

Supplementary Material (SM)

**Change in Rainfall Patterns in the Hilly Region of Uttarakhand
due to the Impact of Climate Change**

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SM 1 Map showing GCM point location in Uttarakhand.

SM 2 List of 26 NCEP/GCM predictors

Predictors (Atmospheric variables)	Origin (i.e. NCEP or GCM)	Time window
Mean sea level pressure	CanESM2	1961-1990
1000 hPa wind speed		(Baseline climate)
1000 hPa zonal velocity		2000-2099
1000 hPa meridional velocity		
1000 hPa vorticity		
1000 hPa wind direction		
1000 hPa divergence		
500 hPa wind Speed		
500 hPa zonal velocity		
500 hPa meridional velocity		
500 hPa vorticity		
500 hPa geopotential		
500 hPa wind direction		
500 hPa divergence		
850 hPa wind speed		
850 hPa zonal velocity		
850 hPa meridional velocity		
850 hPa vorticity		
850 hPa geopotential		
850 hPa wind direction		
850 hPa divergence		
Specific humidity at 500 hPa		
Specific humidity at 850 hPa		
Specific near surface humidity		
Mean temperature at 2 m		
Total precipitation		

SM 3 Table showing the score of different predictors after PC

PCs	Score	Total summation of first 7 PCs	PCs	Score	Total summation of first 7 PCs
PC1	89.99004	89.99004	PC14	0.000668	99.99871
PC2	9.56467	99.55471	PC15	0.000487	99.99919
PC3	0.352653	99.90737	PC16	0.000318	99.99951
PC4	0.035374	99.94274	PC17	0.00019	99.99971
PC5	0.022946	99.96569	PC18	0.000137	99.99984
PC6	0.013162	99.97885	PC19	8.43E-05	99.99992
PC7	0.006646	99.98555	PC20	6.74E-05	99.99999
PC8	0.003629	99.98913	PC21	7.79E-06	100
PC9	0.002732	99.99186	PC22	1.12E-11	100
PC10	0.001984	99.99384	PC23	2.48E-13	100
PC11	0.001901	99.99574	PC24	1.56E-13	100
PC12	0.001244	99.99699	PC25	1.15E-13	100
PC13	0.001054	99.99804	PC26	5.83E-14	100

SM 4 Table showing correlation between 9 predictors before PCA

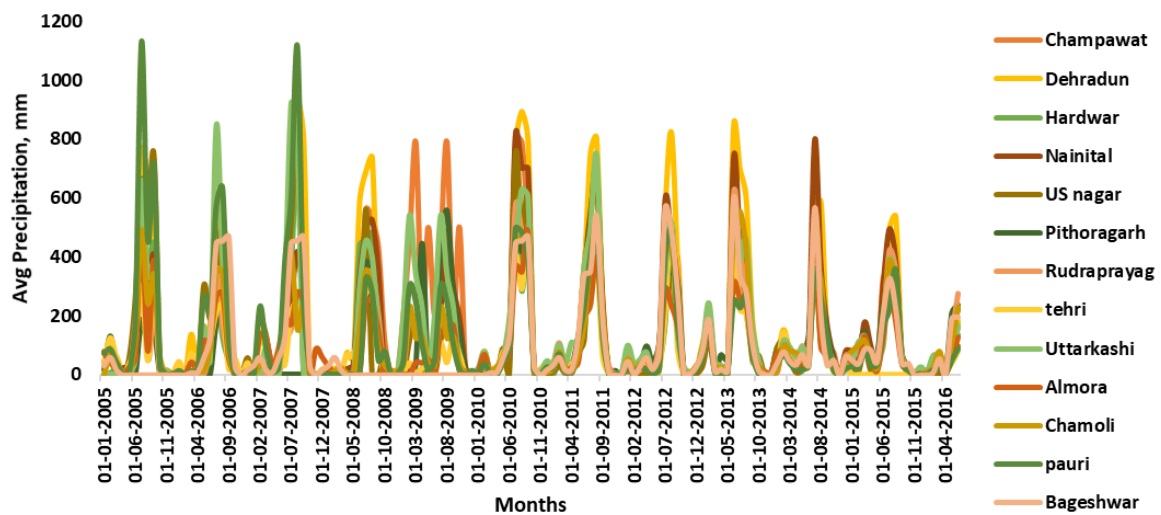
	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9
PC1	1	0.527673	0.255703	0.672074	0.685847	0.188658	0.797942	0.665339	0.673378
PC2	0.527673	1	0.696146	0.885125	0.479155	0.014698	0.487015	0.930171	0.850616
PC3	0.255703	0.696146	1	0.665569	0.242076	0.123365	0.217838	0.673246	0.722237
PC4	0.672074	0.885125	0.665569	1	0.552003	0.02717	0.578878	0.907174	0.859587
PC5	0.685847	0.479155	0.242076	0.552003	1	0.137442	0.867429	0.604516	0.640432
PC6	0.188658	0.014698	0.123365	0.02717	0.137442	1	0.182404	0.024236	0.006538
PC7	0.797942	0.487015	0.217838	0.578878	0.867429	0.182404	1	0.640683	0.669715
PC8	0.665339	0.930171	0.673246	0.907174	0.604516	0.024236	0.640683	1	0.960464
PC9	0.673378	0.850616	0.722237	0.859587	0.640432	0.006538	0.669715	0.960464	1

