ASSESMENT OF MULTISENSOR QUANTITATIVE PRECIPITATION ESTIMATION IN THE RUSSIAN RIVER BASIN

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THE PROBLEM

This study aims to evaluate the impact of a commercial C-band radar for QPE in an area of poor NEXRAD radar coverage and to determine the relative performance of different QPE methods. The primary area of interest in this study is concentrated around the National Oceanic and Atmospheric Administration (NOAA) Hydrometeorology Testbed (HMT) in the Russian River basin north of San Francisco, CA (Figure 1). In this mountainous terrain, the challenge of obtaining reliable QPE's is limited by beam blockage and overshooting, and orographic enhancement. Even if a perfect empirical Z-R relation can be applied, the accuracy is subject to factors such as: radar calibration, ground clutter, attenuation, beam blockages, bright bands and anomalous propagation, etc.

In development of Z-R algorithms, rain gauges provide ground truth to the estimation of Z-R coefficients for a given region. In this study, radar data is taken from the surrounding NEXRAD WSR-88D radars (KMUX, KDAX, KBHX, and KBBX) as well as the C-band TV station radar KPIX. The KPIX radar scans the same area of interest but, unlike the NEXRADs, is closer and has a nearly unobstructed view of the Russian River basin. Rain gauge data from the California Data Exchange Center (CDEC) was used for ingest into QPE processing, and the rain gauges used for validation came from the NOAA HMT and Sonoma County winery gauges (Figure 2).

Analysis Domain : NW corner: 40.0, -124.1 and SE corner: 37.0, -121.4.

Lat-Lon Domain
NW: LL(40.0, -124.1) HR(20.1, 501.02)
NE: LL(40.0, -121.4) HR(72.3, 484.3)
SW: LL(37.0, -124.1) HR(-6.3, 424.9)
SE: LL(37.0, -121.4) HR(49.6, 407.01)

HRAP Domain
NW: HR(-7, 501) LL(39.6549, -125.3503)
NE: HR(73, 501) LL(40.6124, -121.6036)
SW: HR(-7, 407) LL(36.3710, -123.8657)
SE: HR(73, 407) LL(37.2354, -120.3606)

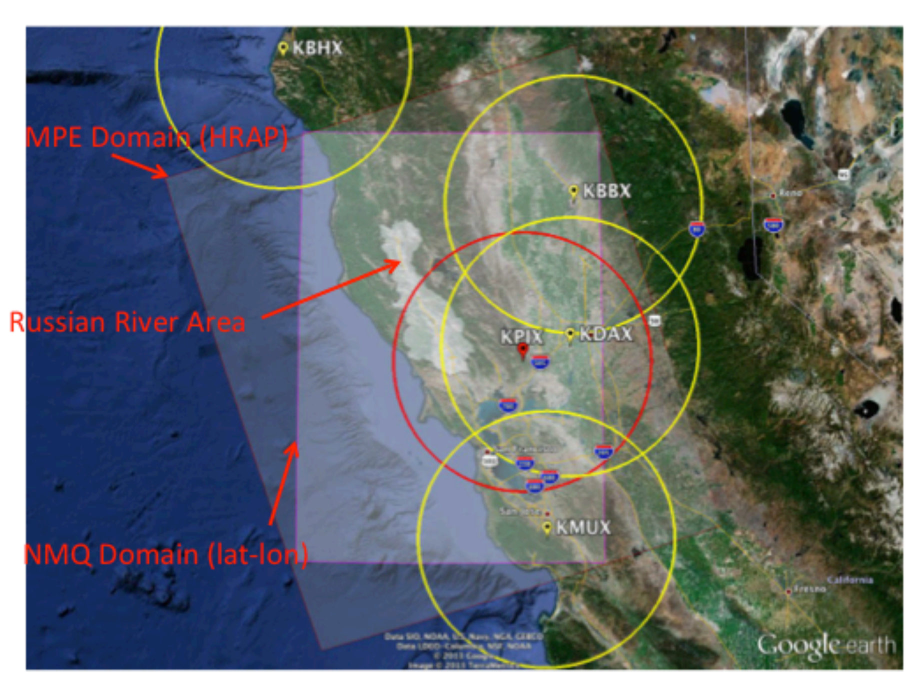

Figure 1: Domain of analysis covering the Russian River Basin with 100km range rings.

