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BY

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Thirty years of total ozone measure at Tamanrasset (Algeria)

Abstract:

the Global Atmosphere (GAW) initiated in early 1994 between the National Meteorological Office (ONM) and the World Meteorological Organization (Geneva) WMO.

The GAW measurement program in the region is divided between the two sites:

Tamanrasset City and Assekrem (50 km north of Tamanrasset). This last station was carried out in 1996 especially for GAW measurements and in operation since March 1997.

The program of measurements carried out in these two sites is:

1- Tamanrasset town

Ozone Total ,Solar and Atmospheric Radiation, Optical thickness (AOD)

2- Assekrem

Surface ozone (tropospheric ozone),Carbon monoxide and Greenhouse gases (GHG)

1- OZONE MONITORING ACTIVITIES

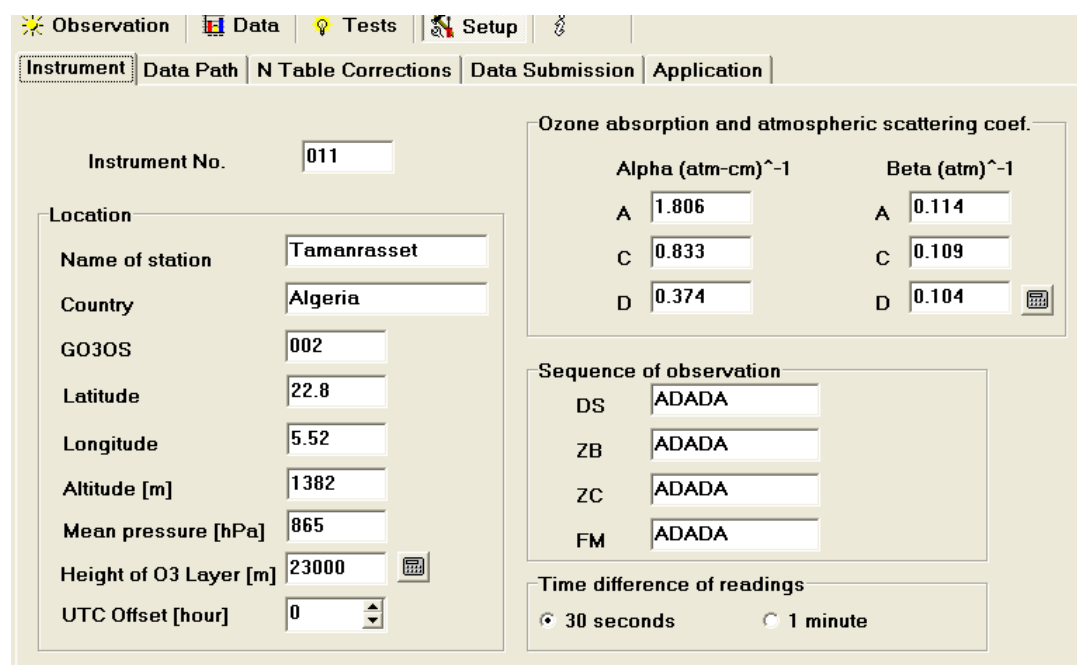
Tamanrasset, given its geographical location and its high altitude, is considered a site for measuring pollution and the chemical composition of the atmosphere on a global scale, which is why it is integrated into the network of GAW stations.

1.1 The History of Total Ozone Measurements

In April 1994, the Dobson spectrophotometer No.11 is installed at Tamanrasset, This equipment is one of the oldest devices in the DOBSON series., after its transfer from the University of Bordeaux (France), was calibrated four times abroad as part of regional campaigns organized by the WMO:

- In 1993 at the CMDL laboratory in Boulder (United States).
- In March 2000 in Pretoria (South Africa)
- In March 2004 in Dahab (Egypt).
- In September 2017 in El Arenosilo (Spain).

1.2 Tamanrasset information:



Observation | Data | Tests | Setup

Instrument | Data Path | N Table Corrections | Data Submission | Application

Instrument No. 011

Location

Name of station: Tamanrasset

Country: Algeria

GO3OS: 002

Latitude: 22.8

Longitude: 5.52

Altitude [m]: 1382

Mean pressure [hPa]: 865

Height of O3 Layer [m]: 23000

UTC Offset [hour]: 0

Ozone absorption and atmospheric scattering coef.

