

# Spatiotemporal Variation of Extreme Rainfall Events in Greater New York Area

Ali Hamidi, *CCNY, NOAA-CREST*

Naresh Devineni, *CCNY, NOAA-CREST*

James F. Booth, *CCNY, NOAA-CREST*

Ralph R. Ferraro, *NOAA STAR, CICS-MD*

Reza Khanbilvardi, *CCNY, NOAA-CREST Director*



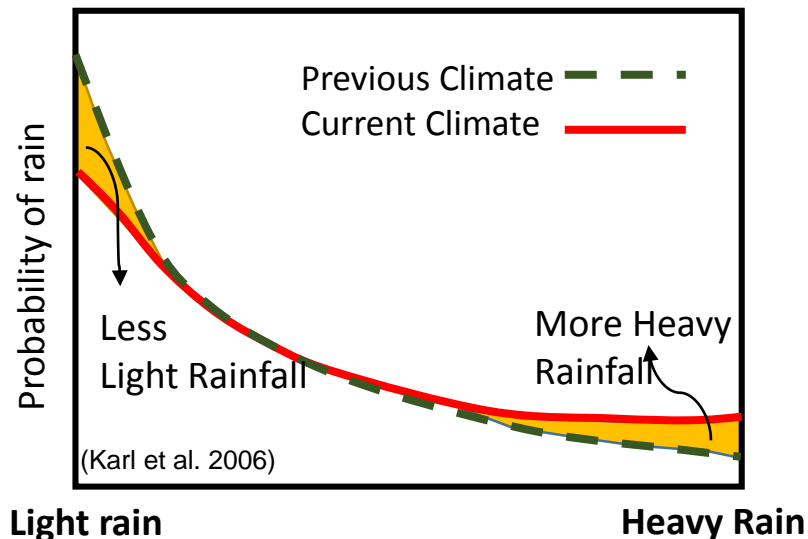
# INTRODUCTION

In Northeast, both historical observations and General Circulation Models (GCMs) for the region generally show a trend towards more and intense precipitation.

Extreme rainfall events, specifically in urban areas, have dramatic impacts on society and can lead to loss of lives and properties.



