

Super-Resolution based Deep Downscaling of Precipitation

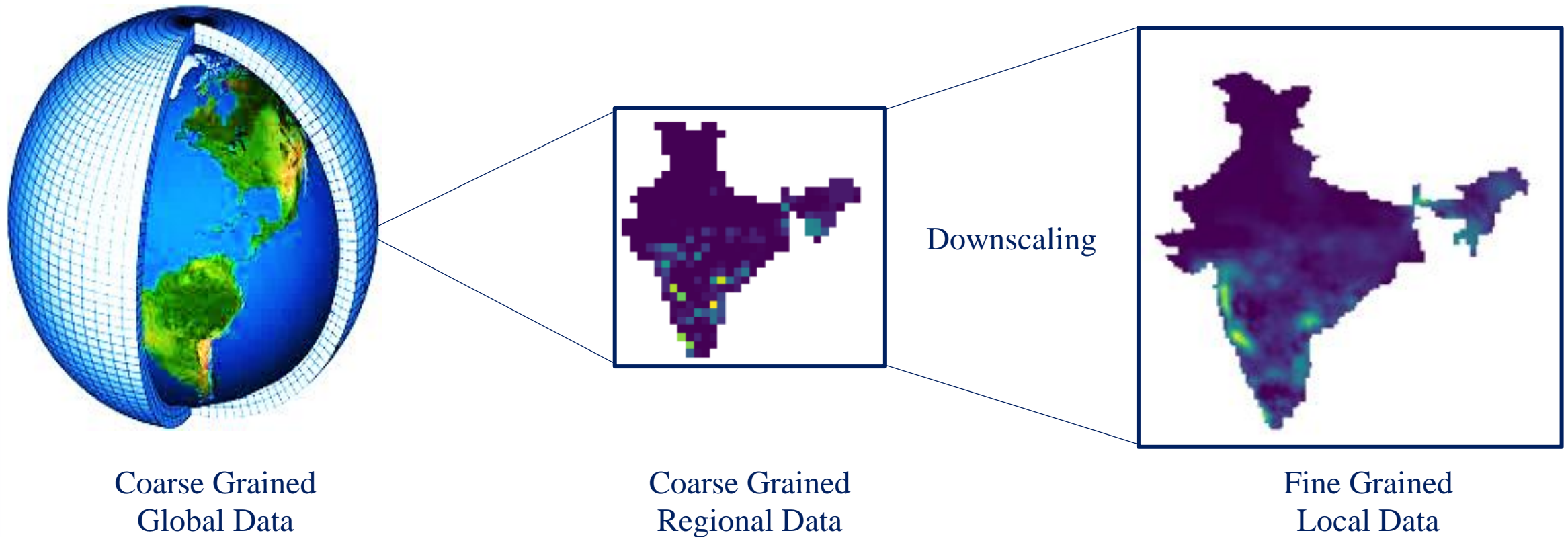
Sumanta Chandra Mishra Sharma

Dr. Adway Mitra

Centre of Excellence in Artificial Intelligence
Indian Institute of Technology, Kharagpur, India

DOWNSCALING

- GCM produces coarse grained climate projections with a spatial resolution of around 100km.
- Downscaling is the procedure to infer high-resolution information from low-resolution data.



