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SEASONAL PREDICTION OF HYDRO-CLIMATIC EXTREMES IN THE GREATER HORN OF AFRICA (GHA)

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Validation of new satellite rainfall products over the Upper Blue Nile Basin, Ethiopia

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Getachew Tesfaye, Tsegaye Tadesse, Berhan Gessesse and Tufa Dinku (2017).

Introduction

- Accurate measurements of rainfall - fine spatial and temporal scale is vital

- Conventionally, rain gauge is the main source of rainfall data in Ethiopia.

- However, are sparse and unevenly distributed, and the analysis using rain gauge stations are greatly limited on the point of measurements.

- An alternative - could be satellite based rainfall estimate (SREs) (Grimes et al., 1999; Verdin et al., 2005).

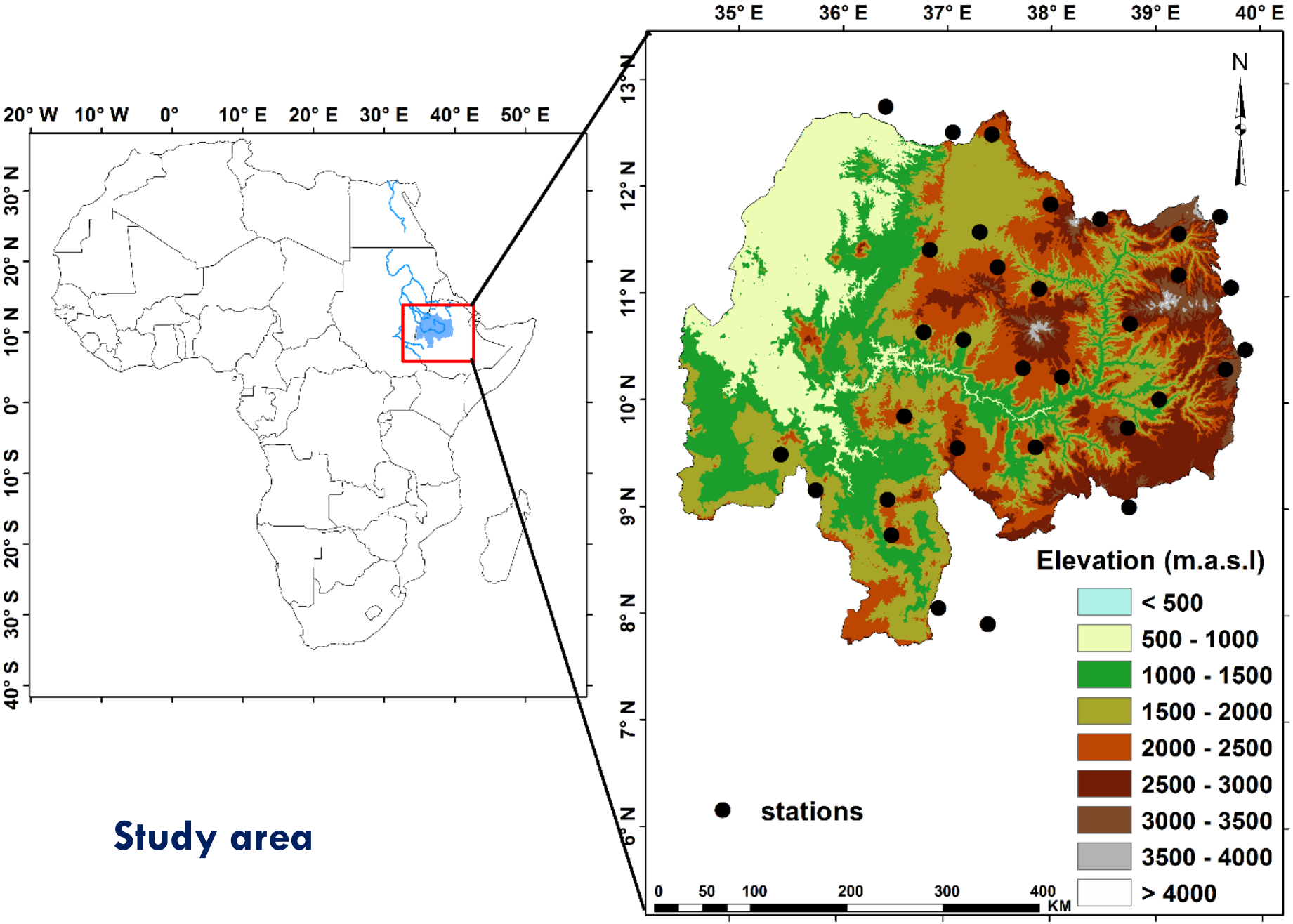
Data

CHIRPS SREs Uncertainty- Needs rigorous validation using gauge stations

SRP	Temporal Coverage	Spatial Resolution	Temporal
CHIRPS v2	1981-presnt	0.05 degree (~5km)	Daily, Penta, dekadal, monthly

Against 32 rain gauge observations of 2000-2015 UBN Basin in Ethiopia

SRP	Temporal Coverage	Spatial Resolution	Temporal
TAMSAT v2	1983-presnt	0.0375 degree (~4 km)	Dekadal, monthly & Seas
TAMSAT v3	1983-presnt	0.0375 degree (~4 km)	Daily
ARC v2	1983-presnt	0.1 degree (~10 km)	Daily


20° W
10° W
0°
10° E
20° E
30° E
40° E
50° E
30° N
20° N
10° N
0°
10° S
20° S
30° S
40° S
35° E
36° E
37° E
38° E
39° E
40° E
13° N
12° N
11° N
10° N
9° N
8° N
7° N
6° N
N
Elevation (m.a.s.l)
< 500
500 - 1000
1000 - 1500
1500 - 2000
2000 - 2500
2500 - 3000
3000 - 3500
3500 - 4000
> 4000
stations
0
50
100
200
300
400
KM