Northeast Rainfall Change with Climate

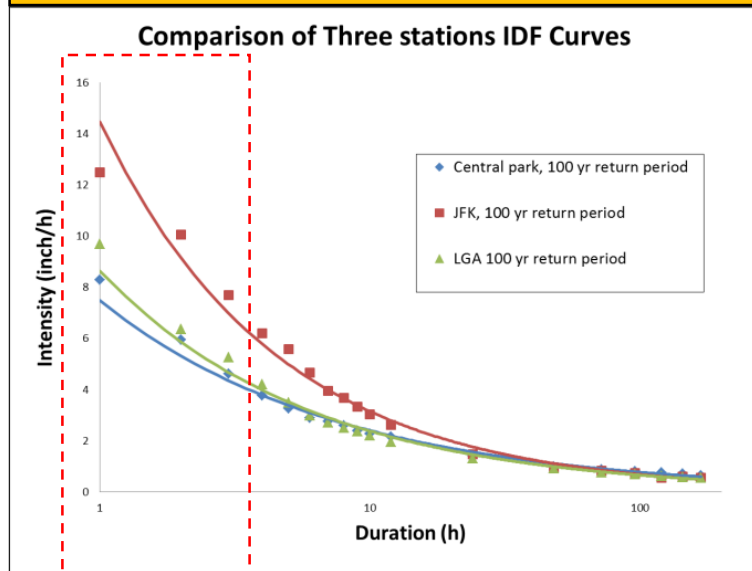


Sandy Hurricane in NYC, Oct. 2012

# INTRODUCTION

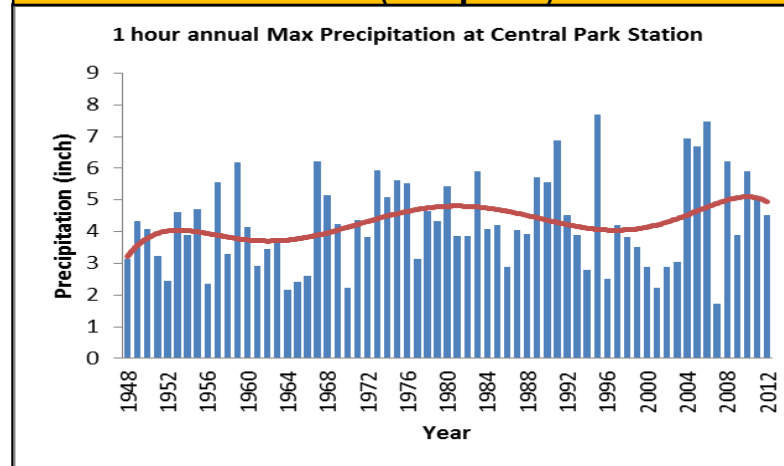
- Urban hydrologic systems are designed based on Extreme Rainfalls (Storms).
- Despite these hazards, little is known about the city-scale variability of heavy rain events. It is unclear how extreme events are distributed within the city as well as at shorter intervals.

Change in Return period of Extreme rain in 3 stations (**Spatial**)



Short rainfall duration shows more variation

Change in Value of Extreme rain in One station (**Temporal**)



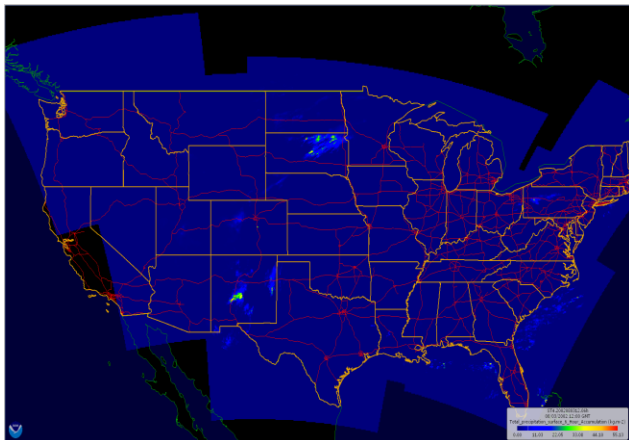
# RESEARCH GOALS:

## Goals:

- Detect Spatial Distribution of storm in **Greater New York Area**.
- Investigate the seasonal variation of extreme rainfalls for different durations.
- Connecting storm clusters with climate pattern.

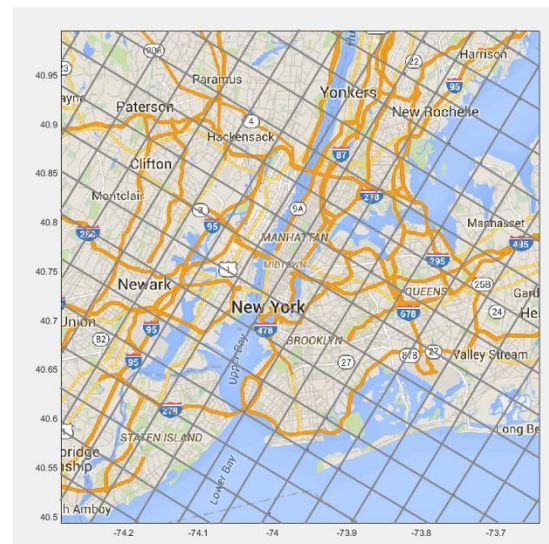
## Means:

Blending Radar-Rainfall data.



