

Statistical and Anomaly Analysis of Climate Trends in the Dallas-Fort Worth Metroplex

By Quinnton DeBolt¹, Dr. Arne Winguth¹

¹The University of Texas at Arlington



Introduction

The purpose of this study is to provide a comprehensive report of historical climate changes of the Dallas-Fort Worth Metropolitan area to understand trends as they relate to predicting future climate conditions for this location. This study provides insights into climate variables such as precipitation trends and temperature change over the course of the time period studied. Statistics such as minimum, maximum and mean are used for both temperature and precipitation as well as an anomaly analysis drawn from a reference period similar to the reference material.

Methods

- Temperature and precipitation data was collected by the National Weather Service station at the Dallas/Fort Worth International Airport* (4 & 5)
- Temperature data was then recorded in Excel, converted from degrees Fahrenheit to degrees Celsius and compared to a selected reference period of 1951-1980, similar to NASA's GISS Surface Temperature Analysis
- Averages and anomaly values from the reference period were then input into MATLAB and Excel to create visual aids in the form of line graphs and bar charts

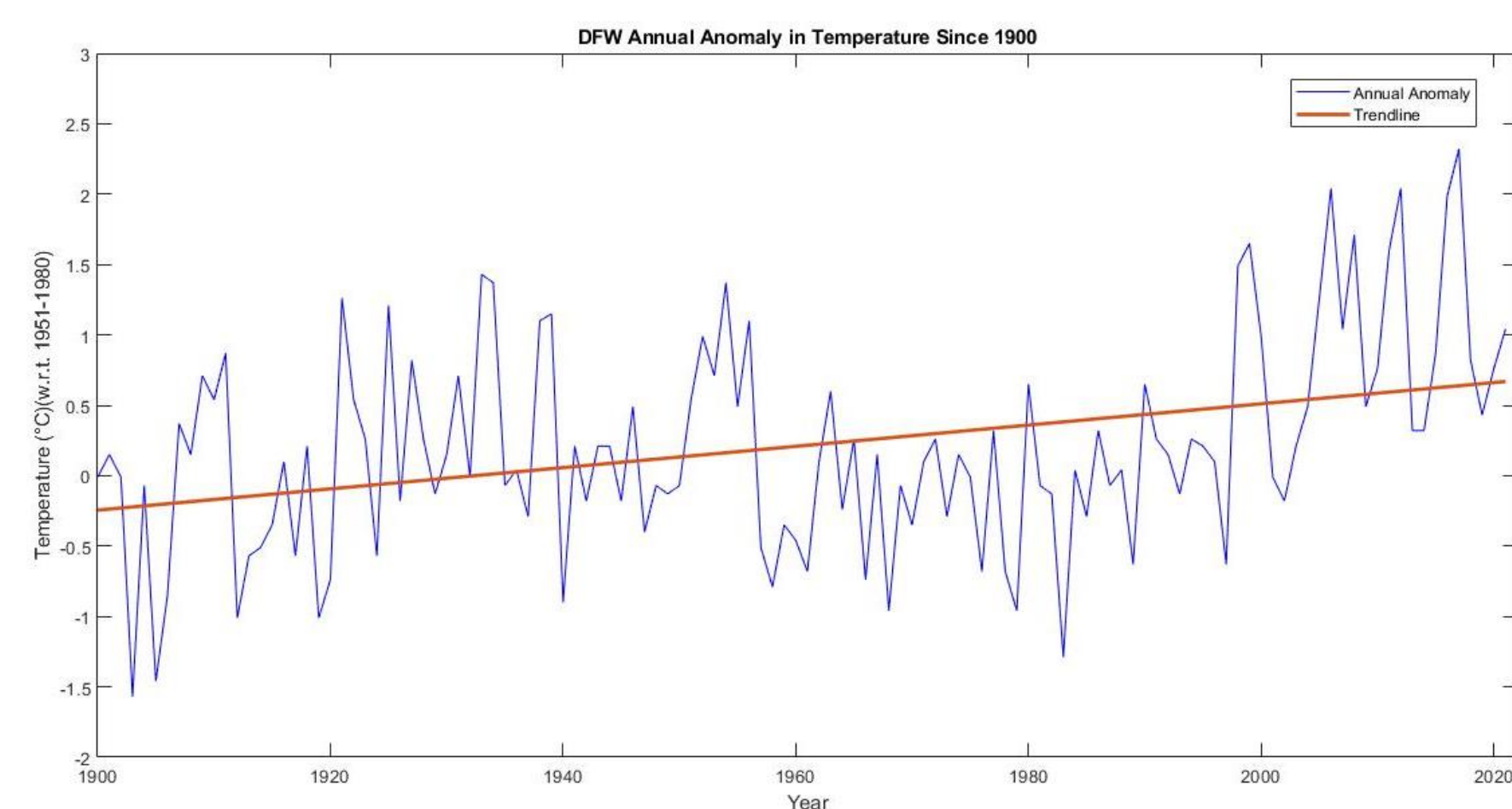


Figure 1: Line graph 'DFW Annual Anomaly in Temperature since 1900'. Shows overall rising trend in yearly temperature anomaly from reference period 1951-1980.

