Regional Trend Analysis for Rainfall of South Florida

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Regional Trend Analysis for Rainfall of South Florida

- Data Preparation
- Selection of Period of Record
- Strategy
- Monthly Statistics
- Frequency Analysis
- Trend Analysis
- Results
- Summary and Conclusion

Regional Trend Analysis for Rainfall of South Florida Objective

- CONSIDER
  - High quality historical rainfall data
  - Fourteen Operation and Management Basins
- CALCULATE
  - Continuous Rainfall time series (monthly, wet/dry seasons and annual)
  - One day, three day and five day maxima per annum
  - Frequency Analysis for One day, three day and five day maxima for 2, 5 and 10 year
- PERFORM Mann Kendall Trend Analysis for
  - Monthly, seasonal, and annual rainfall
  - One day, three day and five day maxima

Regional Trend Analysis for Rainfall of South Florida
Data Preparation

- Traditional Rainfall studies typically
  - consider a select of rainfall stations
  - prepare continuous time series for each station by filling the missing gaps
  - Calculate necessary statistics, e.g., frequency analysis, then apply certain factors (e.g., Areal Reduction Factors) to represent a region.
  - Rainfall statistics are often interpolated across all stations defined on a grid to prepare isohyetal lines
  -

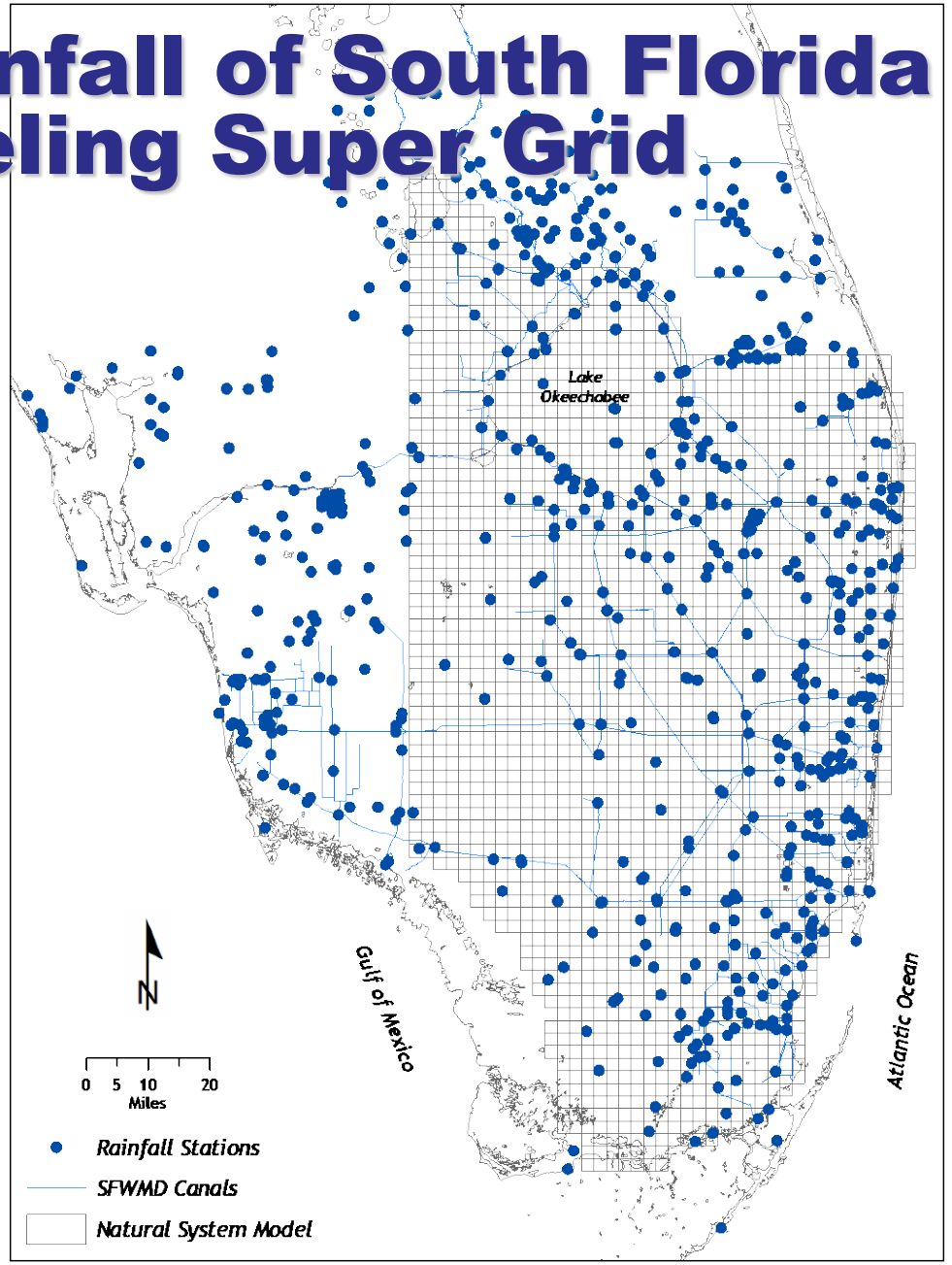
Regional Trend Analysis for Rainfall of South Florida Selection of Period of Record

- Current Rainfall Study
  - considers rainfall input data of the SFWMD premier models
  - Interpolate rainfall on a grid using one of two methods obviating the need to fill missing gaps manually.
  - Considering 14 management basins, for each basin obtain average rainfall data across the group of grid cells belonging to that basin to obtain a continuous time series for subsequent frequency and trend analyses.
  - Previous frequency analysis studies have found data starting from 1935 to be adequate to properly characterize spatial rainfall patterns across the district areas.
  - Period of Record selected is 1/1/1935-12/31/2018

Regional Trend Analysis for Rainfall of South Florida
Rainfall stations and Modeling Super Grid

Rainfall stations spatial distribution.

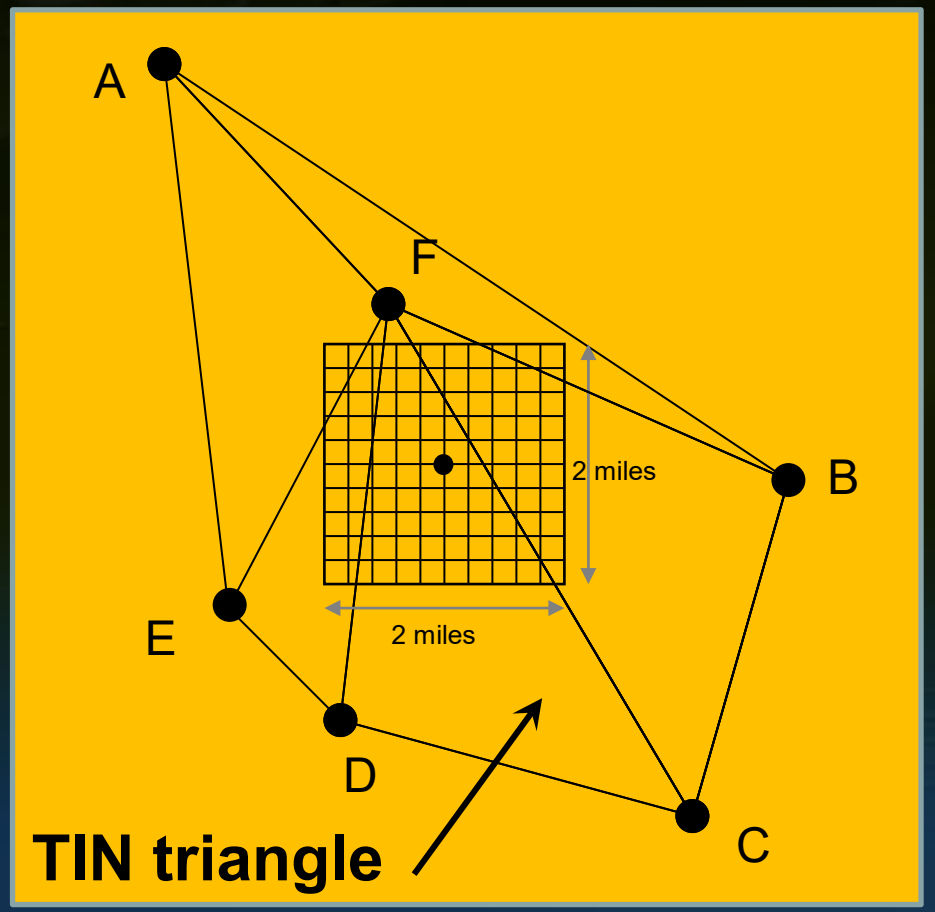
- Number of stations with existing records changes with time and hence left unspecified.