Stage IV Radar Data

*Stage IV  
Nationally mosaicked, manual QC  
4 km × 4km, 1h  
Available From 2002 (13 years)*



Gridded NEXRAD at  
NYC area

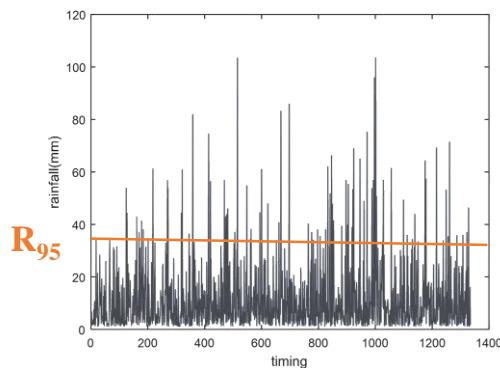
# METHODOLOGY:

Storm parameters we have considered are as following:

- Rainfall Intensity
- Rainfall Duration:
  - *1-hour; short duration rainfall events.*
  - *24-hour; long duration rainfall events.*
- Seasonal Inter-annual Variation (Temporal Distribution):
  - *December – January – February (DJF); winter.*
  - *June – July – August (JJA); summer.*
- Storm Area Exposure (Spatial Distribution)

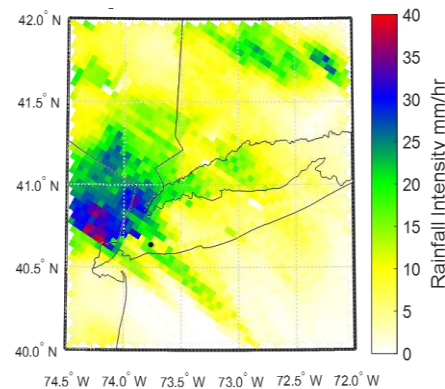
# METHODOLOGY:

Time History Rainfall (mm)

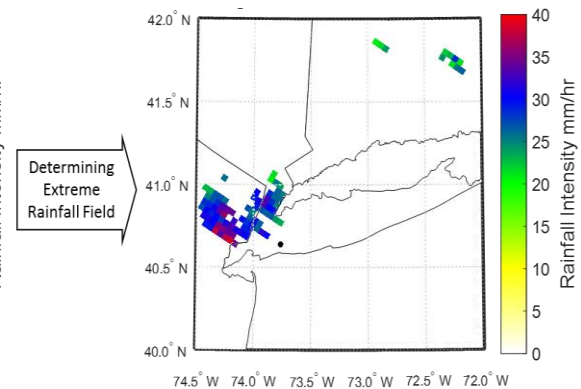


Extreme  
Rainfall Events

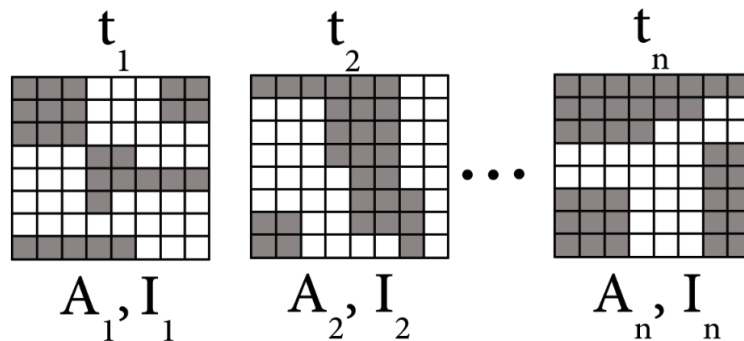
Hourly Rainfall Field (28<sup>th</sup> Aug 2011)



Extreme Rainfall Field (28<sup>th</sup> Aug 2011)



Extreme Events:



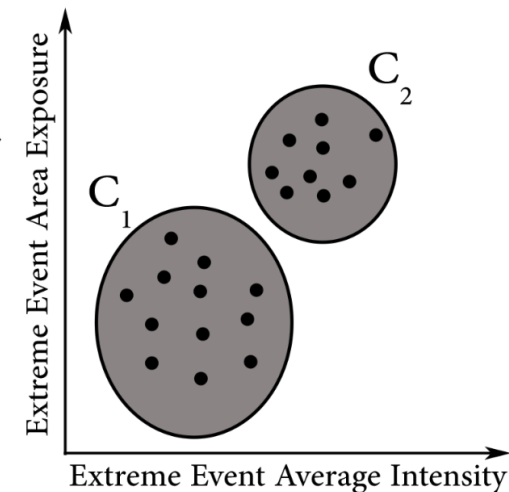
$C_1$

$C_2$

...

