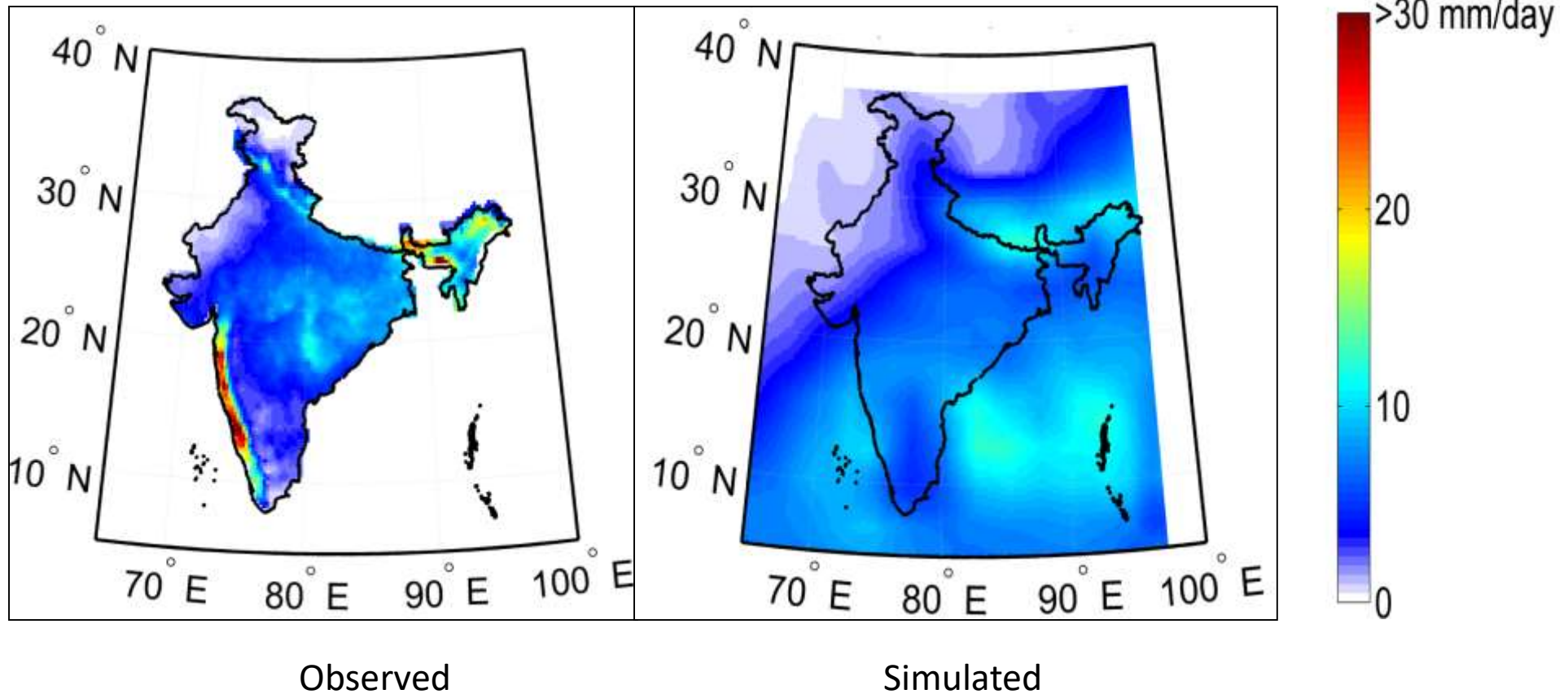


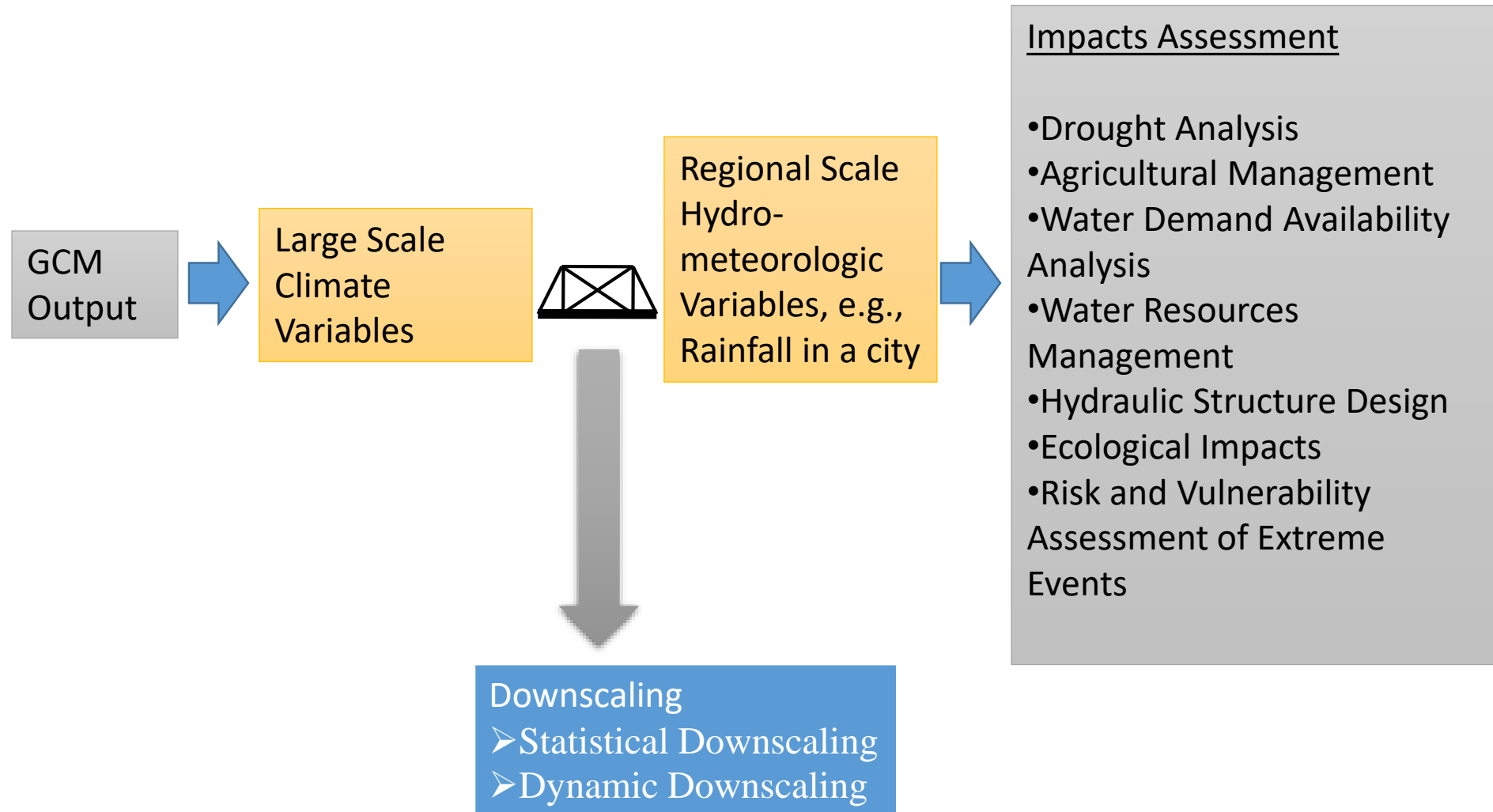
Statistical Downscaling for hydro-climatic
projections with CMIP5 Simulations to assess
Impact of Climate Change