Regional Trend Analysis for Rainfall of South Florida
TIN-10 Estimation for a Model Grid Cell

- A 2X2 mile model grid is divided into 10X10 sub-cells.
- Each TIN triangle plane is used to interpolate rainfall at the intersected sub cells centroids.
- The average of rainfall at the 100 sub-cells provides rainfall estimate at the centroid of the 2X2 mile cell

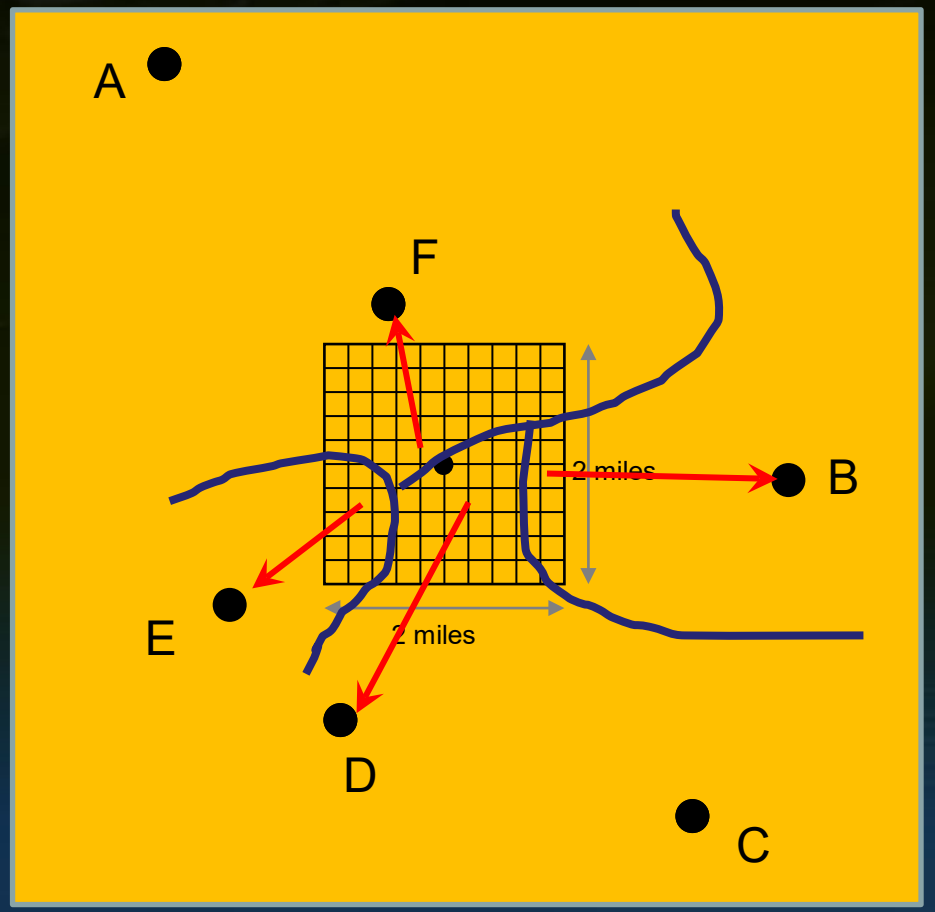
A thru F are rainfall stations with active records



Regional Trend Analysis for Rainfall of South Florida Thiessen-10 Estimation for a Model Grid Cell

- A 2X2 mile model grid is divided into 10X10 sub-cells.
- Each sub-cell is assigned the nearest neighbor.
- The average of rainfall at the 100 sub-cells provides rainfall estimate at the centroid of the 2X2 mile cell

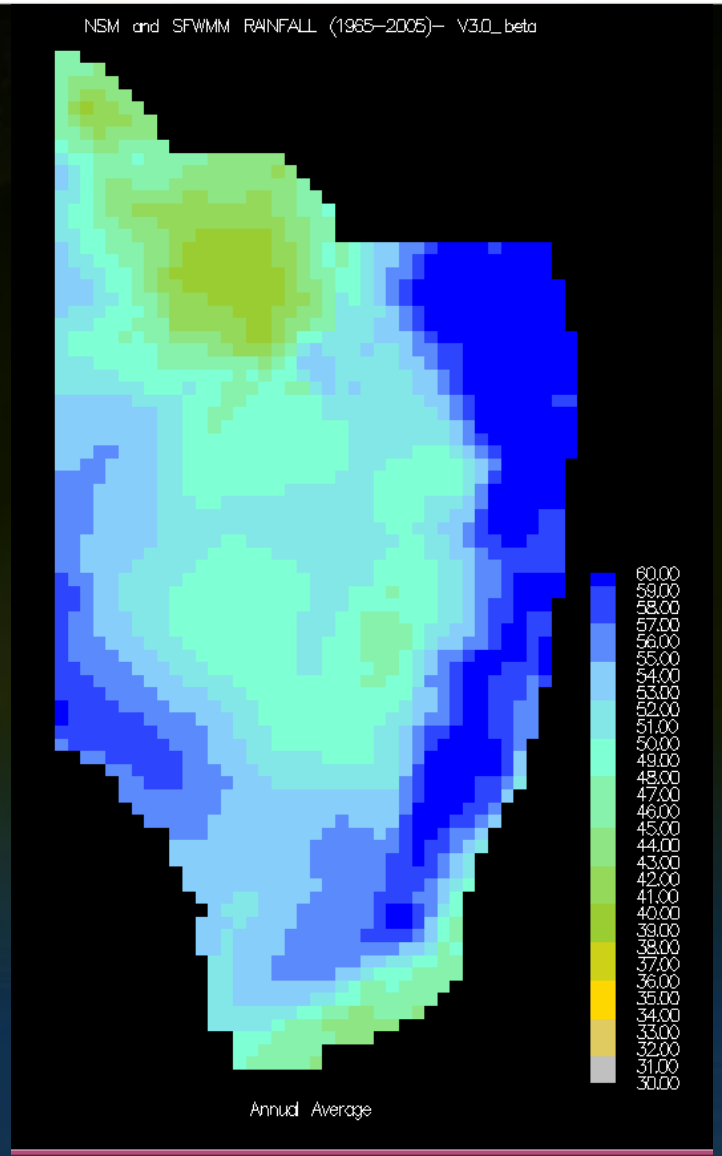
A thru F are rainfall stations with active records



Regional Trend Analysis for Rainfall of South Florida
Rainfall Annual Average

- Florida's coastal areas receive more rainfall throughout the year than inland areas.
- Long-term averages indicate South Florida has an annual rainfall of 52 to 53 inches, and three-quarters of it occurs during the wet season and transitional months.

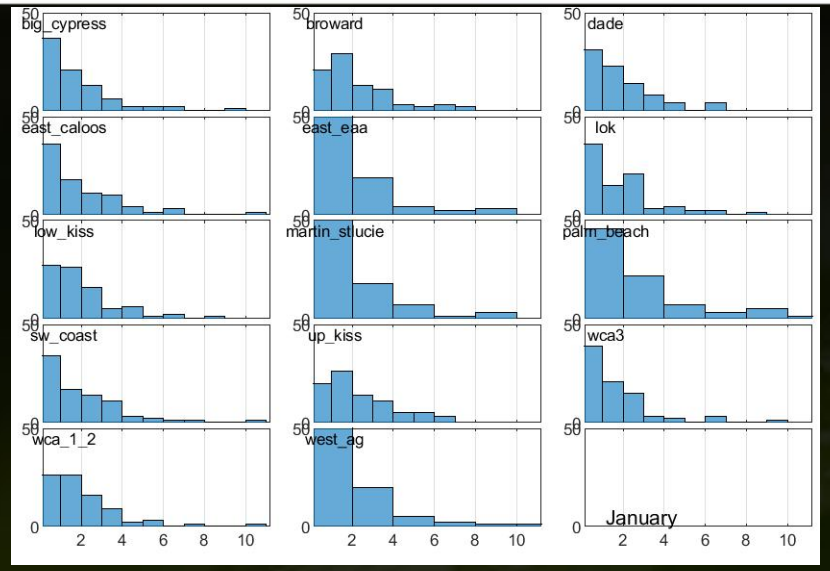
Seasonal Rainfall Averages in South Florida		
Season	Months	Average Regional Rainfall
Dry	November – April	~ 2 inches/month
Transitional	May and October	~ 4 inches/month
Wet	June – September	~ 7 inches/month

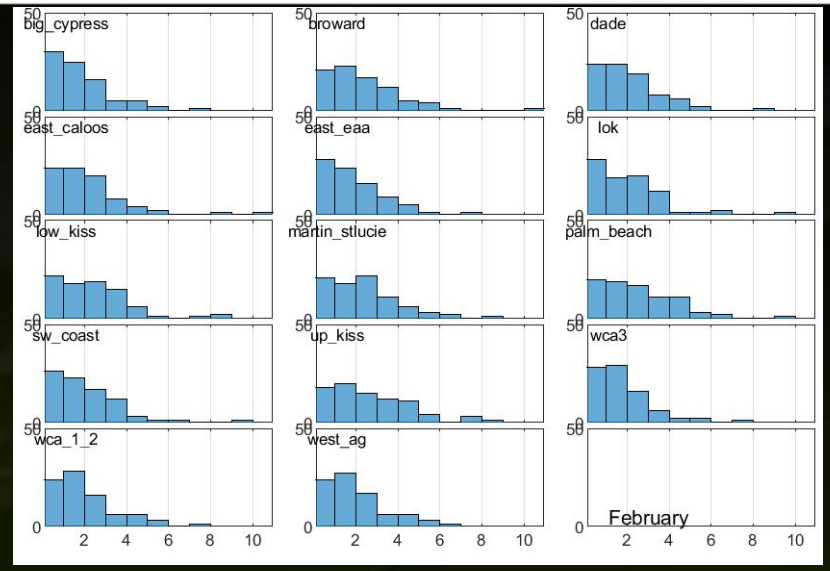


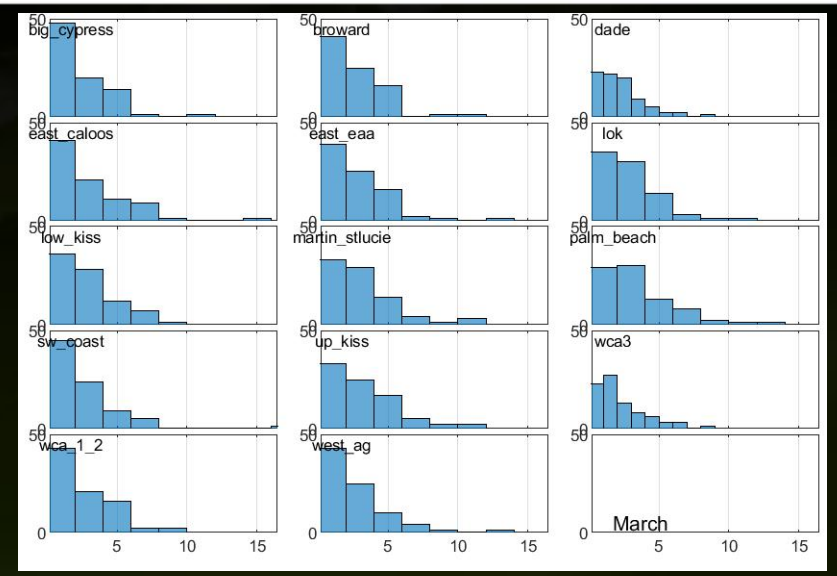
Regional Trend Analysis for Rainfall of South Florida Strategy