$C_1$

Assign  
Clusters  
to Grids



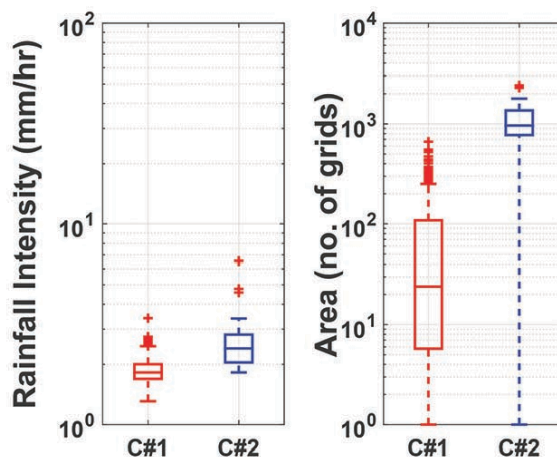
$$G_{ij}: P(C_1) = \frac{\text{total class } C_1 \text{ events hit } G_{ij}}{\text{total events hit } G_{ij}}$$



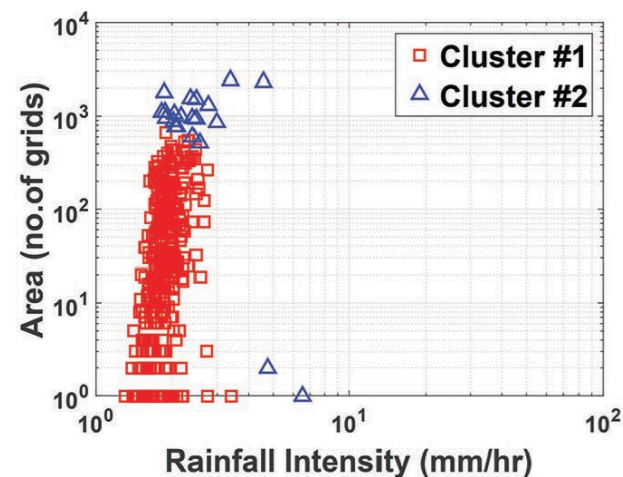
# CLUSTERING RESULTS:

## Clustering Results: K=2

- The optimal number of clusters is determined using Silhouette test



C1:  
Low intensity  
Small area  
exposure



Ex: Clustering Results of Summer (JJA)\_ 24h

C2:  
High intensity  
Large area  
exposure

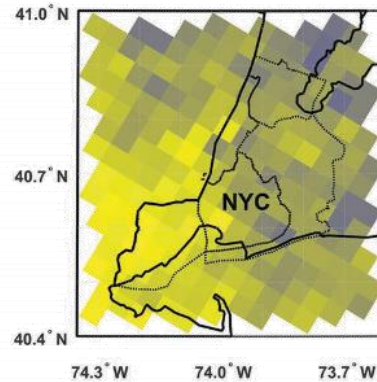
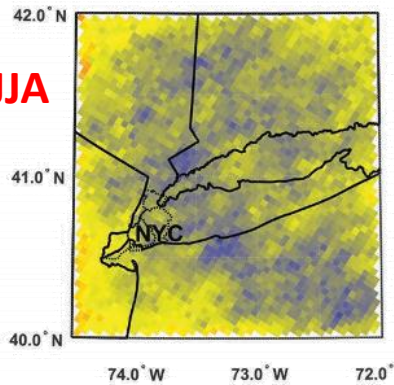
# EXTREME EVENTS DISTRIBUTION:

## 1-h Extreme Rainfall Events:

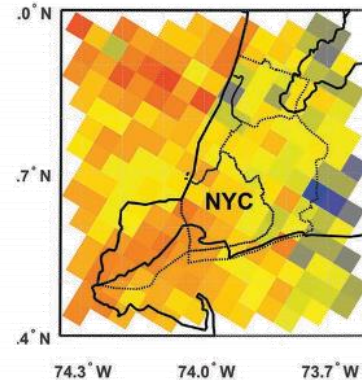
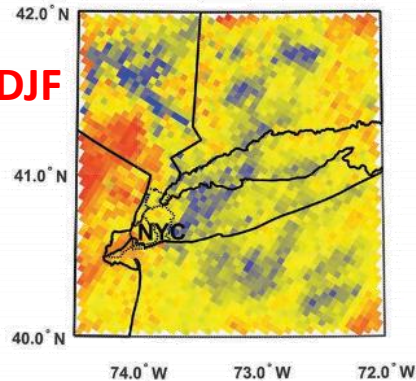
GNY

