

# Assessment of the performance of CORDEX-South Asia experiments for monsoonal precipitation over the Himalayan region during present climate

ICIMOD

**SHRETA GHIMIRE**, Anubhav Choudhary\*, A. P. Dimri\*

\*Jawaharlal Nehru University, New Delhi, India



International Centre for Integrated Mountain Development

Kathmandu, Nepal

FOR MOUNTAINS AND PEOPLE

- ICIMOD is a regional intergovernmental learning and knowledge sharing center serving 8 RMCs of HKH.
- Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal and Pakistan – and based on Kathmandu, Nepal.
- Mission – To enable sustainable and resilient mountain development for improved and equitable livelihoods through knowledge and regional cooperation.

- Analysis of 11 CORDEX-SA experiments along with their ensemble to produce monsoonal precipitation over Himalayan region.
- The Suite – 11 combinations of 6 RCMs with 10 initial and boundary conditions from different GCMs.
- Spatial resolution of  $0.44^{\circ}$  (~50 Km).

**Assessment of the performance of CORDEX-South Asia experiments for monsoonal precipitation over the Himalayan region during present climate: Part I**

**Shreta Ghimire<sup>1,2</sup>, Anubhav Choudhary<sup>1</sup>, \*A. P. Dimri<sup>1</sup>**

**<sup>1</sup> Jawaharlal Nehru University, New Delhi – 110067**

**<sup>2</sup> International Center for Integrated Mountain Development(ICIMOD), Kathmandu, Nepal**

**(DOI: [10.1007/s00382-015-2747-2](https://doi.org/10.1007/s00382-015-2747-2))**

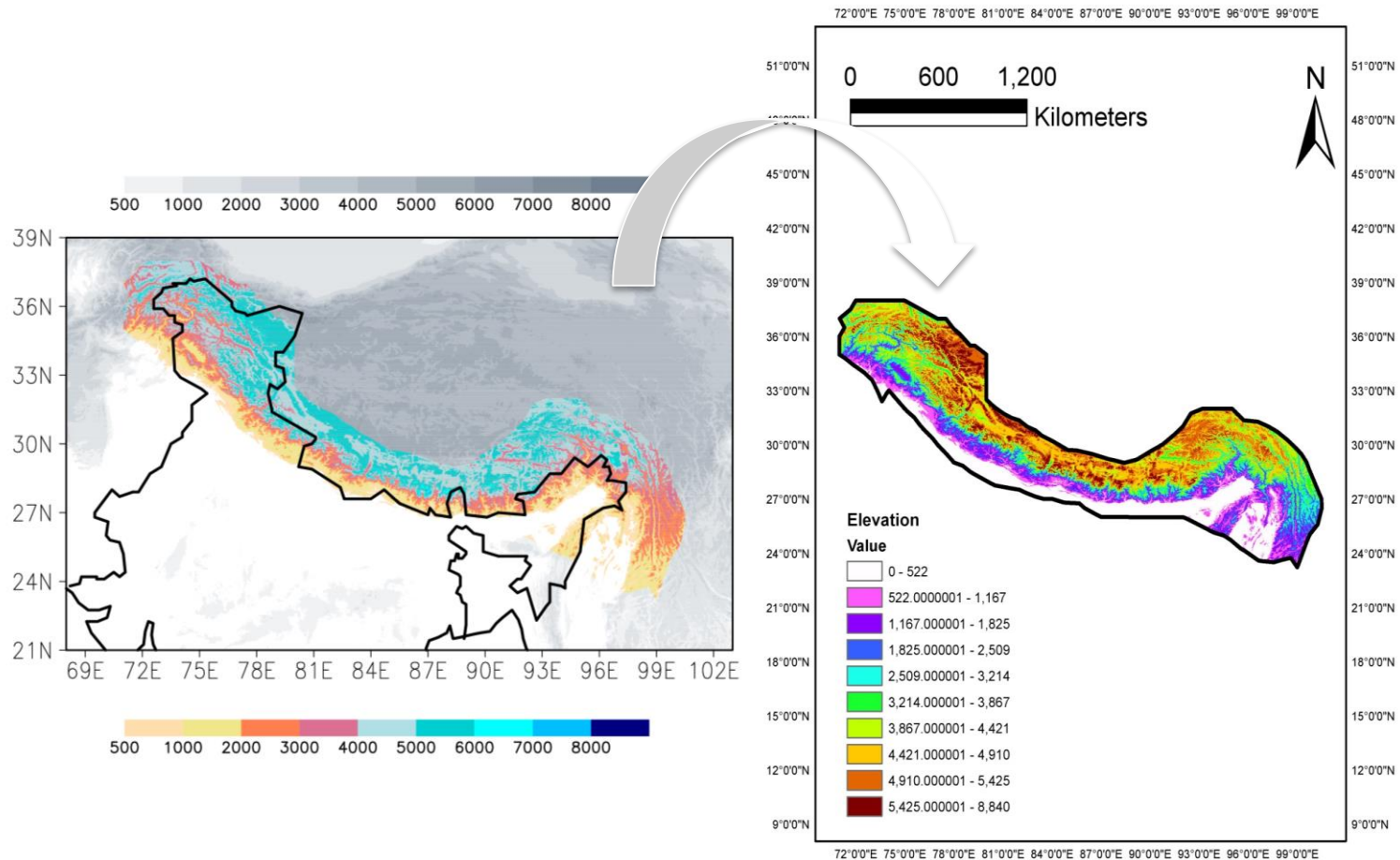
- Himalayan region is very sensitive for climate change.
- The precipitation sensitivity is associated with Indian Summer Monsoon (ISM) over the region.
- So far the CORDEX – SA experiments have not been used to evaluate the monsoonal precipitation over Himalayan region.
- However, Mishra (2015) has used CORDEX-RCMs to study the climate uncertainty in three major basins (Indus, Ganges and Brahmaputra) of Himalayan region.
- Also, Mishra et al., (2014) have used CORDEX-RCMs and Host-GCMs to study the extreme precipitation events over India (which covers some portion of eastern and western Himalayan region).

- Himalayas are the highest chain of mountains forming barrier between Tibetan plateau and alluvial plains.
- The precipitation pattern and the elevation varies as we move from western Himalaya to the eastern and from south to north as well.
- The region consists of high topography reaching more than 8000 m (Kumar et. al., 2015).
- Anders et al., 2006 - “Spatial patterns of the precipitation over the higher altitudes are characterized by the remarkable and persistent variation on the scales of tens of kilometers”.

- Indian Summer Monsoon (ISM) plays a vital role in the Himalaya.
- Contributes 80 % of precipitation in Eastern Himalaya and only 30% in Western Himalaya (Singh et. al., 2011).
- Western Himalaya receives more of its precipitation from Western Disturbance (Dimri and Mohanty, 2009; Rajbhandari et al., 2014)
- Singh et al. (1997), Kulkarni et al. (2013) and Kumar et al. (2015) - due to lack of proper networks of precipitation station in the mountainous region, enough data cannot be collected for the region, which challenges to prepare the gridded data and it limits the study.