Source: Google Images

SIMILAR APPROACH



Low-Resolution Input

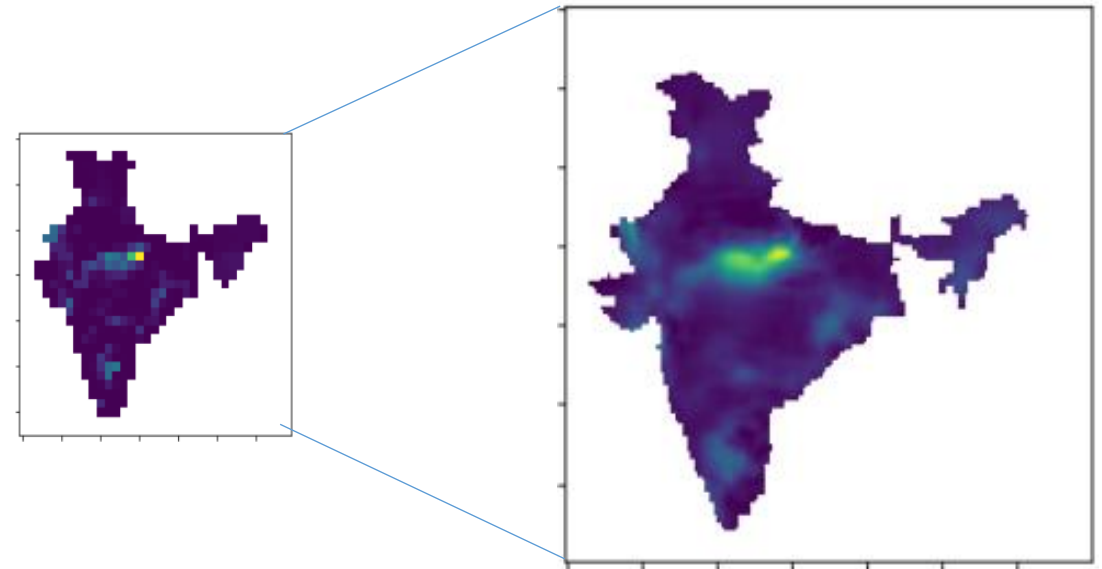


High-Resolution Output

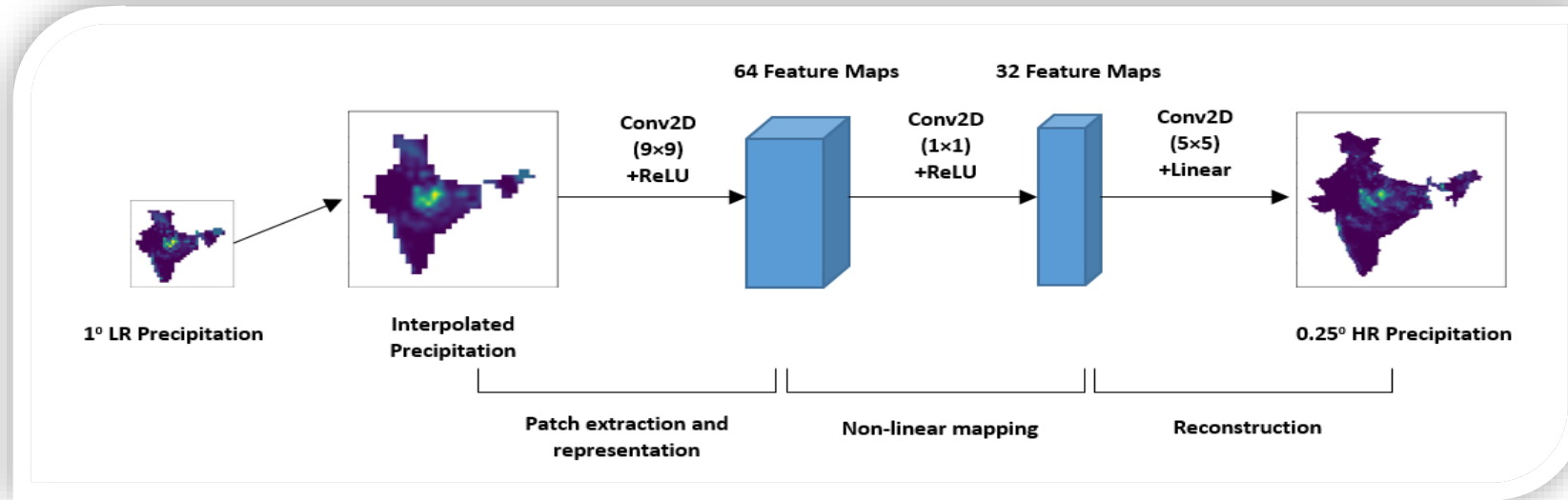
SUPER RESOLUTION BASED DOWNSCALING



- The objective of this work is to use deep learning based super resolution method to find the local scale projections (4x time) of precipitation data.

