Intercomparison of the mass budget of Arctic sea ice and snow in CMIP6 models: a SIMIP activity

Ann Keen & ***Ed Blockley***

- Comparing components of the mass budget, averaged over a defined region of the Arctic, for 1960-2100.

- Where possible use observational datasets to constrain CMIP6 sea ice projections:
  - investigate emergent constraints
  - identify the models that best represent the underlying processes.

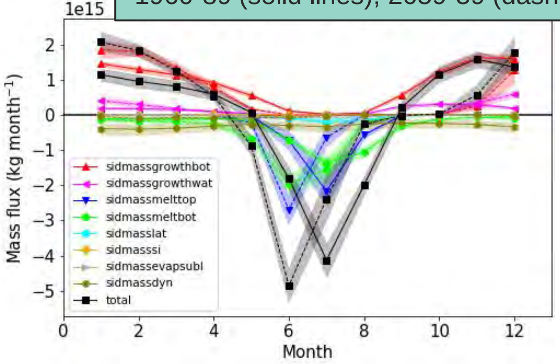
Analysis domain

Example data file

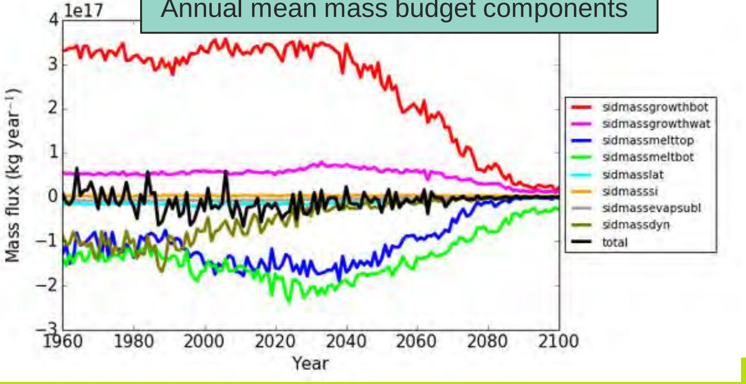
Contact: ann.keen@metoffice.gov.uk
Hist file: n/a
Components of the Arctic sea ice mass budget (Kg s-1):

Year	Month	Area (Km**2)	Mass (Kg)	growthbot	growthwat	melttop	
2005	1	8.27968e+06	2.26271e+16	5.93617e+08	8.30068e+07	-3.67418e-14	-3.
2005	2	8.39876e+06	2.40333e+16	5.24721e+08	6.80426e+07	-1.39610e-14	-5.
2005	3	8.52647e+06	2.52514e+16	4.96171e+08	6.21595e+07	-1.51566e-12	-7.
2005	4	8.45369e+06	2.60615e+16	3.57234e+08	4.19340e+07	-1.04717e+05	-6.
2005	5	8.10770e+06	2.63172e+16	1.62042e+08	1.21404e+07	-1.13815e+07	-1.
2005	6	7.32661e+06	2.56661e+16	2.67292e+07	1.16040e+06	-4.08638e+08	-3.
2005	7	6.18588e+06	2.13970e+16	4.57560e+06	9.94064e+05	-1.20485e+09	-6.
2005	8	4.89934e+06	1.72886e+16	5.50988e+06	3.49773e+06	-2.36384e+08	-5.
2005	9	5.24402e+06	1.61810e+16	1.47524e+08	9.93957e+07	-3.00613e+06	-1.
2005	10	6.36994e+06	1.68719e+16	4.28823e+08	1.14920e+08	-3.43797e+01	-3.
2005	11	7.61631e+06	1.84071e+16	6.11345e+08	1.08903e+08	-4.21868e-13	-4.
2005	12	8.16298e+06	2.01339e+16	6.99854e+08	1.14652e+08	-7.14467e-14	-3.

Monthly mean mass budget components: 1960-89 (solid lines); 2059-59 (dash lines)



Annual mean mass budget components



IMPACTS OF CLIMATE CHANGE ON AGRICULTURAL SYSTEMS

Cabré M.F. * 1 and Nuñez M.N. (1,2)
(1) CONICET - Universidad de Buenos Aires. Centro de Investigaciones del Mar y la Atmósfera (CIMA), Buenos Aires, Argentina
(2) Universidad de Buenos Aires, Facultad de Ciencias Exactas y Naturales, Departamento de Ciencias de la Atmósfera y los Océanos, Buenos Aires, Argentina
* contact: cabre@cima.fcen.uba.ar

Introduction and Motivation

Climate change is expected to impact considerably on agricultural production. In this context, there has been an increasing interest on how climate change could affect areas of agricultural production and yield crops. That is the case of perennial crop production, such as the viticultural production.

The economic relevance of the wine sector in Argentina motivates this work, which is based on the need of more and better climate projections for viticultural impact studies in a context of climate change.

Objective

This work evaluates the possible changes in Argentinean viticultural zoning provided by climate change projections from the IPSL-CM5A-MR model by the near (2015-2039) and the far (2075-2099) future for two emission scenarios (RCP4.5, RCP8.5)*.

* These socio-economic scenarios incorporate the climate projection range of the Intergovernmental Panel on Climate Change (IPCC, 2014) scenarios.

….is to understand how changes in temperature and precipitation could impact on bioclimatic indices, and consequently how theses changes could affect on current winegrowing regions. Therefore, the bioclimatic indices were chosen according to the zoning objectives (e.g. possible geographical shifts and suitability aspects).

Methodology, Data and Study Region

WHY THE IPSL-CM5A-MR MODEL? Because of being the best for the study region among 24 climate models from CMIP5 Project. [As it has been shown in the report of the 3rd National Communication of Climate Change of Argentina (3CN, 2014).]

WHY THIS REGION? Because the biggest grapevine production (99.8%) and cultivated area (99.52%) is concentrated there (INV, 2018).

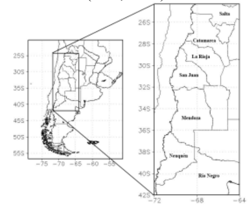
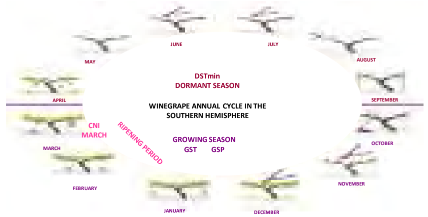


Fig.1 Map of Argentina with the selected study region (left panel) and the study region with names of Argentinean provinces assessed (right panel).

VARIABLES : Monthly Mean Temperature, Monthly Minimum Temperature, Accumulated Precipitation ……

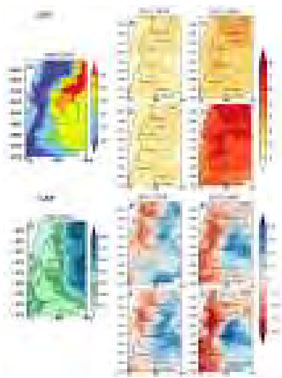
FOR CALCULATING BIOCLIMATIC INDICES



Results and Interpretations

Changes in Spatial Distribution of Bioclimatic Indices

Growing Season Temperature



Growing Season Precipitation

Fig.2 Spatial distribution of GST and GSP top and bottom panels, respectively. (a, f) Present climate (1960-2010). Expected changes for: RCP4.5 (2015-2039) (b, g); RCP4.5 (2075-2099) (c, h); RCP8.5 (2015-2039) (d, i); RCP8.5 (2075-2099) (e, j). [Units are expressed in ºC for GST and mm for GSP. Changes in GSP are expressed in percentage values]

- In general, projected changes of bioclimatic indices are in agreement with those projected for changes in mean climate (Tmed and Precip) both in magnitude and spatial pattern.
- Regardless of the bioclimatic index, the spatial pattern and magnitude of projected changes are similar between both scenarios for near future (2015-2039); while they show differences for the far future (2075-2099), mainly for RCP8.5 scenario.
- Slight/strong changes in the evaluated bioclimatic indices were projected for near/far future under both emission scenarios; with the strongest ones for RCP8.5 scenario (e.g. increases of 8 ºC for CNI, 6 ºC for GST and 3 ºC for DSTmin and increases of around 20% for GSP) mainly over Mendoza, San Juan and La Rioja.
- The current spatial pattern of GST, CNI and DSTmin seems to be displaced to higher latitudes and higher altitudes under future climate conditions. Accordingly, a significant south-southwestward and higher altitude displacement of winegrowing regions is projected to occur, mainly for 2075-2099 under RCP8.5 scenario.
- This displacement may face both opportunities and/or challenges on Argentinean viticulture, because some winemaking regions could be favored; while other winemaking regions could be disadvantaged, especially by 2075-2099 under RCP8.5.

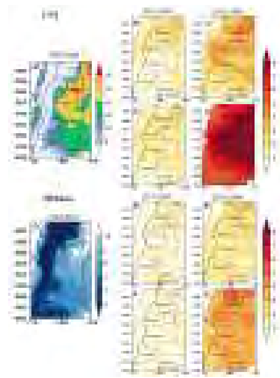
Viticultural Zoning (GST, GSP)	Zoning Suitability (GST, GSP, CNI, DSTmin)
Varieties' selection	Quality of grapevines
Vineyards' location	Quantity of grapevines

IMPACTS OF CLIMATE CHANGE

Provinces	NEAR FUTURE	FAR FUTURE
Mendoza and San Juan	✓	✗
Rest of the Provinces	✓	✓

In general, regardless of the study region, negative impacts are projected to occur, mainly associated with projected increases in CNI, GSP and DSTmin. (greater increase, greater negative impact)

Cool Night Index



Dormant Season Minimum Temperature

Fig.3 Spatial distribution of CNI and DSTmin top and bottom panels, respectively. (a, f) Present climate (1960-2010). Expected changes for: RCP4.5 (2015-2039) (b, g); RCP4.5 (2075-2099) (c, h); RCP8.5 (2015-2039) (d, i); RCP8.5 (2075-2099) (e, j). [Units are expressed in ºC for both indices].

✓ ✗ (Favorable / Adverse) climate conditions for the development of winegrowing regions

Results presented here are the most relevant of an article submitted to Climatic Change. (under revision)
Cabré M.F. and Nuñez M.N. 2018. Assessment of climate change impacts on Argentinean viticultural zoning.

Conclusions

The most significant findings of this work are:

- the application of climate change projections of the IPSL-CM5A-MR model for studying how climate change could affect areas of agricultural production for (2015-2039, 2075-2099) under RCP 4.5 and RCP8.5;
- the interpretation of projected changes in bioclimatic indices, because they would help to identify the possible impacts of climate change on areas of viticultural production in Argentina, thought in terms of changes in vineyards location, varieties selection, quality and quantity of grapevines. .

References

- 3CN: Secretaría de Ambiente y Desarrollo Sustentable de la Nación, 2014. Tercera Comunicación Nacional sobre Cambio Climático. "Cambio Climático en Argentina; Tendencias y Proyecciones". Centro de Investigaciones del Mar y la Atmósfera, Buenos Aires, Argentina. http://ambiente.gob.ar/tercera-comunicacion-nacional/.
- INV (Instituto Nacional de Vitivinicultura) (2018) Informe Anual de Superficie 2017. Departamento de estadística y estudios de Mercado, Mendoza.

Future Works

Similar works of impacts of climate change on viticulture or on any agricultural system of valuable importance for the Argentinean economy could be carried out.

Accordingly, the results of CMIP6 models could be used for going on with future works, validating the CMIP6 Project models for different regions in Argentina, choosing the best results for present climate and using them for future climate with the new socioeconomic scenarios in order to study the possible impacts of future climate conditions on areas of agricultural production and yield crops.

This work is part of the work carried out on climate and its impacts on the productive system of Argentina. Impacts on Agriculture and Livestock already published can be consulted sending a mail to mnunez@cima.fcen.uba.ar

Acknowledgements

Authors thanks the CMIP6 Model Analyses Workshop for the financial support to attend the Workshop held in the Barcelona Supercomputing Center, Barcelona, Spain, 25-28 March 2019.

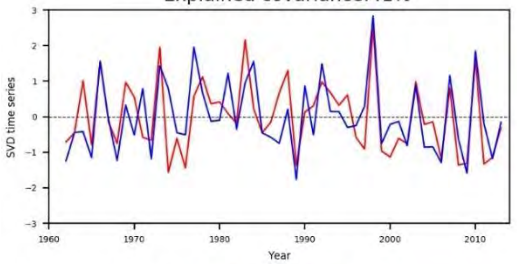
Prediction skill assessment of large-scale variability influence in summer southeastern South America rainfall in multi-model CMIP decadal predictions

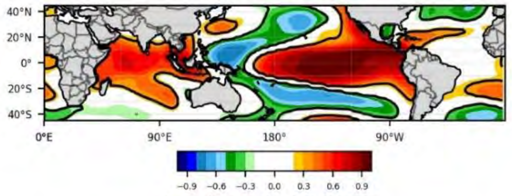
Leandro B. Diaz, Carolina S. Vera, Ramiro I. Saurral (ldiaz@cima.fcen.uba.ar) Buenos Aires, Argentina

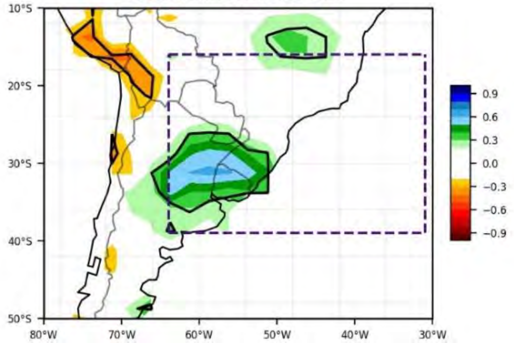
Main questions:

- Is possible to get useful predictions for austral summer Southeastern South America (SESA) rainfall from CMIP5 decadal predictions?
- How to deal with multi-member/model ensemble information?

Approach: Skill prediction assessment of the leading covariability pattern(SVD1) of SESA rainfall and SST anomalies

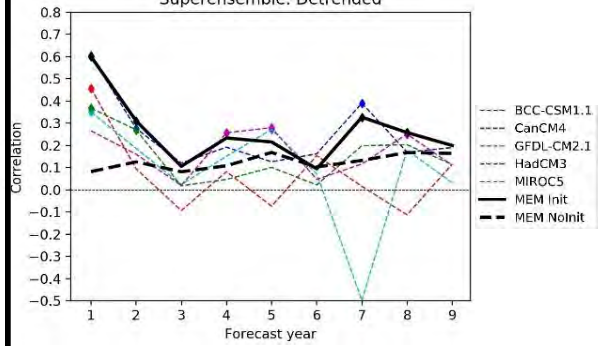


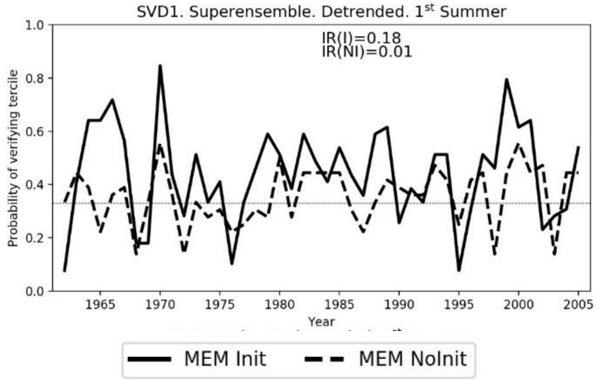




Use of 4 methodologies to compute SVD time series.

Deterministic | Probabilistic





Main results:

- Austral summer SVD1 activity shows skill in the first two prediction years.
- 'Superensemble' metohodology exhibits the best performance against climatology and non-initialized simulations.

See you in P04!!

Projected trends of heavy rainfall events from CMIP5 models over Central Africa

Thierry C. Fotso-Nguemo[1,2]*, Roméo Chamani[2,3], Zéphirin D. Yepdo[1,2], Denis Sonkoué[2], Cédric N. Matsaguim[4], Derbetini A. Vondou[2], Roméo S. Tanessong[5]

[1]Climate Change Research Laboratory (CCRL), National Institute of Cartography, Yaounde, Cameroon; [2]Laboratory for Environmental Modelling and Atmospheric Physics (LEMAP), University of Yaounde 1, Yaounde, Cameroon; [3]Department of Physics, Faculty of Sciences, University of Douala, Douala, Cameroon; [4]Department of Geography, Faculty of Arts Letters and Social Sciences, University of Yaounde 1, Yaounde, Cameroon; [5]School of Wood Water and Natural Resources, Faculty of Agronomy and Agricultural Sciences, University of Dschang, Ebolowa, Cameroon

*e-mail: fotso.nguemo@gmail.com

25 - 28 March 2019, Barcelona, Spain

Abstract

In this study, the projections of daily rainfall from an ensemble mean of 20 global climate models (GCMs) are used to examine projected trends in heavy rainfall distribution over Central Africa, under the representative concentration pathway 8.5. For this purpose, two analyses periods of 40-years have been selected (2006-2045 and 2056-2095) to compute trends in the 90th and 99th percentiles of the daily rainfall distributions. We found that large increase trend is mostly found in the 99th percentile of extreme rainfall events, over southern Chad, northern Cameroon, northern Zambia and in the Great Lakes Area. It is also shown that the largest number of GCMs with a trend of the same sign as the average trend is observed over the above regions. It is thus clear that the projected increase trends in heavy rainfall events may further worse floods which are real problems in the Central Africa countries.

Study area, data used and Methods

Study area

This study focuses on the Central African region as shown in Figure 1, which has a complex and heterogeneous topography with extensive mountain, coast, lakes and rivers.

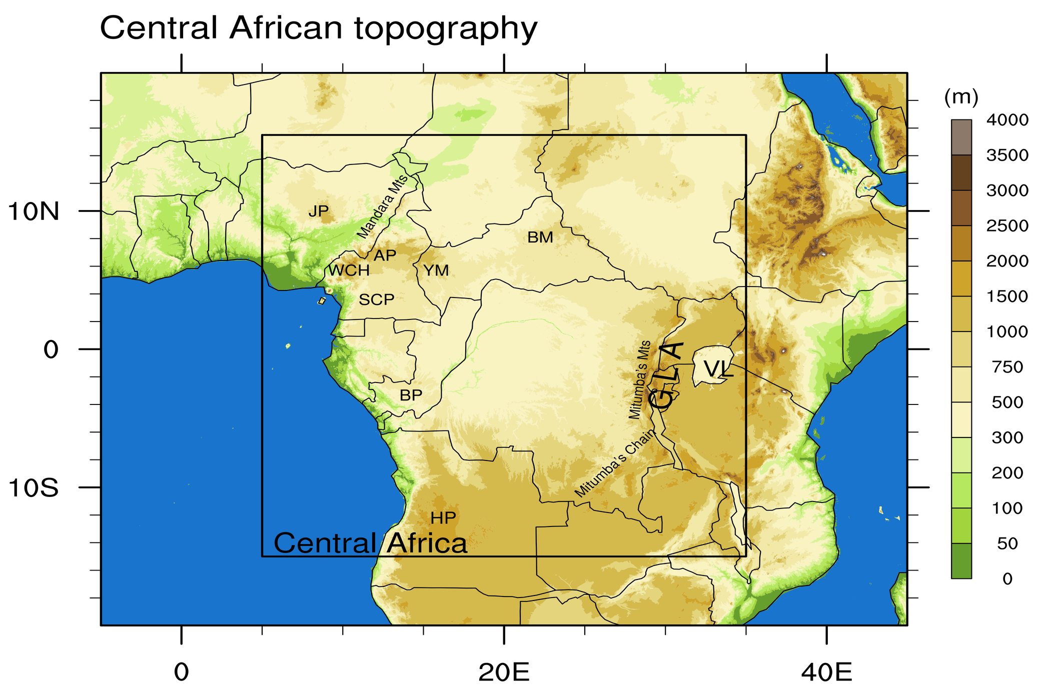


Figure 1: Surface elevation over Central Africa

Data used

- **20 GCMs:** listed in Figure 2 (*historical from 1850 to 2005 and RCP8.5 from 2006 to 2100*);
- **Gridded observations:** GPCP 1DD and TRMM (*from 1998 to 2013*).

