

# Intermediate Results

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# 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.

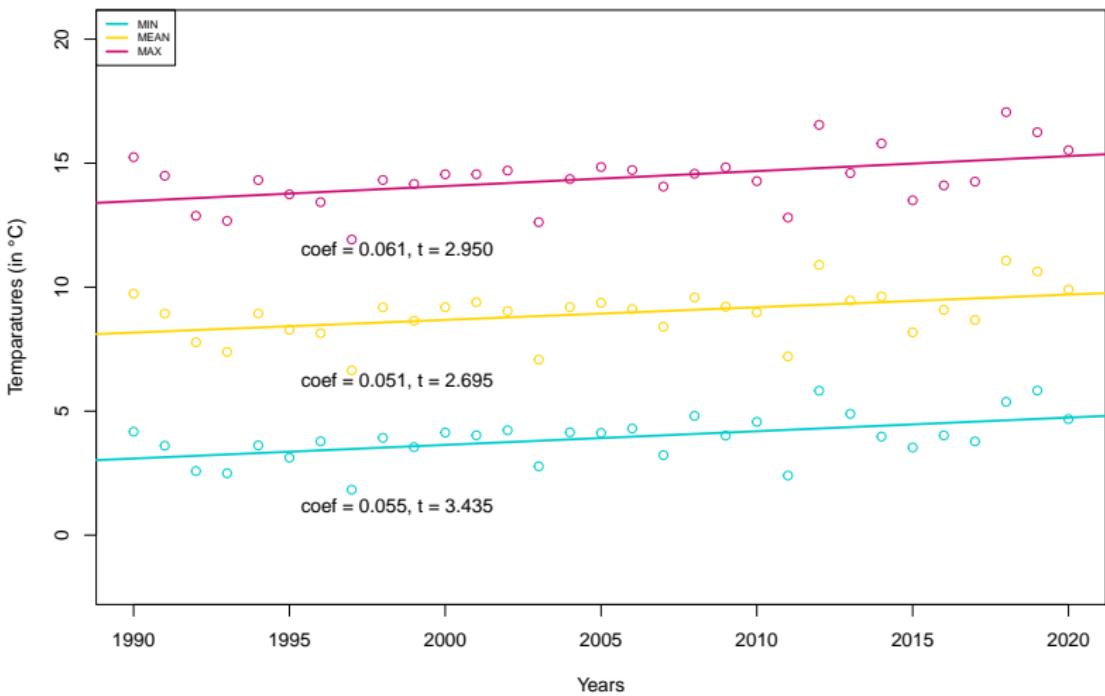
# Ukraine

## Country level

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

# Median

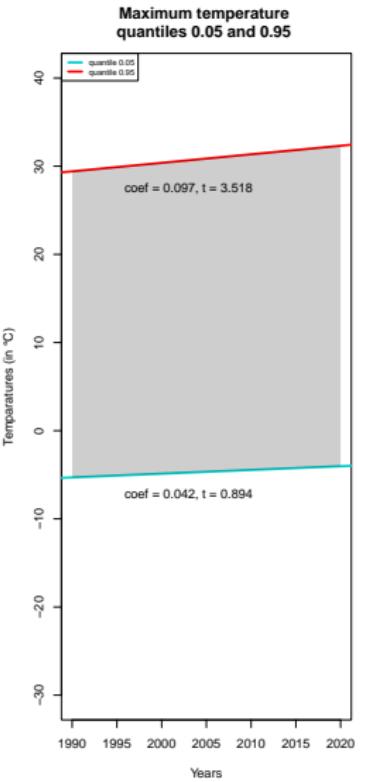
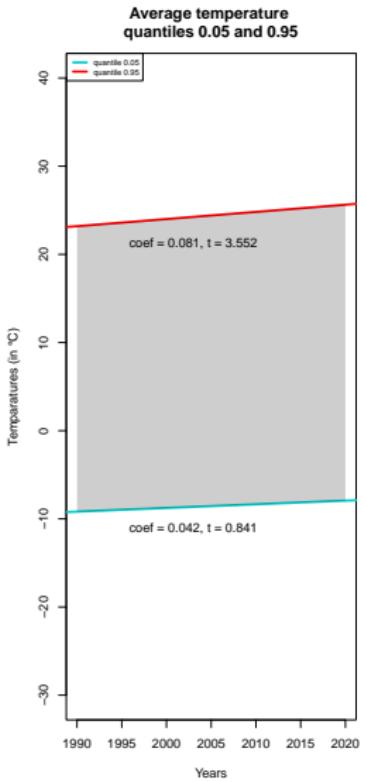
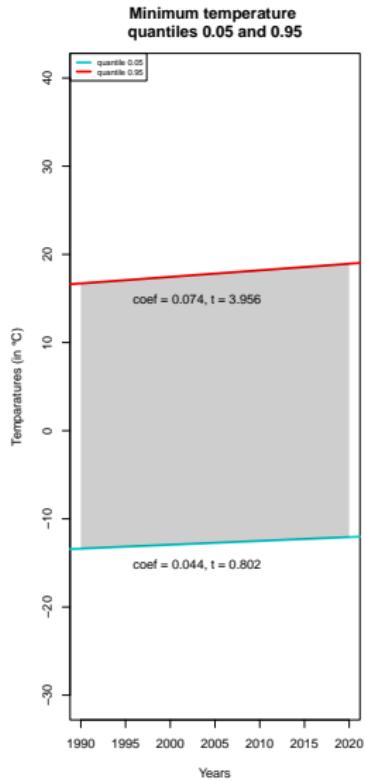
Regression of the median temperature in Ukraine across years



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  $0.061^{\circ}\text{C}$ . This is similar to an increase of approximately  $1.8^{\circ}\text{C}$  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



None of the 0.05 quantiles coefficients are significant, but all of the 0.95 quantiles coefficients are. This means that the maximum values are increasing over the years, but the minimum values are not.

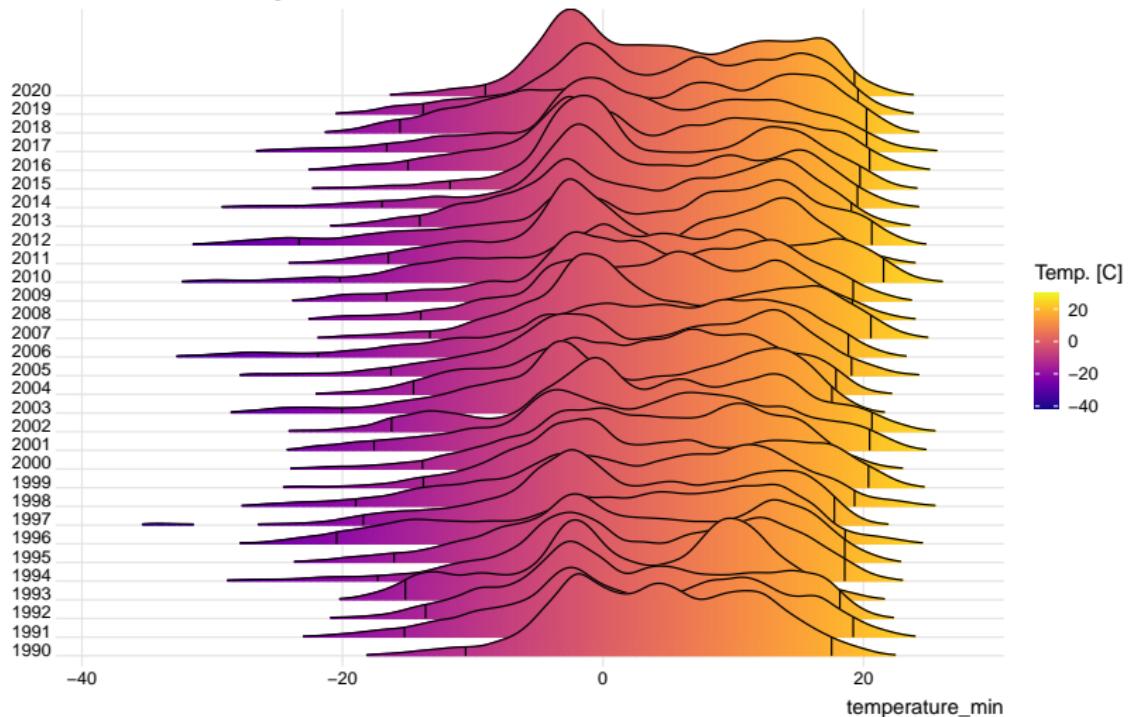
We will now look at the minimum and maximum temperature densities across years in Ukraine.

# Densities

## Minimum temperature

### Temperatures in Ukraine

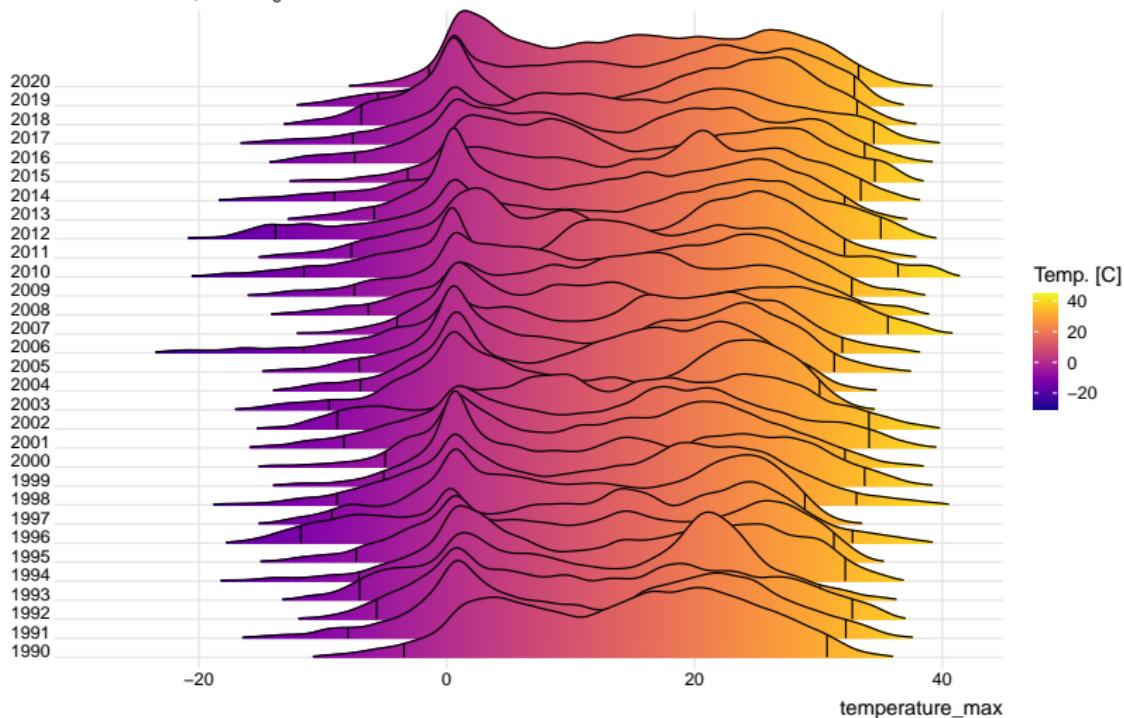
temperature\_min (Celsius) by year between 1990 and 2020  
bandwidth = 0.75, kernel = gaussian



