Applications of Downscaling in Assessing Impacts of Climate Change: Challenges and Unanswered Questions

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Downscaling

GCM Output

Large Scale Climate Variables

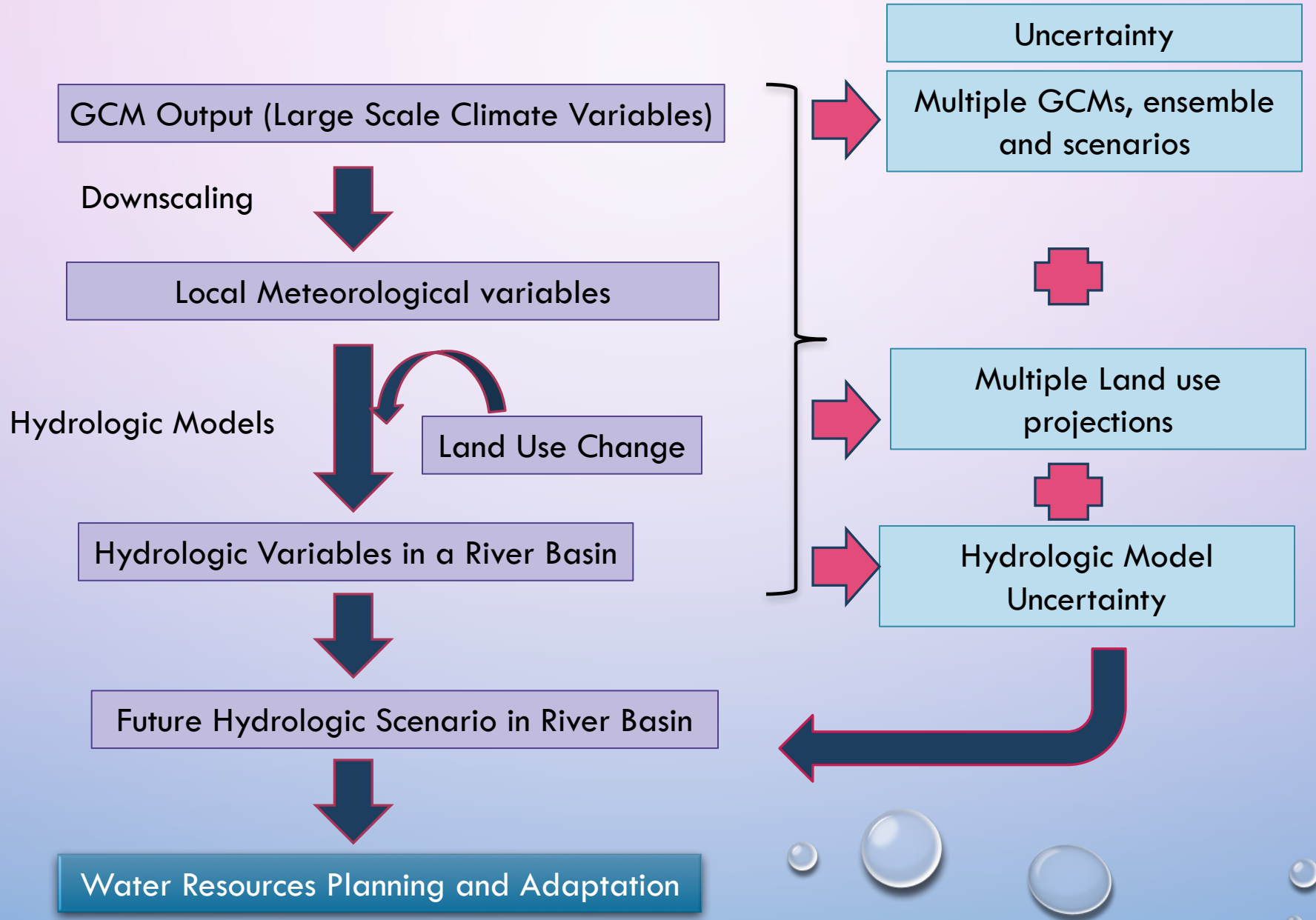
Regional Scale Hydro-meteorologic Variables, e.g., Rainfall in a city

Downscaling
- Statistical Downscaling
- Dynamic Downscaling

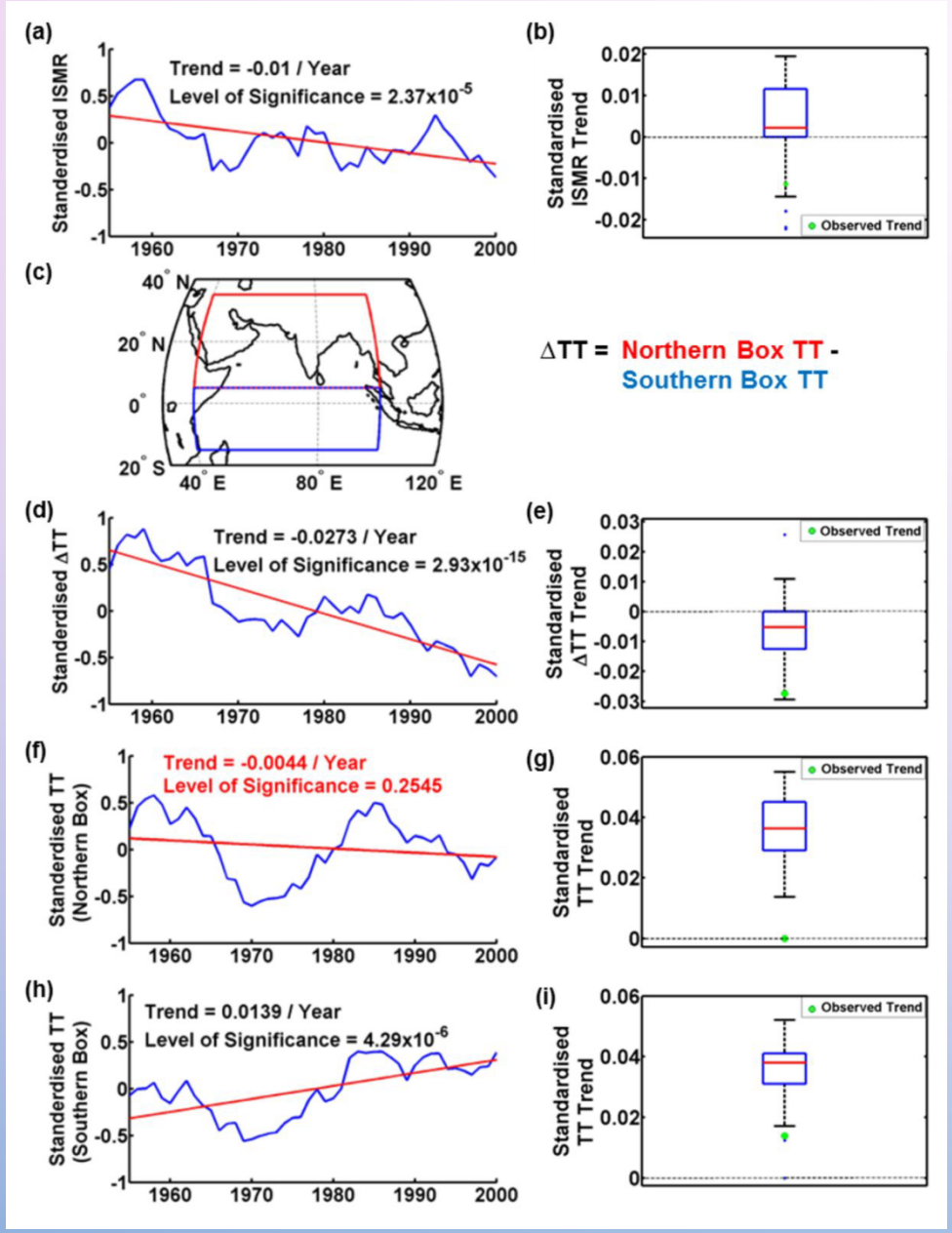
Impacts Assessment

- Drought Analysis
- Agricultural Management
- Water Demand Availability Analysis
- Water Resources Management
- Hydraulic Structure Design
- Ecological Impacts
- Risk and Vulnerability Assessment of Extreme Events

General Framework



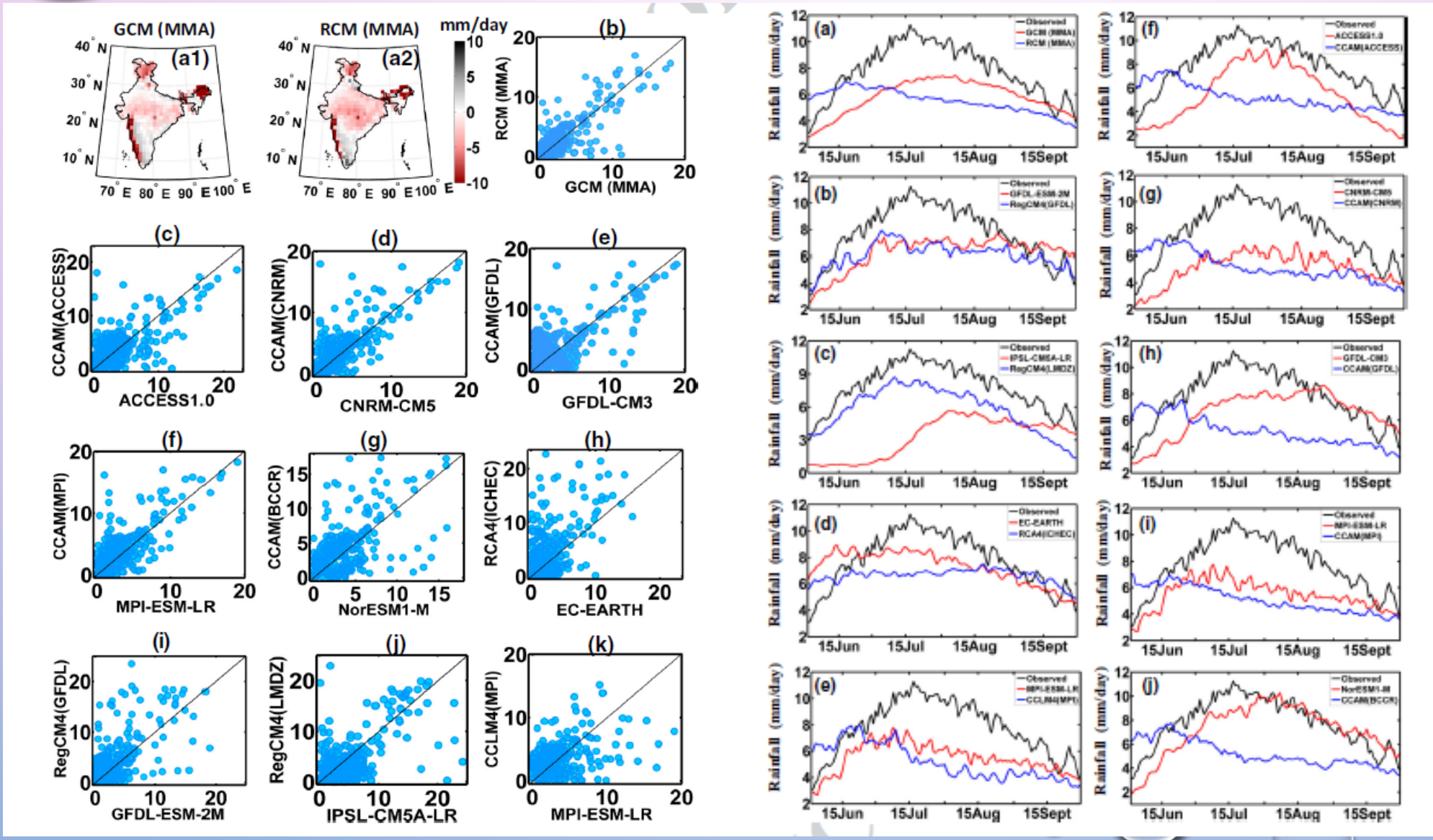
Can GCMs simulate observed trend?