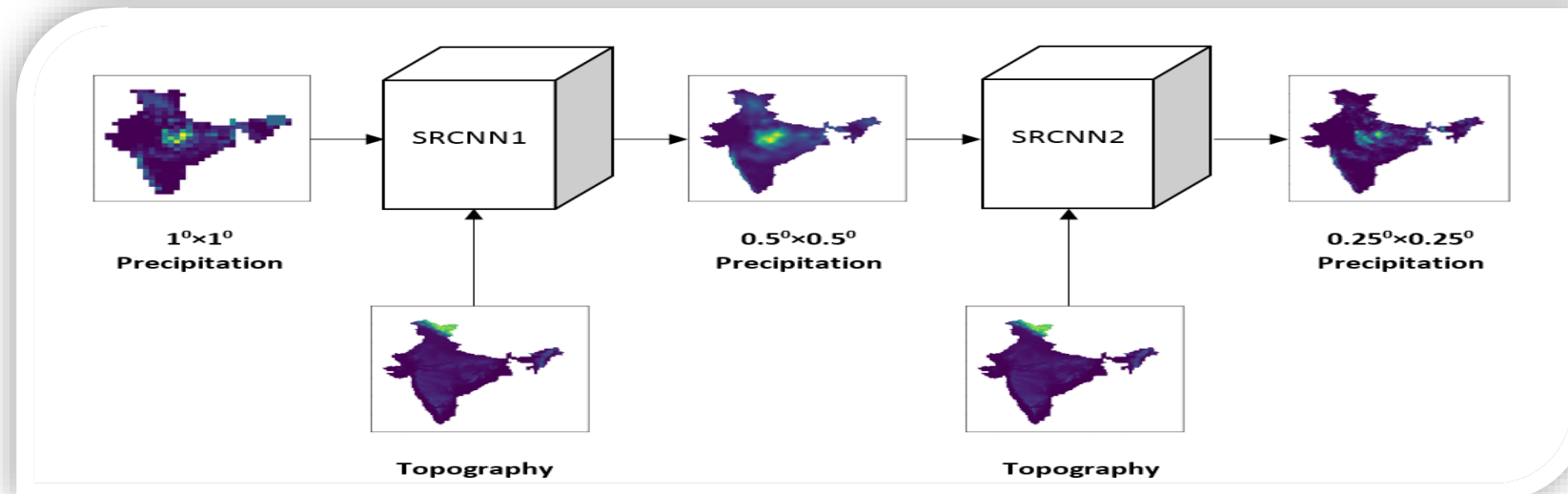


SRCNN



(Dong et.al. 2014 , Vandal et.al. 2017, Kumar et.al 2021)

