WEB ISSN 2535-0013
PRINT ISSN 2535-0005

ANALYZING THE LEVEL OF HIGH TROPOSPHERC OZONE DURING THE SUMMER 2014 and 2015 IN SKOPJE, R.MACEDONIA

Eng. Stoimenovski B.[1], Prof.DSc.Mitreski K.[1], Asist.Prof.DSc.Naumoski A. [1],MSc.Serafimovski D.[2]

[1]Ss. Cyril and Methodius University in Skopje, Faculty of Computers Science and Engineering, Skopje, Macedonia
bbstoimenovski@gmail.com;kosta.mitreski@finki.ukim.mk
[2]Goce Delcev University of Shtip, Faculty of Informatics, Shtip, Macedonia

Abstract:

Ozone is health-hazardous air pollutant and his level in the living environment is very important to be tracked and understand. This specific gas in nowadays occurs as byproduct of certain human activities, especially with car pollution and naturally due to increased temperature. Therefore, it is important to understand the relationship between this variable. The focus of this paper is to model this relationship, with data collected for period of 3 months in 2014 and 2015(summer period). According to the models obtained with machine learning methods, high level concentrations of ozone was found if temperature of the air is higher than 30.15^{o}C and concentrations of NO_2 are lower than 16.93 mg/m^3(in 2013). Encourage by this model, in this paper we go further and extend our research to include more data (from 2014 and 2015) and different methods to find other influencing factors that contributes to high concentration of ozone.

KEYWORDS: THRESHOLD OZONE, DECISION TREE, ENVIRONMENTAL PARAMETERS, TROPOSPHERE

1. Introduction

We have all heard about the ozone layer, located at an altitude of 25-30 kilometres and a width of 20 kilometres that protects us from harmful UV radiation of the Sun, thus protecting life on Earth. This is called “Good ozone layer". However, ground-level ozone (Ozone located in the troposphere) or the so-called “Bad ozone layer" occurs as a byproduct of certain human activities across the globe. Ozone is the only pollutant of nature that is not obtained directly from the source of pollution, but as a result of interaction of nitrogen oxides, volatile organic compounds and meteorological conditions.

The growing number of residents, the majority of vehicles, new industrial plants, global warming is one of the reasons for increased amounts of ozone in the troposphere. Unlike most other air pollutants, ozone is not emitted directly into the air from a source. Ozone is formed by the interaction with the sun[6], particularly ultraviolet light, carbon and nitrogen oxides emitted from vehicles, power plants using fossil fuels, refineries and other industries.

While the ozone in the stratosphere, it protects us from UV radiation, butin the troposphere regarding the environment this pollutant causes adverse effects on growth and reproduction of plants, reduces agricultural yields, affects the ecosystems through changes in water movement, the cycle of minerals / nutrients, habitats, causes disintegration of organic materials, affects the destruction of nylon, rubber and other materials, hurts or destroys animal tissue and it is especially hazardous for people who work outdoors or have respiratory problems.

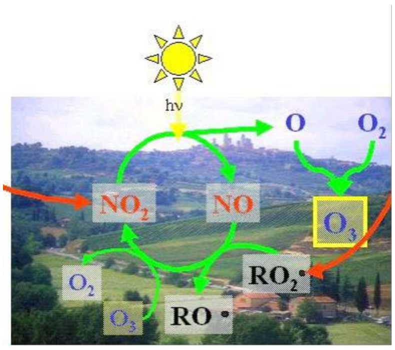

Fig 1: *Ground storm chemistry of ground-level ozone [16]*

The atmospheric chemistry of ground-level ozone creation is shown on Fig 1.When ground-level ozone reaches high levels, people should be informed to take extra precautions because respiratory tissue might be damaged, as well as gum tissue, causing damaging cells through oxidation, etc. This can affect the performance of athletes, the occurrence of frequent asthma attacks, irritation of the eyes, chest pain, coughing, vomiting, headaches, exacerbated heart disease, bronchitis and emphysema[13].

