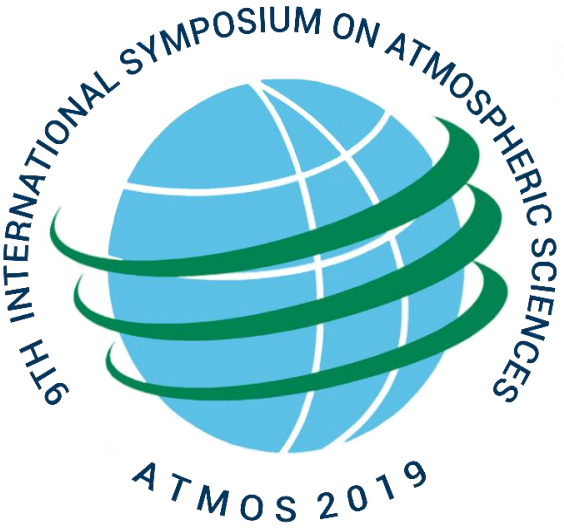

EDITORS

Dr. Kasım KOÇAK
Dr. Levent ŞAYLAN
Dr. Emine Ceren EYİGÜLER
Dr. Zerefşan KAYMAZ
M.Sc. Evren ÖZGÜR

e-ISBN: 978-975-561-482-3

e-Proceedings of the 9th International Symposium on Atmospheric Sciences

International Symposium on Atmospheric Sciences 23.10.2019 – 26.10.2019

ATMOS2019 supports and follows the ethical standards developed at the 2nd World Conference on Research Integrity, Singapore, July 22-24, 2010.

Overall Evaluation of Ozone in Turkey and Data Quality Control

Meryem Mutlu[1], Fatma Başak Saka[1], Melike Bayramçavuş[1], Hüseyin Toros[1]
[1] Istanbul Technical University
Faculty of Aeronautics and Astronautics, Department of Meteorological Engineering
mutlumer16@itu.edu.tr, saka16@itu.edu.tr, bayramcavus16@itu.edu.tr,toros@itu.edu.tr

ABSTRACT

Air pollution can be defined as the concentration of major components of gases in the atmosphere get through critical values and affect life on earth. Although there are numerous of gases which creates pollution in the atmosphere O3, NOX, SOX, CO2, PM 10, PM 2.5 are main problem makers which diffuse the atmosphere because of human activities. Starting from the industrial revolution to our century air pollution origin humans increasingly caused lots of environmental problems. These problems must be searched and prevented before hazardous incidents. The purpose of this research is to specify the general profile of ozone concentration over Turkey between January 2010 to December 2018 periodical. In this case, it is used 21 stations at the Black Sea Region, 7 stations at the Central Anatolia Region, 3 stations at the Aegean Region, 27 stations at the Marmara Region, 6 stations at the Mediterranean Region, 6 stations at the Eastern Anatolia Region and analysed. It is observed that concentrations of ozone have different variabilities in terms of basic climatological features, air quality, urbanization, and population density.

Keywords: *Air pollution, Ozone, Data, Quantity, Turkey*

INTRODUCTION

Increased industrial activities, urbanization, developing technology and some of the chemical activities and their yields appeared in the atmosphere which is the one affected mostly by activities. With increasing chemical activities, air pollution has started observing over the regions. For the measurement of air quality in the atmosphere, O3 is one of the important and risky compounds. There are 2 types of ozone and these are the tropospheric and the stratospheric ozone. Taking into consideration for air quality, tropospheric ozone is observed. Nikolove and Mintcheva states that in urban areas surface ozone can cause health problems and has a bad effect on humanity. This type of ozone can damage the respiratory and lung systems and environment (2018). The tropospheric ozone occurs in the troposphere level naturally by sunlight and the pollutants. This ozone is seen over the urban area and after the late noon and known as bad type ozone. One of the resources of bad type ozone is NOX, and motor vehicles and power plant cause this. Ozone is a complex form of oxygen. The reaction of O2 molecules and oxygen creates O3 that exists in the troposphere and ozone doesn't occur with directly and need to NOx, VOC, and the sunlight. Pollution of the ozone level is related to air conditions. Over temperature, insolation and inactivity of air are favourable conditions for ozone level.