IIT Bombay, IISc Bangalore, IIT Gandhinagar, IIT Kanpur and IIT Guwahati

GCM Simulations for Indian Monsoon Rainfall



Downscaling



Statistical Downscaling

- Data Driven Approach
- Computationally in-expensive
- Based on relationship between large scale climate variables and local scale desired variables
- Basic Assumption: this statistical relationship will not change in altered condition

Statistical Downscaling

- Philosophy:
 - GCMs can not simulate rainfall very well as rainfall is a regional scale phenomena
 - But GCMs simulate well some of the large scale variables, which affects rainfall.
 - Those large scale variables: Predictor
 - Rainfall: Predictand
 - Derive and apply the relationship between predictor and predictand

Proposed Methodology

- Kernel Regression Based Statistical Downscaling (IIT Bombay)
- ANN based Statistical Downscaling (IITK and IITG)
- Bias Correction Spatial Disaggregation (IITGN)
- Uncertainty Modeling (IISc Bangalore)

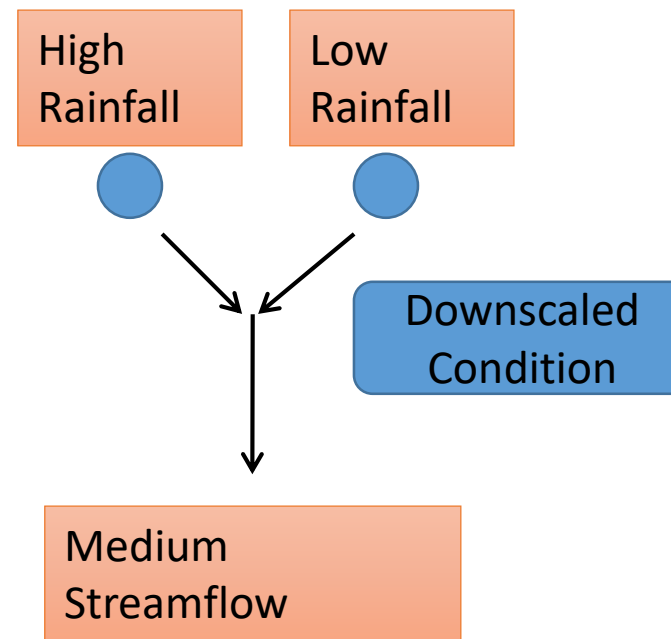
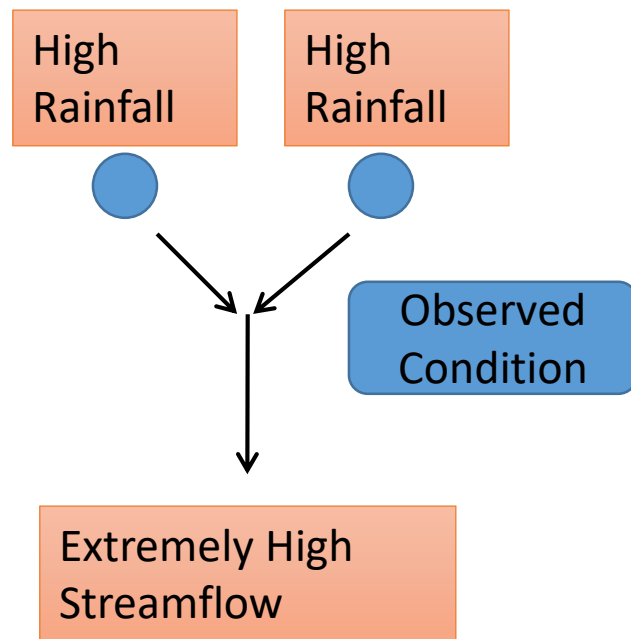
Steps in Statistical Downscaling

- Deriving relationship between predictor and predictand
- Apply the relationship to the GCM simulated predictors to project predictand

