

Analysis of Land Temperatures in the United States over the last century

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1. Abstract

Over the centuries, there has been a global increase in the mean land temperatures. This analysis is specifically directed to the data recorded for United States from the last 115 years. Initially, the increase in temperature on a global basis has been calculated and depicted. Then, we move on to data recorded for United States in particular. This data has been represented in terms of individual states and major cities as well as the whole country. The percentage increase in average land temperature has also been calculated in each case.

2. Introduction

This paper describes the methods and the accompanying results of analysis done on the average land temperatures in the United States from the year 1900. The percentage increase of land temperature in the US is found to be 25.22 % over the last century. The gradual rise over the years could be attributed to solar activity (which has been determined through historical records of sunspot numbers), increase in population and many other factors. The graphs and results associated with the research have been presented here.

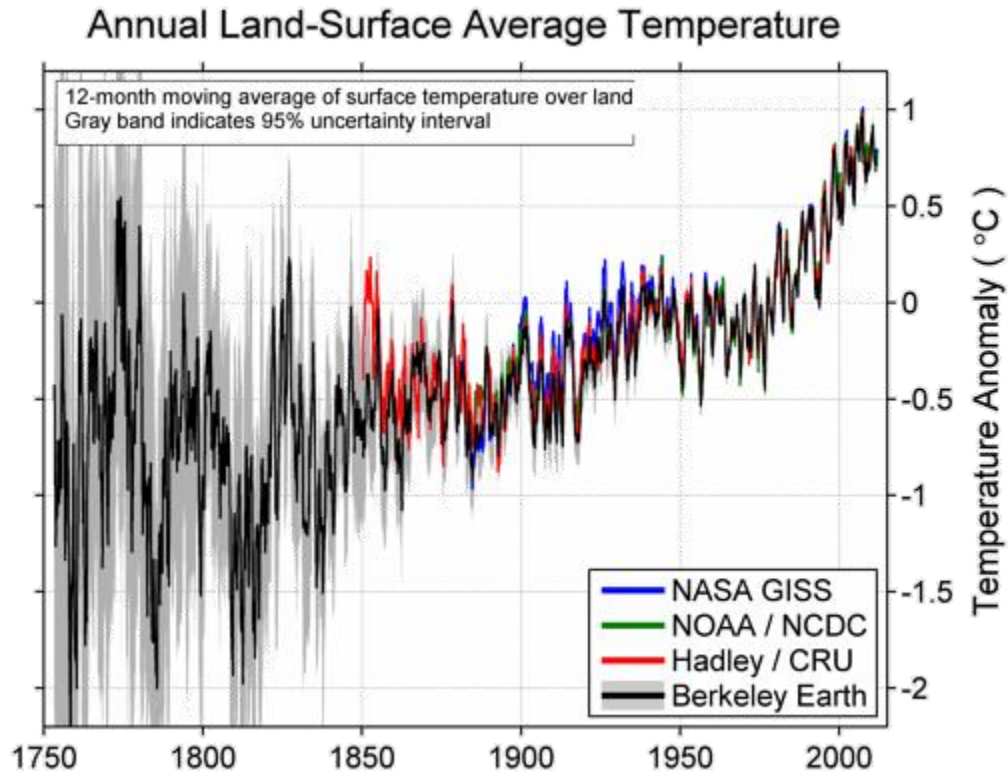


Figure 1 Source: Berkeley Earth

3. Methodology

This section describes the tools used and presents an explanation of how the results and figures have been arrived at. R has been used to process the data as well as to calculate and depict the results.

3.1. Dataset

The data consists of four .csv files obtained from Berkeley Earth project (<http://berkeleyearth.org/data/>). The time period over which the data has been recorded spans around 250 years from 1750 till around 2015.

These are the files used:

3.1.1. GlobalTemperatures.csv

This sheet contains average temperature data (in degrees Celsius) calculated globally over the last 250 years.

3.1.2. GlobalLandTemperaturesByCountry.csv

This contains land temperature data recorded for each country.

