BULGARIA

OBSERVATIONAL ACTIVITIES

One of the goal, outlined in the Recommendations of the last meeting of the Ozone Research Managers is the systematic measurements, which provide the basis for understanding the ozone regime, its trends and validation the effects of the measures requested by the Montreal Protocol.

Column measurements of ozone and other gases/variables relevant to ozone loss
In Bulgaria, the first total ozone measurements were initiated to the early 1960s, under the supervision of Prof. Dr. R. D. Bojkov. Germany carried them out using Dobson spectrophotometer # 64 provided for about 5 years. After a few years interruption Russian filter ozonometers started to be used in the Bulgarian National Institute of Meteorology and Hydrology. In 1998 with the financial support from WMO two Russians ozonometers M-124 were renovated and calibrated at Main Geophysical Observatory – St. Petersburg. The measurements at only one station (NIMH-Sofia) could be maintained (but experiencing technical problems because of the device age). Unfortunately in recent years these devices demonstrated a lot of measurement errors, which leaded to stop further measuremet with it.

Profile measurements of ozone and other gases/variables relevant to ozone loss
In the period 1983-1992, balloon ozone soundings were released once a week at the NIMH-Sofia. For that purpose were used ozonesondes OSE – manufactured in the former German Democratic Republic. The activities were interrupted largely due to financial difficulties resulting from transition to market economy. From May- 2001 a Vaisala DigiCORA III –a PC based radiosounding system for measuring pressure, temperature and humidity has replaced the Russian radiosounding system. The present financial status doesn't allow us to expand the measurements of the ozone vertical profiles with the above-mentioned Vaisala system, because of the expensive additional equipment (ozone sensors, special balloons, etc.).

UV measurements
At the present moment in NIMH we are not provide a modern spectral UV-radiation monitoring. Such kind of regular measurements are very desirable to be developed in our country, but again there is a shortage of funds.

Note: The NIMH experiences financial difficulties to buy modern equipment for measuring Ozone, ozone profiles, UV solar radiation, NOx profiles.

RESULTS FROM OBSERVATIONS AND ANALYSIS

The data, used for the study the total column ozone over Sofia are derived by " SCIAMACHY", which is an atmospheric sensor aboard the European satellite ENVISAT. The comparison between the monthly variations of the total column ozone over Sofia for 2006 and 2007 is presented at the next Fig.1.

A comparison for the monthly mean magnitudes over Sofia, Rome,Thessalonike for 2006 (derived by SCIAMACHY/ENVISAT) are presented at the further Fig.2.

At fig. 3 are presented the comparison for the monthly mean magnitudes of the total ozone (Sciamachy) over Sofia,Rome,Thessalonike and Turkey (Brewer) 2007. The author would like to acknowledge a favour to the colleagues from the Turkish MetOffice for the placing their Brewer data by 2007 at our disposal.

