An Experimental Study of the Rainfall Variability in the Southern Delmarva Peninsula
Part I: Climatology and Physical Variability

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Introduction

- Previously, Tokay and Öztürk (Journal of Hydrometeorology, 2012) studied rainfall variability within a 5 km distance which corresponds to TRMM/GPM precipitation radar approximate diameter.

- A key conclusion of their study was that one cannot extrapolate the variability beyond the maximum gauge separation distance within the network.

- The variability within the TRMM/GPM precipitation radar and microwave sensor is one of the key uncertainty in satellite based rainfall estimation.

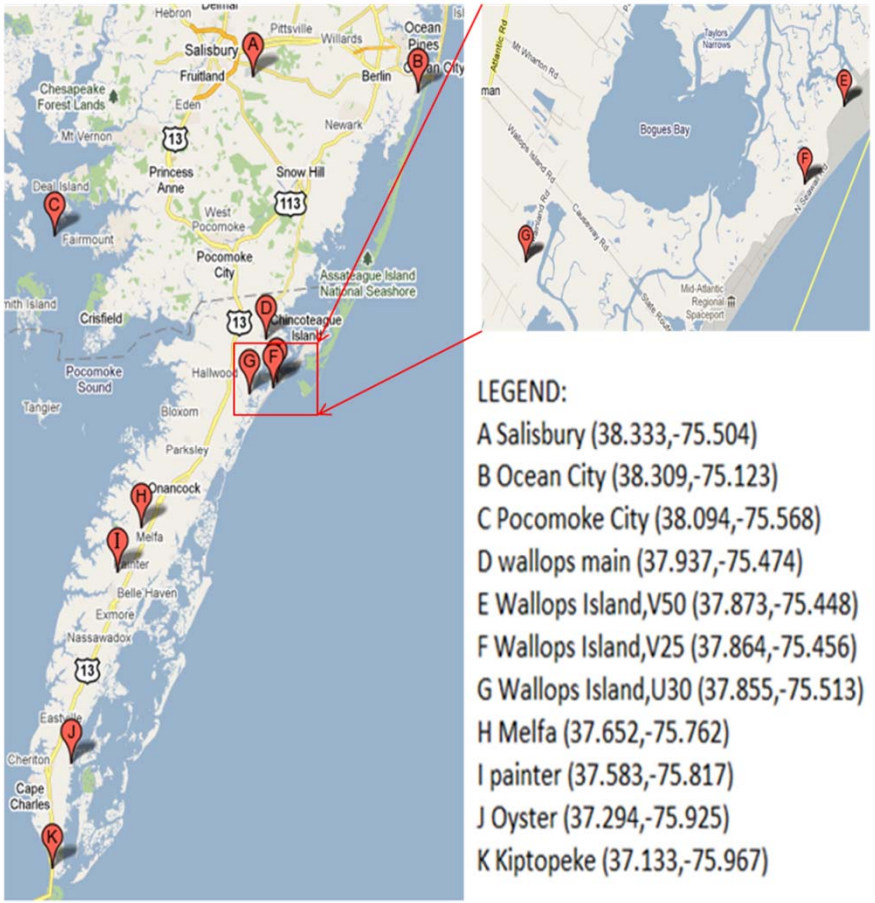
- The instantaneous filed of view (IFOV) for TRMM microwave sensor ranges from The IFOV ranges from 63x37 km at 10 GHz to 7x5 km at 85.5 GHz.

Objective

- The objective of this study is to address the variability of rainfall within the instantaneous field of view of TRMM/GPM Microwave sensors through long term (5+ years) rain gauge measurements at the Mid-Atlantic Region.

Experimental Set Up

- 30 tipping bucket (Met One Inc.) rain gauges were deployed at 11 sites, where 8 sites had triple and the remaining sites had dual gauges.
- The gauges had 0.01 inches resolution, and the time of the tip is recorded to a data logger. The experimental period was from May 2005 to July 2010.
- The gauges sites were distributed from Ocean City, Maryland to Kiptopeke, Virginia where the maximum and minimum distances were 150 km and 1 km, respectively.



Data Analysis

- This study focuses on the variability of rainfall at different climatological periods. The observations were divided into 20 seasons, 10 cold/warm periods, and 5 years. The study was also conducted for 4 distinct weather systems (Hurricanes, Convection, Warm-sector, and Nor'easters)

- The cold period includes winter months, November to March, while warm period includes summer months, May to September. April and October are considered as transitional months, not included in warm and cold periods.

- 10 different integration periods ranging from 5-minute to 12-hour accumulations were considered. 30-minute integration period was established as a base.

- 4 different rain/no-rain thresholds ranging from a single tip (0.254 mm) to 8 tips (2.0 mm) were examined. Two tips (0.5 mm) are established as a base, since single tip may occur due to high wind conditions.