- Study Area
- CORDEX and its Experiments
- Observational Dataset
- Methodology

# Study Area



**Fig. 1: Topography (m) over (Left) Himalayan and Tibetan region (m, grey shaded) and over (right) study area (m, color shaded).**



- COordinated Regional Climate Downscaling EXperiment – South Asia domain.
- sponsored by World Climate Research Programme (WCRP) to direct an international coordinated framework to produce an improved generation of regional climate change projections (Fernández, et al. 2009).
- 11 different suites of dynamically downscaled GCMs.
- 6 Regional RCMs with 10 initial and boundary conditions from different GCMs.
- ~ 0.44° resolution (50 km grid spacing).
- Database – Center for Climate Change Research (CCCR), Indian Institute of Tropical Meteorology, Pune, India.

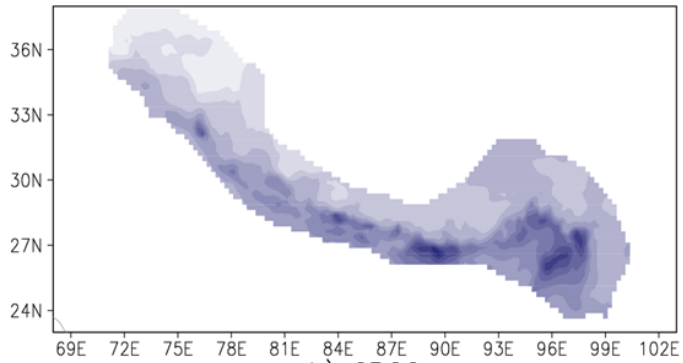


- Asian Precipitation – Highly Resolved Observational Data Integration Towards Evaluation of Water Resources (APHRODITE) project (version 1003R1, 1951-2007; Yatagai et al., 2009).
- Global Precipitation Climatology Center (GPCC) (version 6, 1901-2006; Rudolf et al., 2010).
- Climatic Research Unit (CRU) (version 3.0, 1902-2006; Mitchell and Jones, 2005).
- GPCC and CRU – Monthly precipitation data available at 0.50° spatial and temporal resolution.
- APHRODITE is a daily precipitation data available at 0.25° spatial and temporal resolution.

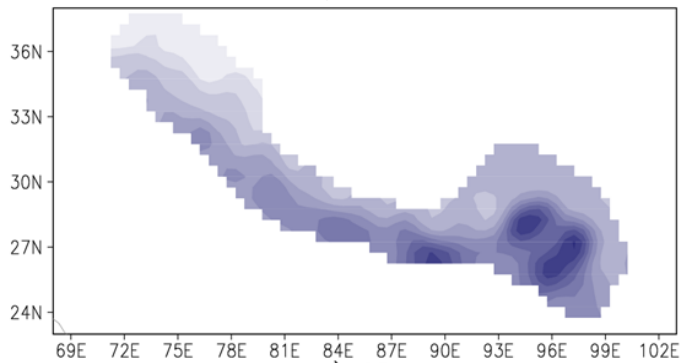
- Time period – 1970-2005 (present climate).
- Months – June-September (dominant Monsoon).
- Lat:  $23^{\circ}$  -  $39^{\circ}$ N
- Lon:  $68^{\circ}$  -  $103^{\circ}$ E
- Climate Data Operators (CDO) – for data post processing and statistical analysis.
- Study region – 2343 grid points.

