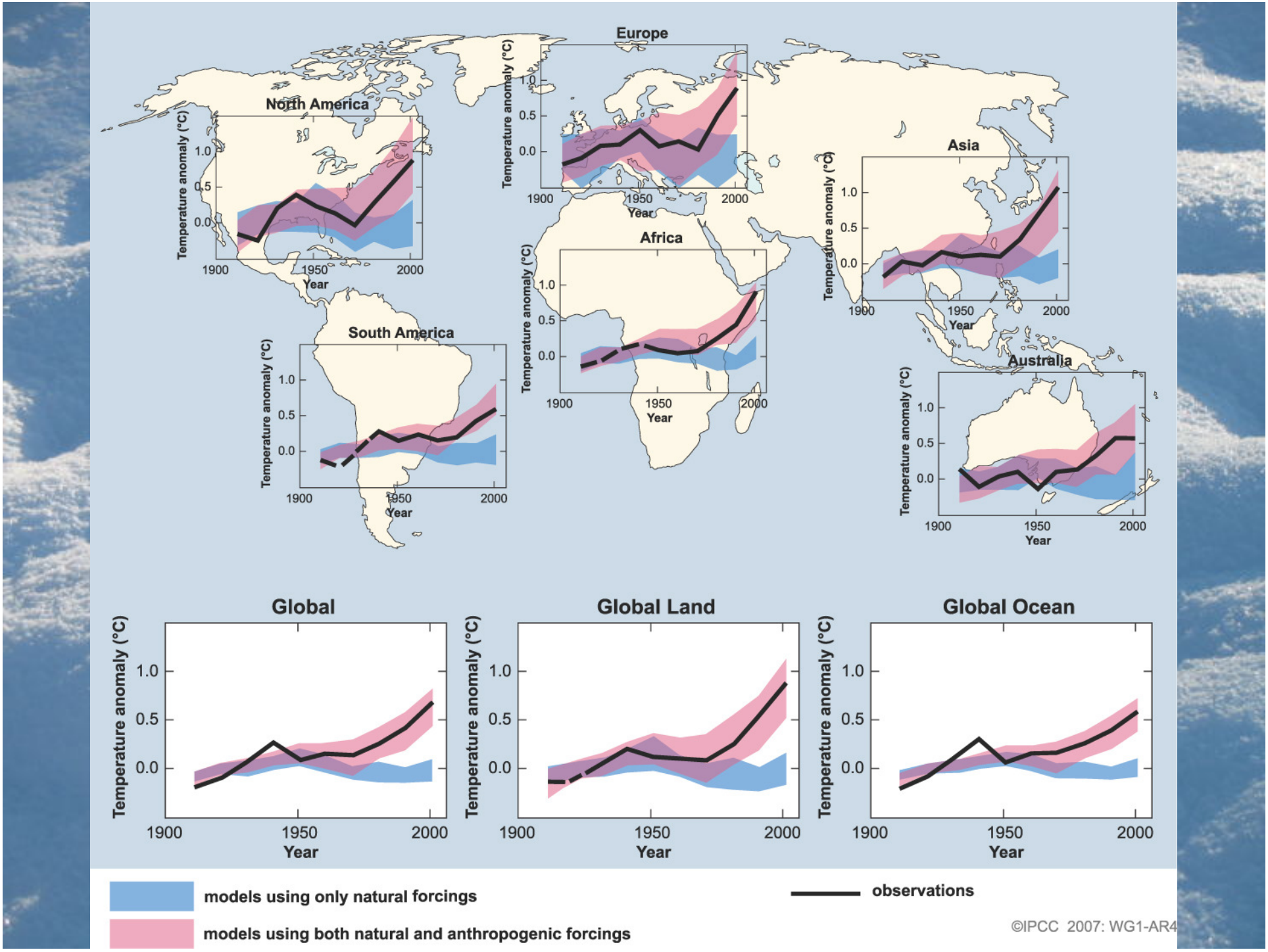
CORDEX

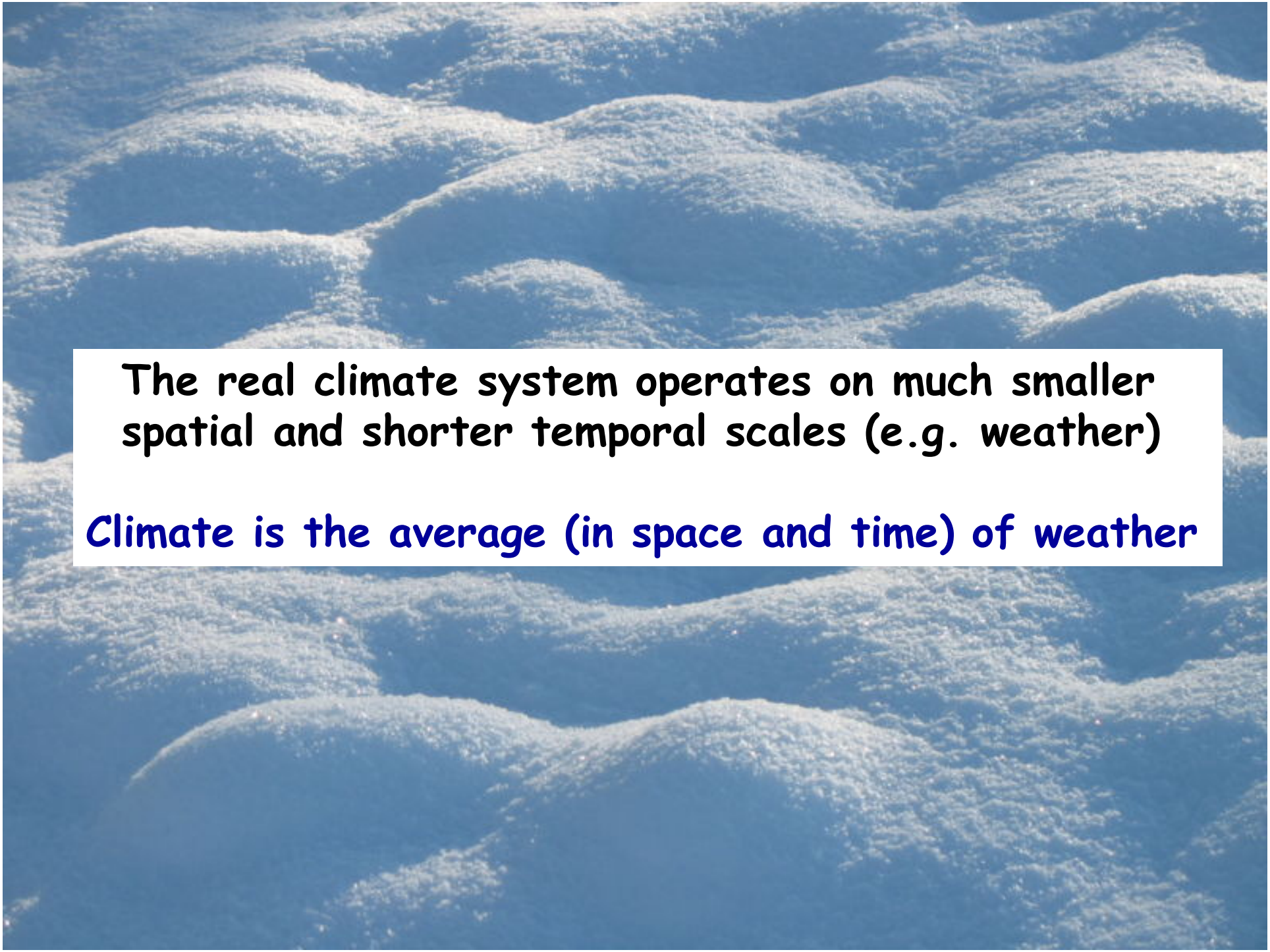
Coordinated Regional Downscaling Experiment

Sponsored by WCRP

High Resolution regional climate simulations for

1. Understanding Regional Climate Process
2. Improving climate models
3. Capacity Building
4. Providing evaluated high resolution regional climate projections for land-regions worldwide
5. Linking climate modelling better with regional impact, adaptation and vulnerability assessment

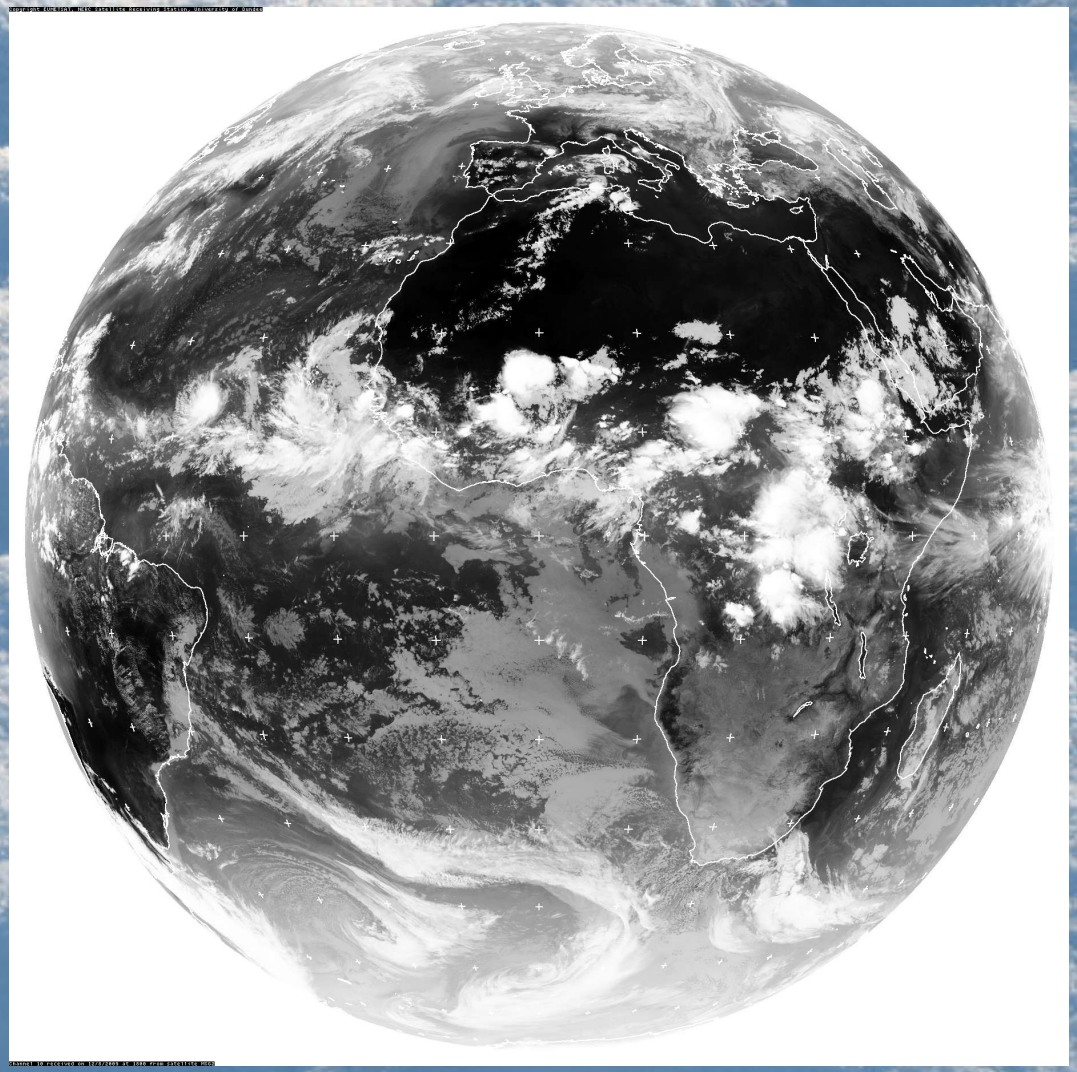




The real climate system operates on much smaller spatial and shorter temporal scales (e.g. weather)

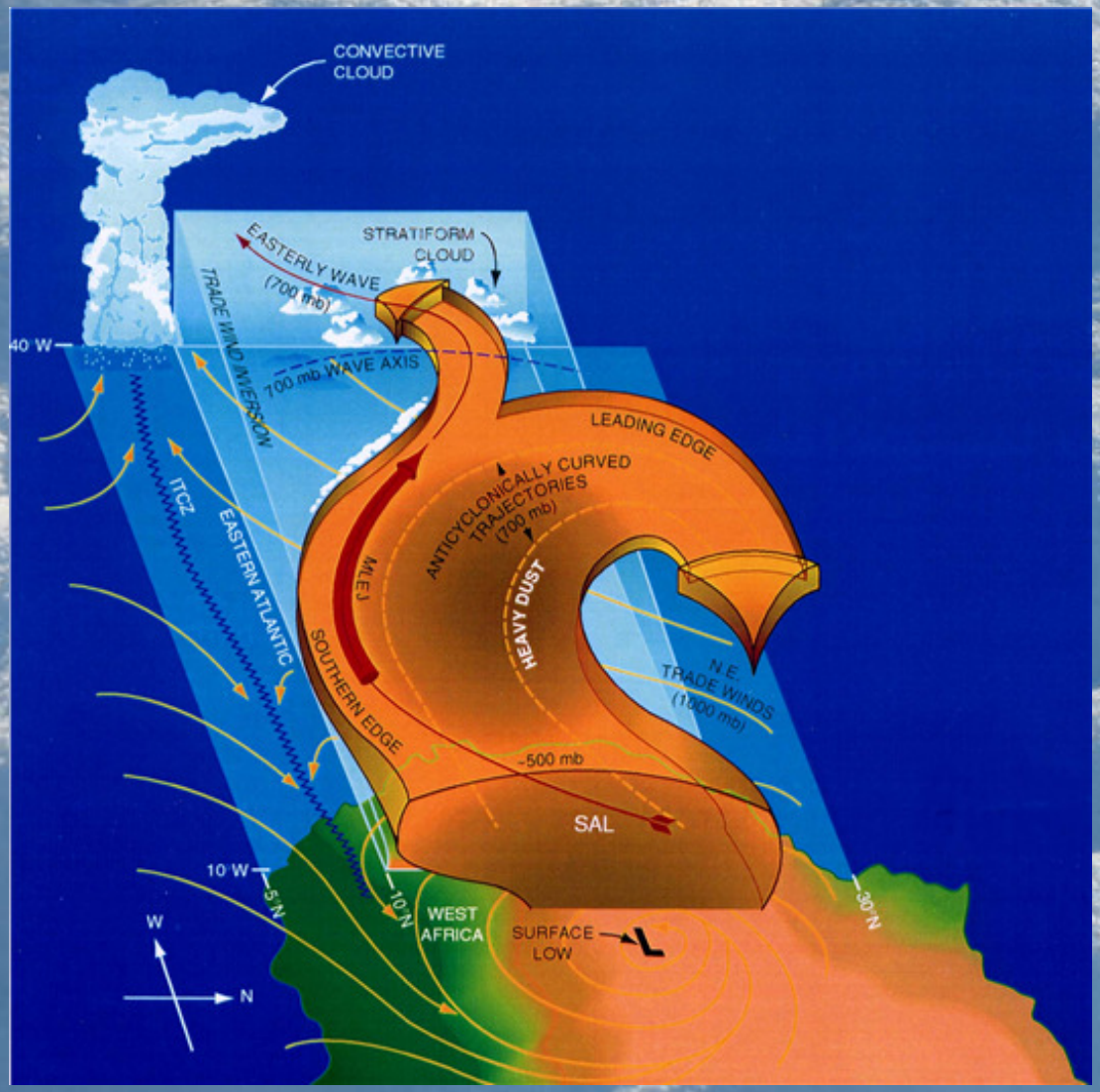
Climate is the average (in space and time) of weather

Larger scale atmospheric motions and surface forcing influence Climate/weather variability in systematic ways in different regions.



African Easterly Waves and sub-saharan rainfall variability

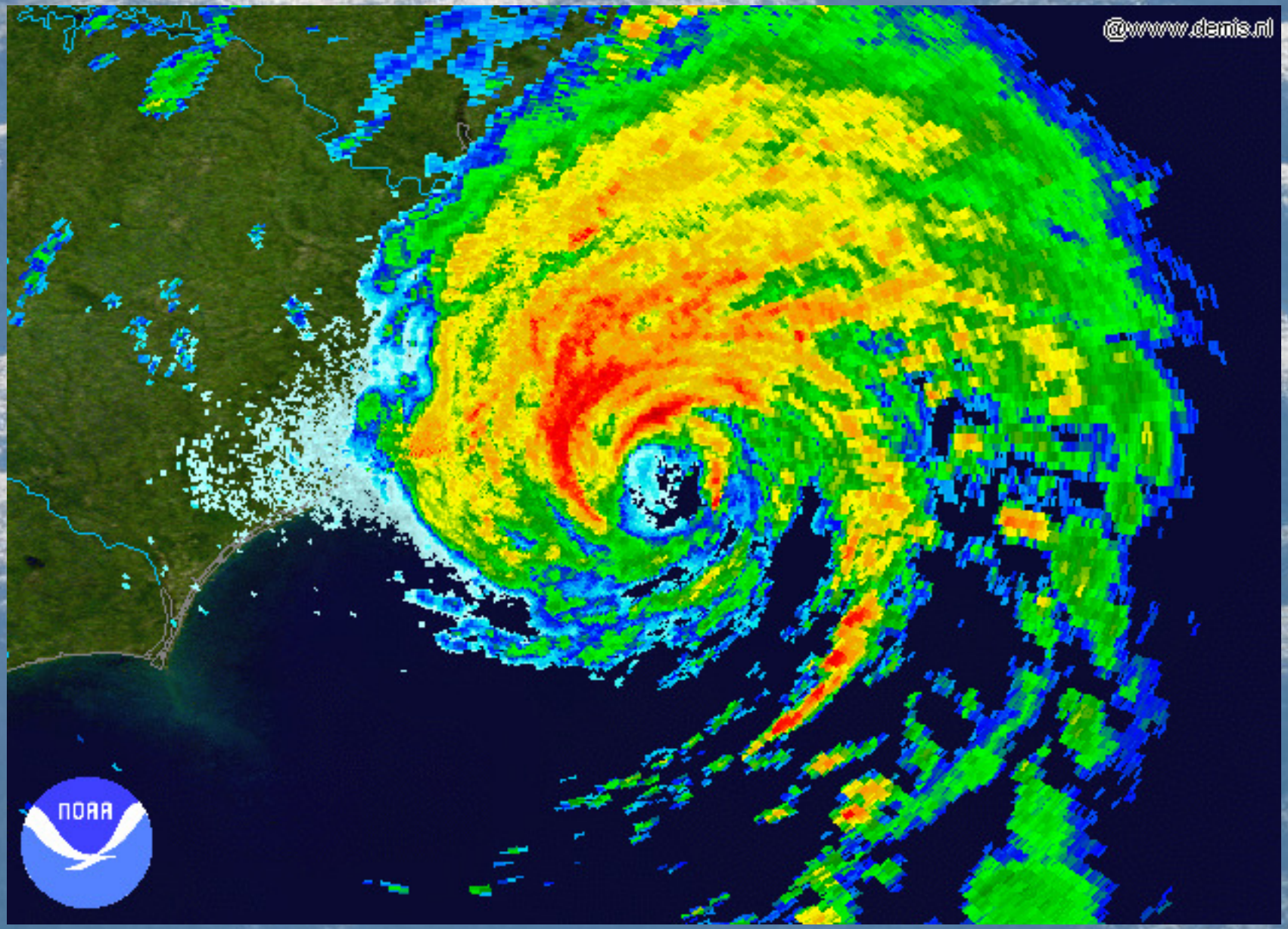
West African Monsoon dynamics & Easterly waves



These interactions involve planetary-scale monsoon circulation, continental scale surface heat gradients, vertically constrained jets (African Easterly Jet), synoptic scale waves, interactions with the subtropical anticyclone and convective scale heating.

Given accurate large scales can we simulate important regional processes?

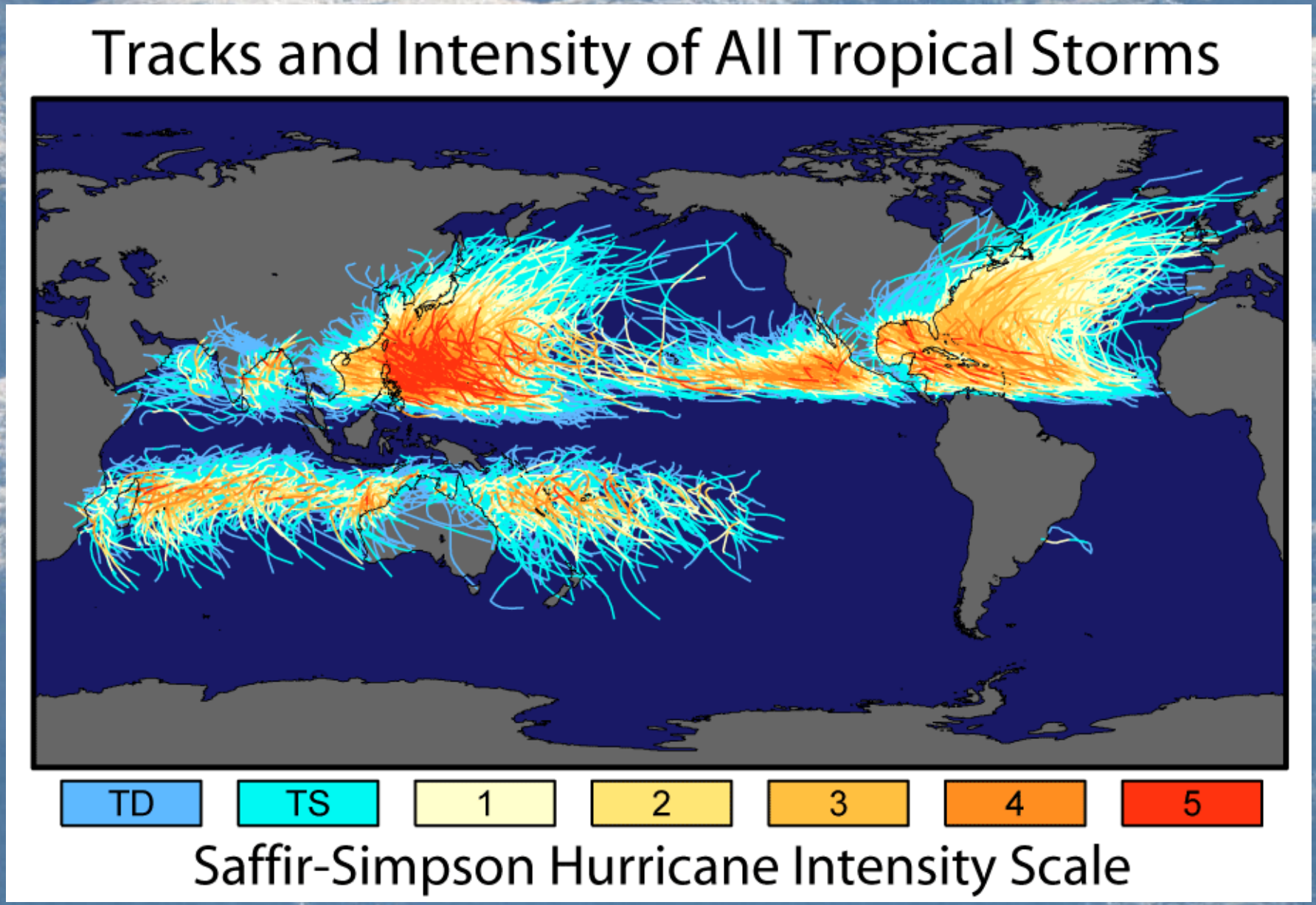
In tropical cyclones convective scale heating plays an important role in cyclone development but is also organized by meso- and cyclone scales



The impact of tropical cyclones occurs primarily at local scales

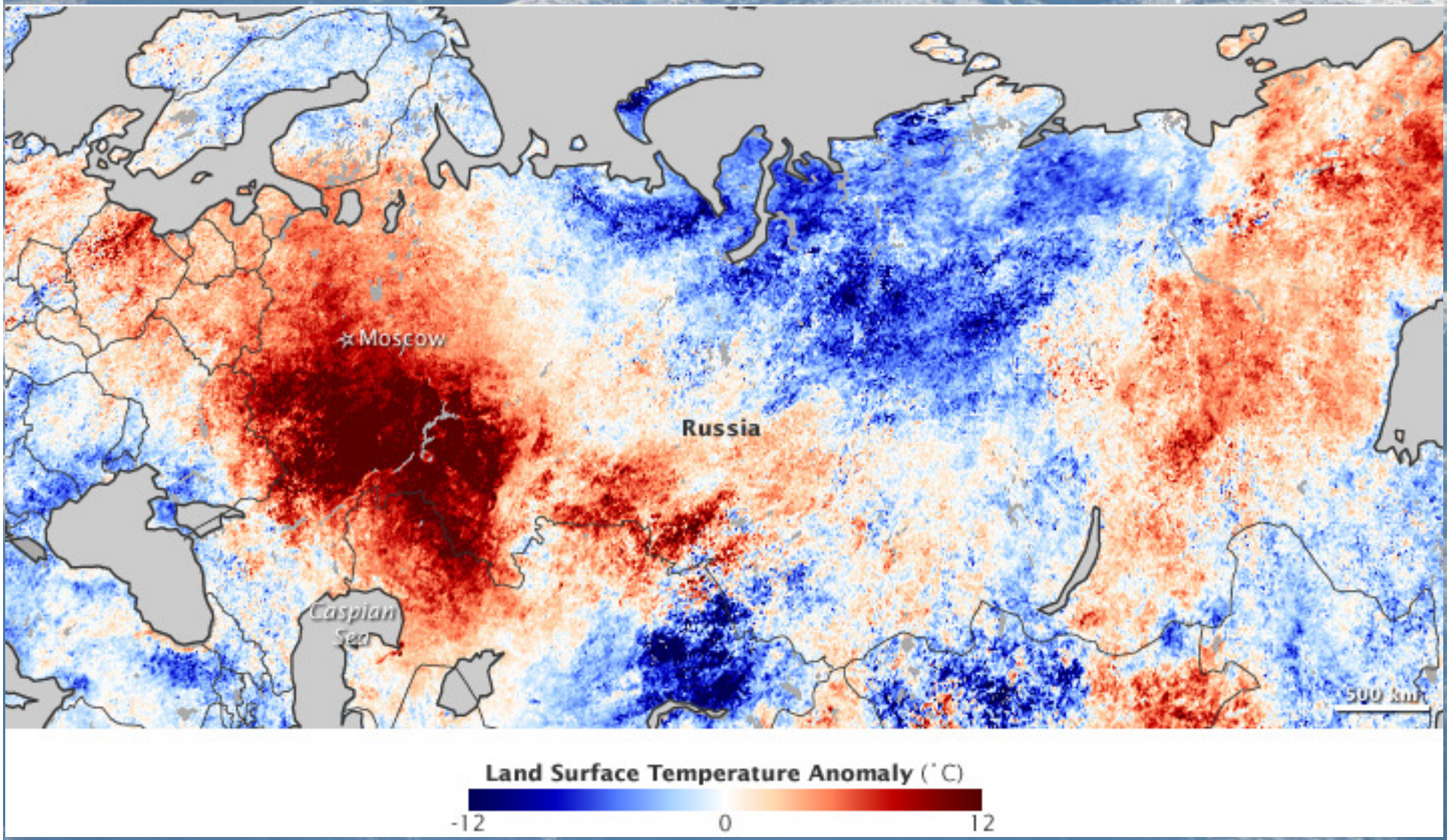
New Orleans 2005

Tropical Cyclones are also influenced by the large scale



Other extreme climate phenomena exhibit regional variability

Russian Heatwave summer 2010: Temperature anomalies



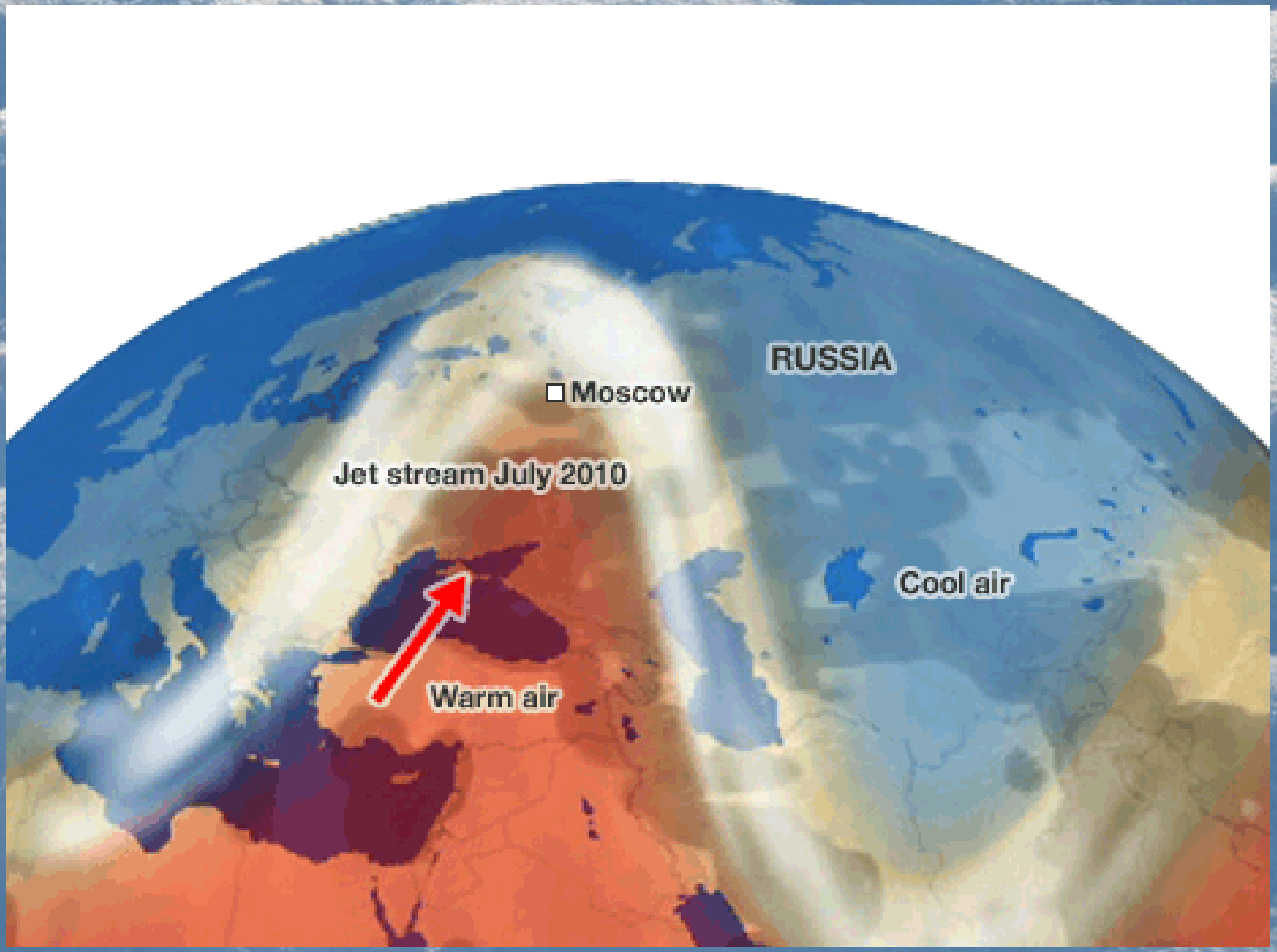
With large (local) impacts on society and nature

Also in summer 2010: Extreme monsoon flooding in Pakistan

Indus River valley 2009

Indus River valley 2010

The underlying causes of such regional/local extremes may have a larger spatial structure

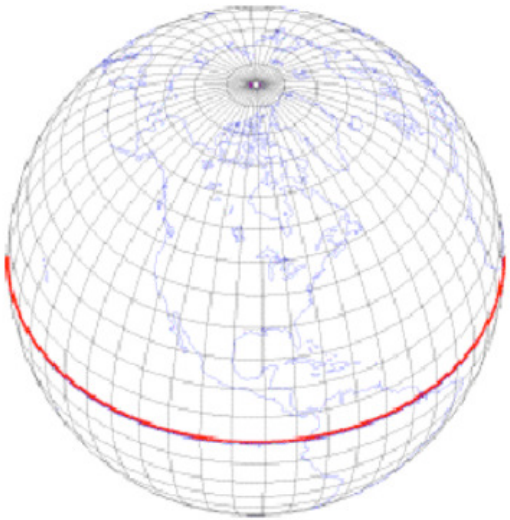


Due to the cost of : process complexity, integration length and need for an ensemble approach) present *GCM* resolutions are ~100-200km

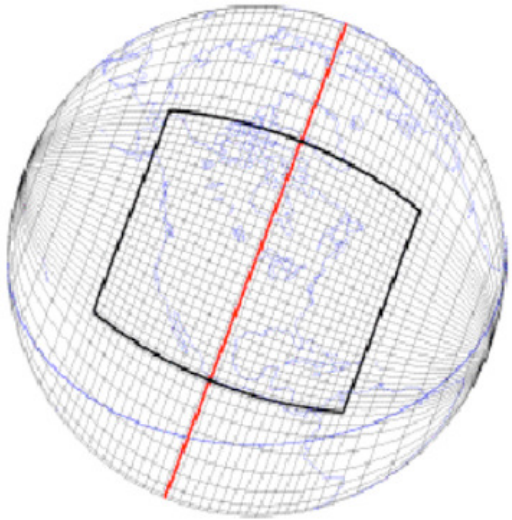
Increasing *GCM* resolution by a factor X leads to an increased compute cost of ~X^3. ***A 10km model is ~1000 times the cost of a 100km model***

Locally increased resolution over a region of interest offers an alternative method for representing specific local phenomena and providing climate information at spatial scales required for planning & decision making

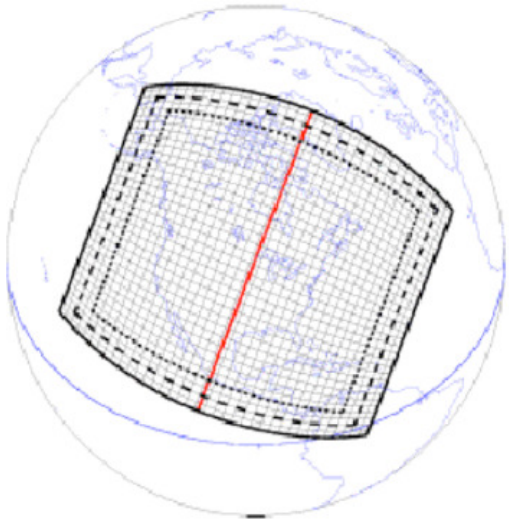
GEM
Global-Regular



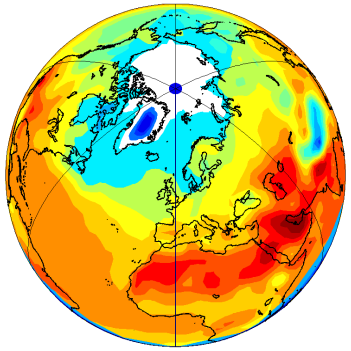
GEM
Global-Variable



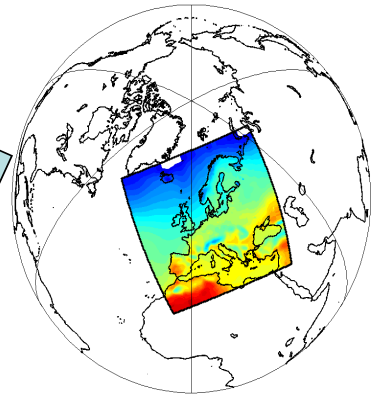
GEM - LAM



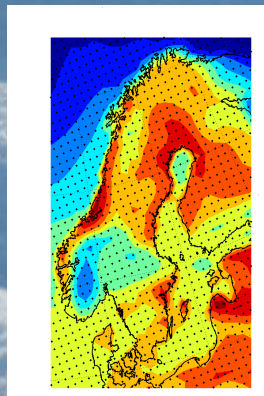
The procedure of developing local climate change impact assessments

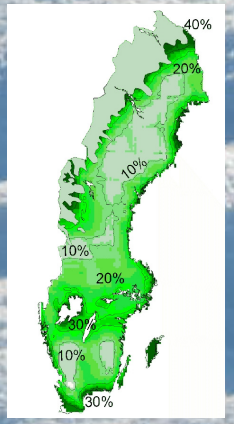


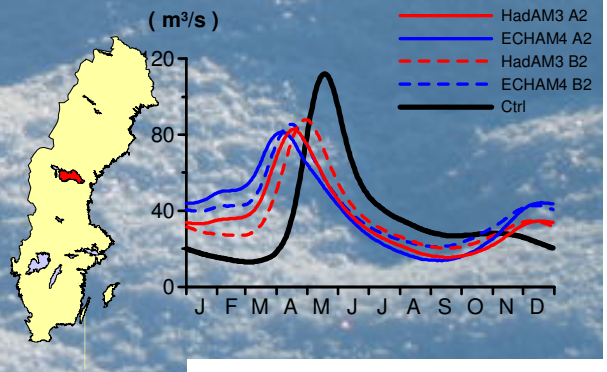
Global Climate Projections & predictions: CMIP5

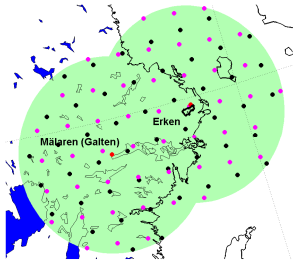


Regional Downscaling : CORDEX









Impact models/studies Hydrology, Agriculture, Infrastructure, Health


Motivating an Ensemble approach to
High Resolution Regional Climate Downscaling

Collaboration allows for an increased number of common RCM projections to be available to all groups, helping to better understand and quantify uncertainty of future climate conditions : Ensembles/PRUDENCE projects.