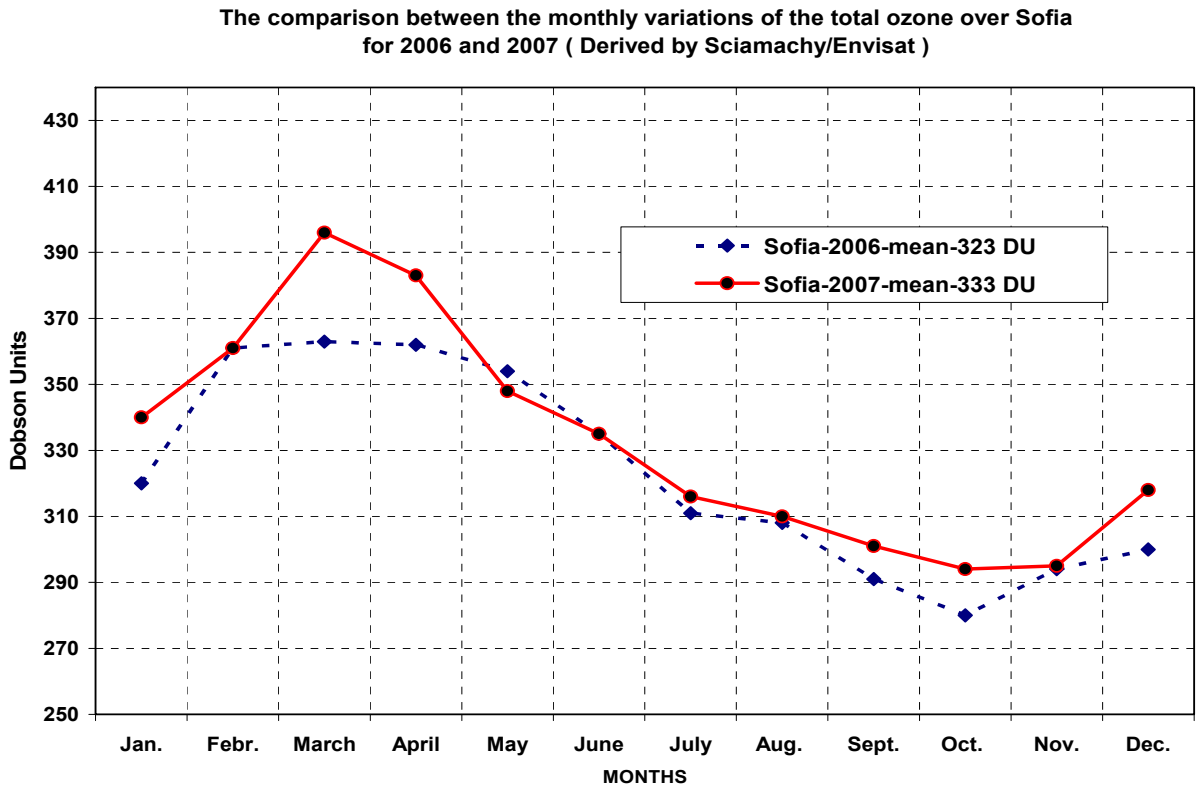

Fig.1

It is clear seen that during 2007, the mean value of the magnitudes of the total column ozone are increased.