Alpha (atm-cm) ⁻¹		Beta (atm) ⁻¹	
A	1.806	A	0.114
C	0.833	C	0.109
D	0.374	D	0.104

Sequence of observation

DS	ADADA
ZB	ADADA
ZC	ADADA
FM	ADADA

Time difference of readings

30 seconds 1 minute

1.3 OZONE MEASUREMENTS:

The Total ozone is measured using the Dobson #11 spectrophotometer. Manual observation consists of carrying out two kinds of observations, of the direct sun (DS) and of the zenith sky (ZB) or cloud (ZC). The measurement of the direct sun which makes it possible to have the thickness of the ozone layer can be carried out in the presence of clouds around the sun provided that the shadow is apparent since the extinction of ultraviolet radiation by the thin clouds which is very minimal. The first (DS) allows us to have the thickness of the ozone layer directly and the second (ZB or ZC) to establish in the future (long series of data) a statistical relationship making it possible to catch the ozone column directly from the observation of the zenith in the case of gaps.

Direct measurements can be carried out in the presence of clouds around the sun provided that the sun is not hidden and the shadow is apparent.

These manual observations are taken daily for Three times. The time of measurement depends on the season and the height of the sun, observation should be carried out when the sun is slightly elevated and far from the zenith. In Tamanrasset, measurements are taken on average at the following times:

	Morning	Around Noon	Afternoon
Winter	09h10 to 10h00	12h00 to 12h15	14h00 to 14h15
Summer	09h00 to 09h30	12h00 to 12h45	15h00 to 15h30

Tab1: Total ozone measurement schedules

All ozone data are monthly submitted to WOUDC (World Ozone and Ultra violet Radiation Data Centre) in Toronto, Canada

An automatic measuring device which is the Brewer #201 (Mk III) has been put into operation since 2011, this instrument provides directly and continuously the thickness of the ozone layer.

The Tamanrasset spectrophotometer is part of a network of other instruments for continuous measurement of stratospheric ozone, mainly that of Spain, which is the country of cooperation led by the AEMET meteorological service. Tamanrasset Brewer #201 is now integrated into the Iberonesia network (www.iberonesia.net/brewer) managed by the RBCC-E center (www.rbcc-e.org) located at the IZANA atmospheric research center (AEMET- Spain).

2- Surface Ozone Measurements:

Assekrem site measures surface ozone outside urban regions, This program is carried out with the Swiss EMPA laboratory (Zurich)

Instrumentation. One ozone analyzer is currently installed at the station for continuous surface ozone measurements (TEI 49C). This instrument was provided as an in-kind contribution by Switzerland with financial support from WMO to replace the defective TEI 49 instrument. The instrumentation is adequate for its intended purpose.

3- Calibrations activities

The attainment of good precision and accuracy requires an instrument to be well maintained, calibrated regularly, and adjusted as necessary.

At the end of each month, an internal calibration of Dobson #11 is carried out to monitor the operating status of the device and to deduce any corrections that must be made to the calculation coefficients of the ozone column for the month. following. This verification essentially concerns the comparison of the mercury(Hg) lamp if it continues to deliver the appropriate wavelengths for the effective absorption of UVB and the standard lamp which controls the stability of the instrument respectively with the two standard lamps.

In general, the regional campaigns organized are organized every 4 to 6 years by WMO for adjustments and general checking of the instruments to possibly correct the measurement drifts and will ensure that the instrument is providing correct data

