

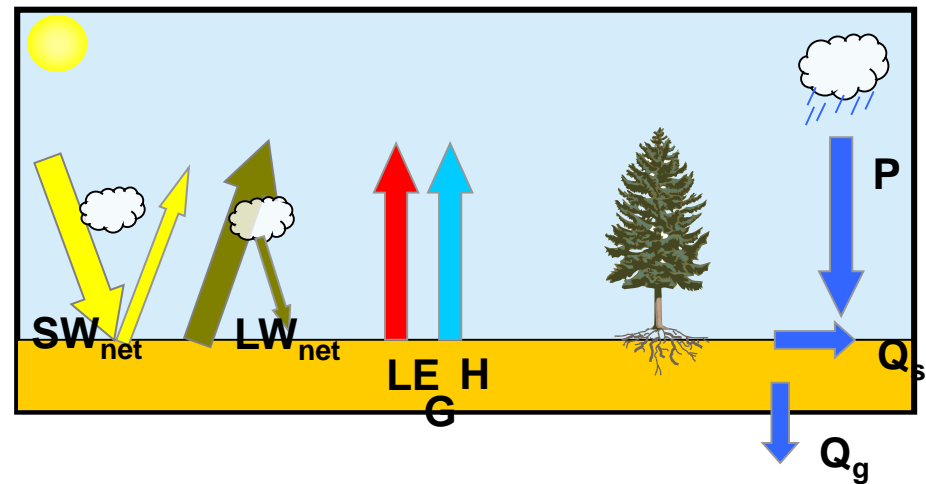
# Assessment of ESA GlobAlbedo for climate model applications - examples using MPI-ESM

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Swantje Preuschmann

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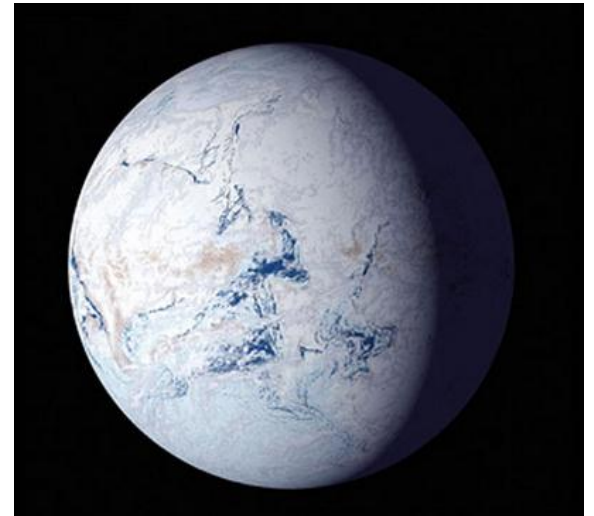
# Surface albedo

- ... of major importance for climate
  - local, regional (water & energy)



# Surface albedo

- ... of major importance for climate
  - local, regional (water & energy)
  - global



*Snowball Earth*

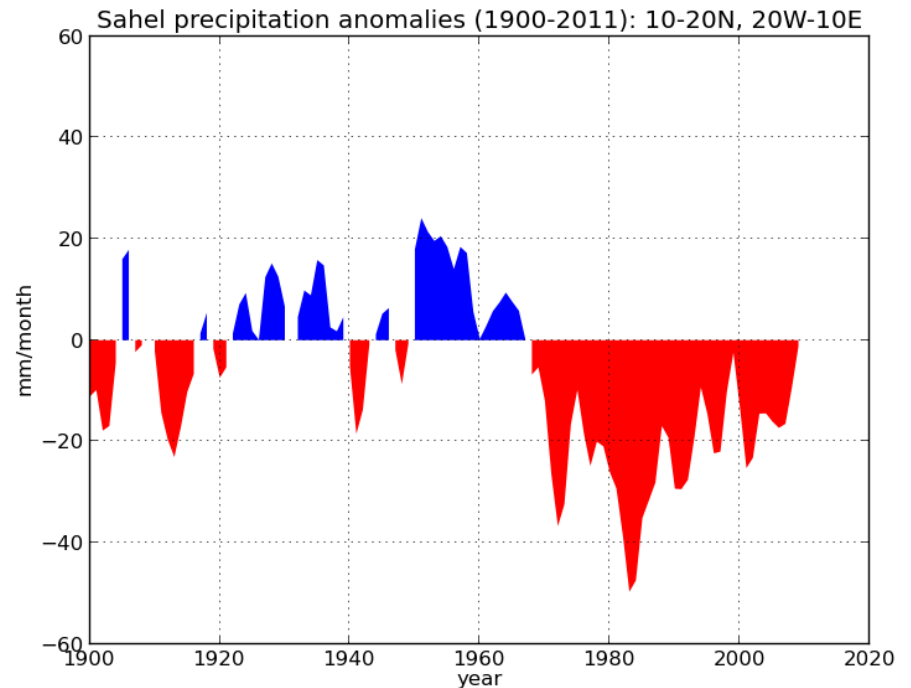
# Surface albedo

- ... of major importance for climate
  - local, regional (water & energy)
  - global
- Small numbers
  - How small is small enough (accuracy requirements, sensitivities)?

