

Temperature and precipitation climatology assessment over South Asia using the Regional Climate Model (RegCM4.3): An evaluation of model performance

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Outline

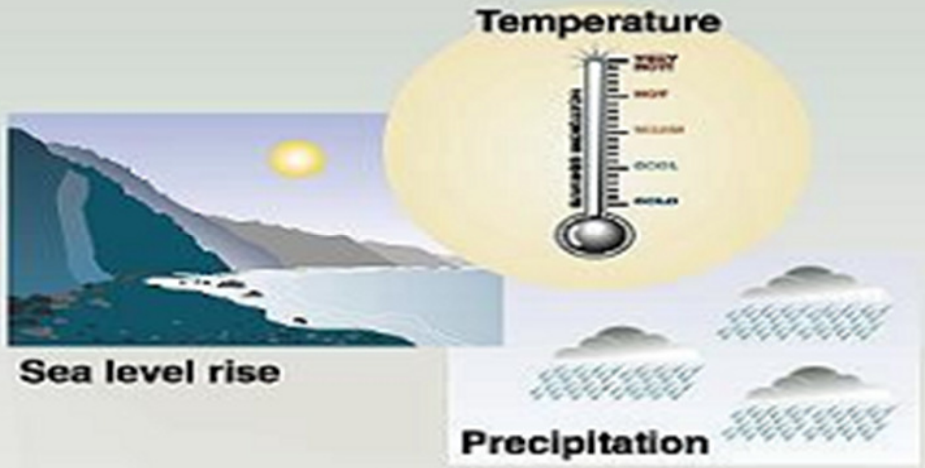
- **Introduction**
- **Materials and methods**

  Regional Climate model (RegCM4.3)

  Experimental design
- **Results**
- **Conclusions**

Potential climate changes impact

Today Climate is much more complex issue than as it was before the industrial revolution



Impacts on...

Health	Agriculture	Forest	Water resources	coastal areas	Species and natural areas
					
Weather-related mortality Infectious diseases Air-quality respiratory illnesses	Crop yields Irrigation demands	Forest composition Geographic range of forest Forest health and productivity	Water supply Water quality Competition for water	Erosion of beaches Inundation of coastal lands additional costs to protect coastal communities	Loss of habitat and species Cryosphere: diminishing glaciers

GRID Arendal UNEP

GRAPHIC DESIGN : PHILIPPE REKACEWICZ

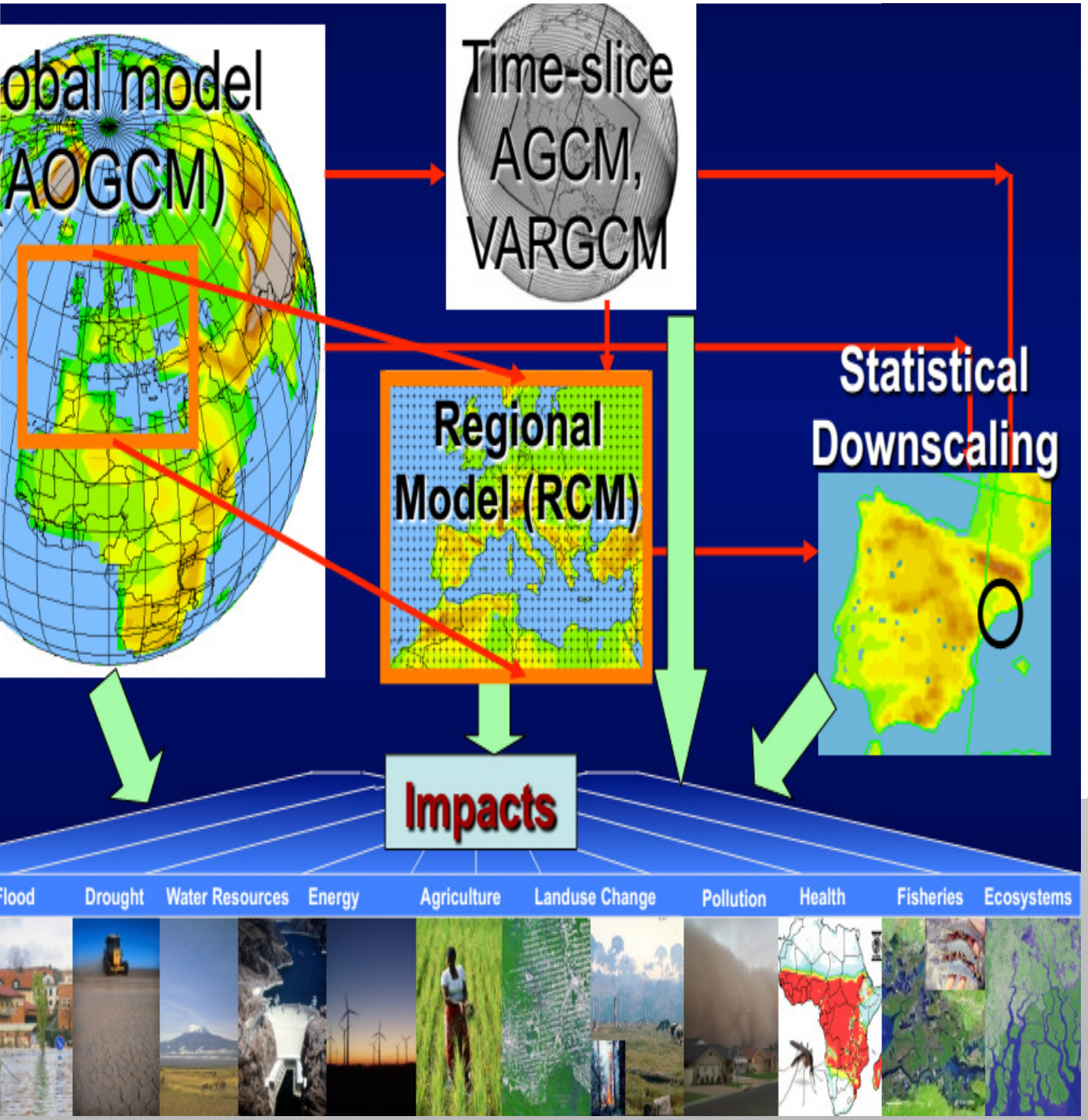
ce: United States environmental protection agency (EPA).

In order to understand the nature, extent and magnitude of these climate changes usually we used General Circulation Models(GCM)

Global Circulation Model (GCM) do not resolve the topography, land use an clouds features at regional scales because of their coarse resolution

SO WE NEED DOWNSCALING.....

