Analysis of Climatological Rainfall Extremes Over the Kennedy Space Center Complex Using a High-Density Observational Network

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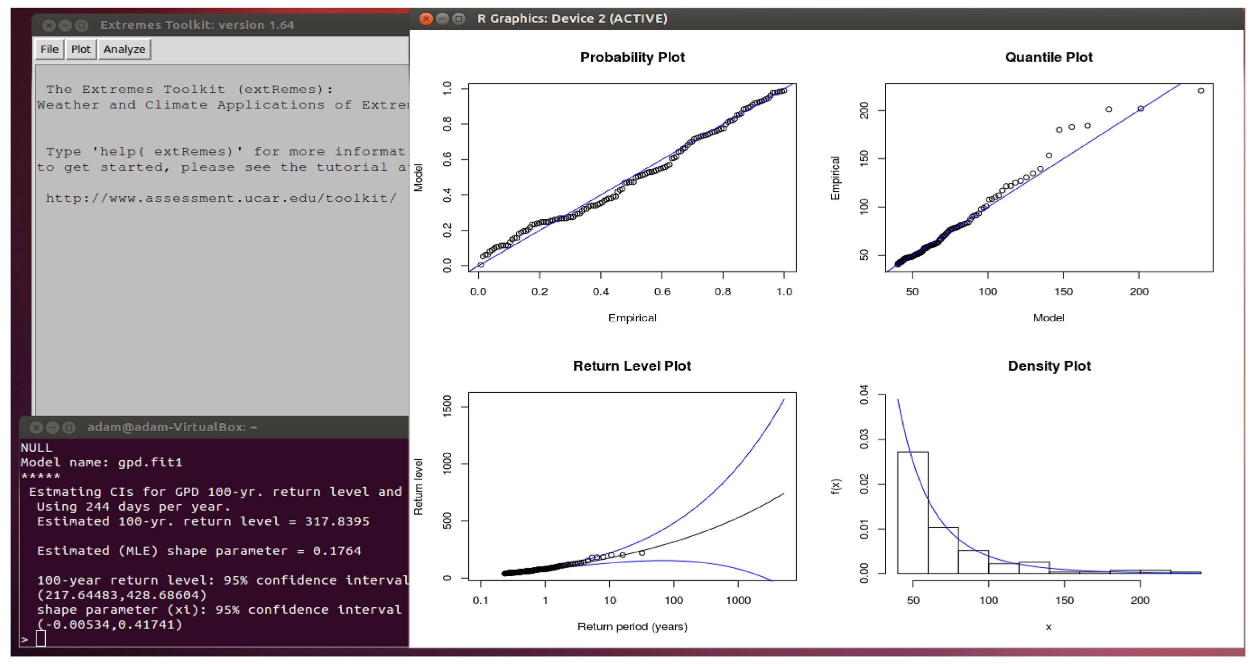
Introduction

- The use of observational datasets to determine the occurrence frequencies of extreme weather events has gained a lot of recent interest due to concerns about the potential regional impacts from global climate change (Gilleland and Katz, 2006).
- Extreme value analysis (EVA) can quantify the return frequency of the most extreme events using climatologically short data sets (Coles, 2001).
- The resulting analyses must be used with caution since they may not accurately reflect the potential of extreme events in the future due to climate change and variability.
- Accurately predicting extreme-event likelihood is important for building realistic long-range planning scenarios for weather- and climate-sensitive interests.

Extreme Value Analysis (EVA) and the Extremes Toolkit (Gilleland and Katz, 2006)