Even if you consider Multi-Model Average → it will give opposite trend

Saha et al. (2014), GRL

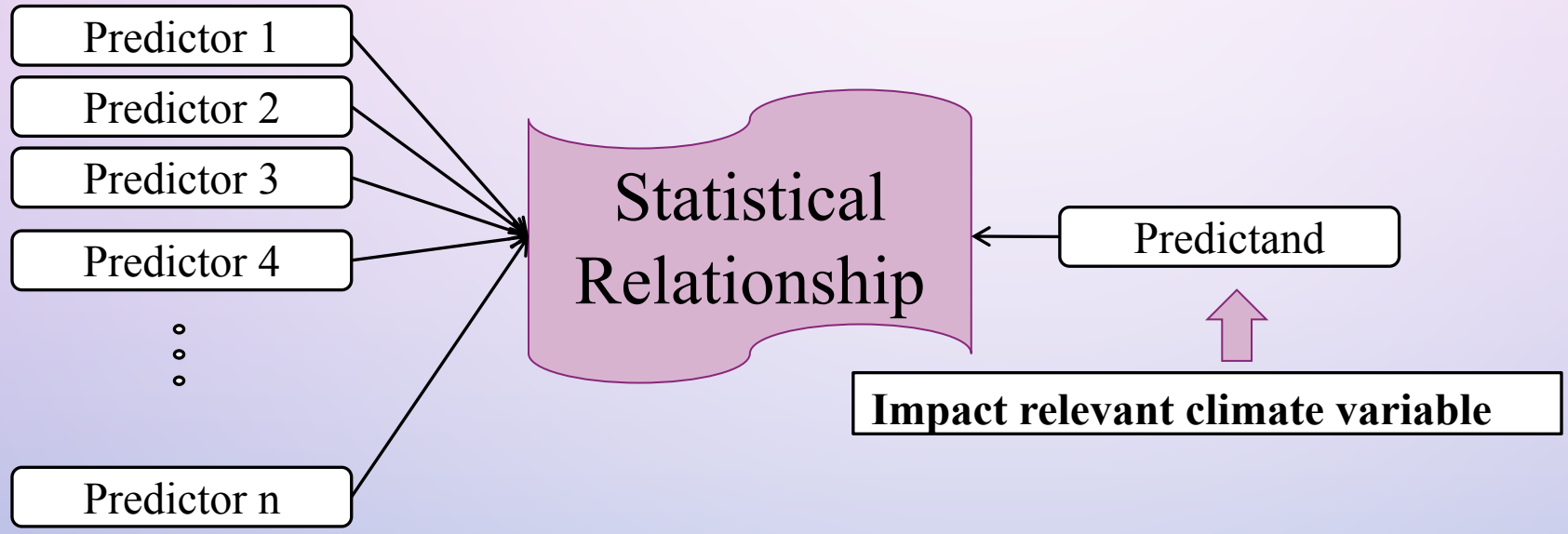
CORDEX Models are great but may need Improvements



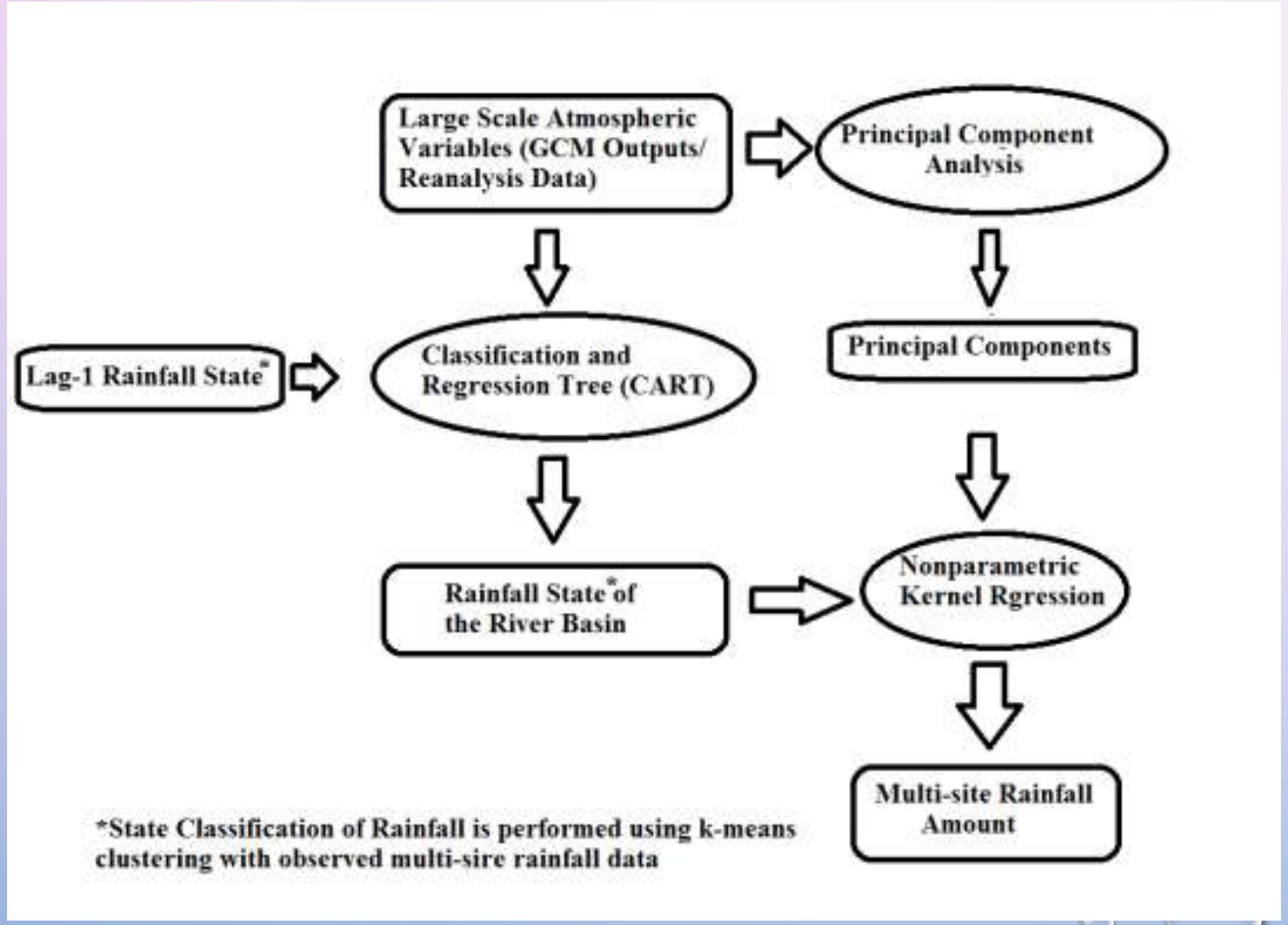
Singh et al. (2016) Climate Dynamics

What about statistical downscaling?

Standard Approach

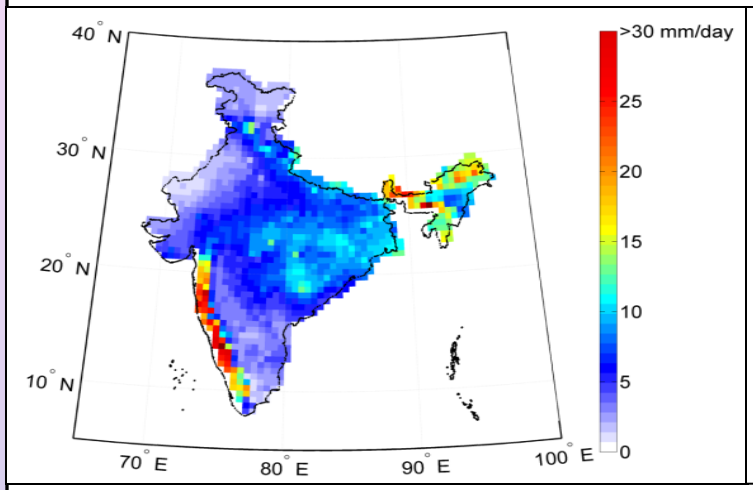


Our Approach

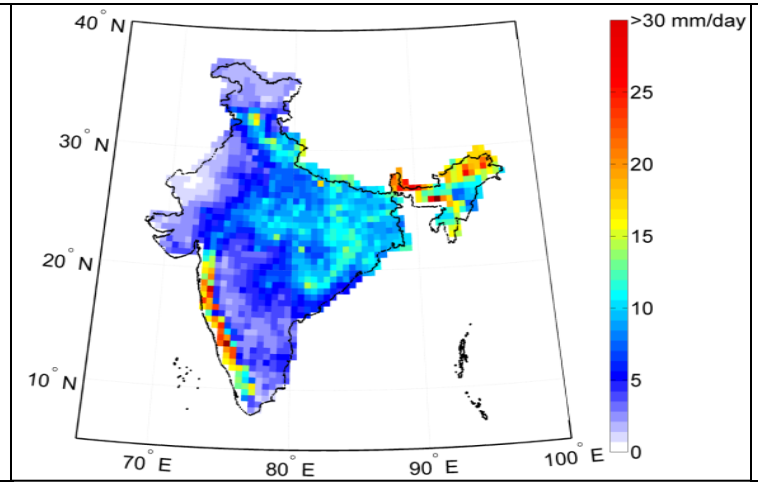


Kannan and Ghosh (2013), WRR

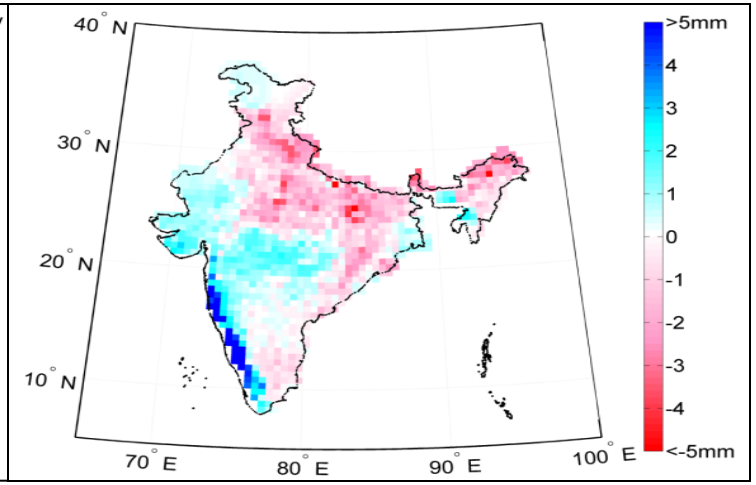
Historic Period Simulations: Comparison of Statistical Properties (1971-2000)