3.1.3. GlobalLandTemperaturesByMajorCity.csv

The Average temperature data of the major cities of each country are recorded in this sheet.

3.1.4. GlobalLandTemperaturesByState.csv

This sheet contains land temperature data recorded with respect to each state of several countries.

All the above data files contain an additional column for average temperature uncertainty, which gives the uncertainty factor for each calculated temperature value.

3.2. Data Pre-processing

R has been used to load and process all the data. The data has been cleaned up in two steps as mentioned below:

3.2.1. NA entries

The data set includes many entries which were blank. Using R, after loading the data, the blank entries have been excluded.

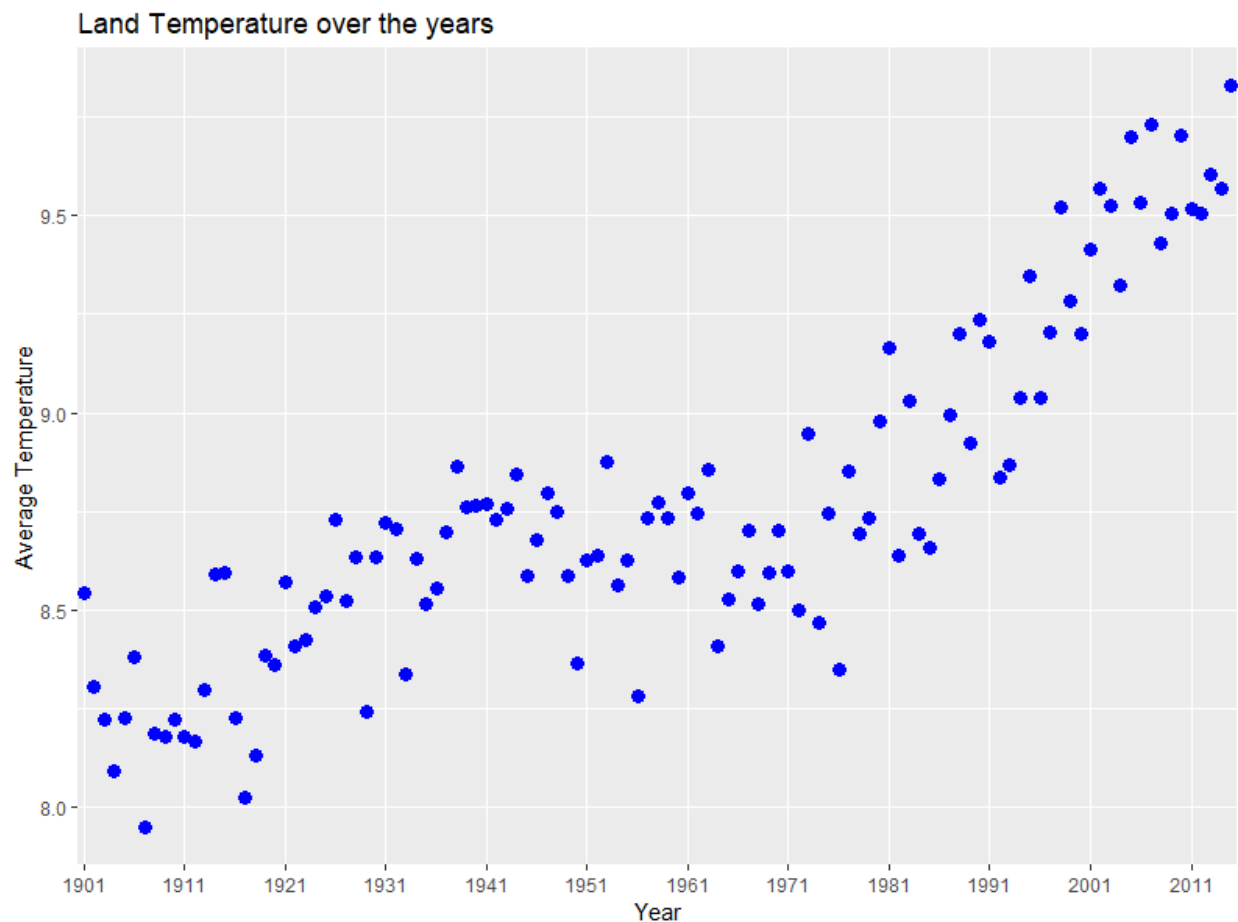
3.2.2. Date discrepancies

The date (“dt” column) which is present in all the files of the data set is in various formats such as yyyy-mm-dd, yyyy/mm/dd and so on. All these dates have been converted to one single format yyyy-mm-dd in order to maintain the consistency of the data.