Method

We focus on the ensemble mean trend for the 90th and 99th percentiles of rainfall distribution by computing the values of these two percentiles at each grid point and for each year. After that, we have computed the slope of the trend line for each of these times series and for each of the 20 models. Finally, we considered the average of the best models slopes (according to the Taylor diagram analysis) as the representative slope values.

Results

Taylor diagram analysis

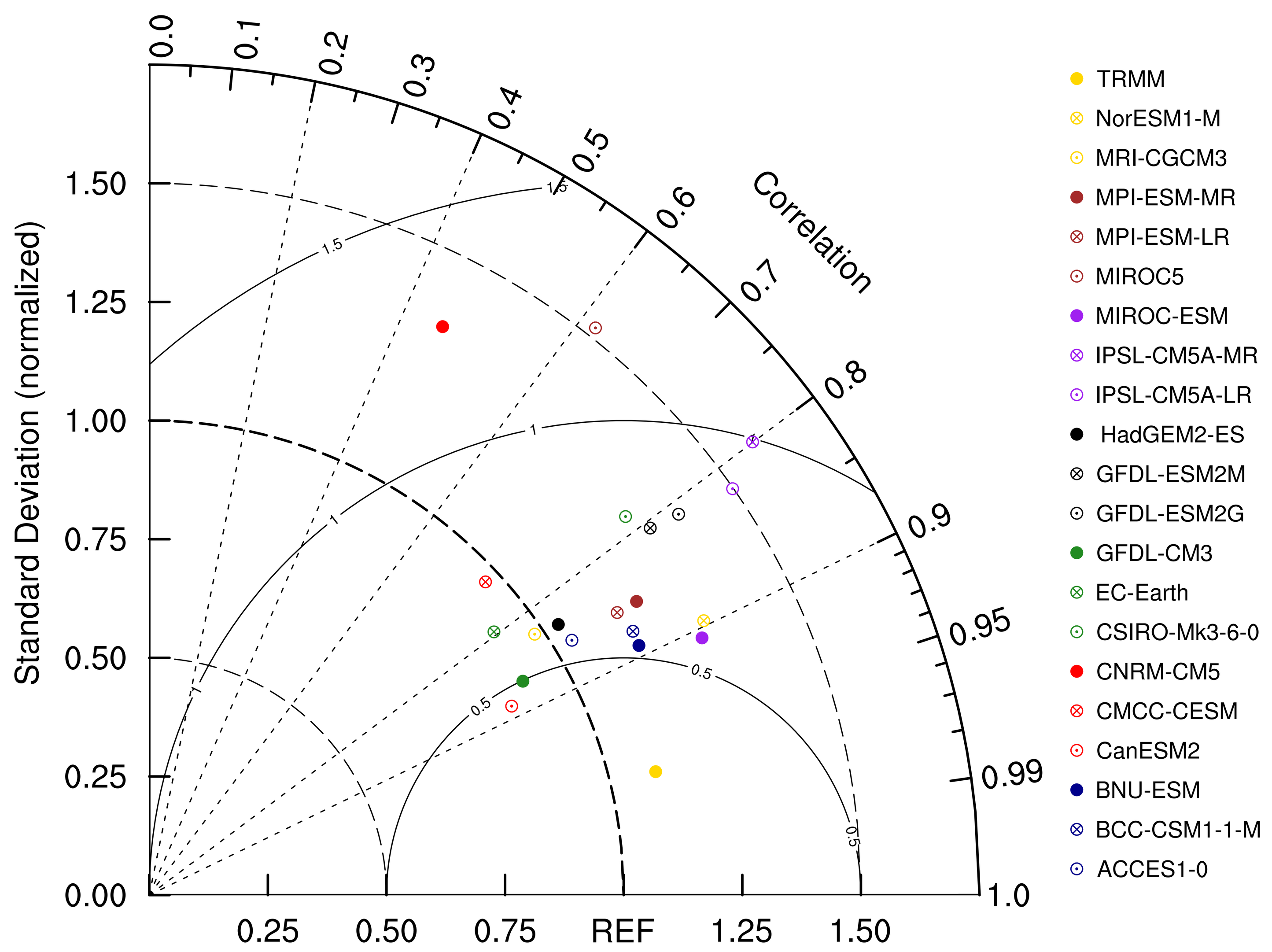


Figure 2: Taylor diagram analysis of monthly rainfall averaged over the Central African domain during the period 1998-2005, from TRMM and the 20 CMIP5 used. GPCP dataset is used as reference point

- The good models include: ACCESS10, BCC-CSM11-M, BNU-ESM, CMCC-CESM, CanESM2, EC-EARTH, GFDL-CM3, HadGEM2-ES, MPI-ESM-LR, MPI-ESM-MR, and MRI-CGCM3.

Trends in the future

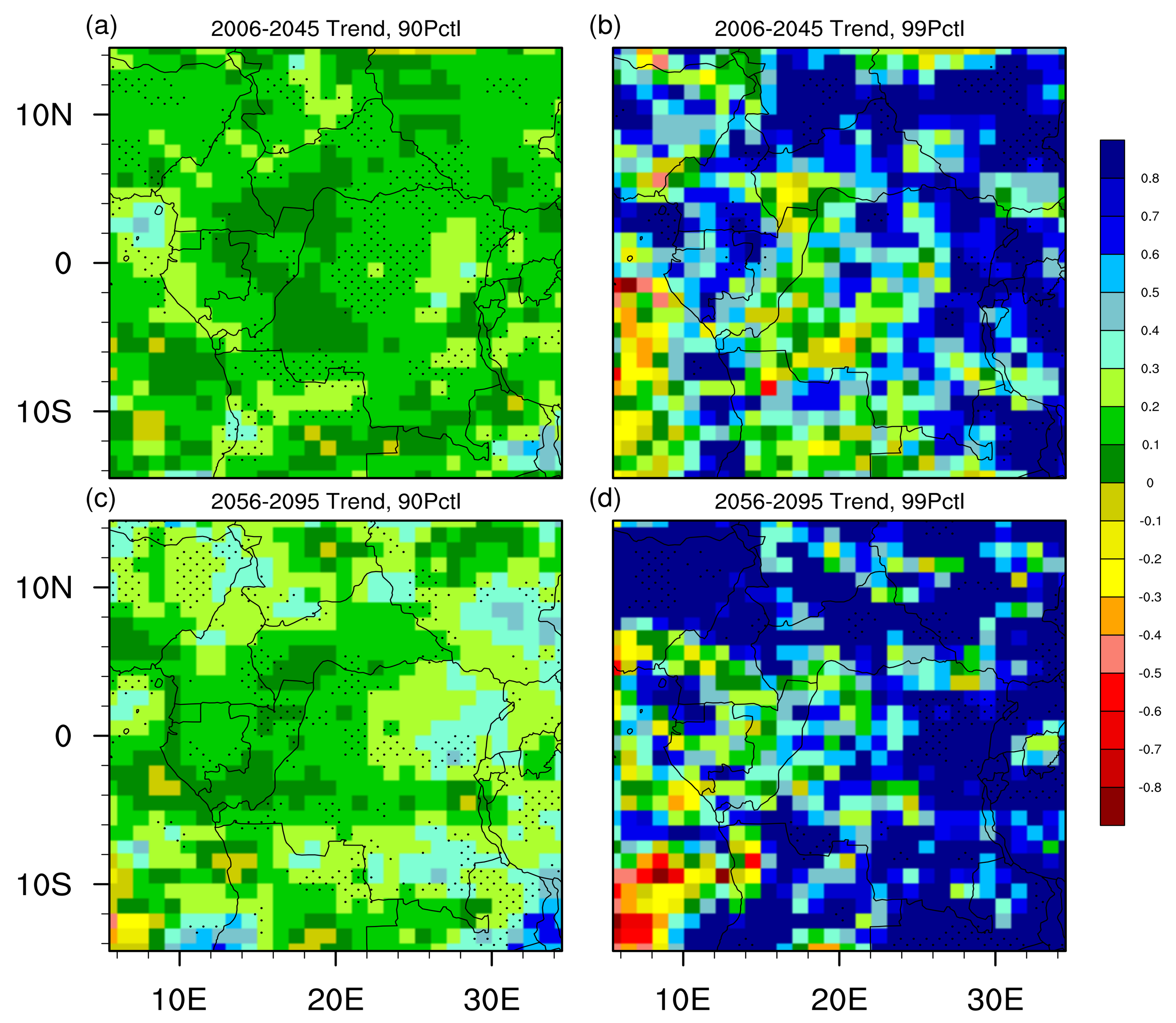


Figure 3: Average trend (in mm/day/decade) in the 90th (a, c) and 99th (b, d) percentiles. Results are for the trend estimates over the period 2006-2045 (a, b) and 2056-2095 (c, d). Stippling indicates statistically significant regions at 95 % confidence level of the Mann-Kendall test

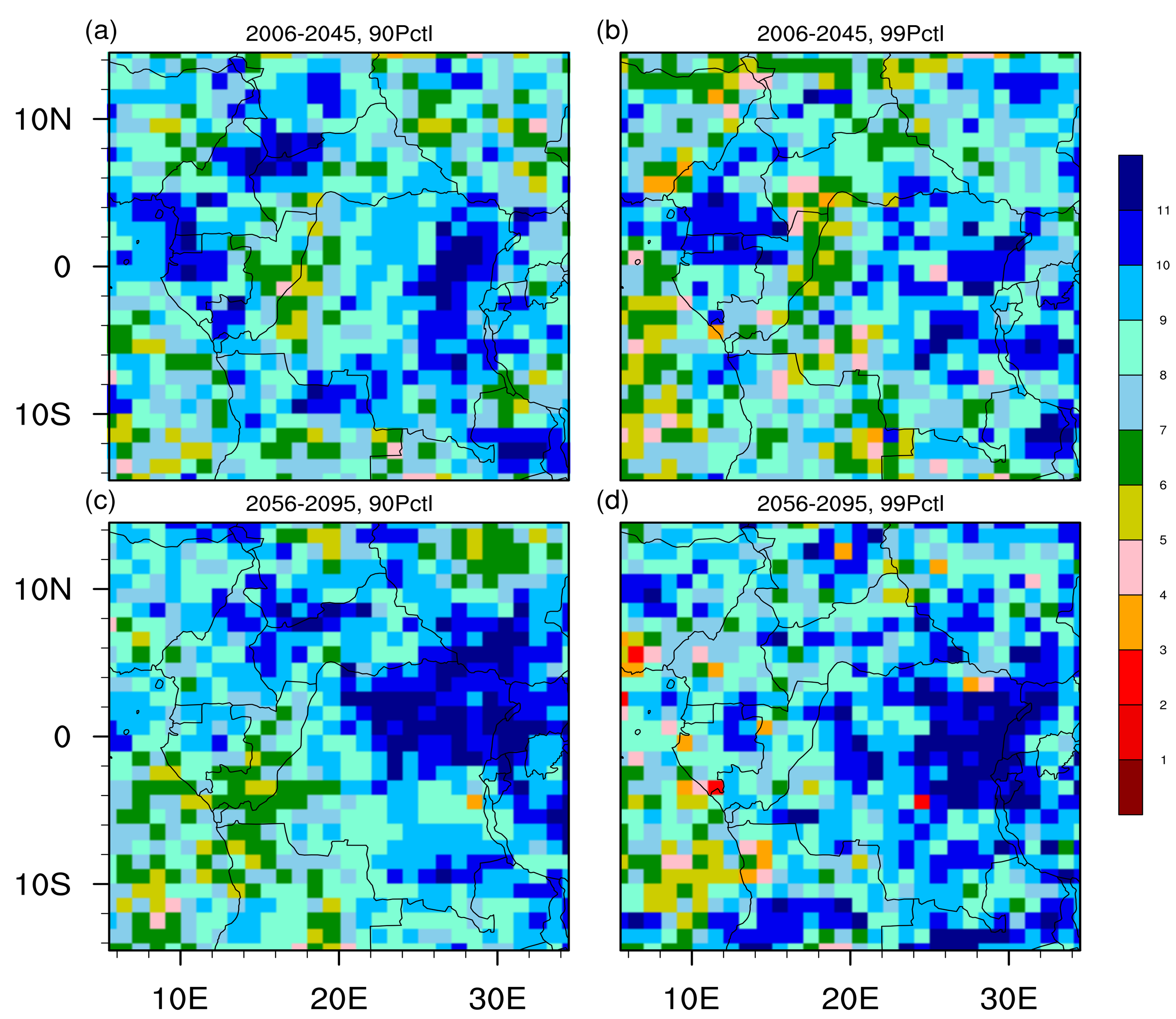


Figure 4: Number of GCMs (out of 11) with the sign of the trend which is the same as the mean trend for the 90th (a, c) and 99th (b, d) percentiles. Results are for the period 2006-2045 (a, b) and 2056-2095 (c, d)

Conclusions

- The focus of this work was to estimate the projected trends in heavy rainfall distribution over Central Africa, under the representative concentration pathway 8.5;
- Among the 20 GCMs used in the study, only 11 could be considered as highly performing models over the Central African domain according to the Taylor diagram analysis;
- Our results also indicate that the northern and eastern parts of the study domain are projected to experience increasing trends in the 90th and 99th percentiles of rainfall events;
- The magnitude of these trends is rather large particularly in the 99th percentiles and for eastern Central Africa;
- The largest degree of agreement is over southern Chad, northern Cameroon, Equatorial Guinea, northern Gabon, northern Zambia, and in the Great Lakes Area, with more than 80 % of the models agreeing on the trend sign.

Acknowledgements

We gratefully thank all the administrator members of the website "`https://climate4impact.eu/impactportal/data/esgfsearch.jsp`", for making available the updated data. We also thank the BSC and WCRP for travel and living supports respectively.

Fidelity of the CAS FGOALS-f3 in representation of summer rainfall climatology and extreme precipitation over the Tibetan Plateau

Lei Wang, Qing Bao, Yimin Liu, Guoxiong Wu, Jinxiao Li, and Bian He

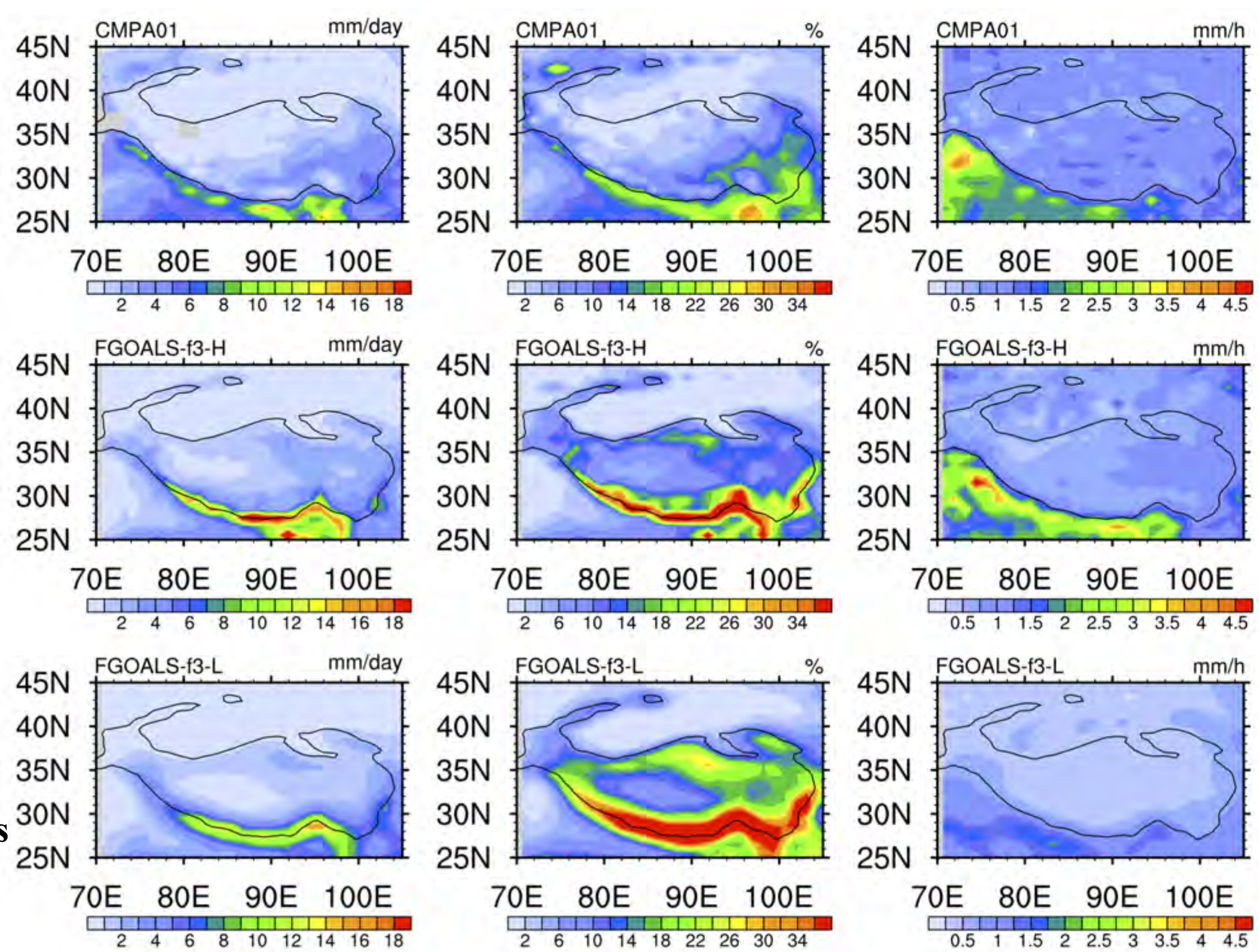
JJA rainfall climatology

Amount | Frequency | Intensity

OBS

FGOALS-f3-H
~25km
HighResMIP

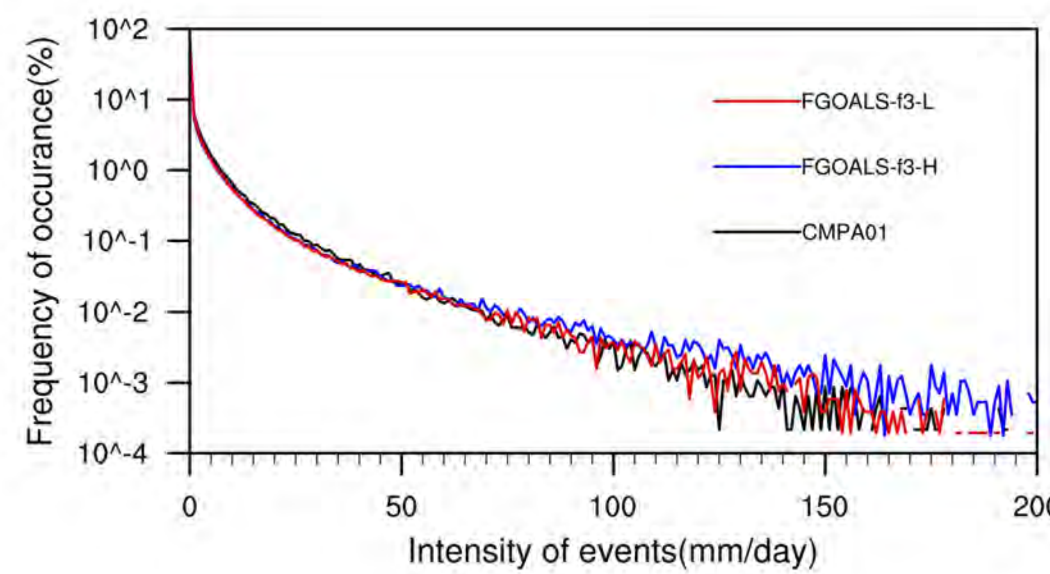
FGOALS-f3-L
~100km
Deck experiments



$$\textit{Frequency} = \frac{\textit{total rainy hours}}{\textit{non}-\textit{missing hourly}} \qquad \textit{Intensity} = \frac{\textit{Rainfall amounts}}{\textit{rainy hours}}$$