# Results and Discussions

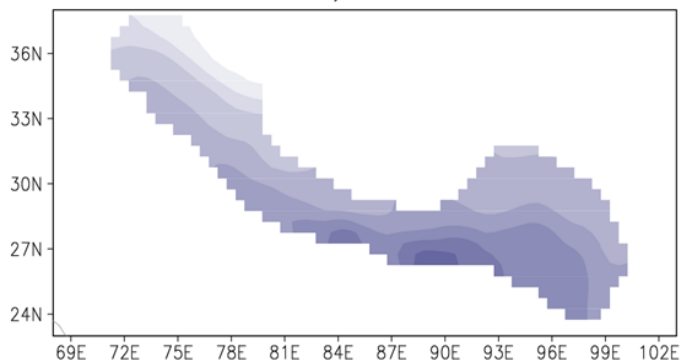
a) APHRODITE



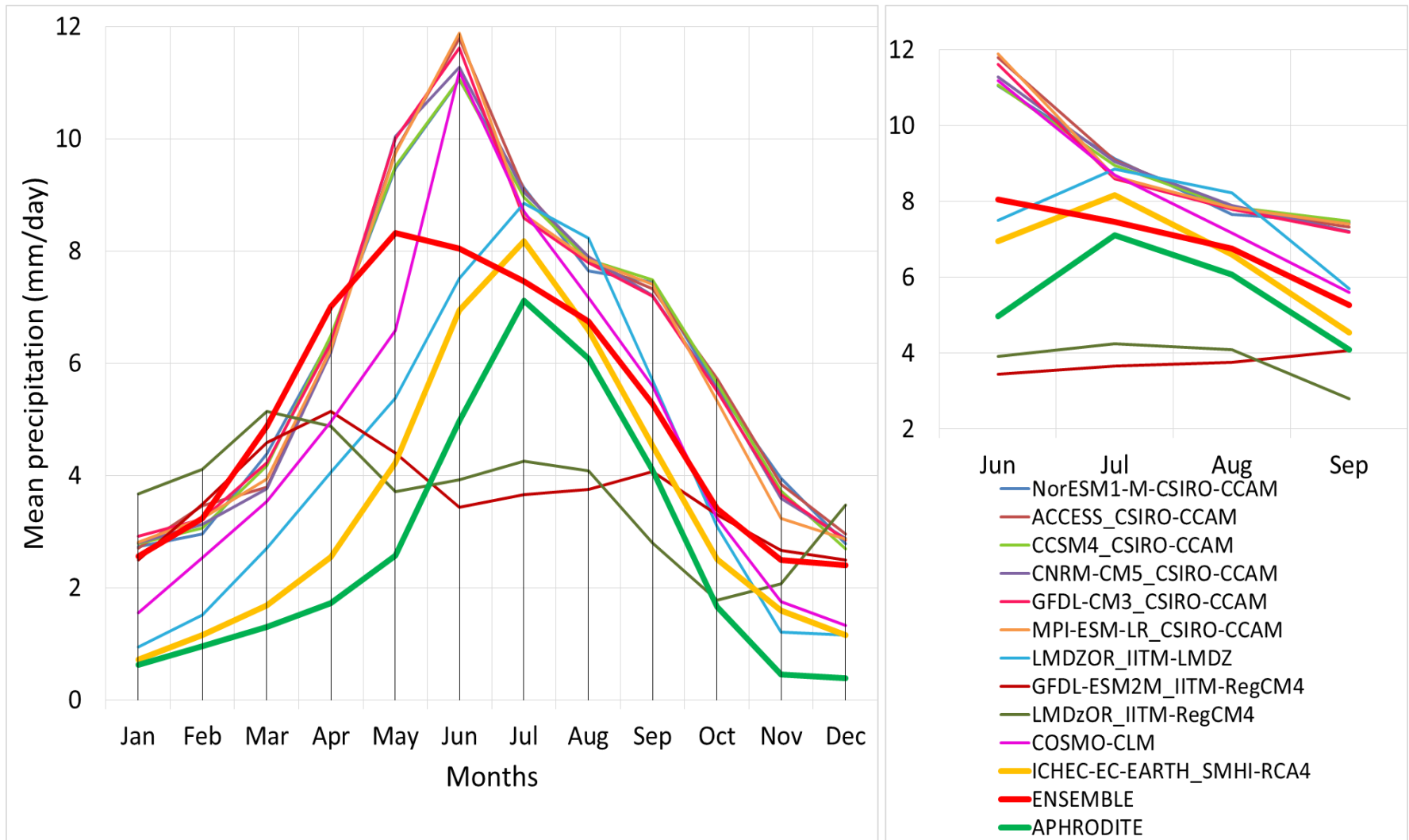
b) GPCC



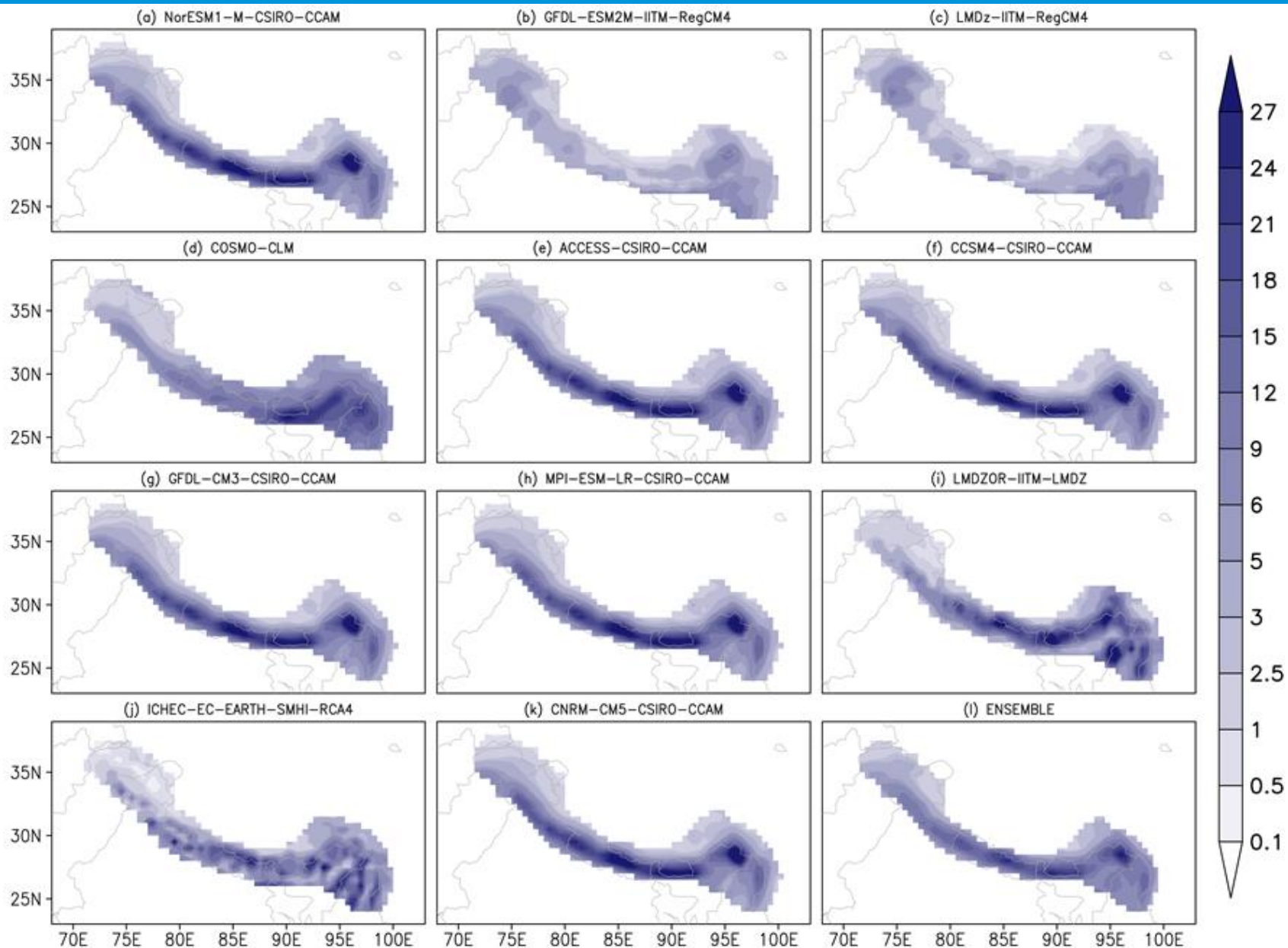
c) CRU



**Fig. 2: Observed JJAS precipitation (mm/day) climatology during 1970-2005 over the study area as shown in Fig.1b in (a) APHRODITE (b) GPCC and (c) CRU.**