# Maximum temperature

## Temperatures in Ukraine

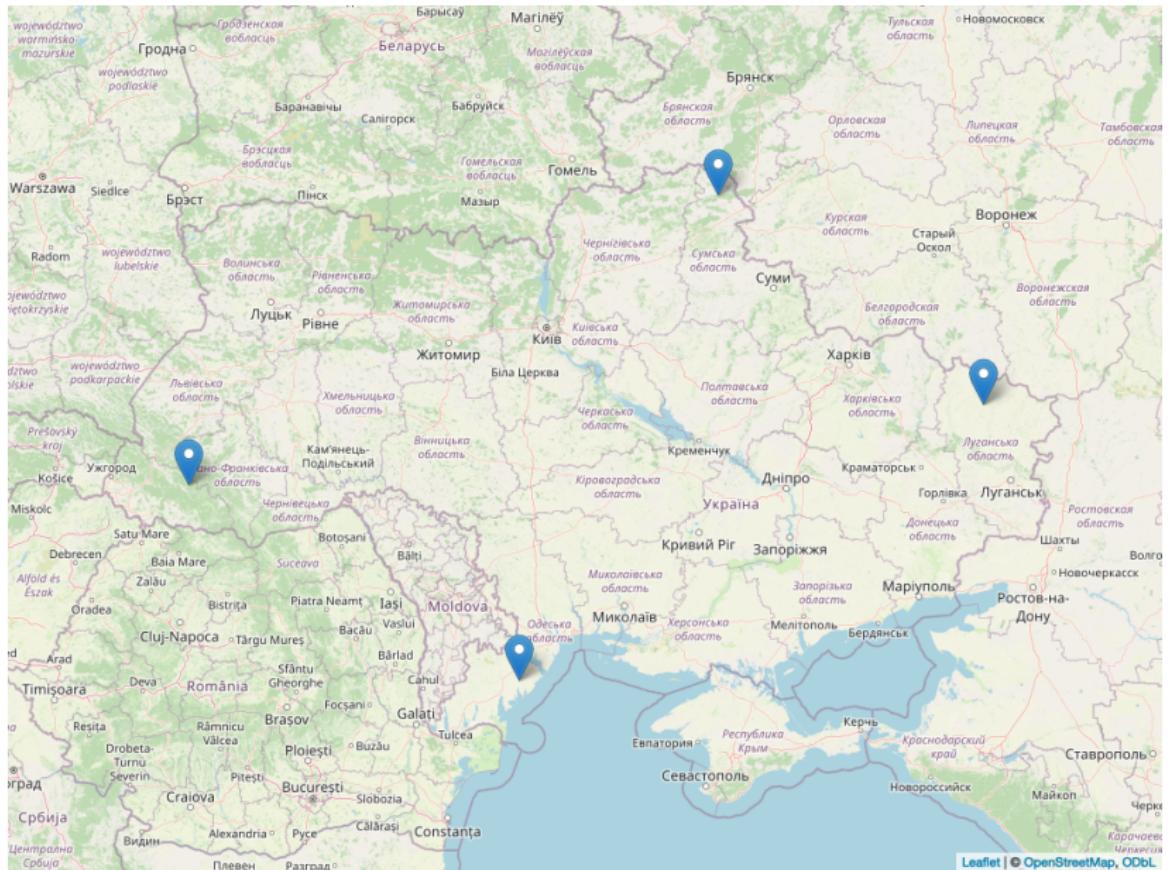
temperature\_max (Celsius) by year between 1990 and 2020  
bandwidth = 0.75, kernel = gaussian



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

## Geographical points analysis

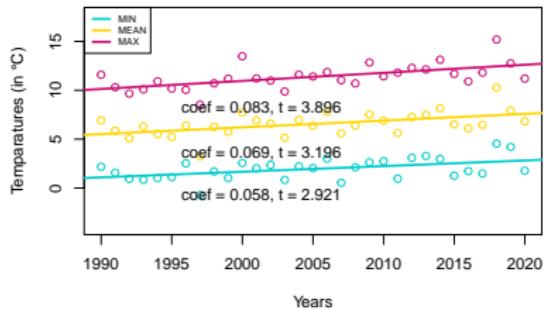
We will now analyze the data at specific geographical points. We will focus on 4 points in Ukraine, one at the West, that is in a mountainous area, one at the East, that is in a flat area, one at the North which has a continental climate, and one at the South, that is in an area close to the sea. We will look at the same plots as for the entire country to see if the results are consistent or not.



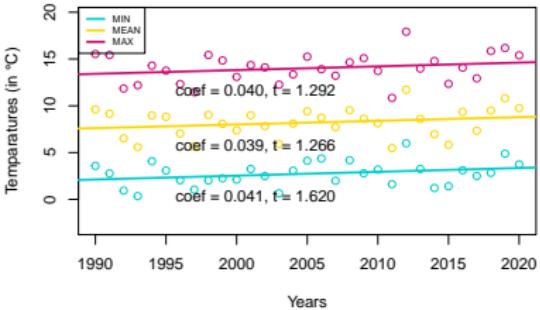
## Median

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.

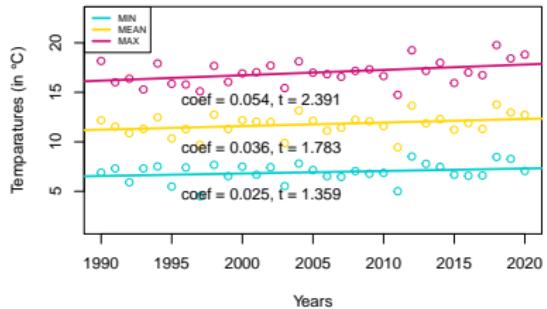
Regression of the median temperature  
in Ukraine across years (West)



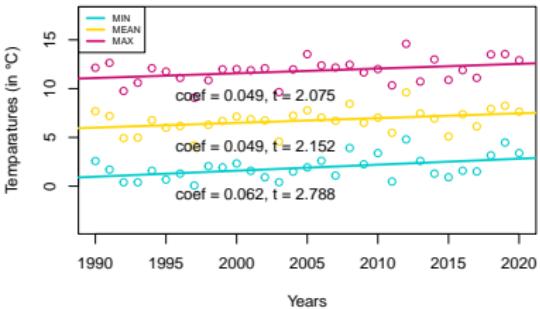
Regression of the median temperature  
in Ukraine across years (East)



Regression of the median temperature  
in Ukraine across years (South)



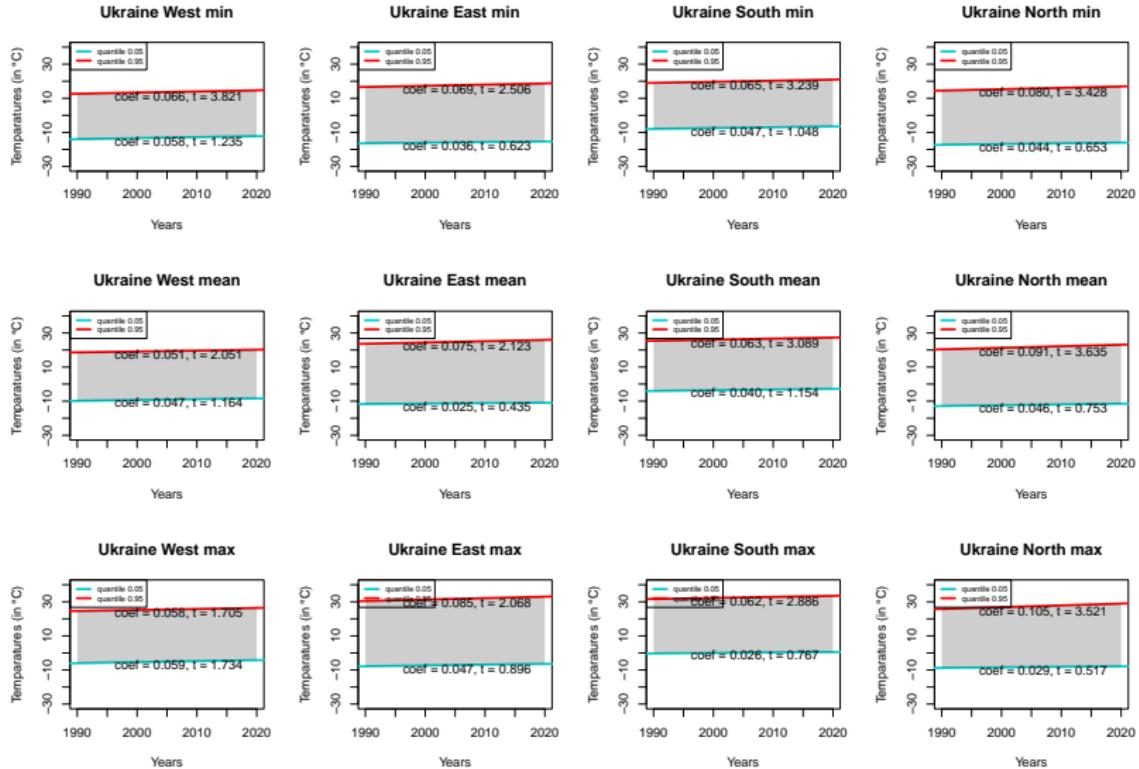
Regression of the median temperature  
in Ukraine across years (North)



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



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.