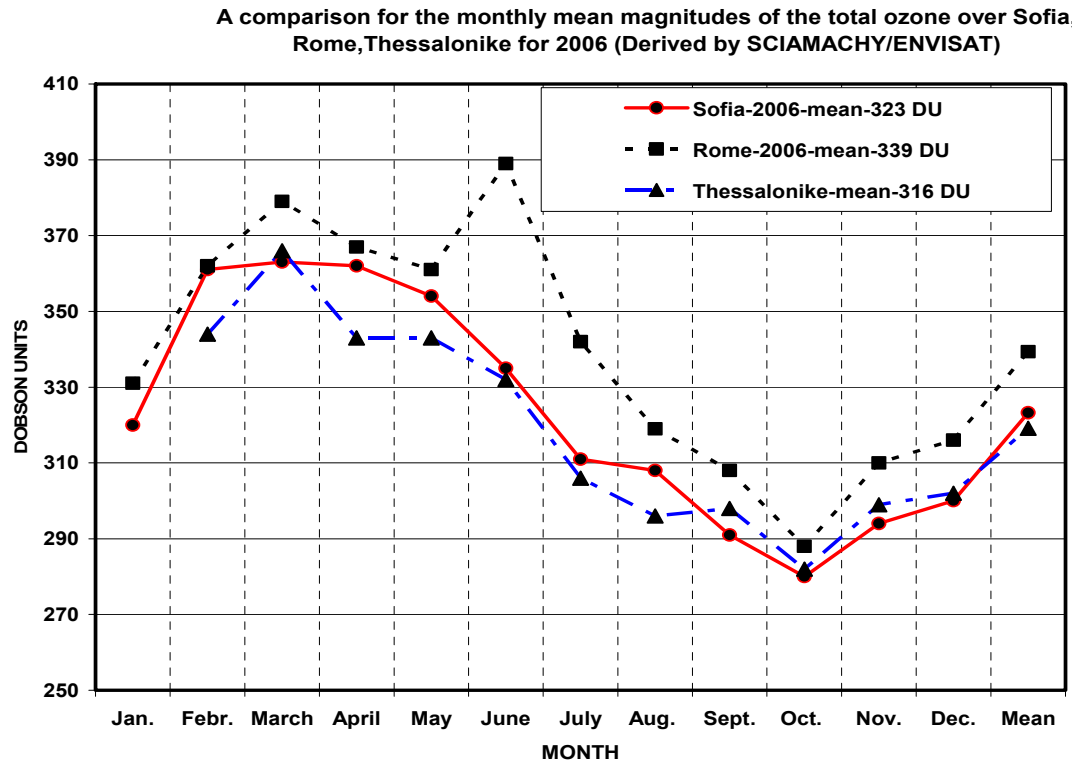

Fig.2

One can see that the annual run for Sofia is similar to those by Thessalonike in a great extend.

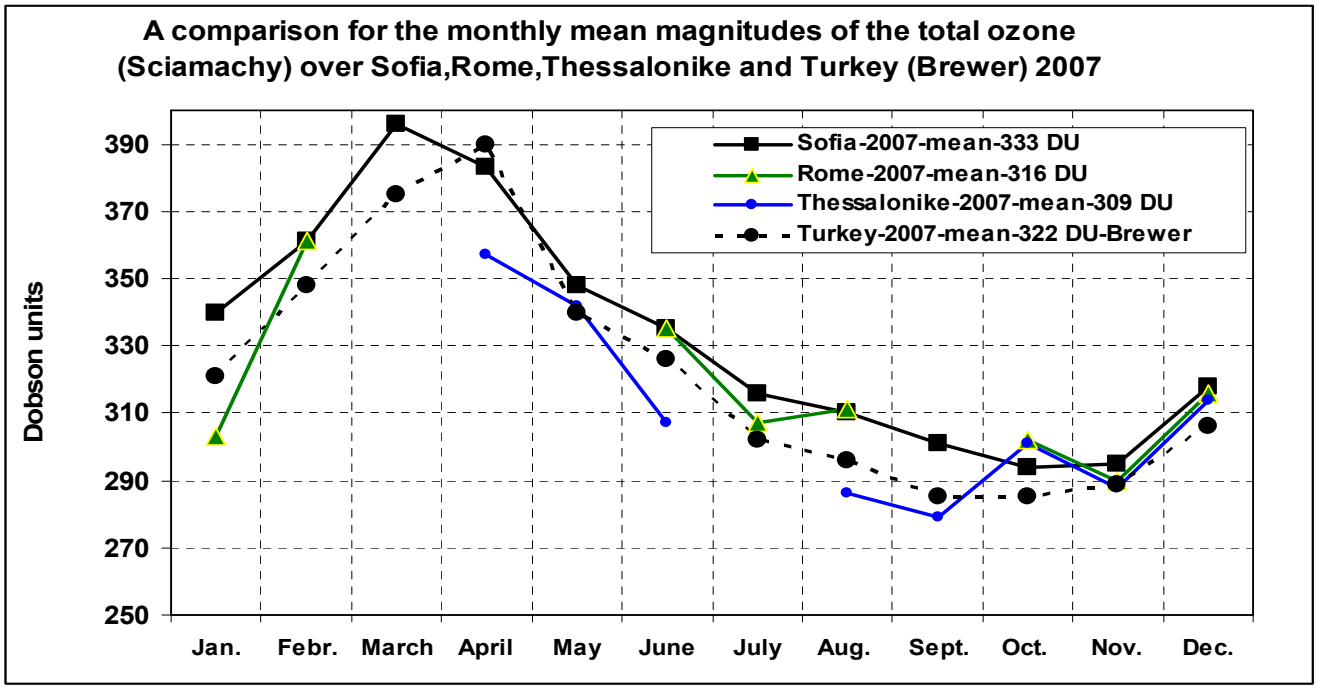

Fig.3

We are going to skip the detail analisys of the results. It is obvious that the annual run of the total column ozone magnitudes follow well their seasonal variations and latitude dependances.

Surface ozone

Another important topic is the surface ozone. Initial investigations of the surface ozone in Bulgaria began ten years ago. The following goals were pursued: to evaluate the surface ozone state in Sofia ; to ascertain the diurnal and seasonal ozone variations, ; to investigate ozone behaviour with respect to meteorological conditions.

