TRAINING ON
Spatial and temporal analysis of climate change indices using the Climate Data Analytical Tool and CORDEX datasets over South Asia

Training organised by ICIMOD,
in collaboration with the UKMO, WCRP/CORDEX, SMHI, and IITM
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CORDEX South Asia datasets based
climate data indices used in the
IPCC WG1 AR6

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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.

https://cordex.org/domains/region-6-south-asia-2/

Centre for Climate Change Research
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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

More information for CORDEX South Asia data access from CCCR-IITM Climate Data Portal and ESGF datanode are provided at: http://cccr.tropmet.res.in/home/cordexsa_datasets.jsp
CORDEX simulations are stored in a distributed archive (the Earth System Grid Federation, ESGF) after standardization & curation: [https://cordex.org/data-access/regional-climate-change-simulations-for-cordex-domains/](https://cordex.org/data-access/regional-climate-change-simulations-for-cordex-domains/)

**Climate Data Store (CDS) CORDEX data subset**

- The CDS subset of CORDEX data is an effort done by Copernicus to consolidate a World-wide CORDEX dataset, and has also contributed to the IPCC-AR6 WGI activities


CORDEX experiment design for dynamical downscaling of CMIP6

- Experiment protocol for RCMs to downscale a subset of climate scenarios from the CMIP6 ensemble of projections generated in ScenarioMIP, and to make these downscaled regional scenarios publicly available
  (https://cordex.org/experiment-guidelines/cordex-cmip6/experiment-protocol-rcms/)

The future scientific challenges for CORDEX

- Developed a White Paper with the purpose to point out scientific challenges in regional climate modelling for better informed decision making process in regions and setting the basis for the CORDEX science plan
  (https://cordex.org/publications/white-paper/)

The Flagship Pilot Studies (FPSs)

- Established with the aim of improving the capability of the models in reproducing regional climate features with a focus on extreme events with large socioeconomic impacts and can for example handle intensive rain, droughts, floods and heatwaves
  (https://cordex.org/experiment-guidelines/flagship-pilot-studies/)
CORDEX South Asia (WAS) Activities

Opportunities and Challenges for better assessment of regional climate change

• More than 40 research publications (2014 onwards) analysed the RCM outputs from the CORDEX South Asia ensemble (see http://cccr.tropmet.res.in/home/cordexsa_pub.jsp)

• Future global meteorological drought hot spots: A study based on CORDEX Data (Spinoni et al., 2020)

• Contrasting regional and global climate simulations over South Asia (Rana et al., 2020)

• Added value of CORDEX-SA experiments in simulating monsoon precipitation over India (Choudhary et al., 2018)

• Understanding the cascade of GCM and downscaling (dynamical versus statistical) uncertainties in capturing the spatio-temporal variability of hydro-climatic projections over India (Sharma et al., 2017)

• Do dynamic regional models add value to the global model projections of Indian monsoon? (Singh et al., 2017)

• Climatic uncertainty in RCMs is far larger than observations over the Himalayan water towers (Mishra 2015)

• Reliability of regional and global climate models to simulate precipitation extremes over India (Mishra et al., 2014)

Grid cells (in red) where models show bias (±10%) for 1 day precip maxima at 25 year return period and (d) models and the area (%) (Fig. 9, Mishra et al. 2014)
CORDEX South Asia (WAS) Activities

Assessments of regional climate change

- Unravelling Climate Change in the Hindu Kush Himalaya: Rapid Warming in the Mountains and Increasing Extremes (Krishnan et al., 2019)

- CORDEX South Asia future projections of regional climate change over India (In Krishnan et al., 2020)
CORDEX South Asia (WAS) Activities

Development of regional capacity for assessment of regional climate change

Regional climate change projections
Climate change analysis using CORDEX regional climate models over South Asia (ICIMOD, UKMO, WCRP & CORDEX-IPO)
12-14 and 19-21 October 2020 | Platform: Microsoft Teams

First CORDEX South Asia Training Workshop-IITM, Pune, India, October 2012
(CCCR-IITM, START, ICTP, CSAG, SMHI & ICSU-ROAP)

Second CORDEX Science and Training Workshop in South Asia- ICIMOD, Kathmandu, Nepal, August 2013
(WCRP-CORDEX, MAIRS, APN, ICIMOD, CCCR-IITM & IAP)
Climate information relevant to regional impact and risk assessment


• It complements other WGI chapters which focus on the physical processes determining changes in the climate system and on methods for estimating regional changes.

• Impacts of climate change are driven not only by changes in climate conditions, but also by changes in exposure and vulnerability (see Cross-Chapter Box 1.3: Risk framing in IPCC AR6; https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Chapter_01.pdf )

• This chapter concentrates on drivers of impacts that are of climatic origin, referred to in WGI as “climatic impact-drivers” (CIDs).

