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Evaluation of GSMaP and Trmm Monthly Rainfall Satellite Data in Wadi Ahin, Sohar Area, Sultante of Oman

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Abstract This research compares the accuracy of Forecasting Global Precipitation Measurement (GPM)-derived satellite precipitation estimates (SPEs) for Wadi Ahin in Sohar area in Sultanate of Oman with Tropical Rainfall Measurement Mission (TRMM). To do so, GSMaP version 7 and TRMM data sets were evaluated at their regional 0.10 and 0.250 spatial resolution respectively. Both the wet and dry seasons were assessed on a monthly basis for each month. A grid cell with two gauges, one ground and the other GSMAP or TRMM, is calculated with the CC, the %RMSE, and the %B for all the considered datasets. Statistical measurements are provided here in more detail. The monthly analysis takes into account the whole period, dry season, and wet season separately for Mean regional and Mean spatial. Verification of monthly rainfall at a spatial level shows that GSMaP underestimates with a correlation coefficient, 0.704, bias -7.88% and RMSE 117.4%. Verification with the regional level shows that GSMAP performs well with a correlation coefficient of higher than 0.9. On the other hand, analysis of TRMM data sets shows a good verification in the spatial level and low accuracy in the regional level where the selected gauges are far from each other. The results indicate the need for improvement of GSMaP and TRMM estimates by doing some combinations between the datasets before application in this wadi.

Keywords Remote Sensing, Satellite, TRMM, GSMAP, Oman, Precipitation

1. Introduction

Forecasting heavy rain that causes floods and landslides is very useful because reliable precipitation estimates play an important role in flood monitoring. While rain gauges and radars are sparse or non-existent in some regions of the earth, such as oceans, deserts, and mountains, this severely limits our understanding of hydrological processes at the local scale. It is now possible to quantify precipitation on a worldwide scale because precipitation techniques developed based on satellite remote sensing. To improve space and temporal rainfall estimation, a mix of gauge and satellite data is required.

Various satellite data have been applied, and the public has access to their goods. The GSMaP rain product produces 0.1-degree spatial resolution by combining data from four satellite microwave radiometers with data from a Geo Infrared radiometer. GSMaP rain products come in a variety of styles.

To fulfil distinctive application necessities, there are two options for GSMaP items: Near-real-time and standard items. The near-real-time item is aiming to supply accessible adherent rainfall rapidly, whereas the standard item applies more sources form moderately exact precipitation gauges. The near-real-time product has around a 3-h delay, and the standard item contains huge inactivity of around 3 days.

Targets of this consider are to develop the quantitative and subjective understanding of the first uncalibrated GSMaP_MWR over Wadi AHIN in Sohar range and to attain superior assertion with rain-gauge information for surge checking. The rest of this paper is organized as takes after. In segment 2, the considered zone is depicted, the precipitation information and mistake measurements. At that point, an introduction of comes about and discourse in this consider are given in segments 3 and 4. At long last, the rundown and conclusions are given in section 5.

2. Methodology and Materials

2.1. Study Region

2.1.1. Flood History in Sohar Area

Muscat, Sohar and Rustaq were named because of the pinnacle 3 flood chance zones in Oman through officers who've drawn up maps wherein humans are the maximum at chance in Sultanate. Around 1,060,927 humans stay in North Batinah and south Batinah, which consist of Sohar and Rustaq. These regions have been tormented by rain and suffered fatalities because of flooding alongside the year. The modern drainage gadget in those regions is inadequate. These regions make giant contributions to the country's economic system; however its miles crucial to spotlight the truth that they may be at risk of flooding and measures ought to be taken to govern the harm. There are many troubles in a few places, and the maximum of which might be due to the bad drainage gadget as there may be no outlet for water. Floods in Sohar have a tendency to be an excessive short-time period event, of excessive velocity, and closing for simply 4 to 6 hours and the harm generally starts evolved to arise inside an hour of the acute rainfall. Several neighbourhood heavy rainfalls were recorded in Sohar, Oman. All of those heavy rainfalls created neighbourhood floods and damage, main to large monetary losses.

