Science and Training Workshop on Climate Change over the High Mountains of Asia

October 08 - 12, 2018, IITM, Pune, India

Day 2: Tuesday, 9th October 2018
Training Session 1: 10:10 – 10:50 hours

IITM Coordinated CORDEX South Asia-Downscaled climate change Projections for the Hindu Kush Himalayan region

J. Sanjay
(with inputs from Climate Change Science & Application Team Members)

Centre for Climate Change Research (CCCR)
Indian Institute of Tropical Meteorology (IITM), Pune

- CCCR-IITM focus on the development of new climate modelling capabilities in India and South Asia to address issues concerning the science of climate change.

- The latest version of the Earth System Model (IITM-ESMv2) developed at CCCR-IITM would be the first climate model from India contributing to the sixth phase of the Coupled Model Intercomparison Project (CMIP6) experiments for the Intergovernmental Panel for Climate Change (IPCC) sixth assessment report (AR6) to be released in 2021.
- CCCR-IITM has also generated an ensemble of high resolution (50 km) dynamically downscaled CMIP5 future projections of regional climate over South Asia and Indian monsoon.
- CCCR-IITM leads the WCRP regional activity Coordinated Regional Climate Downscaling Experiment (CORDEX) over South Asia by coordinating the data archiving, management and dissemination activities
    - These CORDEX South Asia multi-model ensemble datasets are found useful for impact assessment studies and for quantifying uncertainties in the regional projections.

- CCCR-IITM is a scientific knowledge partner on climate science for a segment of the International Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA) research program on climate change Adaptation at Scale in Semi-Arid Regions (ASSAR) of India.

Coordinated Regional Climate Downscaling Experiment (CORDEX):

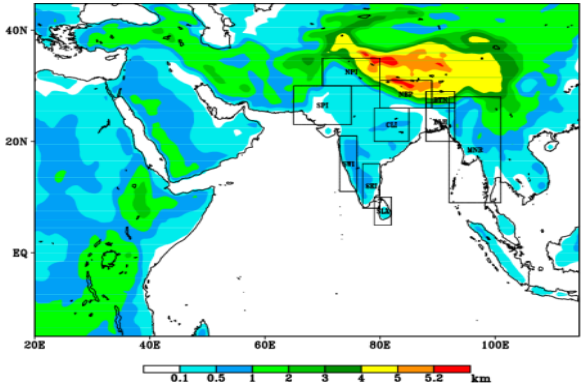
The CORDEX vision is to advance and coordinate the science and application of regional climate downscaling through global partnerships

CORDEX South Asia Co-ordination @ CCCR, IITM, Pune

Centre for Climate Change Research
Indian Institute of Tropical Meteorology, Pune, India

- **Development of multi-model ensemble projections of high resolution (50km) regional climate change scenarios for South Asia**
  - Generation of regional climate projections at CCCR-IITM
    - Downscaled 6 CMIP5 AOGCMs using ICTP RegCM4 regional climate model for historical period 1951-2005, and for two future scenarios (RCP4.5 and RCP8.5) for the period 2006-2099

      http://cccr.tropmet.res.in/home/cordexsa_datasets.jsp
  - Co-ordination with partner institutions for multi-model ensemble projections – SMHI, CSC, IAES, CSIRO, ICTP…



- **Development of an Earth System Grid Federation (ESGF) data node at CCCR-IITM for CORDEX South Asia**
  - Archival, Management, Dissemination of CORDEX South Asia data
  - Published ~2 TB of IITM-RegCM4 outputs on CCCR-IITM ESGF data node after quality assurance as per CORDEX archival specifications.

ESGF Data Node @ CCCR-IITM
http://cccr.tropmet.res.in/home/esgf_node.jsp

- **Summary of 17 CORDEX South Asia datasets available on ESGF (~20 TB)**
  - IITM-RegCM4: Hist (6); RCP8.5 (6); RCP4.5 (6)
  - SMHI-RCA4 : Hist (10); RCP8.5 (10); RCP4.5 (10); RCP2.6 (5)
  - CSC-REMO2009: Hist (1); RCP8.5 (1); RCP4.5 (1); RCP2.6 (1)
- **CCCR-IITM developing a global high resolution (27km) atmospheric version of the IITM Earth System Model**

- **CORDEX South Asia Point of Contact (PoC): Dr. R. Krishnan, Executive Director, CCCR, IITM**
- **CORDEX Science Advisory Team (SAT) member: Dr. J. Sanjay, Scientist, CCCR, IITM**

Downscaled climate change projections for the Hindu Kush Himalayan region using CORDEX South Asia regional climate models

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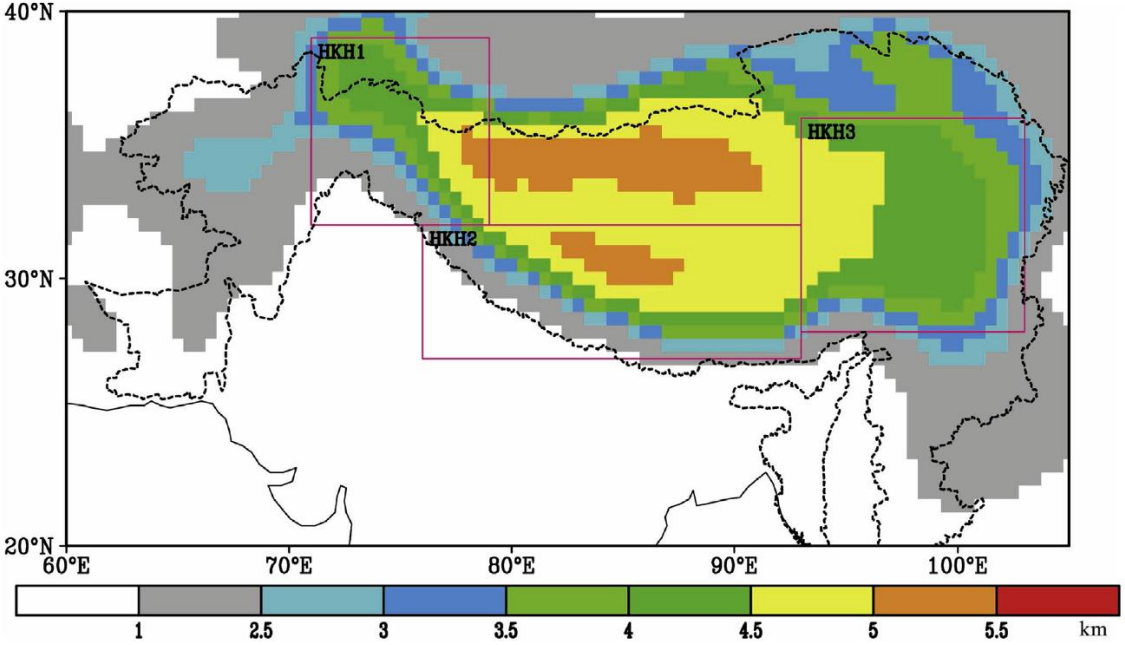
[d] *Laboratory for Climate Studies, National Climate Center, China Meteorological Administration, Beijing 100081, China*



Available online at www.sciencedirect.com
ScienceDirect
Advances in Climate Change Research 8 (2017) 185–198
www.keaipublishing.com/en/journals/accr/

Fig. 1. IITM-RegCM4 RCM elevation (km) over the region covering HKH, with parts of the hilly sub-regions within HKH defined by grid cells in each box above 2500 m a.s.l. (non-greyscale): northwest Himalaya and Karakoram (HKH1); central Himalaya (HKH2); southeast Himalaya and Tibetan Plateau (HKH3). The HKH boundary is shown with dashed line.

- The new information available from CORDEX South Asia are found useful for contributing to the Hindu Kush Himalayan Monitoring and Assessment Programme (HIMAP; http://www.icimod.org/himap)

CORDEX South Asia RCM	RCM Description	Contributing CORDEX Modeling Center	Driving CMIP5 GCM (https://verc.enes.org/data/enes-model-data/cmip5/resolution)	Contributing CMIP5 Modeling Center
IITM-RegCM4 (six ensemble members)	The Abdus Salam International Centre for Theoretical Physics (ICTP) Regional Climatic Model version 4 (RegCM4; Giorgi et al. 2012)	Centre for Climate Change Research (CCCR), Indian Institute of Tropical Meteorology (IITM), India	CCCma-CanESM2	Canadian Centre for Climate Modelling and Analysis (CCCma), Canada
			NOAA-GFDL-GFDL-ESM2M	National Oceanic and Atmospheric Administration , Geophysical Fluid Dynamics Laboratory (GFDL), USA
			CNRM-CM5	Centre National de Recherches Me´te´orologiques (CNRM), France
			MPI-ESM-MR	Max Planck Institute for Meteorology (MPI-M), Germany
			IPSL-CM5A-LR	Institut Pierre-Simon Laplace (IPSL), France
			CSIRO-Mk3.6	Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia
SMHI-RCA4 (six ensemble members)	Rossby Centre regional atmospheric model version 4 (RCA4; Samuelsson et al. 2011)	Rosssy Centre, Swedish Meteorological and Hydrological Institute (SMHI), Sweden	ICHEC-EC-EARTH	Irish Centre for High-End Computing (ICHEC), European Consortium (EC)
			MIROC-MIROC5	Model for Interdisciplinary Research On Climate (MIROC), Japan Agency for Marine-Earth Sci. & Tech., Japan
			NOAA-GFDL-GFDL-ESM2M	NOAA, GFDL, USA
			CNRM-CM5	CNRM, France
			MPI-ESM-LR	MPI-M, Germany
			IPSL-CM5A-MR	IPSL, France
MPI-CSC-REMO2009 (one member)	MPI Regional model 2009 (REMO; Teichmann et al. 2013)	Climate Service Center (CSC), Germany	MPI-ESM-LR	MPI-M, Germany

Spatial Distribution of the Seasonal Mean Climatology 1976-2005

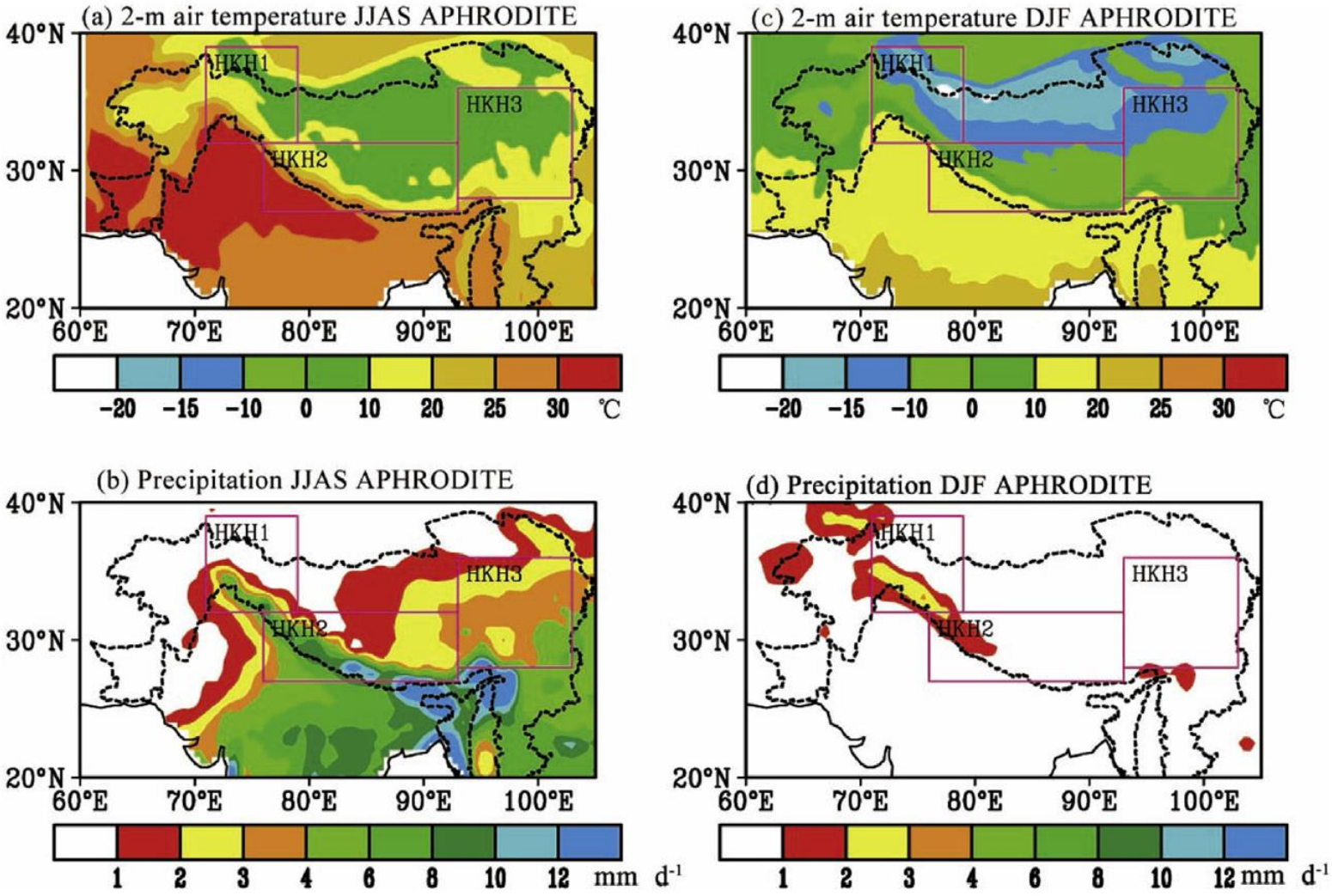


Fig. 2. Spatial distribution of the seasonal mean climatology during 1976–2005 based on APHRODITE gridded observations for (top panels) surface air temperature (°C) and (bottom panels) total precipitation (mm d^{-1}) during (a–b) summer monsoon and (c–d) winter seasons. The HKH boundary is shown with dashed line. The boxes represent the three HKH sub-regions used for detailed analysis (see text).