NYC

JJA



DJF

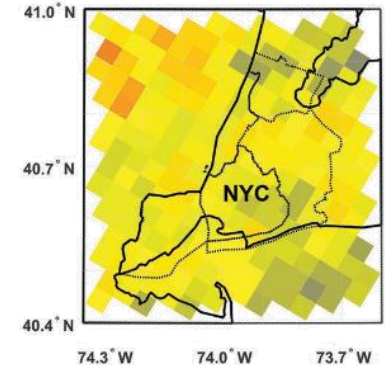
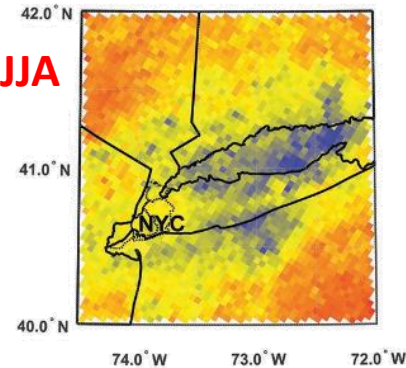


## 24-h Extreme Rainfall Events:

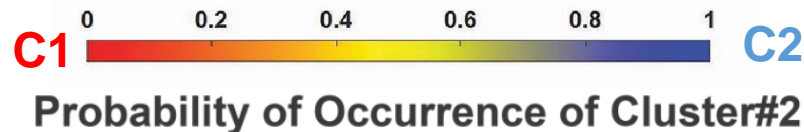
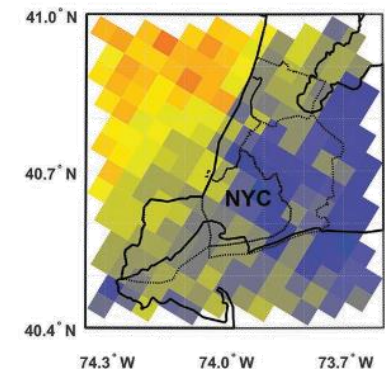
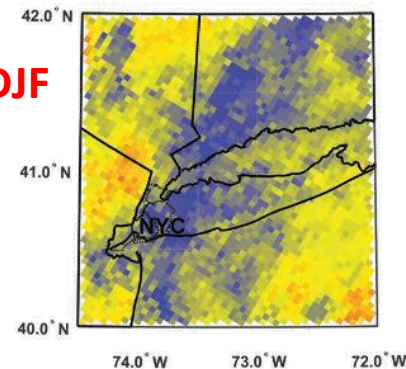
GNY

