

IITM-ICTP Advanced School on Earth System Modeling
IITM, Pune

26 July 2016

ESGF for CORDEX

J. Sanjay



Centre for Climate Change Research (CCCR)
Indian Institute of Tropical Meteorology (IITM), Pune
Earth Science System Organisation (ESSO)
Ministry of Earth Sciences (MoES)
Government of India



Table 1. Overview of the 21 CMIP6-Endorsed MIPs endorsed by mid-August 2015. MIPs marked with * are “Diagnostic MIPs”.

<http://www.wcrp-climate.org/modelling-wgcm-mip-catalogue/modelling-wgcm-cmip6-endorsed-mips>



	Short name of MIP	Long name of MIP
1	AerChemMIP	Aerosols and Chemistry Model Intercomparison Project
2	C4MIP	Coupled Climate Carbon Cycle Model Intercomparison Project
3	CFMIP	Cloud Feedback Model Intercomparison Project
4	DAMIP	Detection and Attribution Model Intercomparison Project
5	DCPP	Decadal Climate Prediction Project
6	FAFMIP	Flux-Anomaly-Forced Model Intercomparison Project
7	GeoMIP	Geoengineering Model Intercomparison Project
8	GMMIP	Global Monsoons Model Intercomparison Project
9	HighResMIP	High Resolution Model Intercomparison Project
10	ISMIP6	Ice Sheet Model Intercomparison Project for CMIP6
11	LS3MIP	Land Surface, Snow and Soil Moisture
12	LUMIP	Land-Use Model Intercomparison Project
13	OMIP	Ocean Model Intercomparison Project
14	PMIP	Palaeoclimate Modelling Intercomparison Project
15	RFMIP	Radiative Forcing Model Intercomparison Project
16	ScenarioMIP	Scenario Model Intercomparison Project
17	VolMIP	Volcanic Forcings Model Intercomparison Project
18	CORDEX*	Coordinated Regional Climate Downscaling Experiment
19	DynVar*	Dynamics and Variability of the Stratosphere-Troposphere System
20	SIMIP*	Sea-Ice Model Intercomparison Project
21	VIACS AB*	VIACS Advisory Board for CMIP6

- Building on experience gained in the global modelling community, a coordinated, international effort to objectively assess and intercompare various regional climate downscaling techniques, including both dynamical and statistical approaches
- Provides a means to evaluate their performance, to illustrate benefits and shortcomings of different approaches, to produce multi-model, multi-method based information and to provide a more solid scientific basis for impact assessments and other uses of downscaled climate information.



CORDEX has a set of four goals:

- To better understand relevant regional/local climate phenomena, their variability and changes, through downscaling.
- To evaluate and improve regional climate downscaling models and techniques
- To produce coordinated sets of regional downscaled projections worldwide
- To foster communication and knowledge exchange with users of regional climate information.

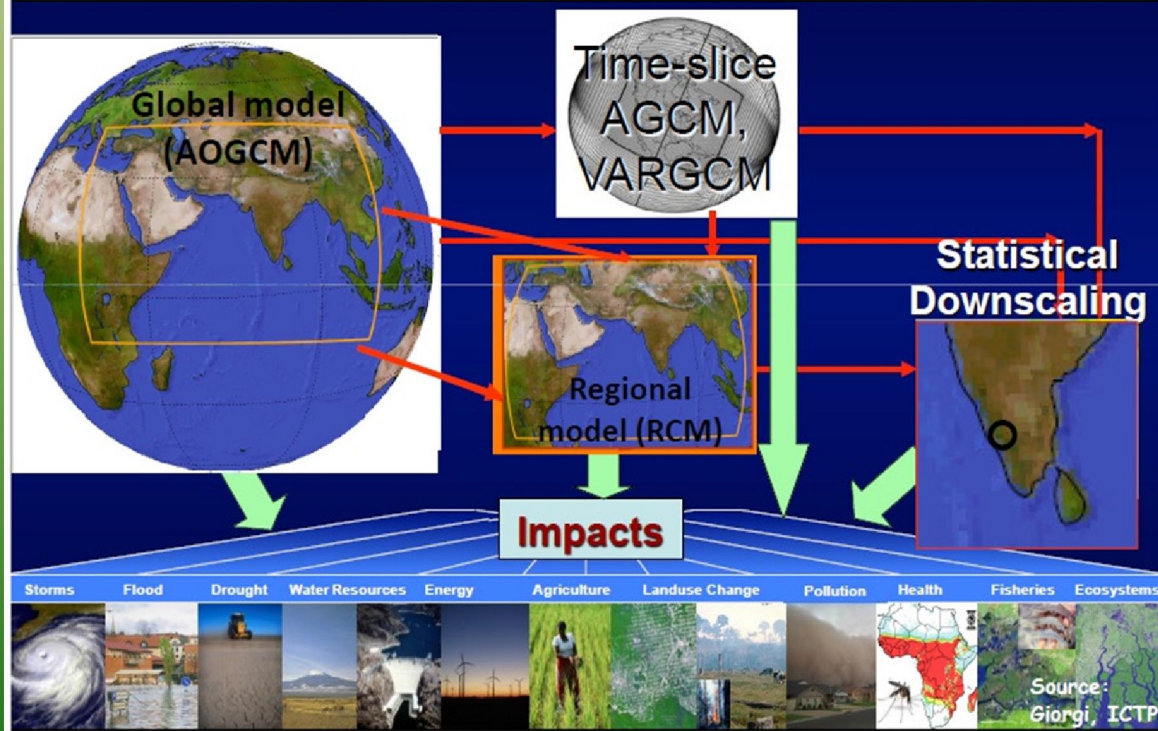
Regional Climate Information for Application Studies

CORDEX South Asia

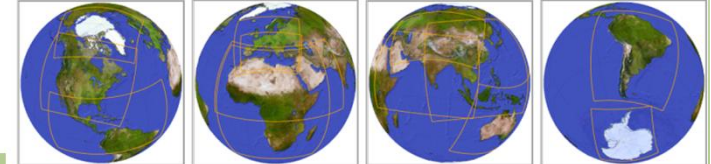


The CORDEX vision is to advance and coordinate the science and application of regional climate downscaling through global partnerships.

