

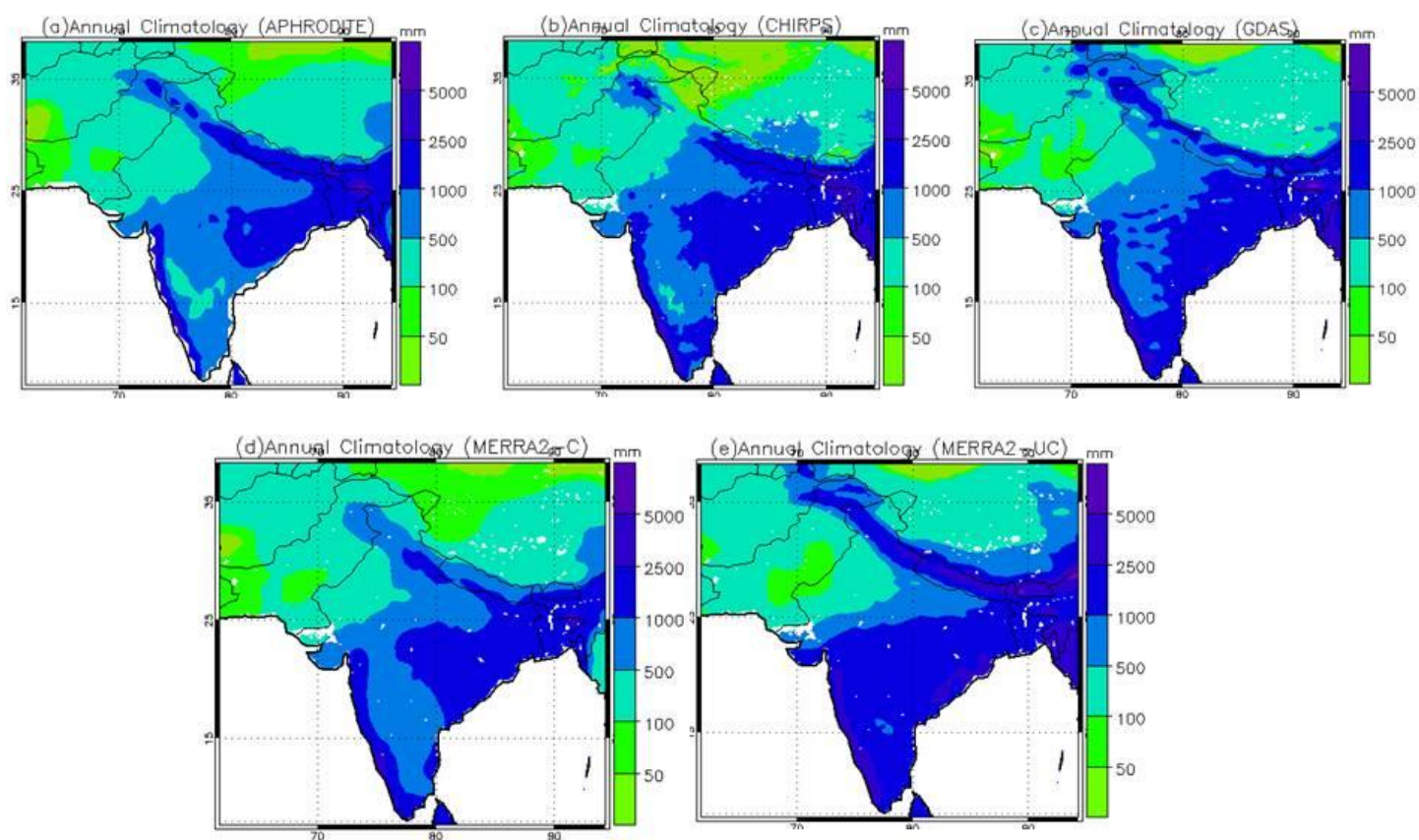
Supplementary Table 1 Root mean square error of monthly accumulated precipitation between station observation and CHIRPS, GDAS and MERRA2-UC and MERRA2-C for the period of 2012-2017.

