Intermediate Results

Théo Druilhe, Pierre Larose, Sigurd Saue and Killian Steunou

27 January, 2024

Introduction

This report presents the latest results of our work on the project. We will present the results of our analysis on the data we have been given, mostly through visualizations.

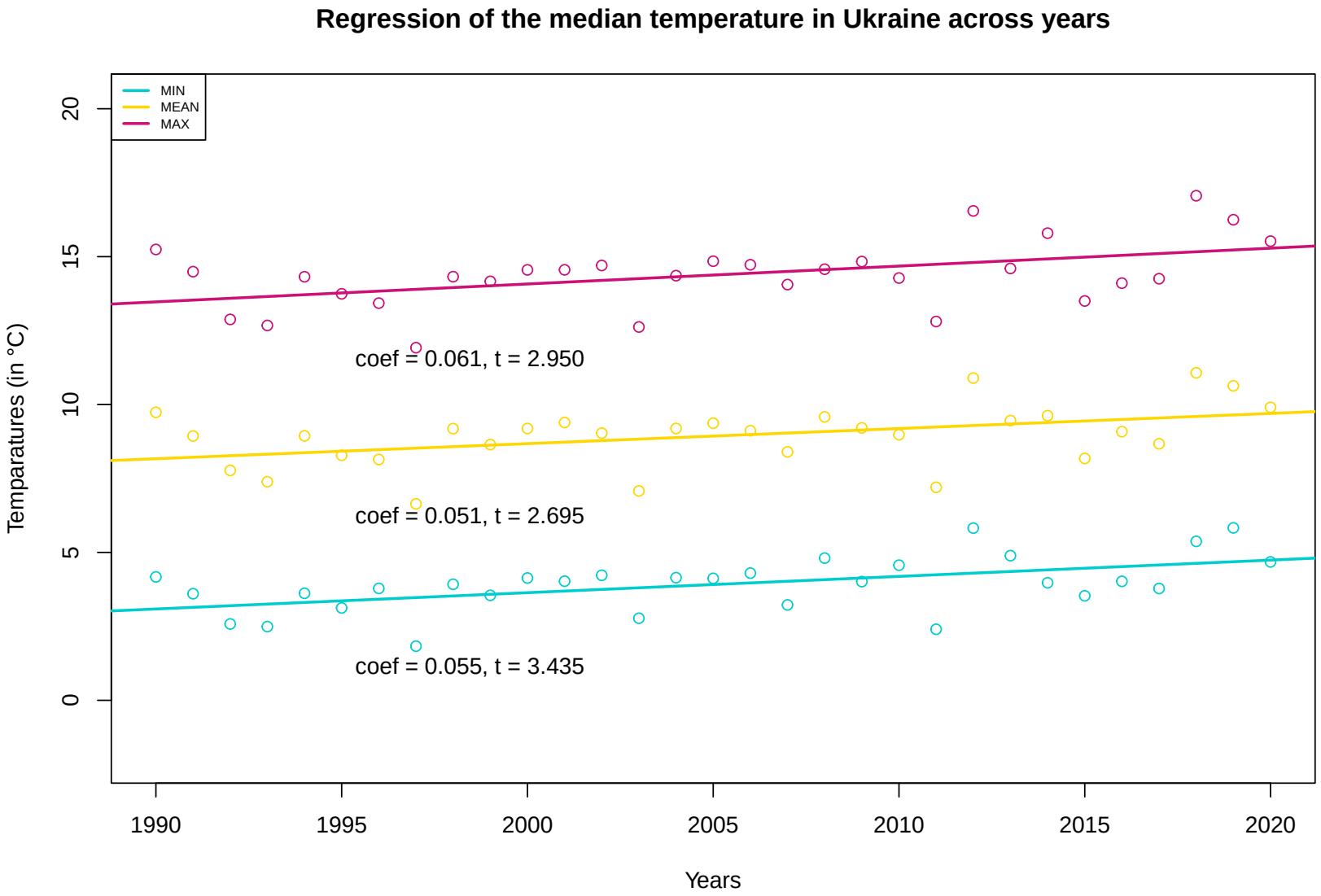
We will conduct our analysis country by country, focusing on Europe through Ukraine, Poland, Spain and Portugal. For each country we will conduct analysis on data at the country level, then we will do it for specific geographical points. All t-tests are performed at the 5% level.

Ukraine

Country level

First, we plot the regression line of the median of our 3 statistics: minimum, maximum and mean temperature.

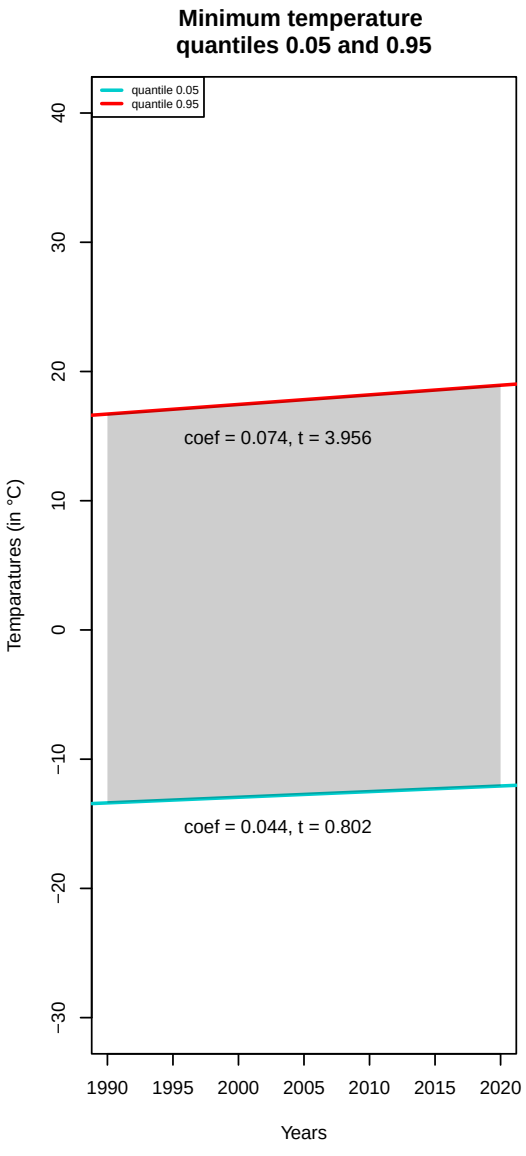
Median

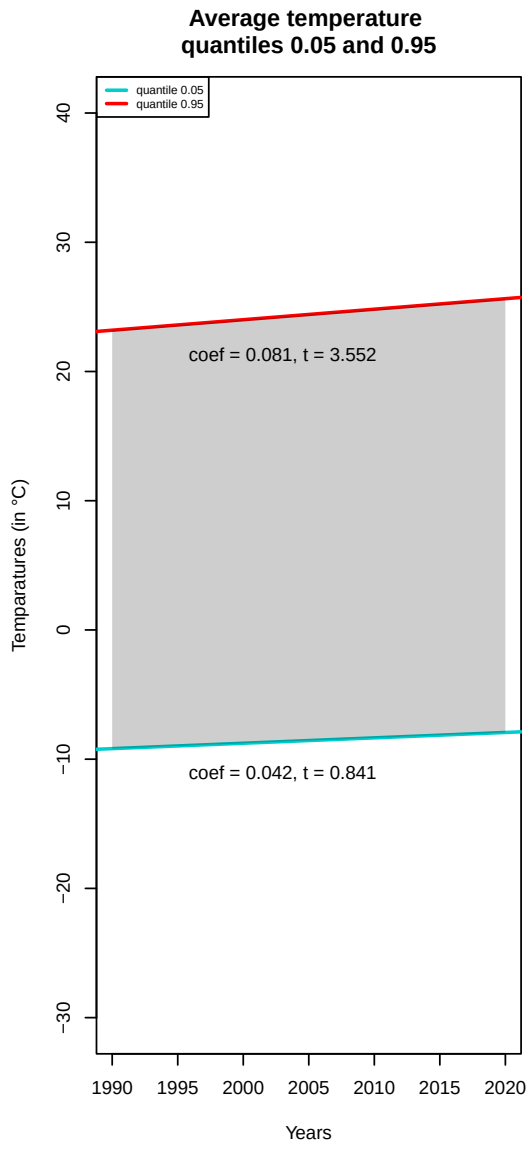

Regression of the median temperature in Ukraine across years
MIN
MEAN
MAX
coef = 0.061, t = 2.950
coef = 0.051, t = 2.695
coef = 0.055, t = 3.435
Temparatures (in °C)
0
5
10
15
20
1990
1995
2000
2005
2010
2015
2020
Years

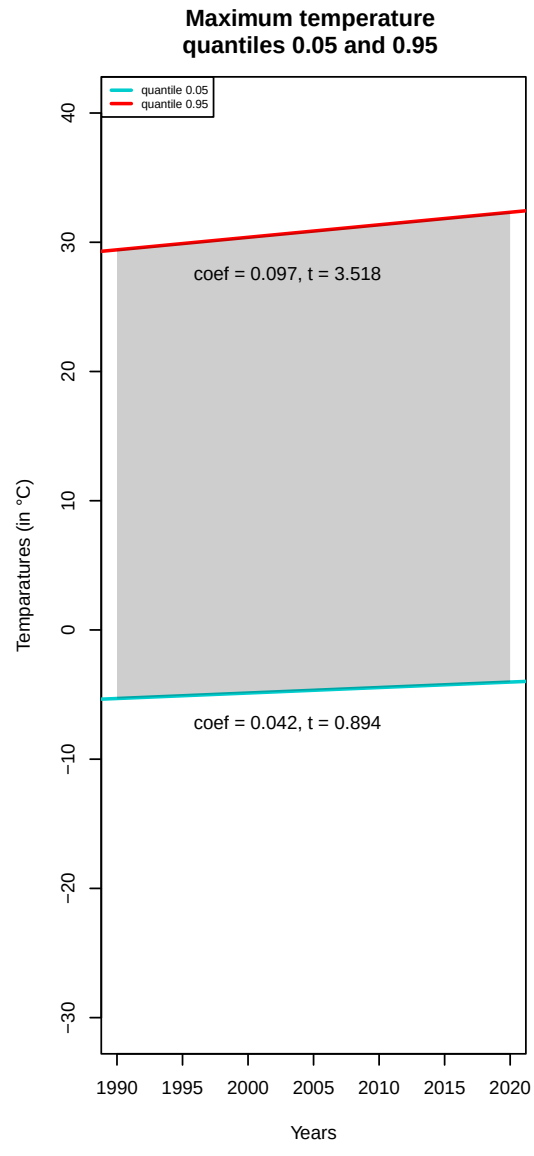
We can see that the median mean, minimum and maximum temperatures are slightly increasing (but still increasing) over the years. The t-tests support this observation, the variable 'Years' is significant. For example, every year, the median of the maximum temperature increases in average by 0.061°C. This is similar to an increase of approximately 1.8°C of the median temperature over 30 years.

