



## Tokyo's 100-year Rainfall Changes

Yukimasa Tsubota and Saki Machida

J. F. Oberlin University, Natural Science Divisions, Atmospheric Science, Yokohama-shi, Japan (tsubota@obirin.ac.jp)

### 1. Introduction

Yonetani (1978) analyzed long-term changes of precipitation at Tokyo and pointed out the wet period (1876-1925), the dry period (1951-1975), and fluctuated period (1926-1950) based on the daily rainfall data from. Zaiki and Mikami analyzed climate variations since the Edo period, and showed the relatively wet 1910s and relatively dry 1960s. They also showed an rainfall increase from the last century to the 21st century. The Meteorological Agency of Japan (JMA, 2015) had analyzed daily rainfall for 51 meteorological stations in Japan. Their overall conclusion didn't show a clear trend but a significant fluctuation and showed that the fluctuation range became larger after the 1970s. They showed that 1920s and 1950s are wet periods in relation to the fluctuations. We shall re-examine the rainfall change in Tokyo in order to identify any signal of climate change in temperature.

### 2. Data.

Tokyo's daily, monthly and annual rainfall data were downloaded from the JMA's web site. We found thirty-two missing daily-rainfalls with no interpolation. Twenty monthly rainfall data have been considered as 'normal data'; for the missing data accounted for less than 20% of the computed monthly data. We can also download daily, monthly, annual average temperatures at Tokyo from the JMA's web site

### 3. Annual and monthly rainfalls

We're using five distinct periods that were based on the 11-year running-mean annual rainfalls of Tokyo. The periods of 1886-1900 and 1961-1990 had relatively few rainfalls; whereas the periods of 1901-1930 and 1990-2015 had relatively greater rainfalls; and the period of 1931-1960 had an average rainfall. This classification was justified by the mean and standard deviation of the annual rainfall for each period. A normal distribution of annual rainfall was confirmed. The 1961-1990 period has a statistically significant difference than other periods except for 1886-1990. The 1961-1990 average rainfall for the month of October shows a significant difference than other periods. We could not find any systematic relation to annual and monthly temperatures changes at Tokyo that shows distinct positive trend, i.e. s warming.

### 4. Annual variability of daily rainfalls

Daily rainfalls are ranked by their quantities such as 0-10mm and then analyzed to check annual trends. There's apparently no linear trends in frequencies, but there is a fluctuation of frequencies. The total number of zero-net rainfall days indicates a positive trend and hence, a positive trend in average rainfall for rainy days.

The daily rainfalls were ranked per annual basis and checked for a linear trend within certain ranks, such as 5th, 10th and 15th, etc. The results show a linear positive trend to the 19th rank having an average daily rainfall of 24.2 mm and a linear negative trend of the 20th and beyond.

Based on our analysis, we can conclude rainfall pattern is changing. More specifically, rain falls same mounts within a shorter period. It is also true that events of extreme temperature in Tokyo are increasing. However, we cannot find any significant change in the frequency of daily rainfall of 10 centimeters or more as discussed in relation to the climate change. The 30-year fluctuation of rainfalls is persistent versus other changes.

### 5. Summary

Our results are consistent with Tokyo's preceding studies but do show different characteristics than the result for the entire state. That's because the entire state's analysis was due to constructive and destructive interferences; and periodic rainfall show different change patterns. The rainfall that we experience depends on the local area; for it's difficult to sense signals in regional and global rainfall changes. It's very important to continue rainfall measurements to determine any climate change.

## References

Japan meteorological Agency, 2015: Weather and Climate Report 2014.

Zaiki, Masumi and Takehiko Mikami, 2013: Climate Variations in Tokyo since the Edo Period, *Journal of Geography*, 122, 1010-1019.

Yonetani, Tsuneharu, 1978: Analysis of Secular Changes of Precipitation at Tokyo, *Tenki*, 25, 661-6670.

## Acknowledgements

This work is partly supported by Grant-in-Aid for Scientific Research (C) No. 25350263, the Japan Society for the Promotion of Science.