Bozkurt et al state that topography and specialty of topographical area are important for dispersion of pollutants since these quantities affect the local winds and atmospheric stability (2018). Besides, traffic, industrial area, the heating process of the region affect the ozone level. Im, Tayanc, & Yenigun state that under anticyclonic conditions low-level wind speed ozone level is observed high (2006). In this study, the data are analysed and presented in relation to environmental contamination in terms of air quality data concentrations of monitoring stations in sixty-four stations of Turkey. These results indicate air pollution levels. Different from other researches, in this study case regional and country base updated 1-year periodic data are used.

METHODOLOGY

Study Area

Turkey is located in 36 ° - 42 ° parallel of 26 ° North - north of the equator between the meridians 45 ° East, a country east of the prime meridian and the rest of the middle generation. Turkey is divided into seven geographical regions. These are Mediterranean, Eastern Anatolia, Aegean, South-eastern Anatolia, Central Anatolia, Black Sea, and Marmara regions. It is surrounded by seas on three sides; to the west is the Aegean Sea, to the north is the Black Sea and to the south is the Mediterranean Sea, to the northwest is the Sea of Marmara. The total population in Turkey about 79 million. Different climatic characteristics and four seasons are seen together. The average elevation is high. Therefore, the difference between the actual temperature and the reduced temperature is high. It has important straits and trade routes. Topographical characteristics are affective mostly since the elevation of Turkey increases with west to east. In Turkey, the winds blowing from the north winds blowing from the south while decreasing temperature increases the temperature. Karayel is a cold wind blowing from the northwest. Mostly storm-shaped work. Yildiz is a cold and strong wind blowing from the north. This wind is more effective in the Black Sea and Marmara regions. Poyraz is a cold wind blowing from the northeast. Mostly storm-shaped work. It has a cooling effect in the summer period. This wind is most effective in Marmara and the Black Sea regions. The Ethesian wind is a wind blowing from the northwest in the Mediterranean and Aegean seas. Effective from May to September, this wind lowers the temperature in the places it blows. Occasionally storm-shaped work. Lodos work from the southwest. It is a wind that raises the temperature in the places where it blows and is more effective in the Western Anatolia and the Marmara Sea. Kible is a hot wind blowing from the south. It is moist because it comes from the Mediterranean Sea. Samyeli is a hot and dry wind blowing from the southeast. This wind, which mostly affects South-eastern Anatolia, damages plants due to its drying effect. Föhner (hairdryer) wind, is more effective in the North Anatolian Mountains and the foothills of the Taurus Mountains in Turkey. As these air masses rise, it cools by 0.5 ° C every 100 meters, while it descends to 1 ° C every 100 meters. Therefore, föhn is a hot and dry wind. These winds can cause sudden snow melting and related flooding.

Measurement technics

In Turkey, it is set that air quality stations between 2005 to 2007 in 81 cities of Turkey by the Turkish environment and urban ministry. (http://mobil.havaizleme.gov.tr/Default.ltr.aspx) The data used in this study are taken from this ministry. To investigate the ozone levels of different cities, it is used 70 stations observations from different regions of Turkey and data which is measured hourly in the 2018 year.

Strategy

The data were obtained from 70 monitoring stations in 26 cities in 2018. For this case study Eastern Anatolia Region, Marmara Region, Black Sea Region, Aegean Region, Mediterranean Region and finally Central Anatolia region station data sets are used in Turkey. In contrast, there is no ozone concentration observation in The South-eastern Anatolia Region. Months containing more than 10 days of missing data are discarded from the original datasets in order to obtain more reliable results. There is a lot of reason that affects the accuracy of the data. Some of them are the location of the station, measurement tool and method. That's why data should be controlled. In this study, SNHT method, Buishand test, Pettitt test, and Von Neumann tests were used for testing the homogeneity. Alexanderson (1986) suggested the Standard Normal Homogeneity Test (SNHT) to determining to homogeneity in time series. SNHT perceive the inhomogeneous data in the beginning or ending the series. The Pettitt test is more sensitive to define to data (Dikbas et al,2010).