DeepSD

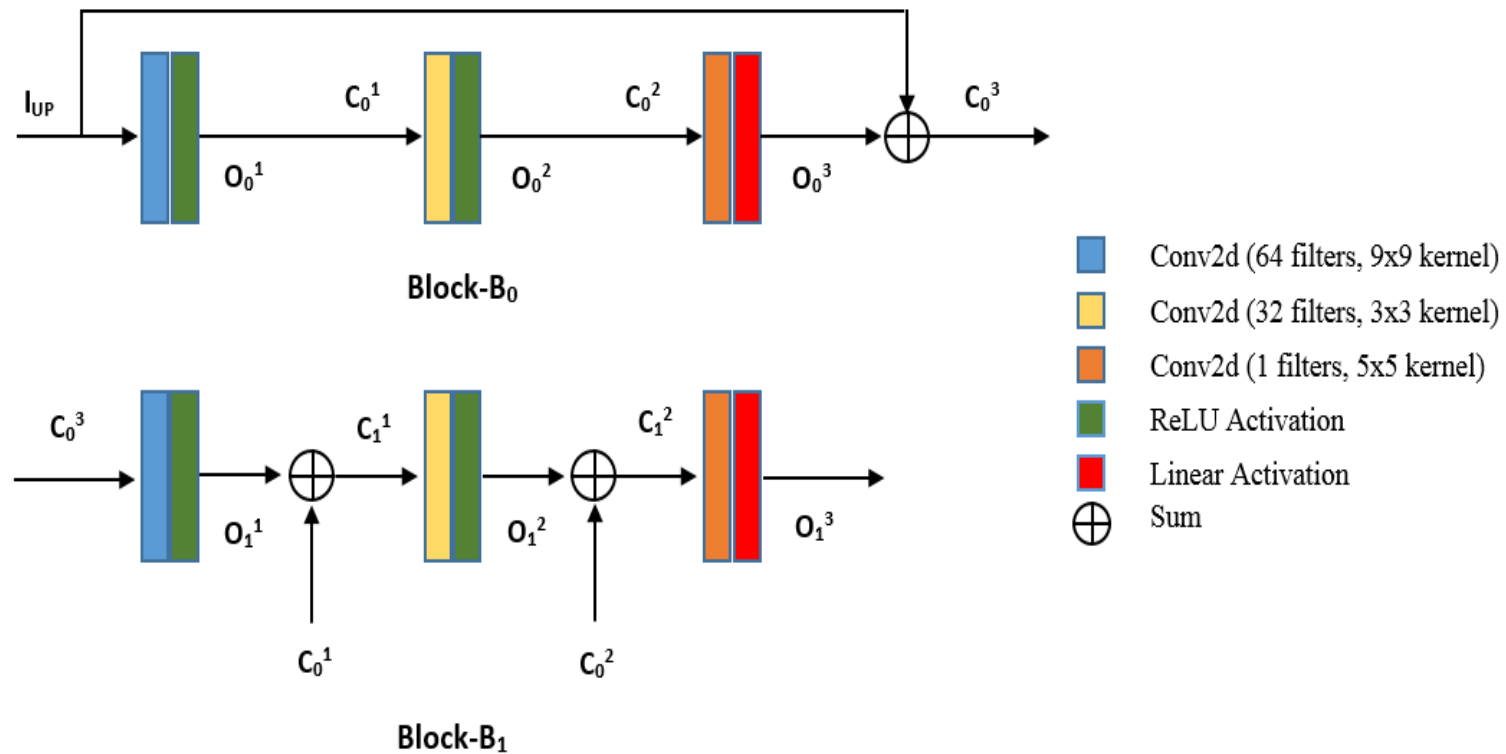


(Vandal et.al. 2017, Kumar et.al 2021)

ResDeepD



Basic Residual Blocks:



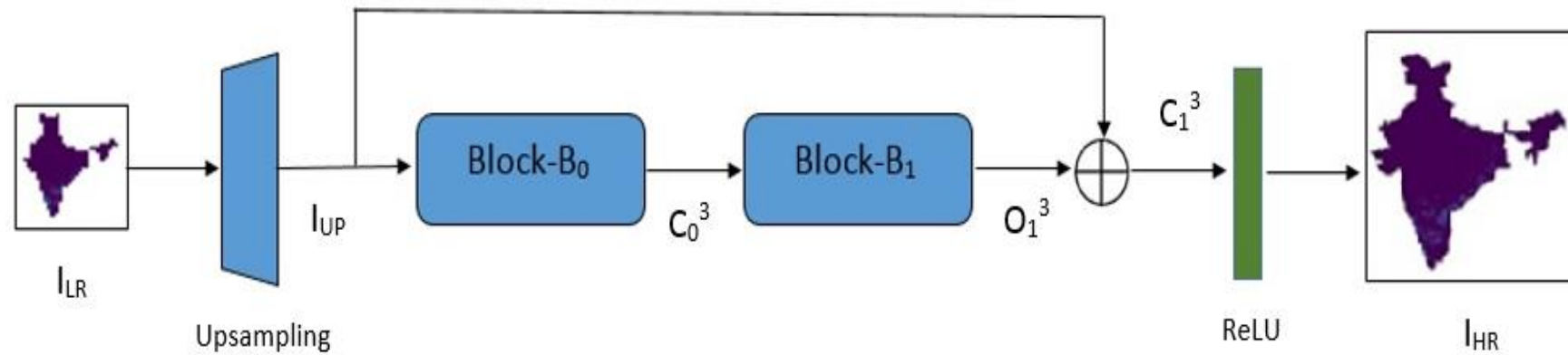
Cumulative output of Block-B₀ is

$$C_0^3 = O_0^3 + I_{UP}$$

Cumulative output of intermediate layers in Block-B₁ is

$$C_1^k = O_1^k + C_0^k$$

I_{UP} : Upsampled Input
 O_i^k : Layer output
 C_i^k : Cumulative Output



$$I_{HR} = \max((B_1(B_0(U(I_{LR}))) + U(I_{LR})), 0)$$

$U(X)$: Upsampling Function

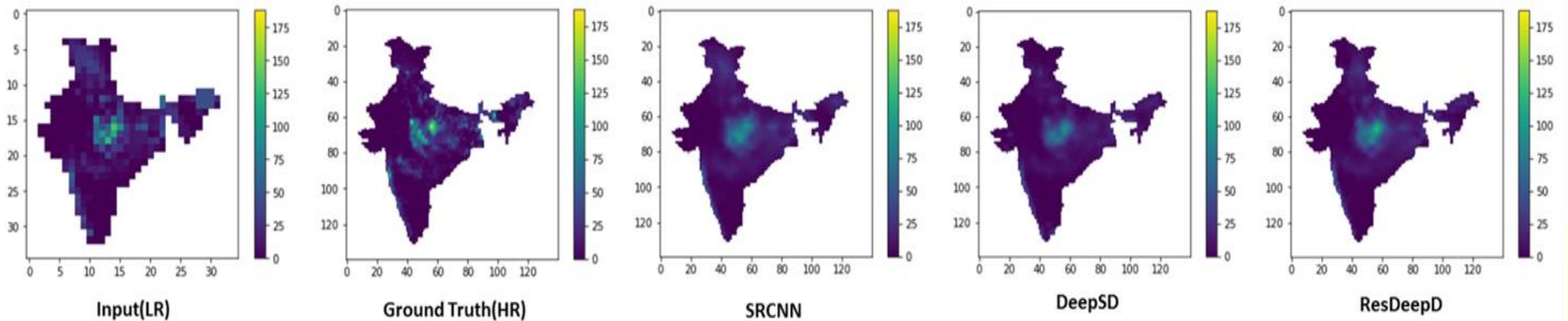
$B_i(X)$: Input to output mapping function for block B_i

