Is TRMM PR V7 better than V6? Evaluation with a Dense Gauge Network

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INTRODUCTION

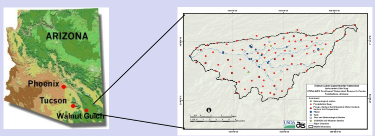
The evaluation of rainfall rate (*R*) estimates from low-orbital satellite observations like TRMM's is conventionally performed by comparisons with other *remote sensing* products (e.g., ground radar fields). Direct comparisons with *in-situ* measurements (e.g., rain gauges) have been limited to rainfall *accumulations*. Such comparisons are associated with large uncertainties due to satellite temporal sampling errors. Comparisons of *instantaneous R* fields (snapshots) from satellite and gauge observations have been avoided, as they are associated with large uncertainties due to volume sampling discrepancies. However, the configuration of the gauge network in the USDA-ARS Walnut Gulch Experimental Watershed (WGEW) justifies such comparisons.

- 149-km^2
- 88 weighing rain gauges
- 1-min reporting intervals
- High degree of temporal synchronization - within seconds

~10 gauges / PR FOV

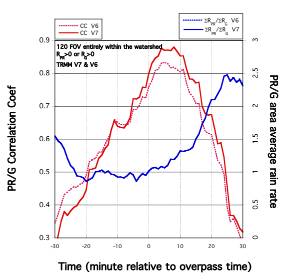
The densest gauge network in the PR coverage area for watersheds > 10 km^2

This configuration allows generating very-high-temporal-resolution *R* fields, and obtaining accurate estimates of the area-average *R* for the entire watershed and for a single TRMM PR field-of-view (FOV).



We compare instantaneous *R* fields (snapshots) from TRMM PR and interpolated gauge *R* fields

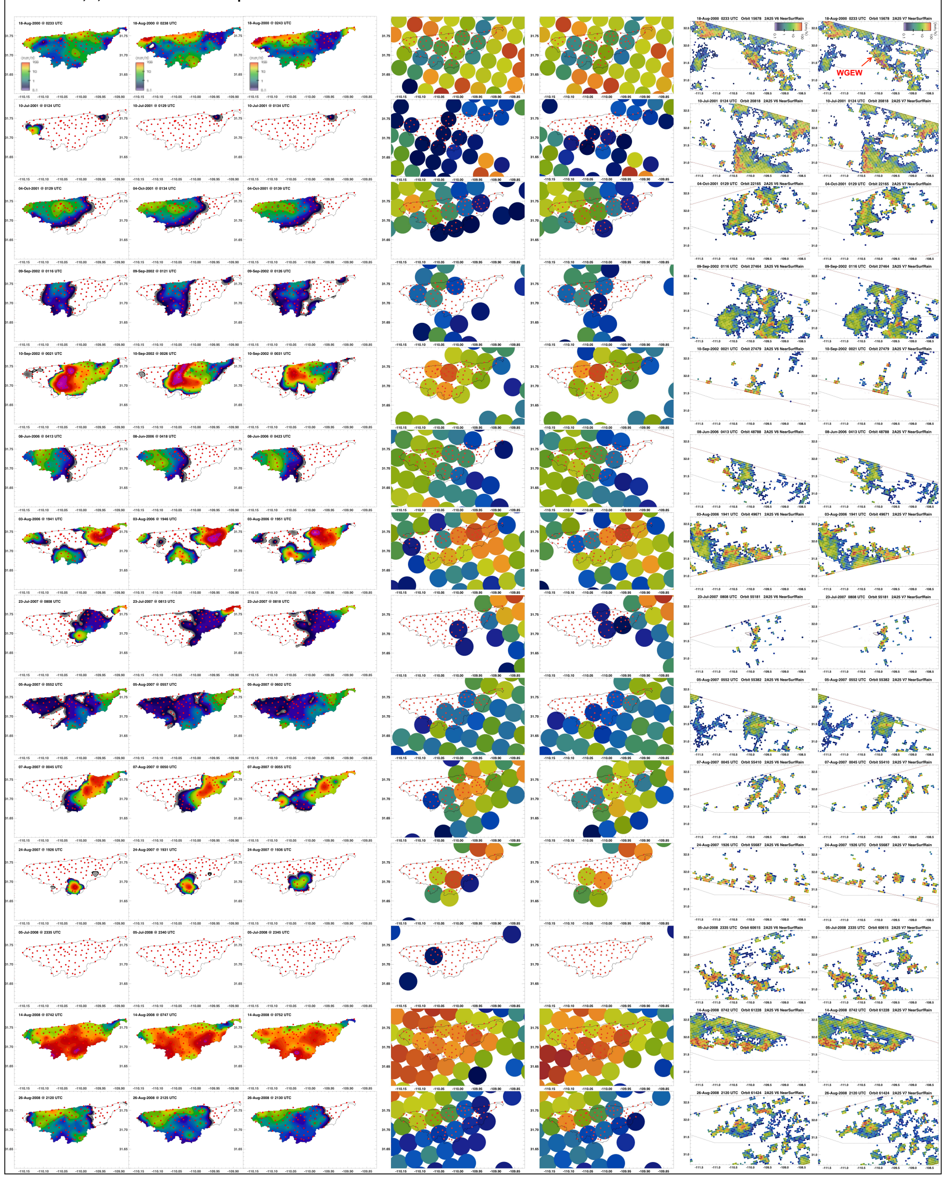
- 25 rainy PR overpasses, 1999-2010
- Interpolated gauge fields resolution: 1 min / 100 m
- Multiquadric biharmonic (MQB) gauge spatial interpolation scheme. Garcia et al. (2008 in *Water Resources Research*) have evaluated both IDW and MQB schemes for WGEW and found MQB superior.
- The high-resolution data allows for time/space shifting of the *R* fields with respect to each other to account for the displacement of the hydrometers
- Special attention is given to the distance of the watershed from the TRMM sub-satellite track. The closer the watershed is to the nadir-line, the closer the PR observations are to the surface, and thus less affected by evaporation and wind displacement common in this environment .



