

Relationship between temperature and Concentration of NO₂

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Introduction

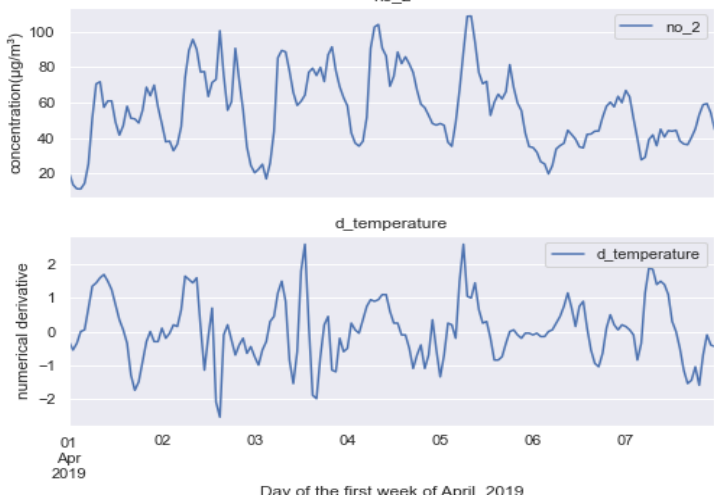
Nitrogen dioxide is a common air pollutant. At low temperatures, it dimerizes (reduces in concentration) to form dinitrogen tetroxide. We are going to investigate this effect with a real-world local data from 2012 to 2022. We formulate a null hypothesis: The average concentration of NO₂ is the same regardless of the temperature; and an alternative hypothesis: The average concentration of NO₂ is higher when the temperature is high.

Methods

We use a line plot of NO₂ level and temperature during the first week of April 2019, to investigate daily patterns and relations between the two. We use box plots of monthly data of both variables to investigate seasonal patterns and relations. Finally, we use a kernel density plot of temperature at noon in Aprils and Mays to decide a threshold to split the data so that hypothesis testing can be performed.

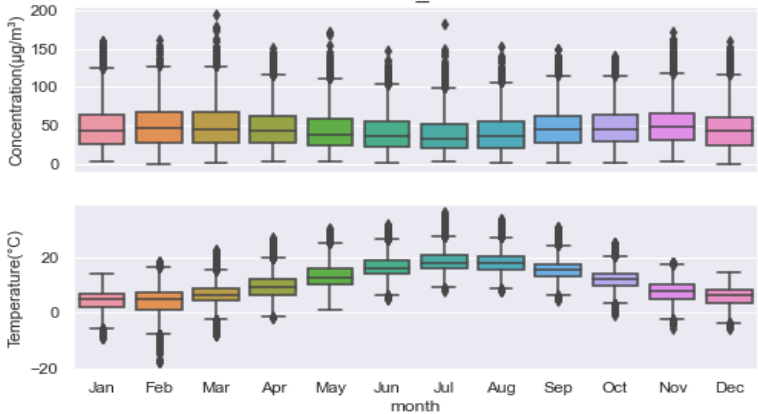
Results

NO2 concentration and the numerical derivative of temperature from 2019-04-01 to 2019-04-07



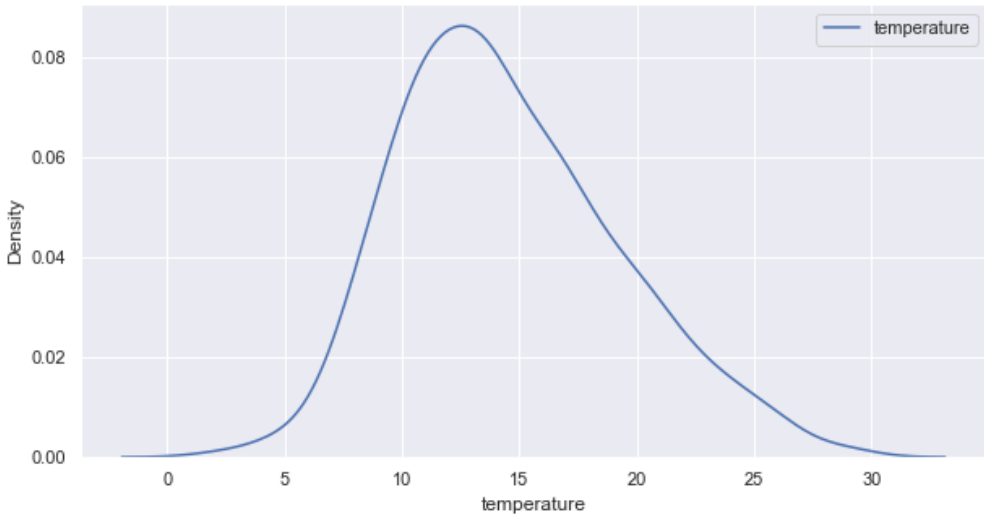
A daily increase in temperature correlates to a following increase in NO₂ levels.

Boxplot comparison between monthly Data of No2 and Temperature



A seasonal decrease in temperature correlates to a slight increase in NO₂ levels.

Kernel density plot of temperature at noon in April and May from 2012 to 2021



We chose a weather threshold of 14, which is between the mean, 14.6 and the median, 13.8. This value also splits the density plot into two almost even halves. We consider a temperature below 14 cold and a temperature above 14 warm. With this threshold we perform a two-sample t-test on the data taken at noon in Aprils and Mays. We obtain a p-value of 0.01 and a confidence interval from 1.24 to infinity. Both result suggest a rejection of the null hypothesis. Thus, we produce a strong statement that the average concentration of NO₂ is higher when the temperature is high.

Discussion

From the line plots and results of hypothesis testing using the threshold decided from the kernel density plot, we can deduce that the average concentration of NO₂ is higher when the temperature is high. However, the line plots concerns only daily patterns, and the hypothesis testing was done on data taken at noon in Aprils and Mays. The box plot opposite behavior with seasonal patterns.

Conclusion

From the results, we can conclude that that the average concentration of NO₂ is higher when the temperature is high on daily/weekly /monthly basis. This also follows the law of chemistry. However, seasonal patterns suggests the opposite. We could investigate further on this topic; one reason might be that NO₂ increases in low temperature due to an increase in usage of heating products.