Comparison of gauge rainfall measurements with TRMM satellite estimates over Kumasi

July 29, 2015

Presented by: Marian A. Osei

Research Team:
Dr. Leonard K. Amekudzi
Marian A. Osei
Maureen A. Ahiataku
Magaret A. Oduro
Eugene Asante-Bekoe

Outline

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Introduction

- Rainfall is an essential resource for socio-economic activities especially in developing countries.
- Rainfall variability in Sub-Saharan Africa has been reported by Owusu et al. (2012), Nicholson et al. (2003), Amekudzi et al. (2015).
- To improve our understanding of the spatio-temporal variations of rainfall rigourous validation has been carried out all over the world by comparing in-situ measurements with satellite estimates. (Friesen 2002; Amekudzi et al., 2011; Adeyewa and Nakamura 2003; Haque et al., 2013).
- In the tropics, the Tropical Rainfall Measuring Mission (TRMM) has been specifically dedicated to monitoring rainfall intensity and distribution.

Motivation and Objectives

Motivation:

- Sparse rain-gauge network in Ghana.
- Inadequate in-country validation of TRMM satellite estimates over Ghana.
- Deployment of automated rain gauges for student training purposes.

Objectives:

- This study aimed at validating TRMM satellite estimates and OTT-pluvio measurements over Kumasi, with the objectives of checking the reliability and consistencies of both measurements.
- To inter-compre rainfall measurements at the same locations using Ghana Meteorological Agency (GMet) deployed rain gauge with OTT-pluvio gauge.

Study Site and Data

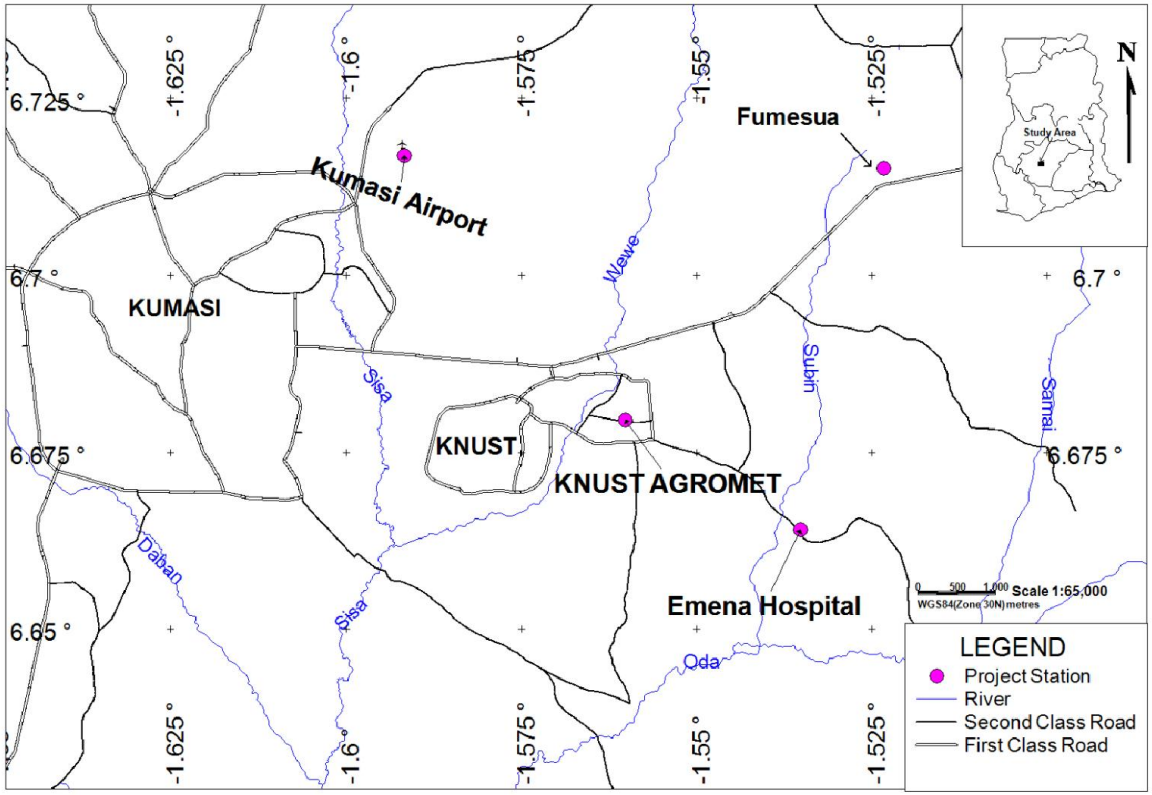

Figure : Study sites located between 6^0 42′ N, 1^0 35′ W

Rain Gauge Types

Figure : OTT-Pluvio Gauge and Standard Rain Gauge (SRG)