2.1.2. Geographic and Climate Characteristics in Sohar

The metropolis of Sohar is positioned in al-Batinah North Governorate in northern Oman (Fig.1). This parent becomes built through overlying topography (i.e., it become downloaded from Shuttle Radar Topography Mission (SRTM) of virtual elevation version with a spatial decision 30 m) of the take a look at the vicinity and floor rain gauge distribution. The annual general precipitation common between 1991-2010 becomes about 106 mm, which shows a robust terrible fashion in rainfall. Cold frontal thru originating inside the North Atlantic Ocean or the Mediterranean Sea convey almost 75% of Sohar's general rainfall from November to April. The wide variety of moist days, which might be described as days with precipitation > 1mm, arises in Sohar approximately 11.7 days/year. That's better than the wide variety of moist days that arise in Muscat (7 days/year), but is considerably decrease than the wide variety of moist days in Salalah (25 days/year). Sohar's month-to-month suggest minimal temperature fluctuates among 14-29°C, even as the month-to-month suggest most temperature levels among 24-36°C. In this take a look at, there may be one vicinity decided on in Sohar referred to as Wadi Ahin. This Wadi is positioned at an elevation of 10 m above sea level. Its coordinates are 24^{o} 13' 54''N and 56^{o} 49'15'' E. Figure 2 suggests the vicinity of the Wadi and the floor rain gauge distribution on it.

2.2. Rain Gauge in Wadi-Ahin

Daily discovered rainfall information from six rain gauges over the Wadi had been used as reference information to validate the GSMaP_NRT estimation. The rain gauge information had been received from the Ministry of Regional Municipalities and Water Resources – Oman at some point of 2006 to 2008 thru all months with inside the year, moist season from November to April and dry season from May to October. The distribution of the rainfall stations changed as proven in Figure 2. The suggested remark information had been received by the use of Thiessen polygon approach through multiplying the information of every rain gauge through the vicinity percent surrounding this station.