We will now analyze the quantiles of order 0.05 and 0.95 of each variable, instead of the medians. We will also plot the regression lines of these quantiles.

Quantiles


Minimum temperature
quantiles 0.05 and 0.95
quantile 0.05
quantile 0.95
coef = 0.074, t = 3.956
coef = 0.044, t = 0.802
Temparatures (in °C)
Years


Average temperature
quantiles 0.05 and 0.95
quantile 0.05
quantile 0.95
coef = 0.081, t = 3.552
coef = 0.042, t = 0.841
Temparatures (in °C)
Years

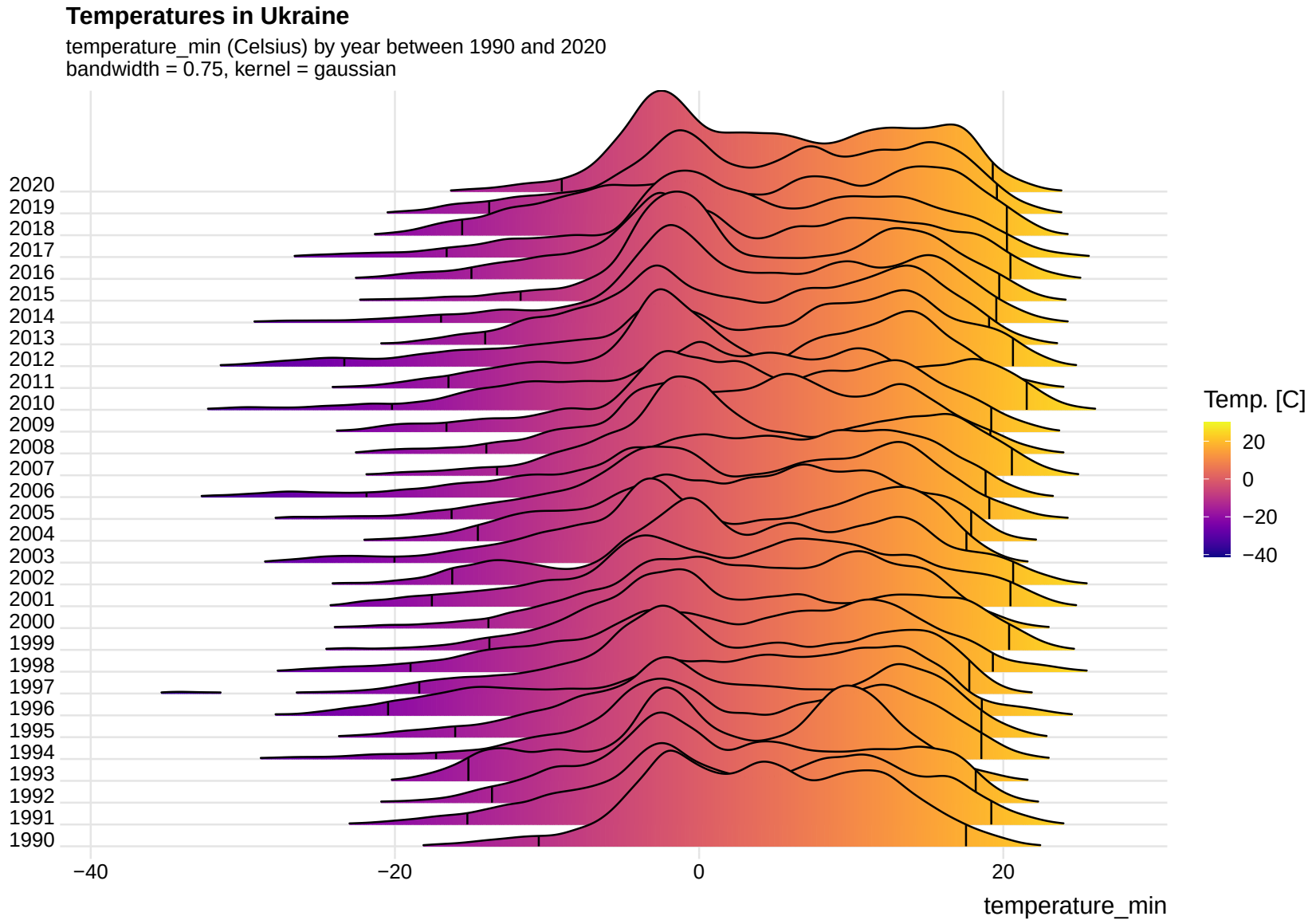

Maximum temperature
quantiles 0.05 and 0.95
quantile 0.05
quantile 0.95
coef = 0.097, t = 3.518
coef = 0.042, t = 0.894
Temparatures (in °C)
Years

The variable is significant for the quantiles of order 0.05 and 0.95 of all variables of temperature. This means that the quantiles of order 0.05 and 0.95 of the minimum, average and maximum temperatures are increasing over the years. This is consistent with the results obtained with the medians. The quantile of order 0.95 shows a much stronger increase than the quantile of order 0.05. This means that the maximum temperatures are increasing much more than the minimum temperatures. For example, the quantile of order 0.95 of the maximum temperature has increased by almost 3°C over 30 years.

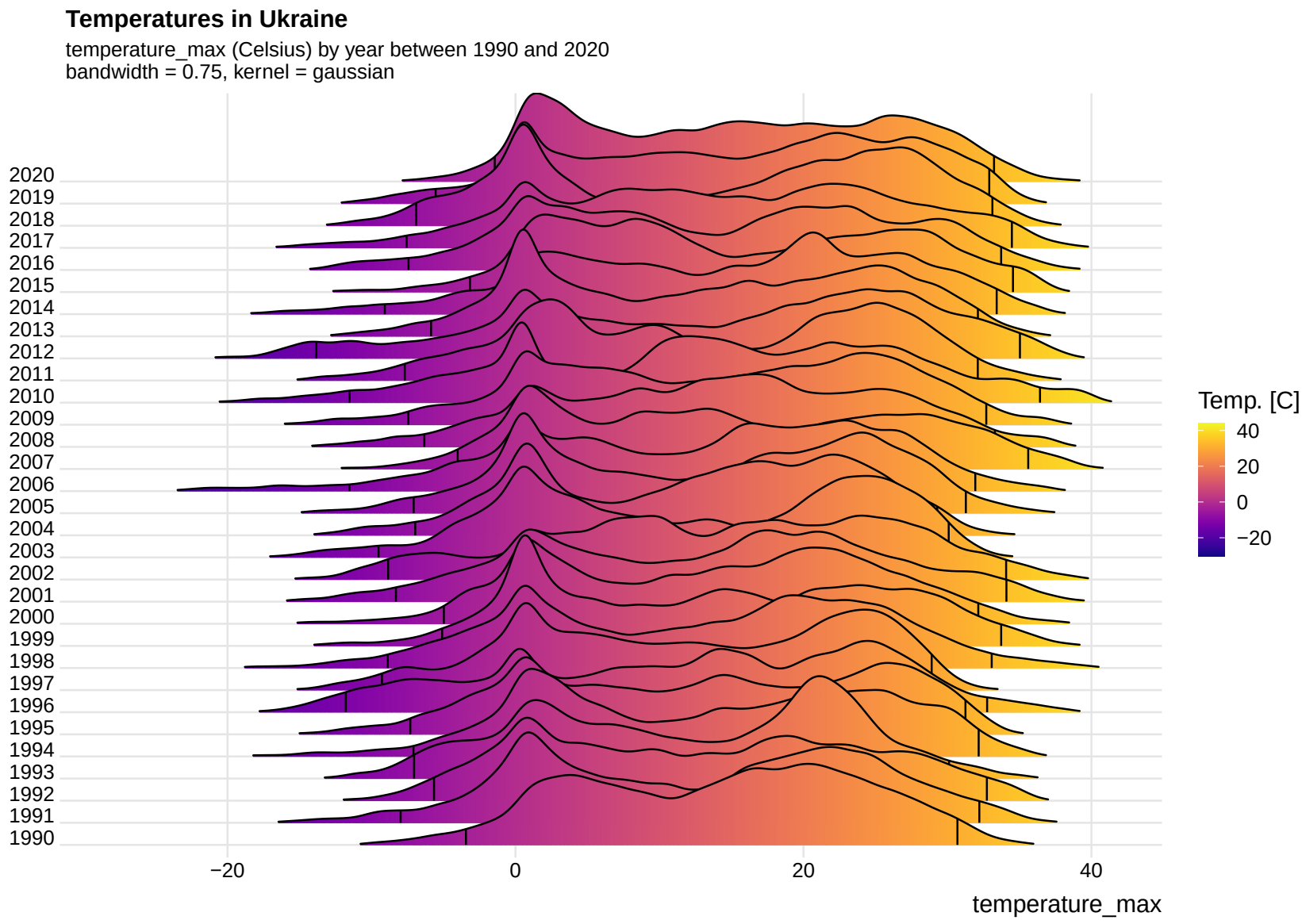
We will now look at the minimum and maximum temperature densities across years in Ukraine.