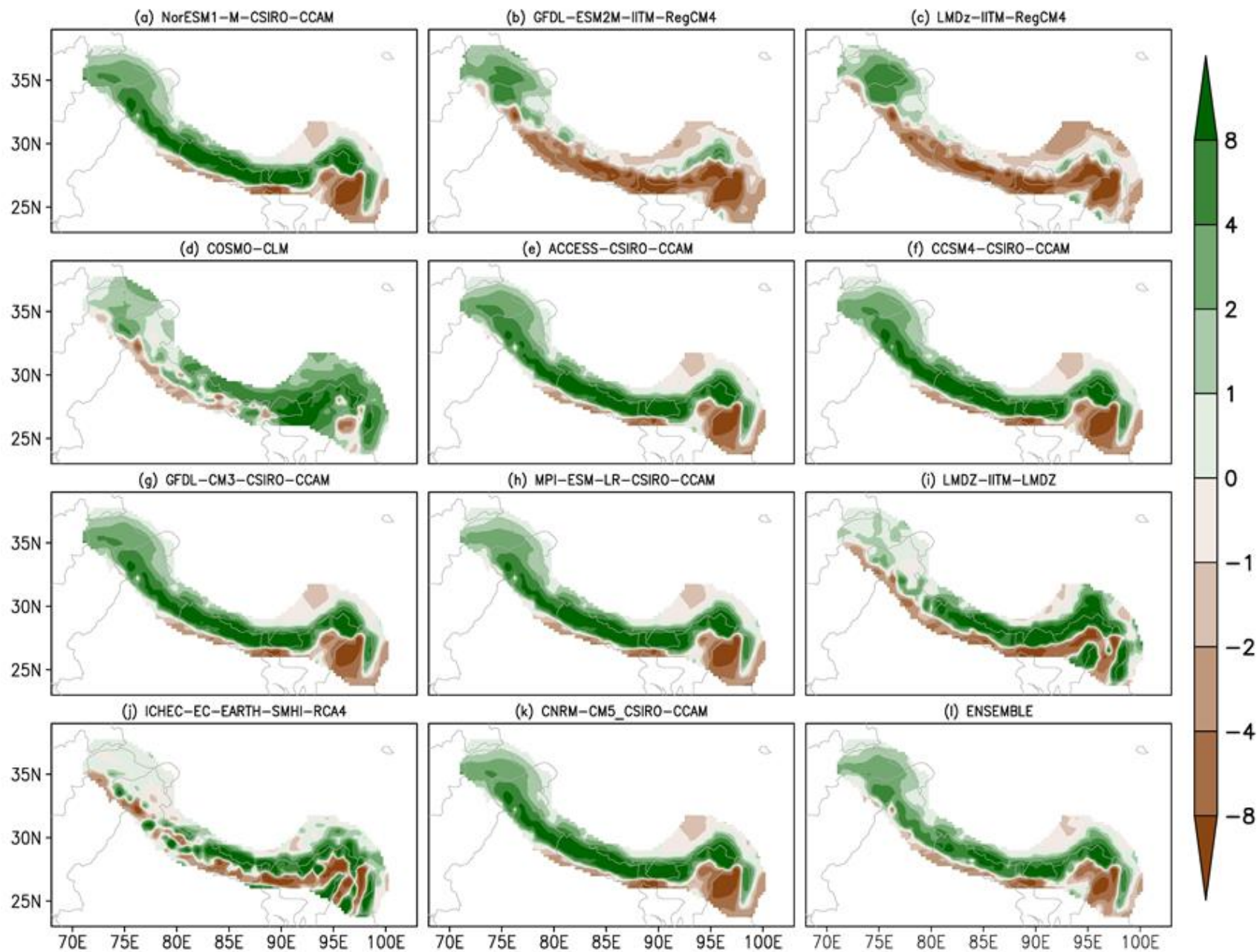


**Fig. 3: (a) Mean annual cycle of precipitation (mm/day) over the period of 1970-2005 and (b) monsoon months (JJAS) precipitation cycle from the 11 CORDEX experiments, their ensemble and corresponding observation. Nomenclature given in Fig.3b corresponds to the respective CORDEX experiment as described in detail in Table 1.**



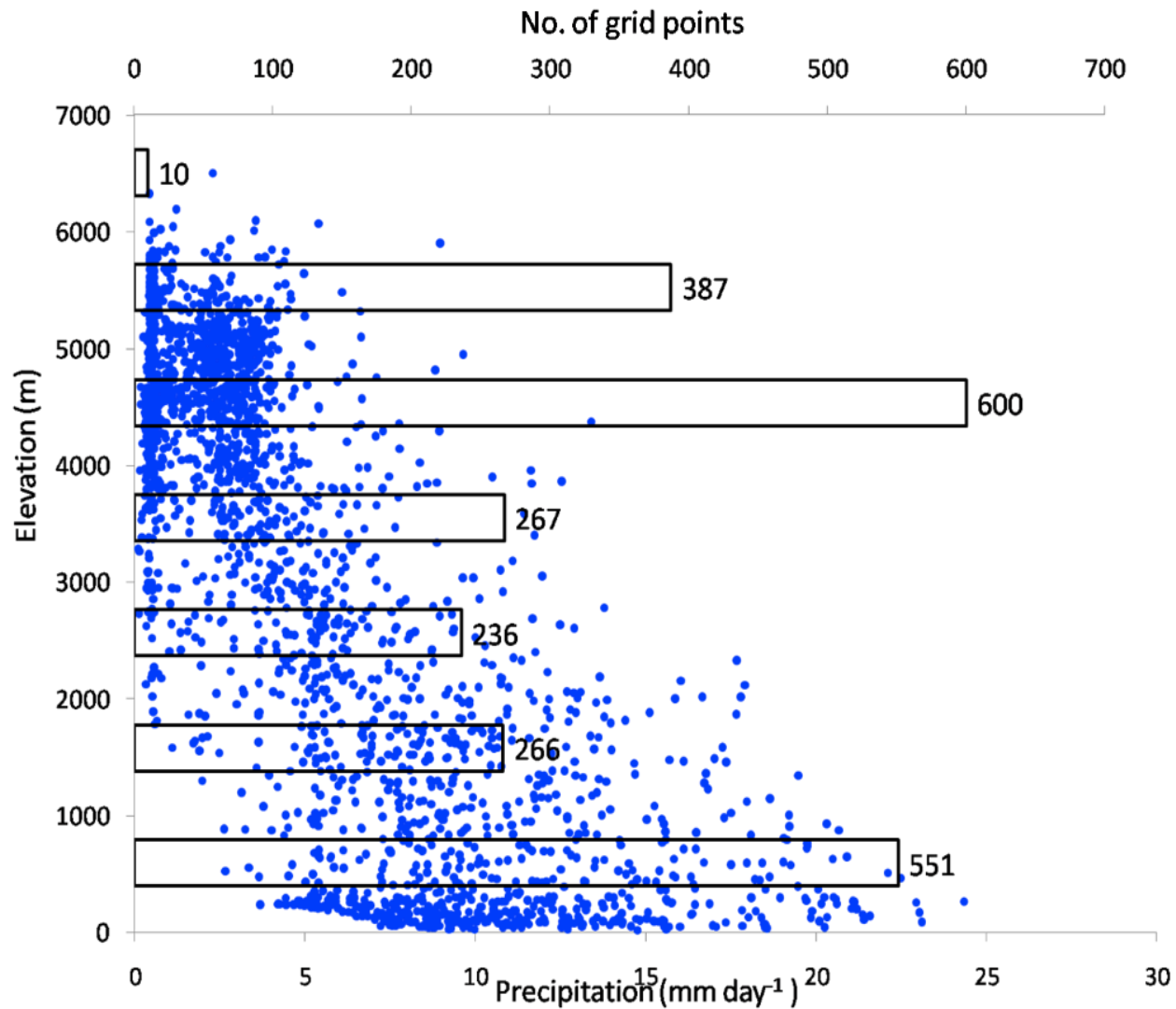
**Fig. 4: JJAS precipitation climatology (mm/day) for 1970-2005 of the 11 CORDEX experiments (a-k) listed in table 1 and their ensemble (l).**