Downscaling regional climate information for impact assessment studies



The CORDEX community



The CORDEX community has grown to now include 13 domains;

- Arctic CORDEX
- North America CORDEX
- Central America CORDEX
- EURO-CORDEX
- MED-CORDEX
- CORDEX Africa
- MENA-CORDEX
- Central Asia CORDEX
- South Asia CORDEX
- East Asia CORDEX
- Australasia CORDEX
- South America CORDEX
- CORDEX Antarctica

CCCR is leading CORDEX (Coordinated Regional Climate Downscaling Experiment) over South Asia Region

High Resolution (50 km) Dynamical Downscaling of CMIP5 Climate Projections based on RCP Scenarios during 1950-2100 using multiple RCMs

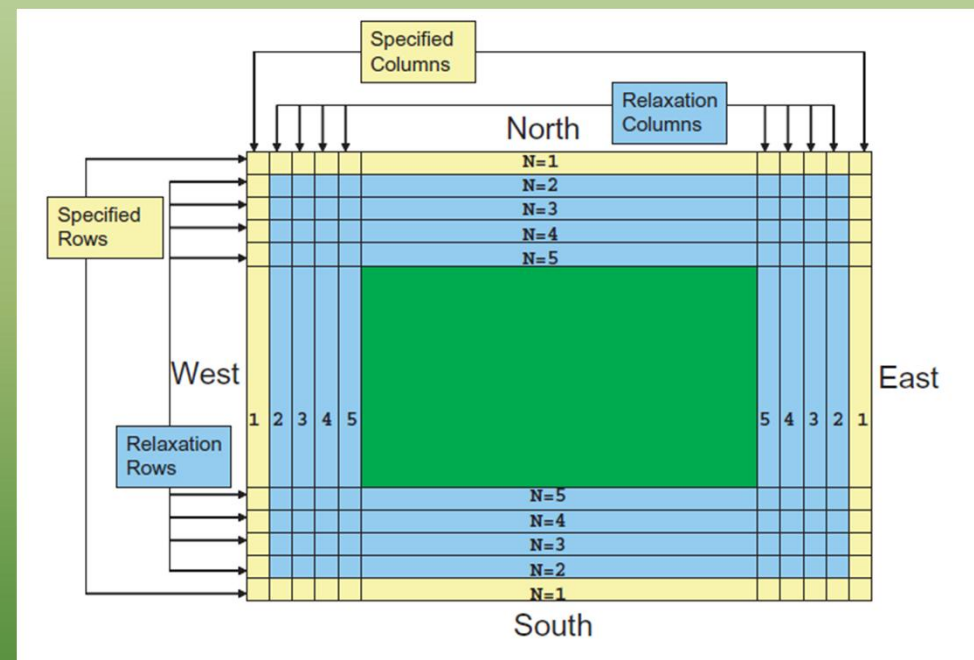
- Dynamical downscaling uses a limited area, high-resolution model (a regional climate model, or RCM) driven by boundary conditions from a GCM to derive smaller-scale information

- Lateral Boundary condition variables:

- Wind
- Temperature
- Water vapour
- Surface pressure

- Lower boundary condition variables:

- SST
- Land Use & Land cover





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

<http://cccr.tropmet.res.in/cordex/files/downloads.jsp>

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)	Rosby 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)	Rosby 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 Météorologie 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



Thanks to:

S. Ingle

M. Mujumdar

CORDEX-South Asia Multi Models Output

Historical (1950 - 2005) | Evaluation Run (1989 - 2008) | RCP 4.5 | RCP 8.5

Historical runs is available to download.

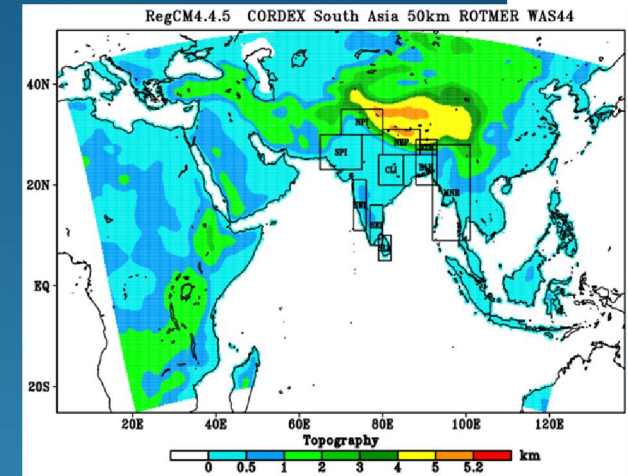
Experiment Name	Rain fall (pr)	Surface Air Temp (tas)	Surface Air Temp. Maximum (tasmax)	Surface Air Temp. Minimum (tasmin)	Sea-level Pressure (psl)	Surface Specific Humidity (huss)	Surface Sonal Wind (uas)	Surface Meridional Wind (vas)	Downward Shortwave Radiation (rsds)
RCA4 (ICHEC)	✓	✓	✓	✓	✓	✓	✓	✓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

Model experiment details please click here ["List of Experiments"](#)

CORDEX South Asia Experiments with IITM-RegCM4 50km



- HPC Resources on IITM Aaditya:
- Configuration: ICTP RegCM4.4.5;
256 X 170 X 18L grids; Dt=60s
- Performance: ~4yr integration/day with 576 cores
(ie.on 36 nodes)
- Disk Storage: ~76GB/year model output



- Completed CMIP5 Downscaling of Historical(56y;1950-2005),
RCP8.5(94y;2006-2099), RCP4.5(94y;2006-2099)
- Driven with 7 CMIP5 AOGCMs: GFDL-ESM2M, CNRM-CM5, CSIRO-Mk3.6,
HadGEM2-ES, MPI-ESM-LR,
IPSL-CM5A-LR & CanESM2

- Total simulation period: 1708 years
- Total Disk Storage: ~150 TB
- Model outputs are being post processed &
extracted for publishing on the

