Examining Temperature Trends in New York City

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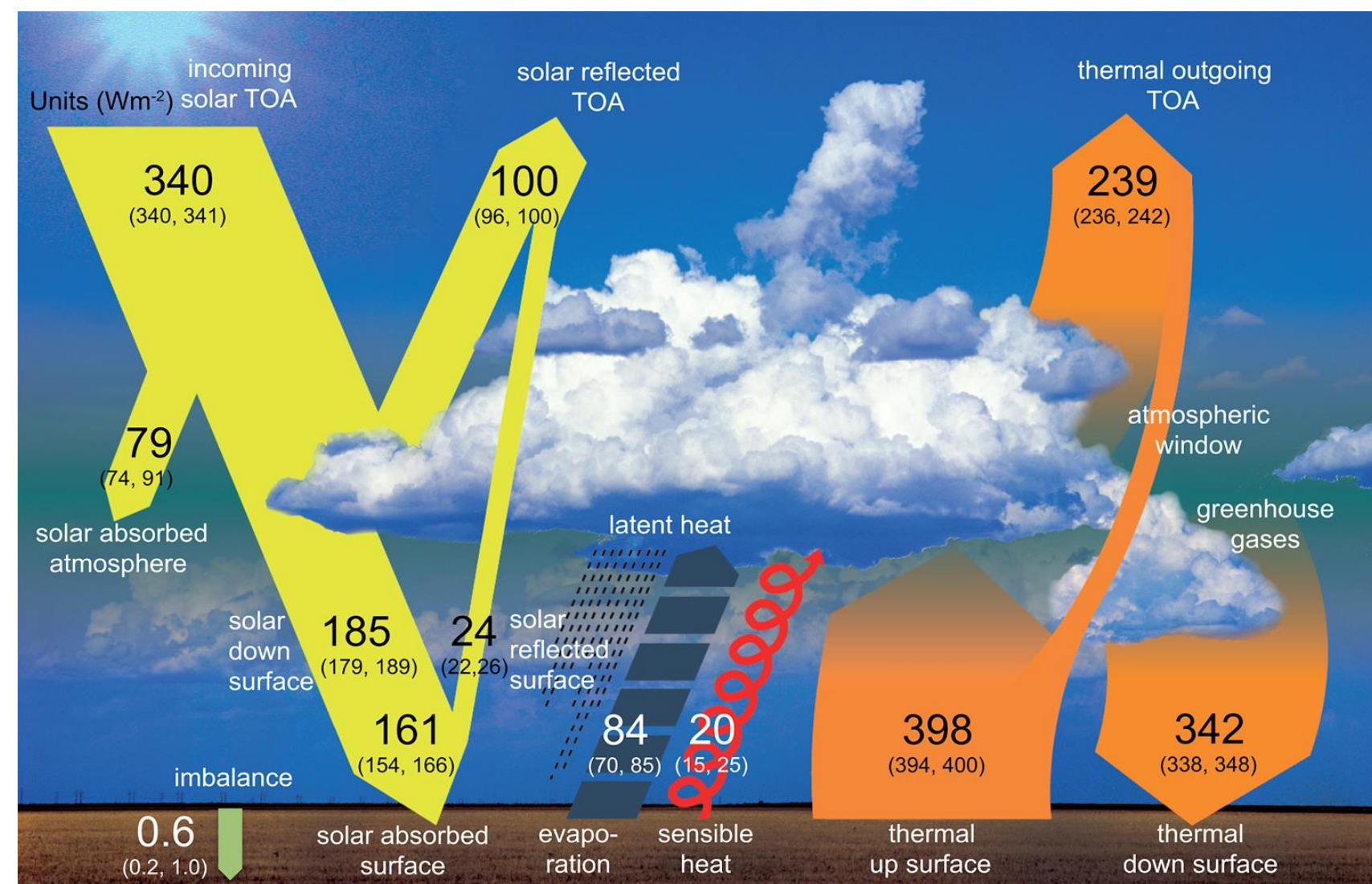
Background

- Earth's temperature is determined by incoming and outgoing radiation
- Anthropogenic activities have changed Earth's radiative balance by adding greenhouse gases (GHGs) into atmosphere
- Absorption by GHGs leads to warming of the surface and atmosphere

