ECAS 2021

The 4th International Electronic Conference on Atmospheric Sciences

16–31 JULY 2021 | ONLINE

Proceedings

Assessment of Satellite and Reanalysis Precipitation Products for Rainfall-Runoff Modelling in a Mountainous Basin†

Hamed Hafizi [1,2] and Ali Arda Sorman [1]*

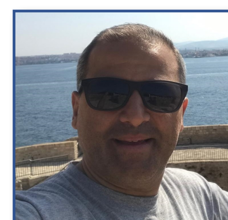
[1] Department of Civil Engineering, Eskisehir Technical University, Eskisehir, Turkey; hamedhafizi@eskisehir.edu.tr, asorman@eskisehir.edu.tr

[2] Department of Hydraulics and Hydraulic Structures, Faculty of Environmental and Water Resources Engineering, Kabul Polytechnic University, Kabul, Afghanistan; hamedhafizi@kpu.edu.af

* Correspondence: asorman@eskisehir.edu.tr

† Presented at the 4th International Electronic Conference on Atmospheric Sciences, 16–31 July 2021; Available online: https://ecas2021.sciforum.net/.

Hamed Hafizi

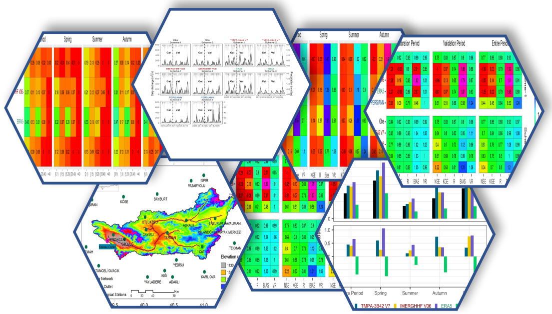


Ali Arda Sorman

Aim of Study

1. To evaluate the consistency of four Precipitation Products (PPs) by direct comparison of PPs with reference data for the period of 2015 to 2019 in daily time steps.

2. The hydrologic utility of PPs for streamflow simulation over a basin with complex topography for five hydrologic years.