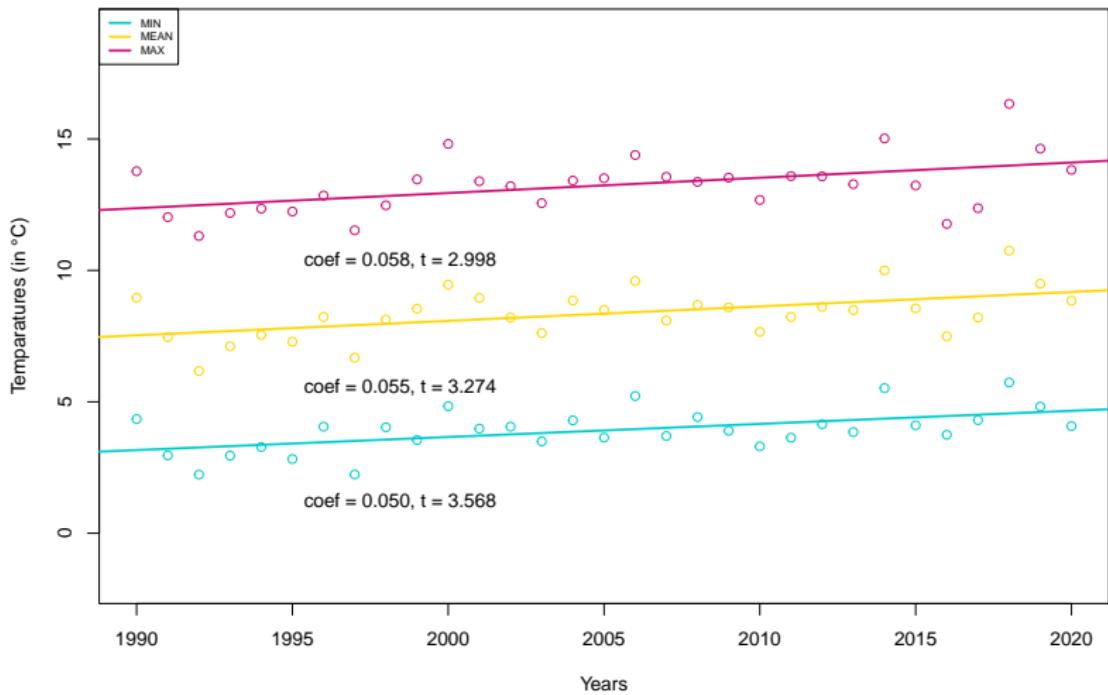
# Poland

## Country level

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

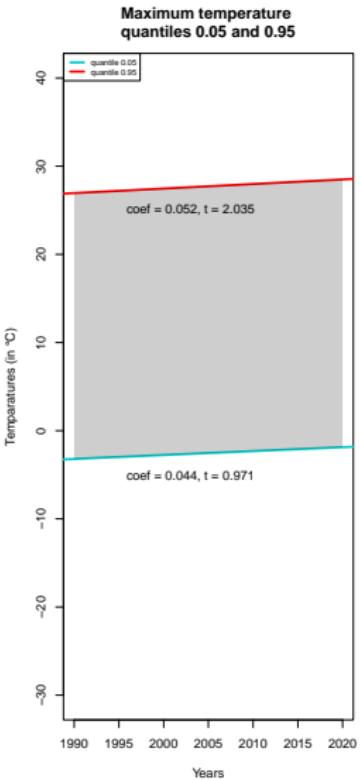
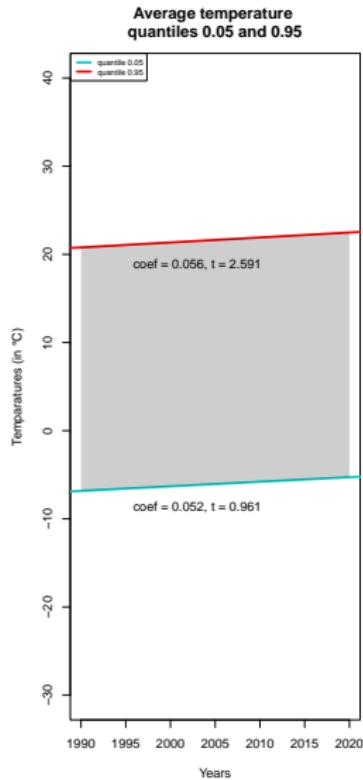
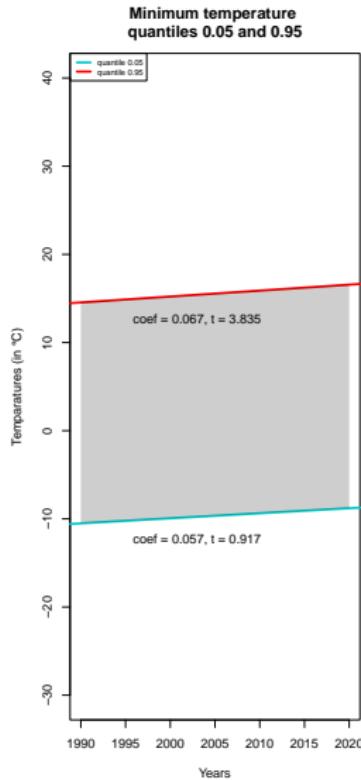
# Median

Regression of the median temperature in Poland across years



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  $0.058^{\circ}\text{C}$ . This is similar to an increase of approximately  $1.7^{\circ}\text{C}$  over 30 years.

# Quantiles



None of the 0.05 quantiles coefficients are significant, but all of the 0.95 quantiles coefficients are. This means that the maximum values are increasing over the years, but the minimum values are not.

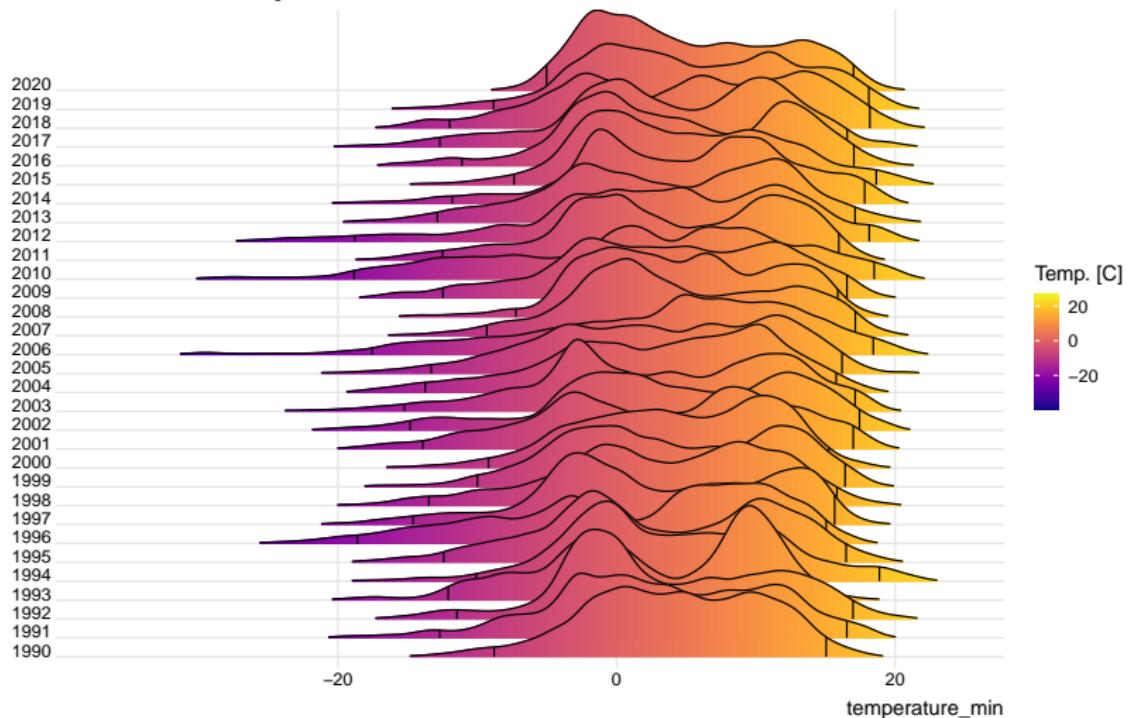
We will now look at the minimum and maximum temperature densities across years in Poland

# Densities

## Minimum temperature

### Temperatures in Poland

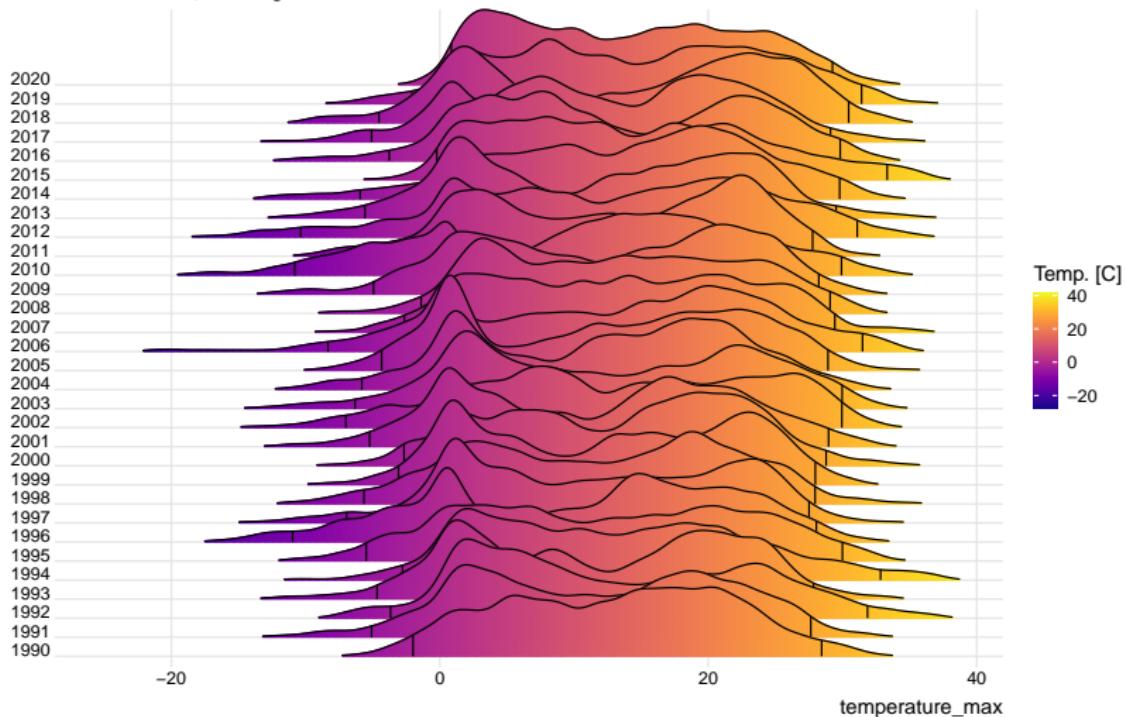
temperature\_min (Celsius) by year between 1990 and 2020  
bandwidth = 0.75, kernel = gaussian