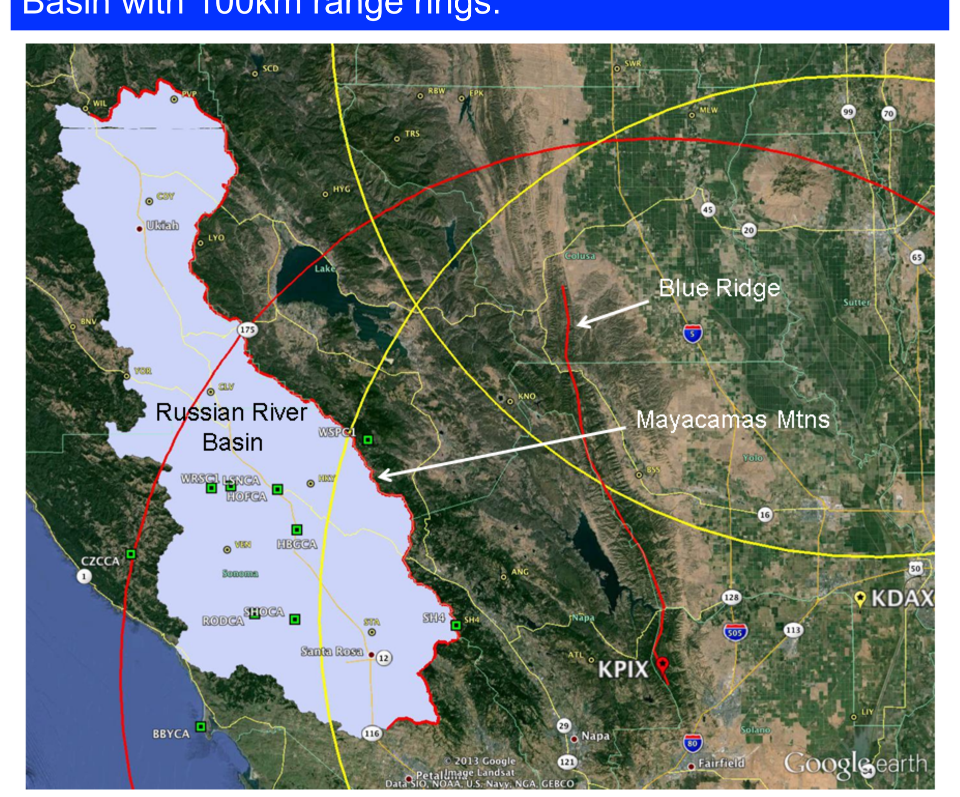

Figure 2: Radar and gauge locations surrounding the Russian River basin. Analysis gauges are yellow and validation gauges are green.

METHODOLOGY

The QPE precipitation fields, generated by NMQ, include: gauge only, radar-only, and radar with VPR and gauge correction. Along with radar input, 52 gauges are used by NMQ for gauge analysis. The computed QPE output are gridded into common latitude-longitude coordinates and compared to an independent validation gauge set consisting of 10 gauges (Figure 2.). The domain of interest for this study is shown in Figure 1. The independent HMT/Sonoma winery gauge QPE is created by gridding the hourly gauge data into lat-lon using inverse distance weighting (IDW) (Figure 3.).

MPE QPE fields were produced using Digital Precipitation Array (DPA) files that use the same radar set and gauge data input as mentioned above for NMQ. This QPE processing, takes advantage of the PRISM (Parameter-elevation Regressions on Independent Slopes Model) climate mapping system for scaling the multisensory estimates in MPE. The MPE output generated follows the 4km by 4km grid used by the Hydrologic Rainfall Analysis Project (HRAP) grid system. The HRAP grid is then converted to lat-lon grid and then compared to the independent gauge data.

The simple KPIX QPE field is calculated using the Martner Z-R relationship. This technique determines rainfall rate from reflectivity, similar to NMQ and MPE. However, no VPR or gauge information is used in order to minimize the complexity in the analysis. The radar reflectivity measurements are gridded to a 0.01 degree lat-lon grid covering the domain of interest using 4/3 earth radius model. The rainfall QPE hourly amounts are obtained by summing the rainfall amount between each consecutive radar scan.

$$F(x,y) = \sum_{i=0}^{n} w_i f_i \qquad w_i = \frac{\frac{1}{d_i^b}}{\sum_{i=0}^{n} \frac{1}{d_i^b}}$$

f_i = gauge value
b = power parameter
d = distance from interpolation point to gauge
i is the gauge number
b=2 and a 2km radius of influence.

Comparison done with common area.