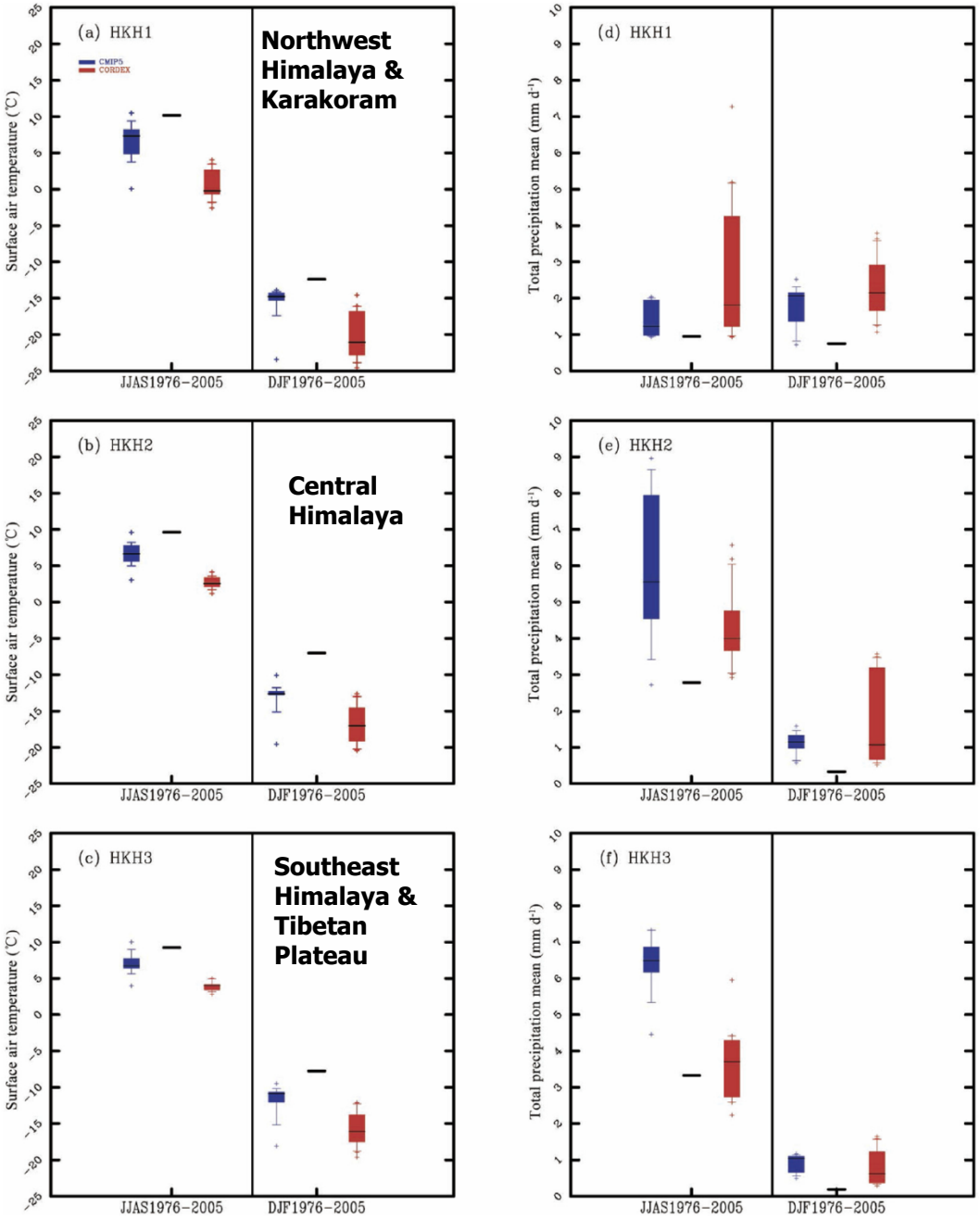
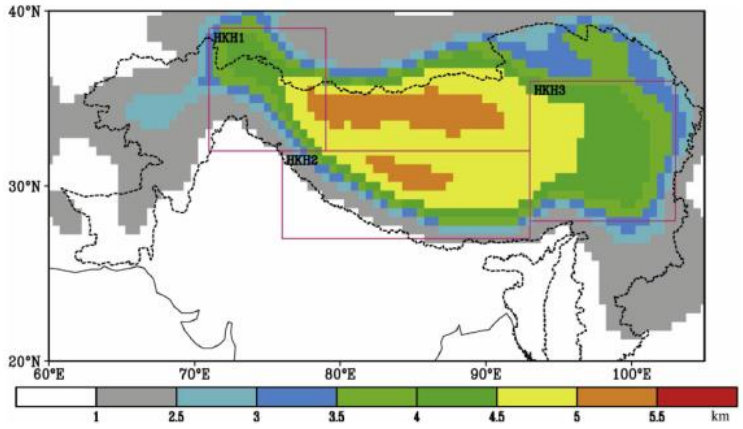


Fig. 4. Boxplots showing the (red colours) CORDEX RCMs and (blue colours) CMIP5 AOGCMs multi-model statistics for seasonal mean (left panels) surface air temperature (°C) and (right panels) total precipitation (mm d^{-1}) during (left sub-panels) summer monsoon and (right sub-panels) winter seasons in the three hilly sub-regions within HKH. The box represents the interquartile range (IQR) and the horizontal black line in each box is the multi-model median value. The whiskers represent the furthest model value within 1.5 times the IQR. The symbols show the outliers. The observed values based on APHRODITE are shown as a thick black line in the middle of each sub-panel.

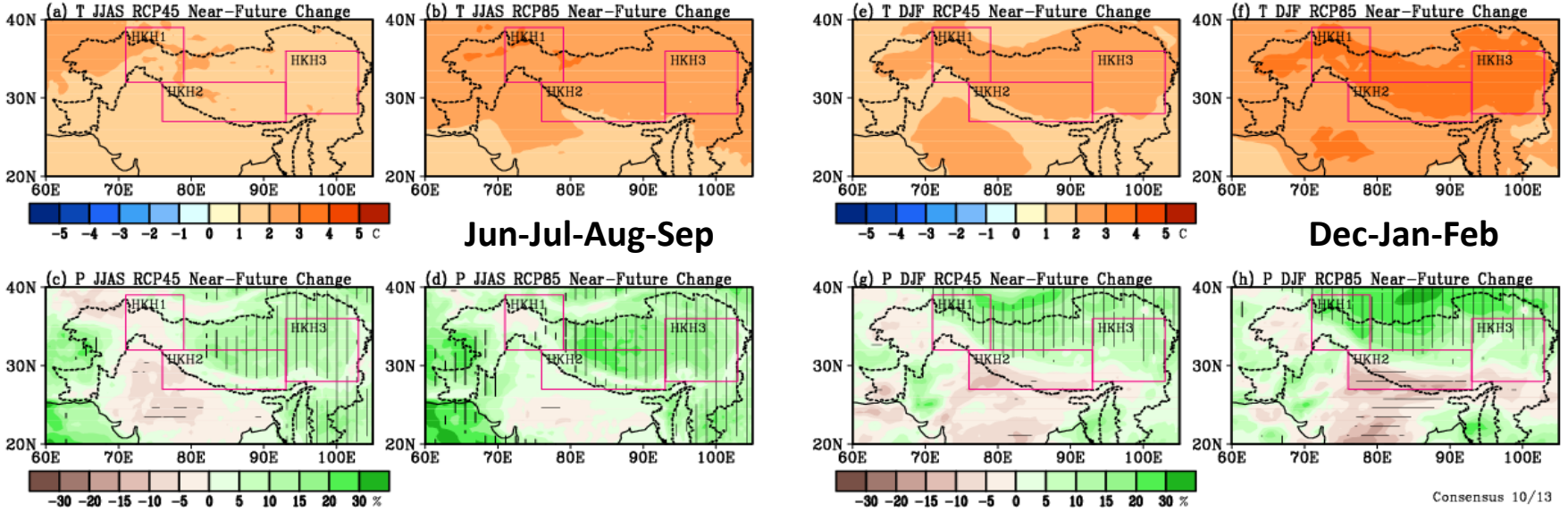
Multi-model Statistics of the Seasonal Mean Climatology for 1976-2005 in the 3 hilly sub-regions within HKH

CMIP5 AOGCMs
CORDEX RCMs
APHRODITE



Future projection of Climate Change (RCP4.5 & RCP8.5) : CORDEX Multi-Model Ensemble Mean

Projected Temperature and Precipitation Change for the Near Future (2036-2065) minus (1976-2005)



Projected Temperature and Precipitation Change for the Far Future (2066-2095) minus (1976-2005)

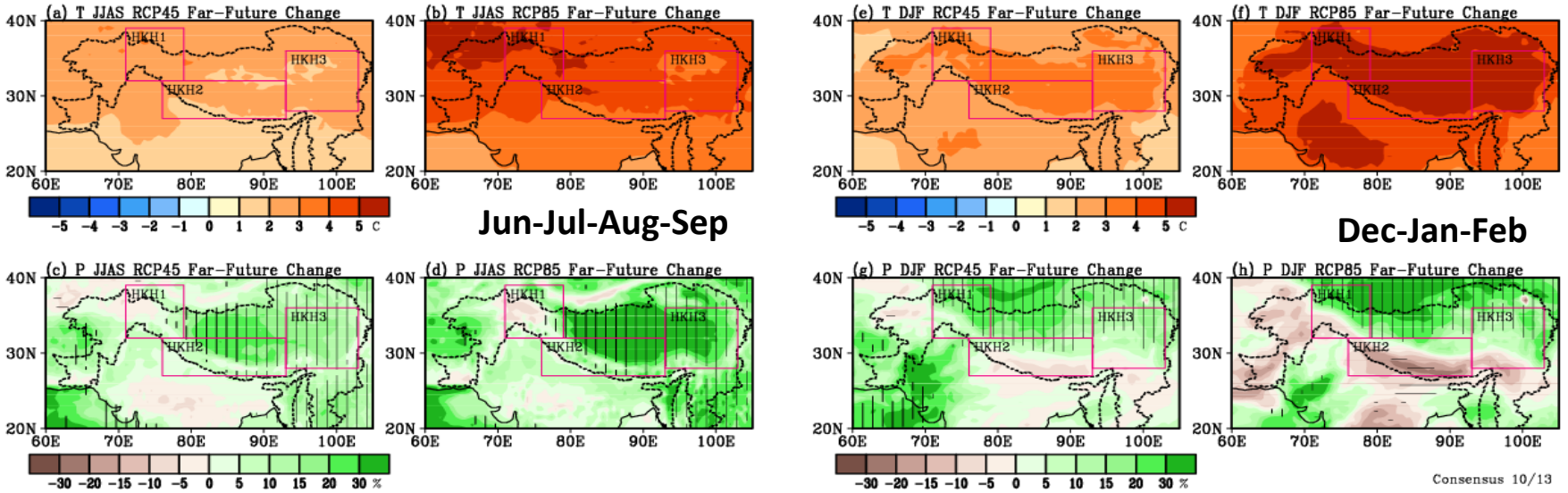


Table 2
Seasonal ensemble mean projected changes in near-surface air temperature (°C) relative to 1976–2005 in three hilly sub-regions within HKH (see Fig. 1): northwest Himalaya and Karakoram (HKH1); central Himalaya (HKH2); southeast Himalaya and Tibetan Plateau (HKH3).

Scenario	Period	Multi-model ensemble mean	Summer monsoon season (June–September)			Winter season (December–February)		
			HKH1	HKH2	HKH3	HKH1	HKH2	HKH3
RCP4.5	2036–2065	CORDEX RCMs	2.0	1.7	1.7	2.3	2.4	2.4
		CMIP5 AOGCMs	2.6	2.1	2.0	2.1	2.7	2.5
	2066–2095	CORDEX RCMs	2.6	2.2	2.2	3.1	3.3	3.1
		CMIP5 AOGCMs	3.3	2.7	2.5	3.0	3.6	3.3
RCP8.5	2036–2065	CORDEX RCMs	2.7	2.3	2.3	3.2	3.3	3.2
		CMIP5 AOGCMs	3.3	2.7	2.5	3.0	3.4	3.2
	2066–2095	CORDEX RCMs	4.9	4.3	4.2	5.4	6.0	5.6
		CMIP5 AOGCMs	5.7	4.7	4.4	5.1	5.8	5.4

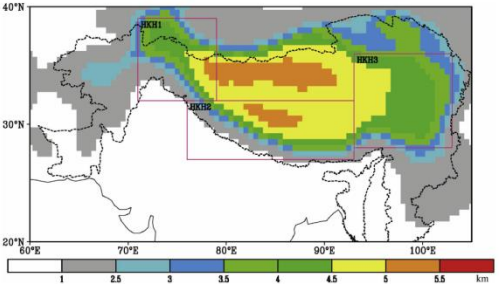


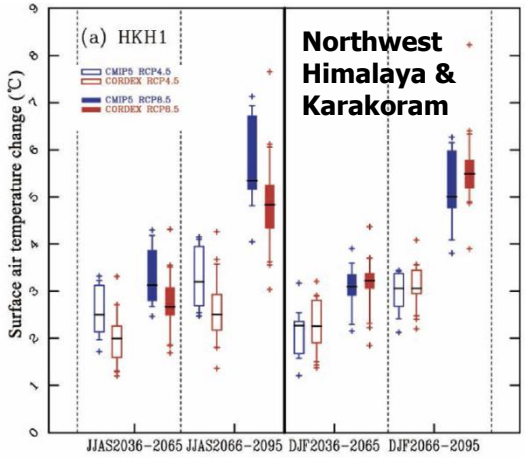
Table 4
CMIP5 global seasonal ensemble mean projected changes in near-surface air temperature (°C) relative to 1976–2005.

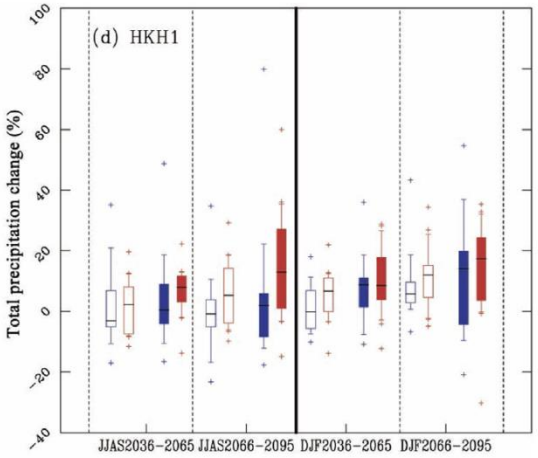
Period	Summer monsoon season (June–September)		Winter season (December–February)	
	RCP4.5	RCP8.5	RCP4.5	RCP8.5
2036–2065	1.4	1.9	1.5	2.0
2066–2095	1.9	3.3	2.0	3.5

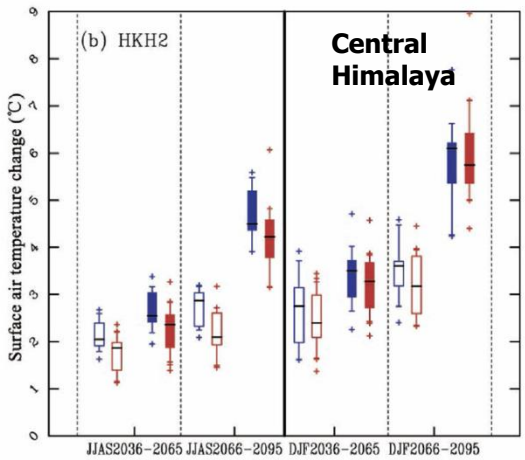
- During summer monsoon (winter) season relatively higher (lower) warming will occur over the hilly regions of HKH1 for both RCPs
- During summer (winter) relatively higher (lower) precipitation increase will occur over the hilly regions of HKH2 & HKH3

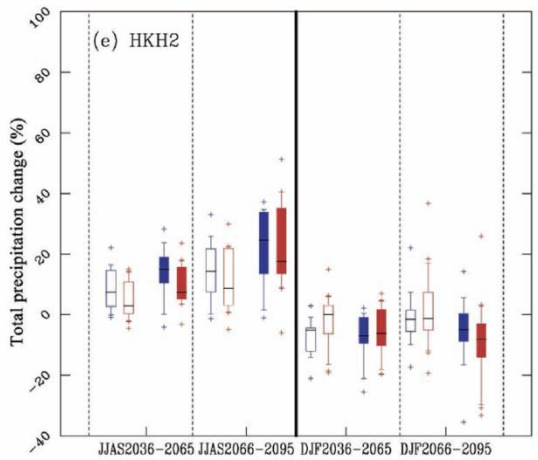
Seasonal ensemble mean projected changes in total precipitation (%) relative to 1976–2005 in three hilly sub-regions within HKH (see Fig. 1): northwest Himalaya and Karakoram (HKH1); central Himalaya (HKH2); southeast Himalaya and Tibetan Plateau (HKH3).