• CIDs are physical climate system conditions (e.g., means, events, extremes) that affect an element of society or ecosystems.

• Depending on system tolerance, CIDs and their changes can be detrimental, beneficial, neutral, or a mixture of each across interacting system elements and regions.

• In chapter 12 the CIDs that could lead to hazards or to opportunities are assessed from the literature and model results since IPCC AR5.

• This will particularly support the assessment of key risks related to climate change by WGII (forthcoming Chapter 16).
Number of days per year with daily maximum temperature > 35°C in AR6 selected Asia regions

- The uncertainty in the assessment of changes in Climatic-impact drivers (CIDs) due to climate models, time, scenarios and regional downscaling are illustrated in figures by comparing the CMIP5, CMIP6 and CORDEX ensembles for global warming levels (GWLs) 1.5°C, 2°C & 4°C

Adapted from IPCC AR6 WGI: Figure 12.SM.1: Regional projections for the number of days per year with maximum temperature exceeding 35°C..... (Ranasinghe, et al. 2021; https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Chapter_12.pdf)
The novel IPCC AR6 WGI Interactive Atlas link: https://interactive-atlas.ipcc.ch/

Regional fact sheet - Asia

Results expanded in the Interactive Atlas (active links)

(active links) are available on the downloaded file:
IPCC WGI Interactive Atlas

A novel tool for flexible spatial and temporal analyses of much of the observed and projected climate change information underpinning the Working Group I contribution to the Sixth Assessment Report, including regional synthesis for Climatic Impact-Drivers (CIDs).

https://interactive-atlas.ipcc.ch/
Spatial distribution of annual maximum 1-day precipitation (Rx1day, mm) over South Asia and adjoining regions averaged for the historical reference period 1986-2005 from the multi-model ensemble (MME) mean of global (CMIP6 and CMIP5) and downscaled regional (CORDEX South Asia) historical climate simulations.

The spatial maps are drawn online using the IPCC Interactive Atlas (Gutiérrez et al., 2021; https://interactive-atlas.ipcc.ch/)
Climate Models Simulated Regional to Local Precipitation Extremes

- Analysis of the climatological spatial distribution of heavy precipitation magnitudes over the South Asia region using the IPCC online Interactive Atlas shows that the downscaled high resolution CORDEX MME mean simulated the intense precipitation extremes along slopes of Himalayan mountains relatively closer to observed (APHRODITE) estimates of Rx1day index than the coarse resolution CMIP5 and CMIP6 MME means.

The spatial maps are drawn using the data extracted from IPCC Interactive Atlas (Gutiérrez et al., 2021; https://interactive-atlas.ipcc.ch/)
Spatial distribution of annual maximum 1-day precipitation (RX1day) from the CMIP6 multi-model ensemble (MME) mean simulations over South Asia & adjoining regions, (left columns) average change (%) projected for the near-term future period 2021-2040 relative to historical period 1986-2005 under 3 greenhouse gas emission scenarios, and (right columns) at 3 global warming levels under SSP5-8.5 scenario. The spatial maps are drawn online using the IPCC Interactive Atlas (Gutiérrez et al., 2021; https://interactive-atlas.ipcc.ch/)
Climate Change Driven Changes in Precipitation Extremes

- Analyses of MME mean global and downscaled regional climate projections using the online IPCC Interactive Atlas implied that scenarios with low GHG emissions (RCP2.6 and SSP1-2.6) would lead to substantially smaller changes in annual Rx1day index beyond 2040 than under very high GHG emissions scenarios (RCP8.5 and SSP5-8.5) over the South Asia region.

The spatial maps are drawn using the data extracted from IPCC Interactive Atlas (Gutiérrez et al., 2021; https://interactive-atlas.ipcc.ch/).
Concluding Remarks

- Future scenarios with low GHG emissions (RCP2.6 and SSP1-2.6) would lead to substantially smaller changes in annual Rx1day index beyond 2040 than under very high GHG emissions scenarios (RCP8.5 and SSP5-8.5) over the South Asia region.

- However it is suggested that additional information on the range of projected outcomes of Rx1day for parts of South Asia available across the CORDEX South Asia MME will be essential for integration of climate information needed for informing local future adaptation decisions, which is not available from the IPCC Interactive Atlas.
Thanks for your attention

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Thank You

• Training organisers ICIMOD, UK Aid-funded ARRCC
• UKMO, WCRP/CORDEX, SMHI & CCCR-IITM
• Director IITM
• CORDEX South Asia Team Members