SM 5 Table showing a correlation between 9 predictors after PCA.

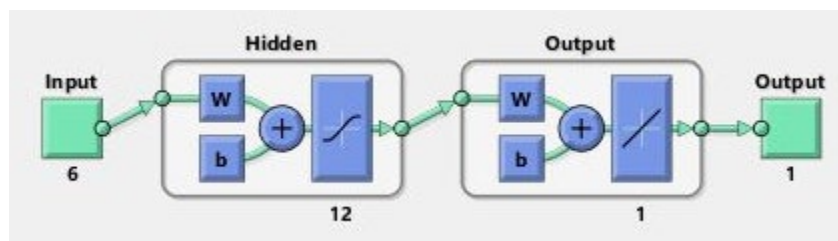
	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9
PC1	1	8.44E-34	3.73E-31	4.75E-33	3.33E-32	5.10E-34	2.12E-34	6.80E-33	1.38E-33
PC2	8.44E-34	1	8.16E-32	4.96E-35	2.08E-32	1.50E-31	5.75E-32	1.71E-32	4.86E-33
PC3	3.73E-31	8.16E-32	1	1.62E-32	1.33E-31	5.61E-32	1.37E-33	6.20E-33	8.34E-34
PC4	4.75E-33	4.96E-35	1.62E-32	1	1.57E-31	4.26E-33	5.04E-33	1.56E-33	3.21E-32
PC5	3.33E-32	2.08E-32	1.33E-31	1.57E-31	1	4.87E-31	1.31E-31	5.69E-33	3.46E-32
PC6	5.10E-34	1.50E-31	5.61E-32	4.26E-33	4.87E-31	1	7.50E-34	1.78E-32	1.51E-32
PC7	2.12E-34	5.75E-32	1.37E-33	5.04E-33	1.31E-31	7.50E-34	1	2.08E-33	2.79E-32
PC8	6.80E-33	1.71E-32	6.20E-33	1.56E-33	5.69E-33	1.78E-32	2.08E-33	1	5.96E-32
PC9	1.38E-33	4.86E-33	8.34E-34	3.21E-32	3.46E-32	1.51E-32	2.79E-32	5.96E-32	1



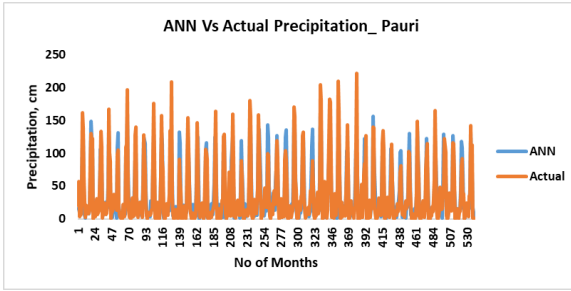
SM 6 IMD grid points in Uttarakhand, shown by (+).



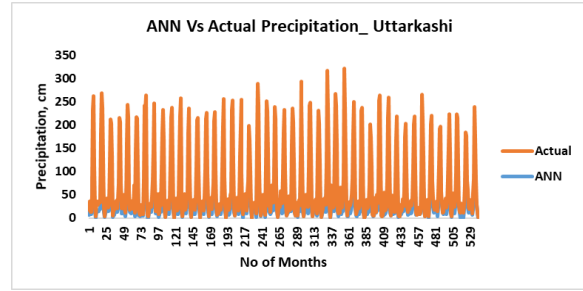
SM 7 Mean monthly rainfall pattern in hilly regions of Uttarakhand.



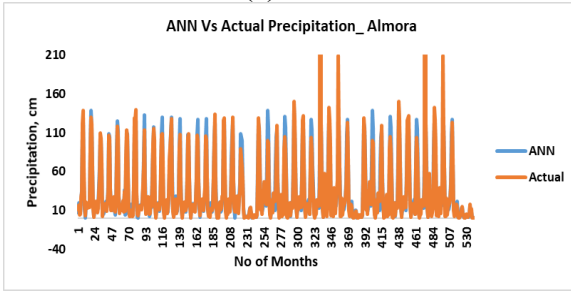
SM 8 A basic ANN structure.