# Maximum temperature

## Temperatures in Poland

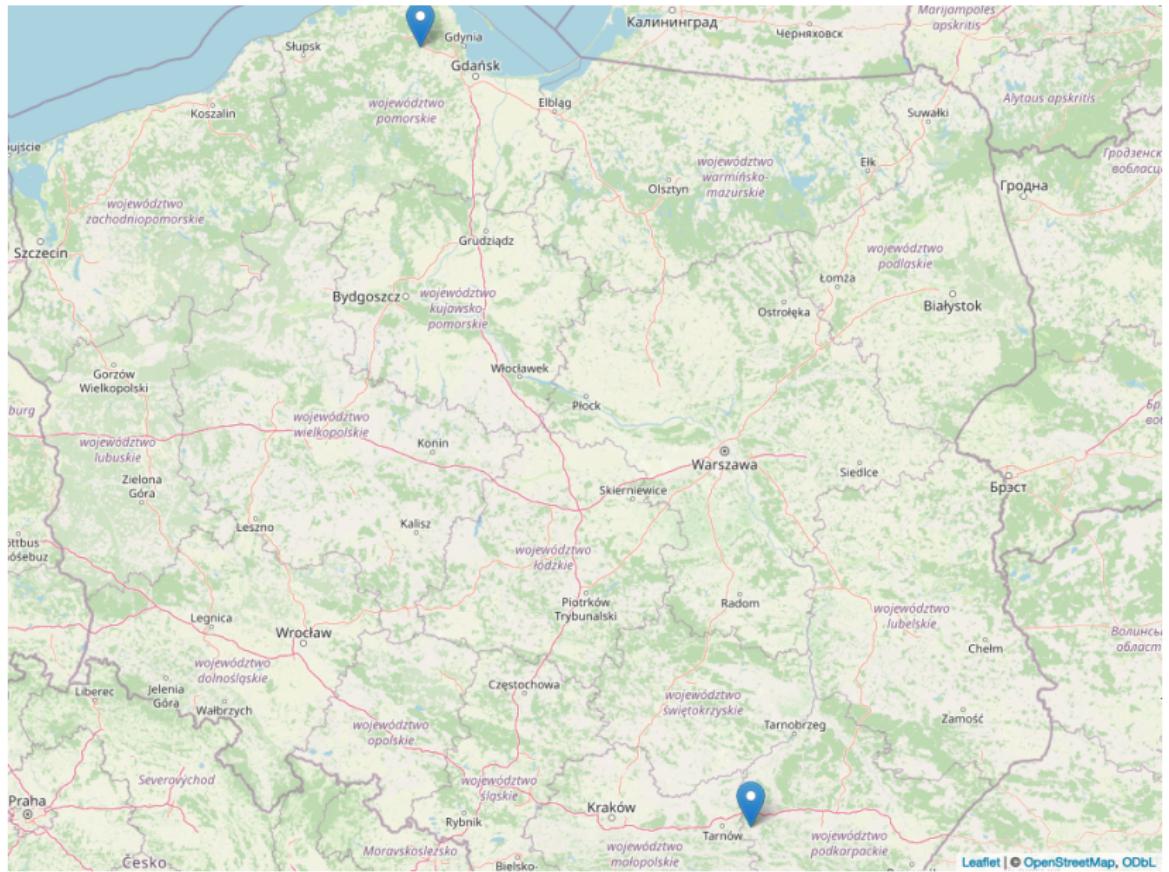
temperature\_max (Celsius) by year between 1990 and 2020  
bandwidth = 0.75, kernel = gaussian



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.

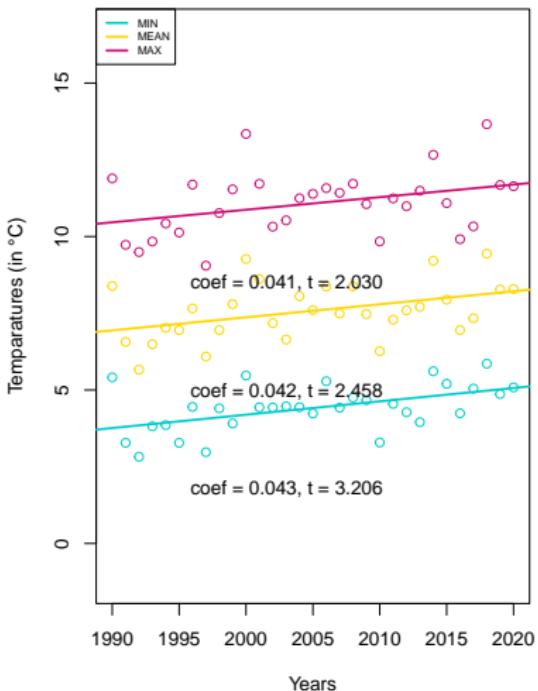
## Geographic points analysis

We will now analyze the data at specific geographical points. We will focus on 2 points in Poland, one at the the North by the sea, and one at the south that should face a continental climate.

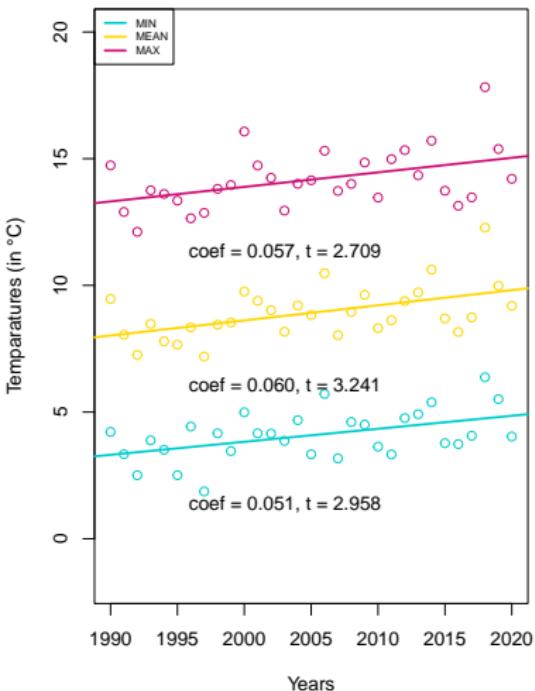


# Median

Regression of the median temperature  
in Poland across years (North)



Regression of the median temperature  
in Poland across years (Center)

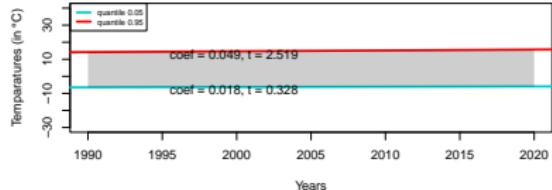


All increases are significant. The increase is the largest for all variable (minimum, mean and maximum) in the center of Poland, with coefficients between 0.05 and 0.06. The increase is the smallest in the north of Poland, with coefficients quite similar for all the three variables, around 0.042.

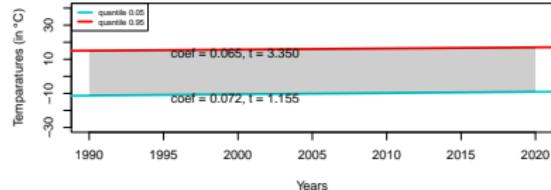
We will now analyze the quantiles of order 0.05 and 0.95 of each variable, instead of the medians. We will also plot the regression lines of these quantiles.