Using Downscaling techniques, high resolution information can be obtained on climate change from comparatively coarse resolution Global Climate Models (GCM)



Downscaling regional clima information for impact assessi studies

Dynamical:

It is needed to bridge scaling gap betwee climate models and various impact asses models because the impact assessment performed at local level

Statistical:

This methods use empirical relationships between GCM outputs and local climate statistics

- **If statistical relationship changes in the this method will not provide the actu world**
- **Regression analysis, neural network, stochastic weather generator**

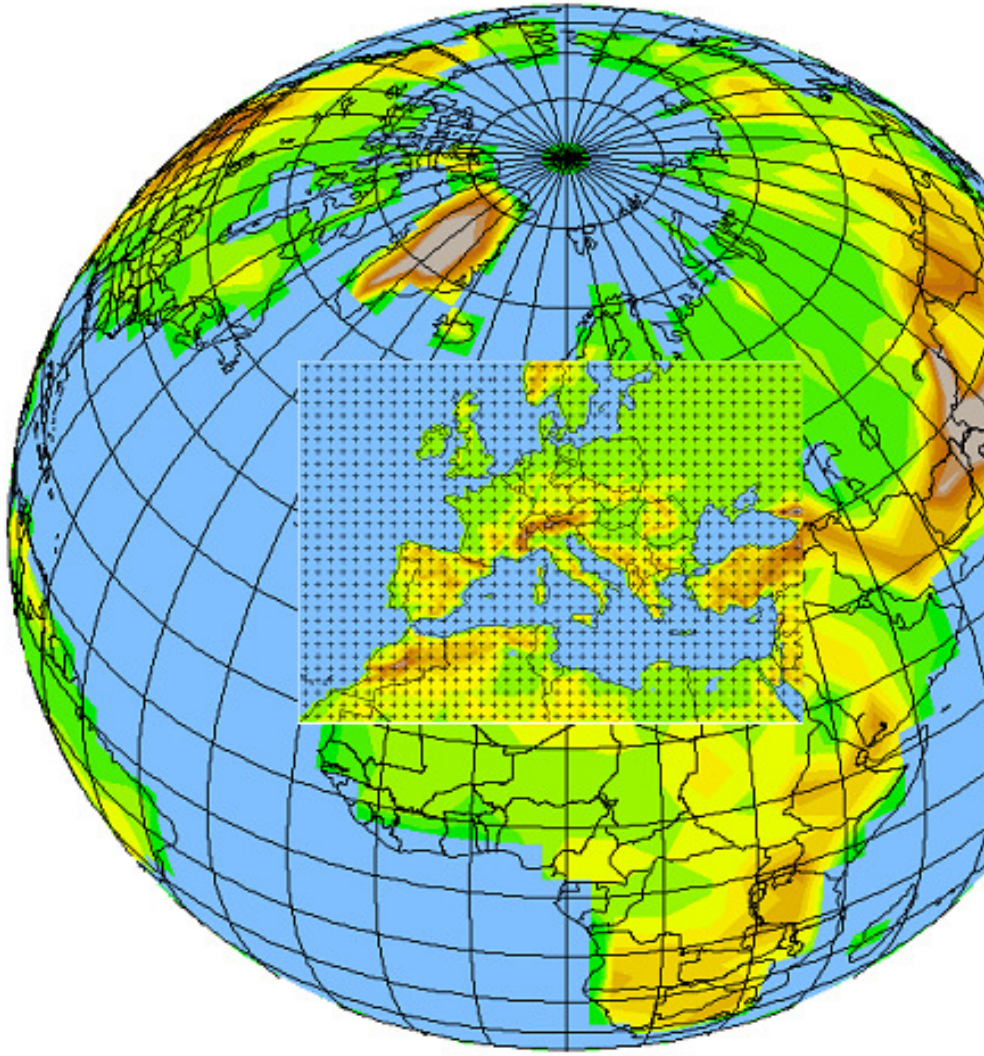
Regional Climate Models

Regional climate models (RCMs) are used to study the regional climate processes, regional climate change impacts and seasonal climate variability

RCM Technique is same like numerical weather prediction (NWP) models, except that it run for a longer time

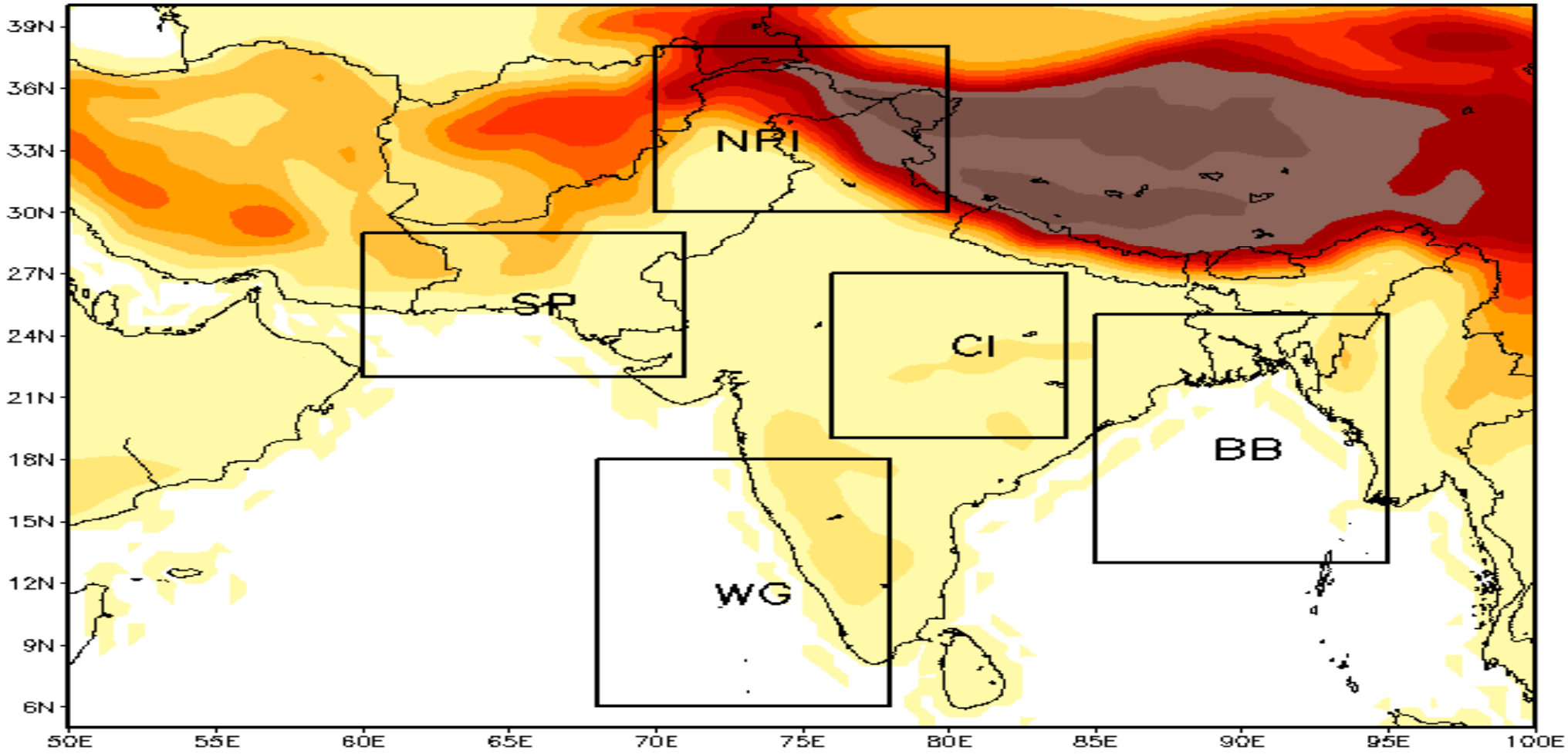
A RCM is Nested within a GCM in order to locally increase the model resolution

Nested RCMs need Initial and lateral boundary conditions (IC & LBC) from GCMs or reanalysis of observations



uth Asia has diverse climate and characterize by complex topographical features and mark
tensive mountain ranges of HKH

ecipitation and temperature regimes of the region are complex due to different weather systems t
evail during the whole year and pose a great challenge to the regional climate models in reproduc
e observed climatology