4. Results

4.1 Global Average Land Temperature

- To calculate the average land temperature on a global basis, the GlobalTemperatures.csv has been used.
- After data loading and pre-processing, the data set was filtered to extract only the rows from date 1900 onwards.
- This data was then summarized to calculate the average for each year and plotted.



As can be seen in the plot, there is a gradual rise in the land temperatures until the 1970s and then it is a steep increase.

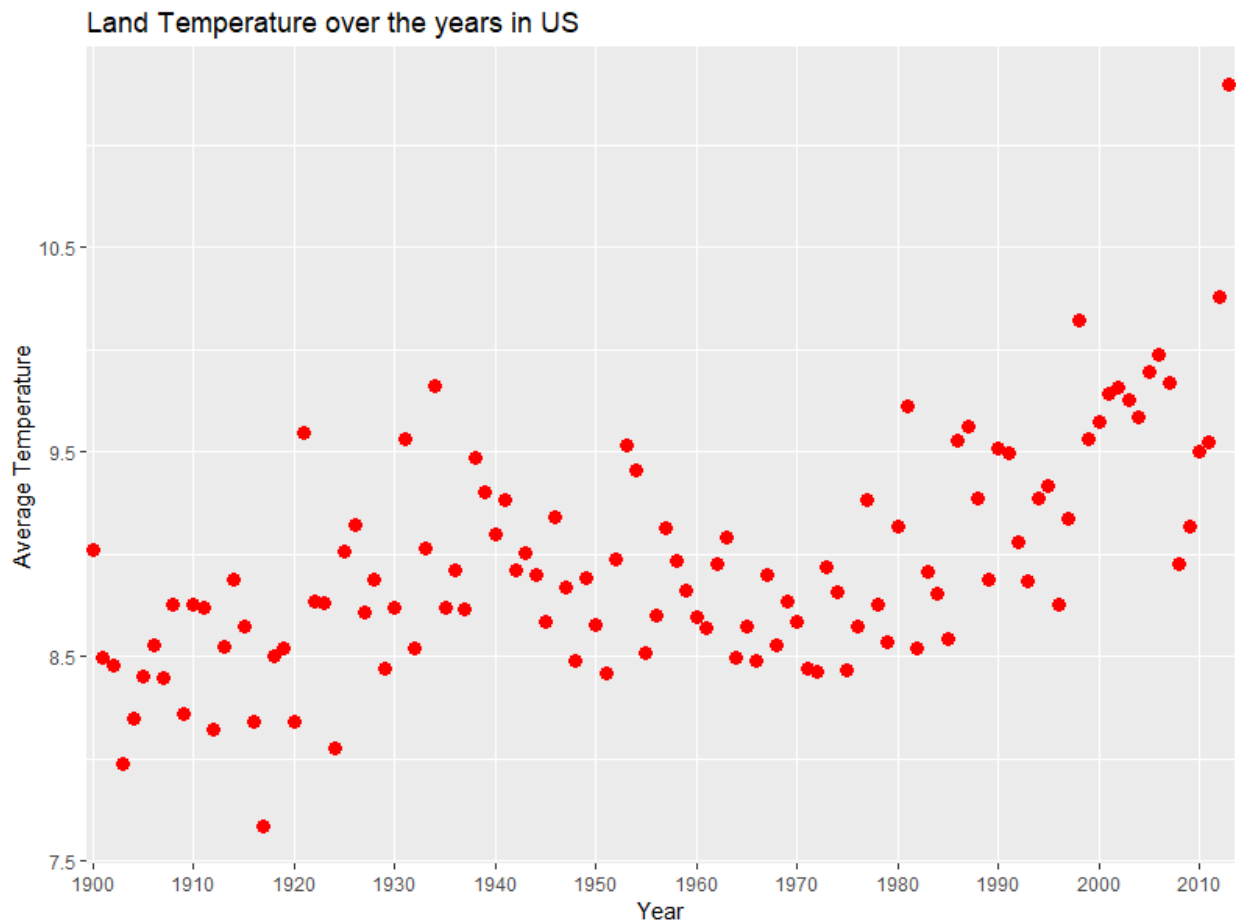
- The percentage increase in temperature has been calculated as:

$$\% \text{ increase} = ((\text{max} - \text{min}) / \text{min}) * 100$$

This was found to be **15.09 %** from the dataset.

4.2. Average Land Temperature in US

- For determining the temperature change in only United States, the data from GlobalLandTemperaturesByCountry.csv has been used.
- The data has been filtered to include only the rows for country “United States” from the year 1900.
- This data was summarized to calculate the mean temperature for each year and plotted.

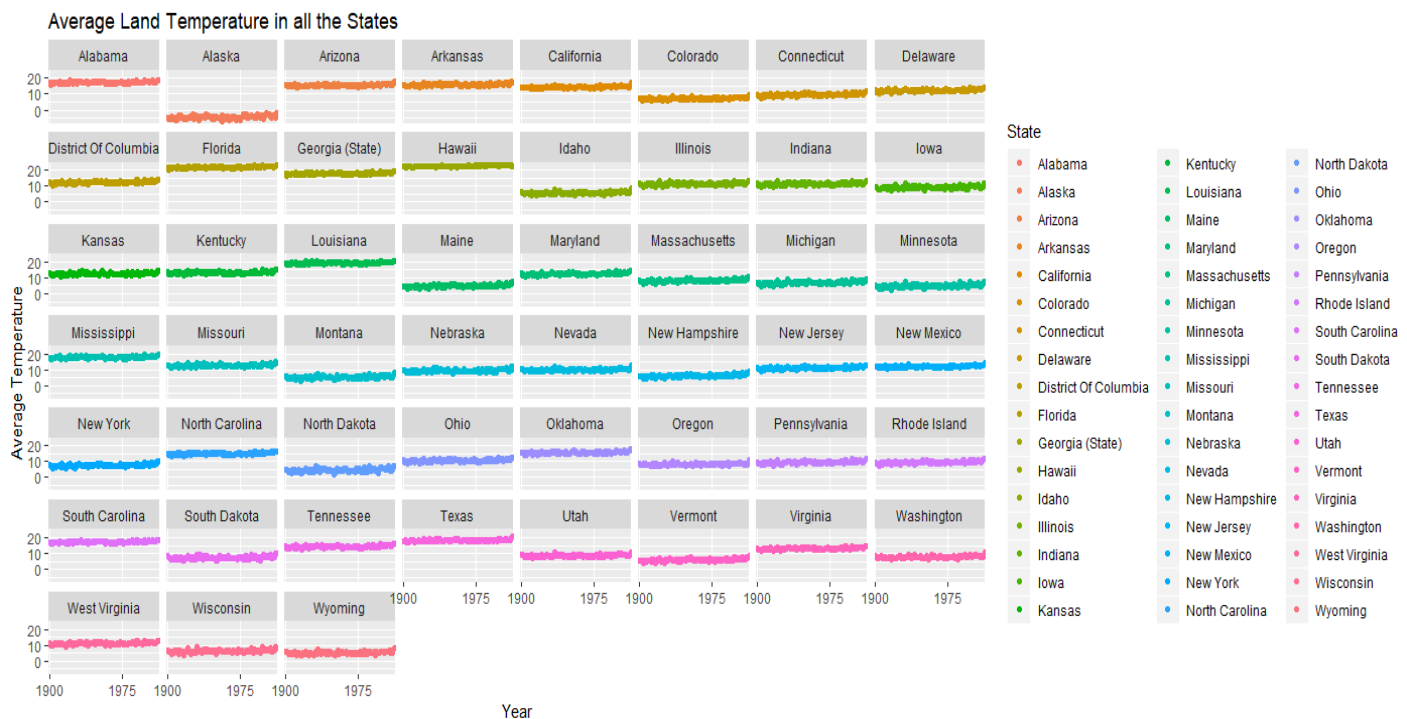


As seen in the above plot, there is a gradual rise in the mean overall land temperature in the US

