WCRP CORDEX South Asia Training Workshop

Indian Institute of Tropical Meteorology, Pune , India
17 – 20 October, 2012

CORDEX South Asia Co-ordination: Role of CCCR-IITM and Partners

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CORDEX

Co-ordinated Regional Downscaling Experiment

Conceived and Sponsored by WCRP

Primary aims of CORDEX

•To provide a framework in which downscaling methodologies can be inter-compared through standardized experiment protocols, commonly evaluated against appropriate observations and thereby improved in performance with recommendations appearing for best practices.

•To provide a coordinated set of downscaled regional climate simulations (statistical and dynamical) for both the historical past and future periods of CMIP5 GCM simulations. Co-ordination per CORDEX domain is in terms of GCMs, RCMs, Empirical Statistical Downscaling (ESD) etc. Possible development of a regional group per CORDEX domain for evaluation, interaction with potential users and training purposes.

•To act as a WCRP capacity building activity, e.g providing a framework for scientists in a given CORDEX region (such as Africa, South Asia etc) to be part of a wider and coordinated international effort, to provide an opportunity for regional scientists to be involved in the production, analysis and delivery of regional climate information.

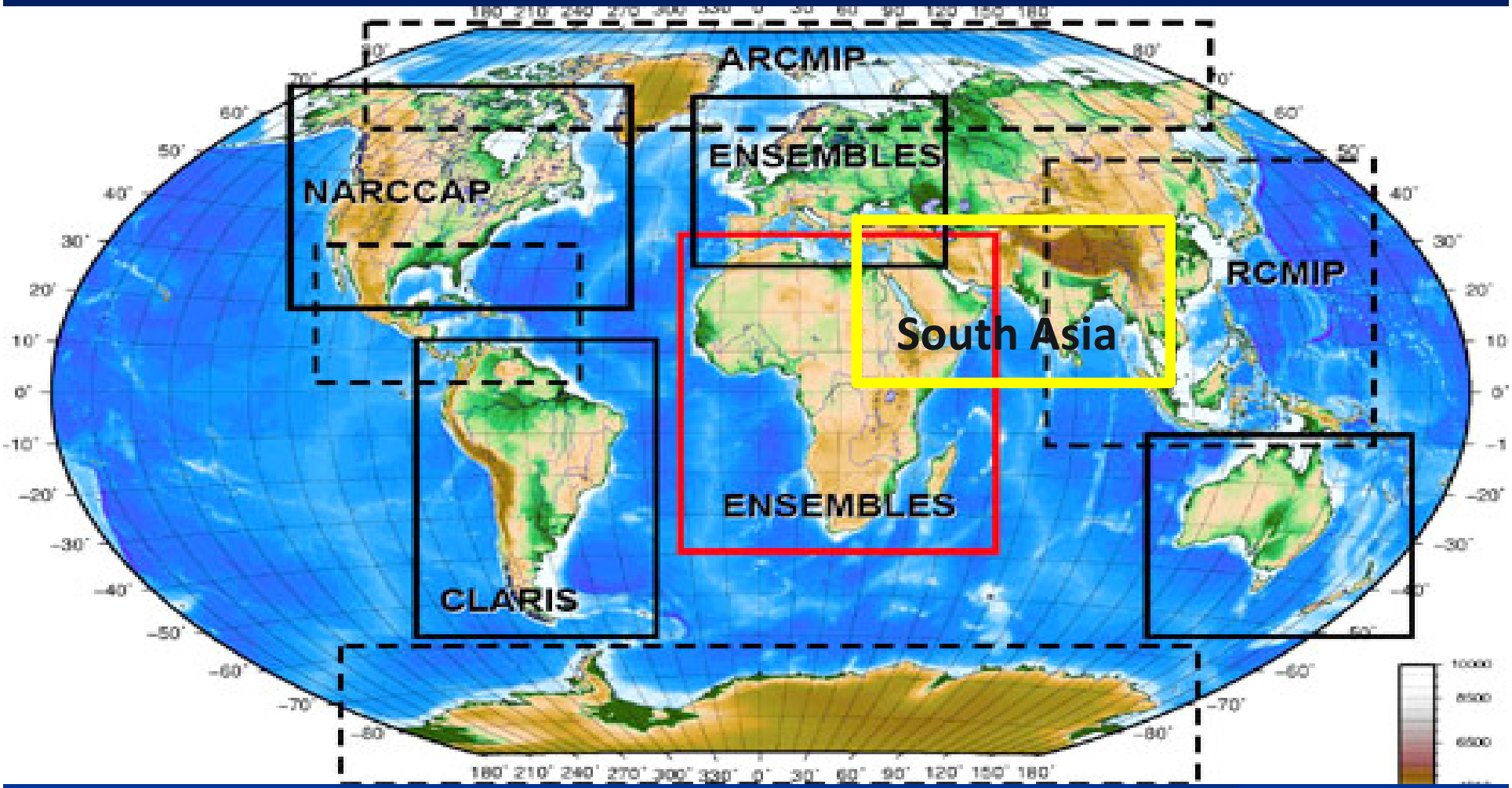
Courtesy: Colin Jones

CORDEX framework and expected deliverables

- *Better understand regional climate processes and improve climate models*
- *Produce reliable high-resolution regional climate change scenarios globally, thereby contributing to the IPCC AR5 and to the climate community beyond the AR5*
- *Evaluate regional climate model performance through a set of experiments aiming at producing regional climate projections*
- *Quantify and understand the uncertainties in regional climate projections*
- *Develop regional capacity for assessment of regional climate change with higher level of confidence of model-based projections and judgment of regional experts*
- *Link climate modeling better with regional impact, adaptation and vulnerability assessment*
- *Integrate the regional downscaling activities, facilitate cross-fertilization of scientific expertise and engage the community of regional scientists for further capacity building in the region*

WCRP CORDEX South Asia

Co-ordinated Regional Downscaling Experiment – CORDEX South Asia



WCRP NEWS

World Climate Research Programme

WMO IOC ICSU

CORDEX-South Asia Planning Meeting, 25-26 February 2012, Pune, INDIA

CORDEX South Asia Co-ordination

Role of CCCR-IITM and Partners

- *Development of multi-model ensemble projections of high-resolution regional climate change scenarios for CORDEX South Asia*
  - *Generation of regional climate projections at CCCR-IITM*
  - *Co-ordination with partner institutions for multi-model ensemble projections*
- *Development of an Earth System Grid (ESG) node at CCCR – IITM for CORDEX South Asia*
  - *Archival, Management, Retrieval and Dissemination of CORDEX South Asia data*
- *Evaluation of regional climate projections over South Asia to provide relevant and reliable regional climate change information for effective harnessing of science-based climate information by the Vulnerability, Impact and Adaptation (VIA) community*
  - *(eg. RCMES, JPL, NASA)*
  - *Pan-CORDEX Science Conference, November 2013, Brussels, Belgium*
- *Development of regional capacity for assessment of regional climate change*
  - *A series of 3 CORDEX training workshops is proposed to be held in South Asia, East Asia and South East Asia in 2013, 2014 and 2015*
  - *Foster synergies and coherence between the various climate downscaling and VIA user communities in the Asian region through direct user engagement*
  - *Workshop will be scientific in nature, will cover state-of-the-art climate downscaling research, training and capacity building*
  - *A bottom-up approach involving participants in the formulation of key science and VIA questions*

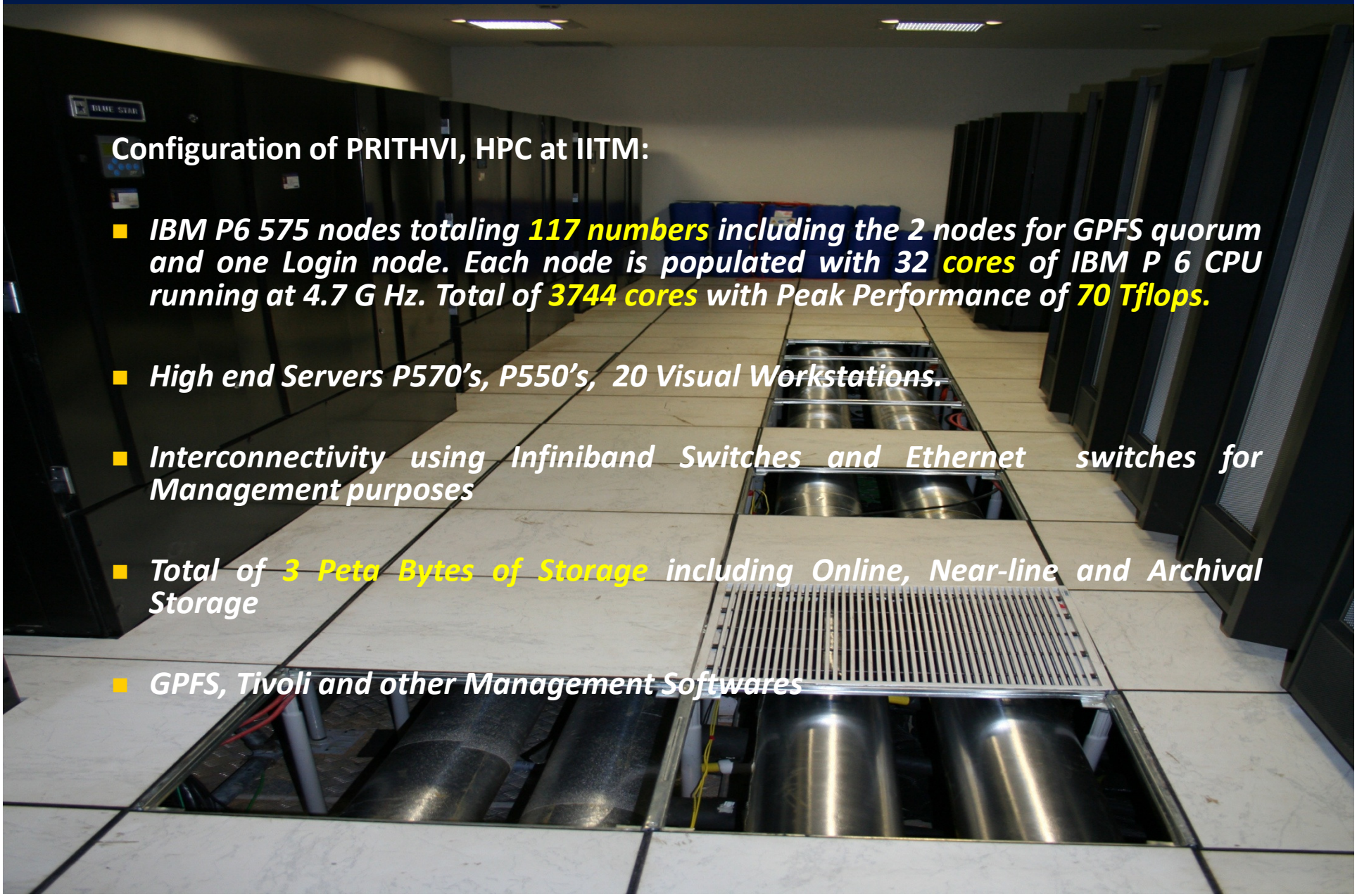
CORDEX: Model Experiments

- Evaulation / Baseline run with ERA – Interim boundary conditions (1989 – 2008)
- Historical run (1950 – 2005)
- Future projection : 2005 - 2100 (eg., RCP 4.5, 6.0, 8.5 Scenario)