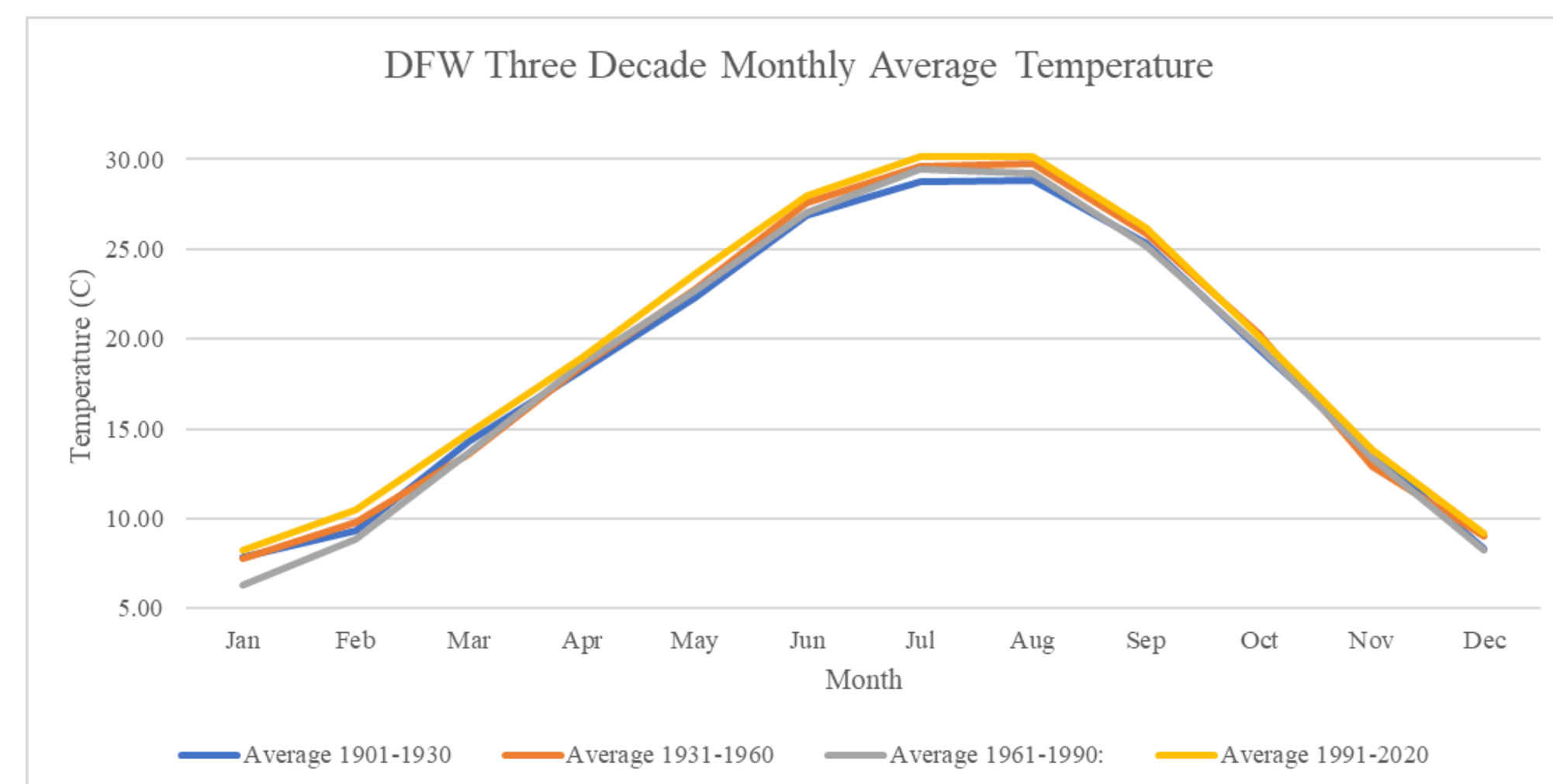


Figure 2: Line chart of mean monthly temperature trends for each of the three-decade periods in the study.

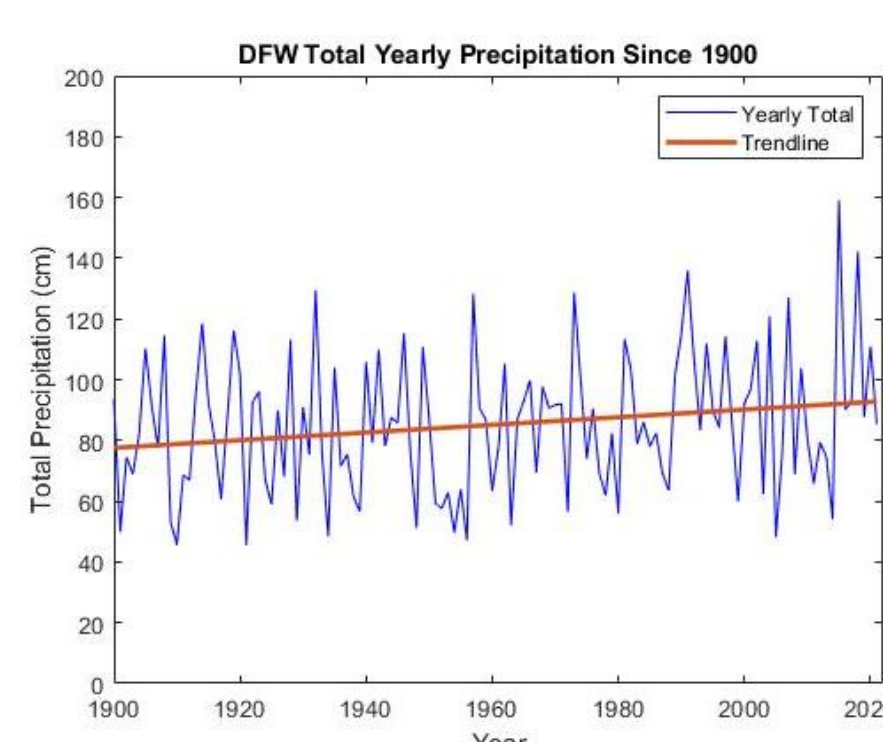


Figure 3: Line graph 'DFW Total Yearly Precipitation Since 1900' with yearly total precipitation in cm and a trendline showing a positive general correlation.