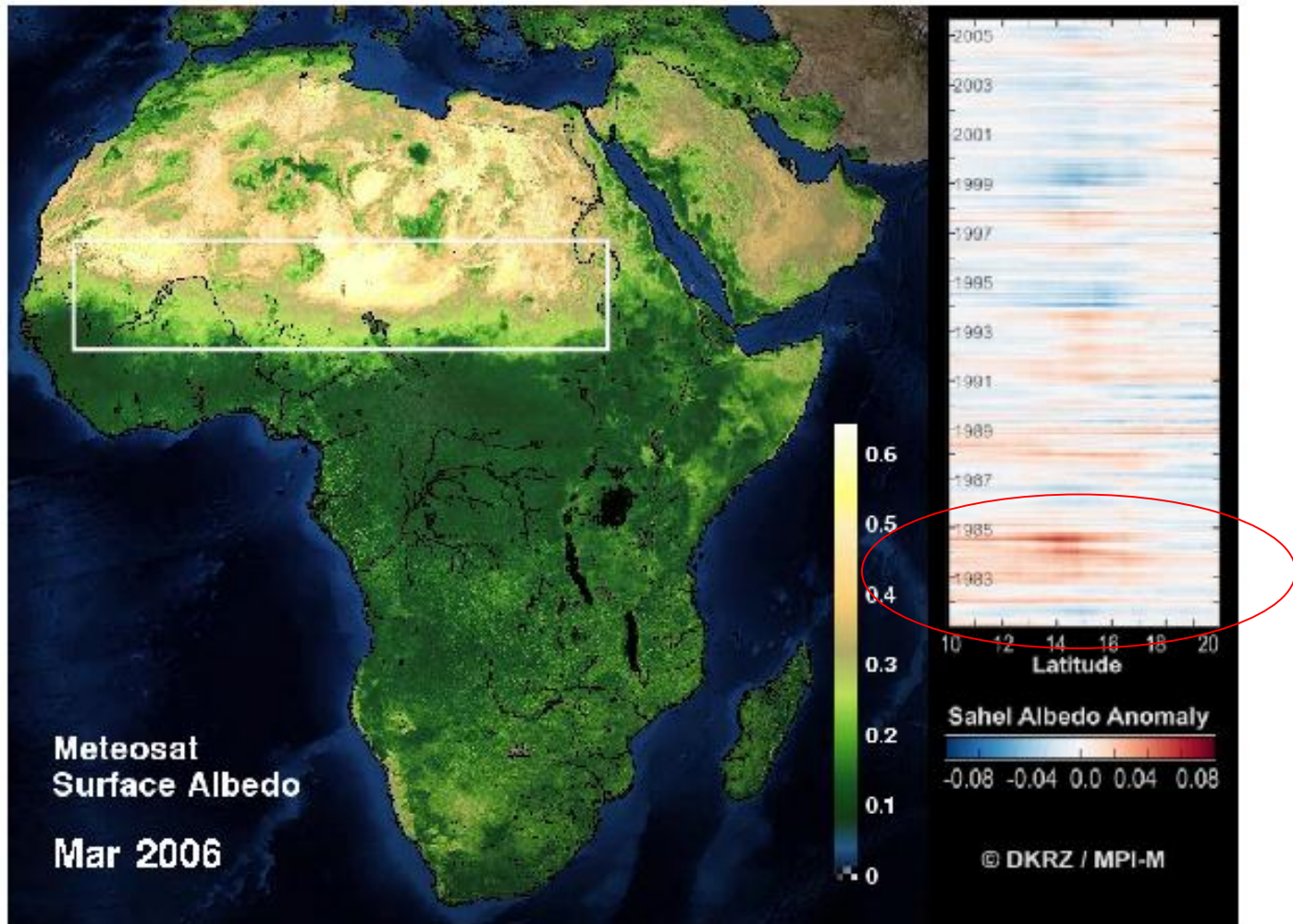
**„Small“ effect big  
impact ...**

# Sahelian drought

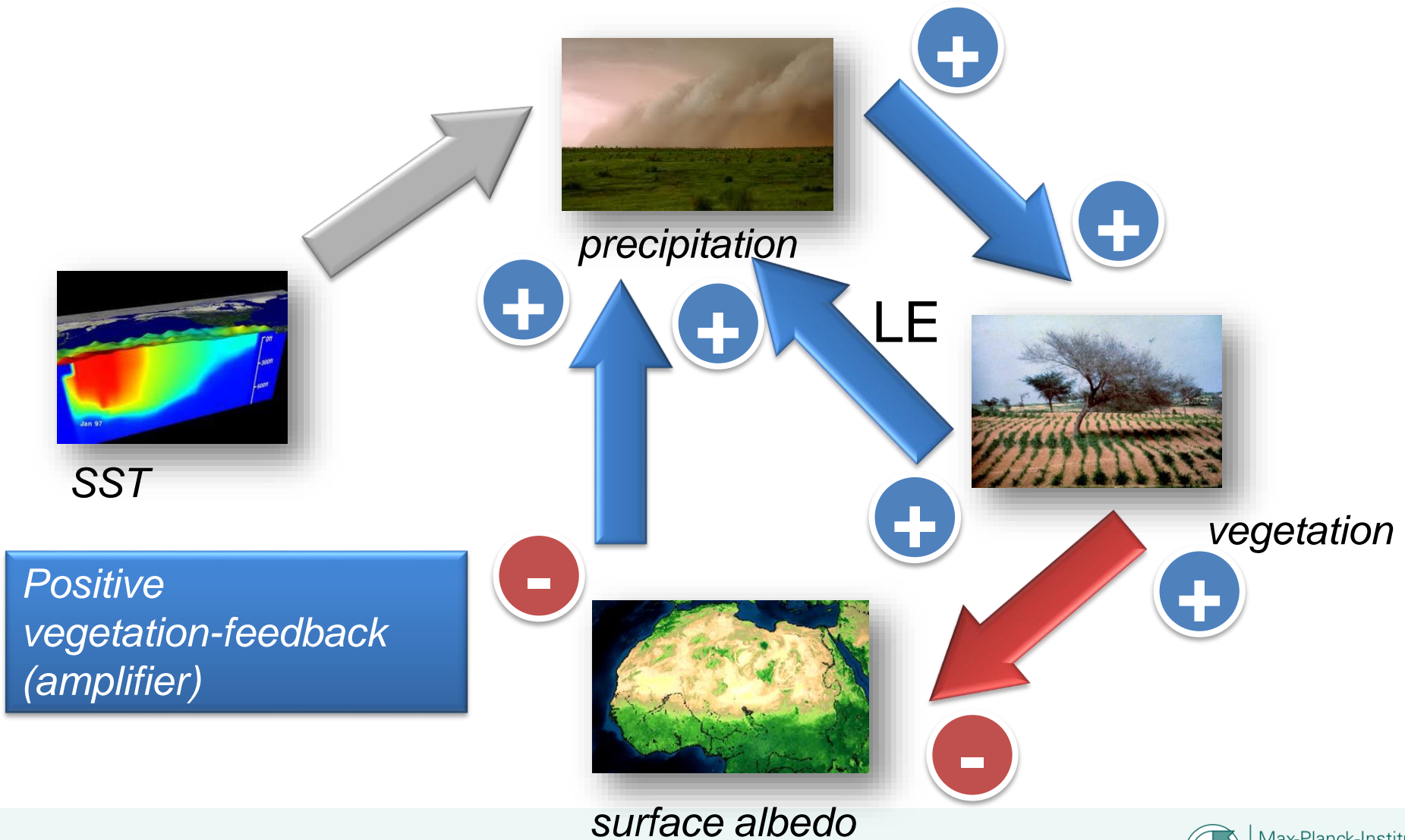
- largest climate anomaly observed so far (recent times)
- Severe impact on humans
- Vegetation/surface albedo feedback as amplifier



# Meteosat surface albedo



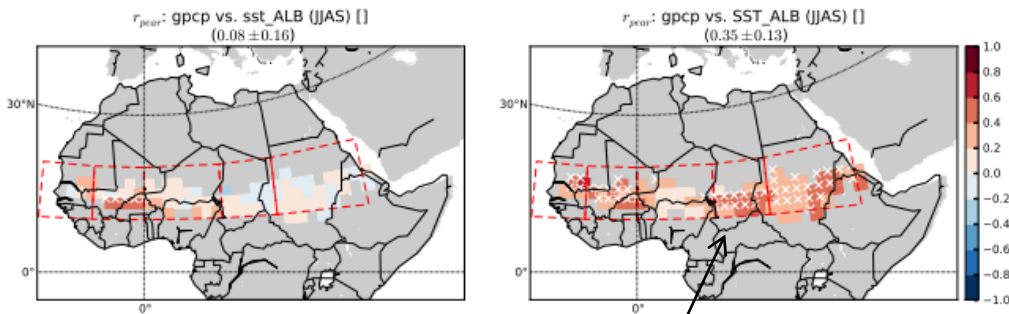
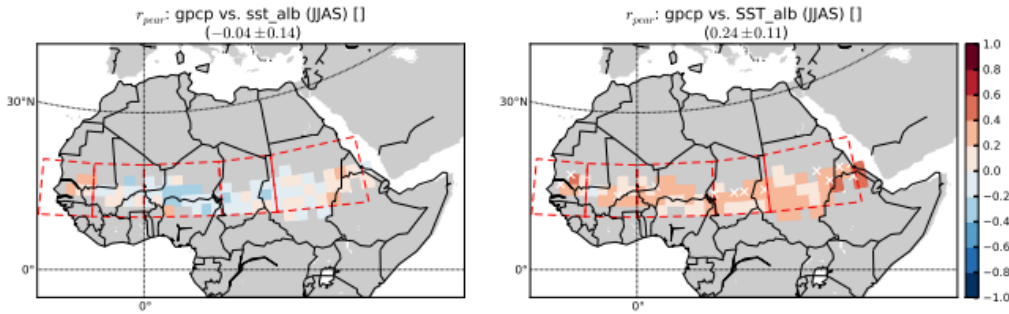
# Surface albedo feedback



