Validation of Near-Real Time Satellite Rainfall Products over Different Homogeneous Regions of India and Assessment of its Bias based on Topographical Analysis

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Introduction

- Floods due to extreme rain events pose a major threat not only to the human life but also have huge impact on socioeconomic growth of agricultural based countries like India, which has highly varied climate and topography.
- For disaster preparedness and flood forecasting over large river basins, there is a need for proper knowledge on space and time distribution of rainfall in real time basis.
- This can be achieved only based on near real time satellite rainfall estimates (SRE) and verification of these products are prerequisite to apply SRE for flood prediction.
- Therefore, a study has been conducted to validate two Near Real Time High Resolution Satellite Precipitation Products (NRT-HRPP’s) namely, Tropical Rainfall Measuring Mission- Real Time (TRMM-3B42 RT) and InSat Multispectral Rainfall Algorithm (ISMSRA) estimates over Indian region.
- As India has highly varied topography, another major study has been conducted to explore the relationship between the bias and topography of a region.

Objectives

1. Evaluation of detection and estimation capabilities of two SRE’s at daily scale for different climate regions of India.
2. Assessment of Biases of two SRE’s based on Topographical Analysis.

Methodology

Extraction of ISMSRA and TRMM 3B42RT for Indian land region

Statistical Validation

Table 1. Statistics used for validation and its description

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Formula</th>
<th>Range</th>
<th>Best Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall</td>
<td>$f = \frac{1}{N} \sum_{i=1}^{N} x_i$</td>
<td>$0 \text{ to } 1$</td>
<td>1</td>
<td>Mean Rainfall</td>
</tr>
<tr>
<td>PD60</td>
<td>$h = \frac{1}{N} \sum_{i=1}^{N} \frac{</td>
<td>x_i - h</td>
<td>}{</td>
<td>h</td>
</tr>
<tr>
<td>FAR</td>
<td>$f = \frac{1}{N} \sum_{i=1}^{N} \frac{</td>
<td>x_i - h</td>
<td>}{</td>
<td>h</td>
</tr>
<tr>
<td>HSS</td>
<td>$C = \frac{1}{N} \sum_{i=1}^{N} \frac{x_i - h}{h}$</td>
<td>$-1 \text{ to } 1$</td>
<td>1</td>
<td>HSS measures forecast accuracy relative to that of a random chance</td>
</tr>
<tr>
<td>CC</td>
<td>$r = \frac{\sum_{i=1}^{N} (x_i - \bar{x})(h_i - \bar{h})}{\sqrt{\sum_{i=1}^{N} (x_i - \bar{x})^2 \sum_{i=1}^{N} (h_i - \bar{h})^2}}$</td>
<td>$-1 \text{ to } 1$</td>
<td>+1</td>
<td>Linear (Pearson) correlation coefficient between reference and SRE</td>
</tr>
</tbody>
</table>

Where: PD60: Probability of Detection, FAR: False Alarm Rate, HSS: Hit Skill Score, CC: Correlation Coefficient, f: rainfall and their average, respectively. i: 1 to N can be defined using contour table given in Table 2.

Table 2. Contingency Matrix

<table>
<thead>
<tr>
<th>Reference Dataset</th>
<th>Class</th>
<th>No (Rain)</th>
<th>Yes (Rain)</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes (Rain)</td>
<td>Rain(i)</td>
<td>False alarm(1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (Rain)</td>
<td>Miss(i)</td>
<td>Correct(0)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Topographical Analysis

- TRMM 3B42 RT performs comparatively better than ISMSRA algorithm.
- Considering the complexity and robustness involved in the TRMM 3B42 RT algorithm w.r.t the simplicity of ISMSRA, it can be said that the accuracy of the TRMM 3B42 RT product is still poor.
- ISMSRA algorithm can be further improved by including more proper input parameters which affect rain rates without making it much complex as TRMM 3B42 RT algorithm involves huge data handling. One such parameter would be orography as ISMSRA shows more dependency on topographic variables than TRMM 3B42 RT.
- Topographical analysis also revealed that only elevation plays important roles in explaining biases but also aspect and local relief also plays important role.

References