NYC

JJA



DJF

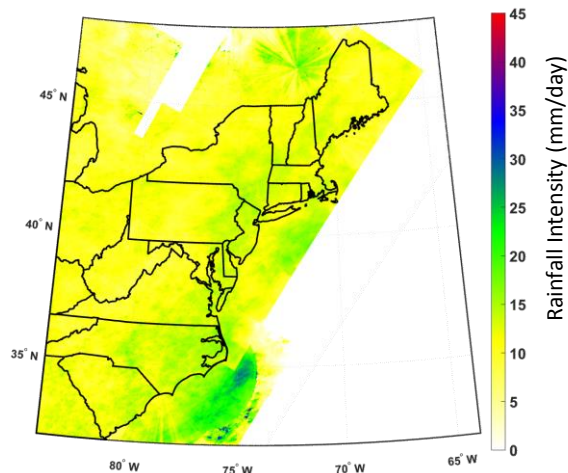




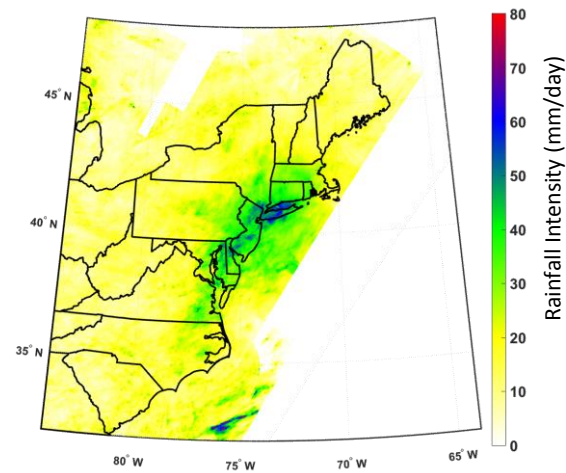
# Compositing of Extreme Events:

Averaging the intensity of rainfall at the extreme event dates to provide storm pattern:

24h\_summer\_C#1



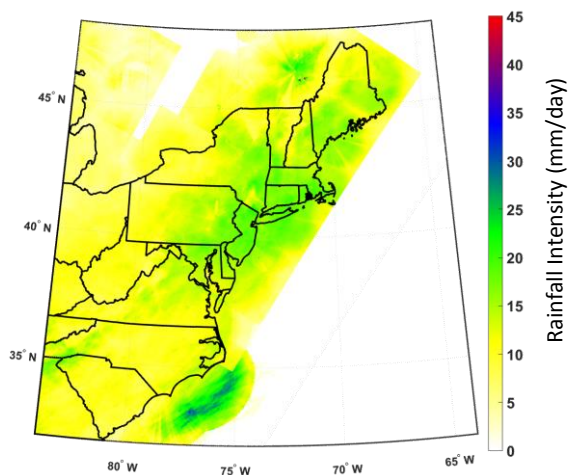
24h\_summer\_C#2



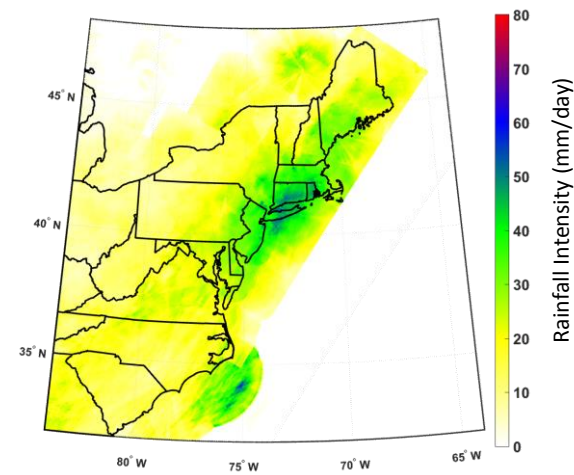
Intensity:

summerC#2 > winterC#2

24h\_Winter\_C#1



24h\_Winter\_C#2



Area Exposure:

summerC#2 < winterC#2

# SUMMARY:

- This study provide evidence for the non-stationairty of extreme rainfall evens at the city scale. So, applying same design criteria for the whole NYC is rejected.
- The clustering of rainfall events are revealed in this study which is important in this context of green roofs, porous pavements and other innovations.
- Substantial variation in rainfall intensity at various hours is evident for different boroughs of the city. For short rainfall duration, spatial distribution is more significant.
- Short rainfall duration showing different pattern comparing to long rainfall duration over NYC and GNY.
- In summer time, for short duration rainfall, NYC is hit by high intensity, large area storm. The same pattern is appeared for long duration rainfall at winter time.
- Conditional subsetting of extreme events verifies summer storm is more intense while in winter the intensity is lower with larger area.

# Acknowledgements

- **NOAA STAR  
& CICS MD at University of Maryland**



**NOAA STAR** CENTER FOR  
SATELLITE APPLICATIONS AND RESEARCH

- **NOAA National Severe Storms Laboratory (NSSL)**



- **CCRUN**



- **NOAA- CREST**

**NOAA- CREST**