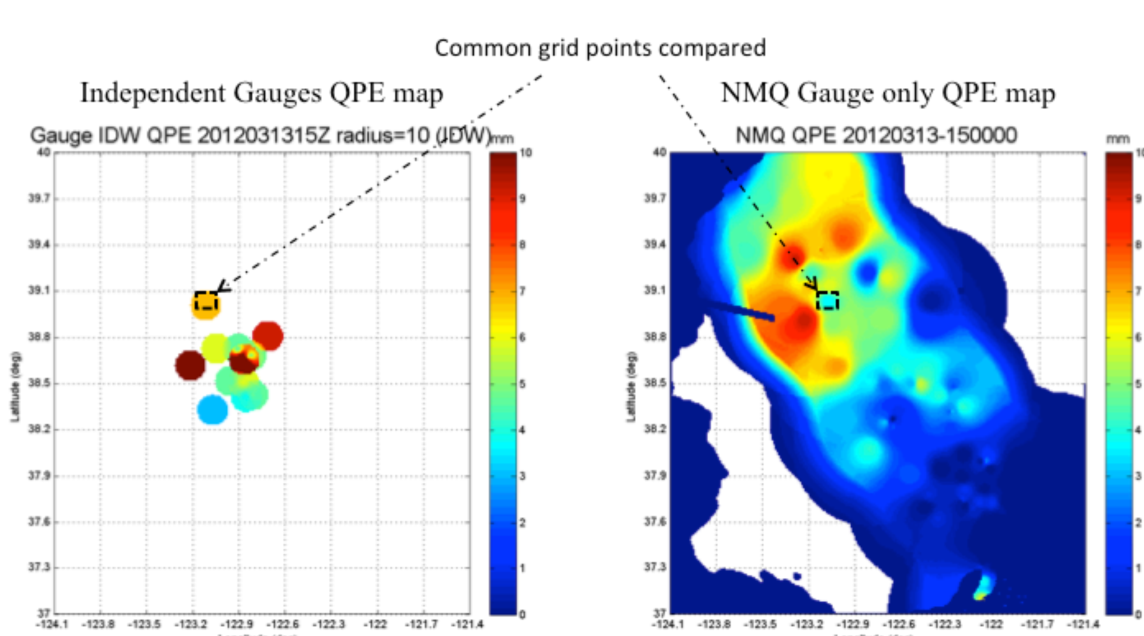

Figure 3: Statistics computed comparing common latitude-longitude grid points between NMQ QPE map and Independent Gauges QPE maps.

ANALYSIS

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the daily statistics for 1 and 6 hour rainfall accumulation can be seen in Figures 4, 5, and 6 for normalized mean bias, normalized standard error, and correlation coefficient respectively. The red indicates NMQ gauge only, black is NMQ radar only, green shows NMQ with VPR and gauge correction, blue plots the simple KPIX QPE, and the magenta shows the MPE QPE's. The missing data for 0315 and 1220 stem from the application of the 6 hour rainfall threshold.

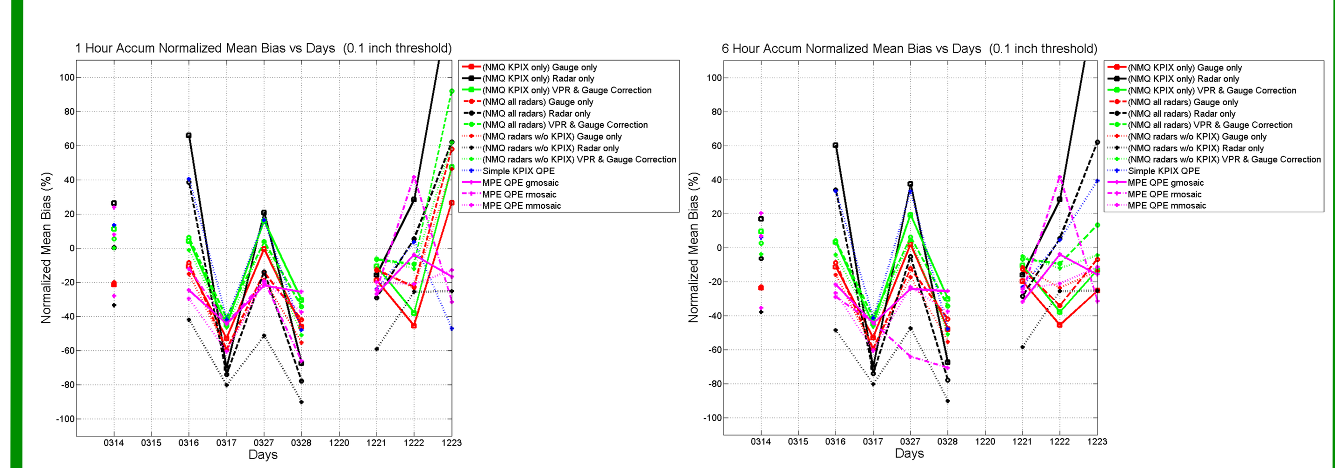

Figure 4: Normalized Mean Bias for 1 hour and 6 hour rainfall accumulation. 1 hour left, 6 hour on right.

