2020

Using Statistical Analysis to Examine Weather Variability in New York City

Ryan Chen
CUNY New York City College of Technology

Yuhuang Wang
CUNY New York City College of Technology

Jiehao Huang
CUNY New York City College of Technology

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Ryan Chen, Yuhang Wang, Jiehao Huang

Applied Mathematics, New York City College of Technology, CUNY
Communication Design, New York City College of Technology, CUNY
Earth and Atmospheric Science, The City College of New York, CUNY

Abstract

As the overall temperature of Earth continues to warm, atmospheric hazards (e.g. heatwaves, cyclones) may be driving increases in climatological trends. This study examines the daily precipitation and temperature record of the greater New York City region during the 1979-2014 period. Daily station observations from three greater New York City airports: John F. Kennedy (JFK), LaGuardia (LGA) and Newark (EWR), are used in this study. Climatological & statistical analyses are performed for the weather variability of New York City metro area to understand the impacts of climate change.The temperature climatology reveals a distinct seasonal cycle, while the precipitation climatology exhibits greater day-to-day variability. Furthermore, annual mean of precipitation and temperature in New York City show increasing trends with temperature trend is significant. After that, this study compare to other research findings with a different region such as Amazon Basin to examine climatological pattern of precipitation in both daily and annual climatological trend. Amazon basin has different climate phenomena than New York City due to different geographical location. Daily Climatology of precipitation in Amazon basin shows the greatest intensity occurred in January to March, with minimum in July. The annual mean of precipitation match with our spatial result generated by GPCP for global precipitation mean for January and July.

Background

- Previous studies have shown that human activities have been changing the climate, leading to more weather variability. In New York State, the annual average temperature statewide has risen about 2.4 °F since 1970 and average annual precipitation has increased across New York State since 1900 (NYS Dept. of Environmental Conservation). This emphasized that studying weather variability in New York City is important due to the impact of anthropogenic warming.
- Another recent study of the seasonal cycle of daily precipitation exhibits two distinct subregions: inland stations and coastal stations. For both subregions, the frequency of extreme precipitation is greatest in the warm season, while the intensity of extreme precipitation shows no distinct seasonal cycle.
- This study uses the Daily Summary Data from NOAA's Integrated Surface Database (ISD) (Smith et al. 2011) .

Data & Methodology

- This study uses station-based daily precipitation and temperature observation from three airports stations: John F. Kennedy (JFK), LaGuardia (LGA) and Newark (EWR).
- Second data source is from GPCP Adler, R.F.,and Coauthors,2003: The version 2 Global Precipitation Climatology Project (GPCP) Monthly Precipitation Analysis (1979–2005)
- Climatology: average atmospheric conditions over time.
- Data is analyze and visualize by using MATLAB
- Linear regression model is applied to analyze trend:

$$\hat{y} = ax + b \qquad a = \frac{\Sigma(x_i - \bar{x})(y_i - \bar{y})}{\Sigma(x_i - x)^2} \qquad b = \bar{y} + m * \bar{x}$$

'a' and 'b' are constants where a indicates the slope and b is the y-intercept.

Conclusions

- Temperature climatology reveals a distinct seasonal cycle while precipitation climatology has no seasonal cycle, but precipitation climatology exhibits greater day-to-day variability.
- As compare to our precipitation climatology of New York City to Amazon basin, the season cycle is different due to different climate phenomena where Amazon basin showed the greatest intensity occur in January to March, minimum in July.
- We observe an increasing trend in the intensity annual precipitation and temperature events over the last 36 years. Moreover, the trend for temperature is significant because the p-value is 0.017.
- The annual mean of precipitation for January and July in New York City does not show significant difference as compare to Amazon Basin's.

Results

Frequency Distribution of NYC Temperature and Precipitation

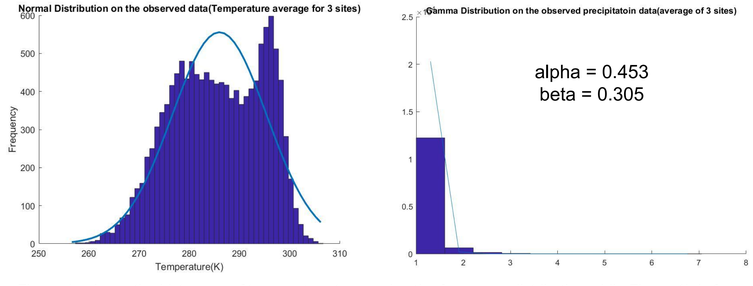


Figure 1a shows the histogram of temperature to examine the frequency distribution while Figure 1b is for precipitation. All bins are averaged of three stations including JFK, LGA, EDR. A normal distribution curve is plotted on the frequency of temperature while gamma distribution curve is plotted on precipitation.