# Quantiles

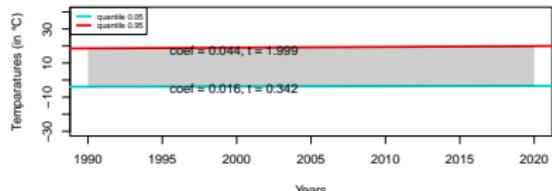
Poland North min



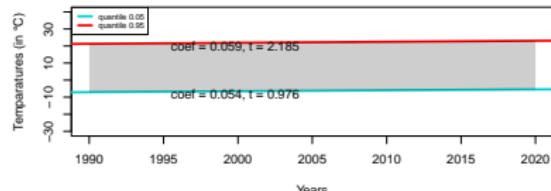
Poland Center min



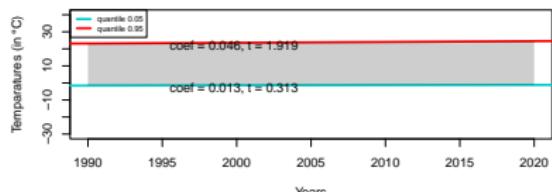
Poland North mean



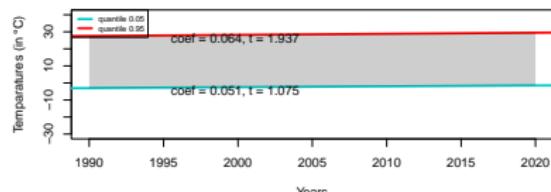
Poland Center mean



Poland North max



Poland Center max



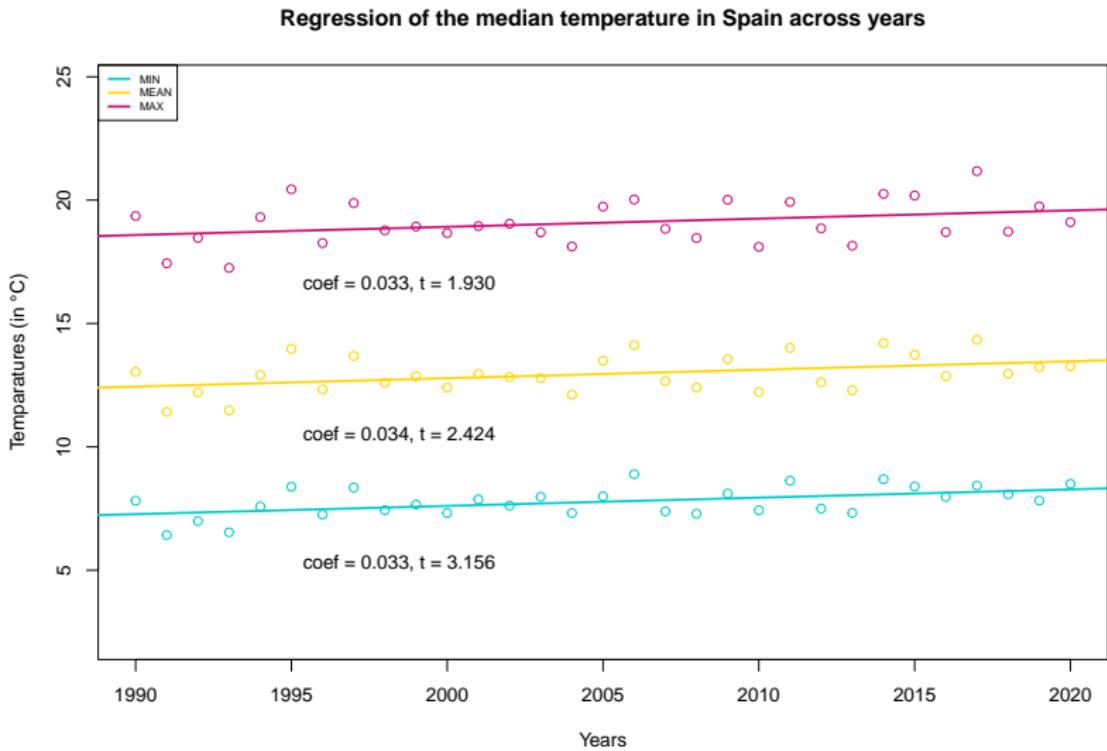
None of the 0.05 quantiles coefficients are significant, but all of the 0.95 quantiles coefficients are except the one for the maximum temperature, probably due to a high variance in the data. The 0.95 quantiles of the average and the minimum temperatures are increasing over the years, with the Center facing a higher increase than the North.

# Spain

## Country level

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

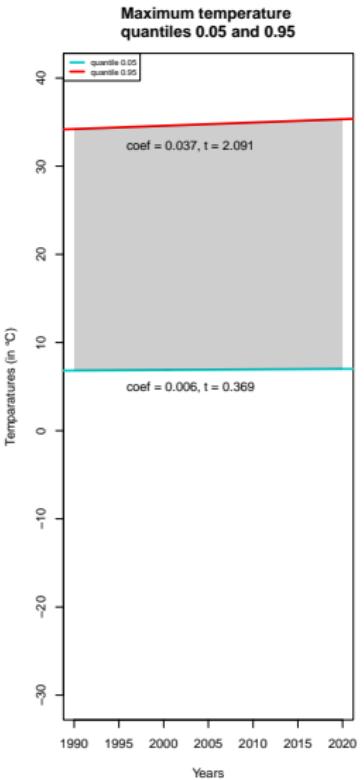
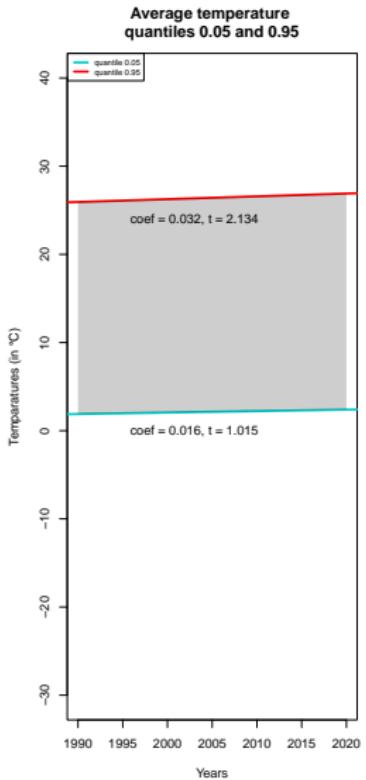
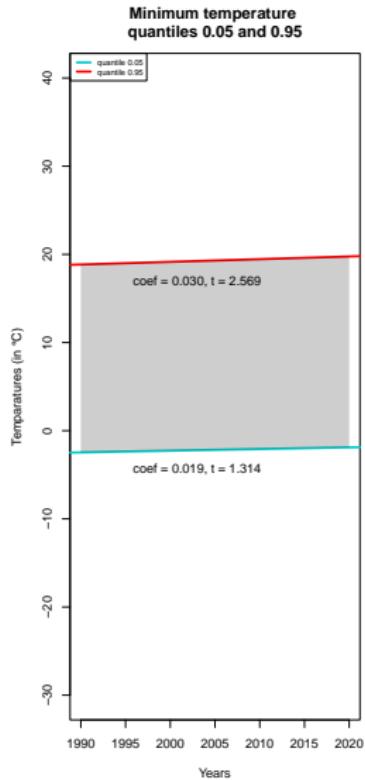
# Median



The maximum temperature does not show a significant increase (probably due to a high variance on the data), but the minimum and mean temperature do. The increase for the minimum and the average temperatures are very similar.

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



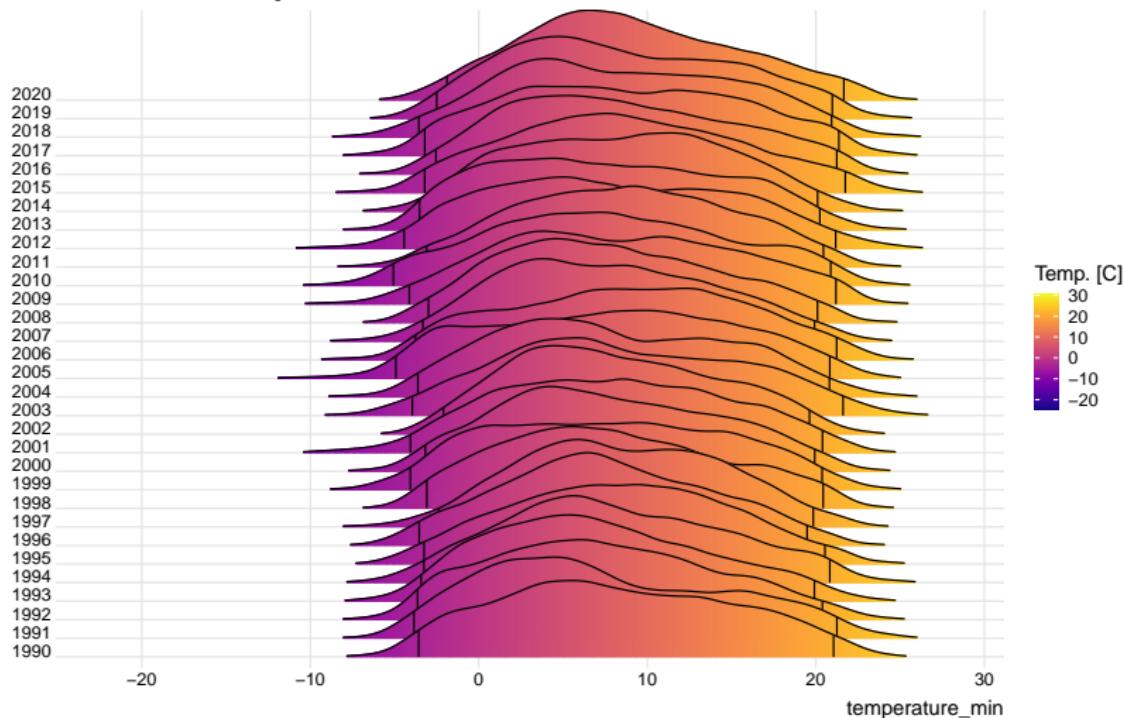
None of the 0.05 quantiles coefficients are significant, but all of the 0.95 quantiles coefficients are, with a small increase.

# Densities

## Minimum temperature

### Temperatures in Spain

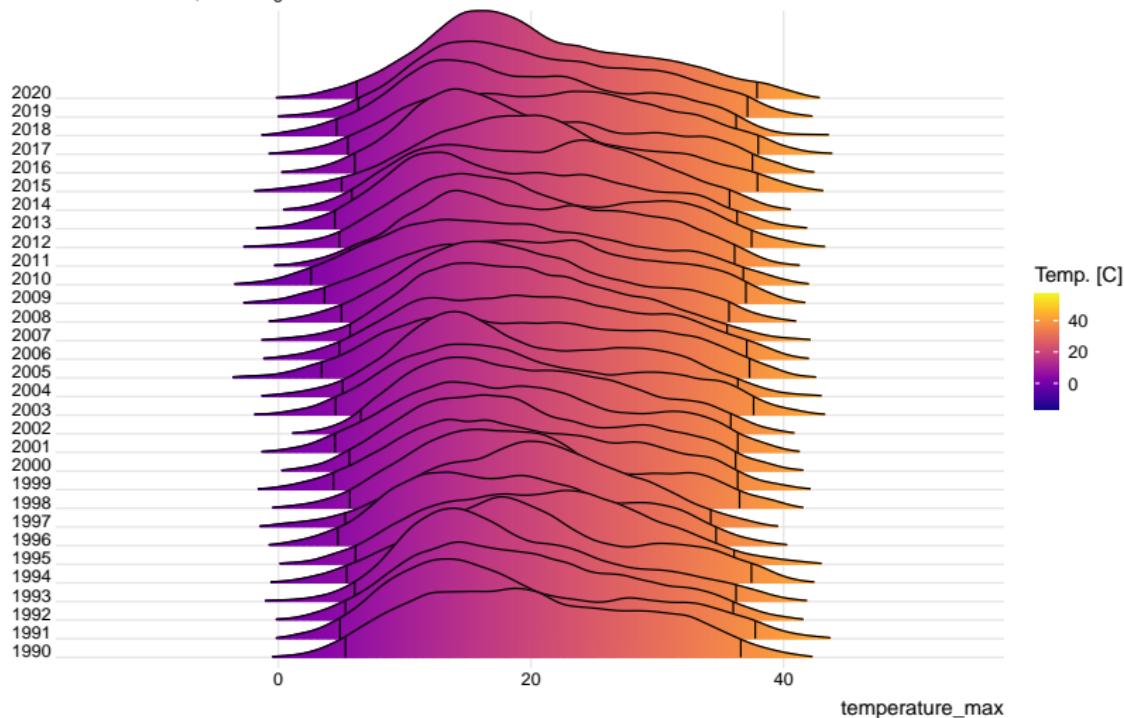
temperature\_min (Celsius) by year between 1990 and 2020  
bandwidth = 0.75, kernel = gaussian