ICTP Regional Climate Model RegCM4.3

International Center for Theoretical Physics (ICTP) regional climate model (RegCM)

- RegCM1 (1989)
  - Dickinson et al. (1989), Giorgi and Bates (1989)
- RegCM2 (1993)
  - Giorgi et al. (1993a,b)
- RegCM2.5 (1999)
  - Giorgi and Mearns (1999)
- RegCM3 (2007)
  - Pal et al. (2007)
- RegCM4 (2012)
  - Giorgi et al. (2012)

ICTP Regional Climate Model RegCM4.3

he dynamical structure of RegCM includes the hydrostatic version of the mesoscale mo
ersion 5 (MM5), of the National Center for Atmospheric Research (NCAR) and Pennsylv
tate University (Giorge et al. 1993)

egCM includes the BATS (Dickinson et al. 1993) as well as the community land model (C
ersion 3.5 (Tawfik and Steiner 2011), as an option in its dynamical core for land sur
rocesses

or radiative transfer, RegCM uses the radiation package of NCAR's global community cli
odel, Version CCM3 (kiehl et al. 1996)

esolved scale precipitation scheme based on SUBEX parameterization of Pal et al. (2000)

he cloud radiation part contains 3 parameters, including cloud fractional cover, cloud li
ater content and cloud effective droplet radius

egCM uses the planetary boundary layer (PBL) scheme based on a diffusion/relaxa
oncept (Holtslag et al. 1990)

Convective precipitation (RegCM4.3)

- The Kuo scheme (Athens et al. 1987)
- The Grell scheme (with two cumulus closure) (Grell et at. 1993)
  1. Arakawa & Schubert
  2. Fritsch & Chappell
- The MIT-Emanuel scheme (Emanuel and Zivkovic Rothman 1999)
- Grell over land and Emanuel over ocean
- Emanuel over land and Grell over ocean