Study Area and Stations Distribution

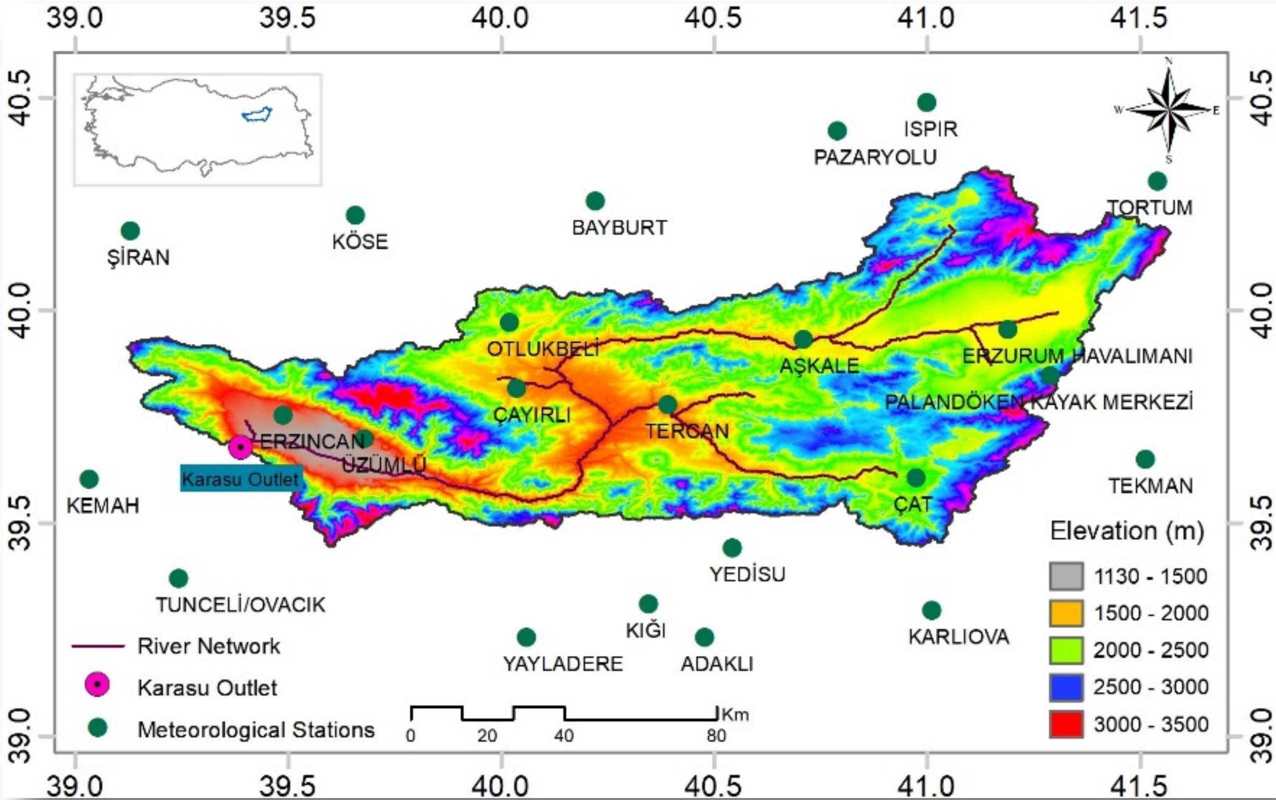


Figure 1. Geographical location, Basin Elevation (m), meteorological stations and hydrological station located at the study area.

Region: Karasu basin; Area: 10250 km^2; Station. No: 23 and Elevation Range: 1130 m to 3500 m.

Precipitation Products (PPs) Properties and Methodology

Table 1. Properties of selected PPs, Abbreviations in the data source column; G, gauge; S, satellite; R; Reanalysis.

Name	Data source(s)	Spatial resolution	Spatial coverage	Temporal resolution	Reference
TMPA-3B42v7	G, S	0.25°	50° N/S	3-hourly	[14]
IMERGHHFv06	G, S	0.10°	60° N/S	30 min	[15]
ERA5	R	0.25°	50° N/S	Hourly	[16]
PERSIANN	S	0.25°	60° N/S	Hourly	[17]

Table 2. Properties of performance indices for evaluation of PPs

Performance indicator	Mathematical statement	Explanation
Kling Gupta Efficiency and its components	$KGE=1-[(R-1)^2+(\beta-1)^2+(VR-1)^2]^{0.5}$ $R=\frac{1}{n}\sum_{1}^{n}(o_n-\mu_0)(s_n-\mu_s)/(\delta_o\times\delta_s)$, $\beta=\frac{\mu_s}{\mu_o}$, $VR=(\delta_s\times\mu_o)/(\mu_s\times\delta_o)$	*R* is *Pearson correlation coefficient*, *β (Bias)* is the ratio of estimated and observed mean, *VR (Variability Ratio)* is the ratio of estimated and observed coefficients of variation, μ and δ are the distribution mean and standard deviation where s and o indicate estimated and observed.
Hansen-Kuiper	$HK=\frac{(H\times CN)-(F\times M)}{(H+M)\ (F+CN)}$	*M (Miss)*; when the observed precipitation is not detected. *F (False)*; when the precipitation is detected but not observed, *H (Hit)*; when the observed precipitation is correctly detected, *CN (Correct Negative)*; a no precipitation event is detected.
Nash–Sutcliffe Efficiency	$NSE=1-\frac{\sum_{i=1}^{n}(Q_i^{sim}-Q_i^{ob})^2}{\sum_{i=1}^{n}(Q_i^{ob}-\overline{Q_i^{ob}})^2}$	n is the sample size of the observed or calculated streamflow. Q_i^{ob} and Q_i^{sim} present the observed and simulated streamflow, $\overline{Q_i^{ob}}$ present the mean observed streamflow.