Pakistan	CHIRPS	GDAS	MERRA2-UC	MERRA2 -C
AWS-Gupis	9.1	35.1	61.5	8.0
AWS-Kalam	109.8	173.1	115.1	108.6
Ganish Bridge	21.8	27.6	57.6	21.9
HS-Gupis	16.0	31.0	53.7	14.6
HS-Kalam	31.0	138.6	93.5	30.6
Lower Dir	110.0	113.8	107.7	105.2
Nowshera	55.6	53.3	47.6	57.3
Zulam	55.7	89.5	63.2	49.0

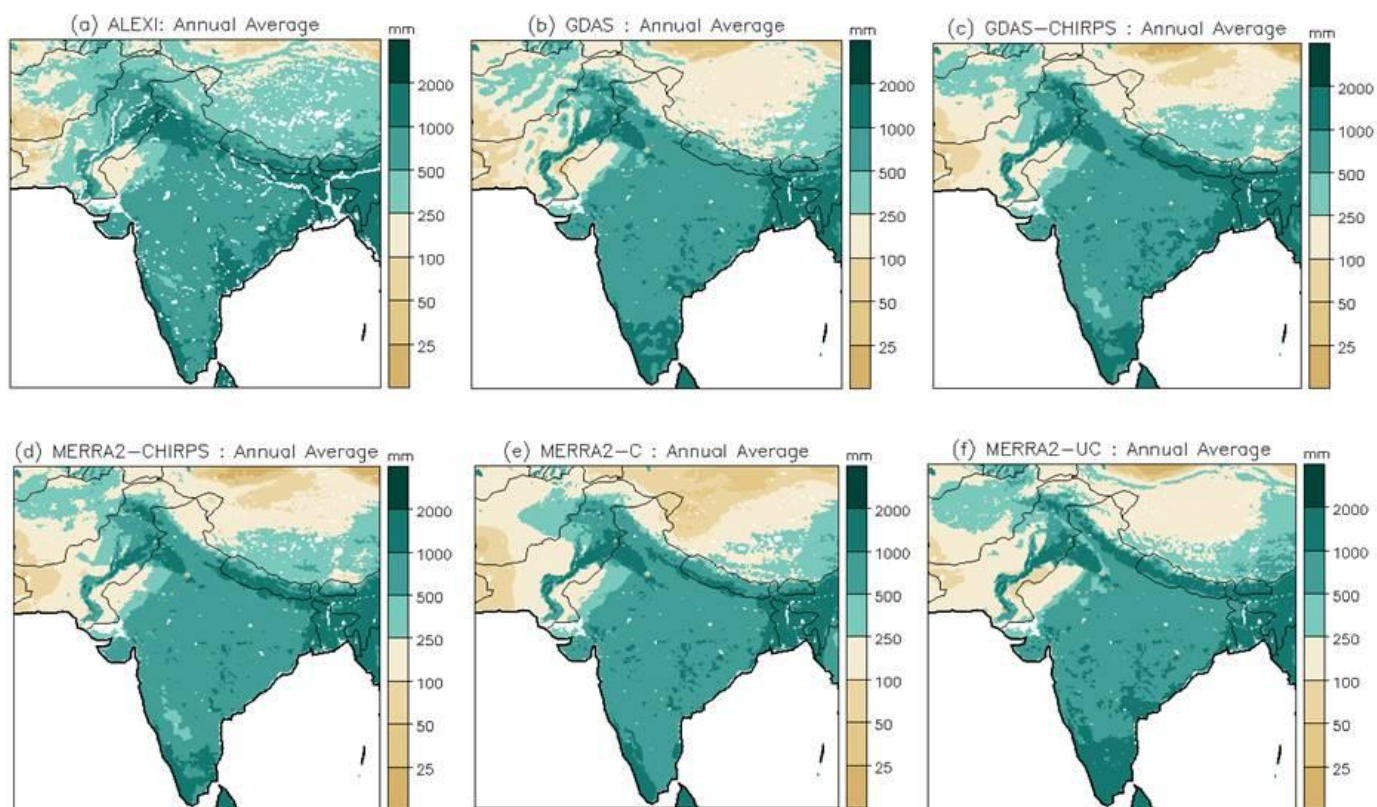
Bhutan	CHIRPS	GDAS	MERRA2-UC	MERRA2-C
AWS-Trashi Yangtse	86.5	71.2	635.7	58.8
Gongrichu	54.7	78.9	686.9	106.4
Korilla	51.1	166.0	418.8	59.2
Pangbang	242.6	286.2	375.9	258.3
Sumpa	74.0	65.6	633.4	70.8
Trashi Yangtse	92.2	100.9	601.8	54.9
Uzorong	60.1	232.7	523.1	96.5

Bangladesh	CHIRPS	GDAS	MERRA2-UC	MERRA2-C
Bhairab Bazar	118.2	133.3	147.5	158.8
Chatlaghat	195.8	335.4	205.4	247.1
Kurigram	308.9	341.9	334.8	274.4
Lalan Shah Bridge	111.6	114.2	147.9	127.7
Sirajganj	129.4	156.6	161.4	130.6
Srimangal	62.1	303.5	138.7	73.1
Sunamgunj	304.2	605.0	501.0	391.9
Zakigunj	197.1	233.4	243.6	158.3