JJA rainfall frequency–intensity

$$frequency - intensity = \frac{RainDays}{sum(RainDays)}$$



Compared with FGOALS-f3-L, FGOALS-f3-H:

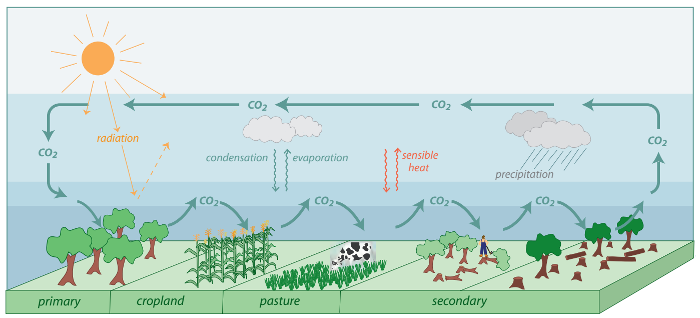
- **better reproduces** the sharp northwestward decreasing gradient of precipitation that starts from southeast slope of TP;
- **reduces the biases** in rainfall frequency and intensity;
- both able to reproduce the frequency-occurrence for extreme precipitation up-to 150 mm/day

Contribution of land use and land cover alterations to changes in regional surface energy balance in CMIP6 Earth System models.

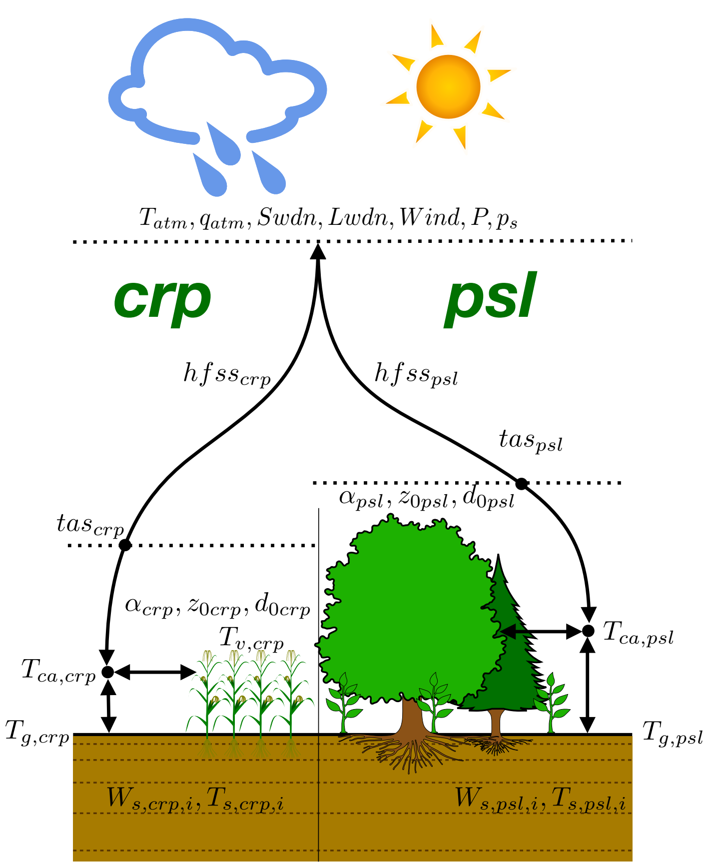
Sergey Malyshev, Elena Shevliakova, John Krasting, Huan Guo

Geophysical Fluid Dynamics Laboratory, NOAA

Land use creates mosaic of tiles

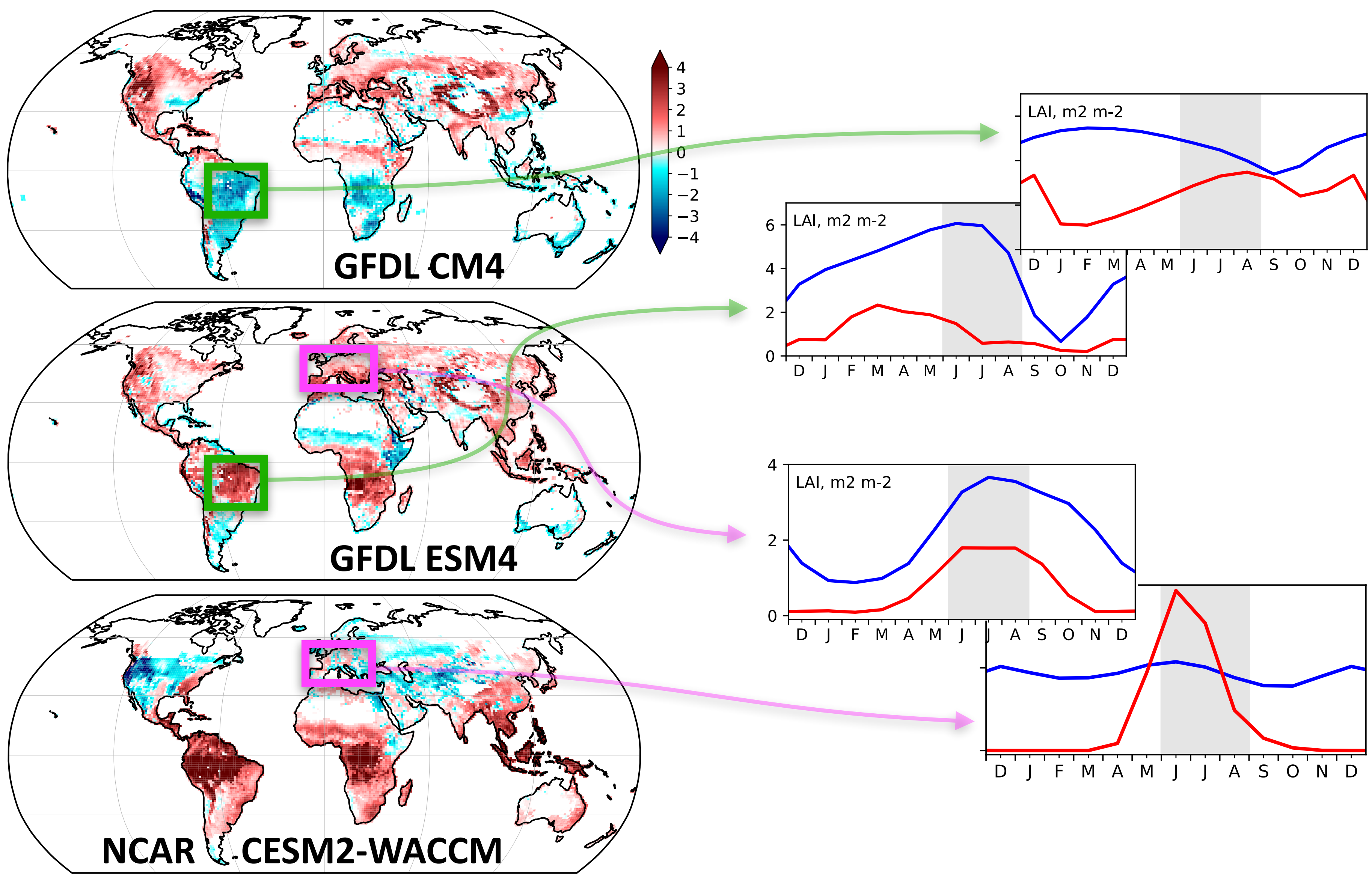


Each tile interacts with the atmosphere



LUMIP provides an opportunity to study local biogeophysical effects of land use simulated by different models. Preliminary results from 4 models:

- Mid-latitude DJF temperature contrast consistent across models, dominated by higher albedo of snow-covered crops.
- JJA is less consistent, model-specific LAI seasonality plays important role in fluxes and temperatures



CMIP6 Model Analysis Workshop, 25-28 March 2019. Session 7 Poster 08

CMIP6 Model Analysis Workshop, 25-28 March 2019, Barcelona (Spain)

Evaluation of the CNRM-CM6-1 Global Climate Model simulations over West Africa within CMIP6

Mamadou Lamine MBAYE[1*], Coumba NIANG[2], Bamol Ali SOW[1], Samo DIATTA[1], Moctar CAMARA[1]

[1]Laboratoire d'Océanographie, des Sciences de l'Environnement et du Climat (LOSEC) Université Assane SECK de Ziguinchor BP 523 Ziguinchor – Sénégal
[2]Laboratoire Physique de l'Atmosphère et de l'Océan (LPAO), ESP/UCAD/Sénégal

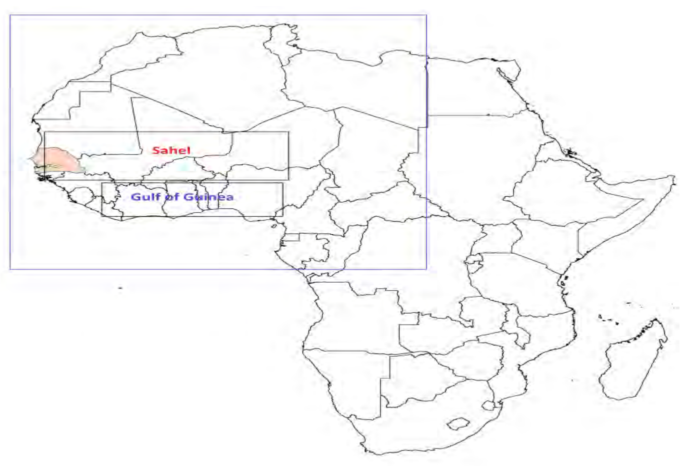
Corresponding author *E-Mail: mlmbaye@univ-zig.sn

1. Objective

Global Climate models are very useful tools for the understanding and the predictability of climate systems and their variability/change; they can provide important information for decision making in some sectors such as agriculture, water resources, etc.

Evaluate the ability of CNRM-CM6-1 model (Voldoire, Aurore, **2018**) to faithfully represent the present day climate over Sahel, Gulf of Guinea, and West Africa

2. Data and Methodology



❖ **Data**

- Daily precipitation: GPCC (1988-2005), CNRM-CM6-1 (1988-2005)
- Monthly temperatures (mean, min, max): CRU (1981-2010), CNRM-CM6-1 (1981-2010)

❖**Methodology**

•**Precipitation**: CWD, CDD, 95P, 99P, SDII, wet day frequency

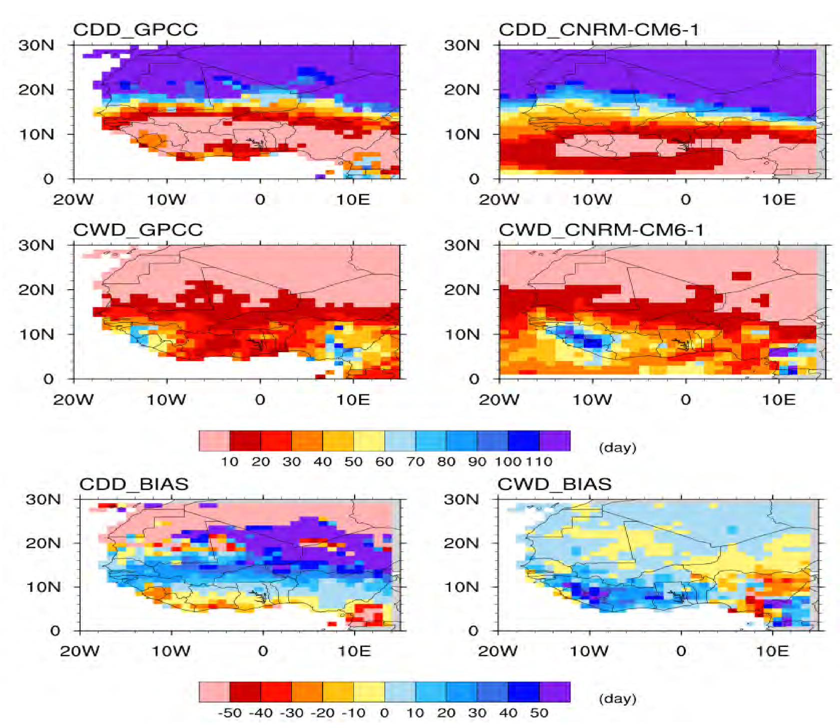
•**Temperatures**: annual mean, diurnal temperature range, annul cycle

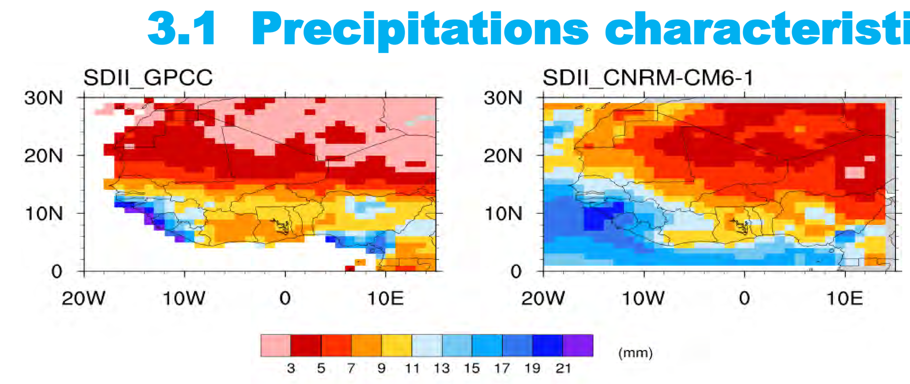
Earth System Model CNRM-CM6-1:

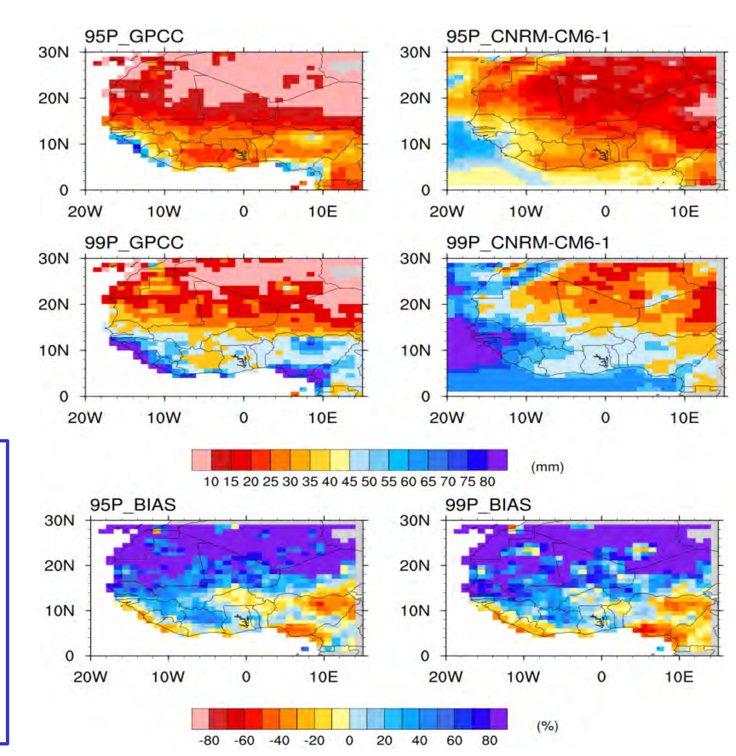
- Run by the **CNRM-CERFACS**
- **Nominal resolutions**: aerosol: 250 km, atmos: 250 km, atmosChem: 250 km, land: 250 km, landIce: 10 km, ocean: 100 km, seaIce: 100 km.