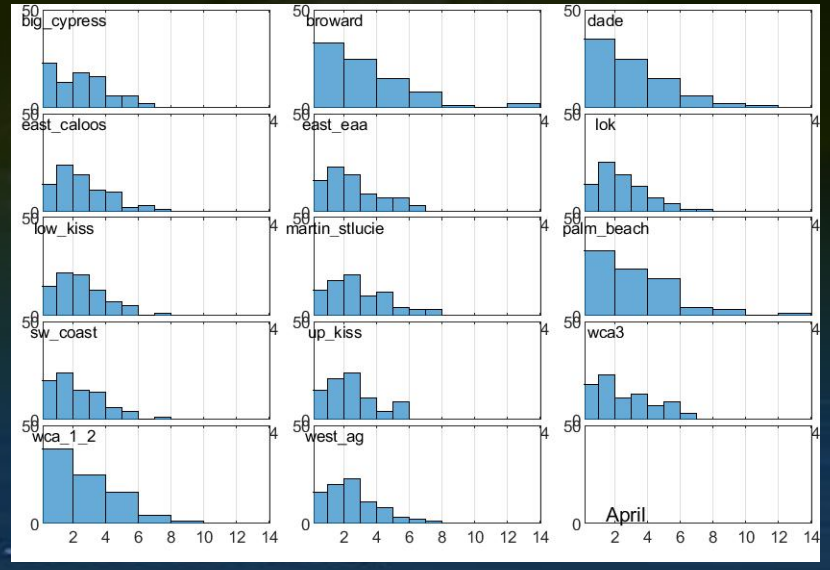
- Spatially interpolate rainfall using Theissen-10 method on the "super grid"
- Calculate continuous regional rainfall daily time series for the 14 management basins for the POR 1/1/1935-12-12/31/2018
- Calculate Monthly, seasonal and Annual rainfall time series for each basin (Group 1)
- Perform Frequency Analysis for 1-, 3- and 5-day maxima (Group 2)
- Perform trend analysis on the two groups.
- Results
- Summary and Conclusion

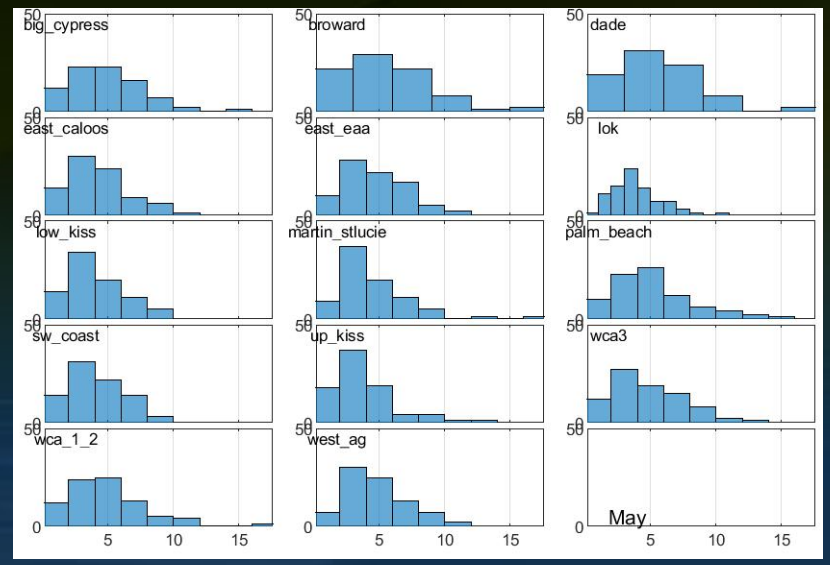
Regional Trend Analysis for Rainfall of South Florida Monthly Maxima