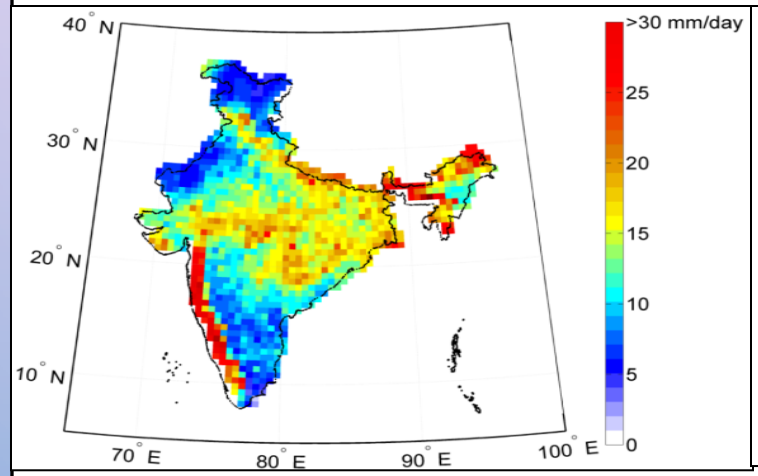
Observed Mean rainfall



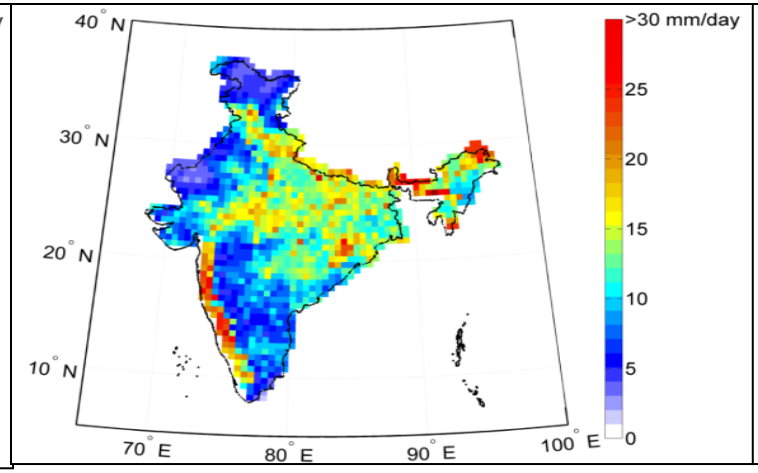
Projected Mean rainfall



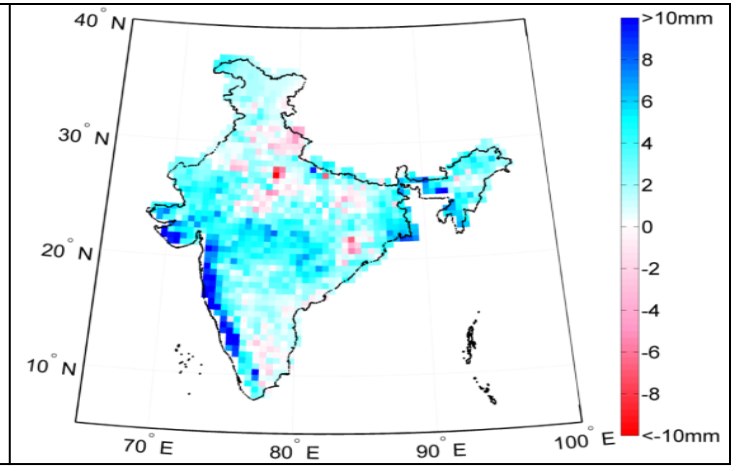
Difference in mean (mm/day)



Observed rainfall standard deviation



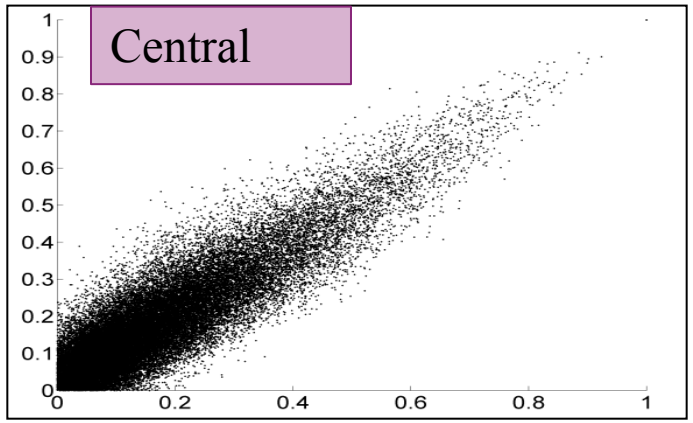
Observed rainfall standard deviation

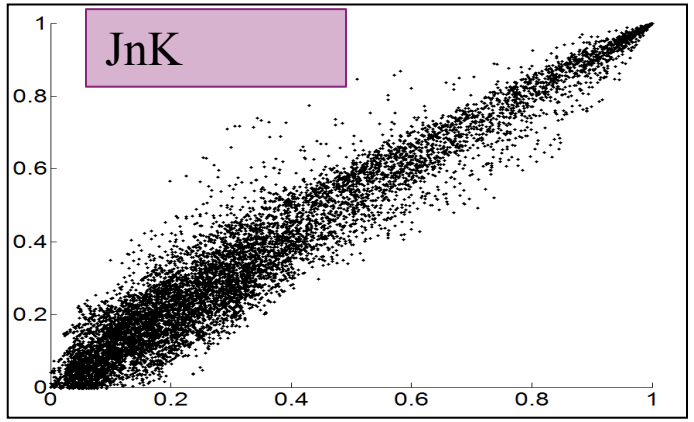


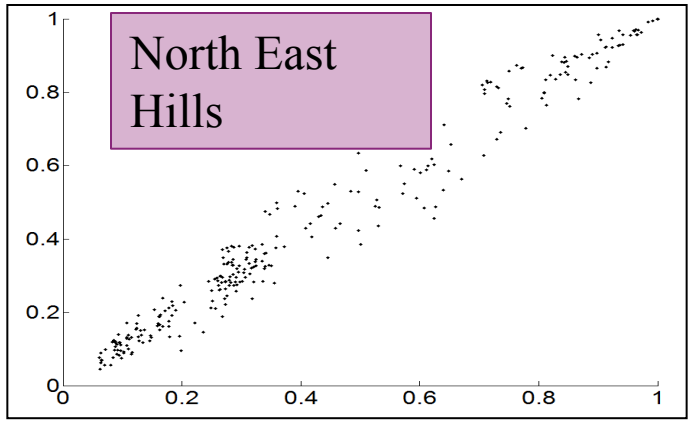
Difference in standard deviation (mm/day)

