CORDEX update and role for the MP

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Acknowledgements: **J. Sanjay, IITM, F. Giorgi, W. Gutowski** (Co-Chairs, CORDEX SAT)

Valerie Masson-Delmotte, Panmao-Zhai (Co-Chairs, IPCC)

Monsoon Panel Meeting

17 September 2016

CLIVAR Open Science Conference, Qingdao, China

Outline

- CORDEX updates
- How can monsoons research be better communicated between the CORDEX community and other monsoons researchers?
- Possible recommendations from the Monsoon Panel to CORDEX in terms of experiment design?
- Are CORDEX models giving better monsoons representation than CMIP5?

Coordinated Regional Downscaling Experiment

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

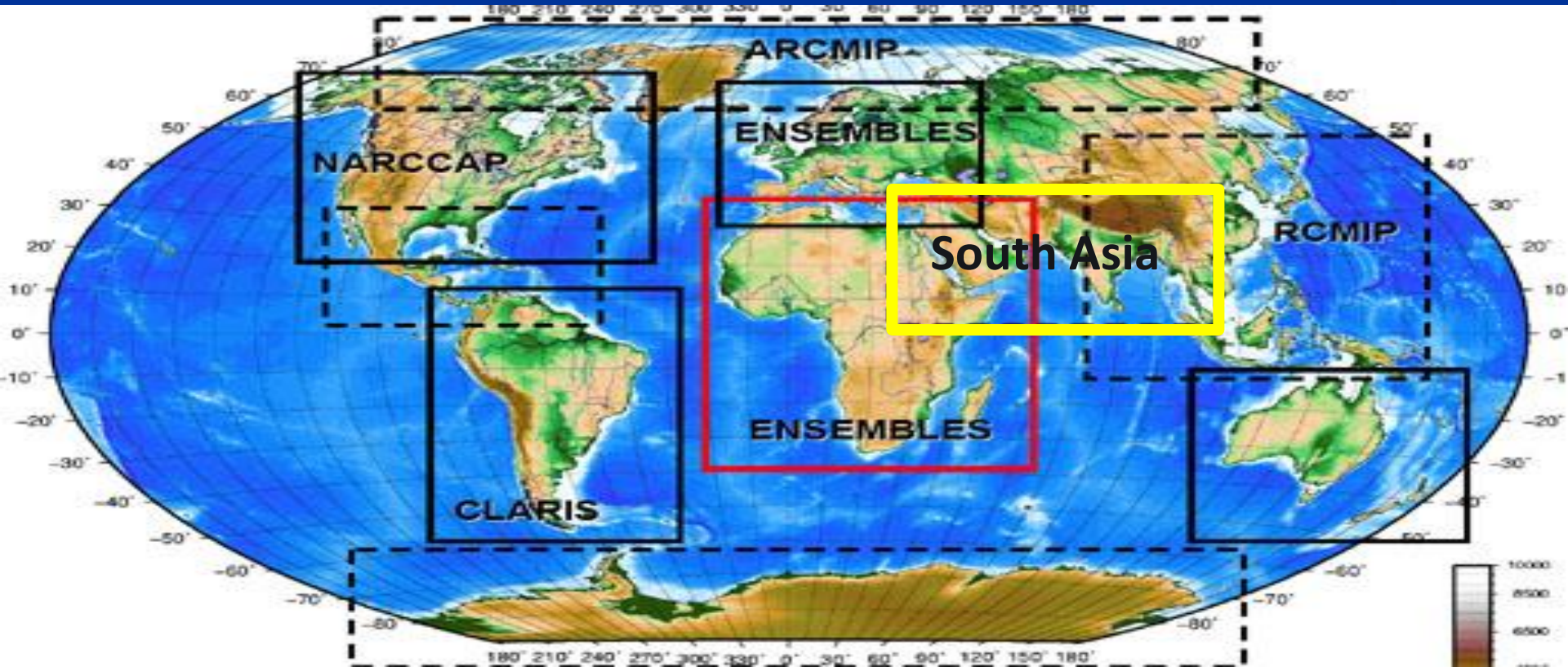
Goals:

O To better understand relevant regional/local climate phenomena, their variability and changes, through downscaling.

O To evaluate and improve regional climate downscaling models and techniques

O To produce coordinated sets of regional downscaled projections worldwide

O To foster communication and knowledge exchange with users of regional climate information

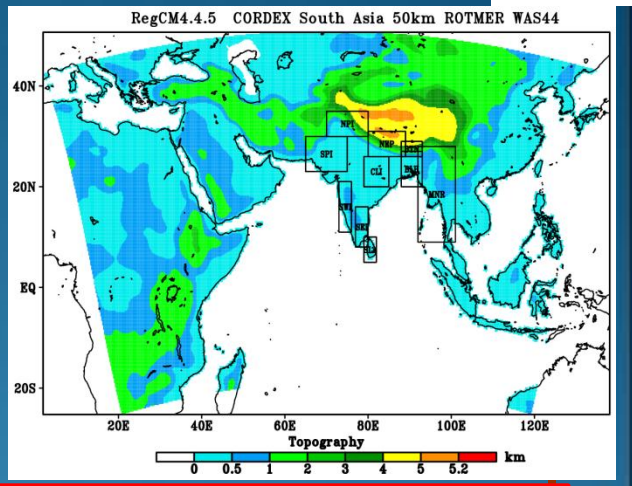


Update on CORDEX South Asia

10 September 2016

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

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- Model
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- Experiment Family
- Time Frequency
- Realm
- CMIP Table
- Ensemble
- Variable
- Variable Long Name
- CF Standard Name
- Driving Model
- Datanode

Enter Text: CORDEX

Search | Reset | Display 10 results per page

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

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CORDEX

- Domain
- [x] WAS-44 (18)
- RCM Model
- Downscaling realisation

SPECS

- Start Date

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

Downscaling RCMs

Driving AOGCMs

Updated: 20/Aug/2016

	ERA-INTERIM	Experiment	CanESM2	CNRM-CM5	EC-EARTH	GFDL-ESM2M	IPSL-CM5A-MR	MIROC5	MPI-ESM-LR
IITM-RegCM4-4		control	published						
		RCP2.6							
		RCP4.5	published						
	published	RCP8.5	published						
SMHI-RCA4		control		published	published	published	published	published	published
		RCP2.6			published				published
		RCP4.5		published	published	published	published	published	published
	published	RCP8.5		published	published	published	published	published	published
MPI-CSC-REMO2009		control							published
		RCP2.6							published
		RCP4.5							published
		RCP8.5							published
IITM-RegCM4-1		control							
		RCP2.6							
		RCP4.5							
	published	RCP8.5							

Published:

- Control(1951-2005):8 RCP2.6(2006-2100):3 RCP4.5(2006-2100):8 RCP8.5(2006-2100):8

For details on ESGF Data access, please browse CCCR-IITM Climate Data Portal:
http://cccr.tropmet.res.in/cordex/files/data_on_esgf.jsp

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

Downscaling RCMs

Driving AOGCMs

Updated: 10/Sep/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-LR	ACCESS1-0	GFDL-CM3
IITM-RegCM4-4	published	control RCP2.6 RCP4.5 RCP8.5	published published published		finished finished finished	finished finished finished		finished finished finished	finished finished finished					finished finished finished	finished finished finished		
SMHI-RCA4	published		finished finished finished		published published published	finished finished finished	published published published published	published published published	finished finished finished finished	published published published	published finished published published	published published published published published published published published	finished finished finished finished				
MPI-CSC-REMO2009																	
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 finished finished
CLMcom-CCLM4-8-17																	

Published:

- **Control(1951-2005):8 RCP2.6(2006-2100):3 RCP4.5(2006-2100):8 RCP8.5(2006-2100):8**

Finished:

- **Control(1951-2005):19 RCP2.6(2006-2100):3 RCP4.5(2006-2100):18 RCP8.5(2006-2100):16**

Important events 2015-2016

- CORDEX Science Advisory Team 2nd Session: 25-27 February 2015 SMHI, Norrkoping, Sweden
- ICRC-CORDEX 2016 conference 17-20 May 2016, Stockholm, Sweden
- Endorsed Flagship Pilot Studies: Five FPS proposals, out of nine, were selected from the first round of submissions and announced at the last day of the ICRC-CORDEX 2016 conference
- The 4th Workshop of the Southeast Asia Regional Climate Downscaling (SEACLID) / CORDEX Southeast Asia Project - *Hanoi, Vietnam, 24-25 Nov 2016*
- Special Session on Regional Climate Modelling at the upcoming UGM meeting Puerto Vallarta, Mexico, 30 October – 4 November 2016 (http://www.ugm.org.mx/raugm/)
- The AGU meeting will be held 12-16 Dec 2016 in San Francisco, California, USA https://agu.confex.com/agu/fm16/preliminaryview.cgi/Session13074

Coordinated Regional Downscaling Experiment CORDEX

CORDEX SAT Meeting, 2nd Session

SMHI, Norrkoping, Sweden

25-27 Feb 2015

WCRP CORDEX

WCRP CORDEX

17TH-20TH MAY 2016 STOCKHOLM, SWEDEN

ICRC-CORDEX 2016

Goal:

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

Focus:

- Analysis guided by CORDEX Science Goals.
- High resolution climate information
- Applications to VIA community and other end users

- Over 350 registered
- Special event for Early Career Scientists
- European Climate Research Alliance (ECRA) side event

WCRP World Climate Research Programme

http://www.icrc-cordex2016.org/

CORDEX – The Birth

- Call by WCRP for greater coordination across downscaling activities
  - JSC-28, Arcachon, 2009
  - G. Asrar, T. Busalacchi

