

Statistical Comparison of Radar Estimated Rainfall Data vs. Rain Gauge Data

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ABSTRACT

This remote sensing project compares NEXRAD MPE data with rain gauge data from around the San Antonio, Texas area. In order to obtain an overall average of the area, an arithmetic average is used. The average difference between the NEXRAD MPE data and the rain gauge data is 0.17 inches and the standard deviation is 0.71 inches. NEXRAD radar overestimates rainfall, but overall is inaccurate. Ultimately the results of this research are indeterminable, because more data should be used to obtain better results.

INTRODUCTION

Water is one of the most important resources on planet Earth. Measurements of how much rain we receive are important in knowing how much we have to use. These measurements are also important in saving lives and property in the event of flooding. Another small reason is the forecasting of fire danger areas in the event of a drought.

The Edward's Aquifer underlies the San Antonio area and provides water to the greater Austin San Antonio area. Levels in the aquifer must be maintained at or above a certain level to prevent several springs from running dry and killing some important species. There is a specific region where the aquifer is recharge from rainfall. There is a need to accurately calculate the rainfall, which falls within the recharge zone.

Another important reason for this research is to prevent deaths from flooding. Flooding is the number one killer of all weather phenomena. If it were possible to obtain an accurate summation of rainfall over a large area, then it would be possible to more accurately forecast flooding and flash flooding.

The most obvious way of measuring rainfall is the rain gauge. This instrument has been used for many years and has been found to be very accurate at a point-to-point basis. Knowing rain fall at one point can be useful, but knowing broader area amounts is much more useful. One way of reducing this problem has been the advent of Radar estimations of rainfall. Radar can see large areas of rain and estimate rainfall rates. These rates can then be used to calculate total amounts of precipitation for a given area. However, the accuracy of Radar estimation can be inconsistent at times.

I proposed to find approximately how inaccurate these estimations are. I expected to find that the Radar estimations are higher than the rain gauge data. This happens due to radar contamination due to hail and snow in rain clouds.

STUDY AREA AND DATA USED

The study area for this project is the general San Antonio area. The latitude and longitude coordinates for the rain gauges can be found in table 1. A map of the coordinates can be found in figure 1. This area was chosen as a representation of the San Antonio metro area where rain gauge data could be found readily. The Boerne location had to be thrown out due to lack of rain gauge data.

NEXRAD MPE (Multi-sensor Precipitation Estimation) data was obtained and used as rainfall estimations. Data from November 1st to November 30th of 2004 was used due to excessive amounts of rainfall. Flooding was a prevalent throughout east and southeast Texas during this time period.

SiteName	ID	Latitude	Longitude
San Antonio	SA	29.5337	-98.4698
Stinson	ST	29.3370	-98.4711
Lackland	LK	29.3842	-98.5812
Randolph	RD	29.5297	-98.2788
New Braunfels	NB	29.7045	-98.0422
Boerne	BN	29.7239	-98.6946

Table 1 - Coordinate Locations for Rain Gauge Sites



Figure 1 - Location of Rain Gauge Sites

METHODS

All days that had measured rain were removed from the rest of the data set. The radar data had to be adjusted to allow for the 5 hour time difference between GMT and US Central time zones. Initially the time zone difference was neglected and once it was taken into account the results were much better. The rainy days were then summed together to get the total rain at each site for each day. The difference between rain gauge data and radar data was then tabulated for each day. All of these days were then averaged together. A scatter plot was then made comparing the radar and gauge data as presented in figure 2. A best-fit line was plotted from the intercept of the origin. An $X=Y$ or 1:1 line was then plotted to show what the ideal results would be.

RESULTS

The average difference between the radar and gauge data was found to be 0.17. This is relatively low and acceptable. The standard deviation of the difference was found to be 0.71. This is two high and is likely from inaccuracies in radar estimation. In figure 2 it is fairly obvious that rain events that were large are widely scattered in the graph. Rain events that were smaller line up better on the 1:1 line. The best-fit line has a CC or R-squared value of 0.61. This means that the line only represents about a 61% fit to the data.