Table 2: The first step WP2B.1 GCM/RCM matrix and relationship with current proposals from WP3.3

GCM's	RCM's												
	METO-HC	MPIMET	CNRM	DMI	ETH	KNMI	ICTP	SMHI	UCLM	C4I	GKSS	MetNo	CHMI
METO-HC	1950-2100				1950-2050			*1950-2050*	1950-2050				*1950-2050*
MPIMET	1950-2100	1950-2100		*1950-2050**		1950-2050	1950-2050			1950-2050			
FUB													
IPSL		*1950-2050*									*1950-2050*		
CNRM			1950-2050	1950-2050*									
NERSC								1950-2050				*1950-2050*	

'Contractually-obliged' simulations currently proposed by WP3.3

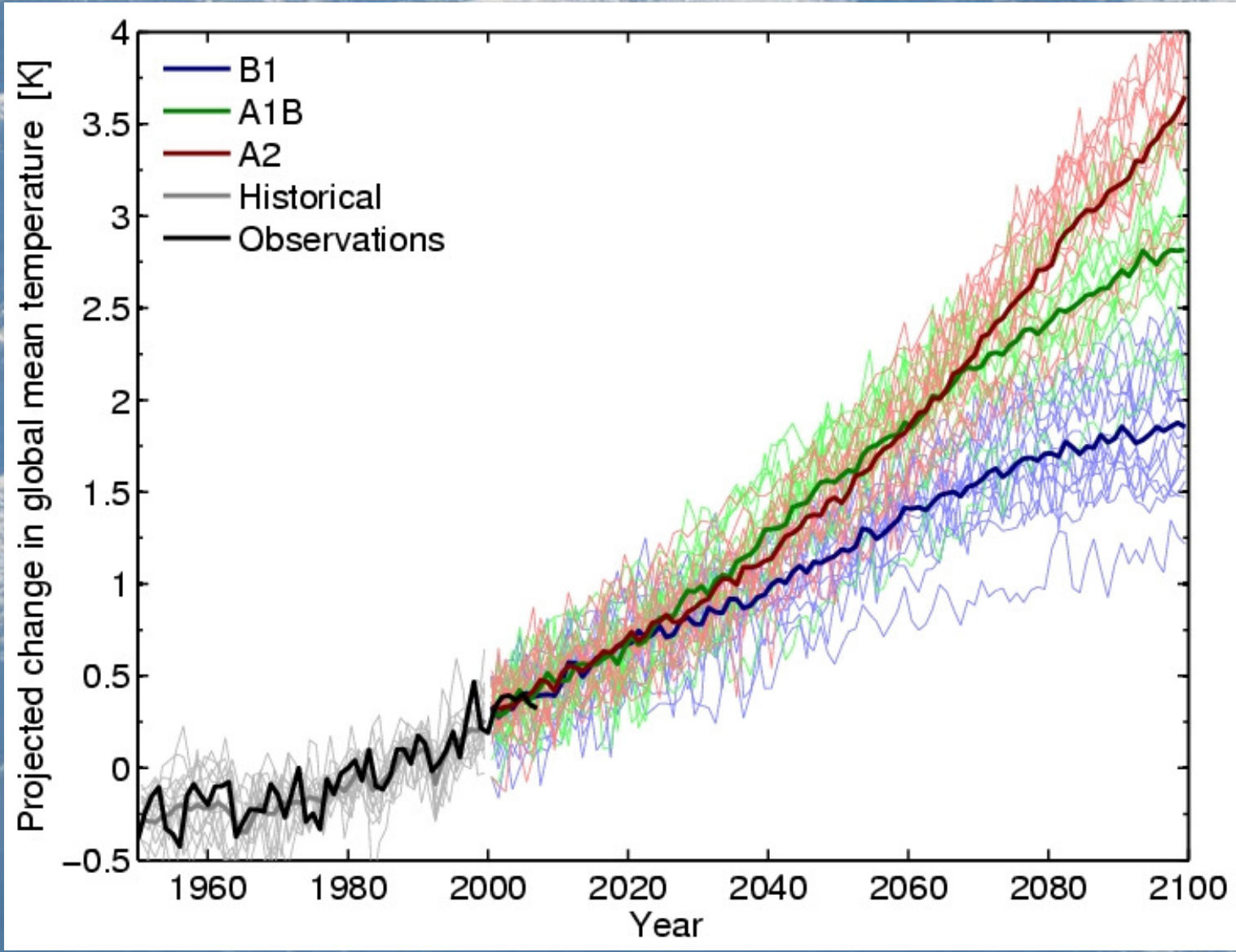
'Non-contractually-obliged' simulations currently proposed by WP3.3

Runs currently proposed by WP3.3 for partners not formally involved in WP2B.1

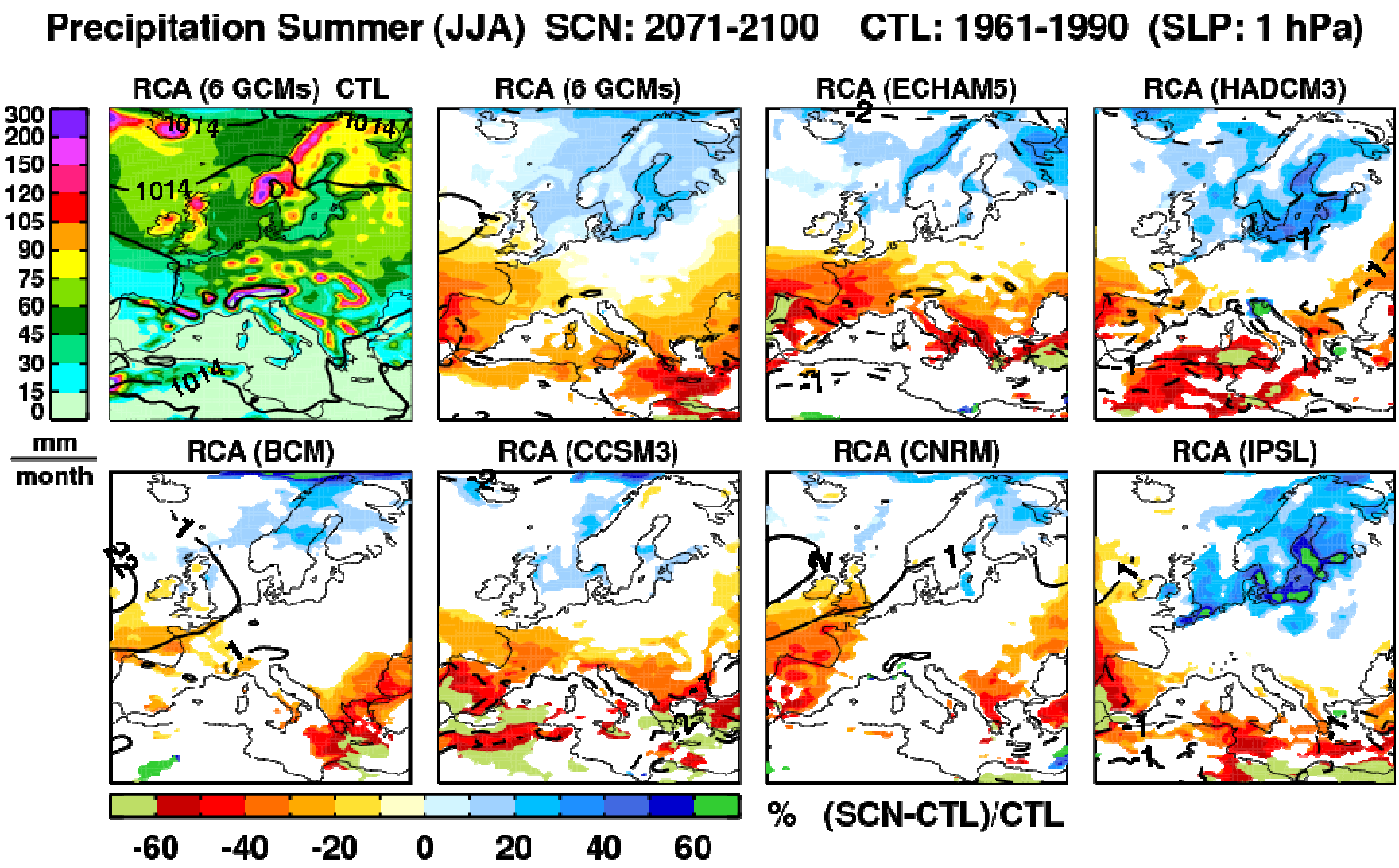
WP2B.1 first-step runs

* One of the DMI runs will be extended to 2100

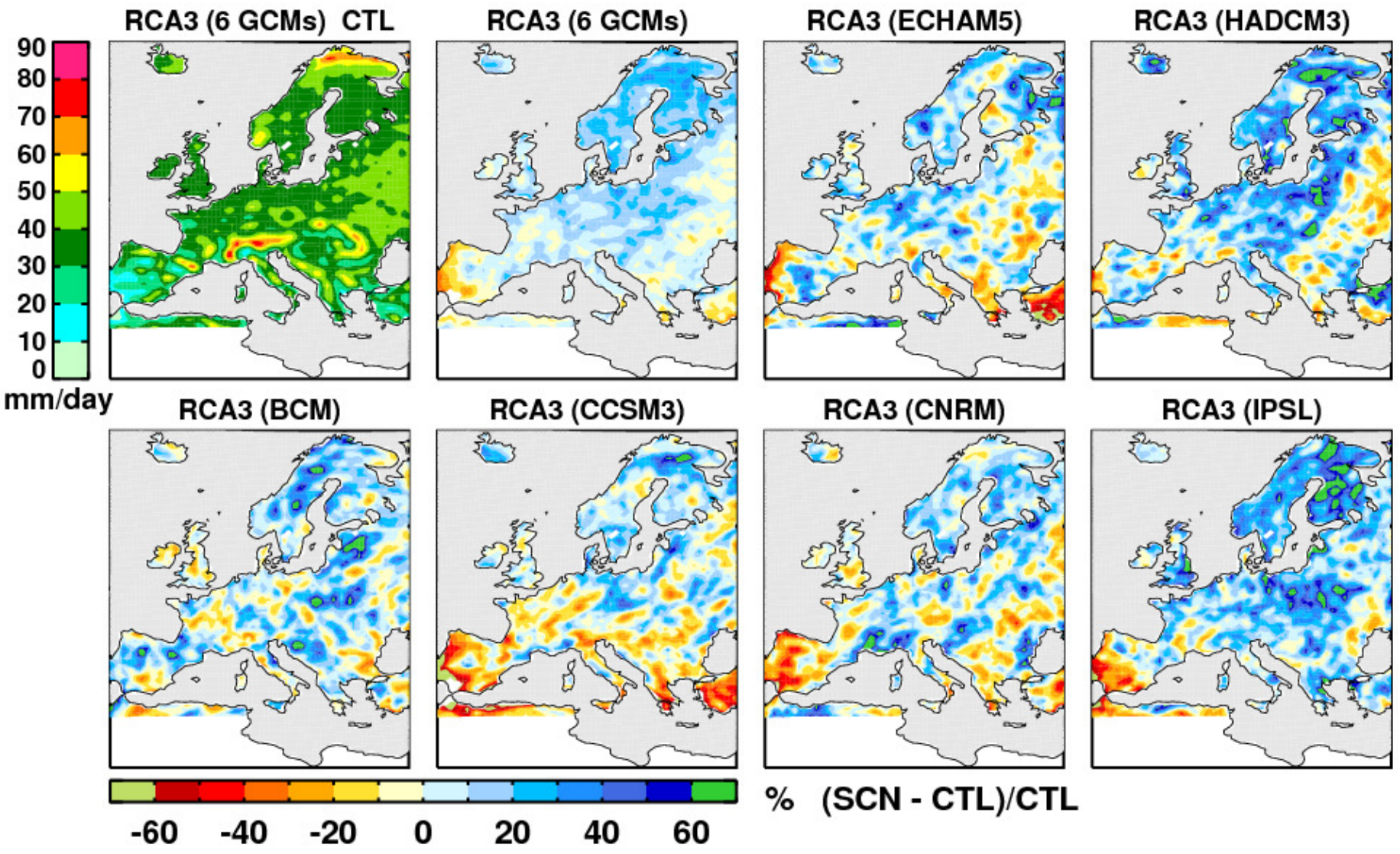
Simulated climate change depends on the GHG scenario assumed for the future



Different GCMs give different regional climate change signals and allows for the identification of robust patterns of change



Maximum daily precipitation accumulation (in a 20 year return period) and percent change in the 20-year event (2071-2100)-(1961-1990)



The Rossby Centre Ensemble

Different AOGCMs

Different initial conditions

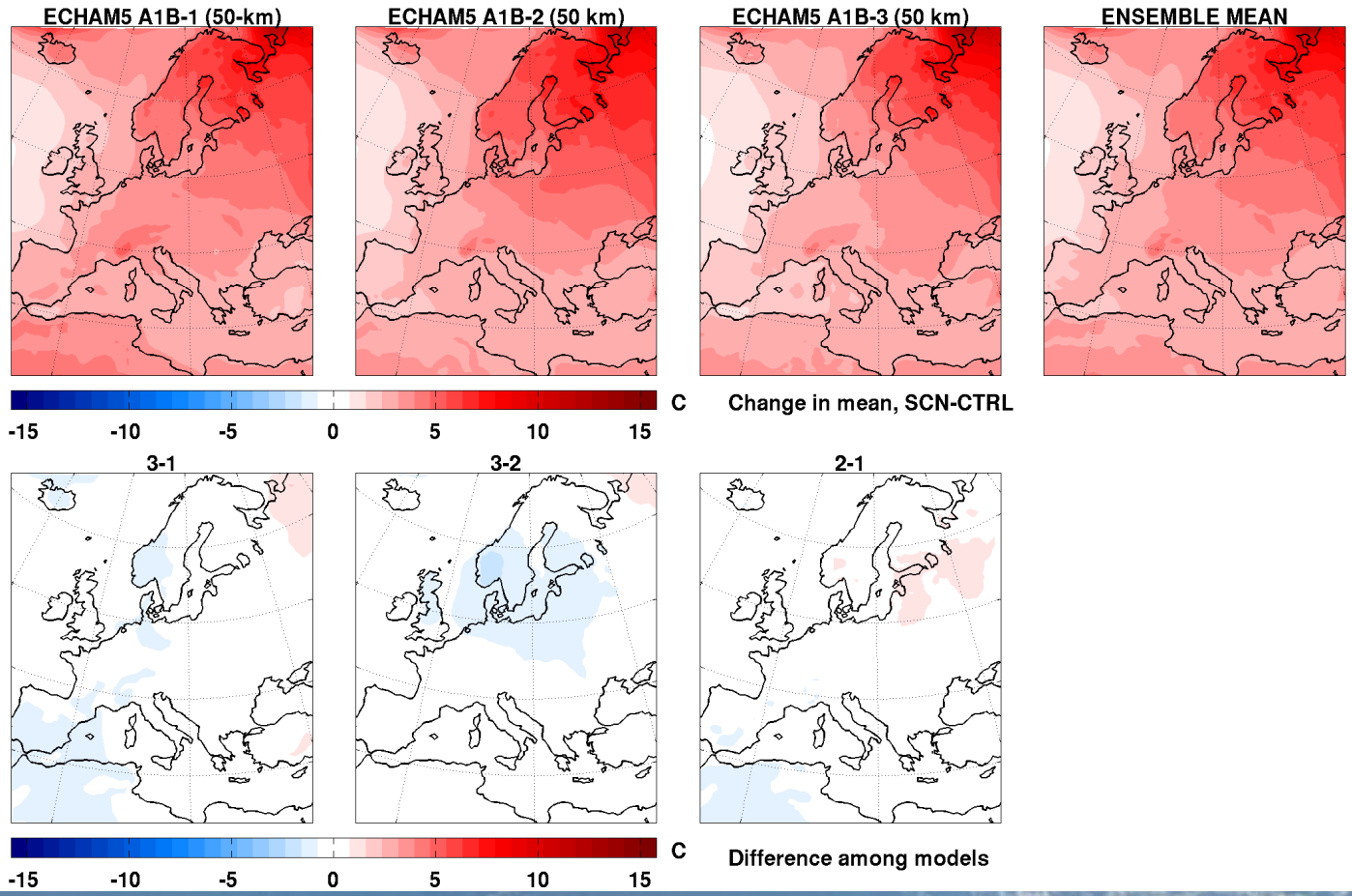
Different model formulation (GCM)

Different emission scenarios

Different resolution

No	AOGCM (Institute, country)		Emission scenario	Horisontal resolution (km)
1	**Arpège (CNRM, France)**		**A1B**	**50**
2	**BCM (NERSC, Norway)**		**A1B**	**50**
3				**25**
4	**CCSM3 (NCAR, USA)**		**A2**	**50**
5			**A1B**	**50**
6			**B2**	**50**
7	**ECHAM4 (MPI-met, Germany)**		**A2**	**50**
8			**B2**	**50**
9	**ECHAM5 (MPI-met, Germany)**		***A2***	**50**
10			**A1B**	**50**
11				**50**
12				**50**
13				**25**
14				***12.5***
15			**B1**	**50**
16	**HadCM3 (Hadley Centre, UK)**	**ref (Q0)**	**A1B**	**50**
17		**low (Q3)**		**50**
18		**high (Q16)**		**50**
19		**low (Q3)**		**25**
20	***IPSL-CM4 (IPSL, France)***		***A1B***	***50***

3 RCM runs all using ECHAM5 A1B GCM as forcing but each ECHAM5 run started from a different initial condition in 1860, allows an estimate of the (natural) variability portion of a regional climate change signal

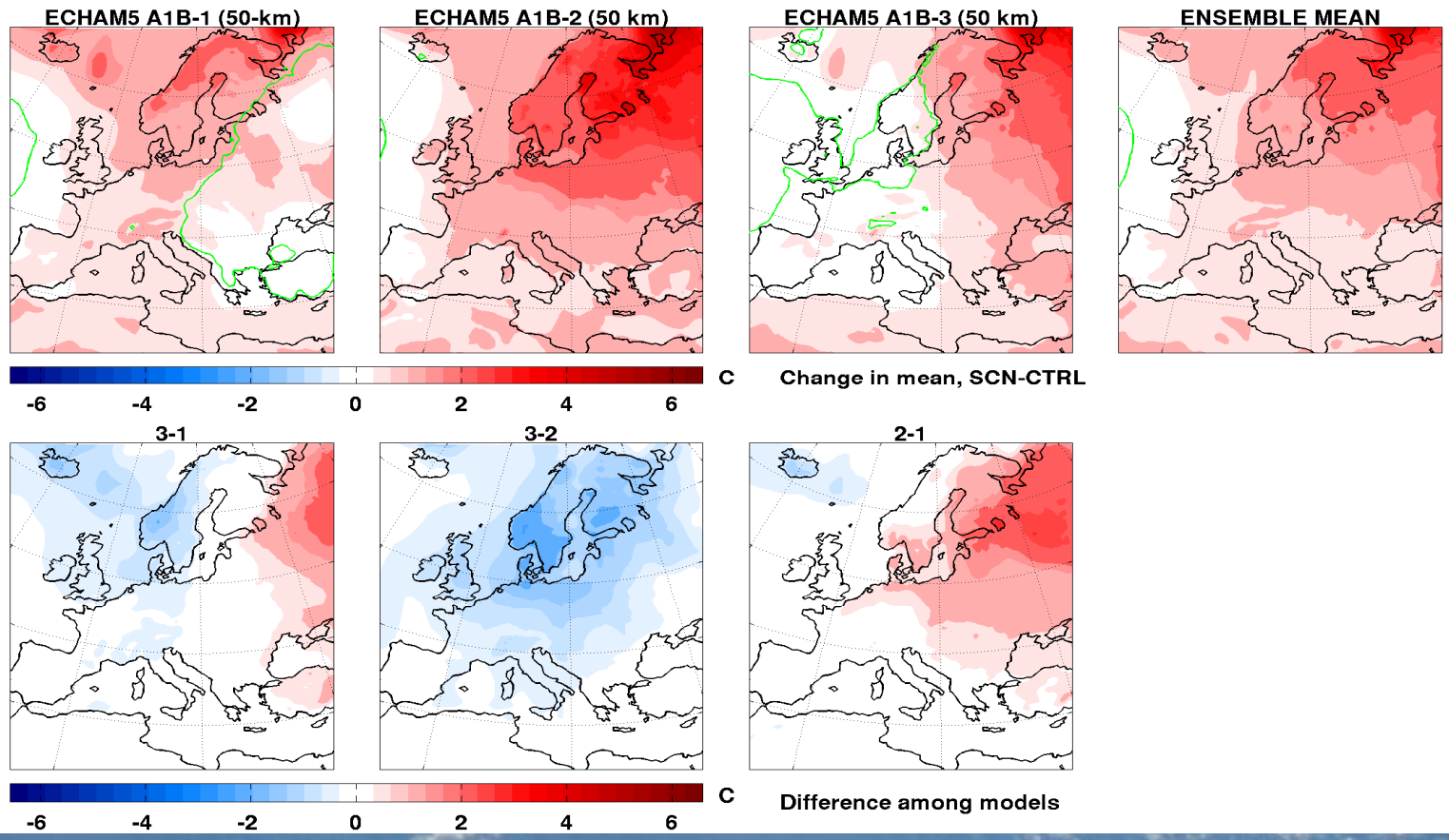


Model estimates of natural variability defined by different initial dates is a lot smaller than the forced climate change signal by ~2075

30yr DJF temperature change from the 3 ECHAM5 GCM forced runs

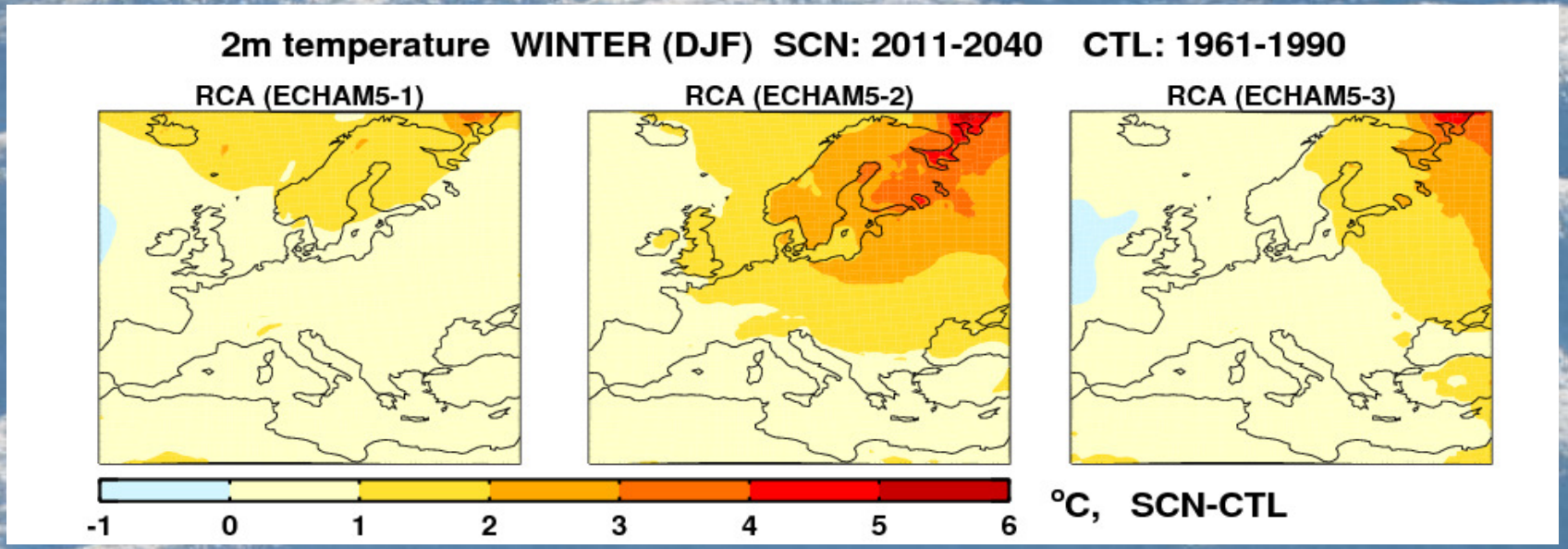
(2016-2045) minus (1961-1990)

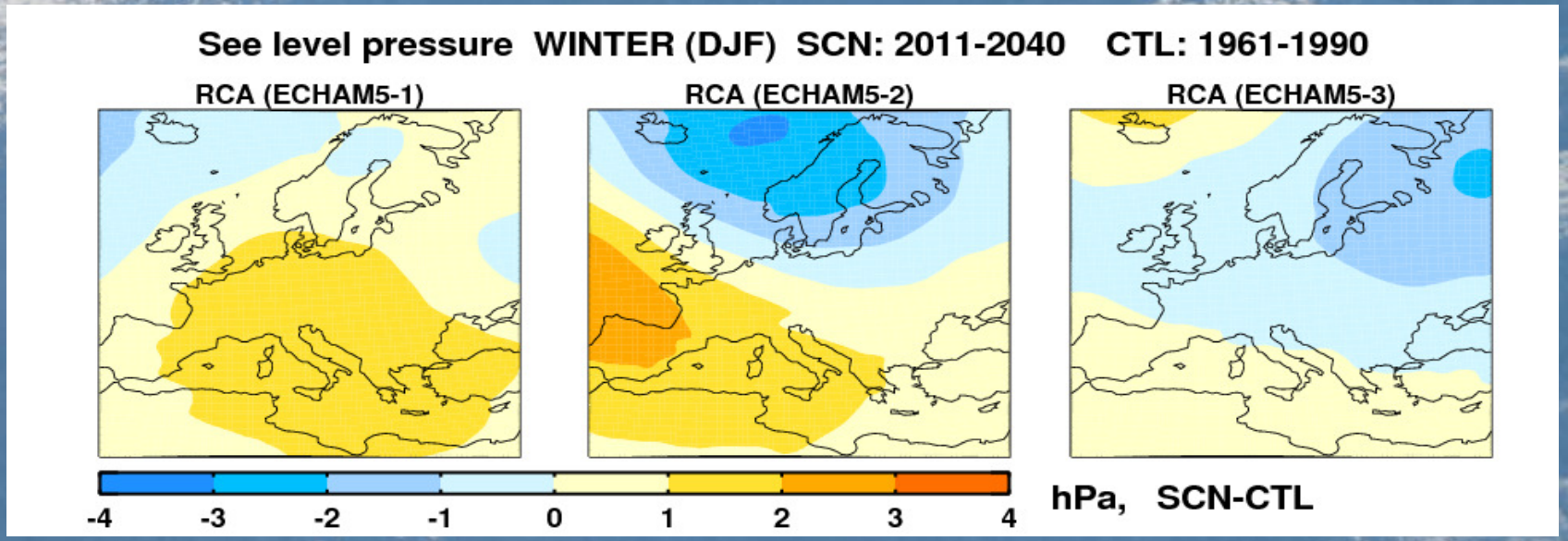
Differences due to natural variability can be of the same magnitude as the simulated climate change signal.