Participating Modeling Groups

- LMDZ model (~ 35 km) CCCR (IITM), IPSL
- RegCM model (~ 50 km) CCCR (IITM)
- HadRM3P model (~ 50 km) CCCR (IITM), Hadley Centre
- WRF model (~ 50 km) - CCCR (IITM), BCCR and TERI
- MRI model (~ 20 km) global model (MRI, Japan)
- RCA model (~ 50 km) Rossby Centre, Sweden
- REMO model (~ 50 km) Max Planck Inst, Hamburg
- CCAM model (~ 50 km) CSIRO, Australia

PRITHVI (High Performance Computing System) , IITM, Pune



Configuration of PRITHVI, HPC at IITM:

- ***IBM P6 575 nodes totaling 117 numbers including the 2 nodes for GPFS quorum and one Login node. Each node is populated with 32 cores of IBM P 6 CPU running at 4.7 G Hz. Total of 3744 cores with Peak Performance of 70 Tflops.***
- ***High end Servers P570's, P550's, 20 Visual Workstations.***
- ***Interconnectivity using Infiniband Switches and Ethernet switches for Management purposes***
- ***Total of 3 Peta Bytes of Storage including Online, Near-line and Archival Storage***
- ***GPFS, Tivoli and other Management Softwares***

CORDEX South Asia Evaluation Experiments

Evaluation runs driven by ERA-Interim boundary conditions (1989 – 2008)

Institute	Model	Resolution	Status
IITM	WRF3.1.1 (Kain Fritsch Cumulus Scheme)	50 km; Mercator	Finished
IITM	WRF3.1.1 (Betts Miller Janjic Scheme)	50 km; Mercator	Finished
IITM	RegCM3.0 (Grell Cumulus Scheme)	50 km; Mercator	Finished
IITM	RegCM3.0 (Emanuel Cumulus Scheme)	50 km; Mercator	Finished
IITM	RegCM4.1.1 (Mixed Cumulus Scheme: Grell - Land & Emanuel-Ocean)	50 km; Mercator	Finished
IITM	LMDZ Variable Resolution GCM (Emanuel Cumulus Scheme)	35 km zoom over South Asia (Nudged with ERA-Interim at lateral boundaries)	Finished
IITM	LMDZ Variable Resolution GCM (Tiedtke Cumulus Scheme)	35 km zoom over South Asia (Nudged with ERA-Interim at lateral boundaries)	Finished
SMHI, Sweden	RCA4	0.44 degree	Finished
Uni Frankfurt	CCLM	0.44 degree	Finished
MPI Hamburg	REMO	0.44 degree	Finished
IITM / UKMO	HadRM3P	0.44 degree	Ongoing
BCCR, Norway & TERI, India	WRF Tropical Channel Model	50 km	

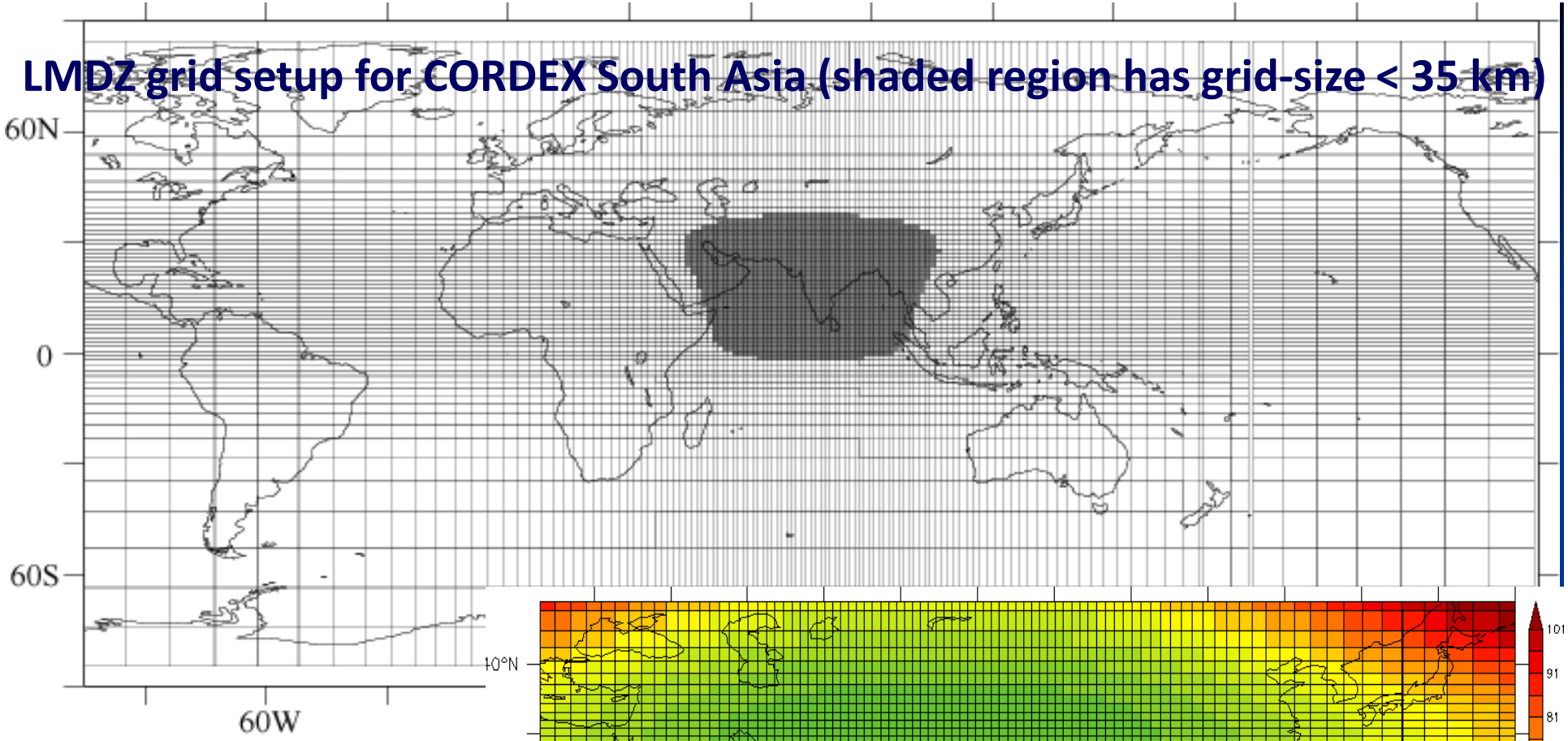
CORDEX South Asia Experiments: Historical runs

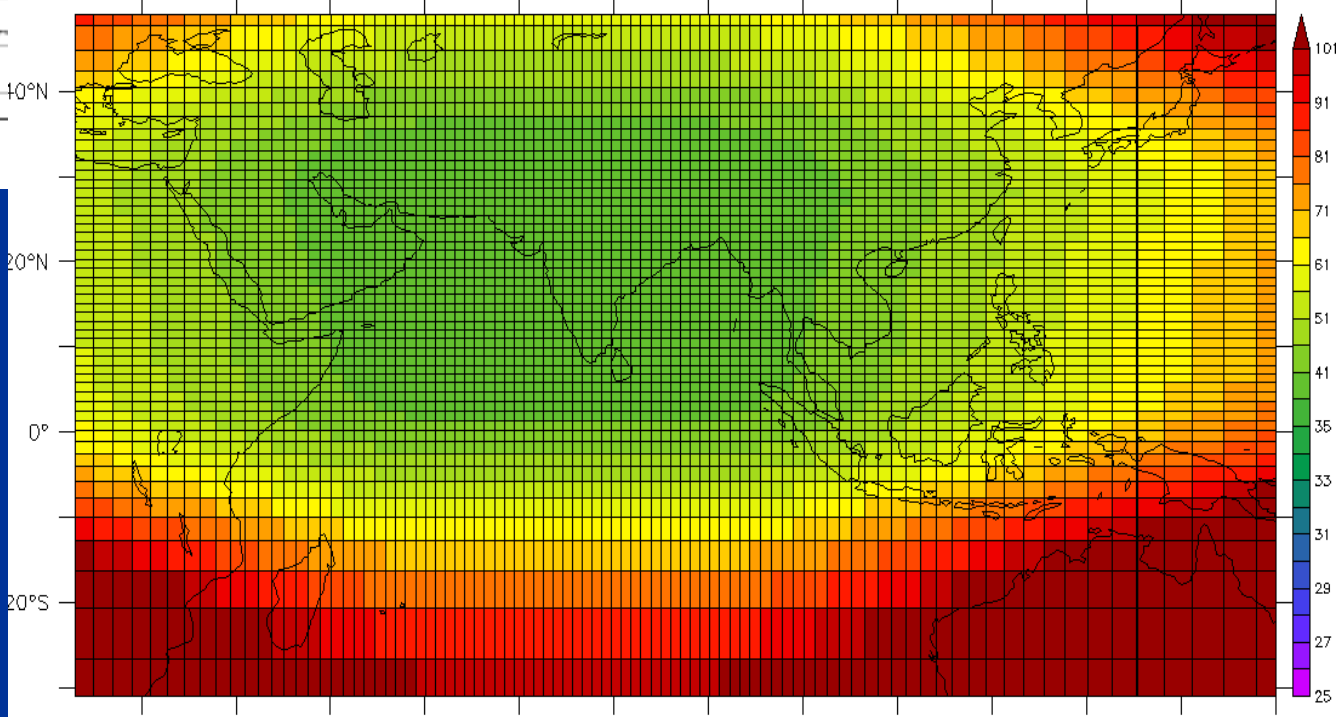
Inst	Model	Resolution	Period	Driving Experiment	Driving LBC	Status
IITM	LMDZ Variable Resolution GCM (Emanuel Cumulus)	35 km zoom over S.Asia	1886 –2005	CMIP5 Historical	---	Finished
IITM	LMDZ Variable Resolution GCM (Tiedtke Cumulus)	35 km zoom over S.Asia	1960 – 2005	CMIP5 Historical	---	Ongoing
IITM	LMDZ Variable Resolution GCM (Emanuel Cumulus)	35 km zoom over S.Asia	1886 – 2005	CMIP5 Historical Natural	---	Finished
IITM	LMDZ Variable Resolution GCM (Tiedtke Cumulus)	35 km zoom over S.Asia	1960 – 2005	CMIP5 Historical Natural	---	Ongoing
IITM	RegCM4	50 km; Mercator	1950 – 2005	CMIP5 Historical	LMDZ	Finished
IITM	RegCM4	50 km; Mercator	1950 – 2005	CMIP5 Historical	GFDL-ESM2M	Finished
Uni Frankfurt	CCLM	0.44 degree	1960 – 2005	CMIP5 Historical	ECHAM6	Finished
MPI Hamburg	REMO	0.44 degree	1950 – 2005	CMIP5 Historical	ECHAM6	Finished
SMHI Sweden	RCA4	0.44 degree	1950 – 2005	CMIP5 Historical		
BCCR, Norway	WRF Tropical Channel Model	50 km	1950 – 2005	CMIP5 Historical		