Densities

Minimum temperature



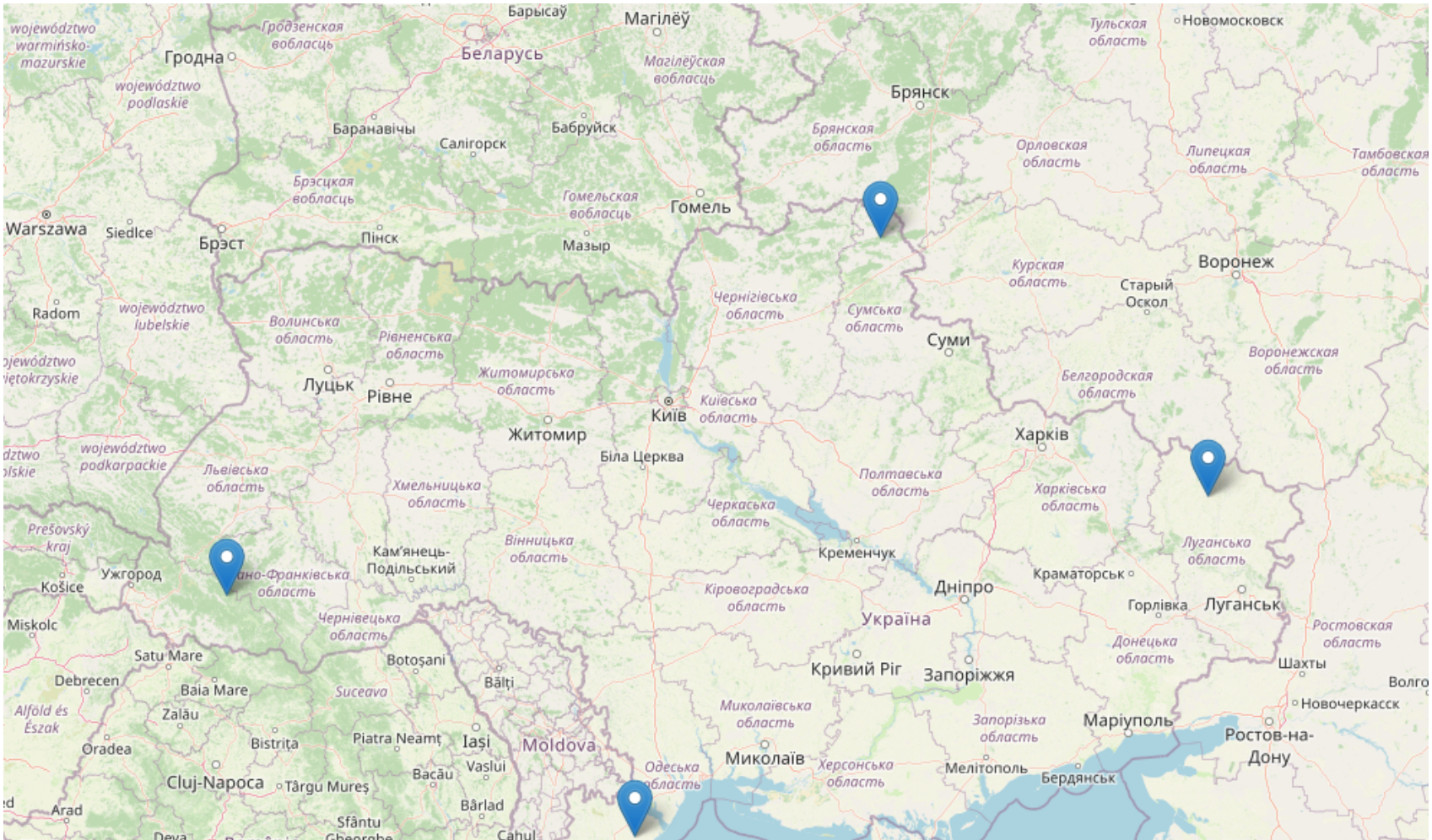
Maximum temperature



We can see that the maximum values seem to be increasing over the years.

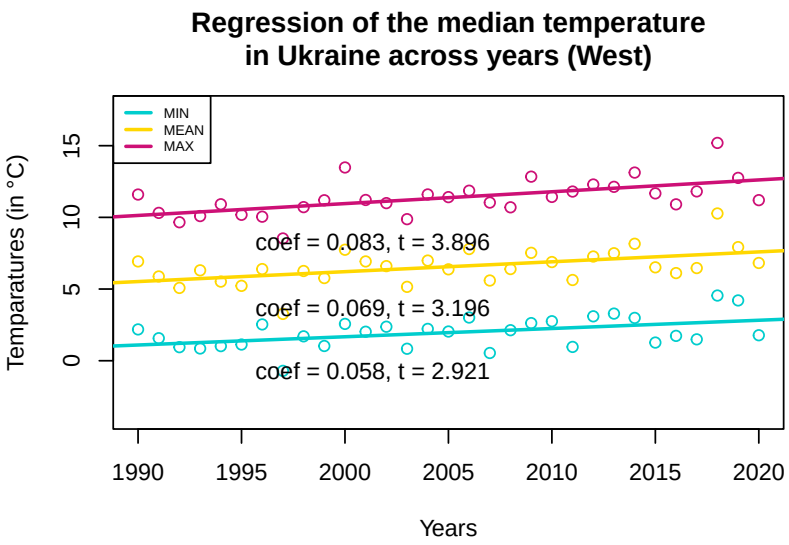
Geographical points analysis

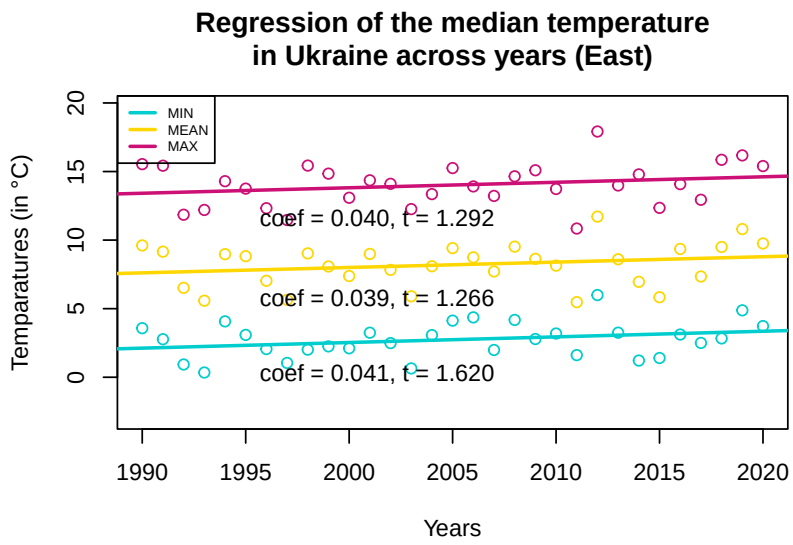
We will now analyze the data at specific geographical points. We will focus on 4 points in Ukraine, one at the West, that is in a mountainous area, one at the East, that is in a flat area, one at the North which has a continental climate, and one at the South, that is in an area close to the sea.

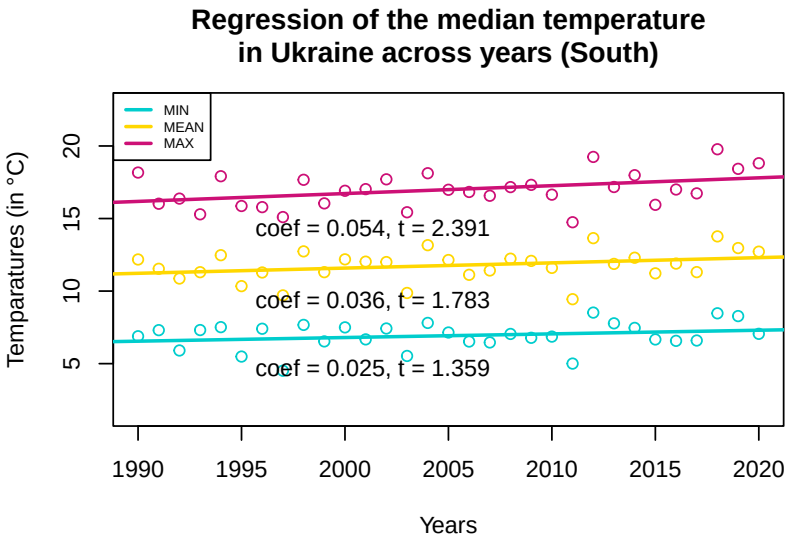


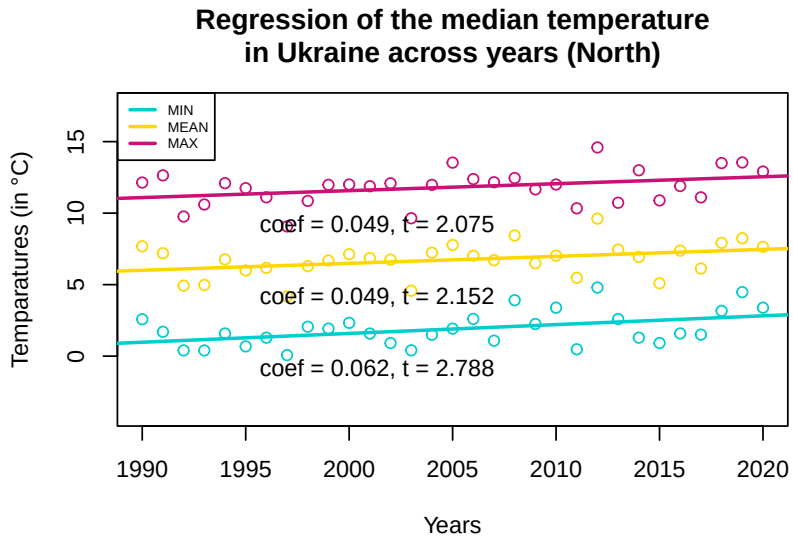
Median

We will first look at the regression lines of the median of the minimum, average and maximum temperatures at each point for our four geographical points.