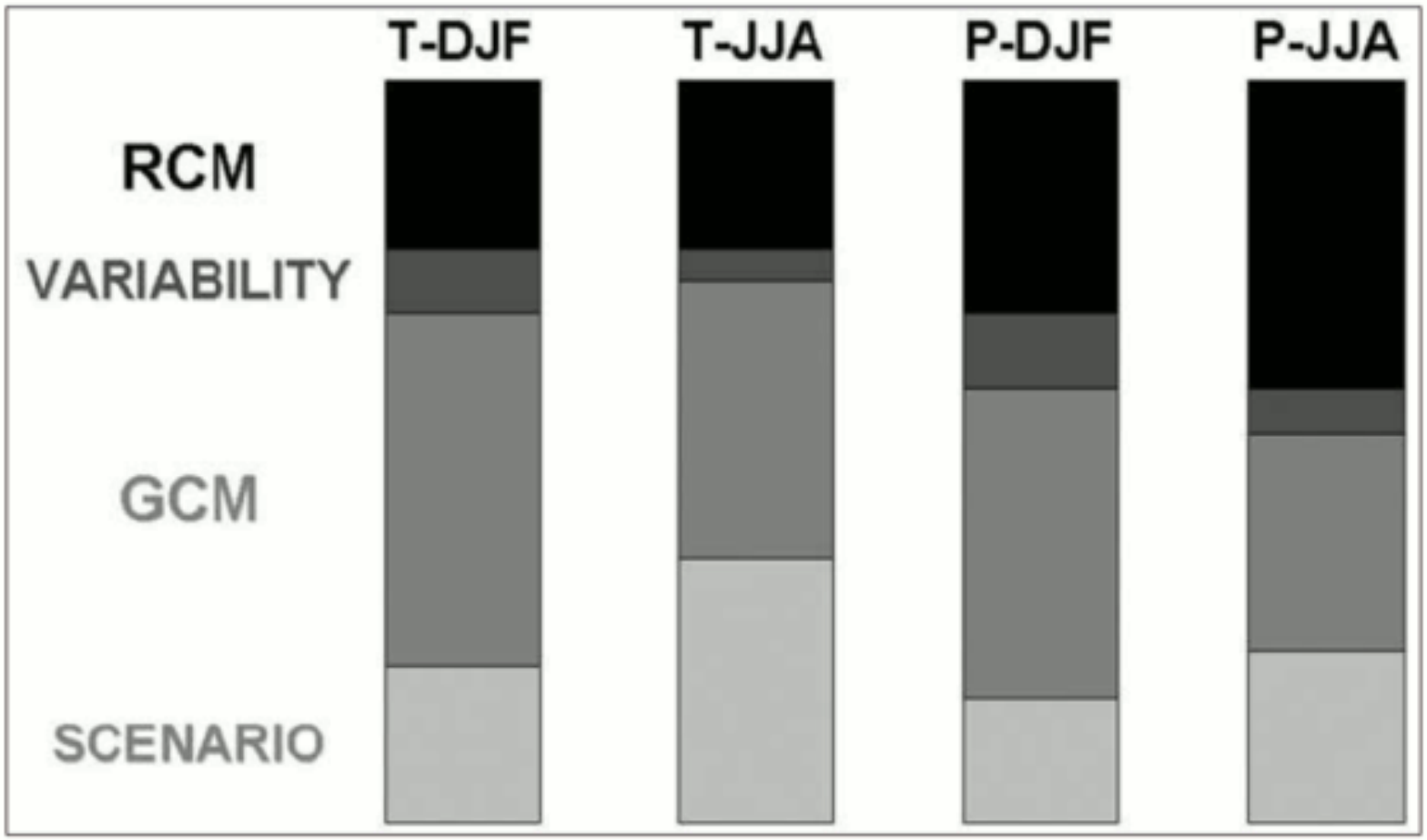


Differences result from circulation responses in each GCM member

Circulation plays a 1st order role in determining regional climate variability and still will in the years of anthropogenic climate change



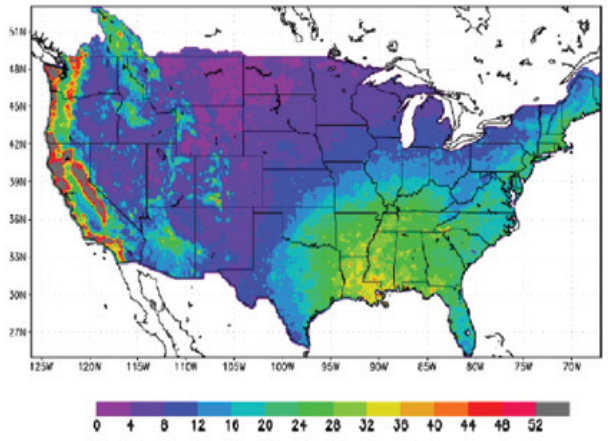




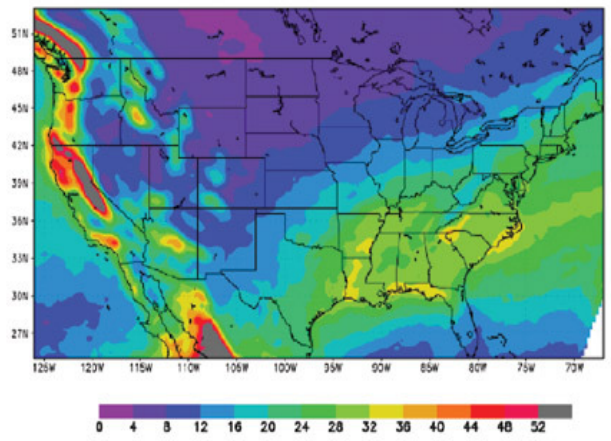
Summary of component contributions to temperature & precipitation climate change uncertainty for Europe
Based on a large matrix of GCM, RCM and emission Scenarios sampled through the ENSEMBLES project

A Downscaling Example

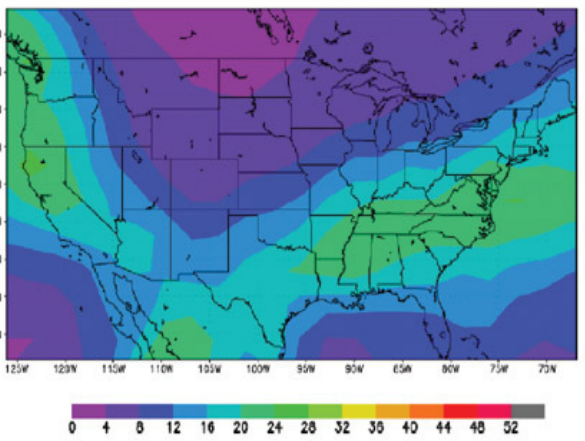
OBS Observation DJF



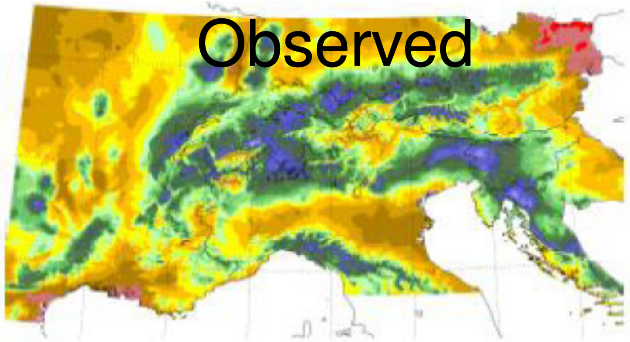
MM5 RCM DJF

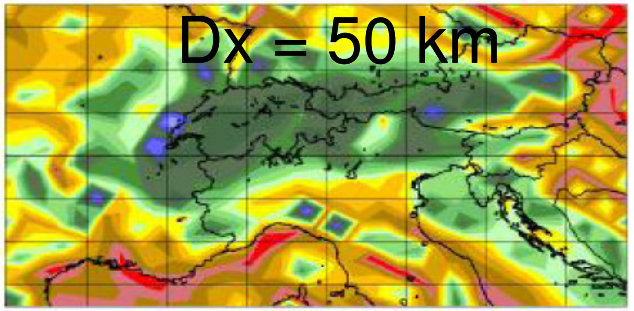


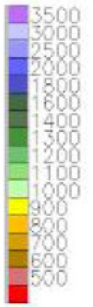
PCM GCM DJF

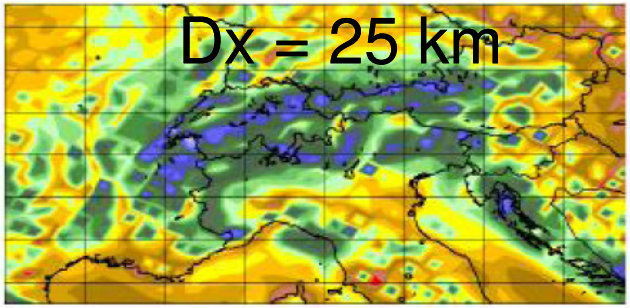


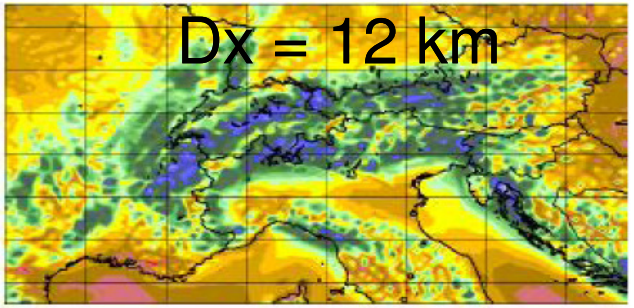
Precipitation simulated over the European Alps



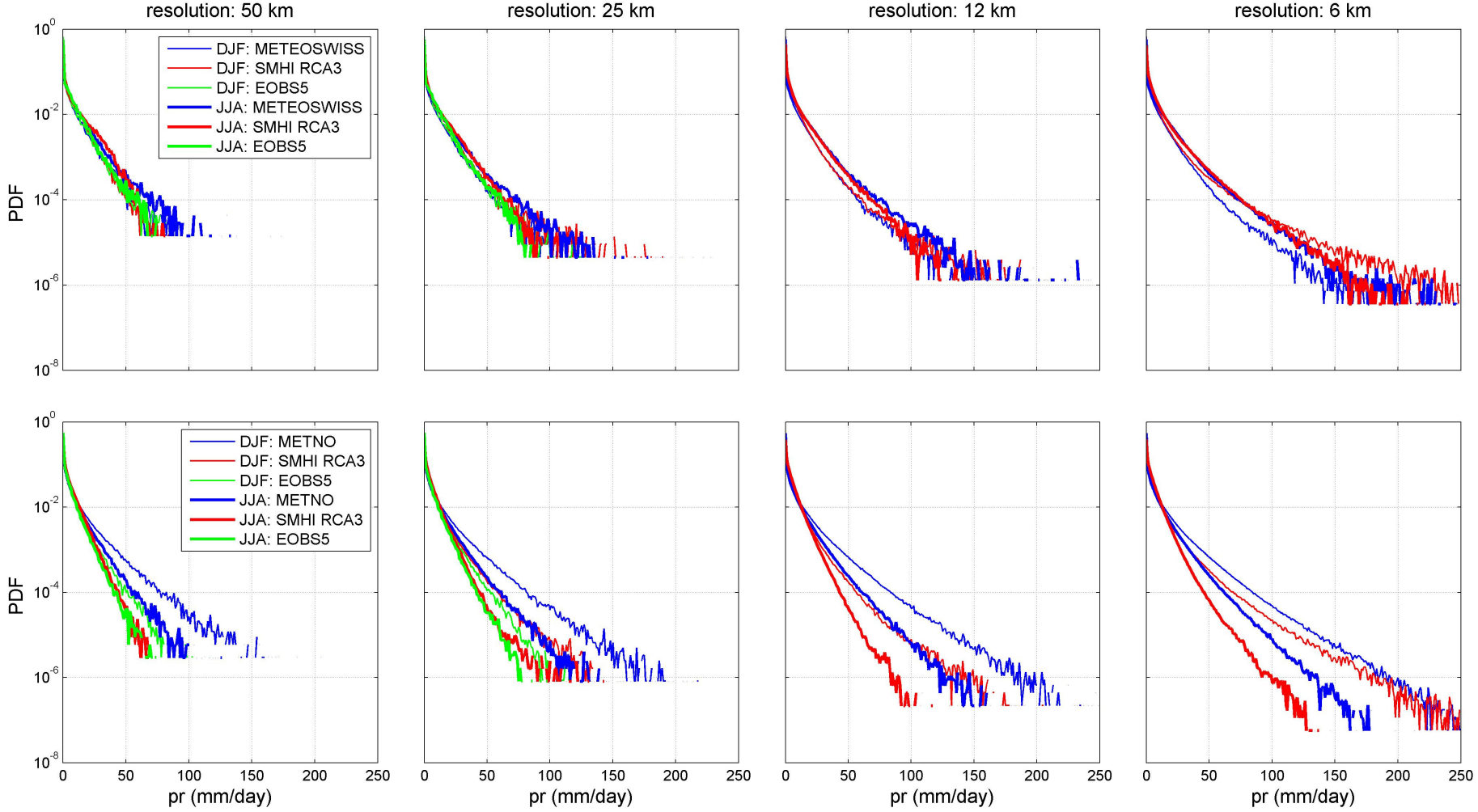






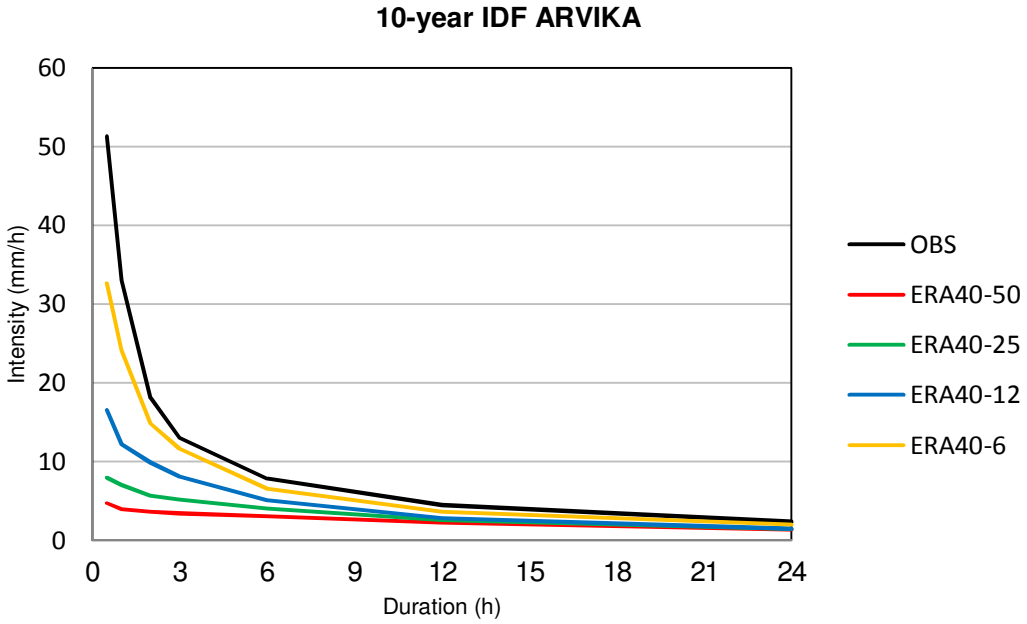


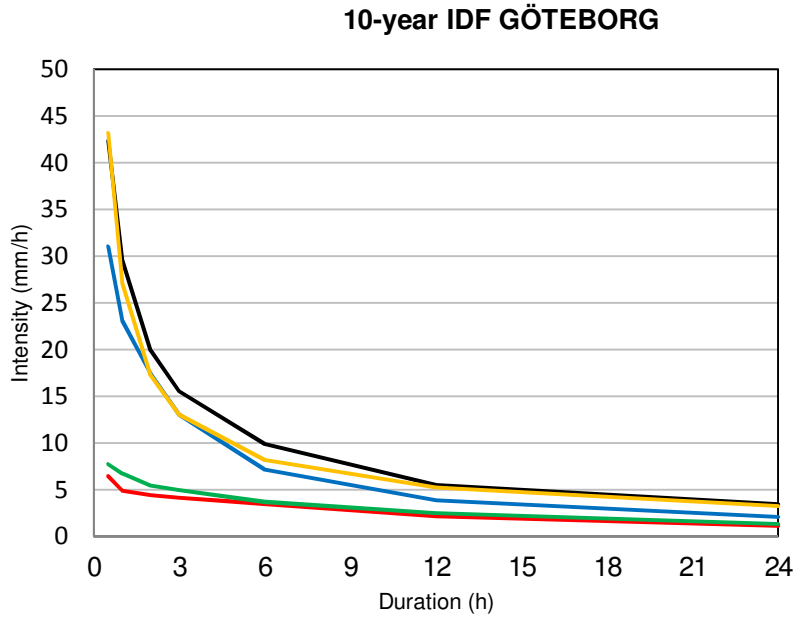
PDFs of daily precipitation amounts over Switzerland as a function of model resolution and season

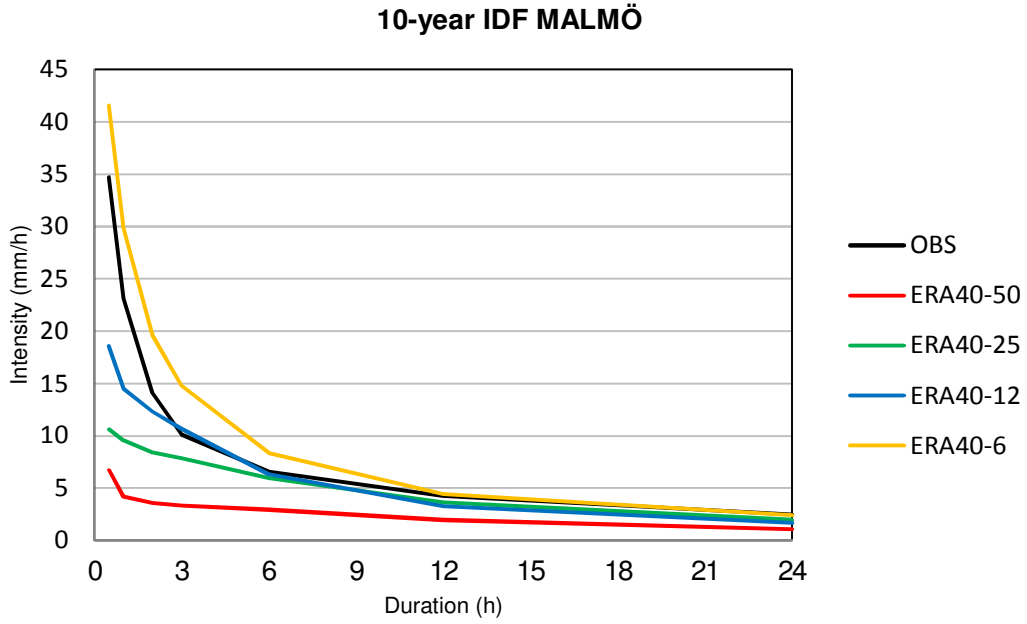


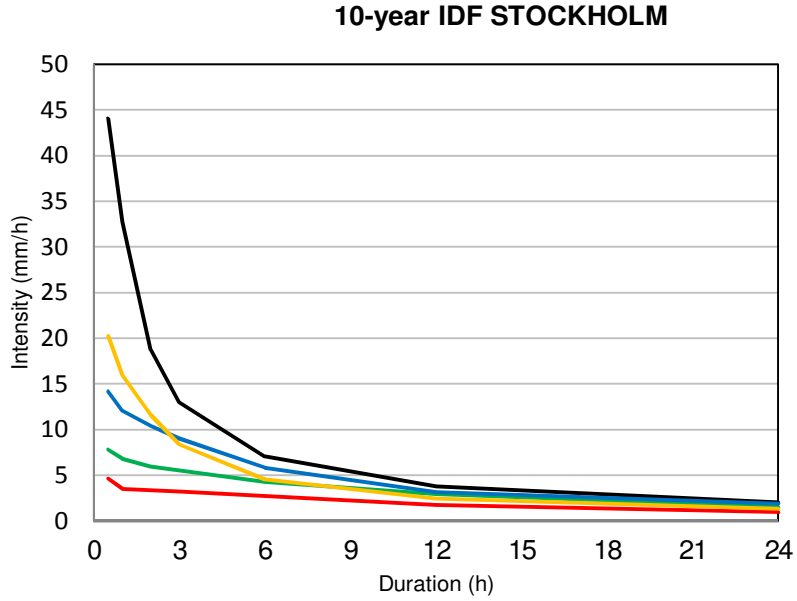
Simulation of intense precipitation improves greatly with resolution

Evaluation of short-term precipitation events for urban hydrology

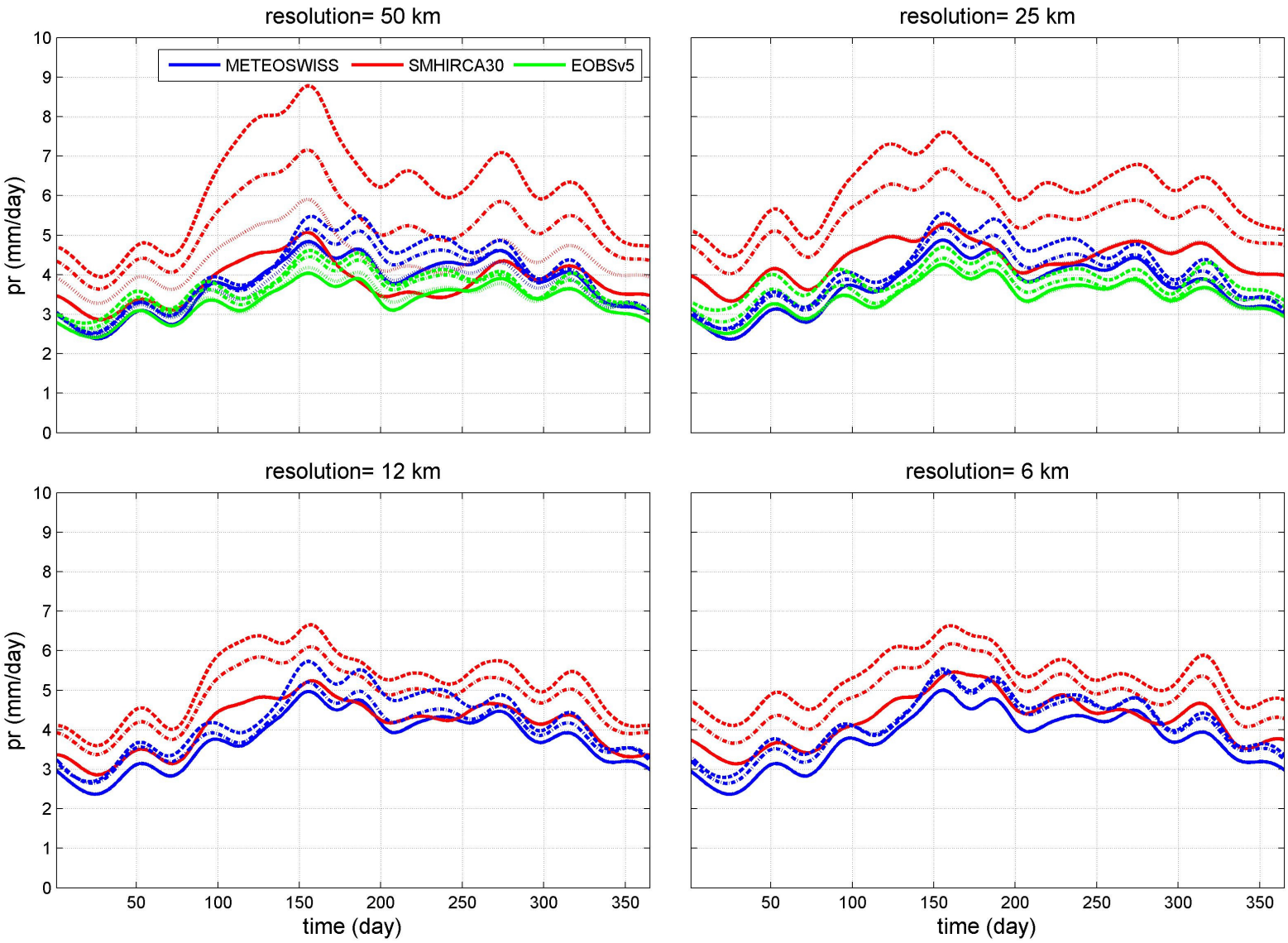




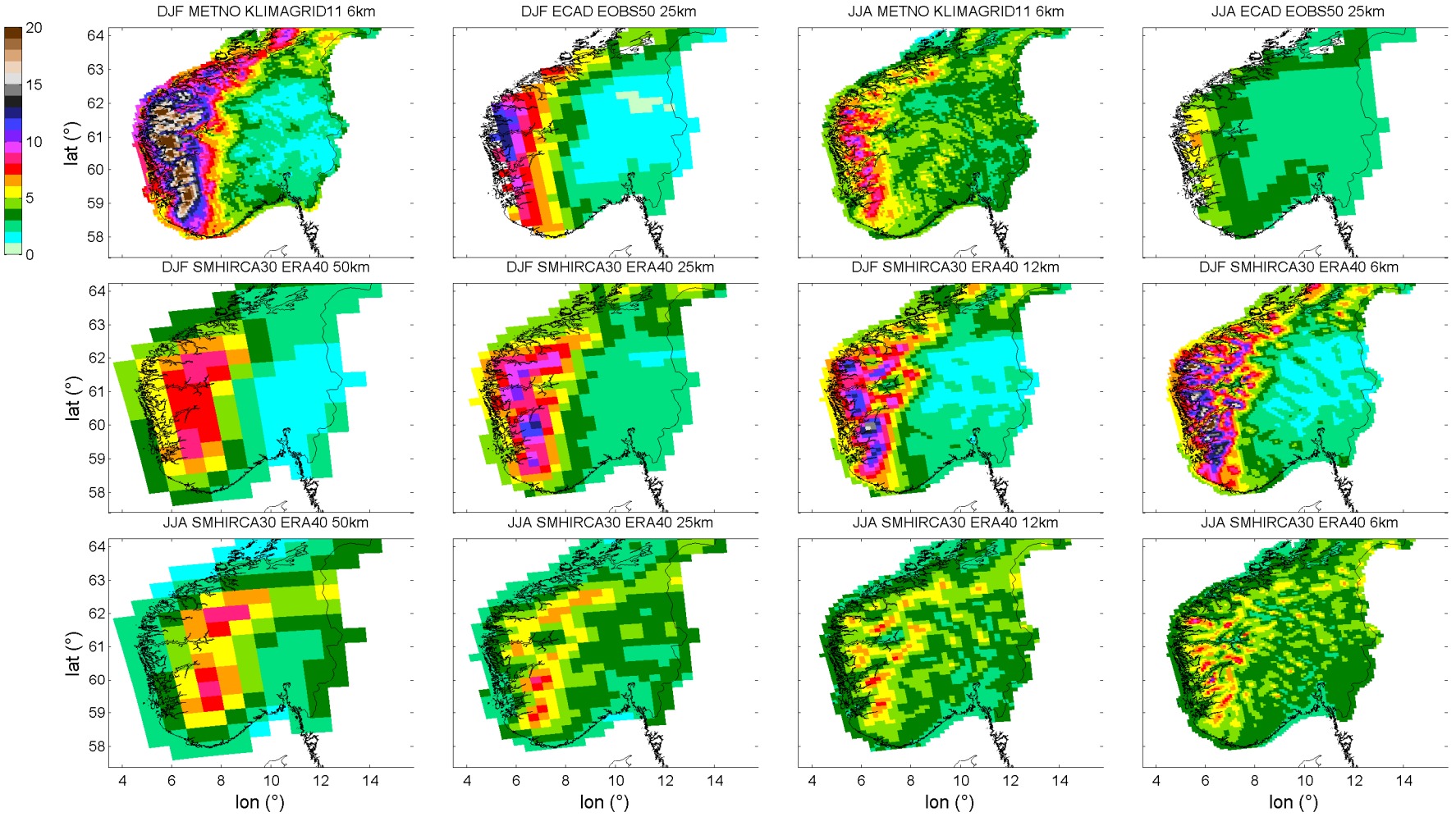




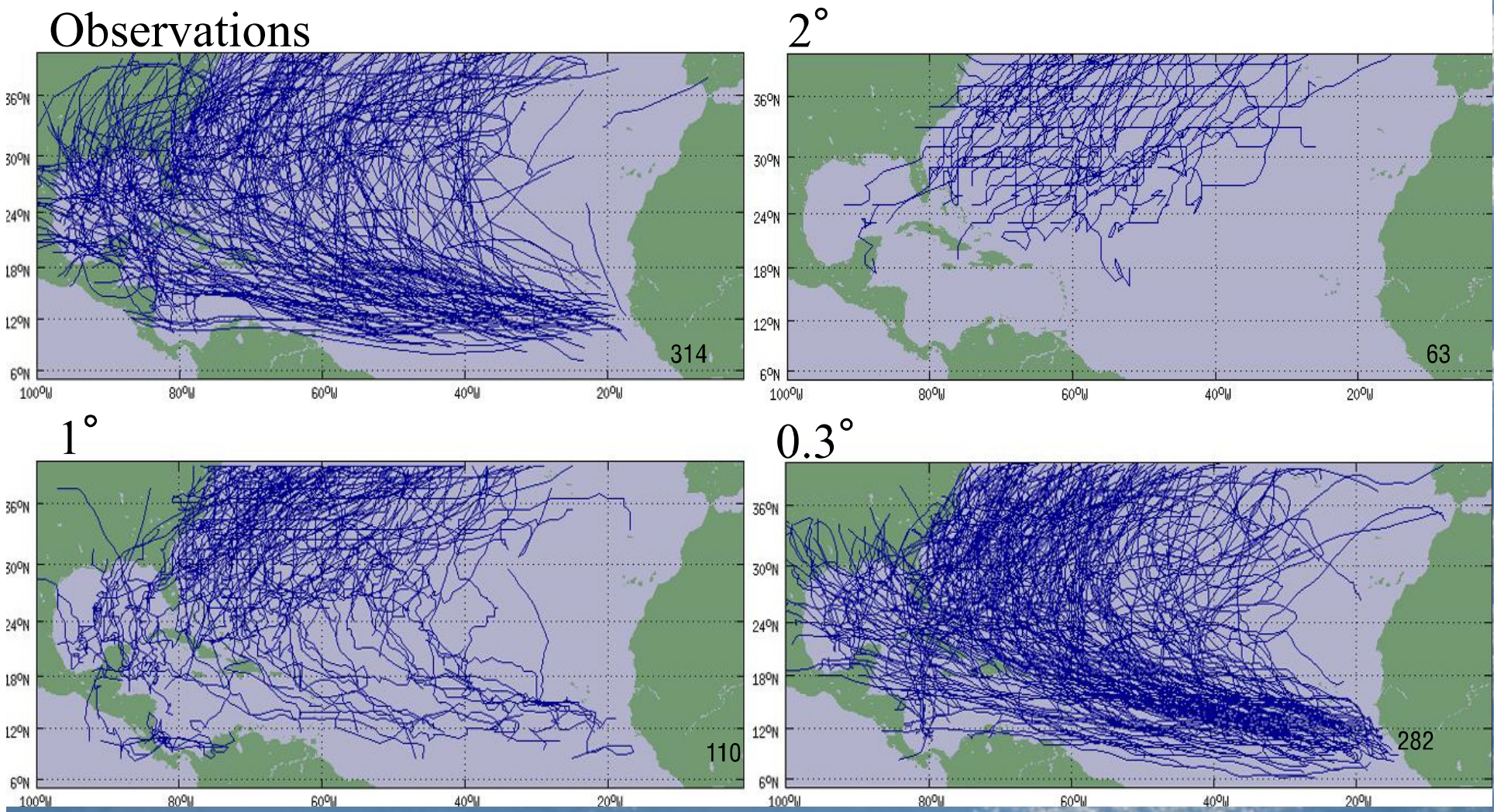
In mountain regions higher resolution improves the simulated mean climate