Result and Discussion: Mean daily Precipitation

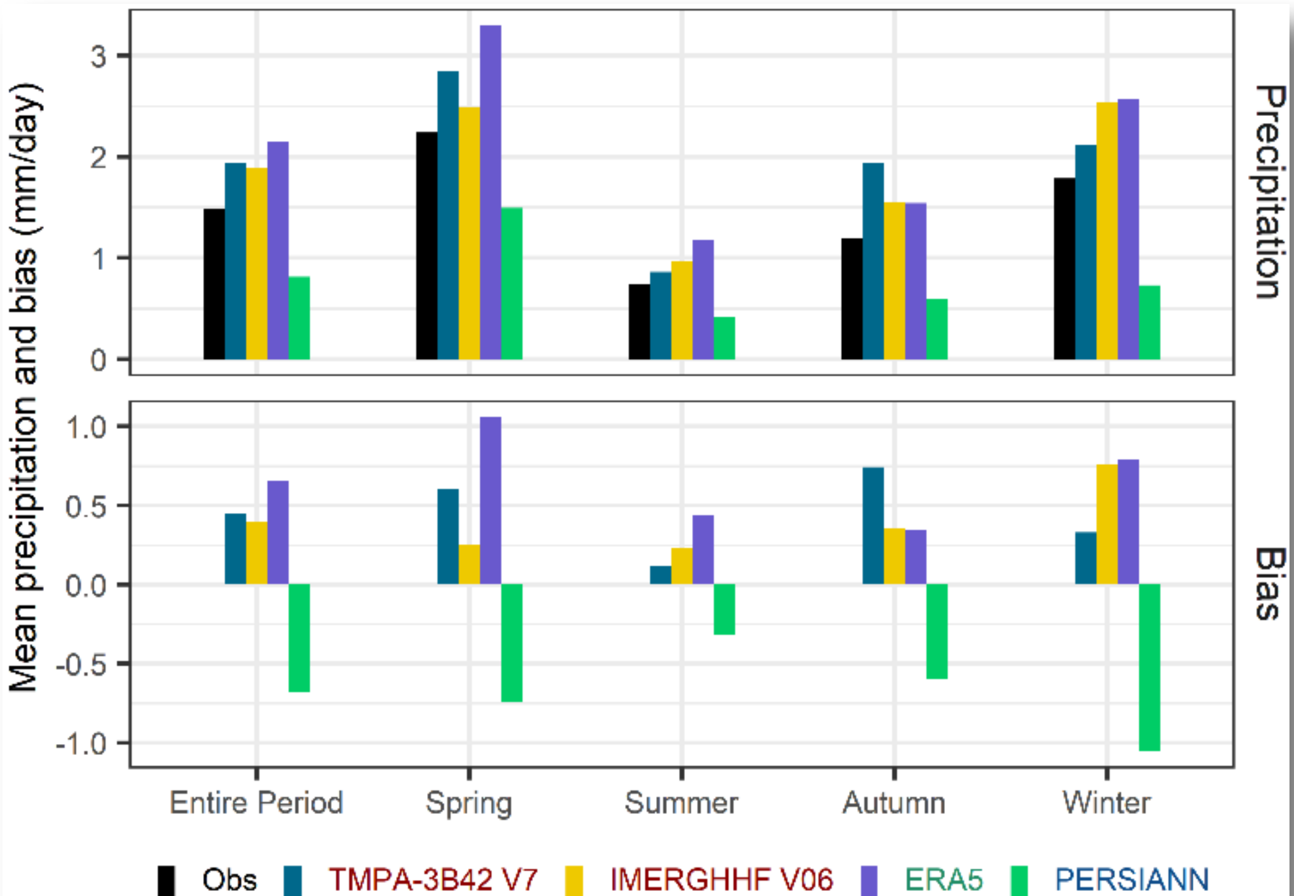


Figure 2. Mean daily precipitation and its bias compared to observed over the study region for the entire period and four seasons.