Despite the evidence of the harmful effects of increased concentration of ground-level ozone has on humans and vegetation, there is constant growth of this pollutant in the EU, US and in other parts of the world[4]. The World Health Organisation[14] emphasises the risk from elevated concentrations of ozone on human health and vegetation and gives instructions for setting the limit value of 100μg/m3 eight-hour daily ozone concentration, although the EU regulation is still with limit value of 120μg/m3. It should be noted that there is no 100% safe threshold level and some individuals may be at risk with limit values less than the recommended ones[1,2,3].

Similar research is being done in R. Slovenia for the town Ljubljana [15] but we would like to extend our research for the town Skopje [17] with more measurements data and more pollution parameters.

2. Data and Methodology

To study the effect and the ratio of meteorological and environmental parameters data mining methods were used. For this purpose, a reliable statistical database of meteorological and environmental parameters was created.

We focus our research for one of the Municipalities in Skopje, the KarposhMunicipality because according to the information published on their Web, they reported "exceeding 8 hours of ground-level ozone”[10,11,12].

At higher temperatures, there are higher ozone values, such that our goal will be to determine the threshold temperature valueat which ground-level ozone exceeds the limit values set by the 2002/3/EC Directive. The value of ground-level ozone according to this directive is set to 120μg / m^3 eight-hour maximum that may be overcame no more than 25 times a year. The average value when the public must be immediately informed is overcoming 180μg/m3, while the alert threshold is at 240μg/m^3.

With proper ranking of the considered parameters of the primary pollutants that participate in the creation of ozone, it is possible to identify specific emitters of primary pollutants that initiate the creation of ground-level ozone. Yet the most important contribution of this paper is the possibility to alert the population of most affordable meteorological parameter - the temperature, for possible high concentrations of ozone. This information can be very useful for the risk group of people that will know the temperature at which to apply the advice of doctors. The institutions should be informed in alarm situations when there is increase of air pollution in urban areas and the need for reduction and regulation of emissions in order to obtain better air quality.

The database is consisted of parameters such as ozone, carbon monoxide and nitrogen dioxide, taken from the database of the Ministry of Environment and Spatial Planning of the Republic of Macedonia from the measurement station of Karposh in the period from 01.01.2014 to 31.12.2015. The database also contains parameters such as temperature humidity and pressure, taken from the database of Hydrometerological Office in the Republic of Macedonia. The database is composed of hourly data in the given time period. Later on, the analysis is limited to the summer months (June, July, August and September). All data was previously processed to meet the demands of selected open source software for data search –WEKA[5].

3. Results and Discussion

The initial examination was conducted with LeastMedSq to establish whether ozone data is linear temperature-dependent or not. However, according to the results we believe that the relationship is nonlinear. In order to determine what is the impact of the other attributes to the ozone, we rank attributes according to the attribute appraiser in WEKA, RreliefFAttributeEval. He implements the instance-based RReliefF method [8] to assessing the relevance of attributes. We use 10-fold cross-validation to calculate the relevance of a multitude of functions and their differences. Ranking of the yearly database parameters is presented in Table 1.

Table1: *- Ranking of the attributes with RReliefF in correlation with their relevance for prediction of the ozone concentration in the period from 01.01.2014 to 31.12.2014.*

Rank	Attribute
1	Temperature
2	Pressure
3	Humidity
4	NO_2
5	CO

WEKA enables us the availability and distribution of all attributes. They are illustrated on the fig.2 below.

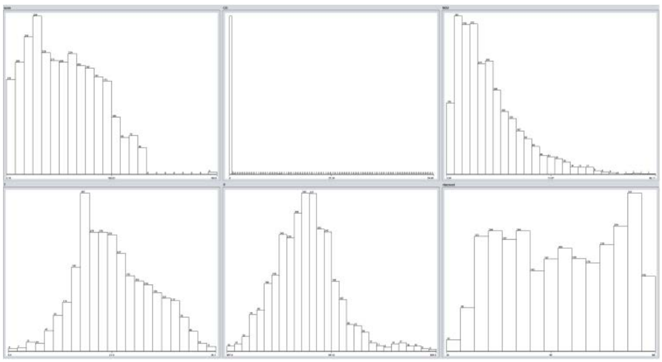

Fig 2: Distribution of attribute value into data in the period from 01.06.2014 to 30.09.2014