surface albedo

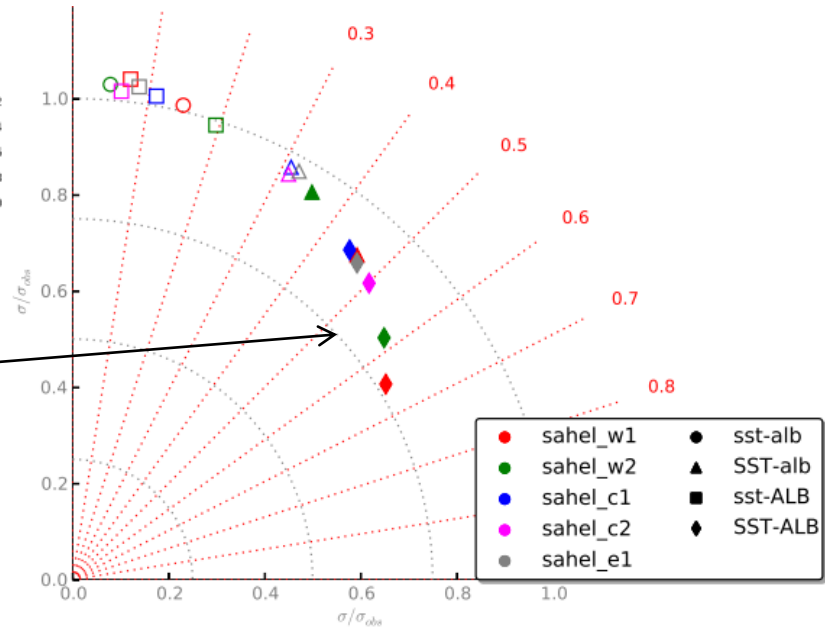


# Reliable albedo data helps for improved rainfall simulations

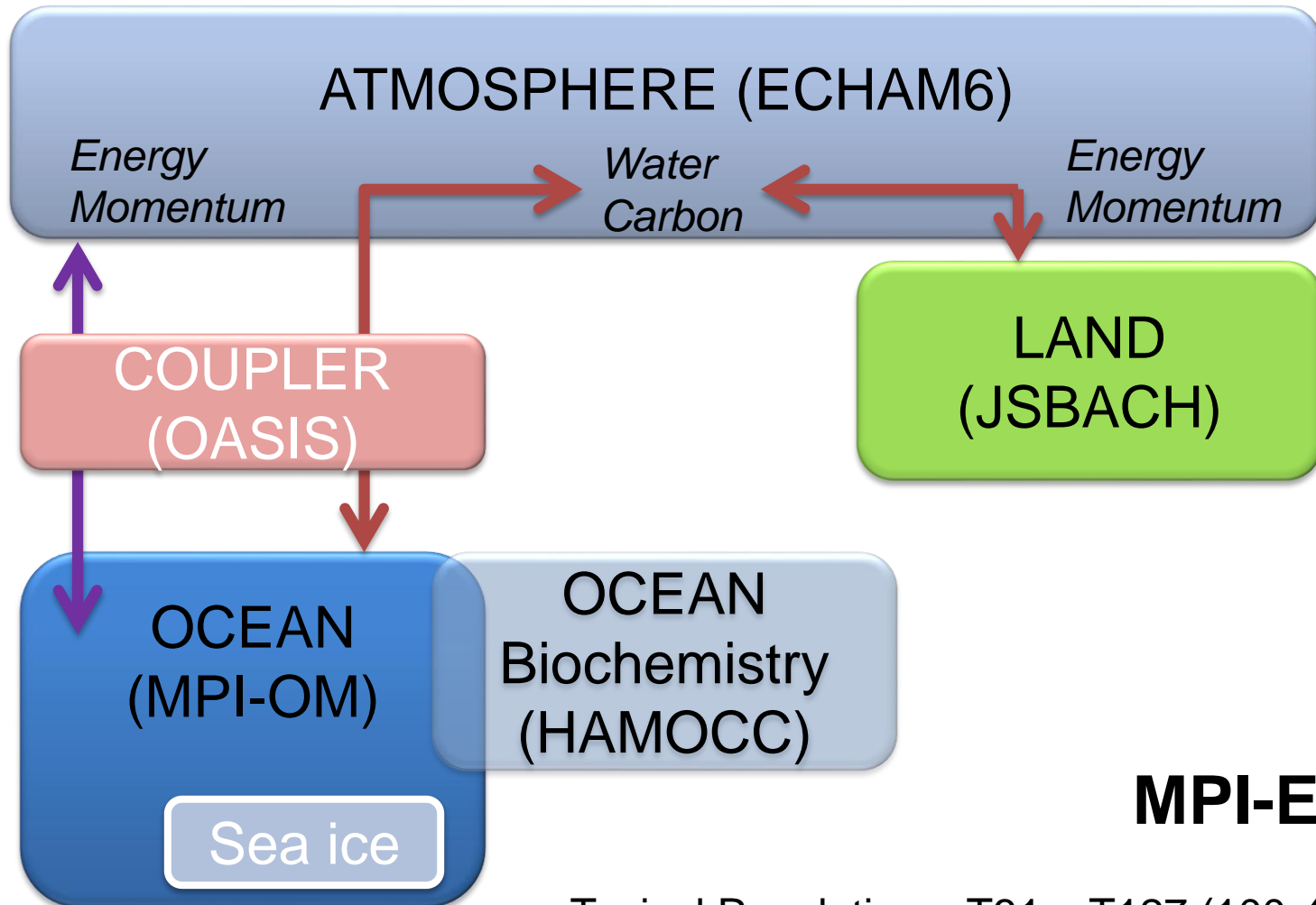


*Meteosat surface albedo (EUMETSAT)*

**With albedo prescribed**



# Earth system models



**MPI-ESM**

Typical Resolutions T31 – T127 (100-400 km)

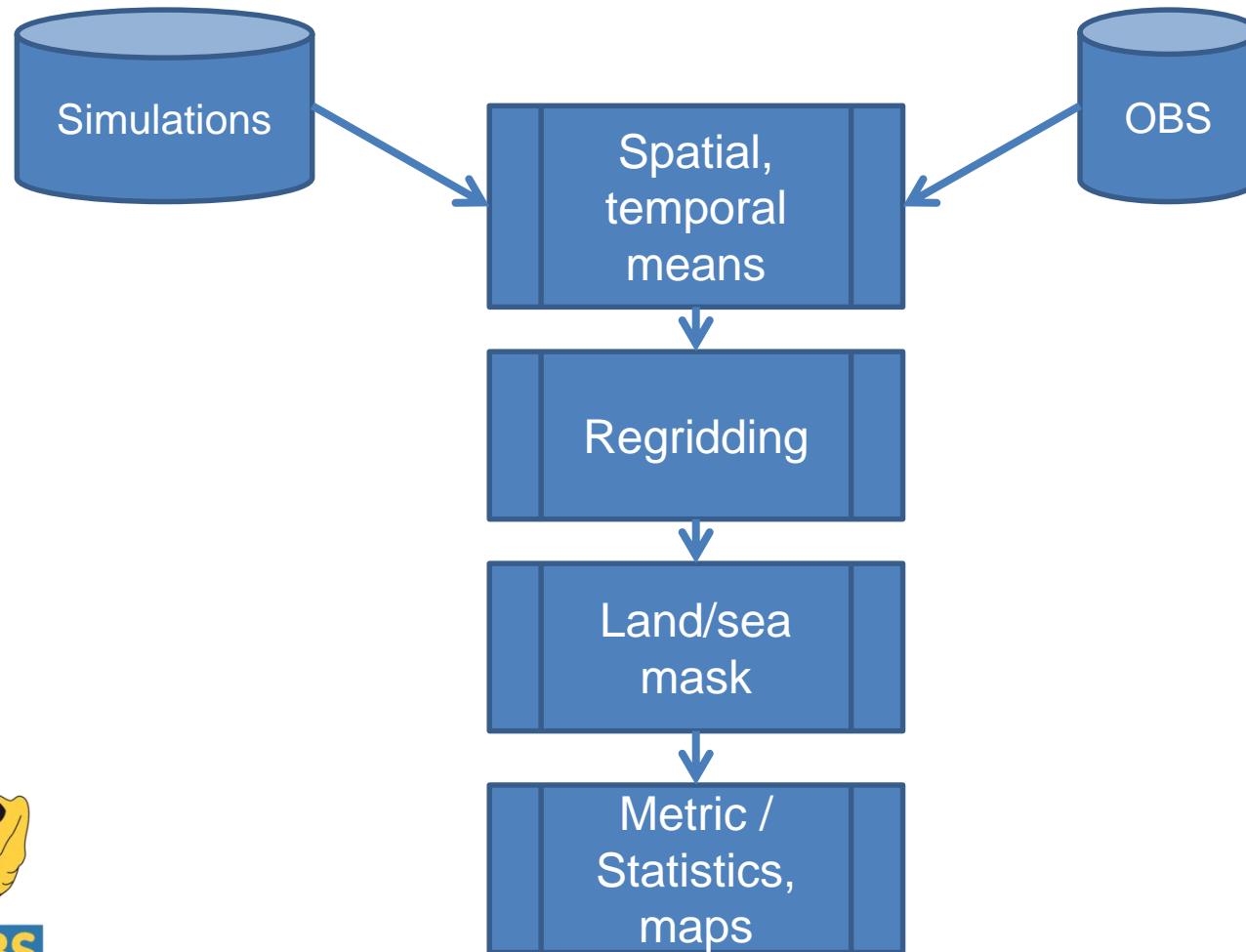
# Globalbedo & MPI-ESM

1. Usability of GlobAlbedo for climate model evaluation?
2. How does usage of GlobAlbedo alter the simulated climate? (feedback)