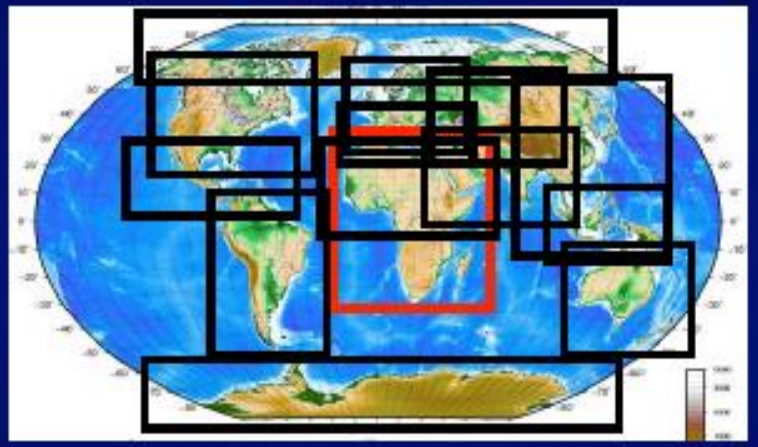
- Initial discussions across the downscaling community
  - Toulouse 2009
  - Hosting by IPSL

- Establishment by the WCRP of the Task Force on Regional Climate Downscaling, TFRCD (2010)
  - F. Giorgi and C. Jones Co-chairs

Courtesy: F. Giorgi

CORDEX – Adolescence

- Design of CORDEX1 framework (Giorgi et al. 2009; Jones et al. 2011)
  - Coordination with CMIP5
  - Regional CORDEX groups



- First Pan-CORDEX Conference
  - ICTP, Trieste, 2011
  - ~180 participants

Courtesy: F. Giorgi

CORDEX – Young Adulthood

- CORDEX becomes a formal WCRP program (2012)
- Establishment of the Science Advisory Team, SAT (2012)
  - F. Giorgi and C. Jones Co-Chairs
  - M. Rixen WCRP contact

- Establishment by WCRP of the Working Group on Regional Climate, WGRC (2013).
- Second Pan-CORDEX conference – ICRC-CORDEX 2013
  - Brussels, Nov. 2013
  - ~400 participants
  - Sponsorship by the EU

Courtesy: F. Giorgi

CORDEX – Adulthood

- Expansion of the SAT (F. Giorgi and W. Gutowski Co-chairs)
- Establishment of the International Project Office for CORDEX (IPOC) at SMHI (2015)
  - E. O'Rourke → I. Lake Directors
  - B. Lee WCRP contact
  - CORDEX listed as Core WCRP project

- Third Pan-CORDEX conference – ICRC-CORDEX 2016
  - Stockholm, Nov. 2016

Approval of CORDEX2 Framework

Courtesy: F. Giorgi

CORDEX Vision and Goals

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

Courtesy:W.Gutowski

- To better understand relevant regional/local climate phenomena, their variability and changes through downscaling
- To evaluate and improve regional climate downscaling models and techniques (RCM, ESD, VAR-AGCM, HIR-AGCM)
- To produce large coordinated sets of regional downscaled climate projections worldwide
- To foster communication and knowledge exchange with users of regional climate information

CORDEX – Scientific Challenges

✧ Added value

Internal variability & added value as functions of scale; Bias correction uncertainties and consistency; User-oriented metrics

✧ Human element

Coupling of regional climate and coastal megacities; Bridging with urban parameterisation development; Land use change

✧ Coordination of regional coupled modelling

Ocean-ice-atmosphere; Lakes; Dynamic land surface; Cryosphere; Natural fires; Atmospheric chemistry; Carbon cycle; Aerosols; Marine biogeochemistry

✧ Precipitation

Convective systems; Coastal storm systems; MJO/Monsoon

✧ Local wind systems

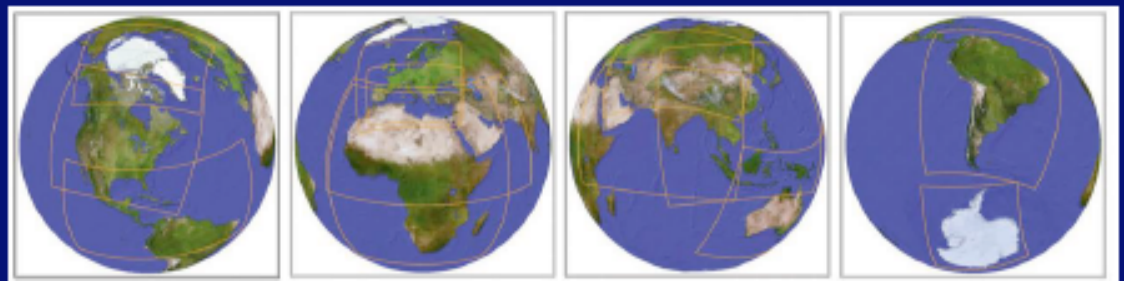
Wind storms; Strong regional winds; Wind energy

WCRP CORDEX

Courtesy: W. Gutowski

Flagship Pilot Studies (FPS)

- Coordinate developments in conv.-permitting climate sim.
- Should have strong basis in
  - Fine-scale processes important to region's climate (physical basis)
  - Observational basis for verification (analysis basis)
  - User applications (VIA basis)
- Potential connection with other WCRP programs, esp. GEWEX
- First FPS call closed 15 Feb. 2016
- 9 proposals reviewed from 6 CORDEX regions
- Details: www.cordex.org



Courtesy:
W. Gutowski

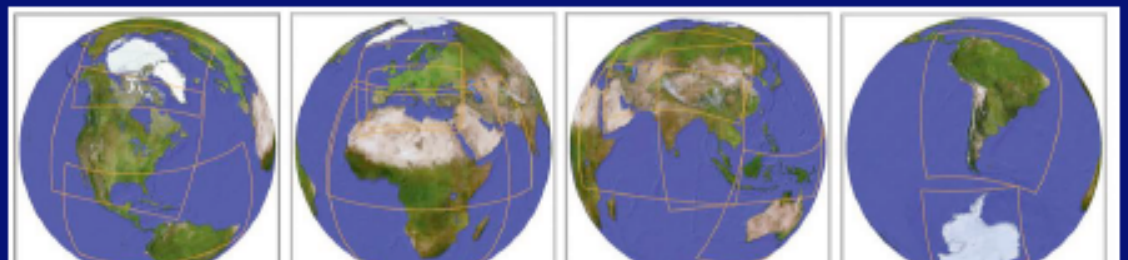
Flagship Pilot Studies (FPS)

Five ready to go forward:

- ✓ EUR+MED: Convective phenomena
- ✓ EUR: Impact of land use changes
- ✓ S. AM: Extreme precipitation events.
- ✓ MED: Role of natural and anthropogenic aerosols
- ✓ MED: Role of air-sea coupling and small-scale ocean processes

Three we will work with further.

One that can fit better with other CORDEX activity.



ourtesy:
V. Gutowski

CORDEX – IPCC Interest

CORDEX Coordinated Output for Regional Evaluations (CORDEX CORE)

- In development
- Motivated by IPCC Workshop on Reg. Climate (Sept. 2015)
- Elements
  - Succinct set of downscalings for each region
  - Provide a core foundation for additional work by others
  - Span plausible range of climate change => 3 distinct GCMs?
  - CMIP5? Historical + RCP8.5?
  - Downscaling: 3-4 RCMs? ESD methods?
  - Resolution?
  - Contribute to IPCC Special Reports?
  - *How far should CORDEX reach toward climate services?*

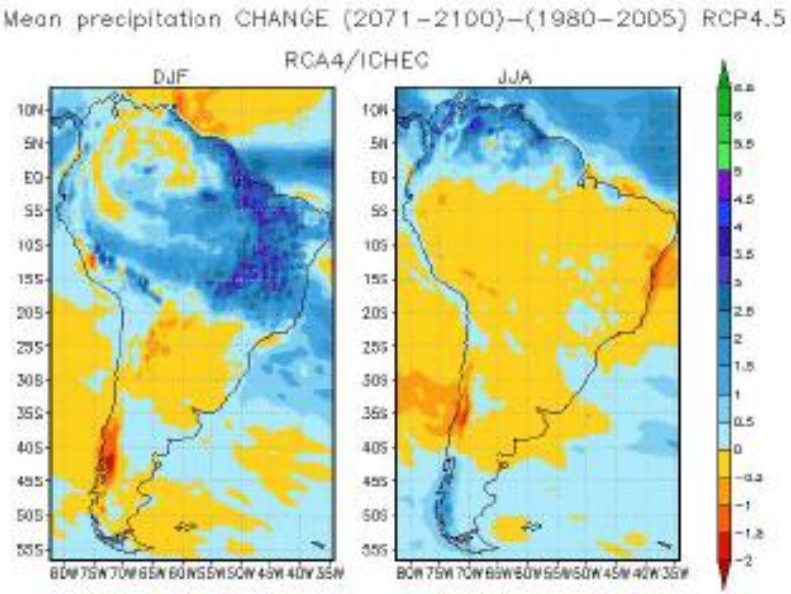
Courtesy: W. Gutowski

CORDEX – Other Recent Science

☞ Submitted paper: *Geoscientific Model Development (GMD)*
Special collection of papers on CMIP6

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

William J. Gutowski, Jr.[1], Filippo Giorgi[2], Bertrand Timbal[3], Anne Frigon[4], Daniela Jacob[5], Hyun-Suk Kang[6], R. Krishnan[7], Boram Lee[8], Christopher Lennard[9], Grigory Nikulin[10], Eleanor O'Rourke[10], Michel Rixen[8], Silvina Solman[11], Tannecia Stephenson[12] and Fredolin Tangang[13]



Courtesy: W. Gutowski

Plans and outlooks of Working Group I of IPCC for the 6th Assessment Report cycle (AR6): regional climate change

Valérie Masson-Delmotte & Panmao Zhai
IPCC WGI co-chairs

Courtesy: Valerie Masson-Delmotte, Panmao-Zhai

ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

Context for the assessment of regional climate change

- Assessment of climate science to support the post-COP21 decision making process for low carbon and climate resilient development pathway
- Last IPCC Plenary decision for the AR6 : consider modalities for addressing and enhancing the treatment of regional issues
- Integration accross Working Group I (Physical science basis) and Working Group II (vulnerability, impacts, adaptation and risk analysis studies)
- Opportunity for effective collaboration with CORDEX along the AR6 cycle :