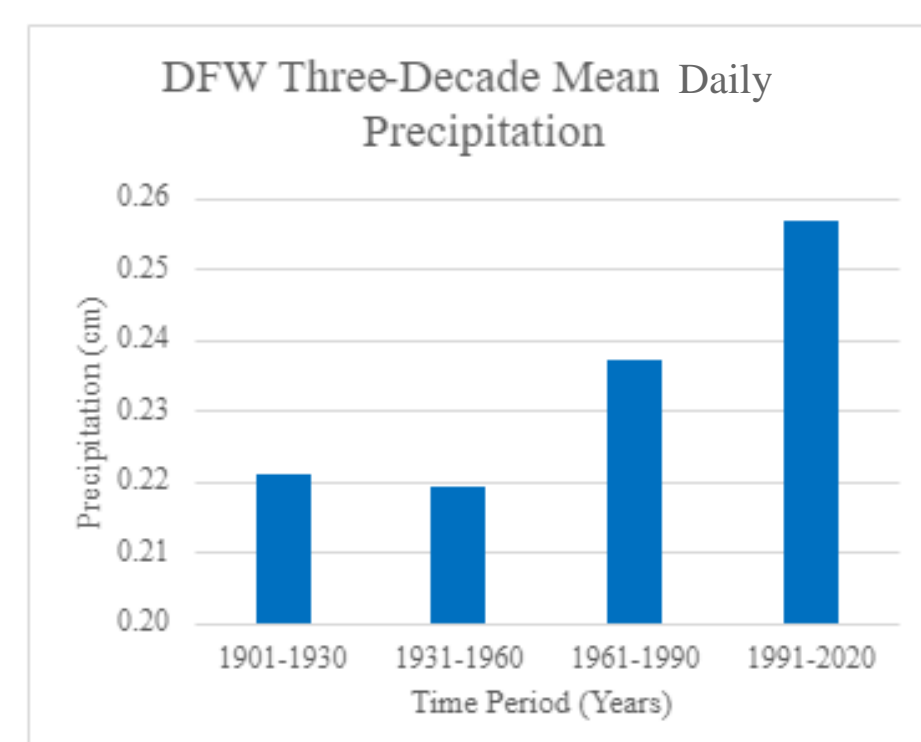


Figure 4: Bar chart of three-decadal average precipitation of periods 1901-1930, 1931-1960, 1961-1990 & 1991-2020.