CORDEX South Asia Experiments: RCP4.5 scenario

Inst	Model	Resolution	Period	Driving Experiment	Driving LBC	Status
IITM	LMDZ Variable Resolution GCM (Emanuel Cumulus)	35 km zoom over S.Asia	2006 – 2100	CMIP5 RCP4.5	---	Finished
IITM	LMDZ Variable Resolution GCM (Tiedtke Cumulus)	35 km zoom over S.Asia	2006 – 2100	CMIP5 RCP4.5	---	Ongoing
IITM	RegCM4	50 km; Mercator	2006 – 2100	CMIP5 RCP4.5	LMDZ	Ongoing
IITM	RegCM4	50 km; Mercator	2006 – 2100	CMIP5 RCP4.5	GFDL ESM2M	Planned
Uni Frankfurt	CCLM	0.44 degree	2006 – 2100	CMIP5 RCP4.5	ECHAM6	Finished
MPI Hamburg	REMO	0.44 degree	2006 – 2100	CMIP5 RCP4.5	ECHAM6	Finished
Rossby Cent Sweden	RCA4	0.44 degree	2006 – 2100	CMIP5 RCP4.5		
BCCR, Norway	WRF Tropical Channel Model	50 km	2006 – 2100	CMIP5 RCP4.5		

LMDZ grid setup for CORDEX South Asia (shaded region has grid-size < 35 km)

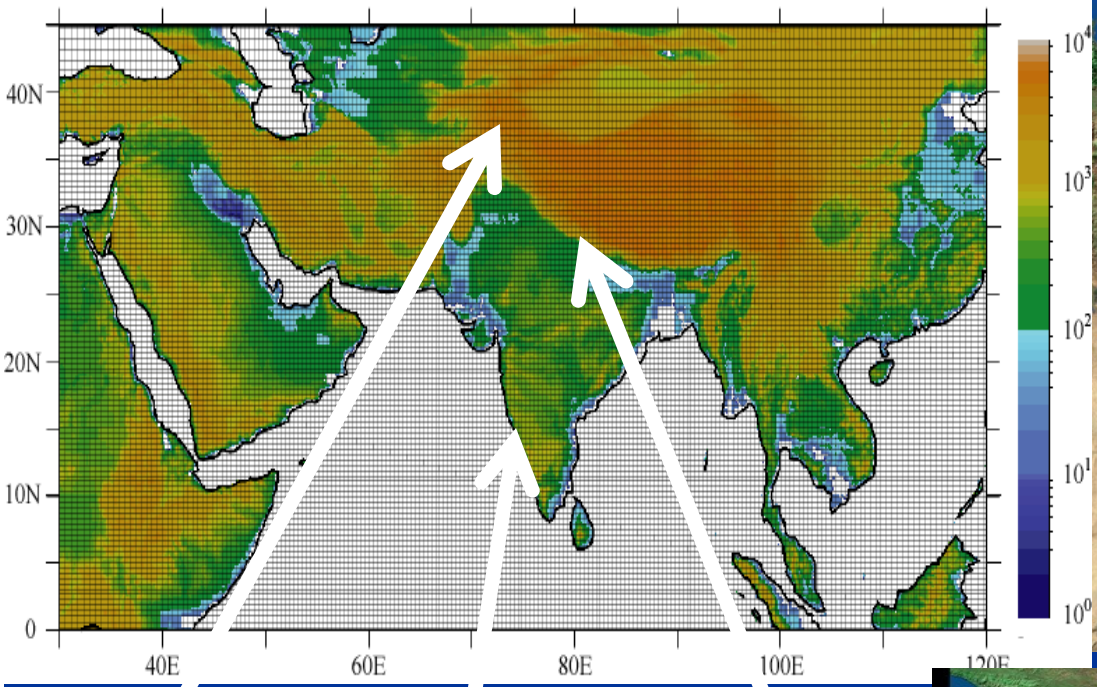




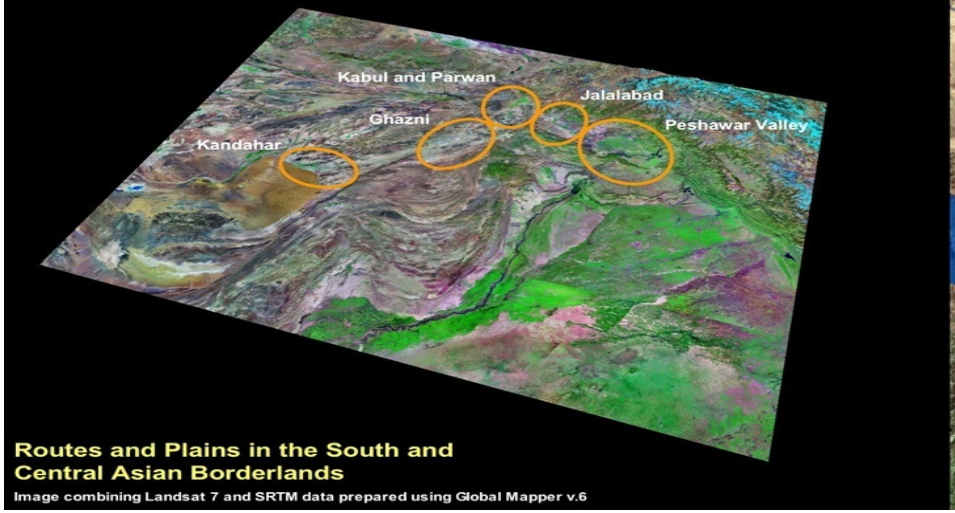
LMDZ global atmospheric model: Variable resolution with zooming capability