A. Homogeneity test

First, the stations were evaluated on a provincial basis, and then the results of the regions were drawn by taking the average of the provinces. Then, homogeneity tests which are Standard Normal Homogeneity test, Von Neumann test, Buishand Test, Pettit test were applied for all data sets. Data

sets exceeding 2 of 4 tests are accepted as homogeny as a result 44 stations data are passed at least 2 test so included calculations and other stations omitted.

Standard Normal Homogeneity Test

All 44 stations passed from standard homogeneity test.

Von Neumann Test

None of the 44 stations passed from Von Nuemann Homogeneity Test.

Buishand Test

12 for 44 passed Buishand test (4 stations in Marmara, 4 stations in Mediterranean, 1 station in Central Anatolia, 0 station in Eastern Anatolia, 1 station in Black Sea and 2 stations in Aegean.)

Pettitt Test

20 for 44 passed Pettitt test (6 stations in Marmara, 3 stations in Mediterranean, 1 station in Central Anatolia, 2 stations in Eastern Anatolia, 7 stations in the Black Sea and 1 station in Aegean.)

Equations

Normal standard test

$$T_v(k) = v(z_1)^2 + (n-v)(z_2)^2$$

$$\bar{z}_1 = \frac{1}{k}\sum_{i=1}^{k}(Y_i - \bar{Y})/s$$

$$\bar{z}_2 = \frac{1}{n-k}\sum_{i=k+1}^{n}(Y_i - \bar{Y})/s$$

$$R = \left(\max_{0\le k\le n} S_k^* - \min_{0\le k\le n} S_k^* \right) \Big/ s$$

Von Neumann Test

$$N = \sum_{i=1}^{n-1}(Y_i - Y_{i+1})^2 \Big/ \sum_{i=1}^{n}(Y_i - \bar{Y})^2$$

Buishand Test

$$S_k^* = \sum_{i=1}^{k}(Y_i - \bar{Y})$$

$$S_k^{**} = S_k^*/s$$

Pettitt Test

$$X_k = 2\sum_{i=1}^{k} r_1 - k(n+1)$$

Calculations

After the homogeneity tests suitable stations firstly locally then regionally added calculations for finding average ozone concentration values.

Visualization

Graphics and tables which is added research paper are made by using Microsoft Office Excel program. and maps are made by using Google Earth pro

RESULTS

According to WHO, it is determined that maximum ozone concentration that 8-hour mean level for creating any dangerous conditions for human health and ecosystem is 120 microgram/cubic meters (Table 1) Data analysis on Turkey in this study showed that maximum mean ozone level is 83,885 microgram / cubic meters on Balikesir / TURKEY. When investigating the topographic characteristic, urban situation and meteorological parameters of Balikesir it is stated that this city is affected by both seas Marmara and Aegean. Elevation of the city is 145 meters but the city is surrounded by mountains too.

For the general situation of Turkey, it is a comment that ozone level of Turkey is good and not harmful for human and nature. In Marmara regions sometimes O3 concentrations can cross the standard level

in summer season and it can be dangerous. On the other hand, in this study, it is used that arithmetic mean formula and peak values are ignored for obtained more reliable results.

Besides, when it is examined on a monthly basis, it is clear that the ozone level is generally more on summer months ,and on winter months ozone level is low. The main effect of this difference is the seasonal change of radiation duration in Turkey. In summer radiation is increasing so ozone concentration increased too (Compare Figure 3 and Figure 4).

Moreover, it is clear that regional average ozone concentration in Marmora and Central Anatolia are greater than other months, on the other hand, Mediterranean and Black Sea region have least ozone pollution (Figure 5).

In Marmara region, Sakarya and Duzce have fewer ozone concentration levels than others. In addition, because of the fact that amounts of urbanization and usage of vehicles in Marmara Region are more than the other regions in Turkey, it can be seen that the level of ozone concentration is more and the ozone pollution increase in Marmara Region (Figure 6).

In Aegean region, both cities have nearly same sunshine duration but on the other hand NOX concentration of İzmir is extremely higher than Manisa (Figure 12) so this situation creates a huge difference and Izmir has extremely more ozone level than Manisa (Figure 7).