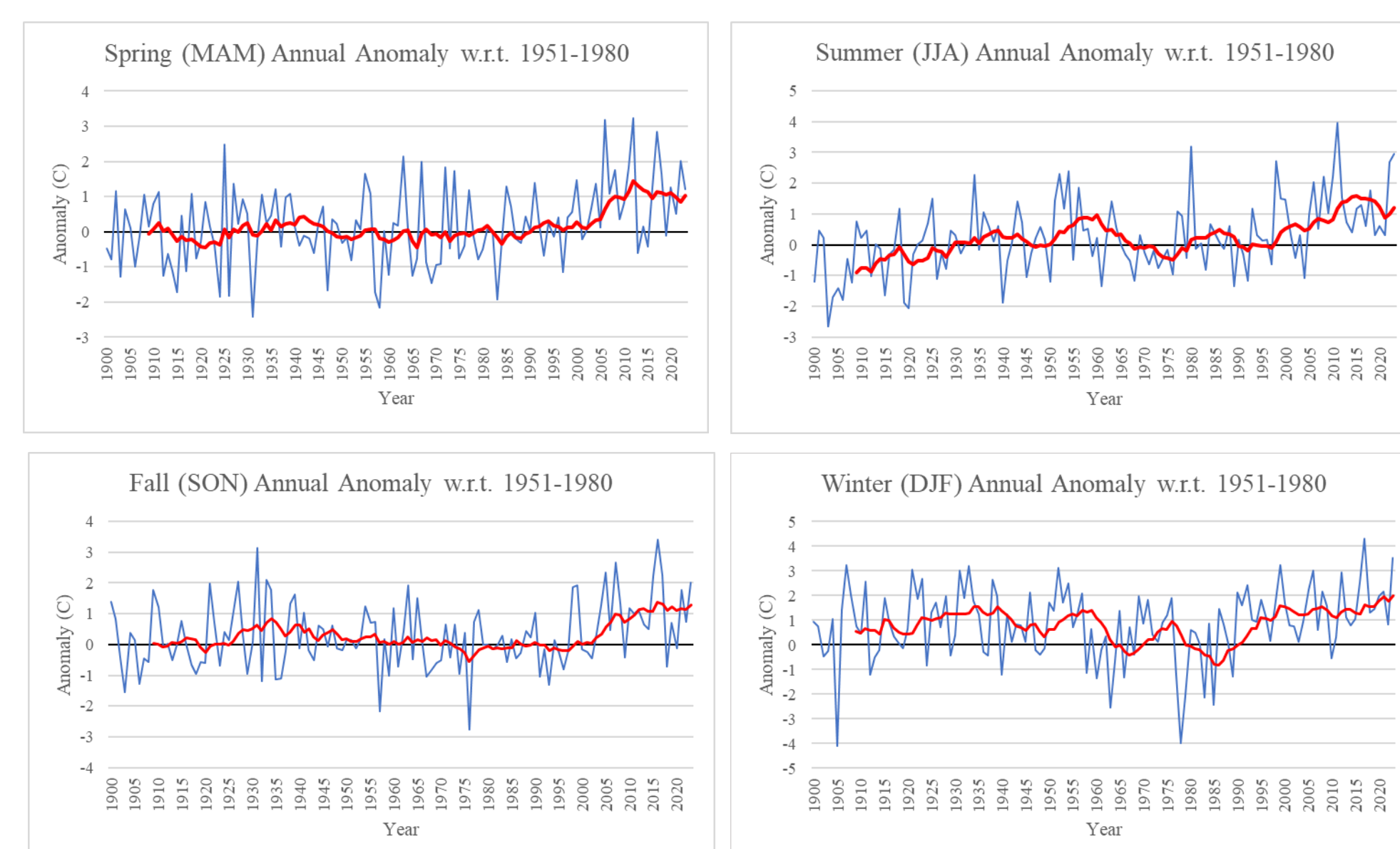


Figure 5: Line chart of seasonal temperature anomalies over the entire time period included in this study. The seasons are broken into Spring (March/April/May), Summer (June/July/August), Fall (September/October/November), and Winter (December/January/February). The red line represents a 10-year moving average.