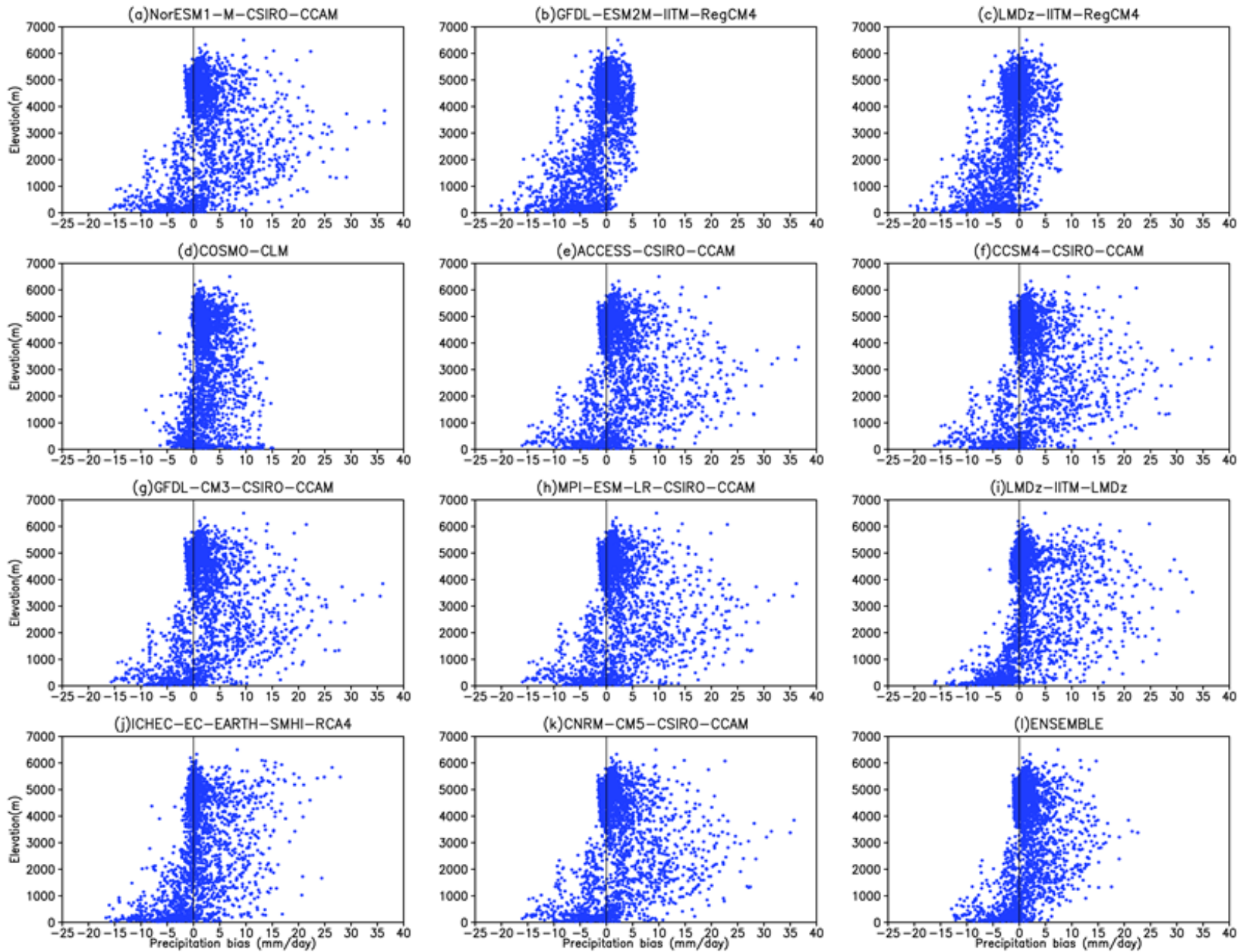


**Fig. 5: Same as Fig. 4, but for precipitation bias (mm/day).**

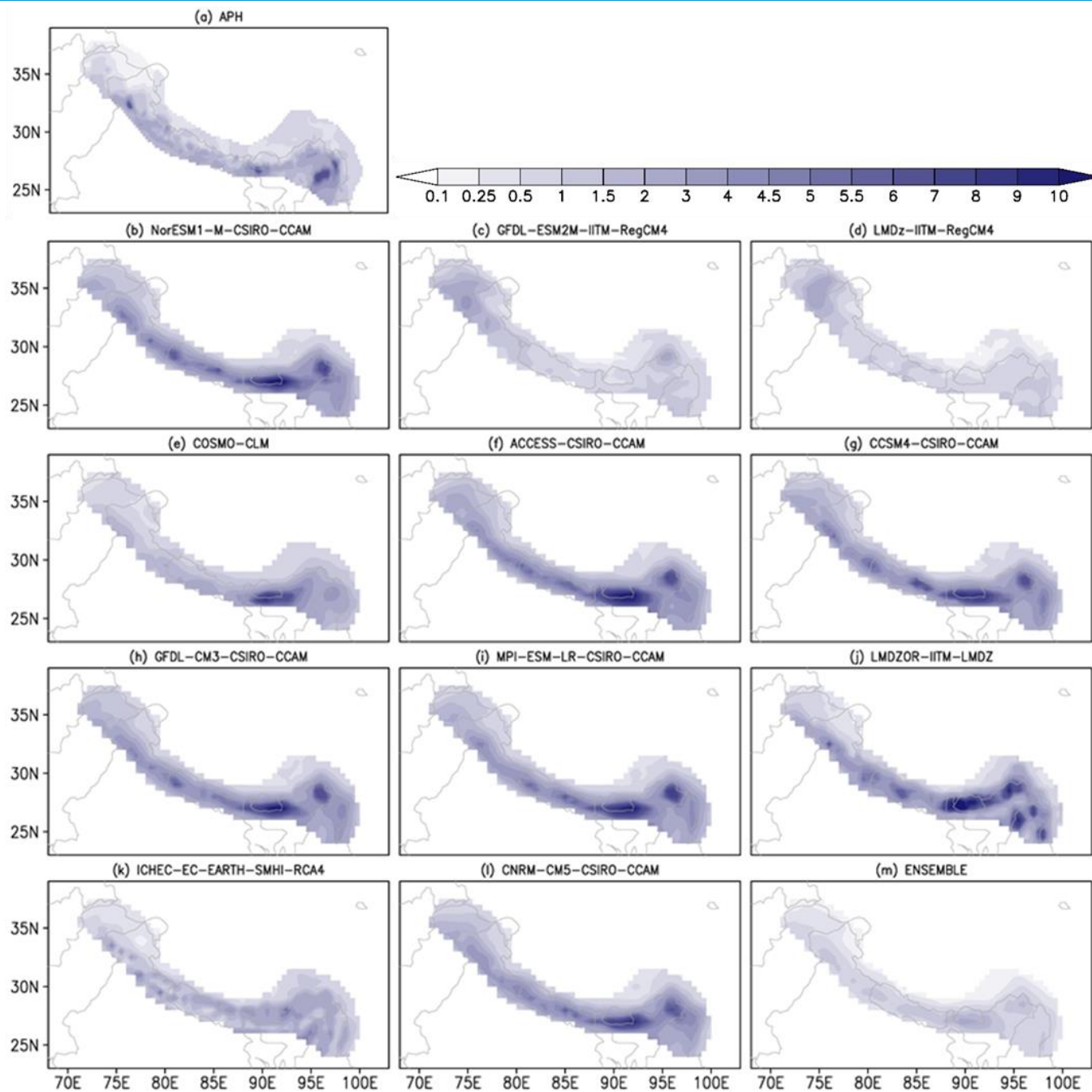




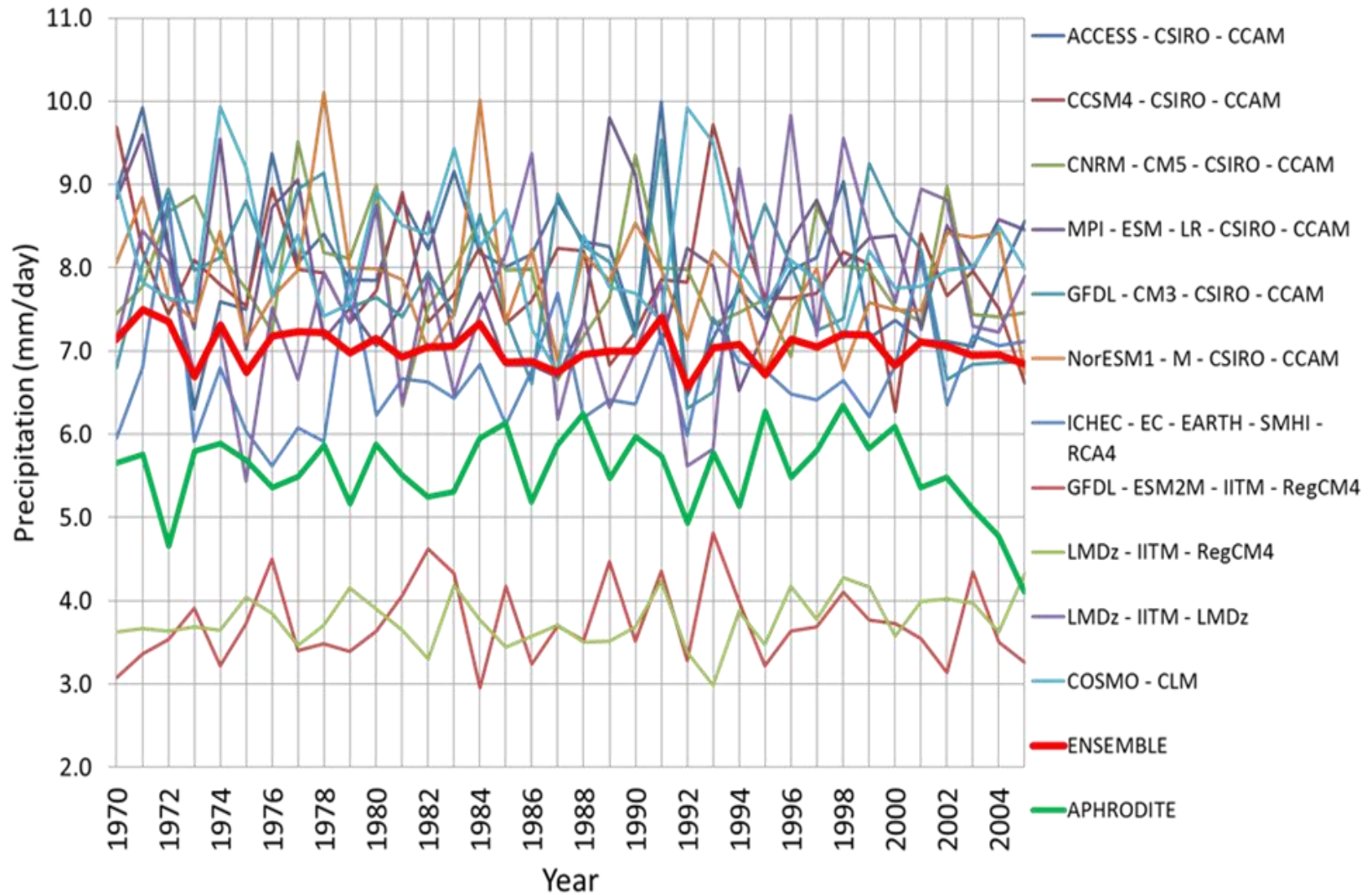
**Fig. 6: Variation in the observed precipitation (mm/day) with elevation.