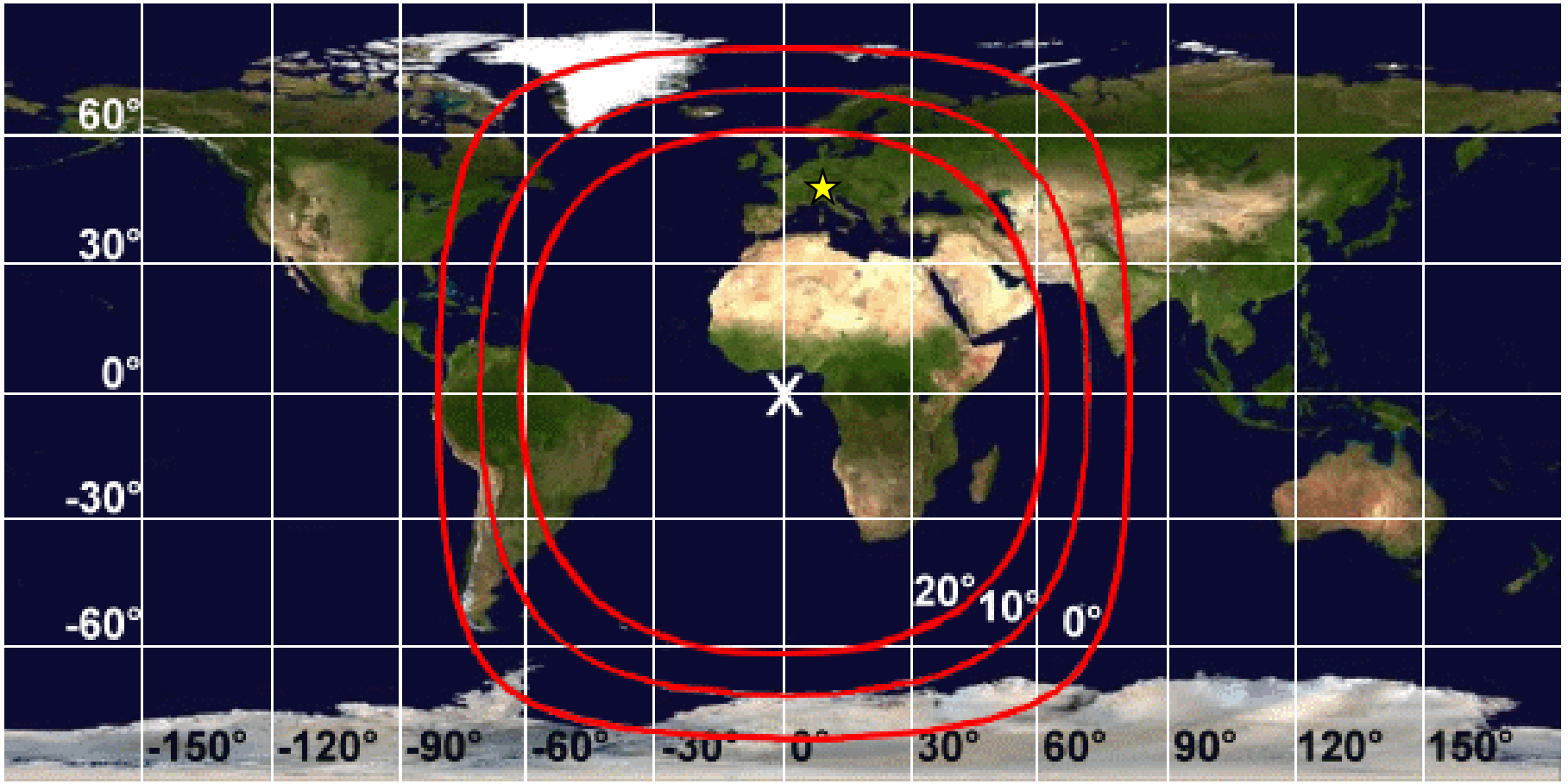





Graphics from: http://de.wikipedia.org/wiki/Geosynchrone_Umlaufbahn

# Meteosat MVIRI

Where are you on the Meteosat disc? (use the ★)

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# MagicSol

## Retrieval for historical radiation datasets

- Retrieval scheme
  1. Get cloud information
     - "Effective Cloud Albedo" ($\boldsymbol{CAL}$)
     - From satellite
  2. Get clear sky information
     - "Clear Sky Radiation" ($\boldsymbol{Rad_{cs}}$)
     - From LookUpTables
  3. Combine 1. & 2.

For more details refer to the previous "Surface Radiation Retrieval" session

$$\boldsymbol{Rad = f(CAL) \cdot Rad_{cs} \approx (1 - CAL) \cdot Rad_{cs}}$$

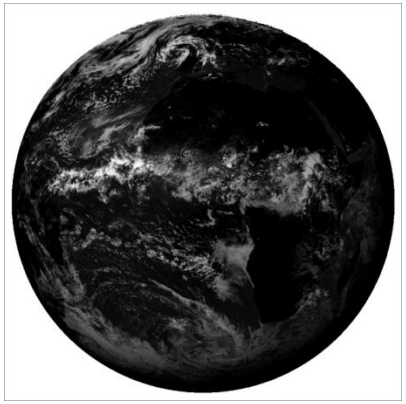
# MagicSol

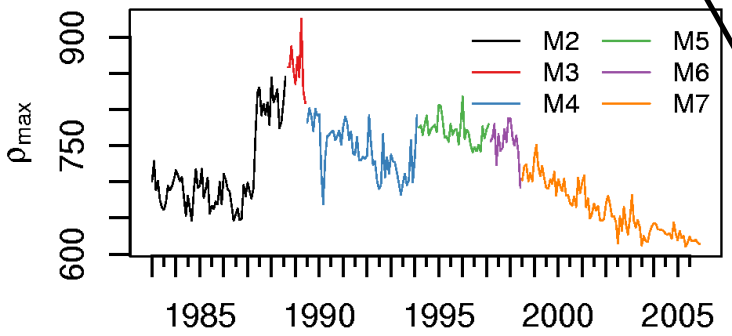
## Retrieval for historical radiation datasets

1. Get cloud information
   - All information together give the “effective cloud albedo” (CAL, a.k.a. cloud index) → Heliosat method