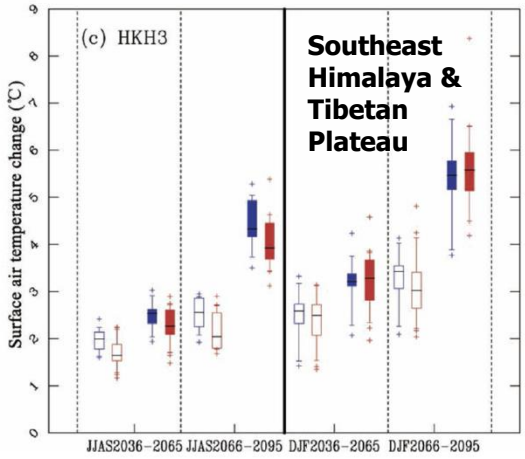
Scenario	Period	Multi-model ensemble mean	Summer monsoon season (June–September)			Winter season (December–February)		
			HKH1	HKH2	HKH3	HKH1	HKH2	HKH3
RCP4.5	2036–2065	CORDEX RCMs	−0.1	4.4	6.8	7.0	−0.7	3.1
		CMIP5 AOGCMs	0.8	6.7	4.6	1.0	−7.7	2.1
	2066–2095	CORDEX RCMs	3.5	10.5	10.4	14.1	1.5	3.7
		CMIP5 AOGCMs	−0.3	11.8	7.3	6.2	−0.7	5.5
RCP8.5	2036–2065	CORDEX RCMs	3.7	9.1	10.2	12.8	−1.3	0.9
		CMIP5 AOGCMs	3.6	10.7	5.7	5.1	−8.5	0.7
	2066–2095	CORDEX RCMs	3.9	19.1	22.6	12.9	−8.8	0.6
		CMIP5 AOGCMs	5.0	19.1	9.7	6.9	−8.1	6.0

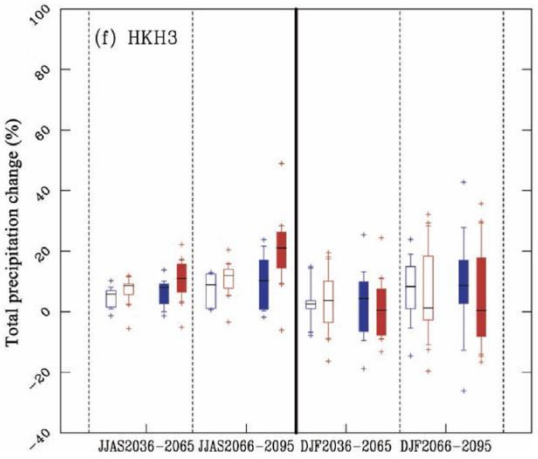




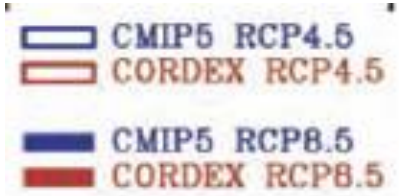


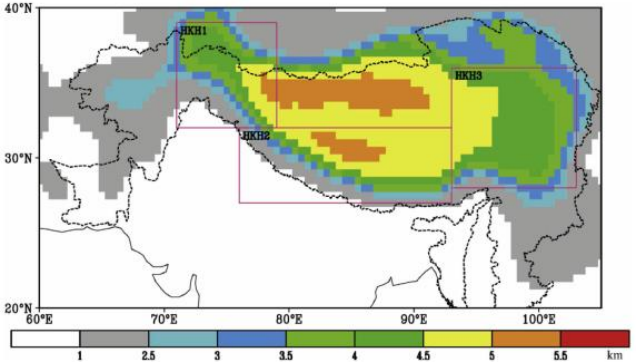






Multi-model Statistics of the Seasonal Mean changes in the near-future (2036-2065) & far-future (2066-2095) with reference to 1976-2005 for RCP4.5 & RCP8.5 scenarios in the 3 hilly sub-regions within HKH





Summary

- There is less agreement among these RCMs on the magnitude of the projected warming over the central & south-east Himalaya for both seasons, particularly associated with higher RCM uncertainty for the hilly sub-region within the central Himalaya.

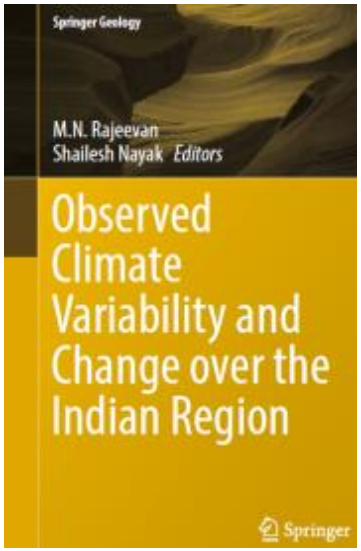
- The downscaled multi-RCMs show good consensus and low RCM uncertainty in projecting that the summer monsoon precipitation will intensify by about 22% in the hilly sub-region within the southeastern Himalaya and Tibetan Plateau for the far-future period under the RCP8.5 scenario.

- There is low confidence in the projected changes in the summer monsoon and winter season precipitation over the central Himalaya due to poor consensus and moderate to high RCM uncertainty among the downscaled multi-RCMs.

Regional Climate Change Scenarios. . . . . .

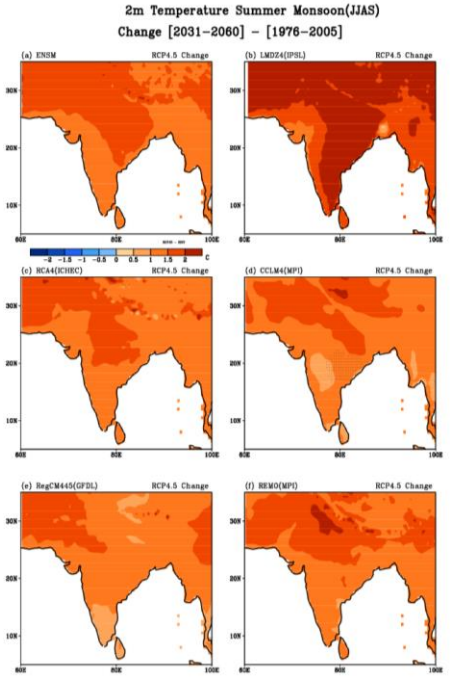
J. Sanjay, M.V.S. Ramarao, M. Mujumdar and R. Krishnan

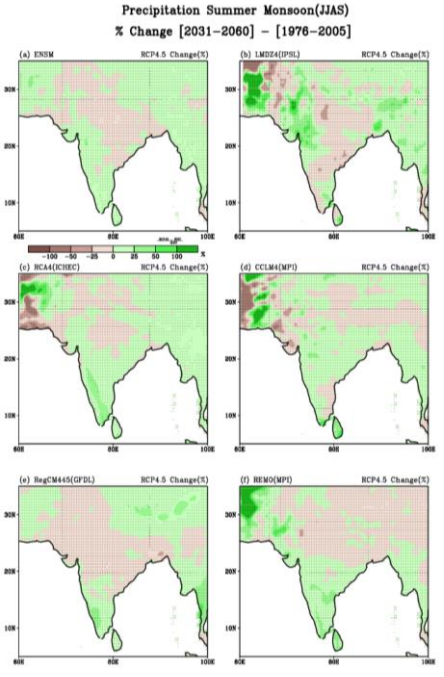
M.N. Rajeevan and S. Nayak (eds.), *Observed Climate Variability and Change Over the Indian Region*, Springer Geology, DOI 10.1007/978-981-10-2531-0_16



Future regional climate change scenarios are created for the period 1950–2100 by downscaling the simulations of four coupled climate models.

1. The projections indicate significant temperature increases (more than 1.5 °C) over the central and northern parts of India in the mid-term (2031–2060) period. The annual warming range over South Asia land areas is 1.8–3.0 °C by 2060.
2. However, the summer monsoon season precipitation change over India is uncertain not just in magnitude but also in sign.





Climate Change over INDIA

An Interim Report

Editors
R. Krishnan, J. Sanjay

Centre for Climate Change Research
ESSO-Indian Institute of Tropical Meteorology
Ministry of Earth Sciences, Govt. of India
July 2017

ESSO

IITM

Dr. Harsh Vardhan, Hon'ble Union Minister for Ministry of Science & Technology and Ministry of Earth Sciences released a report "Climate Change over India" - an interim report on the occasion of Foundation Day of Ministry of Earth Sciences in New Delhi on 27 July 2017.

This report is intended to provide a brief overview of the core research activities of the CCCR at IITM: (a) Updated assessment of observed climate change over India, (b) Future climate projections over India, and (c) Development of the IITM Earth System Model to better understand and quantify climate change and its regional impacts.

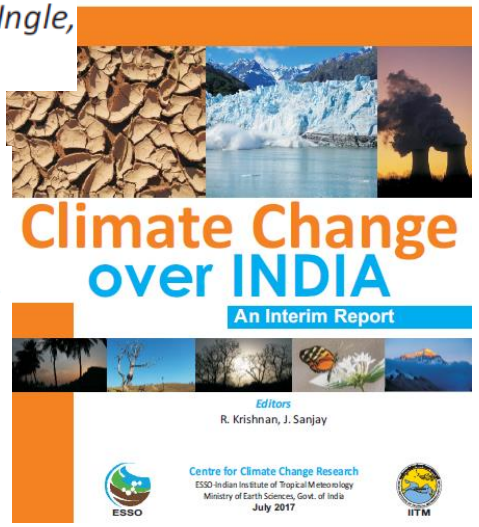
Available at:
http://cccr.tropmet.res.in/home/reports.jsp

Future Climate Change Projections over the Indian Region

Lead Author: J. Sanjay

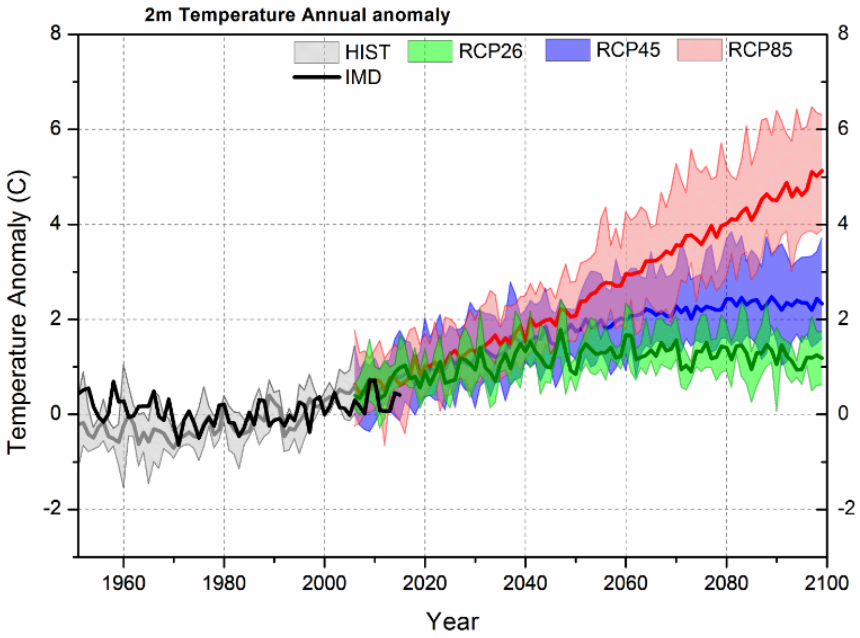
Co-authors: R. Krishnan, M.V.S. Ramarao, R. Mahesh, Bhupendra Singh, Jayashri Patel, Sandip Ingle, Preethi Bhaskar, J.V. Revadekar, T.P. Sabin, M. Mujumdar

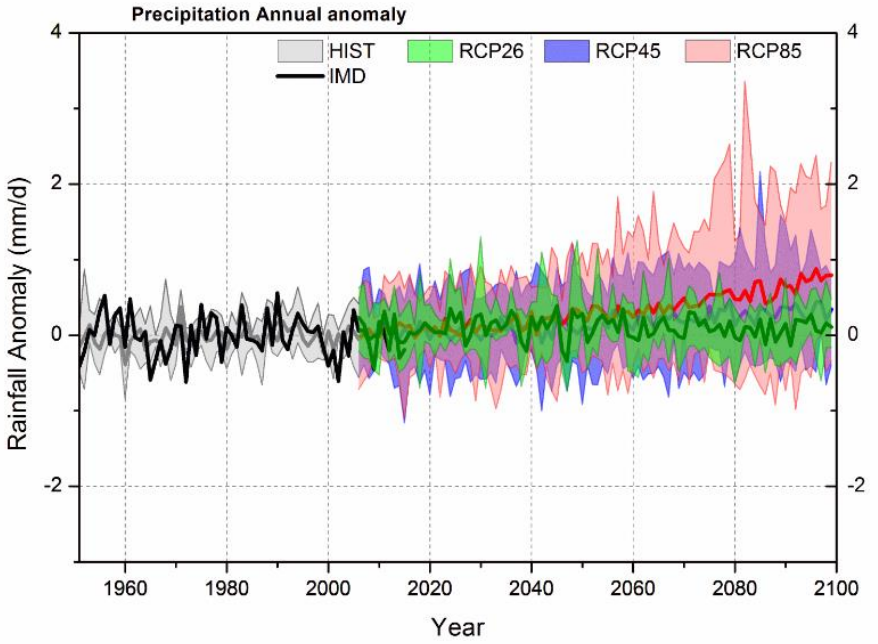
http://cccr.tropmet.res.in/home/reports.jsp



- *The all India mean surface air temperature change for the near-term period 2016–2045 relative to 1976–2005 is projected to be in the range of 1.08°C to 1.44°C, and is larger than the natural internal variability. This assessment is based on a reliability ensemble average (REA) estimate incorporating each RCM performance and convergence, and is associated with less than 16% uncertainty range (Table 2.1, Box 2.4).*
- *The all India mean surface air temperature is projected to increase in the far future (2066–2095) by 1.35 ± 0.23°C under RCP2.6, 2.41 ± 0.40°C under RCP4.5 and 4.19 ± 0.46°C under RCP8.5 scenario respectively. These changes are relative to the period 1976–2005. The semi-arid north-west and north India will likely warm more rapidly than the all India mean (Table 2.1, Fig. 2.1).*

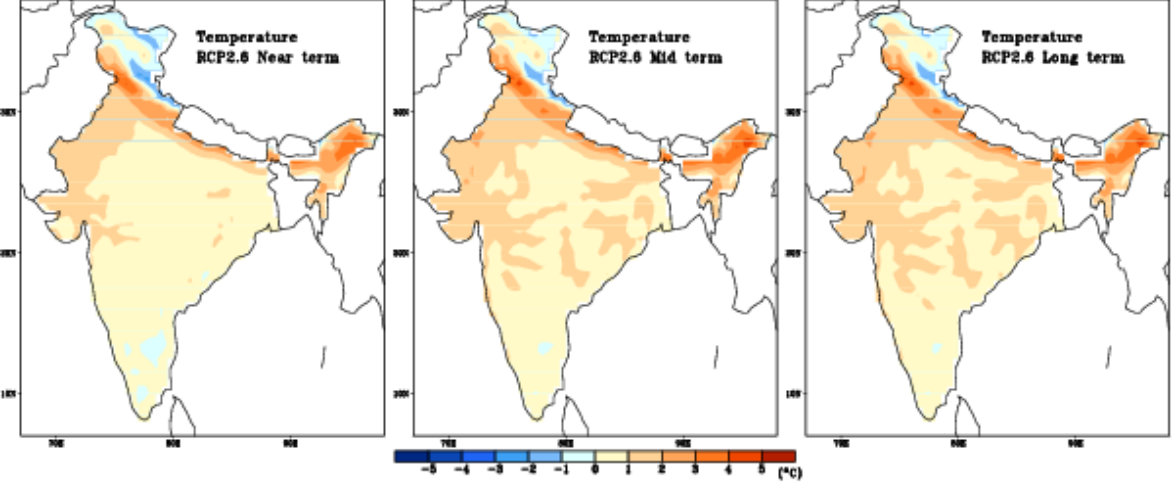
Indian annual mean anomalies (relative to 1976–2005) from CORDEX South Asia concentration-driven experiments

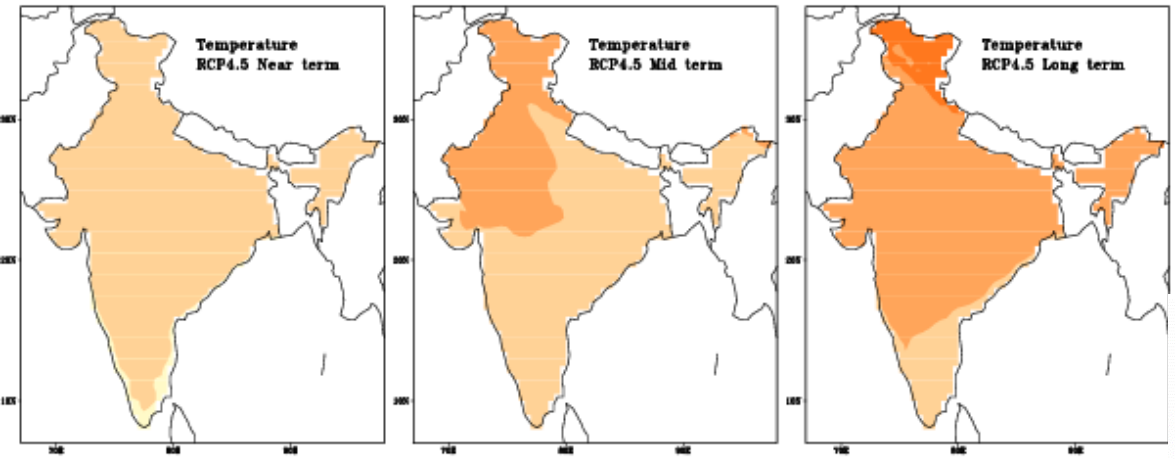


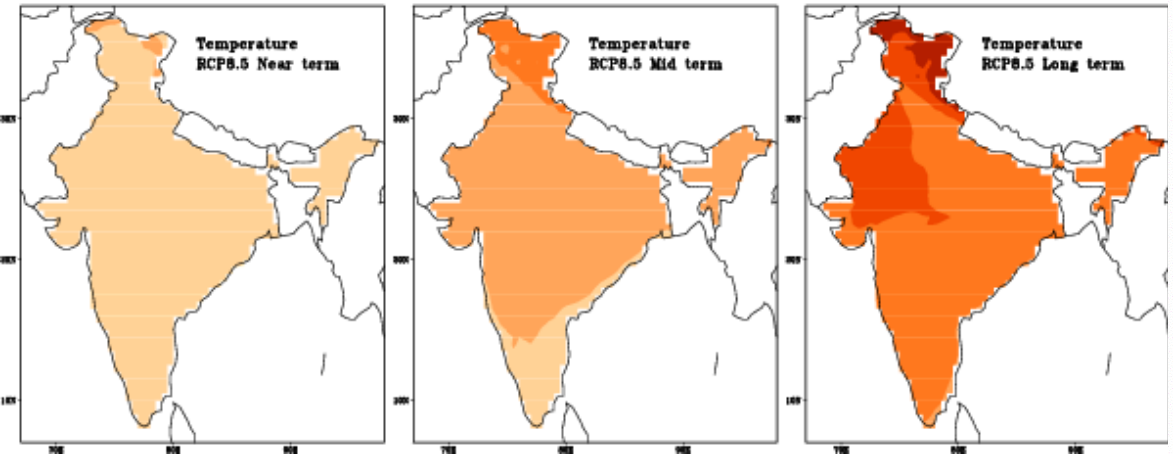


List of the 16 CORDEX South Asia RCM simulations driven with 10 CMIP5 AOGCMs.