DATASET



- **Daily Gridded Rainfall Data Set Over India** (*from: India Meteorological Department*)
 - $1^{\circ} \times 1^{\circ}$ Low resolution data (Shape: 33x35)
 - $0.25^{\circ} \times 0.25^{\circ}$ High resolution data (Shape: 129x135)
 - Only ISMR data is considered
 - Period 1990-2019 (Training: 1990-2012, Testing: 2013-19)
- **CPC Unified Gauge-Based Analysis of Daily Precipitation over CONUS with resolution $0.25^{\circ} \times 0.25^{\circ}$** (*from: NOAA PSL*)
 - The required LR precipitations are generated from the HR data with the help of a bicubic interpolation.
 - Southeast CONUS and parts of its neighboring is considered.
 - Period 1991-2020 (Training: 1991-2014, Testing: 2015-20)
- **Static topographic land elevation data collected from Global 30 Arc-Second Elevation Data Set (GTOPO30)**

RESULT AND DISCUSSION

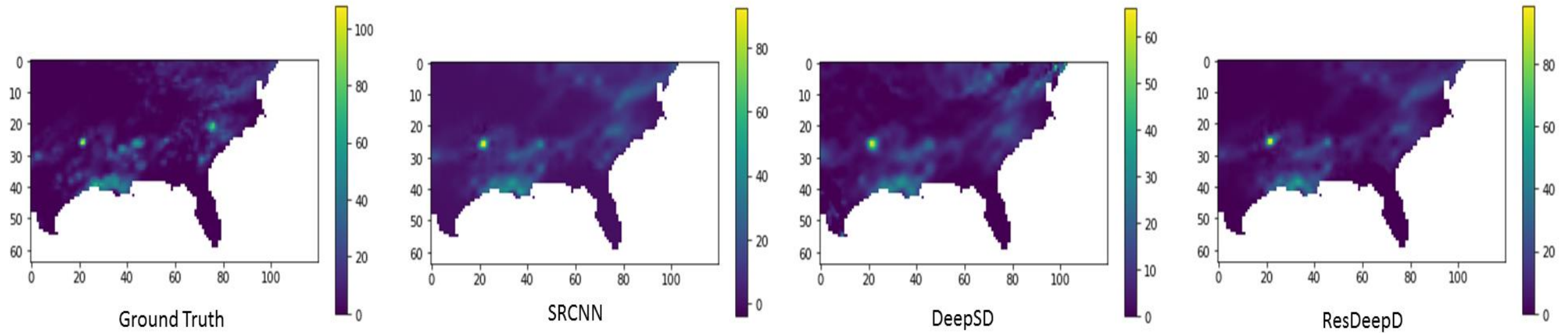


SR Technique/Model	RMSE	PSNR	MSSIM	Corr.Coeff.
SRCNN	5.9372	42.8221	0.9608	0.7355
DeepSD	6.3129	42.2893	0.9576	0.7074
ResDeepD(Proposed)	5.8375	42.9692	0.9633	0.7466

(Comparison of Super Resolution Techniques in Downscaling the ISMR over India)

(The colorbar indicates the amount of rainfall in mm.)

RESULT AND DISCUSSION



SR Technique/Model	RMSE	PSNR	MSSIM	Corr.Coeff.
SRCNN	2.6768	44.5827	0.9787	0.9254
DeepSD	3.4953	42.2653	0.9558	0.8813
ResDeepD(Proposed)	2.6288	44.7397	0.9794	0.9279

(Comparison of Super Resolution Techniques in Downscaling the precipitation over Southeast CONUS)

(The colorbar indicates the amount of rainfall in mm.)



Thank you