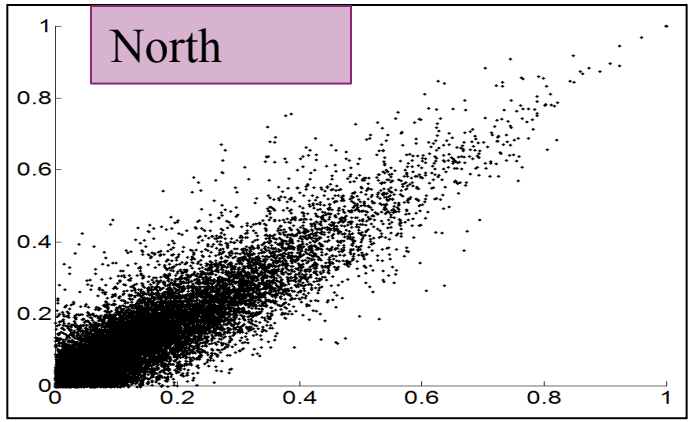
Salvi et al. (2013) JGR

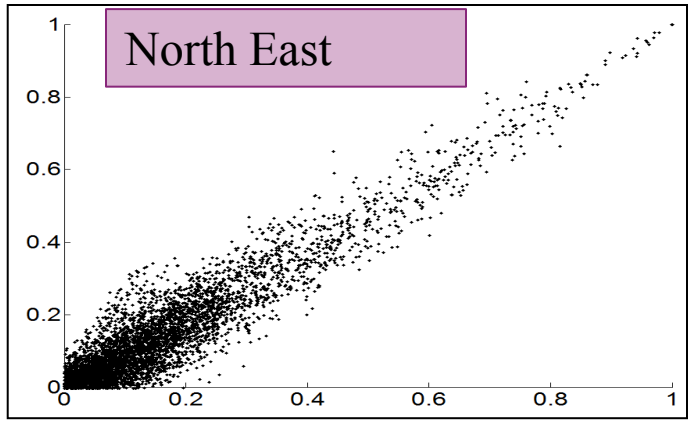
Zone-Wise Cross-correlation plots





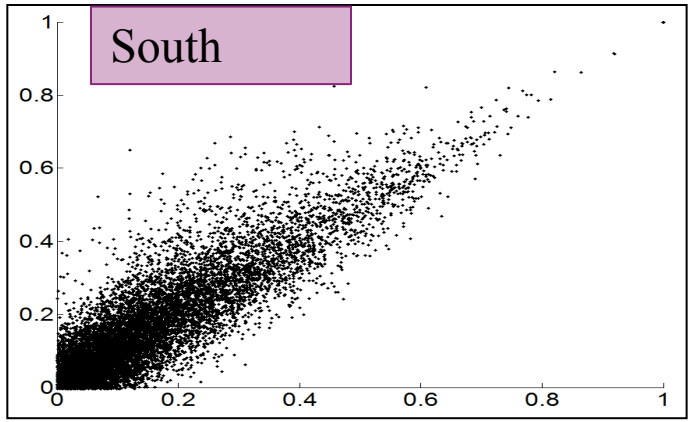


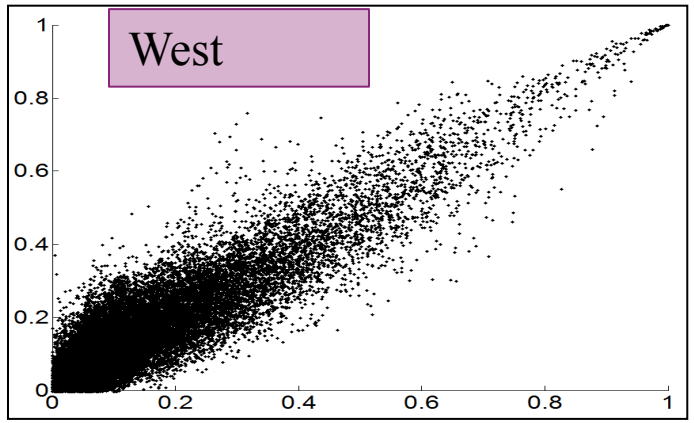




Cross-correlation for observed data on X axis

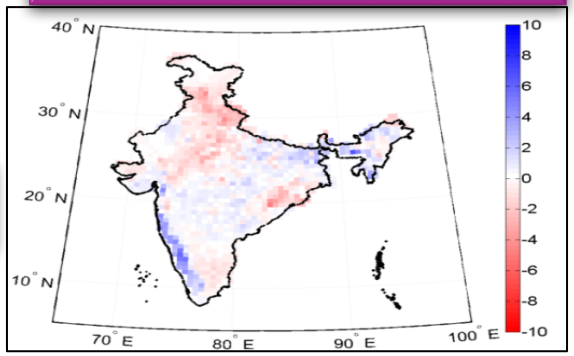
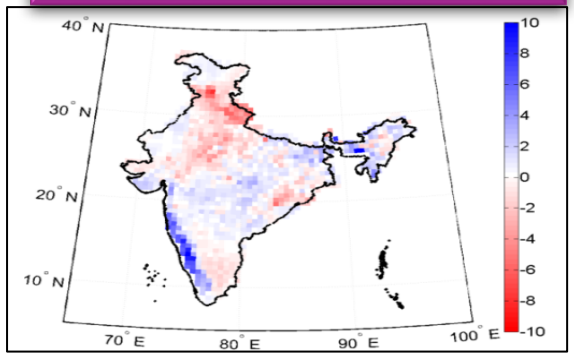
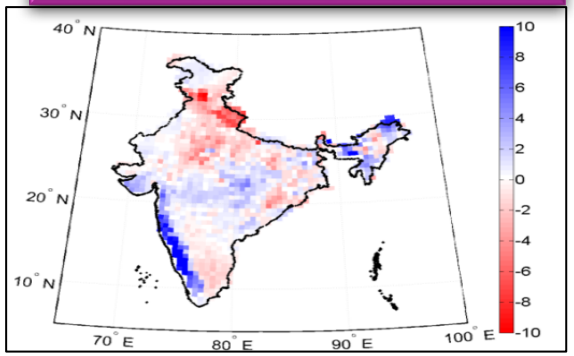
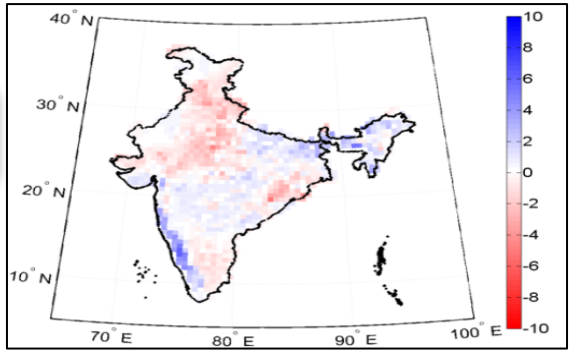
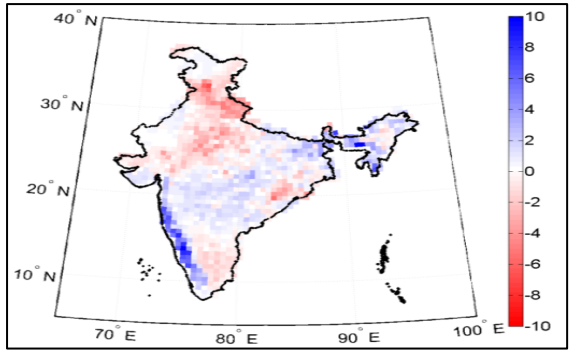
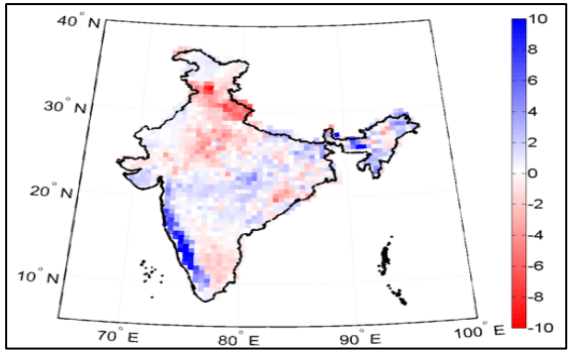
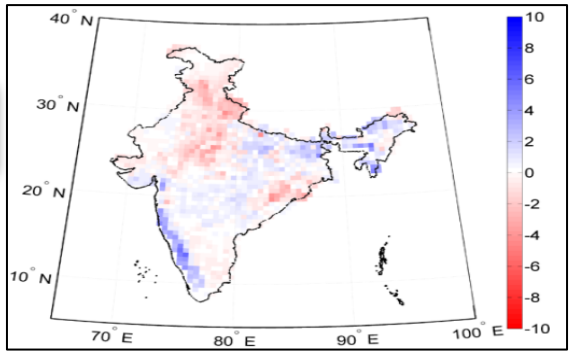
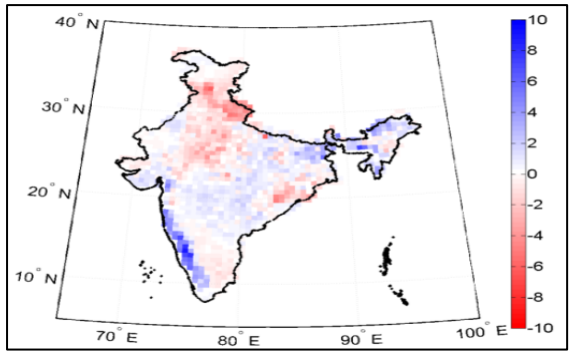
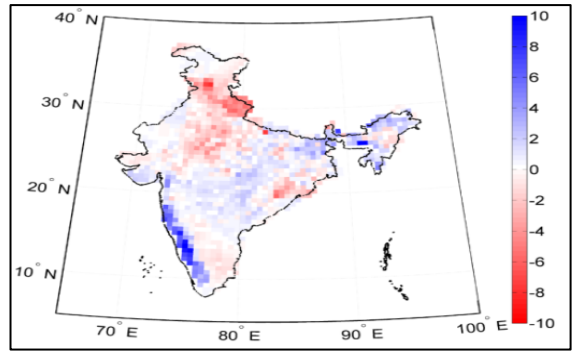
Cross-correlation for simulated data on Y axis