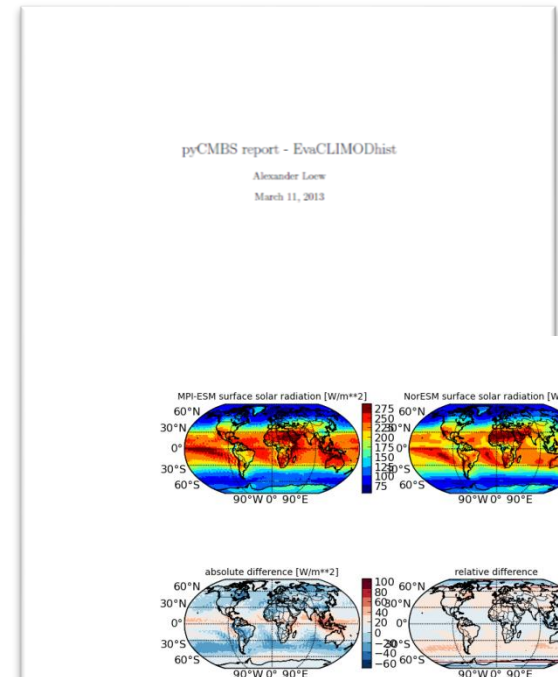
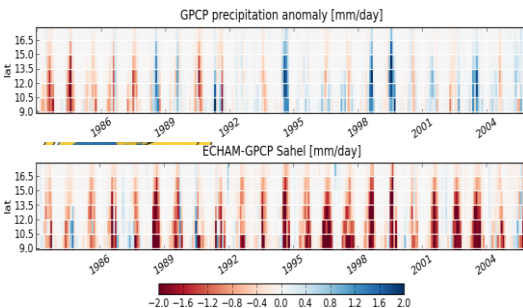
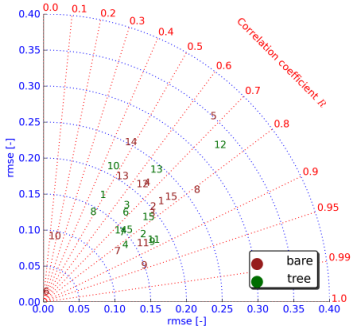
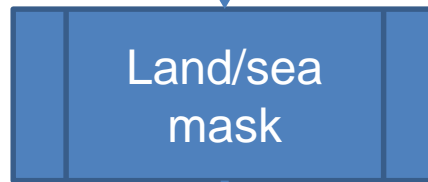
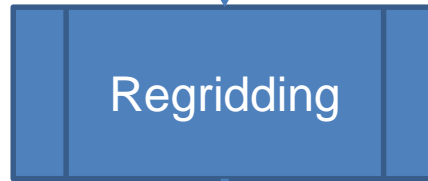
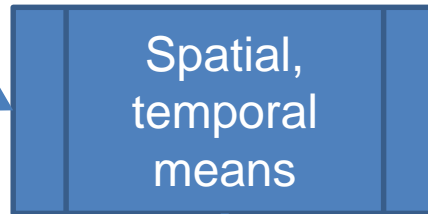
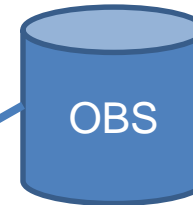
# Climate model evaluation

- **Objective:** Value of GlobAlbedo for climate model benchmarking?

# Automated model evaluation



# Automated model evaluation



python based geoscientific and climate data analysis and model benchmarking tool

2,837 commits 2 branches 1 release 2 contributors

branch: master pycmbs / +

Merge branch 'master' of github.com:pygeo/pycmbs

👤 bull92	authored Friday at 3:41 pm	latest commit c6e2ce8755
📁 demo	[demo] added an ipython notebook with basic demos on pycmbs usage	3 months ago
📁 docsrc	[doc] added documentation for ipython notebook examples	3 months ago
📁 features	[acceptance tests] adding initial BDD tests	2 months ago
📁 notes	[notes/restructuring] added roadmap suggestions	4 months ago
📁 pycmbs	Merge branch 'master' of github.com:pygeo/pycmbs	4 days ago
📁 scripts	[mapping] added functionality to plot polygons on top of maps	a month ago
📄 .coveragerc	[travis] nosetests with coverage	4 months ago
📄 .gitignore	[gitignore] added few items and some files	3 months ago
📄 .travis.yml	[travis] build only master branch	2 months ago
📄 .travis_no_output	[travis] no output travis script, adopted from cartopy	3 months ago
📄 AUTHORS.md	[DOC] installation	3 months ago
📄 CHANGES.md	[CHANGES] adapted changes notice	4 months ago
📄 COPYING_netCDF4	[diagnostic] some additional minor edits	4 months ago

<> Code

Issues 13

Pull Requests 0

Wiki

Pulse

Graphs

Network

HTTPS clone URL

https://github.co

You can clone with HTTPS or Subversion

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# Work performed

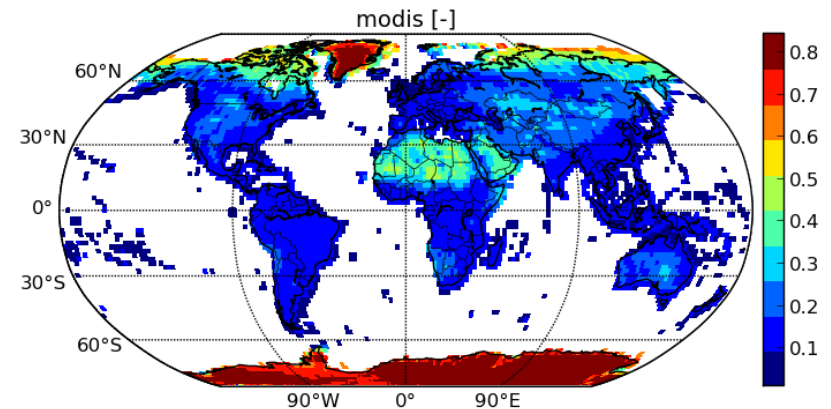
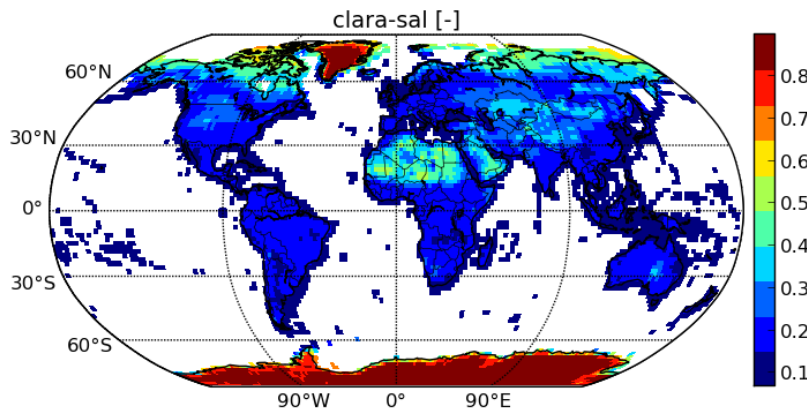
- ✓ Integration of GlobAlbedo (BHR, DHR) data into pyCMBS framework
- ✓ Use GlobAlbedo for evaluation of CMIP5 model simulations
- ✓ Use results as part of CMIP5 surface radiation assessment paper



# Monthly mean surface albedo

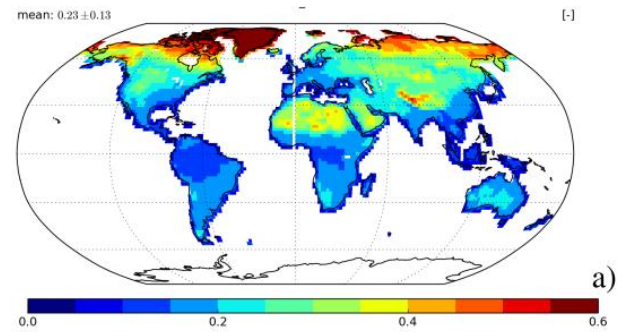
- Surface albedo model:  $\frac{\overline{F}^\uparrow}{\overline{F}^\downarrow}$
- Observations:
  - CLARA-SAL (CM-SAF) = BSA
  - MODIS WSA
  - CERES
  - **Globalbedo (BHR, DHR)**