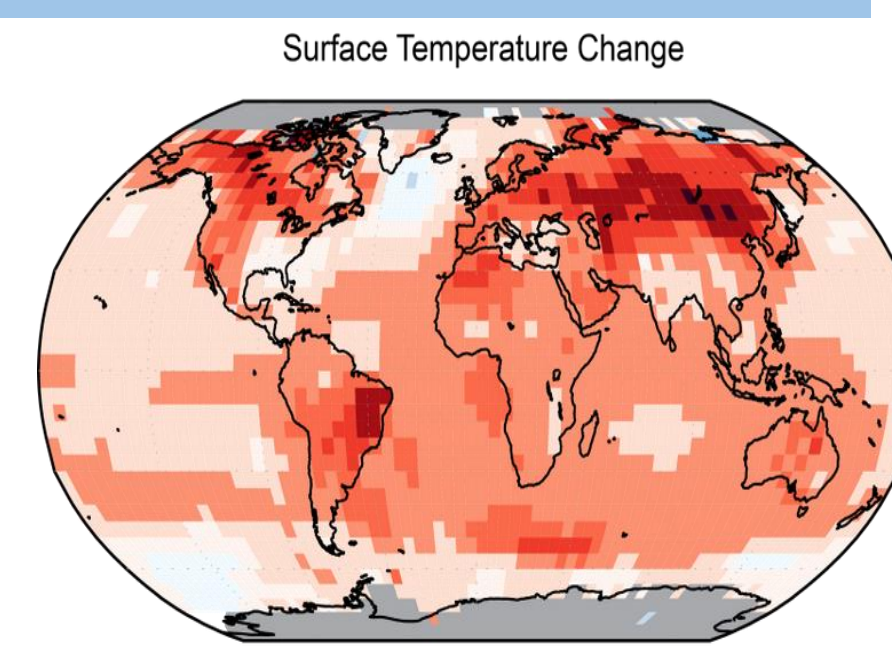https://science2017.globalchange.gov/chapter/2#fig-2-1

Research Questions

- Is New York City (NYC) experiencing more extreme temperatures today than in the past?
- How have the frequency of cold and hot temperature extremes changed over time?

Motivation

- Global mean temperature has increased
- The magnitude of the temperature change at each location varies
- The purpose of my research is to see how temperature has changed in NYC

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Data and Methods

Data: European Center for Medium-Range Weather Forecasts (ECMWF) - 20th Century Reanalysis (ERA-20C)