  New emerging science
  Needs from potential end-users and stakeholders
  Scoping of reports
  Calls for nominations : regional experts

Courtesy: Valerie Masson-Delmotte, Panmao-Zhai

Special and methodological reports

- In the context of the Paris Agreement, special report in 2018 on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways *(in the context of strengthening the global response to the threat of climate change, sustainable development and efforts to eradicate poverty)*

  → Regional dimensions

- Methodological report on greenhouse gas inventories for early 2019

- Special report on climate change and oceans and the cryosphere

  → Coastal areas, regional components of sea level change

- Special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems, *(considering challenges and opportunities both for adaptation and mitigation)*

  → Regional dimensions

Courtesy: Valerie Masson-Delmotte, Panmao-Zhai

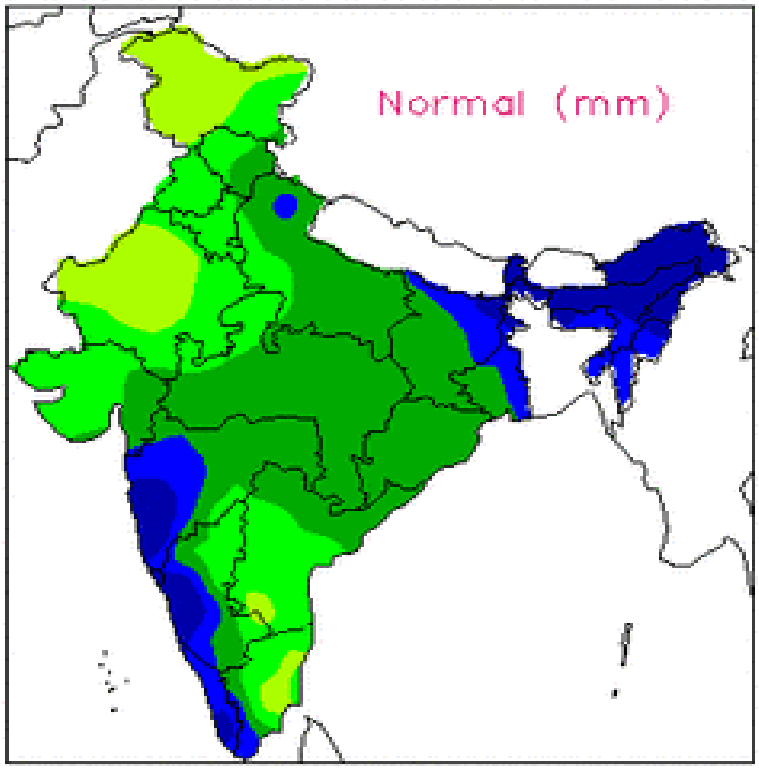
ipcc INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

Topics for discussion

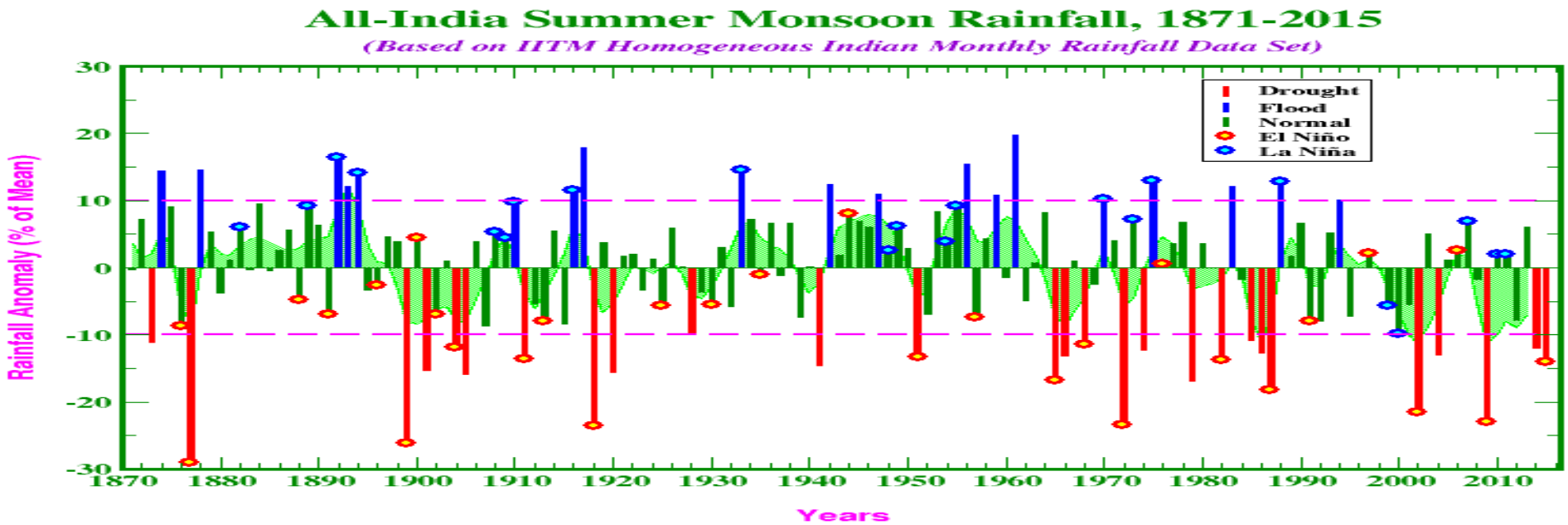
- Recommendations for the IPCC AR6 to bridge the gap between science and practice using regional climate projections?
- CORDEX contributions to the AR6 : lessons learnt from downscaling CMIP5 projections, timeline for dowscaling CMIP6 projections?
- Progress towards a common benchmark for exploration of uncertainty in regional projection and risk analysis?
- Complementarity of CORDEX, climate services, IPCC assessments of regional climate change?
- Future directions and priorities for regional climate projections in the context of high spatial resolution GCM projections?

Courtesy: Valerie Masson-Delmotte, Panmao-Zhai

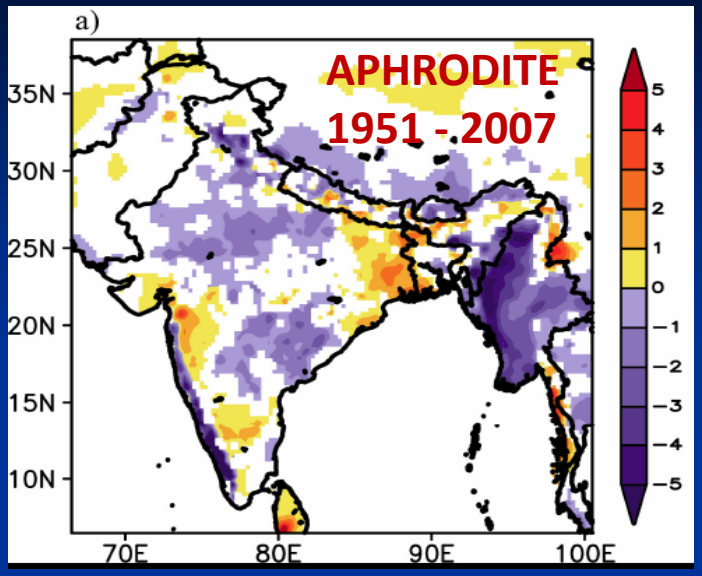


Long-term climatology of total rainfall over India during (1 Jun - 30 Sep) summer monsoon season (http://www.tropmet.res.in)

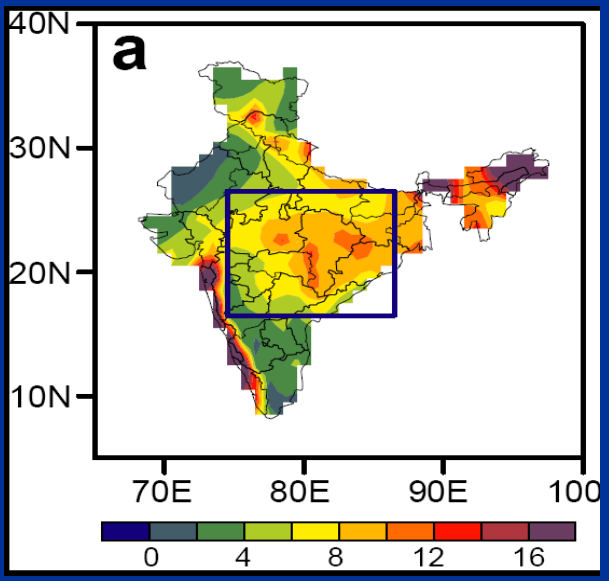
Interannual variability of the Indian Summer Monsoon Rainfall



Spatial map of linear trend of JJAS rainfall (1951 – 2007)