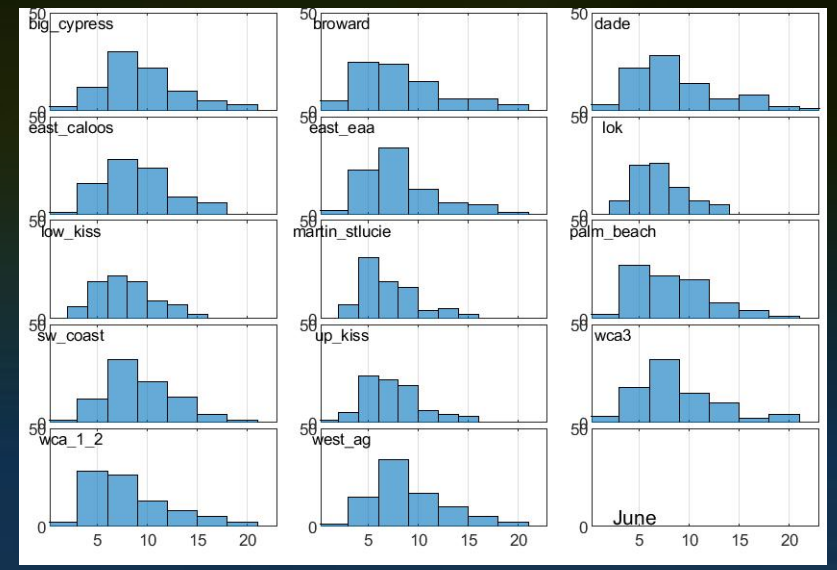




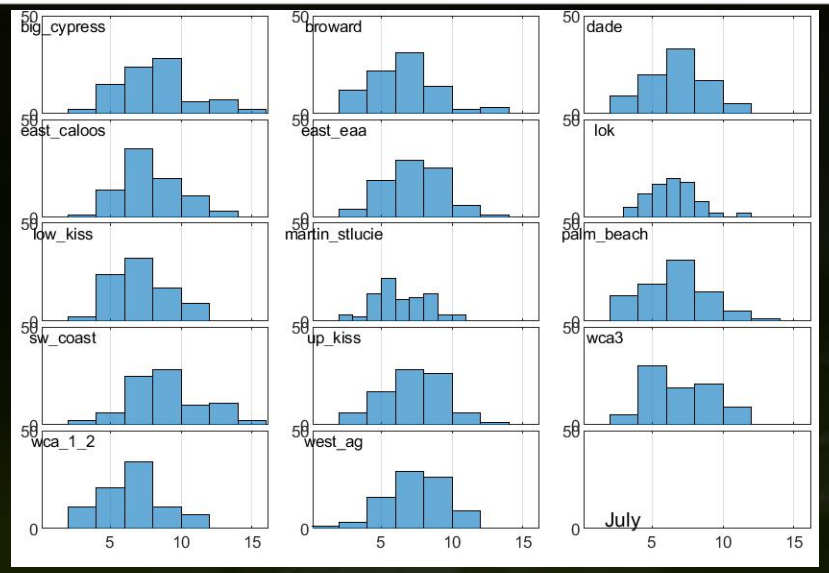


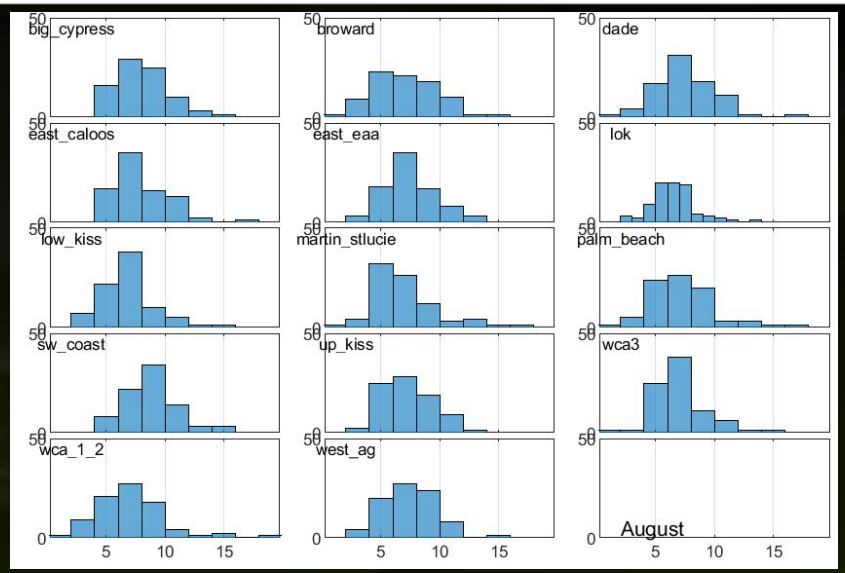


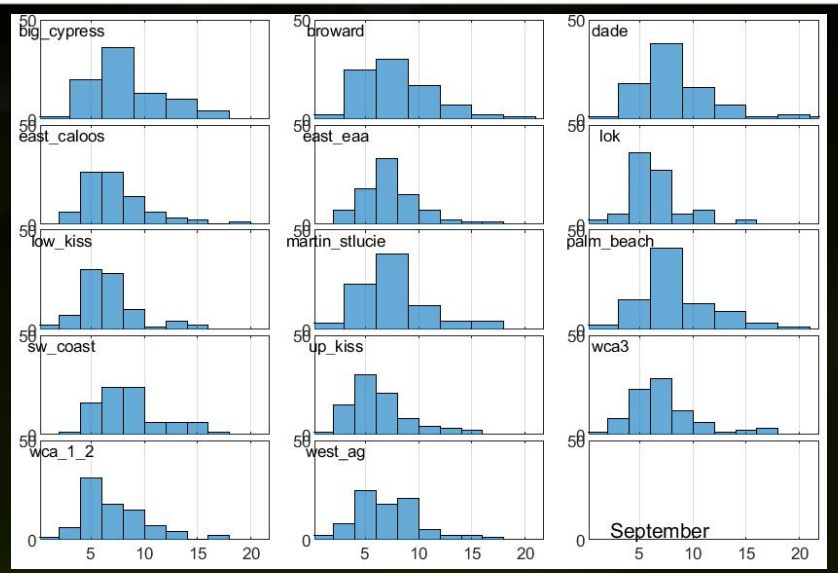


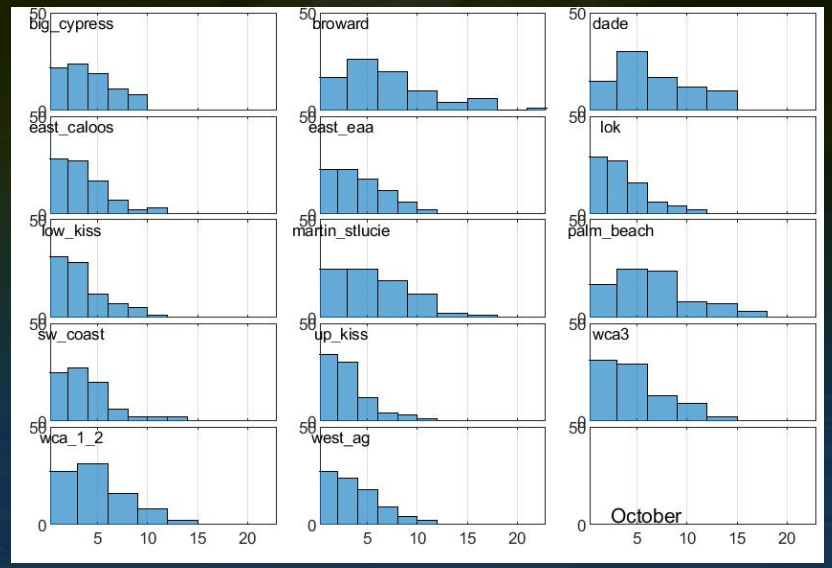


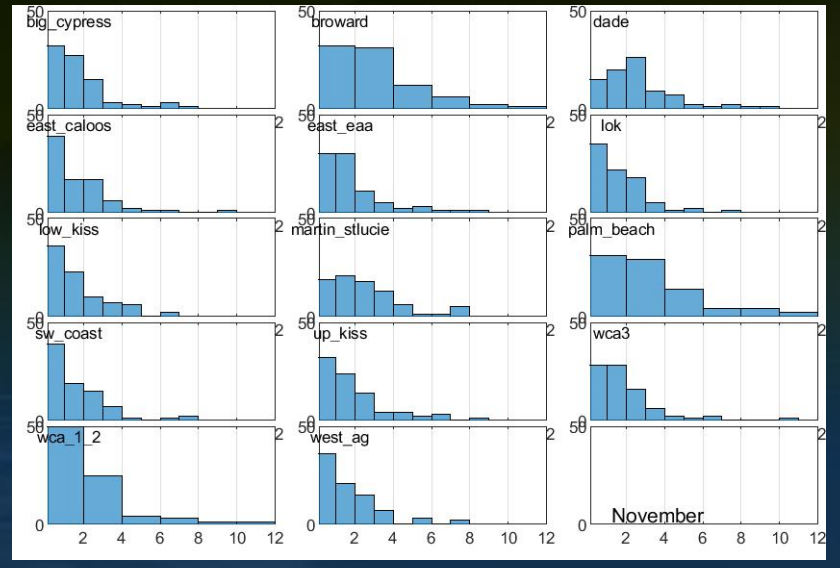
Regional Trend Analysis for Rainfall of South Florida Monthly Maxima Continued