Source: Sabin, CCCR, IITM

Topography (m) and model grids over the Asian region



Hindu Kush **Western Ghats** **Himalayas**

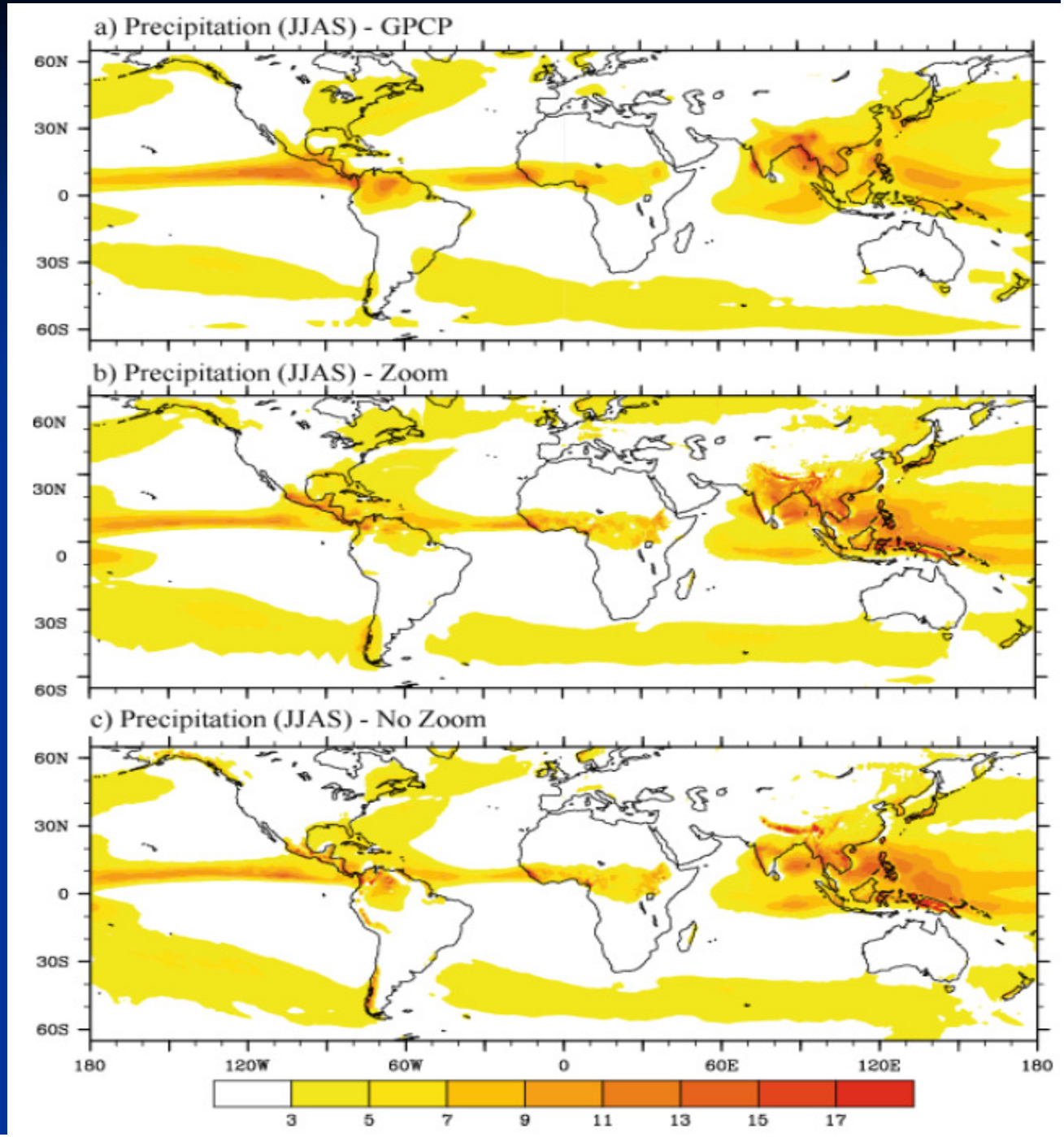


Observed and simulated mean precipitation (mm / day): JJAS

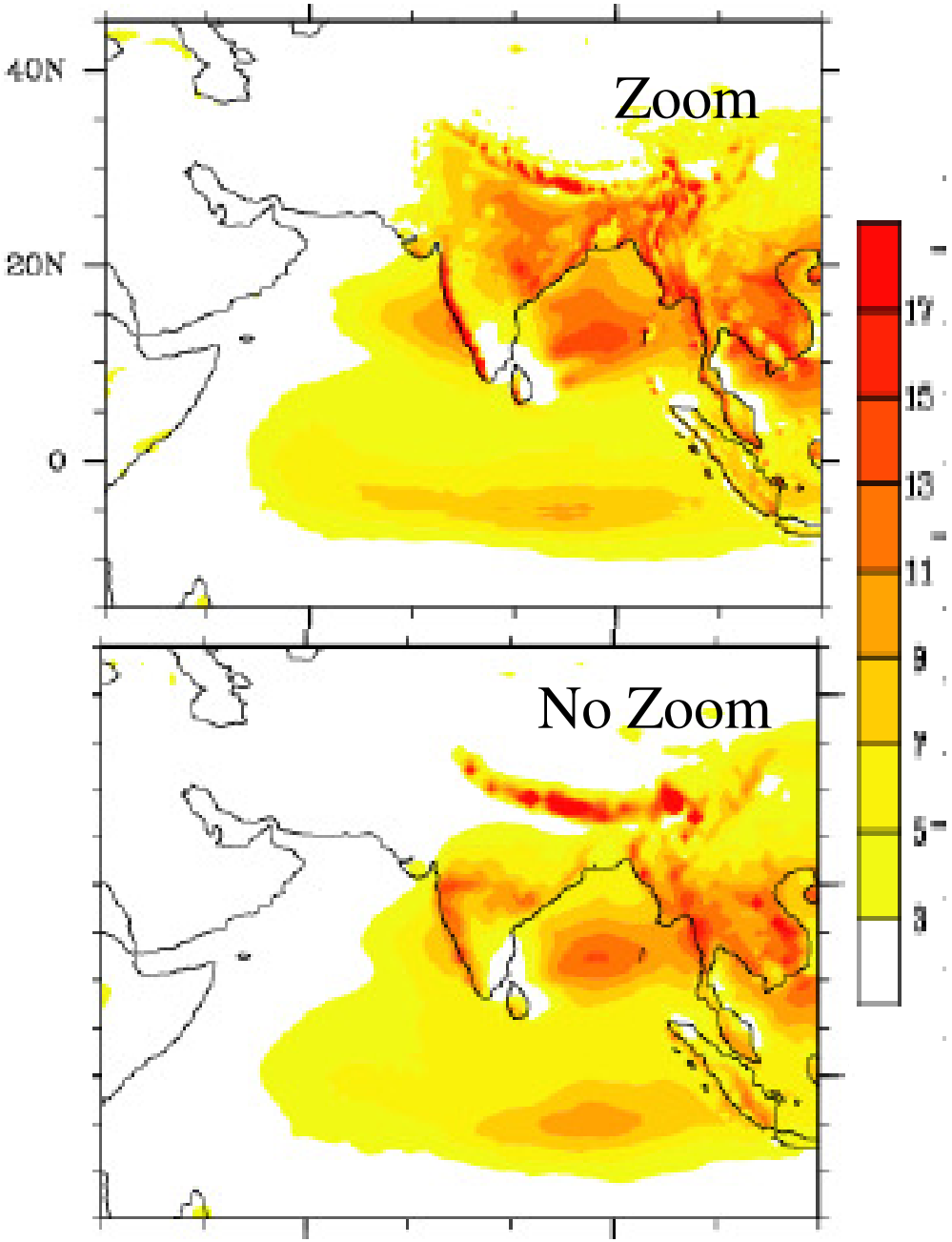
GPCP

Zoom

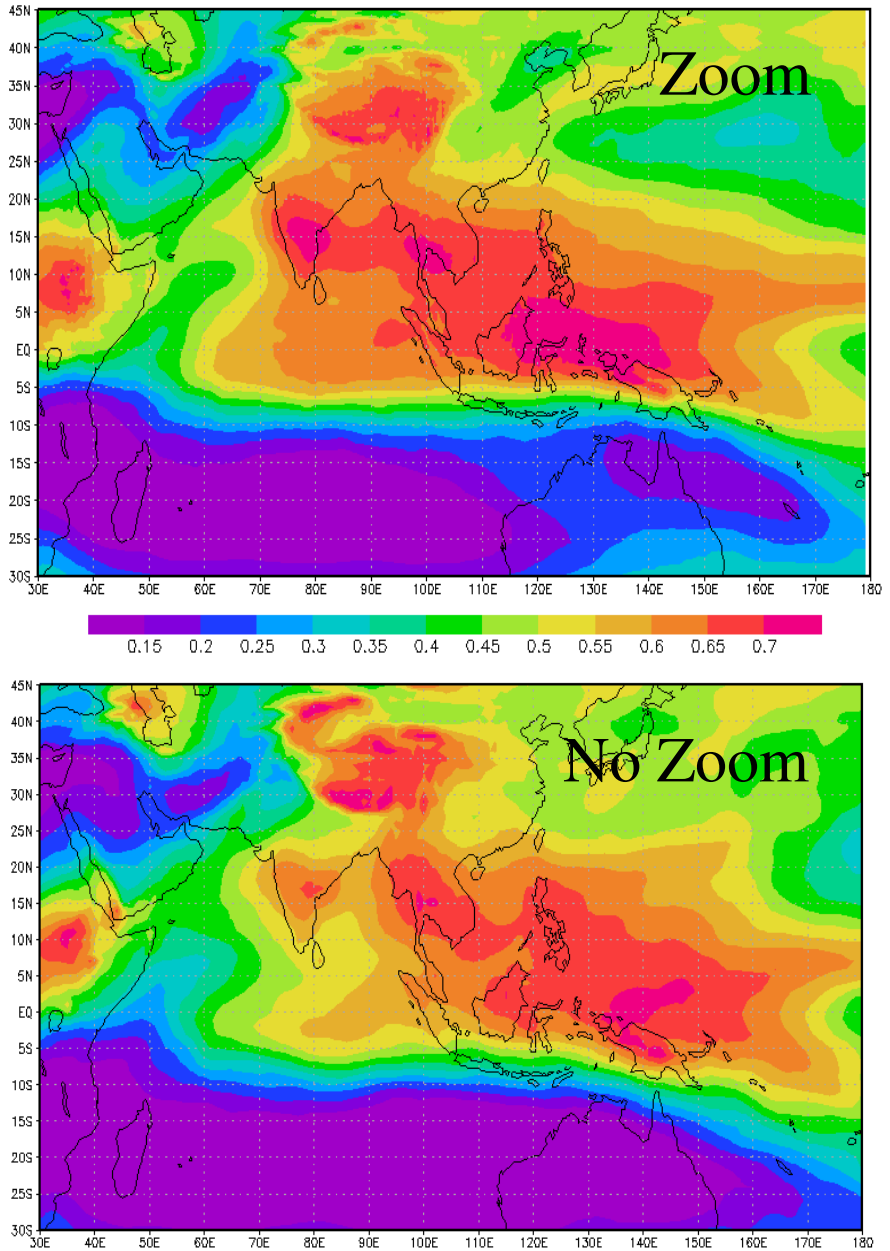
No Zoom



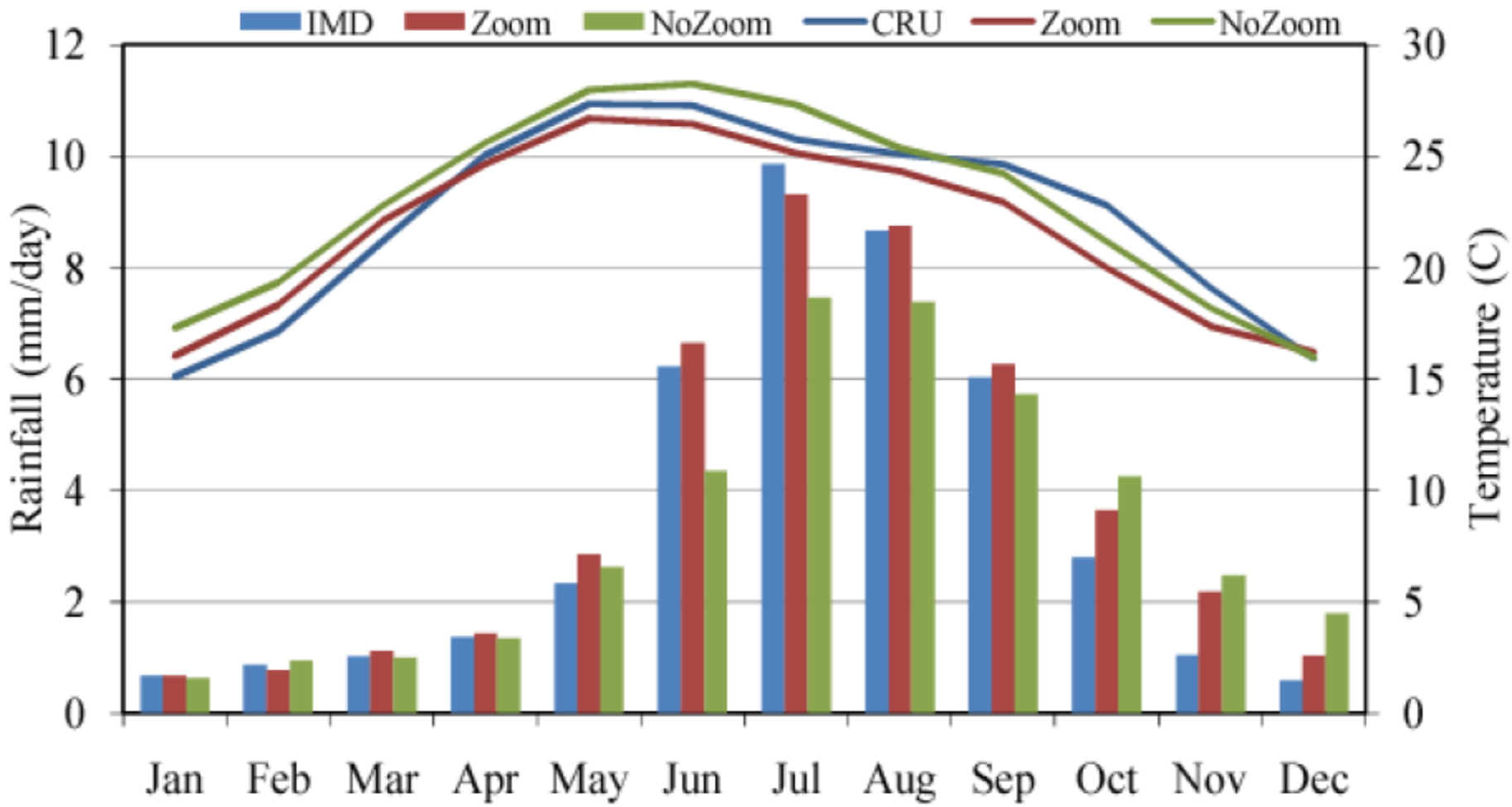
Monsoon rainfall (JJAS)