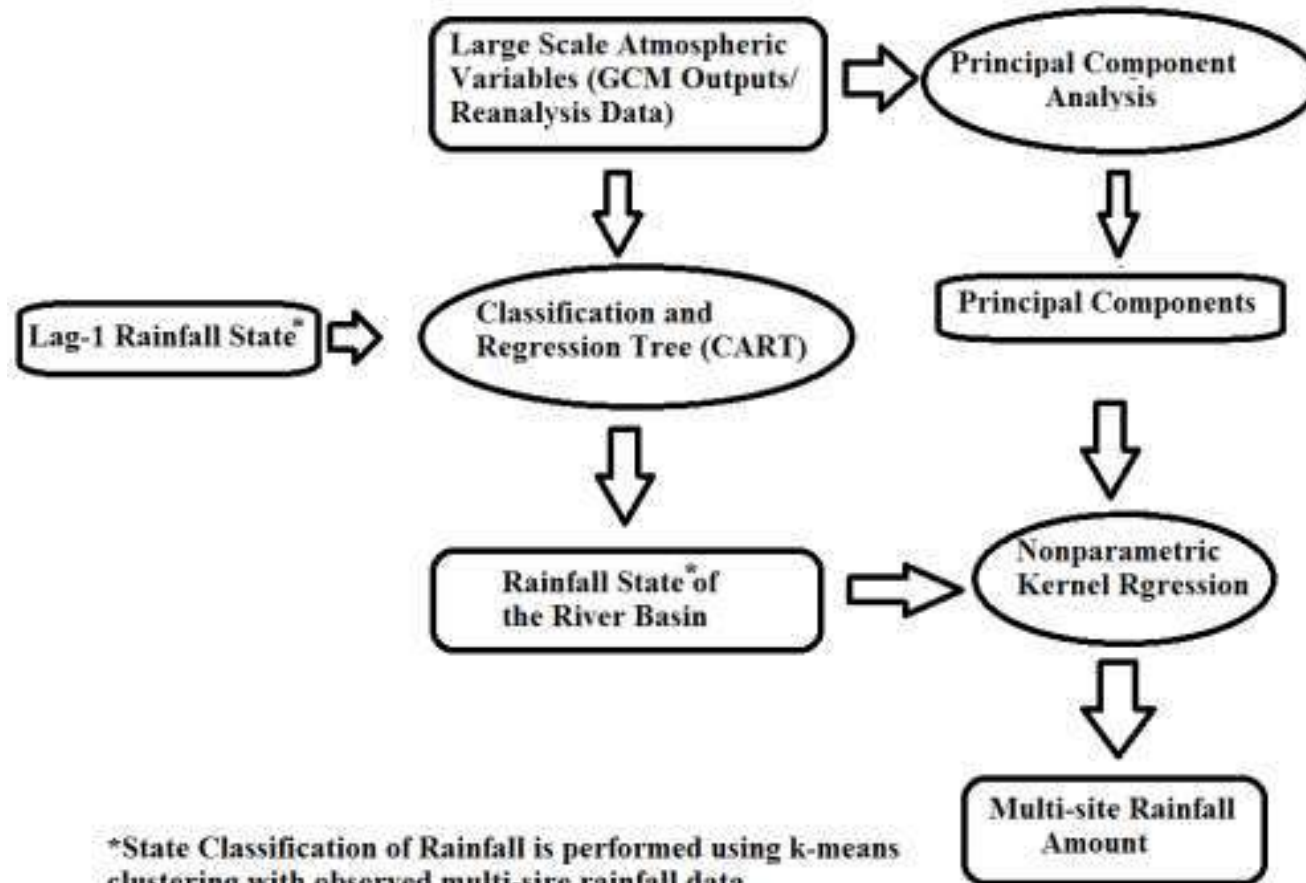
Multi-site Daily Downscaling

- Challenges

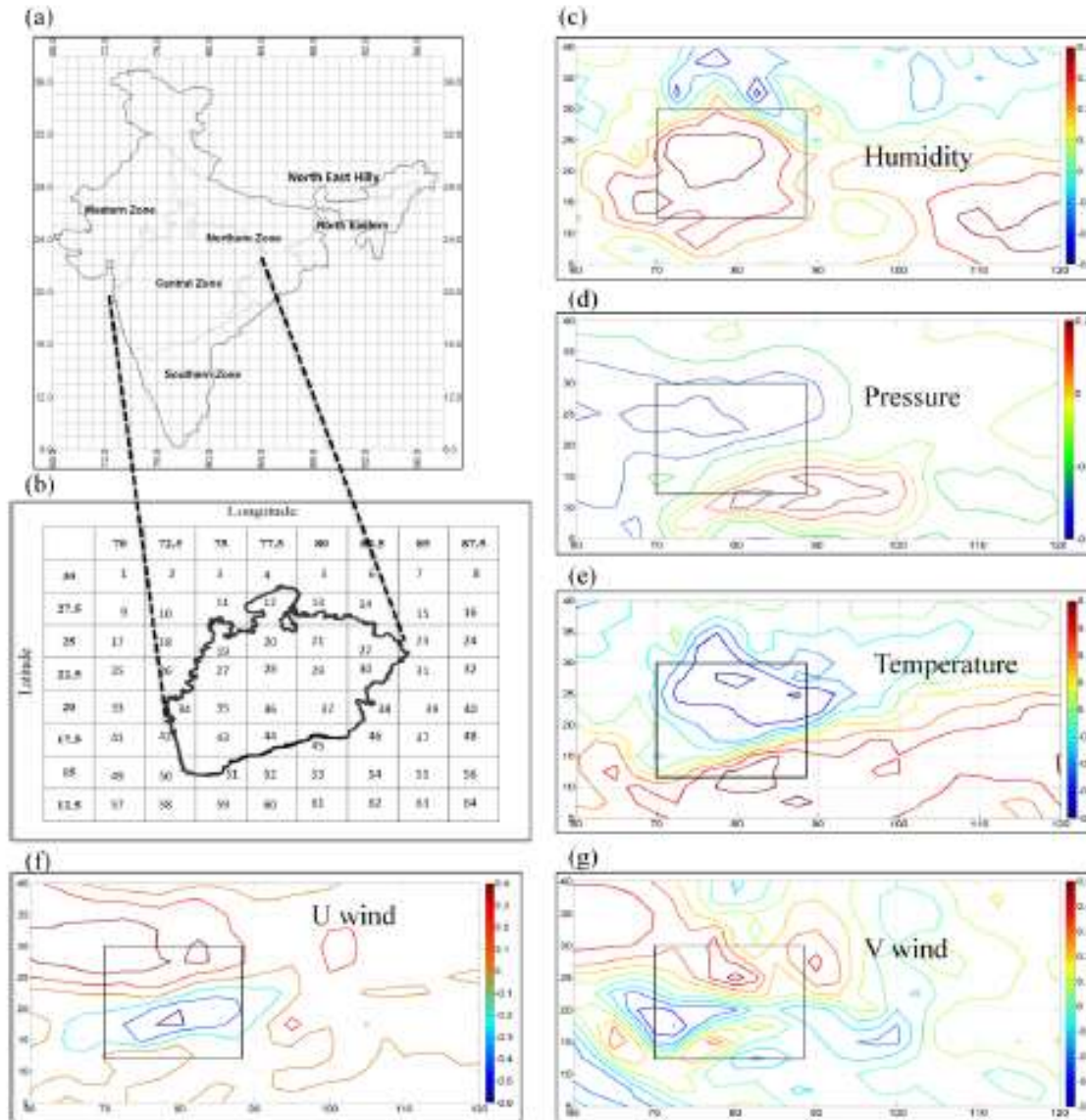
- Cross correlation
- Variability for daily scale