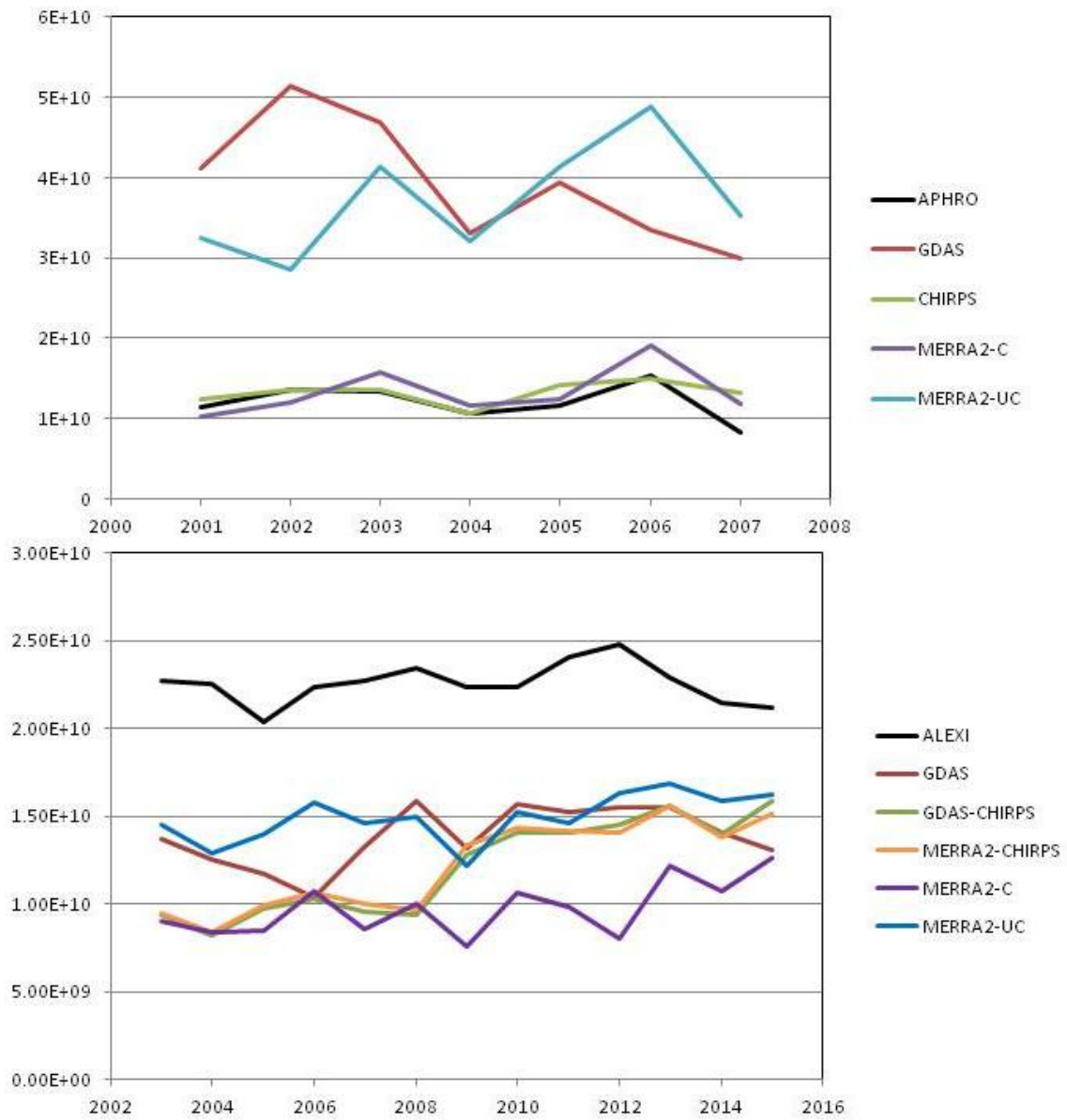
Nepal	CHIRPS	GDAS	MERRA2-UC	MERRA2-C
Bahrabise	165.7	294.1	203.9	200.7
Busti	138.5	156.2	369.4	97.5
Chatara	184.5	188.0	138.372	141.1
Dhankuta	91.9	390.9	283.1	94.2
Jiri	148.3	225.8	314.0	178.3
Lukla	140.8	118.4	387.7	152.3
Okhaldhunga	112.1	76.3	331.8	26.9
Pachuwarghat	97.4	111.9	242.2	75.9
Rabuwabazar	159.4	78.5	329.5	42.9
Tumlingtar	142.4	130.8	392.6	93.8
Turkeghat	179.1	117.2	477.6	115.5