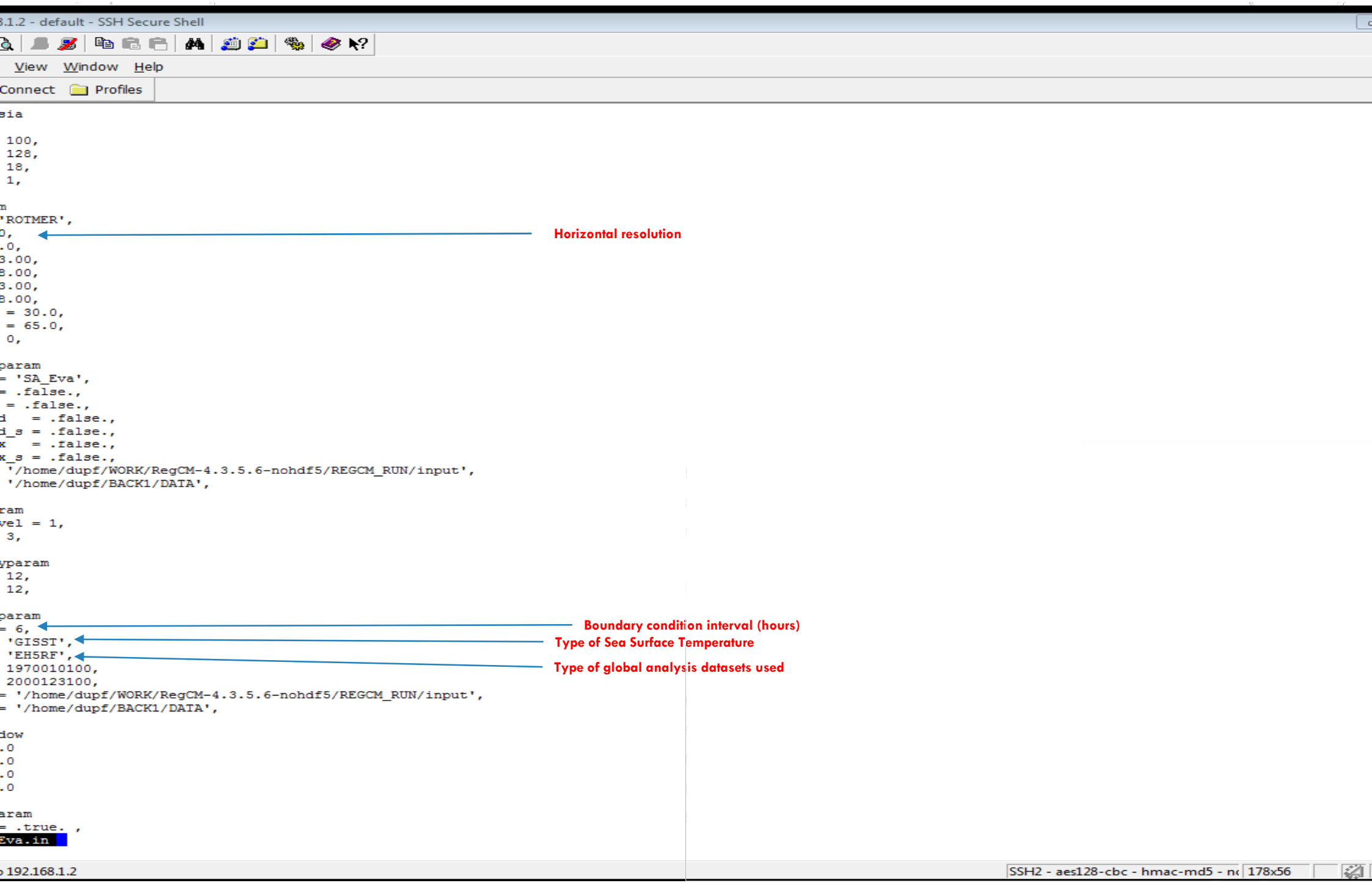
Experimental Design

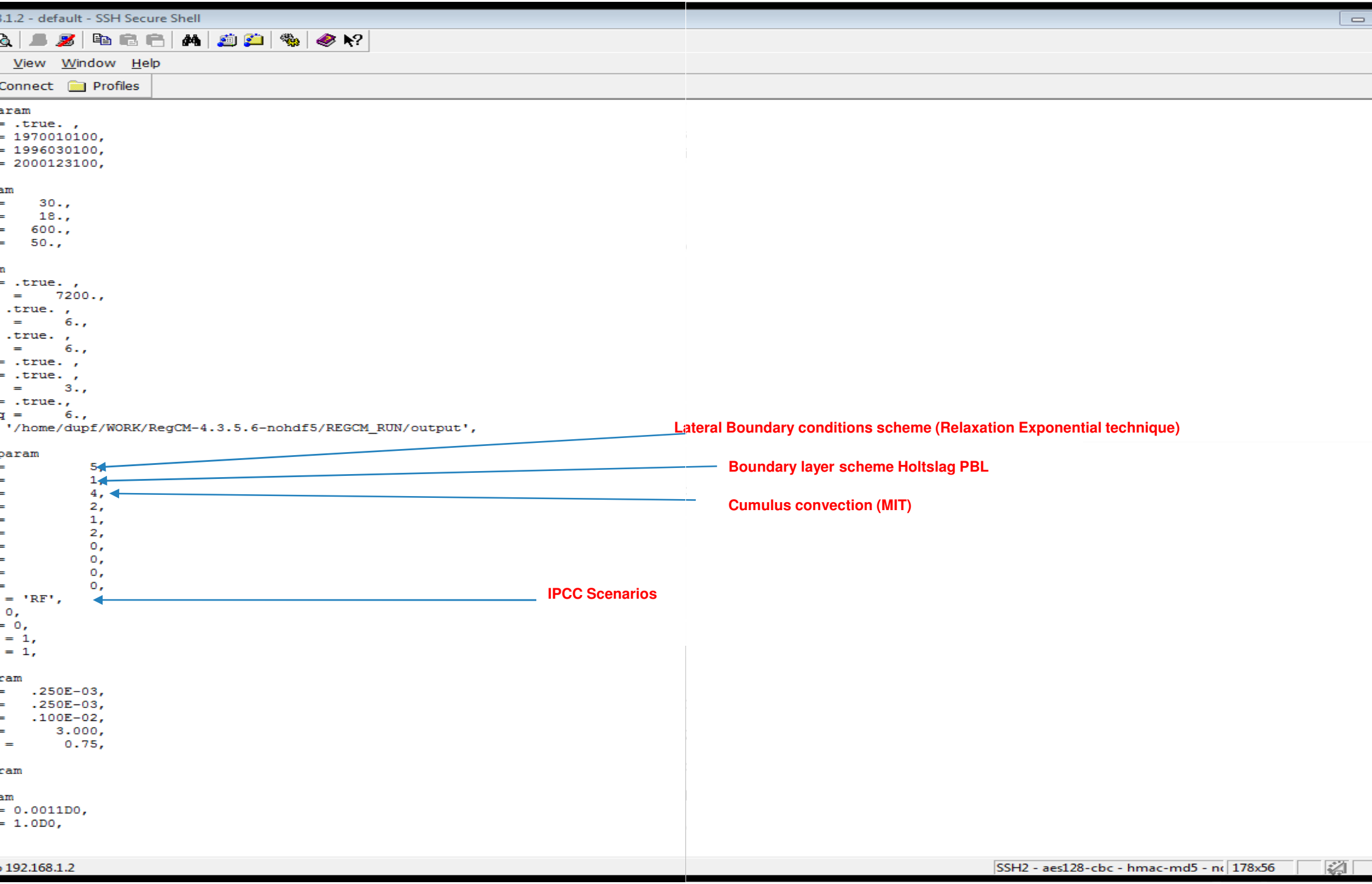
- **Two experiments are conducted for present day simulation (1971-2000)**

  Initial and lateral boundary conditions

  1. **European Center for Medium Range Weather Forecast (ECMWF) 40 years reanalysis (ERA40) data with a grid spacing of $2.5^{o} \times 2.5^{0}$ (RegCM4.3-ERA40)**
  2. **European Community Hamburg atmospheric general circulation model ECHAM5 (RegCM4.3-ECHAM5)**

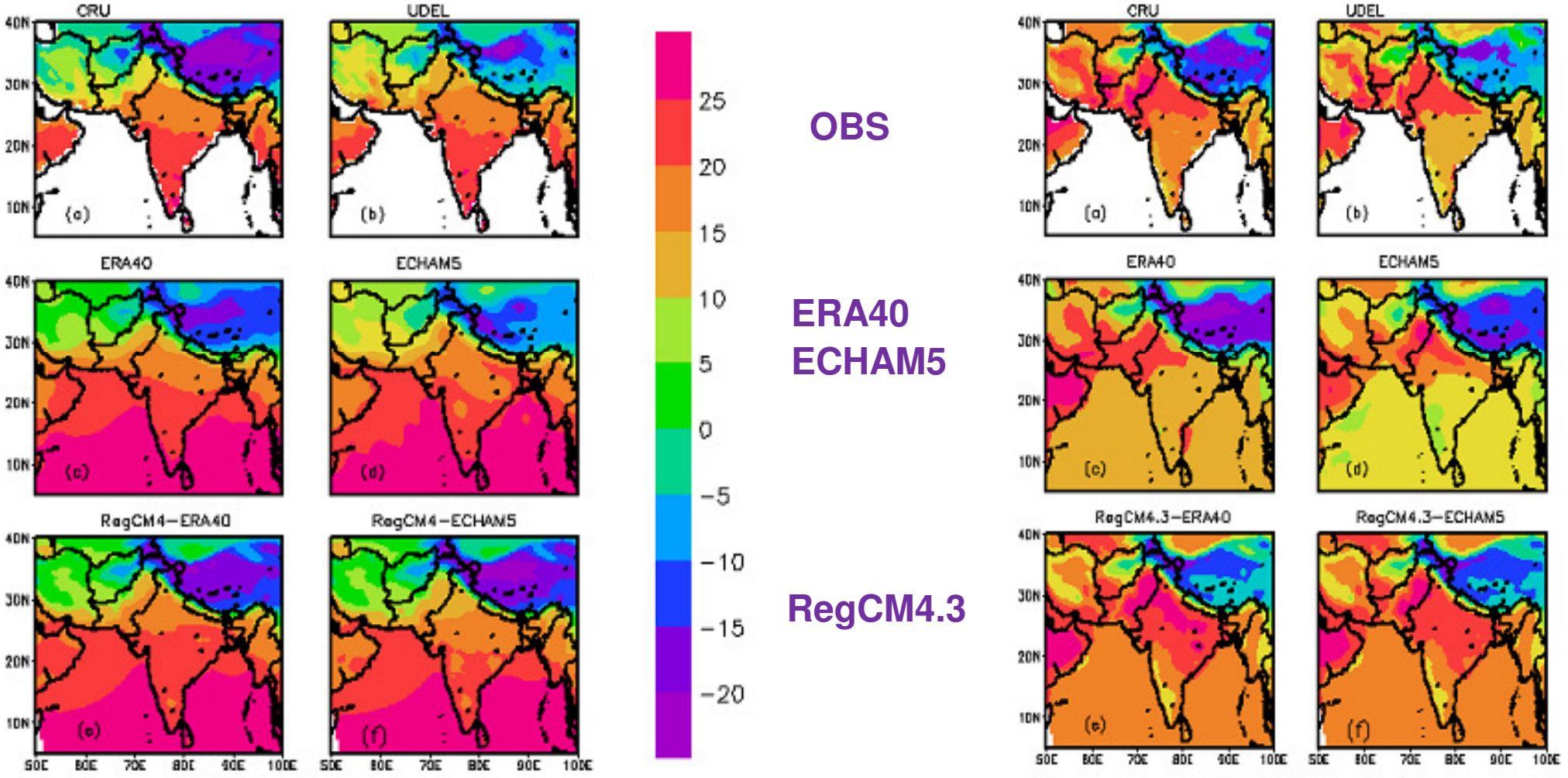
- **Sea surface temperature data is prescribed from Global Ice Coverage and Sea Surfac Temperature (GISST) with a 1x1 degree resolution.**
- **The model topography and land use data are obtained from Global Land Cov Characterization (GLCC) at 10 min resolution.**
- **The horizontal resolution of RegCM4.3 in these experiments is considered as 50km**
- **The total number of vertical levels are defined as 18 sigma level wit 5hPa at the top of th model**


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Type of global analysis datasets used
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3.1.2 - default - SSH Secure Shell
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Lateral Boundary conditions scheme (Relaxation Exponential technique)
Boundary layer scheme Holtslag PBL
Cumulus convection (MIT)
IPCC Scenarios
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Results

Seasonal mean climatology (Temperature)