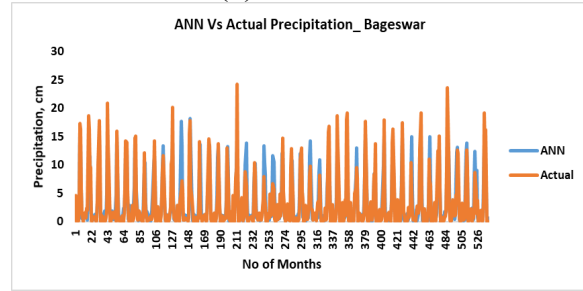
(a) Pauri



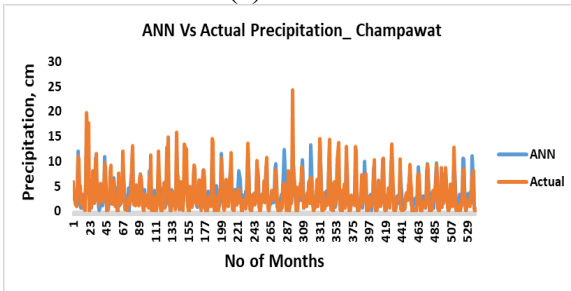
(b) Uttarkashi



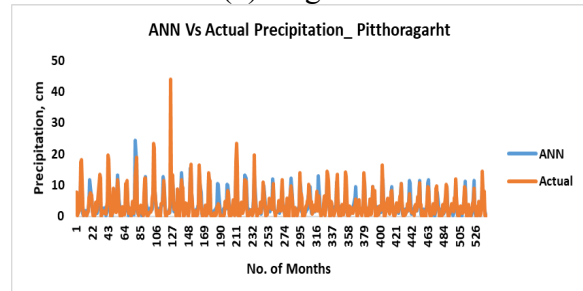
(c) Almora



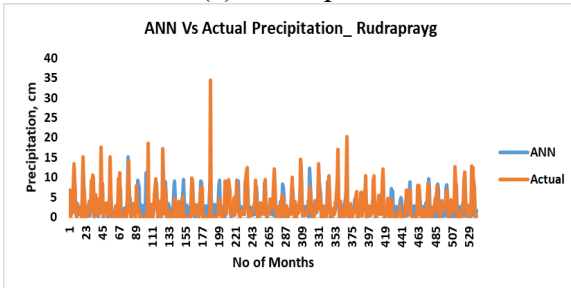
(d) Bageswar



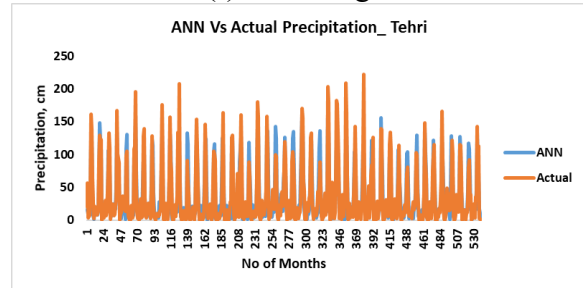
(e) Champawat



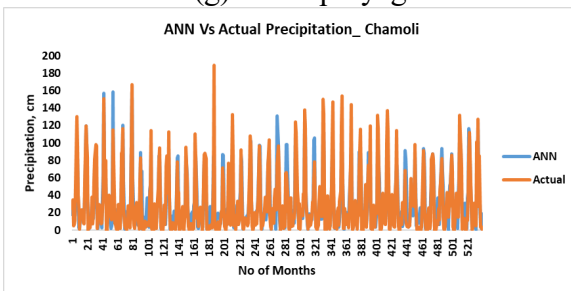
(f) Pitthoragarh



(g) Rudraprayag

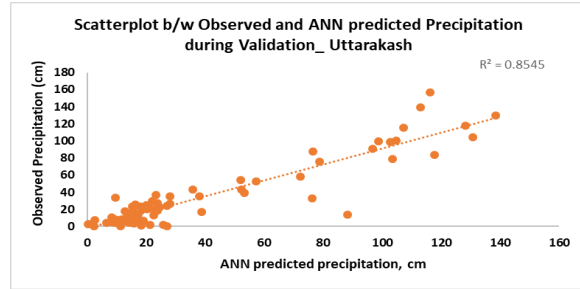
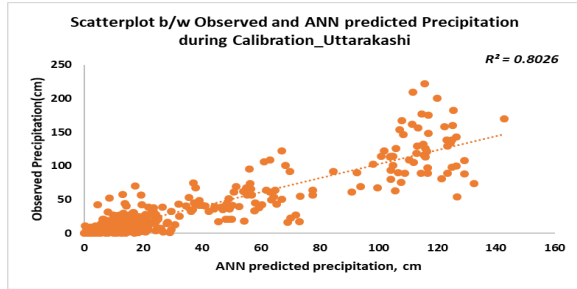