**



**Fig. 7: Variation of precipitation bias (mm/day) with elevation for the experiments and ENS.**

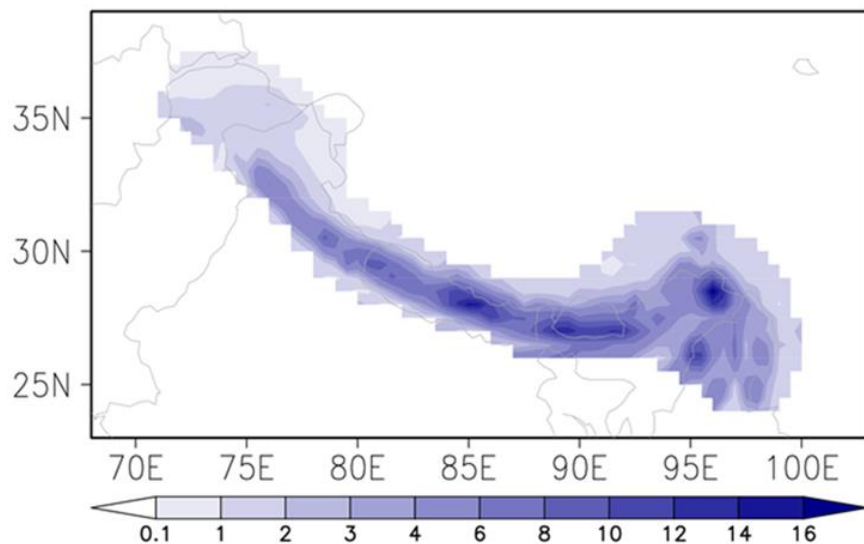


**Fig. 8: (a) Standard deviation (mm/day) for observation and (b-m) same as Fig. 4, but for standard deviation of precipitation.**