Result and Discussion: Performance metrics result for direct comparison

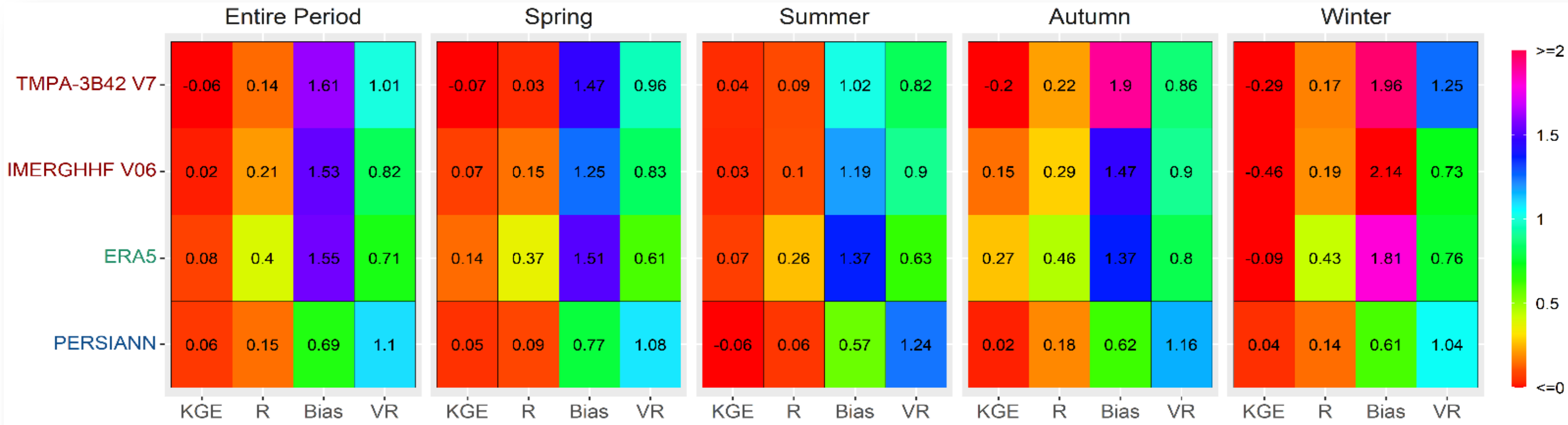


Figure 3. PPs reliability at the regional scale under Kling Gupta Efficiency (KGE) and its components for daily precipitation considering the entire period and four seasons. Y-axis color presents: satellite [blue], gauge and satellite [red], Reanalysis [green].

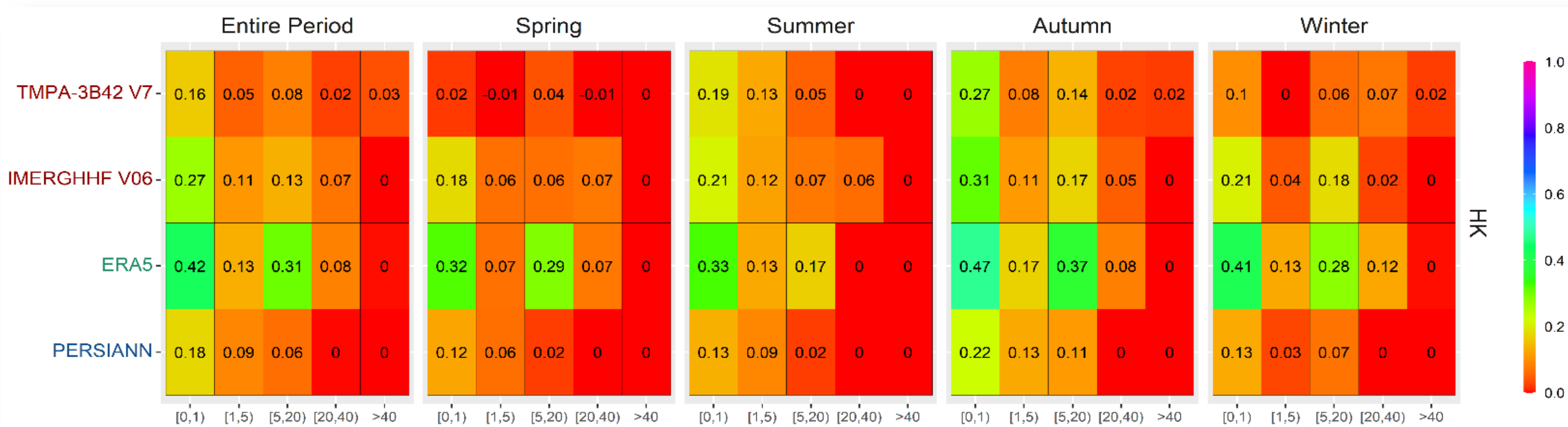


Figure 4. PPs detection ability in reproducing daily precipitation intensities expressed in the form of Hansen-Kuiper (HK) score considering the entire period and four seasons. Y-axis color presents: satellite [blue], gauge and satellite [red], Reanalysis [green].

Hydrologic utility of Precipitation Products (PPs)

Scheme-1 :
model parameters calibrated by observed precipitation.

Scheme-2 :
model parameters calibrated by each PP individually.

