

## TÜRKİYE

### OBSERVATIONAL ACTIVITIES

Ozone measurements were made by Brewer Spectrophotometer in Ankara.

#### Column Measurements of Ozone and Other Gases/Variables Relevant to Ozone Loss

##### Brewer Spectrophotometer

Station	Instrument	Institution	Latitude	Longitude	Start date of observation
Ankara	Brewer MKIII-188	TSMS	39° 57' (N)	32° 53' (E)	Sep.,2006 to 2018

Brewer spectrophotometer is deployed on a solar azimuth tracker, which allows daily automatic measurements of total ozone, zenith sky and direct sun in Ankara station, which is the component of WMO-Global Atmosphere Watch Programme.

#### Profile Measurement of Ozone and Other Gases/Variables Relevant to Ozone Loss

##### Ozonesonde

Station	Instrument	Institution	Latitude	Longitude	Start date of observation
Ankara	Ozonesonde(ECC)	TSMS	39° 57' (N)	32° 53'(E)	Sep.,2006 to Marc 2013

Ozone profile measurements by TSMS Research Department in the method of ozonesonde between January 1994 and March 2013 was held in Ankara.

##### Spectroradiometers

Spectral UVB measurements (290-325 nm) were made with Brewer spectrophotometer #188 MK III at Ankara station between 09 September 2006 and 2018.

Station	Instrument	Institution	Latitude	Longitude	Start date of observation
Ankara	Brewer MKIII-188	TSMS	39° 57' (N)	32° 53'(E)	Sep.2006 to 2018

## Calibration Activities

Calibration of Brewer Spectrophotometer #188 had performed from it was installed in 2006 to 2018. First Brewer S. calibration was carried out by International Ozone Services Inc. (IOS) which provides worldwide ozone and UV calibration services to customers with Brewer Ozone Spectrophotometer instruments. IOS used Brewer Ozone Spectrophotometer #017 as a reference instrument on 07–12 October 2008 in Ankara station.



