Radar- vs Gauge-Derived Precip Estimates

Comparing gridded precipitation fields at SERFC 2005-2017

Ian Blaylock

Southeast River Forecast Center

Contact Information:
Southeast River Forecast Center
4 Falcon Drive, Peachtree City, GA 30269

Phone: +1 (770) 486 0028
Email: `ian.blaylock@noaa.gov`

Introduction

This analysis focuses on the differences between MAP[1] and MAPX[2], the two precipitation datasets used as input into the river forecast model.

MAP represents precipitation using spatially interpolated 24- and 6- hourly measurements that are quality controlled before field generation. MAPX represents precipitation as a spatially continuous field based on continually monitored hourly gauge and radar data, and is a objectively superior dataset.

Despite MAPX being the primary hydrological forcing used since Oct. 2008, SERFC's river forecast model is still calibrated to MAP, as it has been available since the 1950s. Before the forecast model can be re-calibrated to MAPX, a thorough comparison of the two fields must be made.

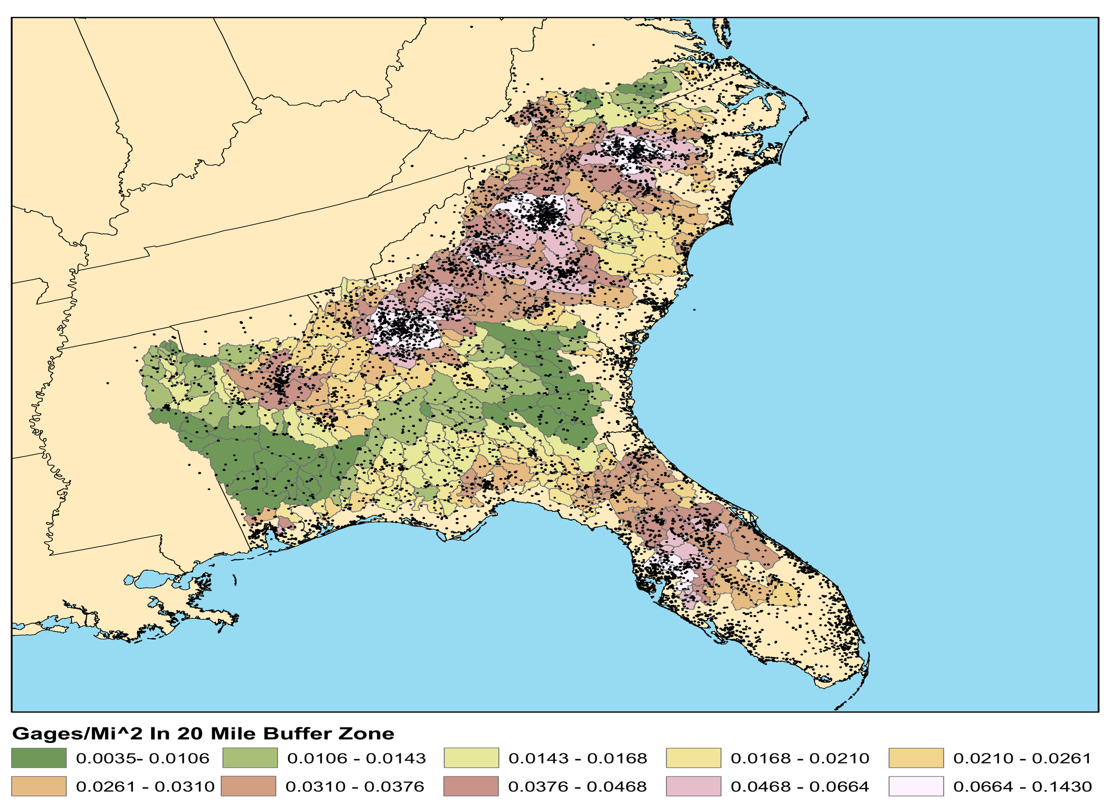

Figure 1: A plot of rain gauge density across SERFC's service area. Southeastern VA, eastern MS, southern AL, and southern GA exhibit low rain gauge coverage. Elsewhere, particularly in urban centers, gauge coverage is significantly higher.

Data and Methodology

MAP Data

Prior to Oct. 2011, SERFC generated MAP using OFS[3]. Since then, MAP has been created using DailyQC[4], which allows for greater quality control before MAP generation. OFS and DailyQC interpolations use Thiessen polygon and inverse distance weighted formulae, respectively.

