An In-depth Analysis of Climate Data from Thirty-Six Stations in France

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Abstract

This study investigates the relationship between mean temperature, altitude, latitude and longitudes. The data consists of different environmental data that can influence the temperature of a location from 36 climate stations in France. Multiple linear regression was used to model these variables to predict the temperature. The results reveal a clear trend of higher altitudes are associated with lower mean temperatures. Latitude also plays a crucial role in the decreasing the temperature of around the climate stations. Although longitude also decreases lower mean temperatures, it effects is not statistically significant. The findings of the study demonstrate that both altitude and latitude affect the temperature patterns around the climate stations.

1 Introduction

One of the most basic factors affecting all forms of life on Earth is temperature. Ecology, agriculture, and climate science are just a few of the many disciplines that rely on a firm grasp of the variables that control temperature trends. Three critical factors that have long been acknowledged to affect temperature are altitude, latitude, and longitude.

The elevation of a certain point in relation to sea level is called its altitude. The air density drops as one climbs higher into the atmosphere because the atmospheric pressure drops. Temperatures are lower at higher altitudes because air is thinner and cannot absorb as much solar heat. In contrast, latitude is the measure of an area's angular separation from the equator. Due to the spherical form of the Earth and the angle of incoming solar radiation, various latitudes get different amounts of solar energy; as a consequence, places closer to the equator get more direct sunlight and higher temperatures, while those further away from the equator get cooler temperatures. Higher latitudes, farther from the prime meridian, are likely to be affected by differing atmospheric circulation patterns, which might cause temperature changes; longitude is the angular distance east or west of the prime meridian.

The purpose of this research is to examine a data set of 36 French climate stations to determine the combined effect of height, latitude, and longitude on mean temperature. Station names, elevations, latitudes, longitudes, average temperatures, maximum and lowest temperatures, relative humidity, annual precipitation, number of wet days, and sunlight hours are all part of the dataset. The main aim of this study is to thoroughly analyze this information from different climate stations so that we can learn more about the factors that drive temperature trends in different parts of the world and the dimensional connection between these variables.

2 Methods

The multiple linear regression model was used to analyze the influence of geographical variables on temperature, using latitude, altitude, and longitude as predictors. Initially, all three variables were included; however, longitude was not statistically significant and was removed from the model, leading to a revised second model that concentrated on the impacts of latitude and altitude. The new model without the longitude was then used to predict the temperatures of high-altitude climate stations, namely Mont-Ventoux and Pic-du-Midi, which were omitted from the data that was used during the modeling. A 3D scatter plot was generated to illustrate the interactions between altitude, latitude, and the expected temperature. An overall summary of the coefficients was also used to explain the model.

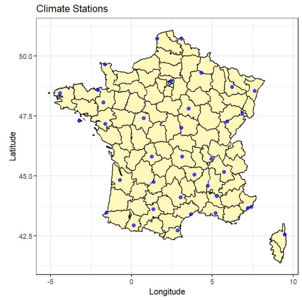

Figure 1: A typical map of France showing the 36 Climate stations

	Estimate	Std. Error	t-value	P-value
Intercept	37.23	2.62	14.21	¡0.0001
altitude	-0.006	0.0009	-7.38	¡0.0001
lat	-0.53	0.06	-9.58	¡0.0001
lon	0.03	0.04	0.81	0.42

Table 1: Coefficients of multiple linear regression using altitude, latitude and longitude.

3 Results and Discussion

The multiple linear regression model estimates the mean temperature in Celsius with an intercept of 37.27 degree Celsius, indicating the expected temperature when altitude, latitude, and longitude are zero. The coefficient for altitude is -0.0064, suggesting that each unit increase in altitude decreases temperature by approximately 0.0064 degree Celsius while latitude has a more substantial negative effect of -0.534, indicating a decrease of 0.534 degree Celsius per unit increase. Longitude's coefficient is 0.0321 but is not statistically significant. The second model of the multiple linear regression results indicate that the mean temperature is significantly influenced by both altitude and latitude. The intercept of 37.91 suggests that when both altitude and latitude are zero, the expected mean temperature is 37.91 degree Celsius. The coefficient for altitude is -0.0063, meaning that for each unit increase in altitude, the mean temperature decreases by approximately 0.0063 degree Celsius. The latitude coefficient is -0.5465, indicating that for each unit increase in latitude, the mean temperature decreases by about 0.5465 degree Celsius The multiple linear regression model estimates the mean temperature in Celsius with an intercept of 37.27 degree Celsius, indicating the expected temperature when altitude, latitude, and longitude are zero. The coefficient for altitude is -0.0064, suggesting that each unit increase in altitude decreases temperature by approximately 0.0064 degree Celsius, while latitude has a more substantial negative effect of -0.534, indicating a decrease of 0.534 degree Celsius per unit increase. Longitude's coefficient is 0.0321 but is not statistically significant. The second model of the multiple linear regression results indicate that the mean temperature is significantly influenced by both altitude and latitude. The intercept of 37.91 suggests that when both altitude and latitude are zero, the expected mean temperature is 37.91°C. The coefficient for altitude is -0.0063, meaning that for each unit increase in altitude, the mean temperature decreases by approximately 0.0063°C. The latitude coefficient is -0.5465, indicating that for each unit increase in latitude, the mean temperature decreases by about 0.5465°C.

In summary, The two multiple linear regression model estimates the mean temperature using altitude, latitude and longitude as predictors, with a difference from the first model that included longitude, the second model did not include longitude because its coefficients is not statistically significant.

	Estimate	Std. Error	t-value	P-value
Intercept	37.91	2.48	15.27	¡0.0001
altitude	-0.006	0.0008	-7.42	¡0.0001
lat	-0.55	0.05	-10.26	¡0.0001

Table 2: Coefficients of multiple linear regression using altitude, and latitude.

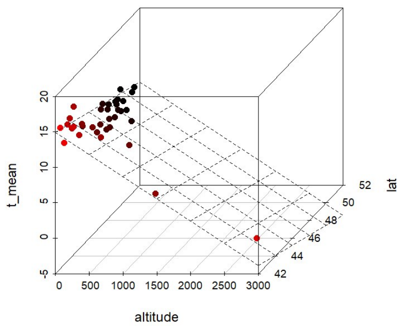

Figure 2: The 3D Scatter plot relationship of altitude, latitude to temperature

The intercept of the second model prediction for the mean temperature is 37.91 which is significantly higher than the first model of 37.27 degree Celsius. The coefficient of altitude for every meters (m) or feet (ft) above sea level and latitude in both models decrease the temperature, for every unit increase in altitude and latitude. This established that the higher the altitude the colder the temperature becomes and also for every distance we travel away from the Equator at 90 degree towards both the North and South pole, the colder the temperature becomes.

The 3D scatter plot helps to visualize the relationship between three variables of latitude, altitude, and mean temperature. The latitude point ranges from roughly 42 to 52, with higher latitudes clustered around 48, the altitude ranges from 0 to 1500, with most data points concentrated below 1000 while the mean Temperature ranges from 0 to 20. The plot shows that higher mean temperature is associated with lower altitudes and latitudes and vice versa. The scatter plot shows a general trend where as the altitudes and latitudes increases the mean temperatures decreases.

Link to R script: Check out our project on GitHub: https://github.com/Toheeb27/Climate_Data_Analysis