In the Black Sea region, Trabzon has the cleanest air in against to region average because of the low ozone pollution. Also, it can be seen that Artvin, Corum, Gumushane, Karabuk, and Samsun have similar ozone rates with each other(Figure8).

In Central Anatolia, there are a huge differences between Ankara and Kirsehir so it is obvious that this situation results because of Ankara is metropolitan city which has a high population(Figure9).

In the Mediterranean region only two city ozone data are existed so compared with Isparta, Adana has more high-quality air conditions(Figure10).

Finally, in the Eastern Anatolia Region, Igdir has more ozone pollution than others. Compared with Igdir, Erzurum and Erzincan have more ozone-free atmosphere and they have similar values(Figure11).

Table 1. Standard Levels of Pollutants, retrieved from: Web-1

		Air Quality Directive		WHO guidelines	
Pollutant	**Averaging period**	**Objective and legal nature and concentration**	**Comments**	**Concentration**	**Comments**
$PM_{2.5}$	One day			25 µg/m³ (*)	99th percentile (3 days/year)
$PM_{2.5}$	Calendar year	Target value, 25 µg/m³	The target value has become a limit value since 1 January 2015	10 µg/m³	
PM_{10}	One day	Limit value, 50 µg/m³	Not to be exceeded on more than 35 days per year.	50 µg/m³ (*)	99th percentile (3 days/year)
PM_{10}	Calendar year	Limit value, 40 µg/m³ (*)		20 µg/m³	
O_3	Maximum daily 8-hour mean	Target value, 120 µg/m³	Not to be exceeded on more than 25 days per year, averaged over three years	100 µg/m³	
NO_2	One hour	Limit value, 200 µg/m³ (*)	Not to be exceeded more than 18 times a calendar year	200 µg/m³ (*)	
NO_2	Calendar year	Limit value, 40 µg/m³		40 µg/m³	

When the regions are analysed according to the arithmetic mean, standard deviation, and their homogeneity situation, Marmara Region has highest ozone level since the region contains the most amount of the country population (See in Figure 3.), organized industrial zones and numbers of motor vehicles.