# Maximum temperature

## Temperatures in Spain

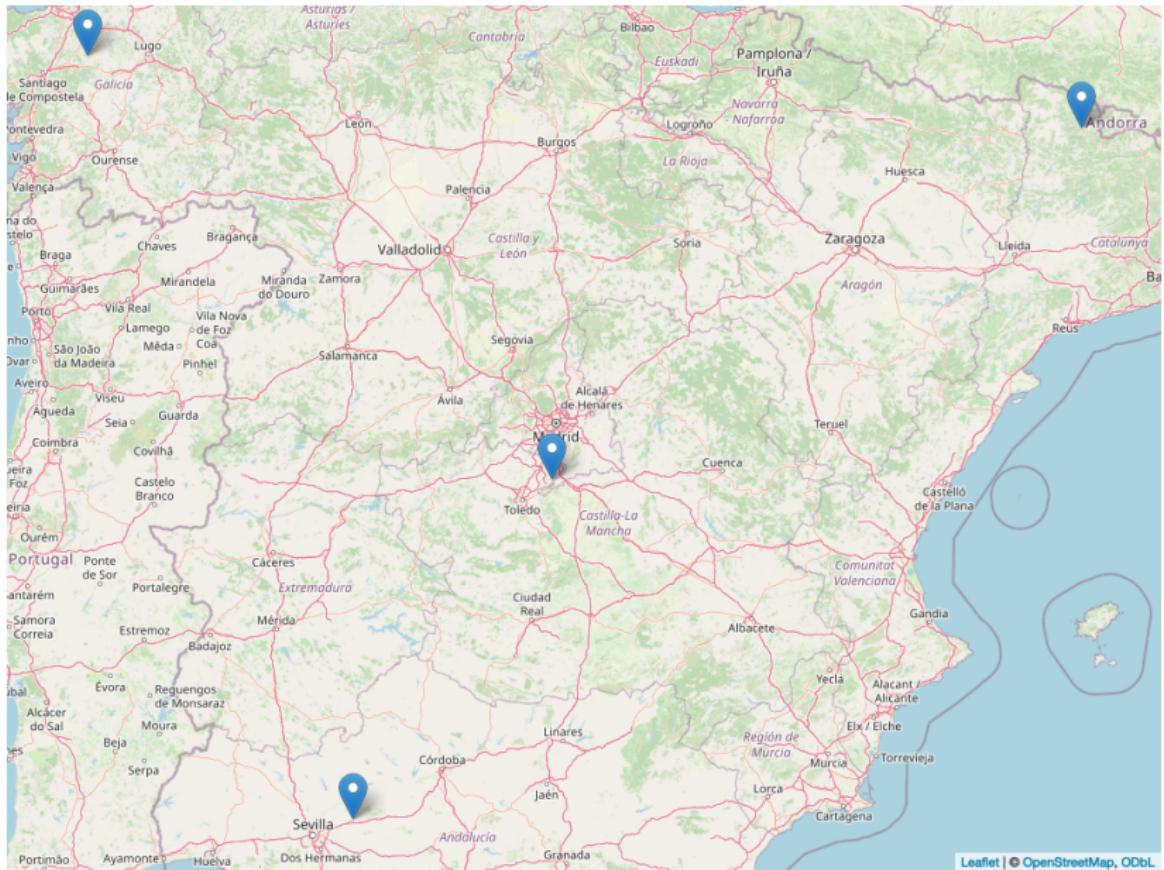
temperature\_max (Celsius) by year between 1990 and 2020  
bandwidth = 0.75, kernel = gaussian



It looks like the mode of the minimum temperature is shifting to the right (higher temperatures) over the years. The maximum seems not to change much.

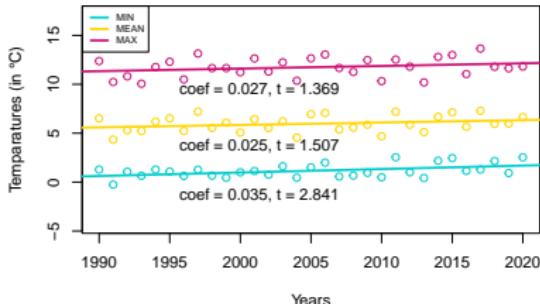
## Geographical points analysis

We will now analyze the data at specific geographical points. We will focus on 4 points in Spain, one in the Pyrenees (North), one in the center of the country around Madrid, one in Galicia (West) and one in the South, in the desert.

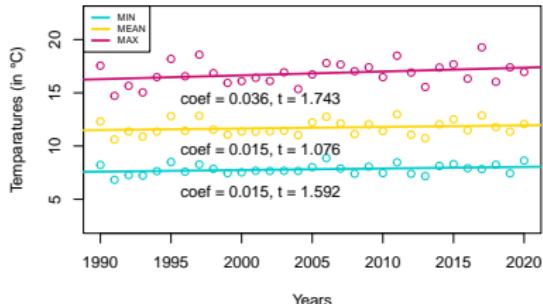


# Median

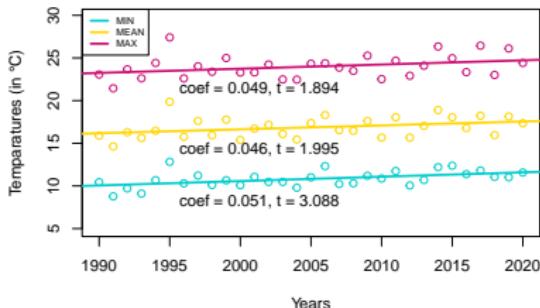
Regression of the median temperature  
in Spain across years (North)



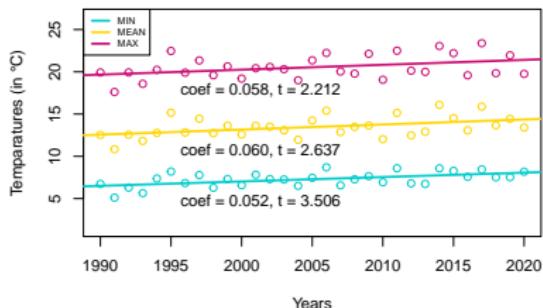
Regression of the median temperature  
in Spain across years (West)



Regression of the median temperature  
in Spain across years (South)



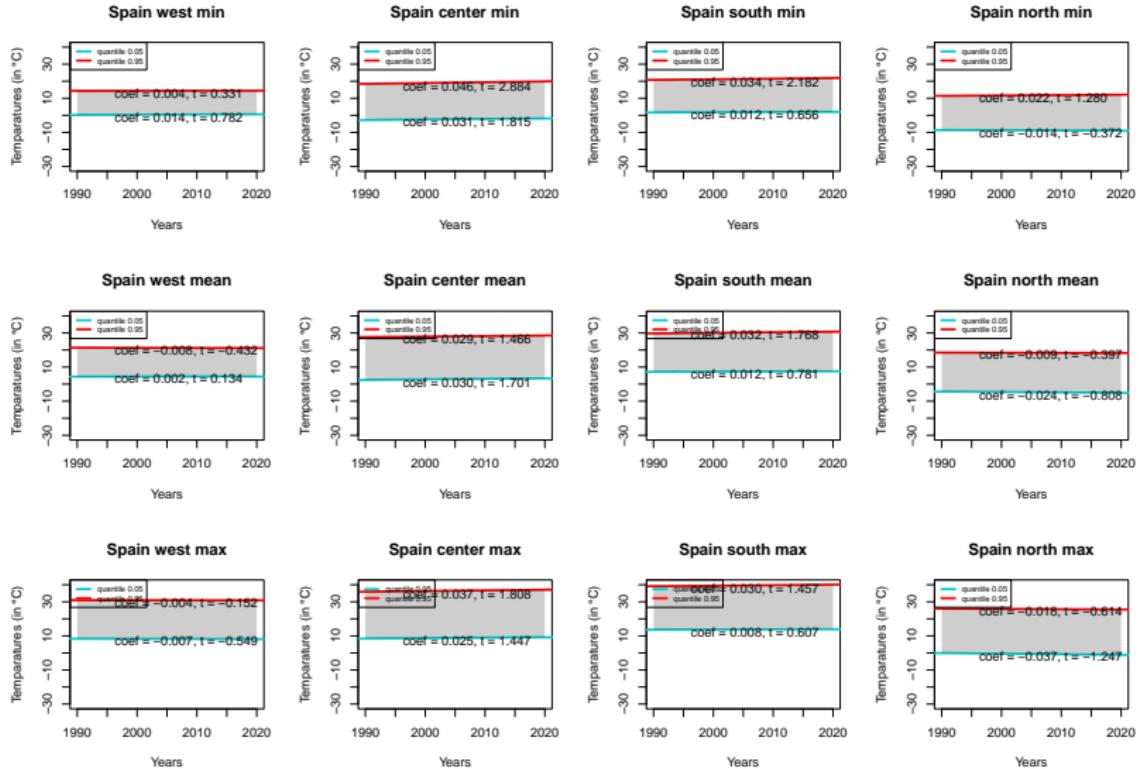
Regression of the median temperature  
in Spain across years (Center)



We observe that there is no significant increase in the median temperature in Galicia. In the Pyrenees, only the minimum have a significant increase and in the desert in the South, the mean and the minimum have some significant increase. In Madrid, we have the most important increases, and all the coefficients are significant.