Seasonal precipitation over Norway as a function of model resolution

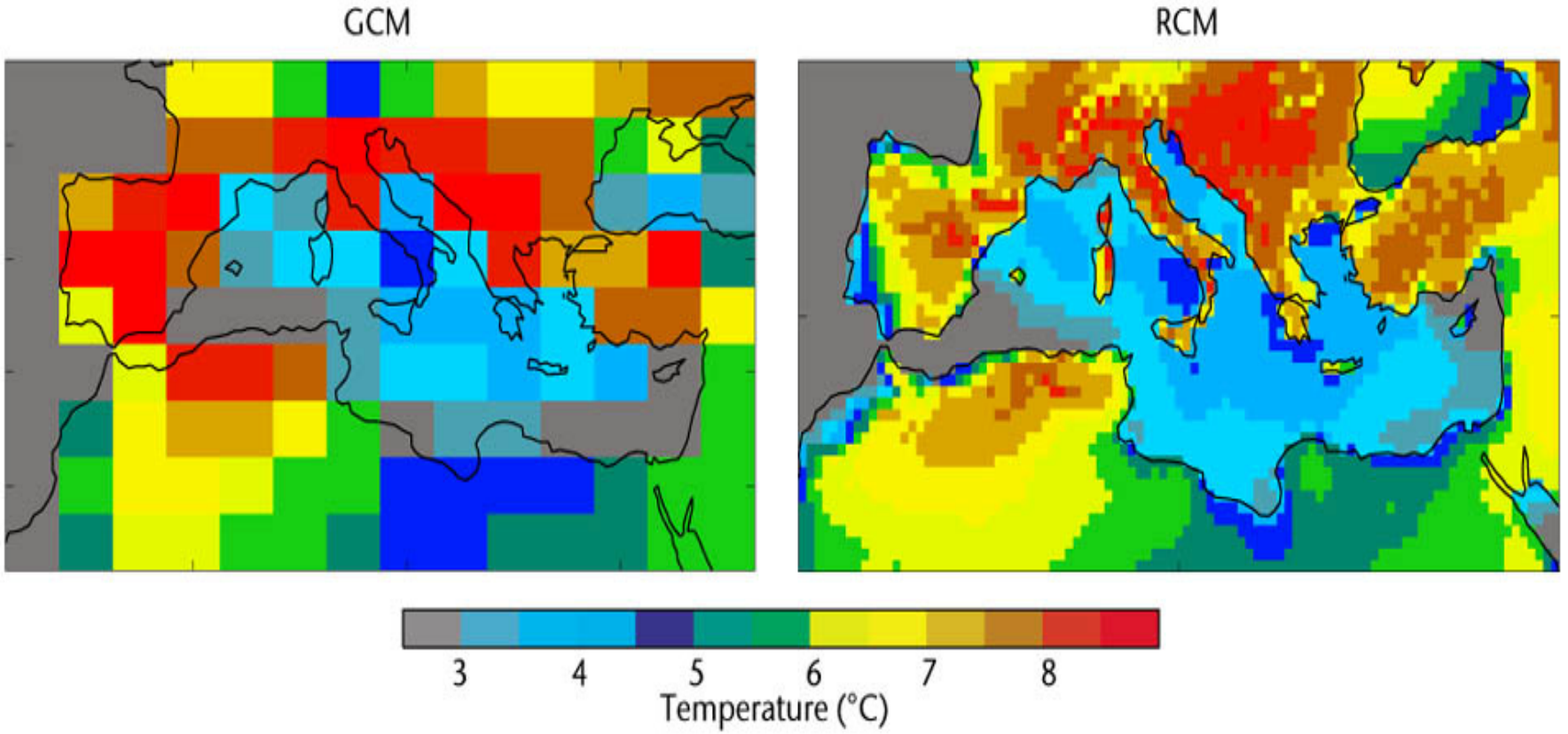


High Resolution helps in simulating Tropical Cyclones



Limited-Area version of GEM at 0.3° downscaling Global GEM at 2°

Summer temperatures in the 2080s
difference to present day, due to A2 emissions

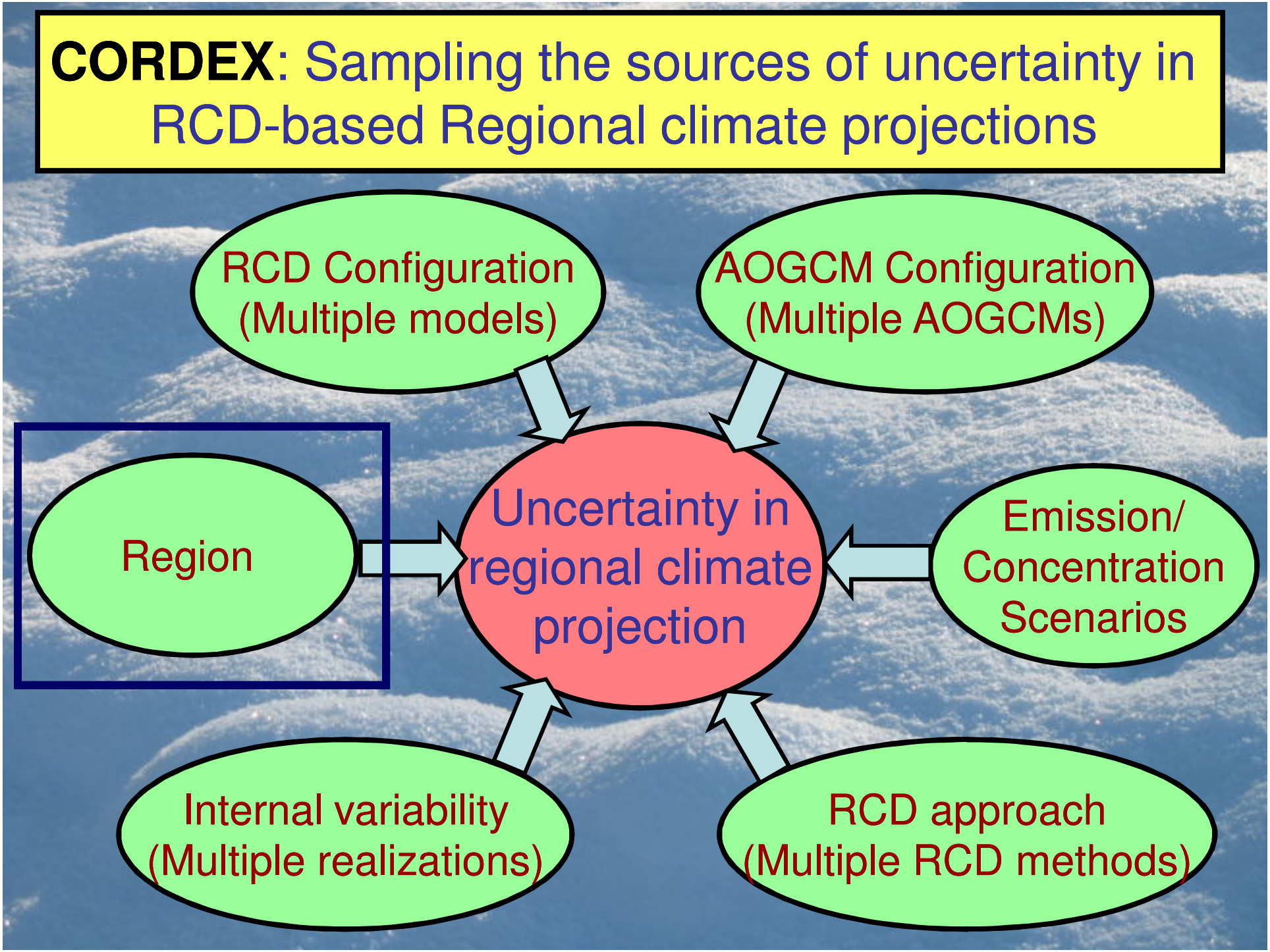


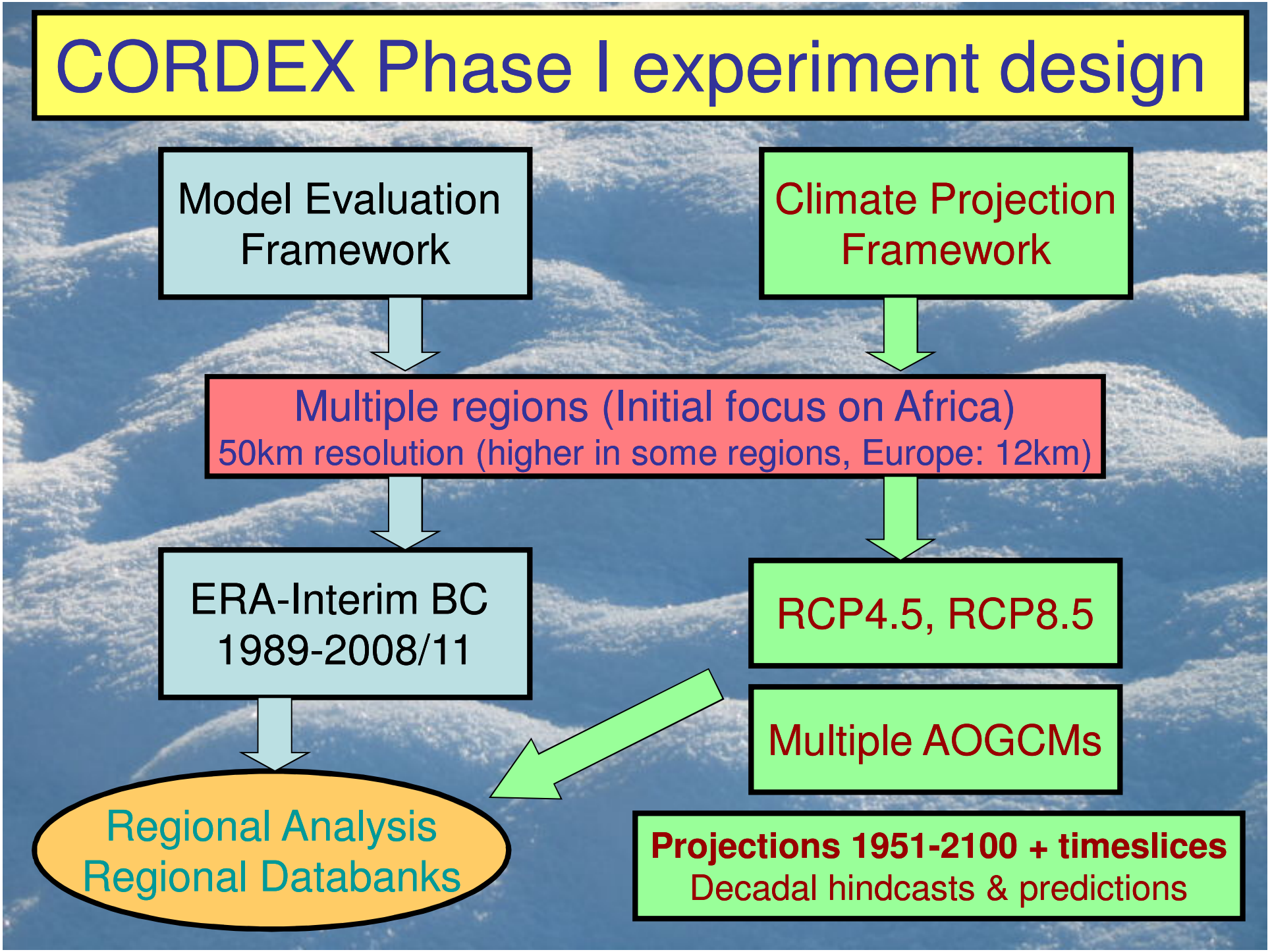
Simulated climate change on islands is very different to the surrounding Mediterranean Sea, and is only captured by the RCM

Hadley Centre models

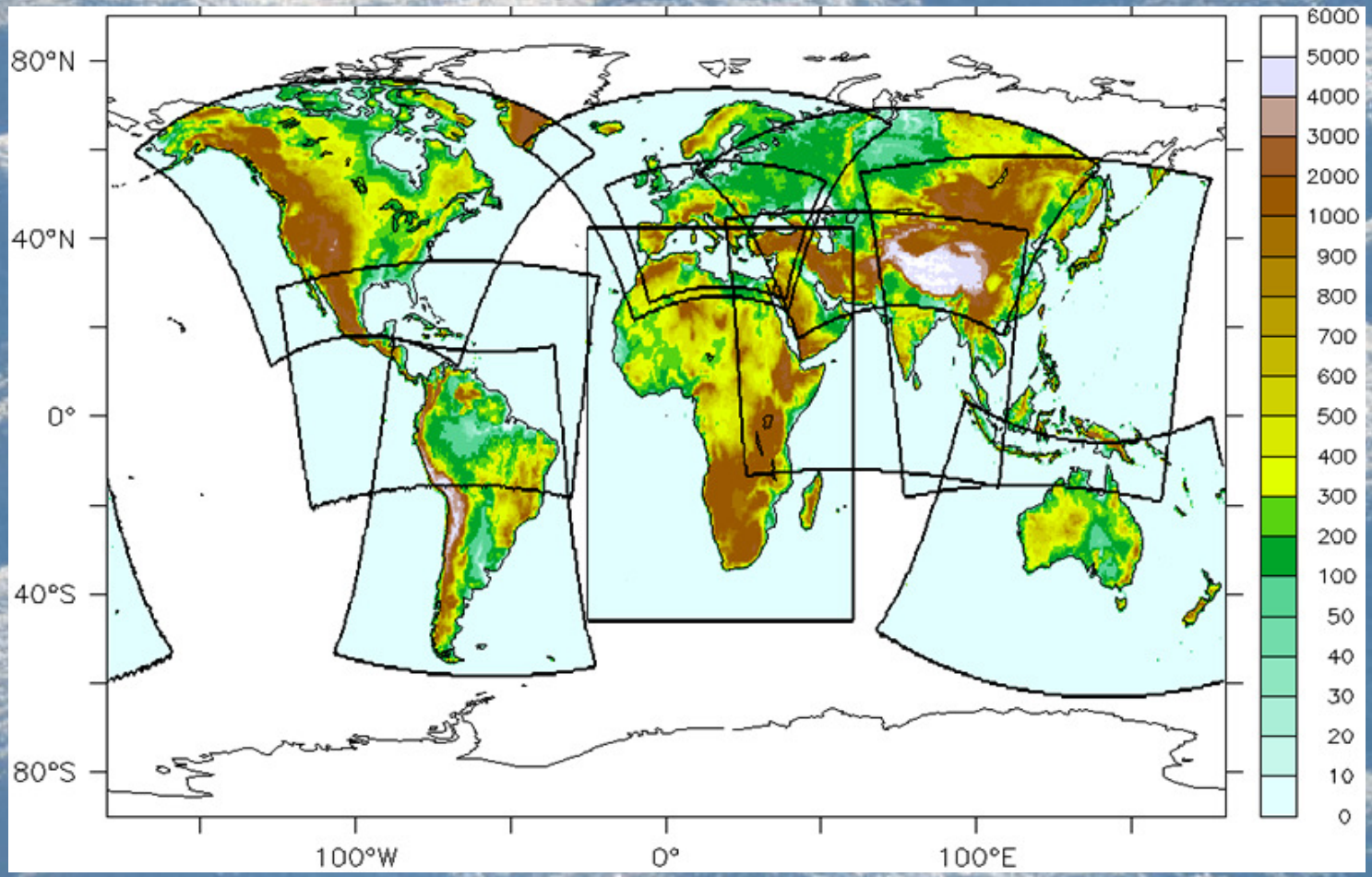
High Resolution (Regional) Climate Models

1. Should reproduce similar large-scales to the driving data
2. Can provide localized improvement in near surface variables of importance to IAV e.g. precipitation in complex topography
3. Can improve simulated climate variability e.g. precipitation
4. Can improve the simulation of small-scale extremes e.g. Tropical Cyclones, convective events
5. Can provide regional ownership of regional climate questions
6. Can provide a means for interaction with regional IAV groups
7. Can be used in training/capacity building


CORDEX: Sampling the sources of uncertainty in RCD-based Regional climate projections
RCD Configuration (Multiple models)
AOGCM Configuration (Multiple AOGCMs)
Region
Uncertainty in regional climate projection
Emission/ Concentration Scenarios
Internal variability (Multiple realizations)
RCD approach (Multiple RCD methods)


CORDEX Phase I experiment design
Model Evaluation Framework
Climate Projection Framework
Multiple regions (Initial focus on Africa)
50km resolution (higher in some regions, Europe: 12km)
ERA-Interim BC 1989-2008/11
RCP4.5, RCP8.5
Multiple AOGCMs
Regional Analysis Regional Databanks
Projections 1951-2100 + timeslices
Decadal hindcasts & predictions

CORDEX DOMAINS (plus Arctic & Antarctica)



- 12 domains with a resolution of 0.44° (approx. 50x50km²)
- Focus on Africa
- High resolution ~0.11°x0.11° for Europe (by some institutions)

Pan-CORDEX conference held in Trieste March 2011

An Africa-CORDEX diagnostics/training group has been formed (30 transdisciplinary African scientists) has had 2 training/analysis workshops using CORDEX-RCM simulation data. 3rd next week.

Euro-CORDEX group established. Europe CORDEX runs in progress

Arctic-CORDEX team will have first meeting in Sweden March 2012

CORDEX East-Asia had a workshop Sept 2011, hosted by KMA to begin to organize and share East Asia downscaling activities. Unsure of status

Meeting between AgMIP and CORDEX held April 2011 to develop a set of climate–agriculture projects: initially over the Americas

CORDEX project detailed in CLIVAR Exchanges special issue on CMIP5

First review paper of ERA-interim forced Africa-CORDEX ensemble accepted for publication in Journal of Climate.

Data and format issues:

6hrly model level data is available from CMIP5 GCMs on the ESG system

Presently 11 GCMs: historical (1950-2005), RCP4.5 & 8.5 (2006-2100) in a common format. At least 1 member per GCM, some GCMs multiple members available. At least 2 GCMs have LBCs for RCP2.6 also.

Translators have been developed, allowing parallel downscaling runs. e.g. at SMHI we have downscaled 6 historical + RCP4.5 + RCP8.5 CMIP5 GCMs over Africa. Plus are also running over Europe and Arctic.

We routinely now run different CORDEX domains or the same domain with different GCM boundary forcing in parallel

http://wcrp.ipsl.jussieu.fr/RCD_Projects/CORDEX/cordex_archive_specifications_110628.pdf

e.g File naming conventions **File names should follow this structure:**
VariableName_Domain_GCMModelName_CMIP5ExperimentName_CMIP5EnsembleMember_RCMModelName_RCMVersionID_Frequency_StartTime_EndTime.nc

CORDEX output specifications now follow as closely as possible CMIP5

CORDEX data will now be archived & broadcast through the ESG system
This has been tested by SMHI and DKRZ using Africa-CORDEX data

BADC, DKRZ, IPSL (European ESG nodes) working with SMHI & DMI to further develop a file checker developed for CMIP5 to be applicable to CORDEX data. This will allow groups to check data and file name compliance for broadcasting through the ESG.

SMHI will test the full system and broadcast Africa-CORDEX data through the ESG node at DKRZ ~April/May 2012.

ESG software is being updated to allow CORDEX file & search attributes

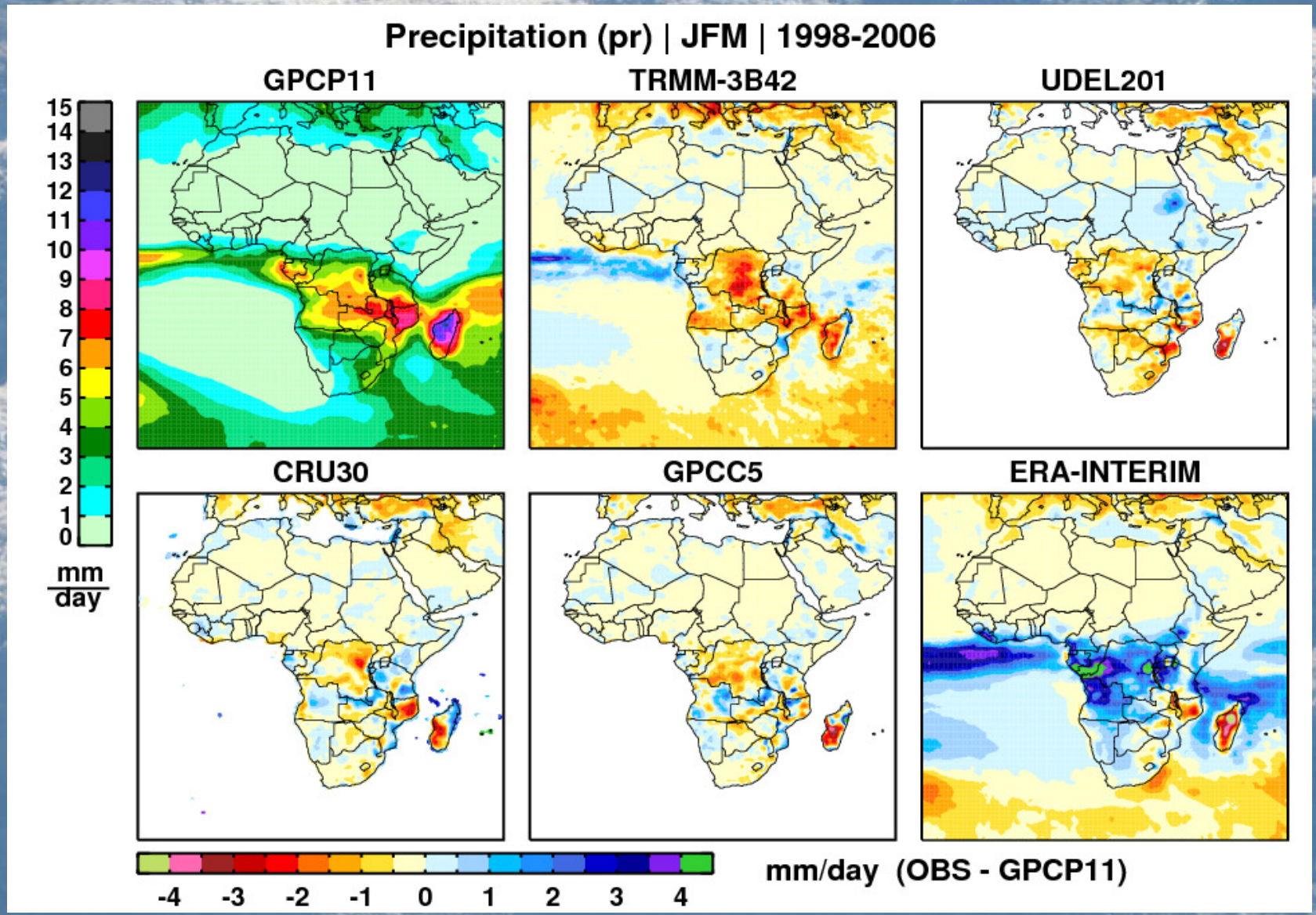
BADC & DKRZ will provide CORDEX archiving in 2012 thru their ESG nodes.

SMHI, DMI and U. Cape Town (Africa-data) will provide similar facilities in 2013. Possibly also IITM (South Asia data) and KMA (East Asia data)

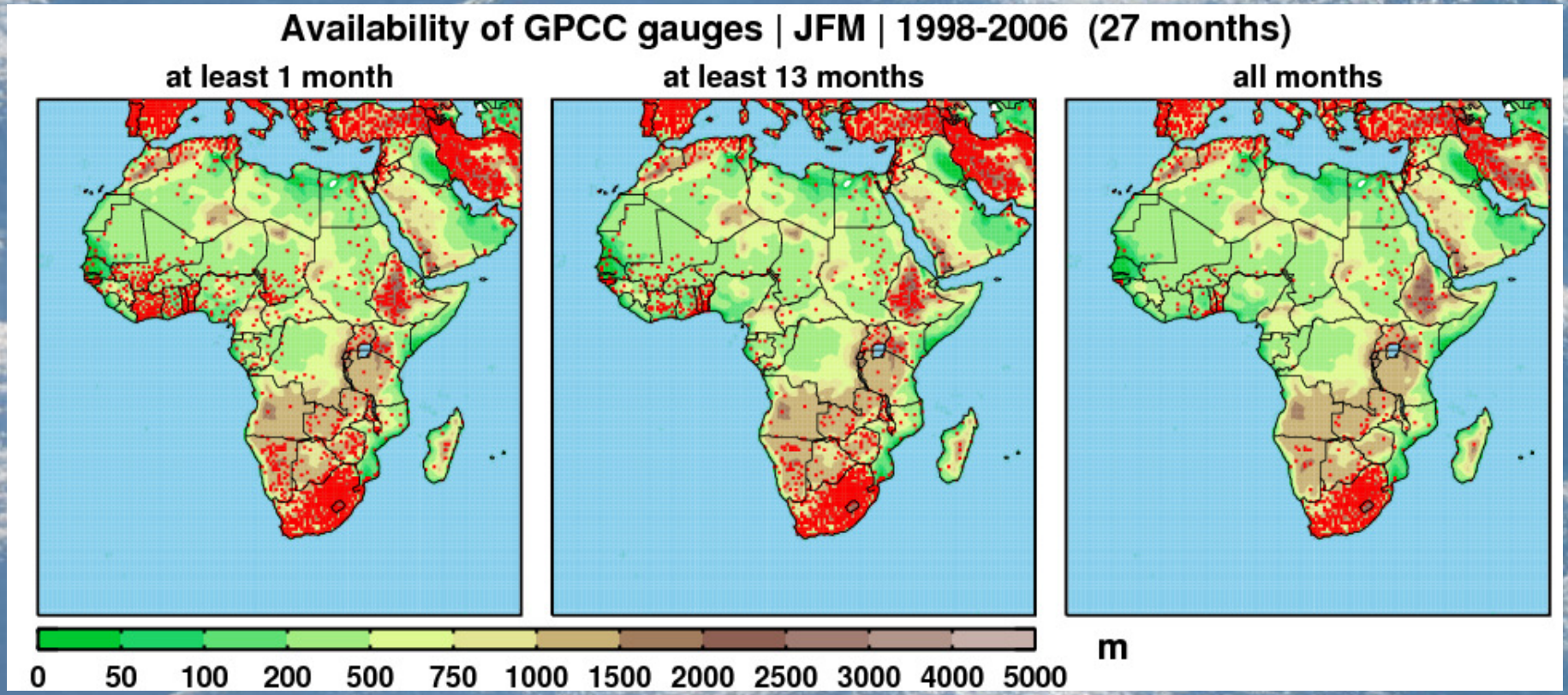
http://wcrp.ipsl.jussieu.fr/RCD_Projects/CORDEX/cordex_archive_specifications_110628.pdf

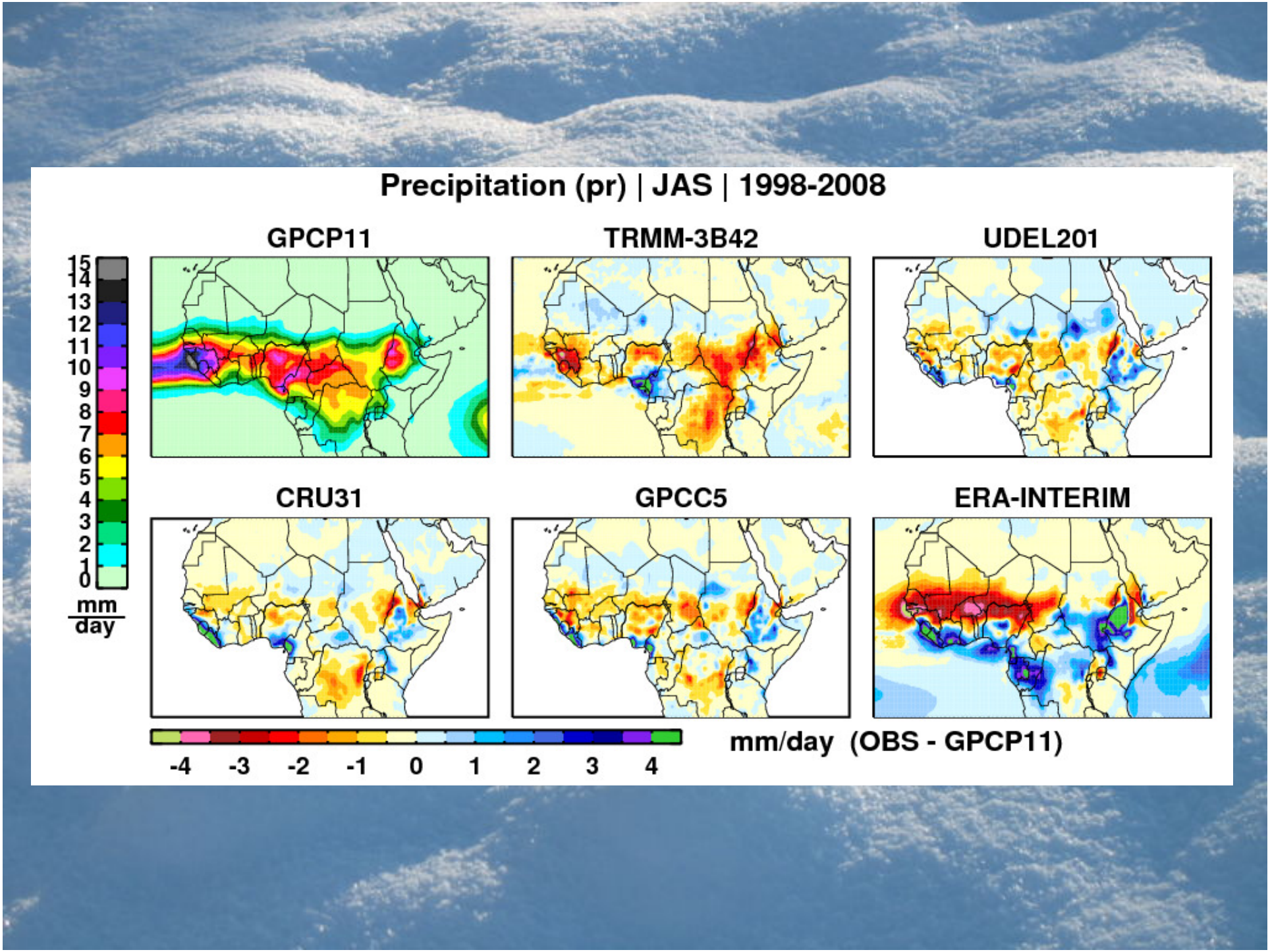
http://cordex.dmi.dk/joomla/

Over Africa it is important to consider observational uncertainty

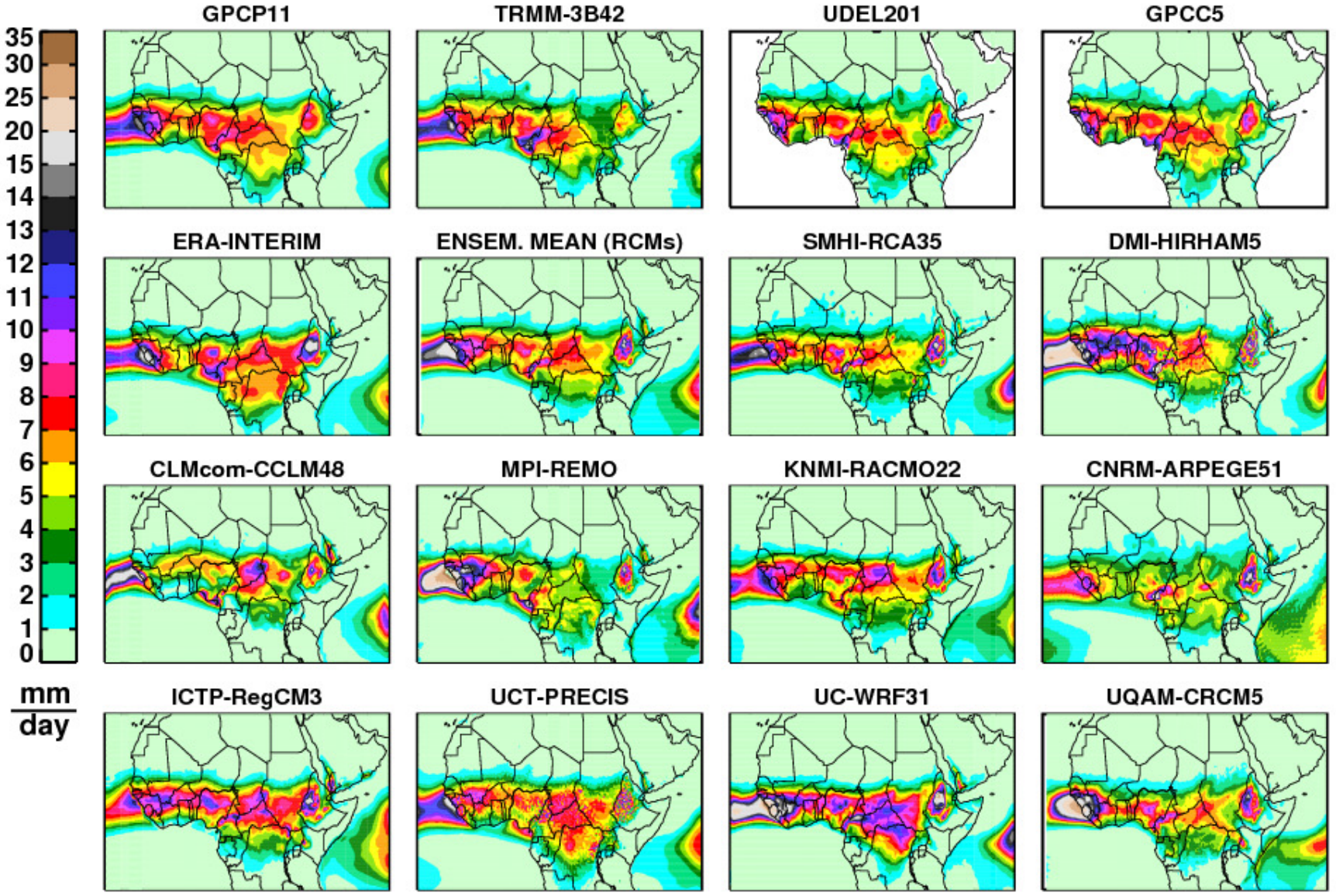


Surface observational coverage is severly limited in some regions



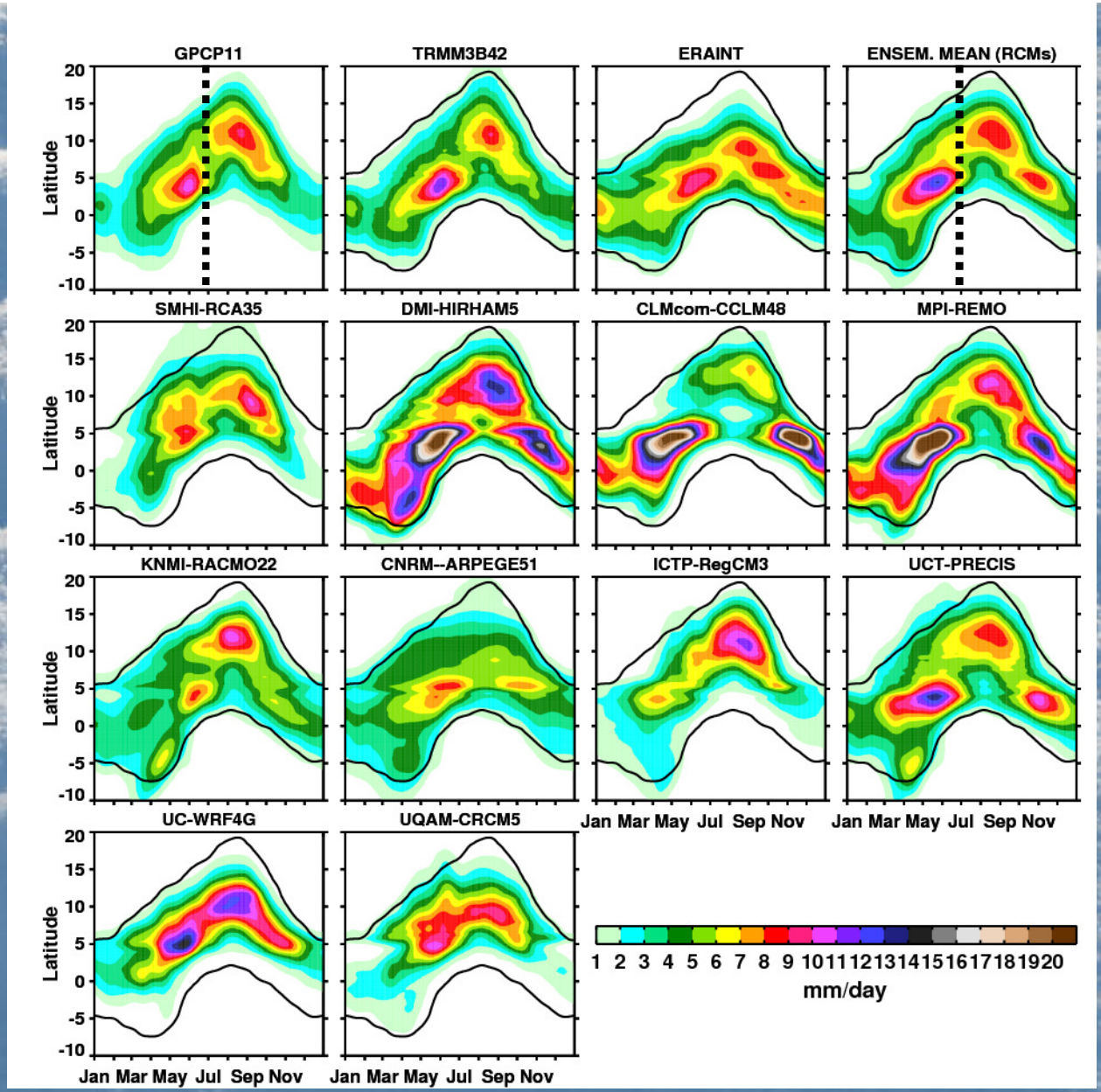

Precipitation (pr) | JAS | 1998-2008
GPCP11
TRMM-3B42
UDEL201
CRU31
GPCC5
ERA-INTERIM
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
mm
day
-4
-3
-2
-1
0
1
2
3
4
mm/day (OBS - GPCP11)