3. Results

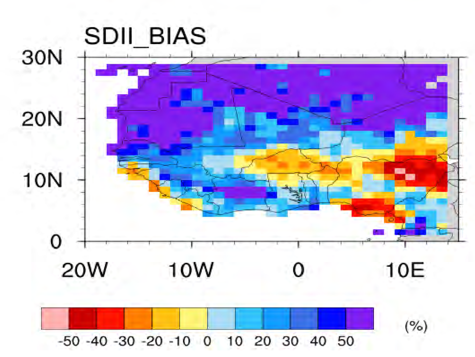
3.1 Precipitations characteristics



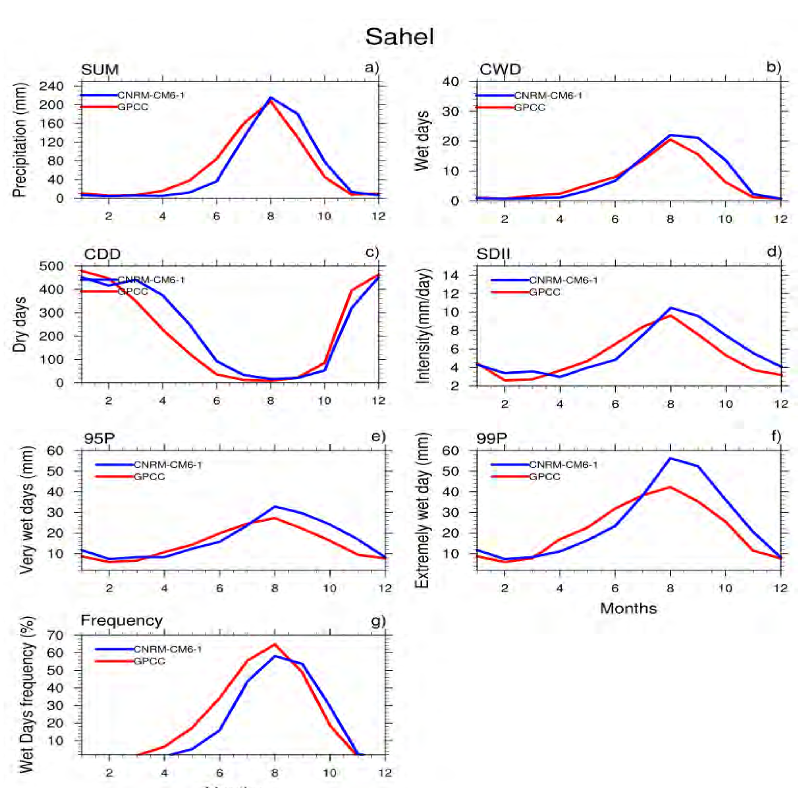




- Well representation of the spatial patterns of extreme rainfall;
- Wet biases in the Guinean Coast;
- Overestimation of rainfall intensity



- Underestimation of heavy rainfall in coast regions;
- Overestimation of extremely wet days in the Sahel;
- Dry biases in orographic regions



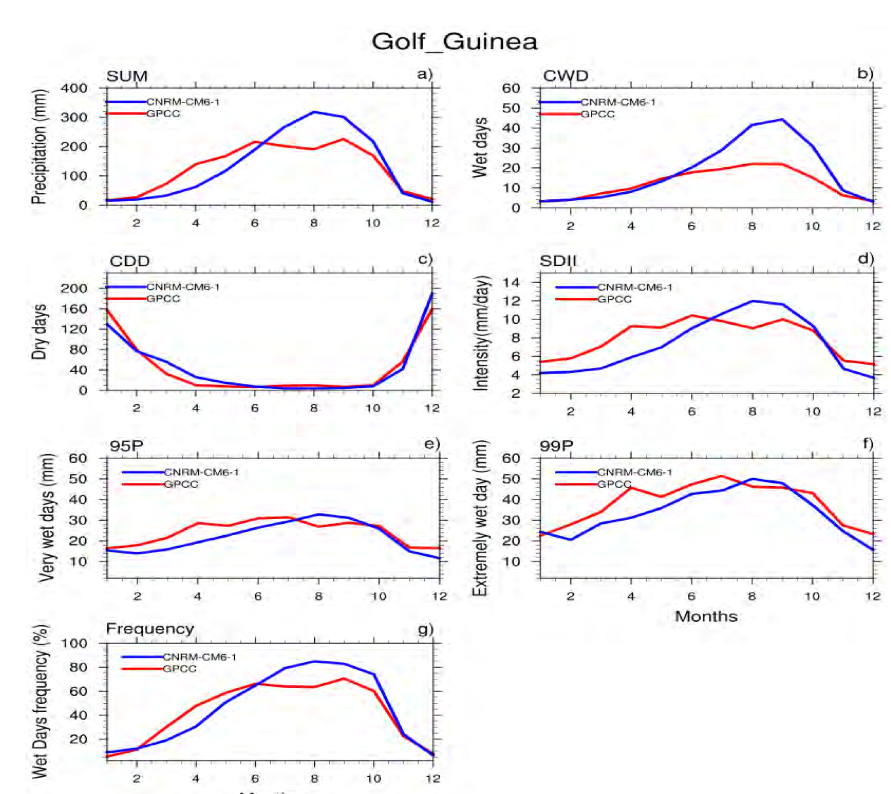
▪Well representation of the seasonal cycle of rainfall and its extremes;,

▪Overestimation of CWD and wet days frequency in Guinea;

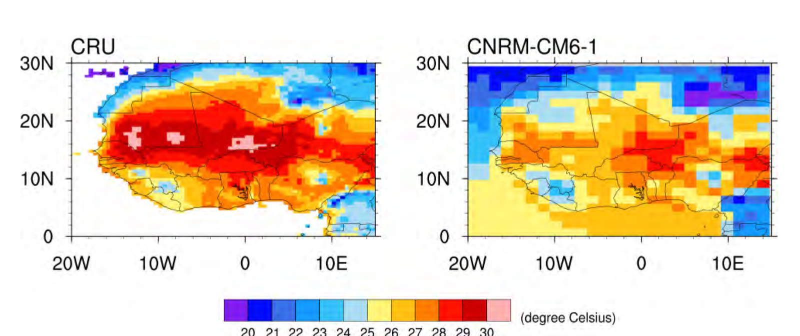
▪Very heavy rainfall overestimated in the Sahel during the main rainy season

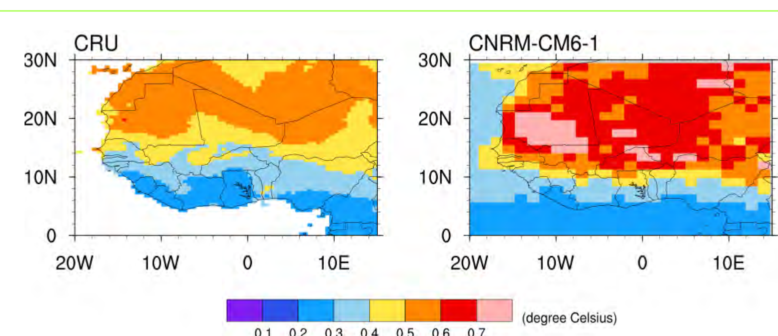
▪Delay and underestimation in the frequency of wet days from the beginning to August in the Sahel

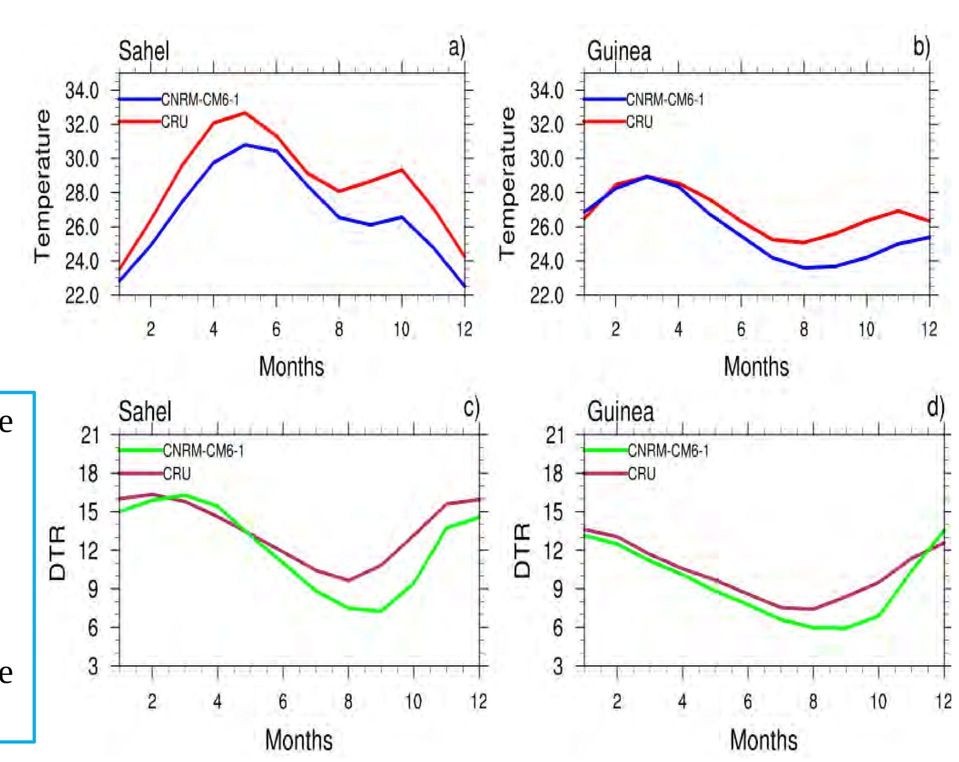
▪Considerable overestimation of rainfall intensity and extremely wet days.

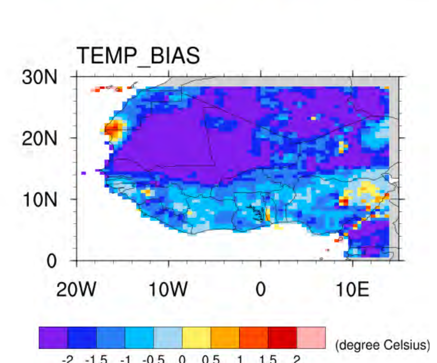


3.2 Temperature characteristics

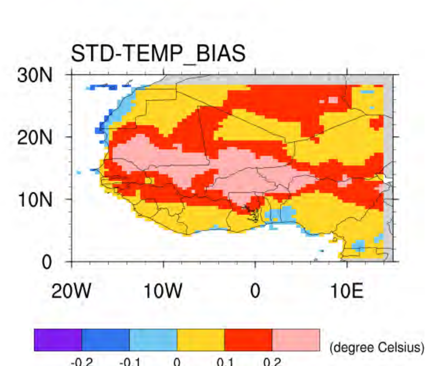








- Spatial pattern of temperature is well represented by the model;
- General cold bias is found;
- Higher variability over the Sahel;
- Overestimation of temperature variability.



- Diurnal Temperature Range (DTR) signal well reproduced in both regions
- General underestimation of mean temperature magnitudes for both regions;
- Diurnal Temperature Range (DTR) underestimated;

Key Messages

- ➢ CNRM-CM6 model reproduces well the main patterns of consecutive wet days, consecutive dry days, very and extremely wet days, and rainfall intensity;
- ➢ Generally underestimation of temperatures over West Africa with cold biases more pronounced in the Sahel;
- ➢ CNRM-CM6 is able to represent the spatial and temporal variability of the present day climate over West Africa even though some biases exist
- ➢ For climate change impact studies, bias correction or statistical downscaling could be applied to bridge the gap between the GCM and impact models at local scale.

Reference

Voldoire, Aurore **(2018)**. *CNRM-CERFACS CNRM-CM6-1 model output prepared for CMIP6* .
https://doi.org/10.22033/ESGF/CMIP6.1375

Acknowledgements

We thank the organizing committee of CMIP6 MODEL ANALYSIS WORKSHOP for their Financial support.

CMIP6 MODEL ANALYSIS WORKSHOP 25-28 March 2019, Barcelona (Spain)

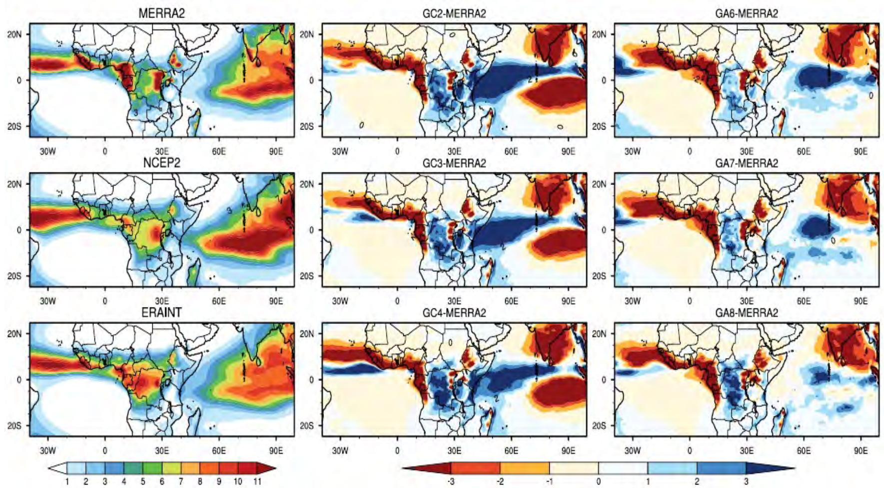
PROCESS-BASED EVALUATION OF RAINFALL IN MetUM OVER CENTRAL AFRICA

Thierry N Taguela[1*], Wilfried M Pokam[1], R Washington[2]

[1]University of Yaounde 1, Yaounde, Cameroon; [2]University of Oxford. *Email:thierrytaguela@gmail.com

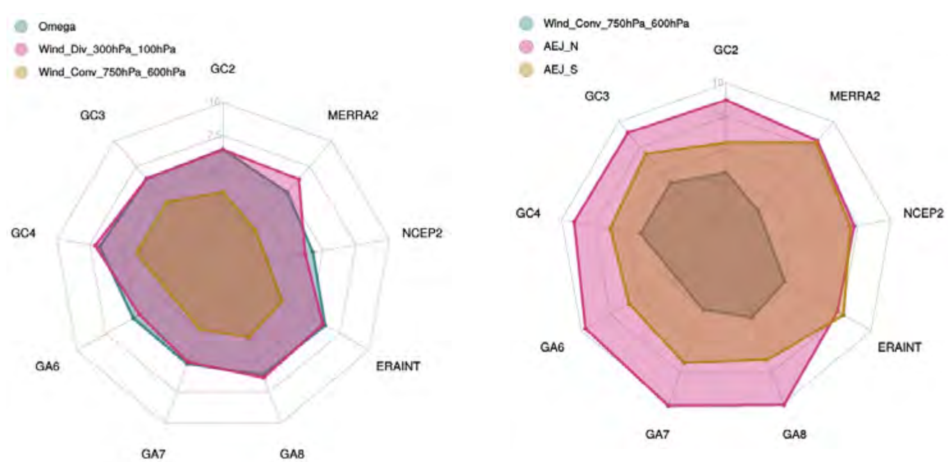
Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Rainfall Climatology



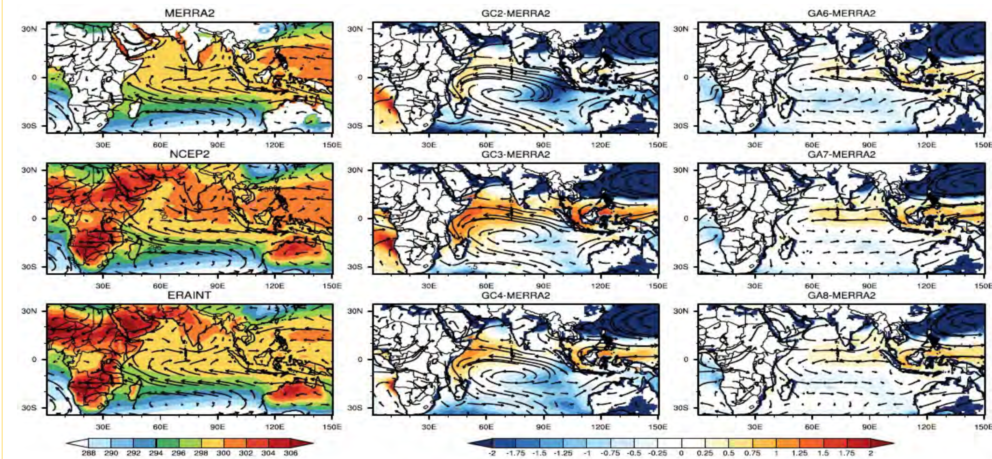
The goal is to understand rainfall biases over Central Africa

Spider Diagrams (SON Season)



AEJ-S is underestimated in UM models, leading to more convergence at mid-level and then more convection

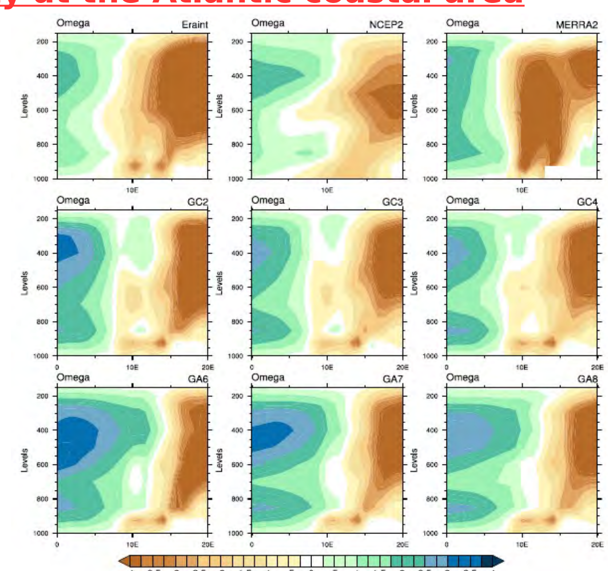
1000hPa Temperature



Temperature biases weak the downward branch of Indian east-West circulation. This lead wind to move to the West, carrying which him moisture from the IO to the continent..

Vertical velocity at the Atlantic coastal area

The downward branche on the Congo Basin Walker circulation is overestimated is models. Then more pressure is observed at around 850hPa over the Eastern part of the Atlantic Ocean basin. This causes a strong wind divergence leading to dry conditions over the Atlantic Coastal area.



How dynamical downscaling can advance our understanding of large- and local-scale drivers of regional climate change

Grigory Nikulin and Erik Kjellström (Rossby Centre, SMHI) [**S7 P11**]

Motivation:

- RCMs can modify climate change signal (CCS) of their driving GCMs
- RCMs and driving GCMs may project contradicting CCS
- RCMs downscaling the same GCM may also produce contradicting CCS

Question:

- What local-scale processes are responsible for such differences in CCS between RCMs and their driving GCM?

Study:

- Systematic analysis of 2 CORDEX ensembles and driving GCMs: Euro-CORDEX (33 sim., 0.11°), Africa-CORDEX (23 si m., 0.44°)
- Identifying regions and seasons with differences between RCMs and their driving GCMs (projections and also biases in a control period)
- attributing such differences (a challenging task)

SMHI FRACTAL FUTURE RESILIENCE FOR AFRICAN CITIES AND LANDS FUTURE CLIMATE FOR AFRICA WCRP CORDEX

Challenges for Brazilian Earth System Model (BESM)

Bruno Pereira [1, 2, @]

1 : Oceanographic Institute, University of Sao Paulo
Praça do Oceanográfico, 191 - Cidade Universitária, Butantã, Sao Paulo/Sao Paulo. CEP:05508-120 - B
2 : Laboratory of Geoecology of Landscape and Environmental Planning - Federal University of Ceará
Departamento de Geografia - Campus do Pici - Bloco 911 - CEP 60455-760 Fortaleza – CE. - Brazil

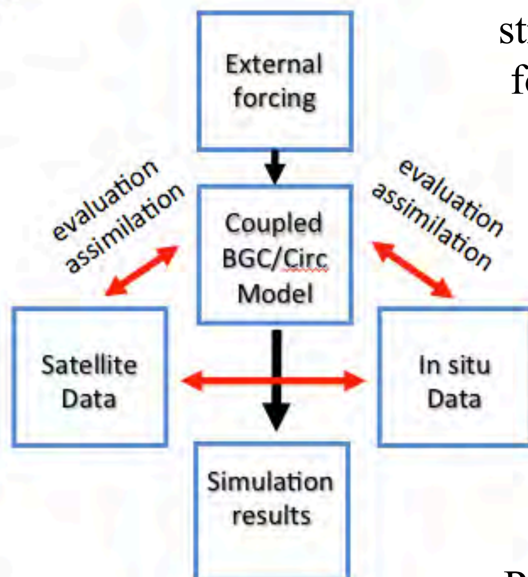
WORLD METEOROLOGICAL ORGANIZATION

QUESTION: Limits of tropical climates and Ecosystem under conditions of extreme multi-stressors

Model skill evaluation

- Does model fit data?
  - NO – what assumption is incorrect?
  - YES – do science
- Qualitative comparisons
  - Does simulation look like data?
- Quantitative comparisons
  - Standing stock (biomass)
  - Rates
  - Derived quantities - f ratio, Redfield ratio

Simulation should reproduce observed
magnitude
phasing



Improving data sampling strategies is powerful approach for improving biogeochemical models in ocean – continent interface

Hoffmann, 2017

Primary production, Food-web, acidification, eutrophication , Hypoxia

Process-based model evaluation and projections over southern Africa from regional and global climate models

Izidine Pinto*, C. Jack, B. Hewitson
Climate System Analysis Group, University of Cape Town, South Africa
(*contact: **izidinep@csag.uct.ac.za**)

Introduction and Aims

Decision-scale relevant climate information on climate change is needed to inform policy and decision making but often involves high uncertainty due to internal variability, emissions scenarios and differing model representations of climate processes at different spatial scales. In order to increase confidence in future climate changes it is valuable to disaggregate the inter-model differences into regional circulation scales and local process scales.