Regression of the median temperature
in Ukraine across years (West)
MIN
MEAN
MAX
coef = 0.083, t = 3.896
coef = 0.069, t = 3.196
coef = 0.058, t = 2.921
Temparatures (in °C)
0
5
10
15
1990
1995
2000
2005
2010
2015
2020
Years


Regression of the median temperature
in Ukraine across years (East)
MIN
MEAN
MAX
coef = 0.040, t = 1.292
coef = 0.039, t = 1.266
coef = 0.041, t = 1.620
Temparatures (in °C)
0
5
10
15
20
1990
1995
2000
2005
2010
2015
2020
Years

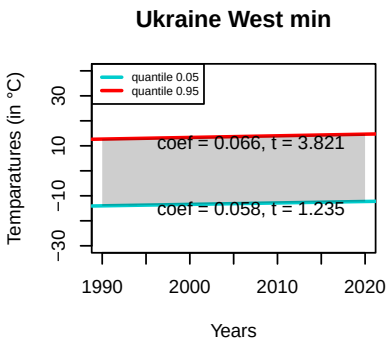

Regression of the median temperature
in Ukraine across years (South)
MIN
MEAN
MAX
coef = 0.054, t = 2.391
coef = 0.036, t = 1.783
coef = 0.025, t = 1.359
Temparatures (in °C)
5
10
15
20
1990
1995
2000
2005
2010
2015
2020
Years

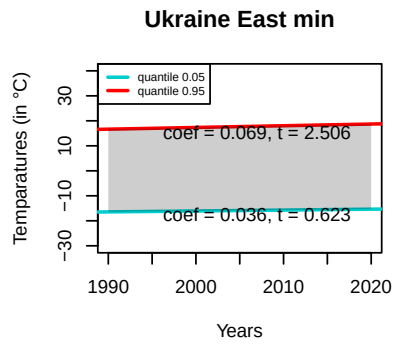

Regression of the median temperature
in Ukraine across years (North)
MIN
MEAN
MAX
coef = 0.049, t = 2.075
coef = 0.049, t = 2.152
coef = 0.062, t = 2.788
Temparatures (in °C)
0
5
10
15
1990
1995
2000
2005
2010
2015
2020
Years

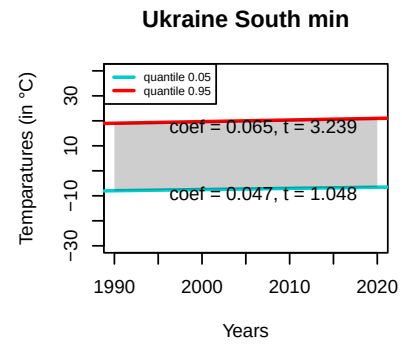
We choose not to freeze the y axis in order to better visualize the regression lines, since we are more interested in the regression coefficients than in the actual values of the variables. We can see that the western region is the one with the highest coefficients on average. We cannot conclude that the temperature is increasing in the eastern region, since none of the coefficients (for min max and mean) are statistically significant, possibly due to the high variance of the data. We remark a slight increase in the temperature in the northern region. For the South, it is similar to the East except for the maximum temperature that is increasing.

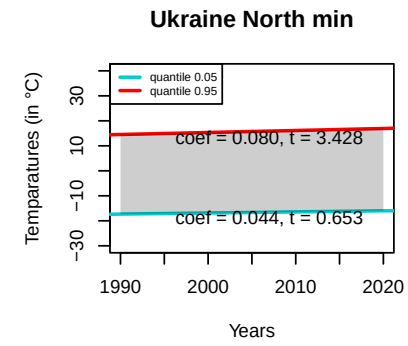
We will now analyze the quantiles of order 0.05 and 0.95 of each variable, instead of the medians. We will also plot the regression lines of these quantiles.

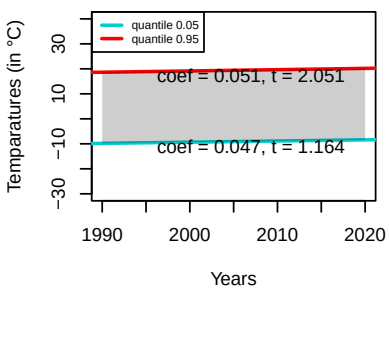
Quantiles

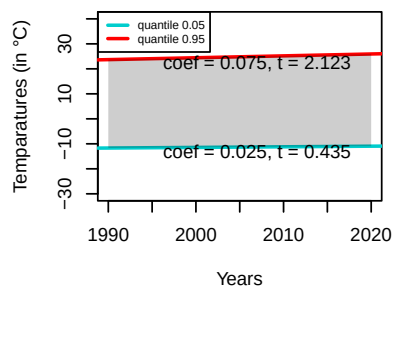

Ukraine West min
quantile 0.05
quantile 0.95
coef = 0.066, t = 3.821
coef = 0.058, t = 1.235
Temparatures (in °C)
Years

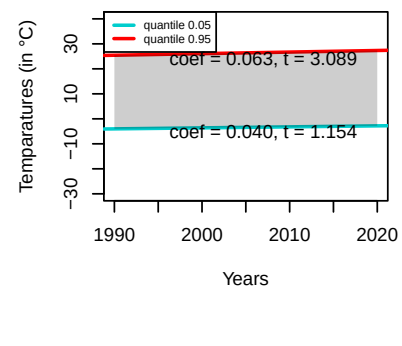

Ukraine East min
quantile 0.05
quantile 0.95
coef = 0.069, t = 2.506
coef = 0.036, t = 0.623
Temparatures (in °C)
Years

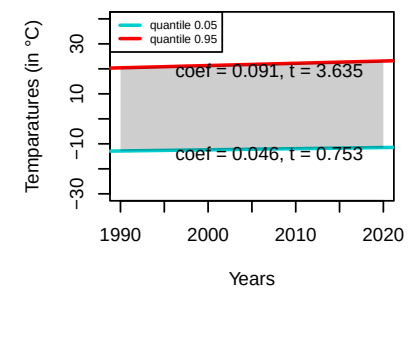

Ukraine South min
quantile 0.05
quantile 0.95
coef = 0.065, t = 3.239
coef = 0.047, t = 1.048
Temparatures (in °C)
Years

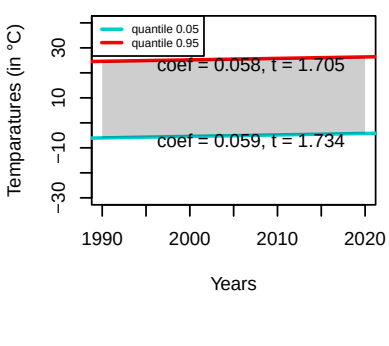

Ukraine North min
quantile 0.05
quantile 0.95
coef = 0.080, t = 3.428
coef = 0.044, t = 0.653
Temparatures (in °C)
Years

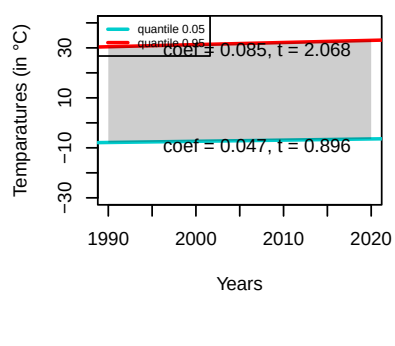

Ukraine West mean
quantile 0.05
quantile 0.95
coef = 0.051, t = 2.051
coef = 0.047, t = 1.164
Temparatures (in °C)
Years

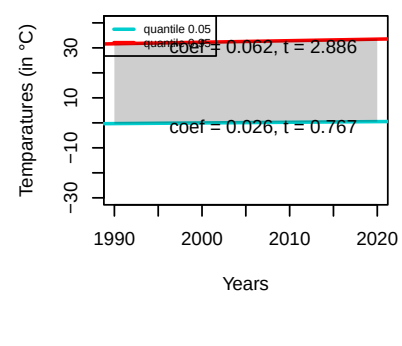

Ukraine East mean
quantile 0.05
quantile 0.95
coef = 0.075, t = 2.123
coef = 0.025, t = 0.435
Temparatures (in °C)
Years

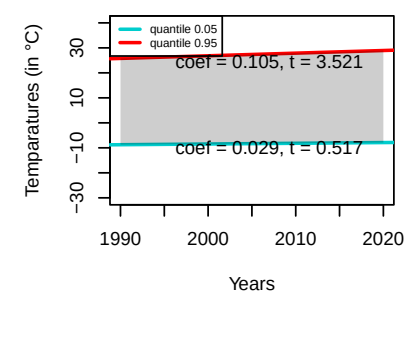

Ukraine South mean
quantile 0.05
quantile 0.95
coef = 0.063, t = 3.089
coef = 0.040, t = 1.154
Temparatures (in °C)
Years


Ukraine North mean
quantile 0.05
quantile 0.95
coef = 0.091, t = 3.635
coef = 0.046, t = 0.753
Temparatures (in °C)
Years


Ukraine West max
quantile 0.05
quantile 0.95
coef = 0.058, t = 1.705
coef = 0.059, t = 1.734
Temparatures (in °C)
Years


Ukraine East max
quantile 0.05
quantile 0.95
coef = 0.085, t = 2.068
coef = 0.047, t = 0.896
Temparatures (in °C)
Years


Ukraine South max
quantile 0.05
quantile 0.95
coef = 0.062, t = 2.886
coef = 0.026, t = 0.767
Temparatures (in °C)
Years


Ukraine North max
quantile 0.05
quantile 0.95
coef = 0.105, t = 3.521
coef = 0.029, t = 0.517
Temparatures (in °C)
Years

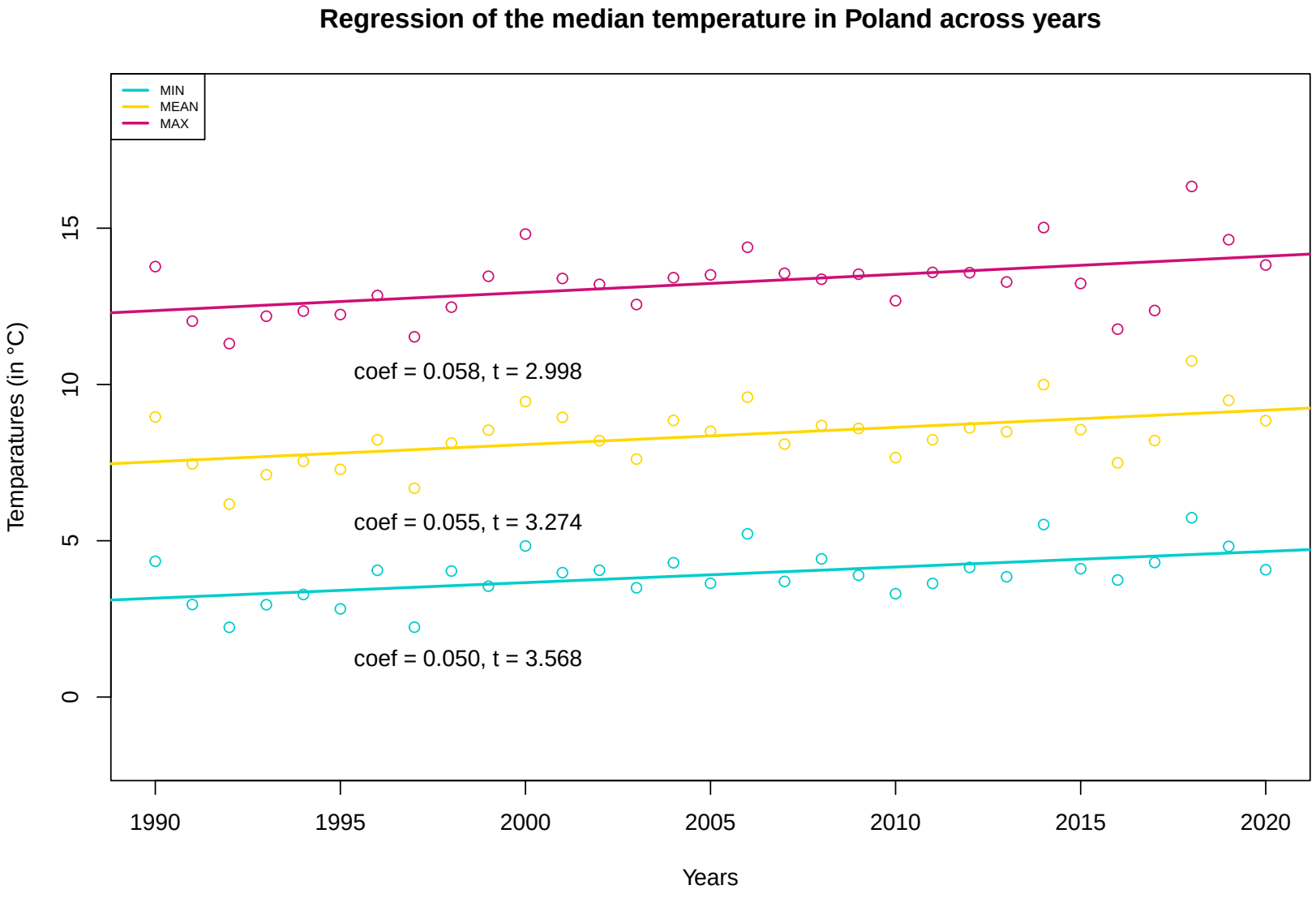
For the 0.95 quantile, the northern region has the largest increase, with coefficients between 0.08 and 0.105, all significant. For the 0.05 quantile, the increases are lower than for the 0.95 quantile globally. We note that none of the 12 0.05 quantile coefficients are significant.