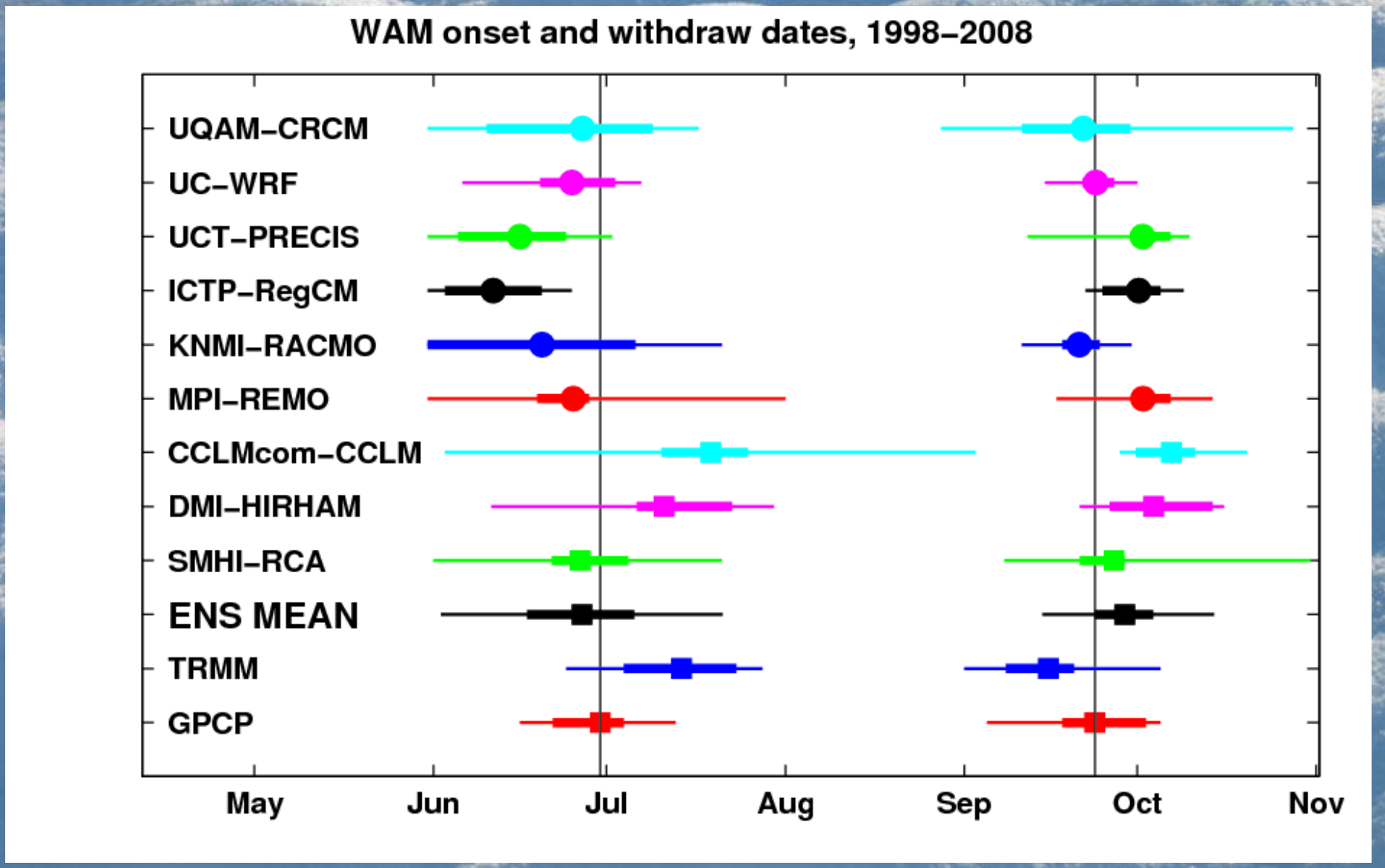
Precipitation (pr) | JAS | 1998-2008



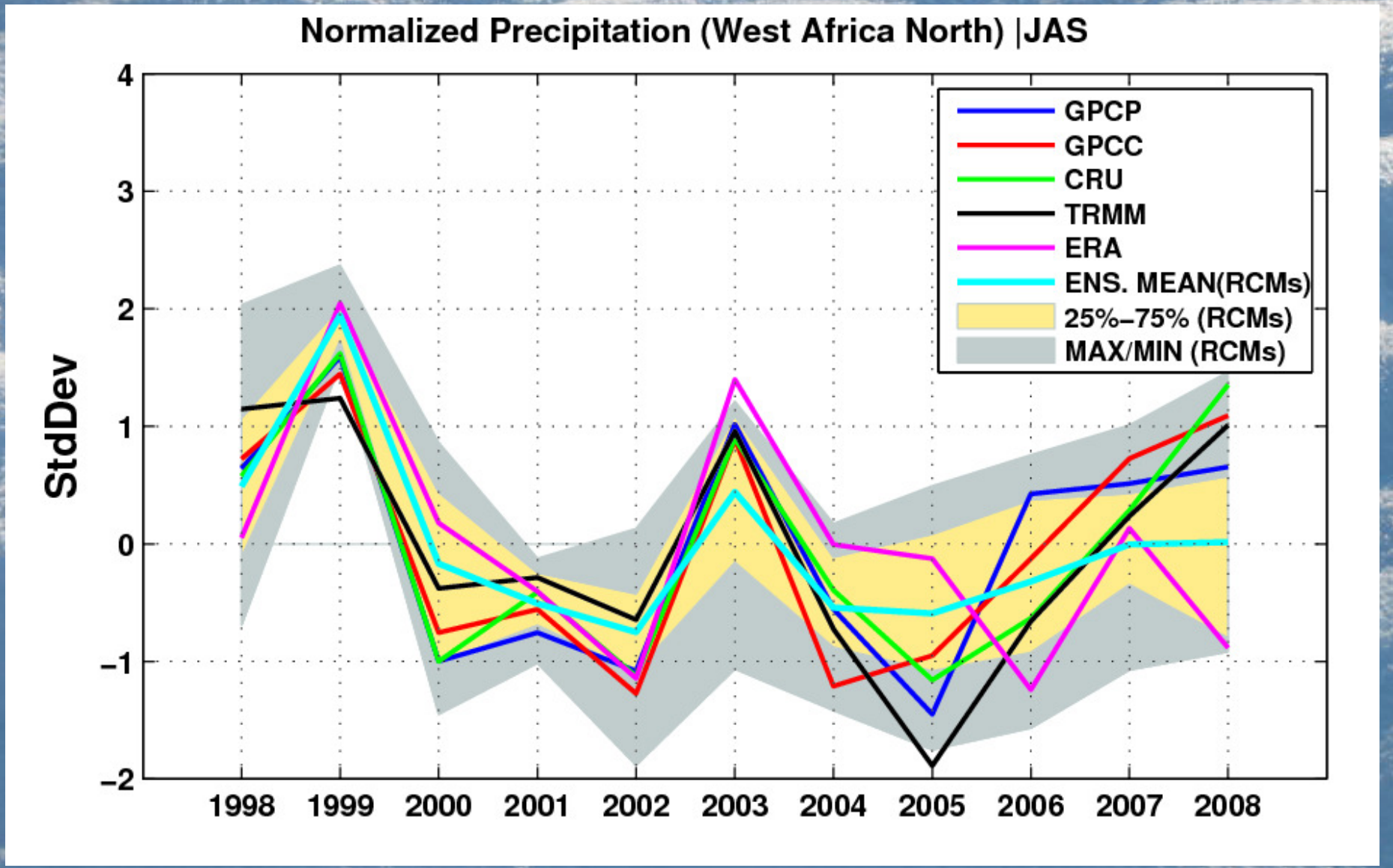
Latitudinal progression of the West African Monsoon

Monthly mean precipitation averaged between 10W-10E

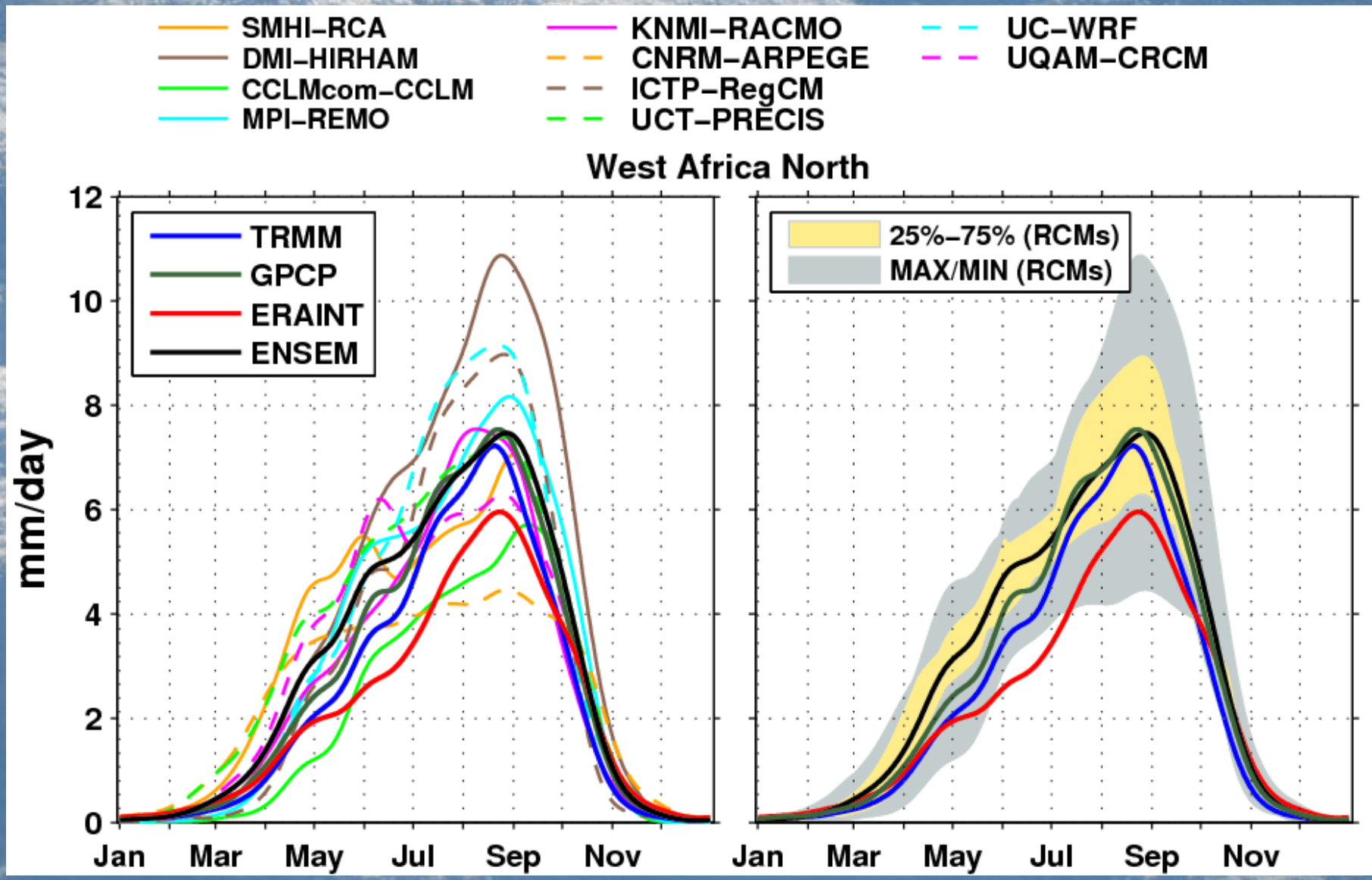


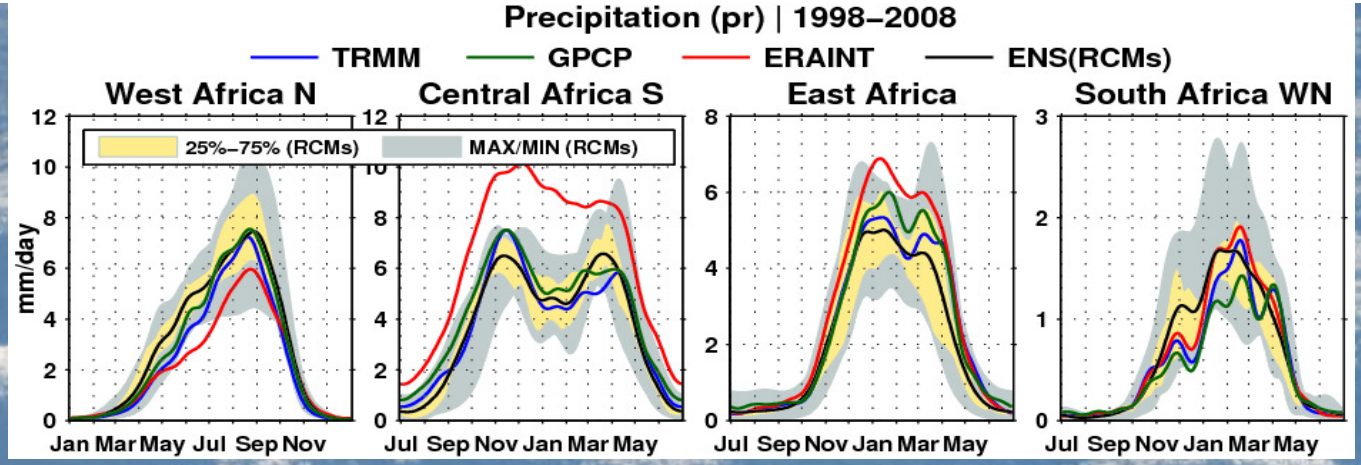

WAM onset and withdraw dates, 1998–2008
UQAM–CRCM
UC–WRF
UCT–PRECIS
ICTP–RegCM
KNMI–RACMO
MPI–REMO
CCLMcom–CCLM
DMI–HIRHAM
SMHI–RCA
ENS MEAN
TRMM
GPCP
May
Jun
Jul
Aug
Sep
Oct
Nov

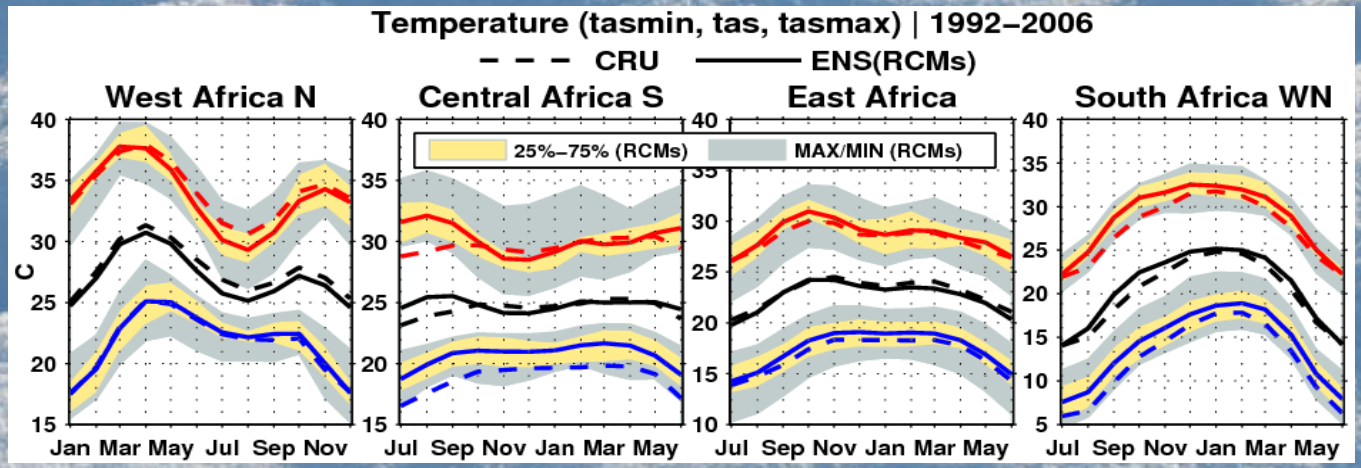
Interannual variation of west Africa rainfall in RCMs forced by ERA-interim

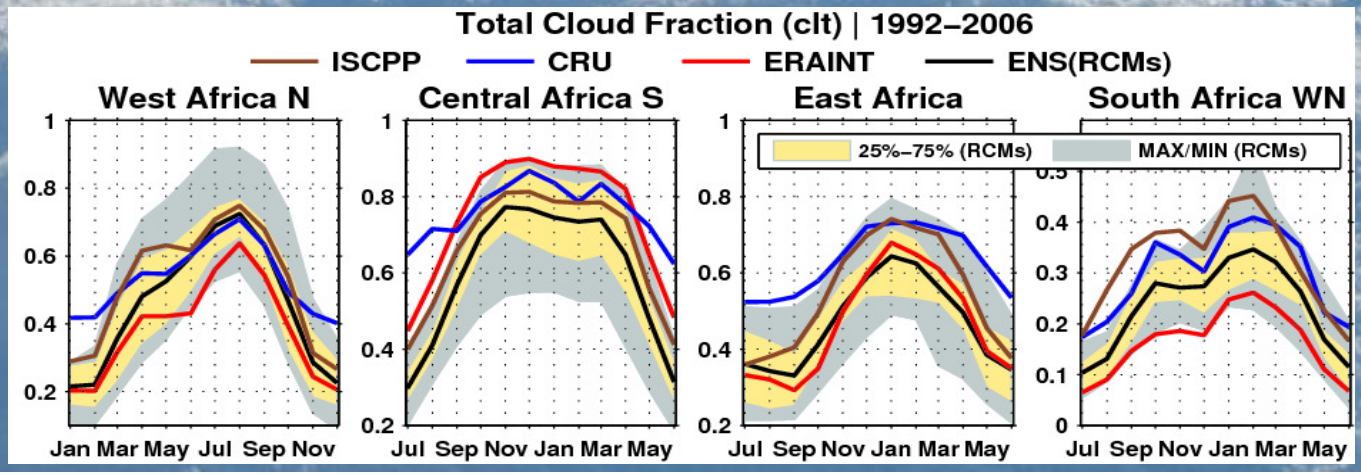


Annual Cycle spatially averaged rainfall west Africa

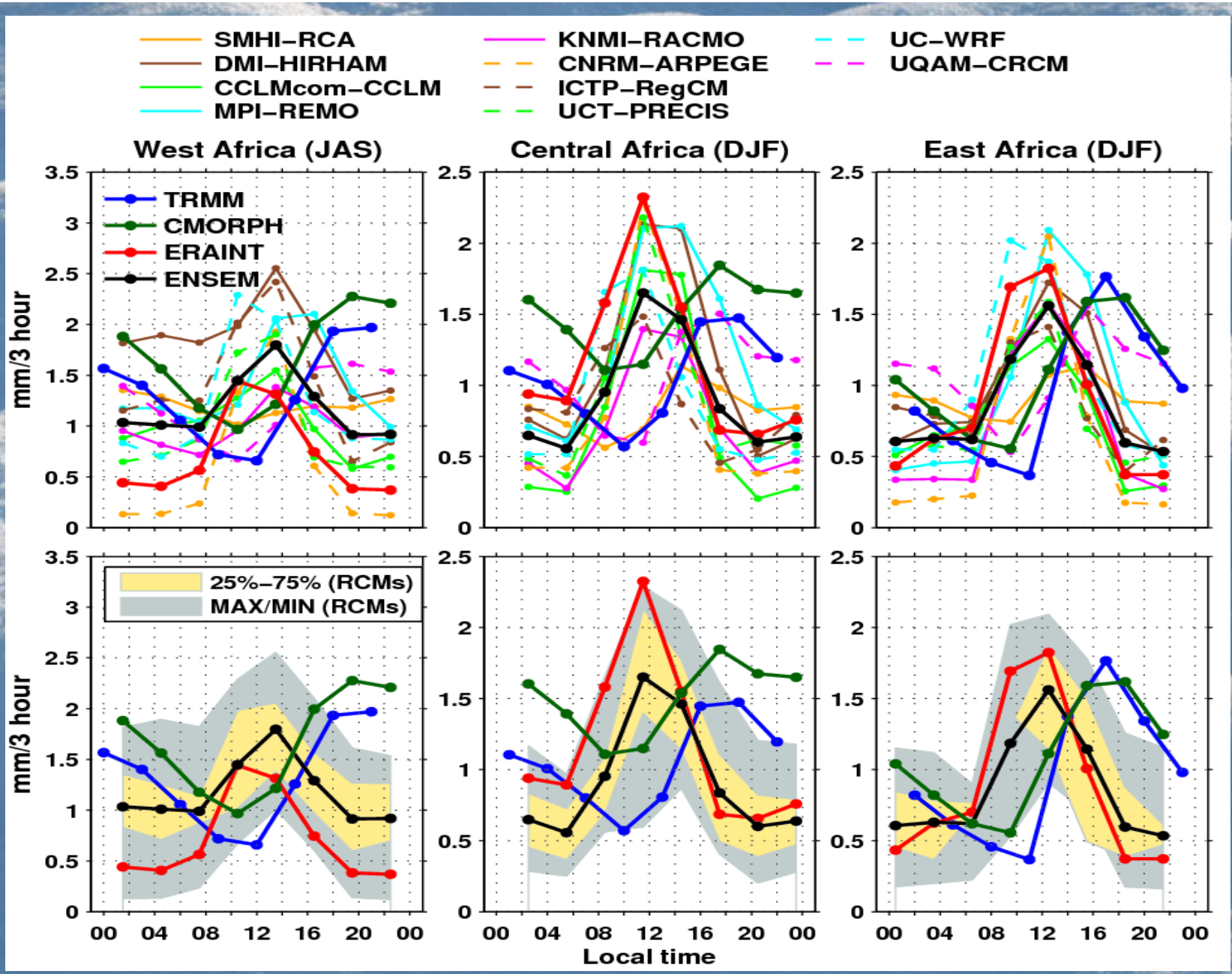



Precipitation (pr) | 1998–2008
TRMM
GPCP
ERAINT
ENS(RCMs)
West Africa N
Central Africa S
East Africa
South Africa WN
25%–75% (RCMs)
MAX/MIN (RCMs)
mm/day
Jan Mar May Jul Sep Nov
Jul Sep Nov Jan Mar May

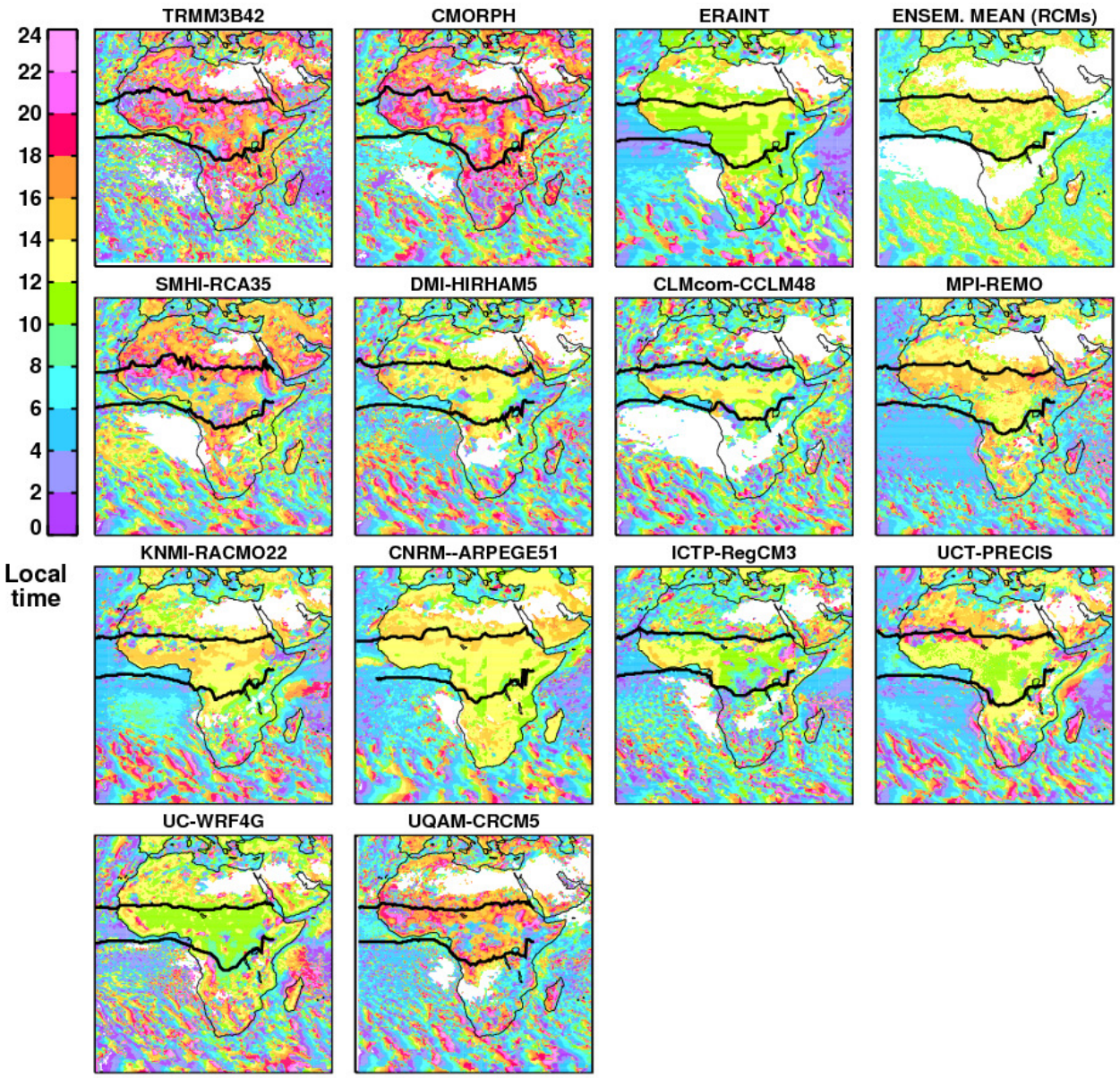

Temperature (tasmin, tas, tasmax) | 1992–2006
CRU
ENS(RCMs)
West Africa N
Central Africa S
East Africa
South Africa WN
25%–75% (RCMs)
MAX/MIN (RCMs)
C
Jan Mar May Jul Sep Nov
Jul Sep Nov Jan Mar May


Total Cloud Fraction (clt) | 1992–2006
ISCPP
CRU
ERAINT
ENS(RCMs)
West Africa N
Central Africa S
East Africa
South Africa WN
25%–75% (RCMs)
MAX/MIN (RCMs)
Jan Mar May Jul Sep Nov
Jul Sep Nov Jan Mar May

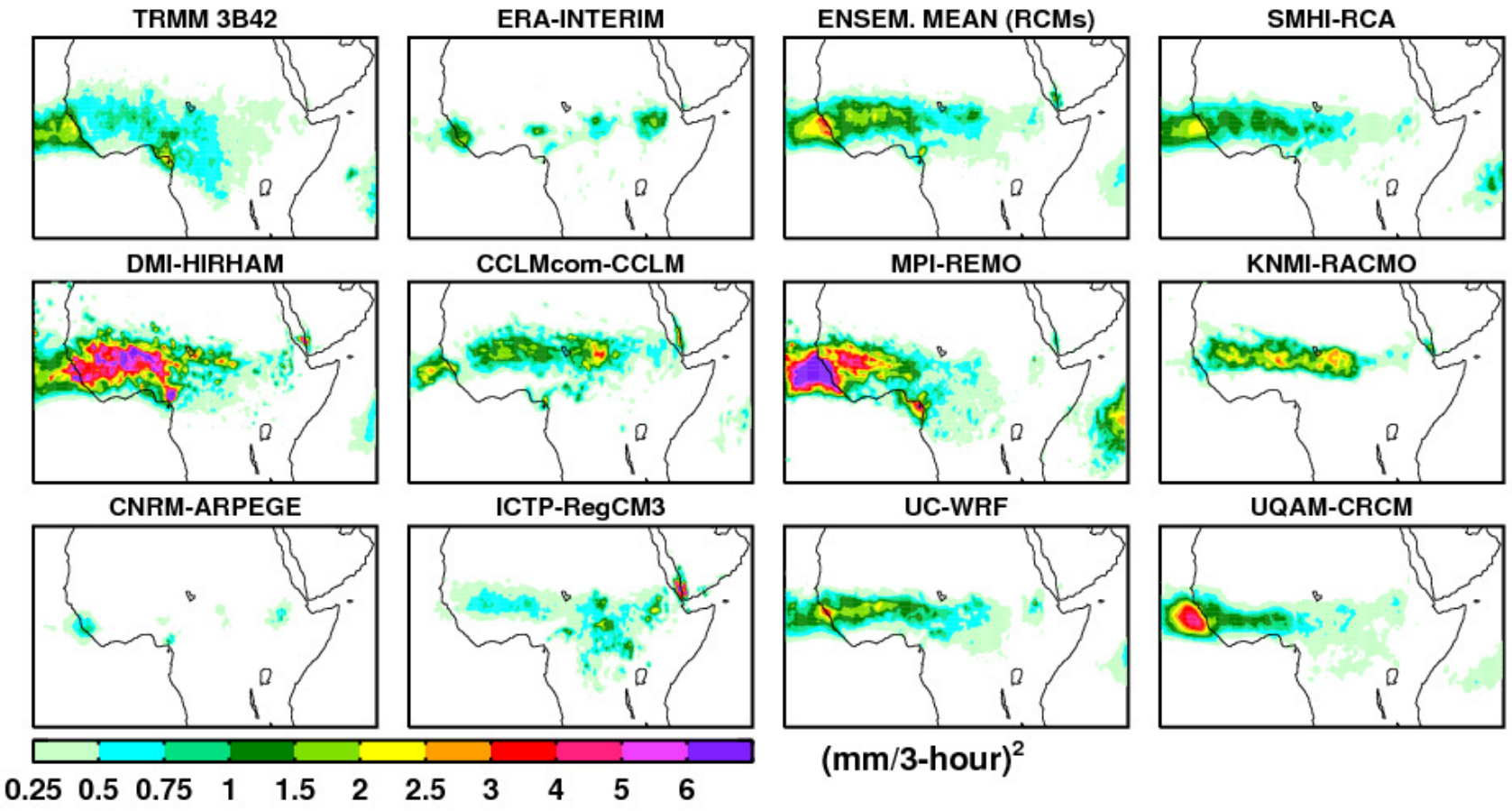
Mean Diurnal Cycle of Precipitation: West Africa JAS



Local Time of maximum rain rate during the day: JAS

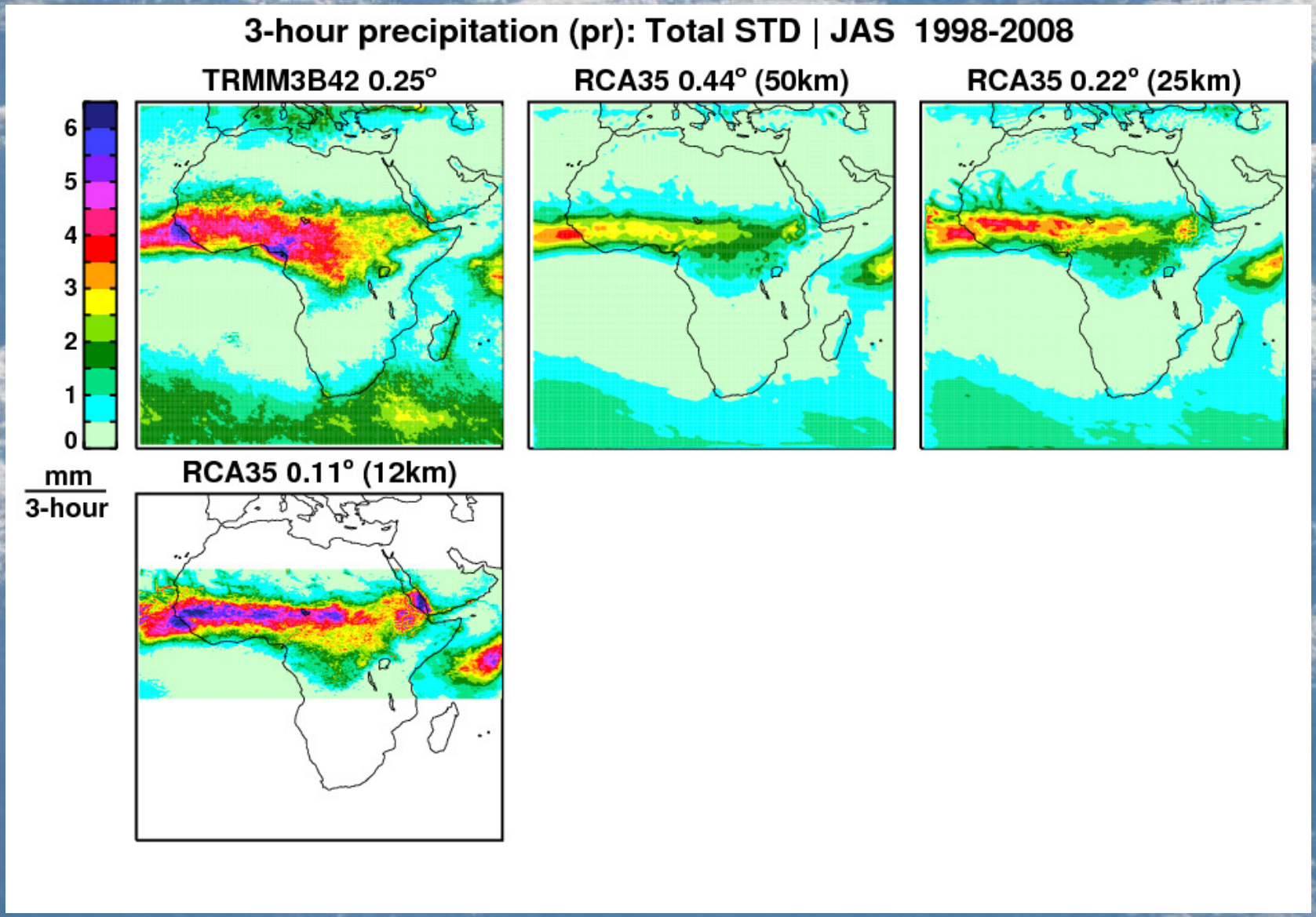


An ensemble can be used to investigate higher order climate variability & potential changes: of importance in impact assessment e.g. agriculture