- GCMs primary tools for climate information -spatial scale not appropriate for regional scale decision making
- Downscaling using RCMs - adds value and provide a better representation of the regional climate

However projections from RCMs and GCMs can differ, particularly in the case of rainfall

This study explores a methodology to investigate projected change as a function of changes in frequency of synoptic circulation with the aid of Self-Organizing Maps (SOM) as additional source of information to assess the robustness and value of downscaled climate.

Data and Methods

4 CMIP5 GCMs, downscaled to 50km by RCA4 and CCLM4 RCM Model

GCM CMIP5	Historical (1976-2005)	RCP 8.5 (2069-2098)
CNRM-CM5	✓	✓
EC-Earth	✓	✓
HadGEM2-ES	✓	✓
MPI-ESM-L	✓	✓
ERA-Interim	(1981-2005)	

We train the SOM using daily mean sea level pressure (MSLP) from the combined GCMs, RCMs and Era-Interim fields. Prior to training the data is standardized by the global (combination of GCMs, RCMs and EI) mean and standard deviation, maintaining in this way individual model error.

Results

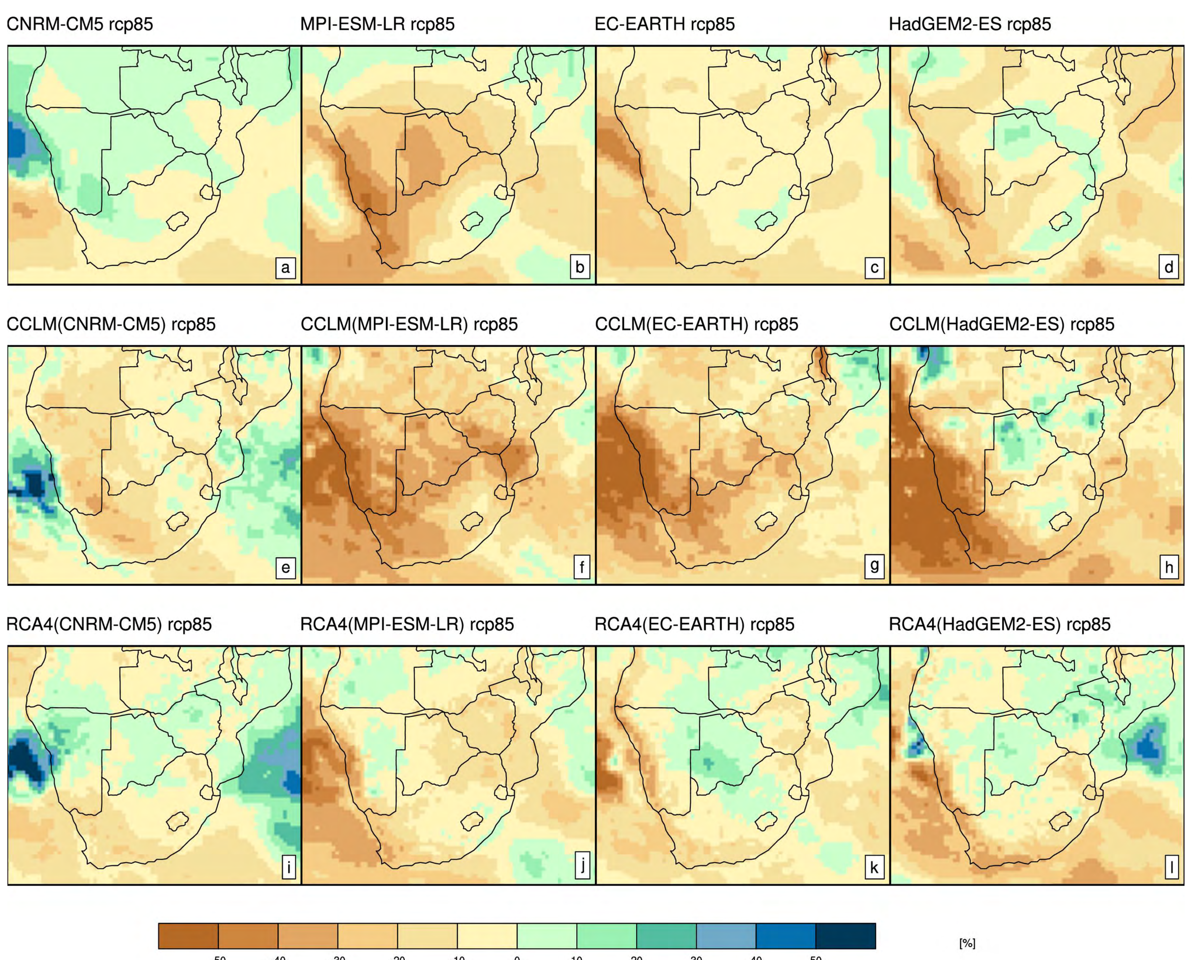


Fig 1. Projected annual mean precipitation changes (%) for the period of 2069-2098 under RCP8.5, relative to reference period 1976–2005. All the data are interpolated to a common 2 resolution.

- CCLM downscaling simulations of changes in precipitation agrees with the driving GCMs with the exception of CNRM over the subcontinent and the Indian Ocean (IO). In the RCA4 downscaled simulations the pattern of change is contrary to the driving GCMs for most parts of southern Africa.

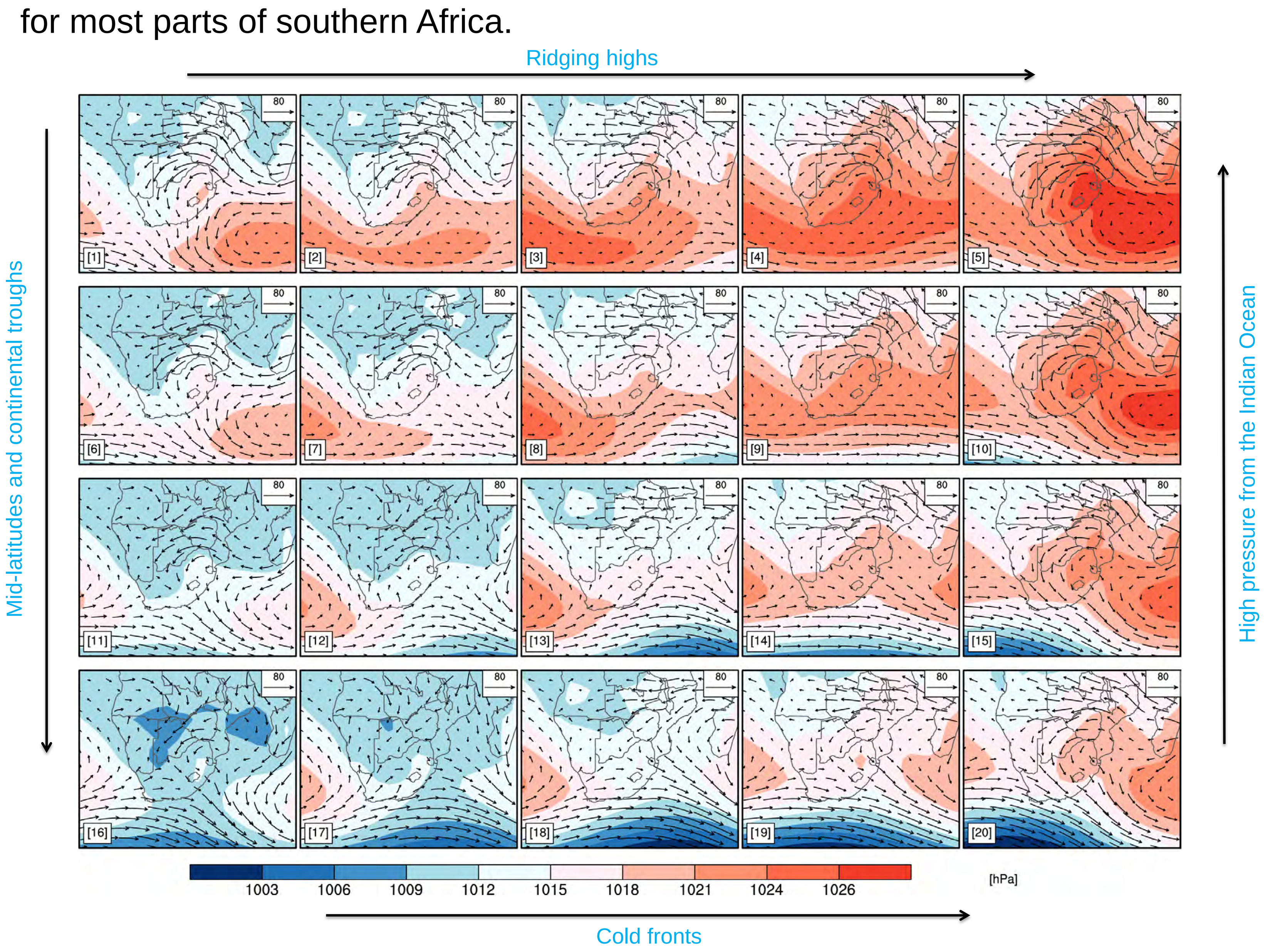


Fig 2. The 5x4 master SOM of SLP. The reds indicate high pressure and the blues lower pressure. Vectors represent moisture transport at 850hpa [units: g kg-1 m s-1] composite associated with each node from ERAINT.

- Similar synoptic circulation patterns are clustered together across the node space while more distinct types are further apart. Features of the low level circulation can be seen through the MSLP patterns - these include the conventionally recognized systems of the South Atlantic and Indian anticyclone, mid-latitude westerlies, west coast trough, coastal low and the continental high and the northeast monsoon. Left = DJF, Right = JJA, Center =shoulder seasons circulation types.

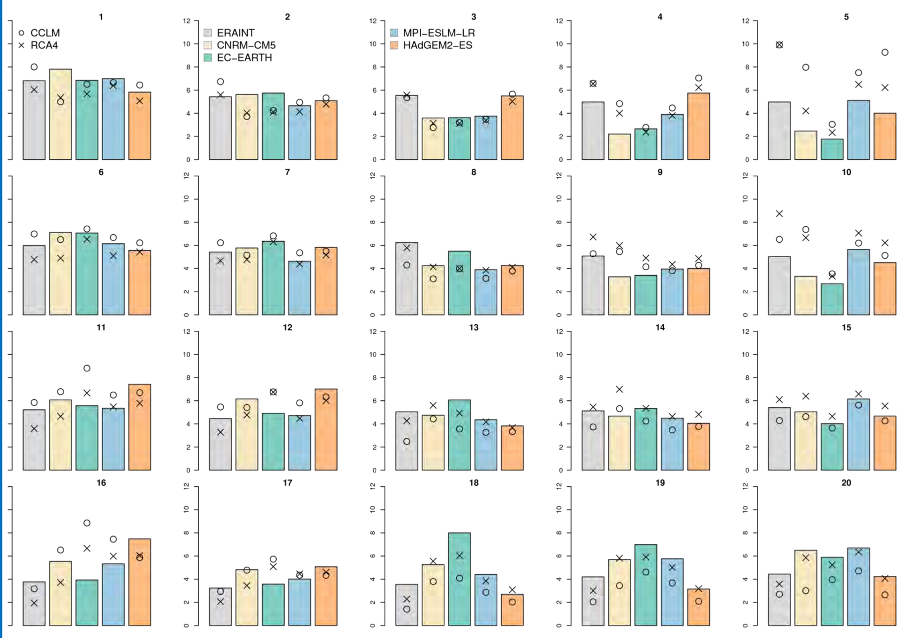


Fig 3. SOM node frequency (%) for ERAINT, GCMs and RCMs for a common period of 1989-2005. Node numbers is shown on top

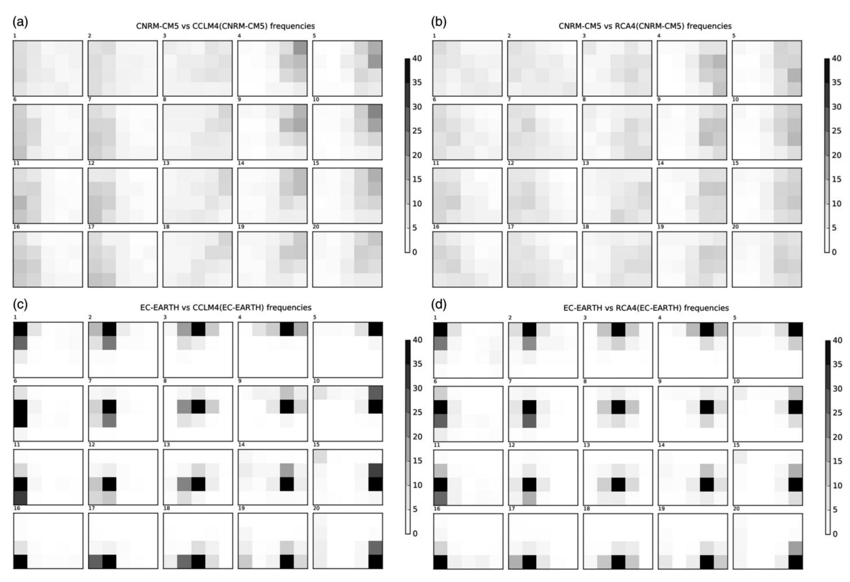


Fig 4. Frequency (%) distribution of RCMs nodes occurrence corresponding to each GCM node occurrence (agreement maps). Node number is shown on top left

CCLM has more of a tendency to overestimate DJF circulation and underestimate JJA frequencies when compared with RCA4. RCMs overestimate nodes 4, 5 and 10 when compared with the GCMs. When CNRM-CM5 maps to for example node 16 (bottom left), the RCMs maps to not only to node 16 but to other nodes. EC-EARTH seems be in phase with both RCMs (GCM and RCM simulating the same circulation)

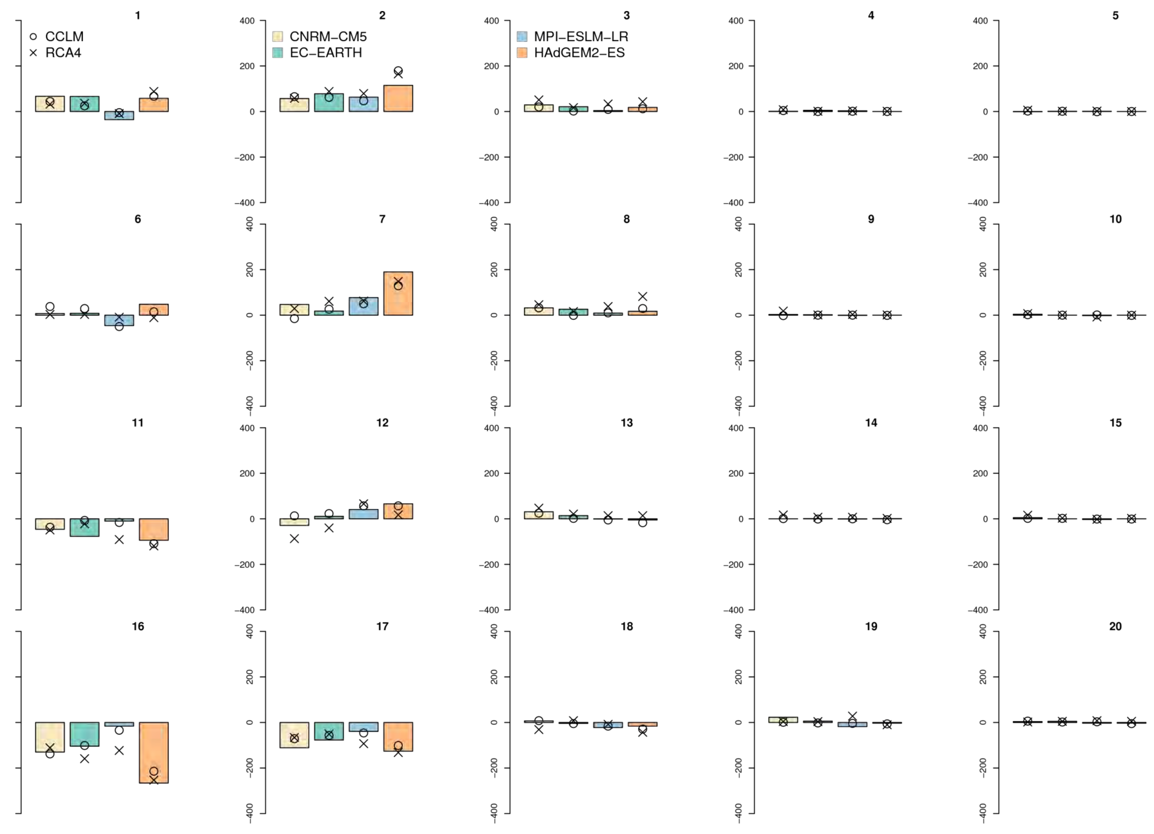
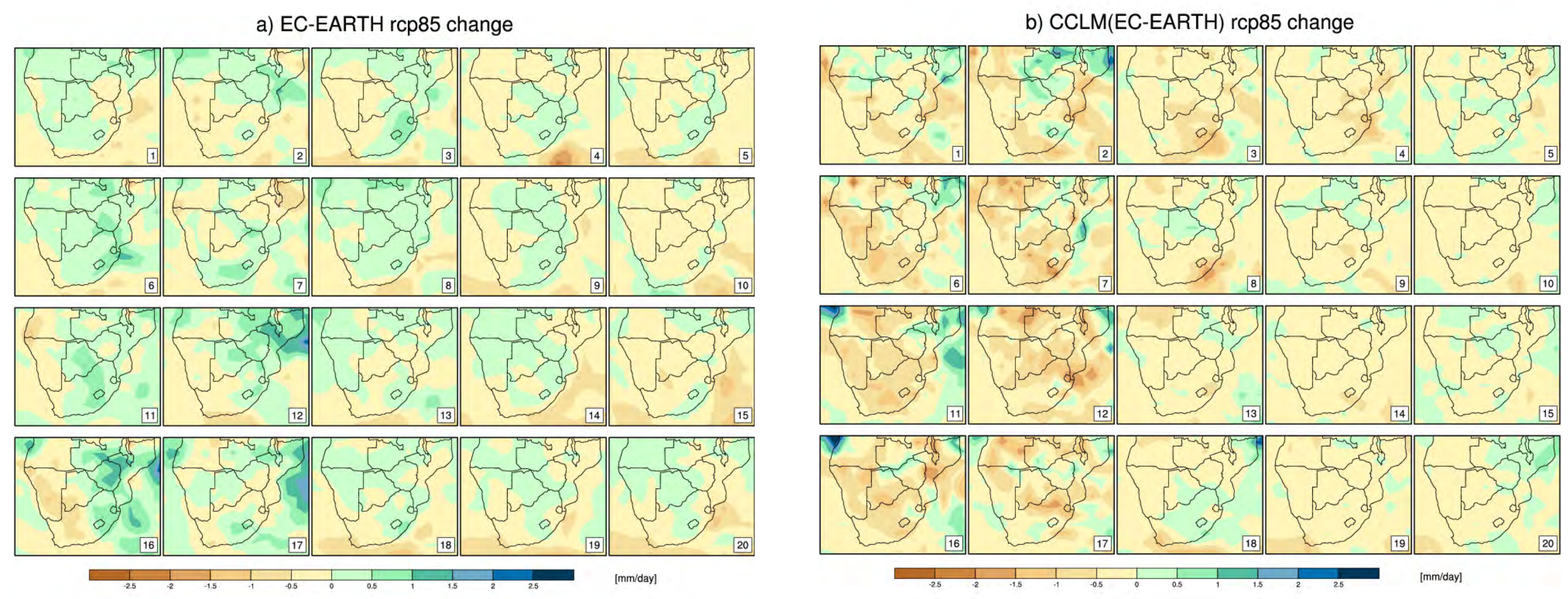


Fig 5. Projected changes in the SOM node frequency for GCMs and RCMs over the periods 2069-2098 relative to 1976–2005 under RCP8.5. Node number is shown on top

On most nodes there is agreement in the sign of change between GCMs and RCMs, although magnitudes differ.