Blue sky albedo product would be probably useful

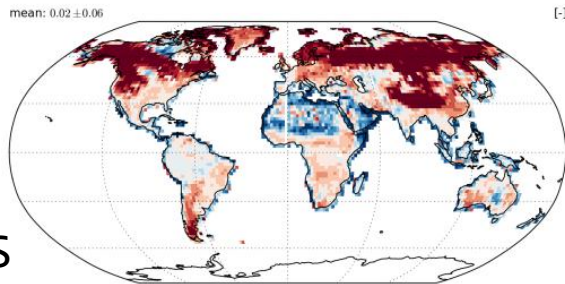


# CMIP5 radiation assessment

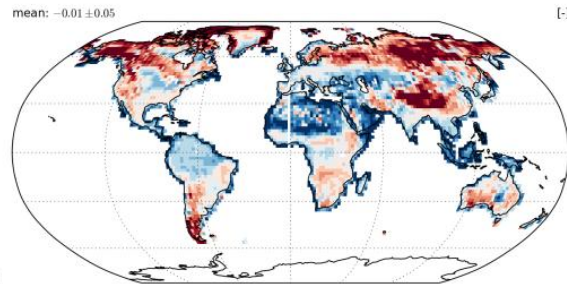
Multimodel mean land surface albedo



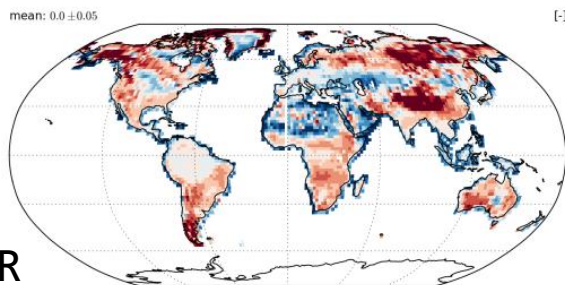
Climatological difference with ...



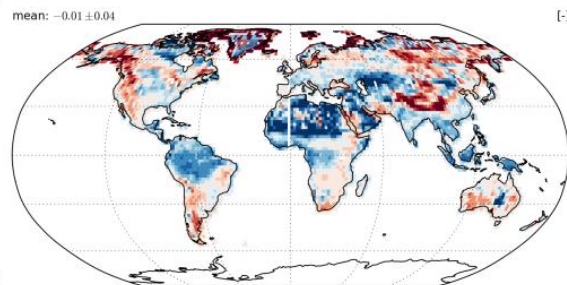
... MODIS



... GA BHR

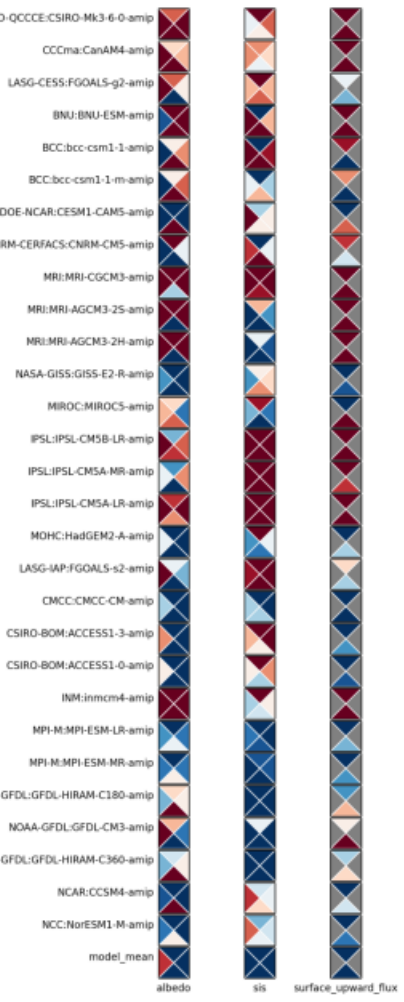
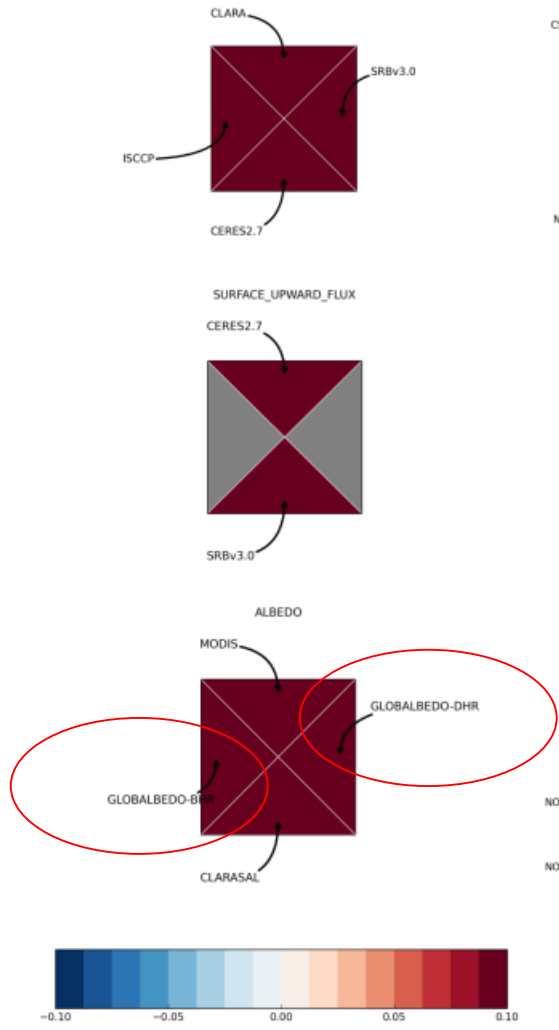


... GA DHR



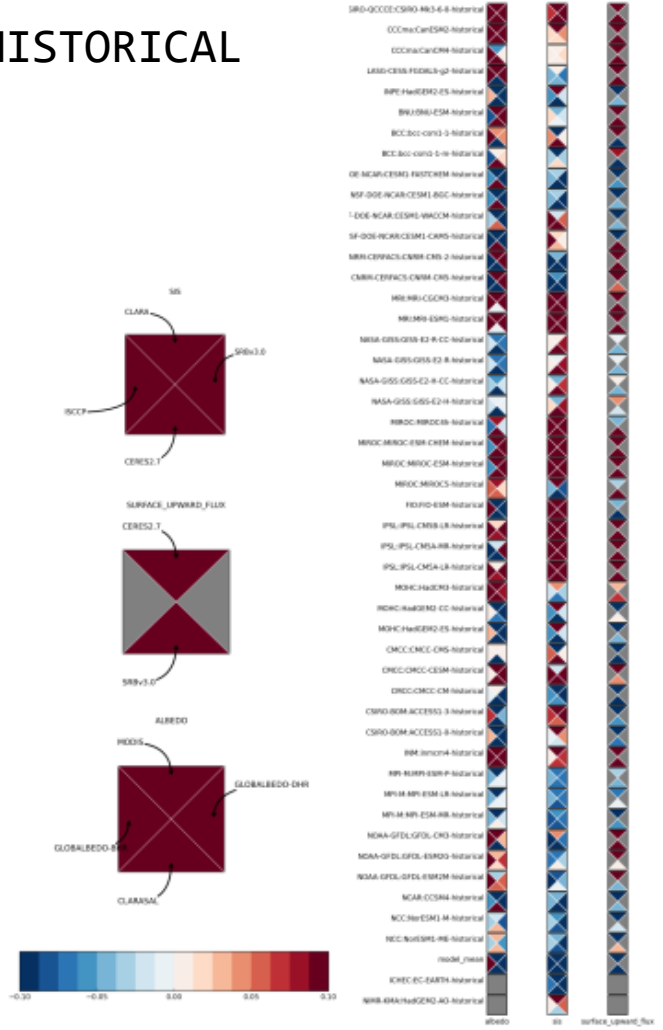
... CLARA SAL

# Model ranking



AMIP

## HISTORICAL



# CMIP5 radiation assessment

- Surface solar radiation flux components
- Whole CMIP5 archive (AMIP, HISTORICAL)