CORDEX South Asia RCM	RCM Description	Contributing CORDEX Modeling Center	Driving CMIP5 AOGCM (see details at https://verc.enes.org/data/enes-model-data/cmip5/resolution)	Contributing CMIP5 Modeling Center
IITM-RegCM4 (6 members)	The Abdus Salam International Centre for Theoretical Physics (ICTP) Regional Climatic Model version 4 (RegCM4; Giorgi et al., 2012)	Centre for Climate Change Research (CCCR), Indian Institute of Tropical Meteorology (IITM), India	CCCma-CanESM2	Canadian Centre for Climate Modelling and Analysis (CCCma), Canada
			NOAA-GFDL-GFDL-ESM2M	National Oceanic and Atmospheric Administration (NOAA), Geophysical Fluid Dynamics Laboratory (GFDL), USA
			CNRM-CM5	Centre National de Recherches Me´te´orologiques (CNRM), France
			MPI-ESM-MR	Max Planck Institute for Meteorology (MPI-M), Germany
			IPSL-CM5A-LR	Institut Pierre-Simon Laplace (IPSL), France
			CSIRO-Mk3.6	Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia
SMHI-RCA4 (10 members)	Rossby Centre regional atmospheric model version 4 (RCA4; Samuelsson et al., 2011)	Rossby Centre, Swedish Meteorological and Hydrological Institute (SMHI), Sweden	ICHEC-EC-EARTH	Irish Centre for High-End Computing (ICHEC), European Consortium (EC)
			MIROC-MIROC5	Model for Interdisciplinary Research On Climate (MIROC), Japan Agency for Marine-Earth Sci. & Tech., Japan
			NCC-NorESM1	Norwegian Climate Centre (NCC), Norway
			MOHC-HadGEM2-ES	Met Office Hadley Centre for Climate Change (MOHC), United Kingdom
			CCCma-CanESM2	CCCma, Canada
			NOAA-GFDL-GFDL-ESM2M	NOAA, GFDL, USA
			CNRM-CM5	CNRM, France
			MPI-ESM-LR	MPI-M, Germany
			IPSL-CM5A-MR	IPSL, France
			CSIRO-Mk3.6	CSIRO, Australia

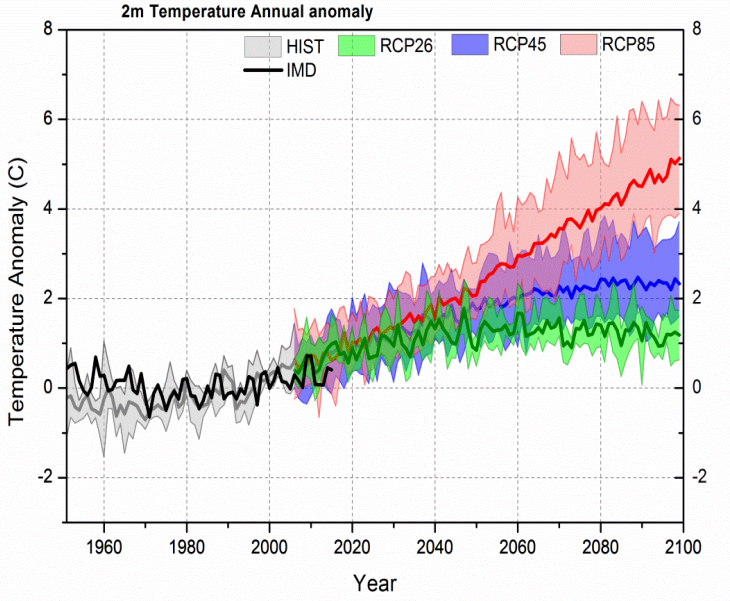






CORDEX South Asia multi-RCM ensemble mean projections of annual average surface air temperature (°C) changes for near-term (2016-2045), mid-term (2036–2065) and long-term (2066–2095) climate under RCP2.6, RCP4.5 and RCP8.5 scenarios, relative to 1976–2005.

- The semi-arid north-west and north India will likely warm more rapidly than the all India mean



CORDEX South Asia multi-RCM reliability ensemble average (REA) estimate of projected changes in annual surface air temperature over India and the associated uncertainty range. The values in parenthesis show the uncertainty in percent for the REA estimate.

Scenario	Annual Mean Temperature (°C)		
	2030s	2050s	2080s
RCP2.6	1.08 ± 0.12 *(11.1%)*	1.35 ± 0.18 *(13.3%)*	1.35 ± 0.23 *(17.0%)*
RCP4.5	1.28 ± 0.20 *(15.6%)*	1.92 ± 0.28 *(14.6%)*	2.41 ± 0.40 *(16.6%)*
RCP8.5	1.44 ± 0.17 *(11.8%)*	2.41 ± 0.28 *(11.6%)*	4.19 ± 0.46 *(11.0%)*

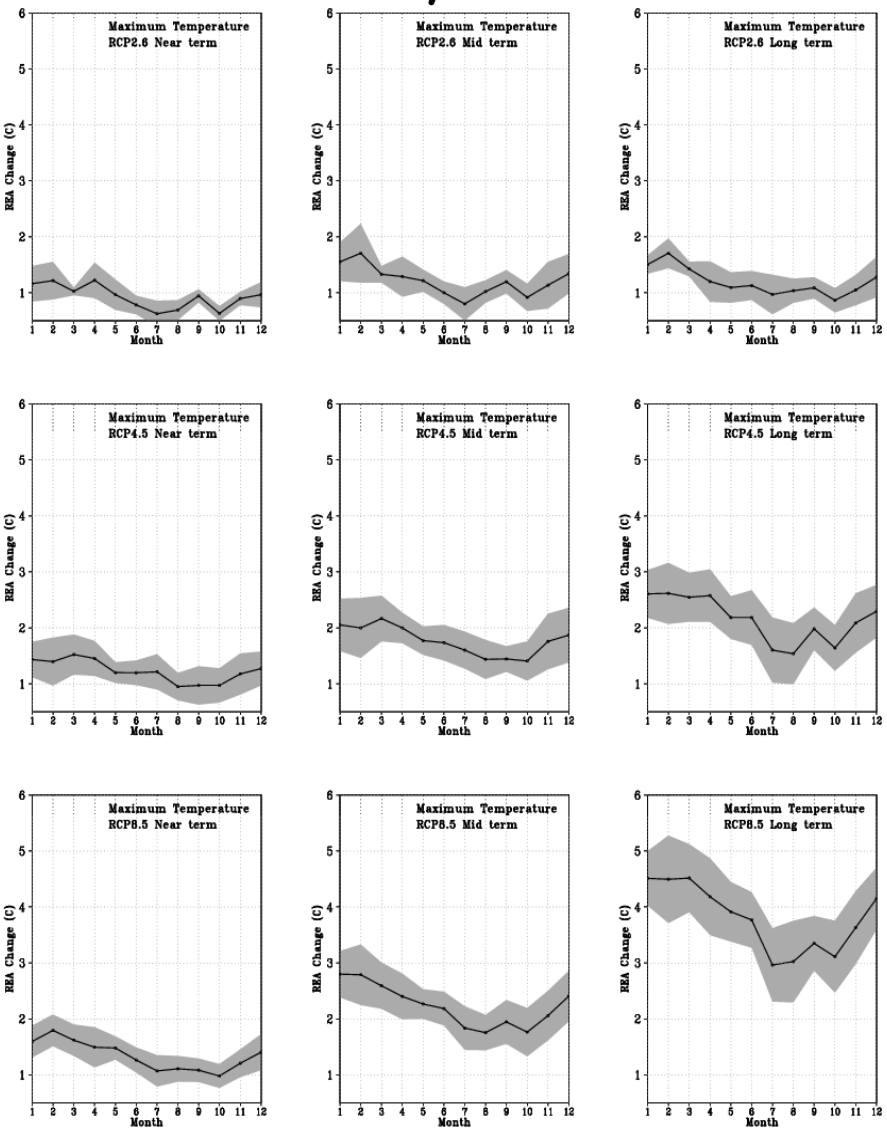
Scenario	Annual Maximum Temperature (°C)		
	2030s	2050s	2080s
RCP2.6	0.99 ± 0.11 *(11.1%)*	1.26 ± 0.16 *(12.7%)*	1.27 ± 0.20 *(15.7%)*
RCP4.5	1.26 ± 0.20 *(15.9%)*	1.81 ± 0.27 *(14.9%)*	2.29 ± 0.36 *(15.7%)*
RCP8.5	1.36 ± 0.16 *(11.8%)*	2.30 ± 0.31 *(13.5%)*	3.94 ± 0.45 *(11.4%)*

Scenario	Annual Minimum Temperature (°C)		
	2030s	2050s	2080s
RCP2.6	1.16 ± 0.17 *(14.7%)*	1.44 ± 0.24 *(16.7%)*	1.35 ± 0.25 *(18.5%)*
RCP4.5	1.36 ± 0.18 *(13.2%)*	2.14 ± 0.28 *(13.1%)*	2.63 ± 0.38 *(14.4%)*
RCP8.5	1.50 ± 0.16 *(10.7%)*	2.60 ± 0.23 *(8.8%)*	4.43 ± 0.34 *(7.7%)*

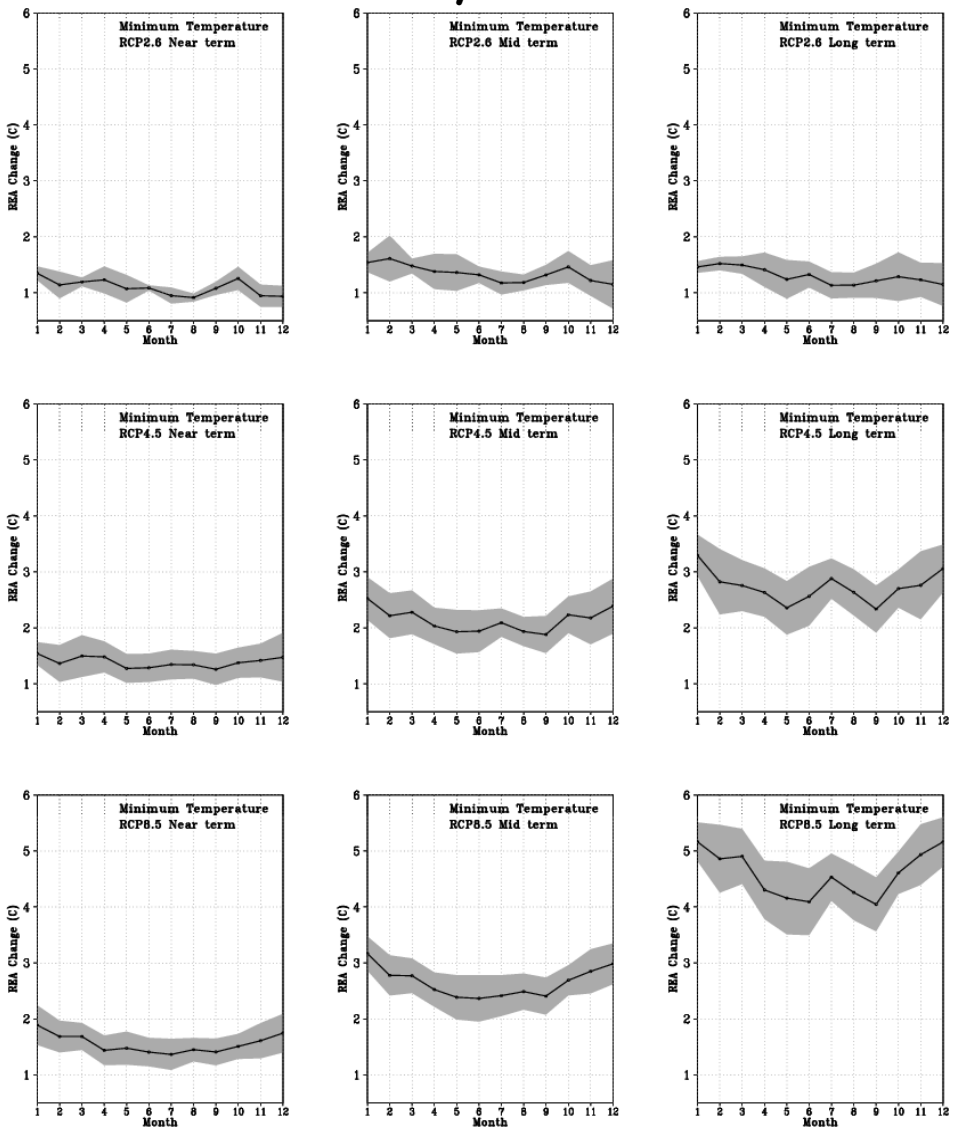
- ***The REA changes for all India annual minimum temperature are more pronounced***