- The percentage rise in temperature over the last century has been calculated to be 25.22%

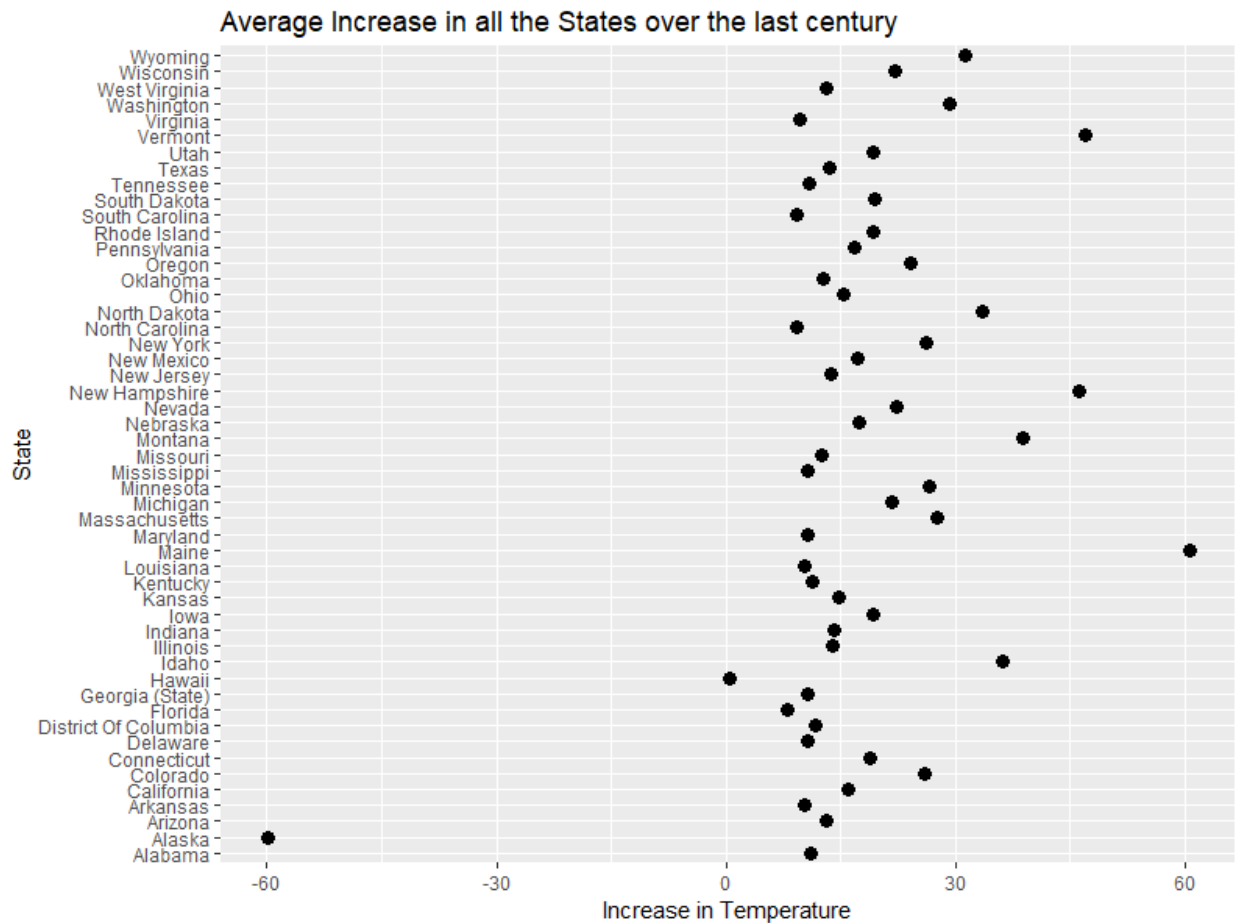
4.3. Average Land Temperature in each US state

