## **On the Capability of RegCM4 in Simulating Mean and Extreme Climate over India**

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# Introduction

- The Indian subcontinent exhibits large spatial and temporal variability in precipitation characteristics (Parthasarathy et al. 1995; Kripalani and Kulkari, 2001; Dash et al., 2002; Dash et al., 2013).
- The Indian summer monsoon precipitation (Jun-Sep) is one of the critical parameter which can affect the agricultural production affecting country's economy.
- Various modeling studies (GCMs and RCMs) studies have been carried out and reported about large mean biases (mostly dry) which, still persists over the core monsoon region.
- The region possesses complex topographical features which can modify the local climate (extremes).
- Regional climate modeling has been an useful tool for dynamical downscaling exercise and issue of "added value" is not well illustrated over the Indian region.

## Impact of model resolution (50km and 25km) in simulating precipitation characteristics over India.

Mean and Bias

- Seasonal variation of precipitation and surface temperature
- Intra-seasonal and annual cycle of precipitation

Issue of Added Value (downscaling as well as upscaling)

- Spatial distribution of precipitation during the summer monsoon (June-Sept)
- Daily precipitation PDFs (over different sub-region regions ) Extremes
- Spatial distribution of R99

(e.g. Torma et al., 2015)



• ICTP's Regional climate model (RegCM)

Characteristics	Description
Model version	RegCM4.7
Domain	South Asian CORDEX Domain
Resolution	50 km (CORDEX p1) and 25 km (CORDEX p2)
Projection	ROTMER
Time integration	1979-2015 ; analysis 1980-2015 (36 years simulations)
Land surface process	CLM4.5
Atmospheric data , surface terrain, SST used	EIN75(0.75x0.75), USGS data , EIN75 SST data
Cumulus parameterization	Emanuel over land and Tietdke over ocean
Planetary Boundary parameterization	UW scheme
Moisture Scheme	SUBEX Pal et al., (2000)

**Observational data sets ( similar period :- 1980-2015)** 

Precipitation IMD (India Meteorological Department) - 25 km (for now) TRMM (from 1998 - 2015)- 25 km

Surface temperature CRU (Climate Research Unit)- 0.5x0.5

#### South Asia CORDEX domain & IMD homogenous regions



Yellow: Northwest Black: Central northeast Blue : West central Green : Peninsular Red : Northeast



 Representation of topographical details as we move towards finer resolution (e.g. NE(1), WC(2), CNE(3))

#### Seasonal variation of precipitation (mm/day) over India



- Captures the seasonality of precipitation i.e. Low values of precipitation during the winter to high during the summer monsoon.
- Dry Biases over the NW and central region decreases as the model resolution increase.
- However, model has tendency of having slight wet bias over certain regions (e.g. PI, NEI)

#### Seasonal variation of surface temperature (°C) over India



- Temp biases are also reasonable compared against CRU.
- Warm bias tends to decrease during monsoon indicating increase in precipitation in higher resolution.



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Northward propagation

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\*Uncertainty in obs (later slides)

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#### Search for Added Value



• Western Ghats (West Central region), Central region , Northeast.

• When upscaled to EIN75 resolution, RCMs replicated better while compared against IMD.

• Downscaling physical phenomena.





Pai et al., 2014

#### **Spatial distribution of RF99**



- Captures the intense extreme events regions.
- The 25 km show more intense extreme events (as seen earlier in PDF tails) over the northeast and parts of peninsular and westcentral region which are due to enhanced topographical forcings.

# SUMMARY

- The mean annual and summer monsoon precipitation mean bias improves while simulating at a finer resolution mostly over the central northeast, westcentral, northwest regions. However, wet bias still persists over the parts of northeast and peninsular region.
- The spatial distribution of mean summer monsoon precipitation at both 50 and 25 km clearly shows the evidence of added value when upscaled on the coarser EIN75 resolution especially over the western ghats in west central and peninsular region, northeast and central northeast regions.
- The precipitation at 50km and 25km resolution shows substantial improvement in extremes over most of the regions compared to EIN75. Compared to IMD data, the 25 km show more intense extreme events (PDF tails) over the northeast and parts of peninsular and westcentral region which are due to enhanced topographical forcings.

