A Preliminary Assessment of GSMaP Daily Rainfall Satellite Data over Wadi Ahin, Sultanate of Oman

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Abstract

The close constant satellite precipitation gauges are alluring for a wide scope of utilizations like outrageous precipitation observing and characteristic danger cautioning. As of late, GSMaP was delivered to enhance nature of precipitation information. Endeavours were considered for exploring and approving presentation of GSMaP utilizing check perceptions over Wadi-Ahin. The investigations showed that GSMaP for the most part overestimated the measure precipitation in Sohar region. Results likewise demonstrated that the remedy ought to be followed up on wet seasons. At long last, the worldwide correlations displayed that the GSMaP product I great concurrence with ground information. All in all, the GSMaP would do well to execution than other satellite information in this examination zone and was a more dependable close to constant satellite precipitation item.

Keywords: Precipitation, GSMaP, Satellite, Gauge, Sohar region.

1 Introduction

Estimation of precipitation are crucial and essential to manage freshwater resources. Also, it's going to be used to predict flood events like rainfall which is the reason of floods. Many areas of earth, like deserts and mountains, ground gauge networks from different measurement methods are non-existent sometimes, which effects the knowledge of world local

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hydrological processes. The last version of precipitation techniques from remote sensing helps in measuring precipitation globally. A combination of ground data, radar measurements and remote sensing data is needed to reduce time rainfall estimation.

Various remote sensing data are applied and their outcomes are existing in public. Old satellite precipitation missions like Tropical Rainfall Measuring Mission (TRMM), Climate Prediction Centre (CPC), many other satellite products, just like (GSMaP) as a combination of different remote sensing data.

GSMaP product has four satellite microwave combined with Geo Infrared radiometers to supply resolution 0.1° spatially. Many versions of GSMaP products are available.

Different applications can be covered. Two groups of GSMaP products are mostly used, Near Real Time and Standard version. Near Real Time is supposed supplying quick precipitation data, while the another product needs other sources to get more precise estimation of precipitation. For the previous reason, Near Real Time has a delay about 3 hours thus the quality features an oversized of 3 days later approximately.

The main targets of this study are enhancing the knowledge of the uncalibrated GSMaP over Wadi AHIN in Sohar area and to get an agreement with ground data for flood risk management[1-11].

2 Materials and Methods

2.1 Study Area

2.1.1 Flood History In Sohar Area

There are many risky zones in Oman where people in danger. People in North Batinah, which include Sohar is one of these risky zones. This area suffered a lot because of the flood risk along the year. The present system in these areas are inadequate. Sohar has an effective contribution to Oman economically but it is fact that very fact that it is at risk so measurements should be taken to regulate this bad effect. Sohar has a flood mostly as a short term storm events with flow velocity higher than other areas. The flood time around four to 6 hours, therefore the effect usually begins within an hour of the rainfall event.

Rainfalls are recorded in Sohar, Oman. Those rainfalls caused risky floods, with a significant economic loss.

2.1.2 Sohar Geographic Landscape and Climate Pattern

Sohar is found in al-Batinah North Governorate in northern Oman as shown in figure 1. This figure was downloaded from digital elevation model that has a resolution of 30 m spatially called (SRTM). Annual total
precipitation average between 1991-2010 was approximately 106 mm, which suggests a robust negative trend in rainfall. Sohar’s monthly mean minimum temperature fluctuate between 14° – 29° C, while the monthly mean maximum temperature ranges between 24-36° C.

During this study, there’s one area selected in Sohar call Wadi Ahin. This Wadi is found at 10 m from mean sea level. Its coordinates are 24° 13’ 54”N and 56° 49’15” E. Figure 2 shows the situation of the Wadi and also the ground pluviometer distribution on that.

Figure 1 The Study Area, Wadi Ahin, and Its Topography

2.2 Rain Gauge in Wadi-Ahin

Observed data taken from six gauges in Wadi considered as a guide to be compared with the GSMaP data estimation. Ground data were collected from MRMWR (Ministry of Regional Municipalities and Water Resources – Oman) during 2006 to 2008 through all months within the year. Seasons are divided to rainy season starting in November and ends in April. The second season is starting in May and ends in October. The Stations were distributed as shown in figure 2. All data are averaged using thiessen polygon method by multiplying the info of every gage by the world percentage surrounded this station.
2.3 GSMaP Near-Real-Time Precipitation Products

The GSMaP algorithm of GSMaP has provided estimation of rainfall data using many process. Moreover, the info set produced by GSMaP product can be collected from GSMaP online page: https://sharaku.eorc.jaxa.jp/GSMaP/.

GSMaP produces 0.1° spatial resolution and temporal resolution around one hour covering 60° N to 60° S from March 2000 till now. The GSMaP product takes the attention of users because of the three hours’ latency. The uncalibrated GSMaP product were discovered along a period (from January 2006 to December 2008). The satellite precipitations were accumulated into daily amounts. Monthly amounts and annual amounts resembling in-situ data.
Figure 3 shows the distribution of observation points that utilized by GSMaP_NRT within the study area.

2.4 Method of Evaluation

In this study, the daily time step used different parameters in the assessment to compare between GSMaP Precipitation data and ground data. The statistical parameters are
- correlation coefficient (CC) (Equation 1)
- The percent root-mean-square error (RMSE) (Equation 2), and
- The percent bias (%B) (Equation 3).