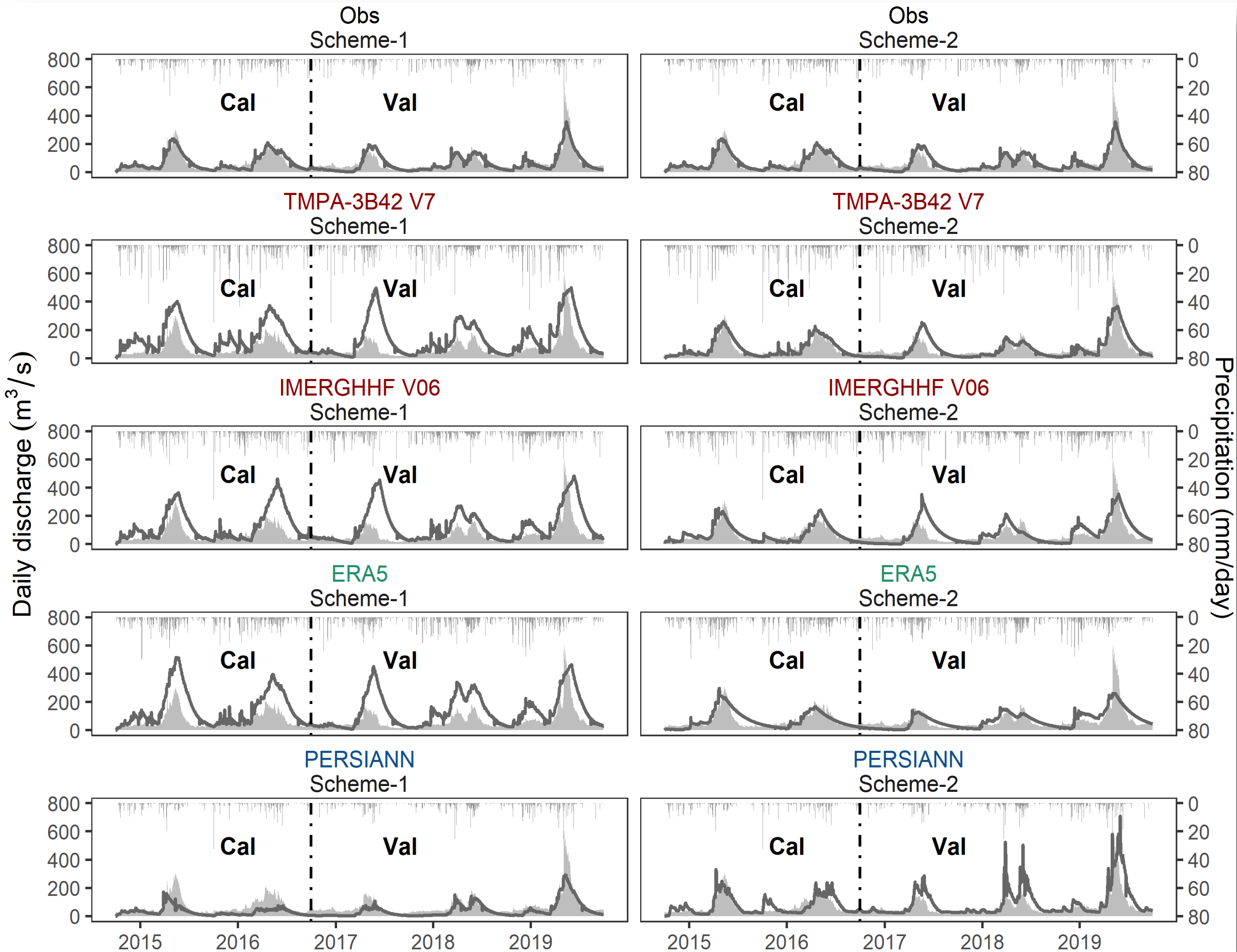


Figure 5. Hydrographs of observed and simulated daily discharge based on observed precipitation and four PPs for calibration (October 2014 to September 2016) and validation (October 2016 to September 2019) period in two schemes.