**Figure 2.** First calibration of Brewer MKIII #188 with the reference Brewer MKIV #017 in Ankara station.



**Figure 3.** Second calibration of Brewer MKIII #188 with the reference Brewer MKIII #158 in Ankara station.

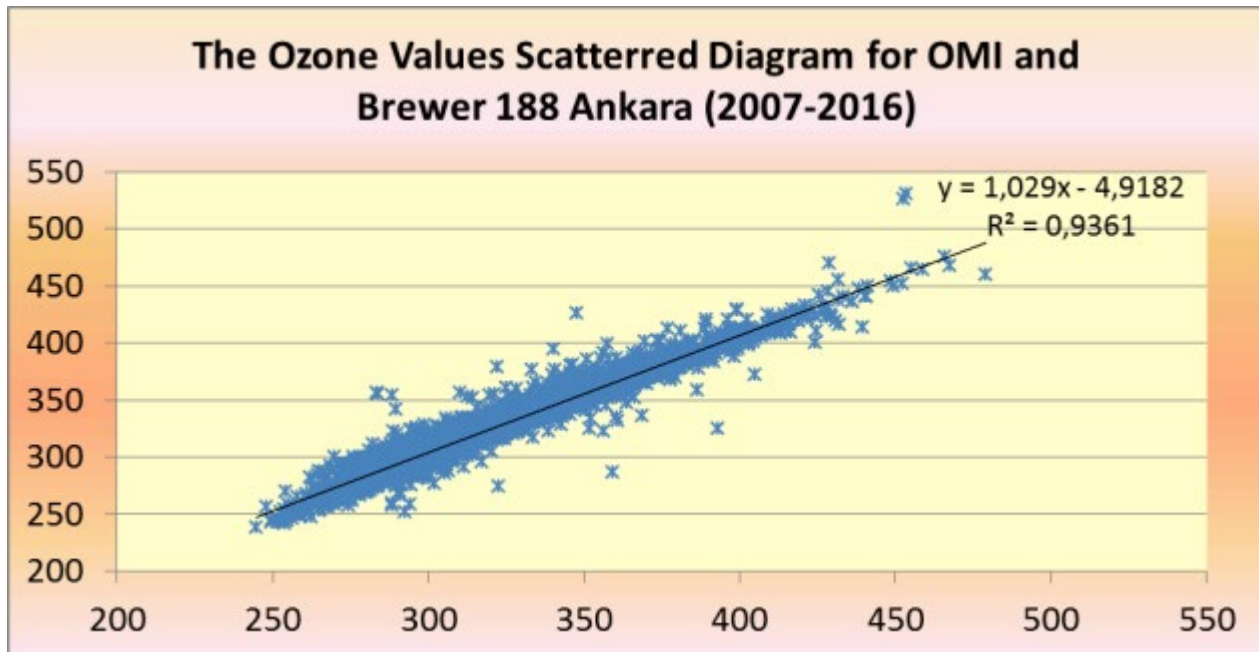


**Figure 4.** Third calibration of Brewer MKIII #188 with the reference Brewer MKIII #158 in Ankara station.

Second calibration of Brewer S. #188 was carried out from 22 to 29 September in 2010 and Kipp& Zonen carried out Third calibration of Brewer S. #188 from 23 to 27 September in 2013. Kipp& Zonen used Brewer Ozone Spectrophotometer #158 as a reference instrument during calibration in Ankara station.

## RESULTS FROM OBSERVATIONS AND ANALYSIS

### Brewer Ozone Variability over Ankara, Comparison Between OMI and Brewer Ozone Measurements for Ankara (2007-2016)



**Figure 5.** Comparison of OMI from NASA Aura Satellite with the total ozone measurements of Brewer S. #188 for 01 January 2007 and 31 December 2016 period.

In figure 5, relationship between total ozone measurements of Brewer #188 and OMI\_TOMS observed total ozone data from satellite indicates high correlation. Correlation coefficient is  $R=0,96$  and  $R^2 =0,9361$ .

### Türkiye's Total Ozone Satellite (TOMS-OMI) Data Assessment for Long Period (1979- 2016)

TOMS-OMI satellite ozone data used in this study is selected from the global data set which is in <http://ozoneaq.gsfc.nasa.gov/> NASA's web address. Data is range Türkiye's 25 ° - 45 ° East Longitude and 34 ° - 42 ° North Latitude, data resolution is 1°x1.25° and data grid consists of 82 points.

Data time range covers from 1979 to 2016 (37 years). The data set which is consist of total 3034 data and is belong to Türkiye domain. 984 of data are used for monthly comparison and 328 of data are used for seasonal comparison.

Average total ozone value has been found in 316 DU from data set which is used in mapping. The lowest average value is 291 DU in point 37 °N and 44 °E in 1993. The highest average value is 351 DU in point 42°N and 28°E in 1991.

The average total ozone is approximately 305 DU at Türkiye's southern latitudes and in northern latitudes is approximately 330 DU. The average total ozone difference is also 25 DU between the northern and southern latitudes in Türkiye.

## SATELLITE DATA AND ANALYSIS

Satellite data has been used in the analysis to address the lack of data caused by the device failure and to ensure continuity of the annual ozone assessment reports. The satellite planned to be used was the one that had been investigated and had a statistically strong relationship between the data from the ground-based observation system and the satellites' data.

In terms of the continuity of ground-based observation analyses, the daily data on the grid number representing Ankara in the OMI global ozone data set from the satellite data were obtained from the <https://ozonewatch.gsfc.nasa.gov> NASA's website.

### Satellites Data

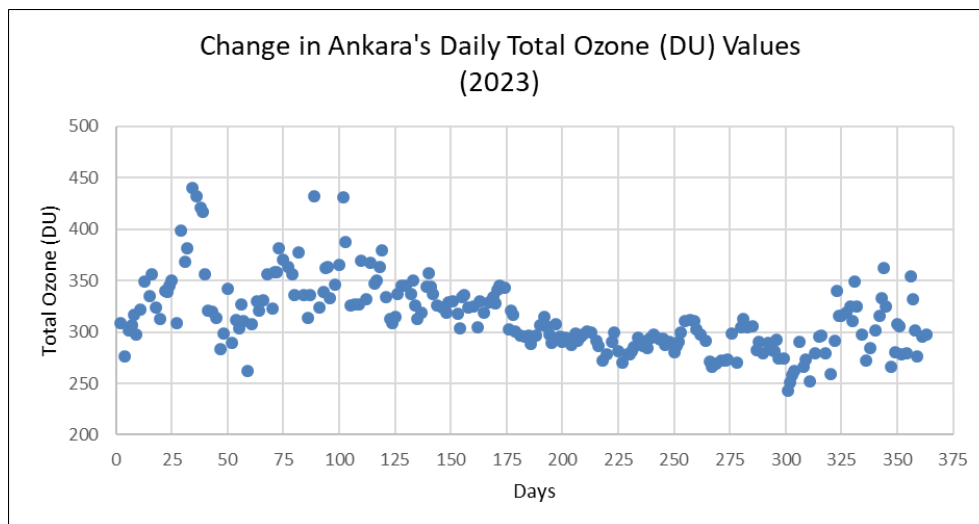
Station	Instrument	Institution	Latitude	Longitude	Start date of usage
Ankara	Aura/OMI	NASA	39° 57' (N)	32° 53'(E)	2018 to present

The total daily ozone data for Ankara, covering one year, has an extension resolution of 0.25°x0.25° with the abbreviation OMT03E. More detailed information on the satellite and the sensor can be found on the NASA website <https://aura.gsfc.nasa.gov/omi.html>.