Study area

Analysis (Point-to-grid)

POD=$H/(H+M)$, FAR=$F/(H+F)$, CSI=$H/(H+M+F)$

Categorical Indices

$$\mathrm{VHI} = \frac{\sum_i^n (S_i | (S_i > t \& G_i > t))}{\sum_i^n (S_i | (S_i > t \& G_i > t)) + \sum_i^n (G_i | (S_i \leq t \& G_i > t))}$$

$$\mathrm{FAR} = \frac{\sum_i^n (S_i | (S_i > t \& G_i \leq t))}{\sum_i^n (S_i | (S_i > t \& G_i > t)) + \sum_i^n (S_i | (S_i > t \& G_i \leq t))}$$

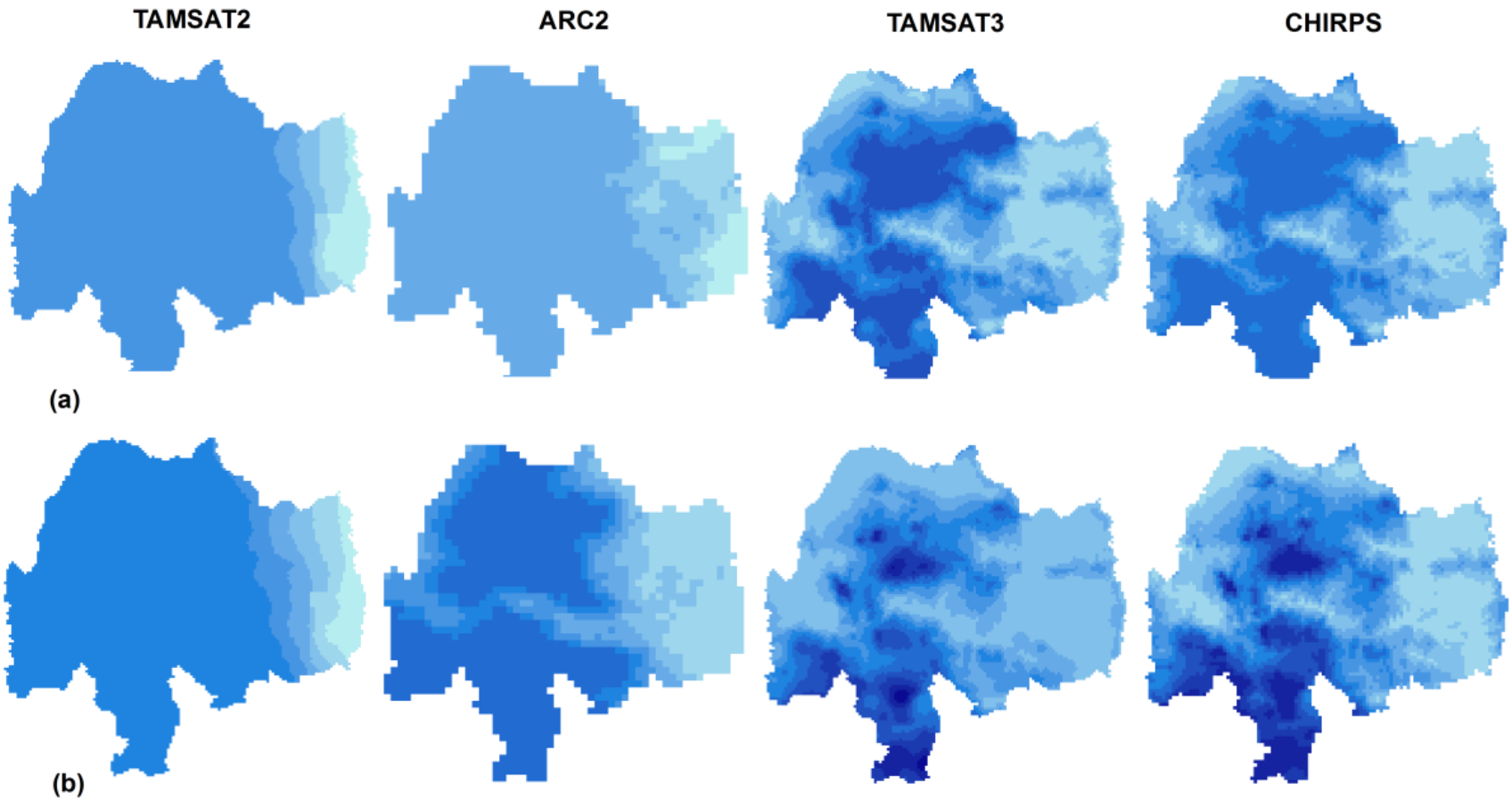
$$\mathrm{VCSI} = \frac{\sum_i^n (S_i | (S_i > t \& G_i > t))}{\sum_i^n (S_i | (S_i > t \& G_i > t)) + \sum_i^n (G_i | (S_i \leq t \& G_i > t)) + \sum_i^n (S_i | (S_i > t \& G_i \leq t))}$$

Volumetric Indices

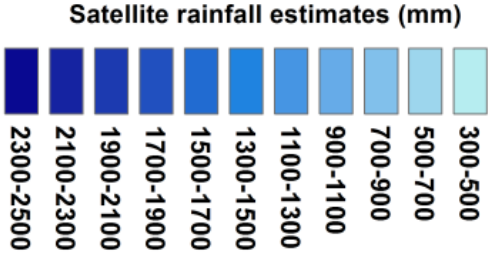
$$r = \frac{\sum (G - \bar{G})(S - \bar{S})}{\sqrt{\sum (G - \bar{G})^2} \sqrt{\sum (S - \bar{S})^2}} \qquad \mathrm{RMSE} = \sqrt{\frac{\sum (G - S)^2}{n}} \qquad \mathrm{Bias} = \frac{\sum S}{\sum G}$$