TRMM Specifications

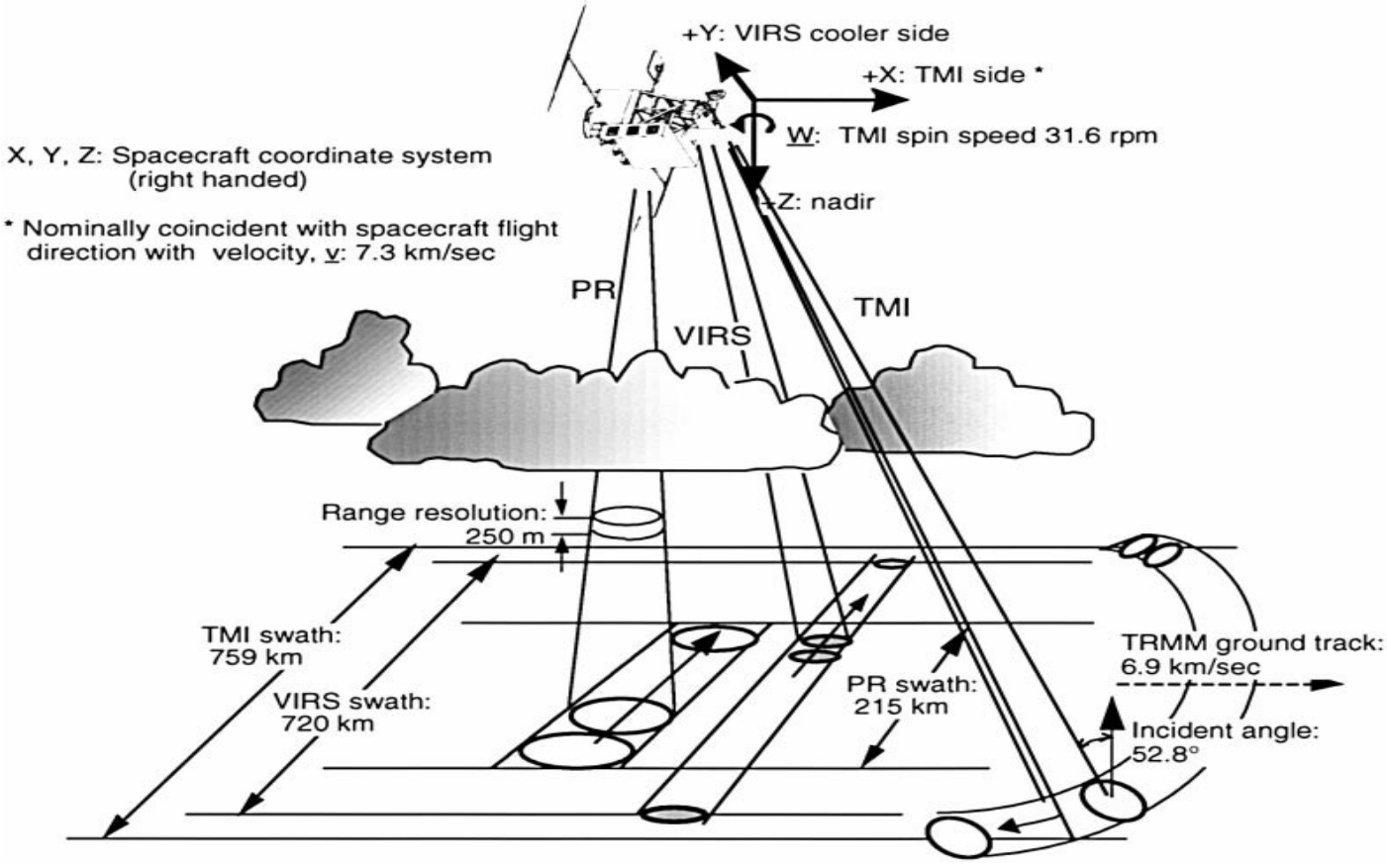

Figure : TRMM satellite and its payloads

Methodology

- Daily rainfall measurements were obtained from four OTT-Pluvio instruments were considered for the period of 2011 to 2013.