CCCR-IITM ESGF data node

Courtesy: Bhupendra, Ramarao, CCCR



Centre for Climate Change Research - IITM



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



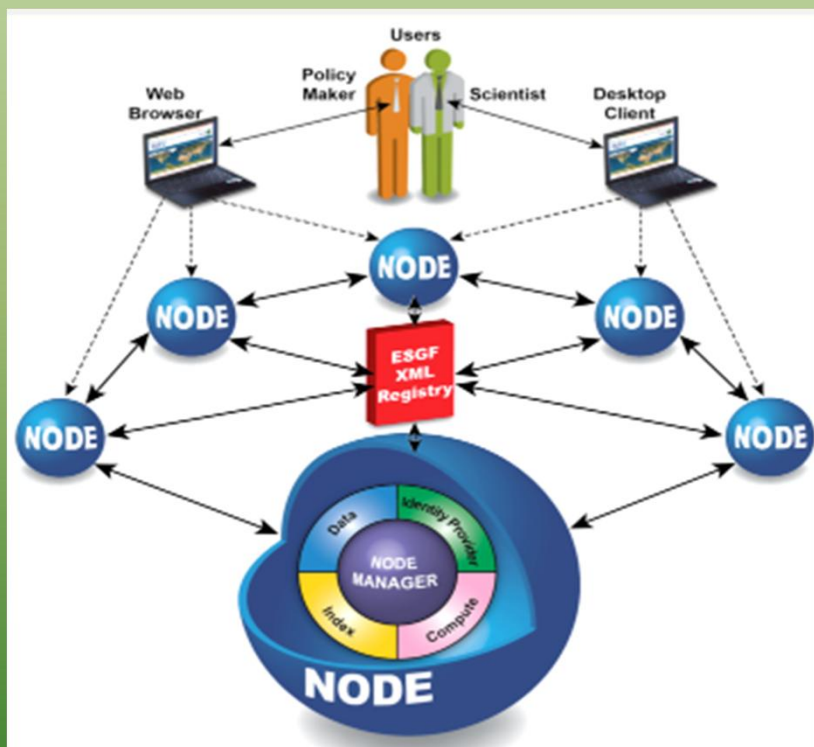
- **Archival, Management, Retrieval and Dissemination of CORDEX South Asia and CMIP6 datasets**
- **ESGF is an international collaboration for the software that powers most global climate change research, notably assessments by the IPCC**

Thanks to:

Sandip Ingle
(CCCR, IITM)

Prashanth Dwarakanath
(NSC, SMHI)

Nikulin Grigory
(SMHI)



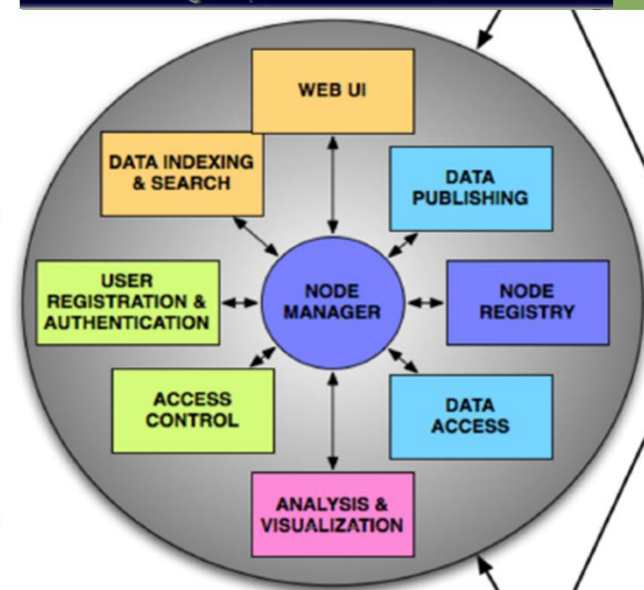
Using a system of geographically distributed peer nodes—independently administered yet united by common protocols and interfaces—the ESGF community holds the premier collection of simulations and observational and reanalysis data for climate change research

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



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



<http://www.cordex.org/>



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Experiment Guidelines ▾

Data access ▾

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Publications ▾

You are here: [Accueil](#) > [Experiment Guidelines](#) > [Experiment Protocol - RCMs](#)

Experiment Protocol - RCMs

The document below describes the recommended scenarios, resolution, and time periods that should be utilised.

- [General instructions for CORDEX integrations](#)

CORDEX Archive specification

The [CORDEX Archive specification document](#) specifies technical aspects of CORDEX archive file and data formats, as well as archive content. It includes a common naming system, the Data Reference Syntax (DRS), which allows the identification of data sets wherever they might be located in a distributed CORDEX archive.

Variables requirements

The [CORDEX Variables requirement document](#) defines what CORDEX simulation variables should be saved, their attributes (including short name, long name, units) and time resolution.

Experiment Guidelines

- ⌵ Experiment protocol - RCMs
- ⌵ How to submit data - RCMs
- ⌵ Experiment Protocol - ESD
- ⌵ Flagship Pilot Studies

Data Amounts CMIP3/CMIP5

Source: DKRZ

- CMIP3 / IPCC-AR4 (Report 2007)
 - Participation: 17 modelling centres with 25 models
 - In total 36 TB model data central at PCMDI and ca. ½ TB in IPCC DDC at WDCC/DKRZ as reference data
- CMIP5 / IPCC-AR5 (Report 2013/2014)
 - Participation: 29 modelling groups with 61 models
 - Produced data volume: ca. 10 PB with 640 TB from MPI-ESM
 - CMIP5 requested data volume: ca. 2 PB (in CMIP5 data federation)
 - Data volume for IPCC DDC: 1.6 PB (complete quality assurance process) with 60 TB from MPI-ESM
- Status CMIP5 data federated archive (August 2014):
 - 2.3 PB for 69000 data sets stored in 4.3 Mio Files in 23 data nodes
 - CMIP5 data is more than 50 times CMIP3
- Extrapolation for CMIP6 data federation:
 - Volume: 150 PB
 - Number of files: 280 Mio Files

Part of
WDCC/DKRZ

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Welcome to the ESGF Node @ LiU



The Earth System Grid Federation (ESGF) maintains a global system of federated data centers that allow access to the largest archive of climate data world-wide. The ESGF datanode at the National Supercomputer Centre, Linköping, is Sweden's first datanode in the ESGF framework. It is a joint activity of [NSC](#) and the Swedish Meteorological and Hydrological Institute ([SMHI](#)). [NSC](#) is an independent organization within Linköping University ([LiU](#)), and is funded by the Swedish Research Council via [SNIC](#) (Swedish National Infrastructure for Computing).

Projects Hosted at the LiU ESGF Node

The following projects require a CoG Account ([create account](#)) and Group Registration (see links below) to access their data. You do not need to join their project in order to register or download data.

- **CORDEX**: Coordinated Regional Climate Downscaling Experiment
 - [CORDEX Data Access Registration](#) (Research License)
 - [CORDEX Data Access Registration](#) (Commercial License)
 - [CORDEX Data Search](#)
- CMIP5: 5th Coupled Model Intercomparison Project
 - [CMIP5 Data Access Registration](#) (Research License)
 - [CMIP5 Data Access Registration](#) (Commercial License)
 - [CMIP5 Data Search](#)

Related Projects Hosted at Other ESGF Nodes

- **Obs4MIPs**: Observations for Climate Model Intercomparisons

Coming Soon:

- CMIP6: 6th Coupled Model Intercomparison Project

Federated ESGF-CoG Nodes

CoG-CU
 ESGF@CEDA
 ESGF@DKRZ
 ESGF@DOE/LLNL
 ESGF@IPSL
 ESGF@NASA/JPL
 ESGF@NSA/AFSP

Search & Download Data ?