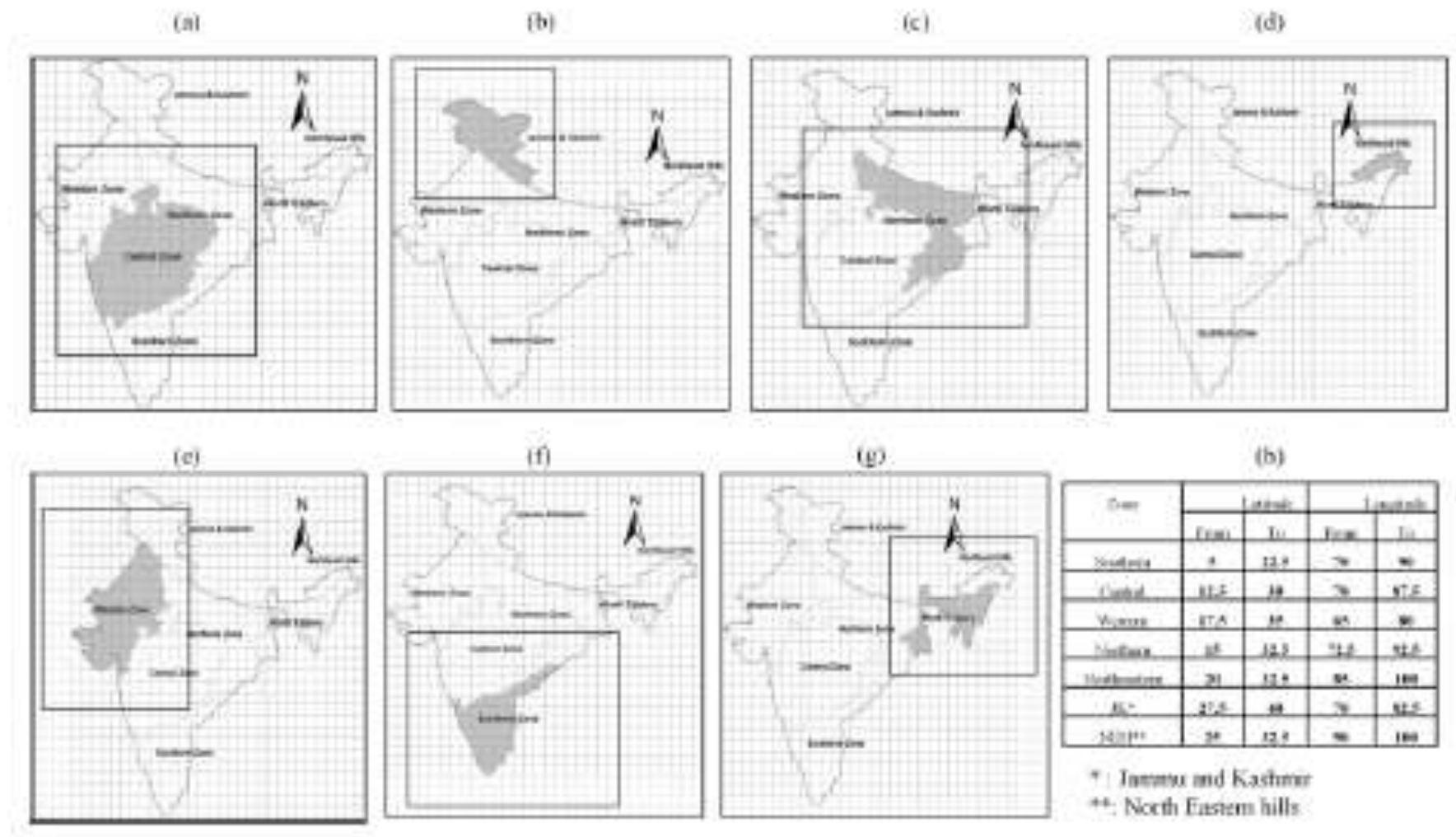
Kernel Regression Based Approach



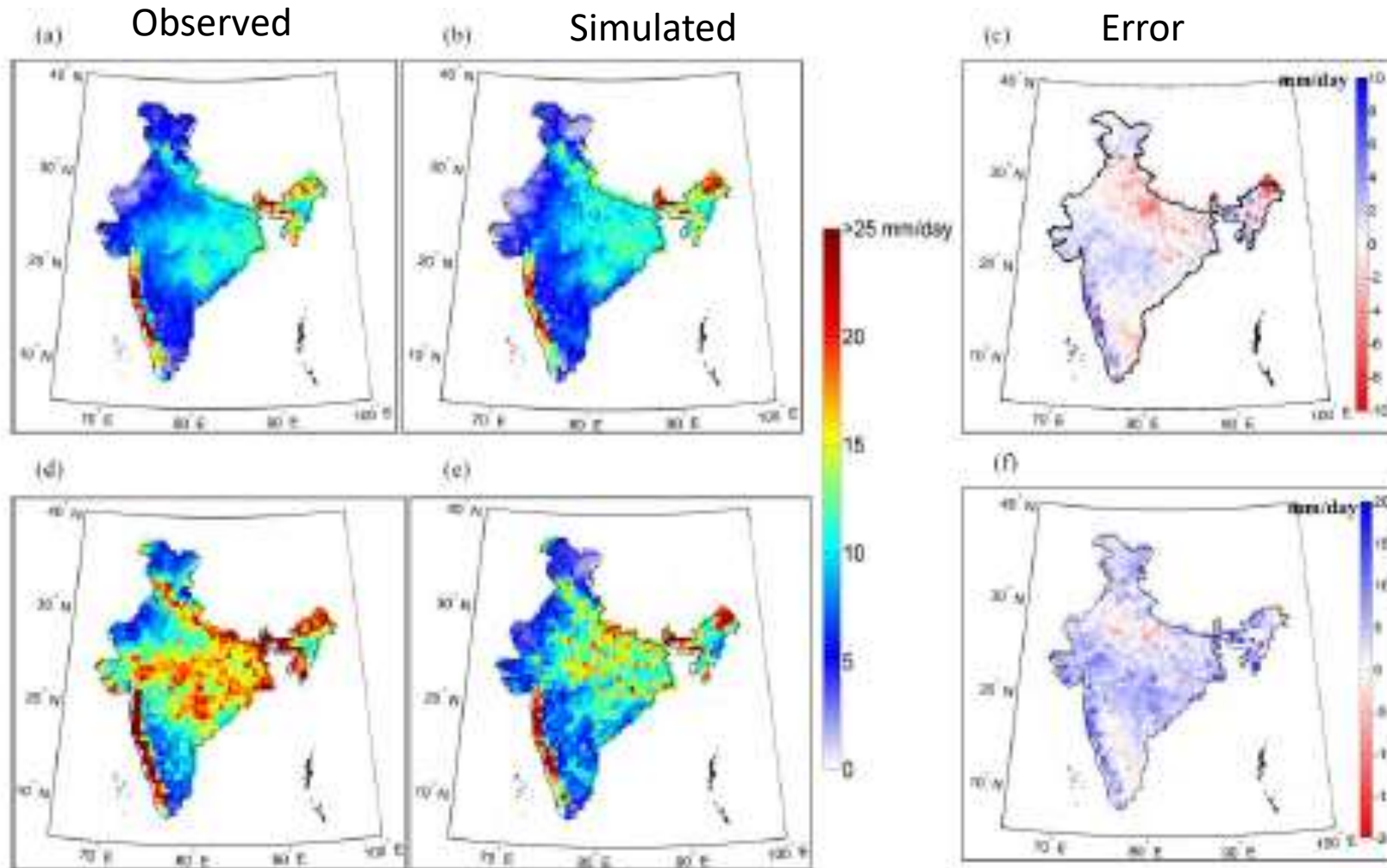
Application to All India



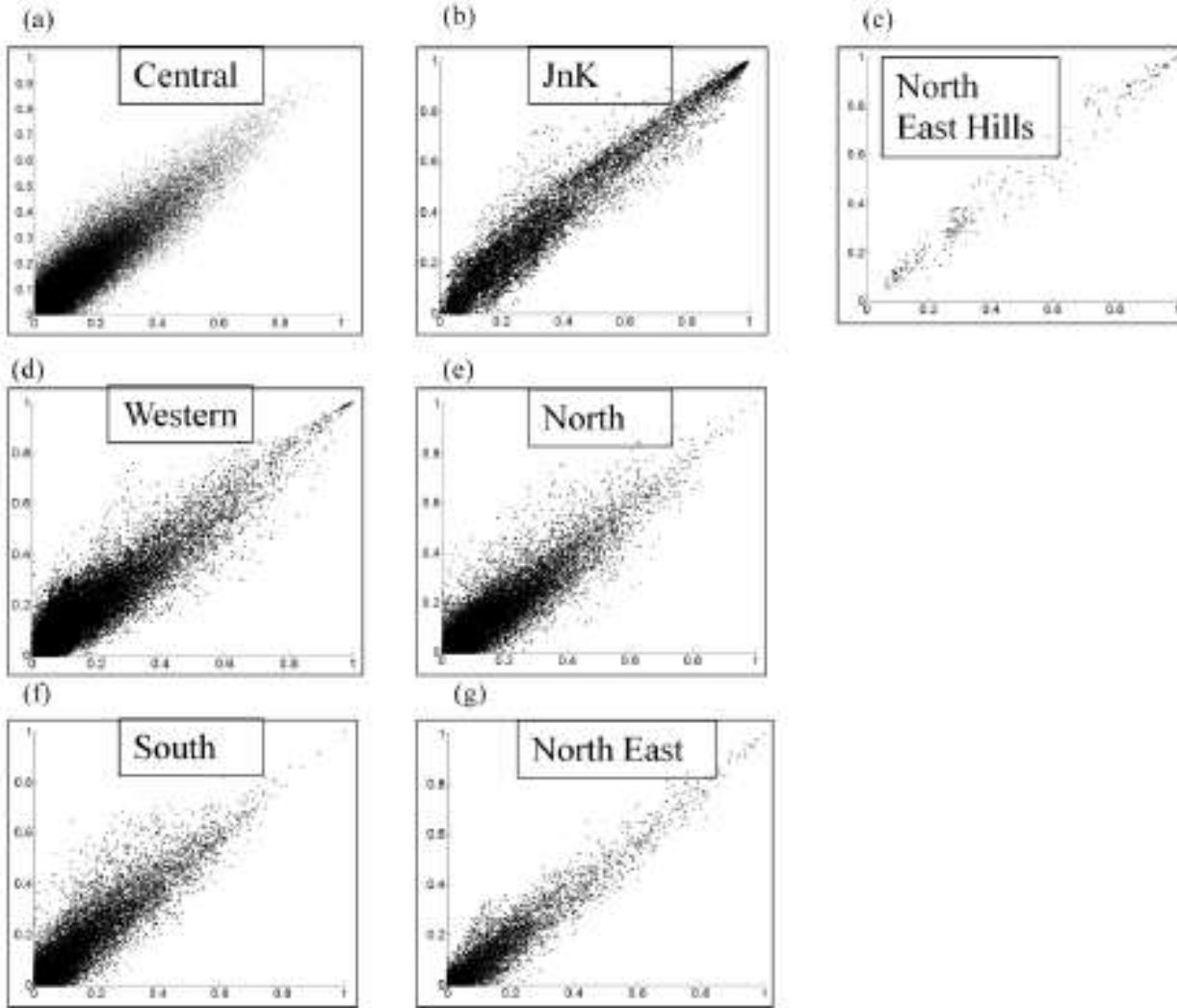
Predictor: spatial domain



Mean and Standard deviation of simulated data

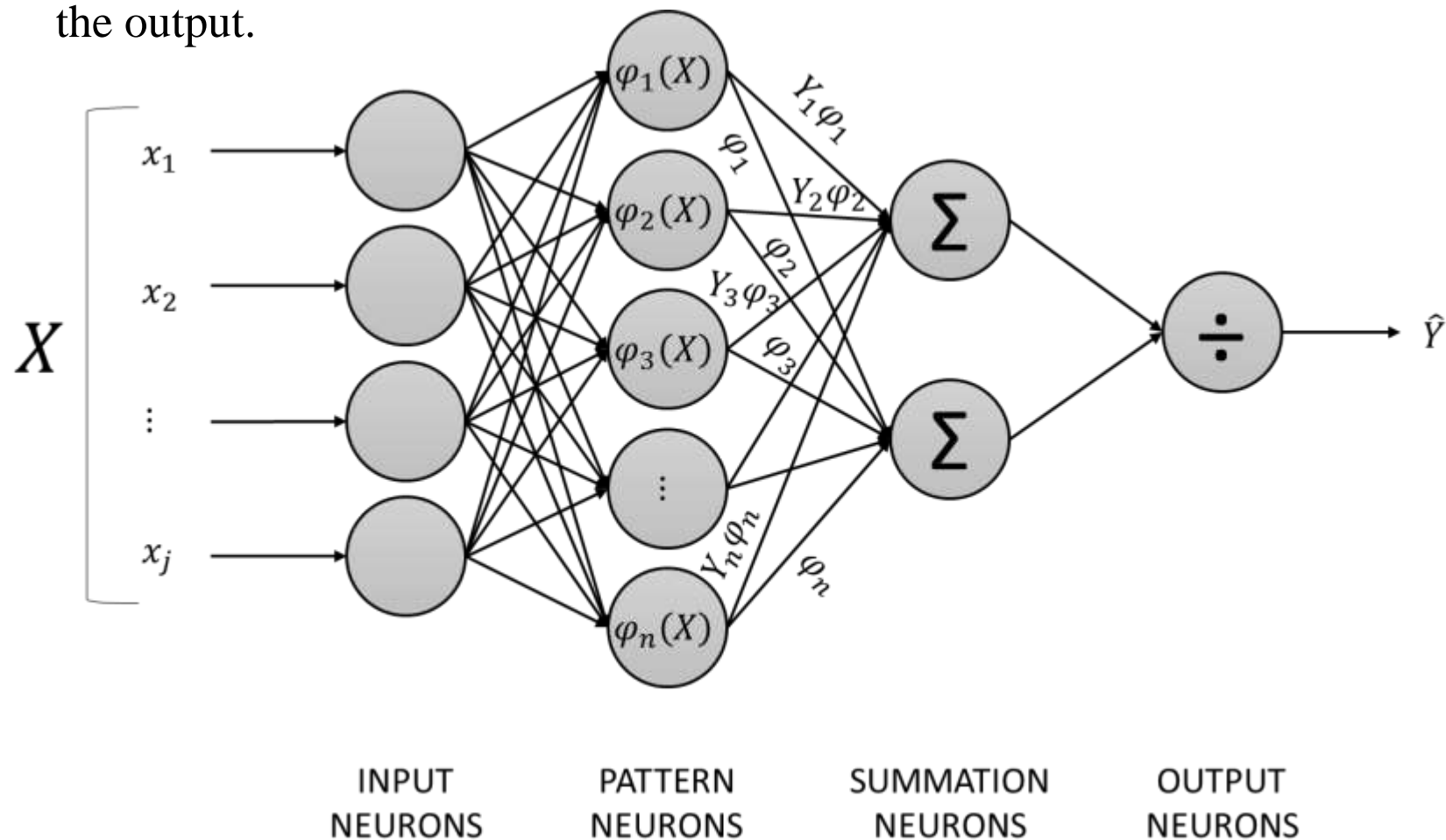


Zone-wise cross correlation



Generalized Regression Artificial Neural Network GRNN

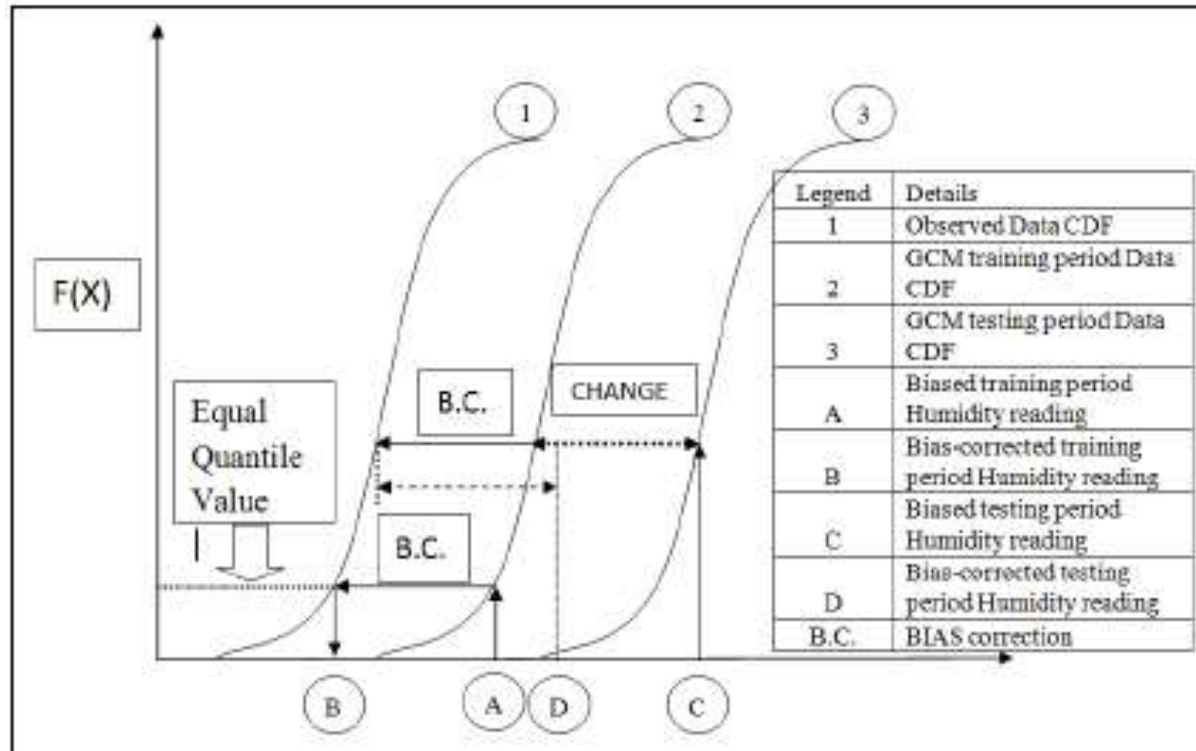
- ✓ GRNN is a probabilistic-based ANN Model for performing regression.
- ✓ Output is estimated using weighted average of the output of training dataset, where the weight is calculated using the Euclidean distance between the training data and test data.