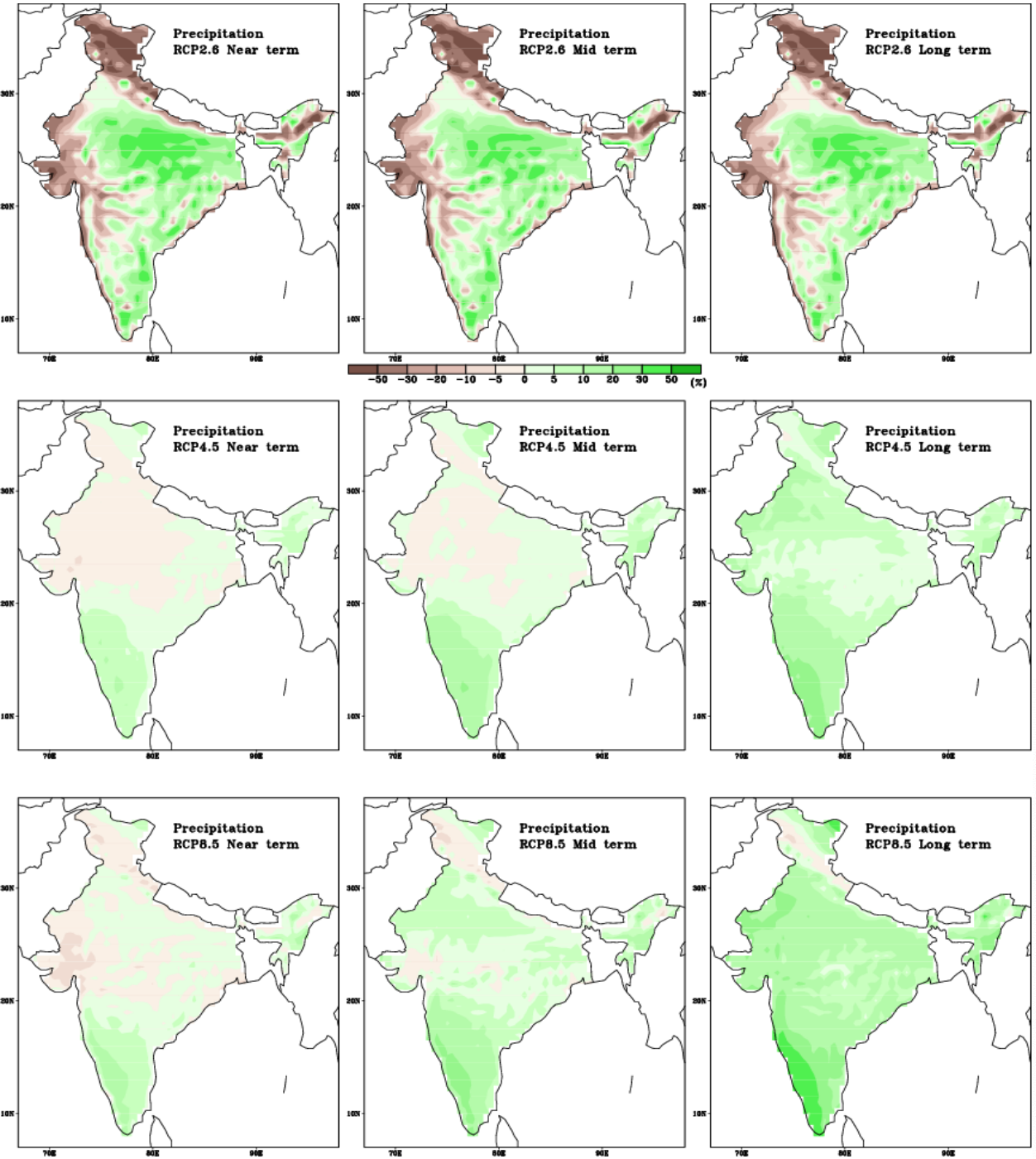
CORDEX South Asia multi-RCM reliability ensemble average (REA) estimate of projected monthly change of all India averaged monthly surface air temperature (°C; solid lines) and the associated uncertainty range (shading) for near-term (2016-2045), mid-term (2036–2065) and long-term (2066–2095) climate under RCP2.6, RCP4.5 and RCP8.5 scenarios, relative to 1976–2005.

Monthly maximum



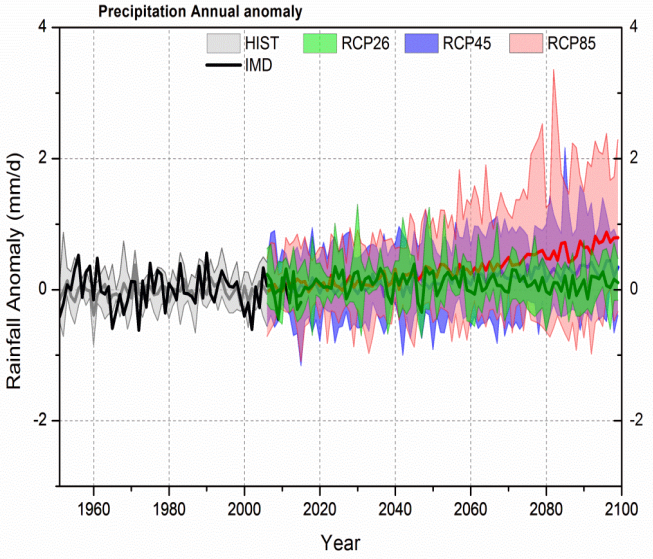
Monthly minimum





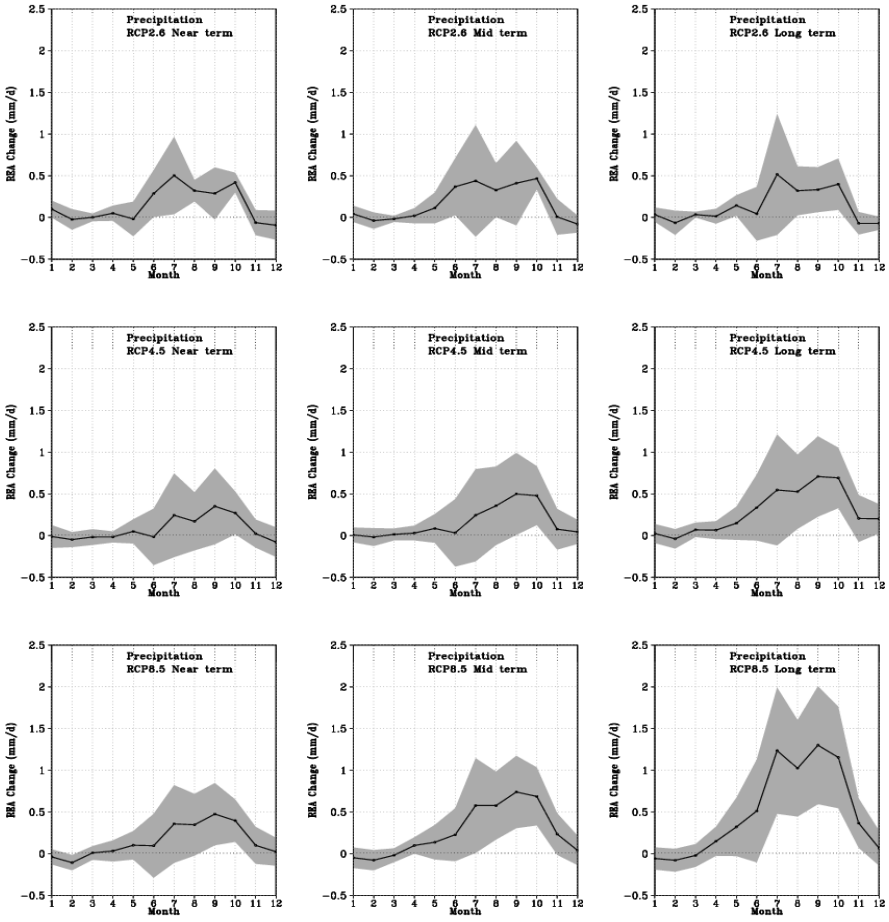
CORDEX South Asia multi-RCM ensemble mean projections of average percent changes in annual mean precipitation for near-term (2016-2045), mid-term (2036–2065) and long-term (2076–2095) climate under RCP2.6, RCP4.5 and RCP8.5 scenarios, relative to 1976–2005.

- The long-term projected annual precipitation increase exceeds 30% along the west coast of India for the high-emission scenario.



CORDEX South Asia multi-RCM reliability ensemble average (REA) estimates of projected changes in annual mean precipitation over India and the associated uncertainty range. The values in parenthesis show the uncertainty in percent for the REA estimate.

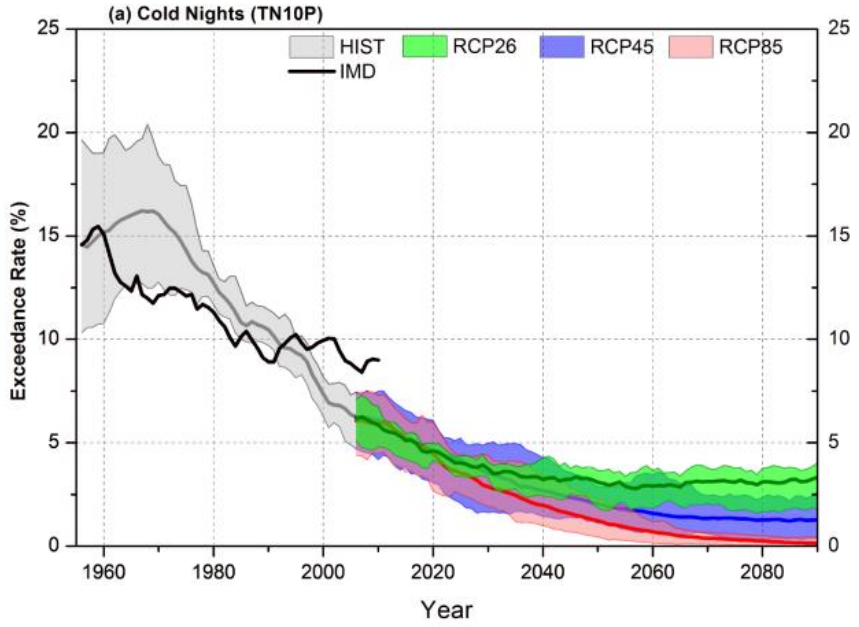
Scenario	Annual Mean Precipitation (mm day^{-1})		
	2030s	2050s	2080s
RCP2.6	0.16 ± 0.12 *(75%)*	0.15 ± 0.17 *(113%)*	0.14 ± 0.13 *(93%)*
RCP4.5	0.07 ± 0.14 *(200%)*	0.15 ± 0.19 *(127%)*	0.30 ± 0.21 *(70%)*
RCP8.5	0.15 ± 0.15 *(100%)*	0.27 ± 0.19 *(70%)*	0.55 ± 0.32 *(58%)*

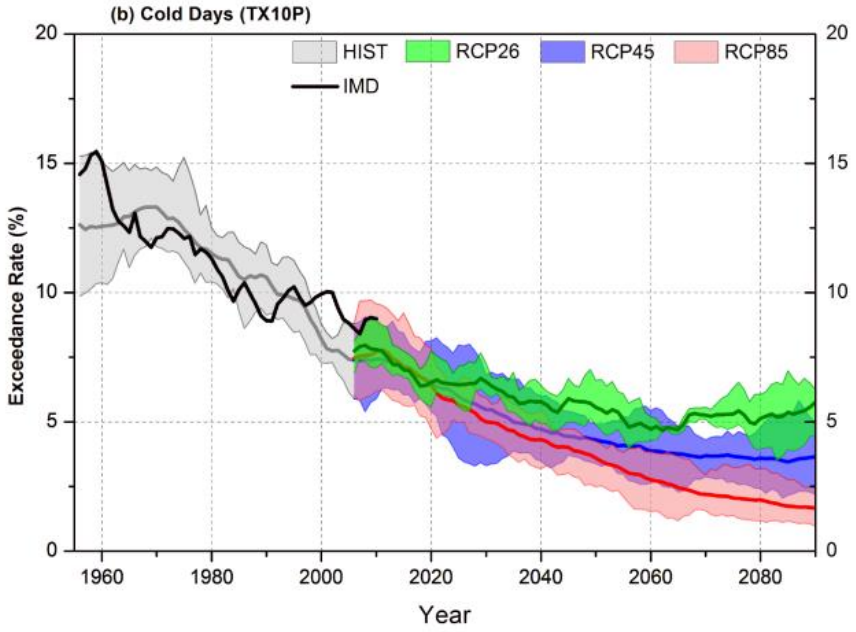


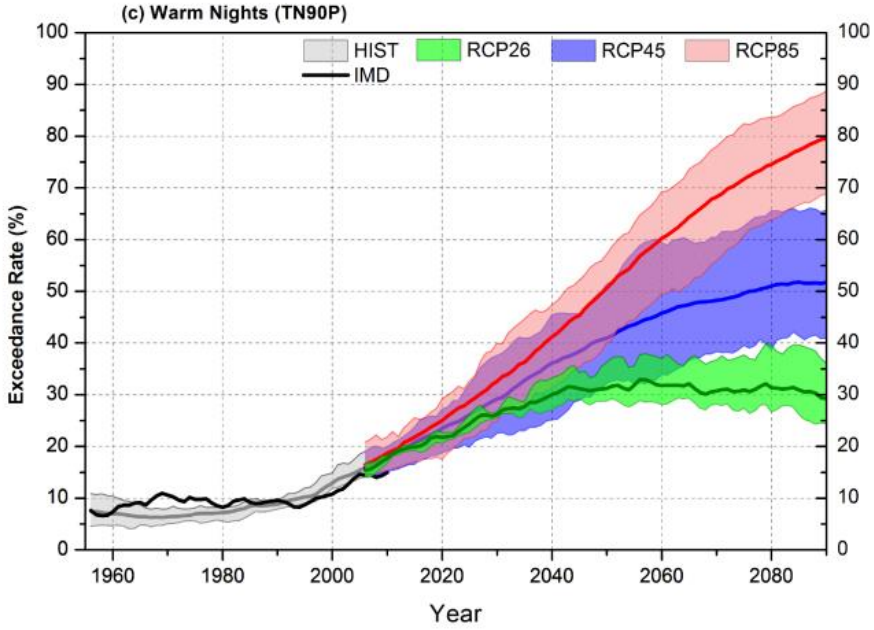
CORDEX South Asia multi-RCM REA estimate of projected monthly change of all India averaged monthly precipitation (mm d^{-1}; solid lines) and the associated uncertainty range (shading) for near-term (2016-2045), mid-term (2036–2065) and long-term (2066–2095) climate under RCP2.6, RCP4.5 and RCP8.5 scenarios, relative to 1976–2005.

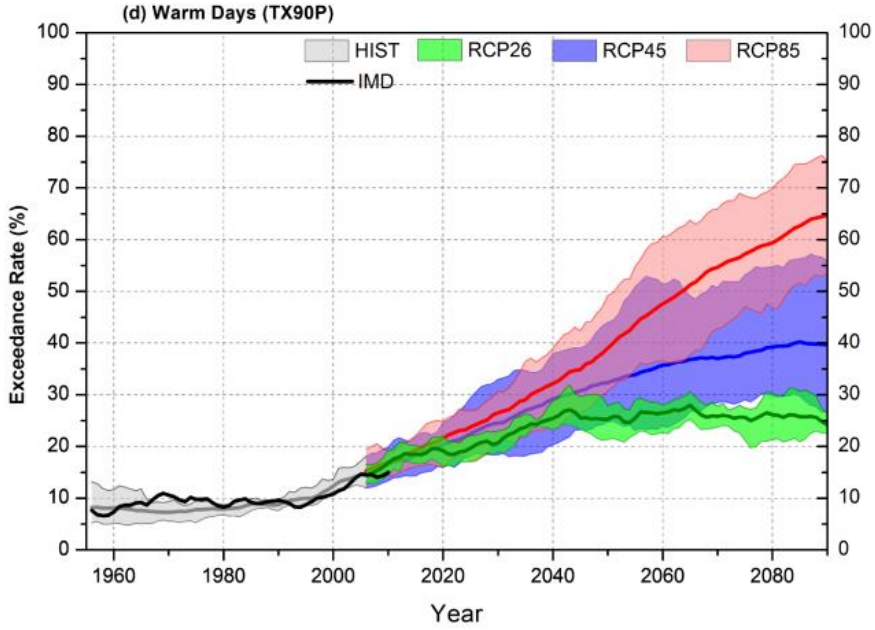
- Although the all India annual precipitation is found to increase as temperature increases, the REA assessment indicates that precipitation changes throughout the 21st century remain highly uncertain.