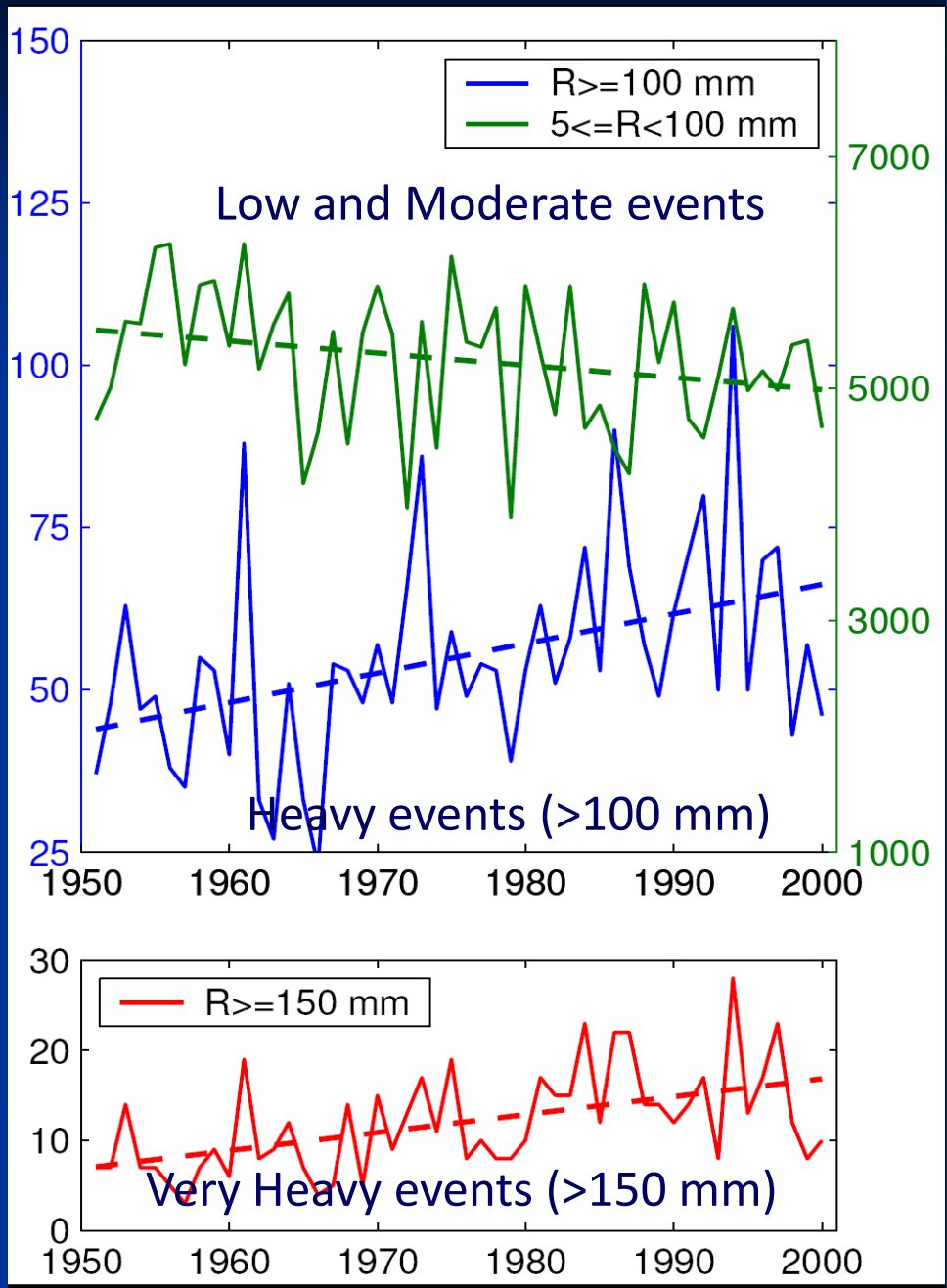


Increasing Trend of Extreme Rain Events over India in a Warming Environment

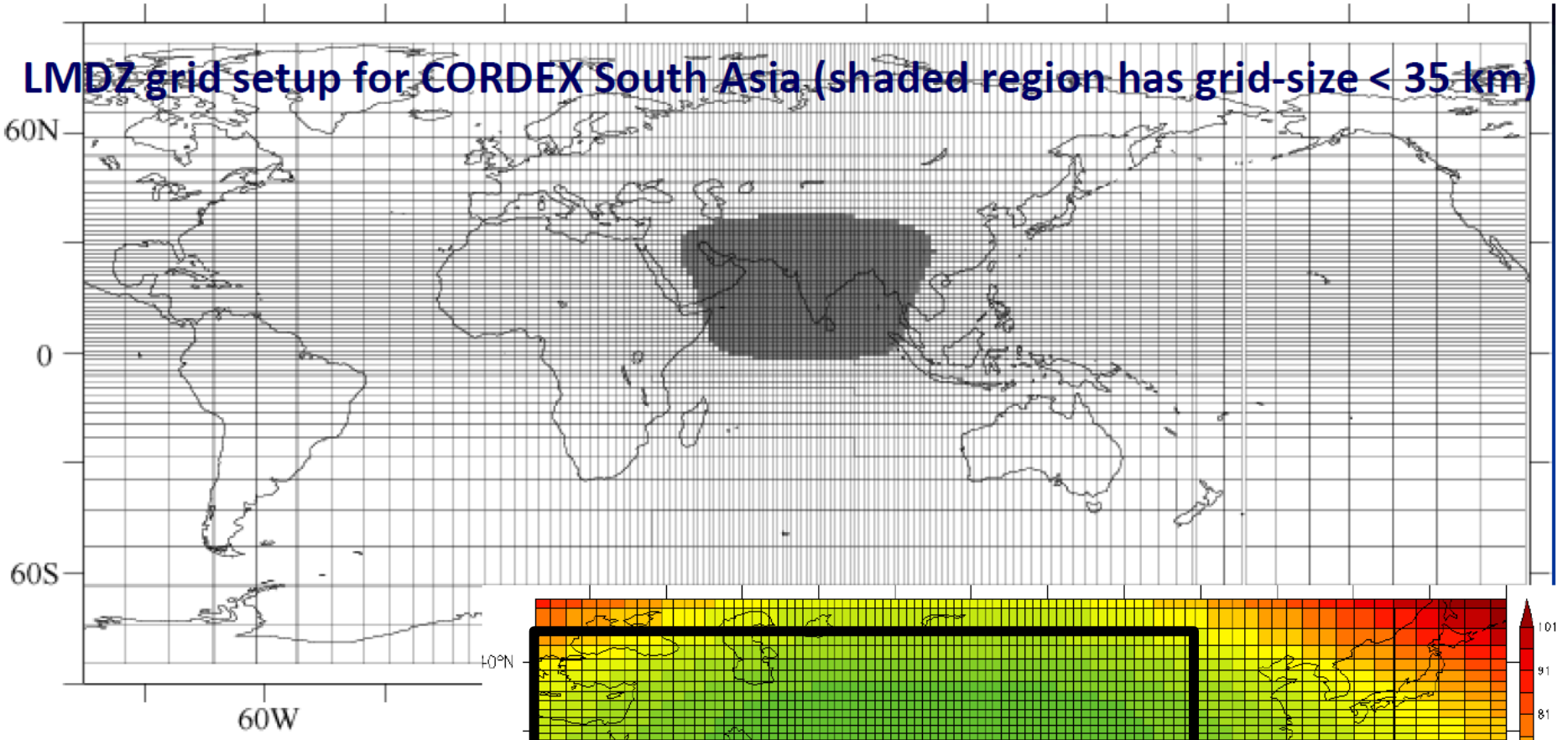


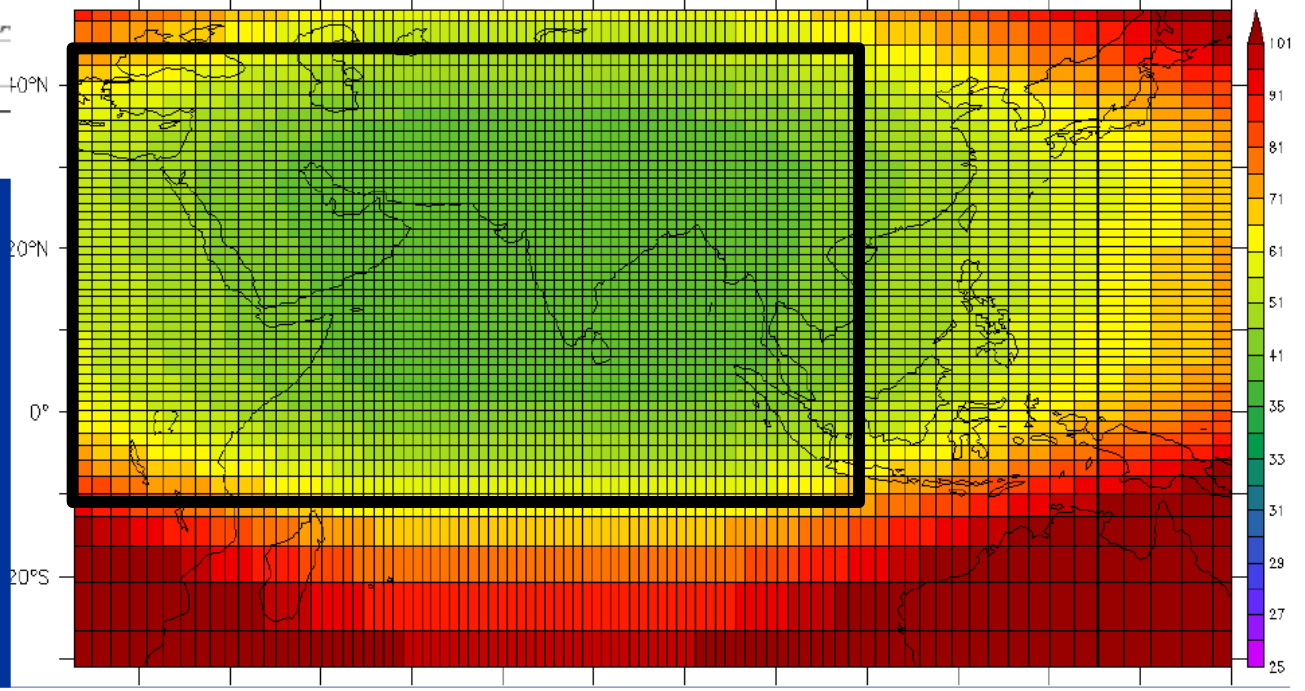
Goswami et al. 2006, Science

Time series of count over Central India



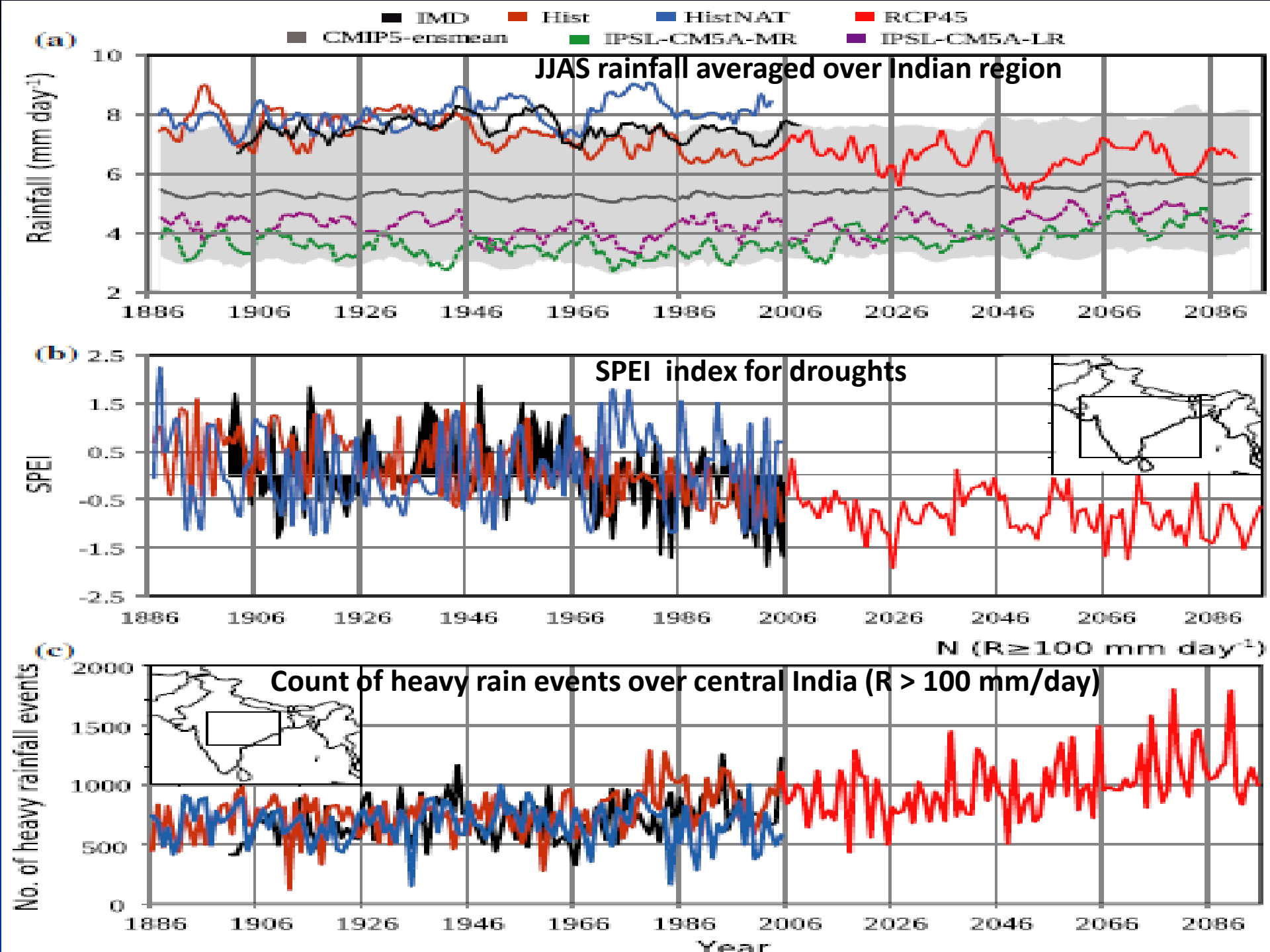
LMDZ grid setup for CORDEX South Asia (shaded region has grid-size < 35 km)





LMDZ global atmospheric model: Variable resolution with zooming capability

Source: Sabin, CCCR, IITM


IMD
Hist
HistNAT
RCP45
CMIP5-ensmean