Methodology

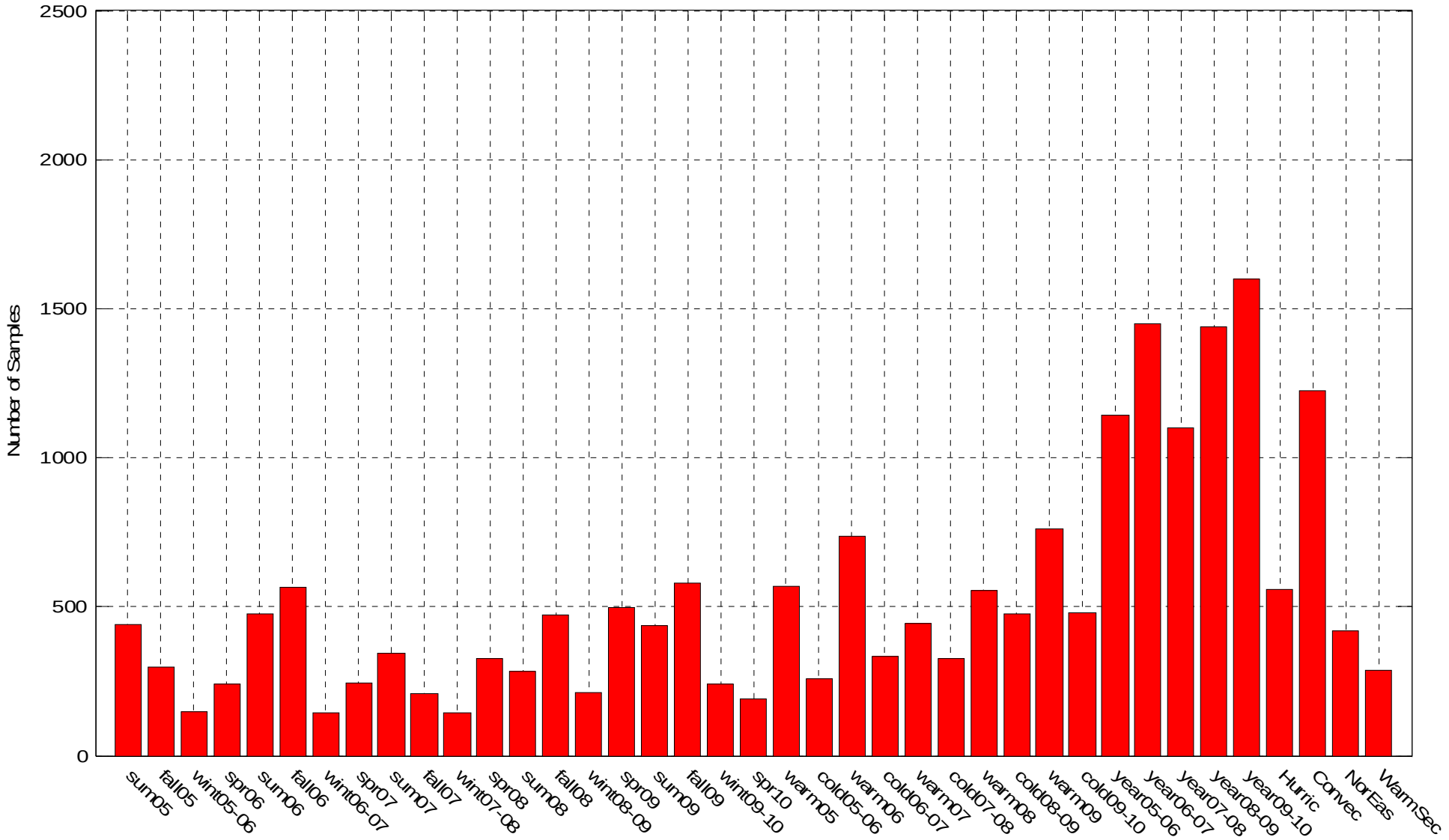
- Since 11 sites were present, there were 55 pairs of correlations. Pearson correlation coefficient (r) is the ratio of covariance of two variables (x, y) to the multiplicative factor of the standard deviation of each variable x, and y.

$$r = \frac{\mathrm{Cov}(x, y)}{(\mathrm{Var}(x)\mathrm{Var}(y))^{1/2}}$$

- A stretched exponential model was then the applied to the correlation (r) and distance (d) pairs for each integration time set using the following equation:

$$r(d) = r_0 \exp\left[-\left(\frac{d}{d_0}\right)^s\right]$$

Sample Size


Number of Samples
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1500
1000
500
0
sum05
fall05
wint05-06
spr06
sum06
fall06
wint06-07
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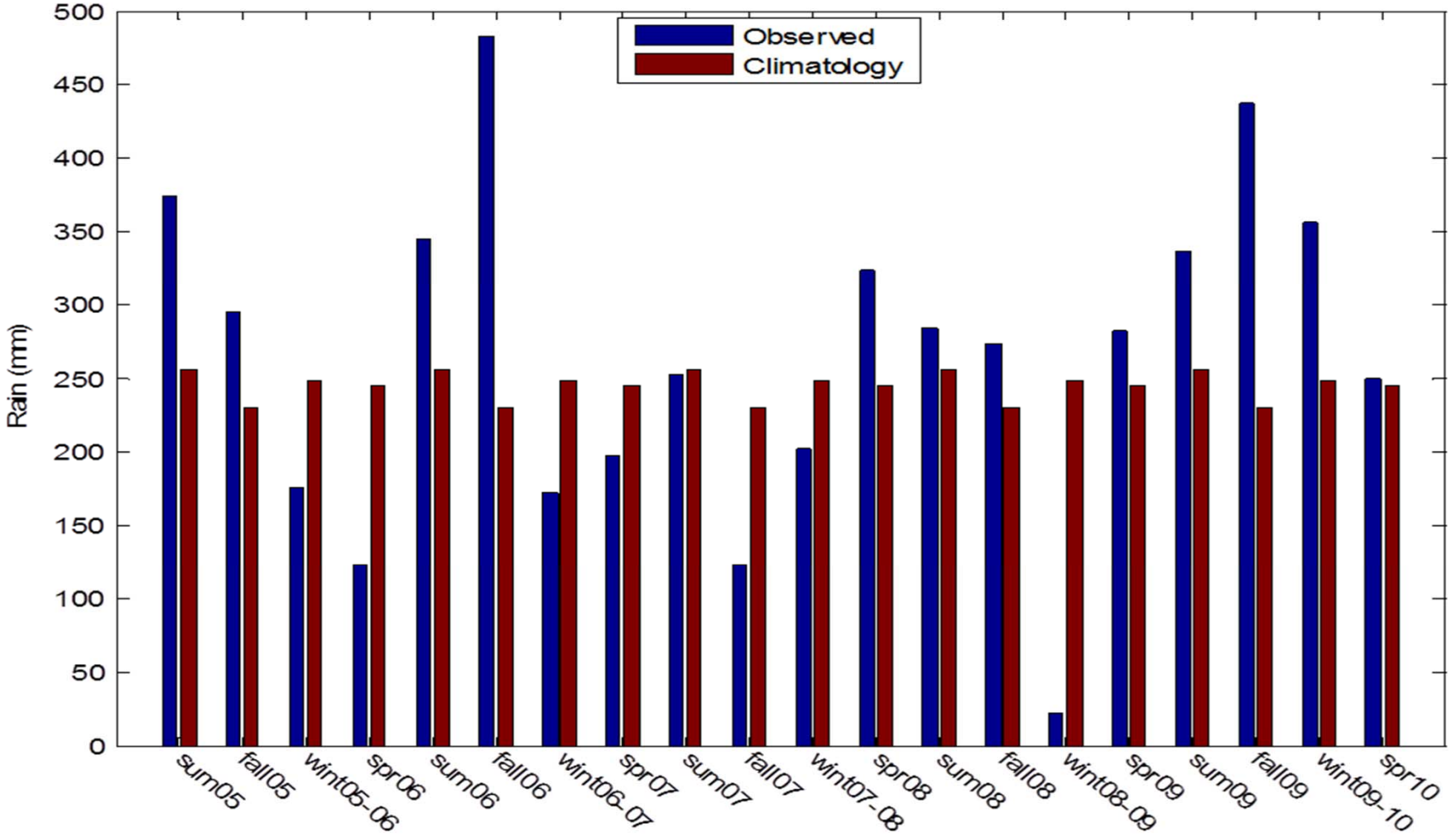
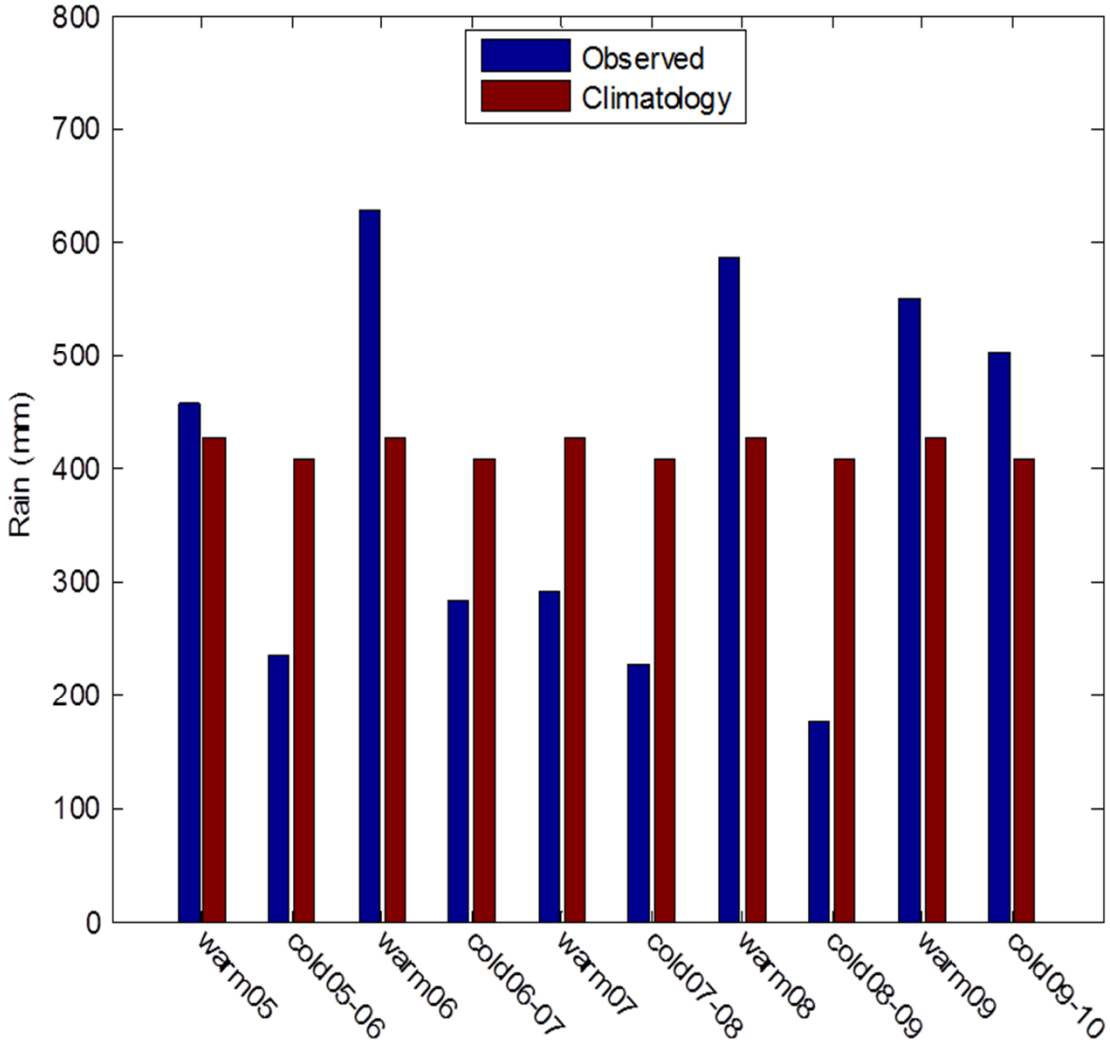
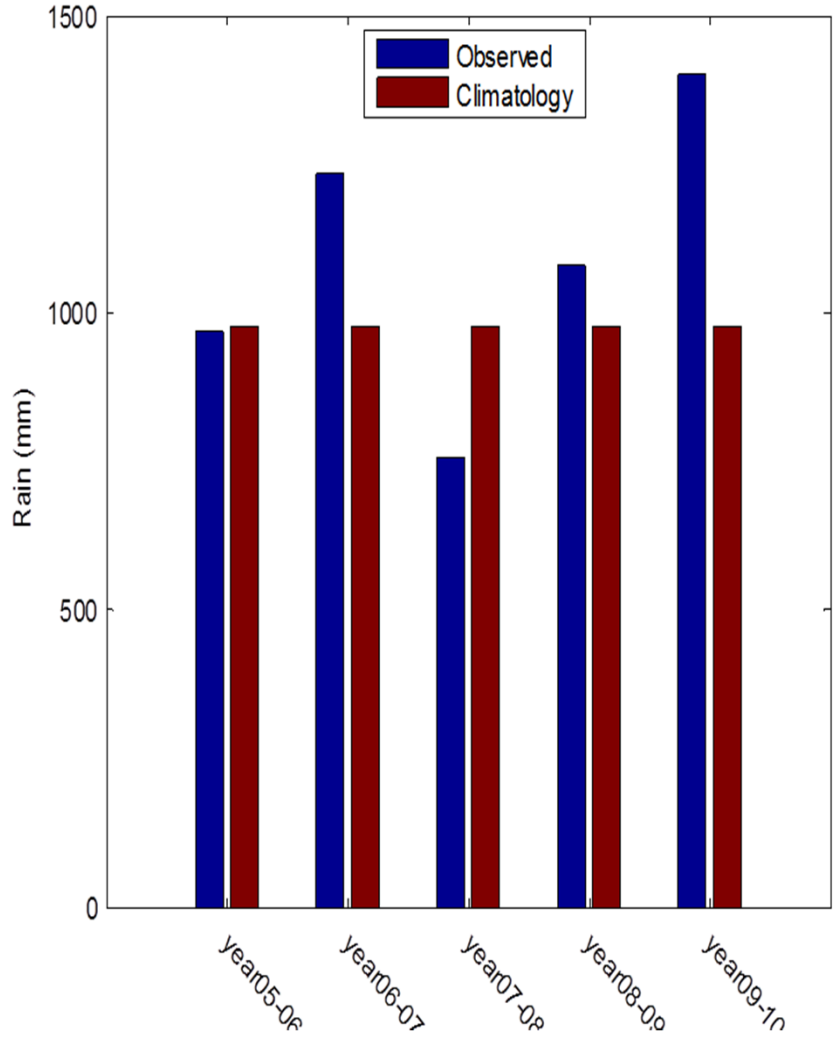
sum07
fall07
wint07-08
spr08
sum08
fall08
wint08-09
spr09
sum09
fall09
wint09-10
spr10
warm05
cold05-06
warm06
cold06-07
warm07
cold07-08
warm08
cold08-09
warm09
cold09-10
year05-06
year06-07
year07-08
year08-09
year09-10
Hurric
Convec
NorEas
WarmSec