$$CAL = \frac{\rho - \rho_{min}}{\rho_{max} - \rho_{min}}$$

→ Cloud image



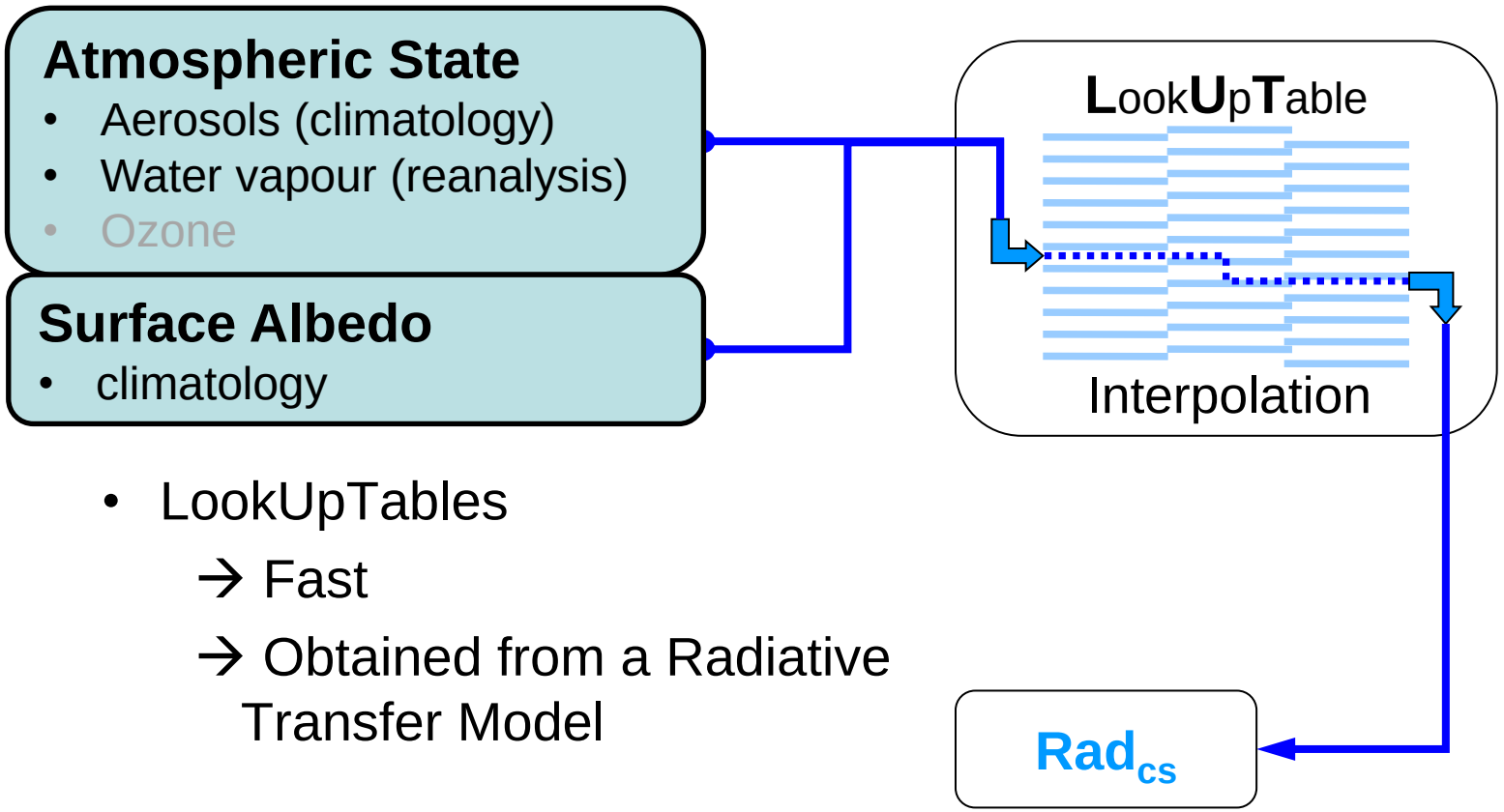



~ Maximum range of pixel brightnesses

# MagicSol

## Retrieval for historical radiation datasets

2. Get clear sky radiation (clear sky gnu-magic)




- LookUpTables
  - → Fast
  - → Obtained from a Radiative Transfer Model



*Müller et al. (2009)*

http://sourceforge.net/projects/gnu-magic

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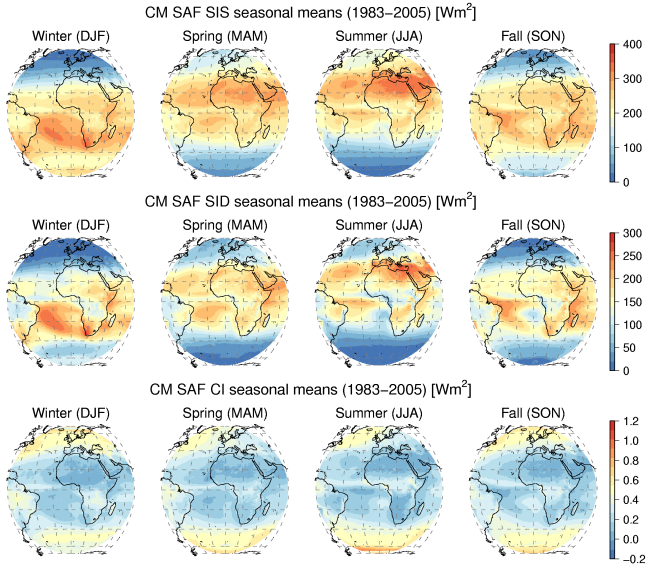
# MVIRI Surface Radiation CDR

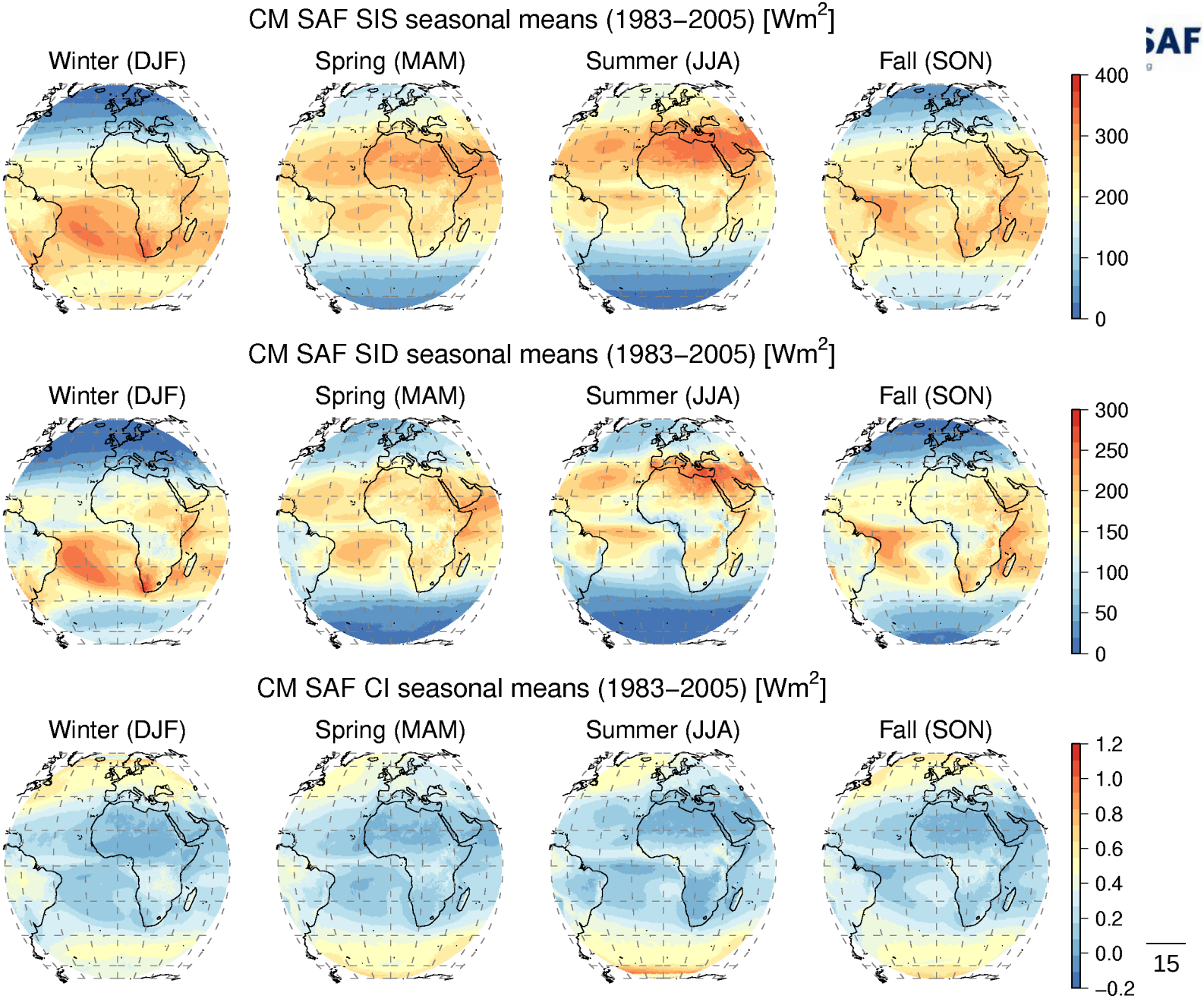



- Available variables:
  - SIS – global radiation
  - SID – direct radiation
  - CAL – cloud albedo (also CI – Cloud index)

- Available coverage
  - 1982 – 2005 (= Meteosat 2 – 7)
  - Meteosat Full Disc

- Available resolutions:
  - hourly, daily and monthly means
  - 0.03° regular lon-lat-grid

# MVIRI Surface Radiation CDR



# Validation Dataset

- Quality of dataset is validated using **Baseline Surface Radiation Network (BSRN)** data
- BSRN is a project of the GEWEX Radiation Panel under the World Climate Research Programme (WCRP).
- Currently about 40 stations in contrasting climatic zones
- Support of the validation and confirmation of satellite and computer model estimates

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| Accuracy requirements | SIS [W/m²] | SID [W/m²] | CAL |
|---|---|---|---|
| Monthly | 15 | 20 | 0.15 |
| Hourly/Daily | 25 | 30 | 0.2 |