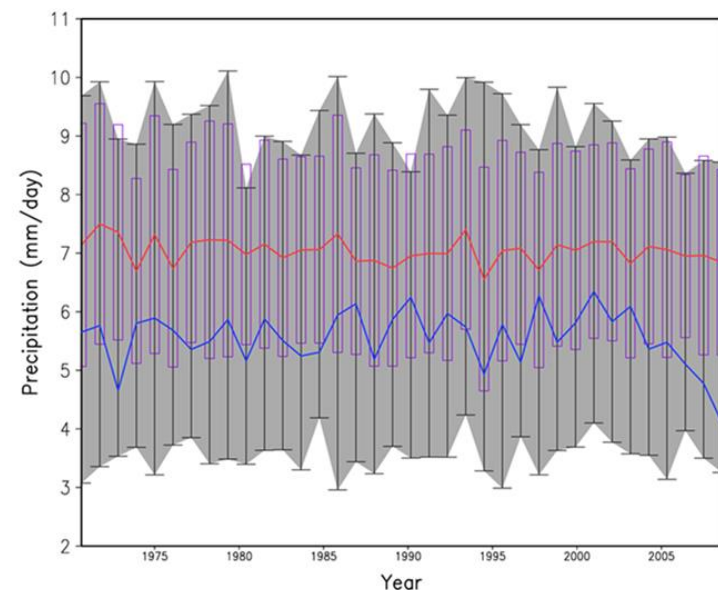
**Fig. 9: Time series of seasonal JJAS precipitation (mm/day) of 11 CORDEX experiments, their ensemble and the corresponding observation averaged over the study region (Fig. 1b).**



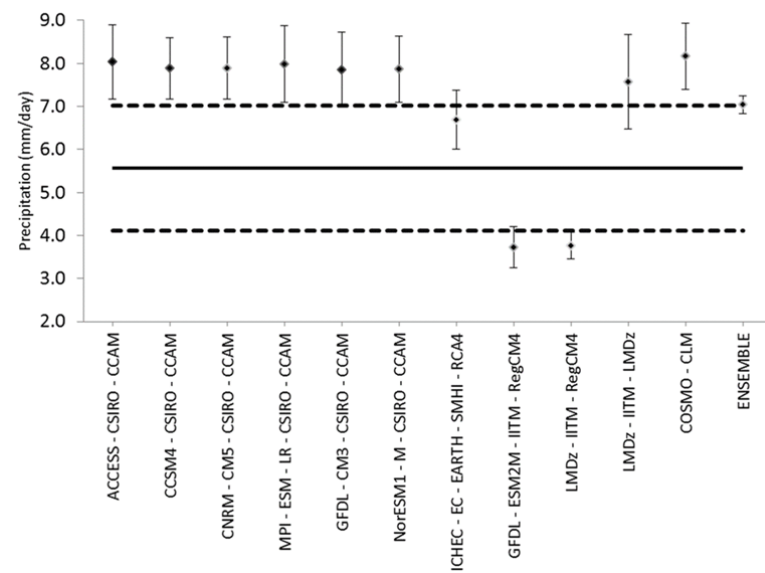


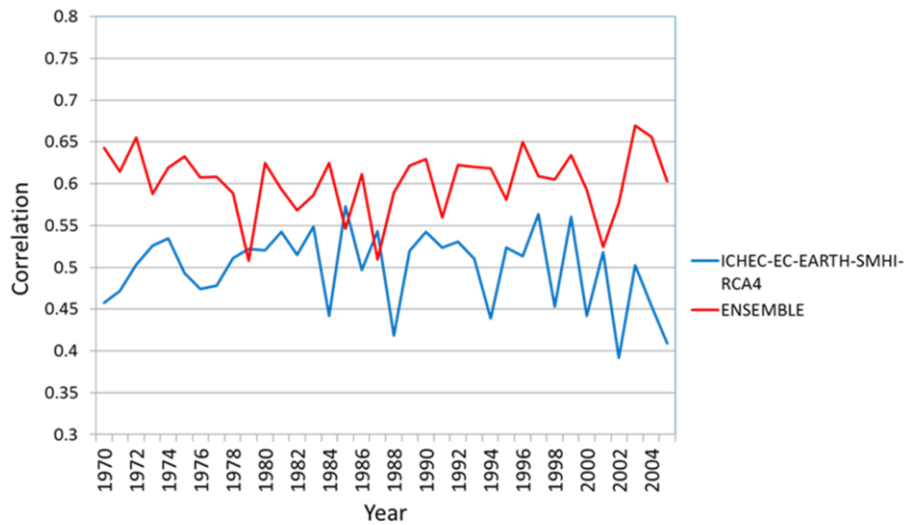
**Fig. 10: Standard deviation of precipitation (mm/day) for 1970-2005 over the study area for 11 experiments.**

**Fig 11: Temporal plot of ensemble spread among the 11 CORDEX experiments during JJAS precipitation (mm/day) averaged over the study area. The ensemble is shown by the red line, the  $\pm$  one standard deviation of the ensemble is denoted with the purple bars and the minimum and the maximum values among all the 11 CORDEX experiments are shown by the shaded region as well as by the whisker plots, whereas the blue line shows the observation APHRODITE data.**

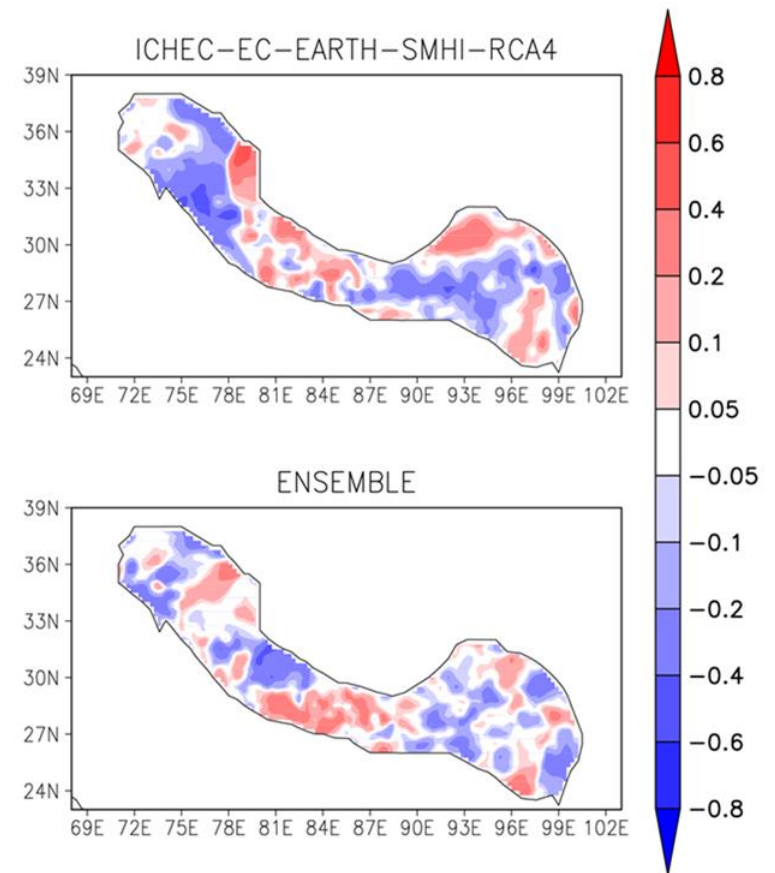


**Fig. 12: Precipitation (mm/day) analysis between 11 CORDEX experiments and corresponding observation. The thick black line denotes the mean precipitation (mm/day) of the observation, the dashed lines represent the  $\pm$  3 standard deviation of the mean of the observation, the dots represent the mean of each CORDEX experiments and the whisker bars associated to each dot are the  $\pm$  1 standard deviation of the mean of each experiments.**