IPSL-CM5A-MR
IPSL-CM5A-LR
(a)
JJAS rainfall averaged over Indian region
Rainfall (mm day-1)
10
8
6
4
2
1886
1906
1926
1946
1966
1986
2006
2026
2046
2066
2086
(b)
SPEI index for droughts
SPEI
2.5
1.5
0.5
-0.5
-1.5
-2.5
N (R≥100 mm day-1)
(c)
Count of heavy rain events over central India (R > 100 mm/day)
No. of heavy rainfall events
2000
1500
1000
500
0
Year

Time-series of year-wise count of heavy rain events (intensity > 100 mm/day) over Central India

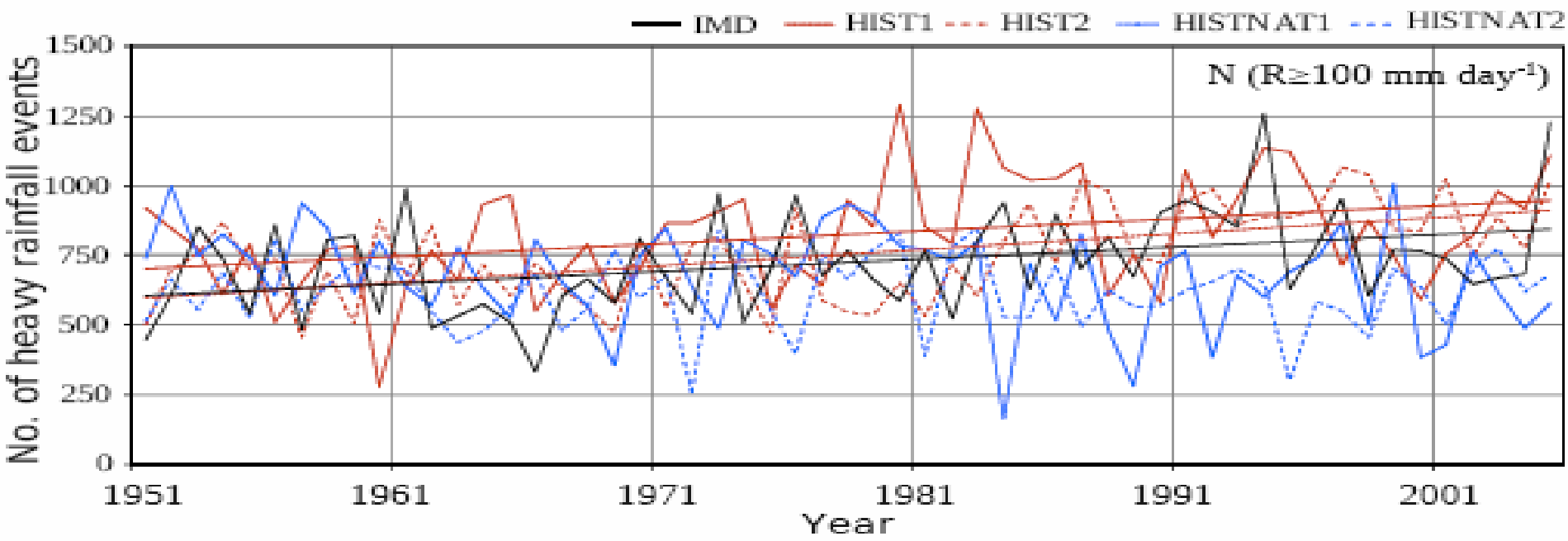
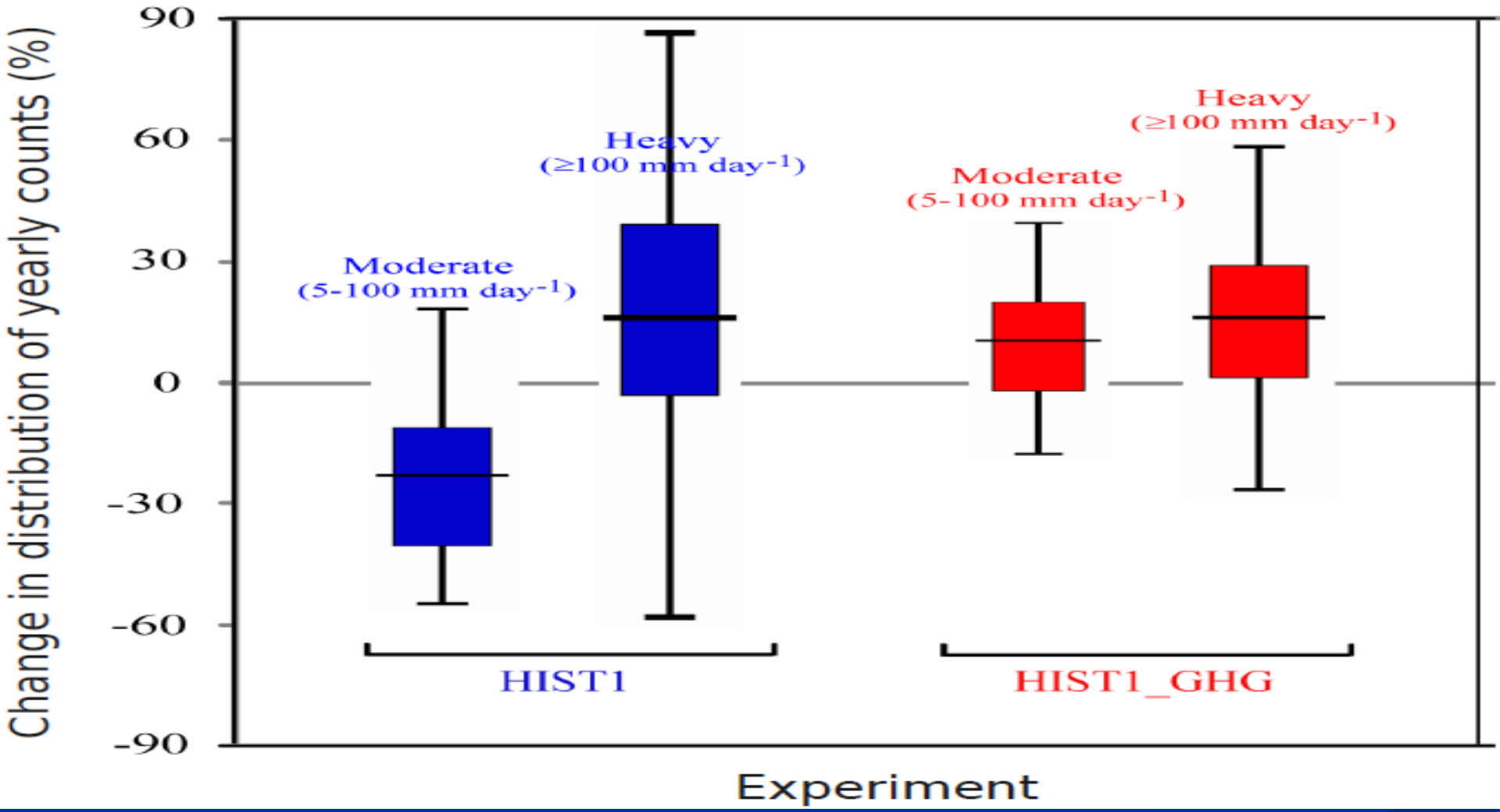