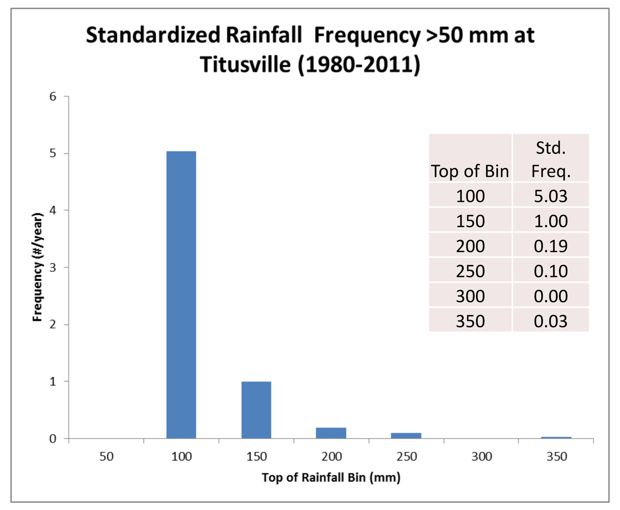
- EVA is used to describe the "tail" behavior of a stochastic process and quantify the likelihood of the unusually large (or small) values.
- The likelihood of rare events is usually quantified using a return period.
- EVA is favored over conventional statistical methods that are based on the Central Limit Theorem, because the normal distribution is often misleading when used to quantify the likelihood of rare events.
- This study employs the generalized Pareto distribution (GPD) to model threshold exceedances.
- The Extremes Toolkit was developed by NCAR scientists Gilleland and Katz (2006) to facilitate the use of EVA over conventional statistical methods where appropriate.

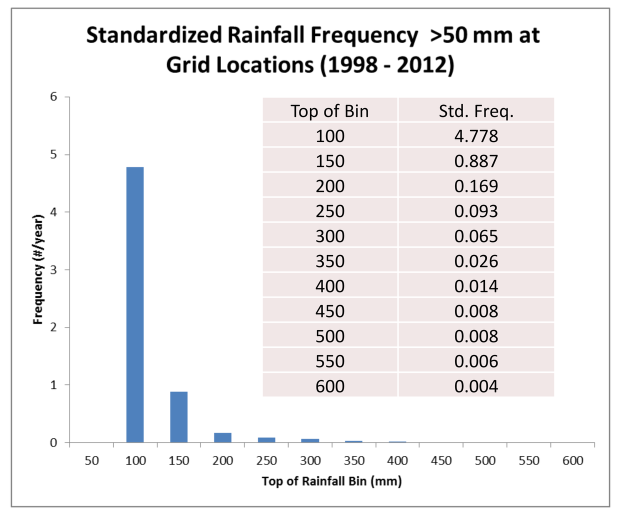


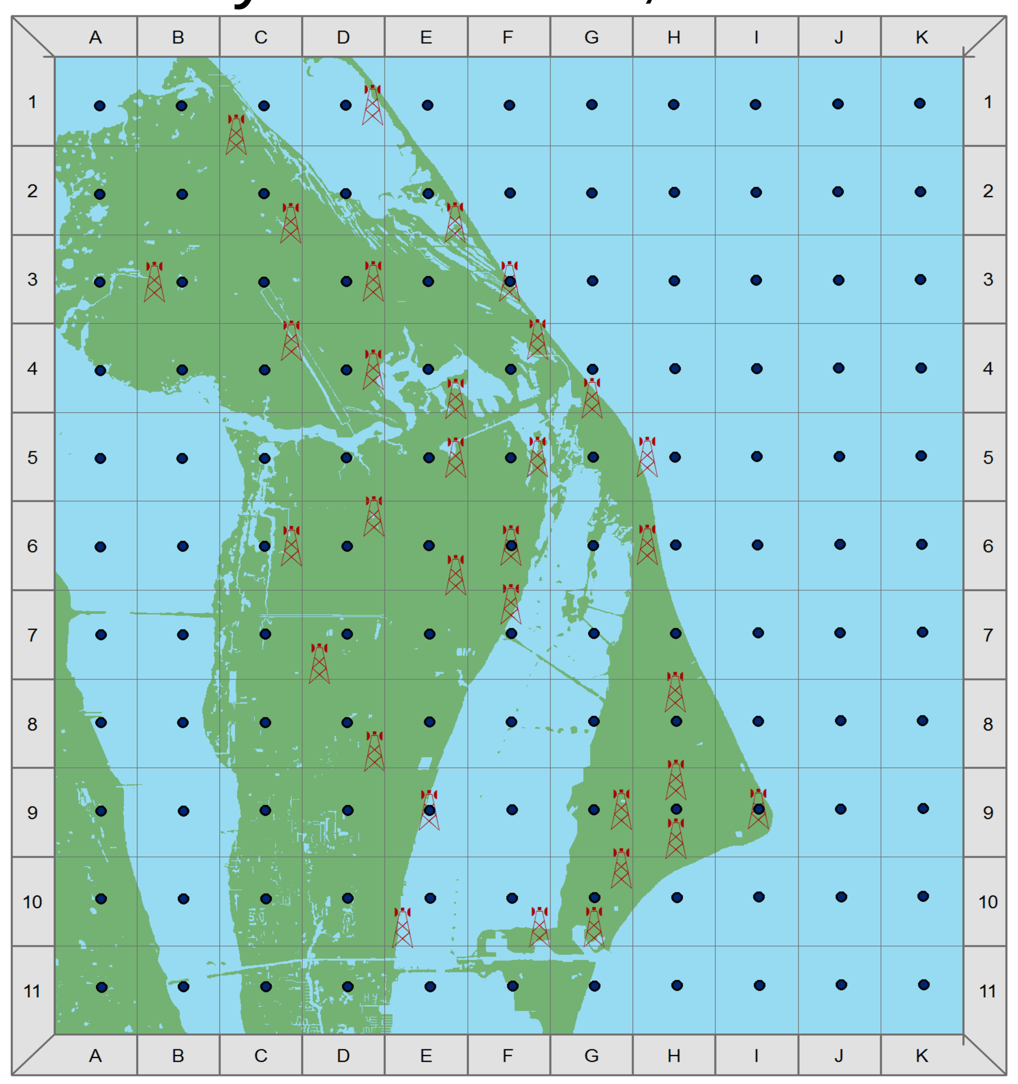
Extremes toolkit output and model fit figures of the Titusville 1980-2011 72hr rainfall