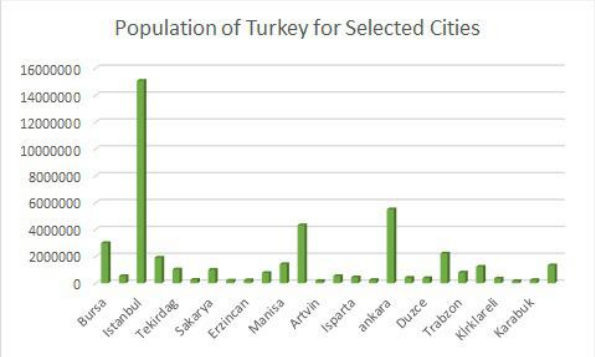

Figure 2. Population of Selected Cities in Turkey, retrieved from: Web-2

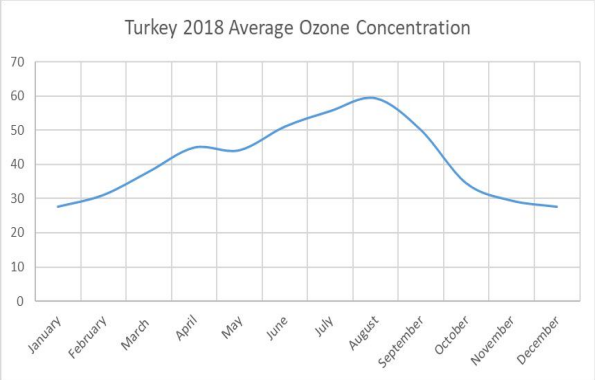

Figure 3. Monthly Turkey Ozone Levels

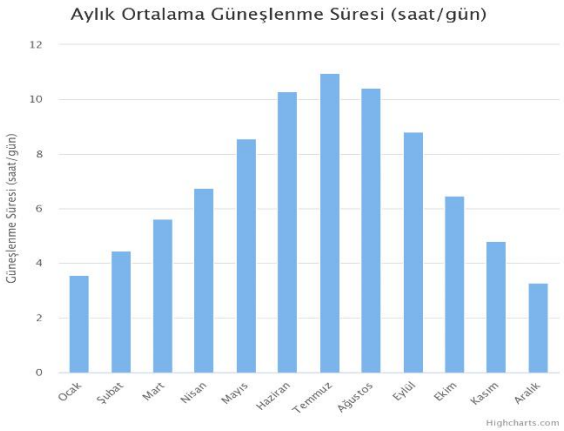

Figure 4. Average radiation duration for months in Turkey, retrieved from: Web-3

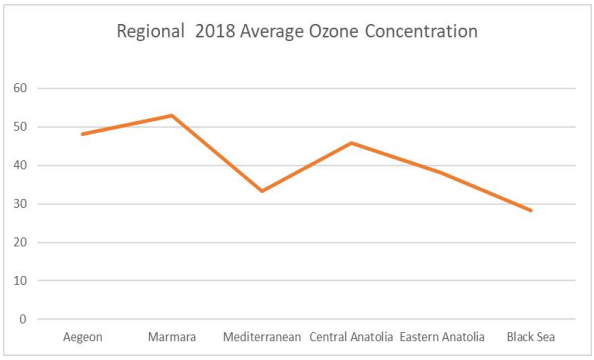

Figure 5. Regional average ozone levels of Turkey

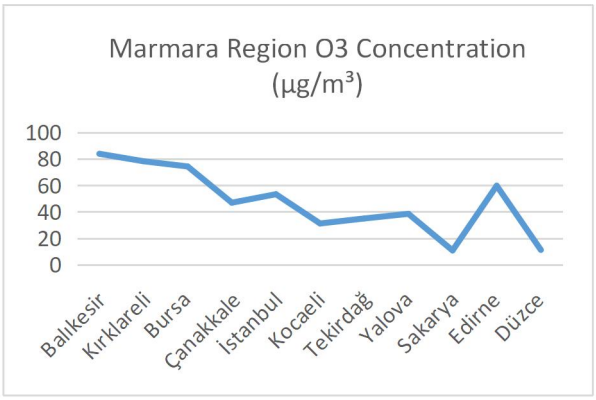

Figure 6. Marmara Region O3 Concentration (µg/m³)

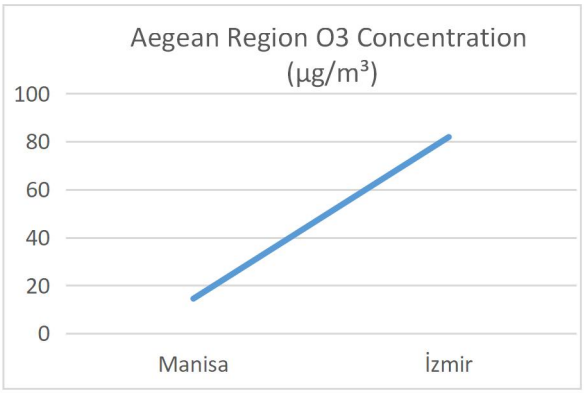

Figure 7. Aegean Region O3 Concentration (µg/m³)

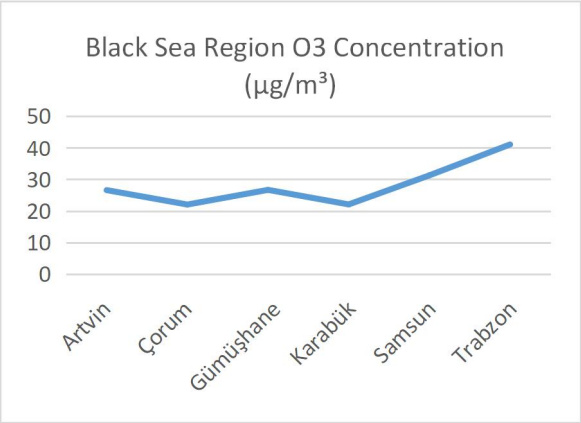

Figure 8. Black Sea Region O3 Concentration (µg/m³)