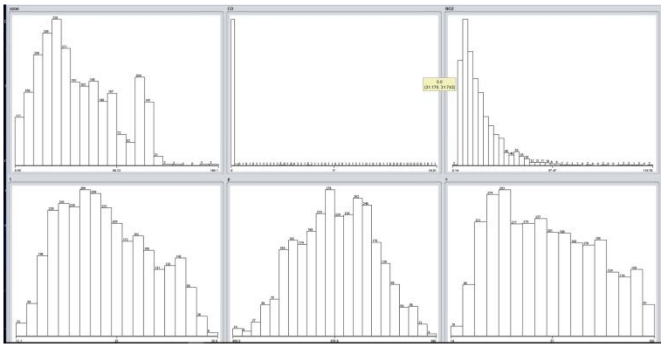

Fig3: *Distribution of attribute values into data in the period from 01.06.15 to 30.9.15*

Availability and distribution of all attributes in the period from 01.06.2015 to 30.09.2015 is shown in Figure 3. For the decision tree we used the model tree (MT).This tree was built by using the M5R algorithm [7] in the WEKA package for data mining. Because of the dependence of the creation of ozone from the high temperatures we will adjust the decision tree to the period from 01.06.2014 to 30.09.2014.

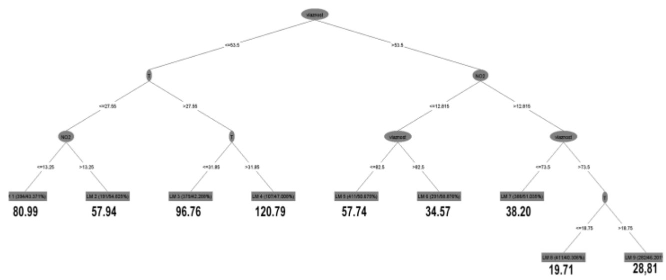

Fig 4:*Modeltree with all parameters for 2014*

According to the model presented in Fig. 4, the humidity, temperature and the NO_2 concentrations are the most important factors for ozone concentrations. High levels of ozone concentrations are present when humidity is lower than 53.5% and the Temperature is higher than 30.15° C. On the other hand, low concentrations of ozone are predicted when humidity is higher than 73.5% and NO_2 concentrations are higher than 12.81 $\mu g/m^3$. It is interesting to note that NO_2 concentrations can be found to play a role in low and high concentrations without strict definition of its value, meaning that this parameter can play role in increasing or decreasing ozone concentrations in different combination of humidity and temperature scales.

4. CONCLUSION

Ozone is a health-hazardousairpollutant and its level is increased with increasing of the air temperature. In this paper, we have analysedthe summer period of 2014 and 2015 in Skopje, R. Macedonia.The M5P decision tree algorithm was used to analyse the data by creating tree hierarchical models, helping us to find threshold values which determine high and low ozone concentrations.

The main objective of this research is determination the most important factors that contribute to low or high ozone concentrations. According to the decision tree model, we found that high temperatures and low air humidity contribute to high levels of ozone, while low temperature and high humidity resulted in low concentrations of ozone. It is interesting to note, since NO_2 concentrations have no particular value range in which contributes to low or high concentrations of ozone, we can conclude that it is important pay factor in reactions forming ozone in different combination scale for temperature and humidity. High temperature is definitely correlated to sunny days when UV light from the sun

WEB ISSN 2535-0013
PRINT ISSN 2535-0005

not only heats the air, but also increases the ozone concertation through chemical reaction between various compounds.

Therefore, in future we plan to extend our models with more data not only in time dimension, but also including other components that play important role in forming ozone concentration.