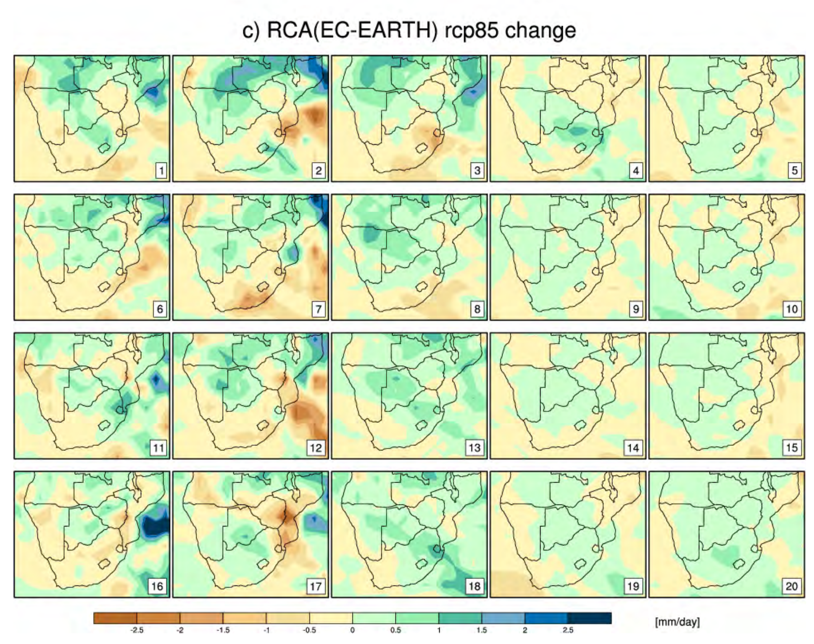


Fig 6. Composites of precipitation change associated with each node (synoptic state) in the 5 × 4 master SOM for the period of 2069-2098 under RCP8.5 scenario, relative to reference period 1976-2005. Node number is shown on bottom right

For e.g., in node 16 both RCMs and GCM agree in the sign of change in the frequency of circulation patterns (Fig 5); however, the precipitation has a different signal of change and patterns. In ECEARTH, results suggest an increase in precipitation over most of east southern Africa, while RCA(EC-EARTH) suggest an increase over the centre of the domain and northern regions and CCLM suggest generally a drying trend.

Summary

- Increase in the occurrence of the oceanic high-pressure systems, a more dominant high-pressure circulation poleward of the continent and
- Decreased occurrence of patterns of continental lows and mid-latitude lows, ie, the synoptic states that reduce precipitation are projected to increase, while synoptic states that enhance precipitation are projected to decrease over time.
- Since the atmospheric circulation is relatively well simulated in both RCMs and GCMs (i.e, the RCM and GCM are in phase regarding to circulation patterns!), the differences in the projected precipitation is due to the representation of local subgrid-scale parameterized processes, such as convection and/or the representation of coastlines i.e, the climate change signal can be a local response dynamic rather than circulation dynamic.

Acknowledgements. This work was funded by Future Resilience for African CiTies and Lands (FRACTAL) project, which is part of Future Climate for Africa (FCFA) program funded by UK's Department of International Development and NERC. The first author is grateful to the CMIP6 Analysis workshop for the financial support to attend the workshop.

ANALYSIS OF FUTURE CHANGES IN EXTREME CLIMATE INDICES IN THE INDONESIAN REGION USING AIMS

I Dewa Gede Arya Putra[*1,2], M Syamsu Rosid[1], Ardhasena Sopaheluwakan[2], Hastuadi Harsa[2], and Jaepil Cho[3]

[1]University of Indonesia (UI), Depok, West Java, Indonesia
[2]Indonesian Agency for Meteorology Climatology and Geophysics (BMKG), Kemayoran, Jakarta, Indonesia
[3]APEC Climate Center (APCC), Haeundae, Busan, South Korea

[*]E-mail: dewa.putra@bmkg.go.id

INTRODUCTION

This research was conducted to answer these questions:

1. How is the performance of the model to project future climate in Indonesia based on relationships that are built on historical data?
2. How are the characteristics of future extreme climate change in the Indonesian region in the near term, medium term, and long term based on the modeling scenario?

STUDY AREA

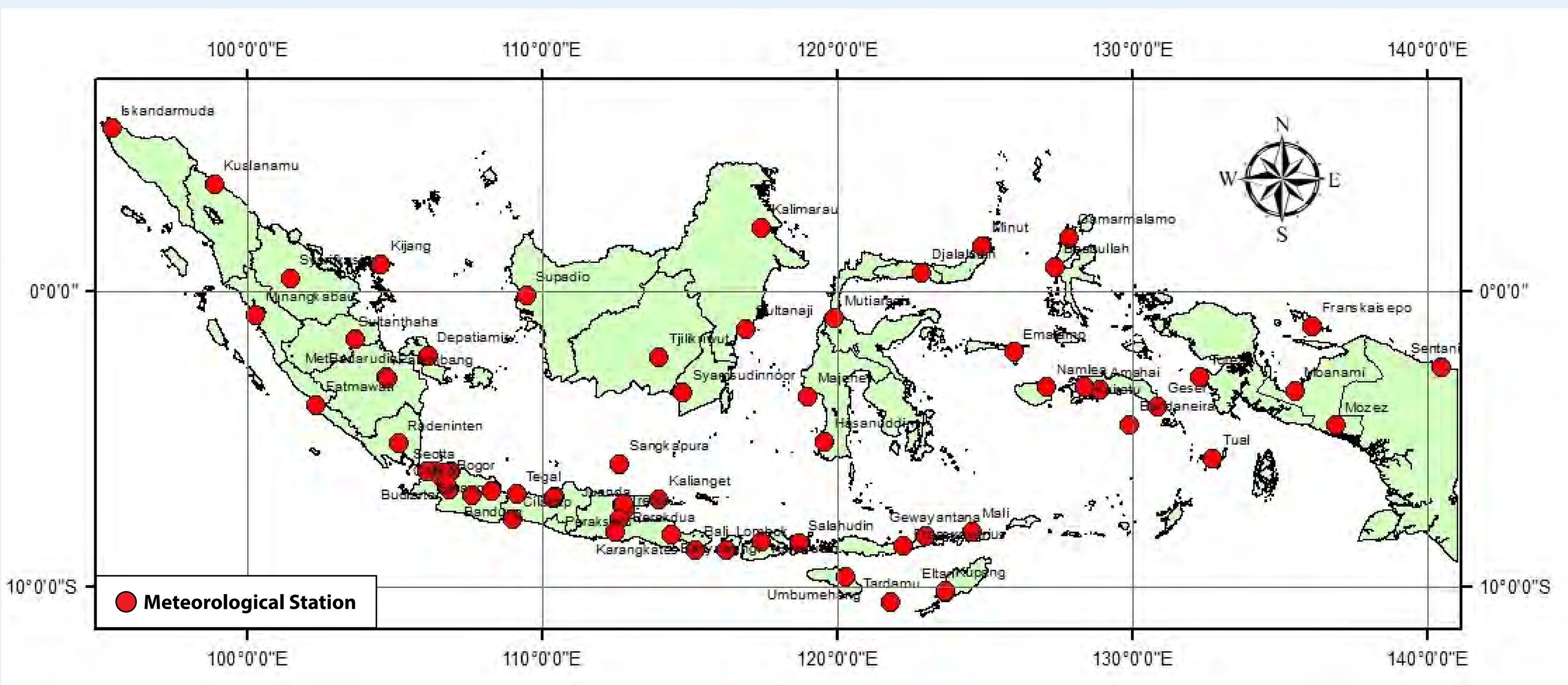


Figure 1. Study Area

METHODOLOGY

Data Preparation
29 GCMs CMIP5.
70 Meteorological Stations.

Raw GCM Analysis Using AIMS
Rank using Spatial and Temporal Correlation of raw GCM with station data.
Selection of 5 GCM with high correlation.

Donwscaling Using AIMS
Simple quantile Mapping for:
- Historical
- Near Future
- Mid Future
- Far Future

Impact Asesment
Make Extreme Indices using ETCCDI.
- PRCPTOT
- CDD
- CWD
- TXx
- TNn

APCC Integrated Modelling Solution (**AIMS**)

Link
https://aims.apcc21.org

Table 1. Selected of Indices from ETCCDI

Index	Description	Unit
PRCPTOT	Annual total precipitation in wet days, (daily precipitation ≥1mm)	mm
CWD	Maximum length of wet spell, maximum number of consecutive days with daily precipitation ≥ 1mm	days
CDD	Maximum length of dry spell, maximum number of consecutive days with daily precipitation <1mm	days
TXx	Monthly maximum value of daily maximum temperature	°C
TNn	Monthly minimum value of daily minimum temperature	°C

RESULTS

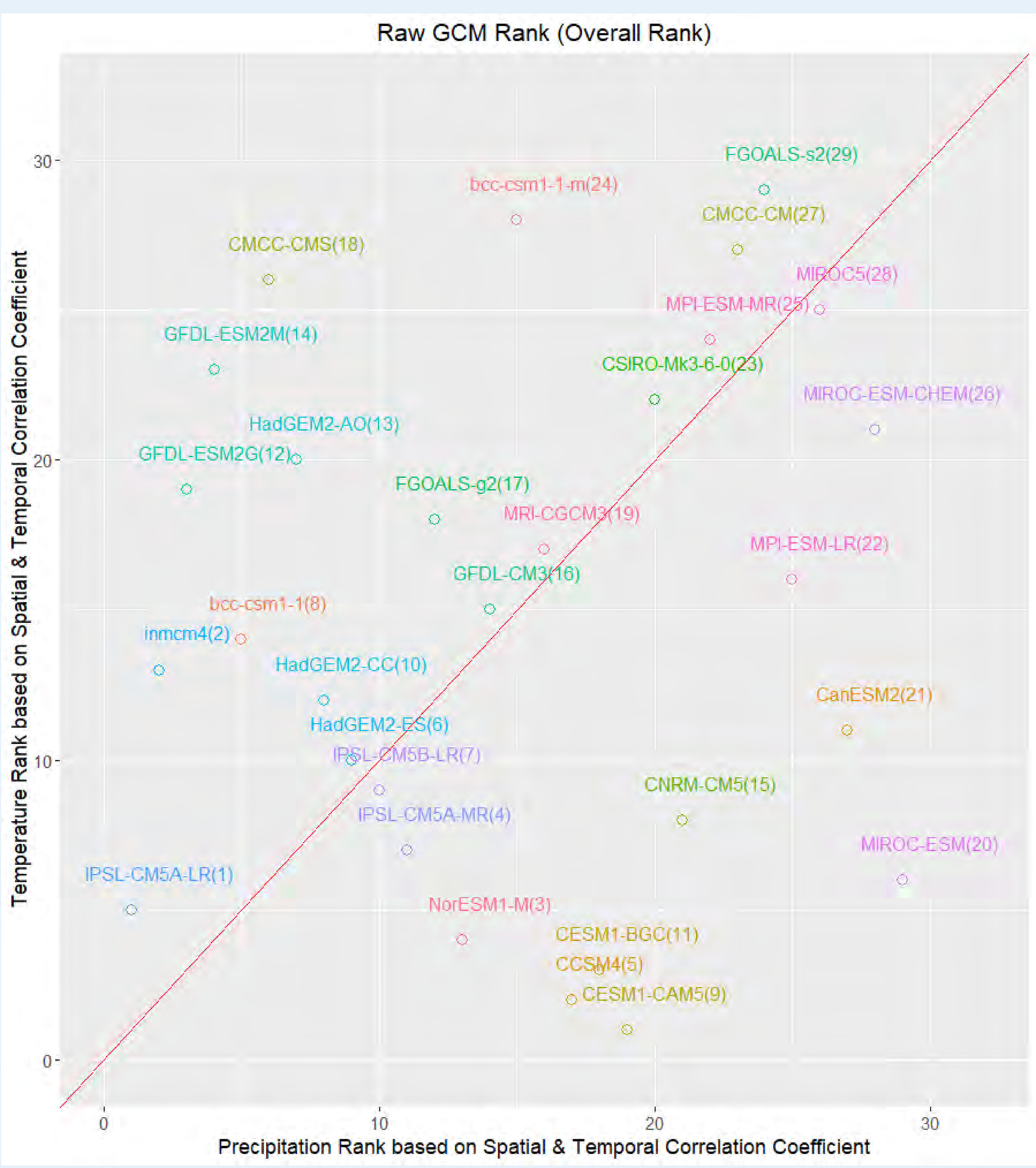


Figure 2. GCM Rank Using Spatial Correlation and Temporal Correlation

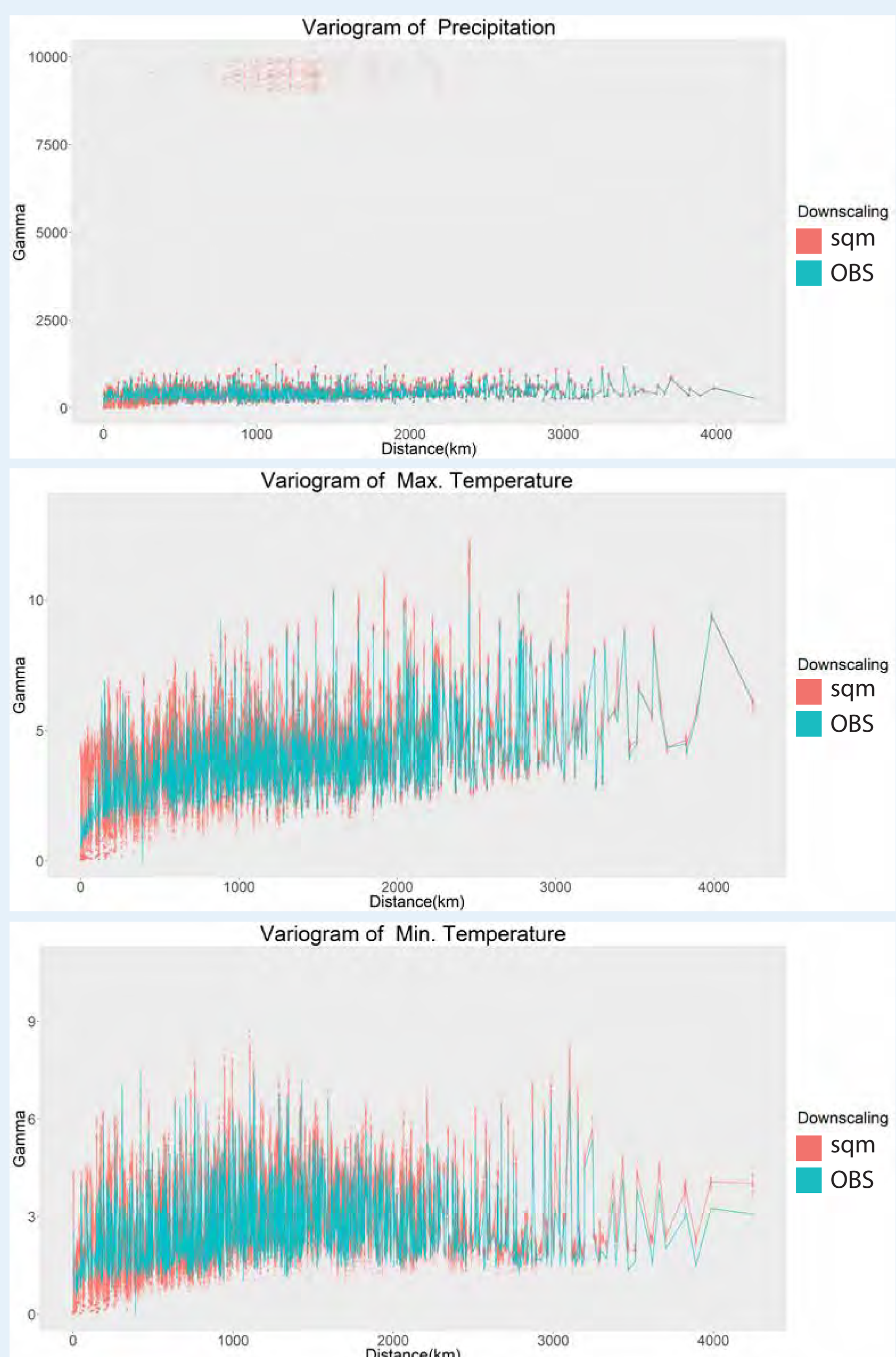


Figure 3. Variogram Analysis

5 GCM with the strongest correlation for precipitation and temperature in the Indonesian Region, namely: IPSL-CM5A-LR, inmcm4, NorESM1-M, CCSM4 and IPSL-CM5A-MR.