Poland

Country level

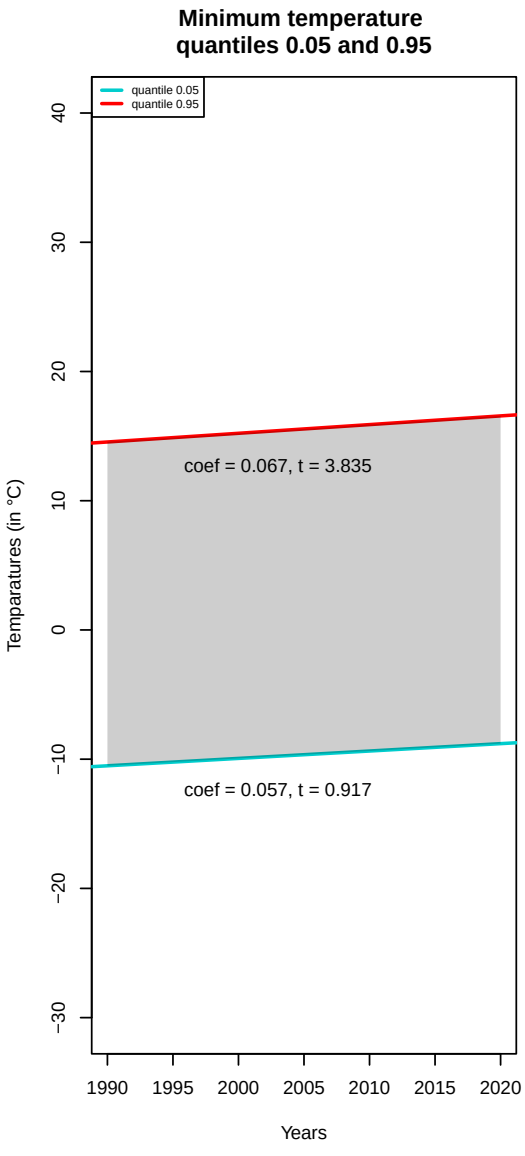
First, we plot the regression line of the median of our 3 statistics: minimum, maximum and mean temperature.

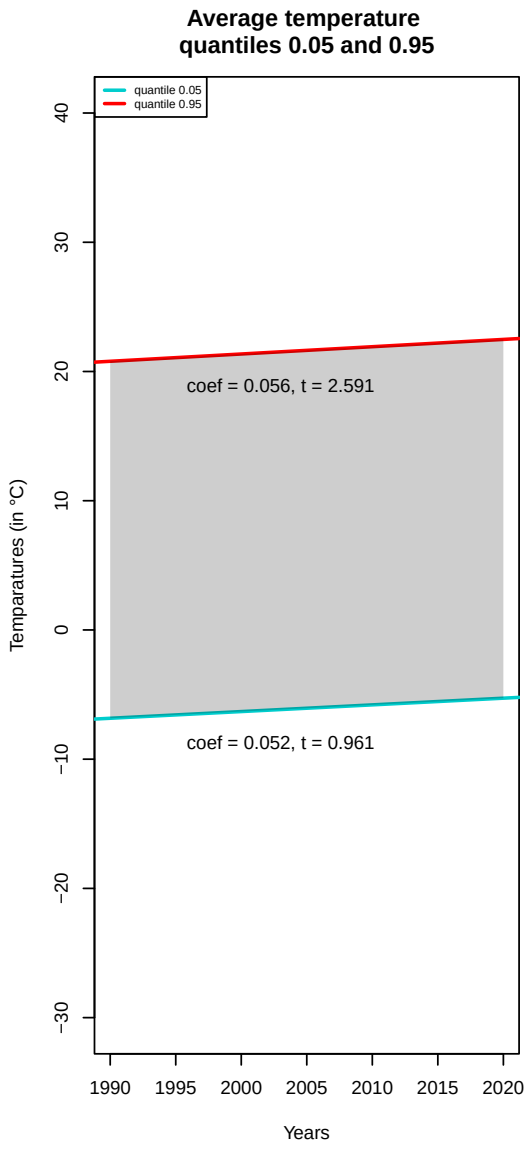
Median

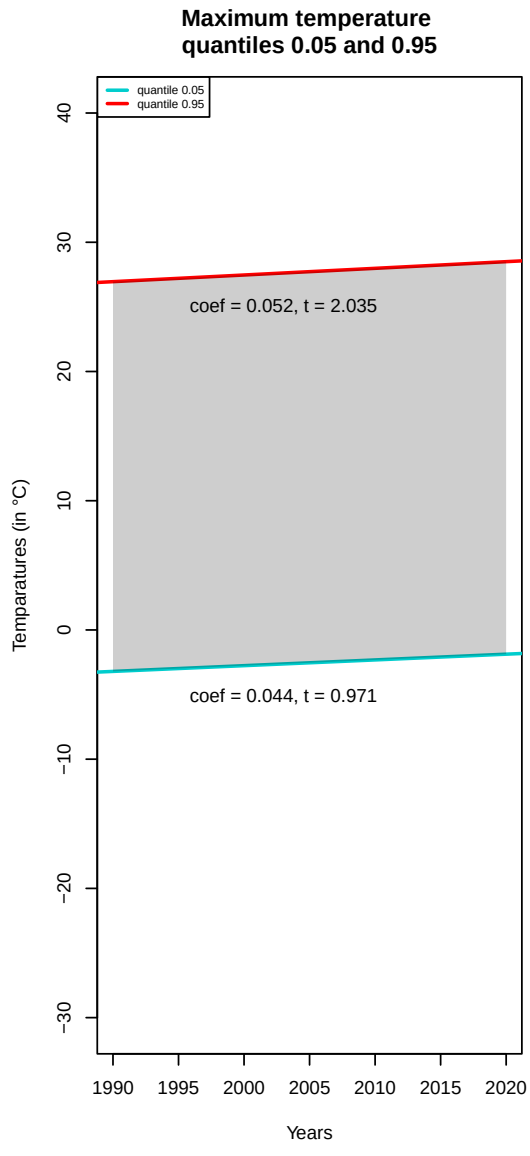

Regression of the median temperature in Poland across years
MIN
MEAN
MAX
coef = 0.058, t = 2.998
coef = 0.055, t = 3.274
coef = 0.050, t = 3.568
Temparatures (in °C)
0
5
10
15
1990
1995
2000
2005
2010
2015
2020
Years

The results are very similar to the ones we obtained for Ukraine. The median mean, minimum and maximum temperatures are slightly increasing (but still increasing) over the years. The t-tests support this observation, the variable 'Years' is significant. For example, every year, the median of the maximum temperature increases in average by 0.058°C. This is similar to an increase of approximately 1.7°C over 30 years.

Quantiles


Minimum temperature
quantiles 0.05 and 0.95
quantile 0.05
quantile 0.95
coef = 0.067, t = 3.835
coef = 0.057, t = 0.917
Temparatures (in °C)
Years