Quality Control and Data Gridding

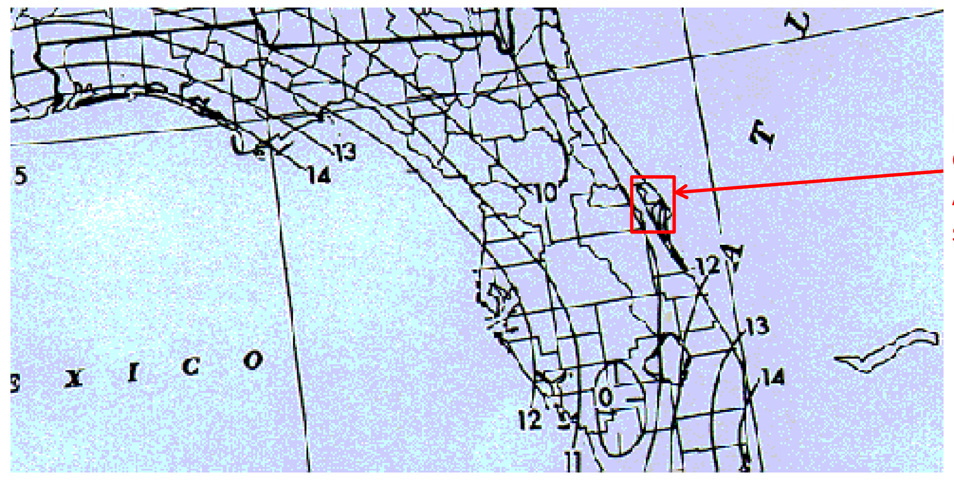
- The observational period of record (POR) from 1998-2012 was acquired from the Tropical Rainfall Measuring Mission (TRMM) website.
- The data was quality controlled and objectively gridded using the General Meteorology Package (GEMPAK) and the built-in Barnes gridding scheme.
- Smoothing of the data was minimized in order to preserve the extremes within the observational data.
- Grid values provided a more complete time series for EVA than the quality controlled observational data.