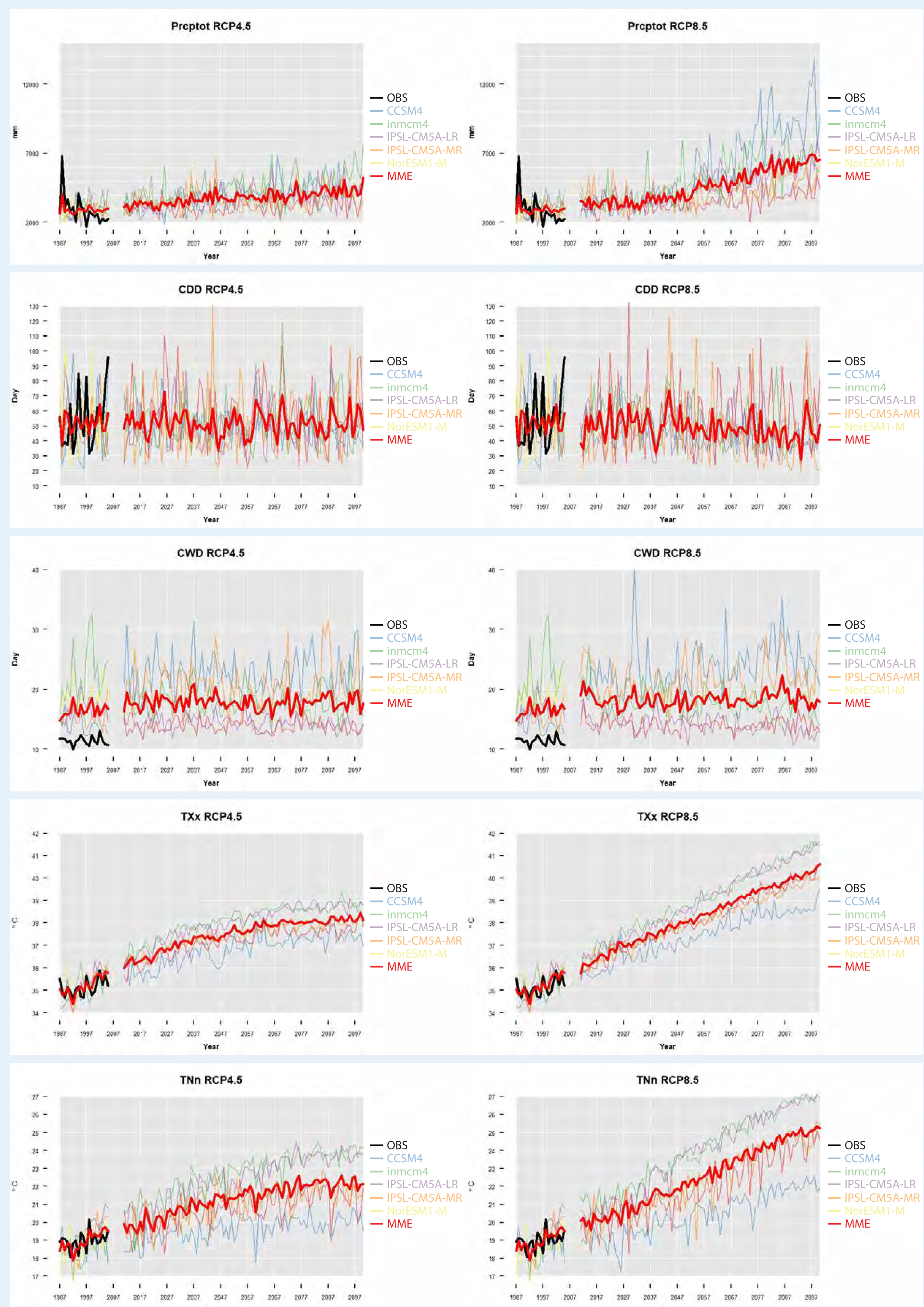


Figure 4. Time Series for 5 Best GCM Rank and MME

Table 2. Percent Future Changes of RCP4.5 Using MME

Time Period	PRCPTOT	CDD	CWD	TXx	TNn
Near (2011-2040)	↑ 15%	0%	↑ 57%	↑ 5%	↑ 7%
Middle (2041-2070)	↑ 32%	↓ -2%	↑ 53%	↑ 7%	↑ 13%
Far (2071-2100)	↑ 43%	↓ -1%	↑ 57%	↑ 8%	↑ 17%

Table 3. Percent Future Changes of RCP8.5 Using MME

Time Period	PRCPTOT	CDD	CWD	TXx	TNn
Near (2011-2040)	↑ 17%	↓ -4%	↑ 60%	↑ 5%	↑ 9%
Middle (2041-2070)	↑ 49%	↓ -3%	↑ 58%	↑ 9%	↑ 18%
Far (2071-2100)	↑ 106%	↓ -11%	↑ 61%	↑ 13%	↑ 29%

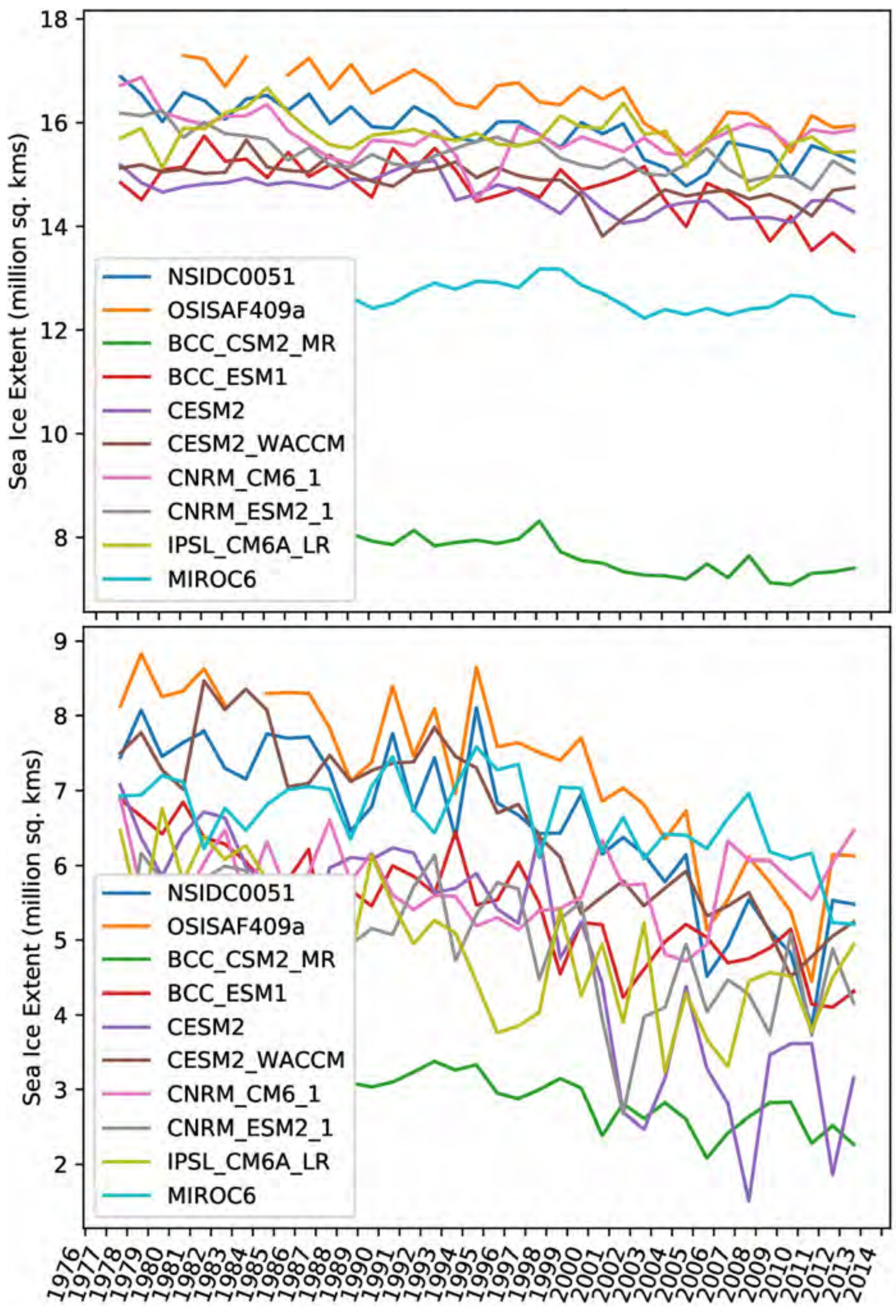
CONCLUSIONS

This study concludes:

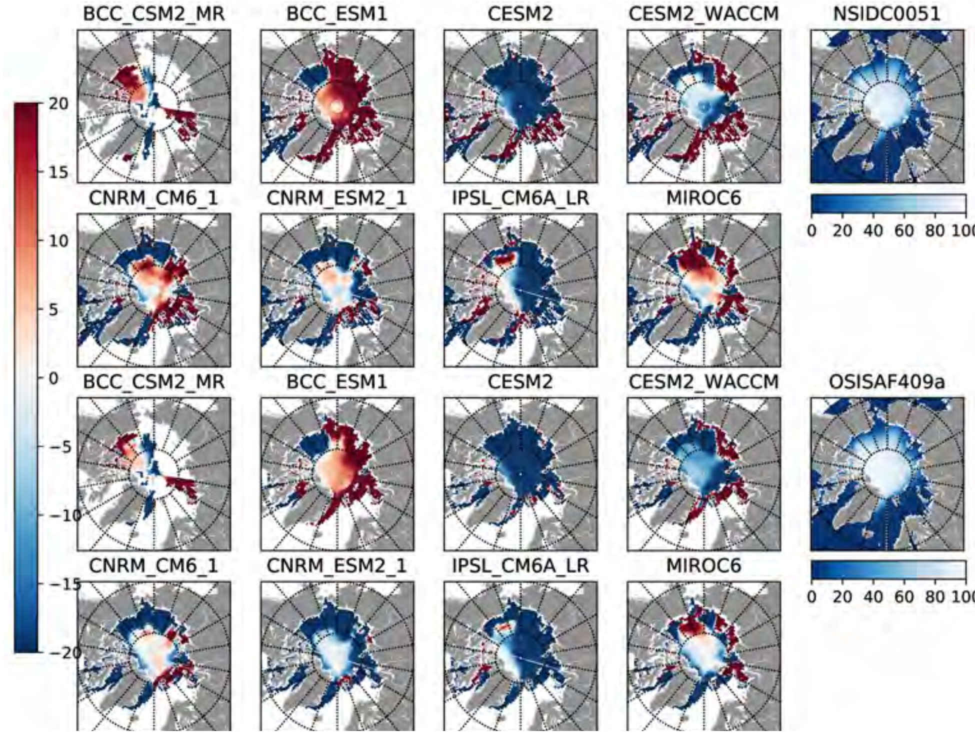
1. From 29 GCMs, 5 GCM are selected with the best spatial and temporal correlations based on precipitation and temperature variables, namely: IPSL-CM5A-LR, inmcm4, NorESM1-M, CCSM4 and IPSL-CM5A-MR. 5 GCM with the highest correlation has a best relationship with the pattern of observations data so that it is well used for projecting the extreme climate of the future in the Indonesian Region.
2. Future extreme climate conditions based on MME projections of 5 GCM show that Prcptot is increasing with decrease CDD, while TXx and TNn conditions will continue to increase both in RCP 4.5 and RCP 8.5 for near future, middle future and far future.

Thursday, Session 7 - P14

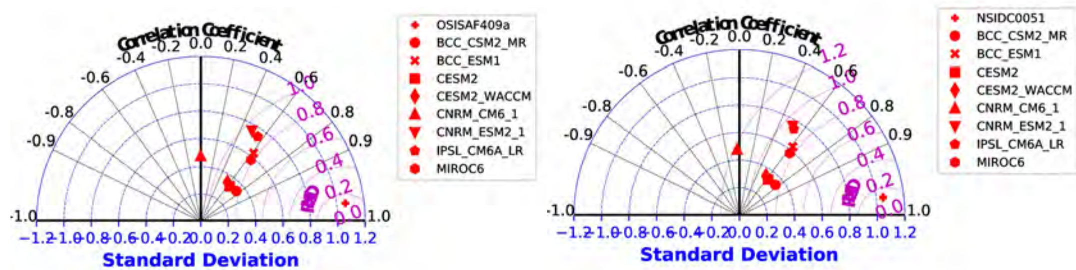
Inter-comparison of Sea-Ice Observational and CMIP6 Multi-model Datasets



Sea-Ice Extent (as calculated from concentration) over the Northern Hemisphere in March (Upper) and September (Lower) over the historical period of 1979-2014 in observations and CMIP6 datasets



Relative Differences (Model-Obs/Obs) in Sea-Ice concentration over the Northern Hemisphere in September as compared to NSIDC0051 and OSISAF409a datasets over the historical period of 1979-2014



Taylor diagram of Sea-Ice Extent over the Northern Hemisphere in September as compared to NSIDC0051(left) and OSISAF409a (right) dataset over the historical period of 1979-2014

7-P17

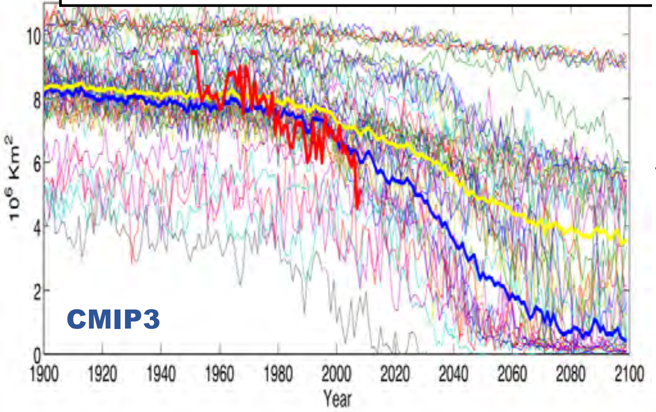
How Different is the Arctic Revealed by CMIP6 models?

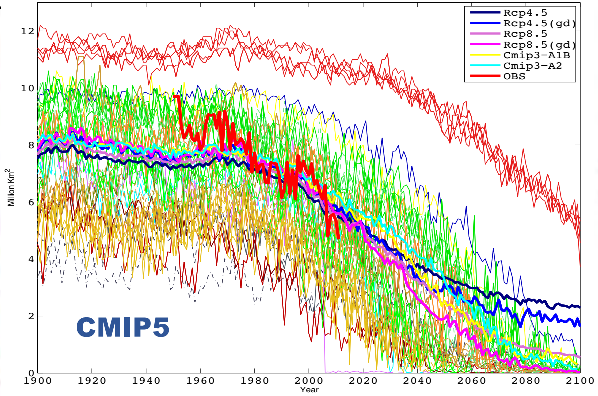
Muyin Wang[1,2] & James E. Overland[2]

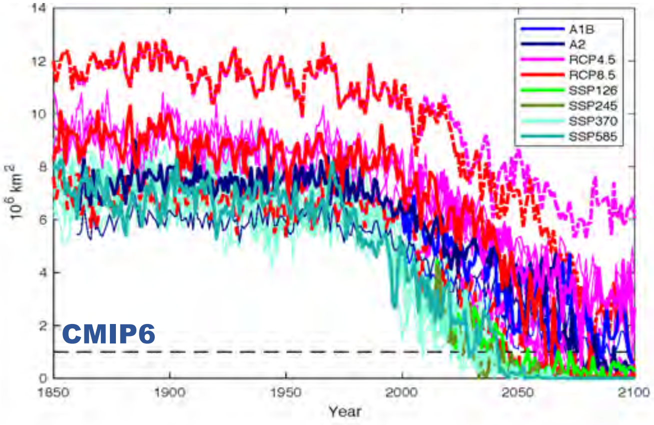
[1] University of Washington, [2] PNOAA/Pacific Marine Environmental Laboratory, Seattle, WA

Based on CMIP3 and CMIP5 model projections and the low record low sea-ice cover in 2007 (4.5 million km^2), Wang and Overland (2009, 2012) predicted an ice-free summer Arctic would come in about 30 years. A decade later, we intend to investigate this issue again, based on simulations from CMIP6 models. With only two of the five models provide valid data needed, and only one model has projections under future emission scenarios, our question is remain largely un-answered – for now.

Model Name	siconc	sithick	sivol	siarean	siextentn	sivoln
BCC-CSM2-MR			3			
BCC-ESM1			3			
CNRM-CM6-1	4	2	2	10	10	10
CNRM-ESM2-1	10	1	1	4	4	4
FGOALS-f3-L						
GFDL-AM4						
GFDL-CM4						
GISS-E2-1G		10	10			
IPSL-/CM6A-LR	31	31	31	31	31	31
MIROC6	10	10				
IPSL-CM6A-ATM-HR						
CESM2-WACCM	3	3	3	3	3	3



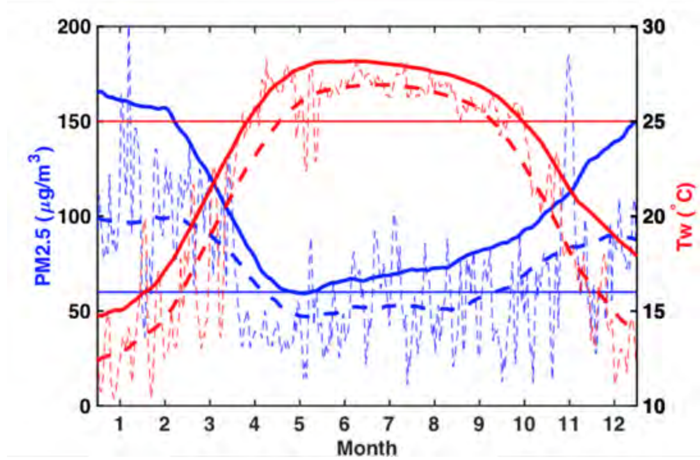




Compound Impact of heat and haze extreme in South Asia

Xu, Yangyang (Texas A&M University)

CMIP6 workshop, Barcelona, Mar 28, 2019

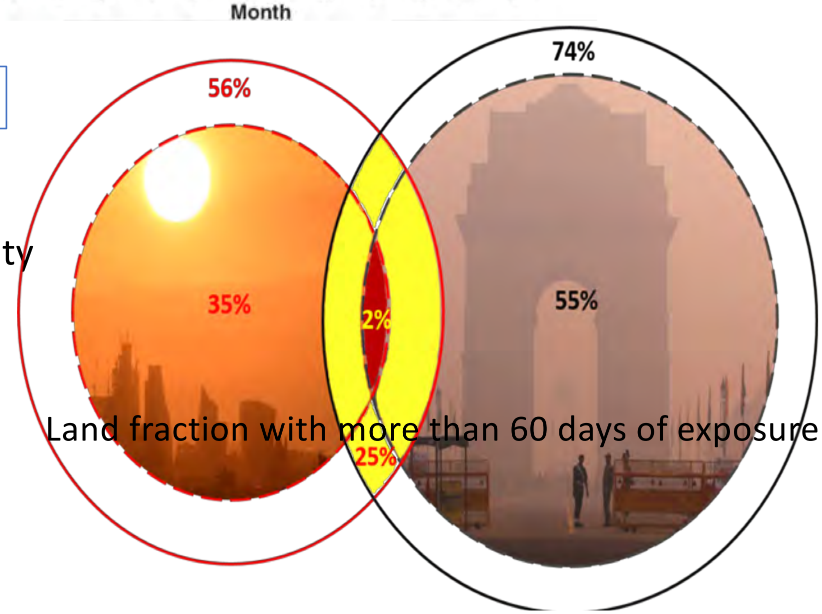


- **Motivation**:

  First large-scale assessment of
  the co- occurrence of heat extreme and haze extreme
  the **future** evolution and
  the **human** exposure

- **Methods**: **1997-2004 (Decade 2000) and 2046-2054 (Decade 2050).**

  2 sets of high-resolution WRF_Chem decadal-long simulation [Kumar, 2018]
  that is evaluated thoroughly based on in situ measurement of air quality and also bias-corrected against meteorological reanalysis.