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



We observe that the northern and western points have non significant coefficients, while the southern and central points have significant coefficients but only for the quantile 0.95 of the minimum temperature. Overall, this does not show any increase of the temperature in Spain.

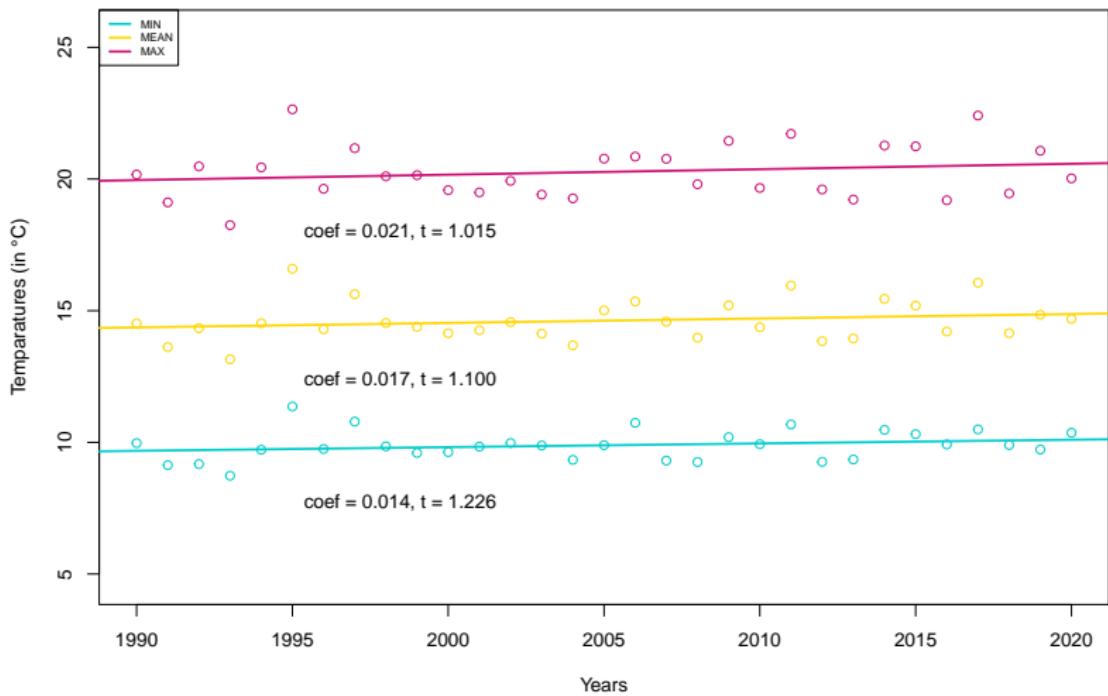
# Portugal

## Country level

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

# Median

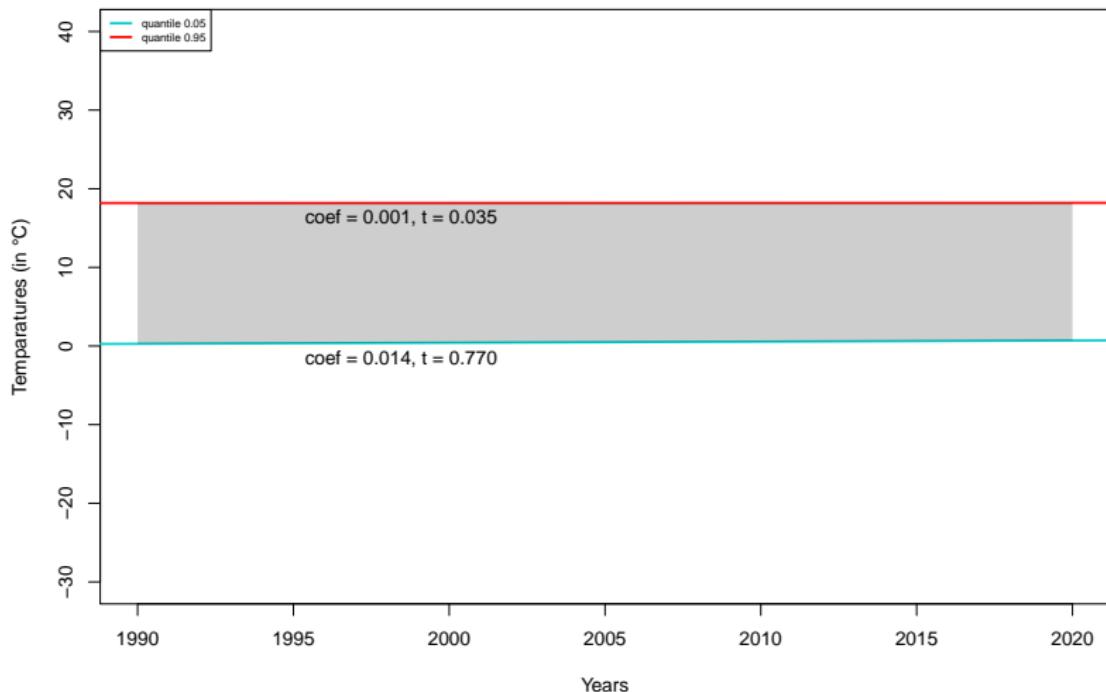
Regression of the median temperature in Portugal across years



We observe that there is no significant increase in the median temperature in Portugal. 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

Regression of the quantiles of order 0.05 and 0.95  
of the temperature in Portugal across years



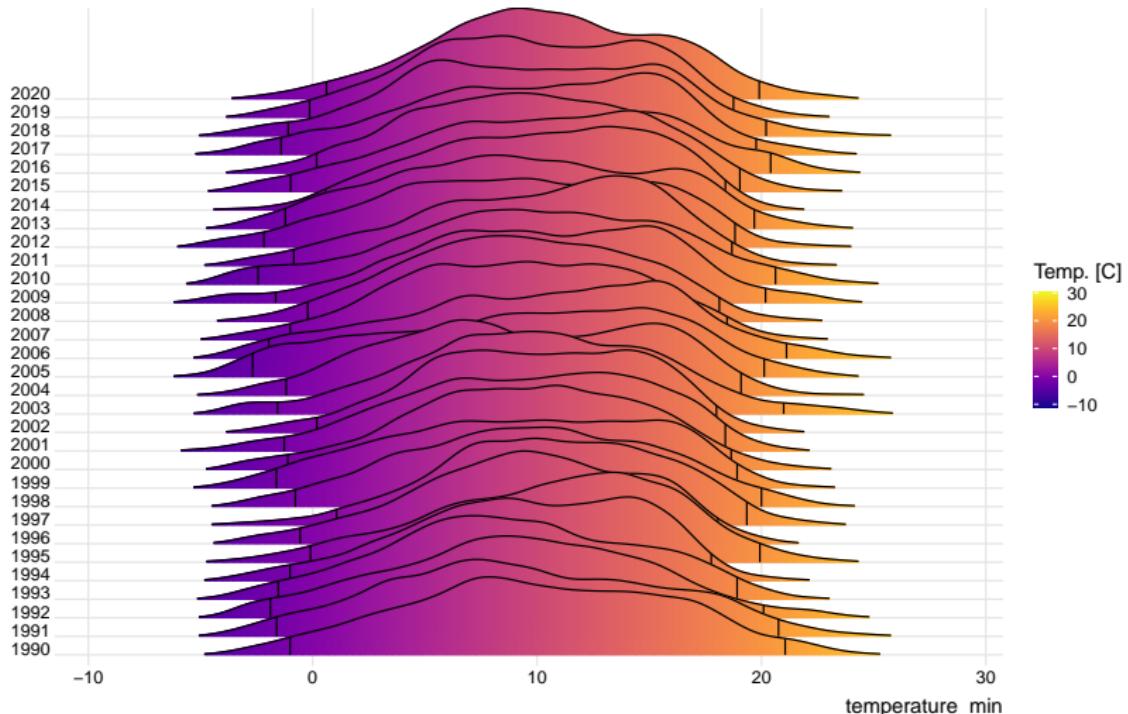
We observe that there is no significant increase in the quantiles of order 0.05 and 0.95 of the temperature in Portugal.

# Densities

## Minimum temperature

### Temperatures in Portugal

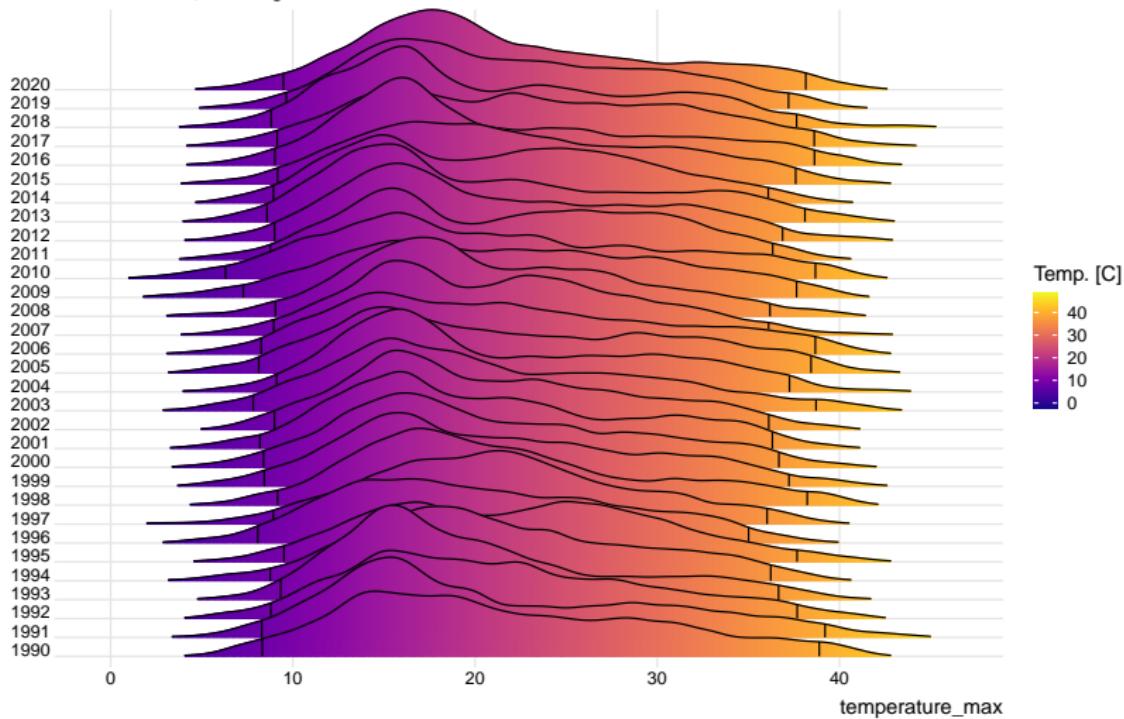
temperature\_min (Celsius) by year between 1990 and 2020  
bandwidth = 0.75, kernel = gaussian