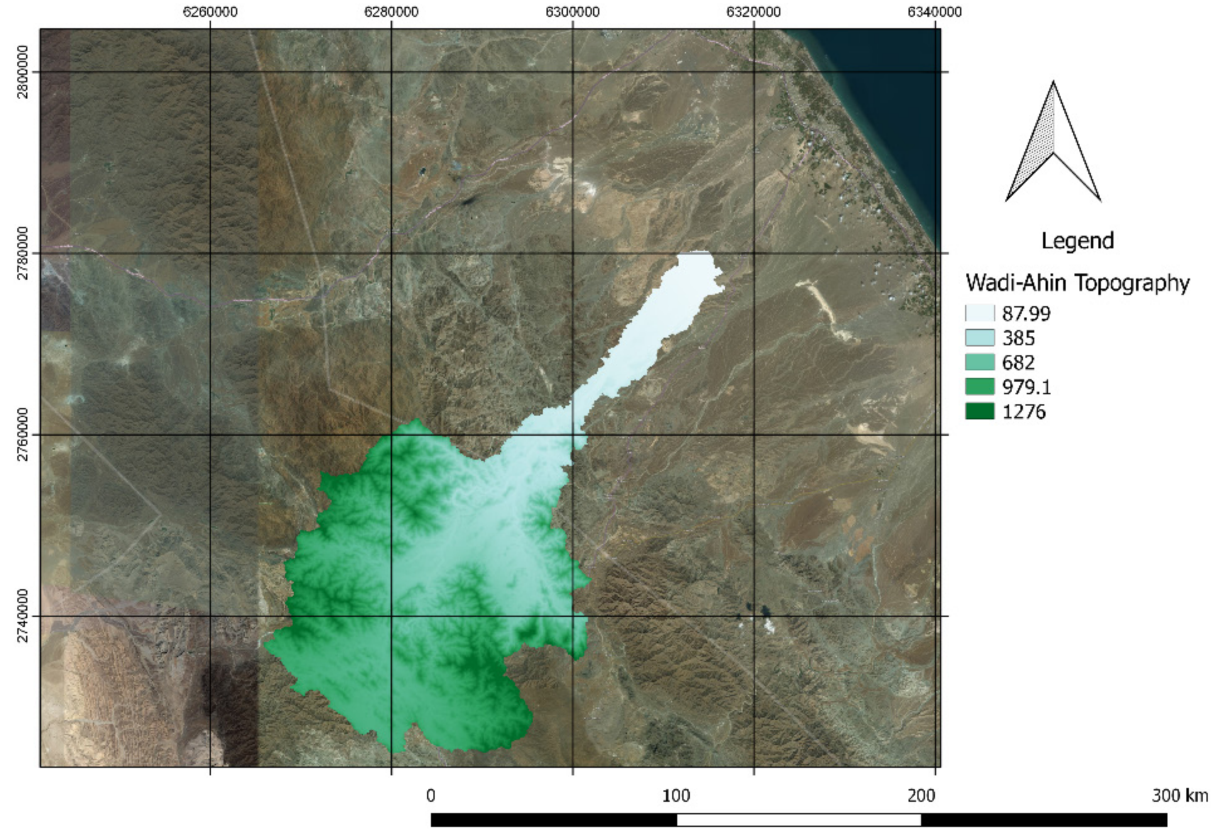


Figure 1. The study area, Wadi Ahin, and its topography

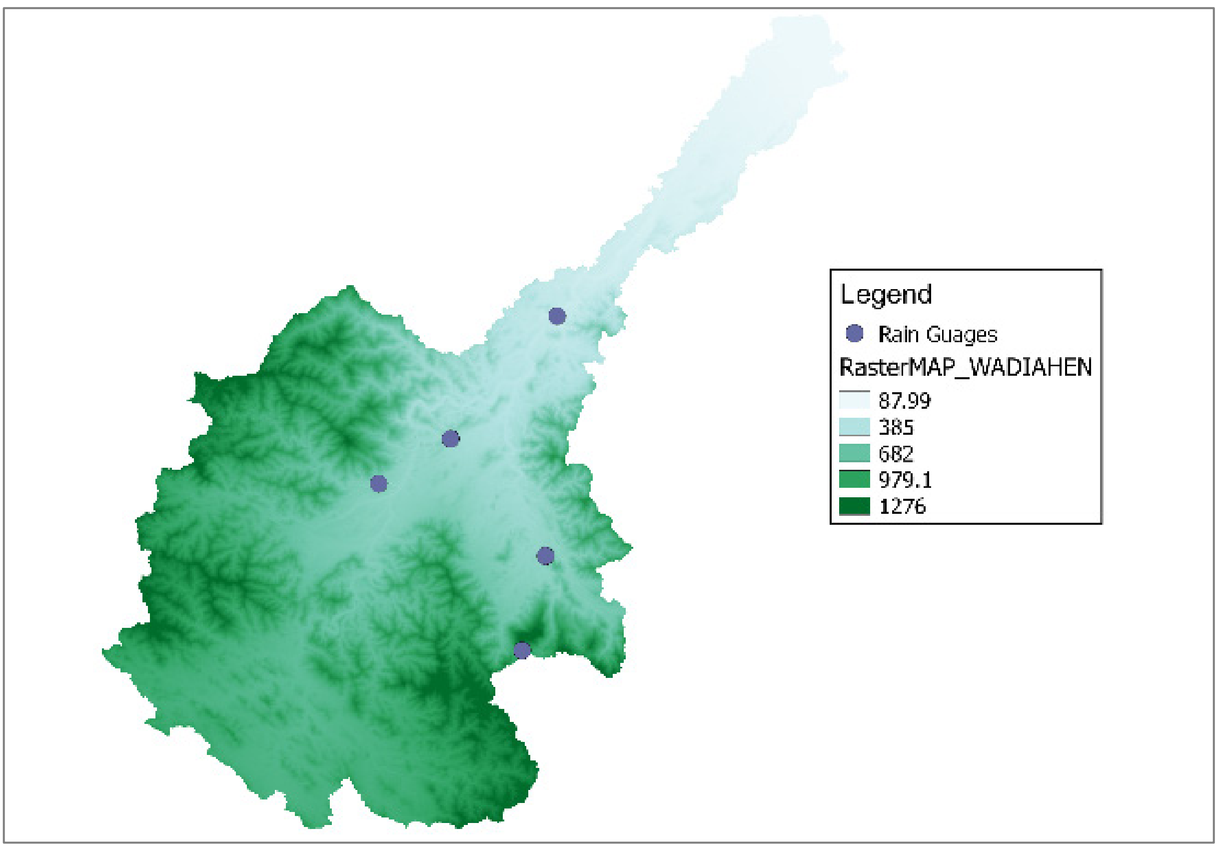


Figure 2. In-situ Rain gauges distribution

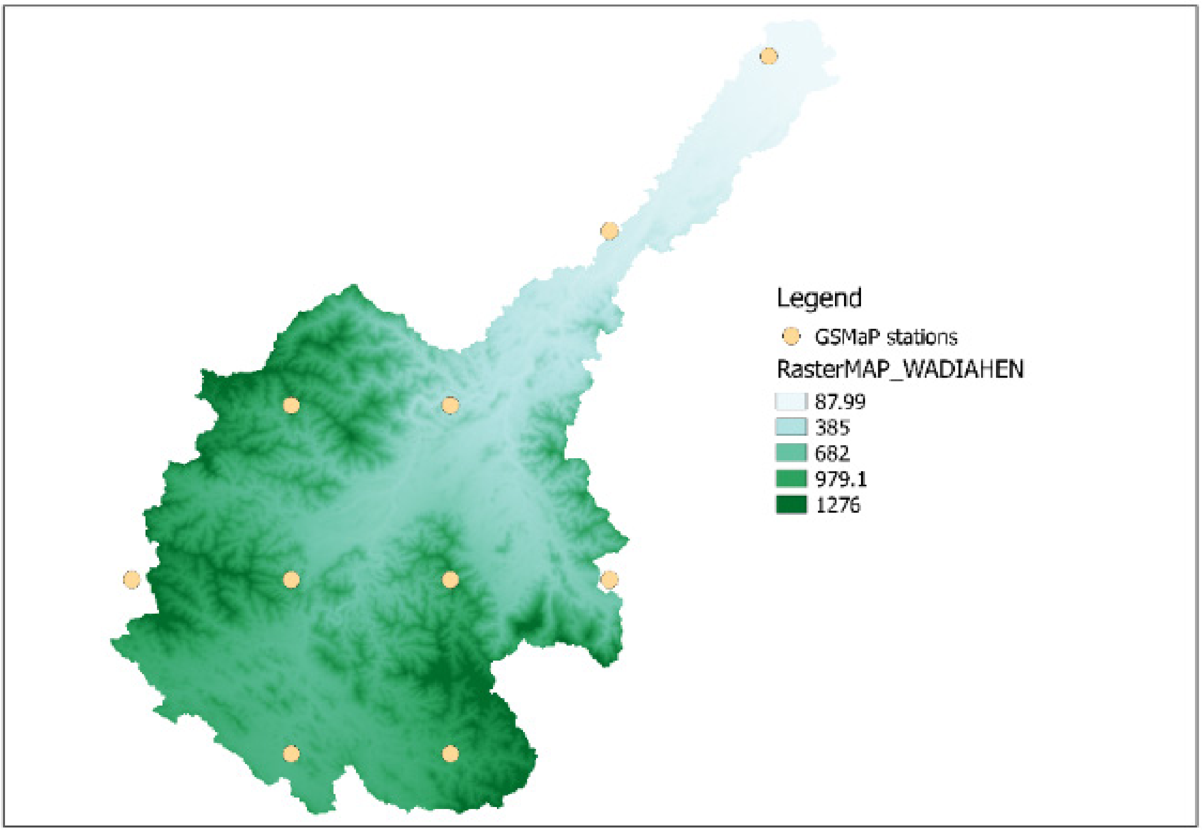


Figure 3. Observation points by GSMaP_NRT

2.3. GSMaP Near-Real-Time Precipitation Products

As one in every Japanese GPM project, the GSMaP set of rules makes use of diverse PMW/IR sensors to provide the 'best' precipitation estimates thru numerous steps. Moreover, the statistics set produced through GSMaP product may be downloaded from: https://sharaku.eorc.jaxa.jp/GSMaP/. The widespread model of the GSMaP statistics set consists of GSMaP_TMI (retrieved from TRMM/TMI set of rules), and different rainfall estimates from passive microwave radiometers like GSMaP_NRT.

The GSMaP product used to compare with the reference dataset is the version of GSMaP_NRT. The GSMaP_NRT uses only the advanced cloud move to maintain near real-time operability. This product produces a spatial resolution of 0.1 in latitude and longitude and a resolution of one hour with the domain covering 60°N to 60°S starting on March 20. In this study, the uncalibrated GSMaP_NRT product was investigated over a complete three-year period (from January 2006 to December 2008). The satellite precipitation was aggregated into daily amounts, monthly amounts and annual amounts corresponding to in-situ data. Figure 3 shows the distribution of observation points that are used by GSMaP_NRT in the study area.

2.4. Method of Evaluation