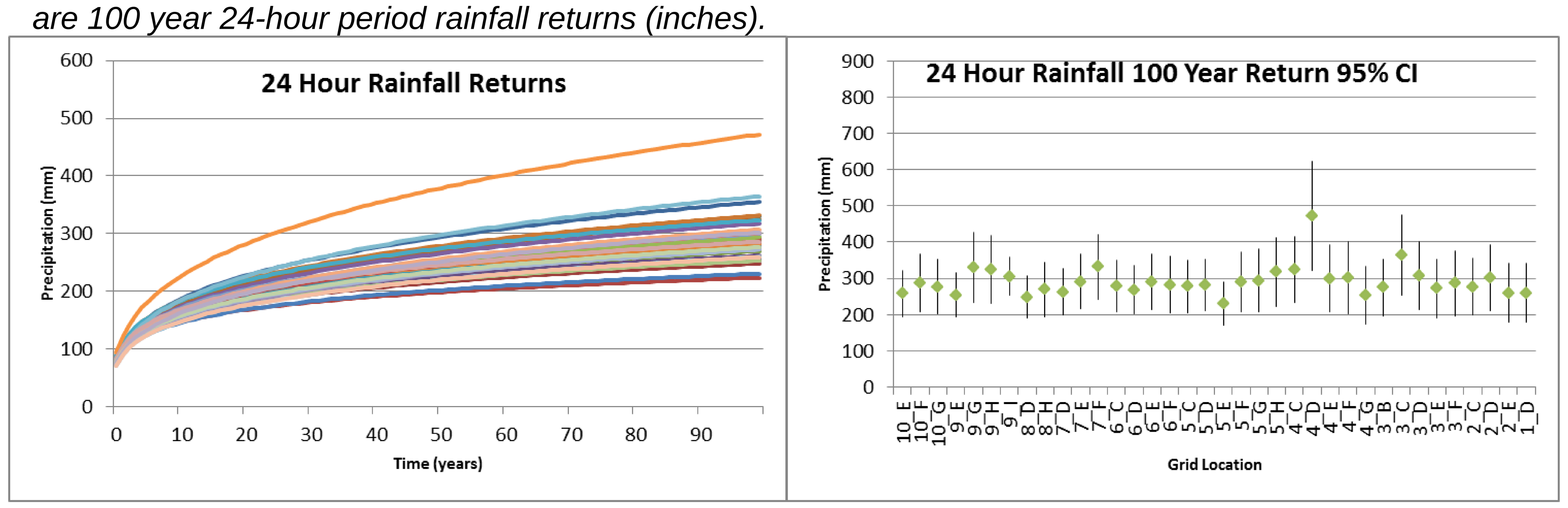




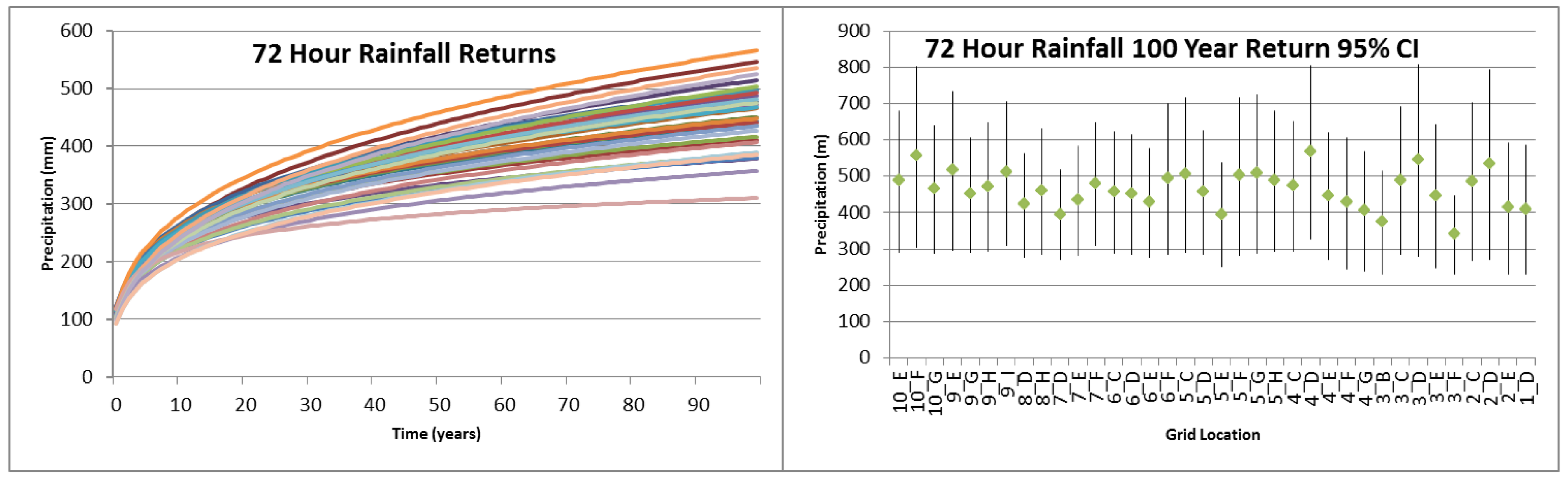
Left Figures: The upper tail of the gridded data distribution (top left) appears to be similar to that of the longer period of record at the Titusville ASOS (bottom left).
Right Figure: Rainfall analysis domain, with blue dots representing grid locations indexed by vertical and horizontal axis coordinates. Red towers represent observation sites with tipping bucket rain gauges.