A couple things may have caused the erratic results in heavy rain events, such as, bright banding or ice in the clouds. Bright banding happens when snow falling through the atmosphere begins collecting water. The water/ snow reflects radar beams much more efficiently than just water. The added reflections add considerable amounts of precipitation to the radar estimation. Another source of contamination could be caused by hail. As radar beams hit the hail, they get bounced all over before getting bounced back to the radar. This can cause a spike on the graphical radar and make it appear to be raining where it is not. Hail spikes can also be called three-body scatter spikes.

There are a few data points that show radar-estimated rain, but do not show any rain gauge amounts. This is likely due to a malfunctioning rain gauge or possibly rain that was too close to the ground to be acquired by the radar. The removal of these points would decrease the standard deviation and make the data more accurate.

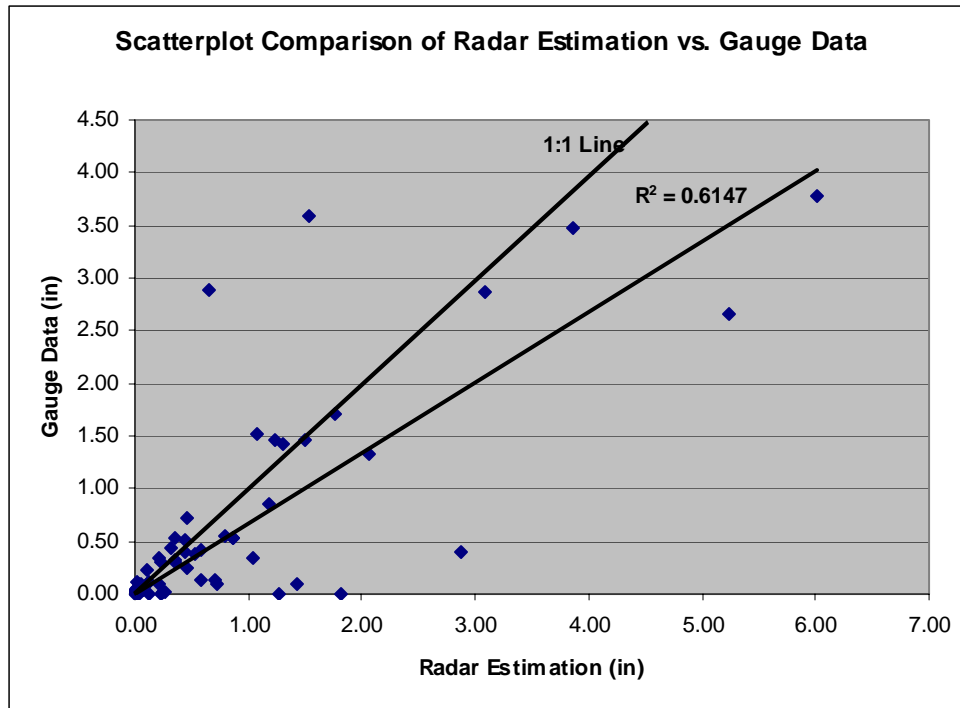


Figure 2 - Scatter plot of NEXRAD Data vs. gauge data

CONCLUSION

In Conclusion, the accuracy of radar estimation is questionable. It looks to be more accurate in smaller rain events, but loses accuracy in large rain events. A larger data set would possibly yield better results. Other methods of averaging the data could also decrease the inaccuracy, such as the Thiessen polygon method or the isohyetal method. Using these methods would require a few more data points. Separating out the contaminated data points would make the data much more accurate, but it is hard to know which are contaminated and which are an accurate representation of the rainfall.

This research shows that more development and research is needed to improve the accuracy of radar estimation. However this method could still be useful in issuing flood warnings. The overestimation of precipitation may lead to a few false flood warnings, but it could still save lives in the long run.

ACKNOWLEDGEMENTS

Thanks to Xianwei Wang for providing data for this project.

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