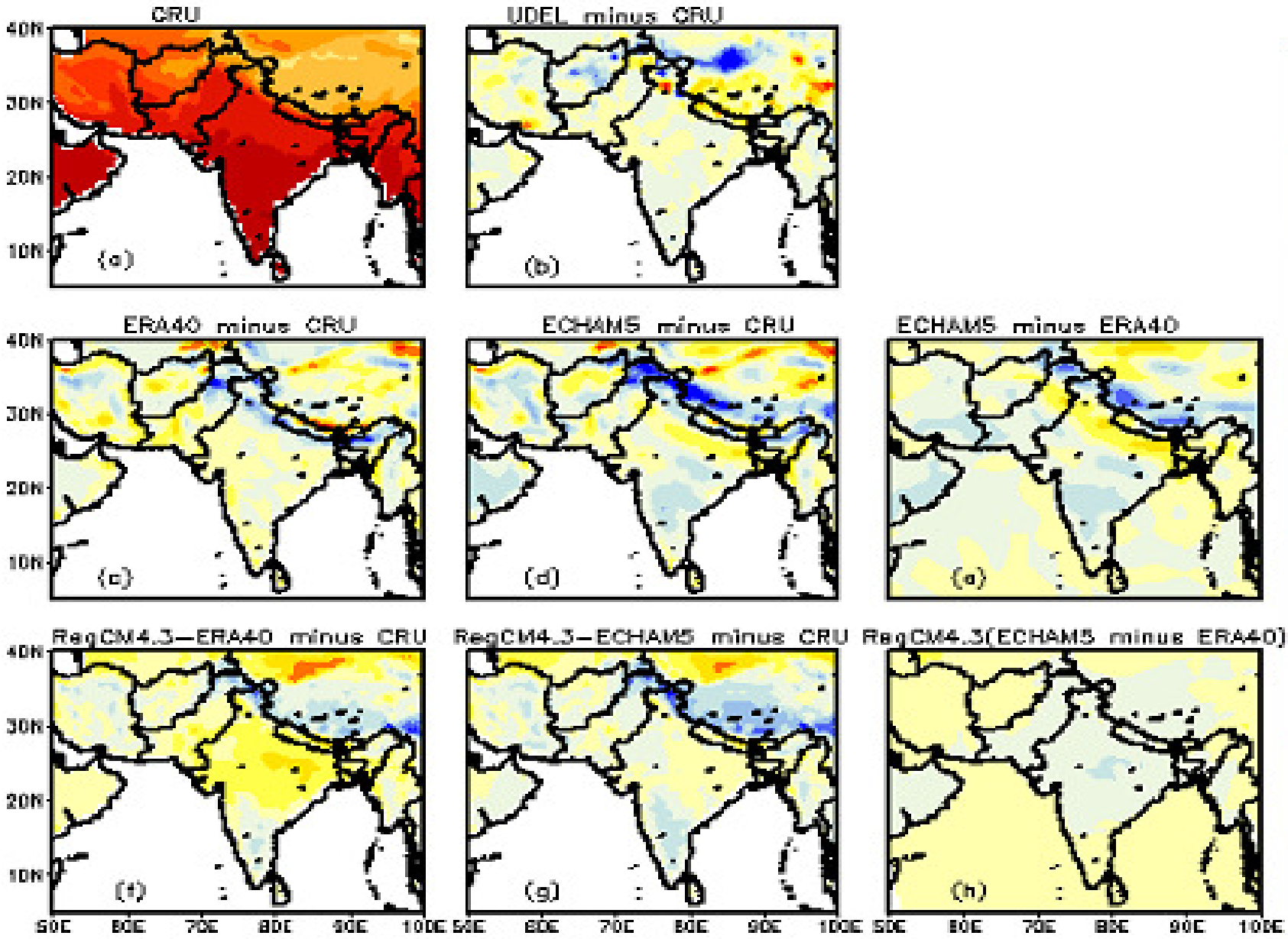


Averaged (1971-2000) two meter air temperature (° C) in DJF (left) and JJA (right)

OBS

RA40-OBS
HAM5-OBS

gCM4.3-OBS



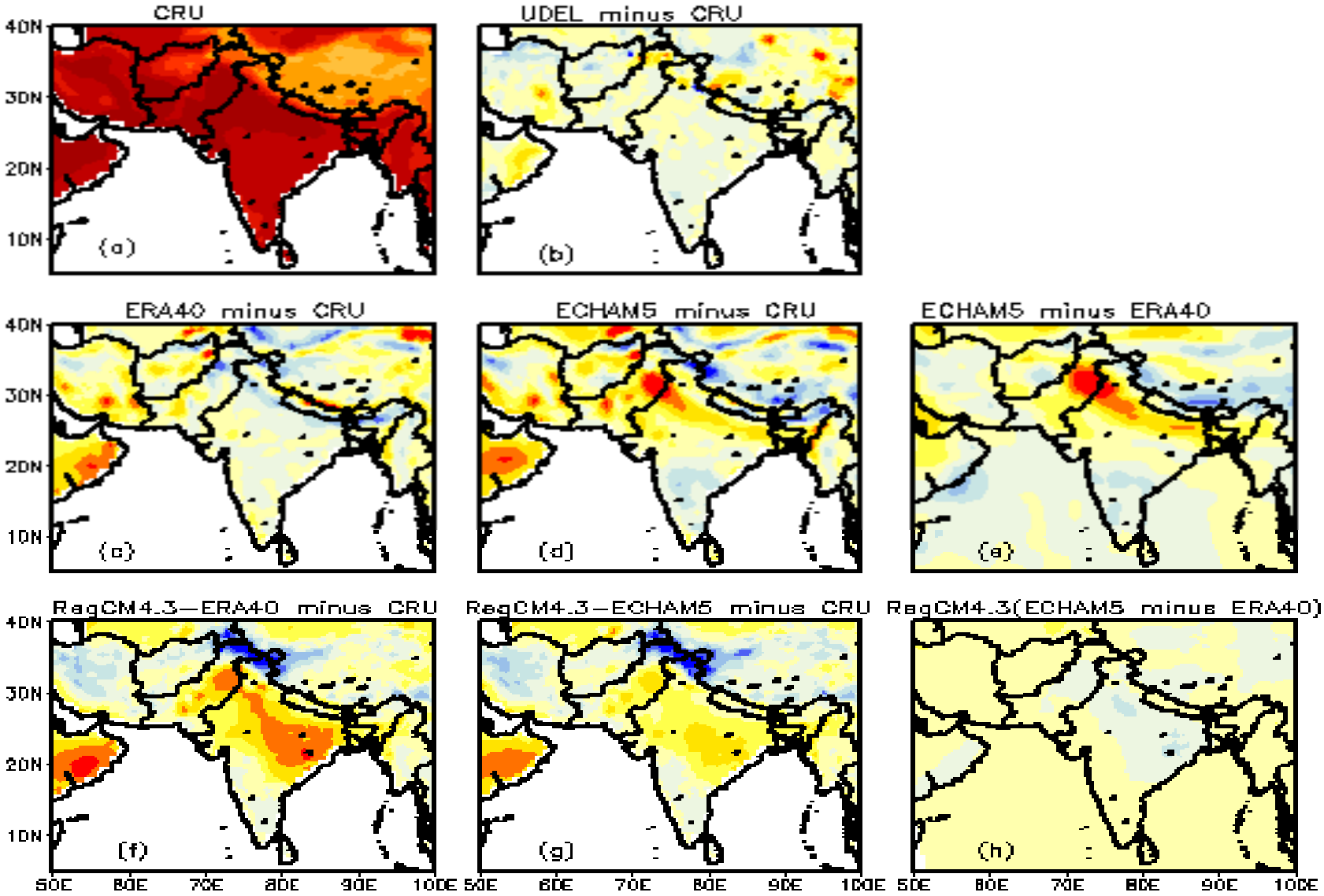
Spatial distribution of temperature bias (^{O}C) for DJF