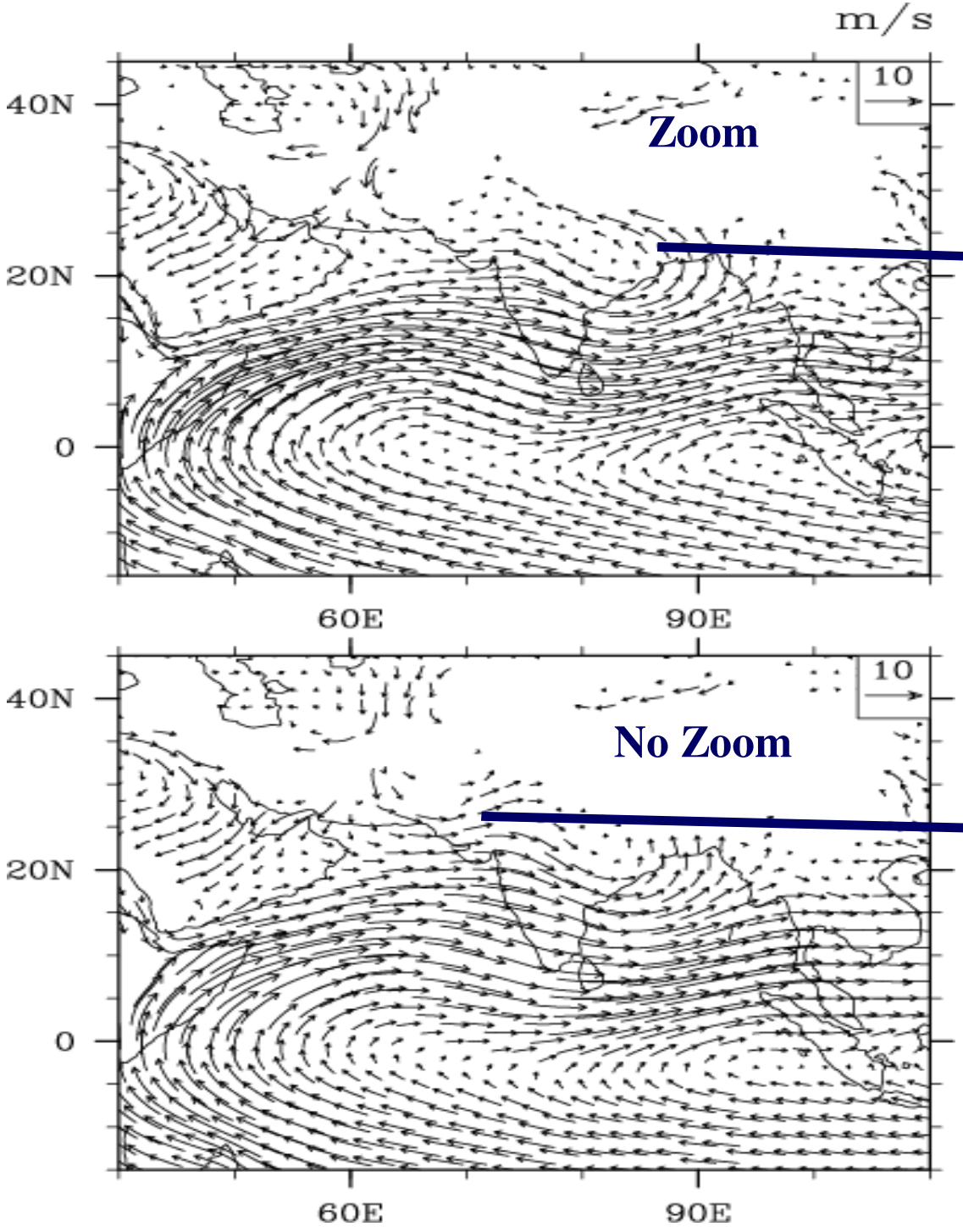


Relative Humidity 500 hPa (JJAS)



Mean annual cycles of rainfall (mm day $^{-1}$) and surface temperature (^{o}C) over the Indian landmass from the zoom and no-zoom runs



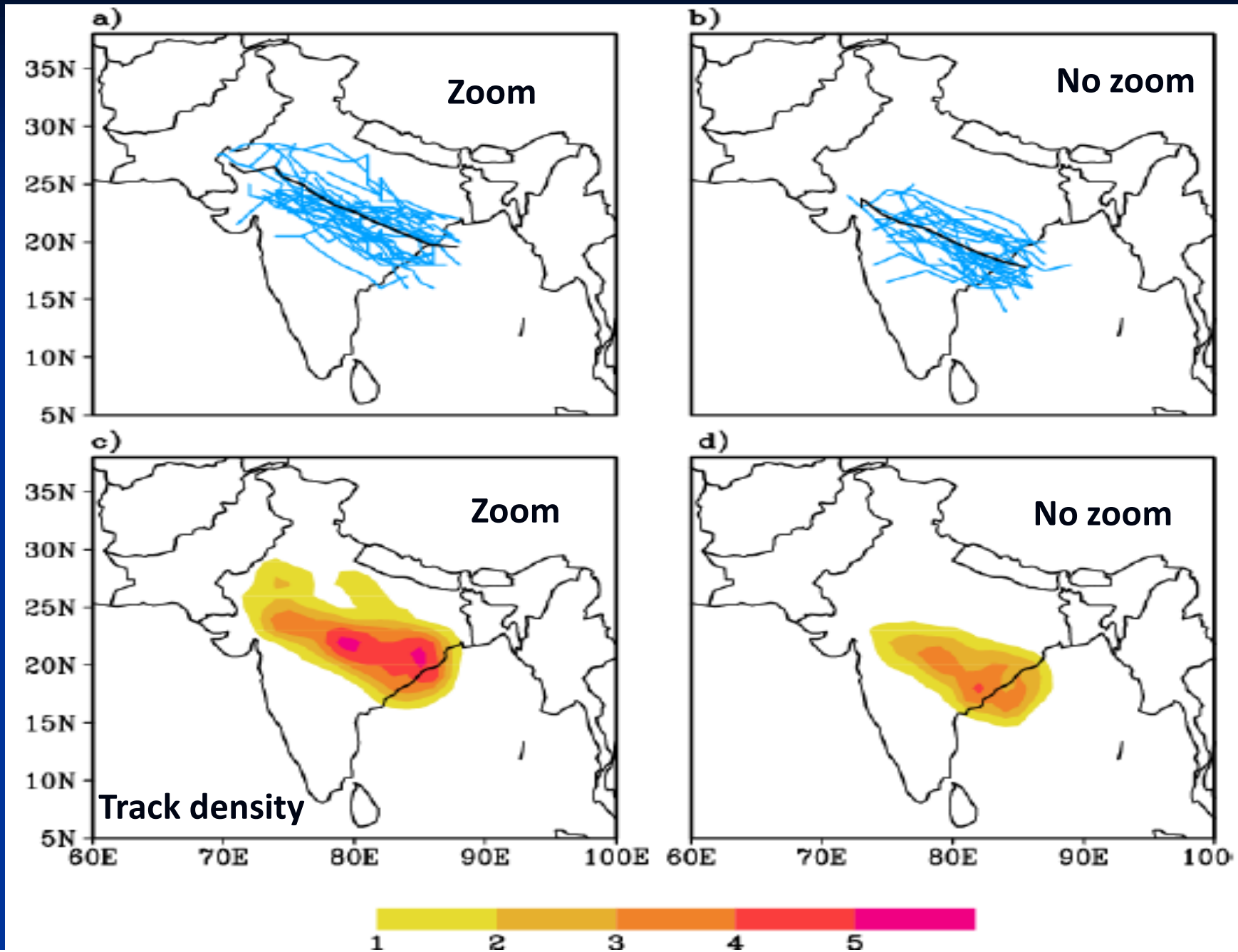


850 hPa winds (JJAS)

Cyclonic turning of moist winds from Bay of Bengal

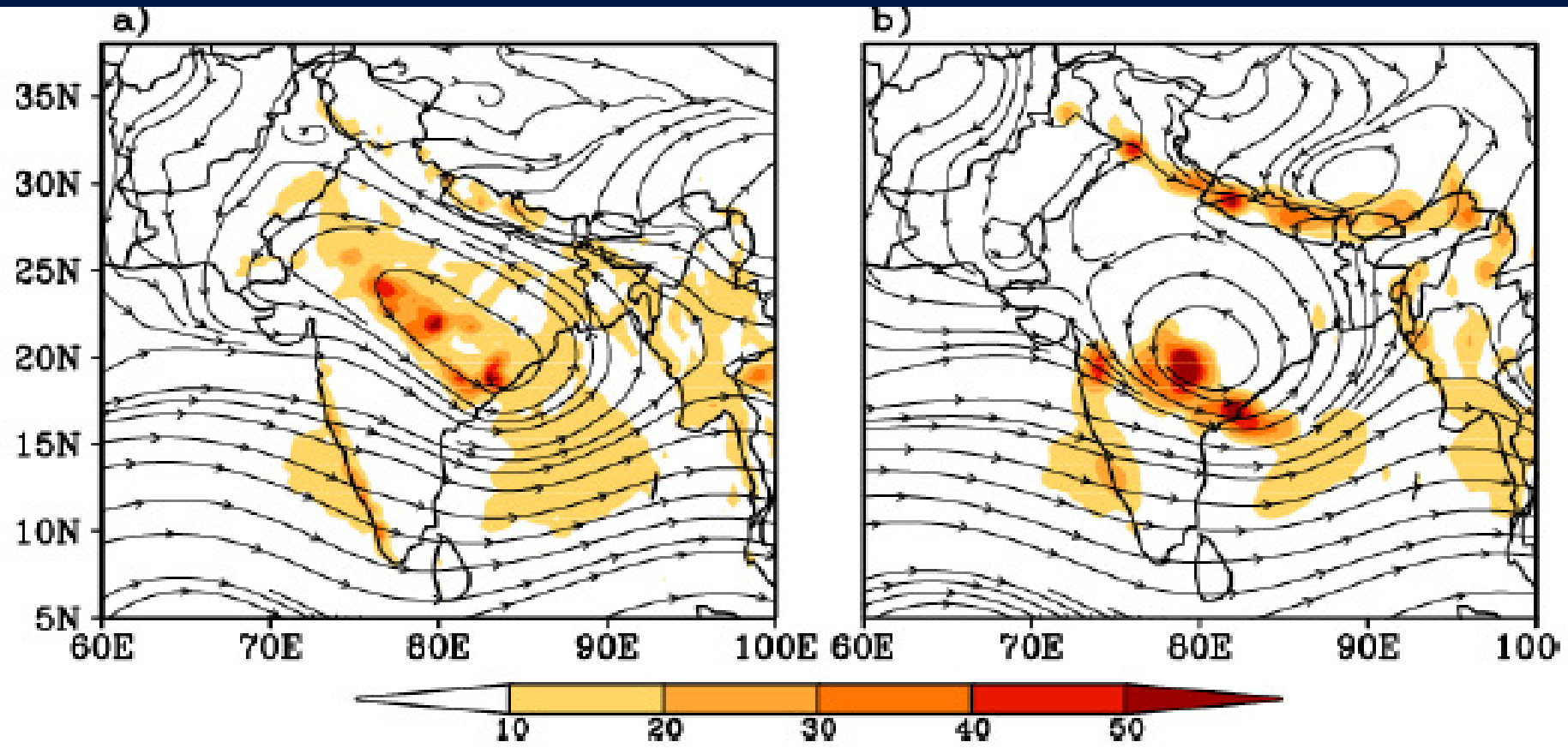
Dry westerly winds from Indo-Pak and adjoining areas