# Maximum temperature

## Temperatures in Portugal

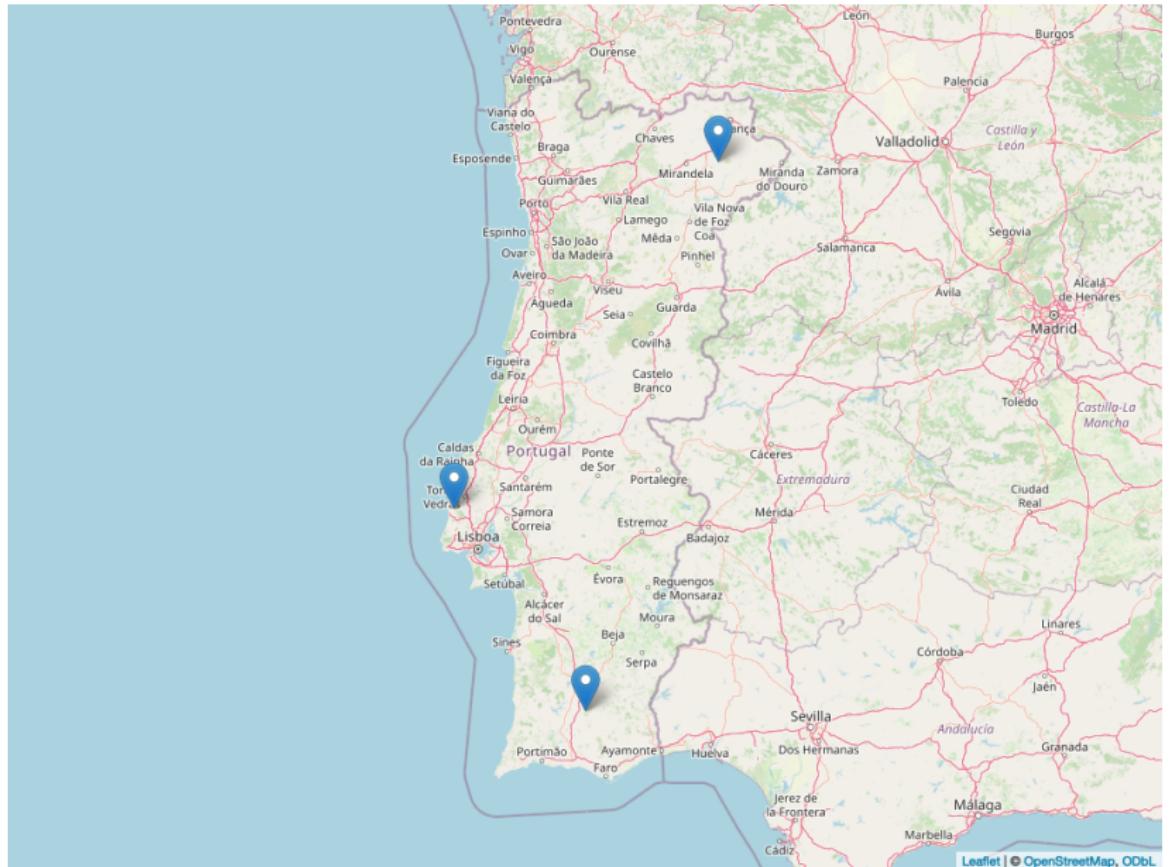
temperature\_max (Celsius) by year between 1990 and 2020  
bandwidth = 0.75, kernel = gaussian



The mode of the minimum temperature in Portugal seems to shift to the right, which means that the minimum temperature is increasing. Nothing can be said about the maximum temperature.

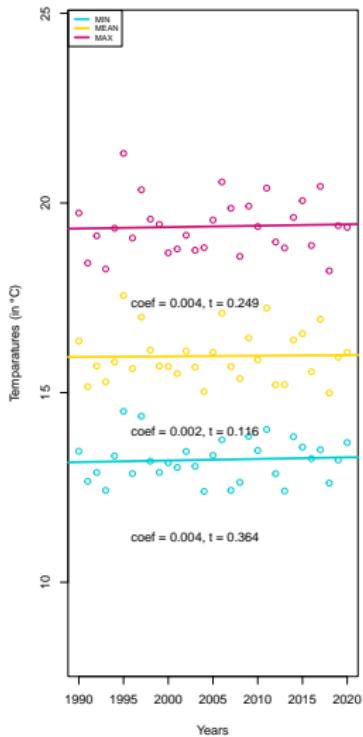
## Geographical points analysis

We will now analyze the data at specific geographical points. We will focus on 3 points in Portugal, one at the north close to Galicia, one at the West that have an oceanic climate and one at the South close to Andalusia.

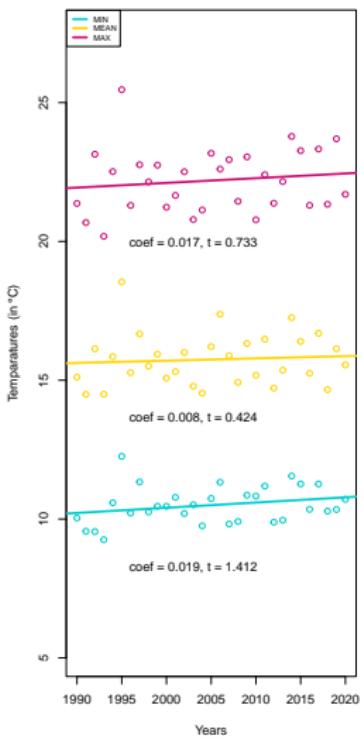


# Median

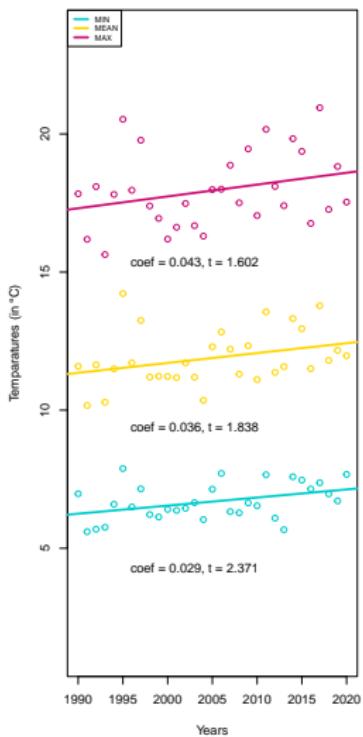
Regression of the median temperature in Portugal across years (West)



Regression of the median temperature in Portugal across years (South)

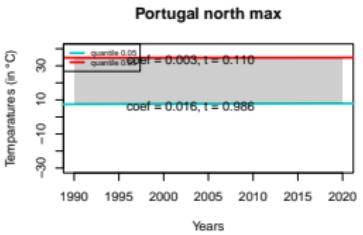
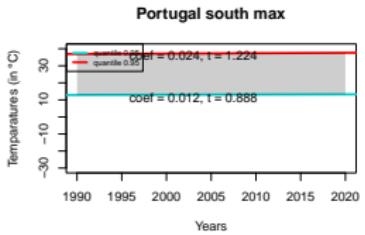
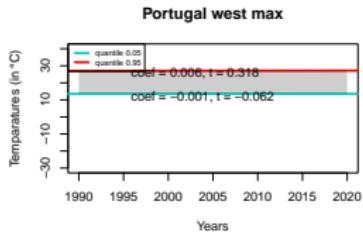
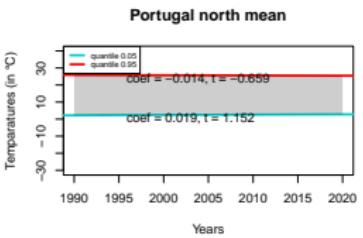
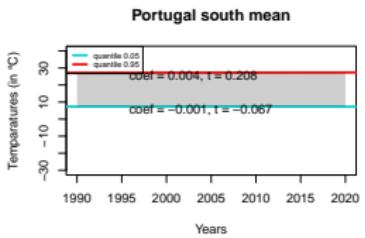
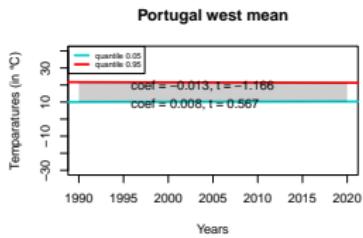
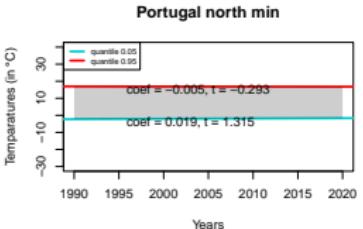
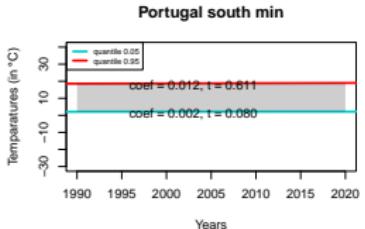
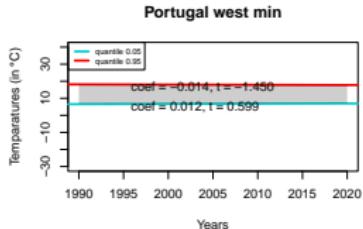


Regression of the median temperature in Portugal across years (North)



Only the minimum temperature at the North has a significant coefficient, but it also has a high variance and the coefficient's value is quite low.

# Quantiles



Nothing can be said about the quantiles of order 0.05 and 0.95 of the temperature in Portugal since none of the coefficients of the regression lines are significant.

## Conclusion

We have seen that the temperature in Spain and Portugal do not seem to increase. In Ukraine and Poland it seems that the maximum temperatures tend to be the one increasing the most.