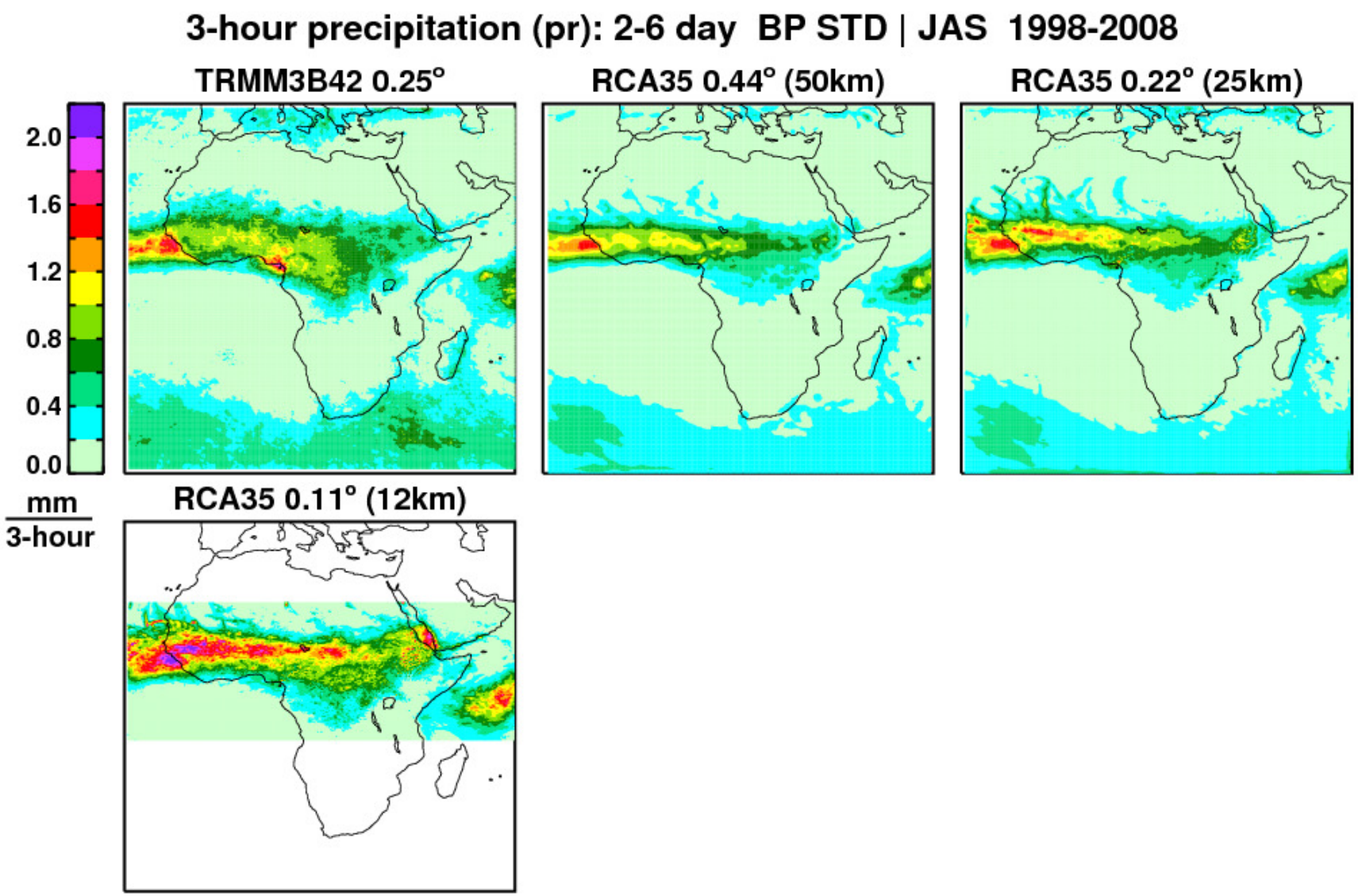


2-6 day band-passed precipitation variance highlights African Easterly Waves that deliver the majority of precipitation in the Sahel region

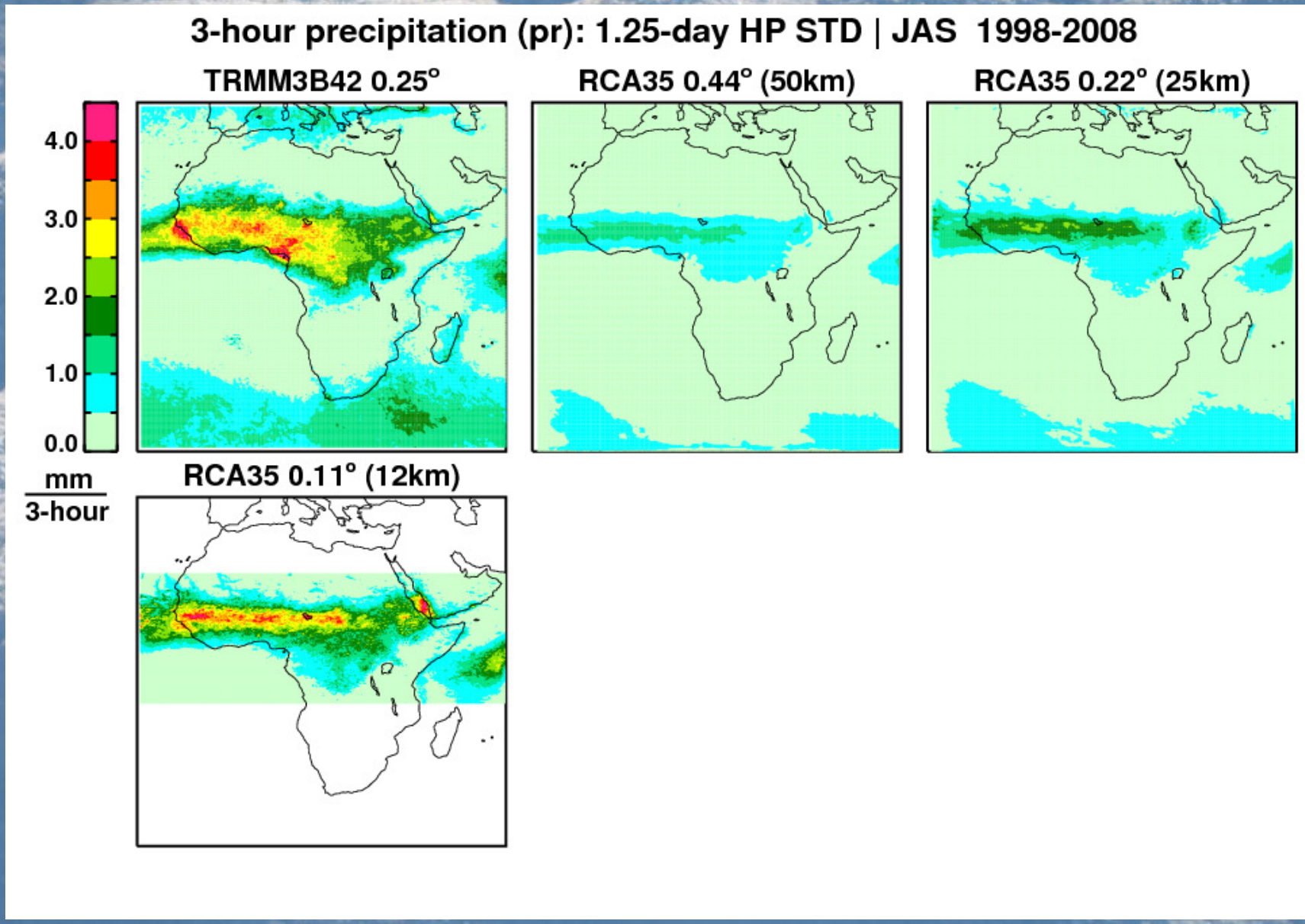
Total Standard Deviation (variance$^{1/2}$) increases with model Resolution: Precipitating systems become more active & realistic



2-6 day band-passed (AEW) Standard deviation of precipitation (JAS)

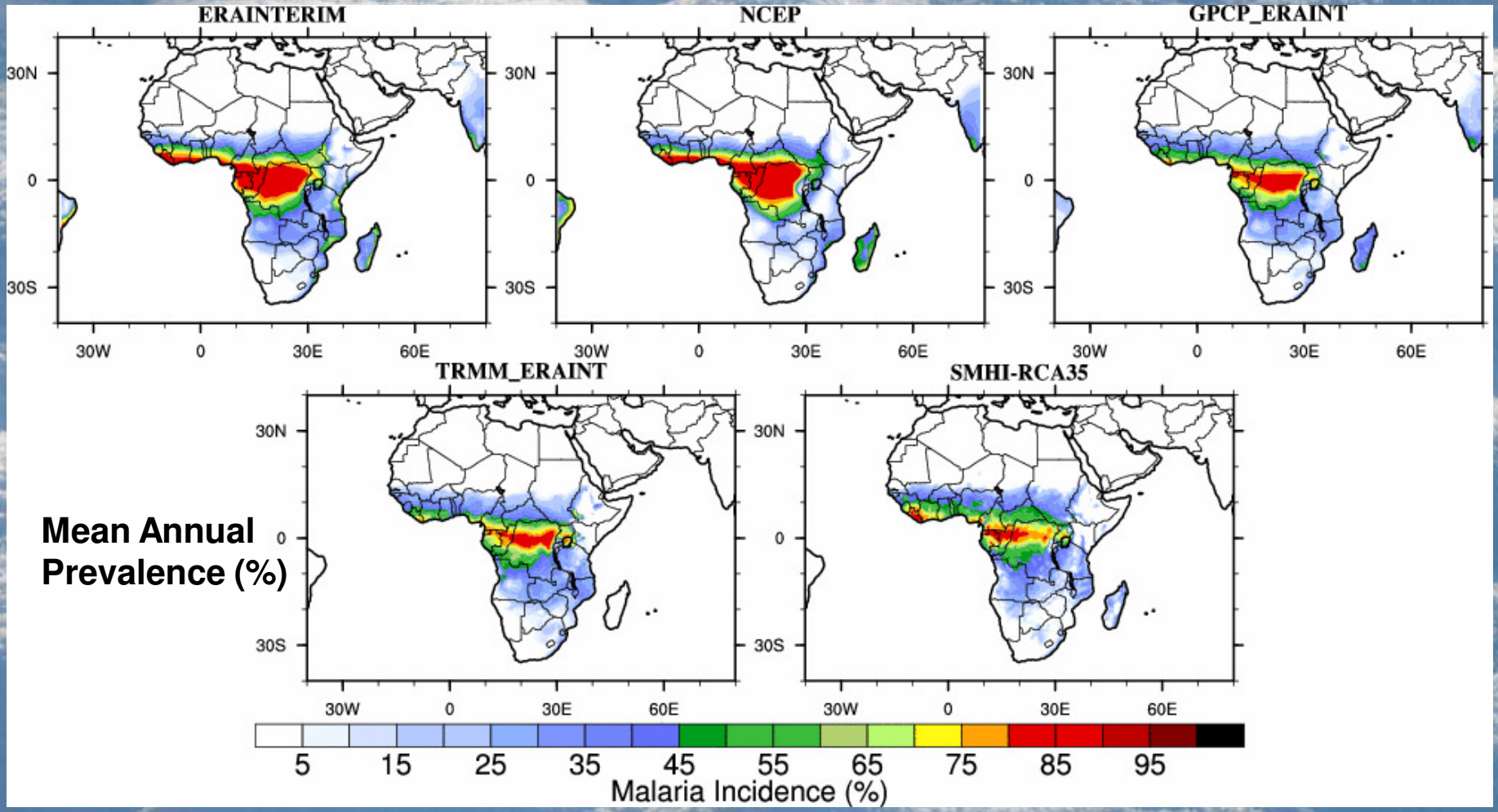


Standard Deviation of rainfall within the diurnal cycle (diurnal amplitude)



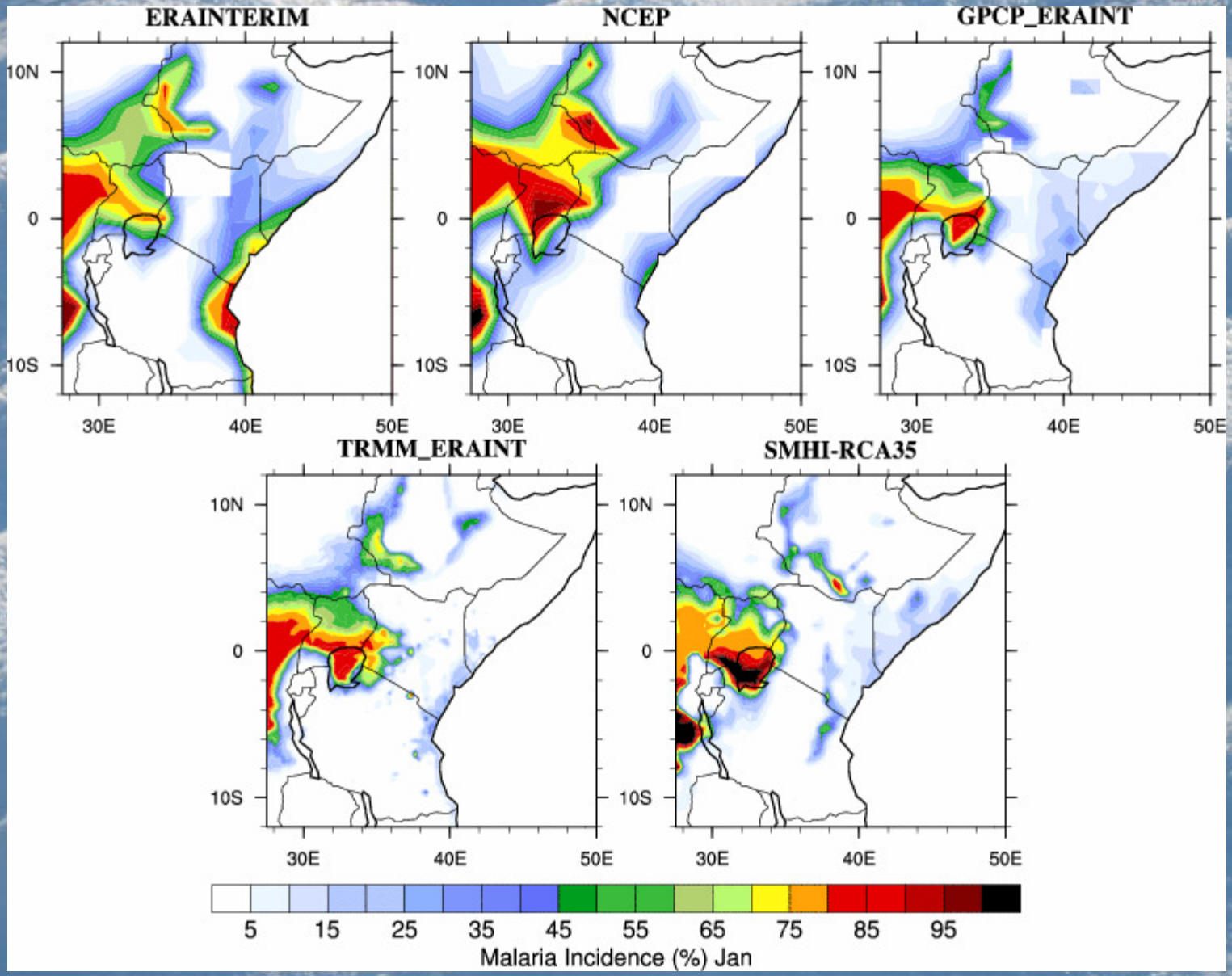

Connecting climate projections with impact models

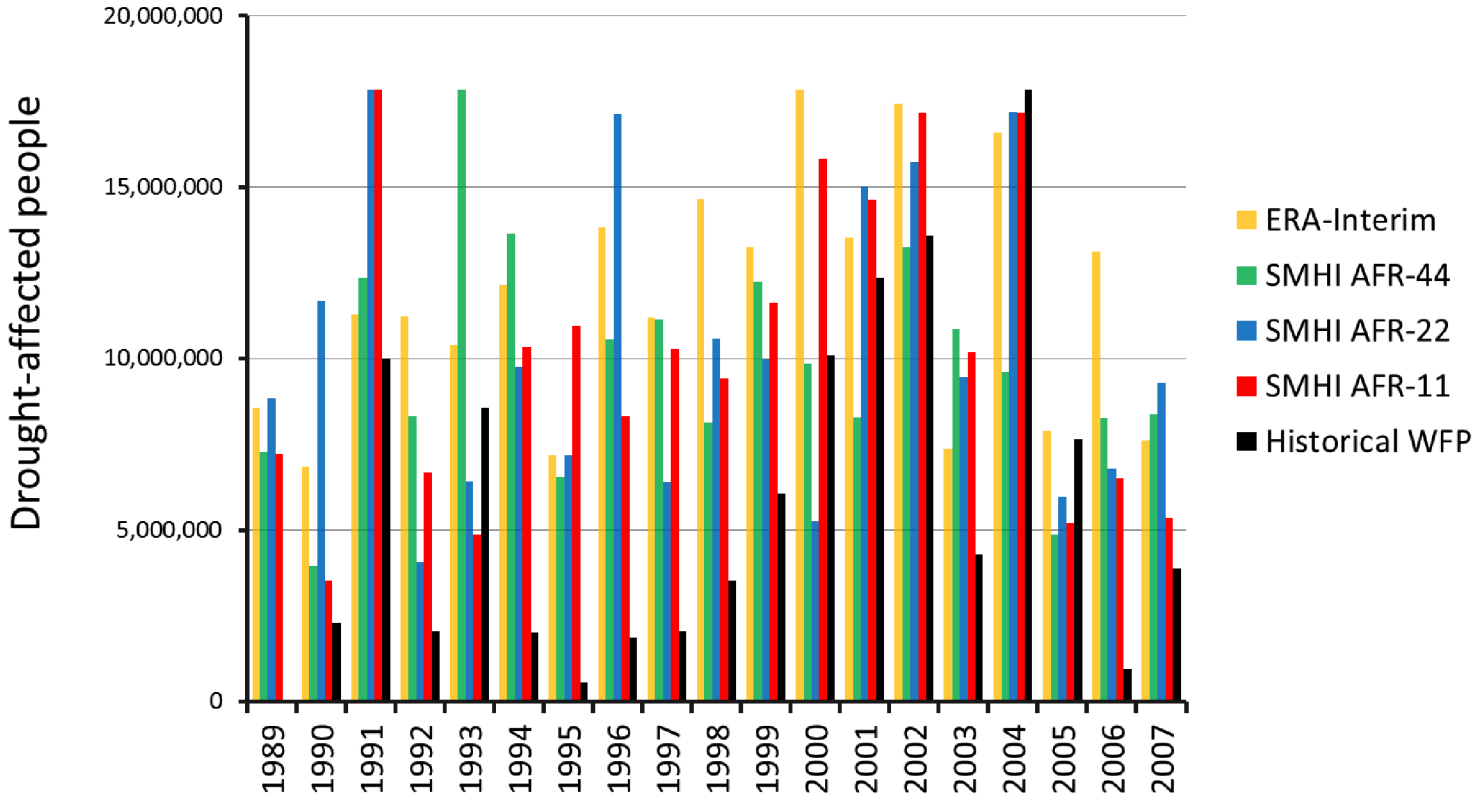
Dynamic Malaria Model driven by climate observations & CORDEX



SMHI (50km^2) reproduces well the mean annual malaria incidence pattern with respect to TRMM-ERAINT & GPCP-ERAINT control experiment

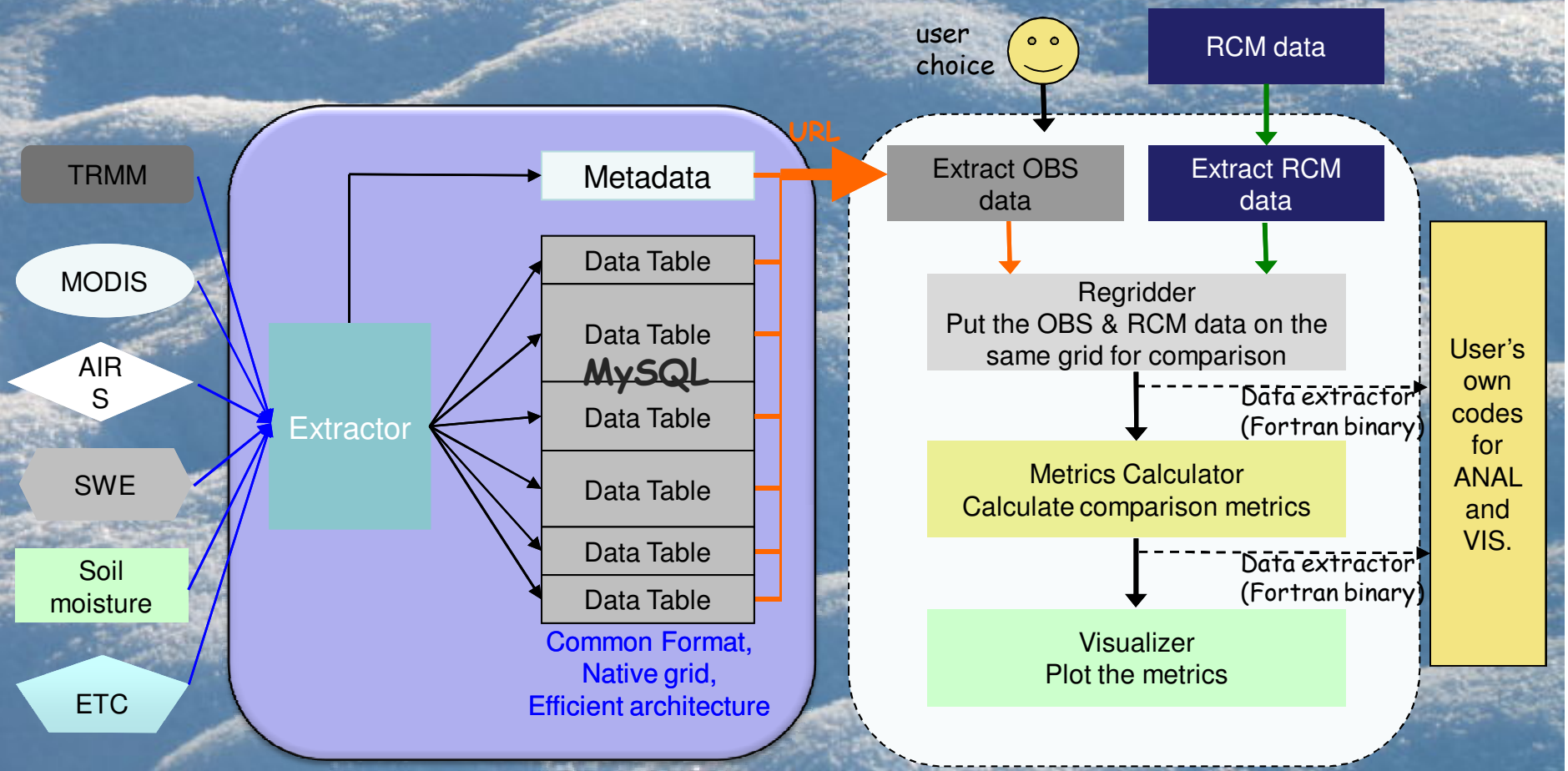
Malaria mean seasonal cycle animation





Number of drought-affected people in Africa from WFP Africa RiskView based on rainfall and potential evapotranspiration using: ERA-Interim, SMHI/RCA (ERA-int) at 0.44, 0.22 & 0.11°.Black bars: historical record of WFP emergency operations (EMOP) in response to drought. EMOP reflects planned interventions & should be considered a lower bound to the actual drought-affected people.

Regional Climate Model Evaluation System (RCMES)
Application to CORDEX (JPL/UCLA; D. Waliser, J. Kim, C. Mattman, et al.)



Raw Data:
Various formats, Resolutions, Coverage

RCMED
(Regional Climate Model Evaluation Database)
A large scalable database to store data from variety of sources in a common format

RCMET
(Regional Climate Model Evaluation Tool)
A library of codes for extracting data from RCMED and model and for calculating evaluation metrics

Regional Climate Model Evaluation System (RCMES)
Application to CORDEX (JPL/UCLA; D. Waliser, J. Kim, C. Mattman, et al.)

AVAILABLE

- AIRS gridded daily 3D temperature and water vapor
- TRMM 3B42 3-hourly gridded daily precipitation
- ERA-Interim 6-hourly surface temperature & dewpoint, 3D temperature & geopotential
- NCEP daily Unified Rain gauge Database (URD), 0.25° resolution
- Satellite-based Snow Water Equivalent (SWE) assimilation data
- MODIS daily Cloud fraction
- Climate Research Units (CRU) monthly precipitation and temperature (Tavg, Tmin, Tmax) at 0.5° resolution.

FUTURE

- CERES radiation, CloudSat atmospheric ice and liquid, MODIS snow cover, ISCCP cloud fraction, MERRA, etc.

Ingest obs/models, re-gridding, calculate metrics (e.g, bias, RMSE, correlation, significance, PDFs), and visualize results (e.g., contour, time series, Taylor).

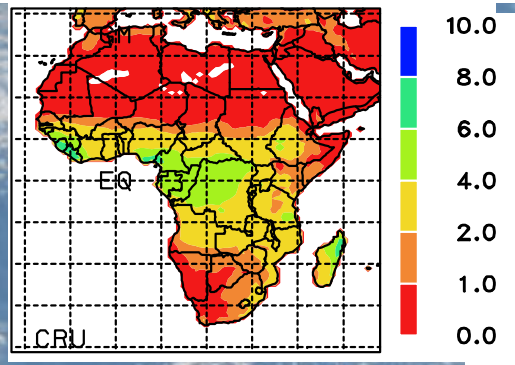
Facilitate the use of observations for:

- RCM evaluation
- RCM development
- Decision Support
- RCM Performance Metrics

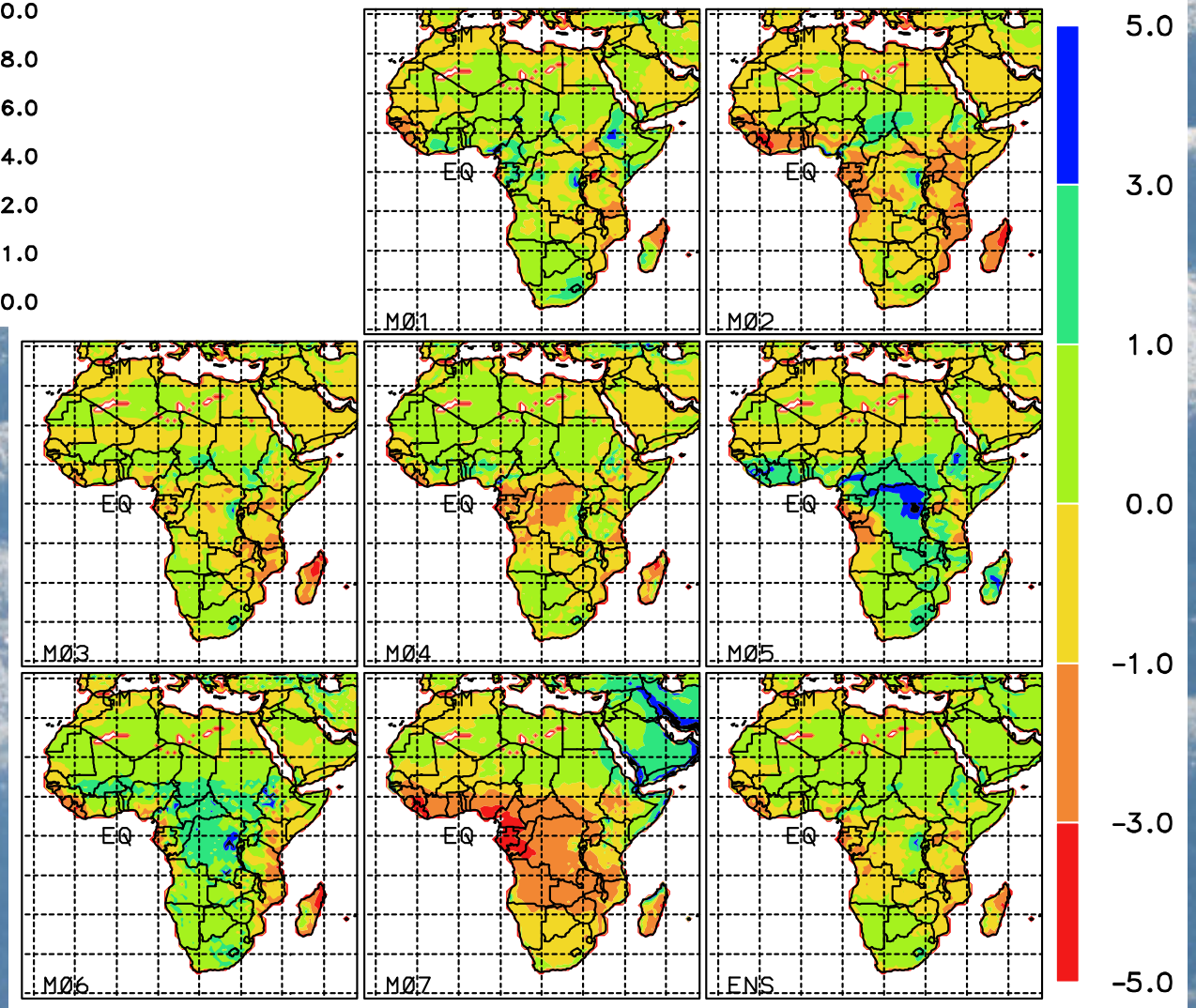
- **Africa – analysis ongoing (UCT, Rossby Ctr)**
- **N. America – just funded via NASA NCA call.**
- **E. Asia – exploring collaboration (KMA, APCC)**

Annual precipitation climatology for 1989-2006

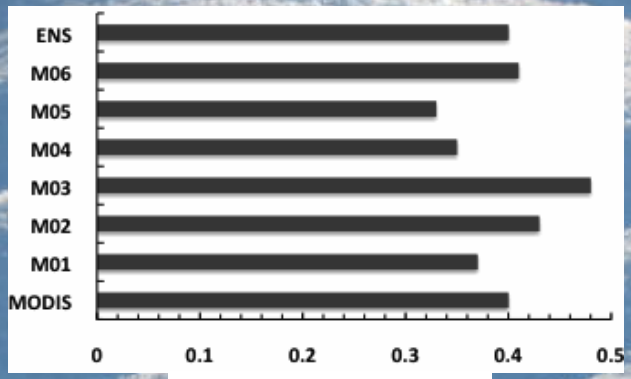
REF (mm/day): CRU



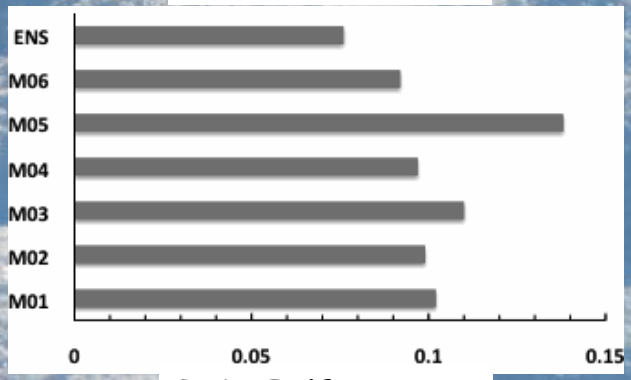
Bias: Annual-mean precipitation climatology (mm/day)