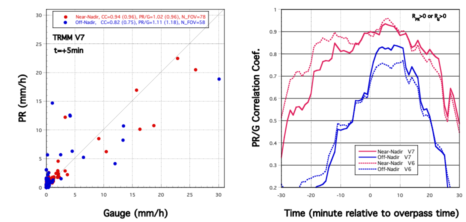
The 25 overpasses include 136 PR FOVs located entirely inside the watershed; 120 of them with rain (PR or G). The figure presents the CCs for the 120 pairs of (PR, G) FOVs (red curves), and the PR/G average rain rate ratio from all FOVs combined $(\Sigma R_{PR}/\Sigma R_G)$ (blue curves) for every minute during an hour, centered at the overpass time. Each (PR, G) pair represents the PR FOV rain rate and G, the corresponding area average rain rate from all 100-m gauge pixels associate with the same FOV. I.e., PR FOV is simulated by the high resolution gauge field.

The correlation is high at overpass time, but the peak occurs several minutes after the overpass, which can be explained by the fact that it takes several minutes for the rain drops to reach the gauge from the time they are observed by the PR. During the time of maximum correlation the PR/G bias is ~1.10.

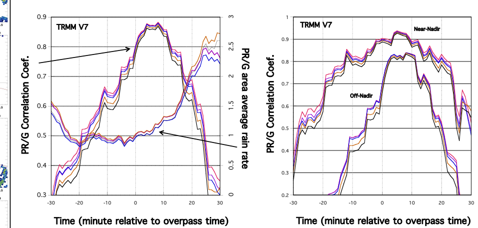
MQB Gauge Rain Rate at 0, 5, and 10 min after overpass time | **PR Near Surface Rain Rate**: V6 | V7 | V6 | V7



FOV Area-Average Rainfall Rate: Classification by Distance from Nadir-line



Scatterplot (upper left panel) of the PR/Gauge rain rate estimates at each PR FOV. All PR FOVs located entirely within the watershed (136) from all 25 rainy overpasses are included. The interpolated gauge rain rate field is based on measurements taken 5-min after the overpass time. The FOVs are classified into two groups according to their distance from the satellite nadir-line. In addition to the correlation, the legend displays the $\Sigma R_{PR}/\Sigma R_G$ from all FOVs combined. Values in parentheses are for V6.



The CCs for different conditional rain cases (left panel) and upon classification by distance from nadir-line (right panel).

In addition, left panel displays the $\Sigma R_{PR}/\Sigma R_G$ from all FOVs combined.

SUMMARY

- The WGEW dense gauge network provides a unique opportunity for assessing rain rate retrievals from remote sensing observations
- Very good agreement between the PR (NearSurfRain) and the interpolated gauge rain rate fields with high correlation and low bias values, especially for the near-nadir cases (CC>0.9); values this high are typically not observed when comparing remote sensing observation (i.e., satellite vs. ground radar rainfall rate fields)
- Shifting in *time* and *space* is required to obtain highest correlations (no shifting in space is presented here)
- Preliminary results using V7 indicate improvement: In V7 (vs. V6) the CCs overall are higher (in particular for off-nadir cases) and the bias is reduced. Although the overall PR/G bias remains almost the same, the PR near-nadir underestimation and off-nadir overestimation are reduced
- Spatial correlation study indicates uncertainties caused by using 10-gauge averages apparently don't contribute in any tangible way to the observed differences between PR and the gauge based fields used in this analysis (Amitai et al., 2011)

- Amitai E., C. Unkrich, D. Goodrich, E. Habib, and B. Thill, 2011: Assessing satellite-based rainfall estimates in semi-arid watersheds using the Walnut Gulch gauge network and TRMM-PR. *35th AMS Conf Radar Meteor,* Sept 26-30, Pittsburgh, PA

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