# Intercomparison datasets

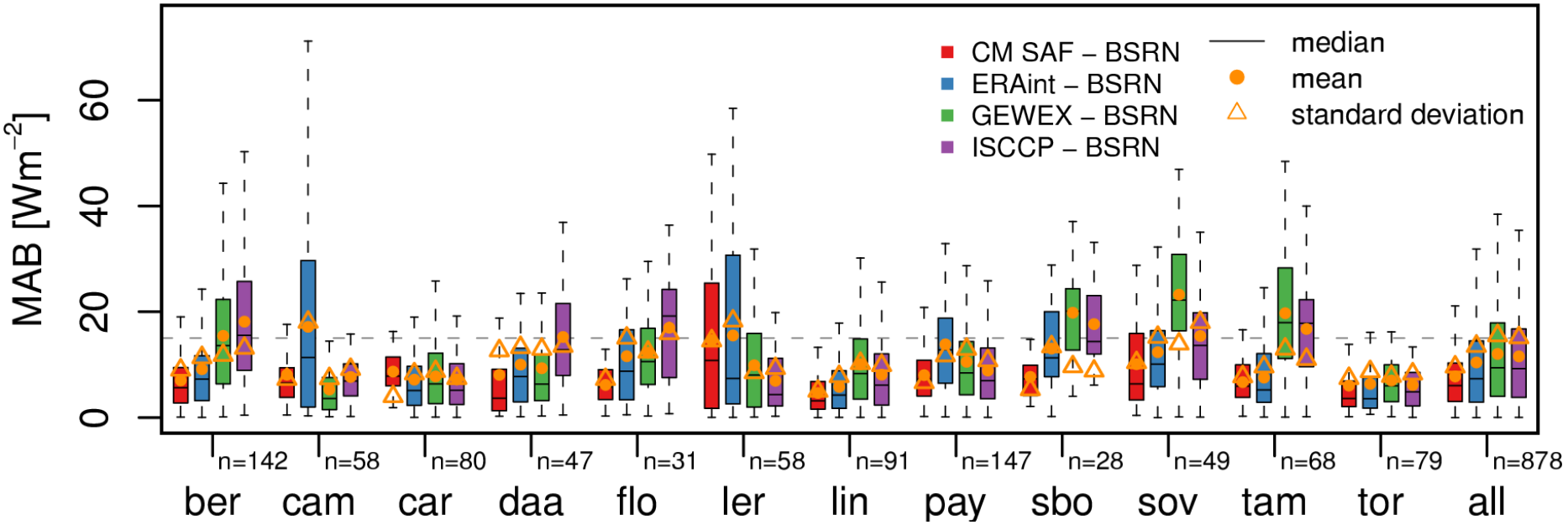
- **ERAinterim** (ECMWF Re-Analysis Project)
  - 6-hourly means, 1989 - present
  - Global coverage on a 1° x 1° global grid

- **GEWEX** (Global Energy and Water-cycle Experiment) Surface Radiation Budget dataset
  - 3-hourly/daily/monthly means, July 1983 - Dec. 2007
  - Global coverage on a 1° x 1° global grid

- **ISCCP** (International Satellite Cloud Climatology Project) Flux dataset
  - 3-hourly means, July 1983 - Dec 2007
  - Global coverage on a 280 km equal-area global grid

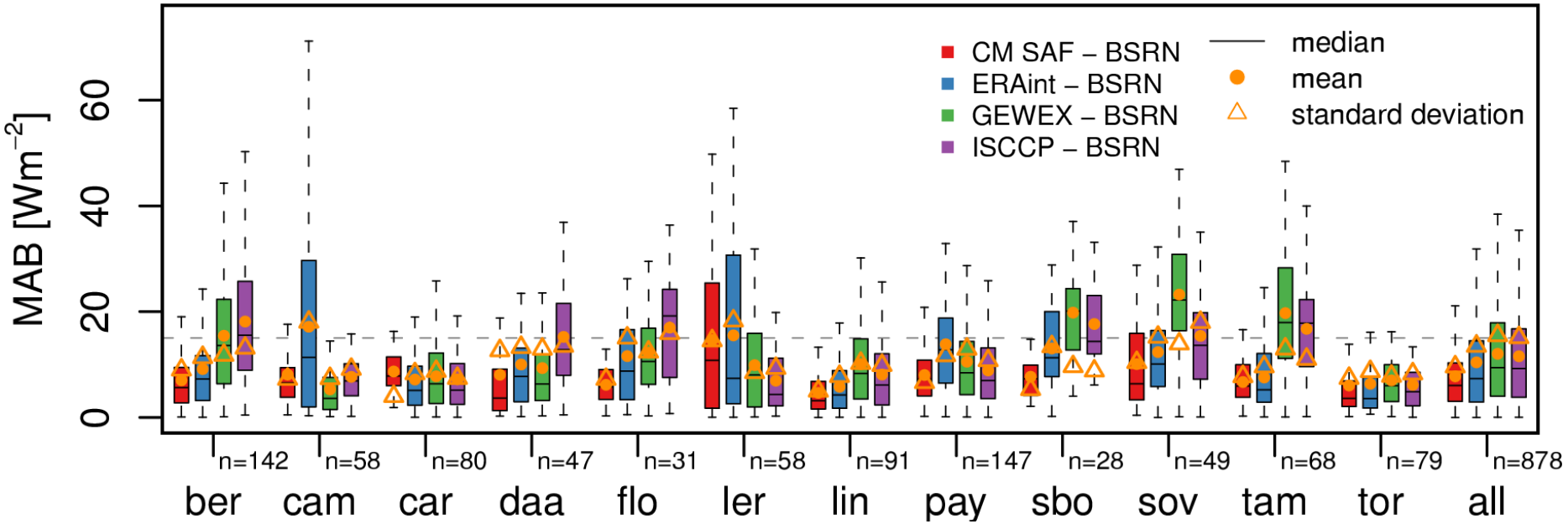
# Validation

## Monthly mean SIS



# Validation

## Monthly mean SIS



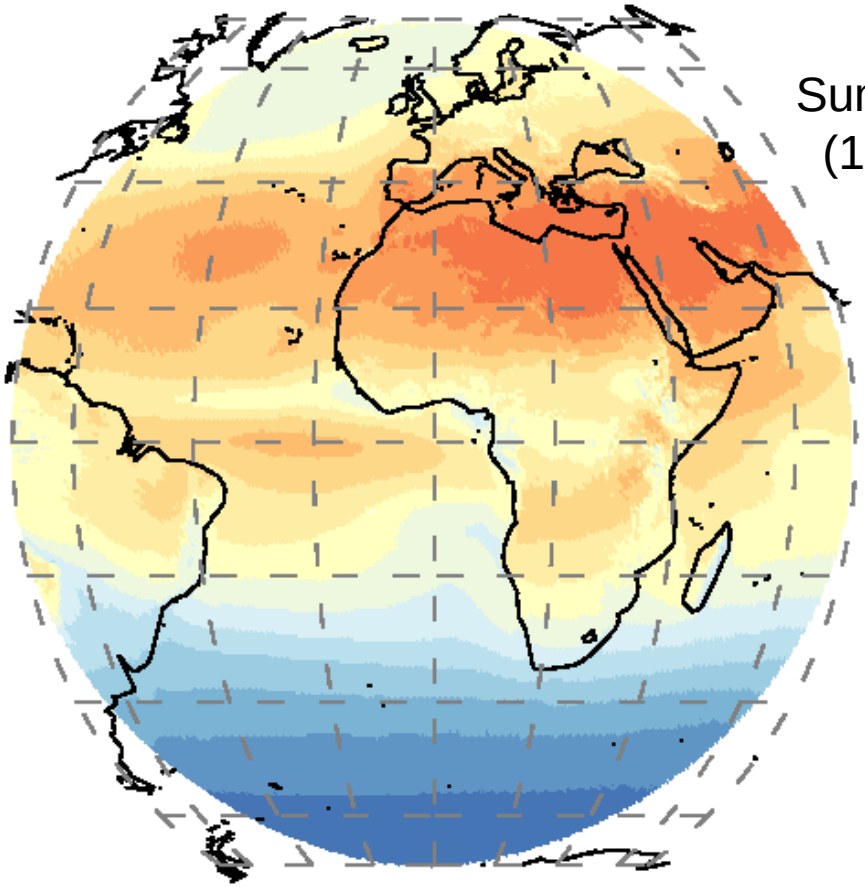

| SIS | $N_{mon}$ | Bias [W/m$^2$] | MAB [W/m$^2$] | SD [W/m$^2$] | AC | $Frac_{mon}$ > 15 W/m$^2$ [%] |
|---|---|---|---|---|---|---|
| CM SAF | 878 | 4.24 | **7.76** | **8.23** | **0.89** | **10.71** |
| ERAinterim | 878 | 5.48 | 10.41 | 12.15 | 0.8 | 24.6 |
| GEWEX | 878 | -2.42 | 12.03 | 11.03 | 0.82 | 31.89 |
| ISCCP | 878 | **-0.02** | 11.56 | 11.25 | 0.78 | 29.16 |