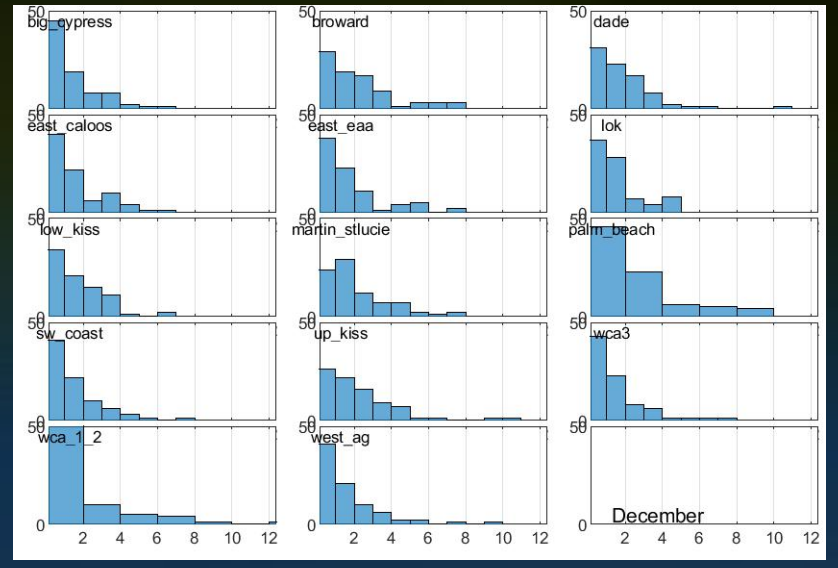




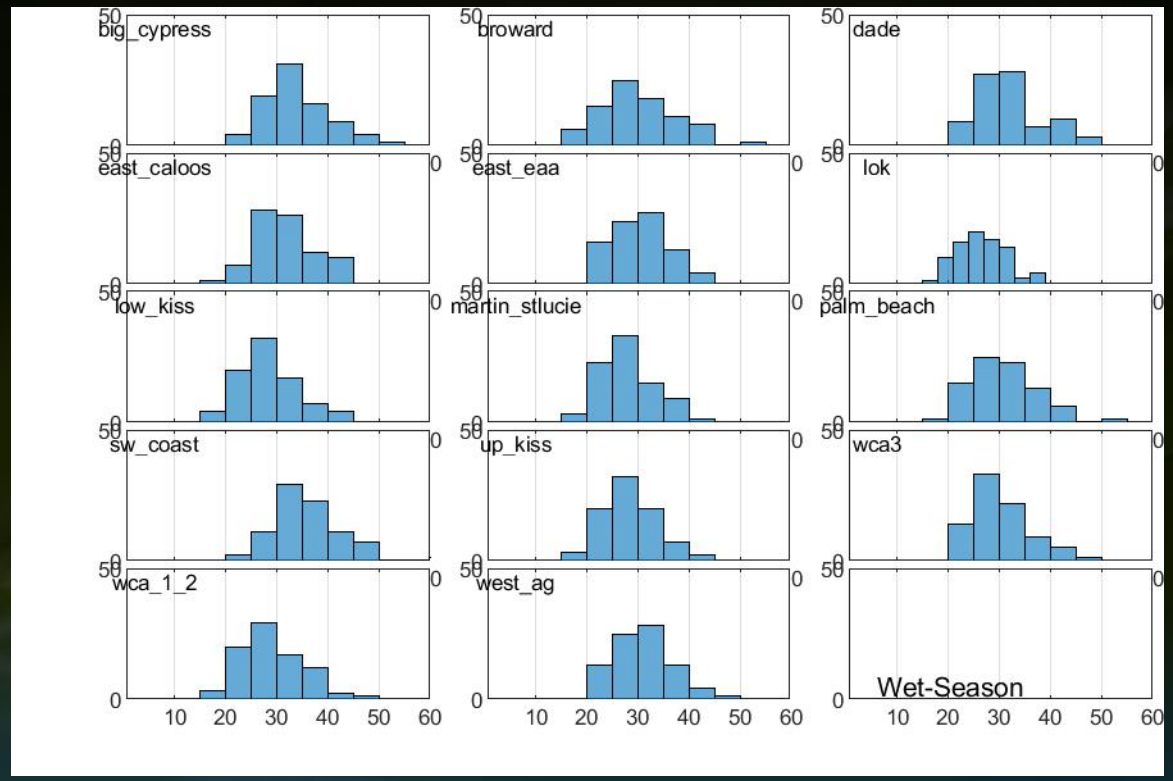


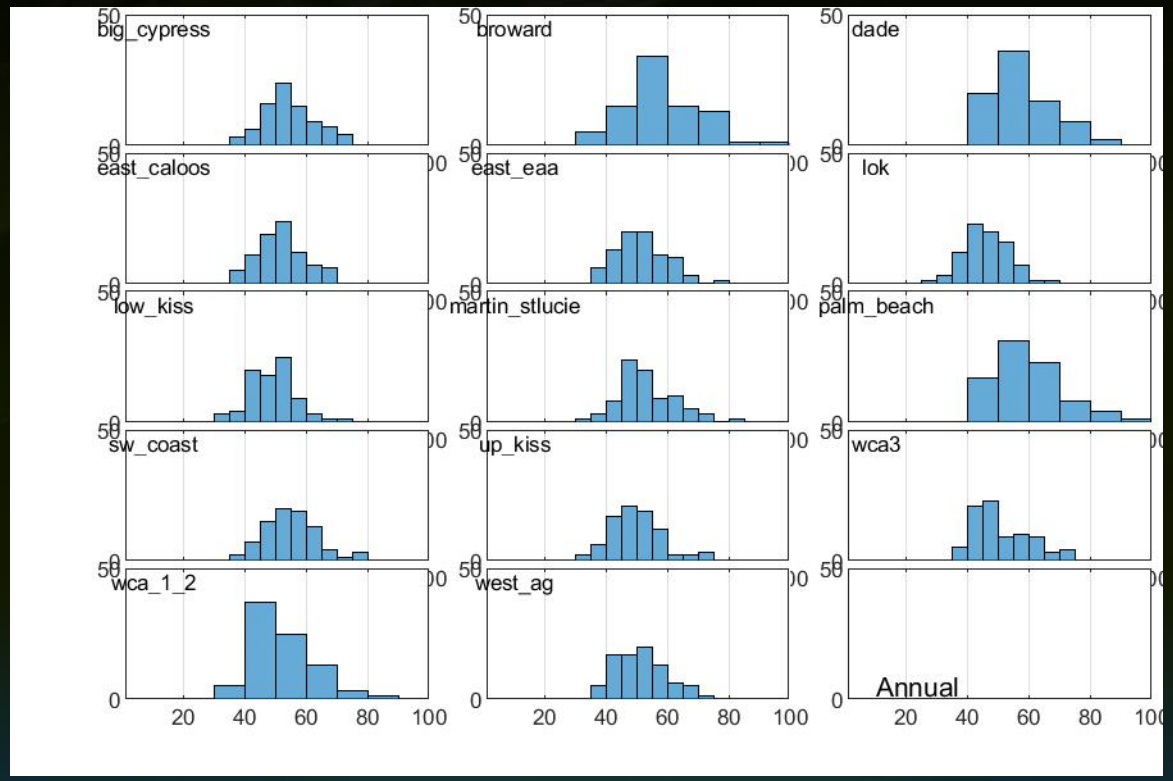




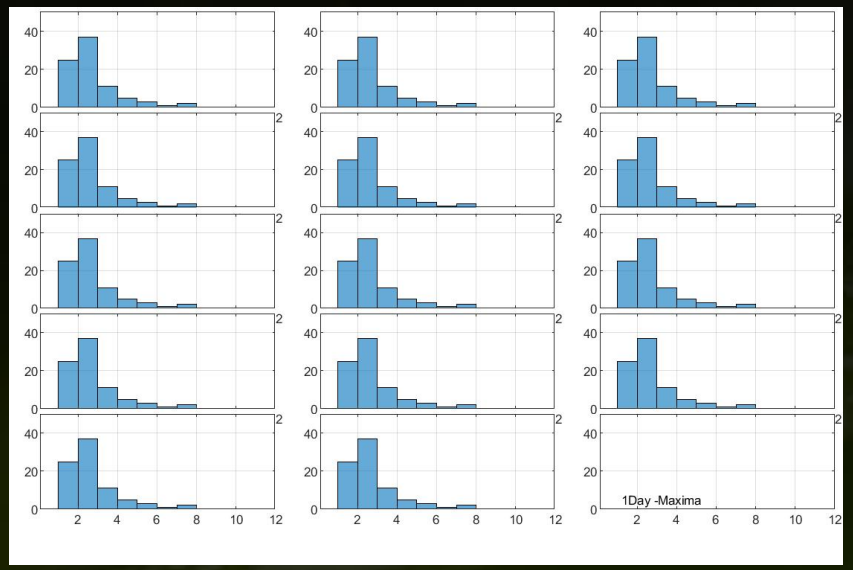


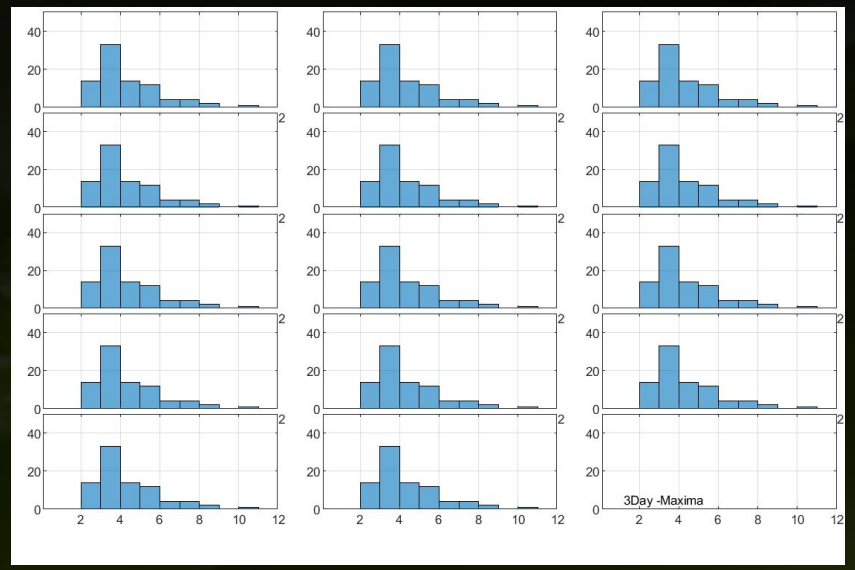
Seasonal and Annual Regional Rainfall Trend Analysis for South Florida

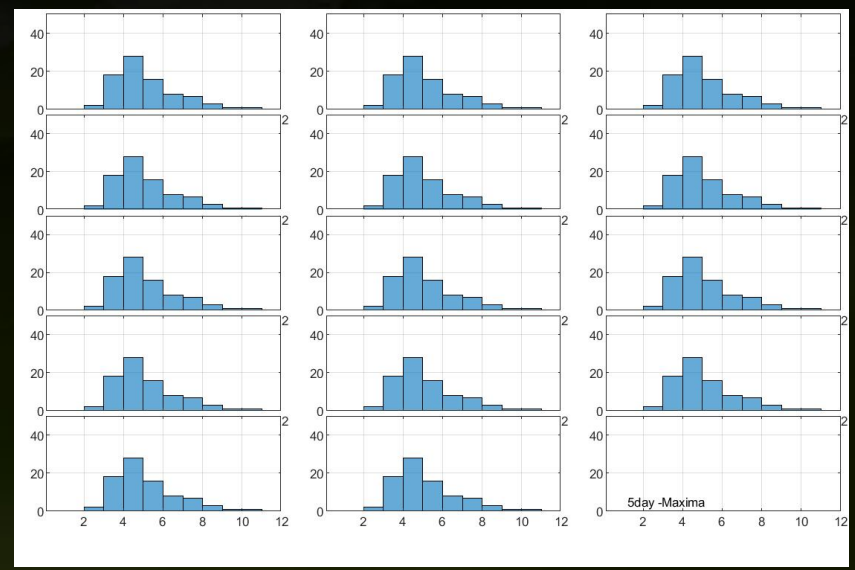




Regional Trend Analysis for Rainfall of South Florida Annual Maxima





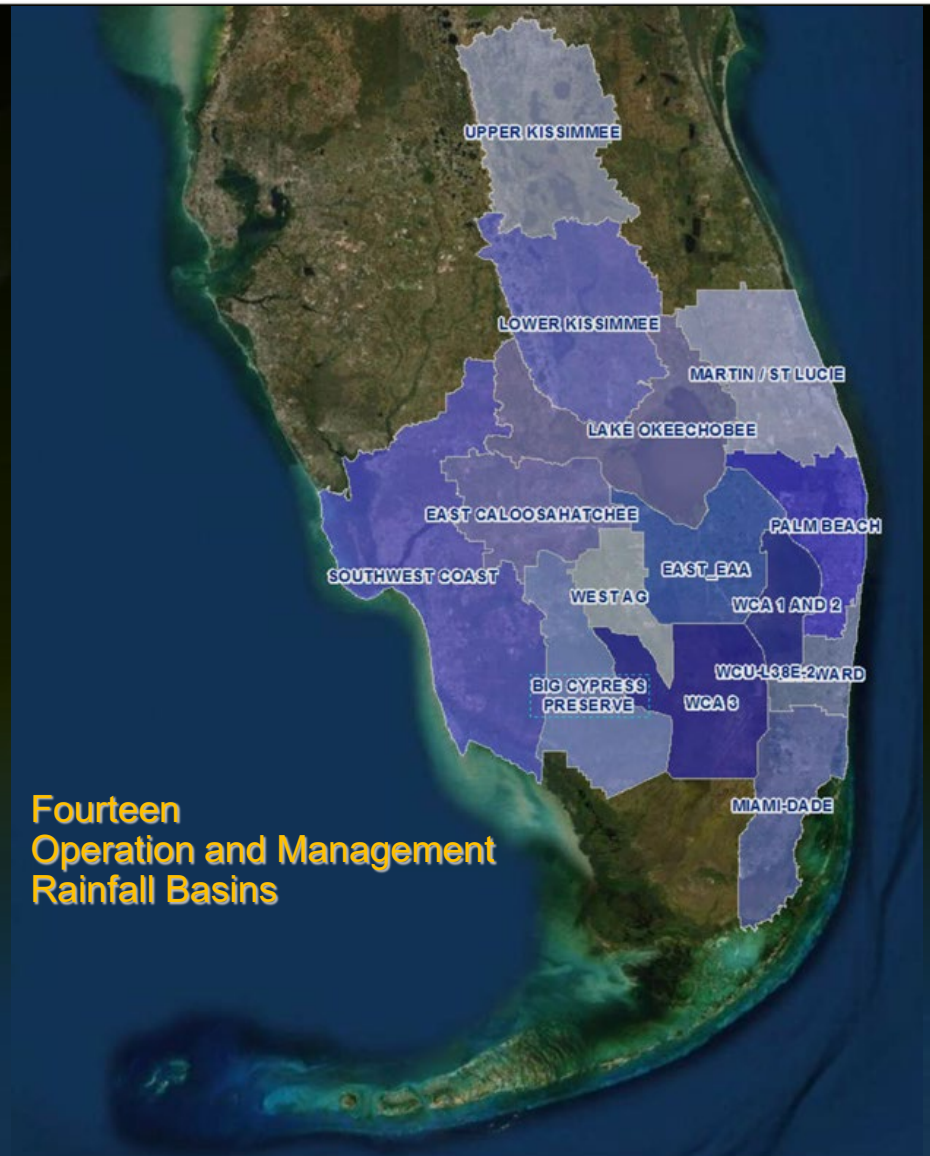


Regional Trend Analysis for Rainfall of South Florida
Mann Kendall Trend Analysis

- MK test (Gilbert 1987) statistically assesses if there is a monotonic upward or downward trend of the variable of interest over time.
- When no trend presents, data must be identically independently distributed (i.e., no serial correlation)
- Samples are unbiased representation of the population
- H_0 : No trend
- H_a : Trend presents
- A trend is considered significant if a double-sided Z test rejects the null hypothesis that there is no trend.
- α = 5%