4- Collaboration international

- Ozone and related research are conducted sporadically within the country, mostly at a few academic institutions such as Tamanrasset University, Oran University, Blida University and Meteorological Institute for formation and research in Oran.
- Algeria Meteorological Office must also acknowledge its many international collaborators with specific references to international programs as:
The World Meteorological Organization (WMO) for her support to attend international intercomparisons and training courses.
WOUDC, Toronto, Canada for the scientific cooperation.
- Twinning with the state Meteorological Agency of Spain (AEMET) for offering the Brewer training course.
- Bilateral cooperation between the INM (Spanish meteorology) and the ONM (Algeria), and in order to strengthen relations between the GAW stations of Tamanrasset and Izana (Canary Islands), the INM purchased and installed at the beginning of October 2006 a CIMEL photometer at the Tamanrasset station. This network is managed by NASA, the raw data are sent automatically by satellite.
- EMPA Suisse provide resources and opportunities for scientific and technical training, at and beyond the instrument-operation level, thereby allowing instrument operators and other scientific personnel in Tamanrasset and Assekrem(Algeria) to use their data, EMPA conducts a biennial system and performance audit of surface ozone and carbon monoxide at the global GAW station, Assekrem.

5- RESULTS ANALYSIS

Figure 1 below shows annual total column of ozone at Tamanrasset GAW station situated at an altitude of 1382m asl (Latitude: 22.8 N, Longitude: 05.52 E). The graph indicates a creasing trend of ozone from 1994 to 2023. The annual mean and standard deviation are 267.4 DU and 2.6 respectively.

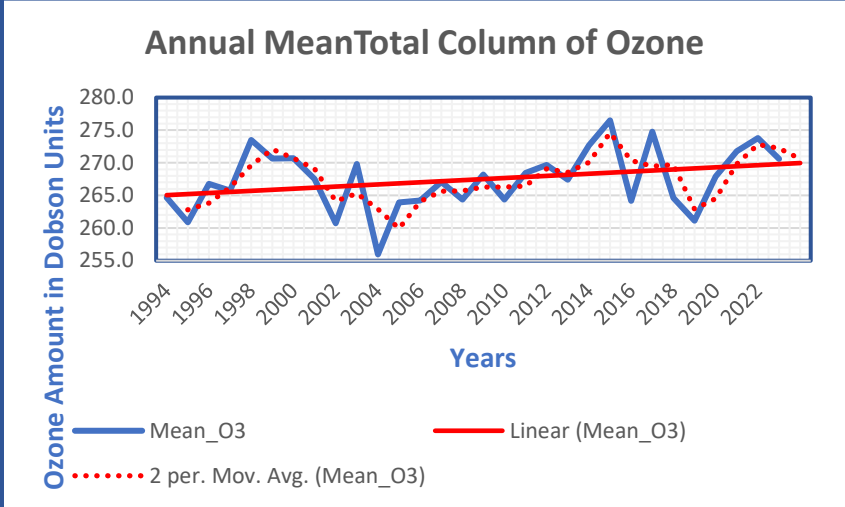


Fig.1: The annual Mean Total Column Of ozone at Tamanrasset, Algeria

The mean monthly total column of ozone is indicated in figure 2 below. The figure shows a seasonal variation of ozone. There is a very slight peak during the period of wind storms in March-May and a major peak in June -September period of monsoonal. Minimum values are realized in November-February with corresponding maximum values in June - August The mean monthly standard deviation is 2.6 D.U