- To calculate the average land temperature on basis of each US state, the GlobalLandTemperaturesByState.csv has been used.
- After data loading and pre-processing, the data set was filtered to extract only the rows from date 1900 onwards of each US state.
- This data was summarized to calculate the average for the entire year and plotted separately for each individual state.



As can be seen above, there is a gradual increase in all of the states over the past century

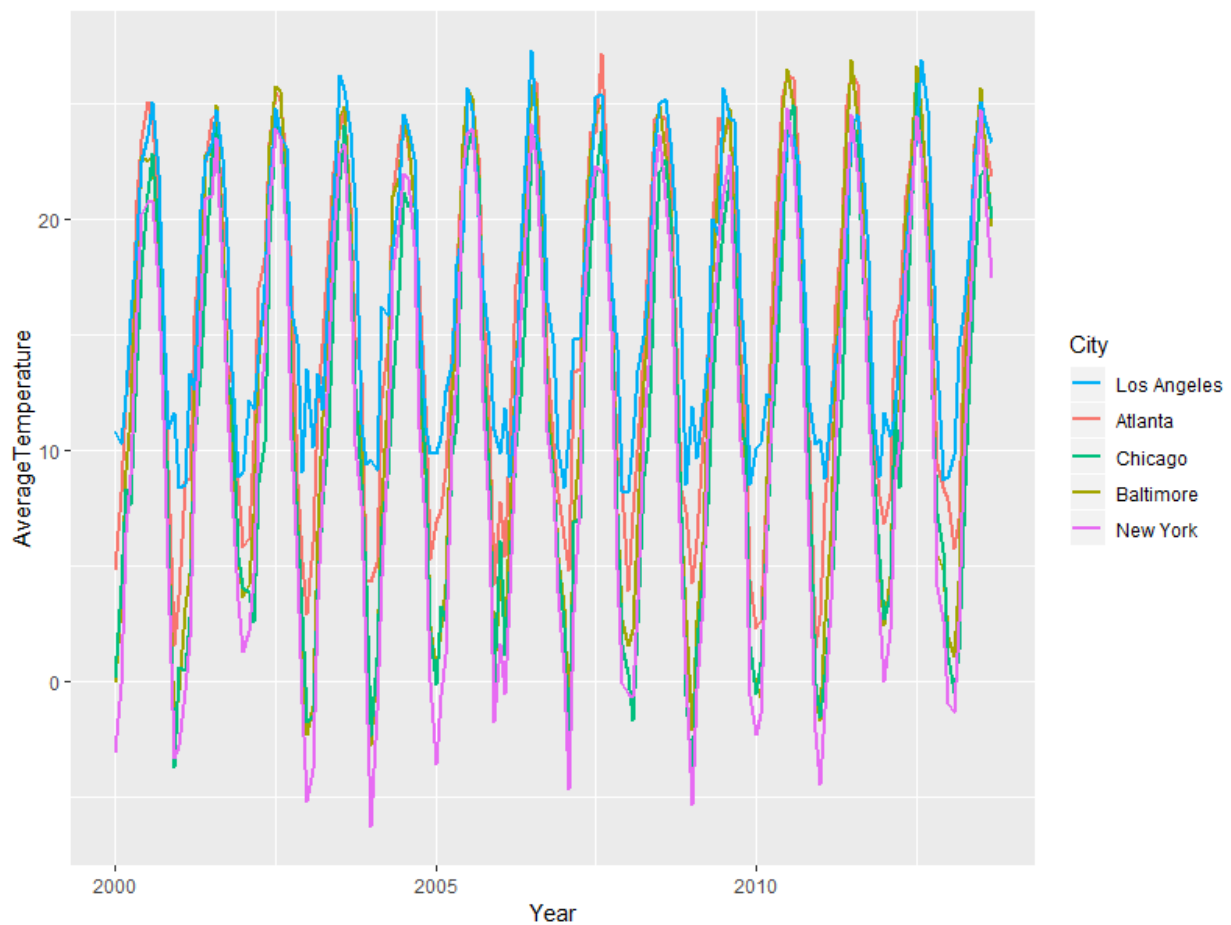
- The percentage rise in temperature with respect to each state has been calculated and depicted in the below plot