Climatology (seasons)

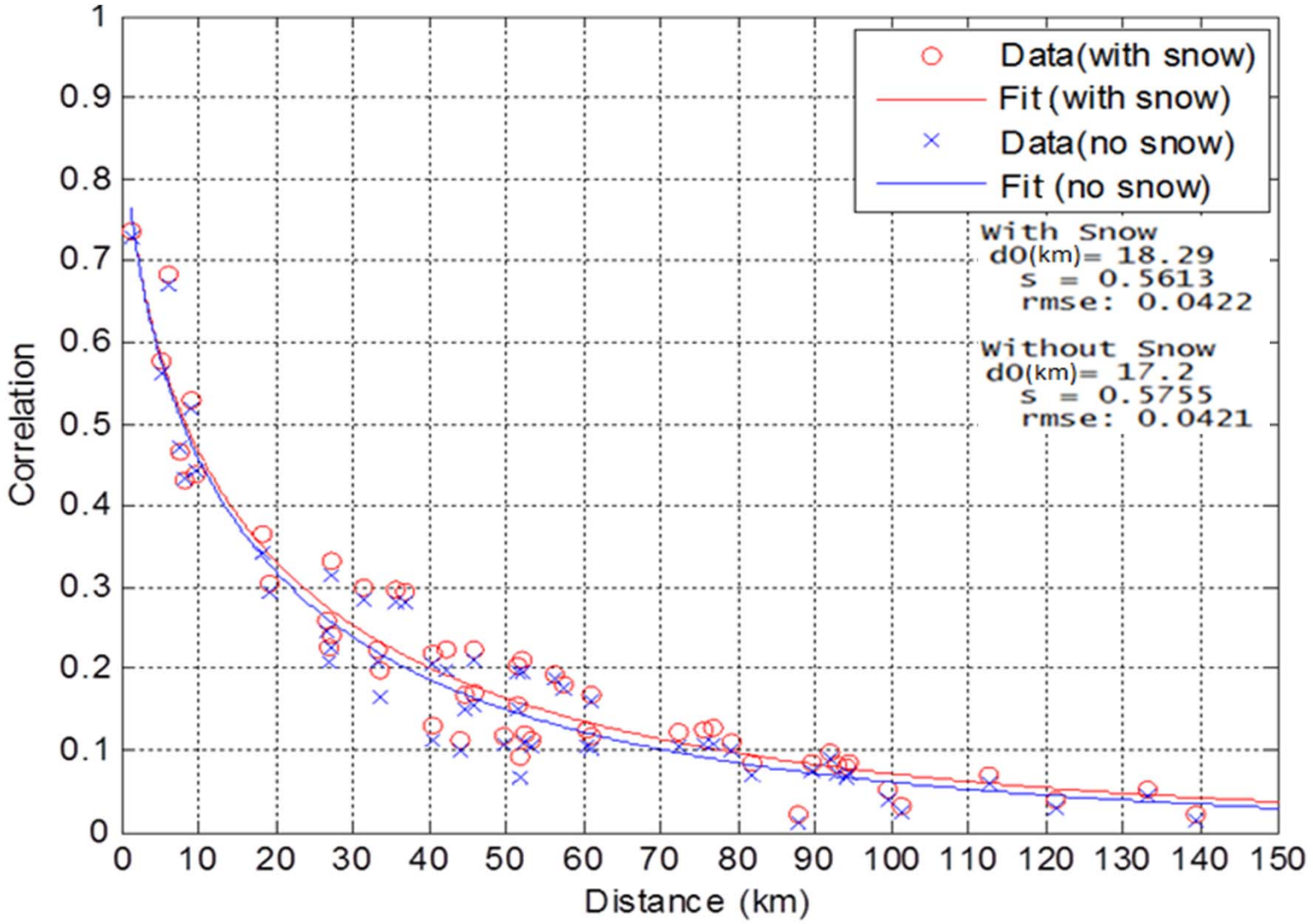


Climatology (warm/cold, yearly)