- Thiessen polygon method was used to calculate for the daily rainfall average for the ground-based instruments using the mathematical expression;

$$P_{ave} = \frac{\sum A_i P_i}{A_T} \tag{1}$$

where A_T= total area of the basin.

- The statistical methods used for comparison include: bias, mean bias error, root mean squared error (RMSE), normalized root mean squared error (NRMSE) and the correlation coefficient.

$$Bias = \frac{\bar{T}_i - \bar{G}_i}{\bar{G}_i} \tag{2}$$

$$MBE = \frac{1}{n}\sum_{i=1}^{n}(T_i - G_i) \tag{3}$$

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(T_i - G_i)^2} \tag{4}$$

$$NRMSE = \frac{\sqrt{\frac{1}{n}\sum_{i=1}^{n}(T_i - G_i)^2}}{\bar{G}} \tag{5}$$

Where G_i= rain gauge measurements, T_i=satellite estimates, $\bar{G}$= average of the rain gauge measurements, n= number of observations.

Results and Discussion

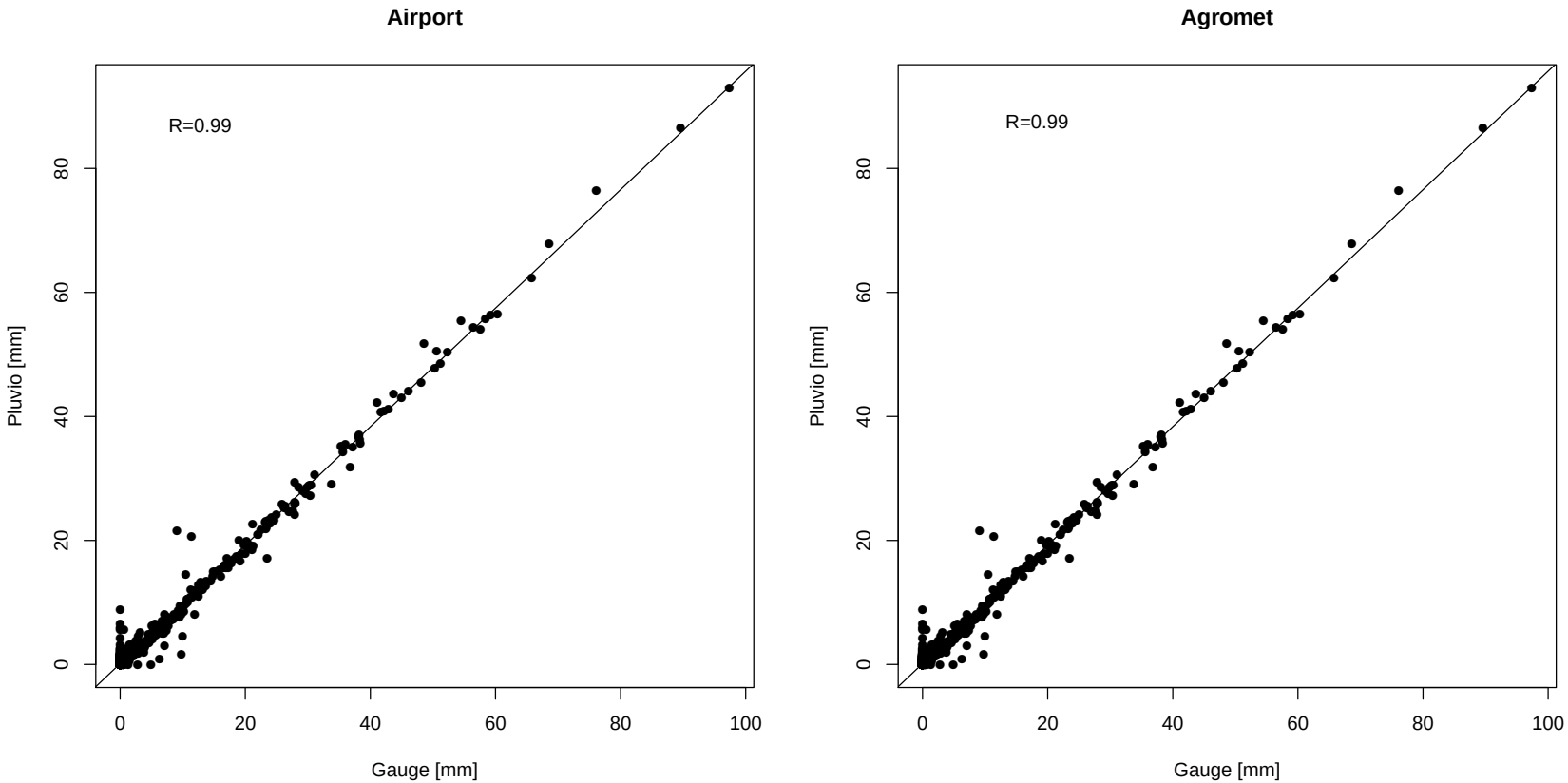

Figure : 3-year correlation plots for Agromet and Airport

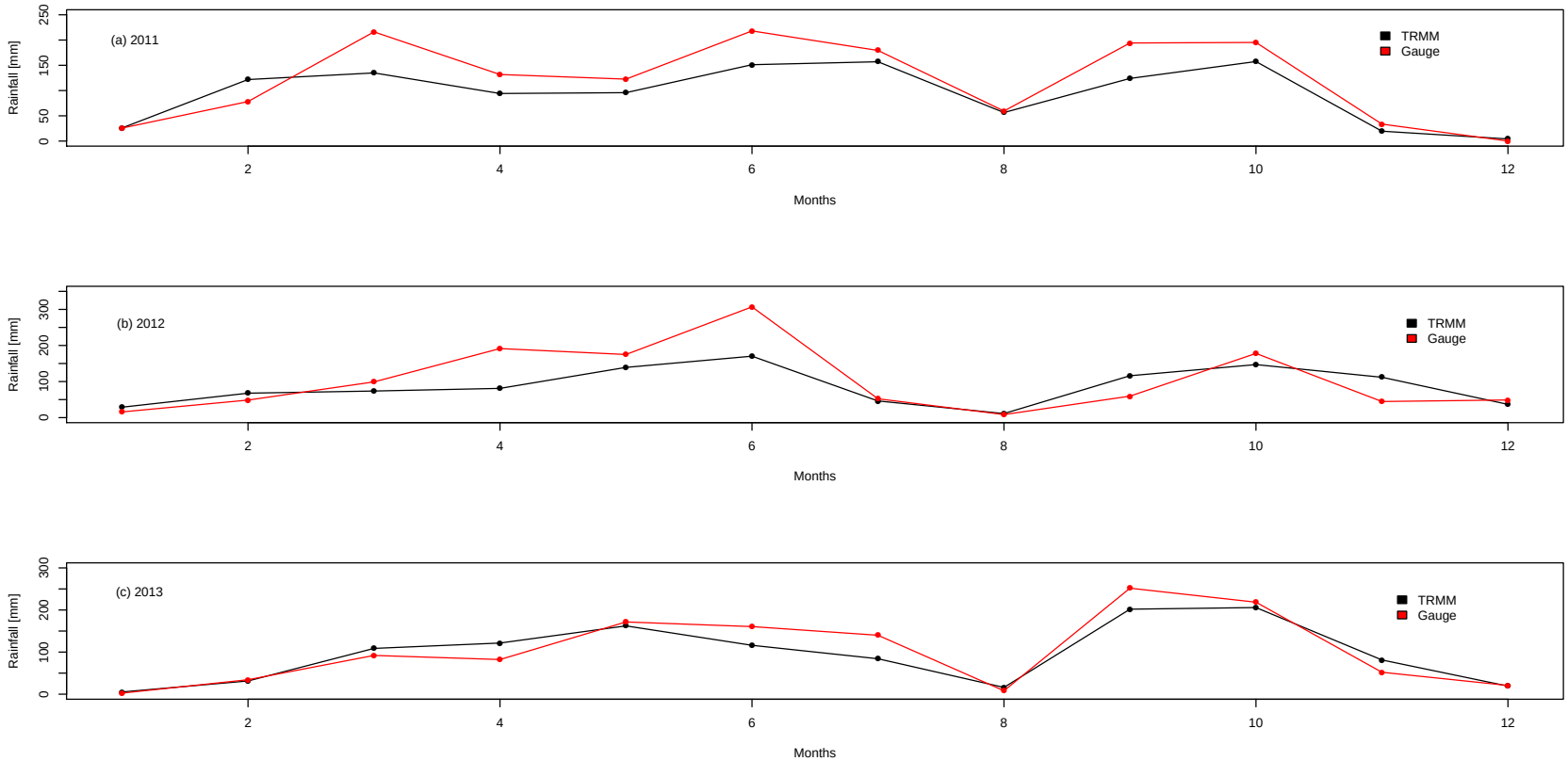

Figure : Monthly averages [mm/month] for TRMM and Pluvio datasets from 2011 to 2013