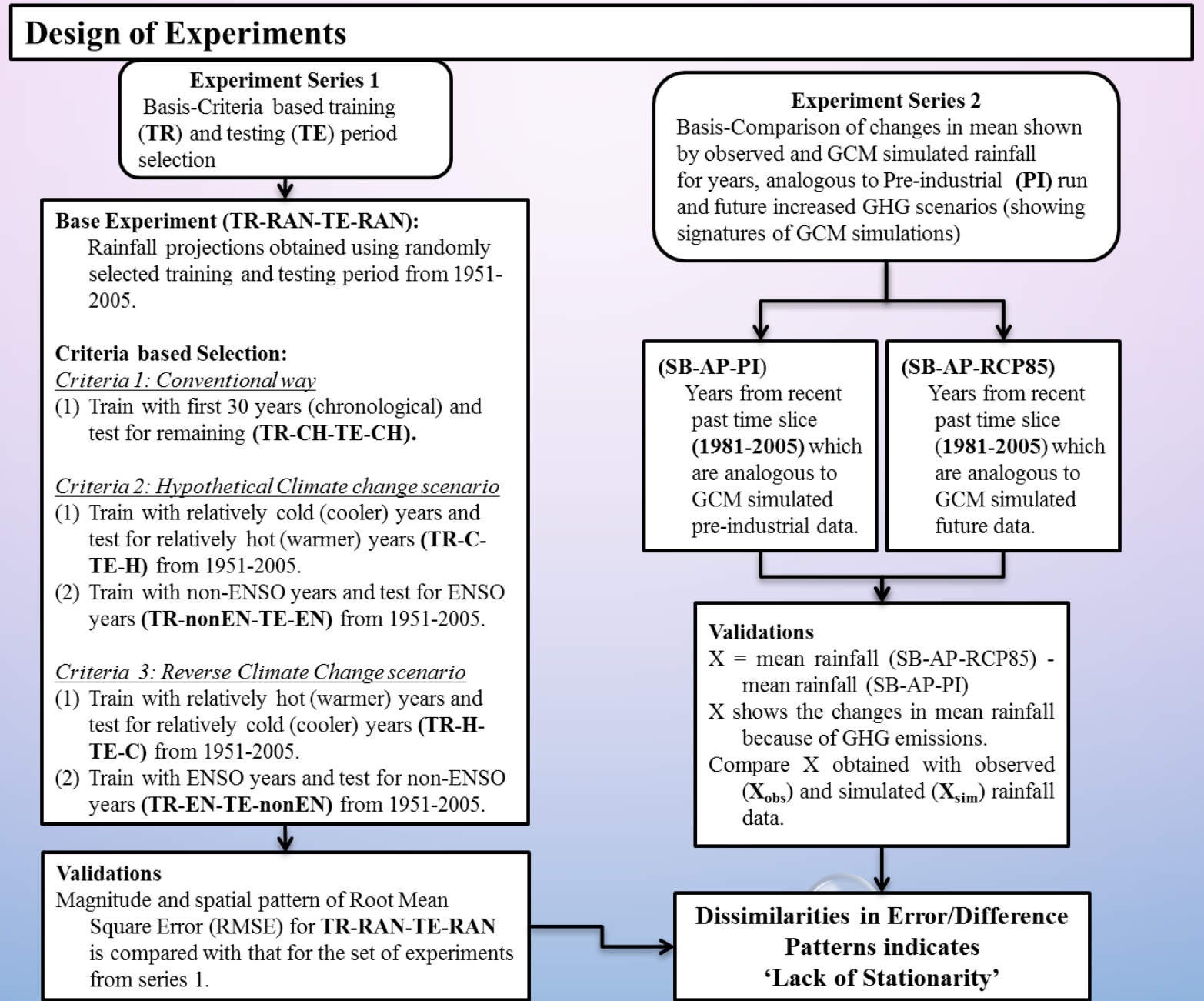


Future Projections

All Dimension are in mm/day

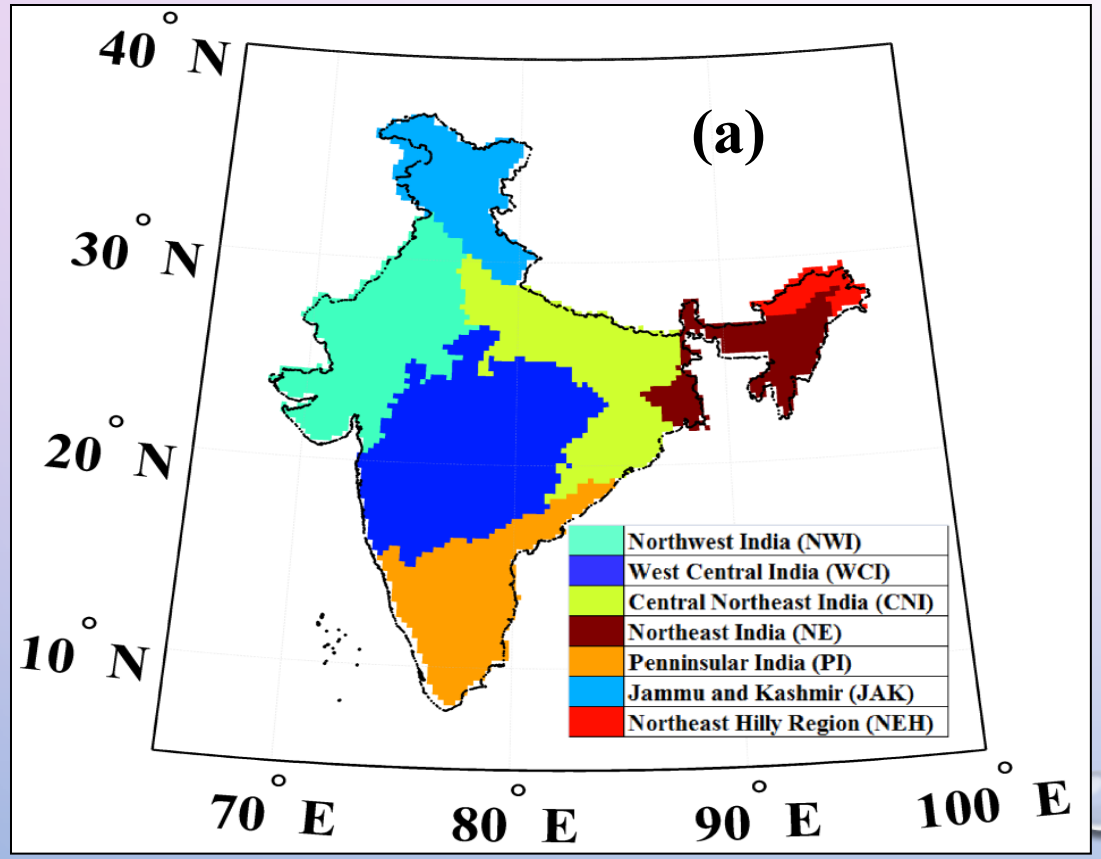
	2010-2039	2040-2069	2070-2099
A2			
A1B			
B1			

Do they work in non-stationary climate?