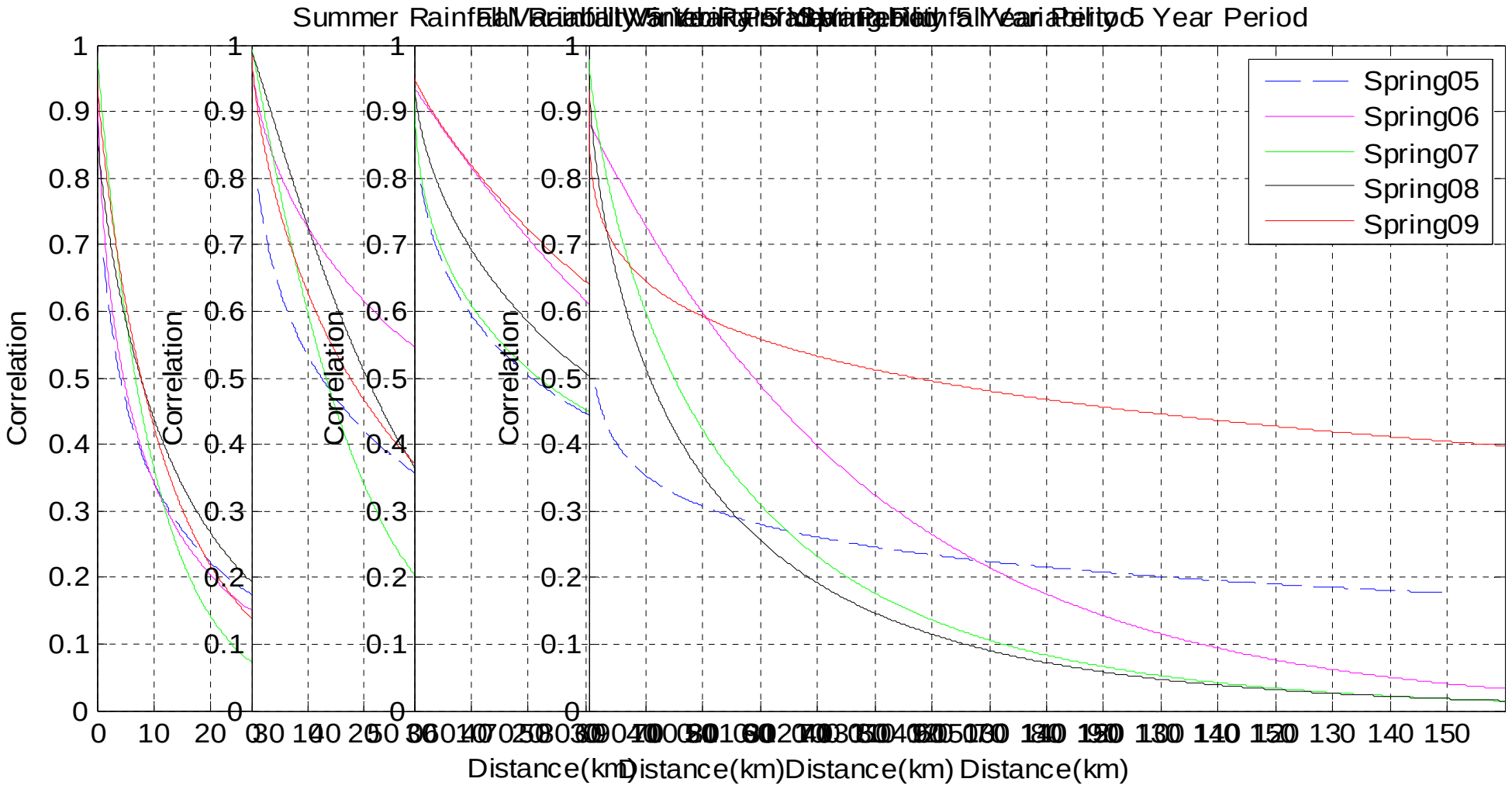




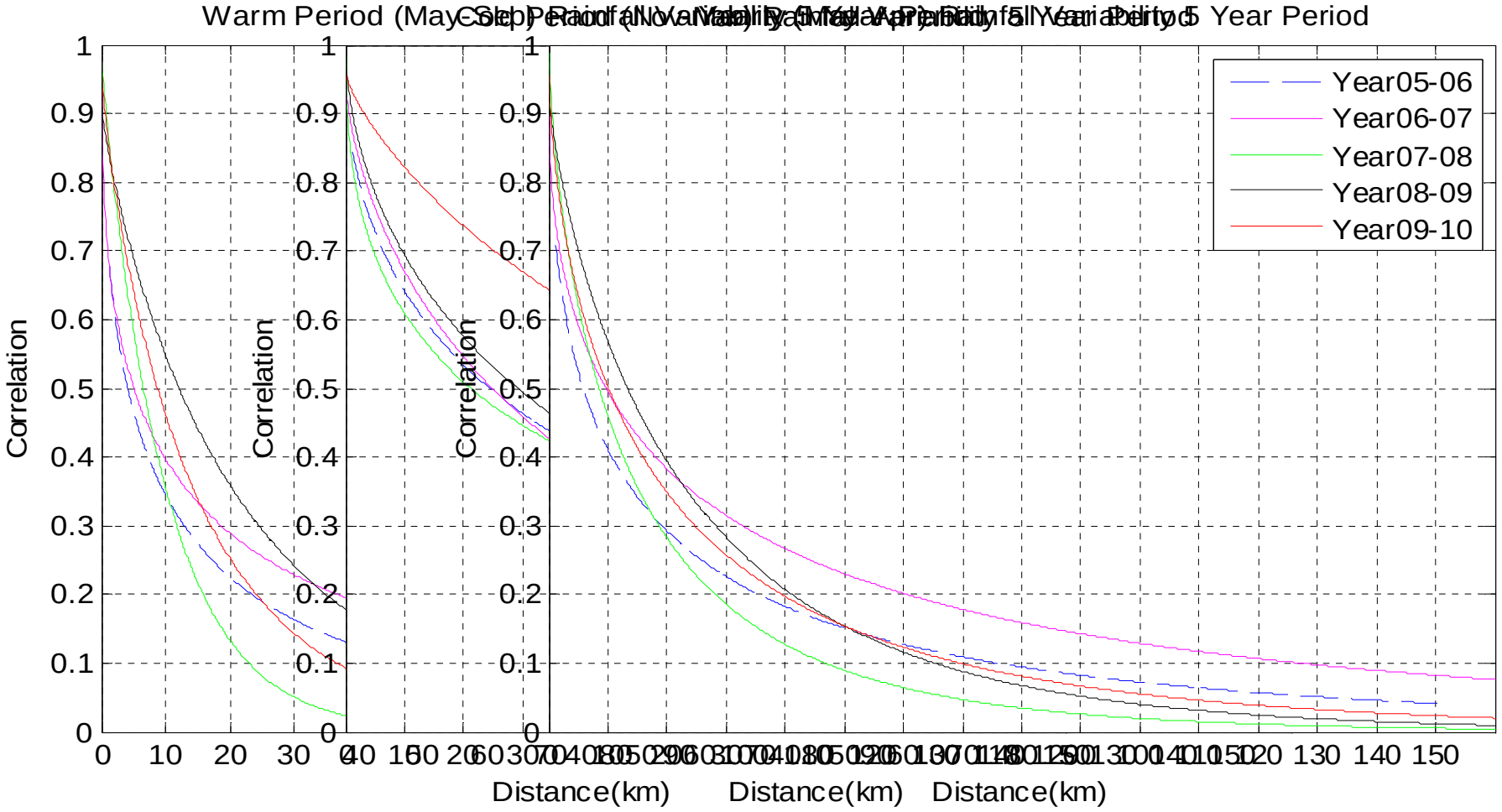
Spatial Variability (snow/no-snow)