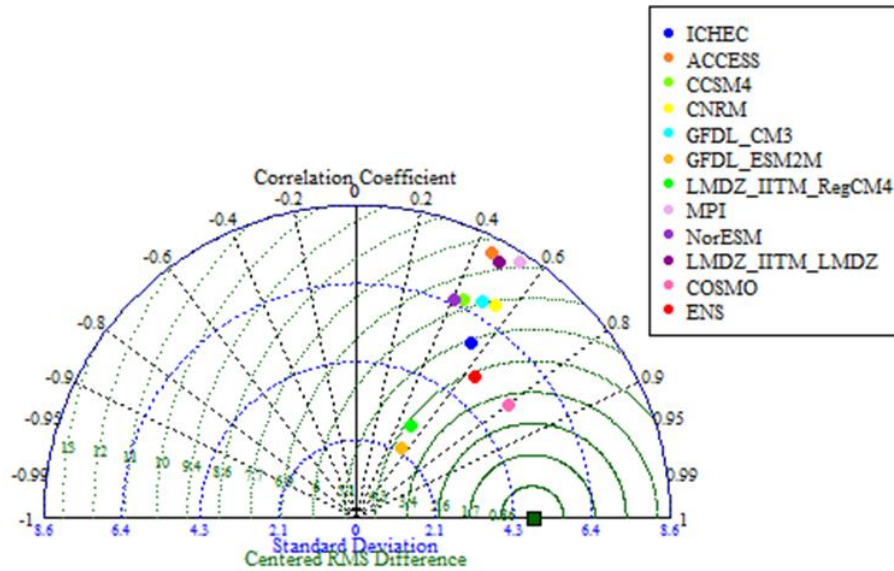




**Fig. 13: Spatial correlation of the JJAS precipitation (mm/day) between the ICHEC and ensemble with corresponding observation.**

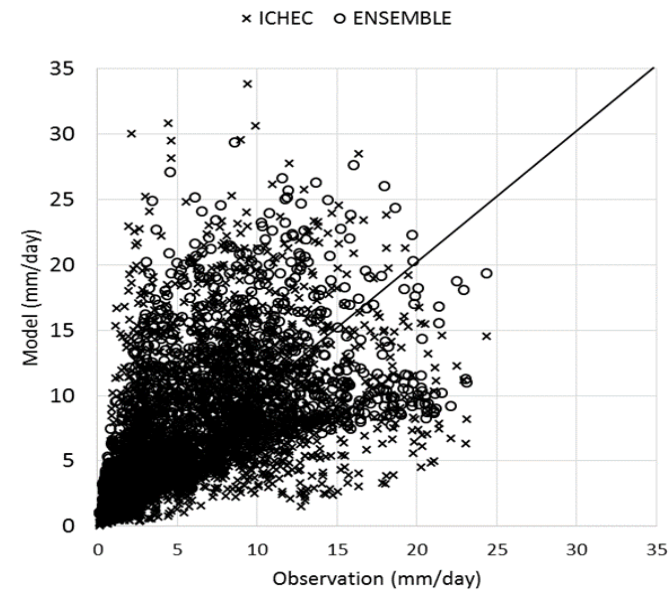


**Fig. 14: Temporal correlation of JJAS precipitation (mm/day) from 1970-2005 of ICHEC and ensemble with the corresponding observation.**

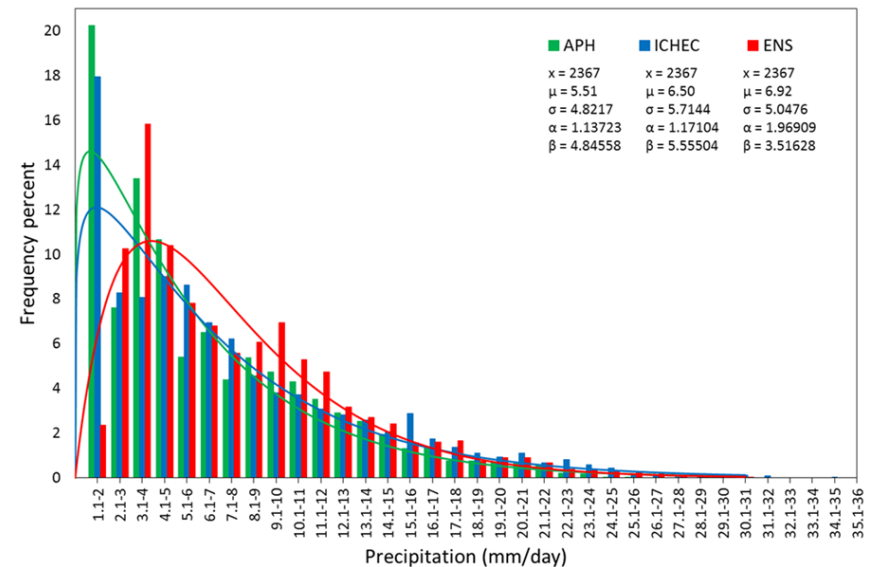


**Fig. 15: Taylor diagram showing statistical comparison of seasonal mean precipitation (mm/day) from 1970-2005 of the 11 CORDEX experiments, their ensemble and the observation.**

**Fig. 16: Scatter plot showing the scatter spread of the precipitation (mm/day) of the ICHEC and ensemble with reference to the observation.**



**Fig. 17: Probability Distribution Function (PDF) showing percentage of precipitation data falling within a particular range (in bar) and gamma distribution (in line).**



- Due to sparse distribution of observation stations, the gridded observational datasets capture very less precipitation
- The study of precipitation in this region is a very complex task due to topography and orography.
- Precipitation pattern widely vary.
- Most of the experiments show wet condition



**Assessment of the performance of CORDEX-South Asia experiments for monsoonal precipitation over the Himalayan region during present climate: Part I**

**S. Ghimire, A. Choudhary and A. P. Dimri\***

**School of Environmental Sciences, Jawaharlal Nehru University, New Delhi – 110067**

**(DOI: 10.1007/s00382-015-2747-2)**

***Assessment of the performance of CORDEX-South Asia experiments for monsoonal precipitation over the Himalayan region during present climate: Part II***

**A. Choudhary and A. P. Dimri\***

**School of Environmental Sciences, Jawaharlal Nehru University, New Delhi –  
110067**

**(Submitted in Climate Dynamics – In Revision)**

# Thank you

ICIMOD