(h) Tehri

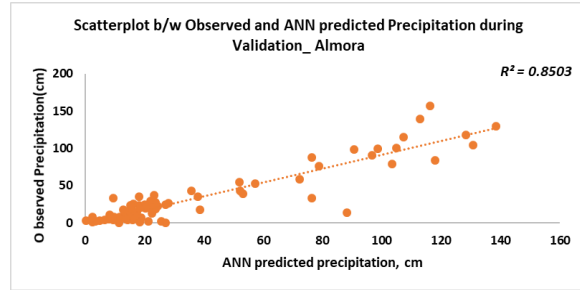
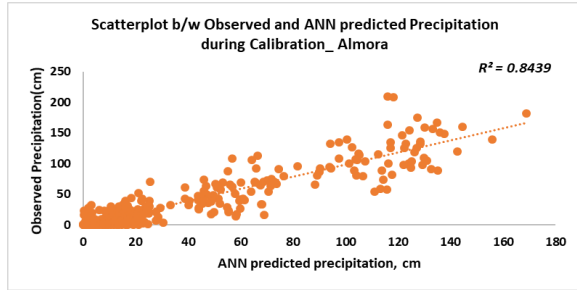


(i) Chamoli

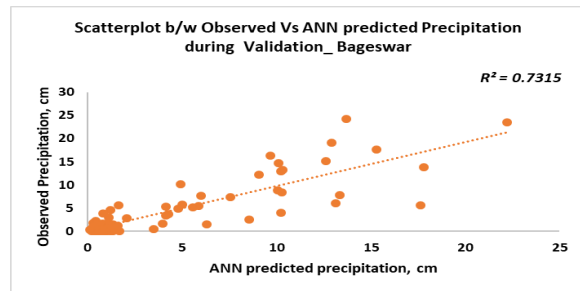
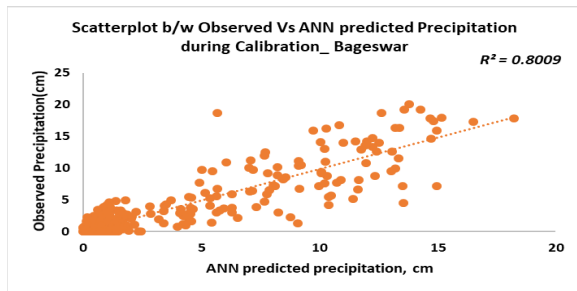
SM 9 ANN vs Actual precipitation for at different locations of Uttarakhand.



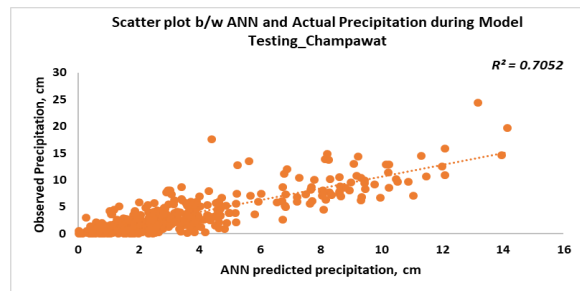
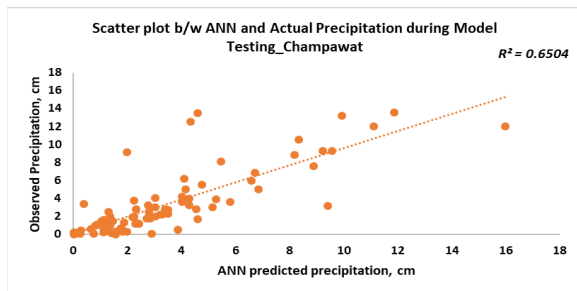
Uttarakshi