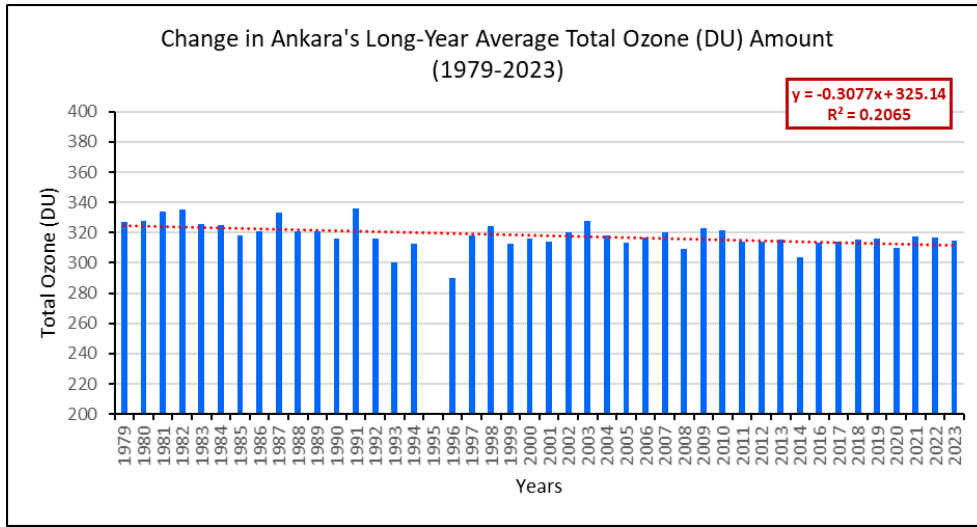
Annual reports on the daily amount of ozone data obtained from the satellite include daily, monthly, seasonal and multi-year changes.

Ankara's total daily ozone values for 2023:

- highest at 439.7 DU on 03.02.2023;
- lowest at 242.9 DU on 28.10.2022;
- Annual average at 314.9 DU.



**Figure 6.** Change in daily Total Ozone values in 2023.



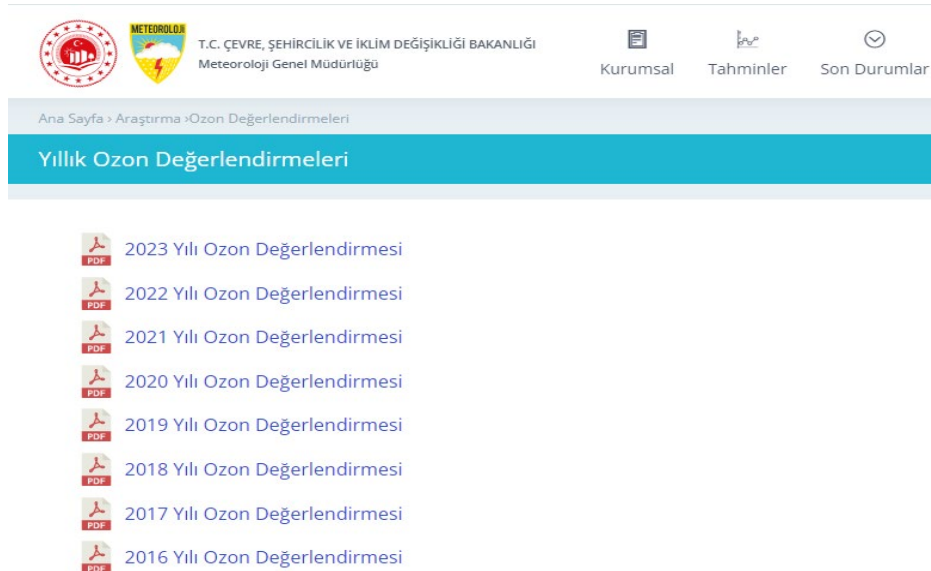
**Figure 7.** Change in long-year average Total Ozone (1979-2023).

According to Ankara's TOMS-OMI satellite ozone data between 1979 and 2023, there is a declining trend in the time series graph of annual total ozone averages. This decline is estimated to be approximately 0.31 DU per annum, while the Regression Rate ( $R^2$ ) = 0.207 is statistically irrelevant.