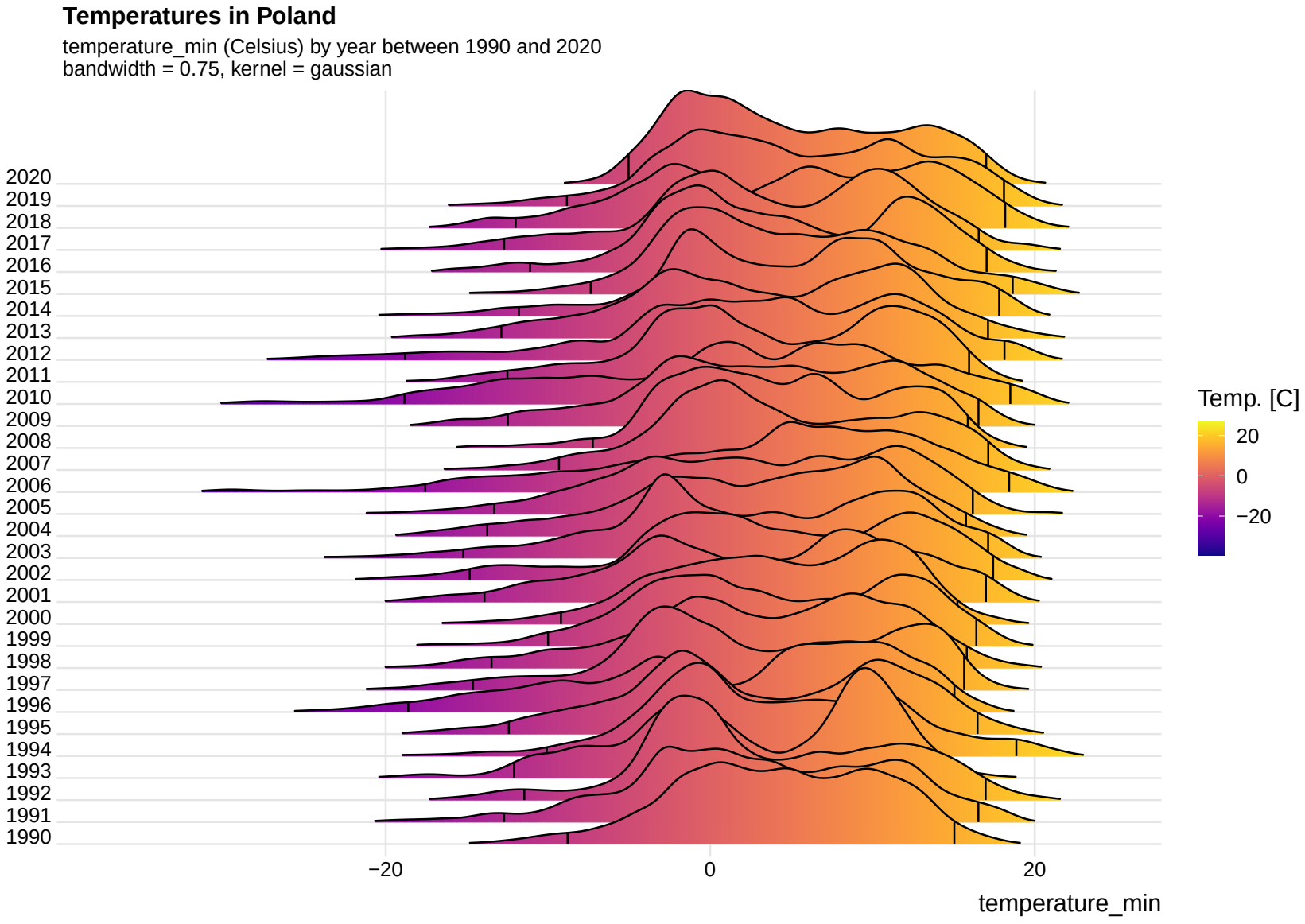

Average temperature
quantiles 0.05 and 0.95
quantile 0.05
quantile 0.95
coef = 0.056, t = 2.591
coef = 0.052, t = 0.961
Temparatures (in °C)
Years


Maximum temperature
quantiles 0.05 and 0.95
quantile 0.05
quantile 0.95
coef = 0.052, t = 2.035
coef = 0.044, t = 0.971
Temparatures (in °C)
Years

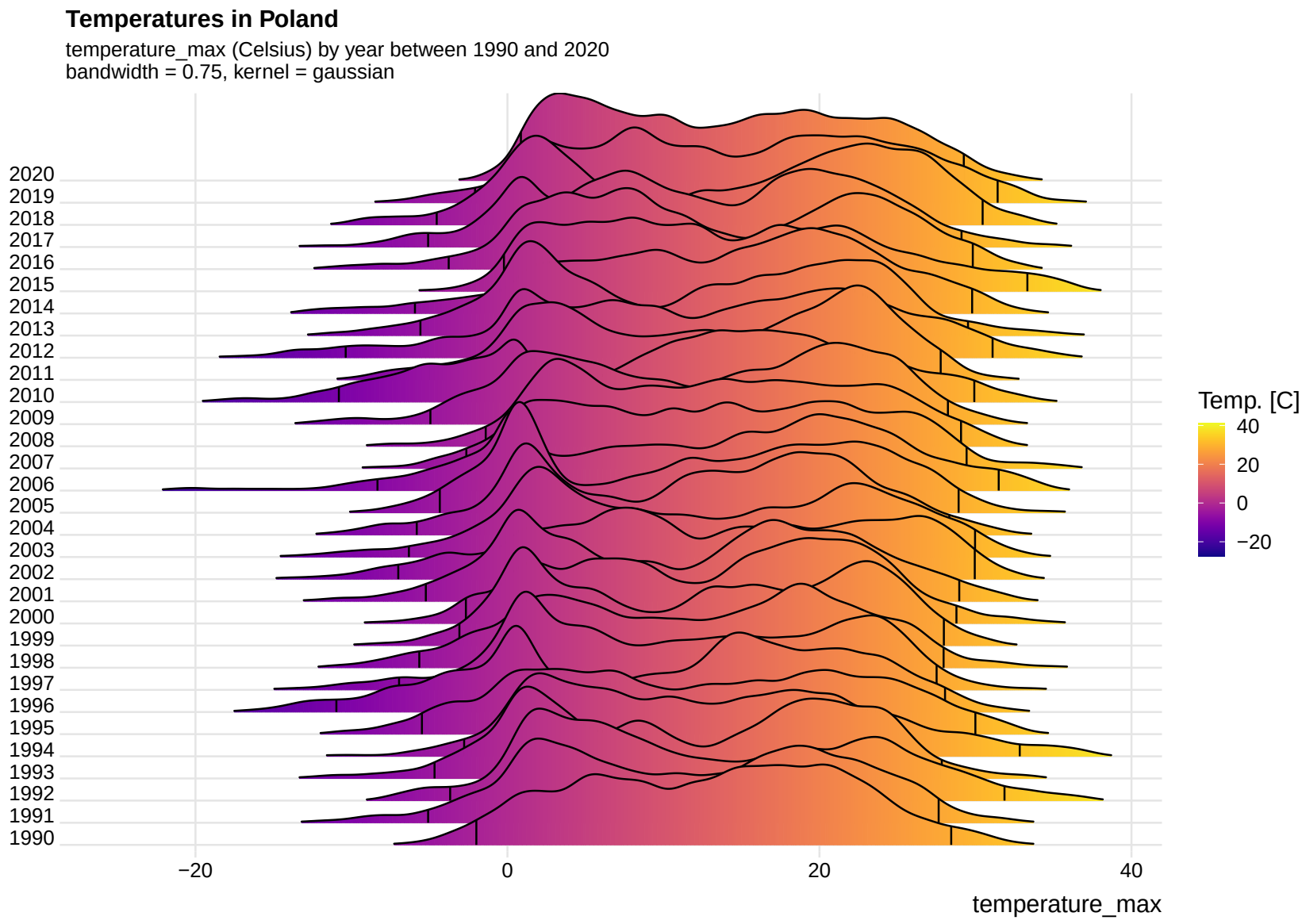
Comments:

Densities

Minimum temperature



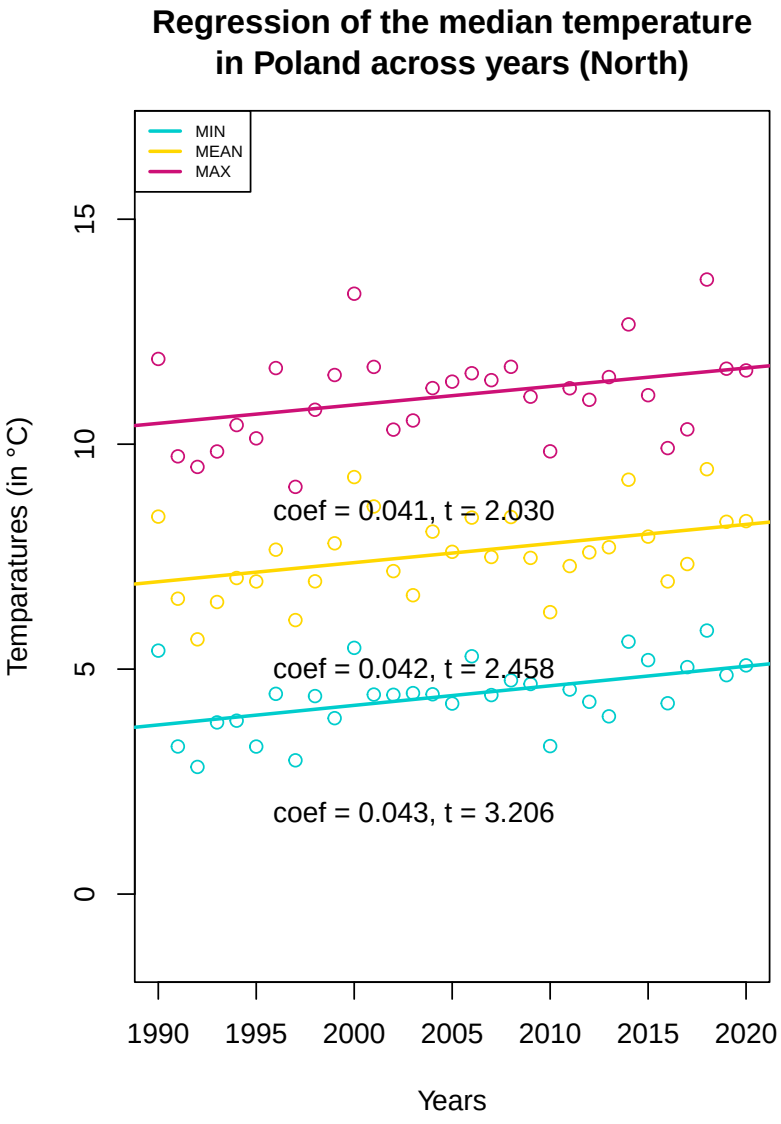
Maximum temperature

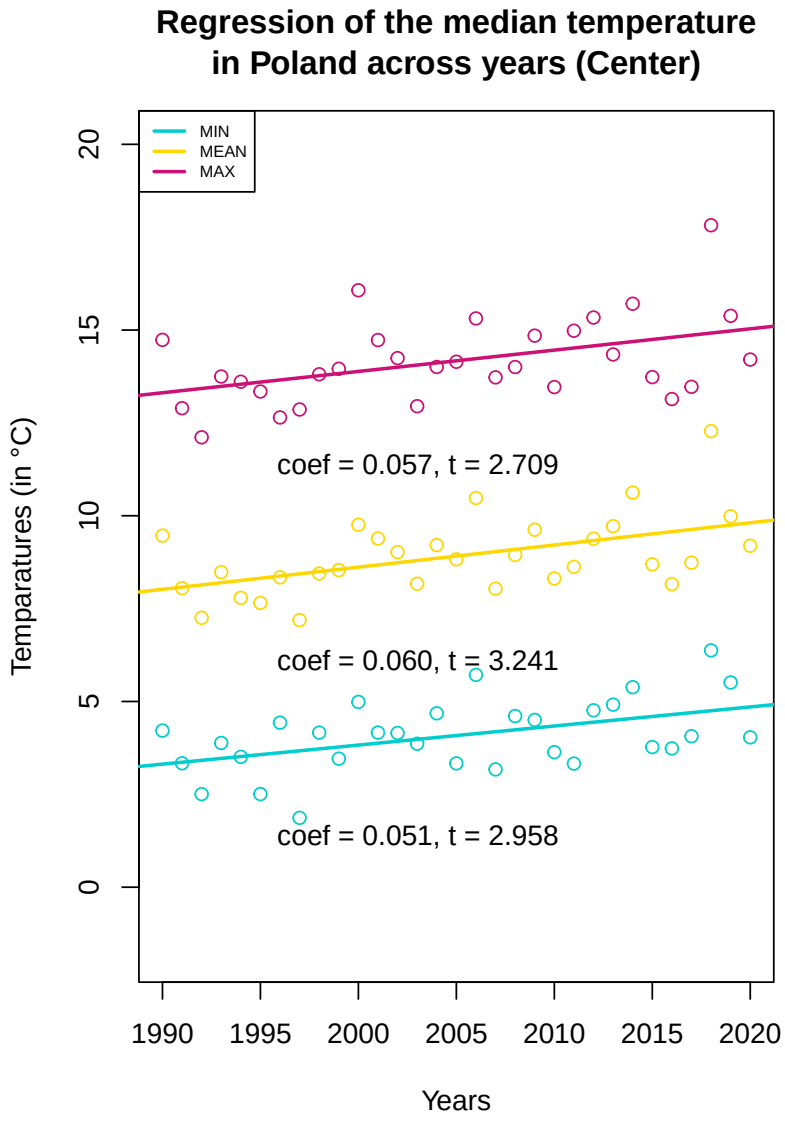


It looks like there is a bimodal distribution for both the maximum and minimum temperature (probably seasonal). It looks like the second mode is slightly shifting to the right over the years. This is consistent with the results of the linear regression.

Geographic points analysis

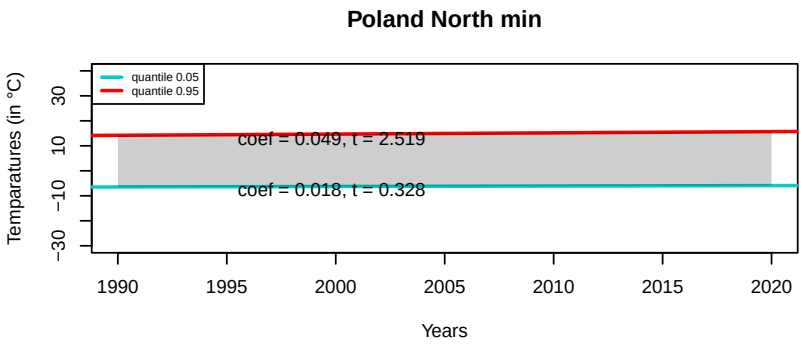
Median

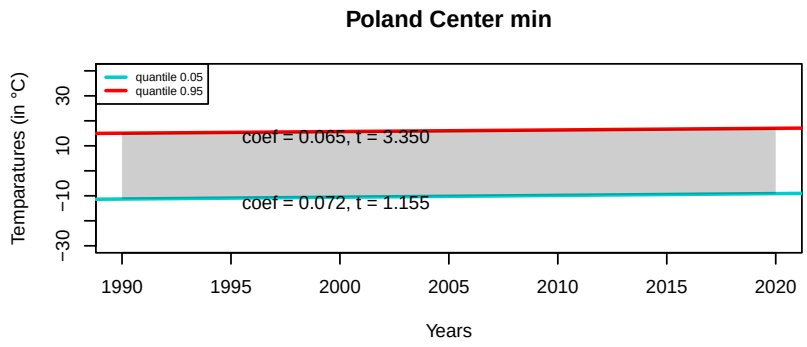


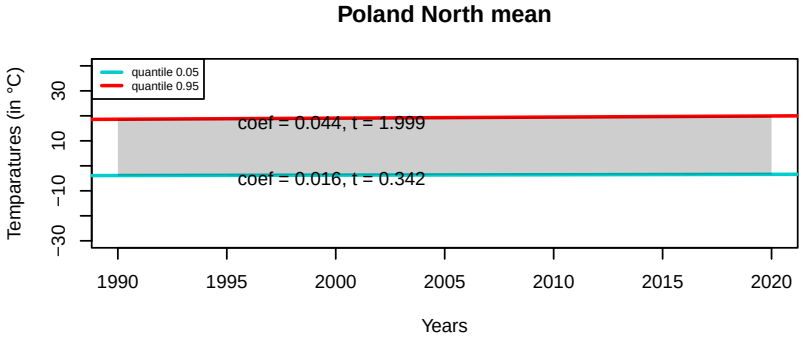


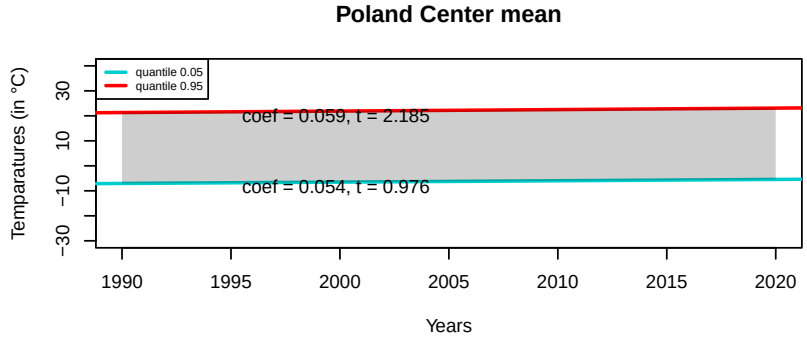
All increases are significant. The increase is the largest for all variable (minimum, mean and maximum) in the center of Poland, with coefficients between 0.05 and 0.06. The increase is the smallest in the north of Poland, with coefficients quite similar for all the three variables, around 0.042.

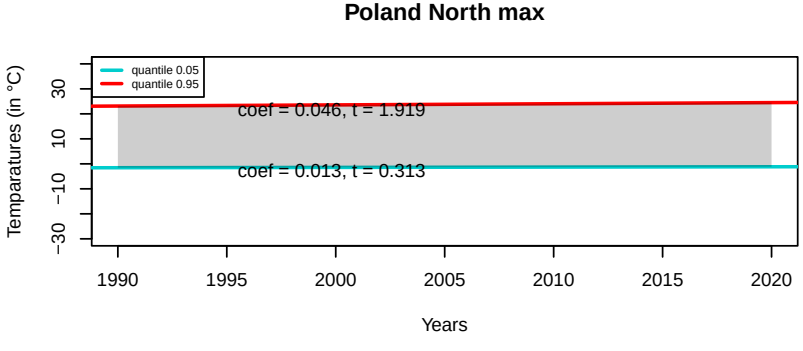
Quantiles

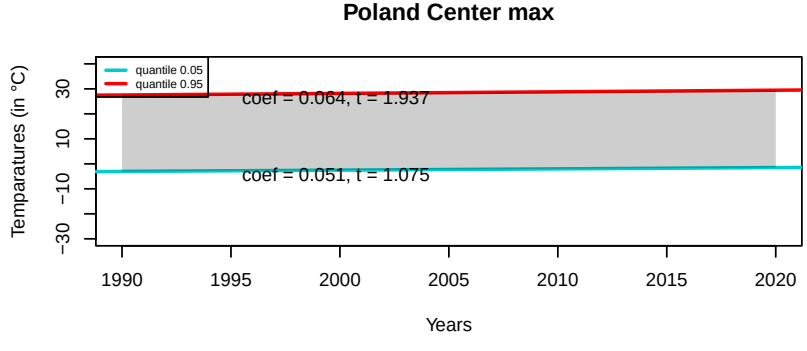

Poland North min
quantile 0.05
quantile 0.95
coef = 0.049, t = 2.519
coef = 0.018, t = 0.328
Temparatures (in °C)
−30
−10
10
30
1990
1995
2000
2005
2010
2015
2020
Years


Poland Center min
quantile 0.05
quantile 0.95
coef = 0.065, t = 3.350
coef = 0.072, t = 1.155
Temparatures (in °C)
−30
−10
10
30
1990
1995
2000
2005
2010
2015
2020
Years


Poland North mean
quantile 0.05
quantile 0.95
coef = 0.044, t = 1.999
coef = 0.016, t = 0.342
Temparatures (in °C)
−30
−10
10
30
1990
1995
2000
2005
2010
2015
2020
Years


Poland Center mean
quantile 0.05
quantile 0.95
coef = 0.059, t = 2.185
coef = 0.054, t = 0.976
Temparatures (in °C)
−30
−10
10
30
1990
1995
2000
2005
2010
2015
2020
Years


Poland North max
quantile 0.05
quantile 0.95
coef = 0.046, t = 1.919
coef = 0.013, t = 0.313
Temparatures (in °C)
−30
−10
10
30
1990
1995
2000
2005
2010
2015
2020
Years

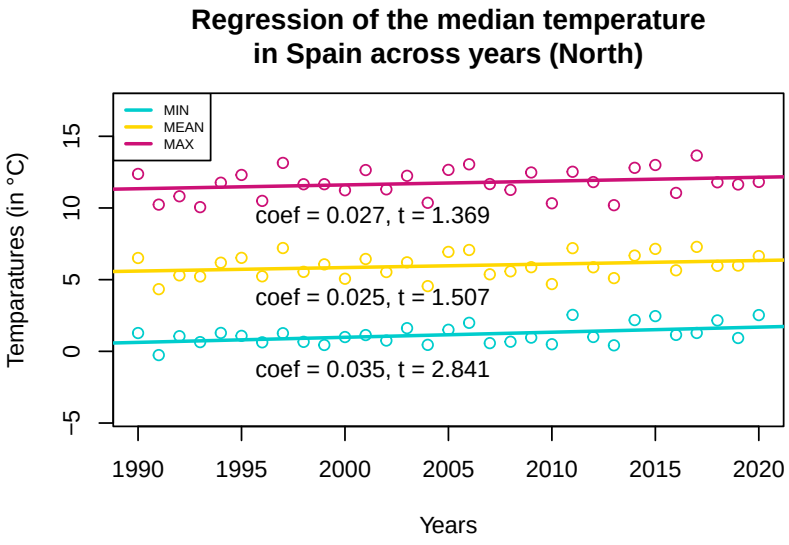

Poland Center max
quantile 0.05
quantile 0.95
coef = 0.064, t = 1.937
coef = 0.051, t = 1.075
Temparatures (in °C)
−30
−10
10
30
1990
1995
2000
2005
2010
2015
2020
Years