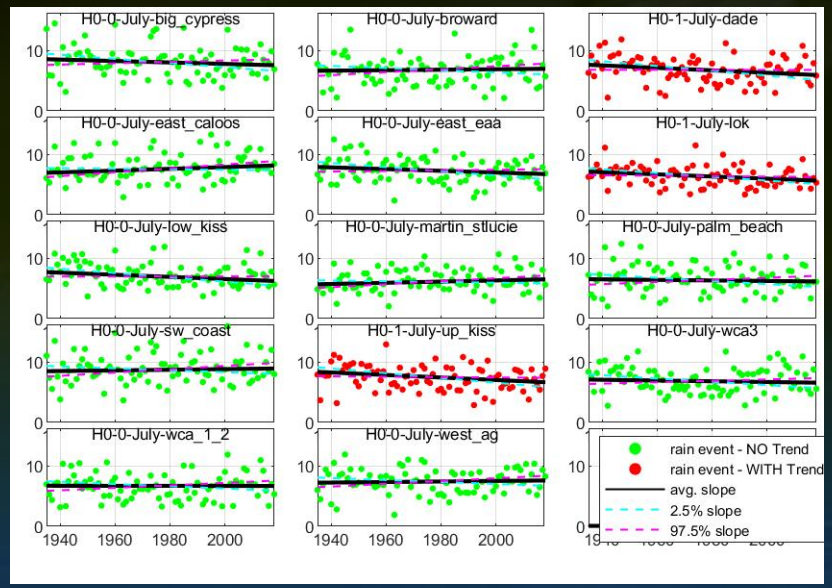
Regional Trend Analysis for Rainfall of South Florida
Rainfall Sum with significant trends

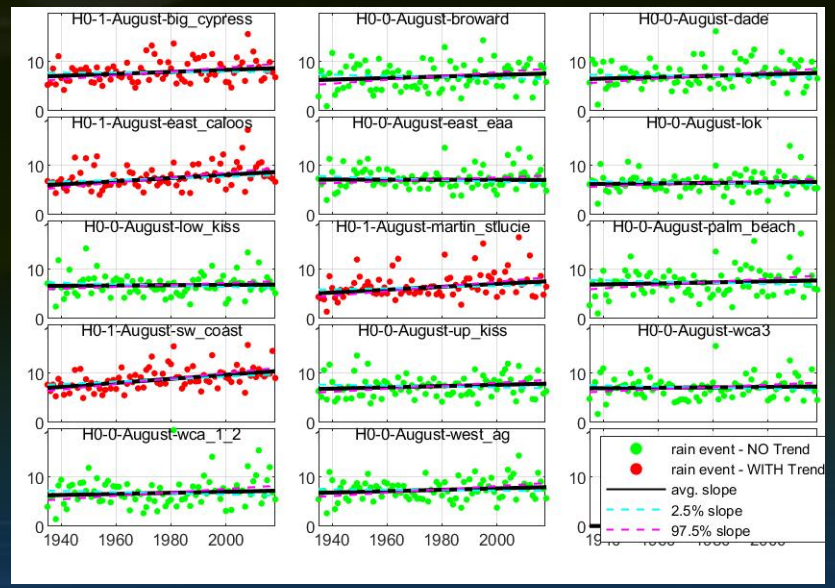
Results for Monthly, Seasonal, and Annual Trend Analysis	
Trend Analysis	**Observed Trend**
January	No trend
February	No trend
March	No trend
April	No trend
May (transitional month)	No trend
June	No trend
July	Downward trend: Miami-Dade, Lake Okeechobee, Upper Kissimmee
August	Upward trend: Big Cypress, East Caloosahatchee, Martin – St. Lucie, SW Coast
September	No trend
October (transitional month)	Downward trend: Broward, Miami-Dade, East Agricultural Area, Martin – St. Lucie, Palm Beach, Water Conservation Areas 1, 2 and 3
November	No trend
December	No trend
Wet Season	Upward trend: East Caloosahatchee, SW Coast Downward trend: East Agricultural Area
Dry Season	Not analyzed
Annual	Downward trend: East Agricultural Area

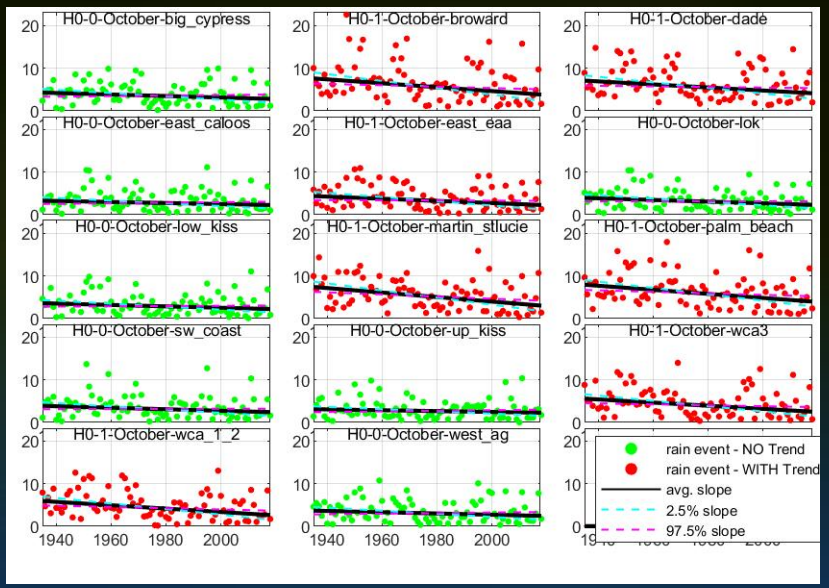


Regional Trend Analysis for Rainfall of South Florida Rainfall Sum with significant trends

Results for Total Monthly Rainfall Trend Analysis	
Trend Analysis	**Observed Trend**
July	Downward trend: Miami-Dade, Lake Okeechobee, Upper Kissimmee
August	Upward trend: Big Cypress, East Caloosahatchee, Martin – St. Lucie, SW Coast
October (transitional month)	Downward trend: Broward, Miami-Dade, East Agricultural Area, Martin – St. Lucie, Palm Beach, Water Conservation Areas 1, 2 and 3

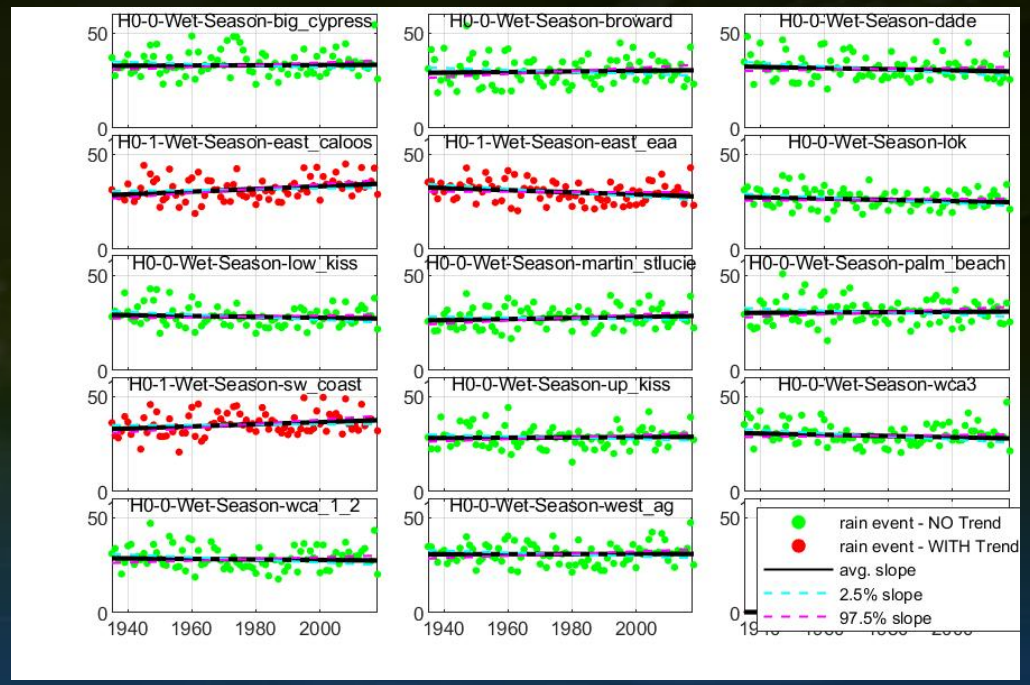


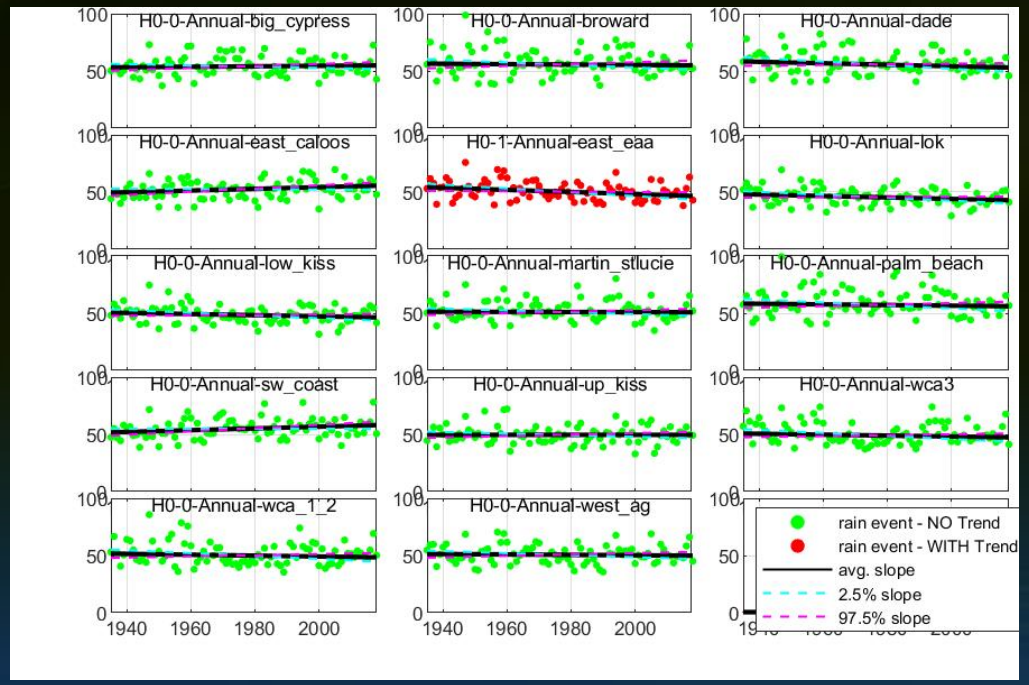




Regional Trend Analysis for Rainfall of South Florida Rainfall Sum with significant trends