Simple Text Search

Go

Search with options

Browse Projects

[This](#) | [All](#) | [My](#) | [Tags](#)

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Peer projects (5)

[ESGF-CEDA](#)
[ESGF-DKRZ](#)
[ESGF-IPSL](#)
[ESGF-JPL](#)
[ESGF-LLNL](#)

Child projects (3)

[CMIP5](#)
[CORDEX](#)
[SPECS](#)

Start typing, or use the 'Delete' key to show all available tags.

ESGF-LIU Tags: None

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Project

☒ CORDEX (62144)

Product

Institute

Model

Experiment

Experiment Family

Time Frequency

Realm

CMIP Table

Ensemble

Variable

Variable Long Name

CF Standard Name

Driving Model

Datanode

-CORDEX-

Domain

RCM Model

Downscaling realisation

-SPECS-

Start Date

Enter Text:

CORDEX



Search

Reset

Display

10

results per page

Search Constraints: ☐ Show All Replicas ☐ Show All Versions ☐ Search Local Node Only

✖ CORDEX

Total Number of Results: 62144

-1- 2 3 4 5 6 Next >>

Please login to add search results to your Data Cart

Expert Users: you may display the search URL and [return results as XML](#) or [return results as JSON](#)

1. cordex.output.AFR-44i.MOHC.ECMWF-ERAINT.evaluation.r0i0p0.MOHC-HadRM3P.v1.fx.areacella

Data Node: esgf-data1.ceda.ac.uk

Version: 20131211

Total Number of Files (for all variables): 1

[\[Show Metadata \]](#) [\[Show Files \]](#) [\[THREDDS Catalog \]](#) [\[WGET Script \]](#)

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Version: 20131211

Total Number of Files (for all variables): 4

[\[Show Metadata \]](#) [\[Show Files \]](#) [\[THREDDS Catalog \]](#) [\[WGET Script \]](#)

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Data Node: esgf-data1.ceda.ac.uk

Version: 20131211

Total Number of Files (for all variables): 4

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4. cordex.output.AFR-44i.MOHC.ECMWF-ERAINT.evaluation.r0i0p0.MOHC-HadRM3P.v1.fx.rog

Data Node: esgf-data1.ceda.ac.uk

Version: 20131211

Total Number of Files (for all variables): 1

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5. cordex.output.AFR-44i.MOHC.ECMWF-ERAINT.evaluation.r1i1p1.MOHC-HadRM3P.v1.mon.huss

Data Node: esgf-data1.ceda.ac.uk

Version: 20131211

Total Number of Files (for all variables): 4

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6. cordex.output.AFR-44i.MOHC.ECMWF-ERAINT.evaluation.r1i1p1.MOHC-HadRM3P.v1.mon.hus950

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Project

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Institute

☐ IITM (18)

☐ MOHC (251)

☐ MPI-CSC (1040)

☐ SMHI (4720)

Model

Experiment

Experiment Family

Time Frequency

Realm

CMIP Table

Ensemble

Variable

Variable Long Name

CF Standard Name

Driving Model

Datanode

CORDEX

Domain

☒ WAS-44 (3665)

☒ WAS-44i (2364)

RCM Model

Enter Text:

CORDEX



Display

10

results per page

Search Constraints: ☐ Show All Replicas ☐ Show All Versions ☐ Search Local Node Only

✖ CORDEX | ✖ WAS-44, WAS-44i

Total Number of Results: 6029

-1- 2 3 4 5 6 Next >>

Please login to add search results to your Data Cart

Expert Users: you may display the search URL and [return results as XML](#) or [return results as JSON](#)

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☒ IITM (18)	
Model	+
Experiment	+
Experiment Family	+
Time Frequency	+
Realm	
CMIP Table	
Ensemble	+
Variable	+
Variable Long Name	+
CF Standard Name	+
Driving Model	+
Datanode	+

Enter Text: Display

results per page

☐ Show All Replicas☐ Show All Versions☐ Search Local Node Only

Search Constraints: ✖ CORDEX | ✖ WAS-44,WAS-44i | ✖ IITM

Total Number of Results: 18

[-1- 2 Next >>](#)

Please login to add search results to your Data Cart

Expert Users: you may display the search URL and [return results as XML](#) or [return results as JSON](#)

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Version: 20160629
Total Number of Files (for all variables): 5
[\[Show Metadata \]](#) [\[Show Files \]](#) [\[THREDDS Catalog \]](#) [\[WGET Script \]](#)

CORDEX

Domain	-
☒ WAS-44 (18)	
RCM Model	
Downscaling realisation	+

SPECS

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Total Number of Files (for all variables): 5
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6. cordex.output.WAS-44.IITM.ECMWF-ERAINT.evaluation.r1i1p1.RegCM4-1.v411.day.uas
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Version: 20160629
Total Number of Files (for all variables): 5
[\[Show Metadata \]](#) [\[Show Files \]](#) [\[THREDDS Catalog \]](#) [\[WGET Script \]](#)

CORDEX South Asia (WAS-44) Datasets Published on Earth System Grid Federation (ESGF)



Downscaling
RCMs



Driving AOGCMs

Updated: 04/Jan/2016

	ERA-INTERIM	ACCESS1-3	CanESM2	CCSM4	CNRM-CM5	CSIRO-Mk3-6-0	EC-EARTH	GFDL-ESM2M	HadGEM2-ES	IPSL-CM5A-MR	MIROC5	MPI-ESM-LR	NorESM1-M	MPI-ESM-MR	IPSL-CM5A-Li	ACCESS1-0	GFDL-CM3
IITM-RegCM4-4	finished	control RCP2.6 RCP4.5 RCP8.5	finished planning finished finished		finished planning finished published	finished planning finished finished	planning planning planning published	finished planning finished published	finished planning finished finished					finished planning finished finished	finished planning finished finished		
SMHI-RCA4	published		finished finished		published published	finished finished	published published	published published	finished finished	published published	published published	published published	finished finished				
MPI-CSC-REMO2009												published published published published					
IITM-RegCM4-1	published							finished running									
IITM-LMDZ4															finished finished		
CSIRO-CCAM	finished			finished finished finished	finished finished finished							finished finished finished	finished finished finished			finished finished finished	finished finished finished
CLMcom-CCLM4-8-17												finished					

Published:

- Control(1951-2005):7 RCP2.6(2006-2100):3 RCP4.5(2006-2100):7 RCP8.5(2006-2100):7