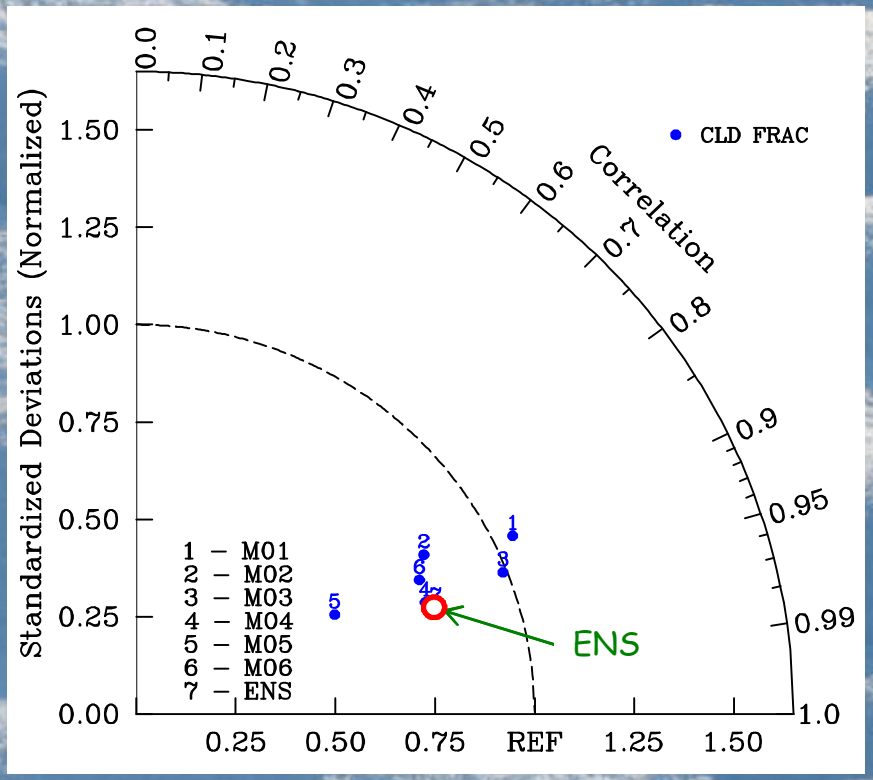
Total Cloud Climatology vs MODIS 2001-2008



Mean (fraction)

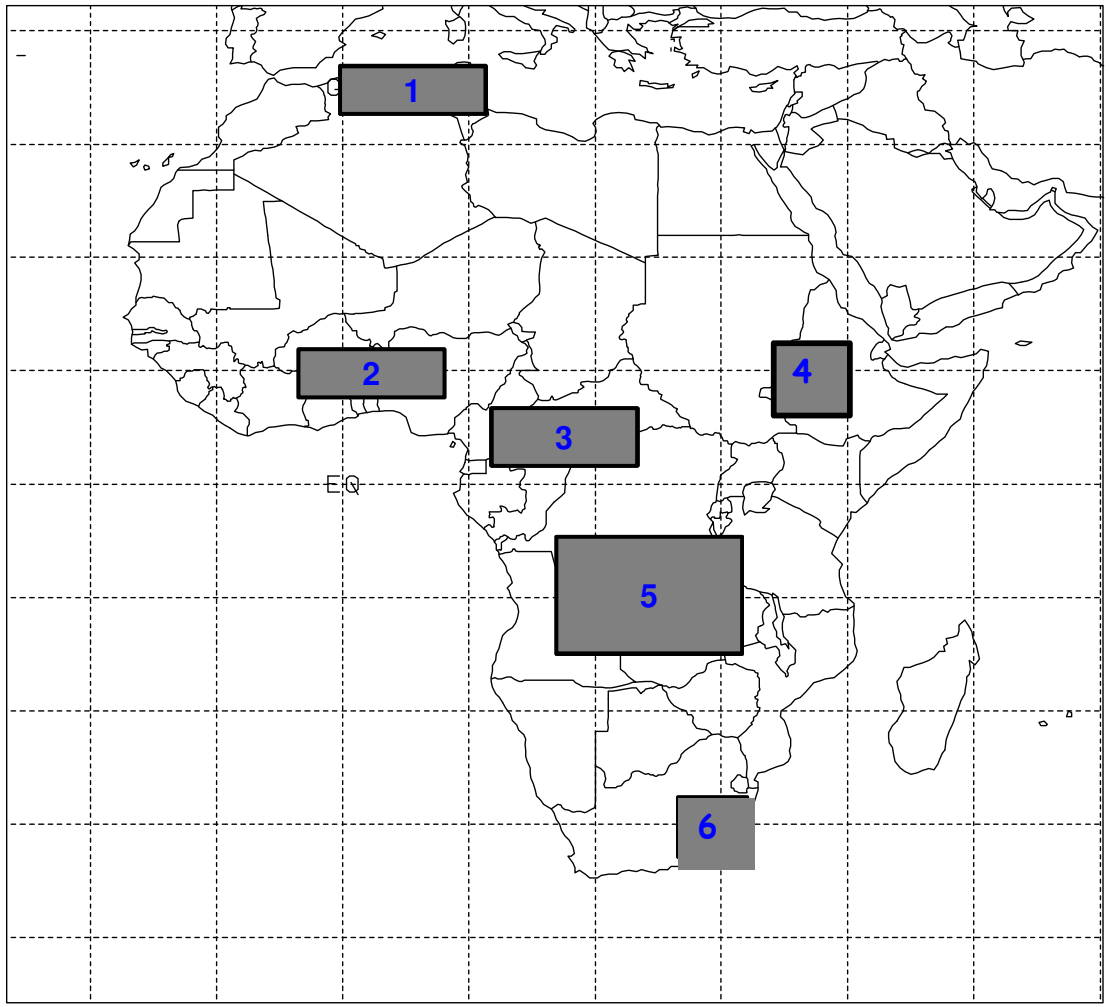


RMSE (fraction)

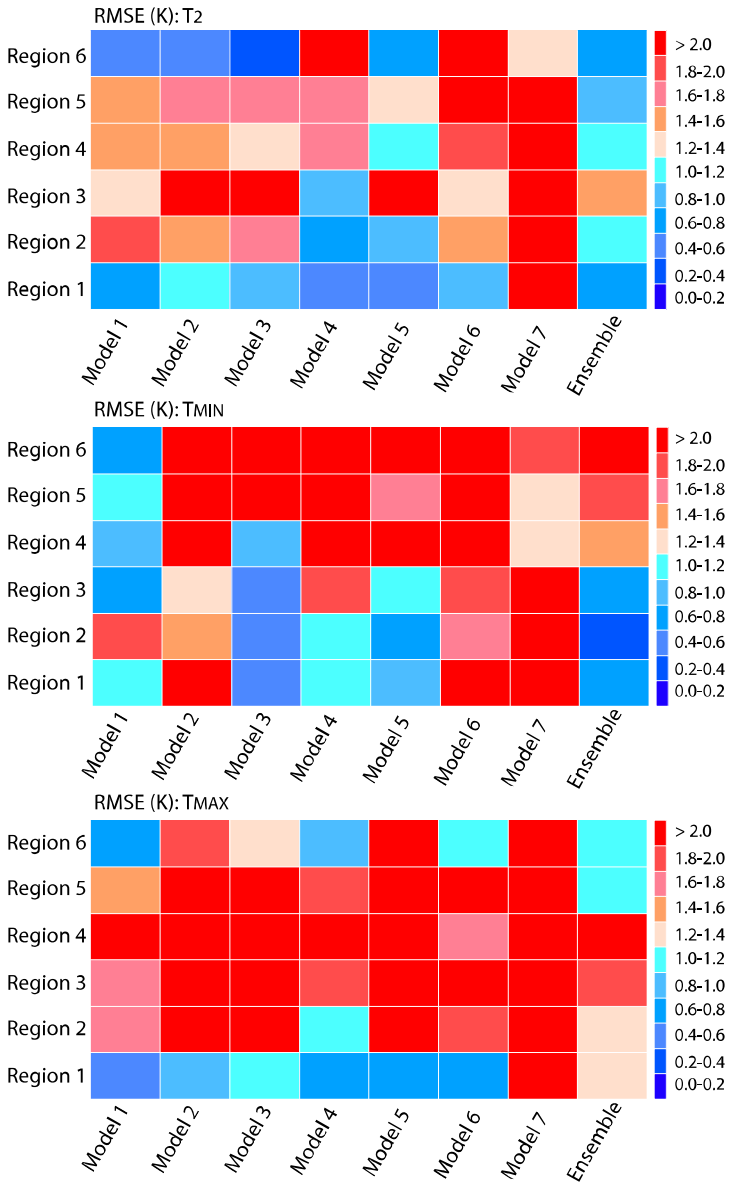


- Model errors range from -17.5% to +20%
- All models generate good spatial pattern (spatial corr. coef. > 0.9 vs. the MODIS data).
- Model ensemble generally agree more closely with the REF data than individual models.
  - the smallest bias and RMSE against the MODIS data.
  - the highest spatial correlation with the MODIS data.
  - Model ensemble does not improve spatial variability.

CORDEX-Africa Hindcast Domain



Annual Cycle RMSE(K)

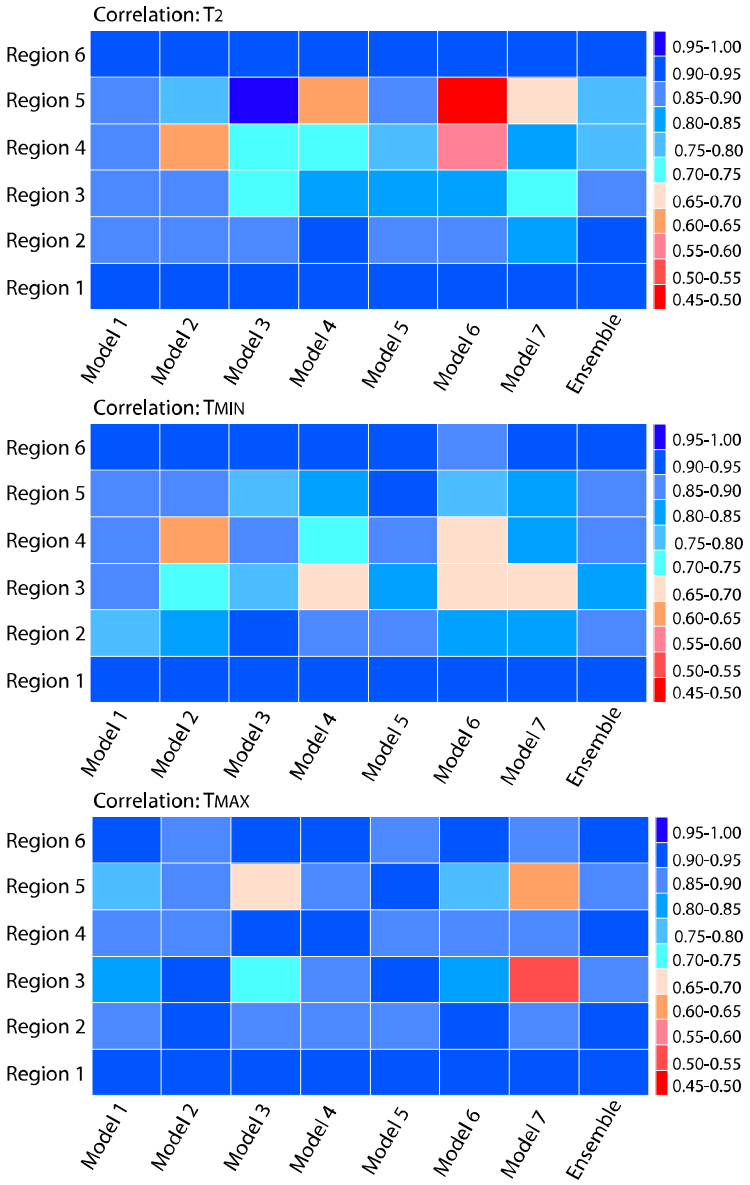


T2m

TMin

TMax

Annual Cycle Correlation



Selecting GCMs for downscaling and filling
A multi-RCP, multi-GCM, multi-RCM matrix

Data availability

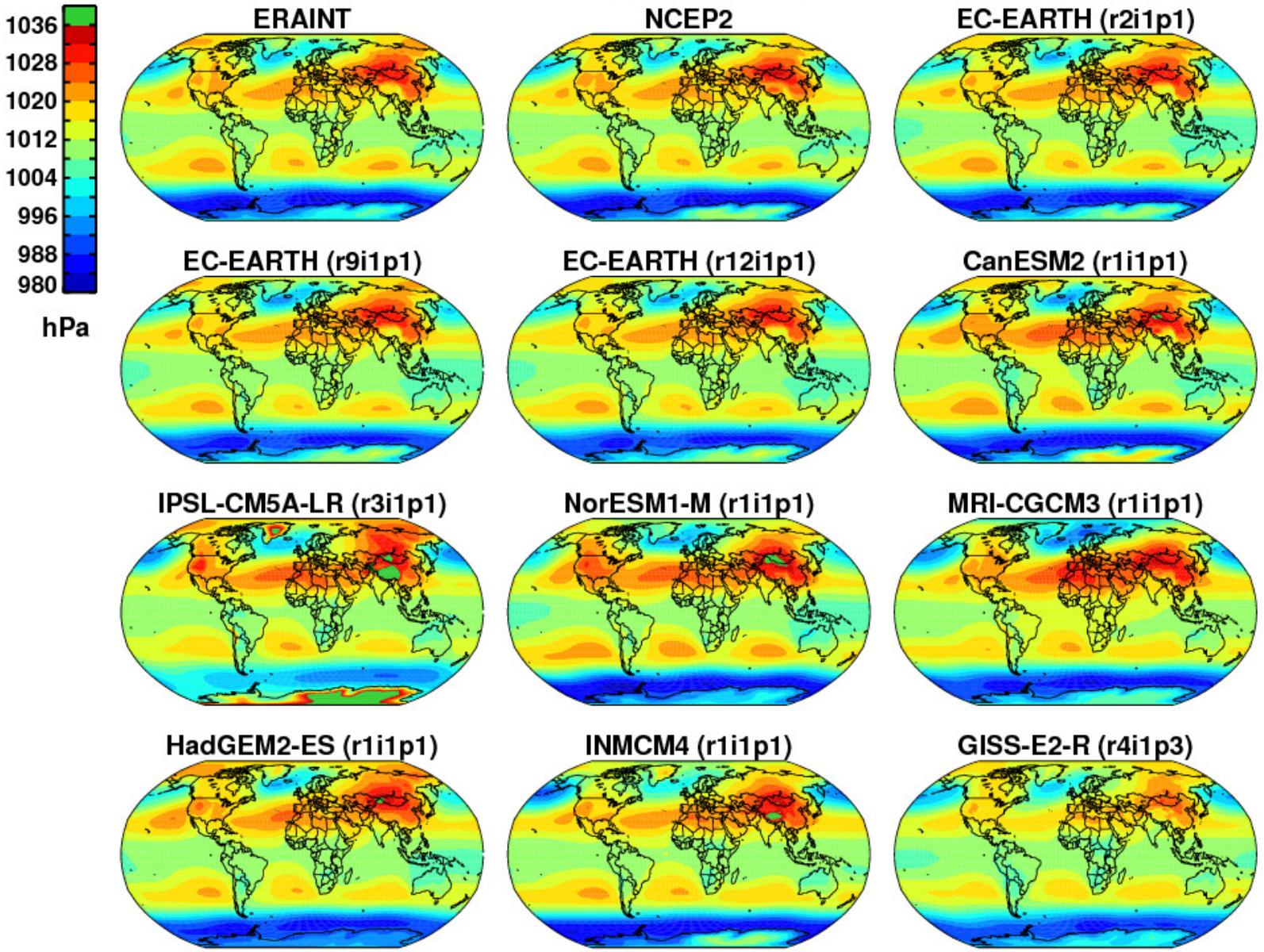
Global performance for historical period

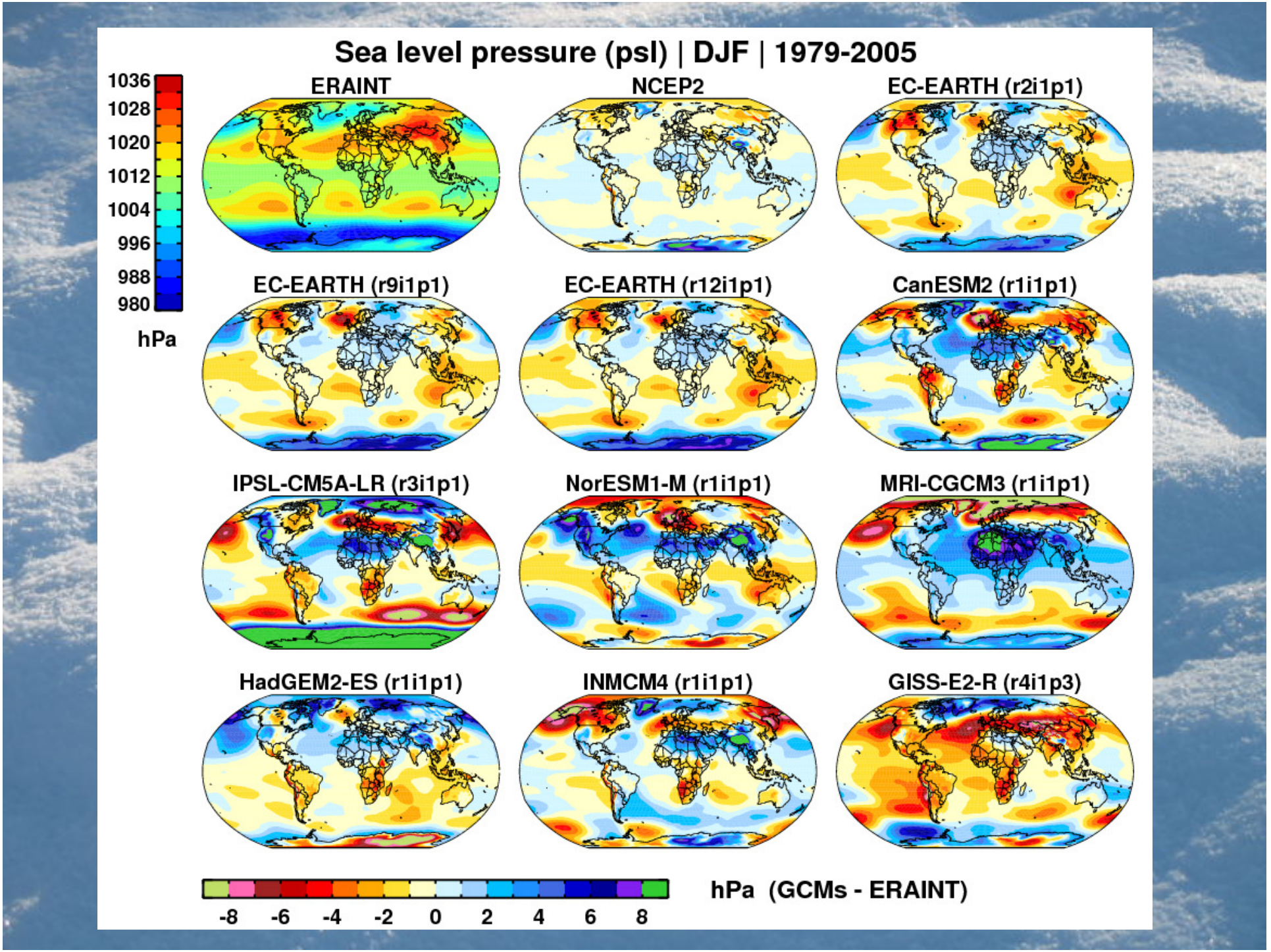
Global Climate Sensitivity

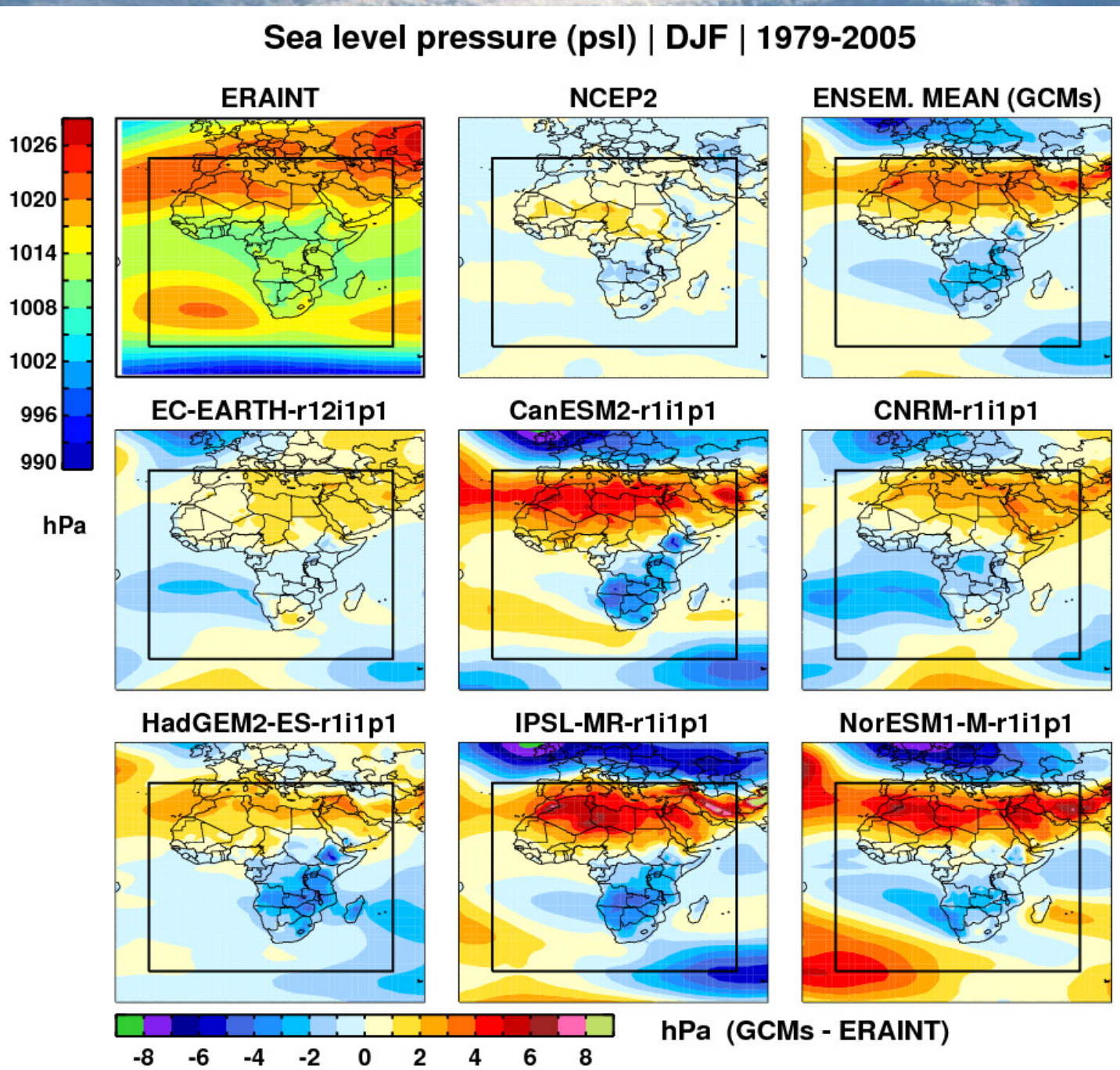
Regional (area of interest) performance historical period

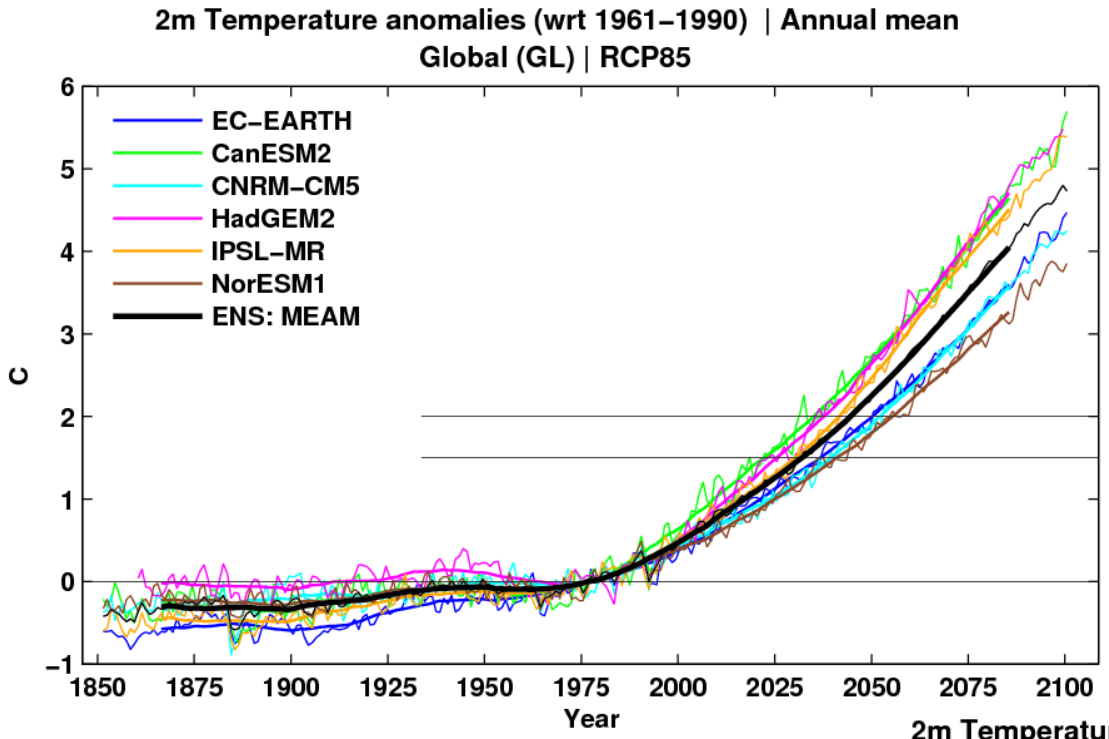
Completeness of process representation in terms of Potential feedbacks e.g. Coupled carbon cycle

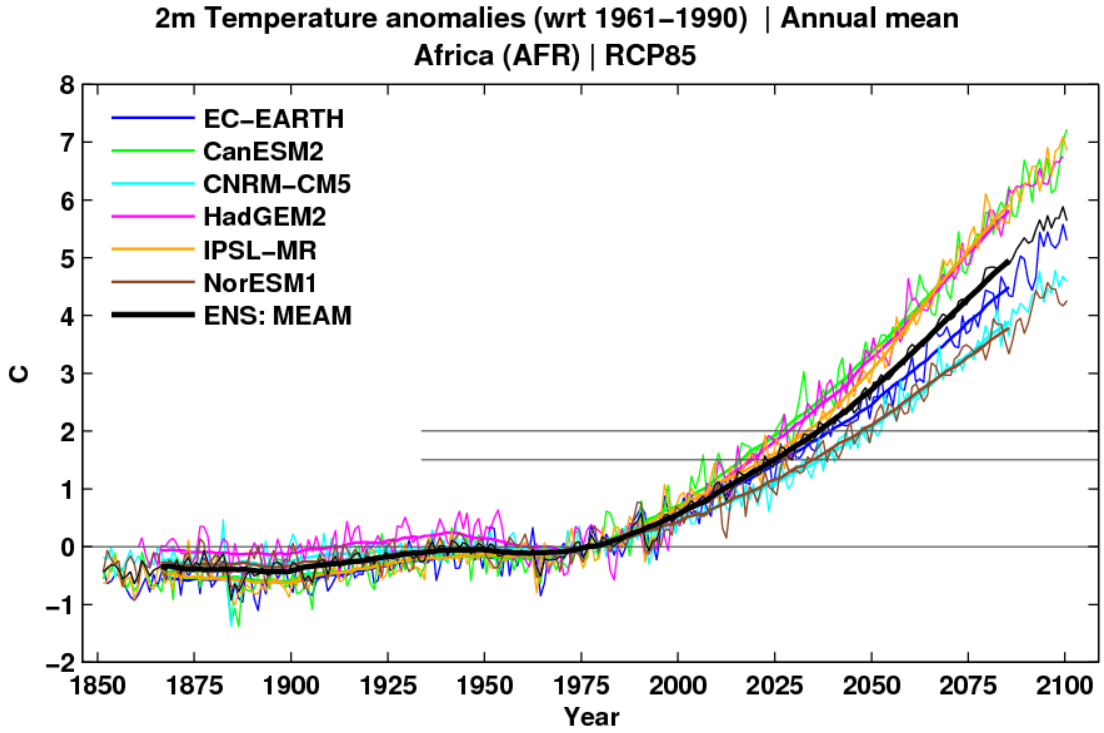
Sea level pressure (psl) | DJF | 1979-2005

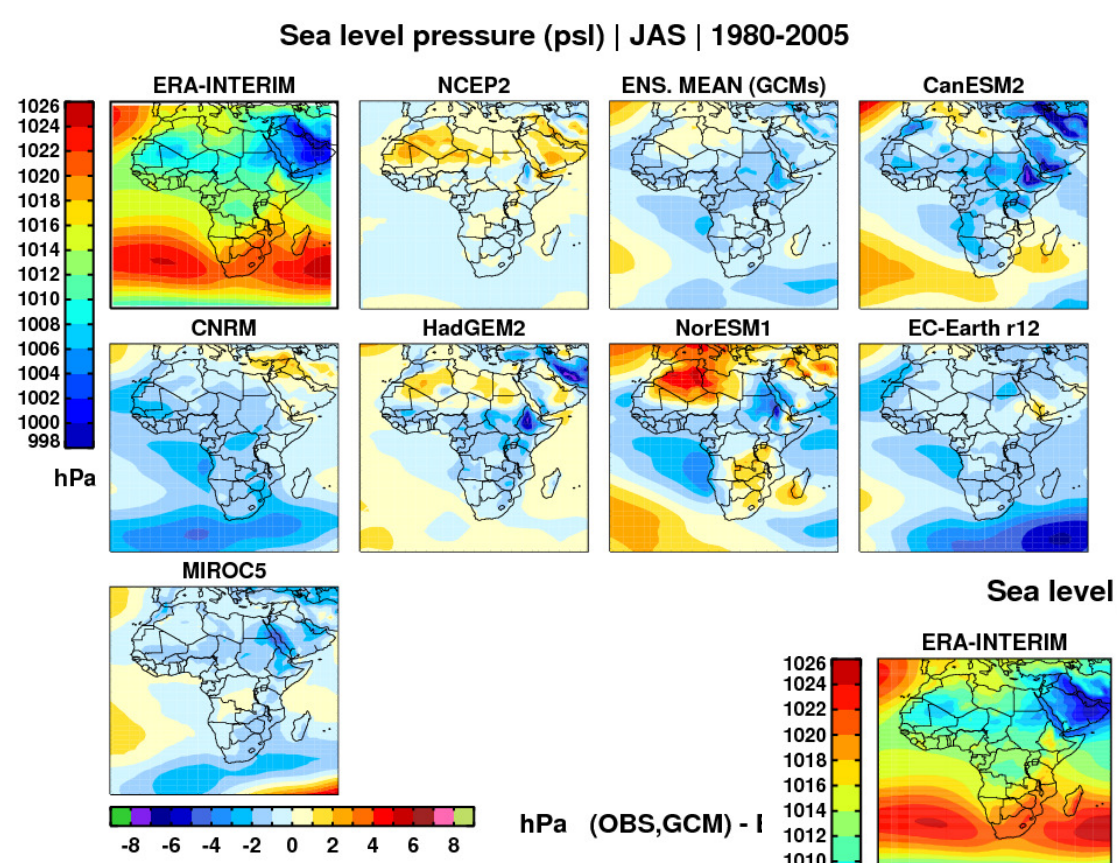


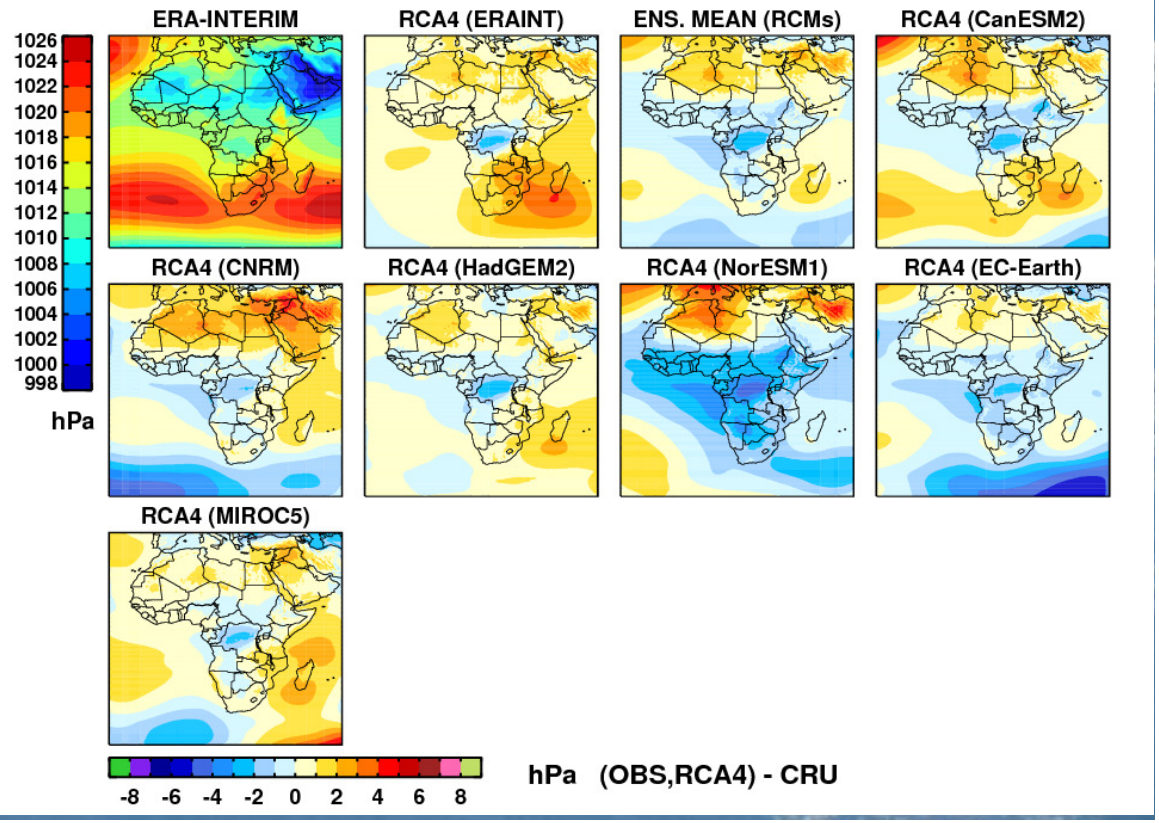

Sea level pressure (psl) | DJF | 1979-2005
1036
1028
1020
1012
1004
996
988
980
hPa
ERAINT
NCEP2
EC-EARTH (r2i1p1)
EC-EARTH (r9i1p1)
EC-EARTH (r12i1p1)
CanESM2 (r1i1p1)
IPSL-CM5A-LR (r3i1p1)
NorESM1-M (r1i1p1)
MRI-CGCM3 (r1i1p1)
HadGEM2-ES (r1i1p1)
INMCM4 (r1i1p1)
GISS-E2-R (r4i1p3)
-8 -6 -4 -2 0 2 4 6 8
hPa (GCMs - ERAINT)