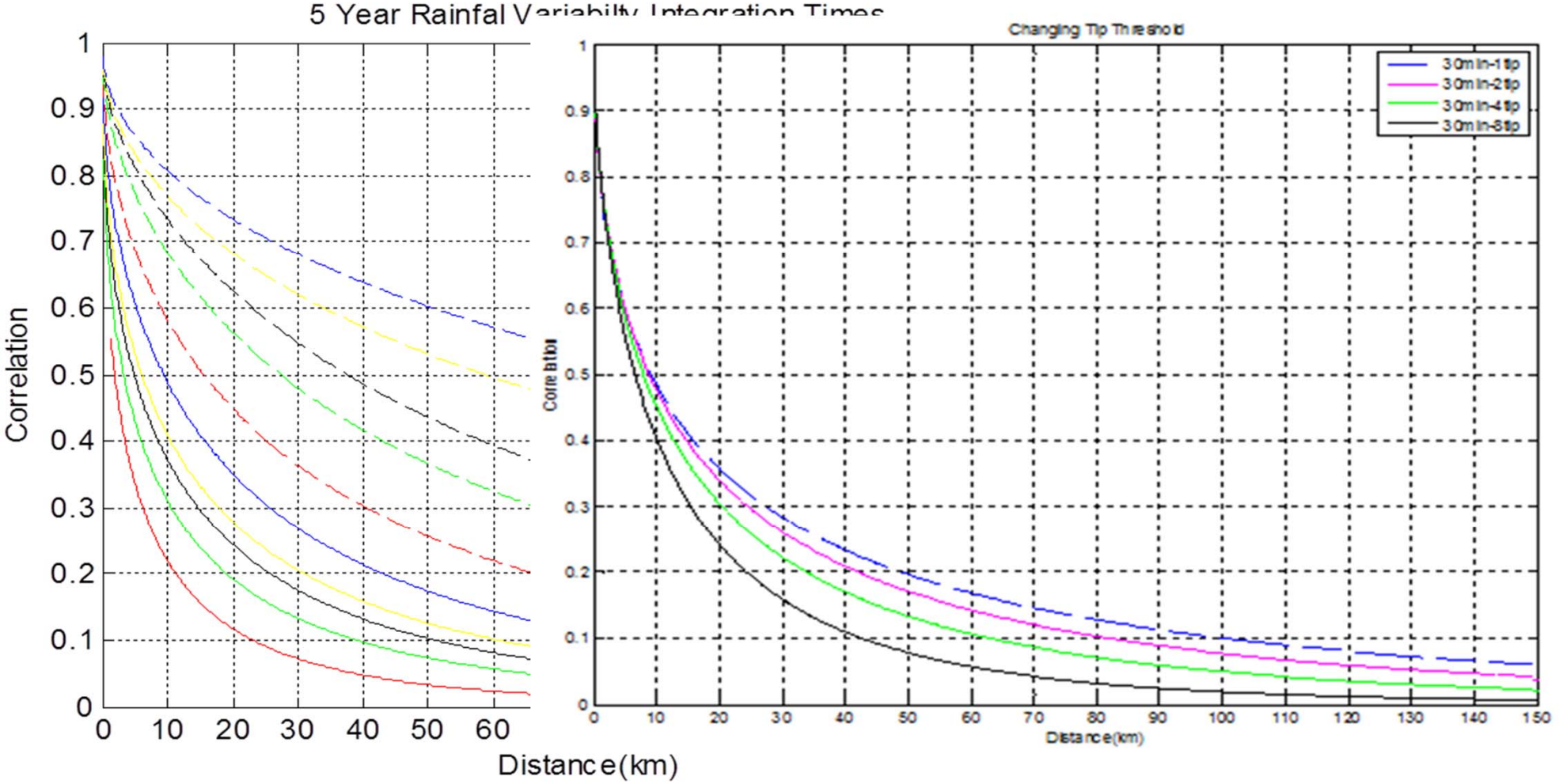
Spatial Variability (seasons)



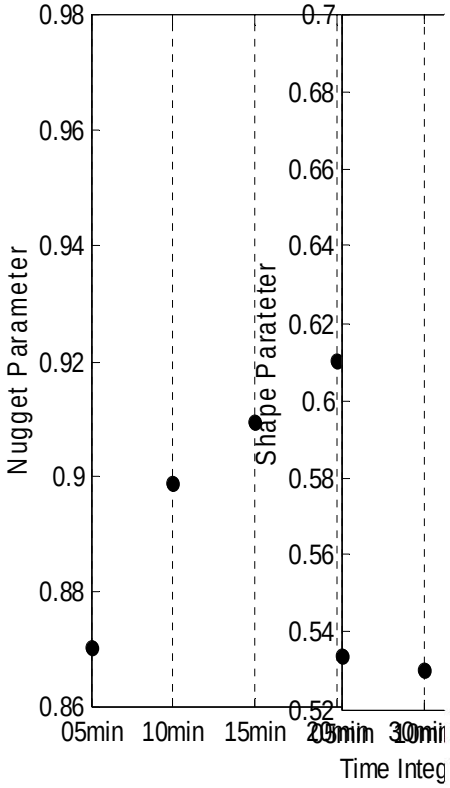
Spatial Variability (warm/cold, yearly)

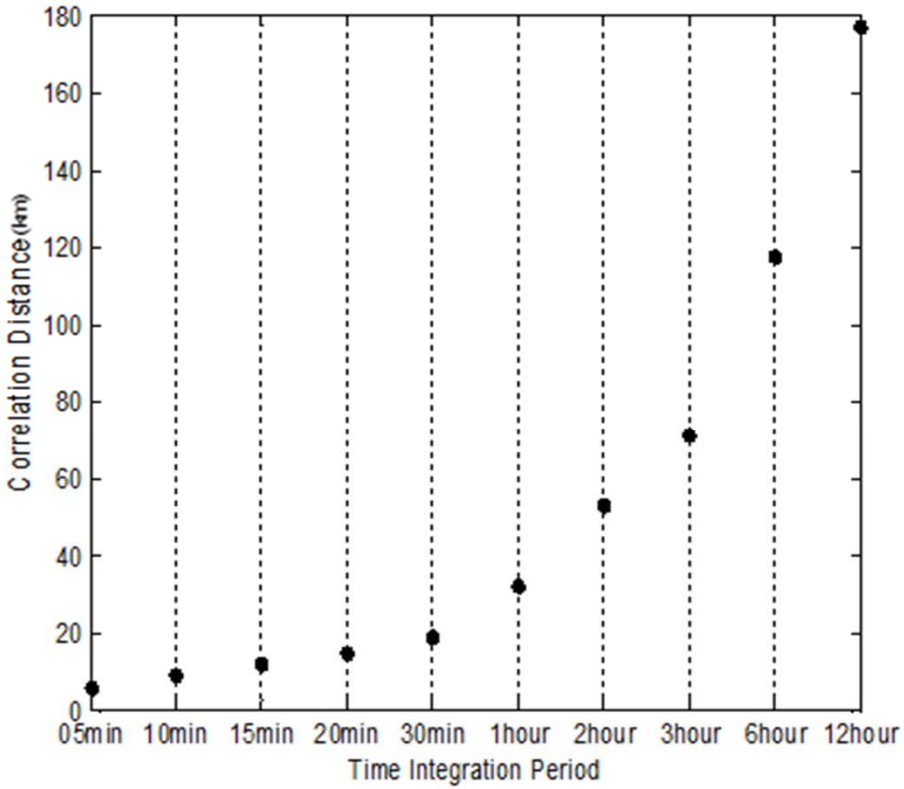


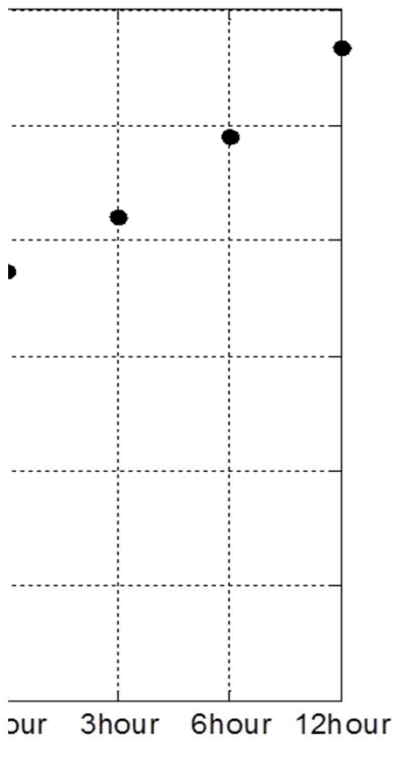
Spatial Variability (rain thresholds)