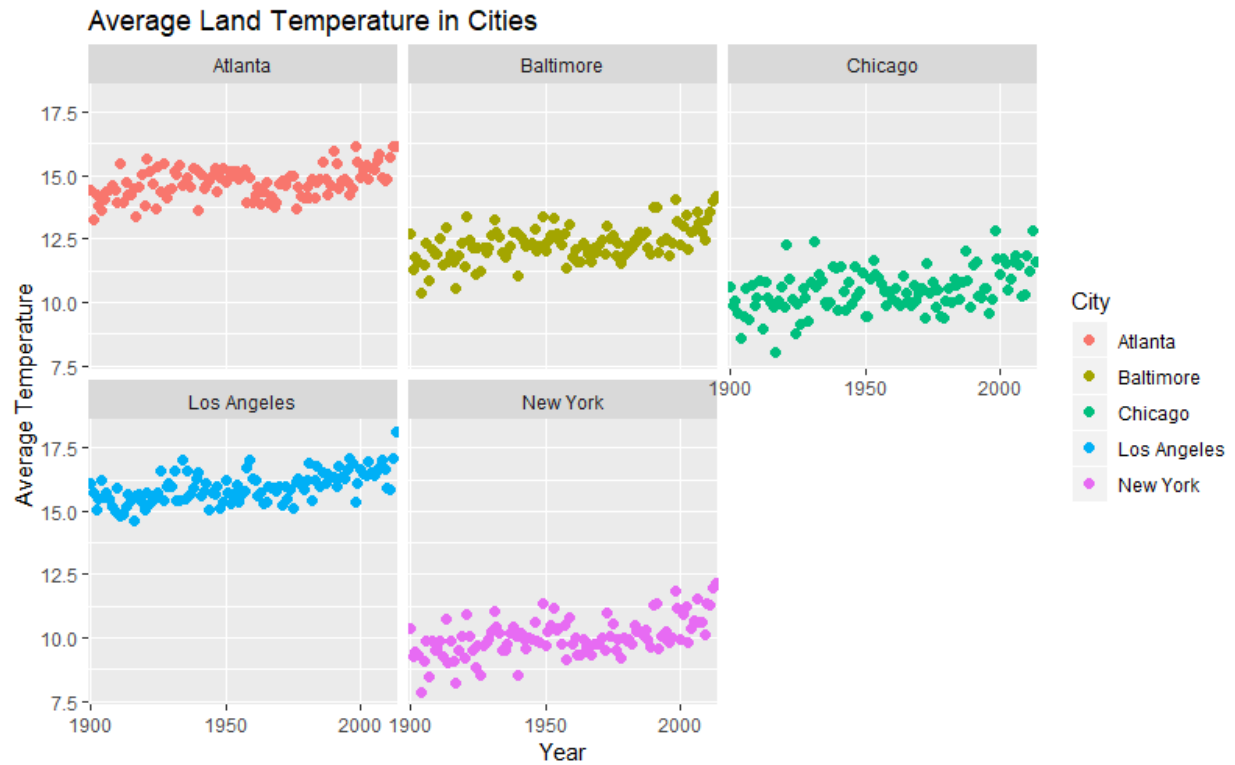
The plot shows that most of the states have experienced a temperature increase of around 10 to 30%.