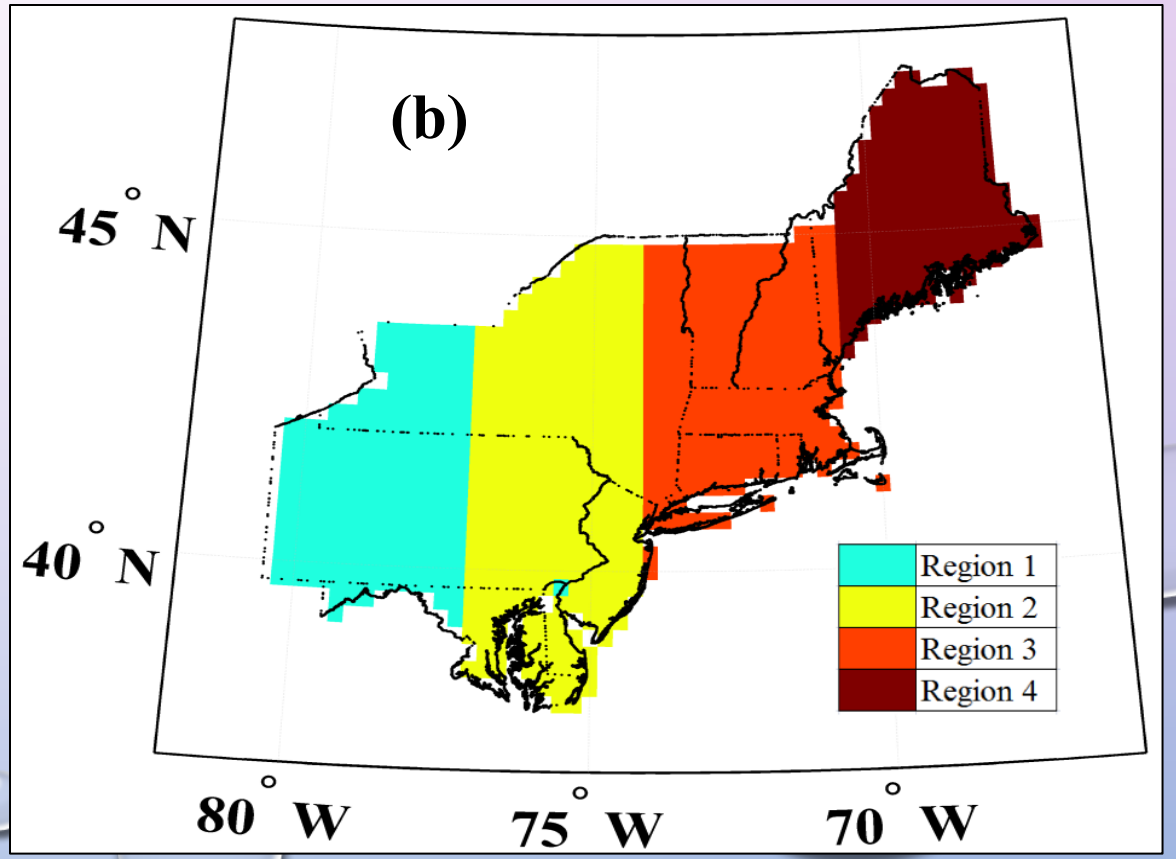


Study Regions: To illustrate the generic nature of methodology

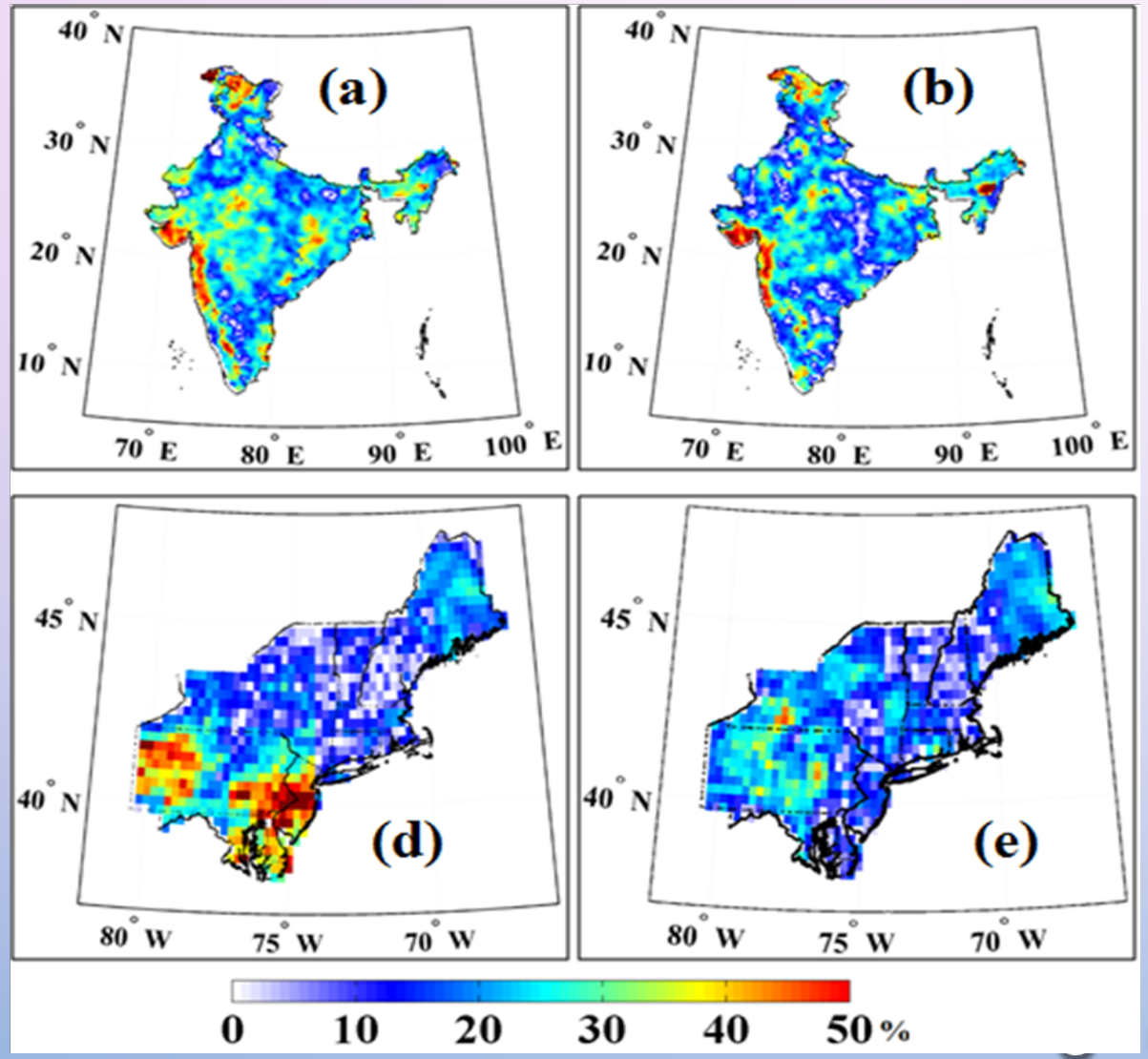
Study Region 1: India



Study Region 2: Northeast US

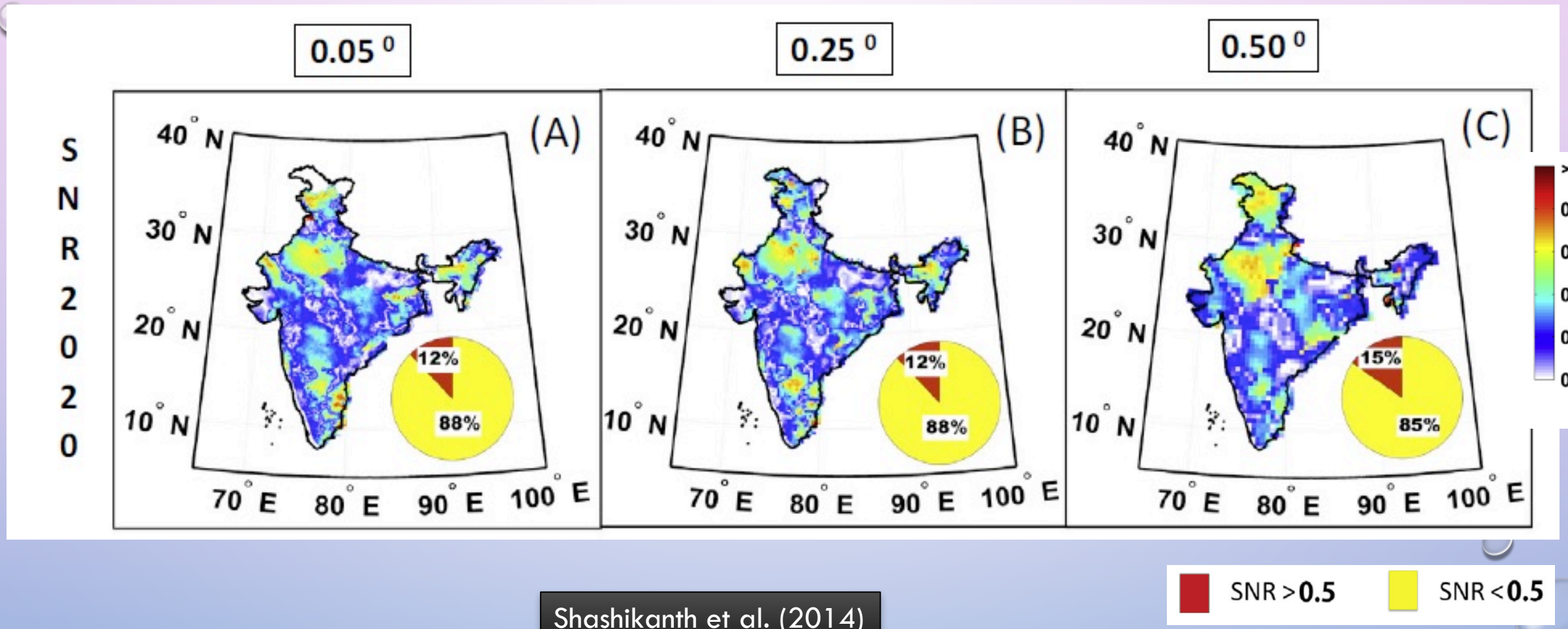


Violation on Non-stationarity



Salvi et al., 2016, Clim Dyn

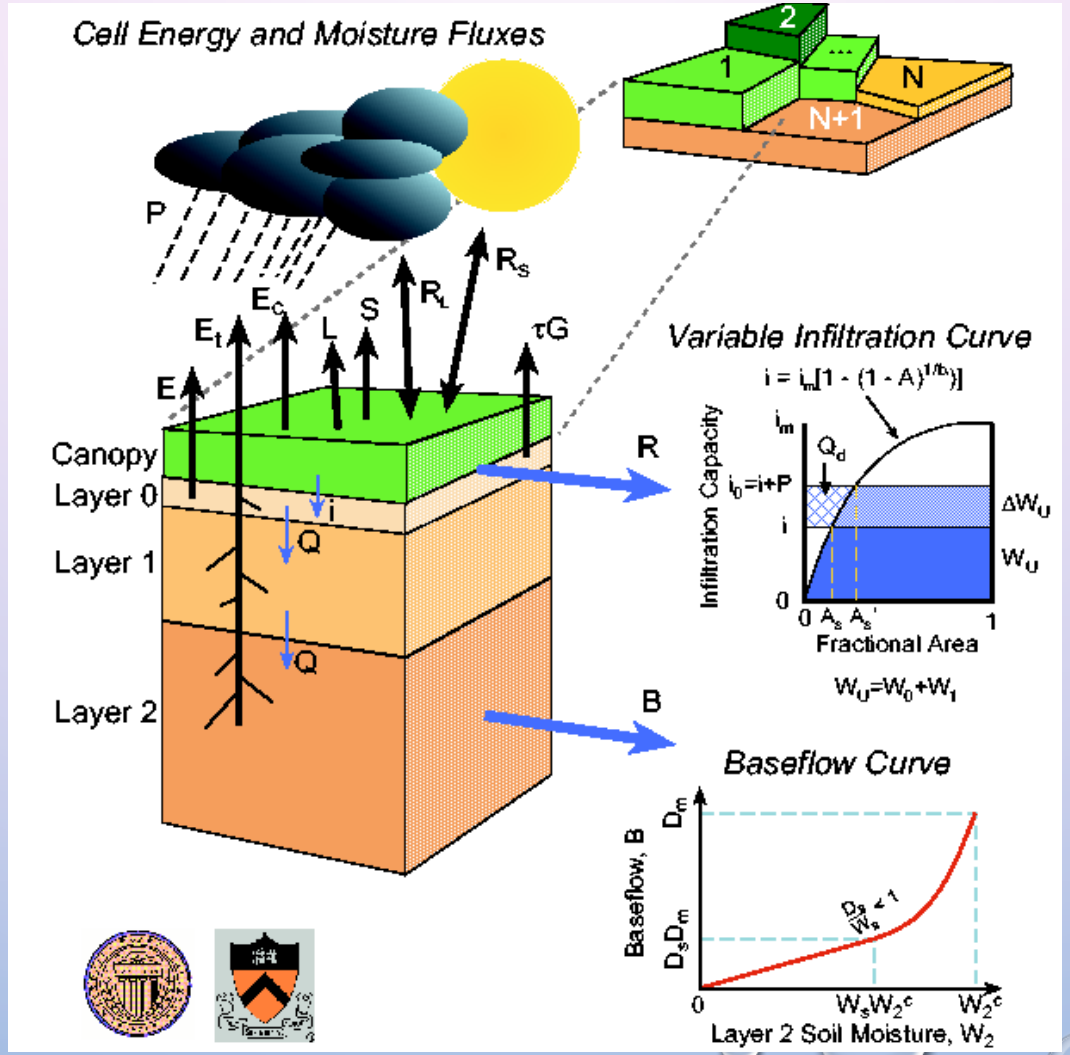
Do they provide any signal of changes?



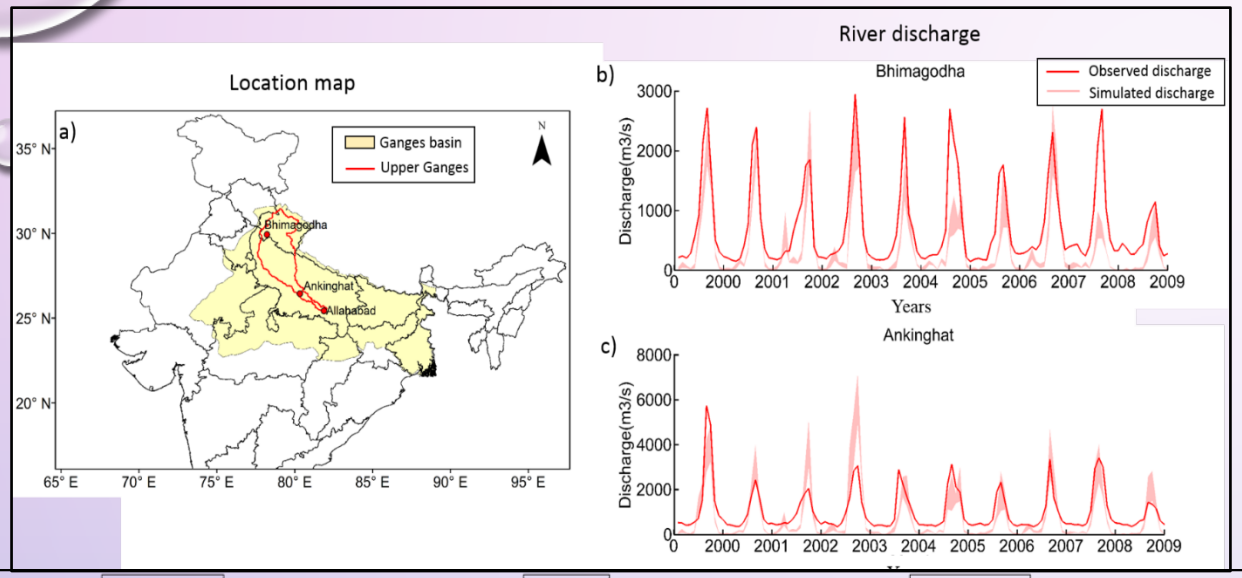
Shashikanth et al. (2014)
Jl. of Hydrology