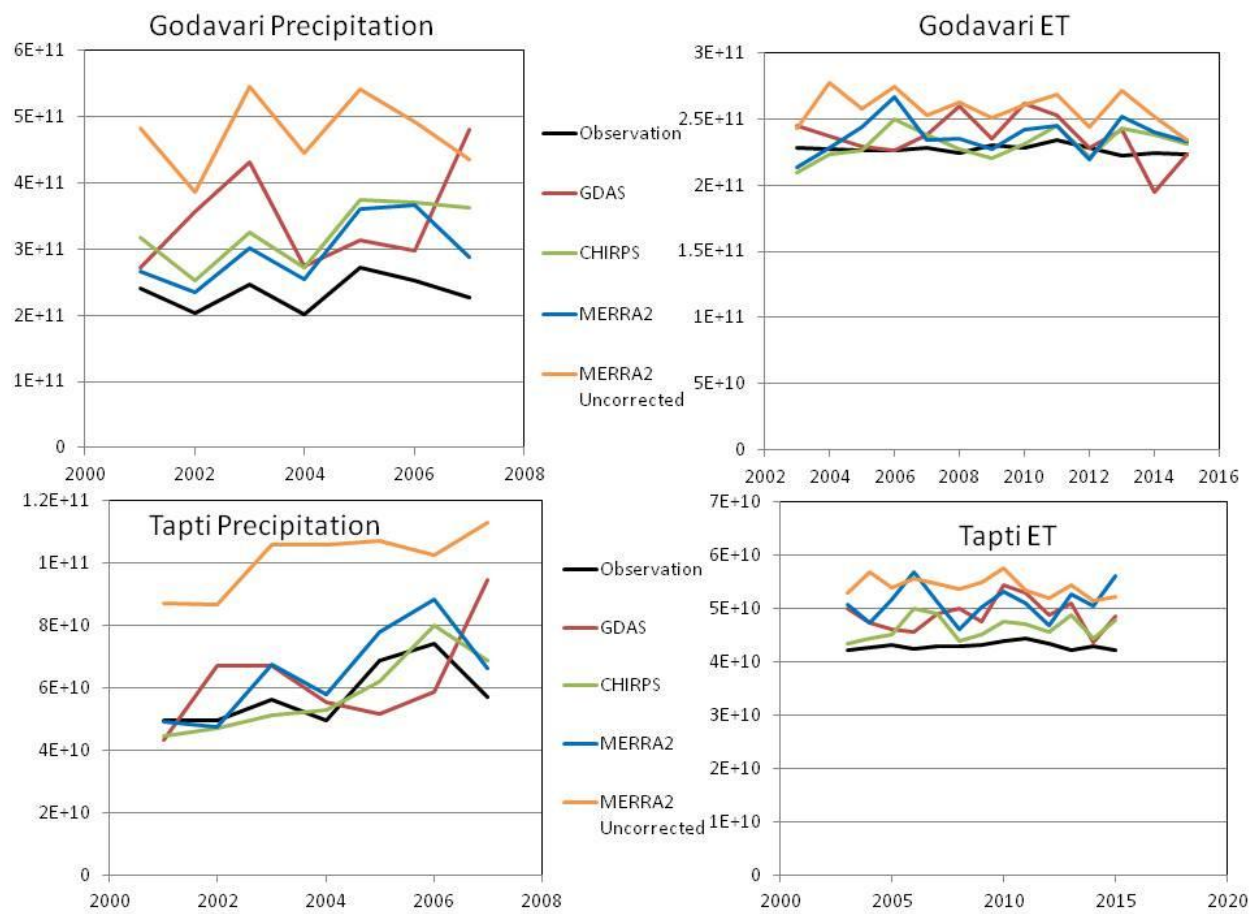
Supplementary Figure 1 Climatology of annual precipitation (mm) based on 2001-2007 for (a) APHRODITE, (b) CHIRPS (c) GDAS (d) MERRA2-C and (e) MERRA2-UC



Supplementary Figure 2 Climatology of annual evapotranspiration (mm) based on 2003-2015 for (a) ALEXI, (b) GDAS (c) GDAS- CHIRPS (d) MERRA2-CHIRPS, (e) MERRA2-C and (f) MERRA2-UC



Supplementary Figure 3 Timeseries of annual precipitation (m³) (top) and annual ET (m³) (bottom) over the upper Indus river basin from observations and from model simulations with multiple meteorological forcings.



Supplementary Figure 4 Same as figure 6 except for Godavari and Tapti rivers.