

Assignment One

Miles Kent

June 18, 2023

Abstract

The purpose of this assignment is to calculate all temperature norms for the heatwave project from the daily data. I will first introduce some definitions. Then, I will discuss the steps to calculate the minimum temperature norms for cold snaps, the maximum temperature norms for heatwaves, and the average temperature norms for each city using daily data. Finally, I will also discuss how we can use these norms to identify heatwaves in our daily climate data.

Comments

All outputs for this assignment are contained within the MATH 497 Assignment 1 folder as CSV files. The R script is contained as well, and is heavily annotated. Please let me know if questions arise during the grading of this assignment.

1 Definitions

1.1 Maximum Temperature Norm

A heatwave can be defined as when the maximum daily temperature reaches above the maximum norm threshold for three or more consecutive days. We define the maximum temperature norm threshold for a geographical region as the upper 90% of all of the daily maximum measurements during a geographical regions warm season (5 warmest months).

1.2 Minimum Temperature Norm

A cold snap can be defined as when the minimum temperature in a 24 hour period (12:00pm - 11:59am) reaches below the minimum norm threshold for three or more of these 24 hour periods in a row. We define the minimum temperature norm threshold for a geographical region as the bottom 10% of all of the daily minimum measurements for a geographical regions cold season (5 coldest months).

1.3 Average Temperature Norm

We define the average temperature norm for a geographical region as the average of all daily average temperature measurements. It can be calculated with the following formula, where TN_{adv} is the average temperature norm for a geographical location, T_n is the daily average temperature for day n , and N_{days} is the number of days being used on our average temperature norm calculation.

$$TN_{adv} = \frac{1}{N_{days}} \sum_{n=1}^{N_{days}} T_n \quad (1)$$

2 Calculation of Norms

All norms are calculated using daily data from the National Oceanic and Atmospheric Association. The file containing all of the data in the assignment one folder is "correctdailycities.zip". We use R 4.0.5 to organize our data and run our calculations. For all of our norm calculations, we only use data contained between January 1st, 1990 and December 31st, 2019.

2.1 Calculation of the Average Temperature Norm by Month

This is done by breaking up the data by city and taking the mean of the average temperatures for each month in our date range of our daily data. The output of this is contained in the "Adverage Norms.csv" file.

2.2 Calculation of Warm and Cold Seasons

We calculate the warm and cold season for each city. This is done by using the calculation above. For the cold season, we find the five months with the lowest average temperature norm by month. For the warm season, we find the five months with the highest average temperature norm.

2.3 Calculation of Maximum Temperature Norm

We can use the calculation of the warm season for each city to calculate the Maximum Temperature Norm. For each city, take all of the daily maximum temperatures from the five warmest months (warm season) and organize them from least to greatest. Out of these temperatures, we take infimum of the top 90% of the temperatures. This is our maximum temperature norm. For each city, this calculation is listed under the "WARM SZN" column in the "warm and cold season

norm.csv" file. We have also done this by month. The calculation by city for each month is contained the "Maximum Norms.csv" file

2.4 Calculation of Minimum Temperature Norm

We can use the calculation of the cold season for each city to calculate the Minimum Temperature Norm. For each city, take all of the daily minimum temperatures from the five coldest months (cold season) and organize them from least to greatest. Out of these temperatures, we take supremum of the bottom 10% of the temperatures. This is our minimum temperature norm. For each city, this calculation is listed under the "COLD SZN" column in the "warm and cold season norm.csv" file. We have also done this by month. The calculation by city for each month is contained the "Maximum Norms.csv" file.

3 Using Calculate Max and Min Norms to Identify Heat Waves and Cold Snaps

We use our Maximum Temperature Norm and our Minimum Temperature norm for each city's warm and cold season to identify heatwaves and cold snaps in our data. To identify a heatwave, we look for when the maximum daily temperature is above our maximum temperature norm for three consecutive days. To identify a cold snap, we look for when the minimum temperature for a 24 hour periods (12:00pm-11:59am) fall below the minimum temperate norm for three or more consecutive days. In summary, and without loss of generality for heatwaves and cold snaps, this done by creating an identification vector and iterating over each daily measurement in chronological order. If the temperature in question is greater (or less then) our norm, append an element to the vector. If it is the opposite, clear the vector. If the vector has a length of 3, append to your data set that we have identified a heatwave or cold snap over the last three analysed days including the way we are on. For every day there is not a heatwave, append that there is no heatwave on the specified dates. We have done this method for our daily data by city. All calculation outputs for this are contained in "daily data w wh.zip". Each file has two extra columns which are "is hw" and "is cs". For each row, the entry is 1, then a heat wave or cold snap has been identified for that row/day/measurement. If the entry is zero, then no heatwave or cold snap have been identified.