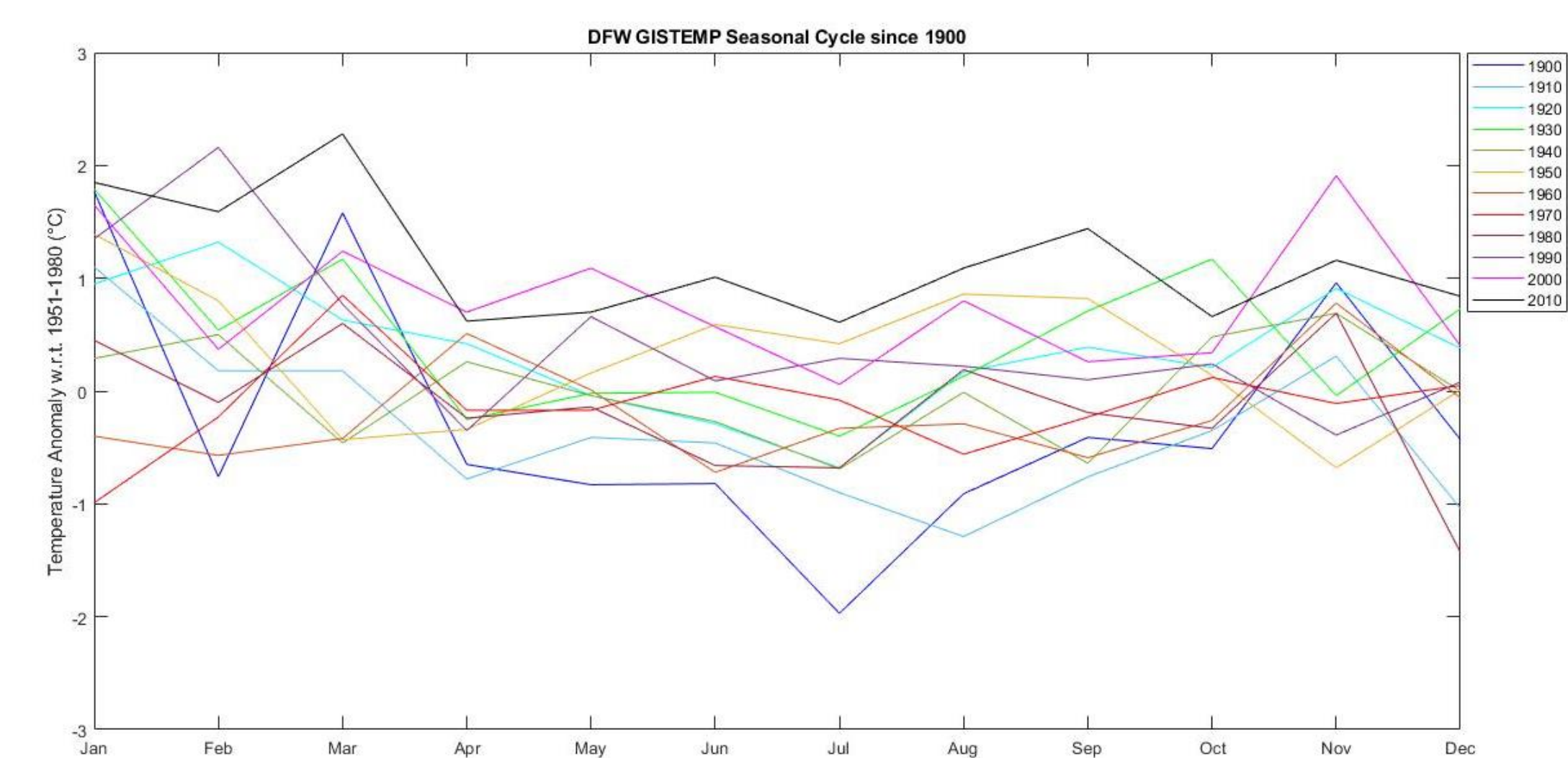


Figure 4: Line graph 'DFW GISTEMP Seasonal Cycle since 1900'. Each line represents a decade of time, with each month of that decade plotted with its average anomaly with reference to 1951-1980.

Results

The annual and seasonal mean temperatures through the time period has shown a steady increase, as shown in Figures 1 and 2. In Figure 1, the trendline has a positive slope, but there is also a more drastic positive trend in the time period of 1980-2021. This shows that the increase in average yearly temperature is accelerating, showing a non-linear change in recent years. Figure 2 also reflects this trend, with the most recent three-decade time period trending higher in monthly mean temperatures than earlier three-decade periods. Figure 3 reveals that the mean yearly precipitation is also increasing, particularly within recent years. This is supported by the three-decade bar graph Figure 4, where a positive trend in mean precipitation is shown. Figure 5 shows the anomalies of seasonal temperature over the 120 year time period, and every season shows a positive anomaly within the most modern three-decade time period. Figure 6 shows these temperature anomalies as a seasonal cycle within decade-long time periods, and this chart also supports the warming climate hypothesis, as most recent decades continuously trend higher in anomaly than previous decades.

Discussion

Possible Contributing factors to the warming trend:

- **Global climate change:** the IPCC's AR6 report shows evidence of climate change caused by anthropogenic activity through **increase in surface temperature** as well as **increased precipitation**.* (3)
- **Urban heat island effect:** DFW's population has multiplied over 30x its amount in 1900* (1 & 2) and the correlating increase in urban development has created a rise in the urban heat island index.* (6)

Possible Errors:

- Extreme weather events: abnormal weather conditions can create extremes that affect yearly temperature averages.