Land fraction with more than 60 days of exposure

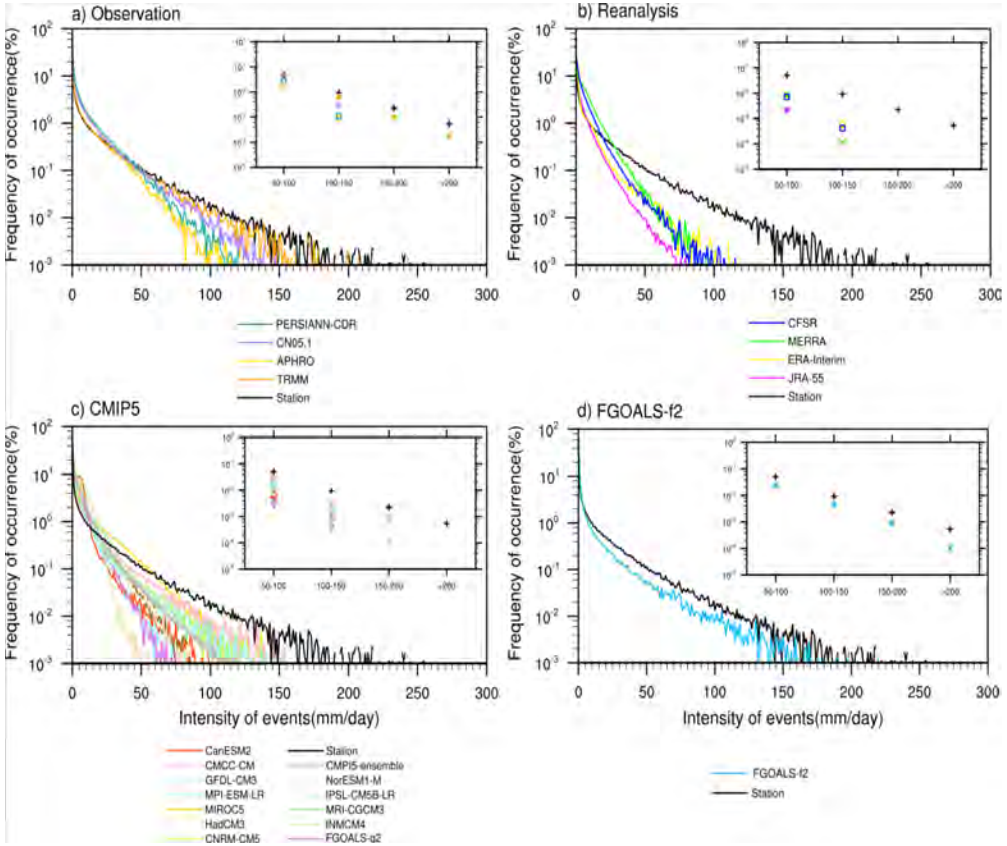
- **Results**:

  Worrying Future Outlook…
  But useful for raising the awareness and anticipating the scale of adaptation

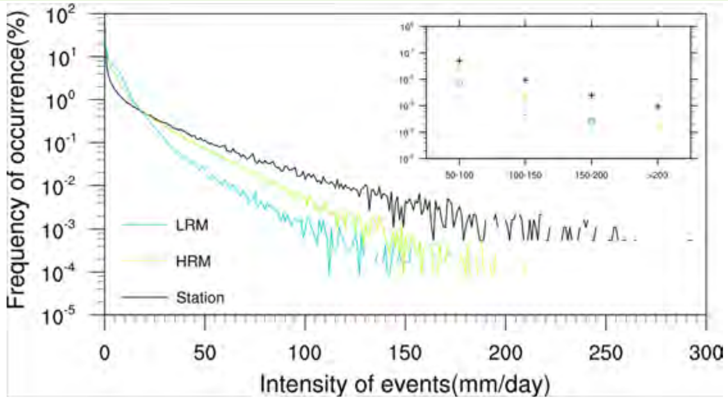
Fidelity of the Observational/Reanalysis Datasets and Global Climate Models in Representation of Extreme Precipitation in East China

Jing Yang et al.

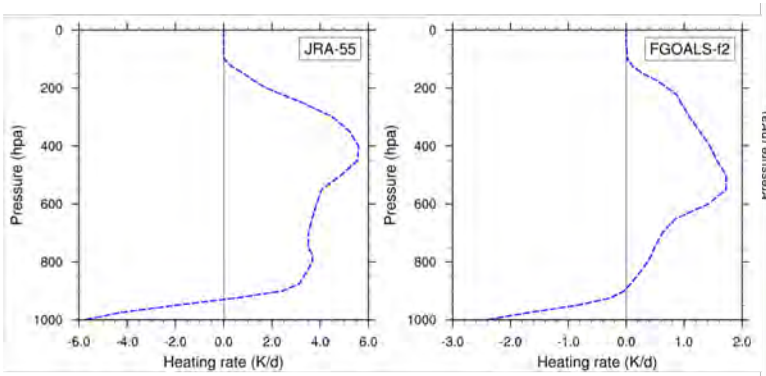
Post Number: 7-P17

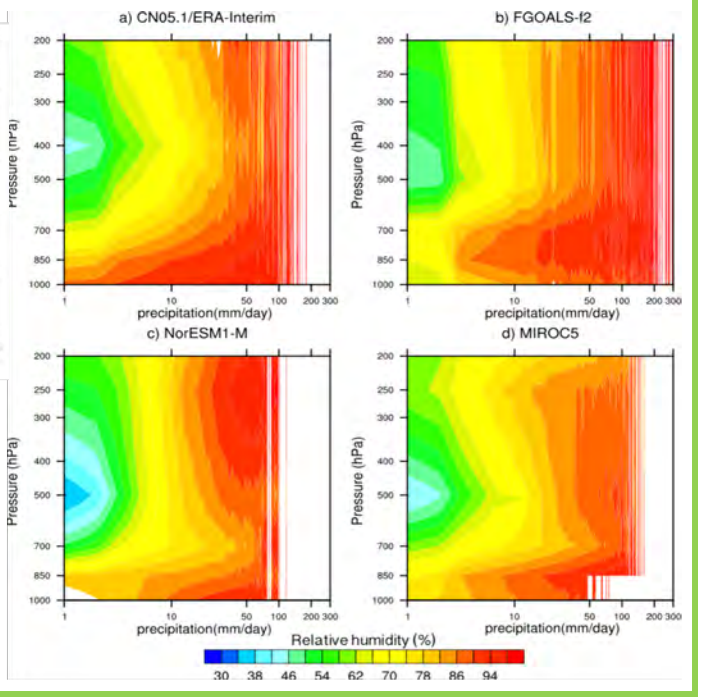


All cannot capture extreme precipitation exceeding 150 mm day, and underestimate extreme precipitation frequency.



Higher resolution can improve the heavy rainfall but not for extreme





More realistic simulation of moisture and heating profiles are crucial for extreme rainfall simulation

Are Climate Models Reliable for Projecting the Impacts of a Half-degree Warming Increment in Heat Extremes in China?

Siyao Zhao [1, 2] (zhaosy@lasg.iap.ac.cn), Tianjun Zhou [1, 2*] (zhoutj@lasg.iap.ac.cn)
1 LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing 100029, China.
2 University of Chinese Academy of Sciences, Beijing 100049, China.

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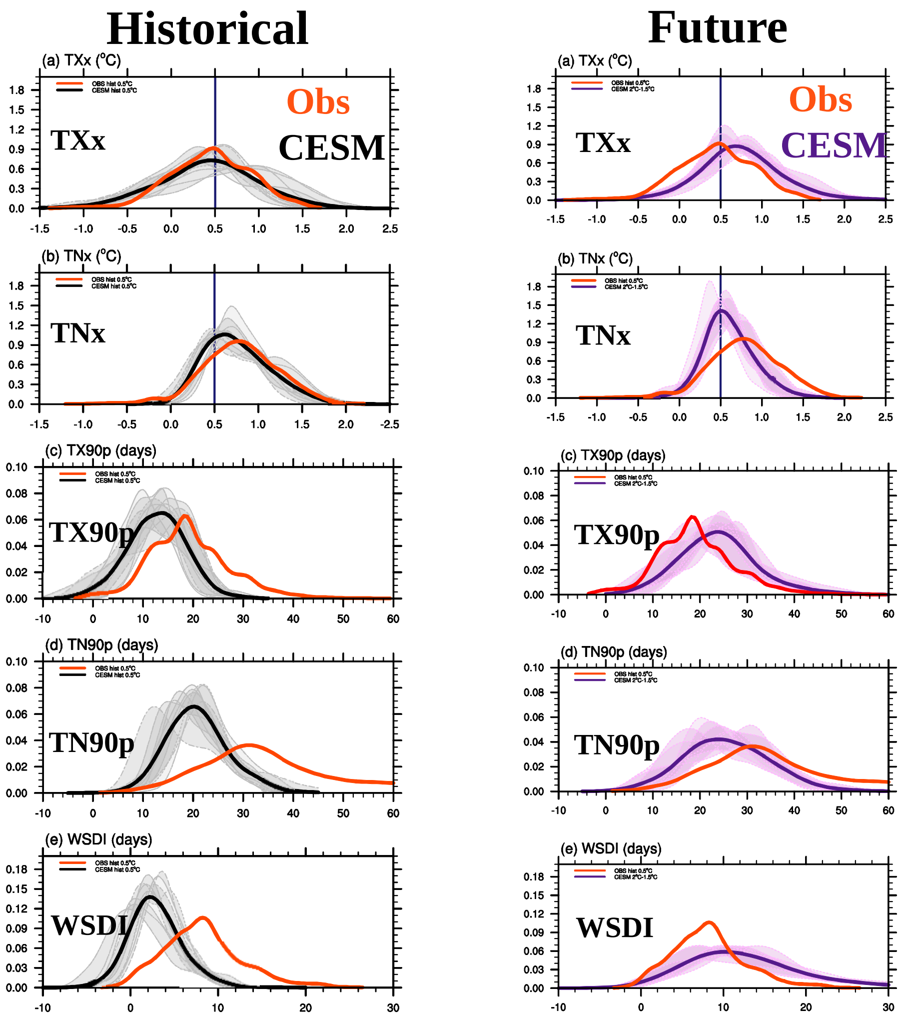
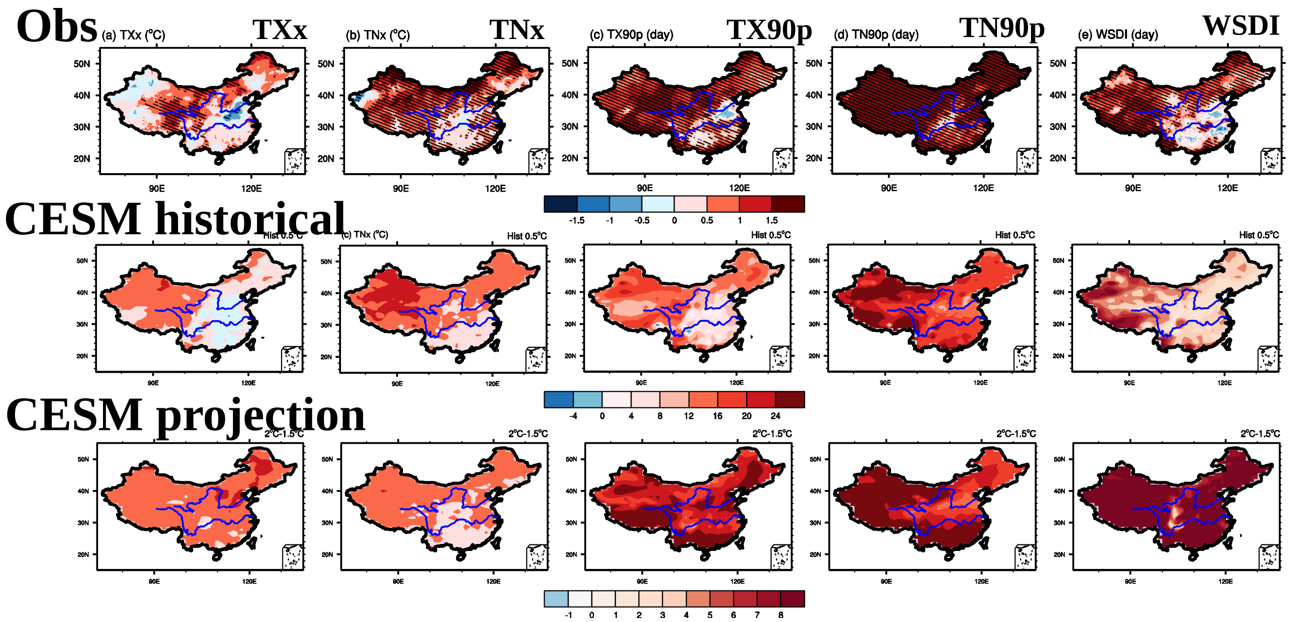


Spatial aggregated PDF



- 1960-1979 versus 1991-2010 → 1.5 ℃ versus 2 ℃
- daytime extremes > nighttime extremes.
- CESM historical simulations can reproduce the changes but with slightly weaker amplitude. The intensity indices are better reproduced
- Observation is a conservative estimate for the future projections in daytime extremes

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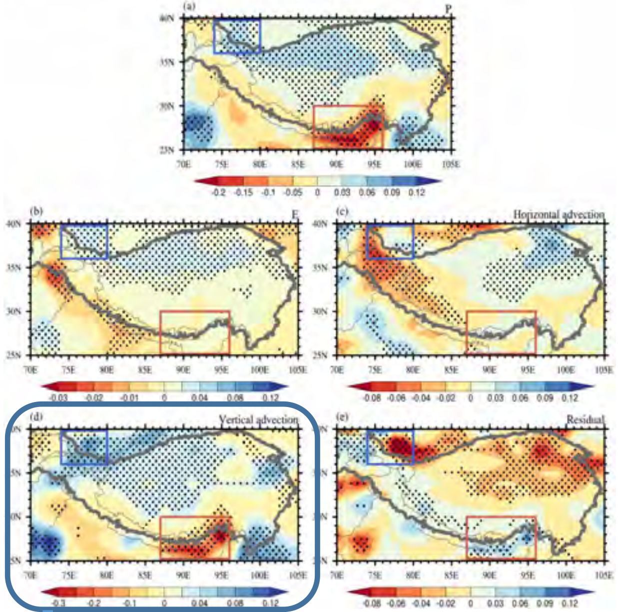
Spatial Uneven Trend of Precipitation in the Tibetan Plateau

Yin Zhao Tianjun Zhou

zhaoyin@lasg.iap.ac.cn

the State Key Laboratory of Numerical Modeling for Atmosphere Sciences and Geophysical Fluid Dynamics (LASG),Institute of Atmospheric Physics (IAP), Chinese Academy of Sciences (CAS)



Vertical Velocity Diagnostic Formula

$$(\sigma\nabla^2 + f_0^2 \frac{\partial^2}{\partial p^2})\omega' = f_0 \frac{\partial}{\partial p}(u'_g \frac{\partial \overline{\zeta_g}}{\partial x} + \overline{u_g}\frac{\partial \zeta'_g}{\partial x} + u'_g \frac{\partial \zeta'_g}{\partial x} + v'_g \frac{\partial \overline{\zeta_g}}{\partial y} + \overline{v_g}\frac{\partial \zeta'_g}{\partial y} + v'_g\frac{\partial \zeta'_g}{\partial y} + v'_g \frac{\partial f}{\partial y})$$

$$+\frac{R}{p}\nabla^2(u'_g \frac{\partial \overline{T}}{\partial x} + \overline{u_g}\frac{\partial T'}{\partial x} + u'_g\frac{\partial T'}{\partial x} + v'_g\frac{\partial \overline{T}}{\partial y} + \overline{v_g}\frac{\partial T'}{\partial y} + v'_g \frac{\partial T'}{\partial y}) \Leftrightarrow$$

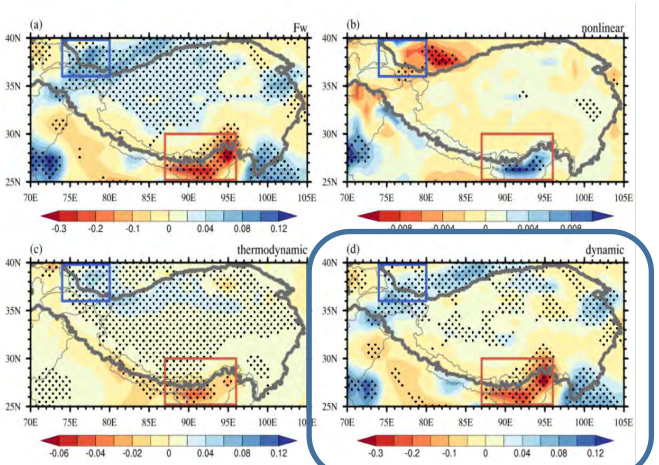
c1~c6 **b1~b7**

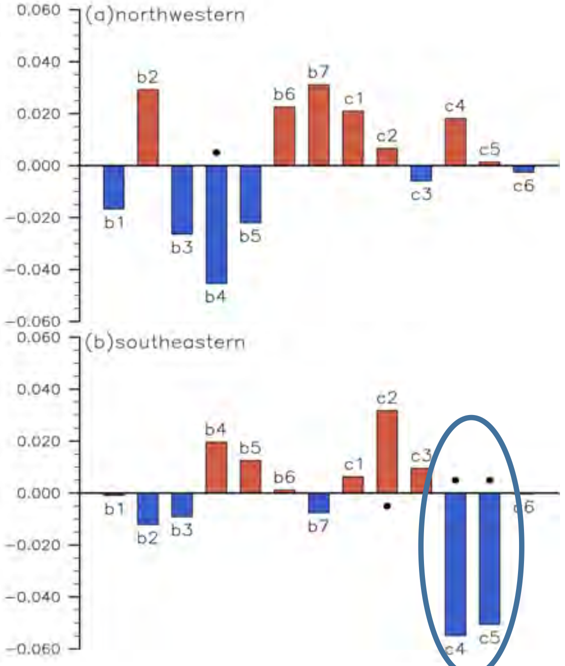
Moisture Budget

$$P' = -\langle V_h \cdot \nabla q \rangle' - \langle \omega \partial_p q \rangle' + E' + \delta'$$

$$-\langle \omega \partial_p q \rangle' = -\langle \overline{\omega} \partial_p q' \rangle - \langle \omega' \partial_p \overline{q} \rangle - \langle \omega' \partial_p q' \rangle$$

$$-\langle V_h \cdot \nabla q \rangle' = -\langle \overline{V_h} \cdot \nabla q' \rangle - \langle V_h' \cdot \nabla \overline{q} \rangle - \langle V_h' \cdot \nabla q' \rangle$$





Summary

southeastern TP	northwestern TP
change of temperature and geostrophic wind	change of atmospheric water vapor
cold advection	wetting trend more precipitation
abnormal downdraft	diabatic feedback
drying trend	abnormal updraft
dynamic	thermodynamic

Plan for CMIP6

- Moisture budget and vertical velocity diagnostic formula are useful methods for precipitation analysis.
- On the basis of the above results, we will focus on the simulation ability of CMIP6 models in context of TP precipitation using the historical simulation experiments.
- The reason for simulation bias will be analyzed utilizing climate dynamics diagnostic methods mentioned above.