- 2-meter temperature, 1900-2010

Steps to decomposing a time series:
1) Fit line to the time series and remove long-term trend
2) Remove seasonality from detrended data
3) Normalize result from 2) by the daily standard deviation
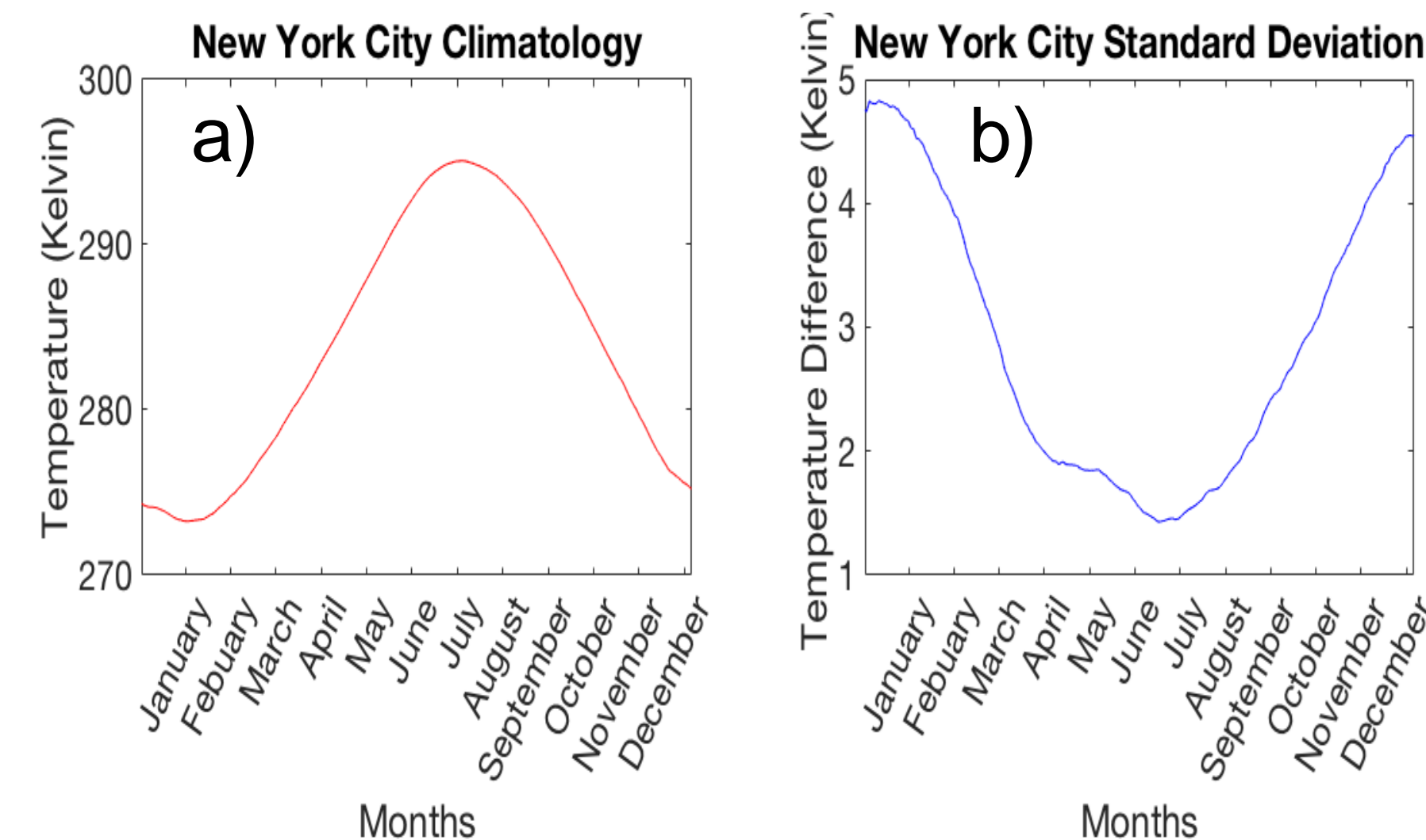
$$z = (data - mean)/standard\ deviation$$

Results

Figure 1. For New York City(1900-2010), a) 2 meter temperature daily climatology and b) 2 meter temperature daily standard deviation climatology; a 31 day running mean is applied.

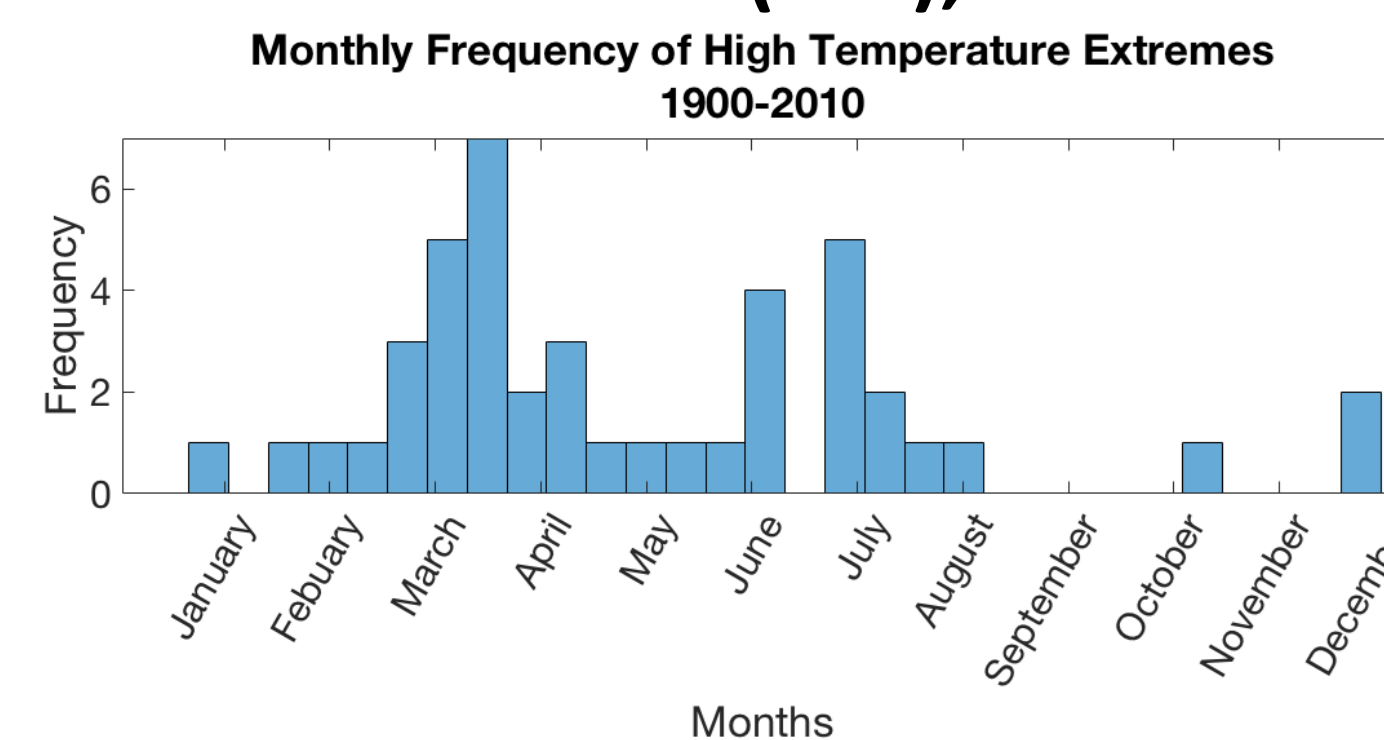**Extremes: z > 2.576 (hot), z < -2.576 (cold)**