- Movement of the weather station: through the DFW temperature and precipitation database is considered a complete record, the data record are from four differing locations over the studies time period of this research.

Conclusion

There is a high likelihood that the average temperature in DFW will continue to rise in the future and the frequency of extreme weather events could increase. The urban heat island index will also rise as development for the area continues.

References*

1. The County Information Program, Texas Association of Counties. Historic Dallas County Population: 1850 - Present [Internet]. Historic Texas County Population. The County Information Program, Texas Association of Counties; 2020 [cited 2022Apr6]. Available from: <https://bcip.org/tac/census/hist.php?FIPS=48113>
2. The County Information Program, Texas Association of Counties. Historic Tarrant County Population: 1850 - Present [Internet]. Historic Texas County Population. The County Information Program, Texas Association of Counties; 2020 [cited 2022Apr6]. Available from: <https://bcip.org/tac/census/hist.php?FIPS=48439>
3. Masson-Delmotte V, Zhai P, Pirani A, Connors SL, Pean C, Chen Y, et al., editors. AR6 Climate Change 2021: The Physical Science Basis [Internet]. Sixth Assessment Report. The United Nation's Intergovernmental Panel on Climate Change; 2021 [cited 2022Apr6]. Available from: <https://www.ipcc.ch/report/ar6/wg1/>
4. US Department of Commerce. DFW - monthly and annual average temperatures [Internet]. DFW - Monthly and Annual Average Temperatures. NOAA's National Weather Service; 2022 [cited 2022Apr6]. Available from: <https://www.weather.gov/lfw/dmotemp>
5. US Department of Commerce. DFW - monthly and annual precipitation [Internet]. DFW - Monthly and Annual Precipitation. NOAA's National Weather Service; 2022 [cited 2022Apr6]. Available from: <https://www.weather.gov/lfw/dmoprecip>
6. Winguth AM, Kelp B. The urban heat island of the north-central Texas region and its relation to the 2011 severe Texas drought. Journal of Applied Meteorology and Climatology. 2013;52:2418-33.