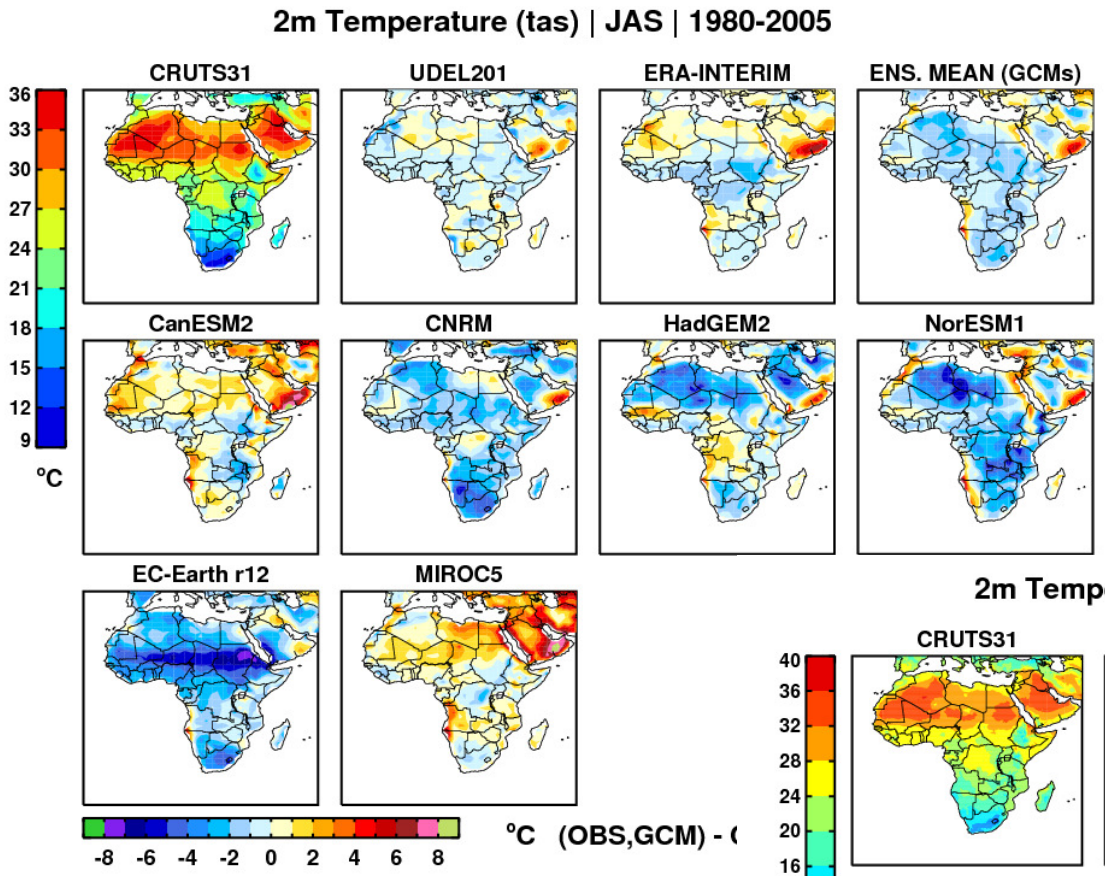

Sea level pressure (psl) | DJF | 1979-2005
ERAINT
NCEP2
ENSEM. MEAN (GCMs)
1026
1020
1014
1008
1002
996
990
hPa
EC-EARTH-r12i1p1
CanESM2-r1i1p1
CNRM-r1i1p1
HadGEM2-ES-r1i1p1
IPSL-MR-r1i1p1
NorESM1-M-r1i1p1
-8
-6
-4
-2
0
2
4
6
8
hPa (GCMs - ERAINT)

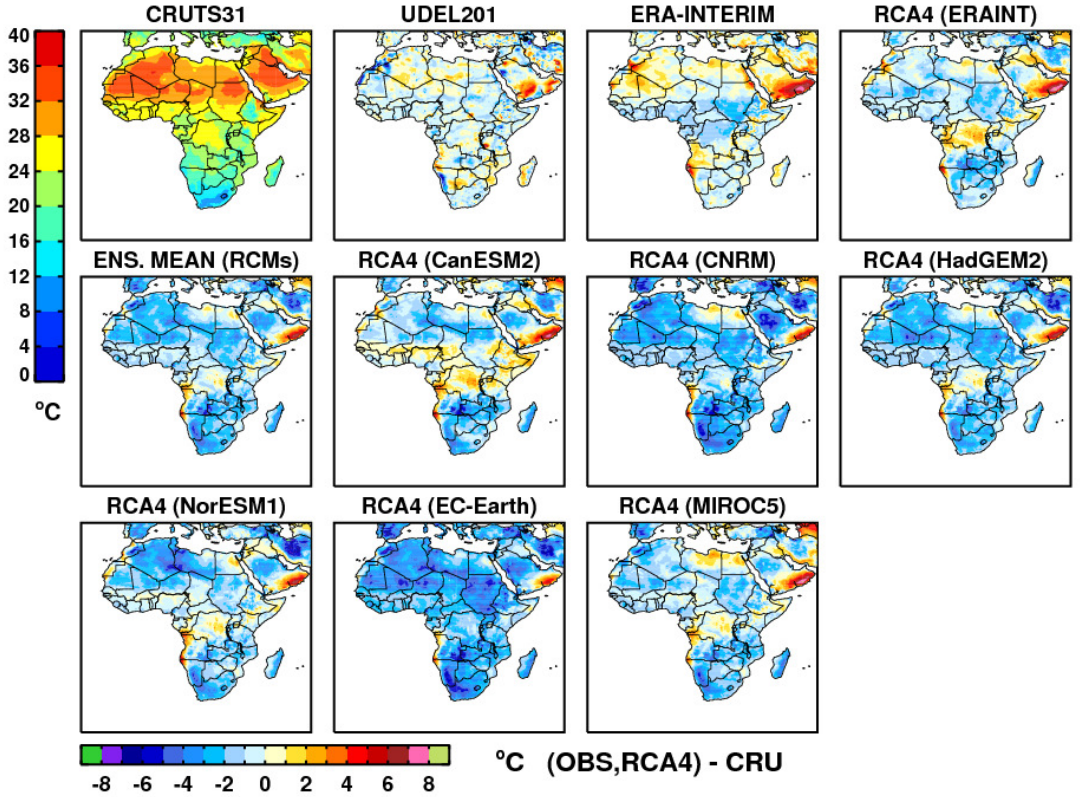

2m Temperature anomalies (wrt 1961–1990) | Annual mean
Global (GL) | RCP85
EC–EARTH
CanESM2
CNRM–CM5
HadGEM2
IPSL–MR
NorESM1
ENS: MEAM
C
Year
6
5
4
3
2
1
0
−1
1850
1875
1900
1925
1950
1975
2000
2025
2050
2075
2100

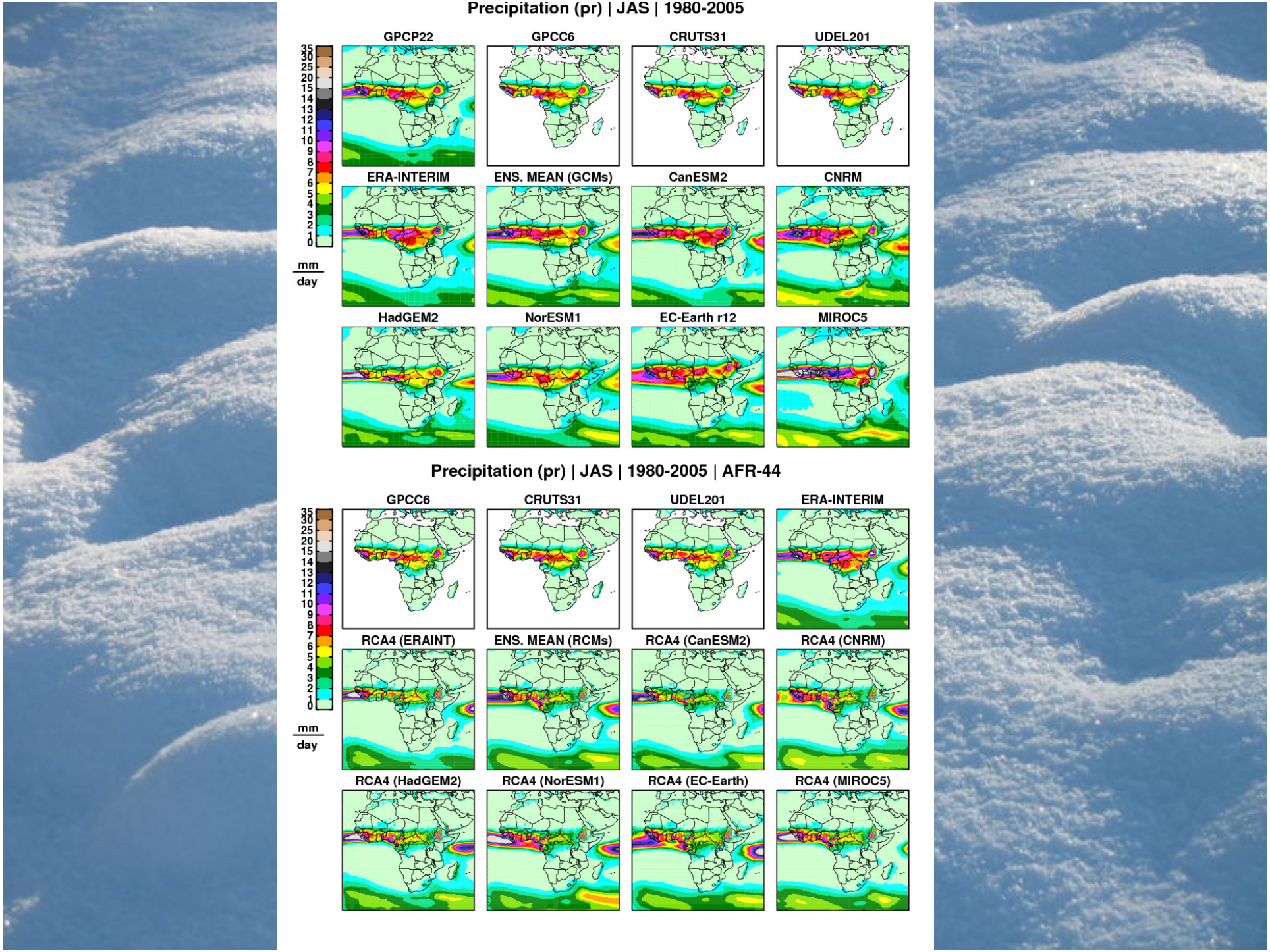

2m Temperature anomalies (wrt 1961–1990) | Annual mean
Africa (AFR) | RCP85
EC–EARTH
CanESM2
CNRM–CM5
HadGEM2
IPSL–MR
NorESM1
ENS: MEAM
C
Year
8
7
6
5
4
3
2
1
0
−1
−2
1850
1875
1900
1925
1950
1975
2000
2025
2050
2075
2100


Sea level pressure (psl) | JAS | 1980-2005
ERA-INTERIM
NCEP2
ENS. MEAN (GCMs)
CanESM2
CNRM
HadGEM2
NorESM1
EC-Earth r12
MIROC5
1026
1024
1022
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
998
hPa
-8 -6 -4 -2 0 2 4 6 8
hPa (OBS,GCM) - I

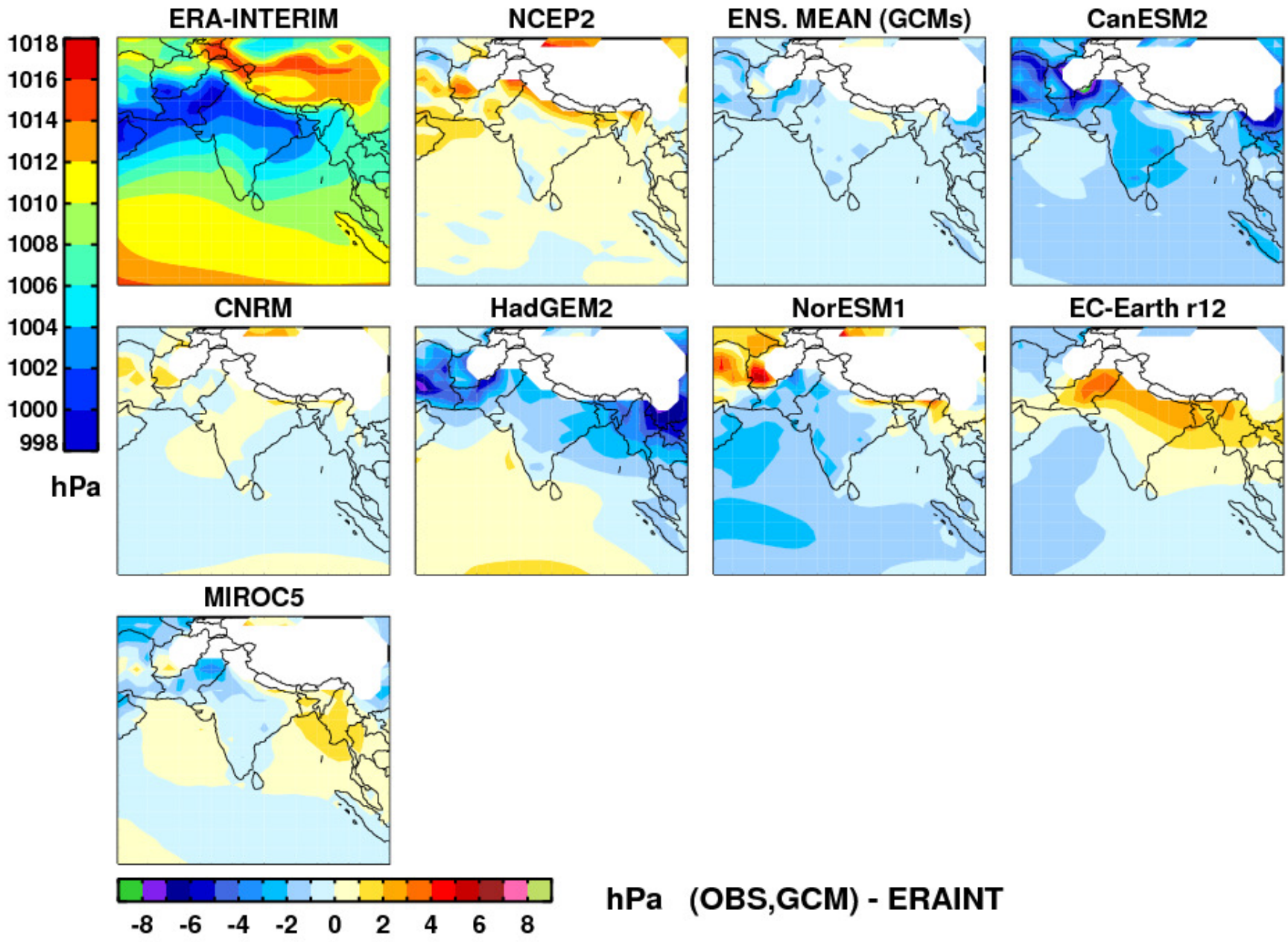

Sea level pressure (psl) | JAS | 1980-2005 | AFR-44
ERA-INTERIM
RCA4 (ERAINT)
ENS. MEAN (RCMs)
RCA4 (CanESM2)
RCA4 (CNRM)
RCA4 (HadGEM2)
RCA4 (NorESM1)
RCA4 (EC-Earth)
RCA4 (MIROC5)
1026
1024
1022
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
998
hPa
-8 -6 -4 -2 0 2 4 6 8
hPa (OBS,RCA4) - CRU

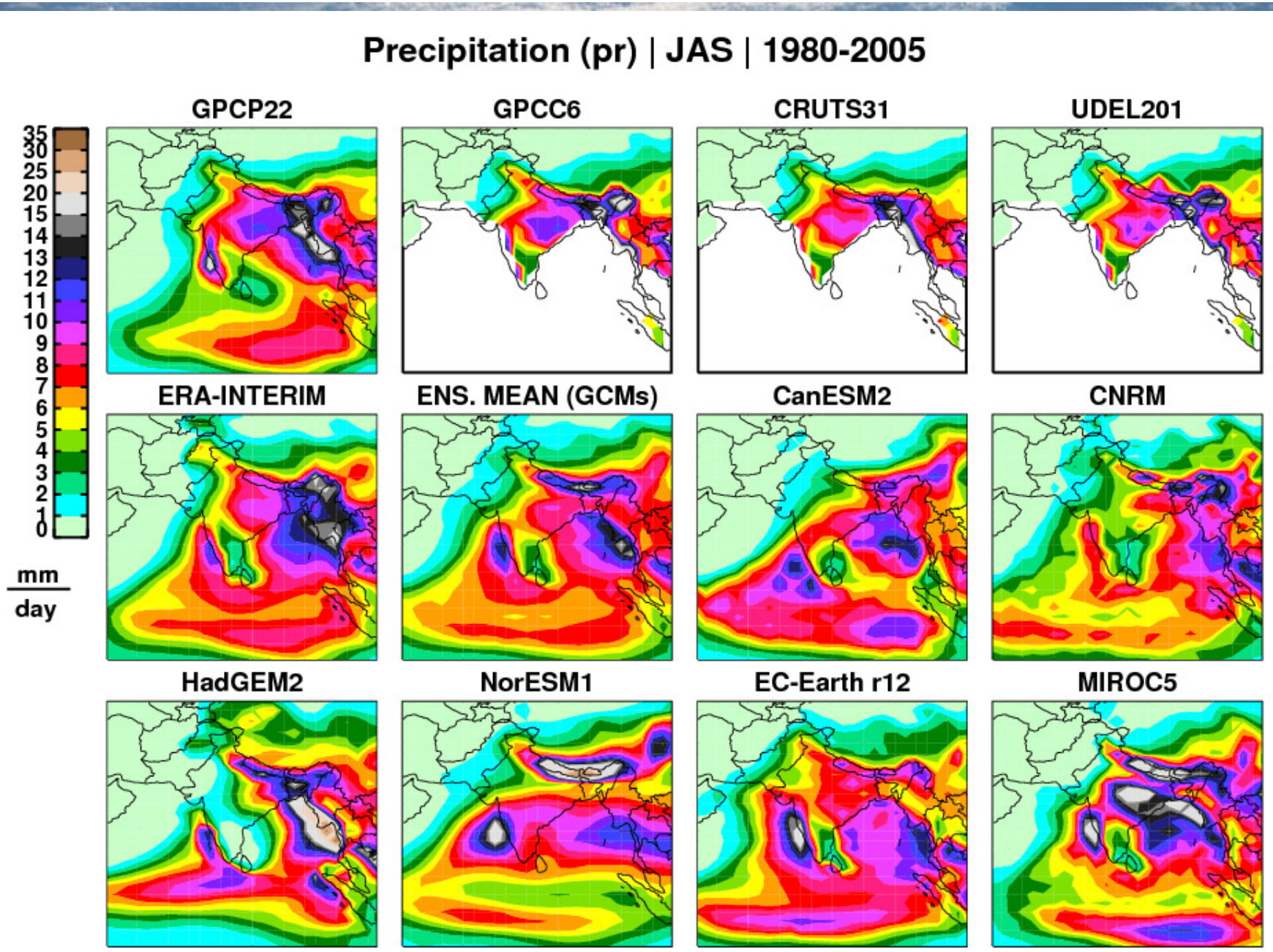

2m Temperature (tas) | JAS | 1980-2005
CRUTS31
UDEL201
ERA-INTERIM
ENS. MEAN (GCMs)
CanESM2
CNRM
HadGEM2
NorESM1
EC-Earth r12
MIROC5
36
33
30
27
24
21
18
15
12
9
°C
-8 -6 -4 -2 0 2 4 6 8
°C (OBS,GCM) - (


2m Temperature (tas) | JAS | 1980-2005 | AFR-44
CRUTS31
UDEL201
ERA-INTERIM
RCA4 (ERAINT)
ENS. MEAN (RCMs)
RCA4 (CanESM2)
RCA4 (CNRM)
RCA4 (HadGEM2)
RCA4 (NorESM1)
RCA4 (EC-Earth)
RCA4 (MIROC5)
40
36
32
28
24
20
16
12
8
4
0
°C
-8 -6 -4 -2 0 2 4 6 8
°C (OBS,RCA4) - CRU


Precipitation (pr) | JAS | 1980-2005
GPCP22
GPCC6
CRUTS31
UDEL201
ERA-INTERIM
ENS. MEAN (GCMs)
CanESM2
CNRM
HadGEM2
NorESM1
EC-Earth r12
MIROC5
35 30 25 20 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
mm
day
Precipitation (pr) | JAS | 1980-2005 | AFR-44
GPCC6
CRUTS31
UDEL201
ERA-INTERIM
RCA4 (ERAINT)
ENS. MEAN (RCMs)
RCA4 (CanESM2)
RCA4 (CNRM)
RCA4 (HadGEM2)
RCA4 (NorESM1)
RCA4 (EC-Earth)
RCA4 (MIROC5)
35 30 25 20 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
mm
day

Sea level pressure (psl) | JAS | 1980-2005




Precipitation (pr) | JAS | 1980-2005
GPCP22
GPCC6
CRUTS31
UDEL201
ERA-INTERIM
ENS. MEAN (GCMs)
CanESM2
CNRM
HadGEM2
NorESM1
EC-Earth r12
MIROC5
35
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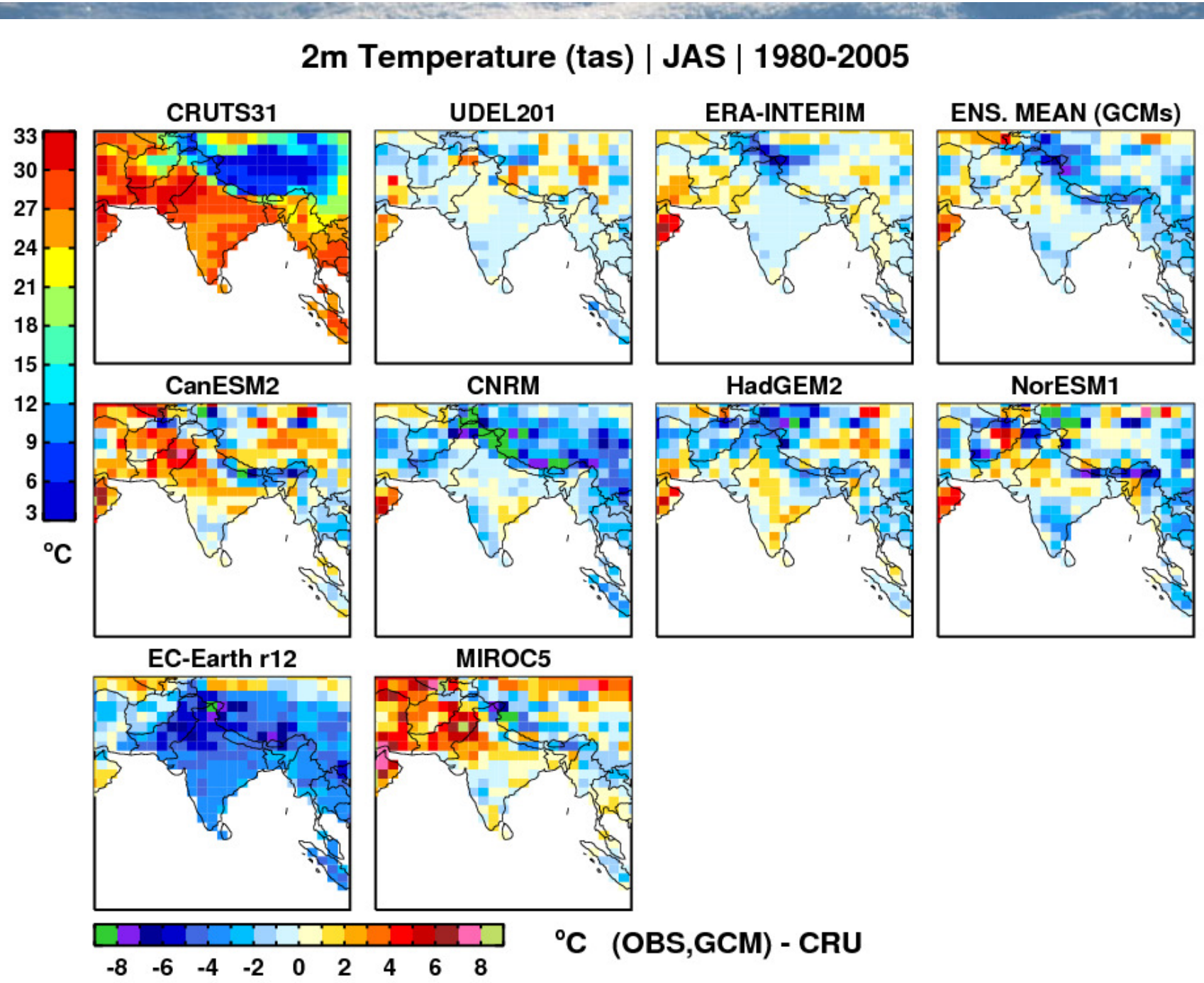
mm
day


2m Temperature (tas) | JAS | 1980-2005
CRUTS31
UDEL201
ERA-INTERIM
ENS. MEAN (GCMs)
CanESM2
CNRM
HadGEM2
NorESM1
EC-Earth r12
MIROC5
33
30
27
24
21
18
15
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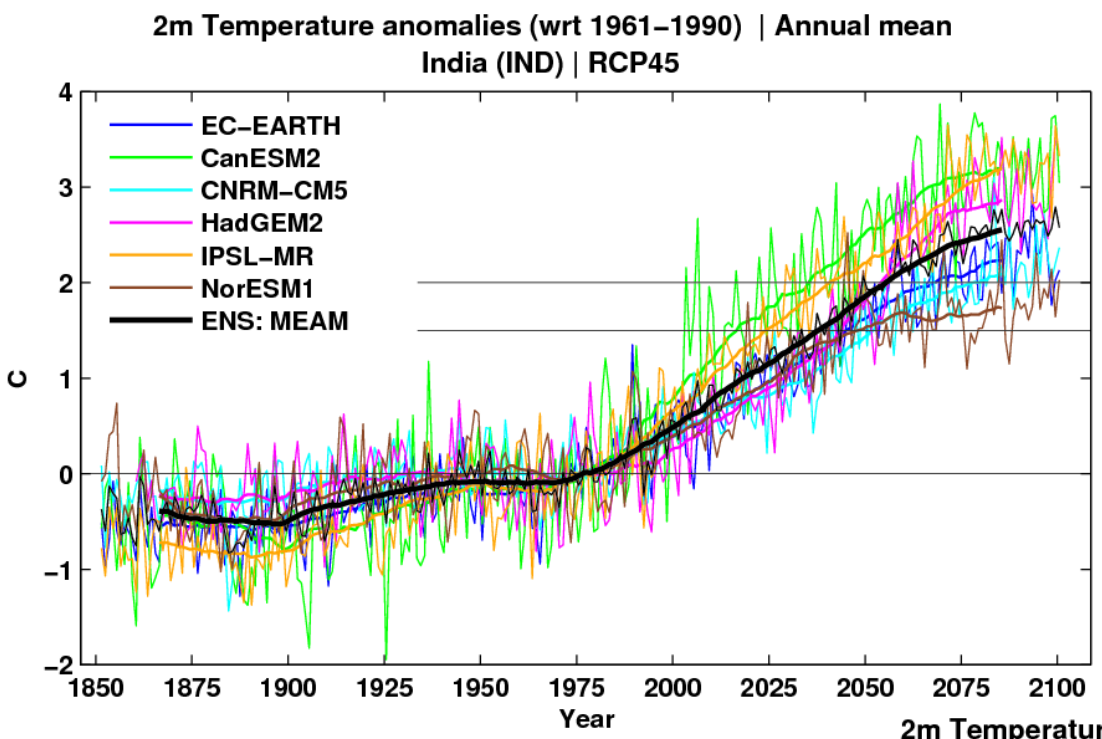
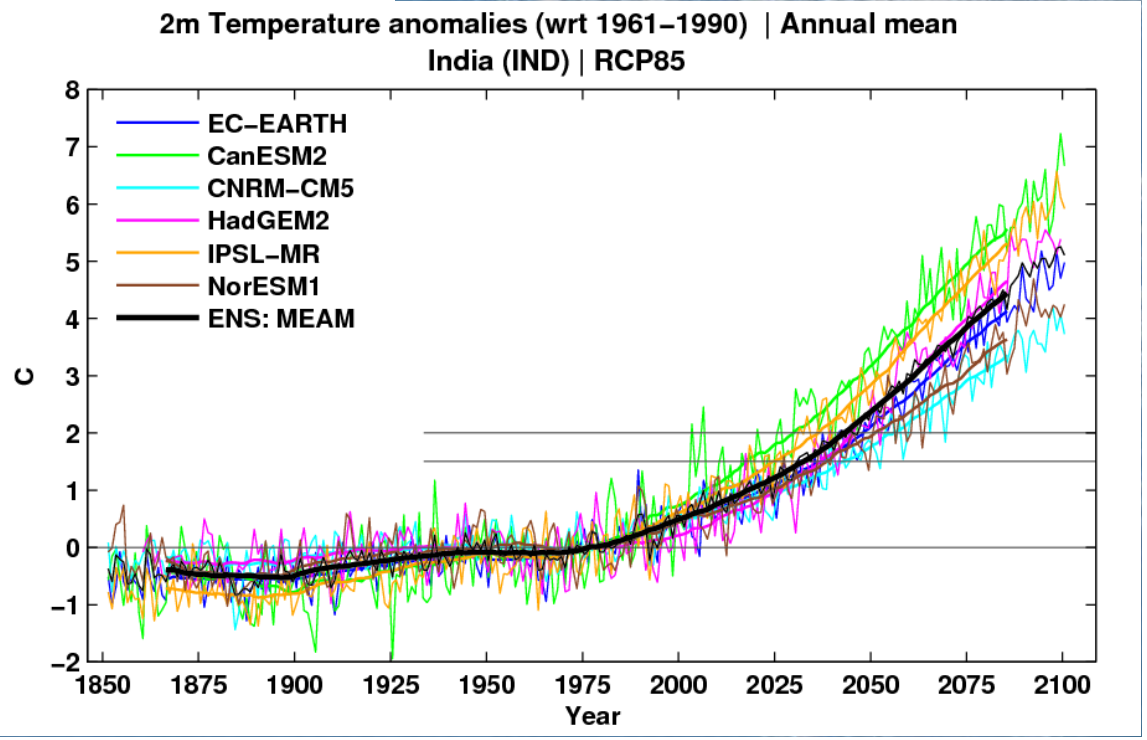
9
6
3
°C
-8 -6 -4 -2 0 2 4 6 8
°C (OBS,GCM) - CRU


2m Temperature anomalies (wrt 1961–1990) | Annual mean
India (IND) | RCP45
EC–EARTH
CanESM2
CNRM–CM5
HadGEM2
IPSL–MR
NorESM1
ENS: MEAM
C
Year
4
3
2
1
0
–1
–2
1850
1875
1900
1925
1950
1975
2000
2025
2050
2075
2100


2m Temperature anomalies (wrt 1961–1990) | Annual mean
India (IND) | RCP85
EC–EARTH
CanESM2
CNRM–CM5
HadGEM2
IPSL–MR
NorESM1
ENS: MEAM
C
Year
8
7
6
5
4
3
2
1
0
–1
–2
1850
1875
1900
1925
1950
1975
2000
2025
2050
2075
2100

GCM	RCP	RCM1	RCM2	RCM3	RCM4	RCM5	RCM6
HadGEM	8.5/4.5/2.6						
MPI-ESM	8.5/4.5/2.6						
EC-Earth	8.5/4.5/2.6						
ARPEGE	8.5/4.5						
IPSL-CM	8.5/4.5						
NorESM	8.5/4.5						
MIROC	8.5/4.5						
MRI	8.5/4.5						
CCSM	8.5/4.5						
GFDL-ESM	8.5/4.5						
CSIRO	8.5/4.5						
CanESM	8.5/4.5						

Procedure

1. Make ERA-interim driven runs and provide selected data to a regional evaluation team

2. Form a regional (South Asia CORDEX) evaluation team, identify metrics and collect suitable observations

3. Feedback evaluation findings to modeling groups

4. Identify and interact with regional IAV communities
   India, Pakistan, Bangladesh, Nepal, Bhutan, Burma, Maldives etc

5. Make and evaluate GCM-driven historical runs

6. Make and assess GCM-driven projection runs.

7. Archive and distribute GCM-RCM projection data and interact with regional IAV communities


Timeline
Commitments
Responsibilities
Follow up