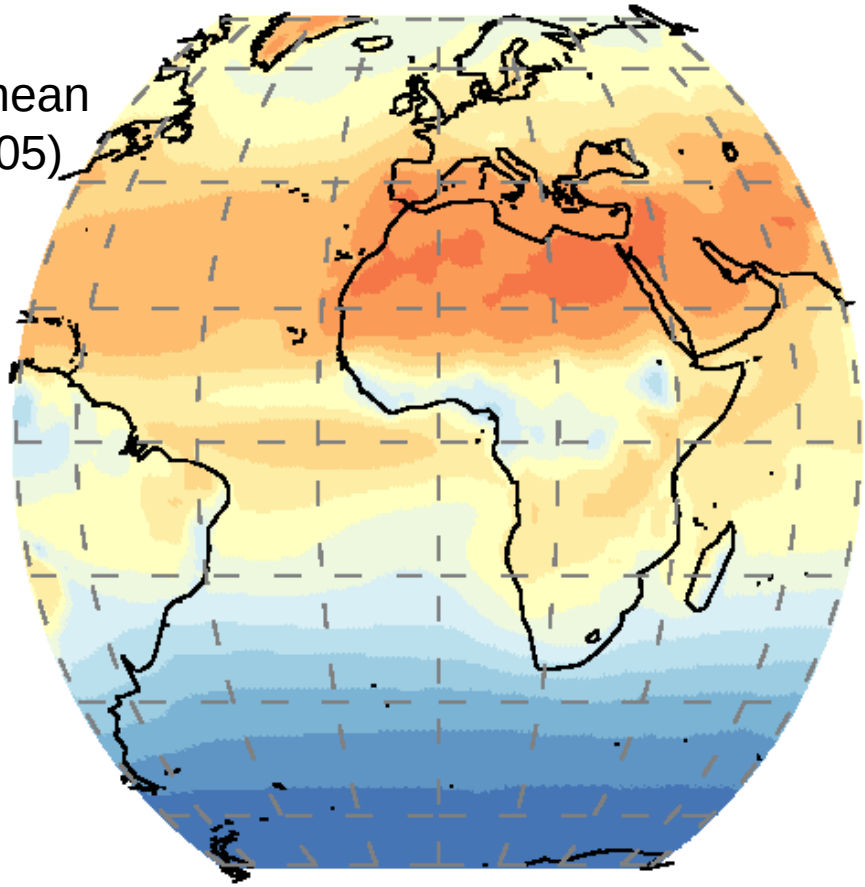
# Intercomparison

CM SAF

ERA interim

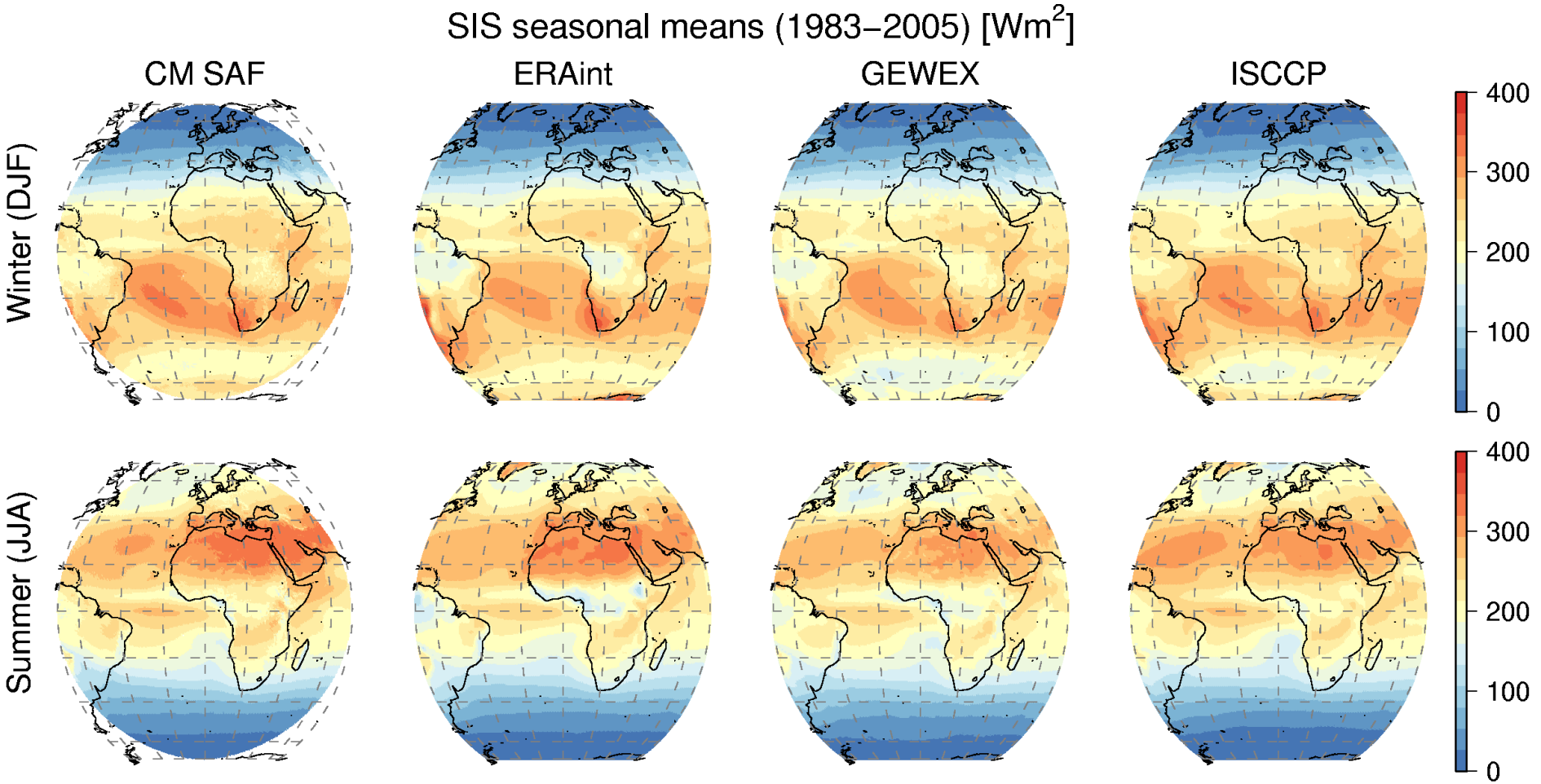
Summer mean
(1983-2005)





- Find the differences! (use the ☆)