JOURNAL OF CLIMATE

## Assessing land surface solar radiation fluxes in the CMIP5 ensemble

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MIKHAIL ITKIN

*Max-Planck-Institute for Meteorology, Hamburg, Germany*

AXEL ANDERSSON

*Satellite-based Climate Monitoring, Deutscher Wetterdienst, Offenbach, Germany*

JÖERG TRENTMANN

*Satellite-based Climate Monitoring, Deutscher Wetterdienst, Offenbach, Germany*

MARC SCHRÖDER

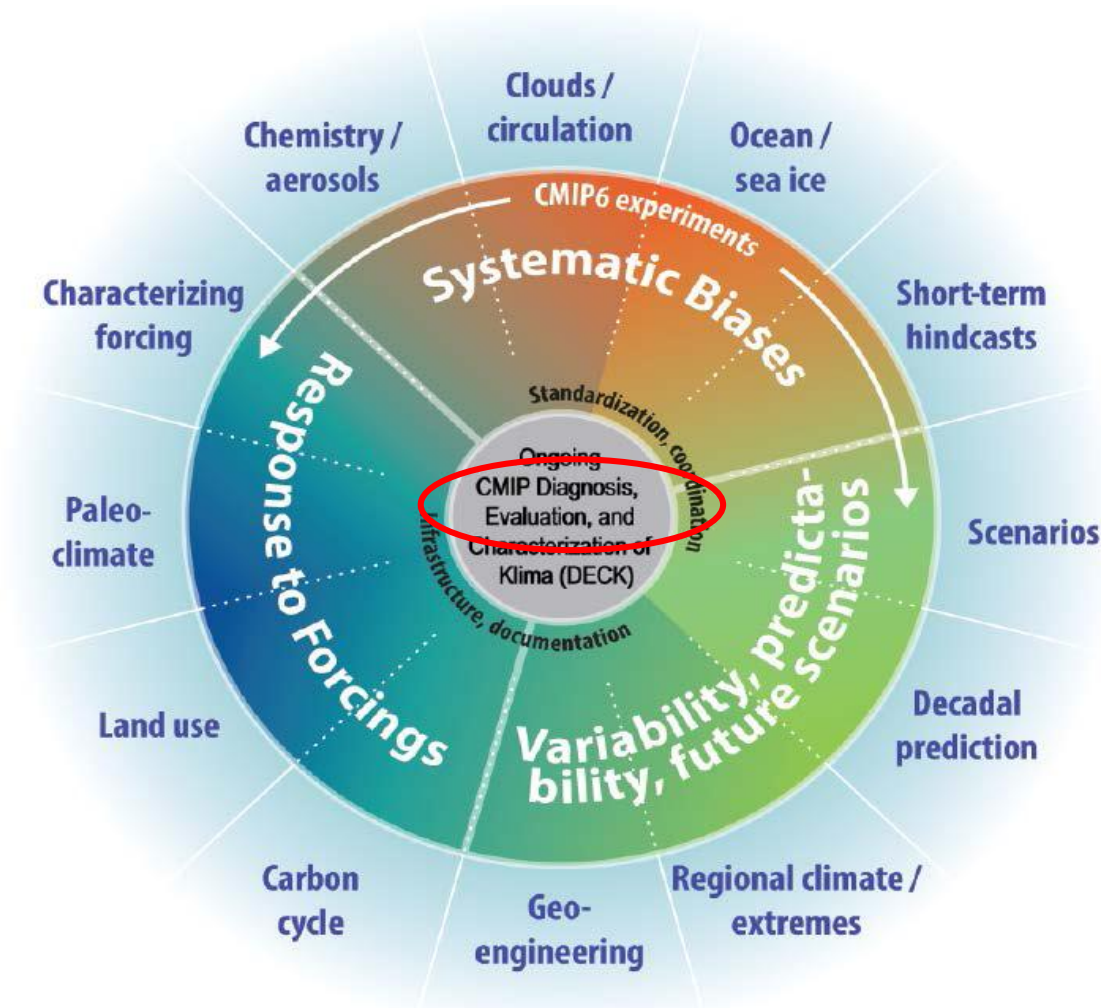
*Satellite-based Climate Monitoring, Deutscher Wetterdienst, Offenbach, Germany*

### ABSTRACT

Earth System models (ESM) are indispensable tools in climate studies. The Climate Modelling Intercomparison Project (CMIP) is a coordinated effort of the Earth System Modelling community to evaluate the state-of-the-art in ESMs. An accurate representation of the terrestrial surface fluxes remains a major challenge in earth system modelling. As the land surface water and energy fluxes are closely related with each other and the terrestrial carbon fluxes, the capability of ESMs to simulate these surface fluxes is of major importance. The present study analyzes the ensemble of CMIP5 models and focuses on the evaluation of land surface solar radiation fluxes. It analyzes more than 90% of the CMIP5 models and experiments for present day climate conditions (*AMIP, HISTORICAL*). It provides the first thorough assessment of surface solar radiation fluxes for CMIP5. The accuracy of each model is quantified against different observational datasets using various skill scores. A unique element is that the study also analyzes how different observational dataset affect the relative ranking between models. It is shown that the model ranking largely varies dependent on the observations chosen. As a consequence the choice of the observational record has a strong effect. It is illustrated that uncertainties in the model ranking are in general smaller between different experiments (*AMIP, HISTORICAL*) rather than the uncertainties related to the observational datasets themselves. It is therefore concluded that in most cases "good models are always good models".

# Towards integrated model evaluation

## CMIP6



# Summary evaluation

- GlobAlbedo provides a useful and competitive data product that is useful for climate model benchmarking similar to other existing datasets.
- Recommendation: study value for regional climate studies (interannual anomalies)
- Integration of GlobAlbedo in ESMValTool for continuous model benchmarking in CMIP6

# GlobAlbedo as boundary condition in MPI-ESM

# Does it matter?

- Objective: Using GlobAlbedo as model boundary condition.