On this take a look at, the monthly time step used exceptional parameters in the evaluation to evaluate between GSMaPPrecipitation information and ground data. These parameters have been divided into statistical metrics and contingency metrics. The statistical metrics are correlation coefficient (CC), the percentage root-suggest-rectangular error (%RMSE), and the percentage bias (%B) as proven in equations 1, 2, 3.

$$CC = \frac{\sum_{i=1}^{N}(G_i - \bar{G})(P_i - \overline{P})}{\sqrt{\sum_{i=1}^{N}(G_i - \bar{G})^2}\sqrt{\sum_{i=1}^{N}(P_i - \overline{P})^2}} \quad (1)$$

$$RMSE(\%) = \frac{\sqrt{\frac{\sum_{i=1}^{N}(G_i - P_i)^2}{N}}}{\frac{\sum_{i=1}^{N}P_i}{N}} \times 100 \quad (2)$$

$$BIAS(\%) = \frac{\sum_{i=1}^{N}(G_i - P_i)}{\sum_{i=1}^{N}P_i} \times 100 \quad (3)$$

N is the number of values,

P is the observed precipitation data,

$\overline{P}$ is the average of ground data for the considered period,

G is the precipitation estimate of the considered GSMaP data, and

$\bar{G}$ is the average of the values of GSMaP rainfall data in the considered period.

3. Results

In this have a look at, the investigation is set the temporal behaviour and the seasonal statistics of the GSMaP_NRT products over Wadi Ahin. with a view to make certain a greater correct comparative examine, the contrast has been implemented between the implied rainfall statistics from in-situ ground products, TRMM records units and GSMaP products for the complete vicinity as shown in determine 4. These suggest values are calculated the use of the Thiessen polygon method.