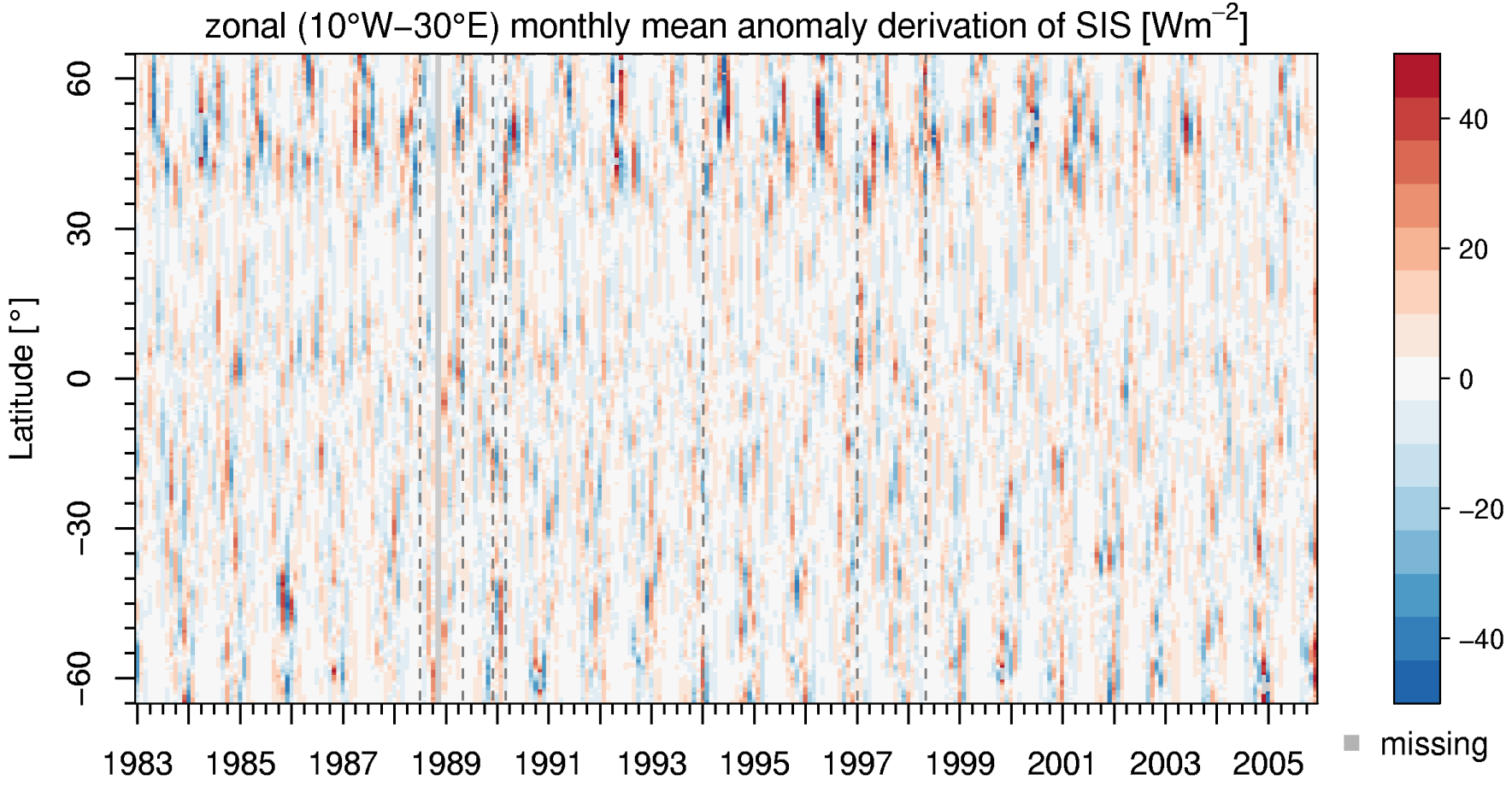
# Intercomparison




- Overall pattern are in good agreement, but significant regional differences are visible

→ especially Tropics and Southern and Northern Atlantic

# Homogeneity



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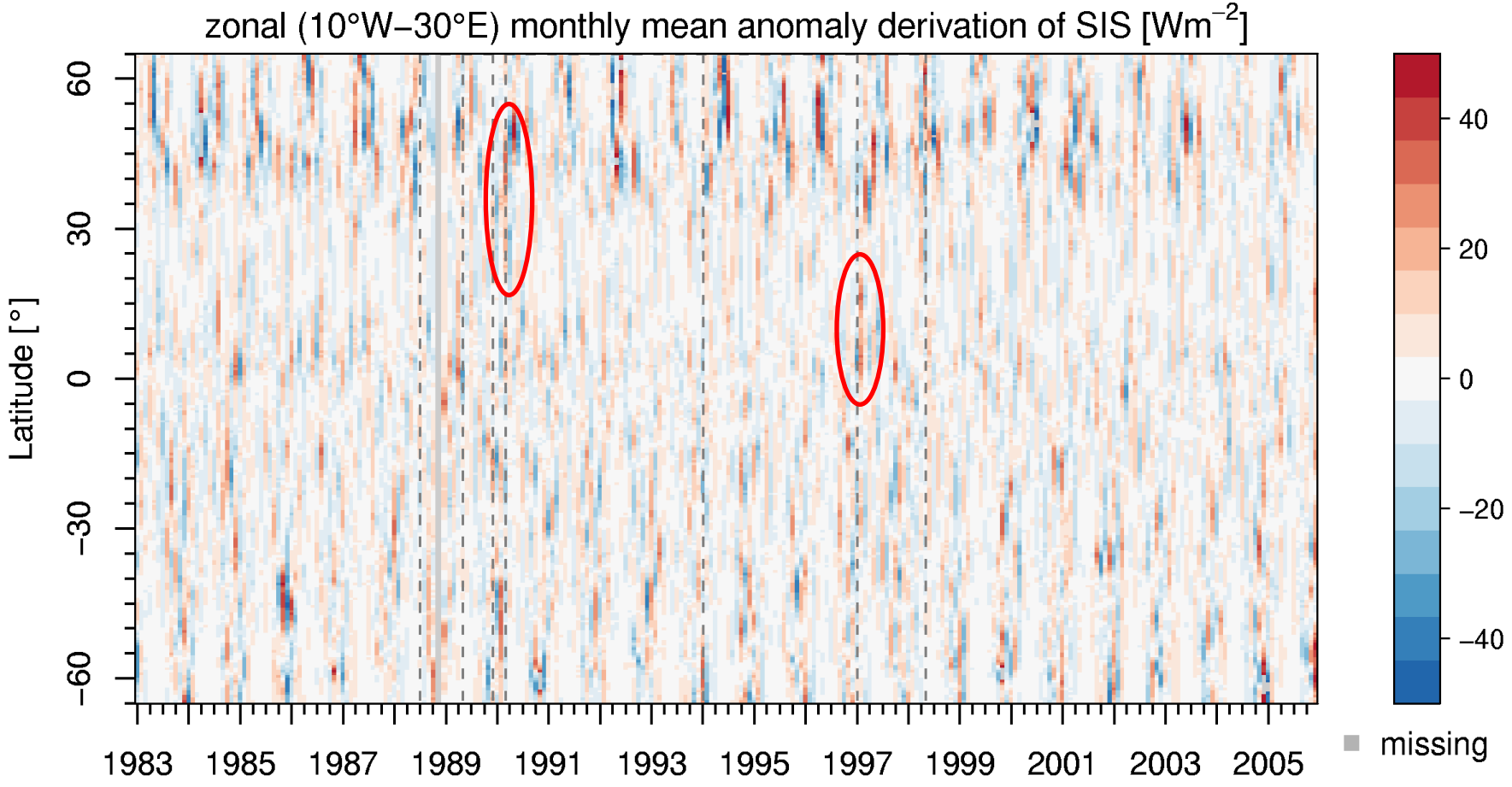
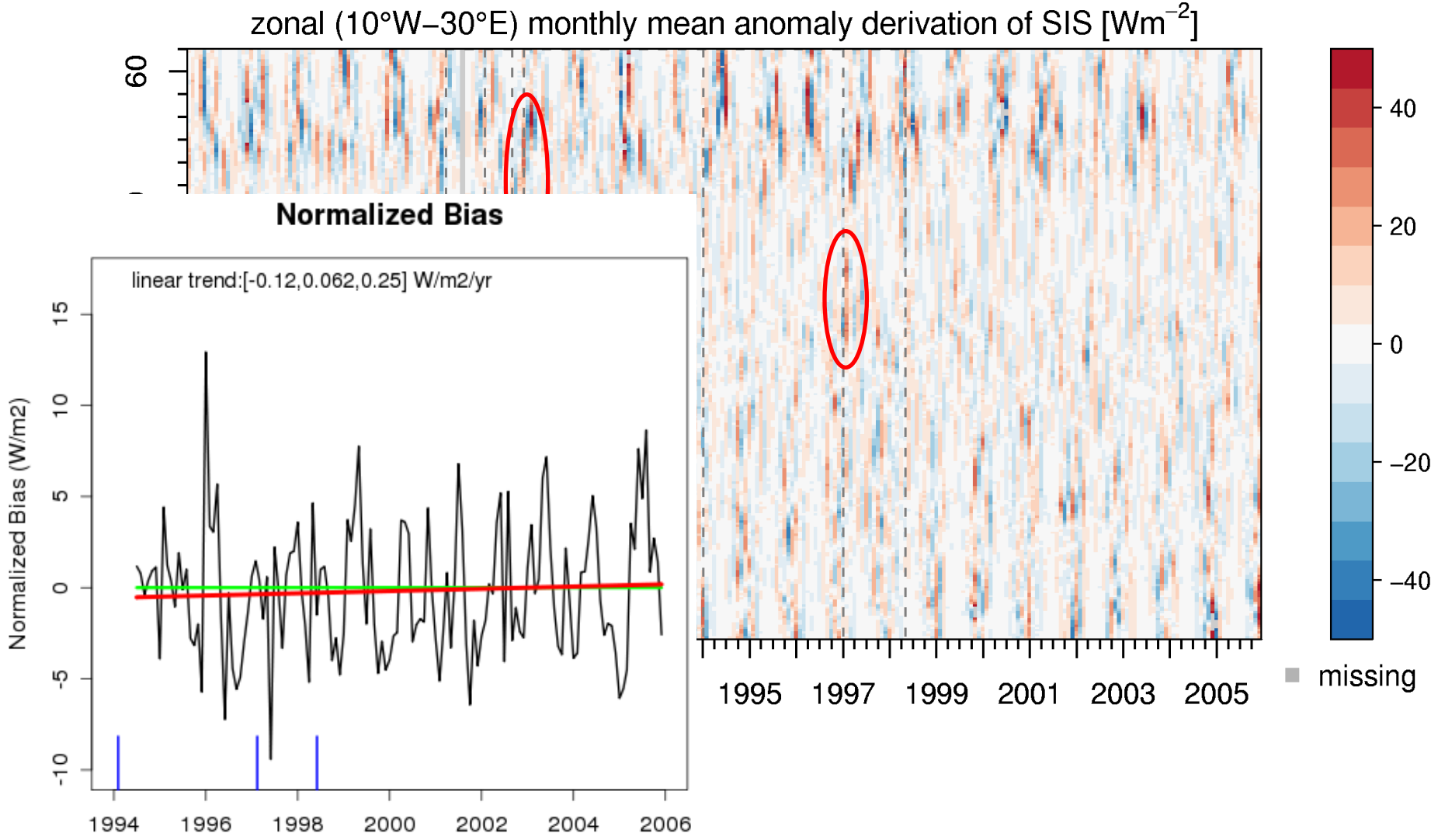
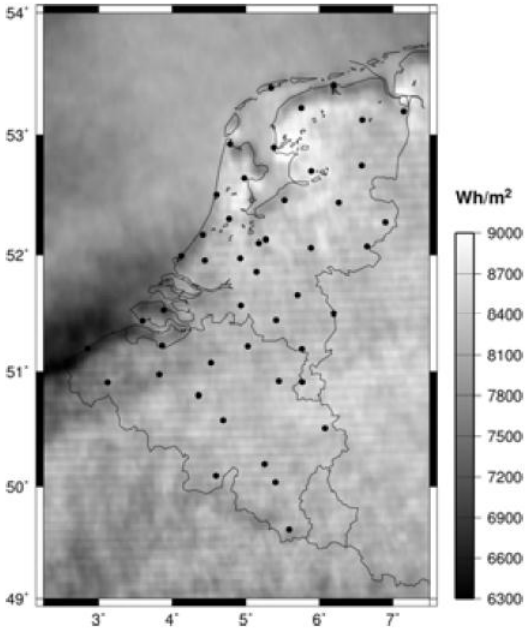