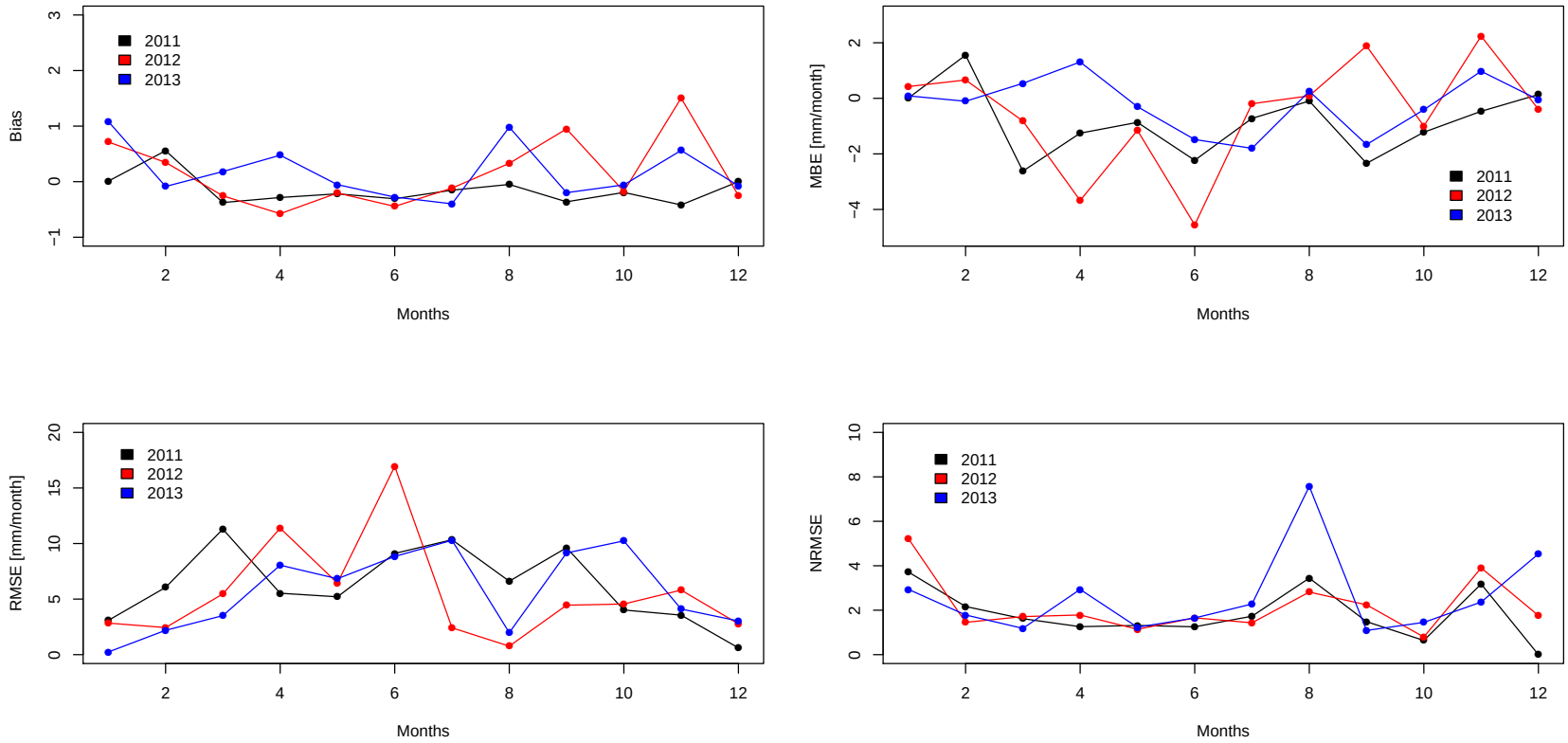

Figure : Plots of Bias, MBE [mm/month], RMSE [mm/month], RRMSE for 2011 to 2013

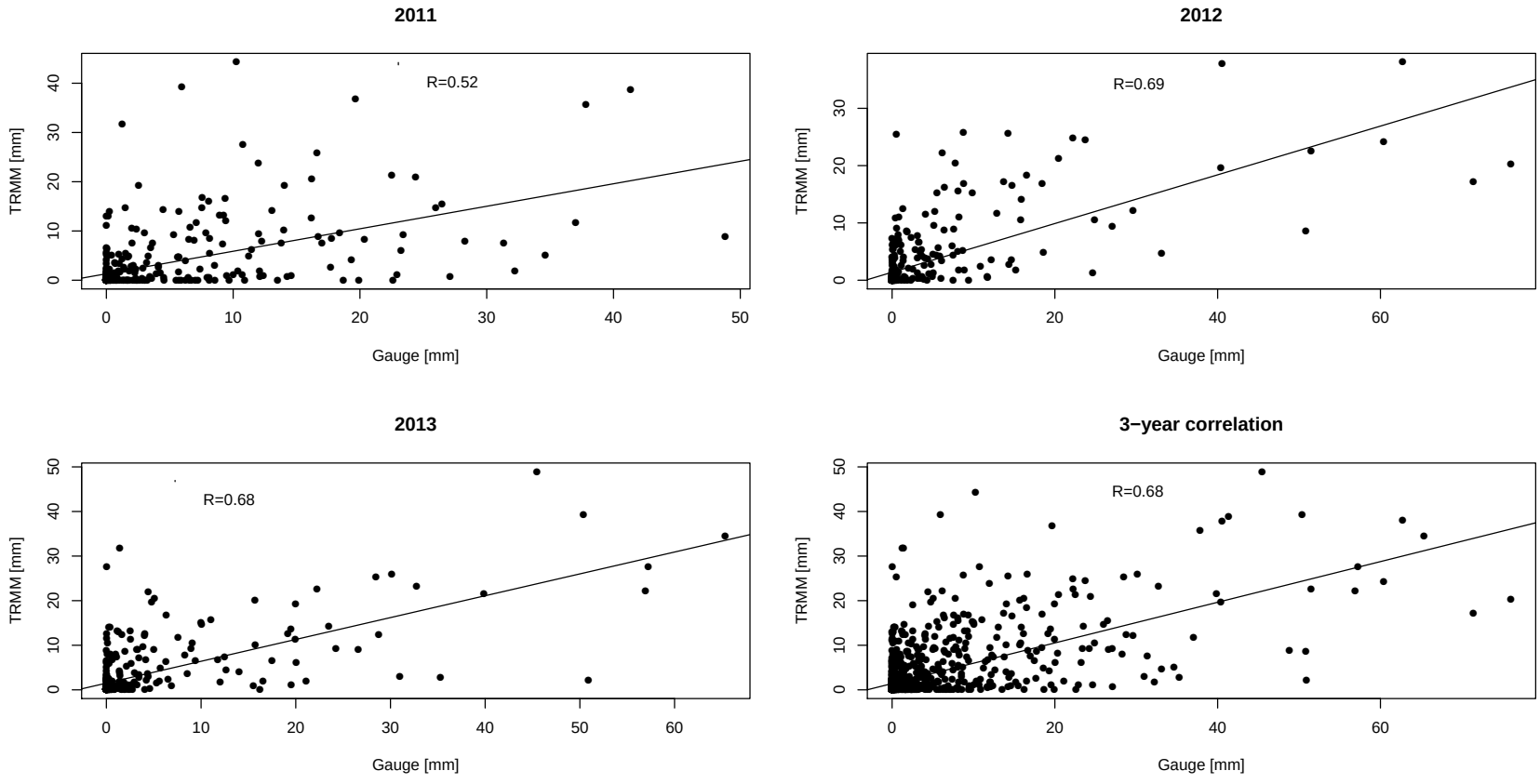

Figure : Annual correlation plots

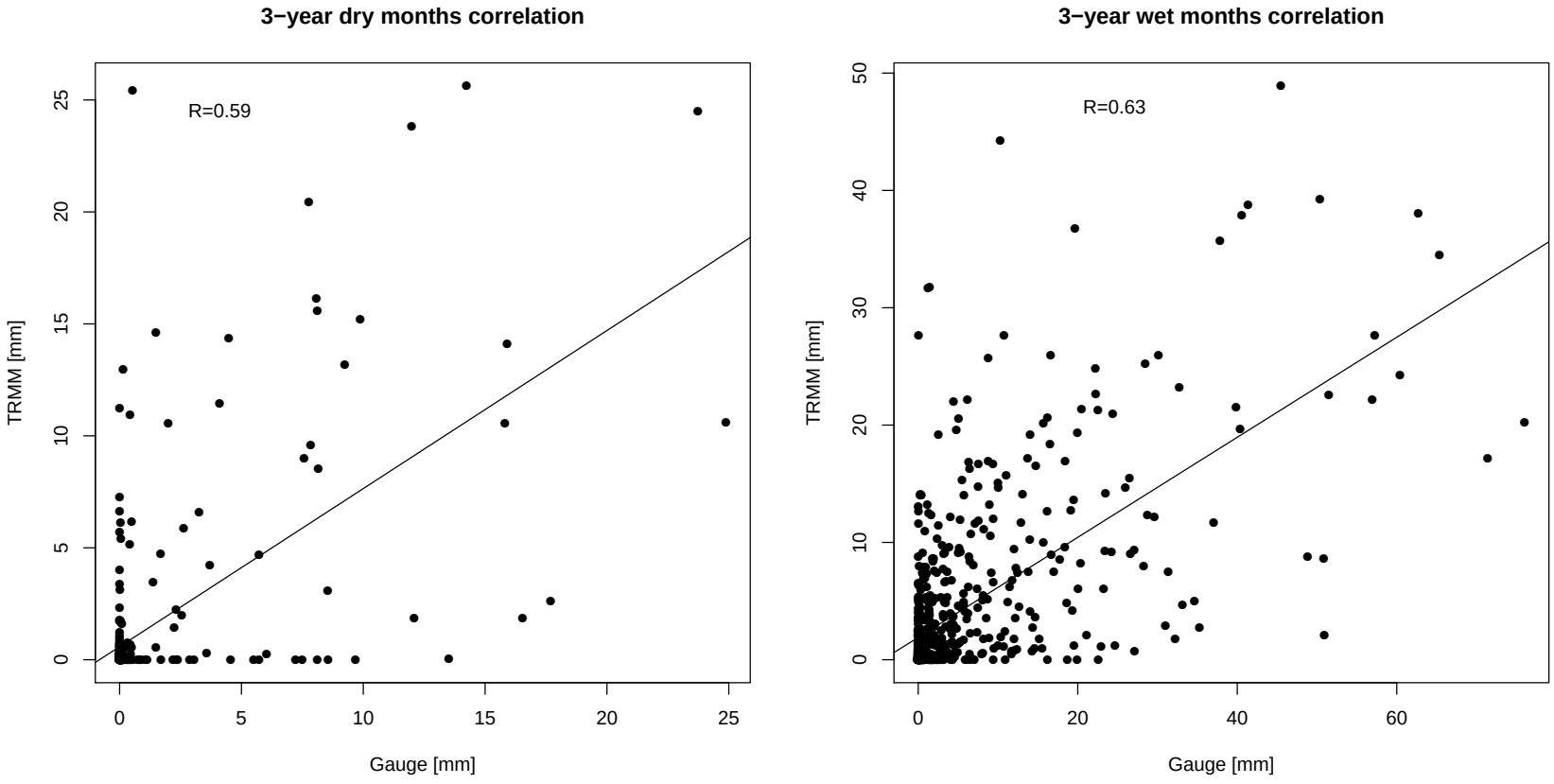

Figure : 3-Year Seasonal Correlation

Summary

Table : Annual averages of Bias [%], MBE [mm/month], RMSE [mm/month], NRMSE and the Total annual rainfall [mm]

Year	Bias	MBE	RMSE	NRMSE	Annual Rainfall Total	
					TRMM	Gauge
2011	-14.97	-0.93	6.25	1.82	1142.49	1454.55
2012	15.21	-0.54	5.52	2.16	1029.88	1228.37
2013	17.82	-0.22	5.70	2.59	1153.67	1234.57

Conclusion

- Analysis of SRG and OTT-Pluvio rainfall measurements were observed to be in close agreement with a correlation coefficient of 0.99 for the years under study.
- Monthly averages showed good agreement between the TRMM estimates and pluvio datasets.
- Analysis showed a general underestimation of TRMM rainfall data by gauge, but quite good agreement in dry seasons.
- Statistical methods used for the validation also proved TRMM to be consistent and reliable with gauge dataset.
- Therefore, TRMM rainfall data has the potential to be used for climate impact studies (agricultural, hydrological and meteorological purposes).

THANK YOU