Figure 3. Monthly frequency of extreme normalized hot temperature anomalies
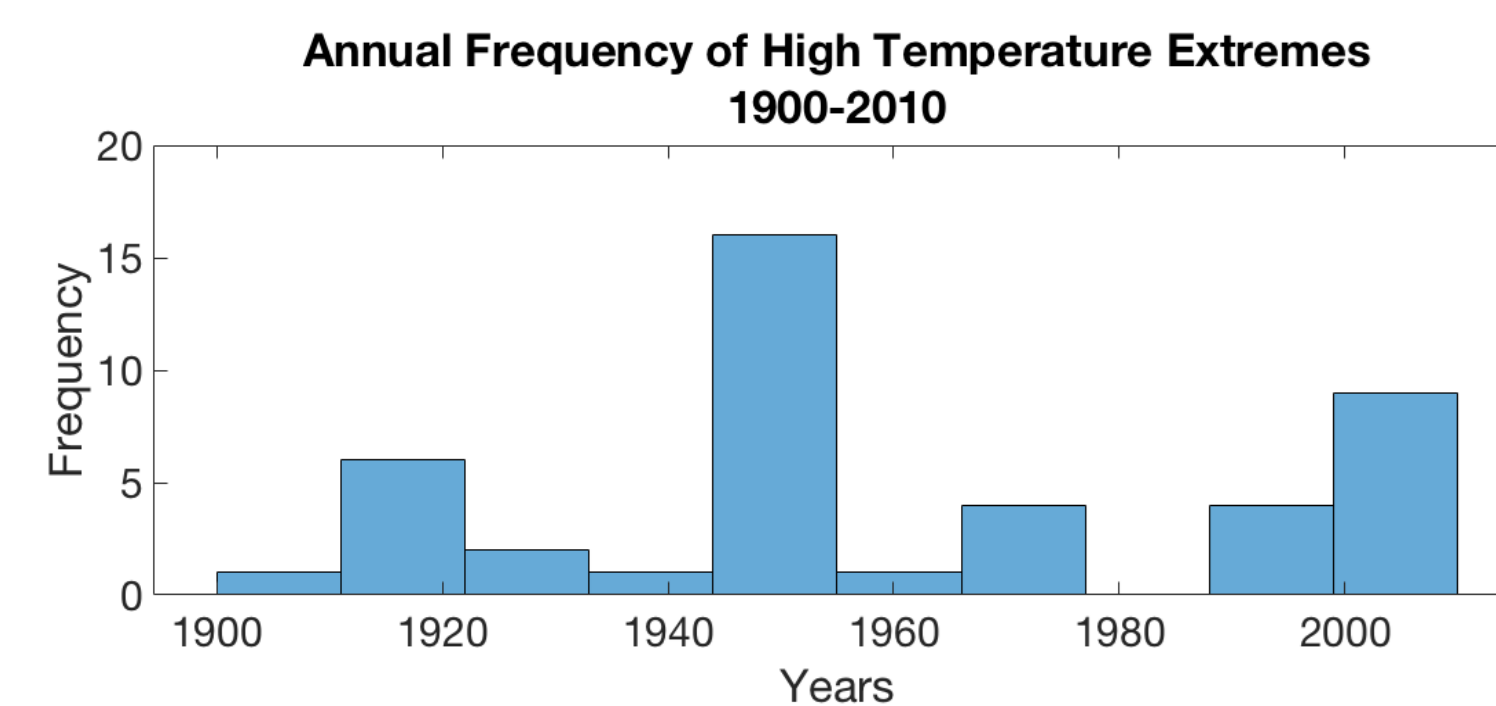