Thinking about the various weathers in Oman, it became rational to subdivide the evaluation into seasonal evaluation. Determine five indicates the scatterplots of month-to-month TRMM and GSMaP against gauge observations over weather seasons, moist season and dry season. , all through the two climate seasons, all of the scatterplots display that the scatter factors of GSMaP have been clustered toward 1:1 line than those of TRMM datasets meaning that the GSMaP turned into greater in settlement with gauge observations. The GSMaP estimate notably overrated the gauge precipitation in the wet season with a BIAS coefficient of 20.53%. On the other hand, the GSMaP estimate underestimates the gauge precipitation in the dry season with a BIAS coefficient of -30.33%. The TRMM estimate significantly underestimated the gauge precipitation in both seasons with BIAS ranging between -3.45% and -31.17% respectively. The RMSE values confirmed an apparent upward fashion in the dry season and a downward trend inside the wet season for each dataset. This suggests that the aggregate among two datasets can reduce the prejudice that can enhance the performance of the datasets in this area. additionally, determine 5 illustrates that the two products had unique performances at these two seasons, with a better settlement from gauge observations in moist season and unsatisfactory overall performance in dry season particularly from GSMaP datasets. Therefore, the satellite precipitation generally had an unsatisfactory performance over the arid regions. as compared to TRMM statistics, the GSMaP glaringly improved the information accuracy, and it had the right values for CC (0.704) and BIAS (-7.8%) values over this area but such effects suggest that the cutting-edge GSMaP still have giant room for in addition enhancing the information fine mainly in the dry season.