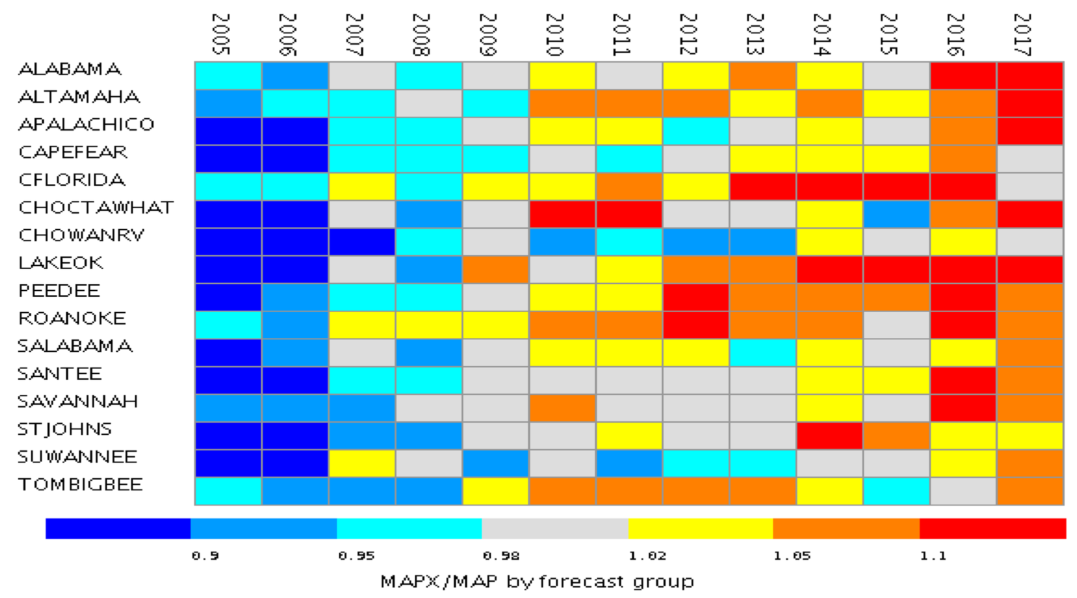

Figure 2: MAP (2005-2008): moderate MAP bias. MAPX (Multisensor Mosaic) era (2008-2016): weak MAPX bias. MAPX (Q3) era (2016-): moderate MAPX bias.

MAPX Data

MAPX data has been available for the full data period, but only became the default operational precipitation field in Oct. 2008. Quality control increased noticeably at this point. It initially consisted of a bias-adjusted radar-gage mosaic, but switched MRMS Q3[5] as the default base MAPX field in Apr. 2016. These field changes manifest as noticeable inflection points in the analysis (Fig. 2).