Figure 4. Annual frequency of extreme normalized hot temperature anomalies
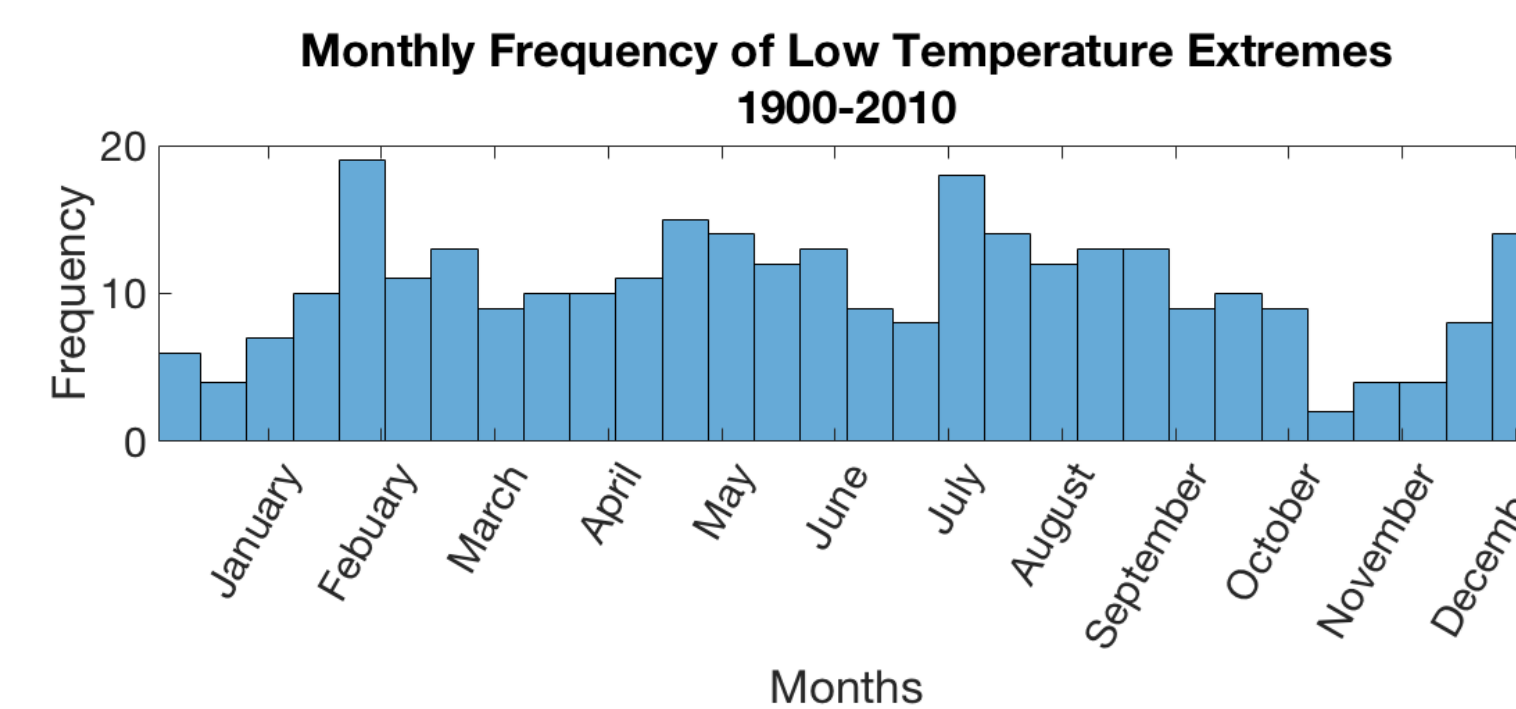