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

(1)

\[
RMSE(mm) = \sqrt{\frac{1}{n} \sum_{i=1}^{n}(G_i - P_i)^2}
\]

(2)

\[
BIAS(\%) = \frac{\sum_{i=1}^{n}(G_i - P_i)}{\sum_{i=1}^{n}P_i} \times 100
\]

(3)

N: number of values,
P: the observed precipitation data,
\(\bar{G}\): the average of ground data for the considered period
G: 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.

Also, four metrics were applied to evaluate the GSMaP data in observing the flood events.

POD: the probability of detection (equation 4),
FAR: the false alarm ratio, (equation 5),
CSI: the critical success Index (equation 6), and
B: the bias (equation 7)

These parameters can be calculated by dividing the data into four classes
a: both GSMaP data and ground data record a flood event;
b: only the GSMaP report precipitation;
c: only the rain gauges’ record precipitation; and
d: precipitation is not registered on either GSMaP or ground gauges.

\[
POD = \frac{a}{(a+c)}
\]

(4)

\[
FAR = \frac{b}{(a+b)}
\]

(5)

\[
CSI = \frac{a}{(a+b+c)}
\]

(6)

\[
B = \frac{(a+b)}{(a+c)}
\]

(7)

All of these metrics are varying from zero to one except B. If POD equal 1 indicates that GSMaP data capacity has the ability to detect the rainfall data
correctly. Also, if CSI equal 1 similar to POD, which shows a good agreement between GSMaP data and ground data. On the opposite, the value of FAR equal zero means an ideal case, which indicates that the GSMaP data have a mistake in reporting the rainfall data when it doesn't exist. In addition, SR which is the remainder of FAR has an ideal score equal one. Regarding to B, if it is higher than one that shows the overestimation during counting the flood days within the GSMaP product, but if B is lower than one indicates the underestimation.

3 Results

3.1 Temporal Comparison of GSMaP_NRT and Ground Data Products

In this study, it's inquiring about the behaviour temporally. The statistical parameters of the GSMaP products over Wadi Ahin, so as to make sure a more accurate comparison, it's divided into two parts, the primary part by applying the comparison between the mean rainfall data from in-situ products and GSMaP products for the full area as shown in figure 4. These mean values calculated using thiessen polygon method. The second part by comparing grids which included a minimum of one gauge to estimate the statistical parameters as shown in figure 5.

![Figure 4 Time Series of Mean Monthly Precipitation and Monthly Gsmap and TRMM Data Sets](image)

Confirming a more accurate evaluation, consider the grids having one gauge at least. The precipitation and statistical metrics in each month from ground network and GSMaP products are shown in figure 5,6,7 using a daily scale from 2006 to 2008 all told months, dry and wet seasons. Also, the statistical parameters seasonally including time of year (May-October) and wet season (November-April). It is seen that GSMaP can capture the variation patterns seasonally and annually over Wadi-Ahin in the wet and dry seasons.
More precipitation than gauge observations in most months are shown in the GSMaP product. Statistical indices clearly show that the GSMaP has better detection and low error. As a result, GSMaP products can improve the satellite data product that specialize in CC and RMSE values, we are able to mention briefly that this satellite product had a good agreement with the ground network observations. Additionally, the performance of GSMaP showed dependent variations seasonally, by getting accepted parameters annually but not accepted enough in wet season. Considering the values of CC as an example, this parameter reduced from 0.936 to 0.918 in wet season. In conclusion, this satellite data can be added to the ground data to scale back error in the estimation of rainfall events using GSMaP product in wet season, that shows more consistency with ground network.

**Figure 5 (A)** Monthly Mean Precipitation Over Grid with at Least One Gauge in Wadi-Ahin.

**Figure 5 (B)** Monthly Mean Precipitation over Grid with At Least One Gauge in Wadi-Ahin (Dry season).
Figure 5 (C) Monthly Mean Precipitation Over Grid with At Least One Gauge in Wadi-Ahind (Wet Season).

Table 1 Seasonal statistics of GSMaP product and ground records from 0.25 box in Wadi-Ahin

<table>
<thead>
<tr>
<th>Seasonally</th>
<th>C.C.</th>
<th>BIAS (%)</th>
<th>RMSE</th>
<th>POD</th>
<th>FAR</th>
<th>CSI</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annually</td>
<td>0.905</td>
<td>-0.606</td>
<td>4.885</td>
<td>1</td>
<td>0.576</td>
<td>0.424</td>
<td>2.357</td>
</tr>
<tr>
<td>Wet season</td>
<td>0.918</td>
<td>-9.72</td>
<td>4.94</td>
<td>1</td>
<td>0.5</td>
<td>0.5</td>
<td>2</td>
</tr>
<tr>
<td>Dry Season</td>
<td>0.936</td>
<td>4.173</td>
<td>4.782</td>
<td>1</td>
<td>0.647</td>
<td>0.352</td>
<td>2.83</td>
</tr>
</tbody>
</table>

Table 1 provides Seasonal statistics of GSMaP product and ground records from 0.25 box in Wadi-Ahin.

4 Conclusions

1. The analyses in this study indicated that the precipitation can be detected temporally over Wadi Ahin.
2. Dividing the satellite product into seasons, results can be validated easier and the correction that sowed an error in the estimation of precipitation data in the wet season.
3. Results in this study confirm that GSMaP product can enhance the uncertainties happened in other satellite data.
4. Hopefully, this study gives an indication for satellite data users.
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References


Biography

Osama Ragab Ibrahim is from Program of Civil Engineering, Engineering Faculty, Sohar University, Sohar, Sultanate of Oman.