Precipitation Products (PPs) Performance for daily streamflow simulation

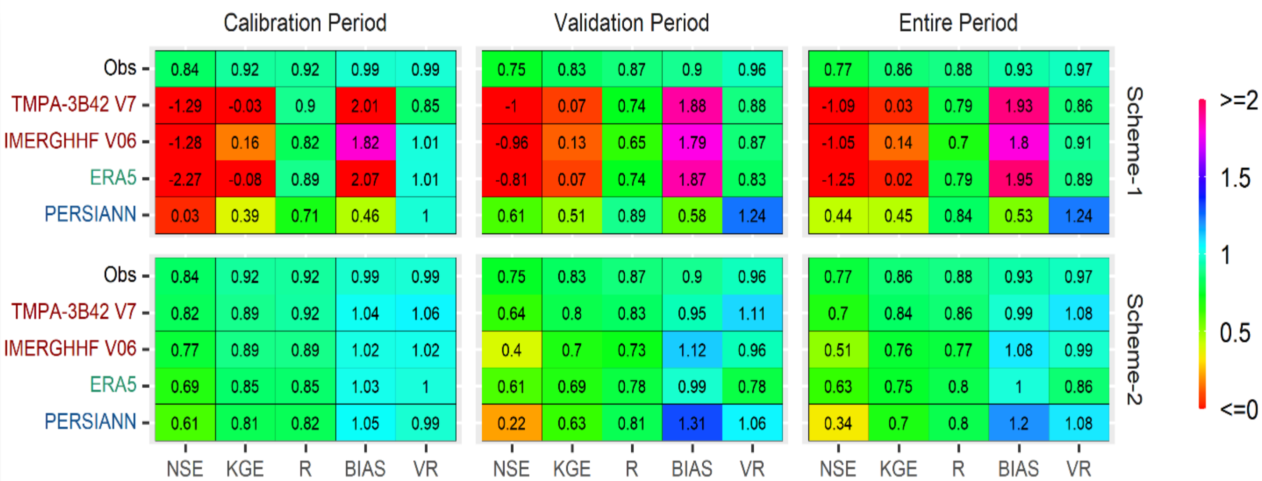


Figure 6. Performance of daily streamflow for observed precipitation and selected PPs.

Table 3. Model parameter range and optimum values for observed and PPs. Number of the column indicates; 0, parameter range; 1, Obs; 2,TMPA-3B42v7; 3, IMERGHHFv06; 4, ERA5; 5, PERSIANN

Parameter and units	**0**	**1**	**2**	**3**	**4**	**5**
Snow correction factor - SCF (-)	0.9 - 1.5	1.44	1.12	1.03	0.91	1.46
Degree-day factor - DDF (mm/°C /day)	0.0 - 5.0	0.36	0.3	0.51	0.36	0.33
Temperature threshold above which precipitation is rain- Tr (°C)	1.0 - 3.0	2.51	1.74	1.43	2.92	2.99
Temperature threshold below which precipitation is snow Ts (°C)	- 3.0 – 1.0	-1.01	-0.01	-0.1	-2.13	1
Temperature threshold above which melt starts - Tm (°C)	- 2.0 – 2.0	-0.5	-1.86	0.87	-0.92	1.87
Parameter related to the limit for potential evaporation - Lpart (-)	0.0 - 1.0	0.88	0.6	0.36	0.82	0.69
Field capacity - FC (mm)	0.0 - 600	132.2	317.8	45.3	115.3	591.5
Non-linear parameter for runoff production - Beta (-)	0.0 - 20	0.97	1.82	5.52	14.75	0.05
Constant percolation rate - K0 (mm/day)	0.0 - 2.0	0.69	1.09	0.73	1.2	1.34
Storage coefficient for very fast response - K1 (day)	2.0– 30	26.39	23.12	20.06	27	27.08
Storage coefficient for fast response -K2 (day)	30 - 250	36.1	38.3	50.9	78.5	245.5
Storage coefficient for slow response - lsuz (day)	1.0 - 100	51.8	87.9	57.5	46.4	98.4
Threshold storage state - cperc (mm)	0.0- 8.0	6.44	5.03	6.97	6.79	0.39
Maximum base at low flows - bmax (day)	0.0 - 30	14.23	13.65	7.78	7.45	15.4
Free scaling parameter - croute (day2/mm)	0.0 - 50	17.81	27.37	24.35	29.37	5.32

Conclusions

- All PPs show high detectability for low intensity precipitation where their detectability strength decreases for high intensity precipitation for the considered entire period and four seasons. Furthermore, **ERA5** shows high detectability in almost all precipitation events compared to other PPs.

- In the direct comparison, all PP performances (median of KGE varies from -0.06 of TMPA-3B42v7 to 0.08 of ERA5) are low for daily precipitation during the entire period. Although PP correlations (R) are higher, high/low bias and variability ratios cause detrimental effects.

- PPs show a better reproducibility for streamflow when evaluated against direct precipitation comparison with gauge data. Moreover, PPs are able to estimate streamflow with high accuracy if model parameters are calibrated by PPs individually. **TMPA-3B42v7** shows the highest performance for streamflow simulation both in calibration (**NSE; 0.82**) and validation (**NSE; 0.64**) periods in scheme-2, followed by IMERGHHFv6 and ERA5. PERSIANN shows variable performance in both schemes for calibration/validation and has the lowest performance of all PP in schem-2.

Future work will include more PPs for direct precipitation comparison as well as hydrologic simulations.

Thank You!!!