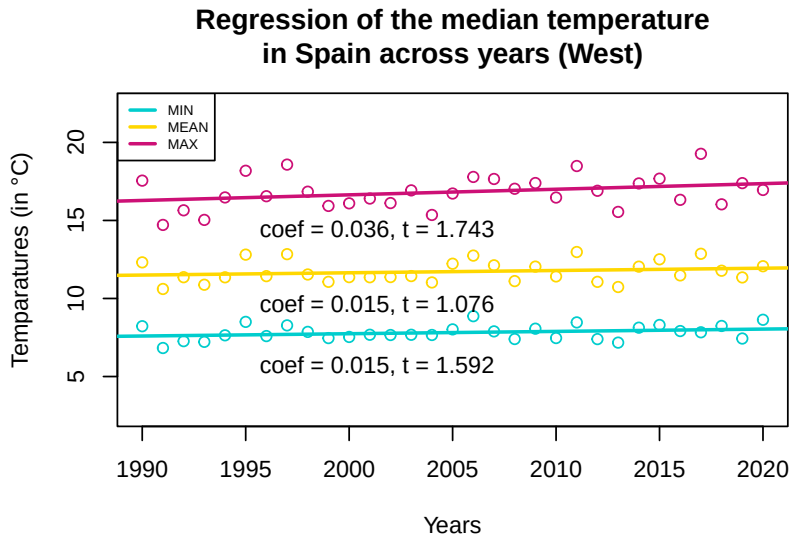
Spain

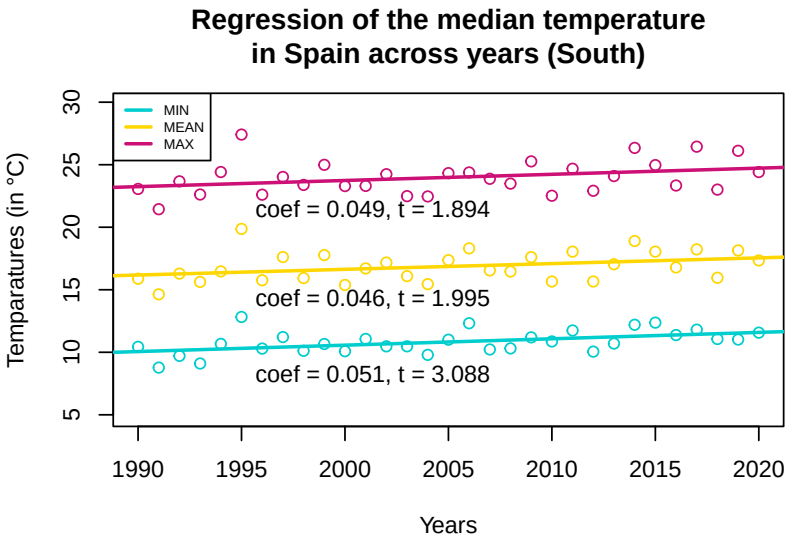
Country level

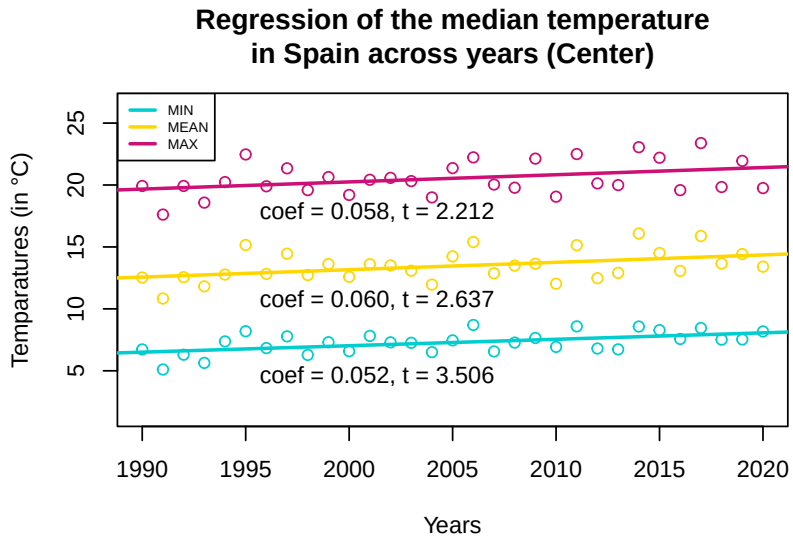
Geographical points analysis

Median









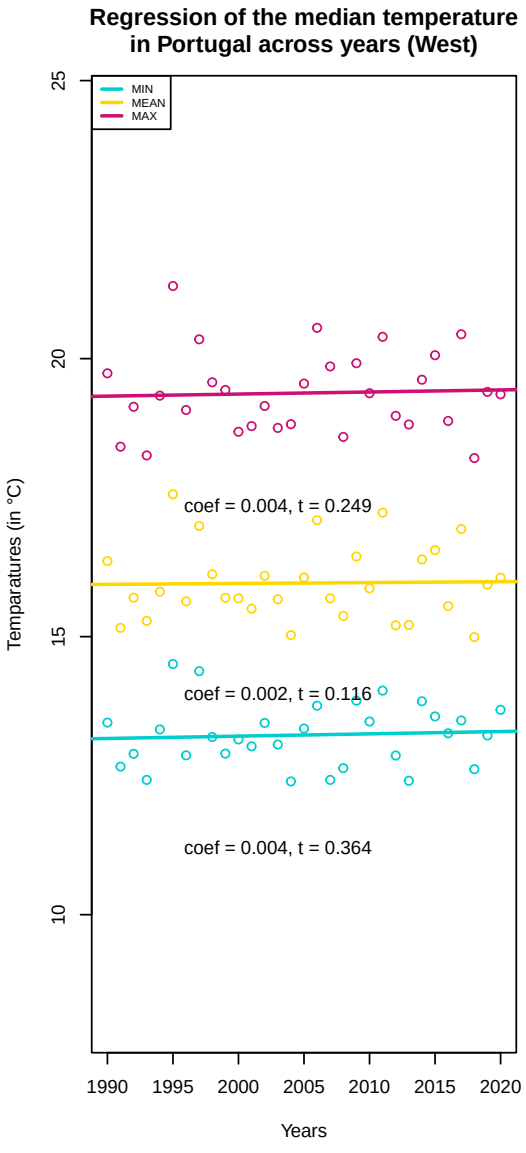
Comments:

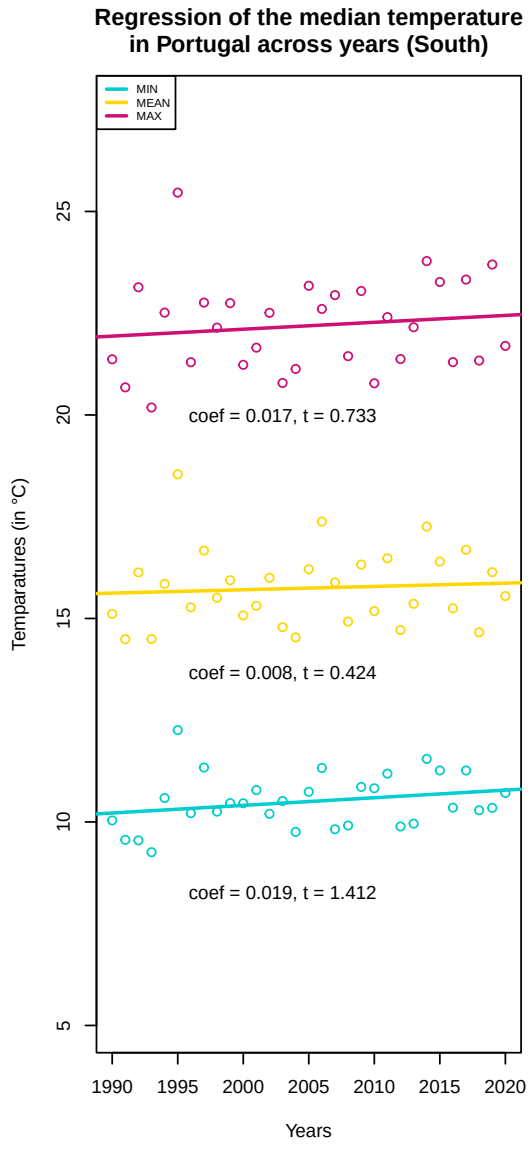
Portugal

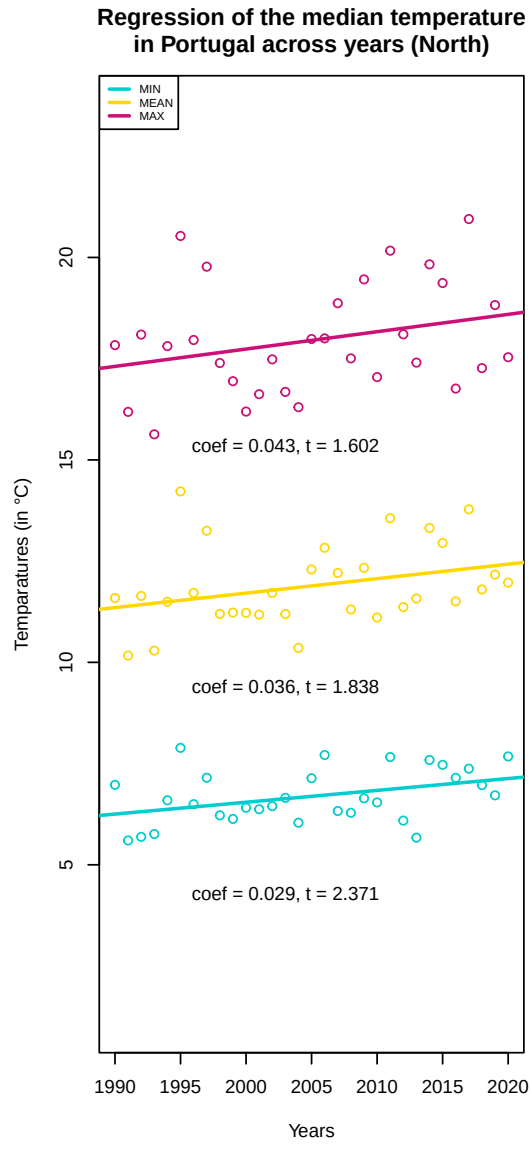
Country level

Geographical points analysis

Median







Comments:

Code quantiles