Statistical tools

Spatial rainfall patterns of satellite products

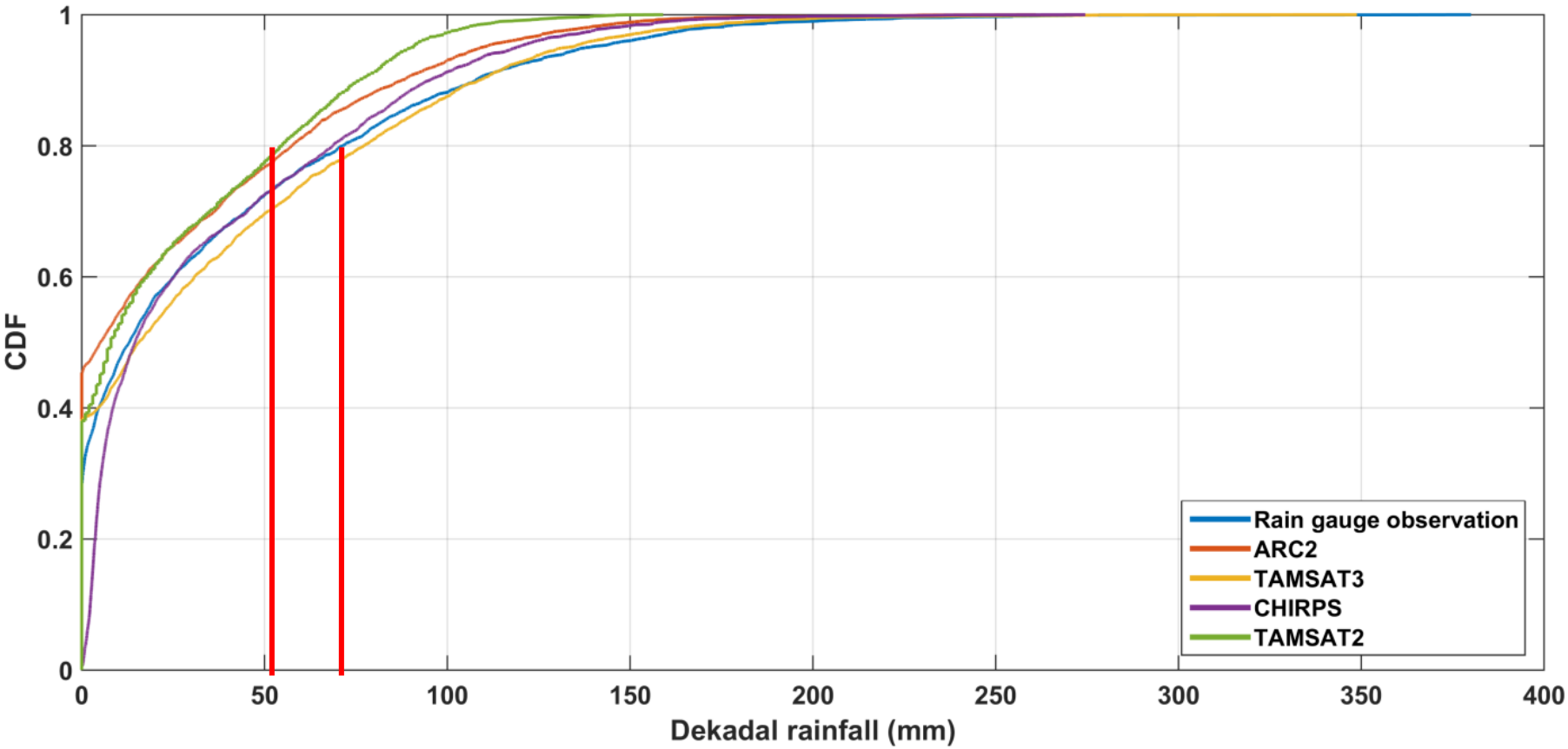


a) Wet season pattern (June to September)
b) Annual Pattern

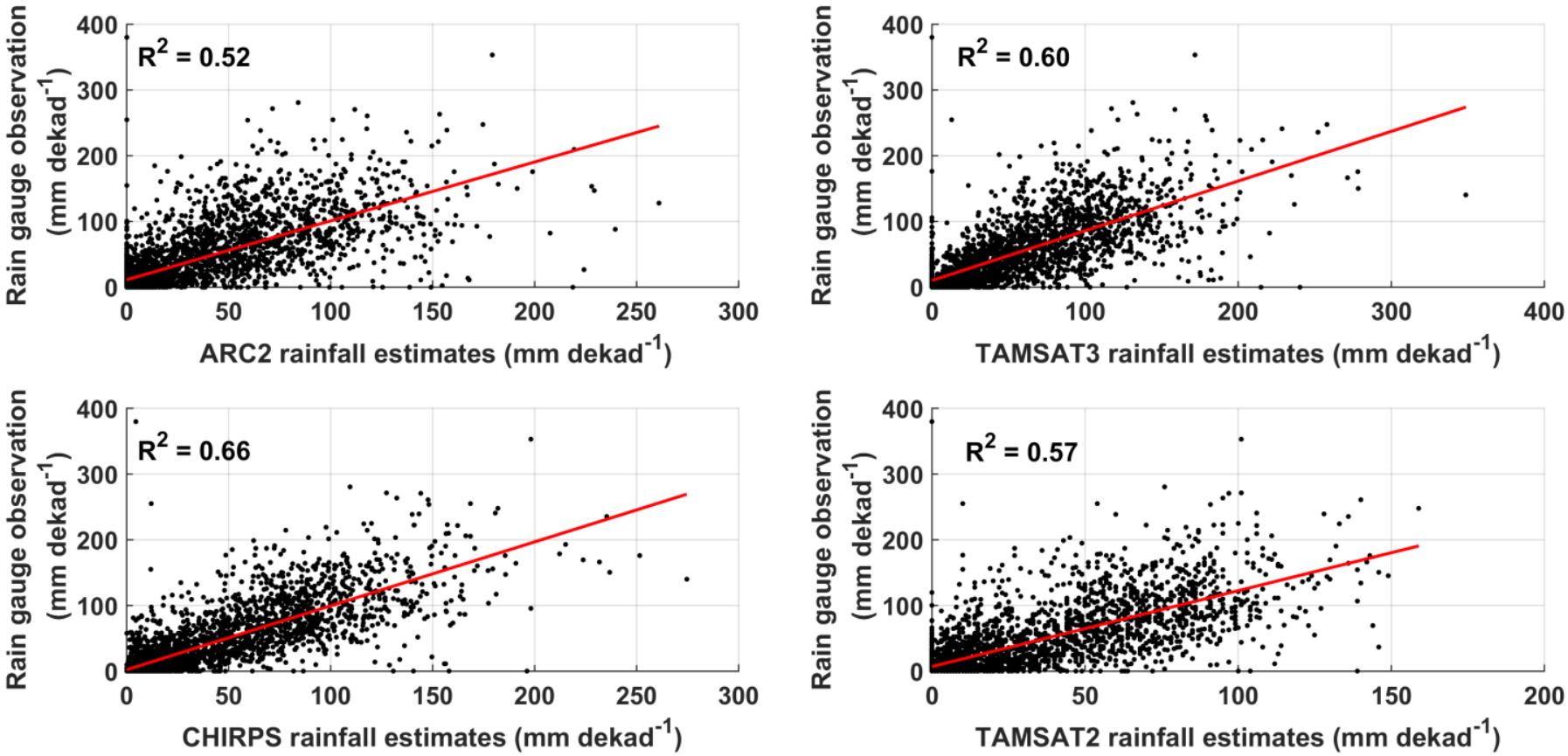


Dekadal comparison

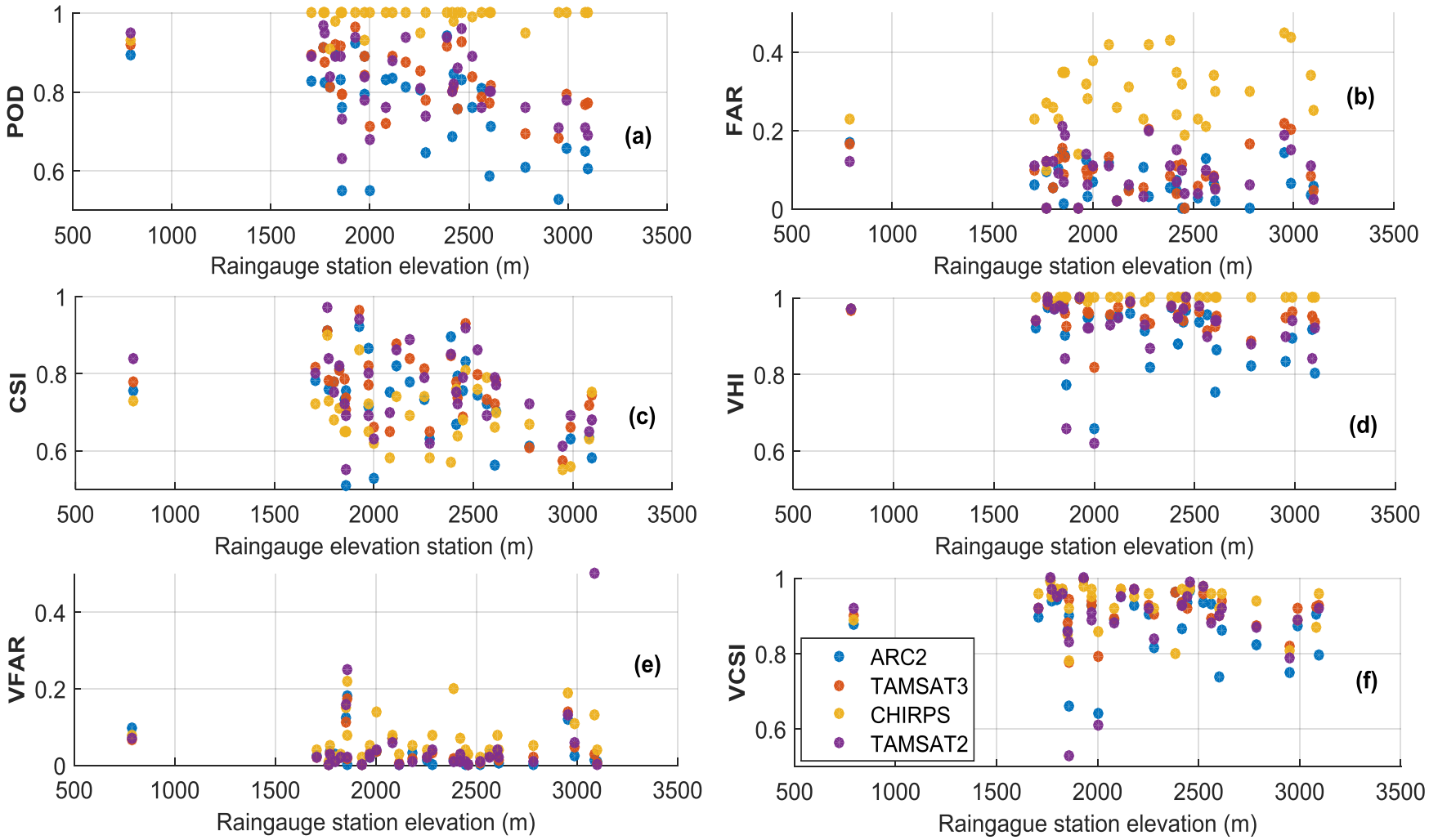
Datasets	POD	FAR	CSI	VHI	VFAR	VCSI	*r*	bias	RMSE
ARC 2	0.75	0.06	0.71	0.91	0.03	0.89	0.72	0.76	35.02
TAMSAT 2	0.83	**0.09**	0.77	0.94	0.03	0.91	0.76	**0.69**	34.03
TAMSAT 3	0.83	0.09	0.76	0.96	0.03	0.93	0.78	1.04	32.19
CHIRPS	0.99	**0.31**	0.68	1.00	0.06	0.94	0.81	0.96	28.45