Table 4 Summary of trends in the frequency of heavy precipitation events over Central India, with intensities ≥ 100 mm day^{-1}, from IMD observations and LMDZ4 simulations

	Trend in the frequency count	Mean frequency count	% change w.r.t mean frequency count	*P* value based on the two tailed student's *t* test
IMD dataset (1951–2005)	430 units (55 years)$^{-1}$	1448	30	<0.01
HIST1 (1951–2005)	499 units (55 years)$^{-1}$	1652	30	<0.01
HIST2 (1951–2005)	638 units (55 years)$^{-1}$	1507	42	<0.01
HISTNAT1 (1951–2005)	−34 units (55 years)$^{-1}$	1356	−3	0.2 (not significant)
HISTNAT2 (1951–2005)	+6 units (55 years)$^{-1}$	1233	0.5	0.8 (not significant)
RCP4.5 (2006–2095)	750 units (90 years)$^{-1}$	1976	38	<0.01

Changes in Heavy & Moderate precipitation types to GHG & regional forcing



Central India: 74.5°E – 86.5°E, 16.5°N - 26.5°N

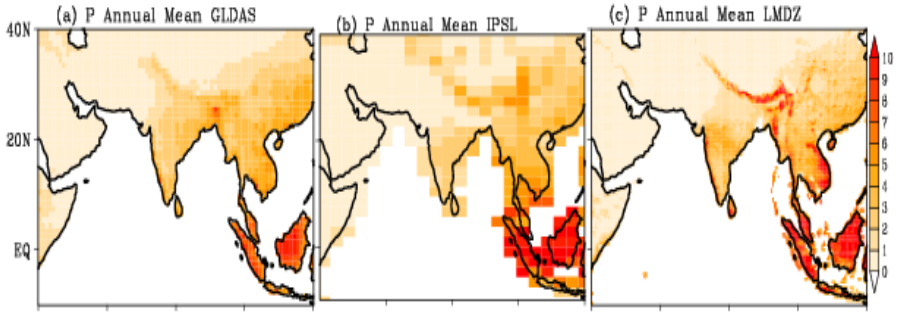
Period:1951-2000

Frequency counts for both categories are relative to HISNAT

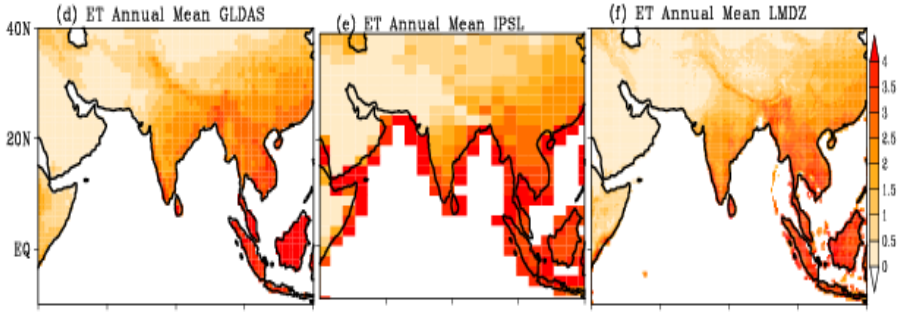
Annual mean water balance (mm d^{-1}) components: (1979-2005)

GLDAS IPSL LMDZ

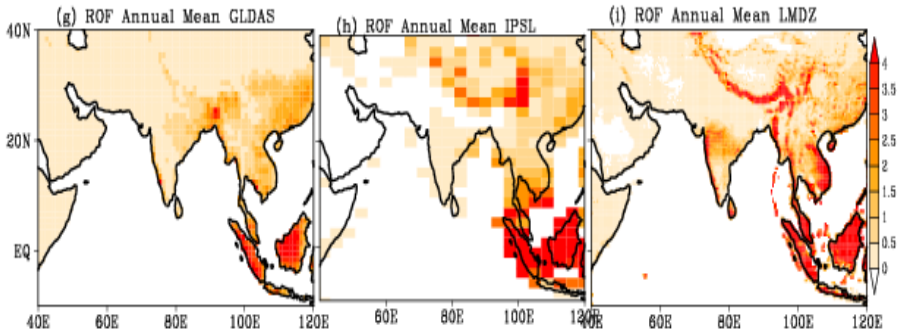
P



ET



R



Water balance averaged over 70°-90°E;10°-28°N

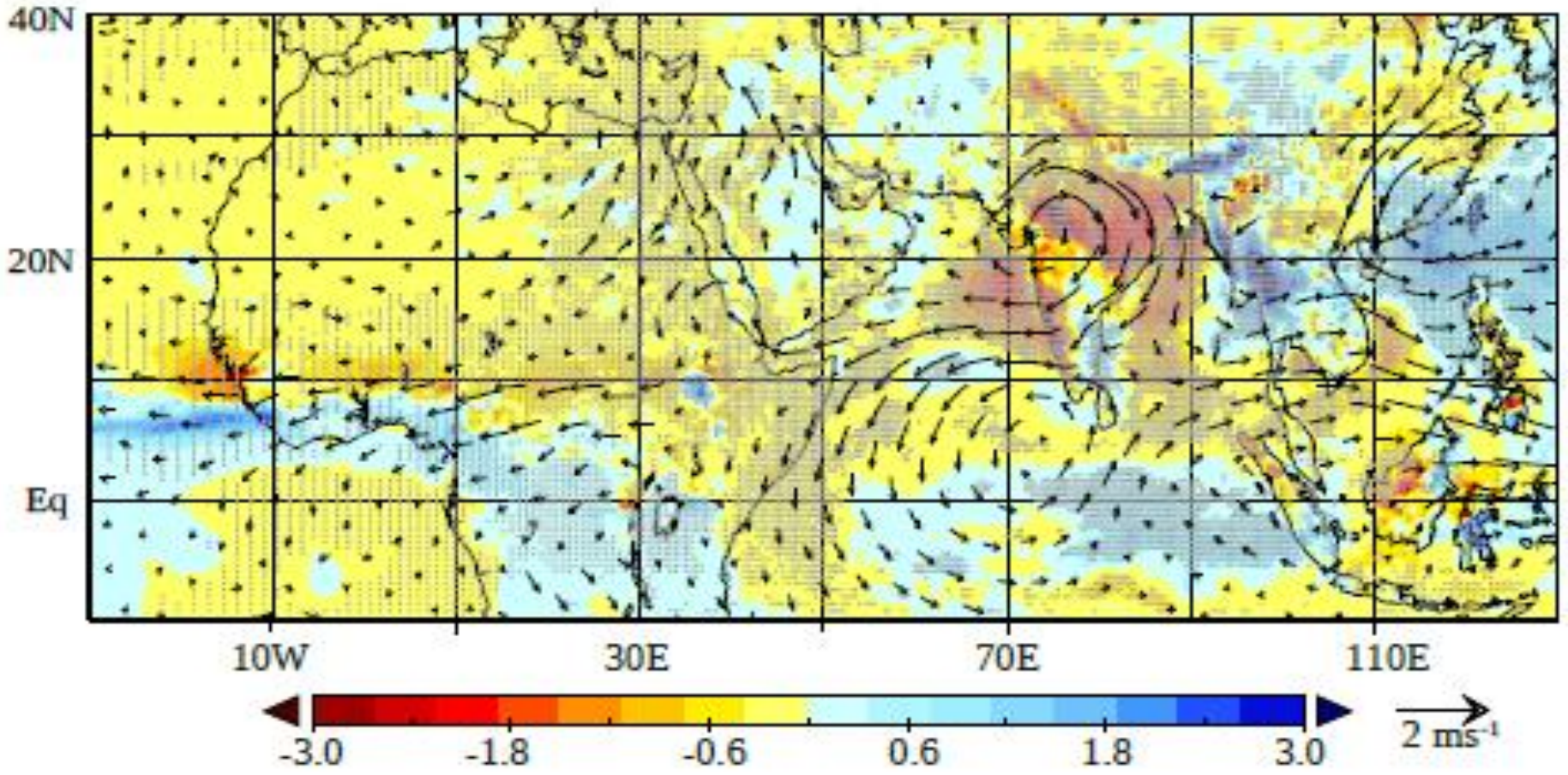
	GLDAS	IPSL	LMDZ
P	2.63	1.81	2.97
ET	1.99	2.25	1.92
R	**0.65**	**0.28**	**1.06**
P-ET	**0.64**	**-0.44**	**1.05**