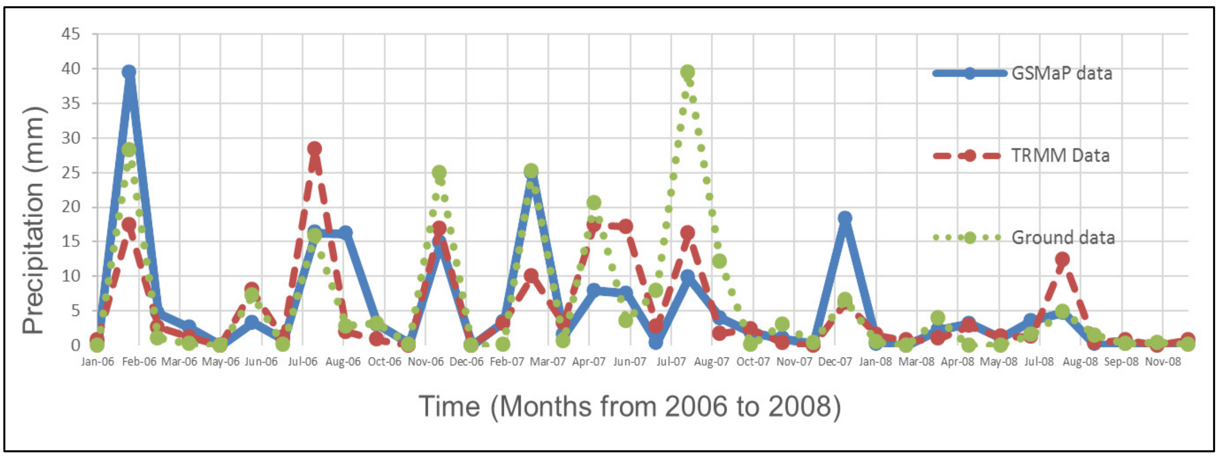
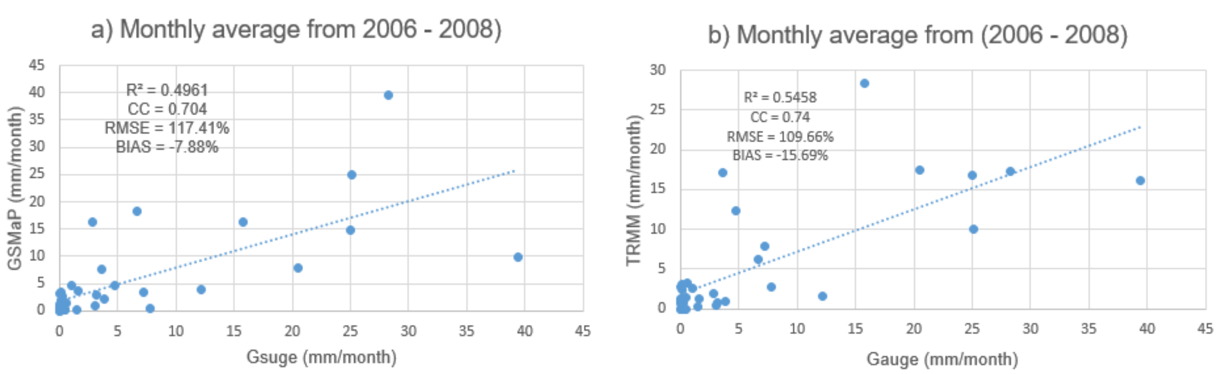