India averages of temperature indices over land as simulated by the CORDEX South Asia multi-RCM ensemble



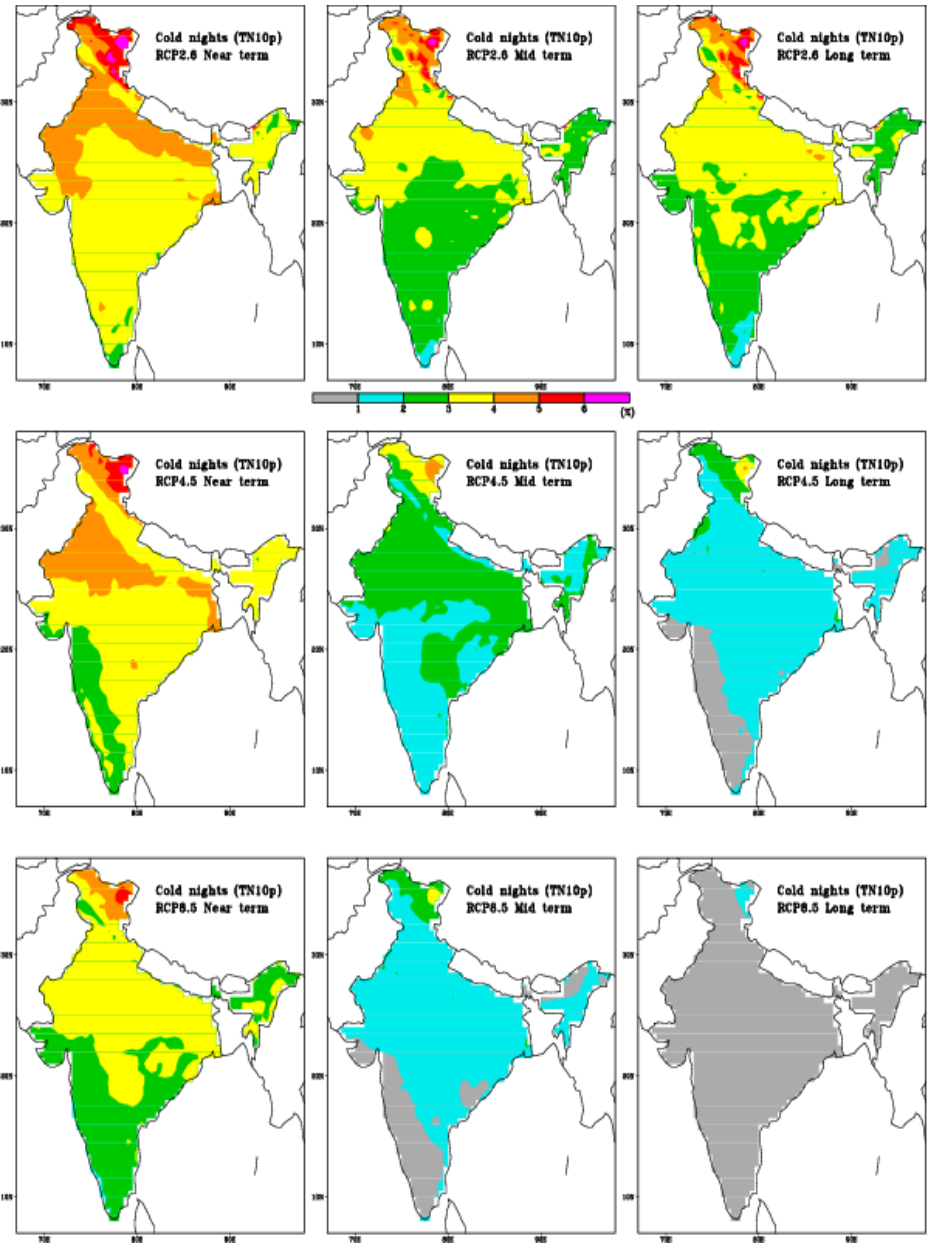




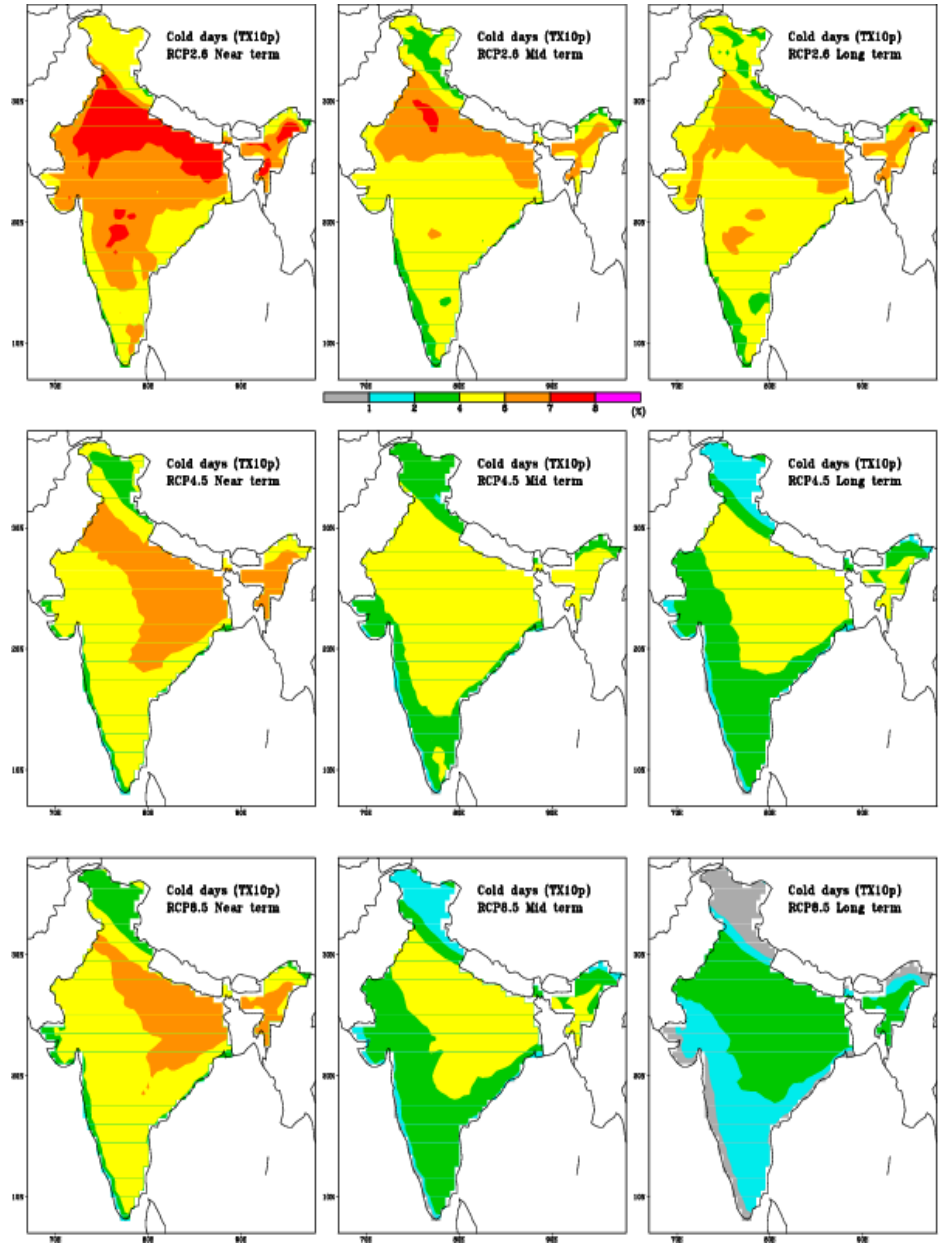


CORDEX South Asia multi-RCM ensemble mean of the annual frequency of

Cold nights (TN10p)

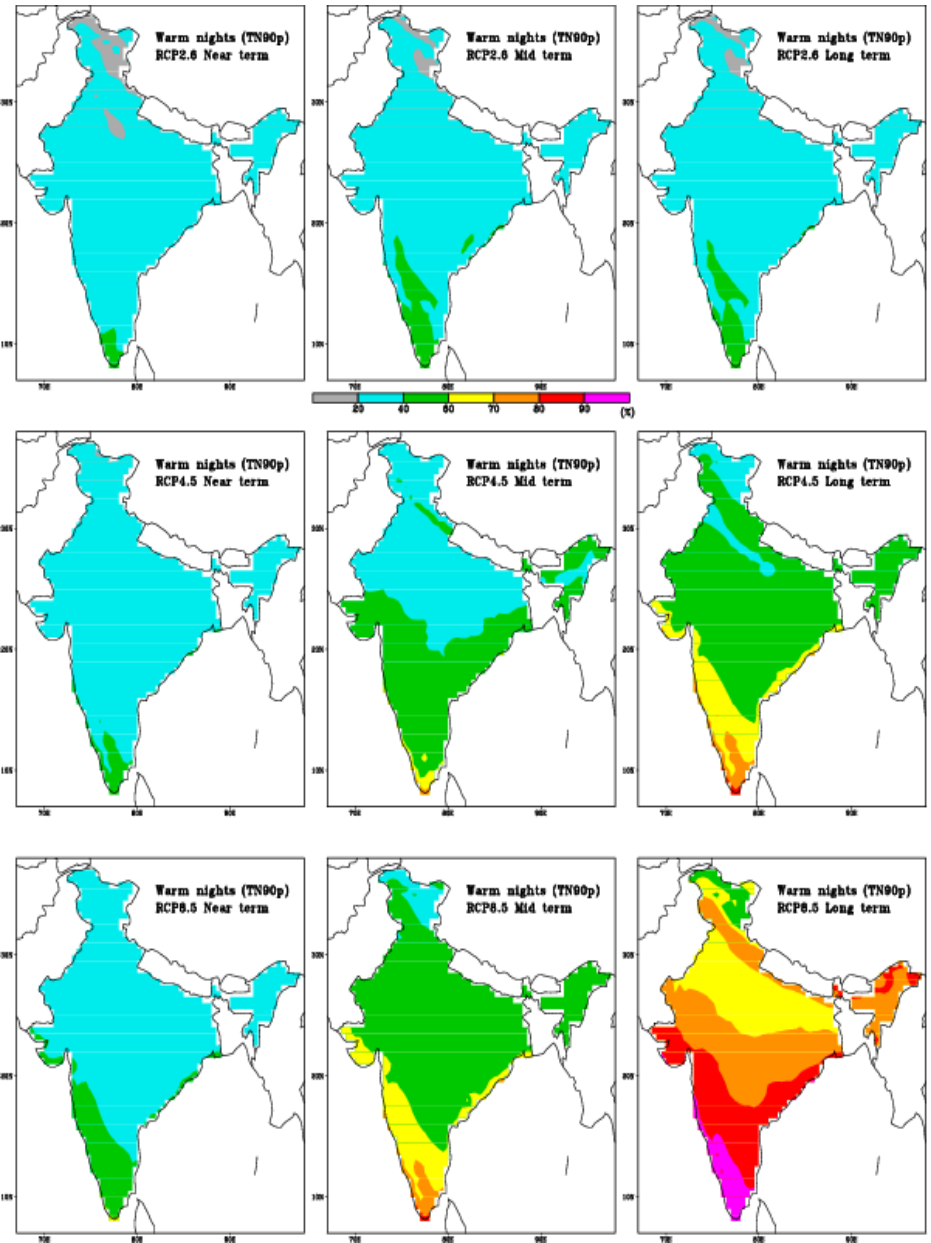


Cold days (TX10p)

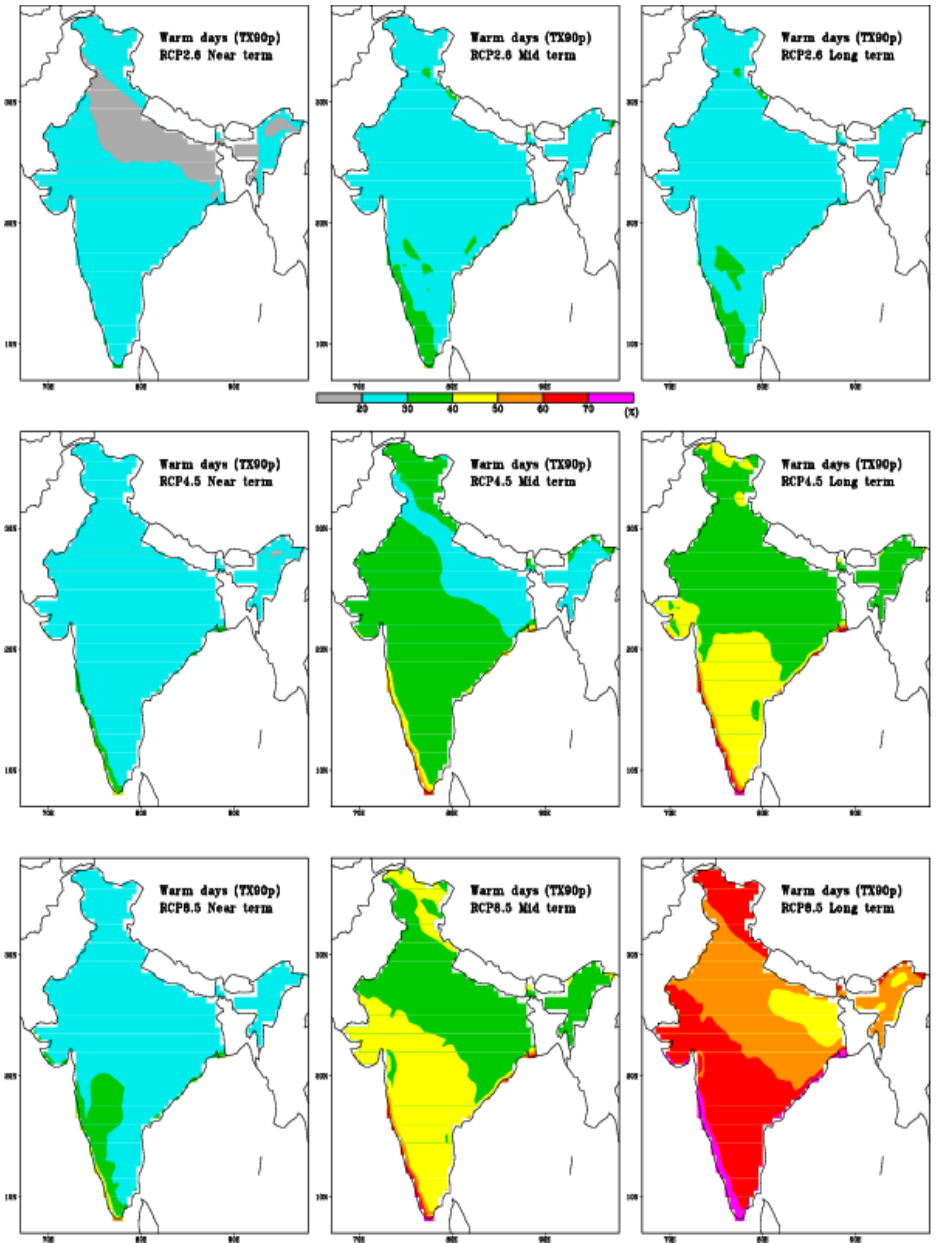


CORDEX South Asia multi-RCM ensemble mean of the annual frequency of

Warm nights (TN90p)

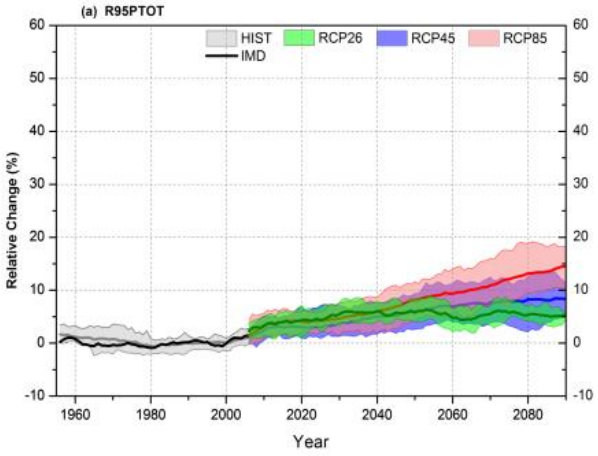


Warm days (TX90p)