# Homogeneity



# Known Issues

- Stripping pattern in Meteosat 2 and 3 data (1982 – 1989; partly up to 1994, if Meteosat 3 was used as backup)
  - Due to uncorrected missing lines during night
  - Consequence: means are too low (order of 5 $Wm^{-2}$ for daily means)
  - Cannot be corrected at the moment, wait for next dataset release (CDOP2)




Courtesy of M. Journée (RMIB)

- Radiation over bright surfaces (e.g., snow and deserts)
  - $\rho_{min}$ retrieval complicated and, thus, unreliable
  - Consequence: Handle radiation fields in this areas with care!

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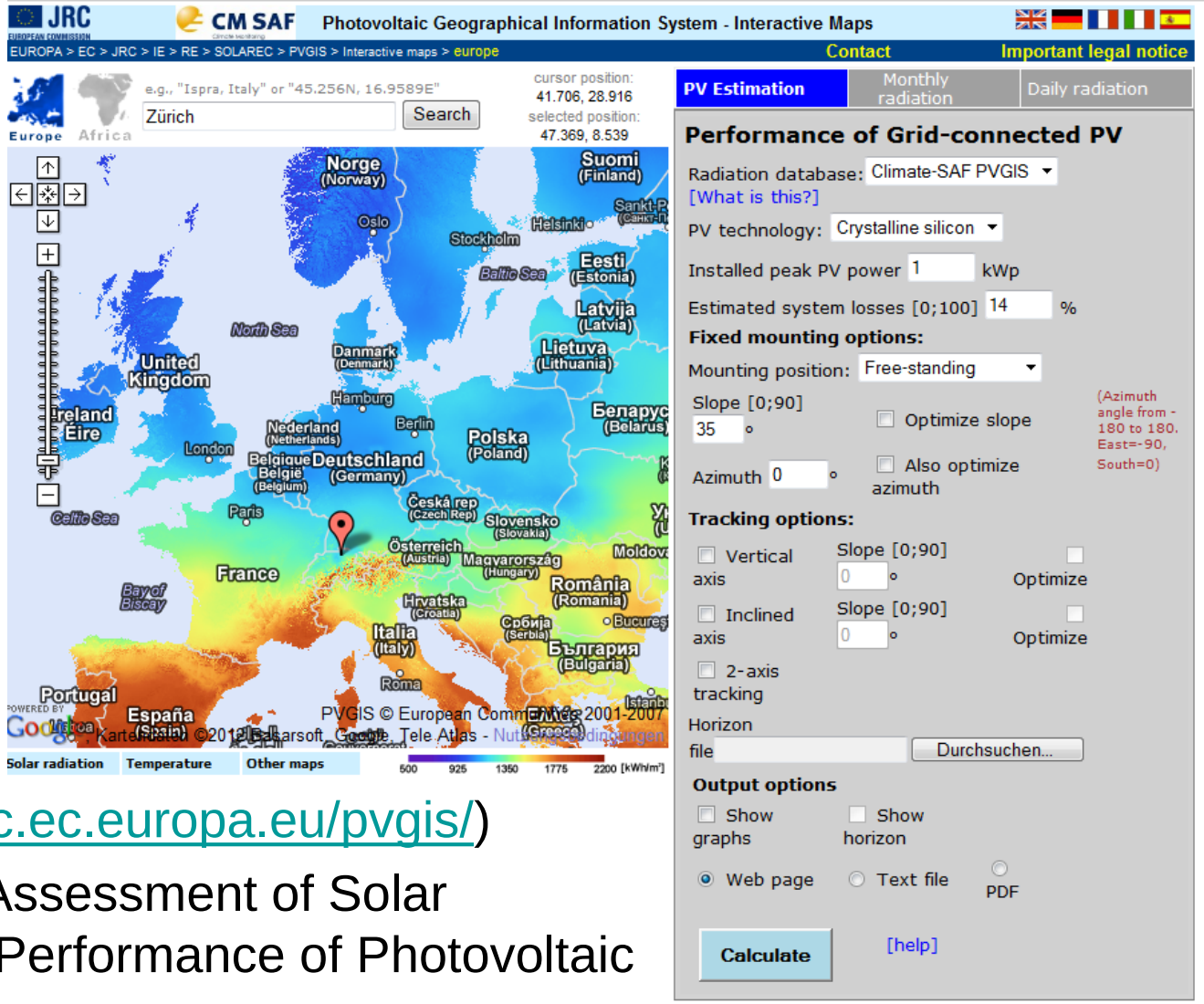
# Applications

- “Brainstorming”

→ “What applications can you imagine for the MVIRI surface radiation Dataset?”