Assessing Hydrological Impacts

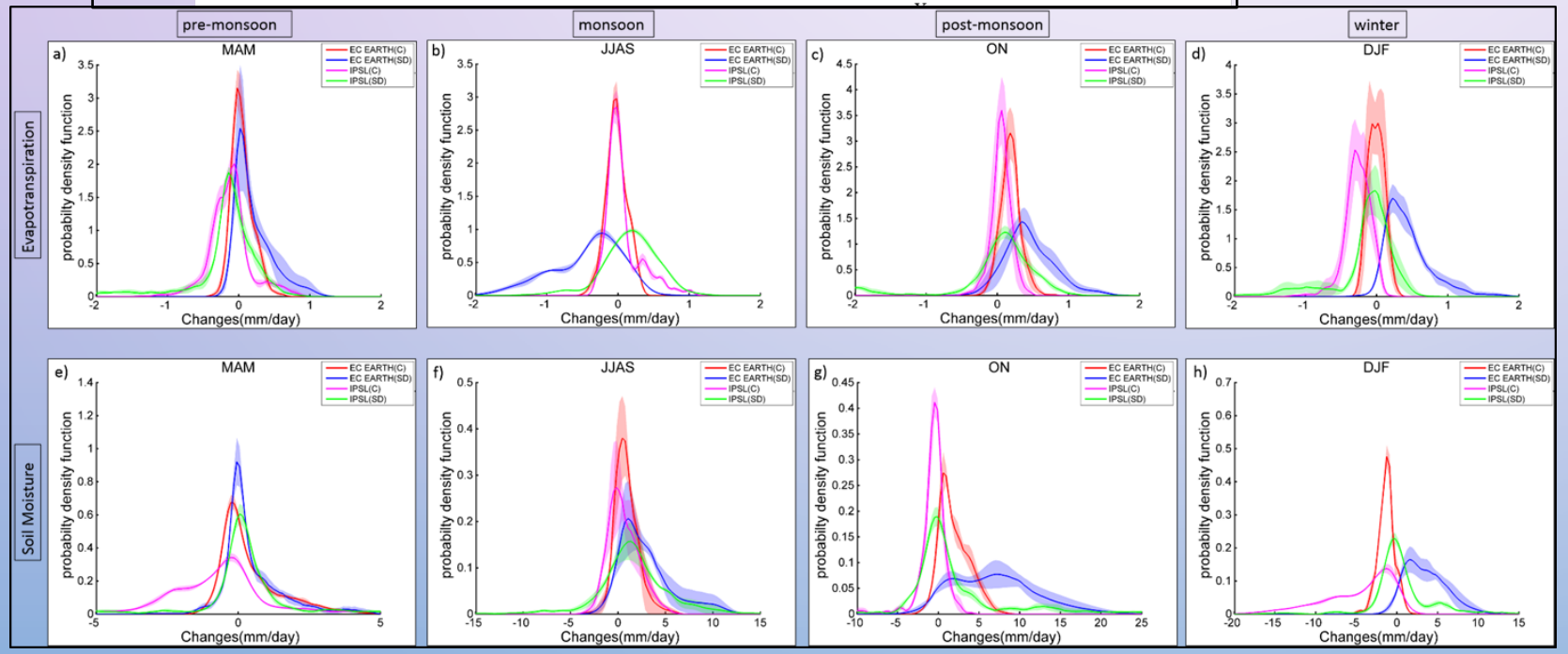
Variable Infiltration Capacity Model



Hydrological Parameterization in the background of Climate Uncertainty

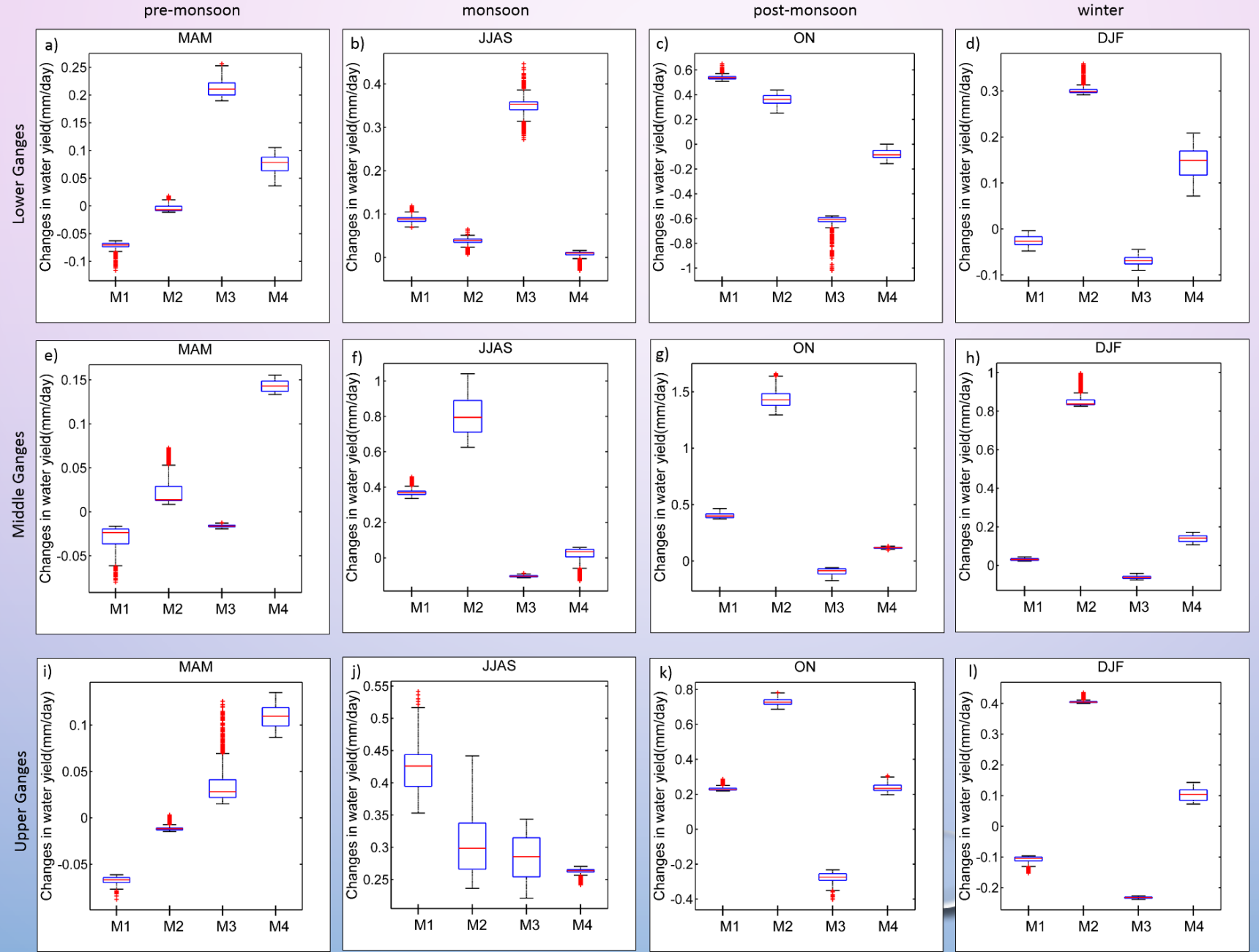


Given the climate uncertainty, you may not even require any hydrological parameterization? ☺



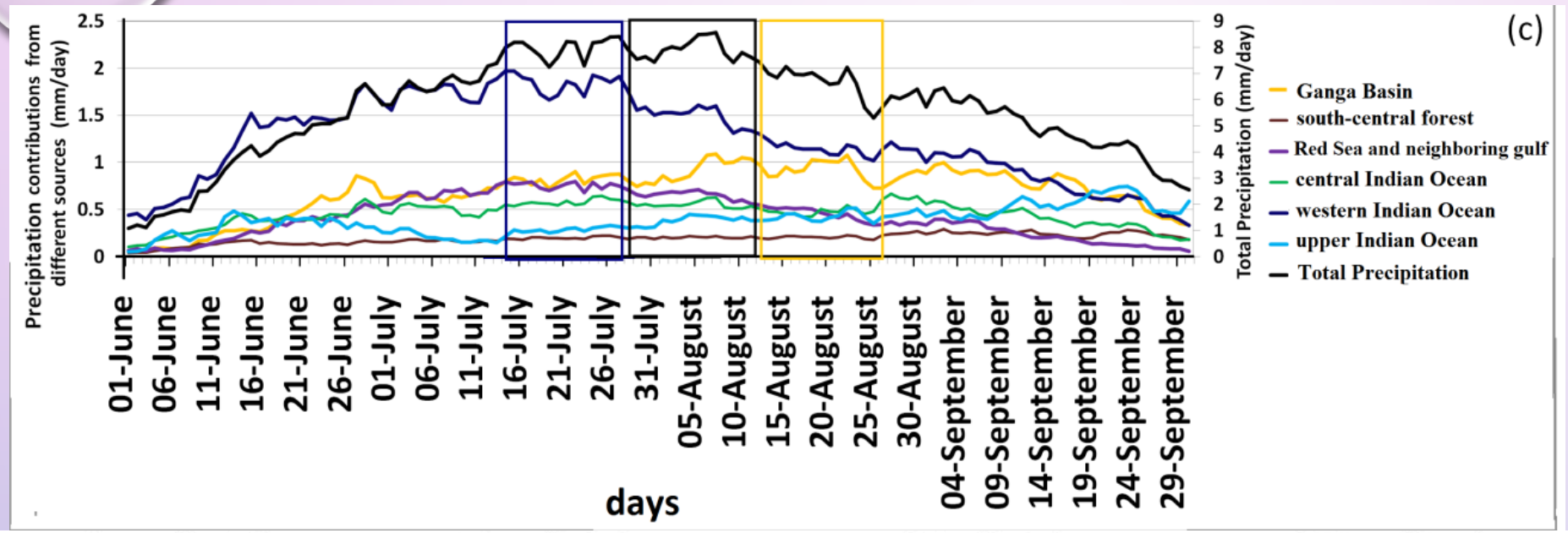
Joseph et al. (2016), Revised manuscript under preparation for JH