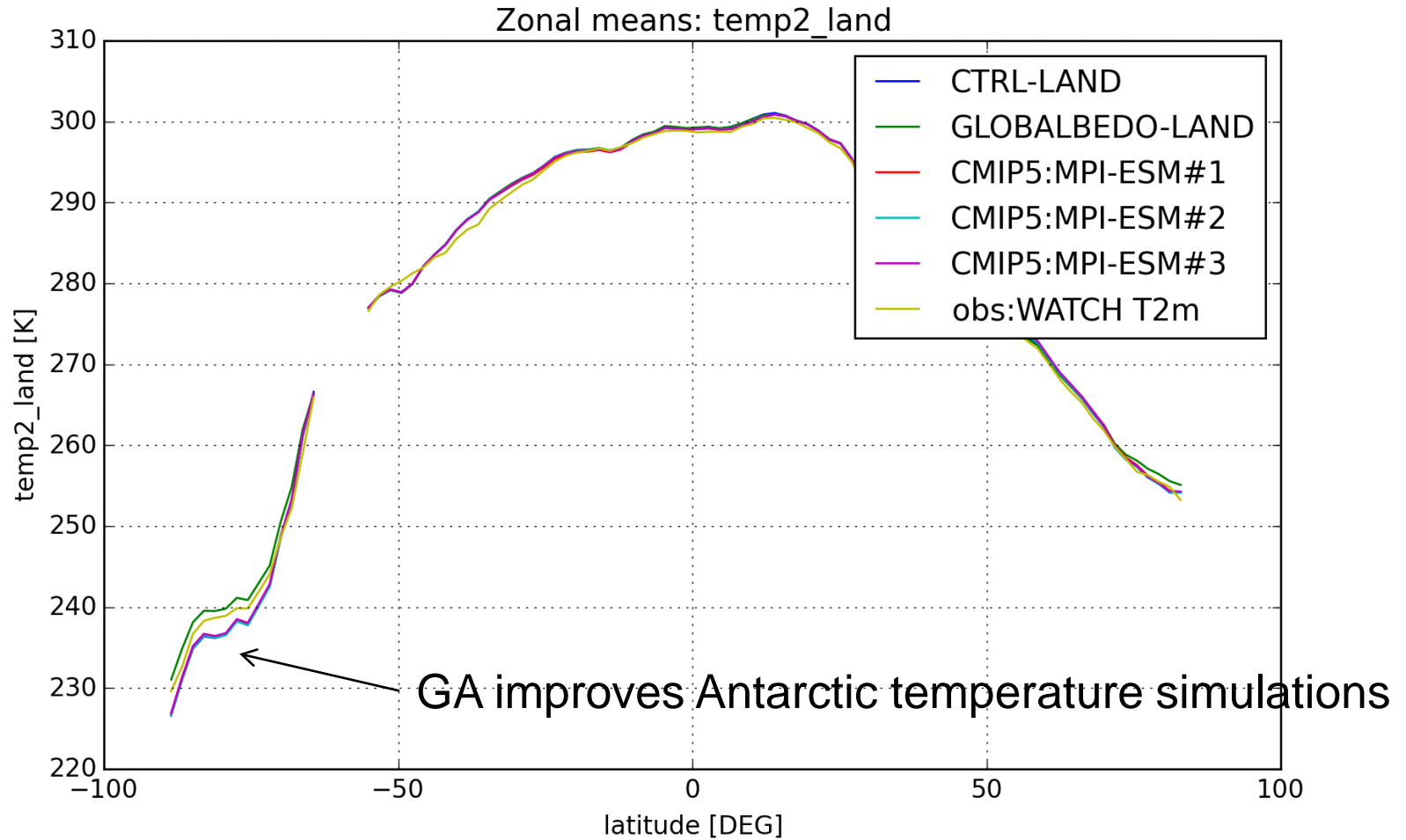
# Tasks

- ✓ Integrate GlobAlbedo as boundary condition in MPI-ESM
- ✓ Perform dedicated (AMIP like) model simulations
- ✓ Validate model results and assess impact on climate

# Data and methods

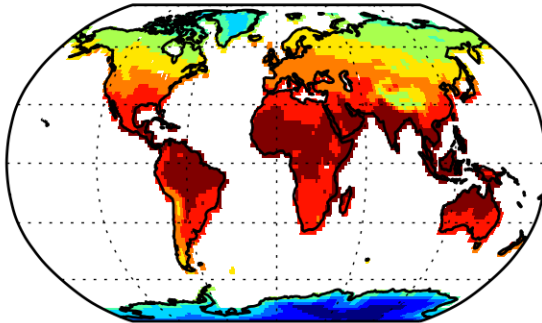
- MPI-ESM
  - GlobAlbedo  $0.5^\circ$  product
  - CMIP5 simulations (as independent reference + internal variability)
1. Perform CTRL simulation with standard model setup (AMIP)
  2. Perform EXPERIMENT with GlobAlbedo as boundary condition

# Results



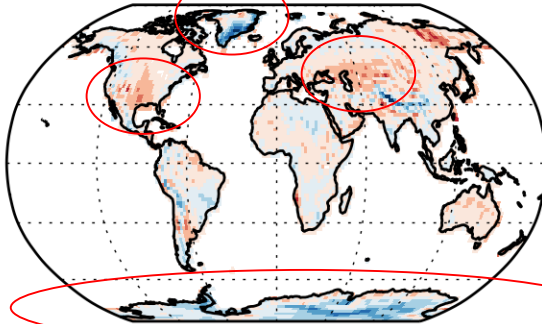
# Effect on temperature

CTRL-LAND  
mean:  $283.29 \pm 18.52$  [K]



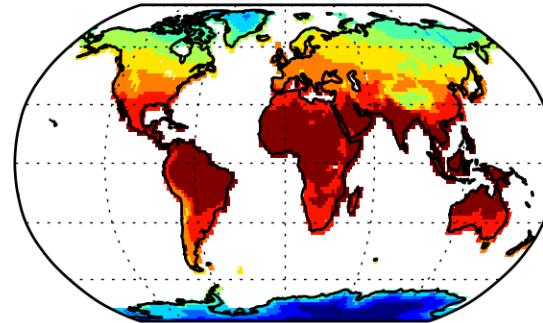
220 230 240 250 260 270 280 290 300  
absolute difference

mean:  $0.42 \pm 1.78$  [K]



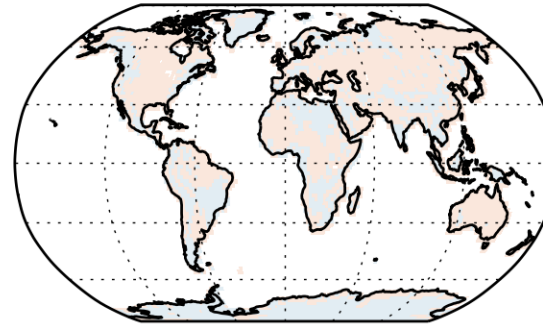
-10 -8 -6 -4 -2 0 2 4 6 8 10

obs:WATCH T2m  
mean:  $282.81 \pm 18.03$  [K]



230 240 250 260 270 280 290 300  
relative difference

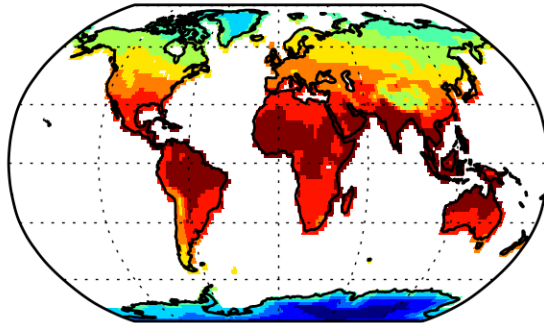
median: 0.0 [-]



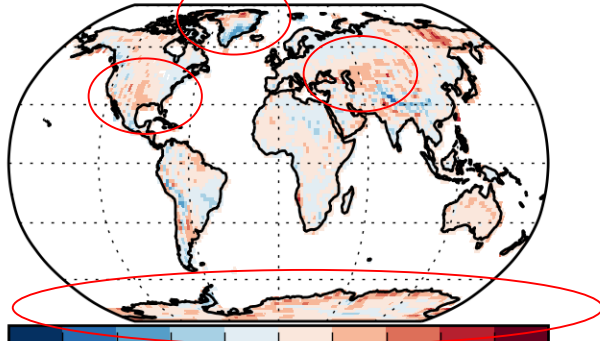
-0.50 -0.25 0.00 0.25 0.50

# Effect on temperature

GLOBALBEDO-LAND  
mean:  $283.47 \pm 17.89$  [K]

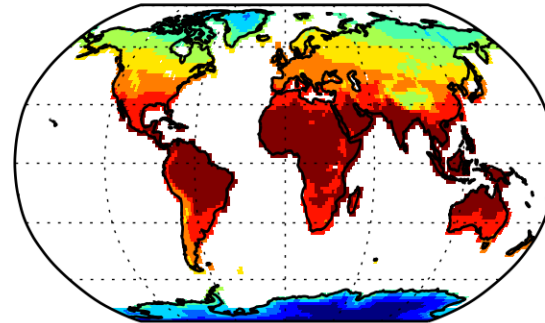


230 240 250 260 270 280 290 300  
absolute difference  
mean:  $0.6 \pm 1.55$  [K]

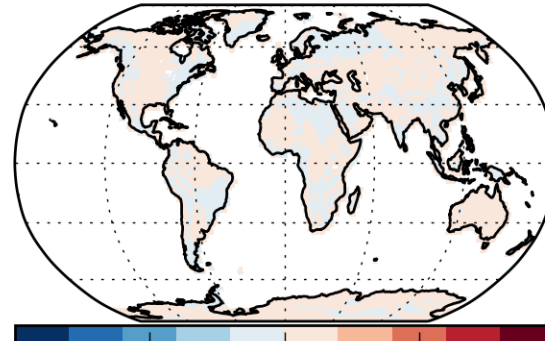


-10 -8 -6 -4 -2 0 2 4 6 8 10

obs:WATCH T2m  
mean:  $282.81 \pm 18.03$  [K]



230 240 250 260 270 280 290 300  
relative difference  
median: 0.0 [-]

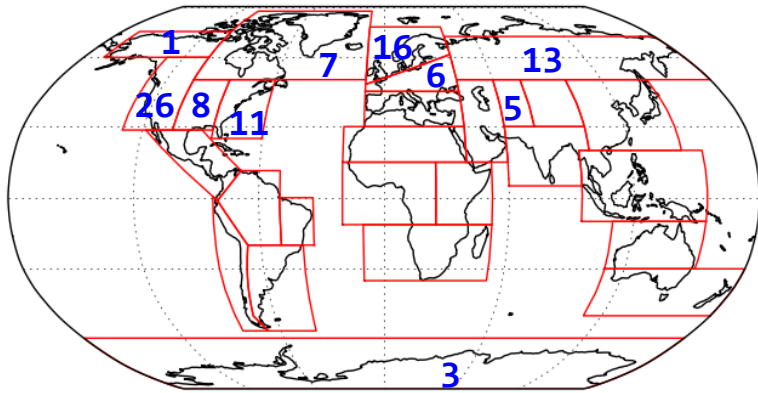


-0.50 -0.25 0.00 0.25 0.50

→ Motivation to improve ice albedo parameterization!