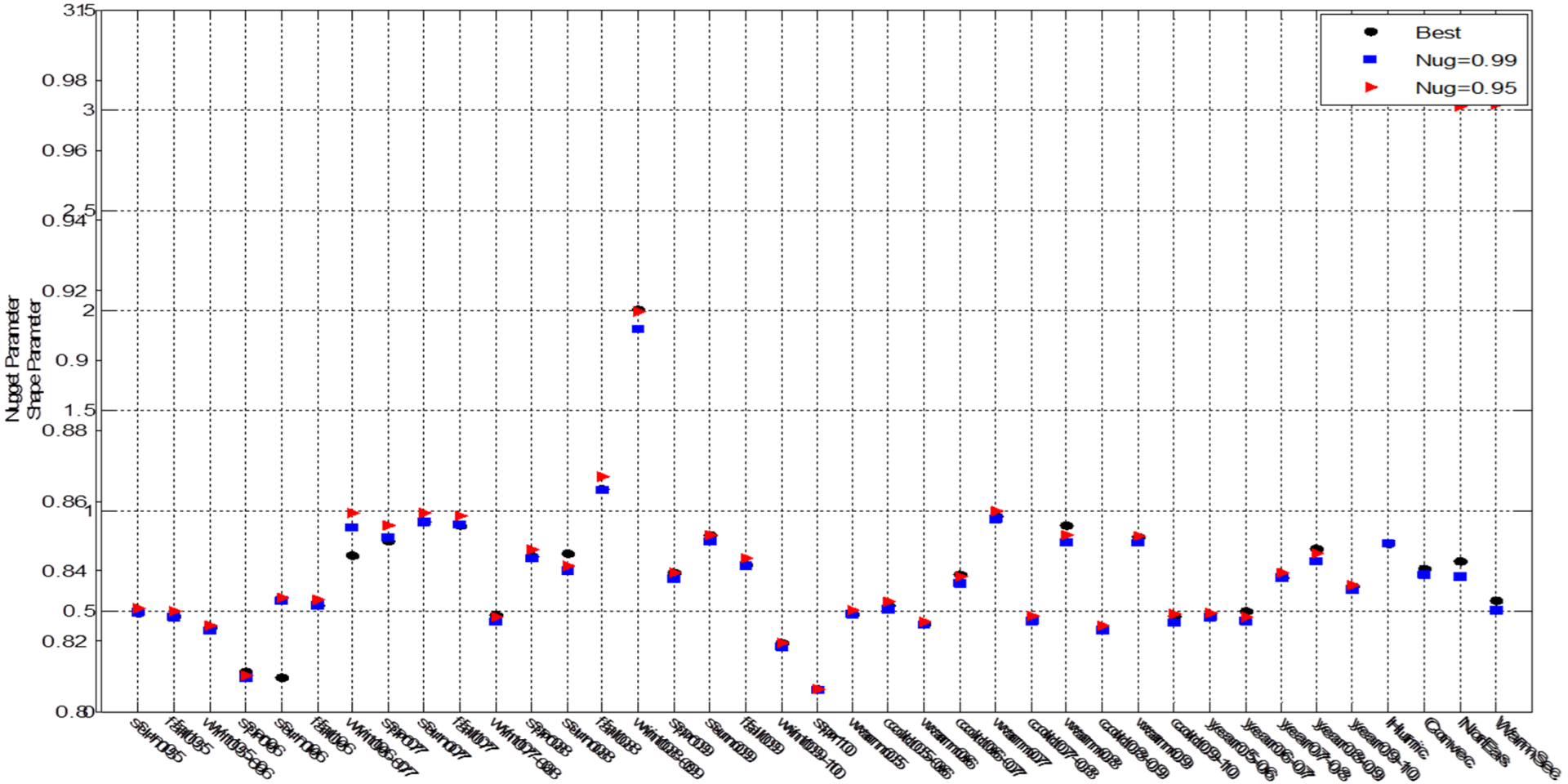
Parameters of Exponential Fit



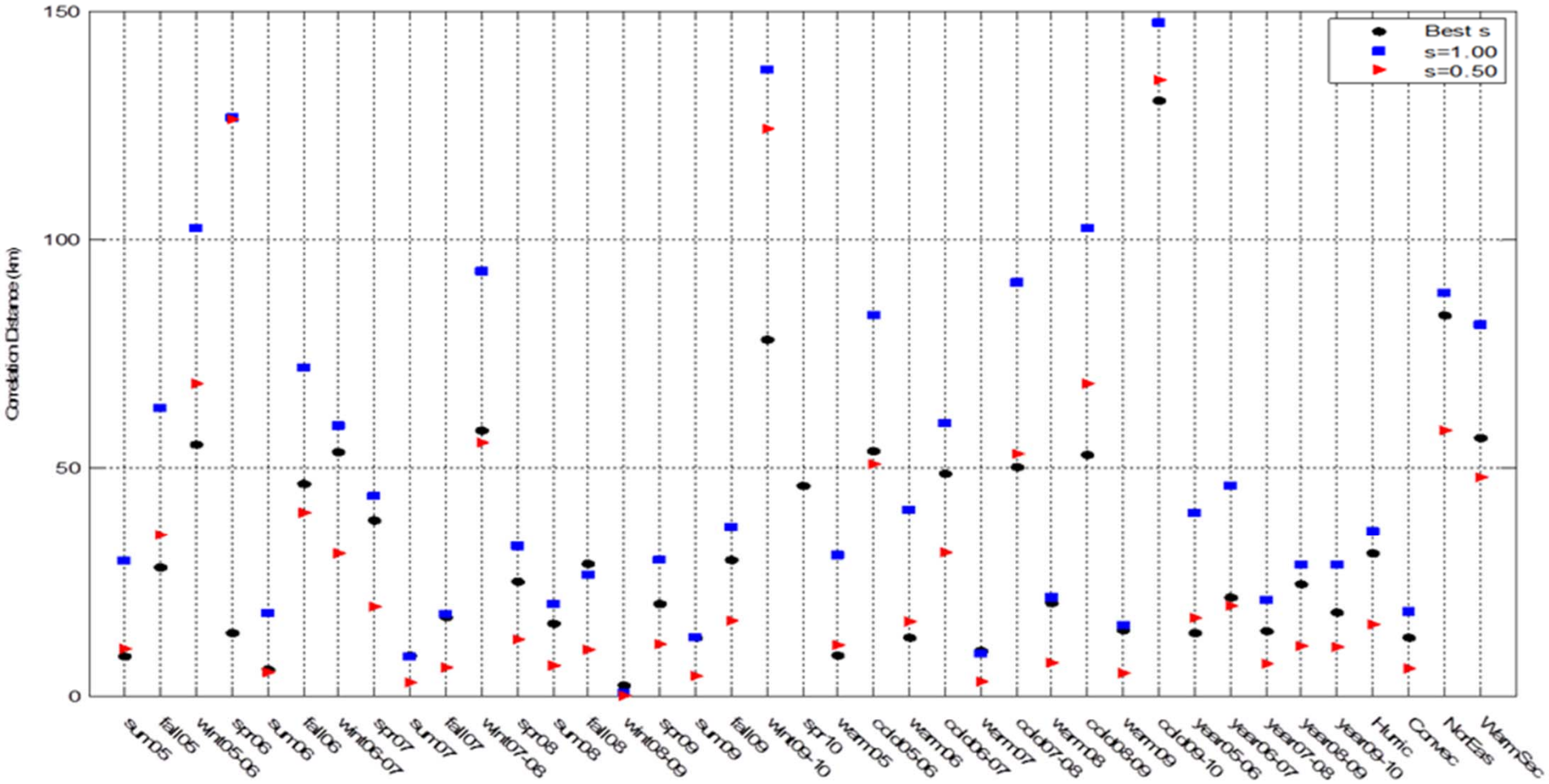




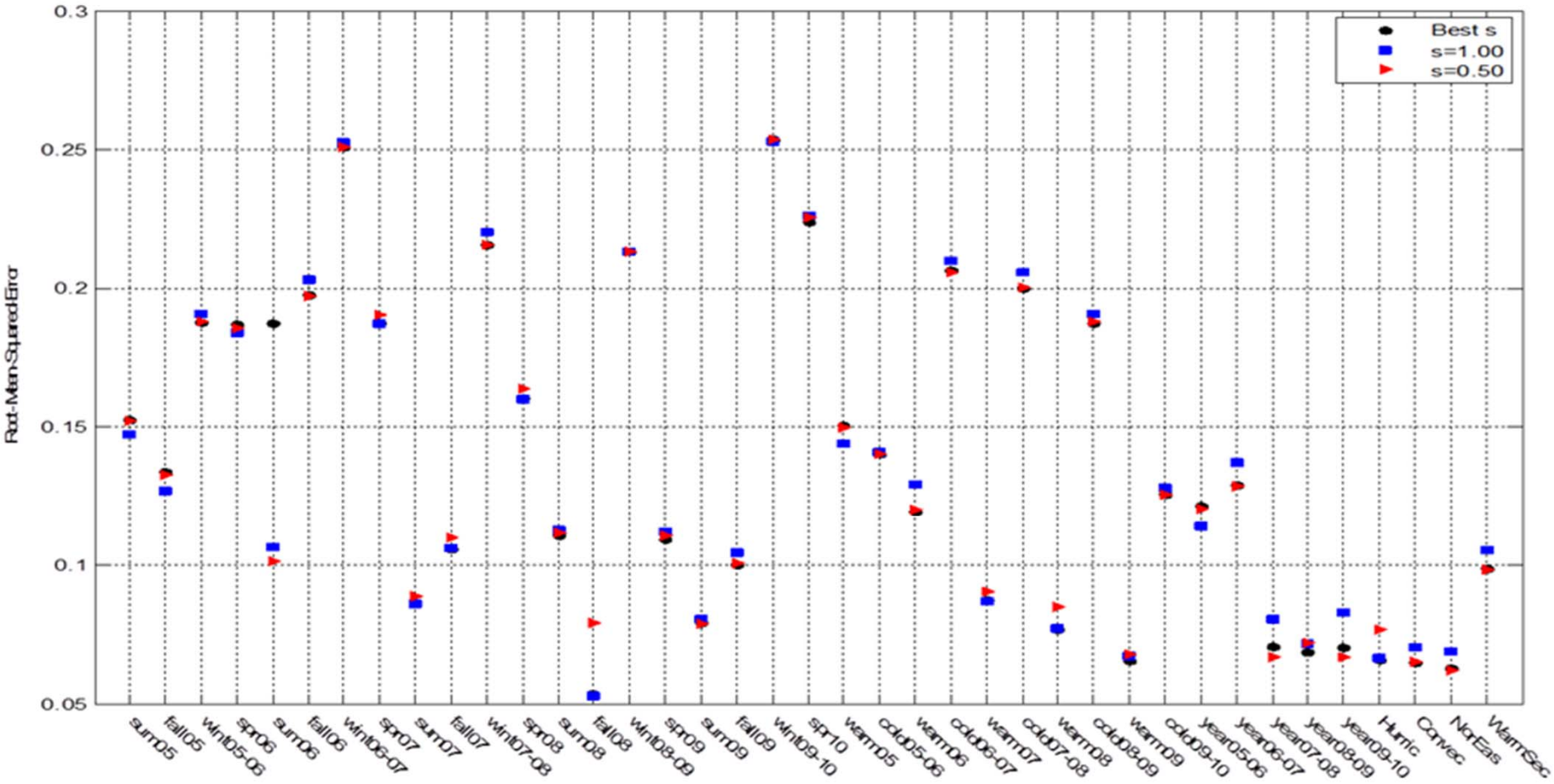
Parameters of Exponential Fit



Parameters of Exponential Fit



Parameters of Exponential Fit



Conclusions

- The correlations fell below 40% at 10 km distance most of the time at a given observational period, while they were below 20% at 50 km distance.
- The variability was more noticeable between the seasons than between the warm/cold periods and between the years. Among the seasons, spring and fall had more year to year variability.
- The parameters of the stretched exponential fit mostly increased with the integration period.
- The nugget parameter was mainly above 0.95 while the shape parameter was mainly between 0.4 and 1.0. The correlation distances remained mostly less than 50 km at a given observational period, while the rmse was less 0.25.
- The variability between the years at a given season may be attributed to the differences in rainfall characteristics. The remnants of tropical cyclones bring abundant rainfall to the Mid-Atlantic region but they may not be observed at a given year.

Status and Future Research

- Seven more sites has been added to the network.
- A dense rain gauge network is deployed to Nassawadox, Virginia. The network will include 25 dual gauge sites at 1 km separation distance in a nearly square area.
- S-band polarimetric radar (NPOL) is currently located at WFF but it is expected to be located at Oyster, Virginia.
- Laser-optical autonomous Parsivel disdrometers will be at dense gauge network site (Phase I) and across Delmarva Peninsula (Phase II).
- The new setup will provide additional data source to investigate the rainfall variability within the satellite IFOV.

Acknowledgements

- Dr. Fernando Miralles
    - WaterSCAPES program