## DISSEMINATION OF RESULTS

### Information to the Public

The annual assessments are published through the official Turkish Meteorological Service website. (<https://www.mgm.gov.tr/iklim/ozondegerlendirme.aspx>)



**Figure 8.** The annual assessments website.

## Relevant Scientific Papers

- 1- Bari D.D., Topcu S., Aksoy B., Kahya C., Incecik S., Acar Y., Ozunlu M., Ekici M., **“A Study Of Daily Total Column Ozone Forecasting Based On Toms Data And Meteorology”**. Perugia, Italy. (IUGG), 2007.
- 2- B. Aksoy, S. Incecik, S. Topcu, D. Demirhan Bari, C. Kahya, Y. Acar, M.Ozunlu, M. **Ekinci “Total ozone over Ankara and its forecasting using regression models”**, International Journal of Remote Sensing, Vol. 30, Issue 17, 2009, pages 4387-4400.
- 3- Topcu, S., D. Demirhan Bari, C. Kahya, S. Incecik, Y. Acar, **“Climatology of erythemal UV radiation in Ankara, Türkiye”**, Asia Oceania Geosciences Society (AOGS),6<sup>th</sup> Annual Meeting, Singapore, 11.08.2009-15.08.2009).
- 4- Topcu, S., D. Demirhan Bari, C. Kahya, S. Incecik, Y. Acar, **“Ankara’nın Erythemal UV radyasyon klimatolojisi”**, Asya Okyanus Yerbilimleri Topluluğu (AOGS), Singapur, Ağustos, 10-15 2009.
- 5- Demirhan Bari D, Kahya C, Topcu S., Incecik S., Aksoy B, Acar Y., Ozunlu M., Ekici M, **“Estimating of Daily Erythemal UV Irradiation in Ankara, Türkiye with an Empirical Model,”**, 2009, Quadrennial Ozone Symposium (QOS), Tromsø, Norway, 29.06.2009 - 05.07.2009.
- 6- Acar, Y., Ekici, M., **“Ankara’nın Brewer Eritemal UV (EUV) Ölçüm Verileri İle Model Eritemal UV (EUV) Tahmin Verilerinin Karşılaştırması”** (Makale-1.Meteoroloji Sempozyumu), 2010.
- 7- Ekici, M., Acar, Y., **“Ankara İçin Brewer Spektrofotometre ve OMI Uydu Toplam Ozon Verilerinin Karşılaştırması”** (Makale,1.Meteoroloji Sempozyumu), 2010.
- 8- Acar, Y., Ekici, M, Yağan, S., Akçakaya, A., **“Brewer Spektrofotometresi (188) Ozon Profil Verilerine Göre Ankara Üzerindeki Ozonun Dikey Dağılımı”**, MGM, Teknik Rapor, Şubat 2013, Ankara, Türkiye.
- 9- Mithat EKİCİ, Osman ESKİOĞLU, Yılmaz AÇAR, Mesut DEMİRCAN, Alper AKÇAKAYA, **“Toms ve OMI Uydu Türkiye Ozon Verilerinin CBS Ürünleriyle Analizi (1979-2012)”**, III. İklim Değişikliği Kongresi, TİKDEK 2013, İstanbul, 3-5 Haziran 2013.
- 10- Yılmaz AÇAR, Serpil YAĞAN, Mithat EKİCİ, Salim ERSOY, Alper AKÇAKAYA, Osman ESKİOĞLU, **“Türkiye Üzerine Gelen Hava Kütlelerinin Ankara’nın Toplam Ozon Kalınlığı Üzerine Etkisi”**, III. İklim Değişikliği Kongresi, TİKDEK 2013, İstanbul, 3-5 Haziran 2013.
- 11- Ekici, M., **“Brewer Ozone Variability Over Ankara And Comparison Between OMI And Brewer Ozone Measurements For Ankara (2007-2013)”** COST Action ES1207 EUBREWNET Open Congress/14TH WMO-GAW Brewer Users Group Meeting, Tenerife / SPAIN, 25-28 March 2014.
- 12 - Ekici,M., Eskioğlu, O., Acar, Y. **“Toms ve Omi Uydu Türkiye Ozon Verileri Analizi (1979-2015) ve Ankara Brewer Spektrofotometre Ozon Verileri (2006-2015) ile Karşılaştırması”** II. Meteorolojik Uzaktan Algılama Sempozyumu 3-5 Kasım 2015 Antalya.

## FUTURE PLANS

- to study on interactions between stratospheric ozone and climate change.
- to contribute to ozone assessments by sharing information.
- to seek for research at the European level implemented through the Framework Programmes for research and technological development (FPs)of European Commission.
- to participate seminars, conferences and meetings related with global ozone research and international monitoring programme.