# Temperature analysis

- Where are larger differences between CTRL and EXPERIMENT?

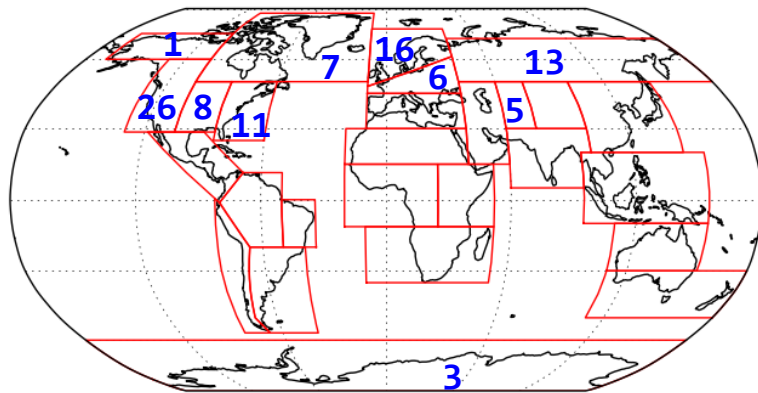


IPCC regions

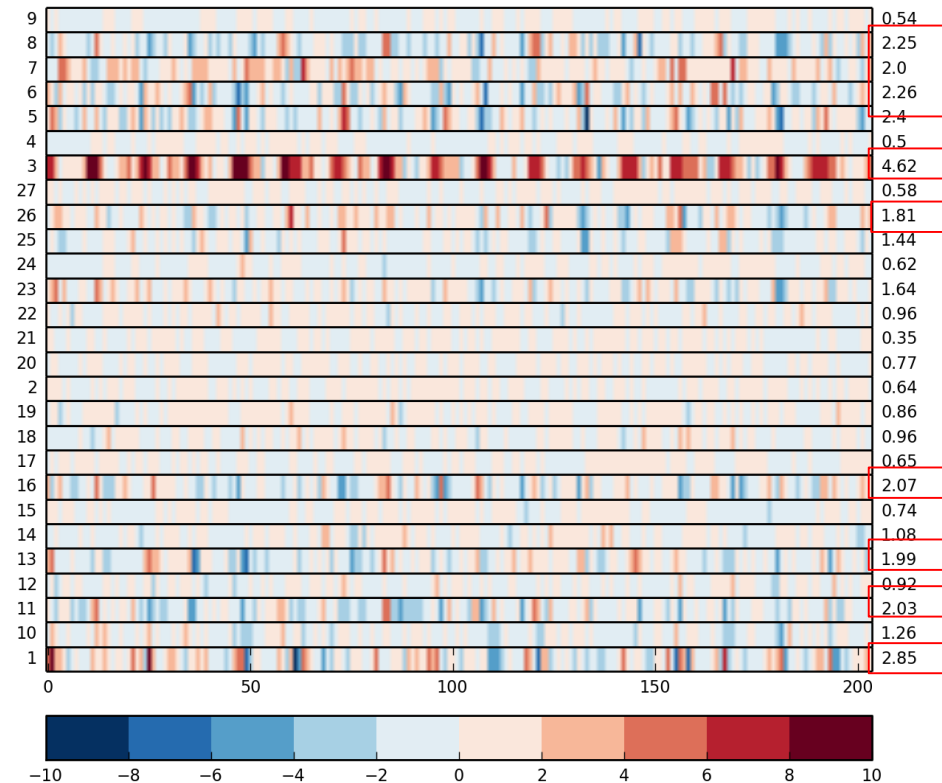
# Temperature analysis

- Where are larger differences between CTRL and EXPERIMENT?

EXPERIMENT - CTRL

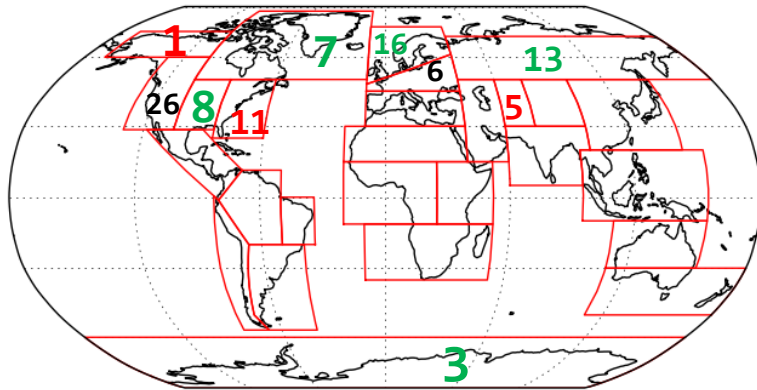


IPCC regions

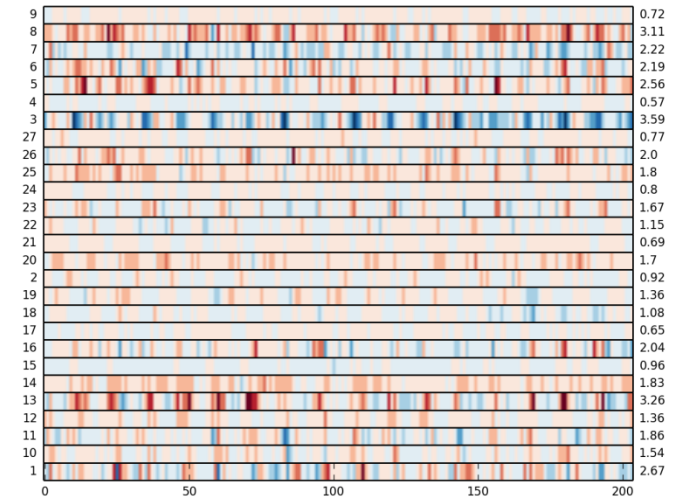


# Do we get improvement?

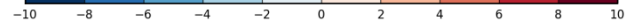
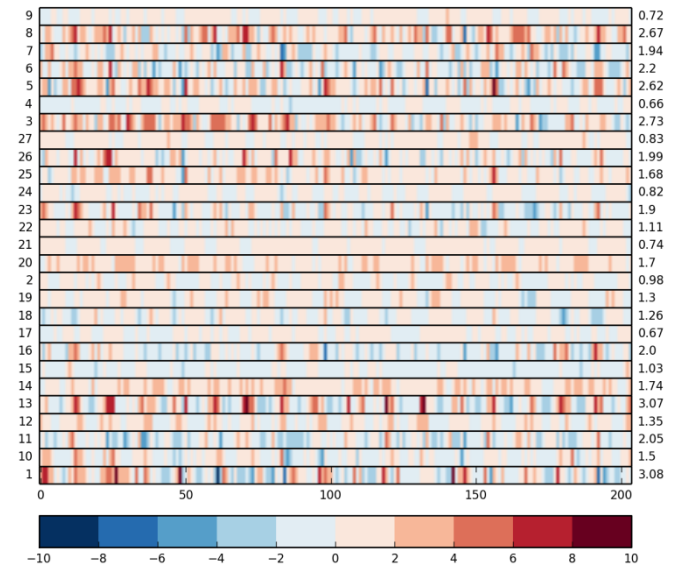
RMSD



CTRL - OBS



EXPERIMENT - OBS



Difference between temperature observations and simulations



# Summary impact assessment

- Impact mainly on regional scale
- Mainly slight improvement of T2m simulations using GlobAlbedo
- Improvement of ice albedo required in MPI-ESM

# Conclusions

- GlobAlbedo turned out to be a very usefull dataset for different aspects of climate modelling
- More regional analyis required
- More longterm data record required (temporal anomalies);  
QA4ECV