5. ACKNOWLEDGMENTS

This work was supported (by using their data bases) from the Hydro- meteorological Institute-Skopje and the Ministry of Environment and Spatial Planning of the Republic of Macedonia.It was partially financed by the Faculty of Computer Science and Engineering, Skopje, R. Macedonia

6. REFERENCES

[1] EC. *Council Directive 96/62/EC of 27 September 1996 onambient air quality assessment and management*. Retrievedfrom: http://eur-lex.europa.eu/legalcontent/EN/TXT/?uri=CELEX:31996L0062.
[2] EC. *Directive 2002/3/EC of the European Parliament and ofthe Council of 12 February 2002 relating to Ozone inambient air*. OJL 67, 3 March 2002. Retrieved from:http://eur-lex.europa.eu/legalcontent/EN/TXT/?uri=celex:32002L0003
[3] EC. *Directive 2008/50/EC of the European Parliament andof the Council of 21 May 2008 on ambient air quality andcleaner air for Europe*. Retrieved from: http://eurlex.europa.eu/legalcontent/EN/TXT/?uri=CELEX:32008L0050.
[4] European environment agency (EEA). 2012. *Air quality inEurope — 2012 report.* EEA Report No 4/2012,Copenhagen.
[5] Hall, M., Frank, E., Holmes, G., Pfahringer, B., Reutemann,P., and Witten, I. 2009. The WEKA Data Mining Software:An Update. *SIGKDD Explorations*, 11, 1: 10–8.
[6] Lee, J.D., Lewis, A.C., Monks, P.S., et al. 2006. Ozonephotochemistry and elevated isoprene during the UKheatwave of august 2003. *Atmos. Environ.* 40, (Dec. 2006),7598–7613. DOI= doi:10.1016/j.atmosenv.2006.06.057.
[7] Quinlan, R.J. 1992. Learning with Continuous Classes. In:*Proceedings of the 5th Australian Joint Conference onArtificial Intelligence*. World Scientific, Singapore, 343-348.
[8] Robnik-Sikonja, M., and Kononenko, I. 2003. Theoreticaland Empirical Analysis of ReliefF and RReliefF. *Mach.Learn*. 53, (Oct. 2003), 23-69.
[9] Salvato, J., A., Nemerow, N., and Agardy, F., J. 2003.*Environmental engineering*. Fifth edition. John Wiley &Sons: New Jersey.
[10] Ministry of Environment and Spatial Planning of the Republic of Macedonia, 2013, http://airquality.moepp.gov.mk/?page_id=1505
[11] Hydrometerological Office in Skopje, 2013,http://www.meteo.gov.mk/
[12] National Hydrometerological Service – R. Macedonia, 2013, Bazinameteoroloskipodatoci, http://www.meteo.gov.mk/index.php?option=com_content&view=category&id=30&Itemid=59&lang=mk
[13] Williams, S., Nitschke, M., Weinstein, P., Pisaniello, D.L.,Parton, K.A., and Bi, P. 2012. The impact of summertemperatures and heatwaves on mortality and morbidity inPerth, Australia 1994 –2008. *Environ. Int.* 40 (Apr 2012),33–38. DOI= doi:10.1016/j.envint.2011.11.011.
[14] World Health Organization (WHO). 2006. *Air qualityguidelines for particulate matter, Ozone, nitrogen dioxideandsulfur dioxide. Global update 2005. Summary of riskassessment*. WHO, Geneve.
[15] Johanna A. Robinson, SašoDžeroski, David Kocman,MilenaHorvat “Analyzing the formation of high tropospheric Ozoneduring the 2015 heatwaves in Ljubljana with data mining”Proceedings of the 18th International Multiconference, INFORMATION SOCIETY – IS 2015, Volume A, pp.96-99.
[16] Tropospheric ozone,(2011),Prof.Dr. Ivan Grzhetik, Chemical Engineering- Beograd.
[17] Stoimenovski B., Mitreski K., Davcev D., Naumoski A.” Analysing the level of high tropospheric ozone during the summer of 2013 in Skopje, R. Macedonia”, V International Conference „Ecology of urban areas“, Serbia, 2016