# Applications

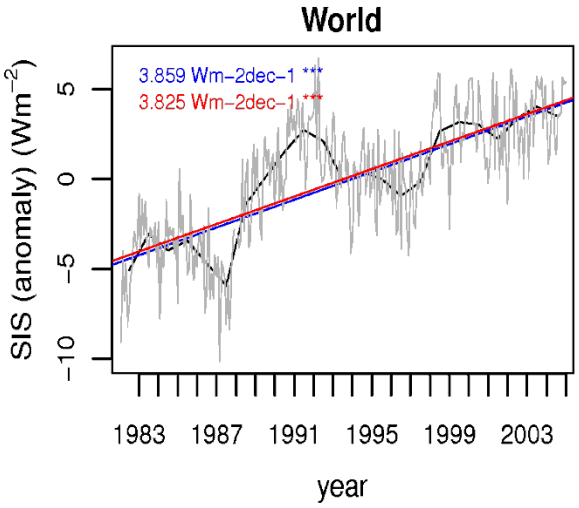
Solar Energy potential

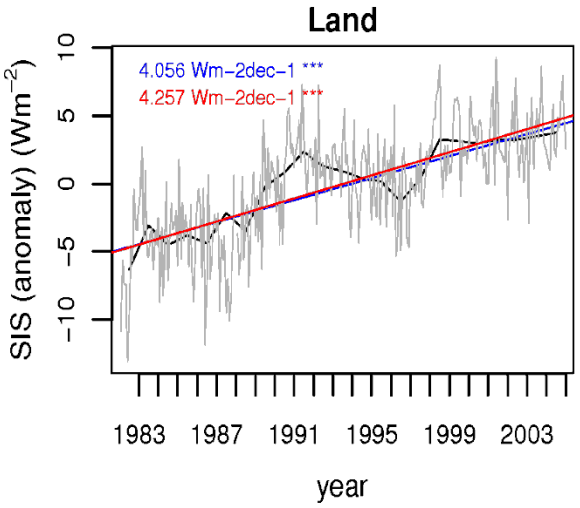


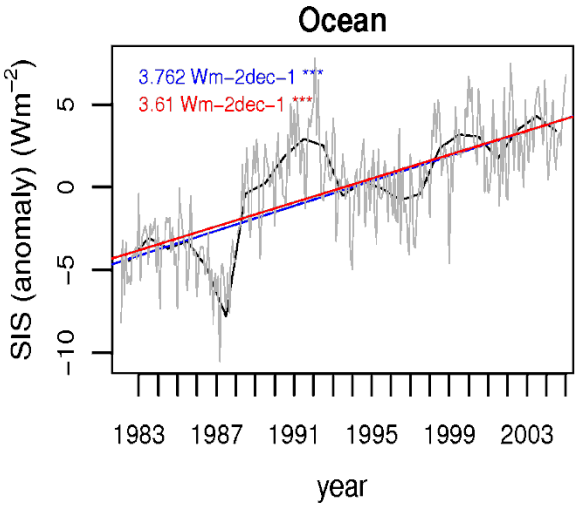

- PVGIS (http://re.jrc.ec.europa.eu/pvgis/)
  - Geographical Assessment of Solar Resource and Performance of Photovoltaic Technology

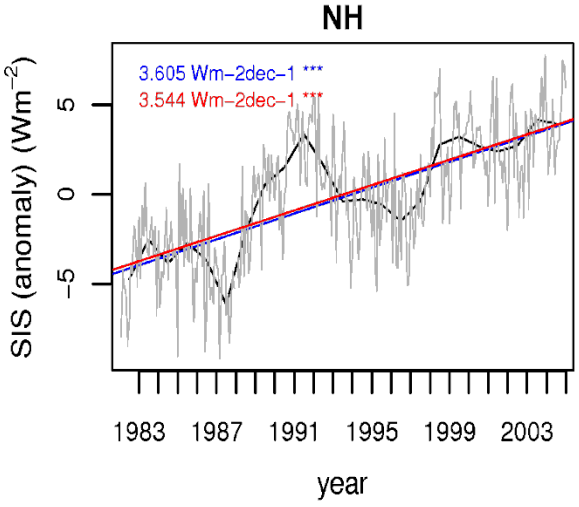
# Applications

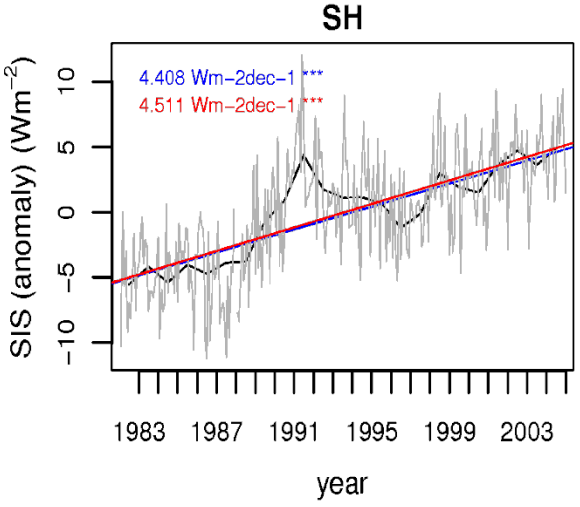
## Trend Analysis

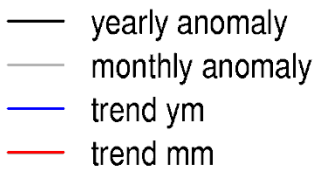


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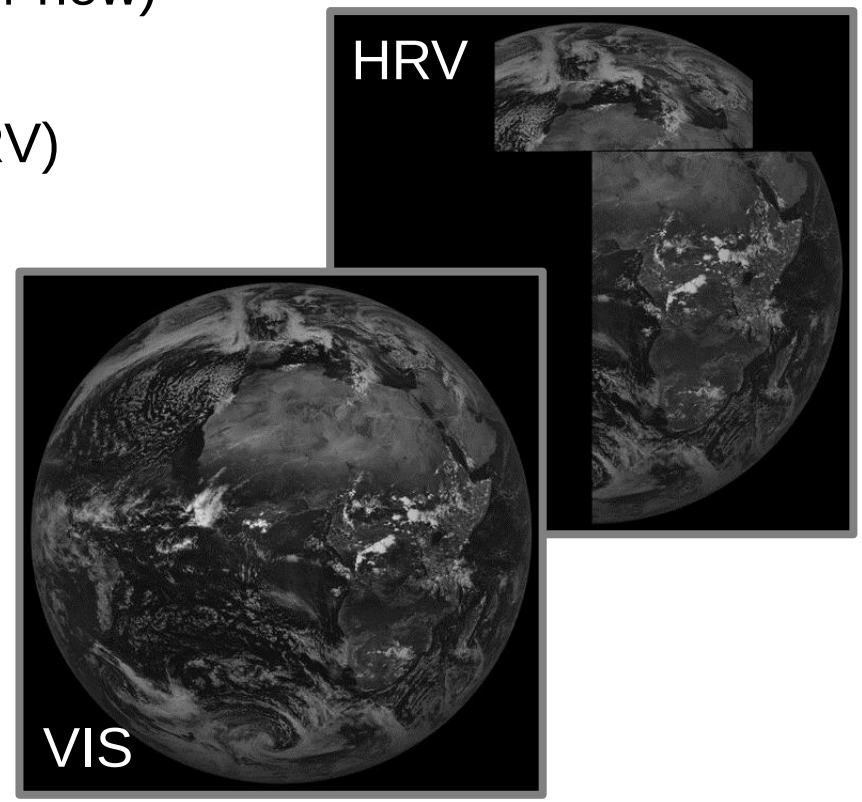
# Extension with SEVIRI data?

- SEVIRI = Spinning Enhanced Visible and InfraRed Imager
  - Onboard Meteosat Second Generation satellites (Meteosat 8-10 → 2004-now)

- High resolution visible (HRV) channel:
  - Differences in spatial coverage
  - → Only useful for subsets (e.g., Europe, Africa)
  - Similar spectral properties