Alhora

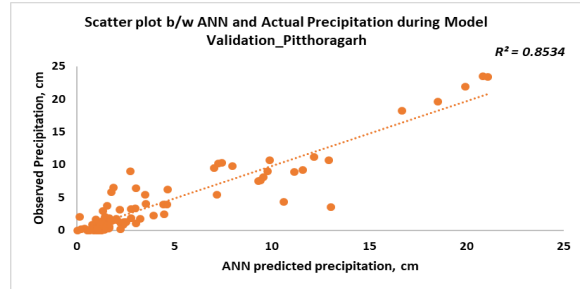
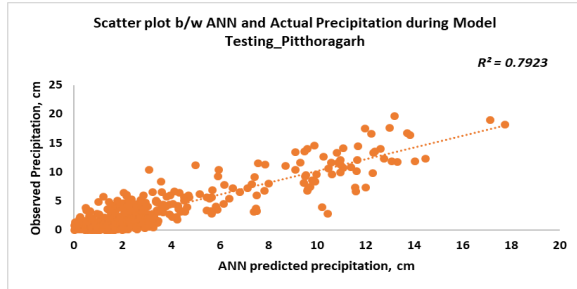


Bageswar

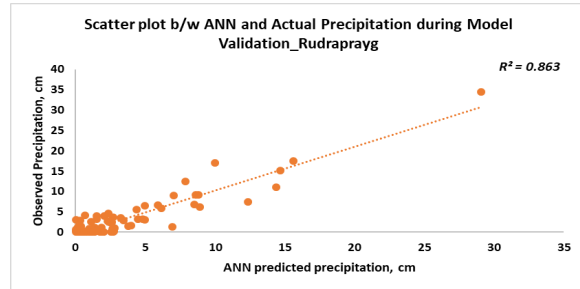
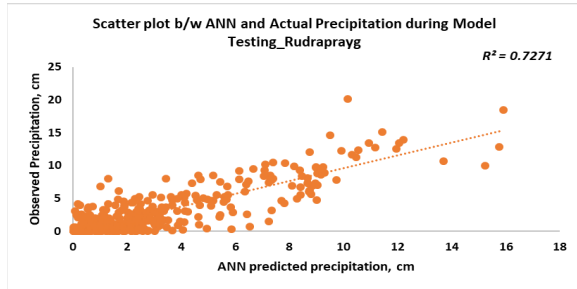


Champawat

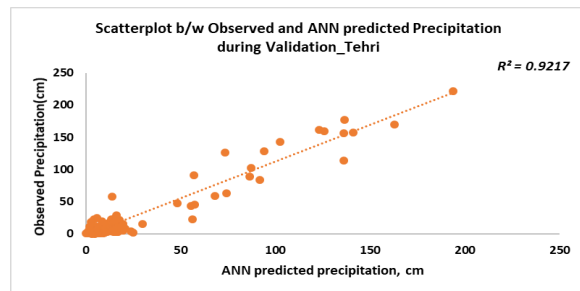
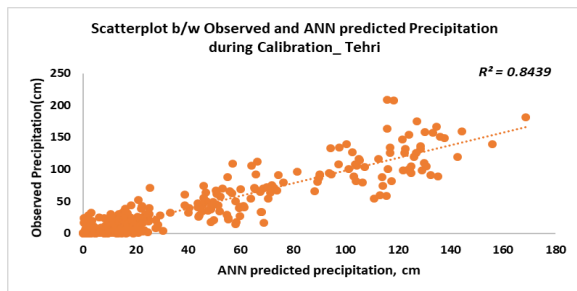
SM 10 Scatterplot between observed and ANN predicted of precipitation during calibration and validation



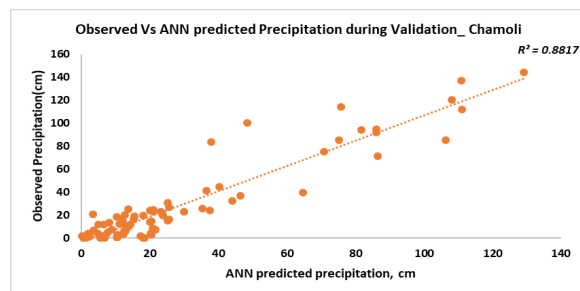
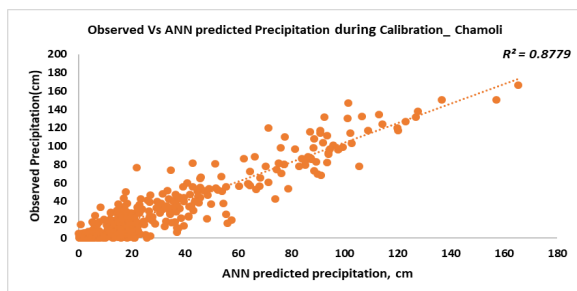
Pitthoragarh



Rudraprayag



Tehri



Chamoli

SM 10 Scatterplot between observed and ANN predicted of precipitation during calibration and validation (*continued*)