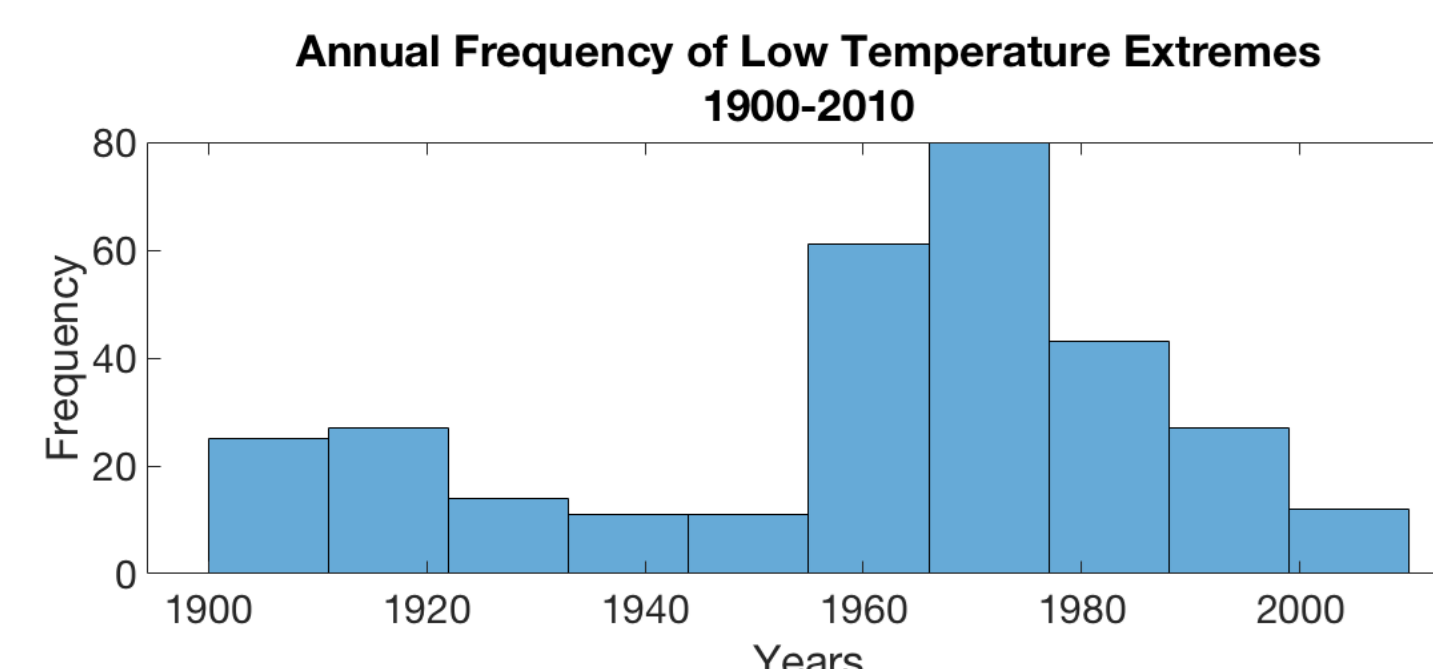Figure 5. Monthly frequency of extreme normalized cold temperature anomalies