4.4. Average Land Temperature in major cities of the US

- The average land temperature on basis of a few US cities has been calculated using the GlobalLandTemperaturesByMajorCity.csv file.
- The data has been filtered and only the rows with major US cities have been included in the calculations.
- The average temperature data has been plotted for each of the cities as shown below.

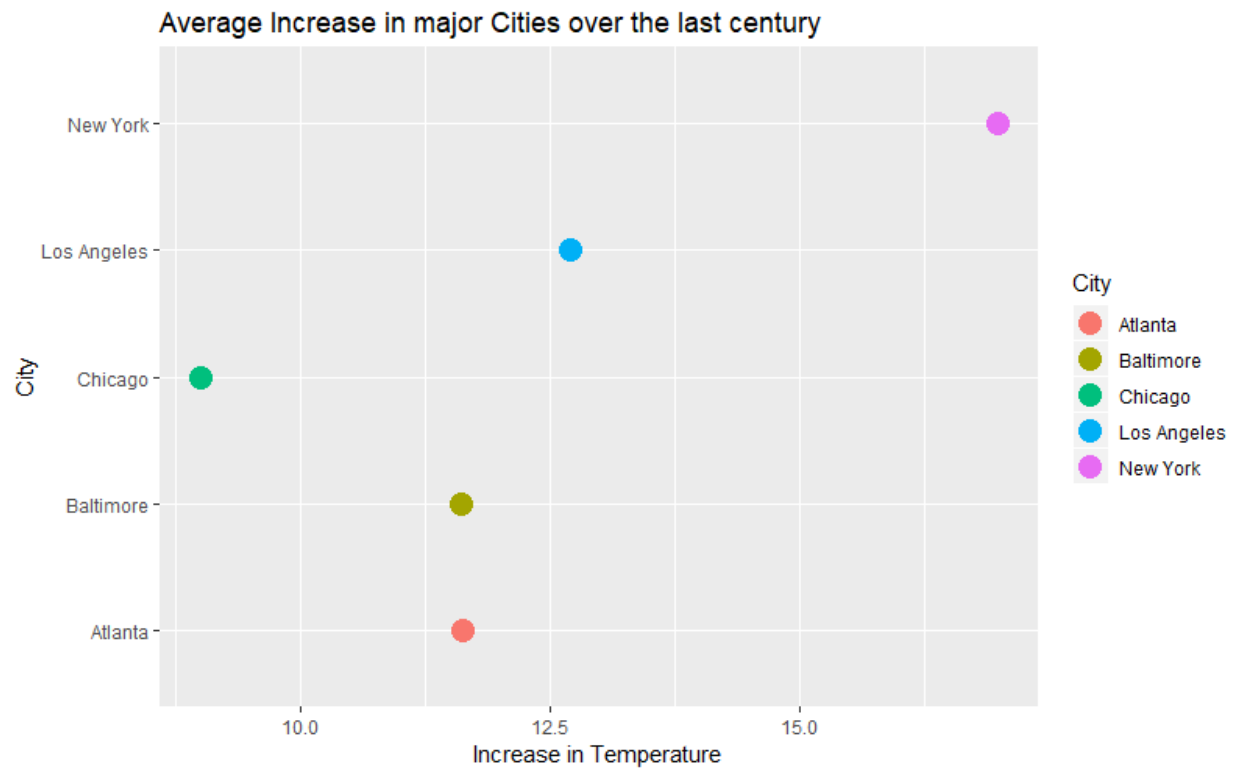


- The data recorded over the last century has also been depicted for each city separately below.



The cities also show a gradual increase in the average land temperature.

- Below is the plot showing the percentage increase in each of the above cities.



New York City has shown the maximum percentage increase of 16.98 % whereas Chicago has experienced a minimum increase of 8.99 % in land temperatures.

5. Conclusion

- The percentage increase in average land temperature globally has been determined to be 15.09% over the last century.
- The temperature rise in United States in particular has been calculated to be 25.22%.
- Most of the states have experienced a temperature increase between 10 to 30 %.
- Of all the major cities, the temperature rise in New York has found to be the maximum, that is, 16.98 %.