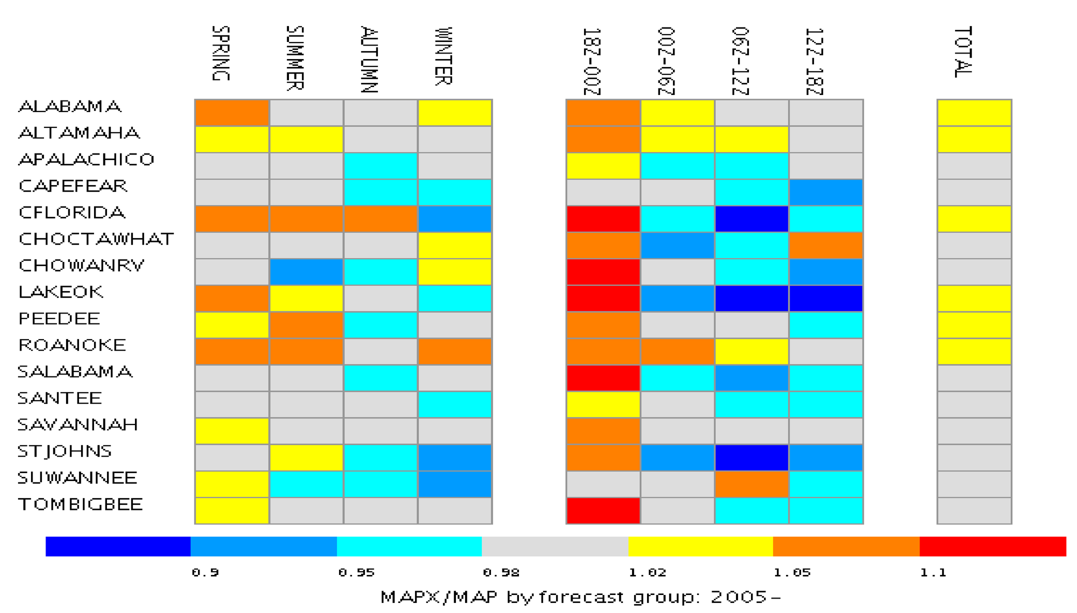

Figure 3: Diurnal and seasonal $\overline{R}$ trends. Weak MAP bias predominates throughout much of the day, while moderate to strong MAPX bias was observed in the afternoon. Spring and summer exhibit weak to moderate MAPX bias, while fall has a weak MAP bias and winter is neutral.

Analysis

Using data from 2005-2017, the relationship between the two fields was assessed using the ratio of their aggregate values, with $\overline{R} = \frac{\sum_{i=0}^{n} MAPX_i}{\sum_{i=0}^{n} MAP_i}$. $\overline{R}$ values were divided into seven categories:

Strong MAP	$0 <= \overline{R} <= 0.9$	Weak MAPX	$1.02 <= \overline{R} < 1.05$
Moderate MAP	$0.9 < \overline{R} <= 0.95$	Moderate MAPX	$1.05 <= \overline{R} < 1.1$
Weak MAP	$0.95 < \overline{R} <= 0.98$	Strong MAPX	$1.1 <= \overline{R} < \infty$
Neutral Ratio	$0.98 < \overline{R} < 1.02$		

$\overline{R}$ was compared to gauge density (ρ_g) and radar distance (R_{dist}). ρ_g was calculated by finding the number of rain gauges contained within a 20-mile buffer zone around each basin and then dividing by the area of the buffer. R_{dist} was calculated as the distance from each basin centroid to the nearest radar. $\overline{R}$ was also assessed across multiple river basins to assess its spatial varibility. Interannual, diurnal, and seasonal $\overline{R}$ trends were also assessed.

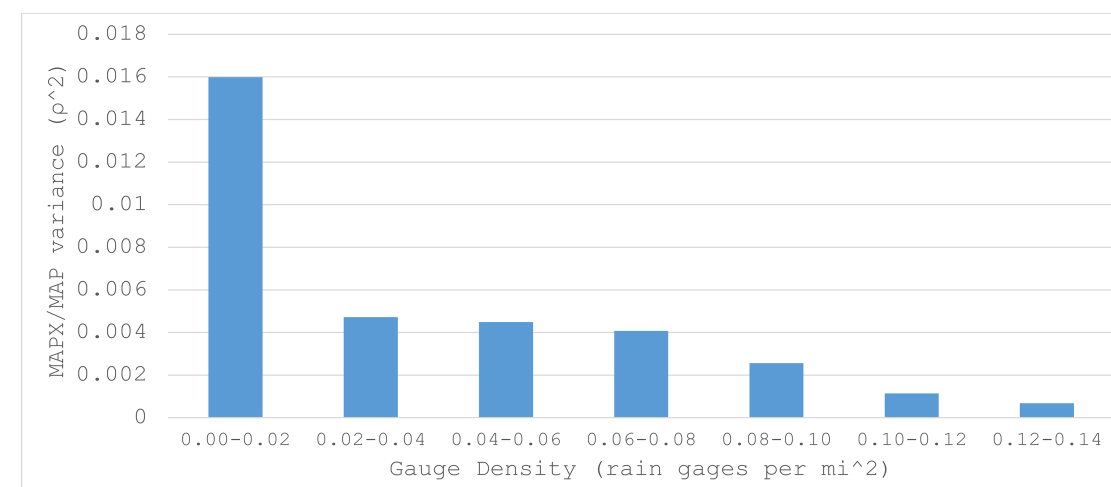

Figure 4: Variability in $\overline{R}$ as a function of ρ_g. The study indicated that spatio-temporal trends in $\overline{R}$ are more pronounced in regions with higher gauge coverage.

Results

Prior to Oct. 2008, MAP biases prevailed ($\overline{R} \lessapprox 1$) (Fig. 2). Once MAPX begin to receive routine quality control, weak MAPX biases developed. When MRMS Q3 became the primary dataset in Apr. 2016, moderate to strong MAPX biases were observed. The OFS $\Rightarrow$ DailyQC transition did not impact $\overline{R}$.