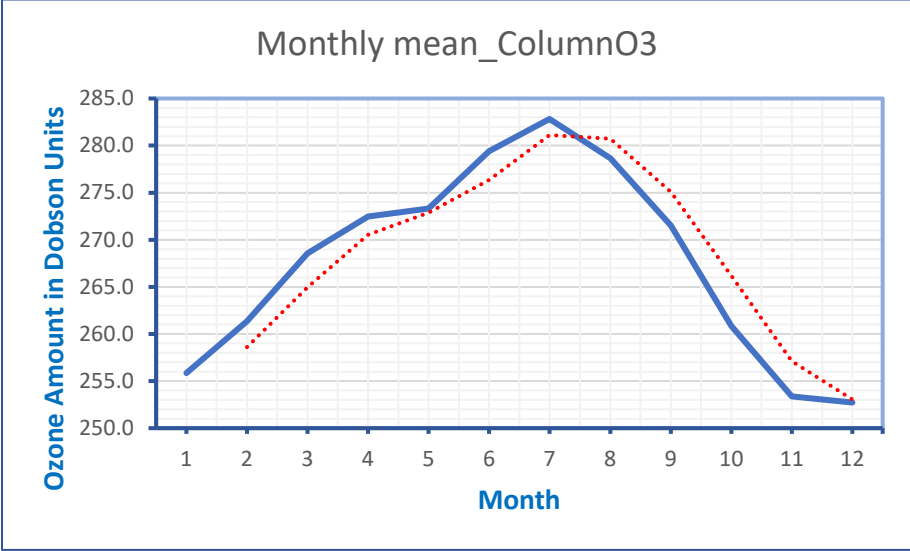


Fig.2: The Monthly Mean Total Column Of ozone at Tamanrasset, Algeria

The **Figure. 3** shows the daily mean observations where the lowest ozone layer thickness in Tamanrasset is 217 DU which is the equivalent of 2.2 mm, it was recorded on December 26, 2009. The absolute maximum is 334 DU, it was recorded on April 1 2015.

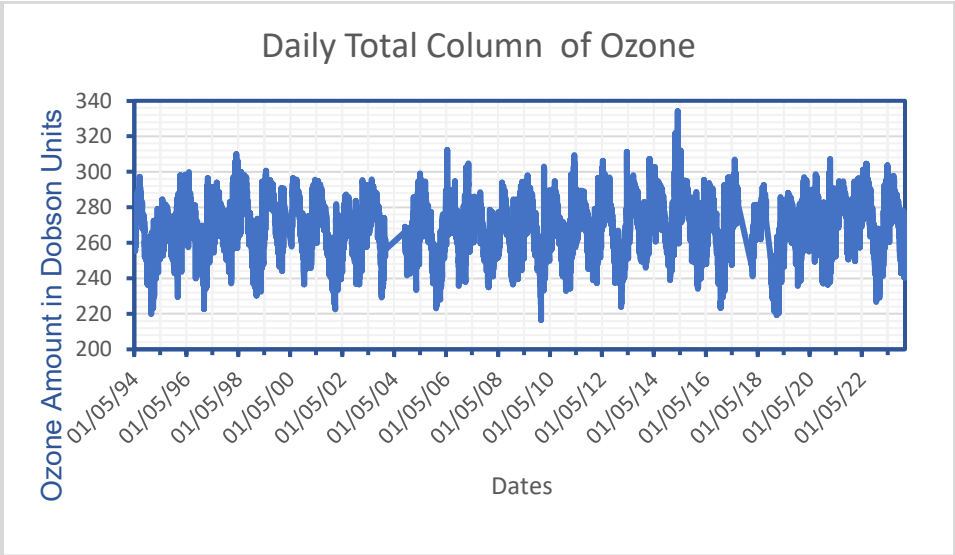


Fig.3: The Daily Total Column Of ozone at Tamanrasset, Algeria

The Tri-hourly observations of total ozone by Dobson #11 have been recorded since 1994 between the extreme minimal absolute thicknesses of 213.8 DU observed at 09:00 UT, it was recorded on December 26,2009 (**Fig.4**) and maximal absolute is 335.5DU, it was recorded on Avril 01th 2015(**Fig.5**). The ozone layer expands more at noon to a normal value of 267.4 DU which did not exceed the variation of plus or minus 2.6 DU throughout the measurements.