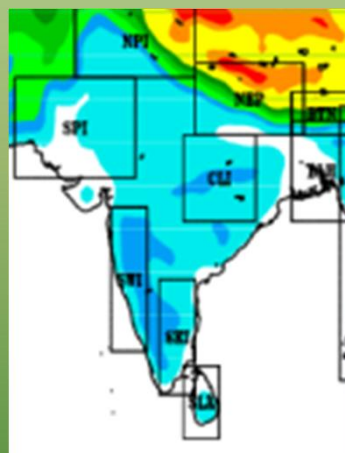
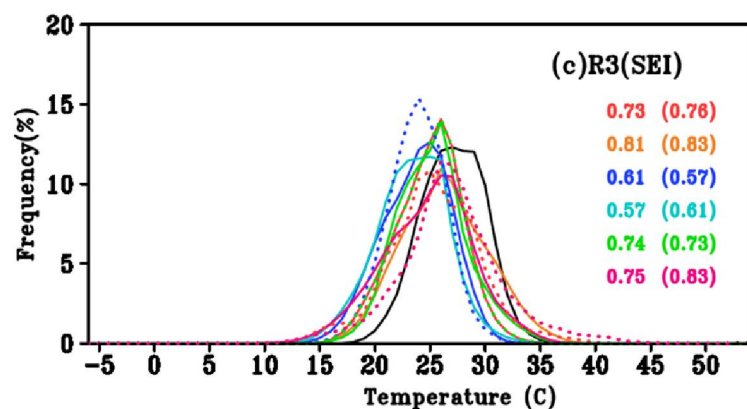
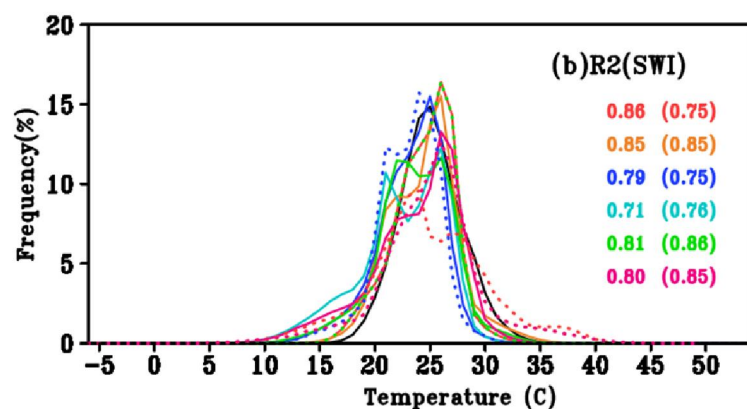
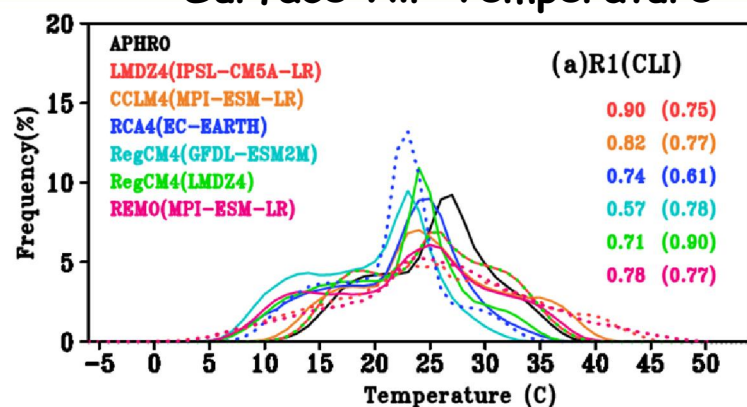
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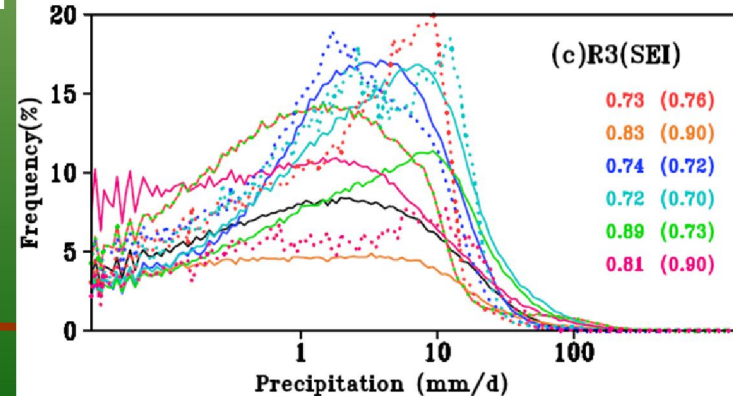
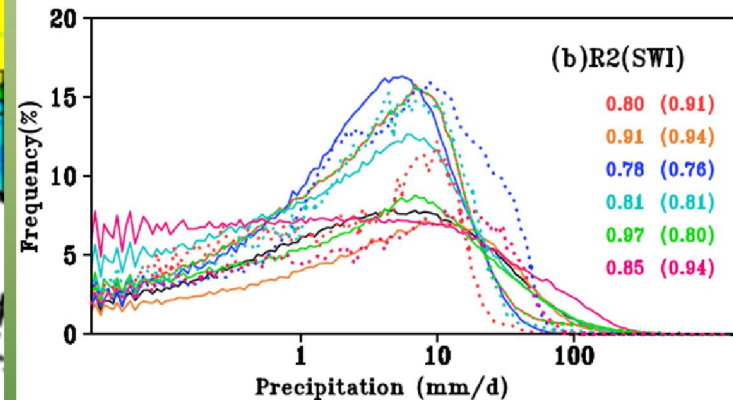
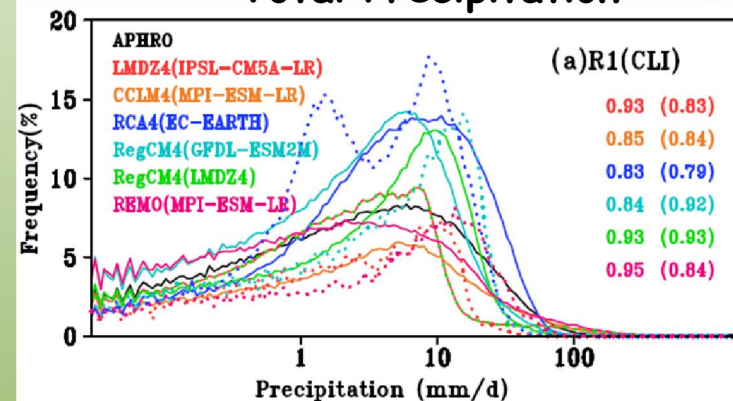
CORDEX South Asia 1986-2005 Daily Probability Density Functions