Results for Seasonal and Annual Trend Analysis	
Trend Analysis	**Observed Trend**
Wet Season	Upward trend: East Caloosahatchee, SW Coast Downward trend: East Agricultural Area
Annual	Downward trend: East Agricultural Area

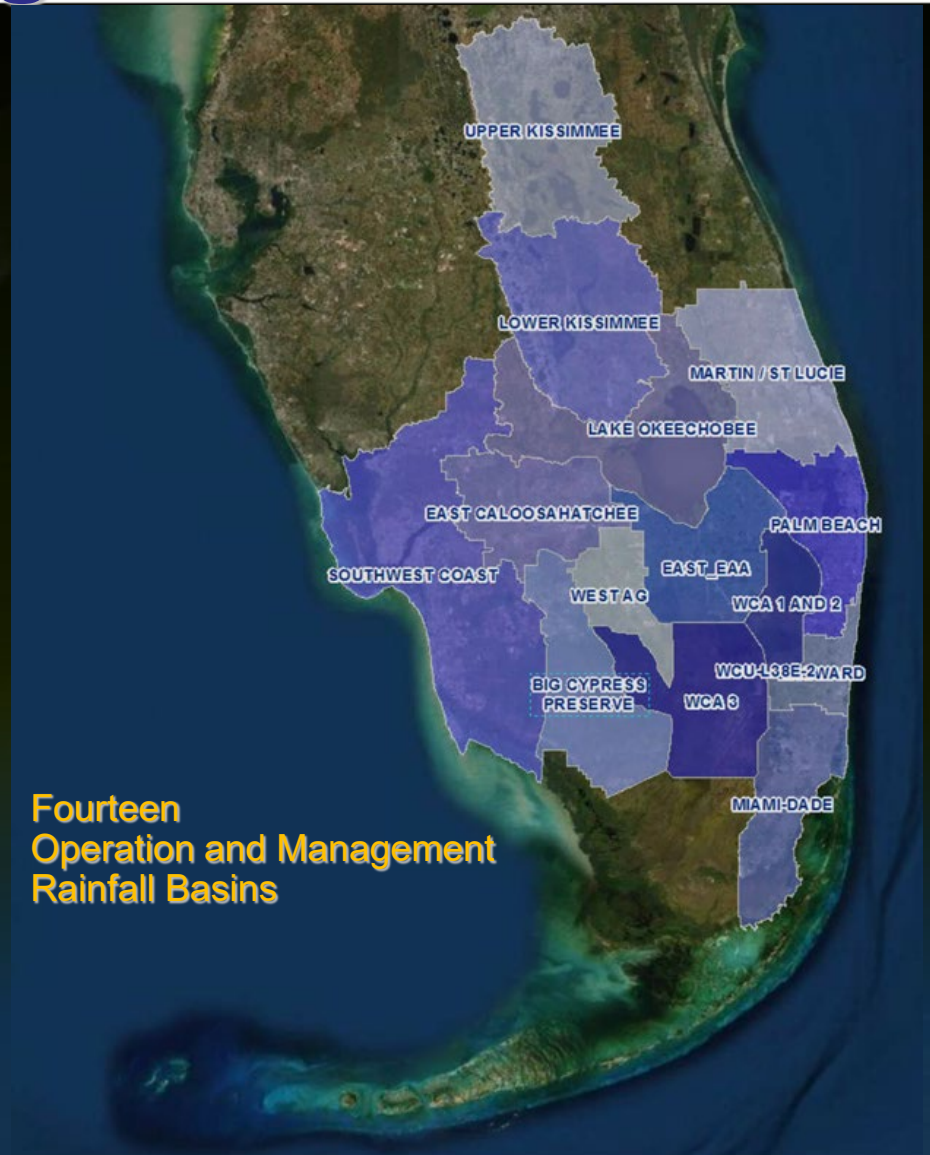




Regional Trend Analysis for Rainfall of South Florida
Rainfall Frequency with significant trends

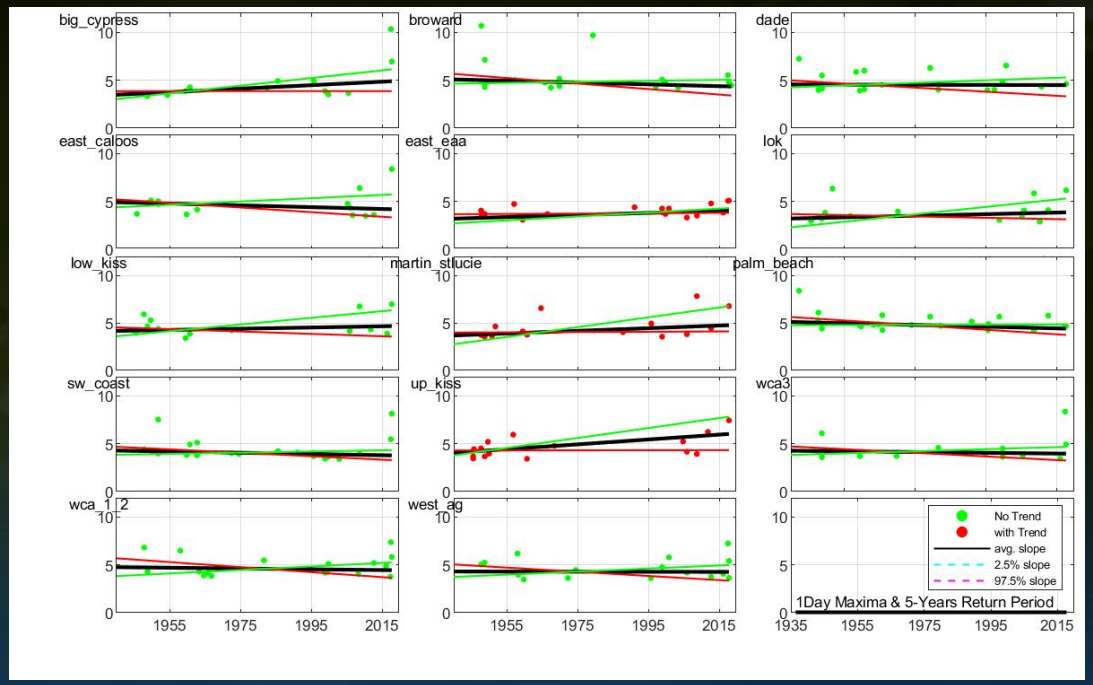
Results of the annual 1-, 3-, and 5-day Maxima Frequency Trend Analyses

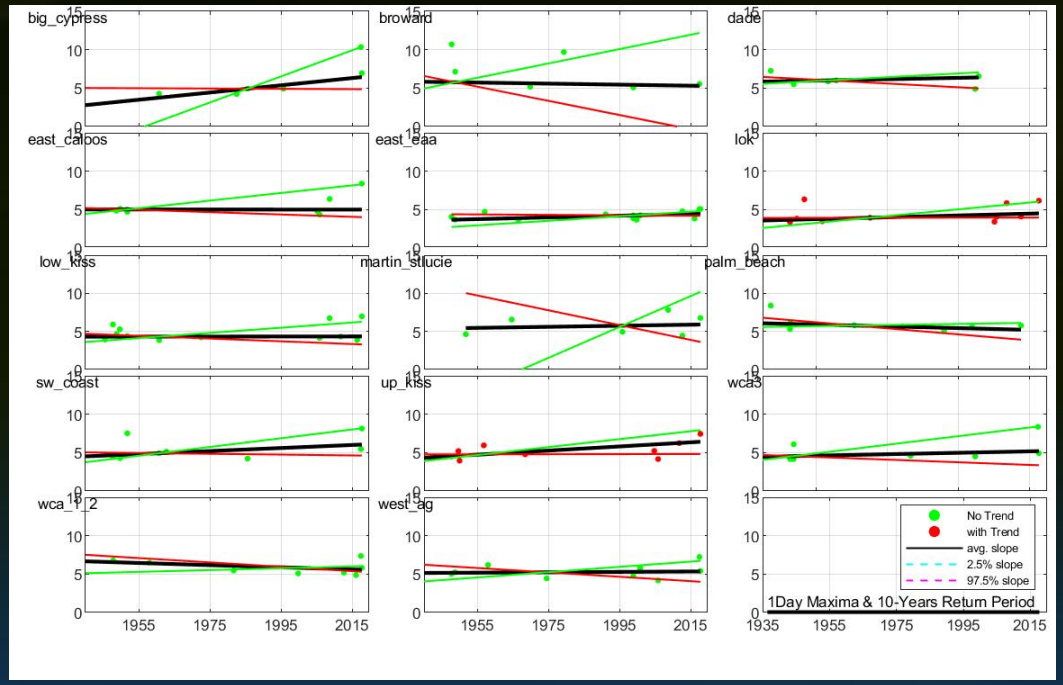
Frequency Trend Analysis	Observed Trend
1-day, 2-year	No significant trend
1-day, 5-year	Upward trend: East Agricultural Area, Martin – St. Lucie, Upper Kissimmee
1-day, 10-year	Upward trend: Lake Okeechobee, Upper Kissimmee
3-day, 2-year	No significant trend
3-day, 5-year	No significant trend
3-day, 10-year	No significant trend
5-day, 2-year	No significant trend
5-day, 5-year	Downward trend: Broward
5-day, 10-year	Upward trend: East Caloosahatchee



Results of the annual 1-Day Maxima Frequency Trend Analyses

Results of the annual 1-Day Maxima Frequency Trend Analyses	
Frequency Trend Analysis	**Observed Trend**
1-day, 5-year	Upward trend: East Agricultural Area, Martin – St. Lucie, Upper Kissimmee
1-day, 10-year	Upward trend: Lake Okeechobee, Upper Kissimmee