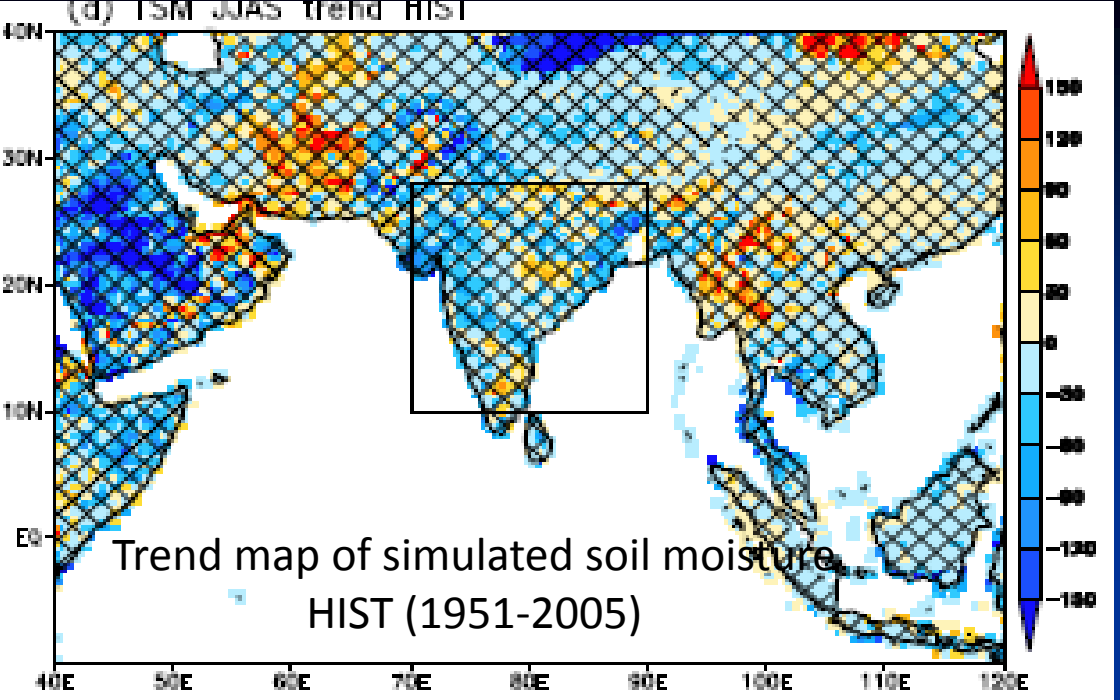
The water balance is highlighted

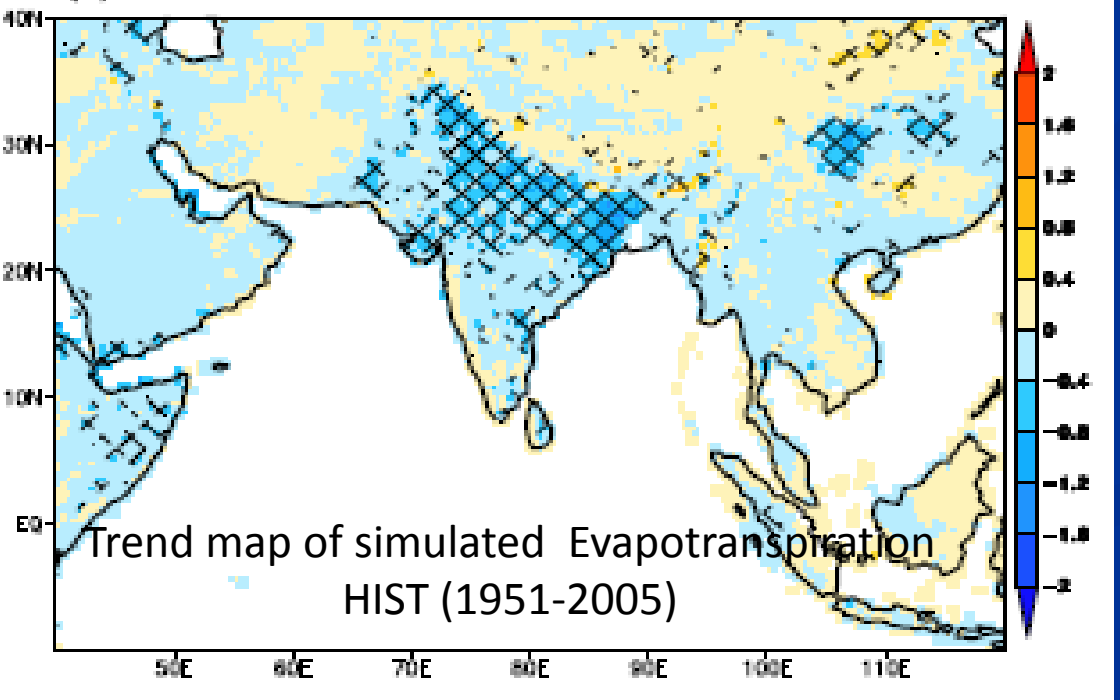
Source: MVS. Ramarao, R. Krishnan
J. Sanjay, TP. Sabin (2015): ESD