Surface Air Temperature



Total Precipitation



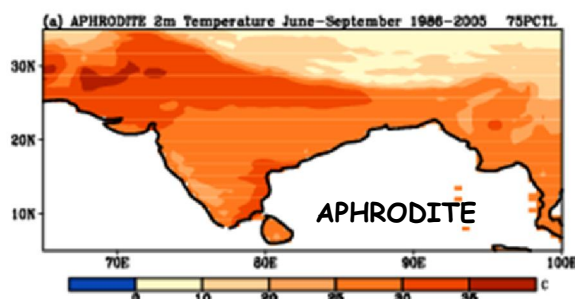


CMIP5

CORDEX RCMs

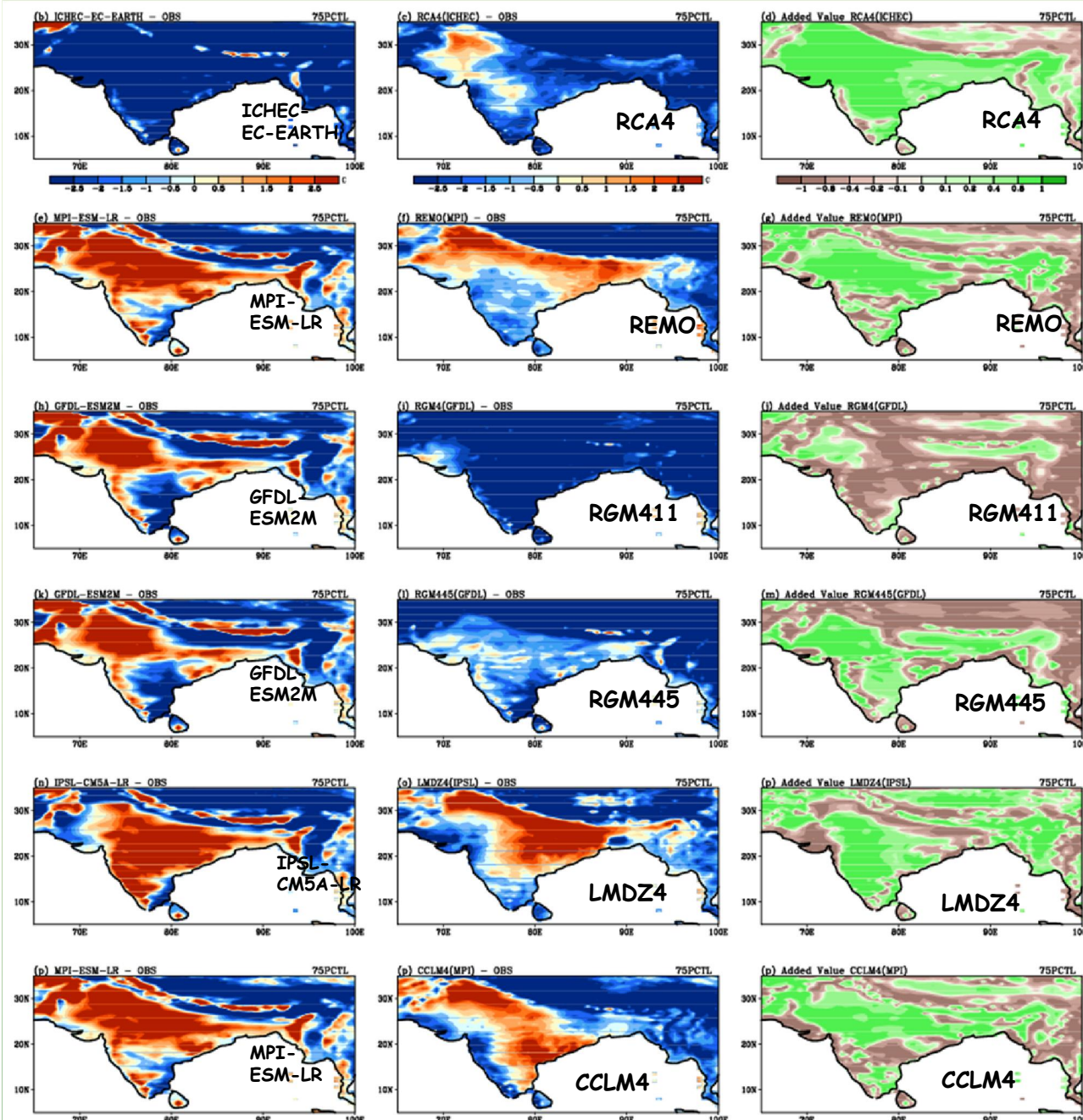
Added Value

Historical Runs Driven
with CMIP5 AOGCMS
June-September
Daily 75th Percentile
2m Temperature Bias
w.r.t APHRODITE
1986-2005



AV is positive where the
RCM's squared error is
smaller than the driving
AOGCM's squared error.