Annual Mean of Precipitation and Temperature (1979-2014)

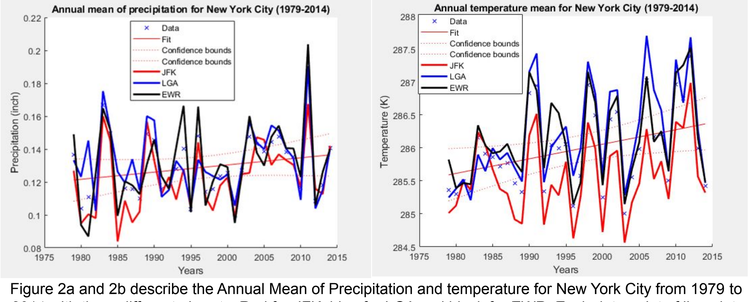


Figure 2a and 2b describe the Annual Mean of Precipitation and temperature for New York City from 1979 to 2014 with three different airports. Red for JFK, blue for LGA and black for EWR. Each data point of line plot represents the annual average of precipitation.The red trend line is the linear regression line while the dashed lines are the 95% confidence bounds of the trend.

Daily Climatology of Precipitation and Temperature

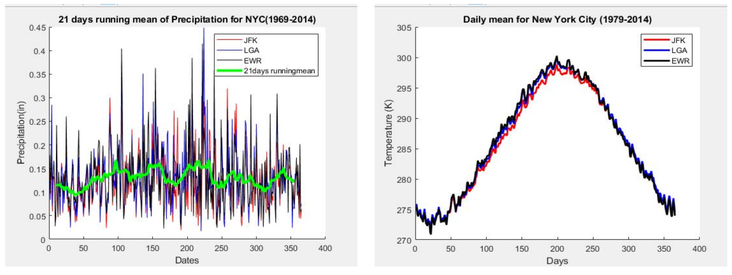
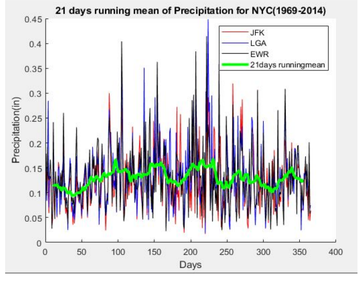


Figure 3a and 3b describes the daily mean of precipitation for New York City from 1979 to 2014 with three different airports. Red for JFK, blue for LGA and black for EWR. Each data point is the daily average of 365-daily precipitation.(leap day excluded) The green line represent the 21 days running mean to examine the pattern of seasonal cycle.

NYC



Amazon Basin

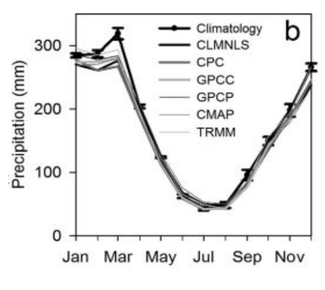


Figure 4a is daily climatology for precipitation, Figure 4b multiple datasets of climatology in Amazon Basin reveal a seasonal cycle for monthly average of precipitation.

Annual Mean of Precipitation for January and July

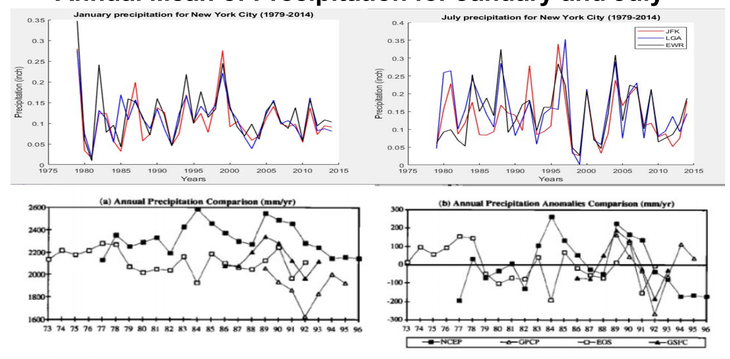


Figure 5 shows the comparison of January and July precipitation of New York City to Amazon Basin, the result states that New York City has higher precipitation on January where Amazon Basin has higher precipitation on July.

January Climatology

July Climatology

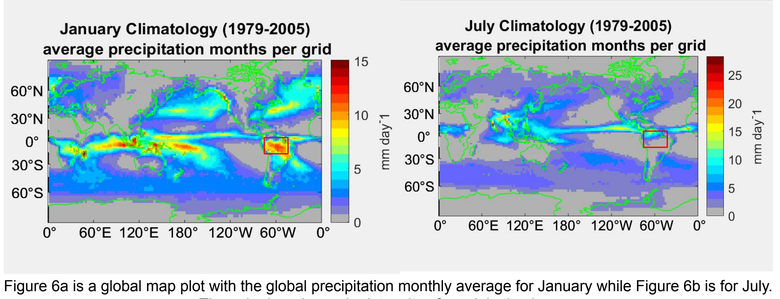


Figure 6a is a global map plot with the global precipitation monthly average for January while Figure 6b is for July. The color bar shows the intensity of precipitation in mm.

Acknowledgement

The project is supported by the Emerging Scholars Program at the New York City College of Technology, CUNY. A special thanks to the director of the program Prof. Hamid Norouzi and we greatly appreciate our mentor Jiehao Huang for the guidance, patience, and support throughout this research project.