Mean difference maps (All-forcing minus Natural) during 1951-2005

JJAS rainfall and 850 hPa winds



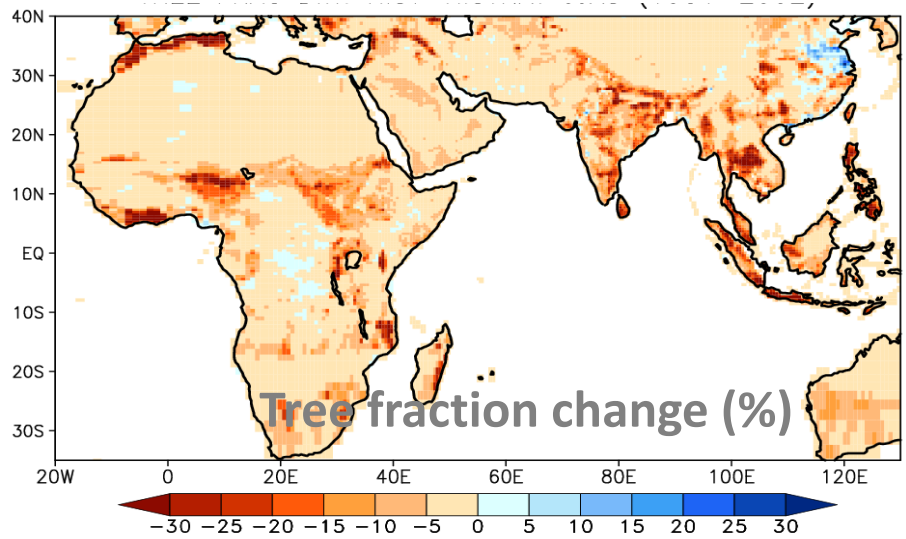


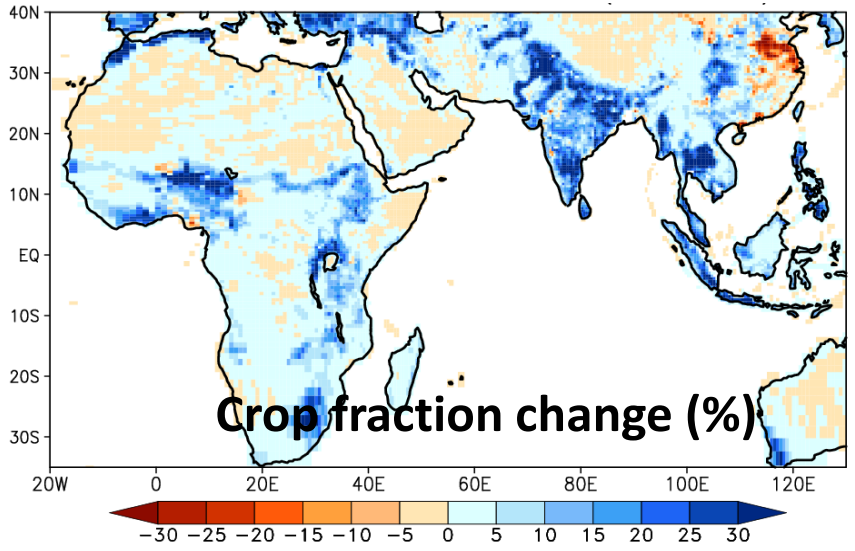


Land-surface response to changes in monsoon Precipitation

Ramarao, Krishnan , Sanjay & Sabin (2015) - Earth System Dynamics

(HIST minus HISTNAT): 1951-2002





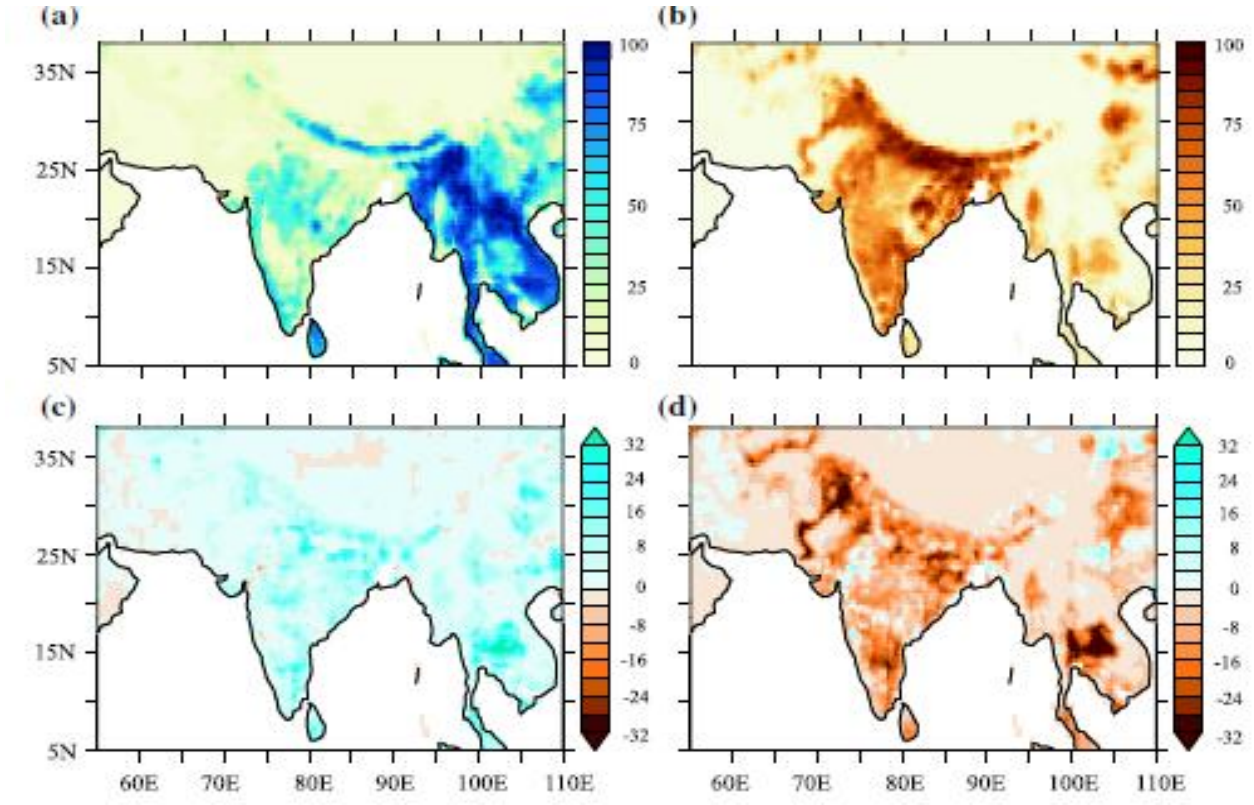


Fig. 8 Spatial maps of land-use used in the LMDZ4 experiments. **a** Mean tree-fraction (%) for the period 1951–2000. **b** Same as **a** except for crop-fraction (%). **c** Change in tree-fraction (%) shown by difference [(1891–1930) minus (1951–2000)] map. **d** Same as **c** except for crop-fraction (%). Note the larger spatial coverage of tree area over South and Southeast Asia and China during (1891–1930) relative to (1951–2000); while the crop area coverage was less during (1891–1930) relative to (1951–2000)

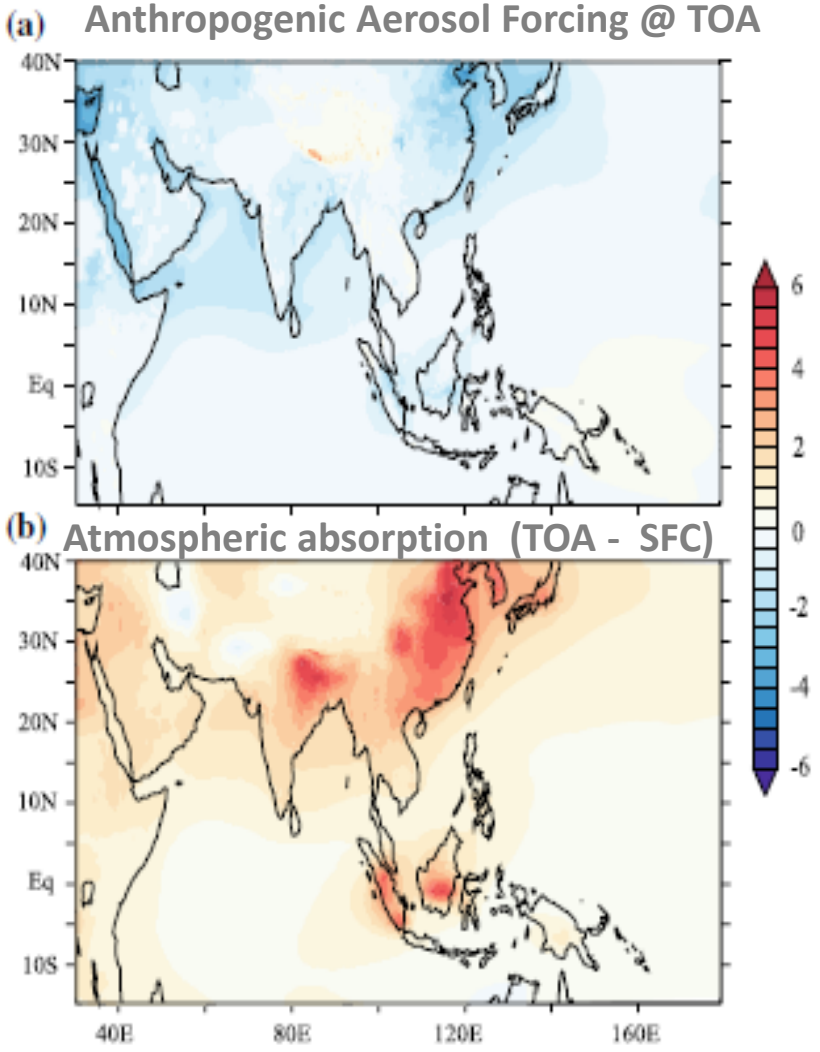


Fig. 9 Spatial distribution of mean anthropogenic aerosol forcing from the HIST1 experiment during 1951–2005. **a** Anthropogenic aerosol forcing (Wm^{-2}) at the top-of-atmosphere (TOA). **b** Atmospheric absorption (Wm^{-2}) due to anthropogenic aerosols (i.e., aerosol-forcing @ TOA minus aerosol-forcing @ Surface). The mean aerosol forcing is computed for the JJAS season from the HIST1 simulation during the period 1951–2005

Map of JJAS SST trend (1951-2005)

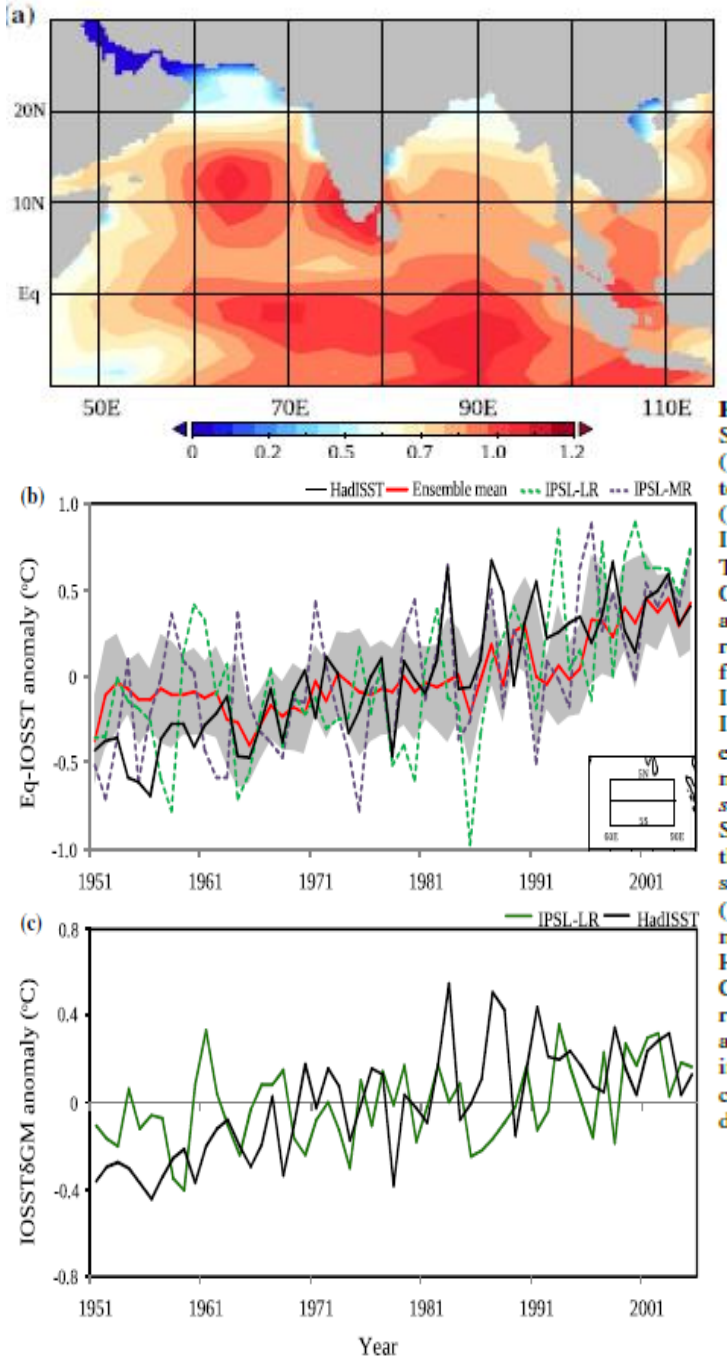


Fig. 10 Tropical Indian Ocean SST warming trend during (1951–2005). **a** Spatial pattern of linear trend of SST (°C per 55 years) from the IPSL-CM5A-LR simulation. **b** Time-series of equatorial Indian Ocean SST (IOSST in °C) anomalies averaged over the region (5°S–5°N, 60°–90°E) from HadISST (*black line*), IPSL-CM5A-LR (*green line*), IPSL-CM5A-MR (*purple*), ensemble mean of CMIP5 models (*red line*). The *grey shading* shows the spread of SST anomalies simulated across the CMIP5 models. **c** Time-series of IOSSTδGM anomalies (°C) (IOSSTδGM = EQIOSST minus Global Mean SST) for HadISST (*black line*), IPSL-CM5A-LR (*green line*). The rapid warming of IOSSTδGM is apparently linked to weakening of the summer–monsoon cross-equatorial flow in recent decades (Swapna et al. 2014)

Important value additions from high-resolution modeling of monsoons

- Resolving monsoon orographic precipitation over narrow mountain ranges like Western Ghats and Arakan Yoma
- Interactive feedbacks between monsoon winds & precipitation (latent heating) are improved
- Improved resolution of forcing from aerosols and land-use and land-cover
- Better representation of surface water balance and land-atmosphere feedbacks.
- High resolution global AGCMs and variable resolution global AGCMs with telescopic zooming are included in the CORDEX framework
- SST forcing in atmospheric GCM → Superpose SST anomalies from coupled model on the observed climatological SST. *AGCM simulations with imposed SST are reported to be more realistic in capturing the observed decadal variations of the Sahel monsoon rainfall as compared to the CMIP5 coupled models (Roehrig et al. 2013). While errors due to lack of coupling are mostly related to interannual variability, stand-alone AGCMs well reproduce circulation and precipitation response to long-term climate change (He et al. 2014).*

Thank you