Figure 4. Mean monthly precipitation and Monthly GSMaP and TRMM data sets (Time series)



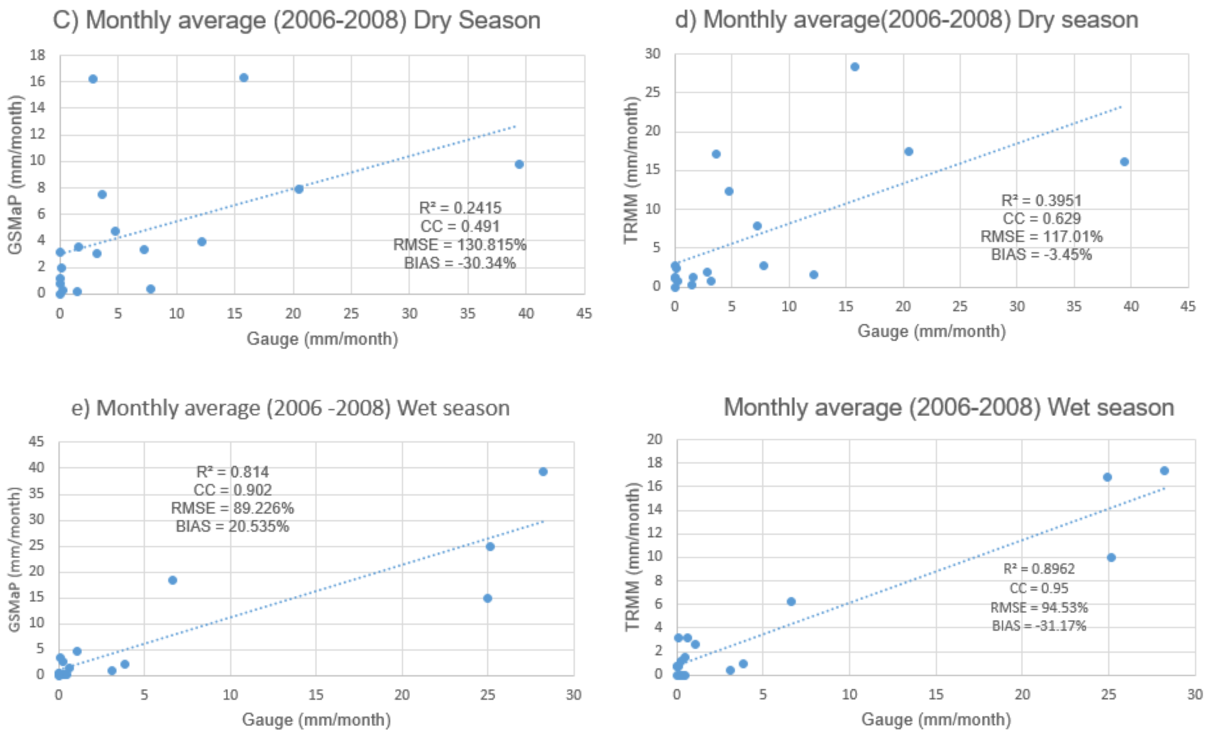


Figure 5. Monthly precipitation for GSMaP (left) and TRMM (right) versus gauge observations in dry and wet seasons: (a,b) Annually; (c,d) Dry season; (e,f) Wet season.(Scatterplots)

4. Conclusions

Lately, the GSMaP set of rules builders proposed a dataset to enhance the accuracy of the rainfall data globally. In this have a look at, we in comparison and proven the GSMaP product with TRMM and gauge facts over Wadi Ahin Basin in Sohar vicinity, Sultanate of Oman.

Our analyses confirmed that GSMaP product has slightly overestimated the reference precipitation inside the wet season and underestimated in dry season.

In the end, all of the effects on this examine advocate that GSMaP can efficiently lessen the uncertainties in TRMM datasets whilst doing combination between TRMM and GSMaP datasets.

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