OBS

RA40-OBS

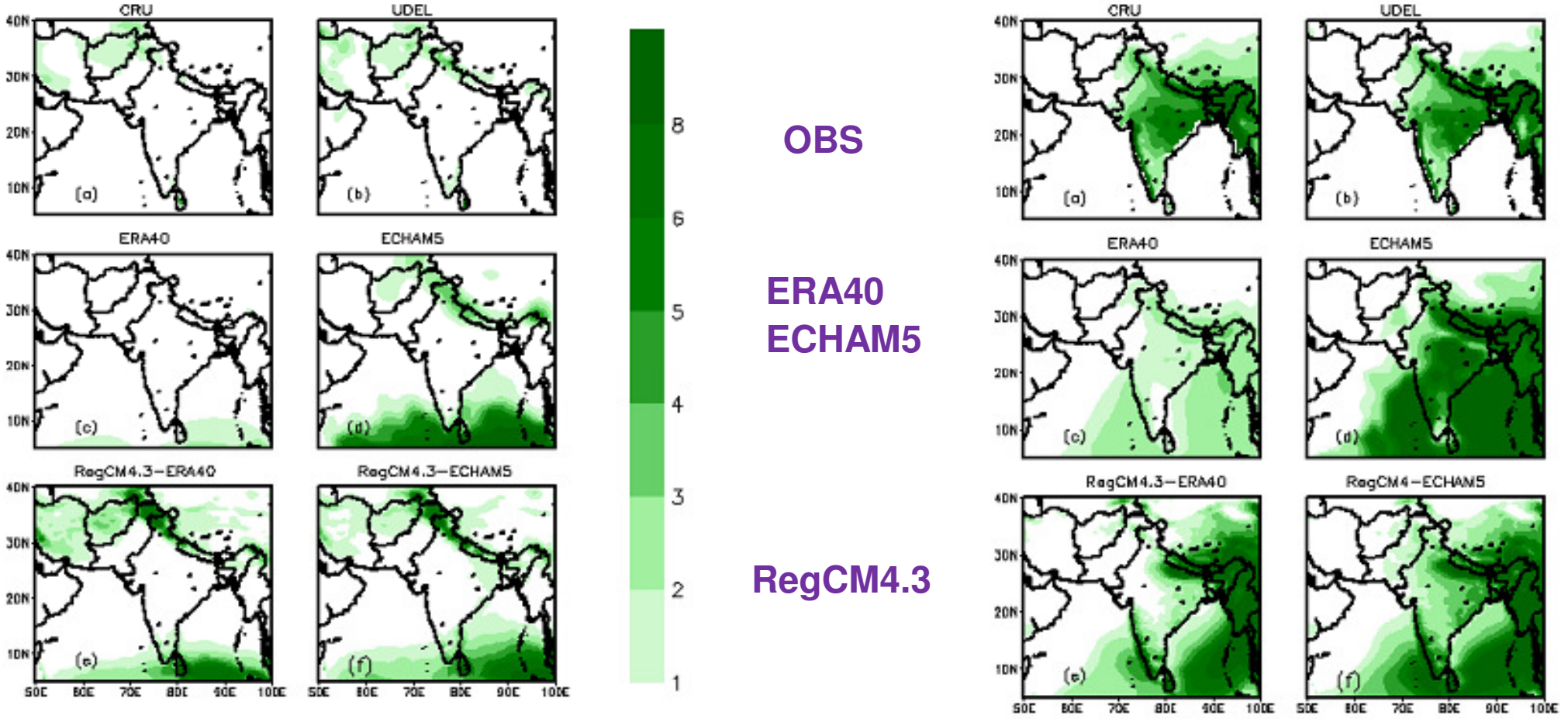
HAM5-OBS

egCM4.3-OBS



Spatial distribution of temperature bias (^{O}C) for JJA

Seasonal mean climatology (Precipitation)

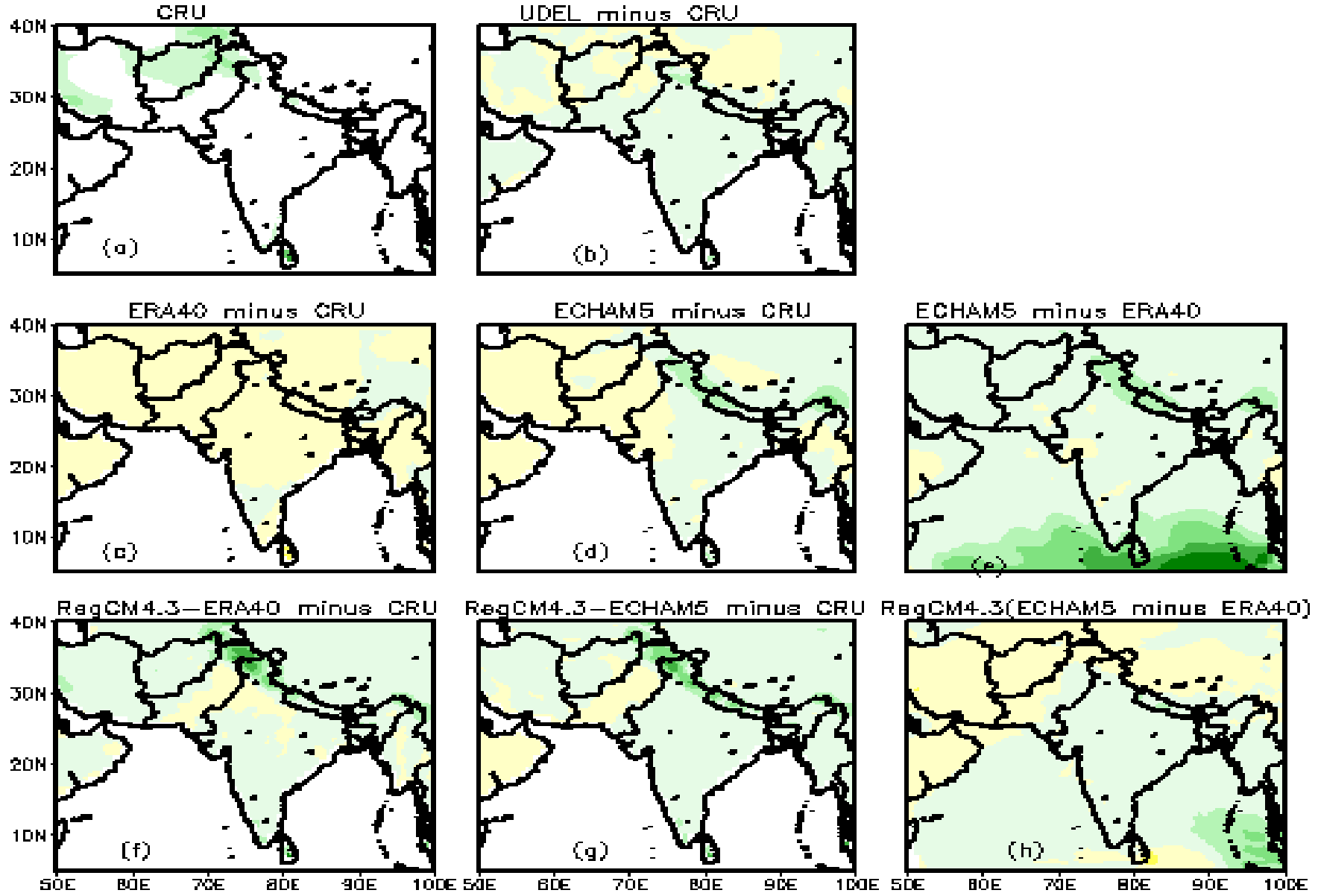


DJF (left) and JJA (right) average (1971-2000) precipitation (in mm/day)