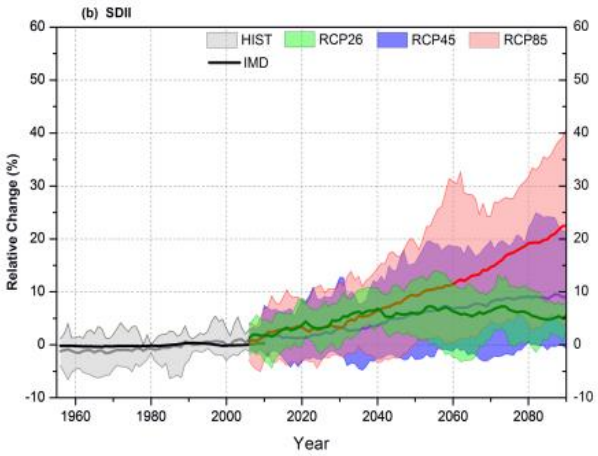


India averages of precipitation indices over land as simulated by the CORDEX South Asia multi-RCM ensemble

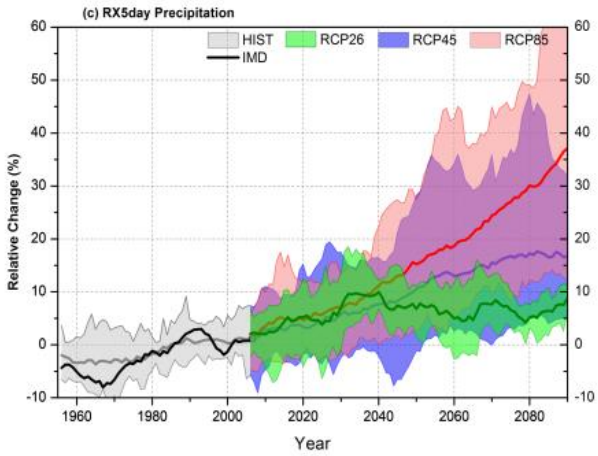
Contribution of very wet days to total wet day precipitation (R95PTOT)



Simple daily intensity index (SDII)

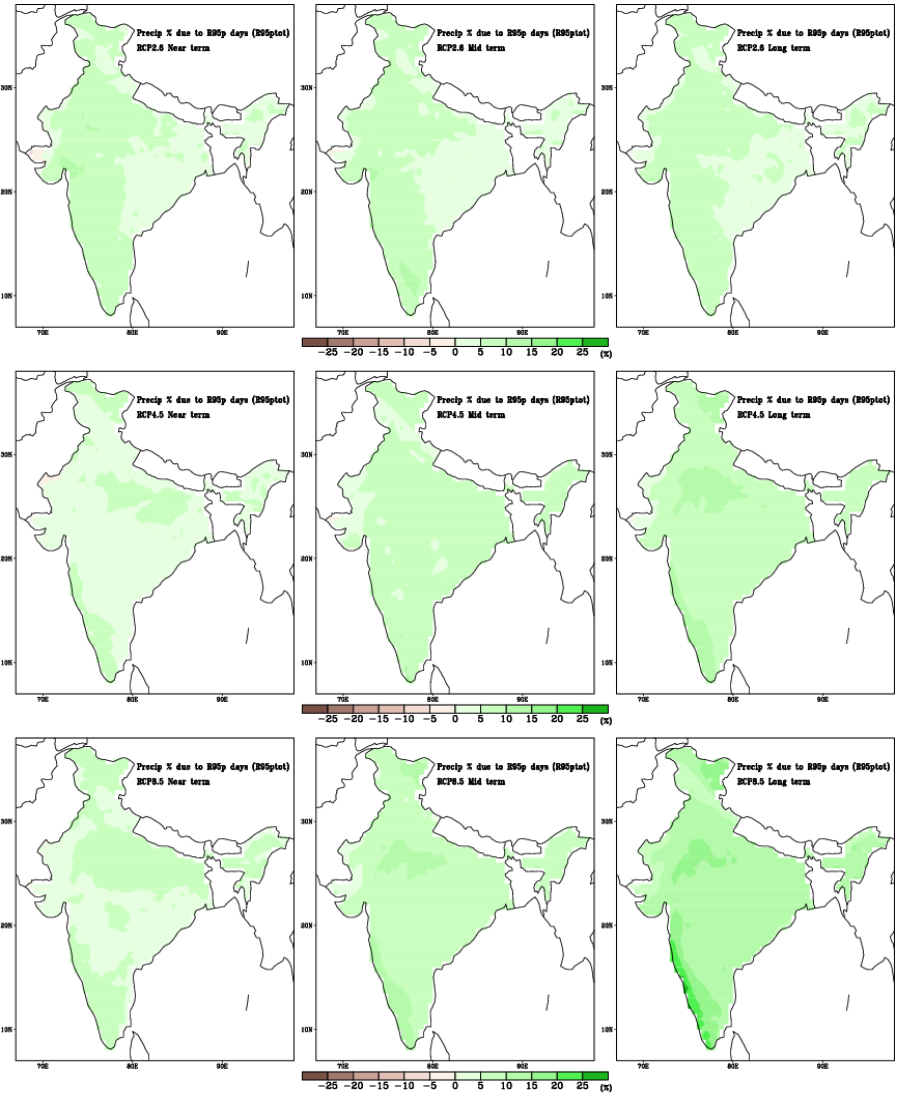


Maximum 5-day precipitation (RX5day)

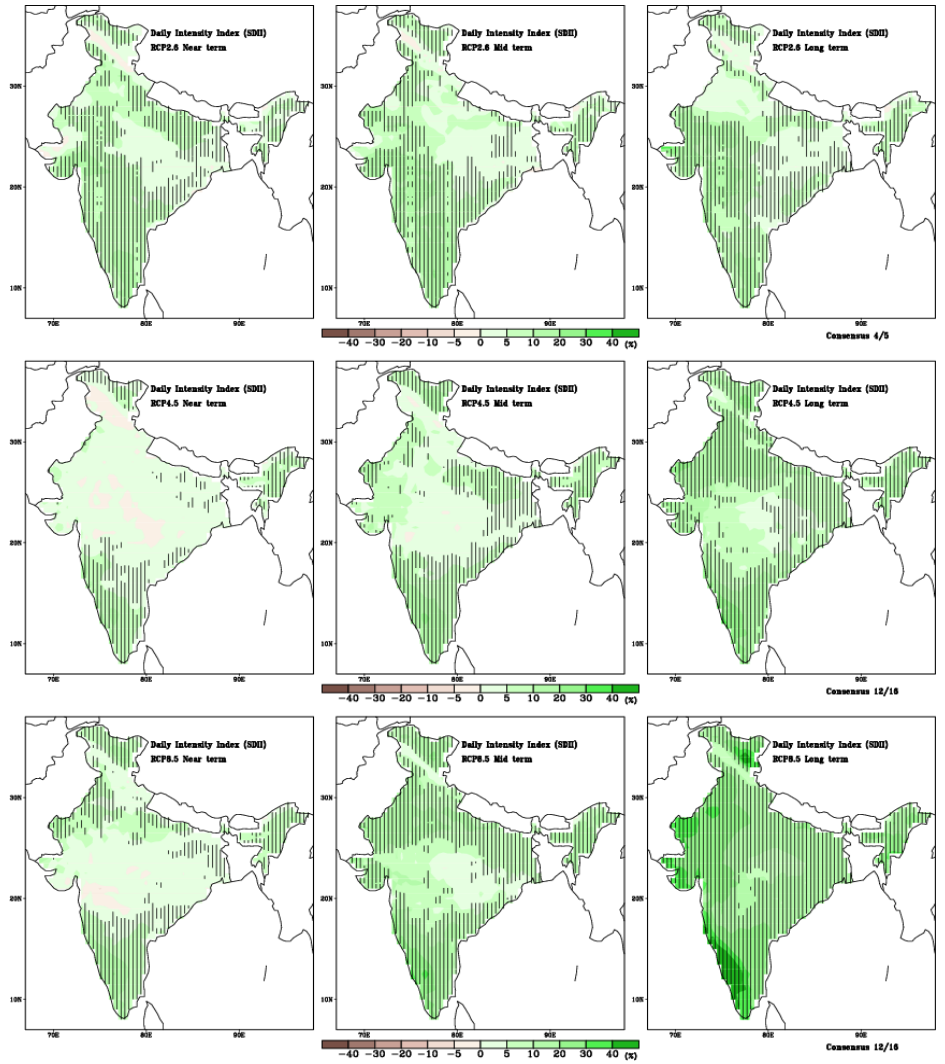


CORDEX South Asia multi-RCM ensemble mean for the absolute precipitation indices

Contribution of very wet days to total wet day precipitation (R95PTOT)

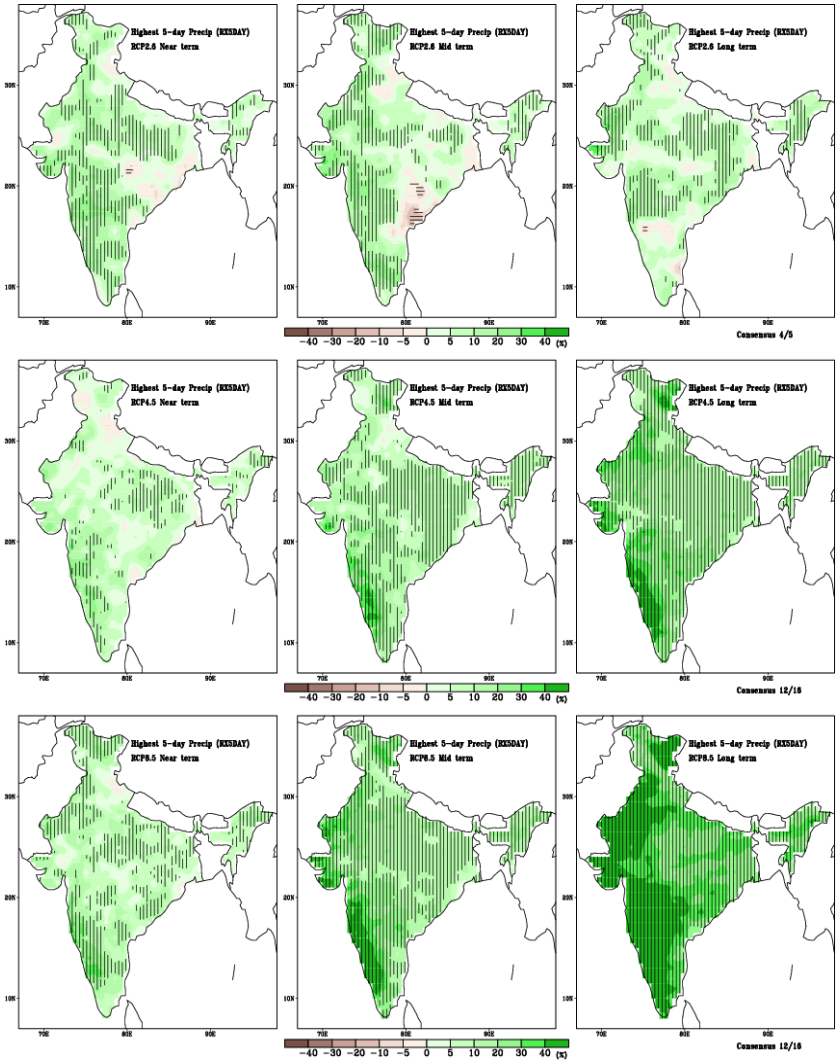


Simple daily intensity index (SDII)

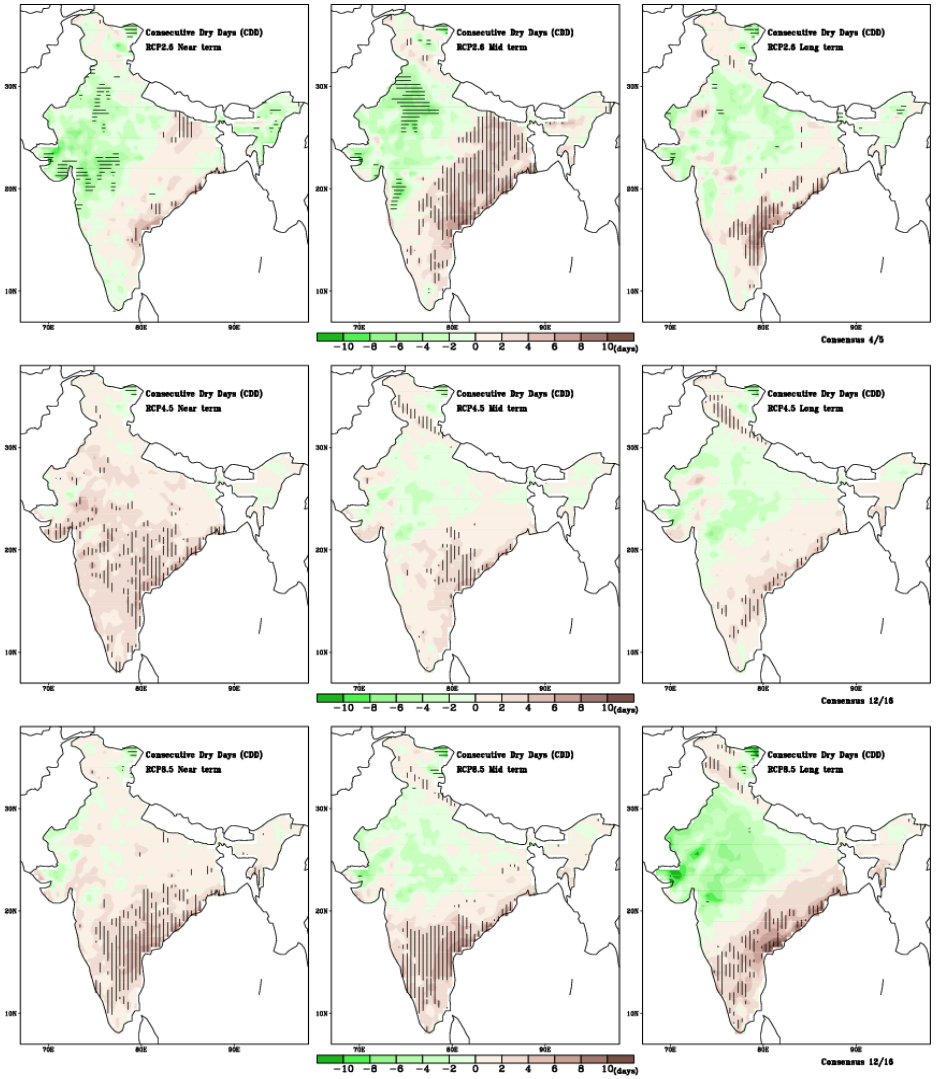


CORDEX South Asia multi-RCM ensemble mean for the absolute precipitation indices

Maximum 5-day precipitation (RX5day)



Maximum number of consecutive dry days (CDD)



- The increases in CDD combined with increases in RX5day indicates an intensification of both dry and wet seasons along the west coast and the adjoining peninsular region over India

Centre for Climate Change Research
Indian Institute of Tropical Meteorology, Pune, India

ESSO

Ministry of Earth Sciences

Thanks to:

S. Ingle

M. Mujumdar

- **CORDEX South Asia data (50km) is available on the CCCR-IITM Climate Data Portal (non-ESGF):**

About Climate Data Portal http://cccr.tropmet.res.in/home/old_portals.jsp

The CCCR Climate Data Portal is designed to facilitate the dissemination of climate information using a publicly accessible FTP and web-based interface. click here

CORDEX-South Asia Multi Model Output http://cccr.tropmet.res.in/home/ftp_data.jsp

Evaluation Runs (1989 - 2008) | Historical Runs (1950 - 2005) | RCP4.5 Scenario Runs | RCP8.5 Scenario Runs

Historical (1950-2005)

Experiment Name	Rain fall (pr)	Surface Air Temp (tas)	Surface Air Temp. Maximum (tasmax)	Surface Air Temp. Minimum (tasmin)	Sea-level Pressure (psl)	Surface Specific Humidity (huss)	Surface Zonal Wind (uas)	Surface Meridonial Wind (vas)	Downward Shortwave Radiation (rsds)
RCA4(ICHEC)	✓	✓	✓	✓	✓	✓	✓	✓	--
RegCM4(GFDL)	✓	✓	✓	✓	✓	✓	✓	✓	✓
RegCM4(LMDZ)	✓	✓	✓	✓	✓	✓	✓	✓	✓
CCLM4(MPI)	✓	✓	--	--	✓	✓	--	--	--
LMDZ4(IPSL)	✓	✓	✓	✓	✓	✓	✓	✓	--
REMO2009 (MPI)	✓	✓	✓	✓	✓	✓	✓	✓	✓
CCAM(ACCESS)	✓	--	✓	✓	✓	--	--	--	--
CCAM(CNRM)	✓	--	✓	✓	✓	--	--	--	--
CCAM(CCSM)	✓	--	✓	✓	✓	--	--	--	--
CCAM(GFDL)	✓	--	✓	✓	✓	--	--	--	--
CCAM(MPI)	✓	--	✓	✓	✓	--	--	--	--
CCAM(BCCR)	✓	--	✓	✓	✓	--	--	--	--