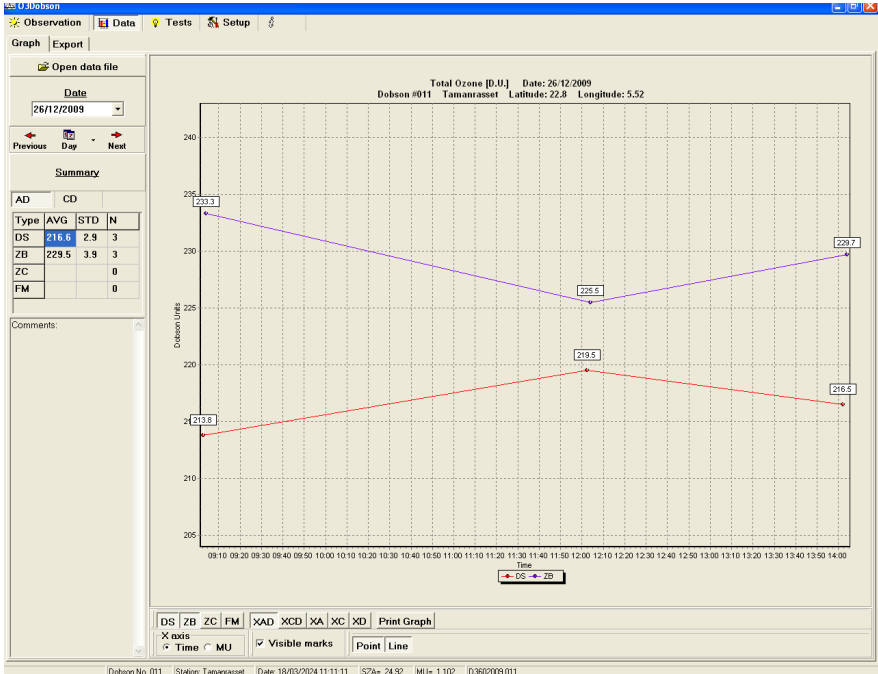


Fig.5: the extreme minimal absolute thicknesses observed in period 1994-2023

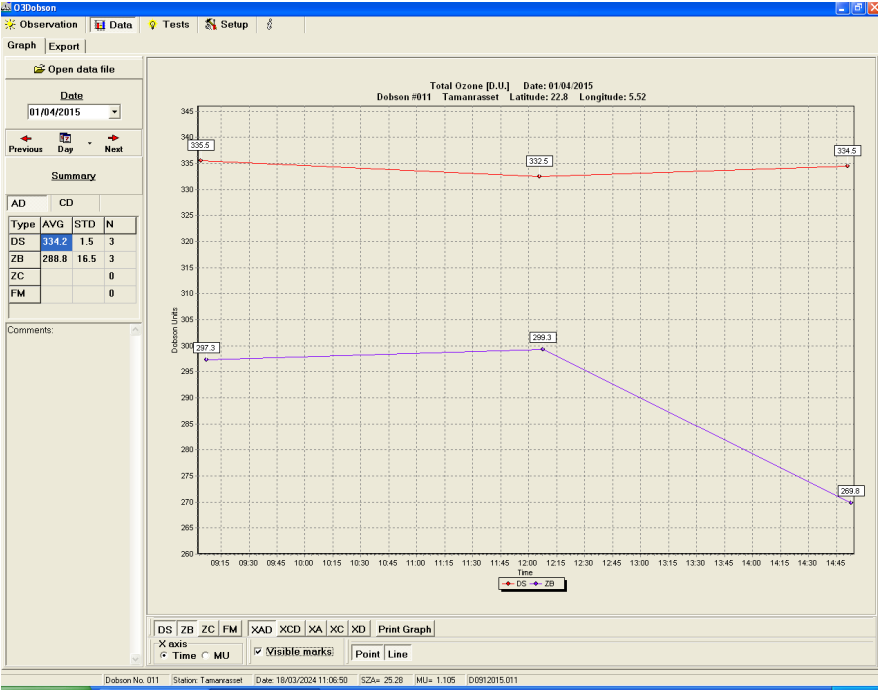


Fig.6: the extreme maximum absolute thicknesses observed in period 1994-2023

6- Conclusion

The processing of total ozone data in Tamanrasset since April 1994 shows that the ozone layer is relatively stable in this region from one year to the next. Measures show that total ozone undergoes a seasonal variation with maximums in the summer period from May to September of around 280 D.U (Dobson Units) and minimums during the winter period of 250 D.U.

The annual average of total ozone in Tamanrasset is 267 D.U, a value entirely within normal for a station located at 22° North latitude.

The years when the ozone layer was below normal during this period are 1995, 2004, 2015 and 2018

7-NEEDS AND RECOMMENDATIONS

- Providing a continued maintenance and calibration of instruments such as Dobson, and Brewer spectrophotometers with the support of WMO is important.
- Need to get financial support to start measuring ozone vertical distribution by ozonesonde in Tamanrasset air stations. Because it is very important to study the tropospheric ozone budget and its impact in climate change.
- Participate in a scientific research program for ozone and climate change modeling.