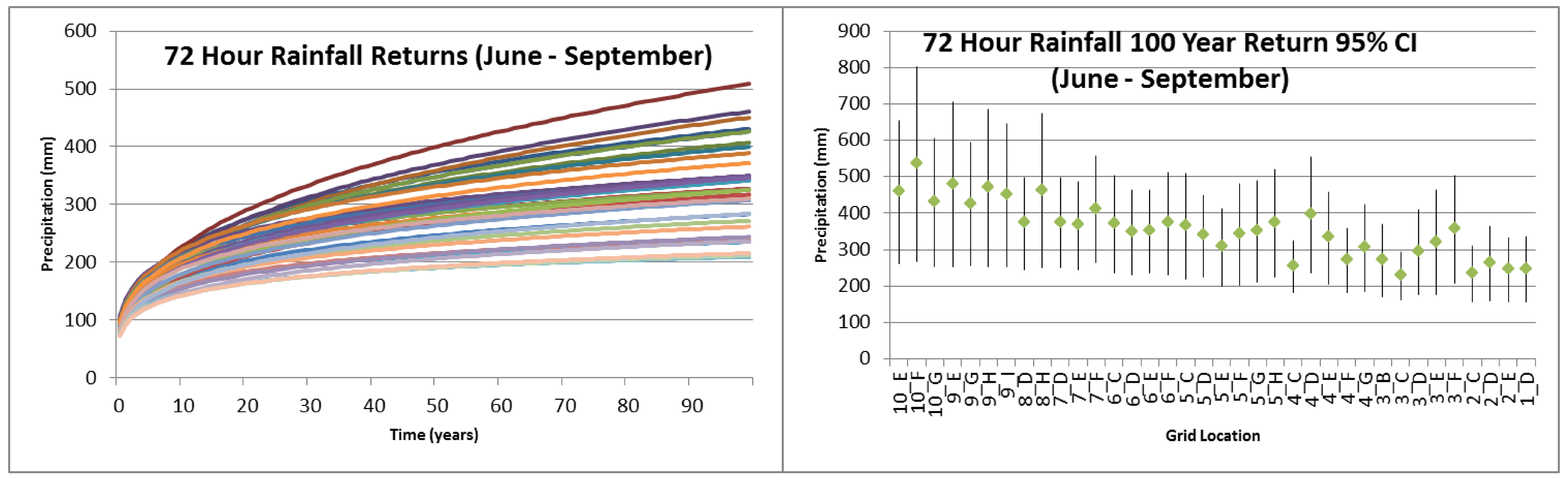
Rainfall Frequency Atlas of the United States quantifies rainfall return levels over the Eastern U.S. This analysis is relatively coarse and values are now over 50 years old (U.S. Weather Bureau,1961). Contours are 100 year 24-hour period rainfall returns (inches).