Sanjay et al. under revision

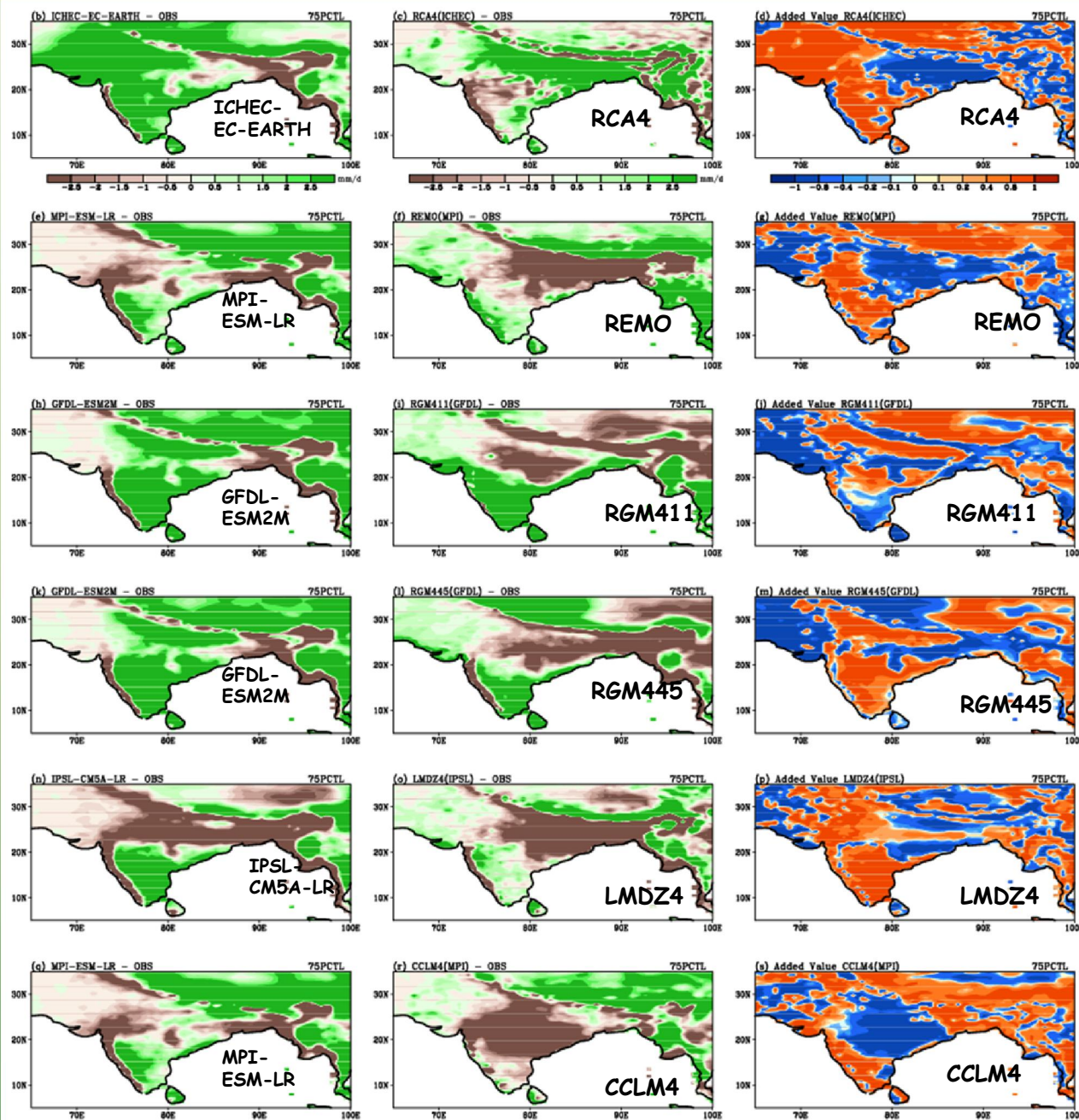




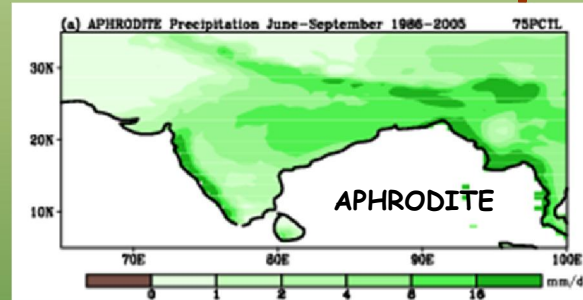
CMIP5

CORDEX RCMs

Added Value



Historical Runs Driven
with CMIP5 AOGCMS
June-September
Daily 75th Percentile
Precipitation Bias
w.r.t APHRODITE
1986-2005



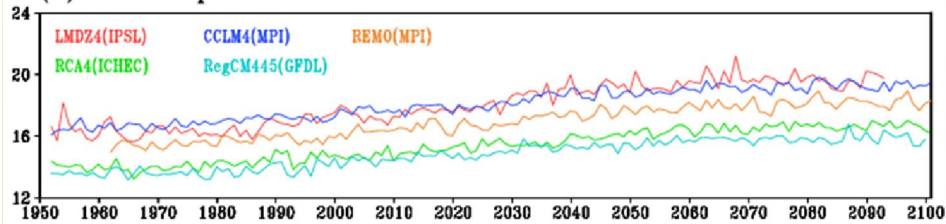
Sanjay et al. under revision

CORDEX RCP4.5 Projected Changes relative to 1976-2005

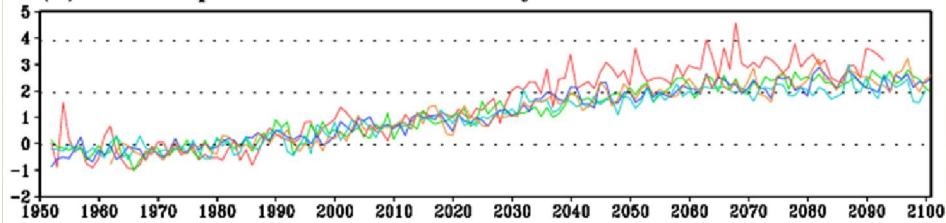
averaged over land grid points in South Asia (60°E-100°E, 5°N-35°N)



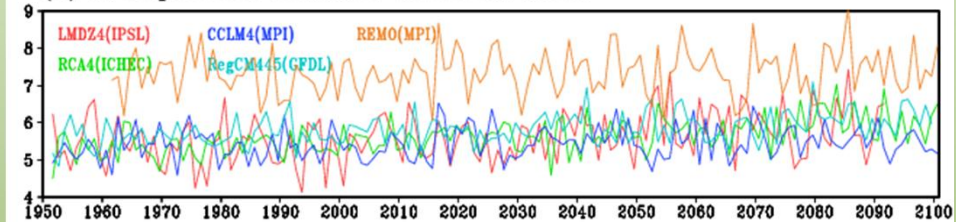
(a) 2m Temperature Annual Mean



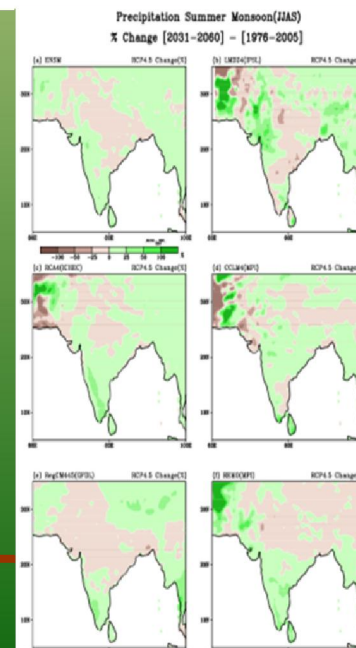
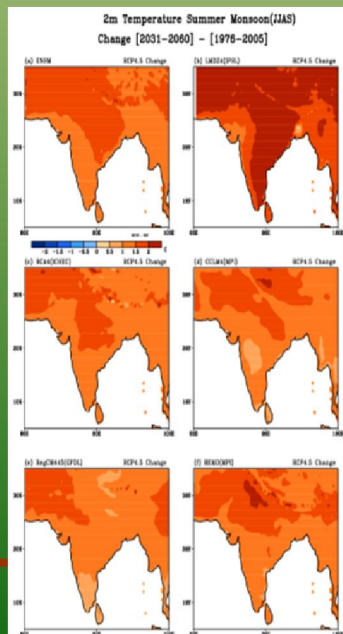
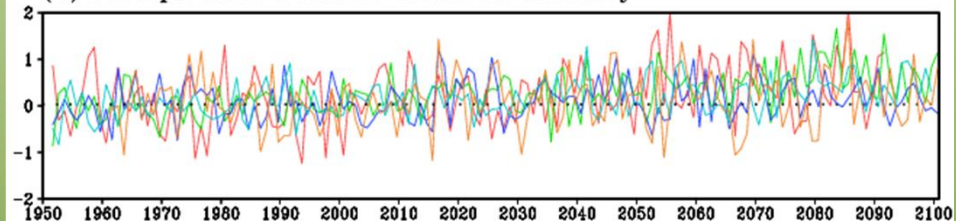
(b) 2m Temperature Annual Anomaly