Table: List of CORDEX South Asia Regional Climate Model (RCM) Experiments

Experiment Name	RCM Description	Driving GCM	Contributing Institute
CCLM4(MPI)	COnsortium for Small-scale MOdelling (COSMO) model in CLimate Mode version 4.8 (CCLM; Dobler and Ahrens, 2008)	Max Planck Institute for Meteorology, Germany, Earth System Model (MPI-ESM-LR; Giorgetta et al 2013)	Institute for Atmospheric and Environmental Sciences (IAES), Goethe University, Frankfurt am Main (GUF), Germany
RCA4(ICHEC)	Rossby Centre regional atmospheric model version 4 (RCA4; Samuelsson et al., 2011)	Irish Centre for High-End Computing (ICHEC), European Consortium ESM (EC-EARTH; Hazeleger et al. 2012)	Rosssy Centre, Swedish Meteorological and Hydrological Institute (SMHI), Sweden
CCAM(ACCESS)	Commonwealth Scientific and Industrial Research Organisation (CSIRO), Conformal-Cubic Atmospheric Model (CCAM; McGregor and Dix, 2001)	ACCESS1.0	CSIRO Marine and Atmospheric Research, Melbourne, Australia
CCAM(CNRM)		CNRM-CM5	
CCAM(CCSM)		CCSM4	
CCAM(GFDL)		GFDL-CM3	
CCAM(MPI)		MPI-ESM-LR	
CCAM(BCCR)		NorESM-M	
LMDZ4(IPSL)	Institut Pierre-Simon Laplace (IPSL) Laboratoire de Me´te´orologie Dynamique Zoomed version 4 (LMDZ4) atmospheric general circulation model (Sabin et al., 2013)	IPSL Coupled Model version 5 (IPSL-CM5-LR; Dufresne et al. 2013)	Centre for Climate Change Research (CCCR), Indian Institute of Tropical Meteorology (IITM), India
RegCM4(LMDZ)	The Abdus Salam International Centre for Theoretical Physics (ICTP) Regional Climatic Model version 4 (RegCM4; Giorgi et al., 2012)	IPSL LMDZ4	CCCR, IITM
RegCM4(GFDL)	ICTP RegCM4	Geophysical Fluid Dynamics Laboratory, USA, Earth System Model (GFDL-ESM2M-LR; Dunne et al. 2012)	CCCR, IITM
REMO2009(MPI)	MPI Regional model 2009 (REMO2009; Weblink: http://cccr.tropmet.res.in/cordex/docs/REMO-CORDEX-DATA-WAS-IITM_4.pdf	MPI-ESM-LR (Giorgetta et al 2013)	Climate Service Center, Hamburg, Germany

http://cccr.tropmet.res.in/home/docs/cordex/Table_CORDEX_Expts_all.doc

Development of CCCR-IITM Earth System Grid Federation (ESGF) node

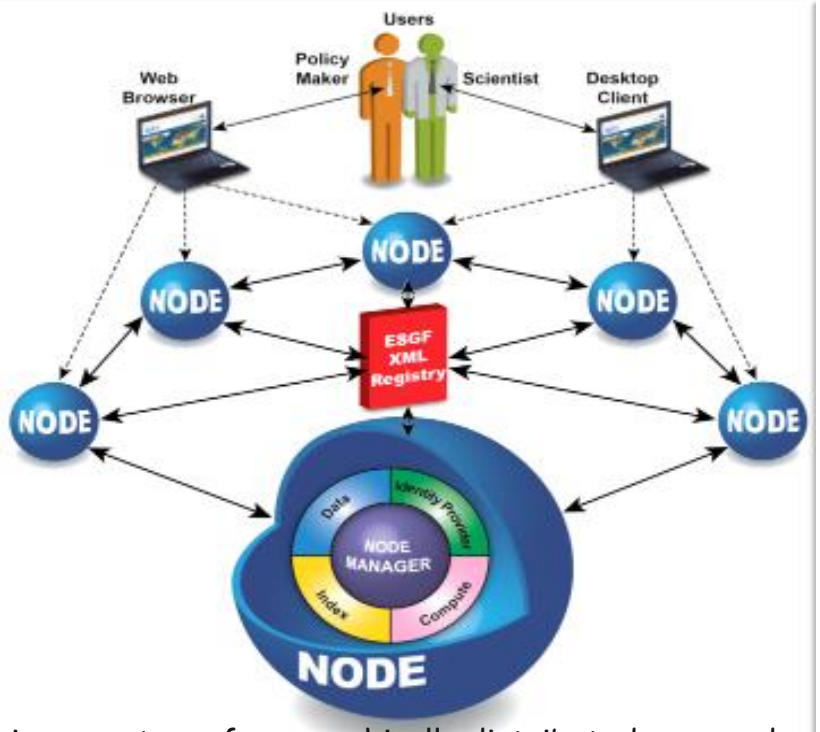
Thanks to:

Sandip Ingle, R.Mahesh (CCCR, IITM)

Prashanth Dwarakanath (NSC, SMHI)

Nikulin Grigory (SMHI)

- **Archival, Management, Retrieval and Dissemination of CORDEX South Asia and CMIP6 datasets**
- **ESGF is an international collaboration for the software that powers most global climate change research, notably assessments by the IPCC**



Using a system of geographically distributed peer nodes—independently administered yet united by common protocols and interfaces—the ESGF community holds the premier collection of simulations and observational and reanalysis data for climate change research

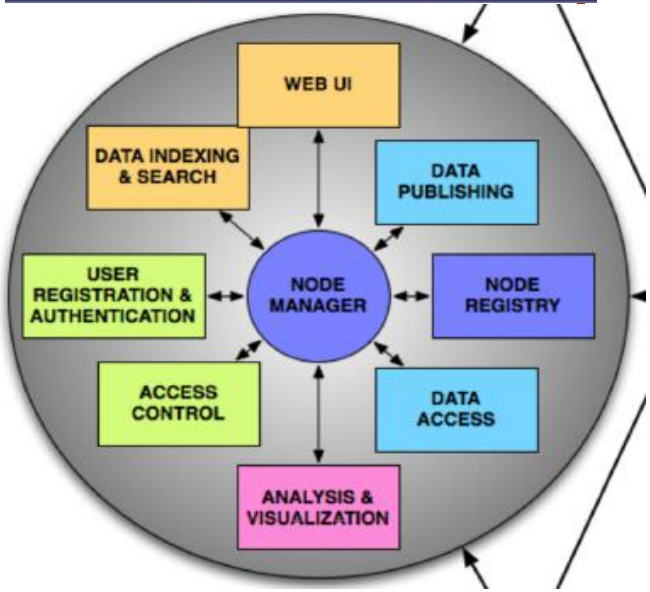
http://esgf.llnl.gov/mission.html

ESGF Earth System Grid Federation

CCCR Centre for Climate Change Research - IITM

Peer Nodes

- ANL Node
- BADC Node
- BNU Node
- CCCR-IITM Node
- CMCC Node
- DKRZ Node
- DMI Node
- E_INIS-ICHEC Node
- IPSL Node
- NASA-GSFC Node
- NASA-JPL Node
- NCI Node
- NERSC Node
- NOAA-ESRL Node
- NOAA-GFDL Node
- ORNL Node
- PCMDI Node
- PIK Node
- SMHI-LIU-NSC Node
- UIO Node
- UNICAN Node



The quality checked CORDEX-South Asia Data are published on the CCCR-IITM Earth System Grid Federation (ESGF) Data Node

The ESGF maintains a global system of federated data centers that allow access to the largest archive of climate data world-wide

http://cccr.tropmet.res.in/home/cordexsa_datasets.jsp

CORDEX South Asia RCM	RCM Description	Contributing CORDEX Modeling Center	Driving CMIP5 AOGCM (see details at https://verc.enes.org/data/enes-model-data/cmip5/resolution)	Contributing CMIP5 Modeling Center
IITM-RegCM4 (6 ensemble members)	The Abdus Salam International Centre for Theoretical Physics (ICTP) Regional Climatic Model version 4 (RegCM4; Giorgi et al., 2012)	Centre for Climate Change Research (CCCR), Indian Institute of Tropical Meteorology (IITM), India	CCCma-CanESM2	Canadian Centre for Climate Modelling and Analysis (CCCma), Canada
			NOAA-GFDL-GFDL-ESM2M	National Oceanic and Atmospheric Administration (NOAA), Geophysical Fluid Dynamics Laboratory (GFDL), USA
			CNRM-CM5	Centre National de Recherches Me´te´orologiques (CNRM), France
			MPI-ESM-MR	Max Planck Institute for Meteorology (MPI-M), Germany
			IPSL-CM5A-LR	Institut Pierre-Simon Laplace (IPSL), France
			CSIRO-Mk3.6	Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia
SMHI-RCA4 (6 ensemble members)	Rossby Centre regional atmospheric model version 4 (RCA4; Samuelsson et al., 2011)	Rosssy Centre, Swedish Meteorological and Hydrological Institute (SMHI), Sweden	ICHEC-EC-EARTH	Irish Centre for High-End Computing (ICHEC), European Consortium (EC)
			MIROC-MIROC5	Model for Interdisciplinary Research On Climate (MIROC), Japan Agency for Marine-Earth Sci. & Tech., Japan
			NOAA-GFDL-GFDL-ESM2M	NOAA, GFDL, USA
			CNRM-CM5	CNRM, France
			MPI-ESM-LR	MPI-M, Germany
			IPSL-CM5A-MR	IPSL, France
MPI-CSC-REMO2009 (1 ensemble member)	MPI Regional model 2009 (REMO2009; Teichmann et al., 2013)	Climate Service Center (CSC), Germany	MPI-ESM-LR	MPI-M, Germany

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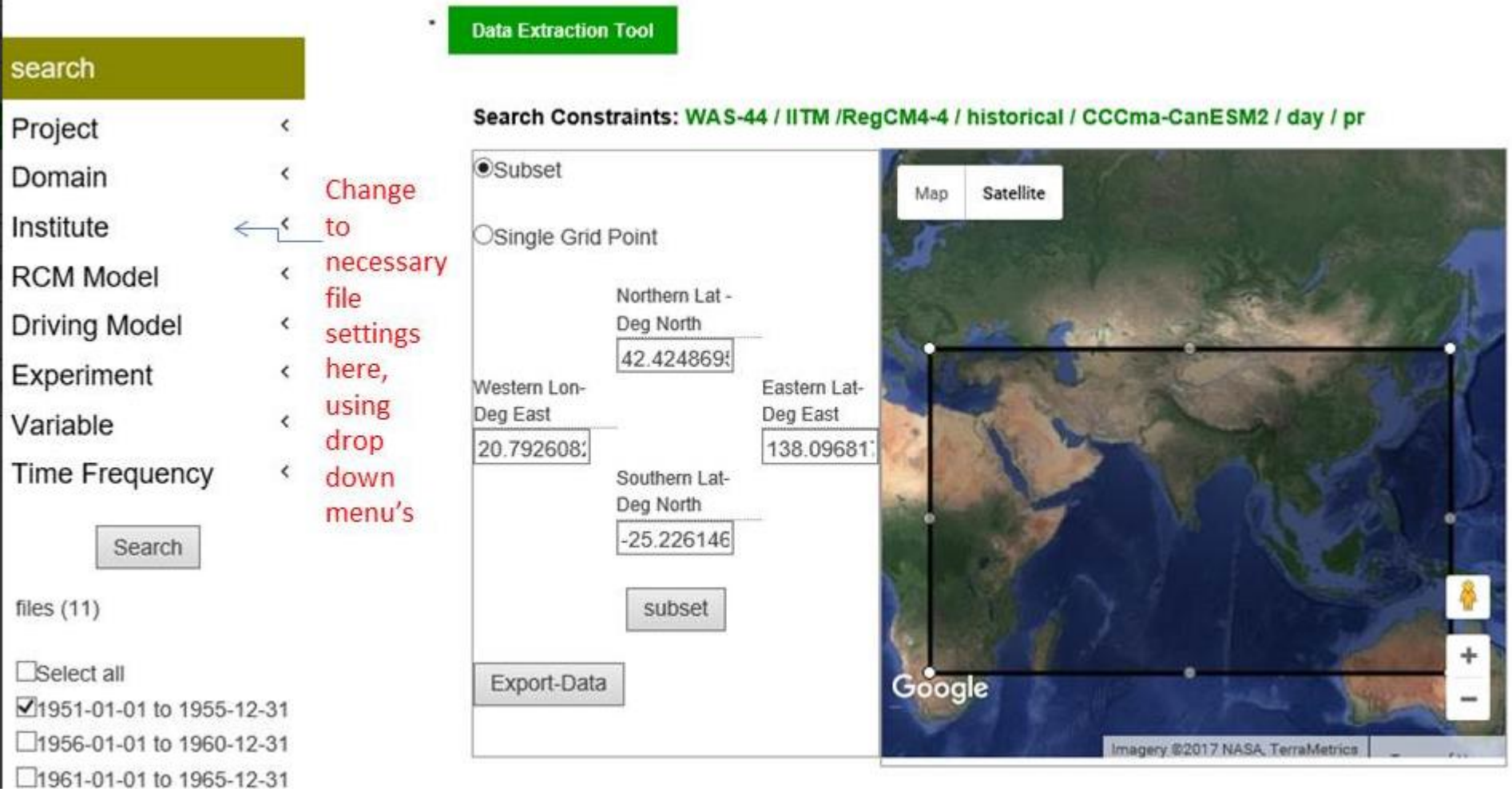
Indian Institute of Tropical Meteorology, Pune, India

http://cccr.tropmet.res.in/home/data_cccrdx.jsp

This is a trial version of a Web Interface based on python under development by CCCR-IITM for users to explore and remotely access subsets (some variables in a particular region for a particular time slice) of authorised datasets available on ESGF in the framework of CORDEX South Asia simulations, and download the selected subset in CSV, Text or NetCDF data formats.



CORDEX South Asia Related Publications

http://cccr.tropmet.res.in/home/cordexsa_pub.jsp

>> Sanjay, J., Krishnan, R., Shrestha, A.B., Rajbhandari, R., Ren, G.-Y (2017) Downscaled climate change projections for the Hindu Kush Himalayan region using CORDEX South Asia regional climate models. Advances in Climate Change Research, 8, 185-198, DOI: 10.1016/j.accre.2017.08.003.

>> Sanjay, J., R. Krishnan, M.V.S. Ramarao, R. Mahesh, Bhupendra Singh, Jayashri Patel, Sandip Ingle, Preethi Bhaskar, J.V. Revadekar, T.P. Sabin, Milind Mujumdar (2017) Future climate change projections over the Indian region. In Climate Change over India – An Interim Report. Editors: R. Krishnan and J. Sanjay, Published by Centre for Climate Change Research, IITM, pp. 38, available for download at http://cccr.tropmet.res.in/home/reports.jsp

>> Iqbal, W., Syed, F.S., Sajjad, H., Nikulin, G., Kjellström, E., Hannachi1, A (2017) Mean climate and representation of jet streams in the CORDEX South Asia simulations by the regional climate model RCA4. Theor Appl Climatol, 129:1–19, DOI: 10.1007/s00704-016-1755-4

>> Sharma, T., Vittal, H., Chhabra, S., Salvi, K., Ghosh, S. and Karmakar, S. (2017) Understanding the cascade of GCM and downscaling uncertainties in hydro-climatic projections over India. Int. J. Climatol., DOI:10.1002/joc.5361

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Thanks for your attention

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