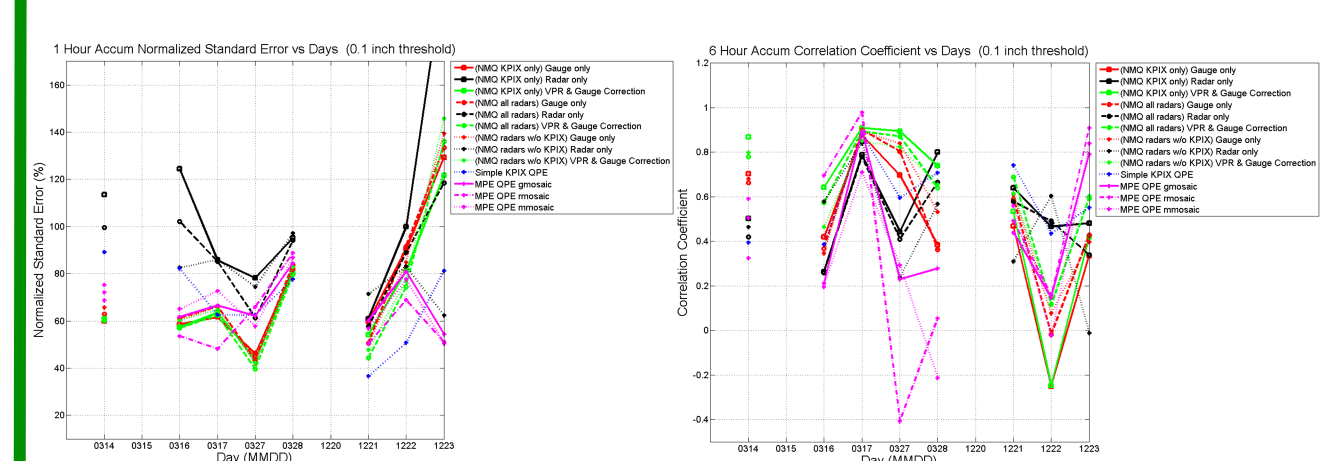

Figure 5: Normalized Standard Error for 1 hour and 6 hour rainfall accumulation. 1 hour left, 6 hour on right.

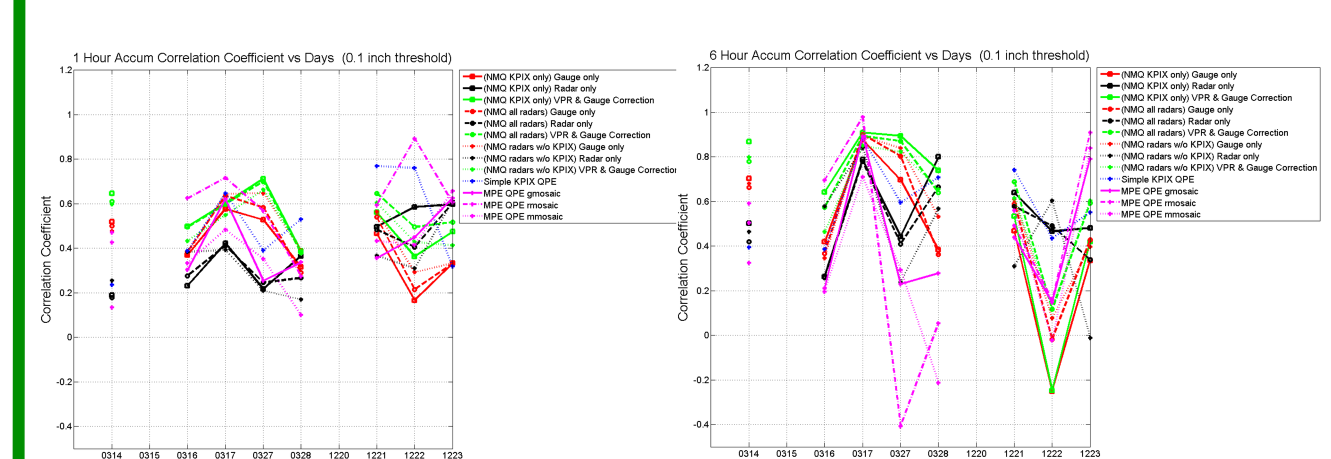

Figure 6: Correlation Coefficient for 1 hour and 6 hour rainfall accumulation. 1 hour left, 6 hour on right.