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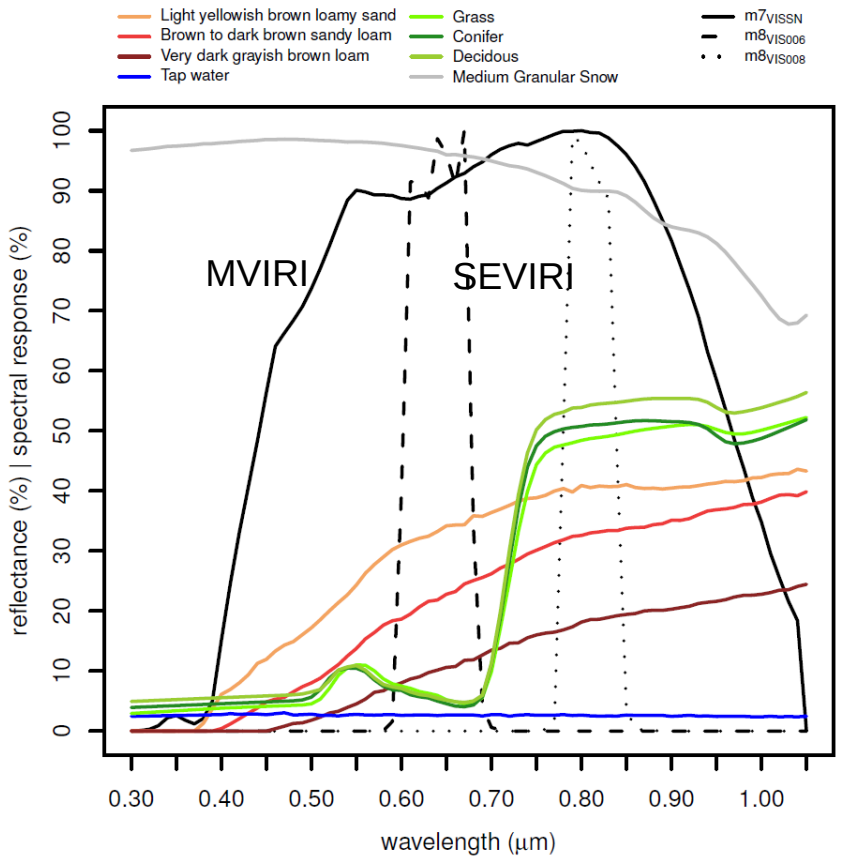
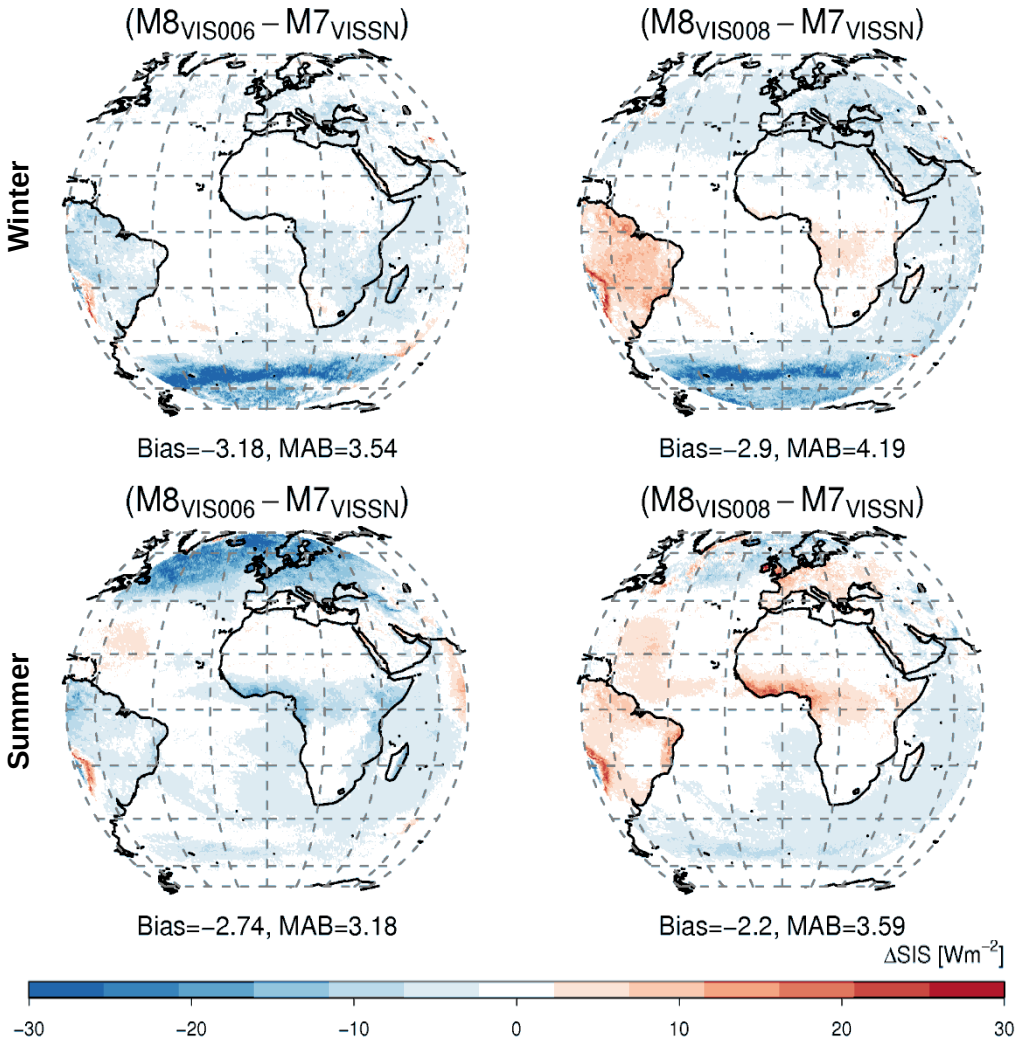



- Narrowband VIS channels
  - Differences in spectral characteristics (broadband vs. narrowband)
  - → Large differences especially for vegetation
  - Similar spatial coverage

# Extension with SEVIRI data?

- How to solve? (use the ★)
  - → **Combination of the SEVIRI VIS channels** to generate a broadband channel similar to MVIRI
  - → **Average SIS of the SEVIRI VIS channels** to even out the differences



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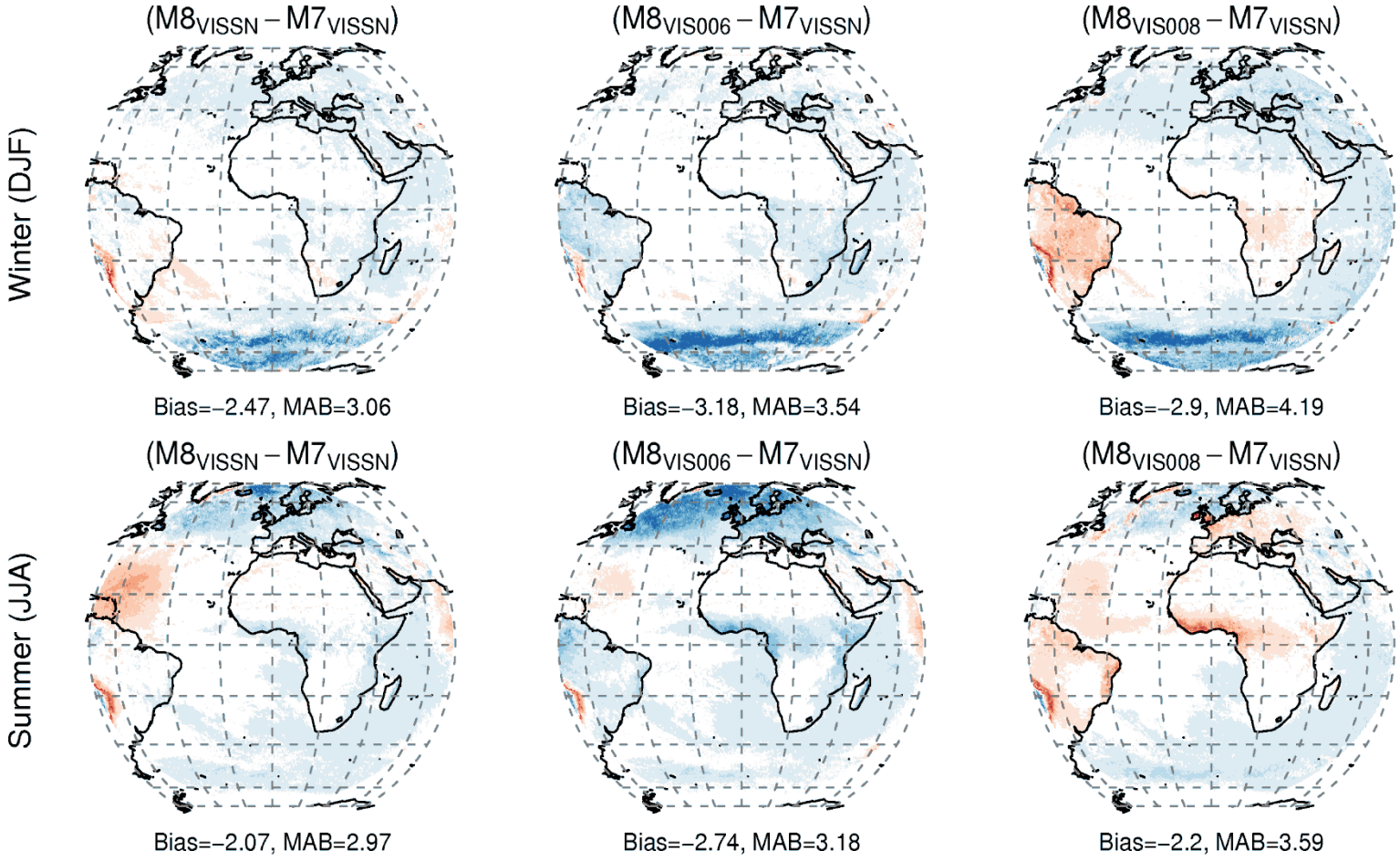

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