OBS

A40-OBS
AM5-OBS

CM4.3-OBS



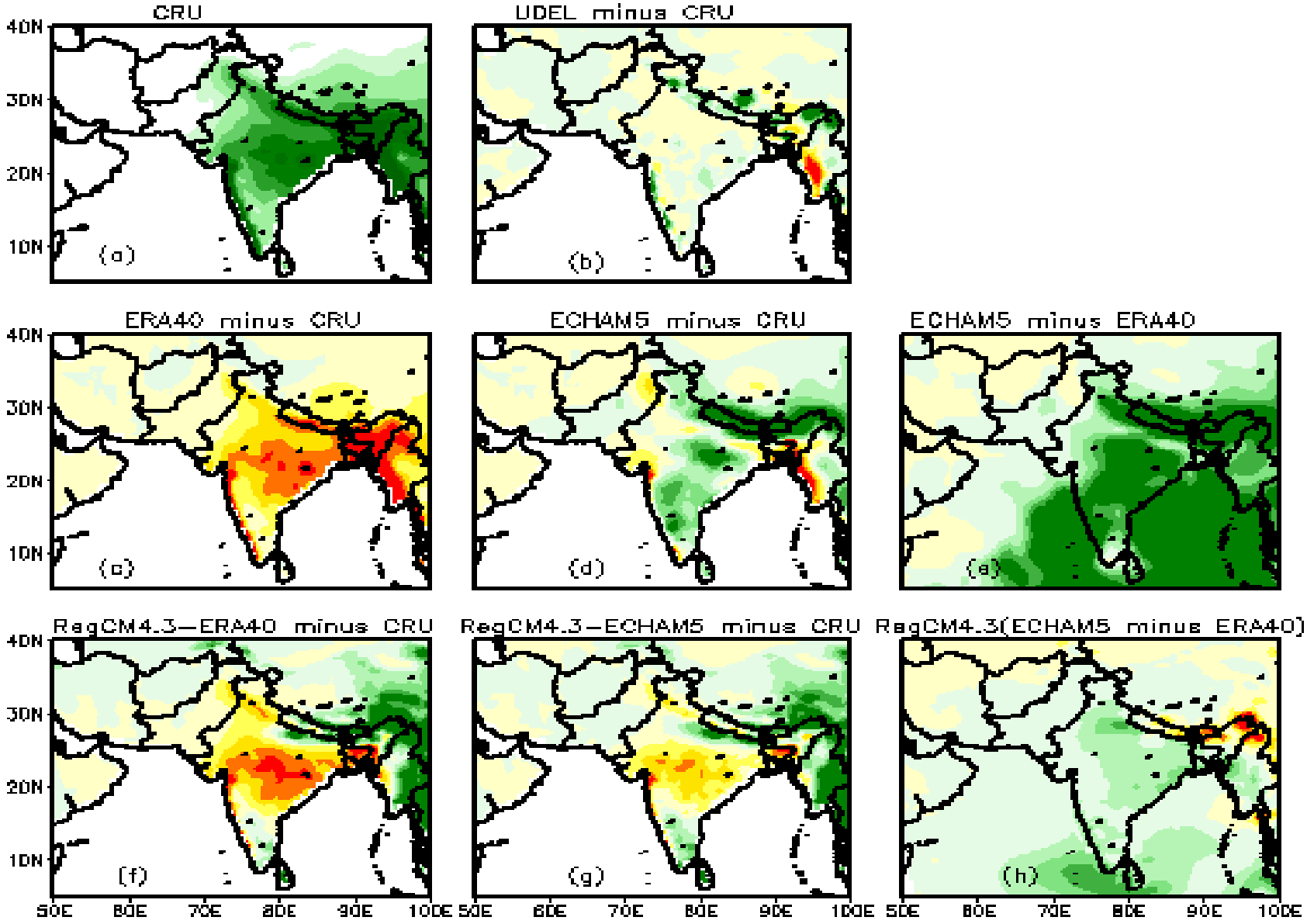
Biases in mean (1971-2000) precipitation (mm/day) for DJF