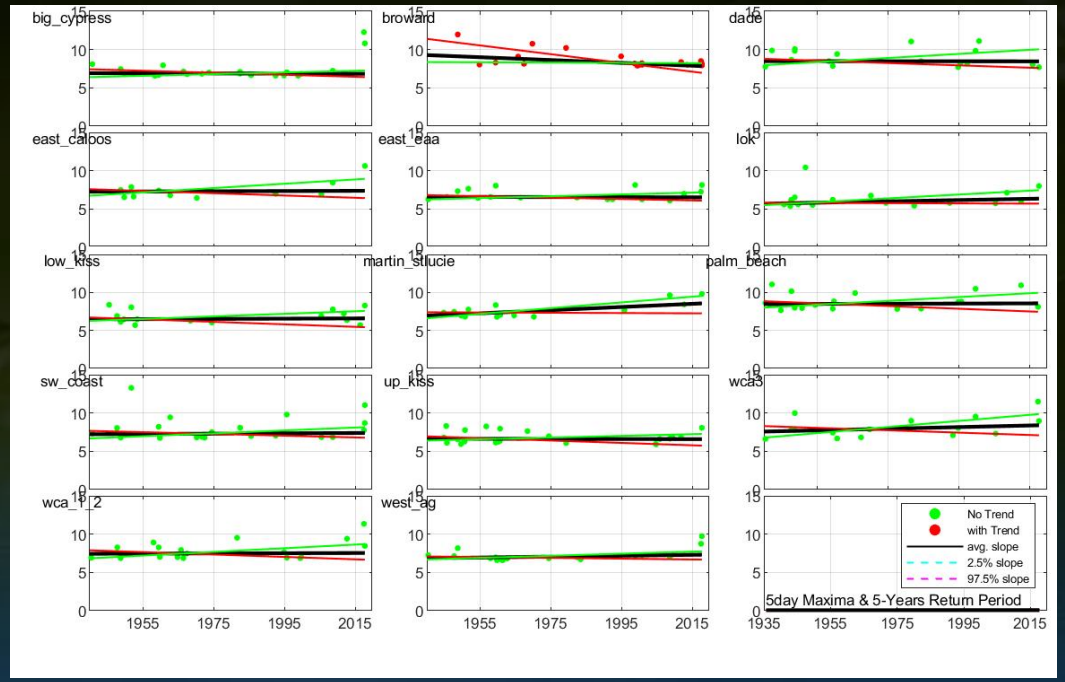


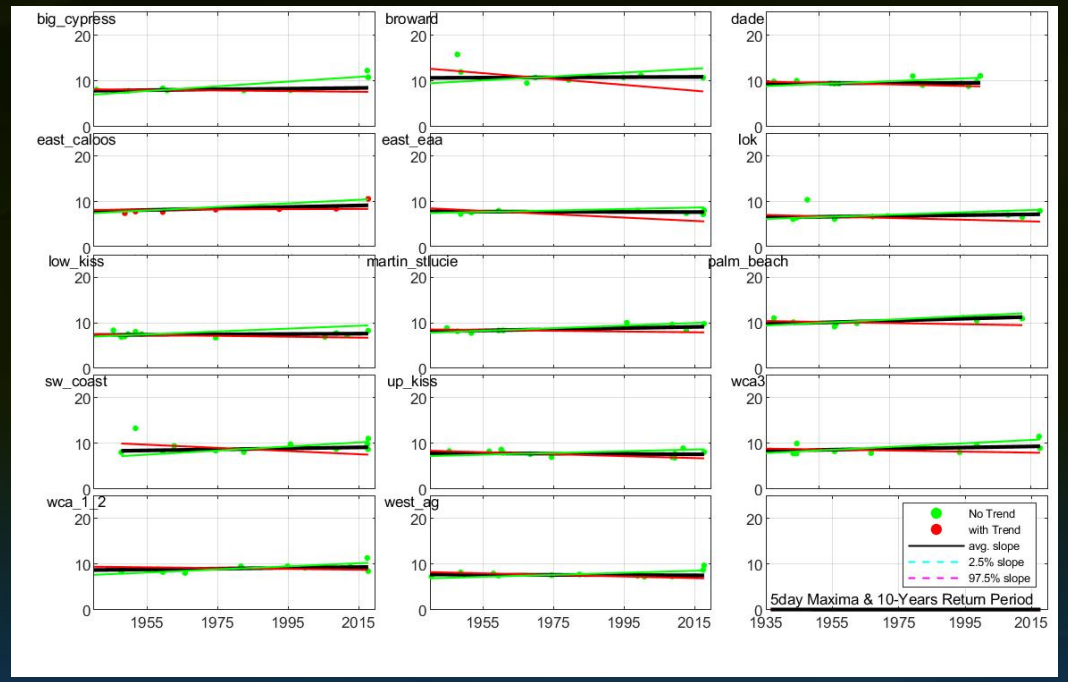


Results of the annual 5-Day Maxima Frequency Trend Analyses

Results of the annual 5-day Maxima Frequency Trend Analyses

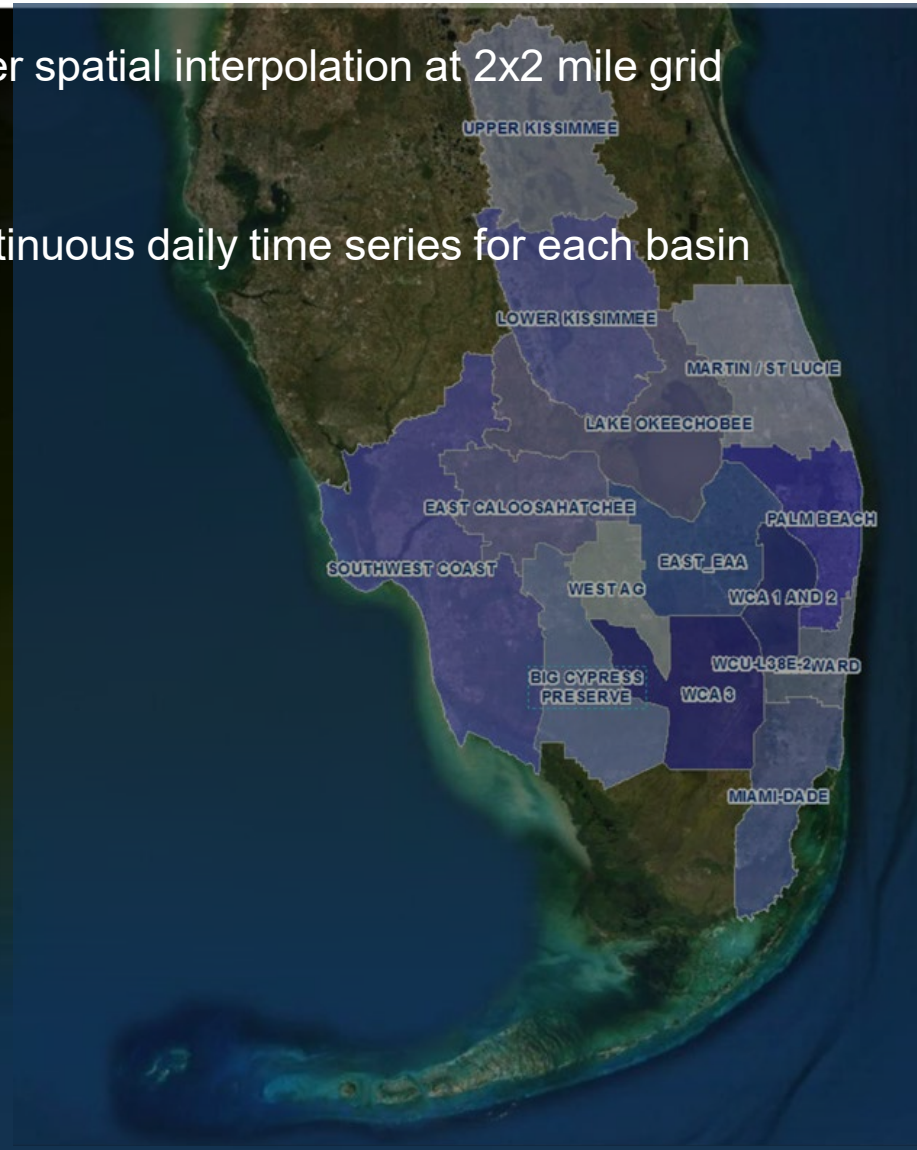
Frequency Trend Analysis	Observed Trend
5-day, 5-year	Downward trend: Broward
5-day, 10-year	Upward trend: East Caloosahatchee





Summary of Regional Trend Analysis for Rainfall of South Florida

- District model input rainfall data has undergone a great deal of scrutiny and proper spatial interpolation at 2x2 mile grid covering SFWMD area
- Spatially averaged rainfall data within each of the 14 OMD basins to obtain a continuous daily time series for each basin between 1935 -2018
- Calculated monthly, wet season and annual rainfall time series
- Calculated annual 1-, 3- and 5- day maxima
- Performed Mann Kendall trend analysis on the quantities 3 and 4.



Regional Trend Analysis for Rainfall of South Florida Conclusion

Results of the annual 1-, 3-, and 5-day Maxima Frequency Trend Analyses	
Frequency Trend Analysis	**Observed Trend**
1-day, 2-year	No significant trend
1-day, 5-year	Upward trend: East Agricultural Area, Martin – St. Lucie, Upper Kissimmee
1-day, 10-year	Upward trend: Lake Okeechobee, Upper Kissimmee
3-day, 2-year	No significant trend
3-day, 5-year	No significant trend
3-day, 10-year	No significant trend
5-day, 2-year	No significant trend
5-day, 5-year	Downward trend: Broward
5-day, 10-year	Upward trend: East Caloosahatchee

- If near future climate exhibit non-stationarity, it is expected to see more significant trend detected.
- We recommend the repetition of this analysis every 10 years or if climate non-stationarity persists within a shorter time frame

Results for Monthly, Seasonal, and Annual Trend Analysis	
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January	No trend
February	No trend
March	No trend
April	No trend
May (transitional month)	No trend
June	No trend
July	Downward trend: Miami-Dade, Lake Okeechobee, Upper Kissimmee
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December	No trend
Wet Season	Upward trend: East Caloosahatchee, SW Coast Downward trend: East Agricultural Area
Dry Season	Not analyzed
Annual	Downward trend: East Agricultural Area