Figure 6. Annual frequency of extreme normalized hot temperature anomalies
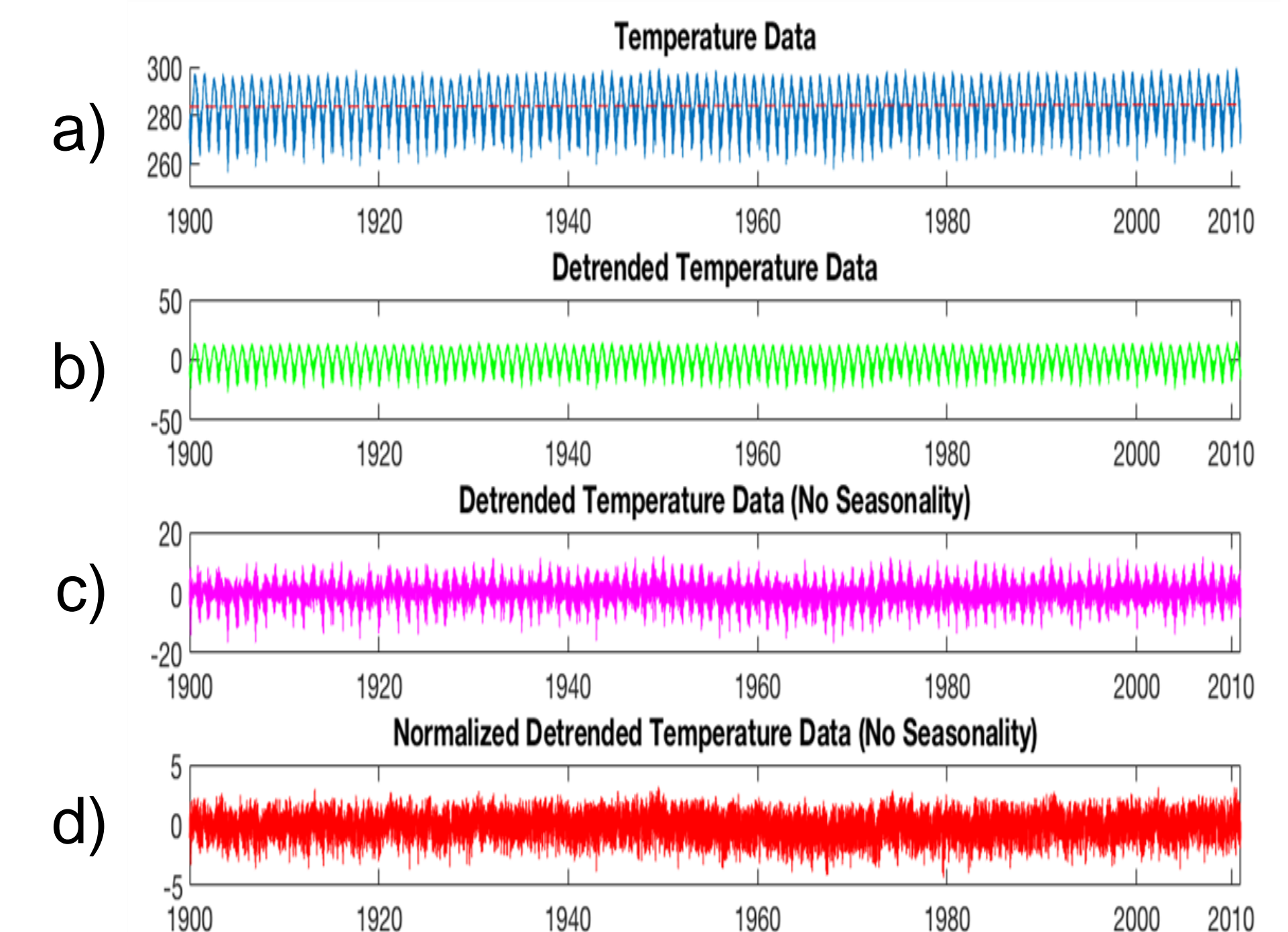

Figure 2. For New York City(1900-2010), a) 2 meter temperature daily time series (Kelvin; blue line) with linear fit (red dash line), b) detrended temperature anomalies, c) seasonality removed from b), d) normalized data from c)

Conclusions

- In summer temperature is the highest but the variance is the lowest compared to winter when temperature is the lowest and variance is the highest (Figure 1.)

- Since 1900 the temperature in NYC has been increasing at a rate of about 0.0811° C (0.15° F) per year (Figure 2.a)

- Hot temperature extremes happen the most in March and April in NYC (Figure 3.)

- Cold temperature extremes happen the most in February in NYC (Figure 5.)

- Most hot temperature extremes occurred in 1950 in NYC (Figure 4.)

- Most cold temperature extremes happened in 1970 in NYC (Figure 6.)

References

- https://science2017.globalchange.gov/
- Hersbach, H., C. Peubey, A. Simmons, P. Berrisford, P. Poli, and D. Dee, 2015: ERA-20CM: A twentieth-century atmospheric model ensemble. *Quart. J. Roy. Meteor. Soc.*, **141**, 2350 - 2375.