(c) Precipitation Summer Monsoon Mean



(d) Precipitation Summer Monsoon Anomaly



High resolution simulation of the South Asian monsoon using a variable resolution global climate model

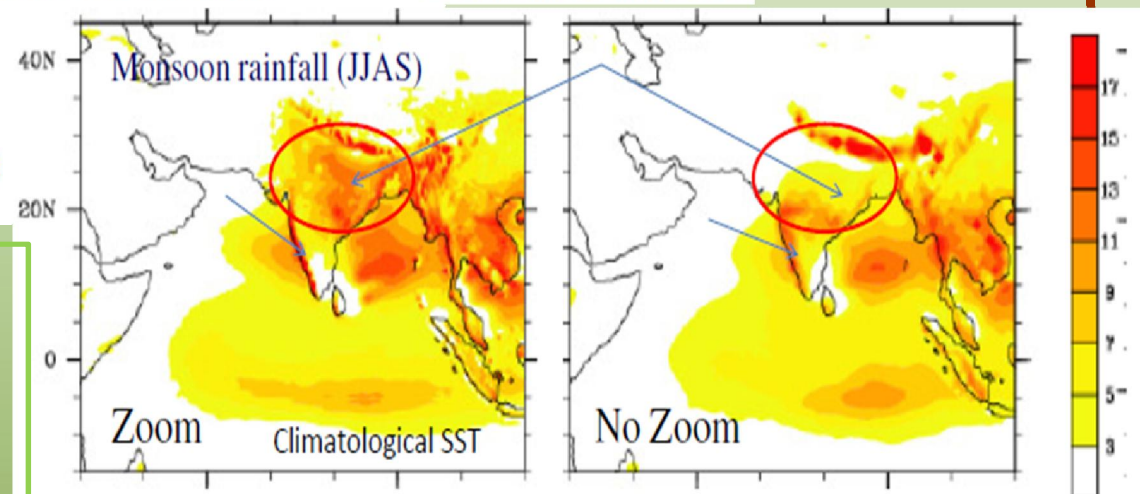
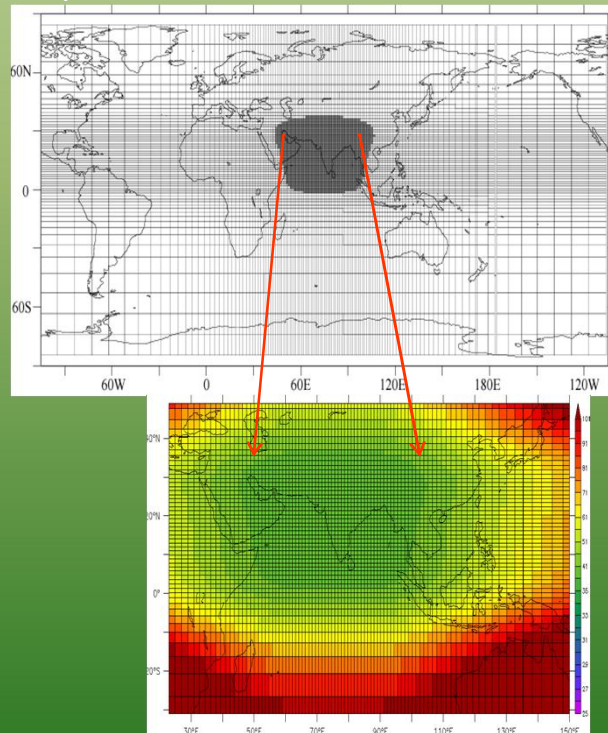
Clim Dyn (2013) 41:173–194
DOI 10.1007/s00382-012-1658-8



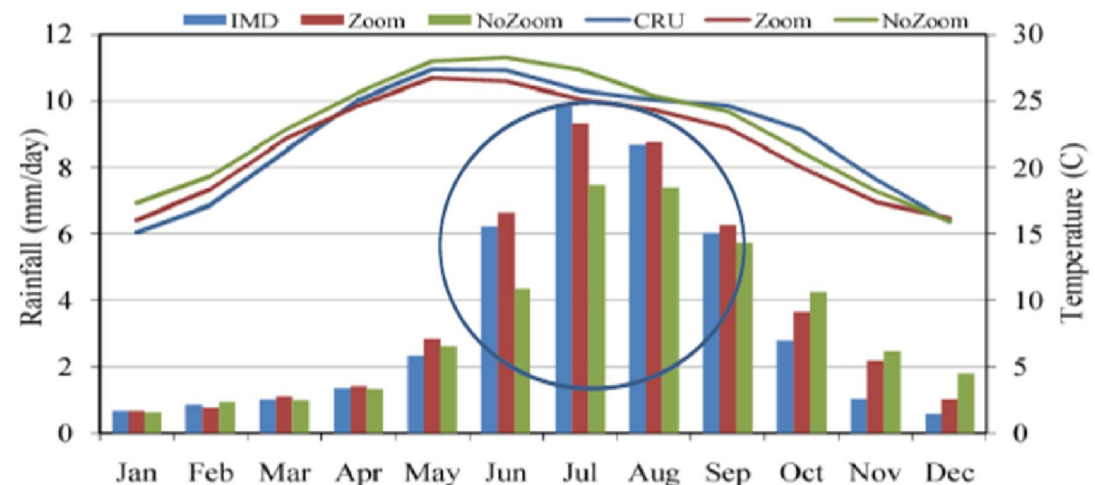
T. P. Sabin · R. Krishnan · Josefine Ghattas ·
Sebastien Denvil · Jean-Louis Dufresne ·
Frederic Hourdin · Terray Pascal



Laboratoire de Météorologie Dynamique, France,
Global Climate Model (LMDZ4) having high-
resolution telescopic zooming (horizontal grid size
~35 km) over South-Asia



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





Geosci. Model Dev. Discuss., doi:10.5194/gmd-2016-120, 2016

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WCRP COORDINATED REGIONAL DOWNSCALING EXPERIMENT (CORDEX): A Diagnostic MIP for CMIP6

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Thanks for your attention

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Thank You

- ICTP
- CCCR, IITM