Simulated tracks of monsoon low pressure systems (LPS) – Lows and Depressions



Zoom

No zoom



Precipitation (mm day $^{-1}$) and 850 hPa streamlines averaged during a typical case of long lived monsoon depression in the Zoom & No-Zoom simulations

Understanding regional climate change over South Asia

High resolution (~ 35 km) dynamical downscaling at CCCR, IITM

Historical (1886-2005):

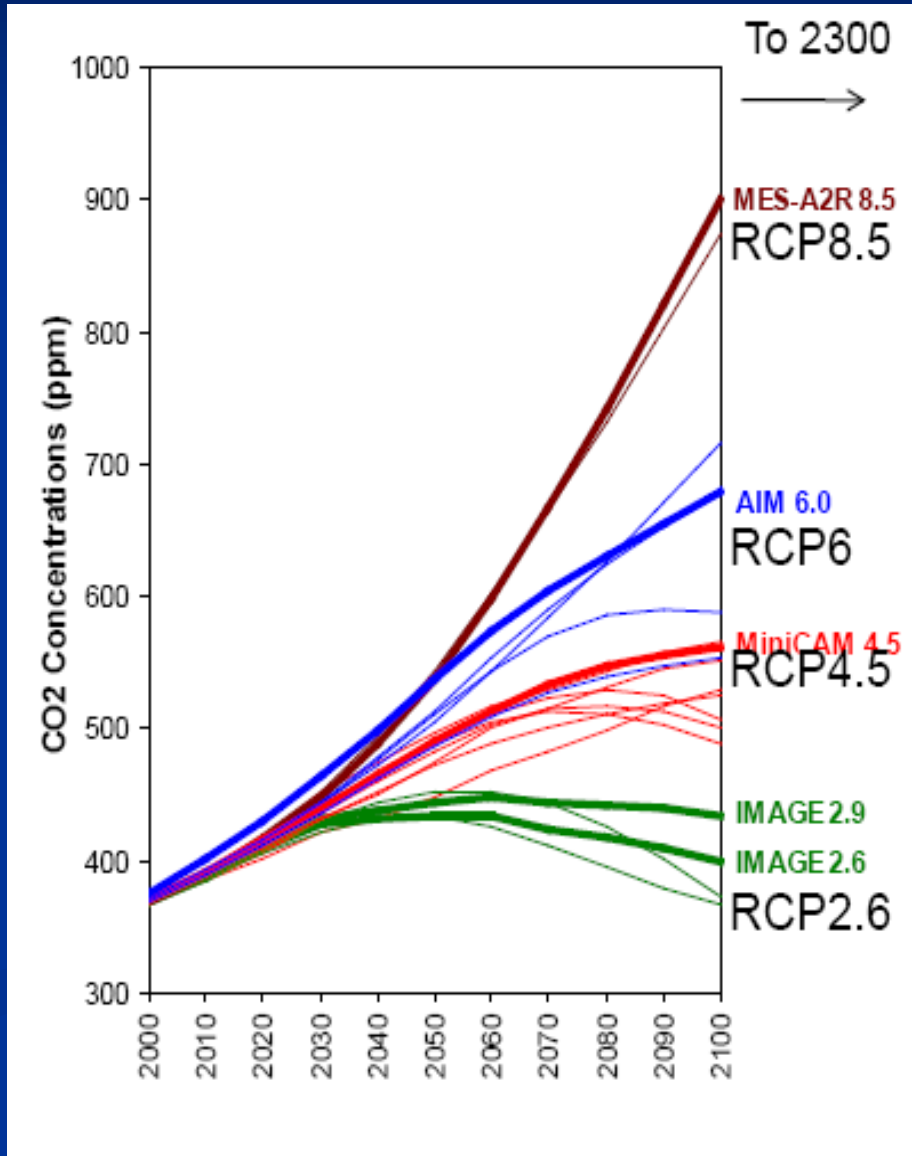
Includes natural and anthropogenic (GHG, aerosols, land cover etc) climate forcing during the historical period (1886 – 2005) ~ 120 years

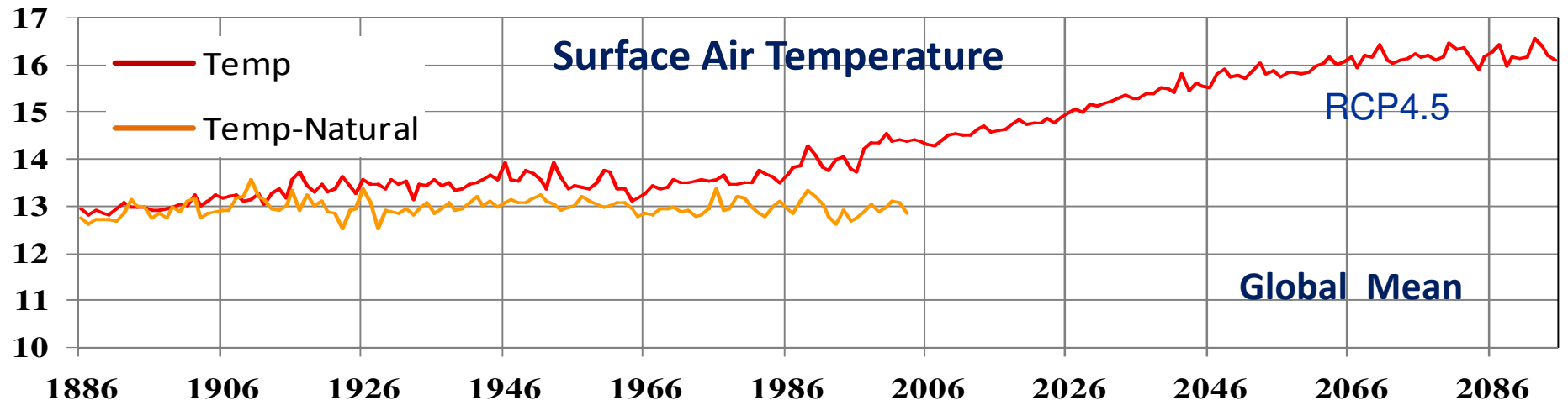
Historical Natural (1886 – 2005):

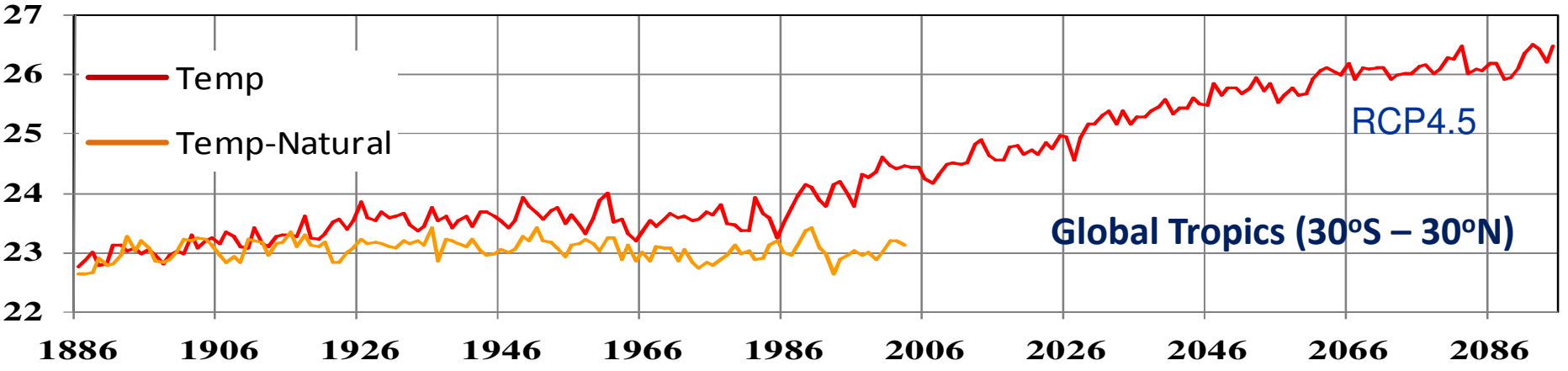
Includes only natural climate forcing during the historical period (1886– 2005) ~ 120 years

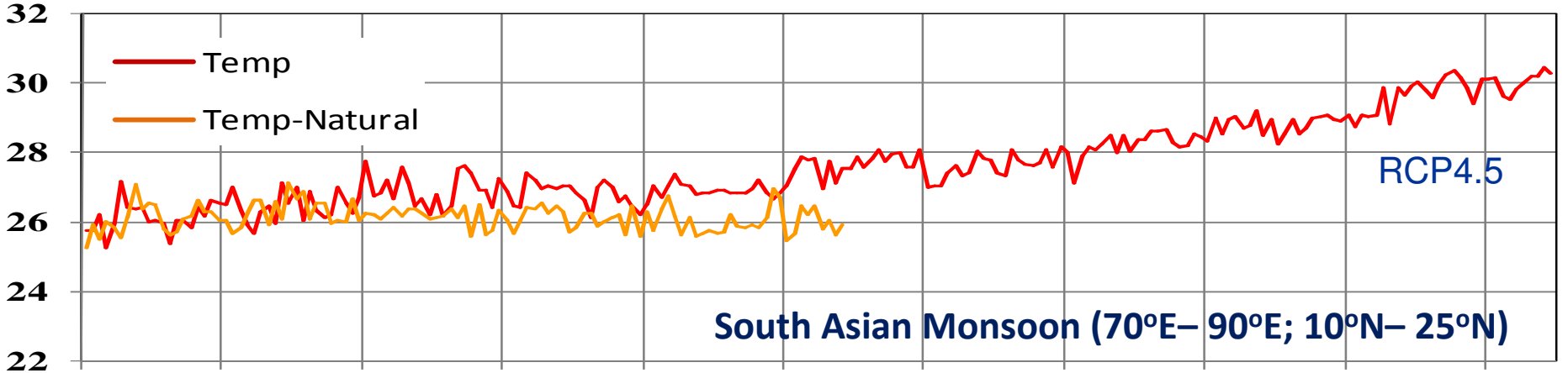
RCP 4.5 scenario (2006-2100) ~ 95 years:

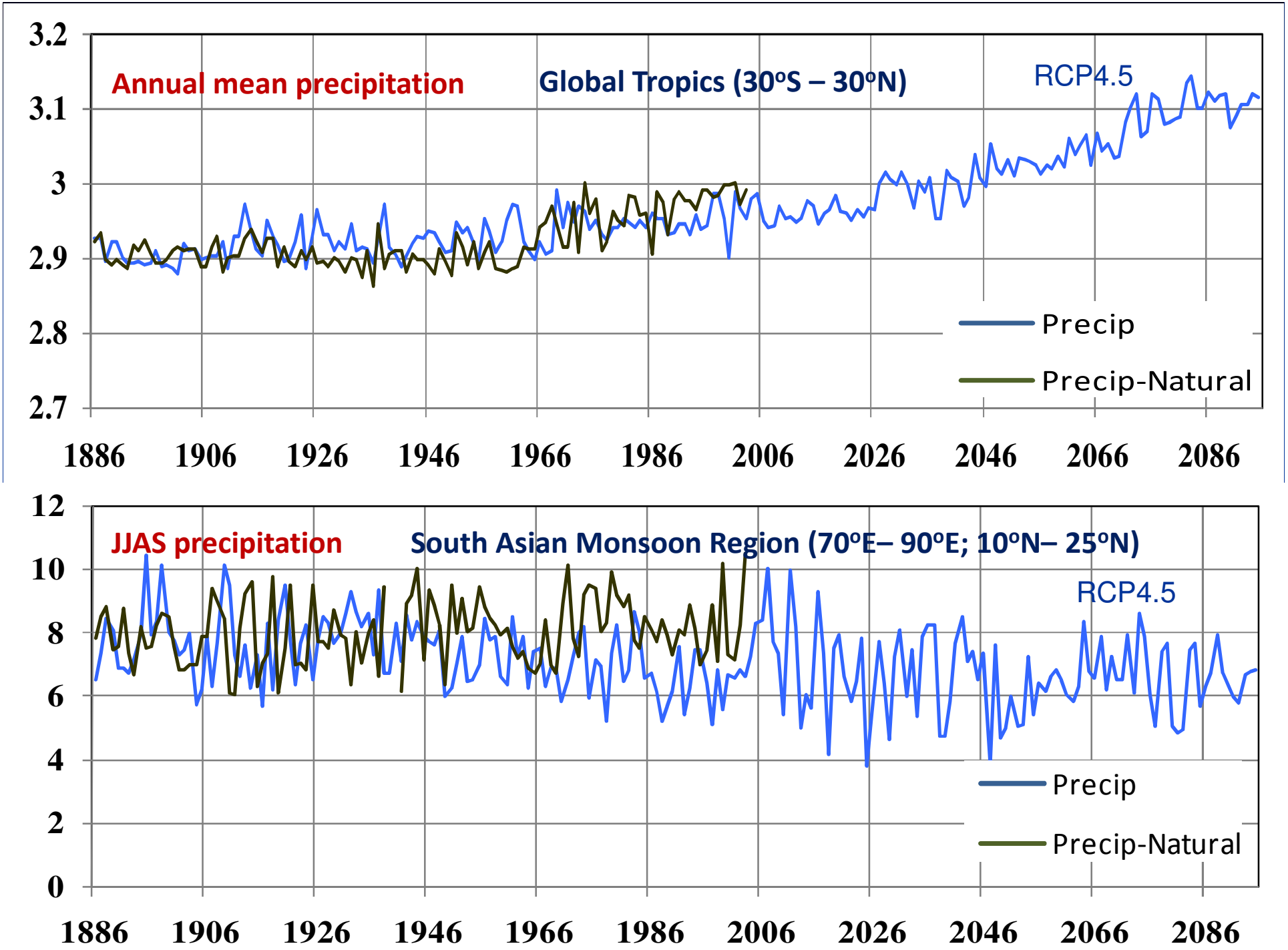
Future projection run which includes both natural and anthropogenic forcing based on the IPCC AR5 RCP4.5 climate scenario. The evolution of GHG and anthropogenic aerosols in RCP 4.5 scenario produces a global radiative forcing of + 4.5 W m^{-2} by 2100




Surface Air Temperature
Temp
Temp-Natural
RCP4.5
Global Mean
17
16
15
14
13
12
11
10
1886
1906
1926
1946
1966
1986
2006
2026
2046
2066
2086


Temp
Temp-Natural
RCP4.5
Global Tropics (30°S – 30°N)
27
26
25
24
23
22
1886
1906
1926
1946
1966
1986
2006
2026
2046
2066
2086


Temp
Temp-Natural
RCP4.5
South Asian Monsoon (70°E– 90°E; 10°N– 25°N)
32
30
28
26
24
22

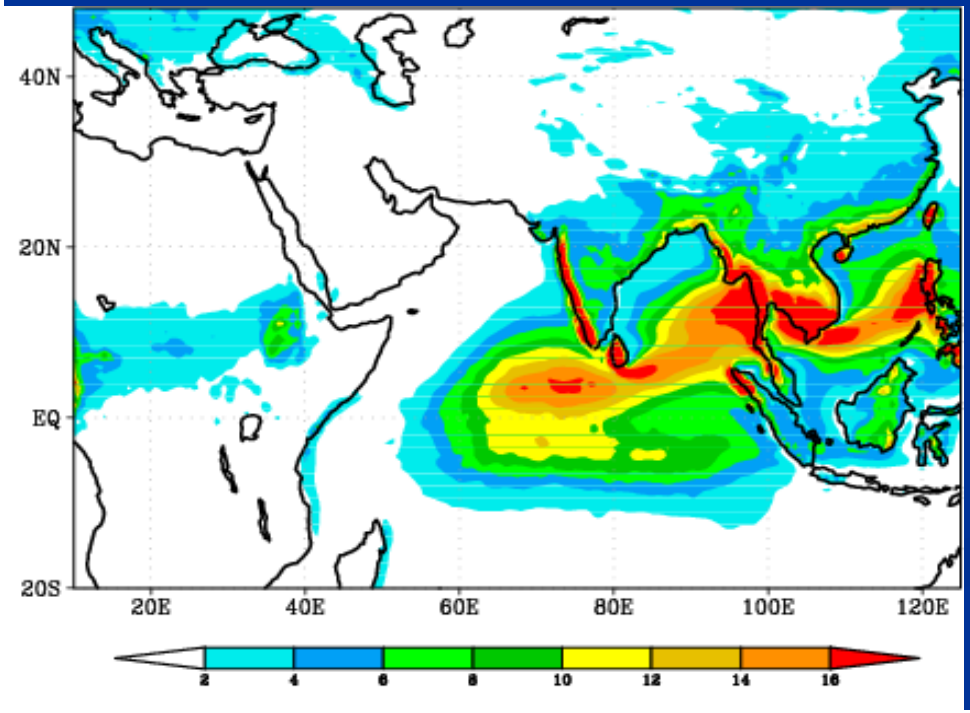

Annual mean precipitation
Global Tropics (30°S – 30°N)
RCP4.5
Precip
Precip-Natural
3.2
3.1
3
2.9
2.8
2.7
1886
1906
1926
1946
1966
1986
2006
2026
2046
2066
2086
JJAS precipitation
South Asian Monsoon Region (70°E– 90°E; 10°N– 25°N)
RCP4.5
Precip
Precip-Natural
12
10
8
6
4
2
0
1886
1906
1926
1946
1966
1986
2006
2026
2046
2066
2086

High resolution dynamical downscaling of regional climate change scenarios over West Asia using RegCM4

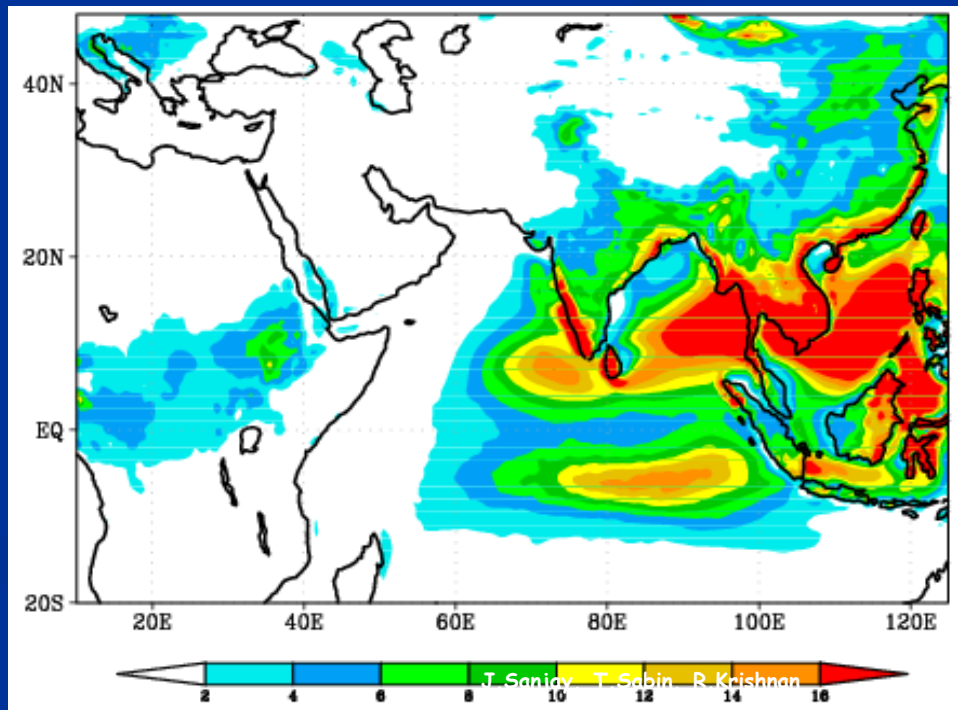
- RCM: RegCM4.1 coupled to CLM3.5 LSM ; 50 km Mercator projection [with Mixed Cumulus: Land (Grell) and Ocean (Emanuel)]
- Forcing: Daily 3D atmospheric lateral boundary conditions from the LMDZ AGCM with high resolution zooming (~35 km) over India, forced with SST from LMDZ ESM IPCC AR5 RCP4.5 simulations during 2006-2100
- Runs on IITM Prithvi HPC