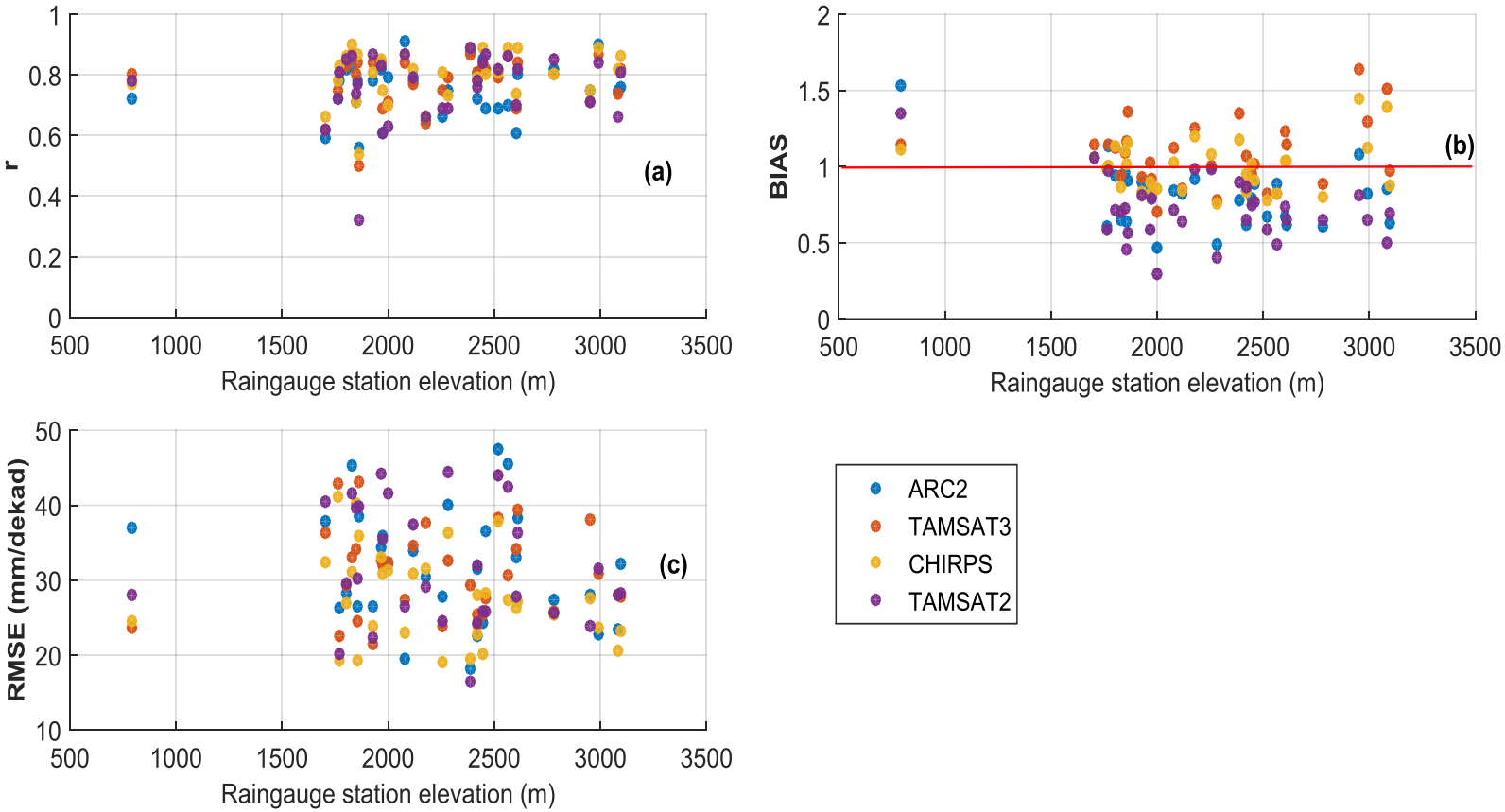


	At 80% frequency level	Difference
CHIRPS	2.69 mm	Above
TAMSAT 3	5.9 0 mm	**Above**
TAMSAT 2	13.84 mm	**Below**
ARC2	16.3 mm	**Below**