RESULTS

Results in looking at all 10 days of rainfall events indicate that regardless of NMQ radar input the NMQ QPE product that implements VPR and gauge correction show the closest comparison to the independent gauge set. The simple KPIX also compares well, which is somewhat surprising given the simplicity of the QPE algorithm compared to NMQ and MPE. It is of interest to note how much better the simple KPIX QPE compares to the NMQ radar only QPE especially when the NMQ uses only KPIX as input. The daily statistics in Figs. 4-6 show the large day-to-day variability in relative performance of the QPEs and it is therefore difficult to draw a solid conclusion.

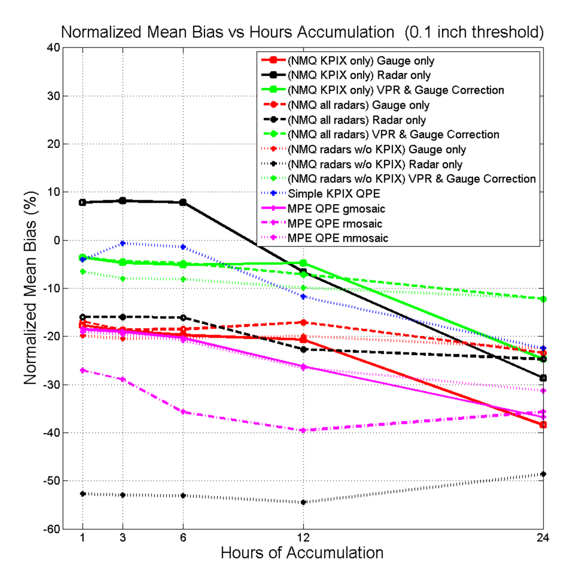

Figure 7: Normalized Mean Bias versus hours of accumulation considering 10 days

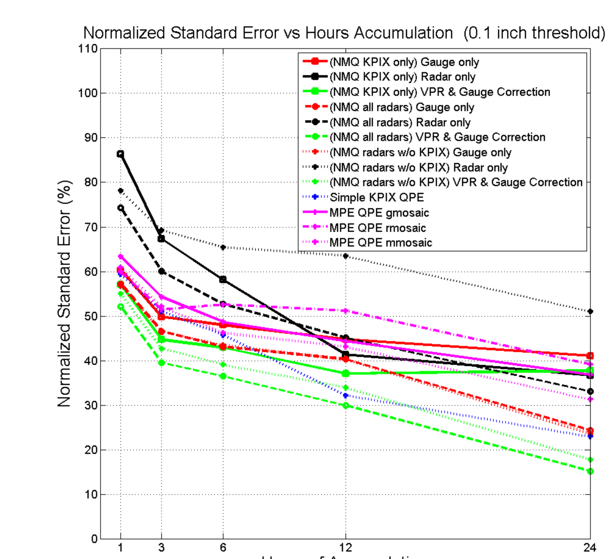

Figure 8: Normalized Standard Error versus hours of accumulation considering 10 days

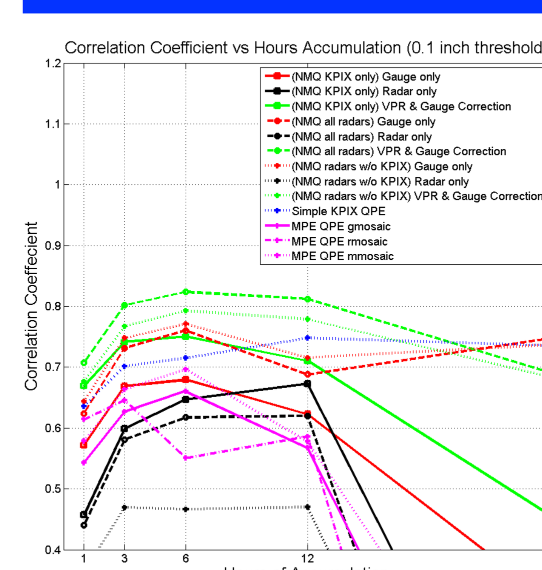

Figure 9: Correlation Coefficient versus hours of accumulation considering 10 days

ACKNOWLEDGEMENTS

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