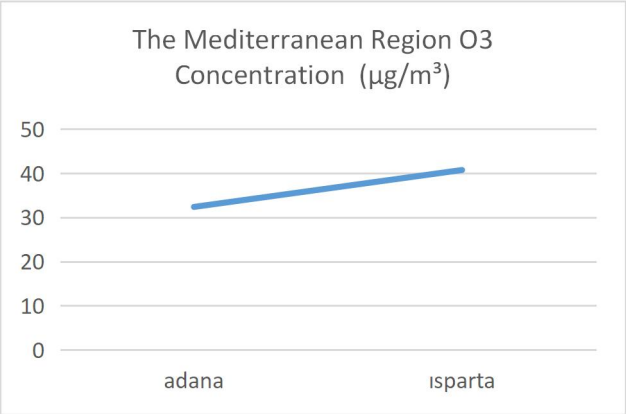

Figure 10. Mediterranean Region O3 Concentration (µg/m³)

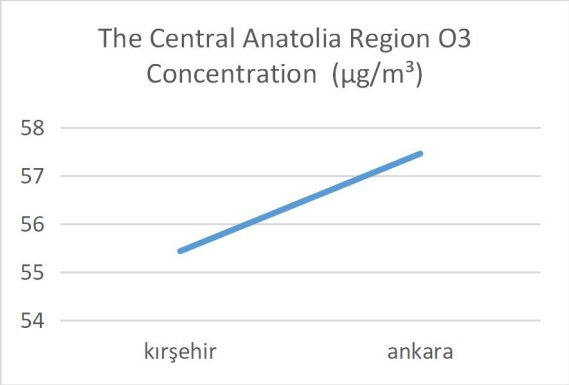

Figure 9. Central Anatolia Region O3 Concentration (µg/m³)

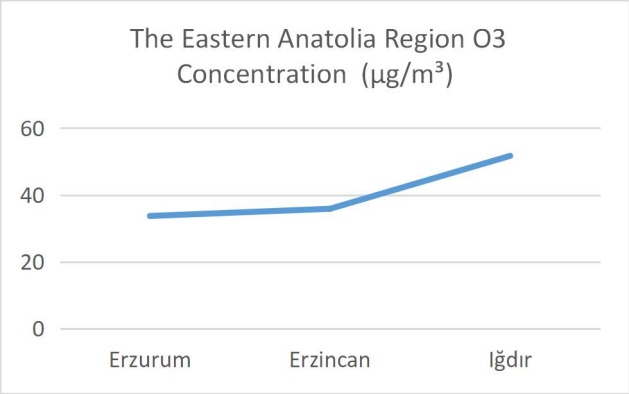

Figure 11. The Eastern Anatolia Region O3 Concentration (µg/m³)