R2 = 0.52
Rain gauge observation (mm dekad-1)
ARC2 rainfall estimates (mm dekad-1)
R2 = 0.60
Rain gauge observation (mm dekad-1)
TAMSAT3 rainfall estimates (mm dekad-1)
R2 = 0.66
Rain gauge observation (mm dekad-1)
CHIRPS rainfall estimates (mm dekad-1)
R2 = 0.57
Rain gauge observation (mm dekad-1)
TAMSAT2 rainfall estimates (mm dekad-1)

Comparison- Elevation





Indices	Stations elevation			
	ARC 2	TAMSAT 3	CHIRPS	TAMSAT 2
POD	-0.55	-0.55	0.34	-0.44
CSI	-0.43	-0.38	-0.26	-0.31
BIAS	-0.44	0.18	0.10	-0.39

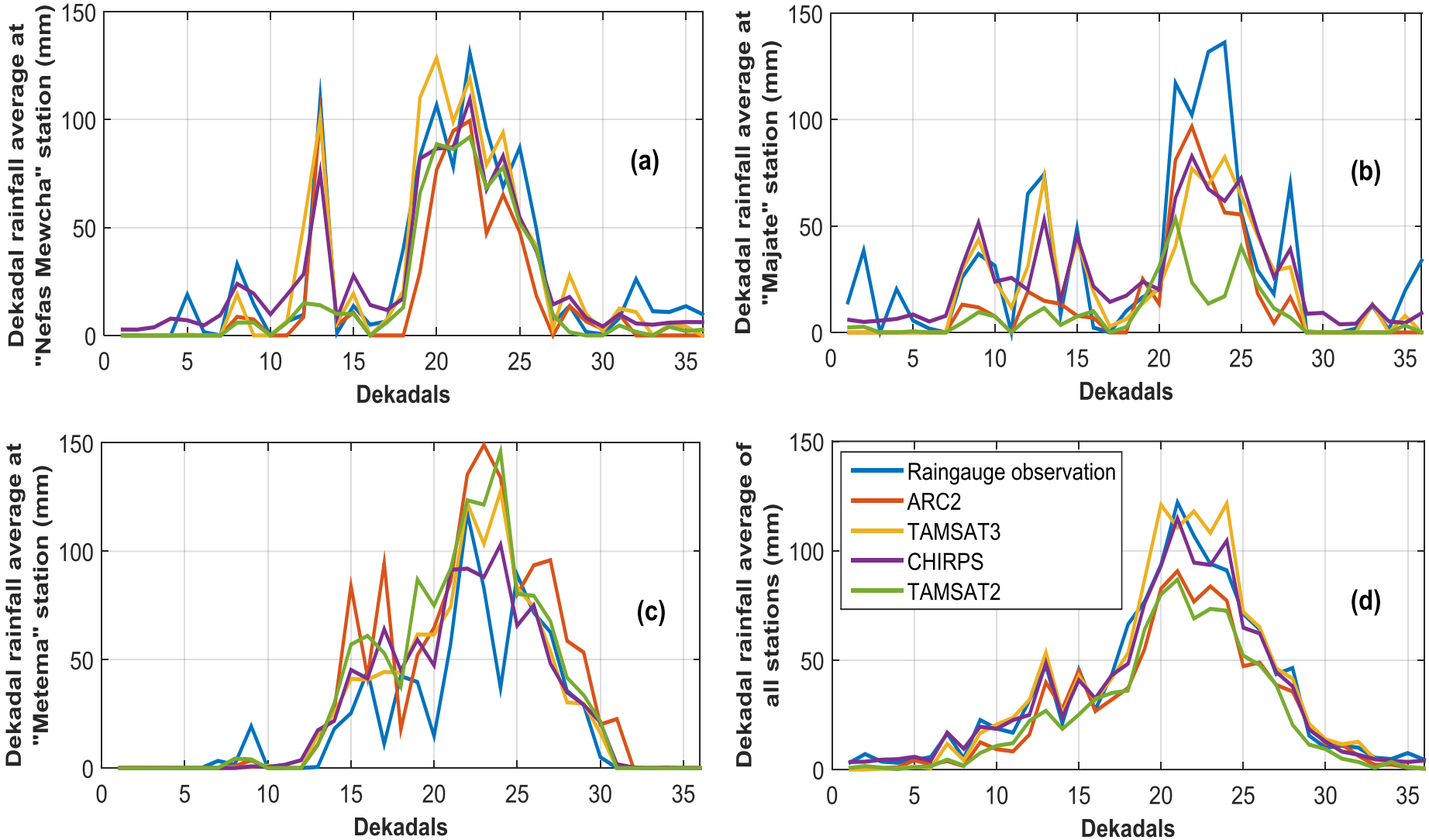


Figure 7:

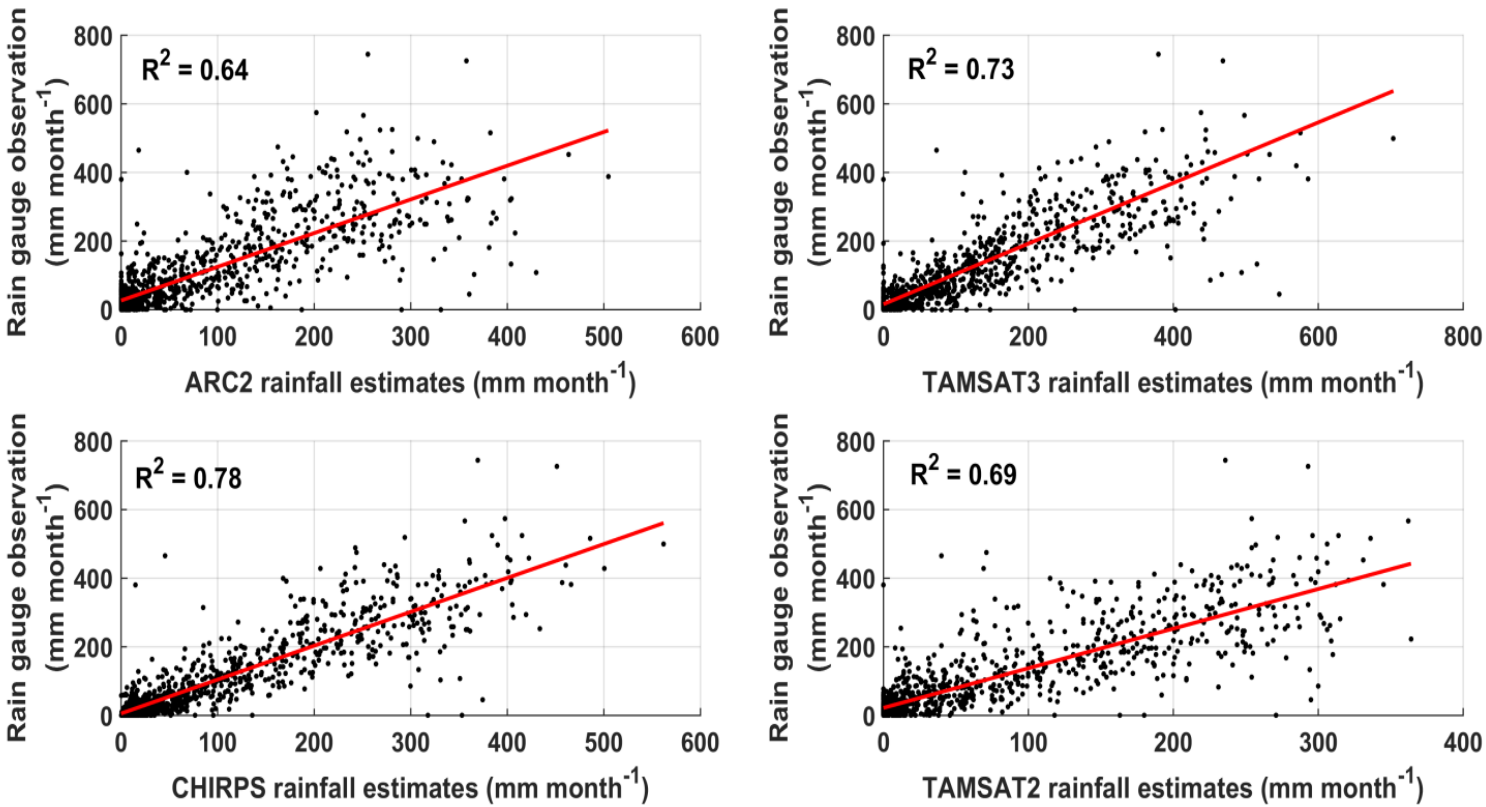
a) Nefas Mewucha (3098m)

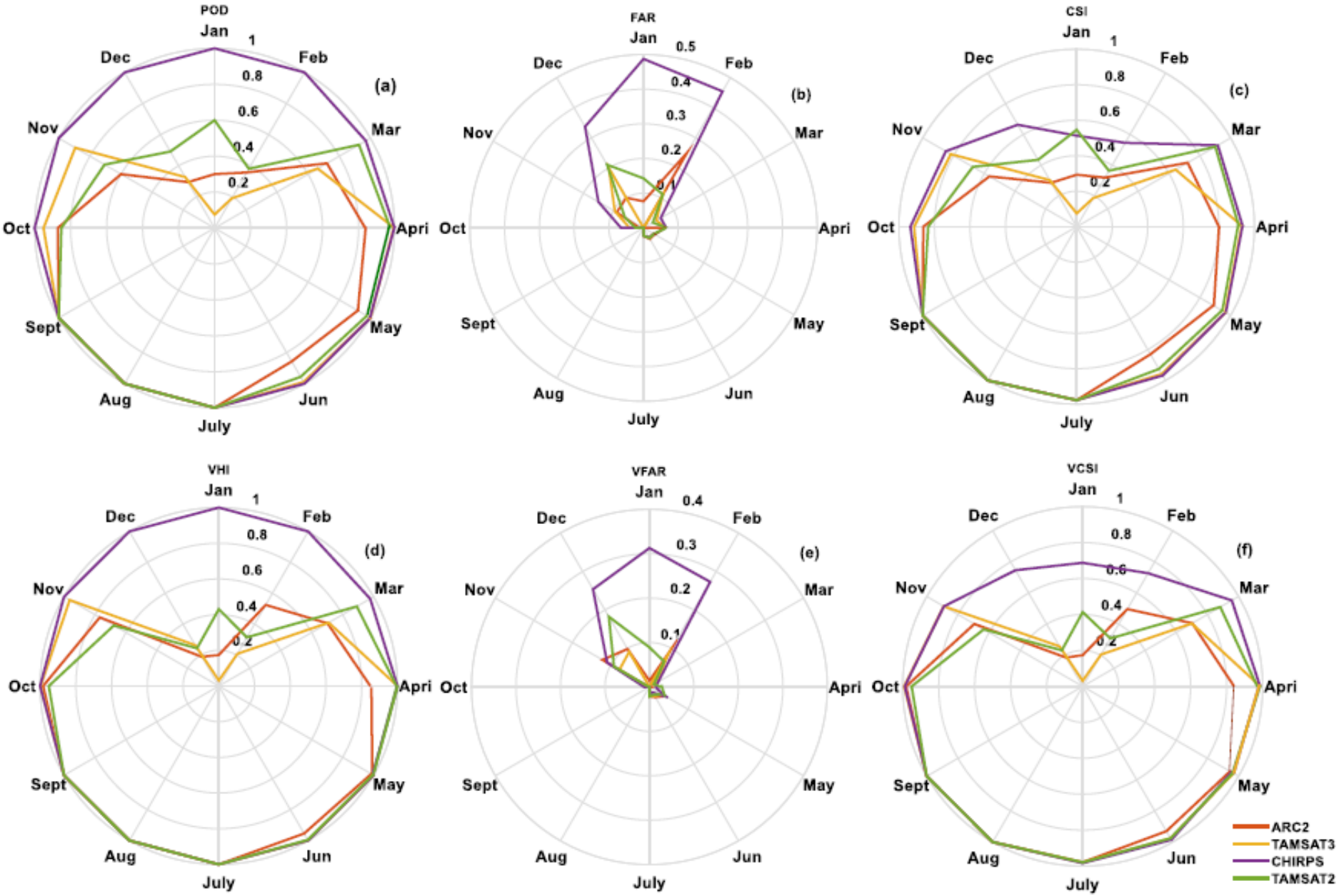
b) Majate (2000m)