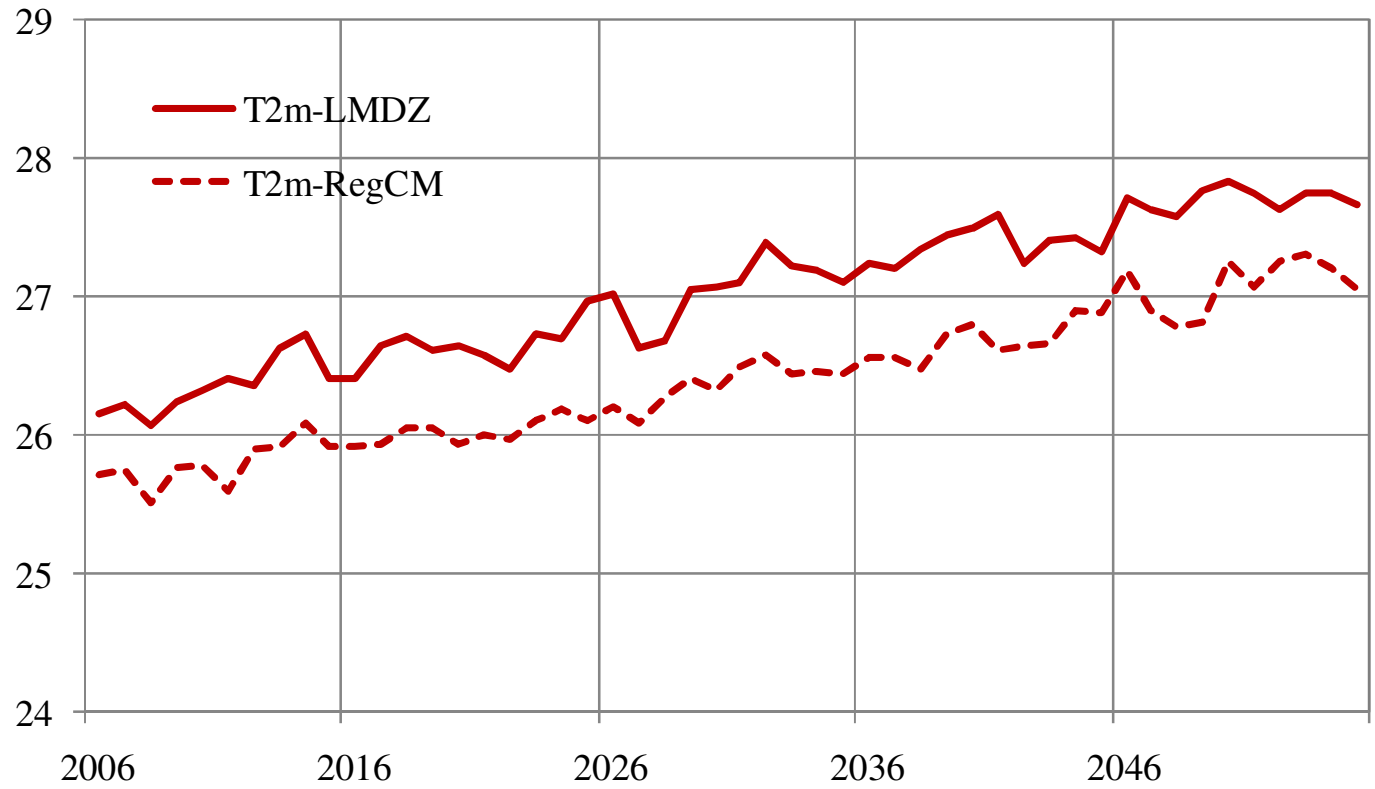
JJAS Mean Precipitation (mm day $^{-1}$)

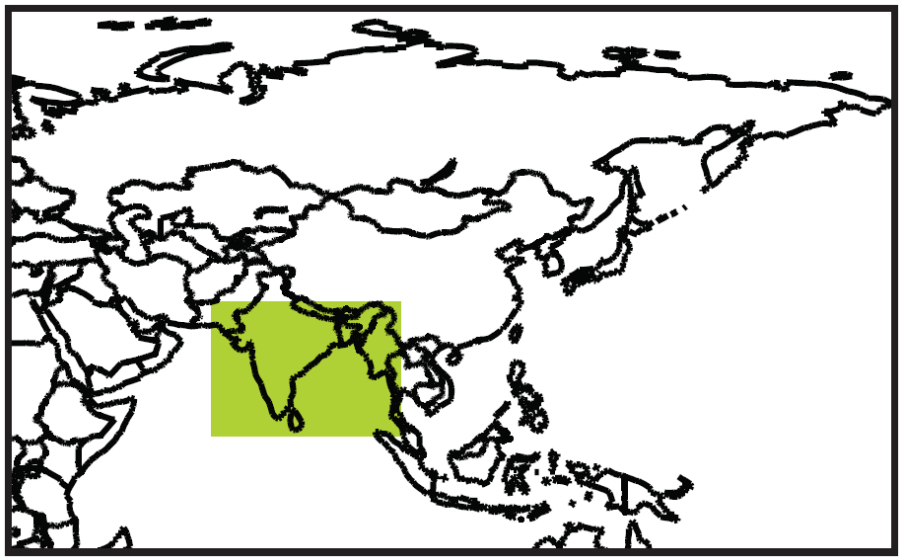
ERA-Interim Evaluation 18 yr (1989-2006)



RCP 4.5 Scenario 55 yr (2006-2062)



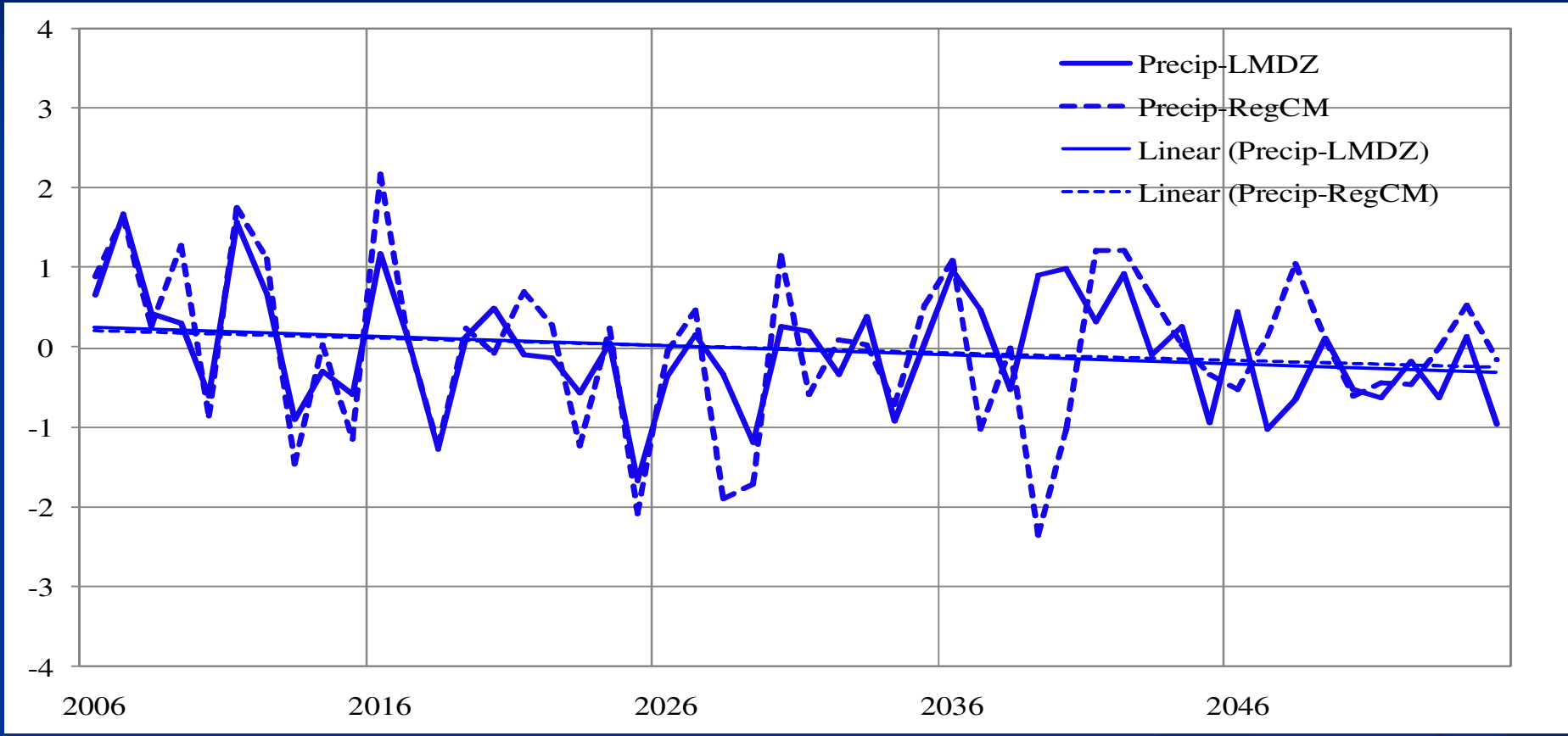




Annual mean surface air temperature

60E-100E : 5N-25N

JJAS rainfall anomaly



Summary

•Generation of CORDEX South Asia multi-model simulations at IITM and Partner Institutions - Evaluation run, Historical runs and future scenarios eg. RCP4.5.

•Multi-model approach to quantify uncertainties in regional climate projections

•Development of regional capacity - CORDEX training workshops proposed to be held in South Asia, East Asia and South East Asia in 2013, 2014 and 2015

Discussion Points

•Need to standardize the format of CORDEX South Asia model outputs from multi-model ensemble simulations

•Archival, management and sharing of CORDEX South Asia model outputs - Mechanism to consolidate model outputs from all partner institutions

•Framework for developing an ESG node at CCCR, IITM for CORDEX South Asia

•Framework for Evaluation of CORDEX South Asia model simulations . Quantify

•Develop synergistic linkage between climate downscaling and VIA user communities in Asia through direct user engagement

CORDEX South Asia

- Implementation of Integrated Rule-Oriented Data System (iRODS) in CCCR Data Portal

  a) Managing & sharing CORDEX South Asia model outputs, CFS outputs, observed data (eg. Fluxnet) – Data archival, management and hosting
  b) Possibility of publishing the datasets in future through an Earth System Grid (ESG)
  c) Recommended by Dr. Colin Jones, SMHI for data sharing under CORDEX
  d) Sandip Ingle has installed the basic iRODS server and web browser. Implementation of rules ongoing for secure data management and sharing

- Regional Climate Model Evaluation System (RCMES)

  a) RCMES developed by NASA Jet Propulsion Laboratory (JPL) and UCLA
  b) Recommended by Dr. Collin Jones, SMHI as an evaluation tool for CORDEX S Asia
  c) Dr. J. Sanjay visited JPL, Pasadena, California for collaborative discussions and training with Dr. Duane Waliser's group on RCMES during 29 September to 7 October 2012.
  d) RCMES enables ready accessibility of satellite observations together with in-situ, assimilated and reanalysis datasets for regional climate modeling community
  e) RCMES includes a central database (RCMED) to store multiple datasets in a common format and codes for calculating predefined statistical metrics to assess model performance (RCMET)

Thank you