Hydrological Parameter Calibration lost its value? ☺

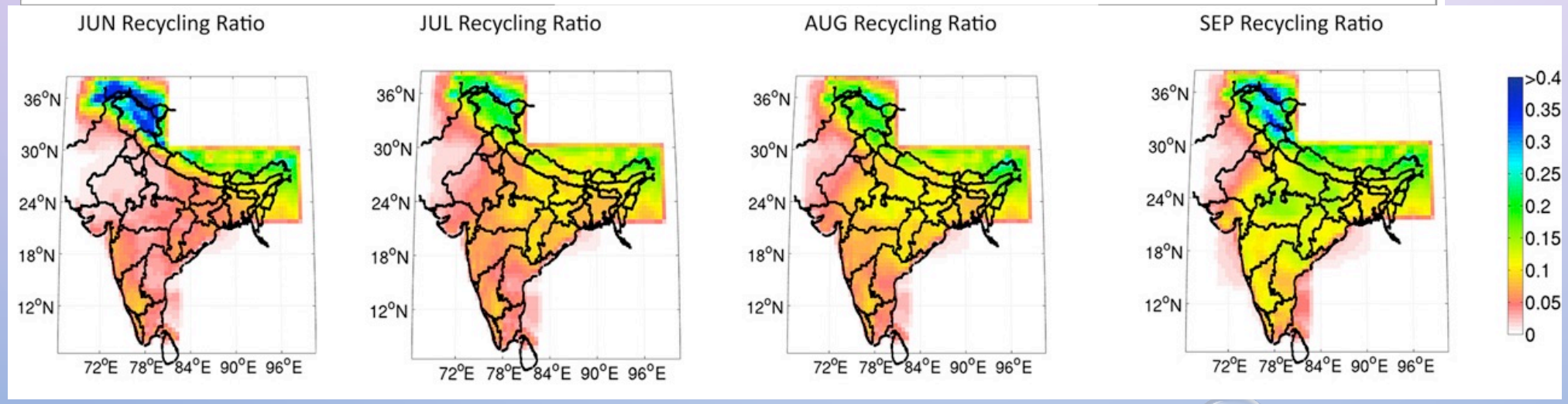


M1- EC EARTH CORDEX
M2- EC EARTH SD
M3- IPSL CORDEX
M4- IPSL SD

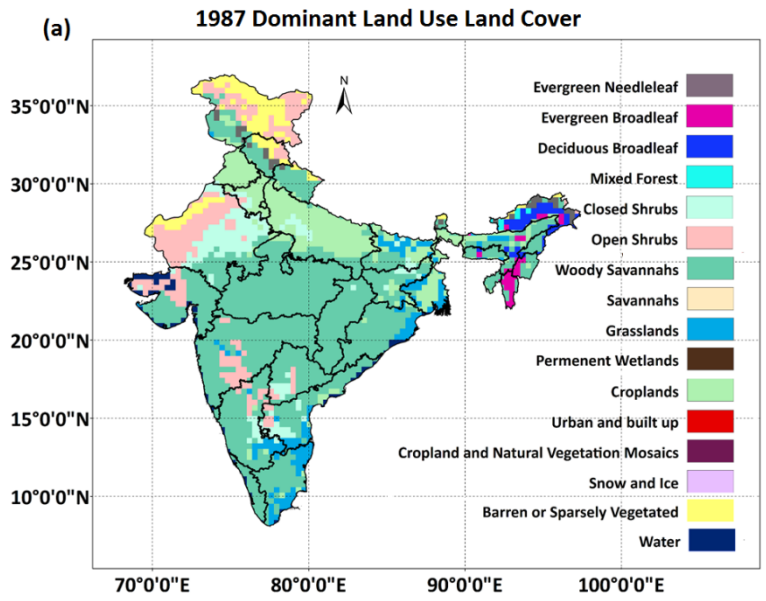
Land Surface Feedback

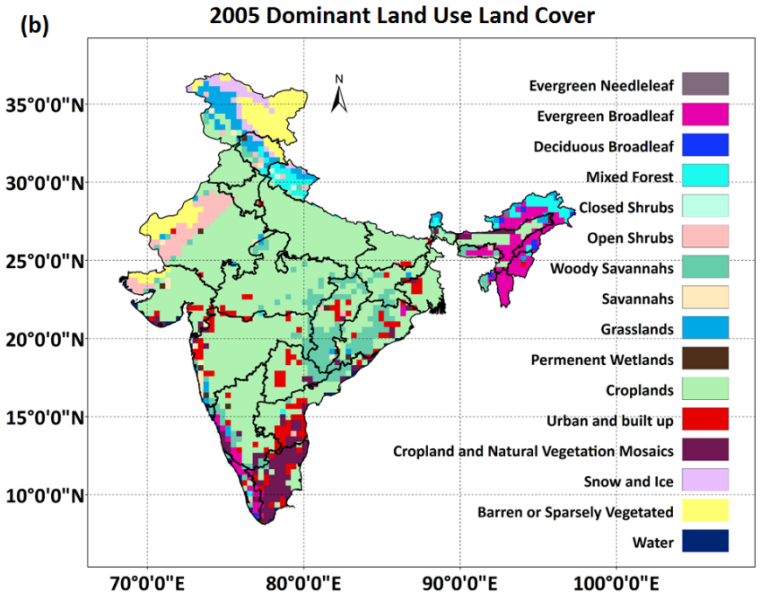


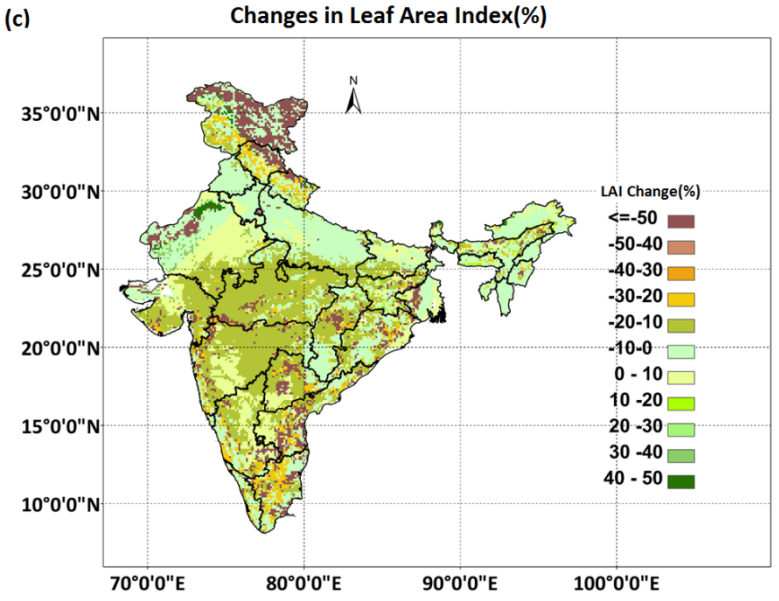
Pathak et al. (2016), JHM and JI of Climate



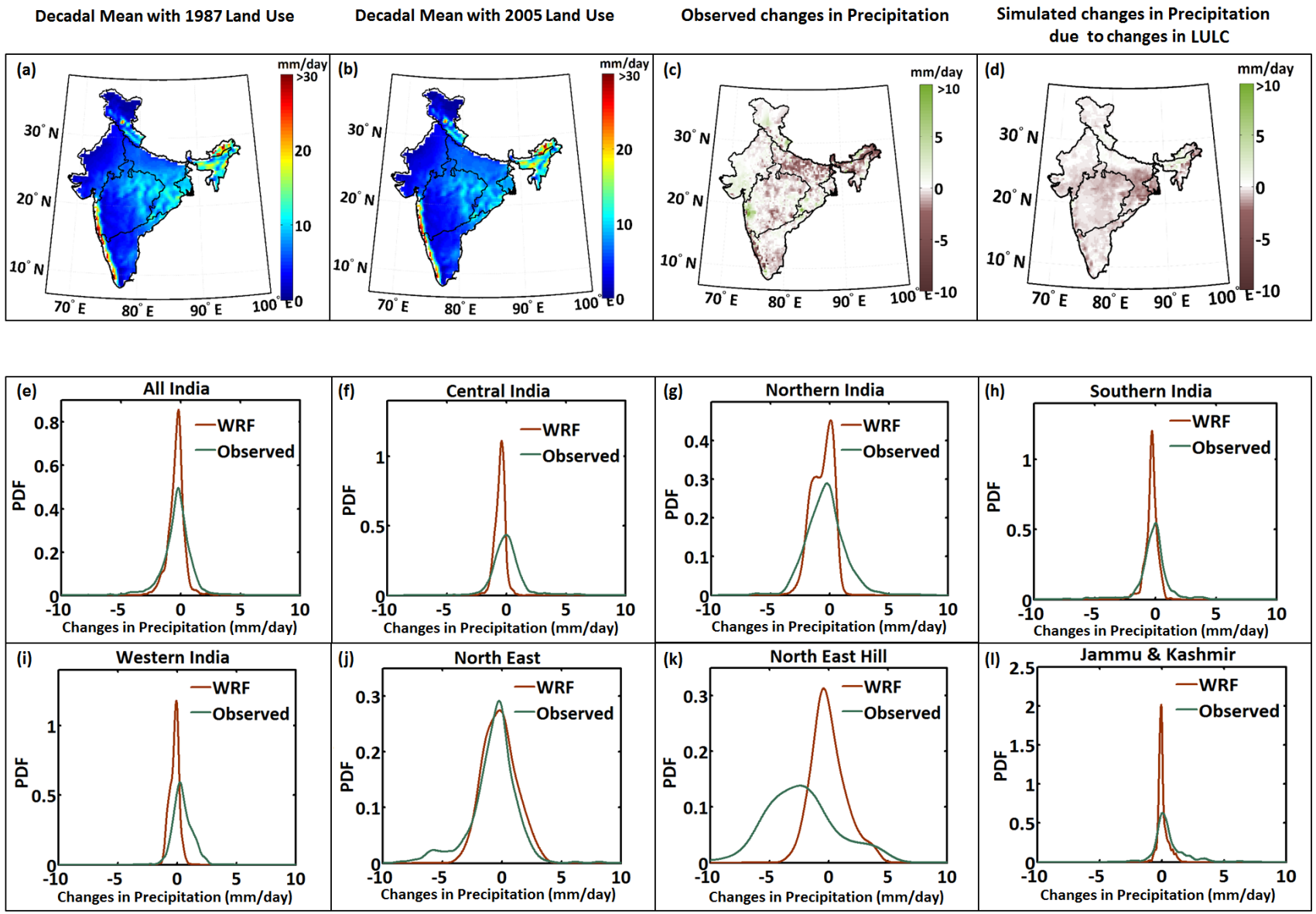
LULC Changes in India



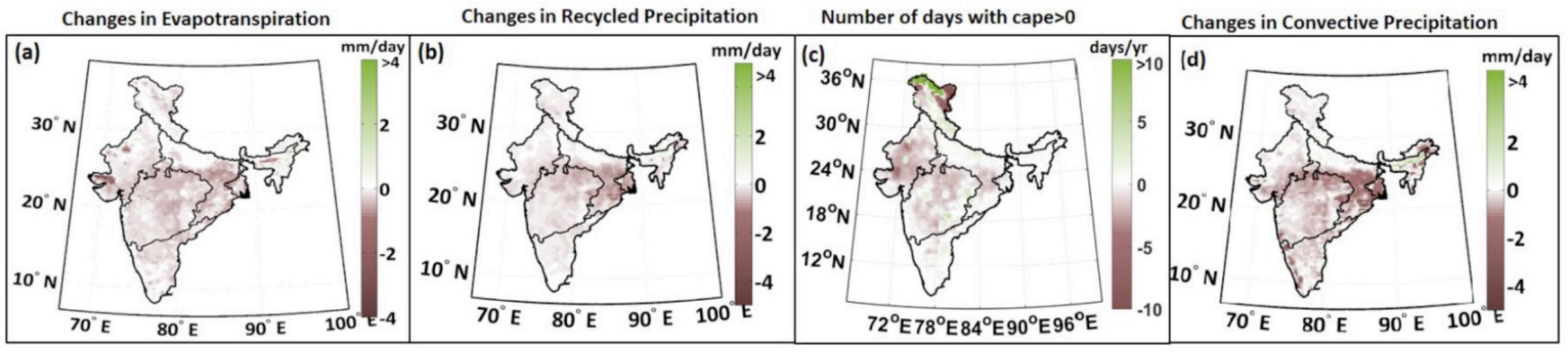




Impacts of LULC: Changes Partially Consistent with Observed Changes



Processes



Paul et al. (2016), Scientific Reports (Nature Publishing Group)

Open Questions

- We use the word “Uncertainty”, but are we really “Confident” enough in providing regional projections with different changing sign and magnitudes to water resources managers for developing adaptation strategies?
- Shouldn’t we consider feedback from regional LULC changes and growing urbanization?
- We are worried about ‘stationarity’ in statistical downscaling relationship; but with a high bias in Dynamic downscaling, we have to use bias correction… are regional biases stationary?

Thank you