- ✓ If the distance is large then the weight will be very less and if the distance is small it will put more weight to the output.



$$\varphi_i(X) = \exp\left(-\frac{(X - X^i)^T (X - X^i)}{2\sigma^2}\right)$$

$$\hat{Y} = \frac{\sum Y_i \varphi_i}{\sum \varphi_i}$$

BCSD (Bias Correction)



Uncertainty Modeling

- Multi-model averaging
 - Equal Weights to all the model
- Bayesian Model Averaging
 - Two criteria
 - Performance for historic period
 - Convergence for future period
 - Weights based on the criteria
 - Weighted averaging

Selected GCMs and rainfall predictors

Sets of GCMs:

- ✓ **CCCMA CanESM2**
- ✓ **CNRM CM5**
- ✓ **MPI ESM MR**
- ✓ **MPI ESM LR**
- ✓ **BNU ESM**

List of Predictors:

- TAS (Near surface air temperature)
- T850 (Air temperature at 850hpa)
- T500 (Air temperature at 500hpa)
- UAS (Eastward near surface wind velocity)
- U850 (Eastward wind velocity at 850hpa)
- VAS (Northward near surface wind velocity)
- V850 (Northward wind velocity at 850hpa)
- Q850 (Specific humidity at 850hpa)
- PSL (Sea level air pressure)
- Z500 (Geopotential height at 500hpa)

Selection Criterion for GCMs and Predictors:

- Availability of data for the desired period (Historical-1951-2005; Future-2006-2100 for RCP4.5 and RCP8.5)
- Simulation capacity of GCM for a particular predictor
- Correlation of predictor with the predictand

Status

Work completed:

- Downscaling of 5 GCMs (kernel regression) for Precipitation and Temperature
- Development of data portal: under progress (IITB products will be available during next month)

Recruitment:

- Partially done at the institutes

Purchase

- Partially completed

Other activities if time permits

- Development of an mobile APP based on downscaled future projections corresponding to different future scenarios
- Possibility of including the projections in WRIS through MoWR