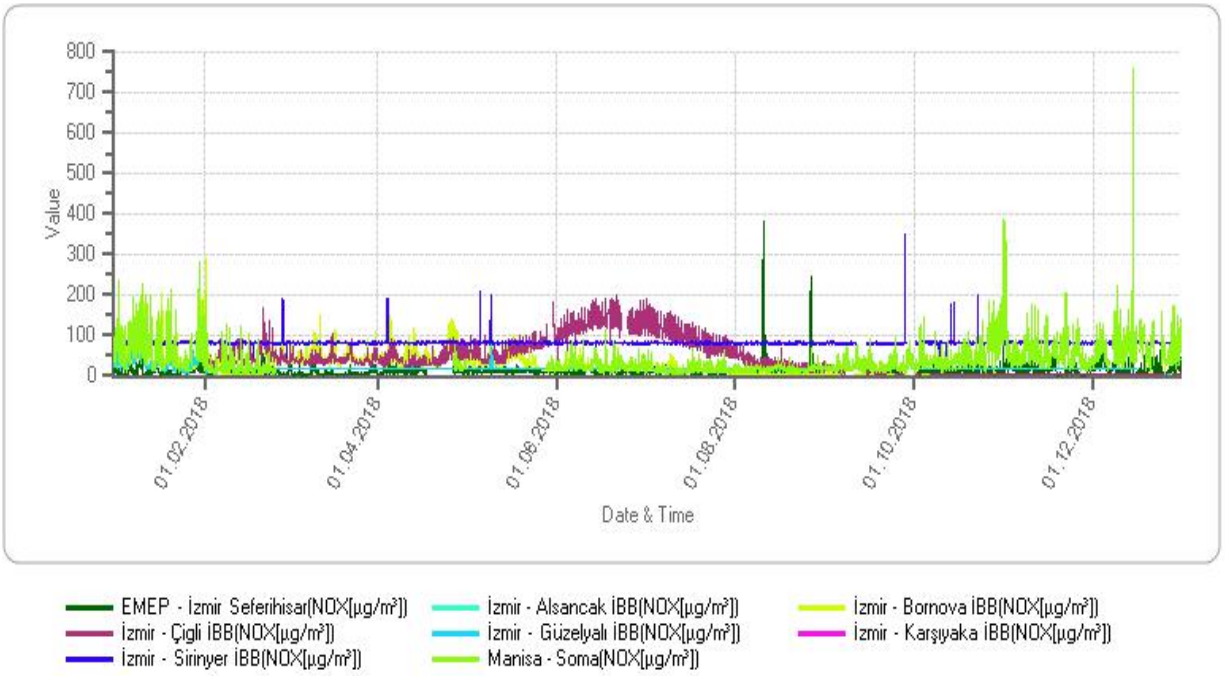

Figure 12. The total NOX concentration of Aegean region at 2018 (µg/m³)

CONCLUSION

The analyses presented in this article include the concentrations of O3 obtained in Turkey. The main objective of this study is to show how effects ozone to air pollution. Besides, because of the effects of temperature to the ozone level, in summer months O3 amount is bigger than others. In Marmara Region; the average ozone concentration 53,023 µg/m³. In Aegean Region; the ozone concentration values are 48,181 µg/m³. In Black Sea Region; 28,265 µg/m³. In Mediterranean Region; 33,388 µg/m³. In Central Anatolia; 45,774 µg/m³. In Eastern Anatolia Region 38,212 µg/m³. The results indicate that O3 concentration is more in Marmara and Central Anatolia regions. The work presented here is a to the pollution limit, Mediterranean Region and Black Sea Region are very good; therefore, these regions have clean air in terms of ozone level. Marmara Region, Aegean Region, Central Anatolia Region, and Eastern Anatolia Region have clean air, too.

ACKNOWLEDGEMENTS

The authors are grateful to Ministry of Environment and Urbanism of Turkey for the air quality data.

REFERENCES

Bozkurt, Z., Üzmez, Ö. Ö., Döğeroğlu, T., Artun, G., & Gaga, E. O. (2018). Atmospheric concentrations of SO2, NO2, ozone and VOCs in Düzce, Turkey using passive air samplers: Sources, spatial and seasonal variations and health risk estimation. *Atmospheric Pollution Research*, *9*(6), 1146–1156. https://doi.org/10.1016/j.apr.2018.05.001

İm, U., Tayanç, M., & Yenigün, O. (2006). Analysis of major photochemical pollutants with meteorological factors for high ozone days in Istanbul, Turkey. *Water, Air, and Soil Pollution*, *175*(1–4), 335–359. https://doi.org/10.1007/s11270-006-9142-x

Çerçi, G. (2006). Türkiye'deki meteoroloji istasyonlarının yağış ve sıcaklık verilerinin homojenlik testleri. Istanbul, Turkey.

European Environment Agency. (2019, February 18). Retrieved from https://www.eea.europa.eu/themes/air/air-quality-standards

Nikolova, Nina & Mintcheva, Neli. (2018). Evaluation of Ozone Concentration in Sofia, Bulgaria. Aerul şi Apa: Componente ale Mediului. 2018. 229-238. 10.24193/AWC2018_27.

T.C. Çevre ve Şehircilik Bakanlığı. (2018). Retrieved from http://mobil.havaizleme.gov.tr/Default.ltr.aspx

Dikbas, F., Firat, M., Koc, A. C., & Gungor, M. (2010). Homogeneity Test for Turkish Temperature Series. *Balwois*, *25*(8), 1–5.

Web-1: https://www.eea.europa.eu/themes/air/air-quality-standards

Web-2 :http://www.tuik.gov.tr/Start.do

Web-3 : https://www.mgm.gov.tr/tahmin/mevsimlik-tahmin.aspx