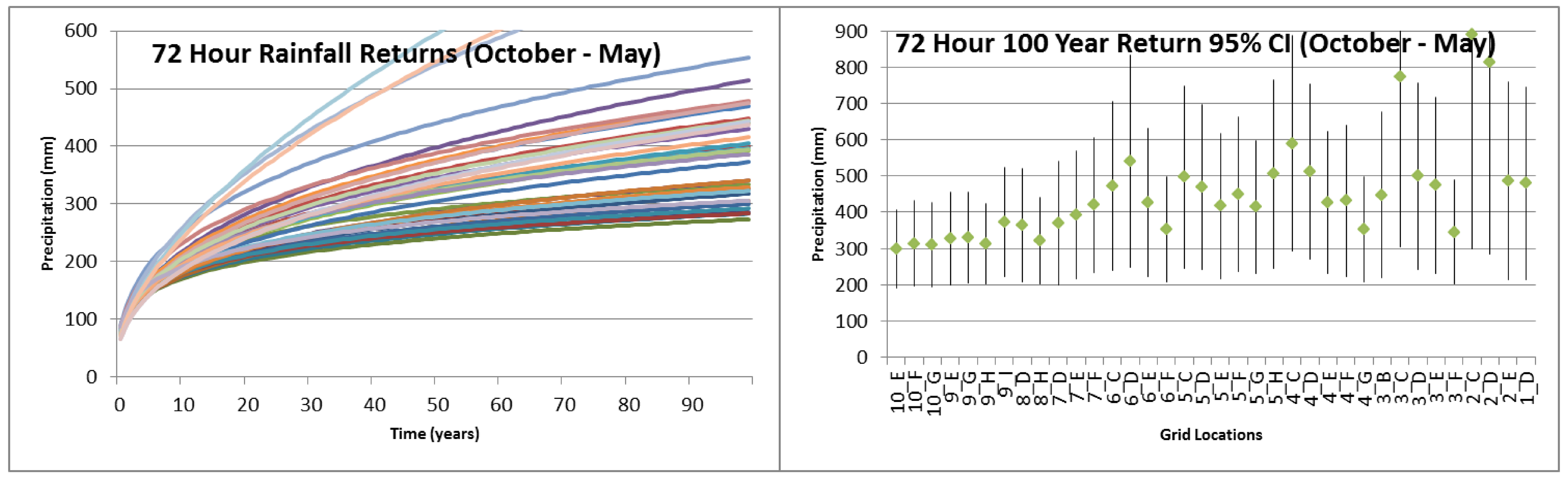
*EVA results at grid points using a threshold of 25 mm without declustering, average exceedances = 204**



*EVA results at grid points using a threshold of 50 mm with declustering, average exceedances = 83**



*EVA results at grid points using a threshold of 50 mm with declustering, average exceedances = 50**



*EVA results at grid points using a threshold of 40 mm with declustering, average exceedances = 50**

*Average exceedance is the mean number of values that exceed the threshold.

Preliminary Results

- The rainfall-return analyses resulted in strong model grouping between most of the grid locations.
- The network observed rainfall events during the 1998 – 2012 POR appear to be 100 year events according to EVA results.
- The unrealistic return levels in the dry season are likely caused by high variances within the model due to threshold selection being too high (insufficient number of exceedances).
- There appears to be a geographic difference in the return levels within the wet season.
- Grid locations near the southern side of the network appear to have higher return levels than the north side.
- A best estimate (model consensus) is that the 100-year return event amount is around 300 mm for a 24-hour period and 450 mm for a 72-hour period.
- The observed 72-hour maximum, 627 mm, exceeds the model consensus maximum and suggests that this was an extremely rare event, therefore only considering the 100 year 72-hour event consensus is misleading.

References

Coles, S.G. *An Introduction to Statistical Modeling of Extreme Values.* Springer-Verlag, London.
Gilleland, E., and Katz, R.W., 2006. *Analyzing seasonal to interannual extreme weather and climate variability with the extremes toolkit (extRemes). 18th Conference on Climate Variability and Change*, 29 January – 2 February, 2006, Atlanta, Georgia., American Meteorological Society.
U.S. Weather Bureau, 1961 [Available online at [http://www.erh.noaa.gov/Tp40s.htm]