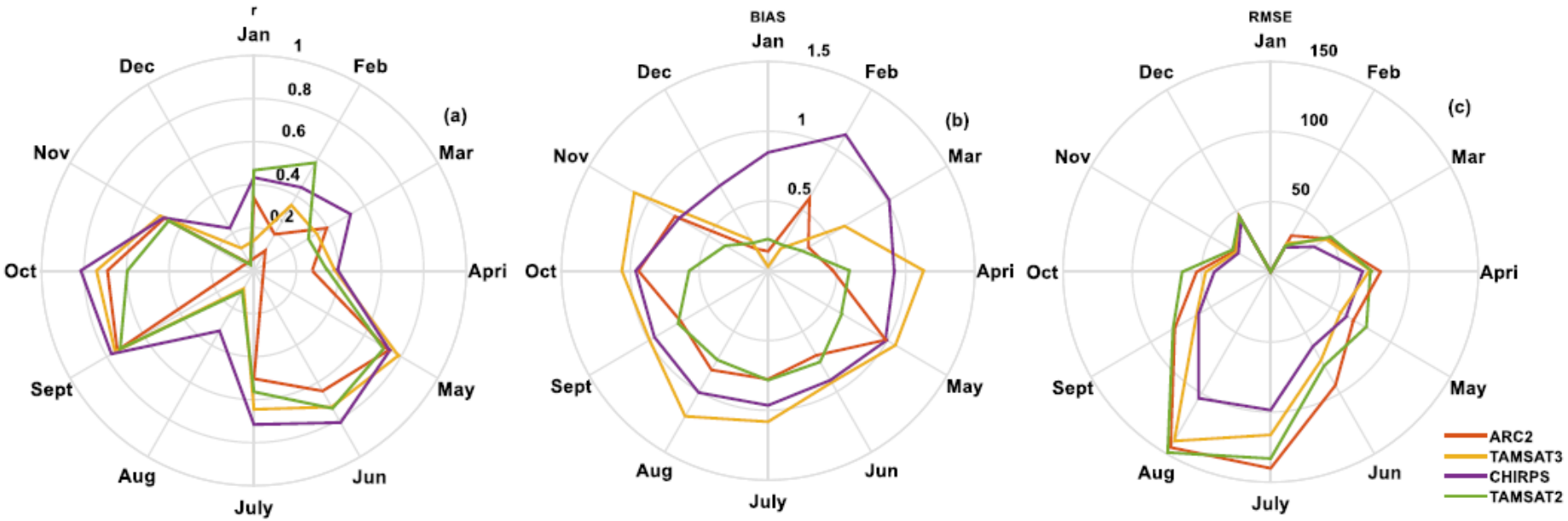
c) Metema (790m.

Monthly comparison

Datasets	POD	FAR	CSI	VHI	VFAR	VCSI	*r*	bias	RMSE
ARC 2	0.78	0.03	0.76	0.95	0.02	0.93	0.80	0.76	79.21
TAMSAT 2	0.86	0.04	0.83	0.97	0.01	0.96	0.83	**0.69**	78.65
TAMSAT 3	0.83	0.04	0.80	0.97	0.01	0.96	0.85	1.03	69.28
CHIRPS	1.00	0.14	0.86	1.00	0.02	0.98	0.88	0.96	59.03




POD
(a)
FAR
(b)
CSI
(c)
VHI
(d)
VFAR
(e)
VCSI
(f)
Jan
Feb
Mar
Apri
May
Jun
July
Aug
Sept
Oct
Nov
Dec
ARC2
TAMSAT3
CHIRPS
TAMSAT2


r
(a)
Jan
Feb
Mar
Apri
May
Jun
July
Aug
Sept
Oct
Nov
Dec
1
0.8
0.6
0.4
0.2
BIAS
(b)
1.5
1
0.5
RMSE
(c)
150
100
50
ARC2
TAMSAT3
CHIRPS
TAMSAT2

Conclusion

CHIRPS in the UBN basin in Ethiopia is very encouraging and relatively better than TAMSAT and ARC 2).

CHIRPS at different elevations and during the wet months could make the product more appropriate for various hydrological and rainfall analysis functions in complex topographic areas, such as the UBN basin.

The performance of TAMSAT 3 is very comparable to CHIRPS product and score close values to CHIRPS in many of the validation indicators, particularly to the bias ratios.

The recent version of TAMSAT product (TAMSAT 3) has well addressed many of the weaknesses of TAMSAT 2 (e.g., underestimations up to 31% in this study).

Thank You!