OBS

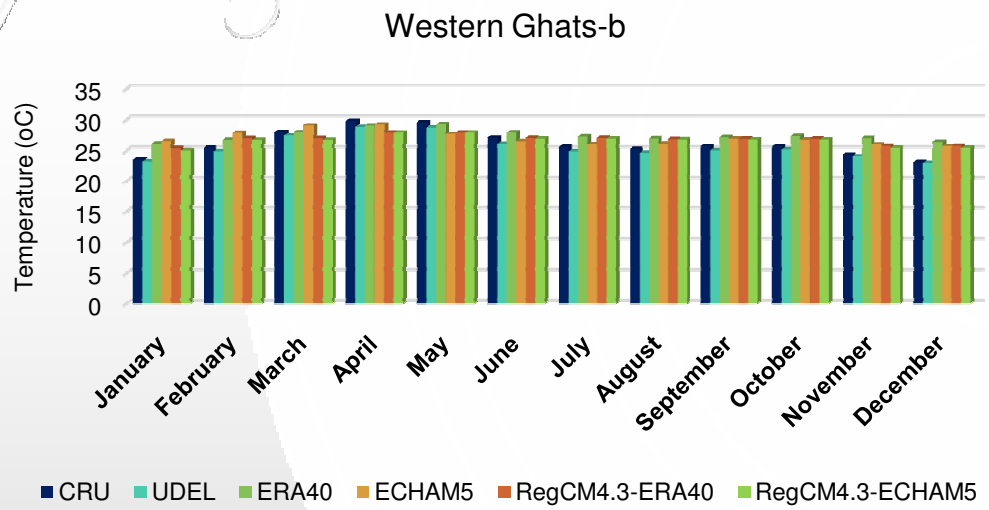
RA40-OBS

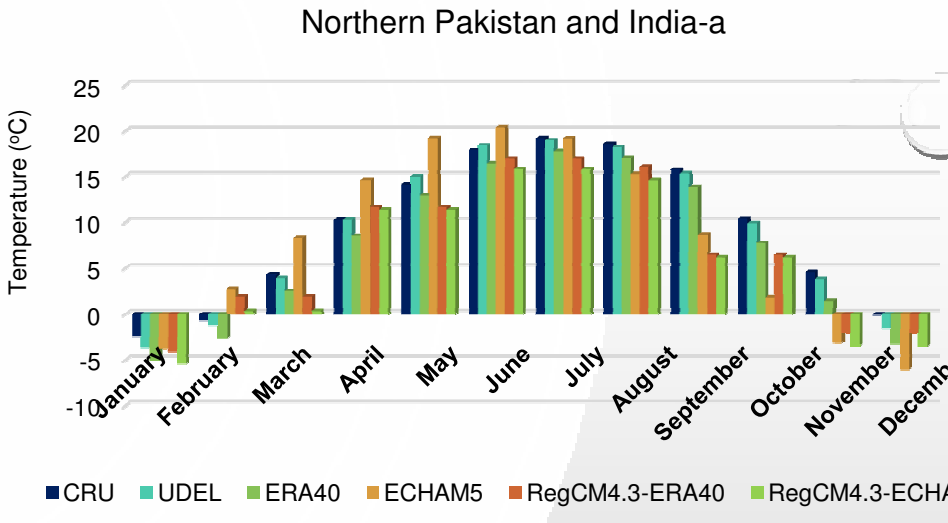
CHAM5-OBS

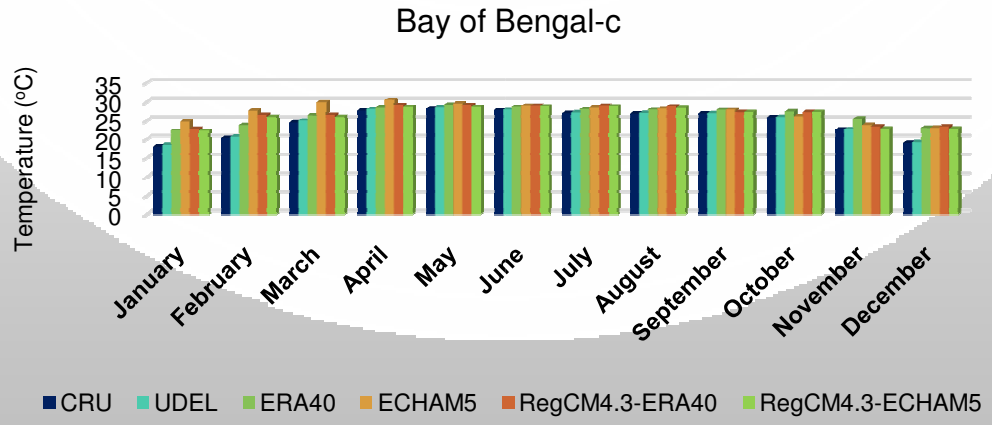
egCM4.3-OBS



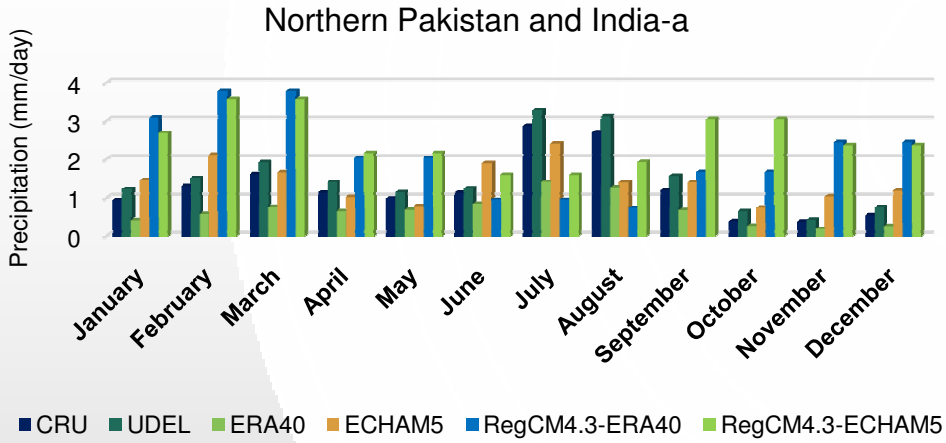
Biases in mean (1971-2000) precipitation (mm/day) for JJA

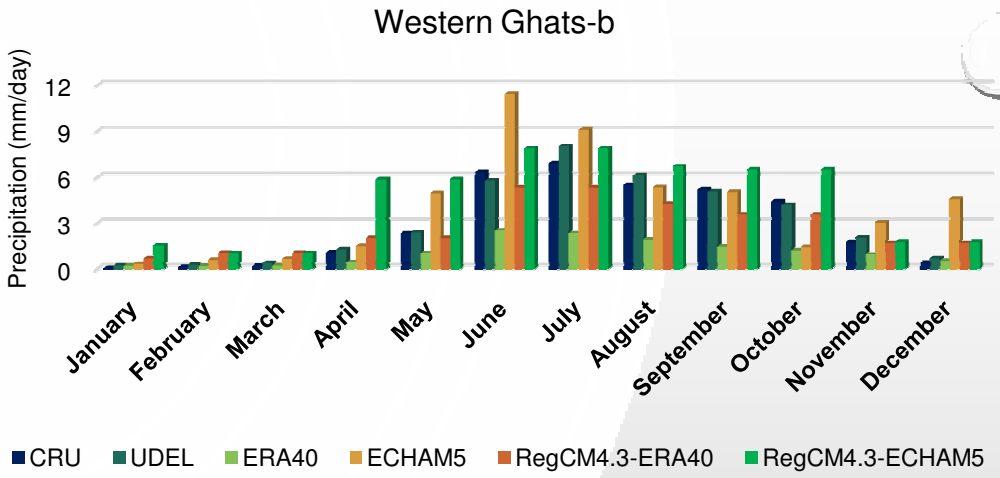


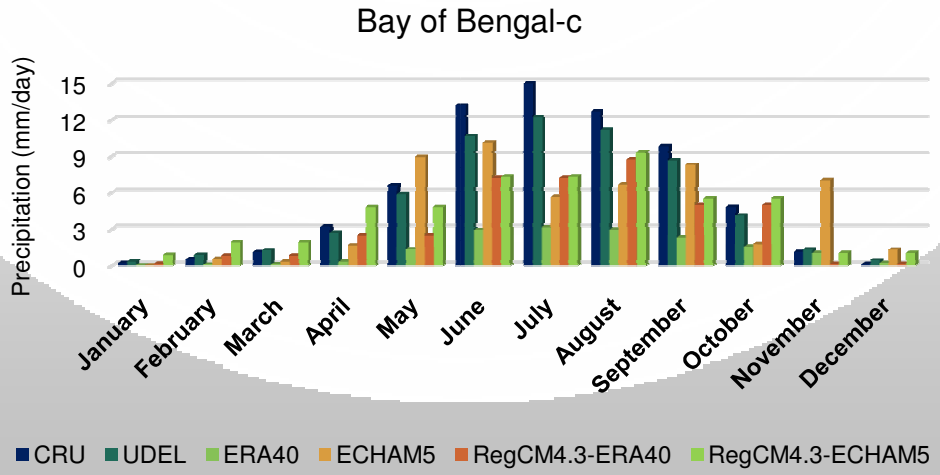




Annual cycle of monthly area averaged temperature (° C) over 3-sub regions from 1971-2000







Annual cycle of monthly area averaged precipitation (mm/day) over 3-sub from 1971-2000

Conclusion

valuation of RegCM4.3 with two experiment (1971-2000)

ain features of Precipitation and Temperature are reproduced well

igh precipitation intensity with wet bias in winter over the foothills of HKH

ain characteristics of the summer monsoon precipitation are also captured well

iases inherited from GCM/Reanalysis, complexities of the domain and internal dynamic o

egCM

nnual cycle of temperature and precipitation analyzed and compare over NPI, WG and BB

ynamic downscaling improved the output of reanalysis and global GCM in many part of S

sian domain

urther investigation is required to take account the large differences between the driving

nd RCM by using other available parameterization and land surface schemes schemes

Thank you !

Comment & Suggestions