$\overline{R}$ exhibits distinct seasonality and diurnal variation. In general, $\overline{R} \gtrapprox 1$ for spring and summer, while $\overline{R} \lessapprox 1$ for fall and winter (Fig. 3), suggesting a possible tie between $\overline{R}$ and convective precipitation. This notion is supported by strong MAPX bias between 18Z and 00Z – during which most convection occurs – compared to other times of day.

The river basins most affected by $\overline{R}$ biases are those of Central and South Florida. This may be associated with more frequent deep convection in the region. However, the Suwannee river basin of South Georgia and North Florida – with a similar climate but slightly higher relative incidence of stratiform precipitation – exhibited a weak MAP bias throughout much of the analysis period, adding ambiguity to this assessment.

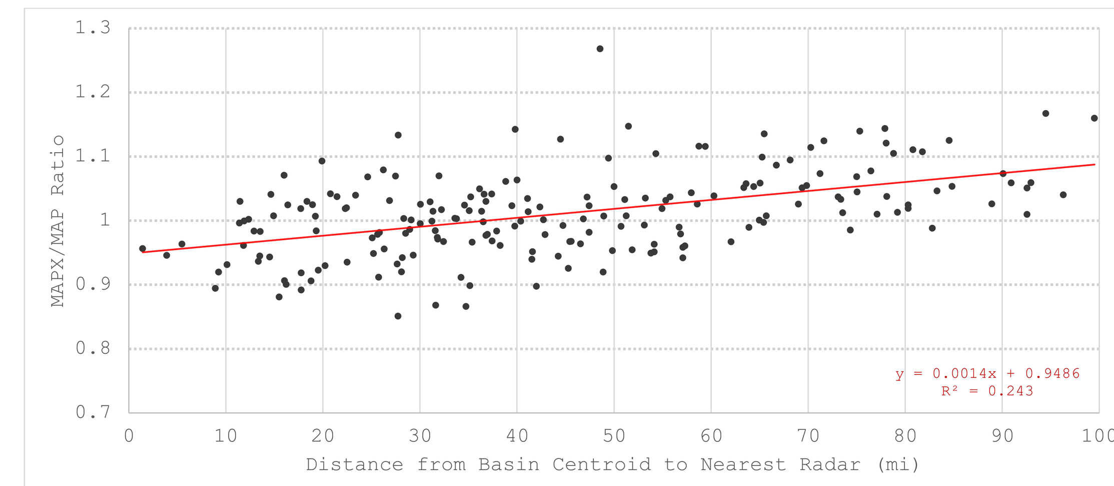

Figure 5: Variability in $\overline{R}$ vs. radar distance. MAP biases predominate with close proximity to a radar, while MAPX biases are more pronounced as basin distance increases.

$\overline{R}$ has a moderate positive correlation with R_{dist}, with a slight MAP bias ($\overline{R} < 1$) when $R_{dist} \lessapprox 40$mi. When $R_{dist} \gtrapprox 40$mi, increasingly strong MAPX biases tend to occur. The reason for this is unknown.

ρ_g does not have a strong impact on the magnitude of $\overline{R}$. However, the variance of $\overline{R}$ across basins is inversely proportional to ρ_g. As ρ_g impacts MAP significantly more than MAPX, this suggests that $\overline{R}$ is a more meaningful metric in areas with higher ρ_g.

Conclusions

- There has been a trend for increasing MAPX/MAP ratios ($\overline{R}$) across the Southeastern United States since 2005.
- Peak MAPX biases occur during spring, summer, and the afternoon, suggesting a link to convective activity.
- MRMS Q3 produces stronger MAPX bias compared to Multisensor Field Bias Mosaic.
- Once MAPX began to receive consistent quality control, $\overline{R}$ went from a weak MAP bias to a weak MAPX bias.
- More valuable statistics are provided from regions with higher rain gauge coverage.
- The MAPX/MAP ratio becomes more biased towards MAPX with increasing radar distance.

[1]MAP - Gauge-derived gridded precipitation estimates
[2]MAPX - Radar-derived, gauge-adjusted gridded precipitation estimates
[3]OFS - Operational Forecast System. The component of NWSRFS (National Weather Service River Forecast System) responsible for deterministic stage forecasts.
[4]DailyQC - a sub-component of the MPE (Multisensor Precipitation Estimate) Editor used for MAP creation.
[5]MRMS Q3 - A higher quality precipitation field generated by a heuristic process at National Severe Storms Laboratory