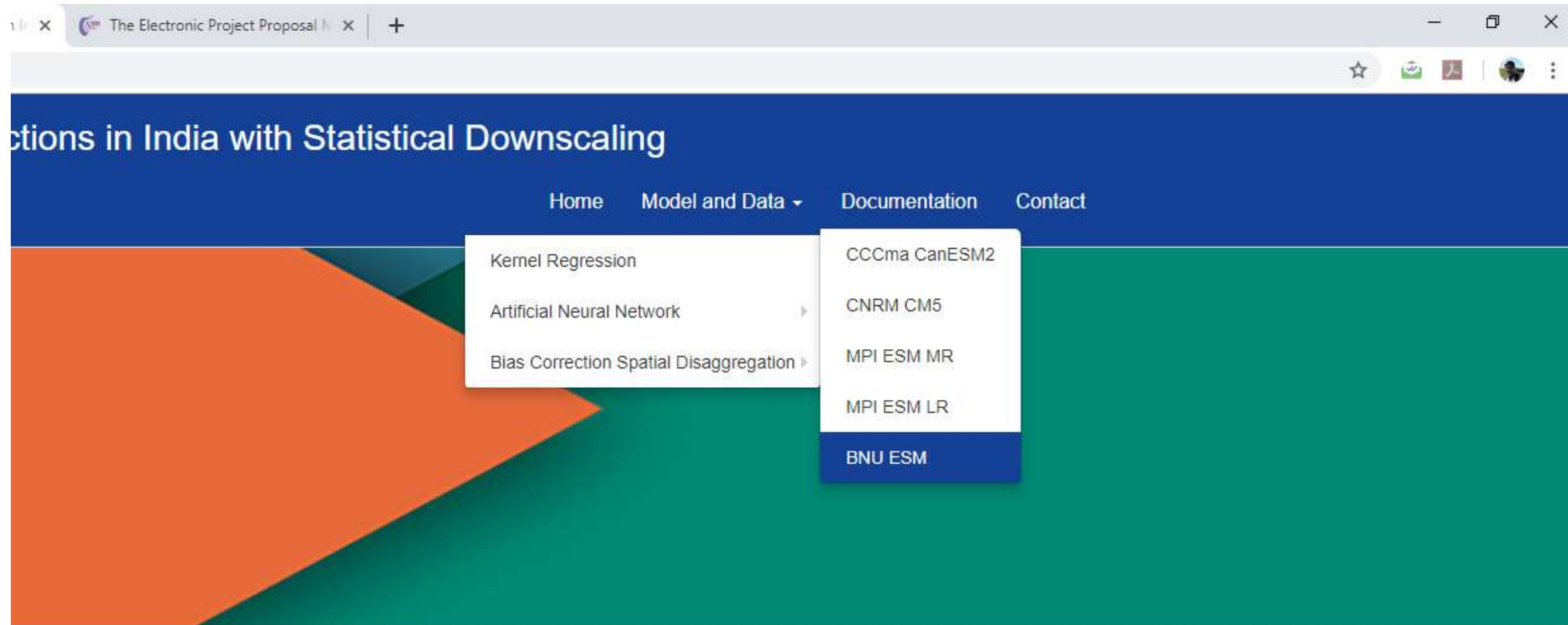
Portal- <http://www.civil.iitb.ac.in/climate/index.html>

The screenshot shows a web browser window with the following content:

- Browser Tabs:** CC-IITB Internet Access, (no subject) - subimalghosh@..., Regional Climate Projections in..., The Electronic Project Proposal
- Address Bar:** Not secure | www.civil.iitb.ac.in/climate/index.html
- Page Title:** Regional Climate Projections in India with Statistical Downscaling
- Navigation Menu:** Home, Model and Data, Documentation, Contact
- Decorative Header:** A large graphic with an orange arrow pointing right into a green background.
- Main Content:**
 - ### Welcome to Regional Climate Projections in India with Statistical Downscaling
 - If you are using data from Kernel Regression based Statistical Downscaling please cite the following papers-

 - » Salvi, K., S. Kannan, and S. Ghosh (2013), High-resolution multisite daily rainfall projections in India with statistical downscaling for climate change impact assessment, *J. Geophys. Res. Atmos.*, 118, 3557-3558, <http://dx.doi.org/10.1002/jgrd.50280>.
 - » Kannan, S., and S. Ghosh (2013), A nonparametric Kernel regression model for downscaling multisite daily precipitation in the Mahanadi basin, *Water Resour. Res.*, 49, <http://dx.doi.org/10.1002/wrcr.20118>.
 - "This work is funded by Indian National Committee on Climate Change (INCCC), Ministry of Water Resources, Government of India"
- Footer:** © Copyright 2019 | Contact Us | 022 2576 7319

Portal



Portal

Regional Climate Projections in India with Statistical Downscaling

Home Model and Data Documentation Contact

BNU ESM

About BNU ESM :

PRECIPITATION	TAS	TR50
T500	UAS	UR50
WAS	V850	Q850
PSL	Z500	

© Copyright 2019 Contact Us | 822 2576 7319

Downloading Data

The screenshot shows a web browser window with the URL www.cvlirb.ac.in/climate/esp/egpage5.html. The page title is "Regional Climate Projections with GCMs". The main content area is titled "BNU ESM" and includes a sub-section "About BNU ESM :". Below this, there is a grid of buttons for different climate variables: PRECIPITATION, TAS, T850, T1500, UAS, U850, VAS, V850, Q850, and PSL. A modal window titled "Precipitation" is open over the "PRECIPITATION" button, containing the following links: "Historical Data - Click Here", "BNU_ESM_RCP45 Data - Click Here", and "BNU_ESM_RCP85 Data - Click Here". A "Close" button is located at the bottom right of the modal. The footer of the page contains the text "© Copyright 2019" and "Contact Us | 022-2576-7319". The Windows taskbar at the bottom shows the search bar and various application icons.

Thank You