Site description. The measurements were performed in Sofia, located in the western part of Bulgaria (42^{o} 49' N, 23^{o} 23' E, 530 m. a.s.l.). The observation site is about 7 km to southeast of Sofia center and possesses a ground cover of fairly well vegetation. At 100 m distance from the site the road of considerable car traffic runs. The ozone recorder was installed at height of about 10 m above the ground level.

Instrument. The ozone detector used in the investigations is chemiluminescent analyzer, model 3-02P1, OPTEC Inc. The measuring principle of the sensor is arisen in ozone presence chemiluminescence of an organic dye, adsorbed on the solid state composition. The ozone analyzer has the following characteristics: response time is no more than 1 s, the sensitivity is 2 µg/m3. Periodically, the analyzer was calibrated by using an external O3 generator.The measurements were performed mostly at the daylight hours and less regularly in twenty-four hour period. The analysis of the diurnal ozone variations is carried out by using the hourly values of the ozone concentrations determined as 15-min average.

Diurnal variations. The pattern of diurnal variations of the surface ozone concentrations is strongly influenced by meteorological conditions. The pronounced O3 maximum in the daytime, which is explained in terms of vertical mixing process and photochemical ozone production, occurred on clear windless afternoons.

The ozone data show a maximum in summer months, roughly three-four times higher that in winter months. During the fine windy weather the dilution of the atmospheric pollutants takes place. So the decreased ozone concentrations are detected and ozone level is approximately constant throughout the day. However, in the cases when vertical exchange is limited (autumn-winter

period, nocturnal inversions) the wind enhances the vertical mixing and increases the ozone content near the ground. The cloudiness strongly decreases the ozone concentrations near the ground but when it is foggy the ozone content is very low, often zero.

So, the ozone concentrations sensitively reflect meteorological conditions at which measurements are performed. It is very like that more realistic information about temporal and spatial ozone variations may be obtained if ozone data received at similar meteorological situations are analyzed. The surface ozone behavior clearly shows a seasonal variation with a summer maximum.

The variations are indicated by monthly mean, obtained by averaging clear and overcastted days mean concentrations. The minimal, 19-33 μg/m3 ozone concentrations were detected during winter period, the maximal, 50-90 μg/m3 ozone content near the ground was observed in summer months.

Only in windless days diurnal cycle of ozone concentrations displays pronounced maximum in the early afternoon (12:00-14:00 Local Time). The forcing of the wind with increased speed and the cloudiness decreases ozone pollution. Average summertime daylight means at site vary from 100 to 50 μg/m3, depending on meteorological circumstances.

The peak concentrations during photochemical episodes rarely exceeded 125 μg/m3 and are observed a several times during summer season.

It is considered that episodes with high surface ozone concentrations in southern Europe show local character and are associated with local primary pollutant emissions, but in western Europe summer smog is due to long-range transport of ozone and its precursors and so has transboundary character.

Summary :The experimental data from Sofia site and from other sites of Balkan peninsula (with the exception of Athens), for which information is available show that summer ozone concentrations (peak and average) have more lower values in comparison with those, measured in western and central Europe.

In general, the ozone pollution doesn't exceed the EU threshold values. The result is consistent with the model calculations, which show that in spite of the efficiency of the photochemical ozone production (the number O3 molecules per NOx molecule) is higher in southern Europe than in western Europe, the chemical ozone formation per unit area is more intensive in the western part of the Continent due to the high precursors concentrations.

DISSEMINATION OF RESULTS

Data reporting

At the present moment, as we haven't own data provided from our measurments, we temporally do not deliver any information to the Toronto center-Canada.

Information to the public (e.g. UV forecasts)

In case of inquiry we provide roughly information on a base of distributed Large-Scale UV Index forecasts by Germany.

Relevant scientific papers

1. ***St. Kolev*** *and V. Grigorieva, Surface and Total Ozone Over Bulgaria, 2005, Kluwer Academic Publishers, NATO publishing unit,.*
2. *Grigorieva, V., **S.Kolev** and M.Mihalev; Investigation of correlations between the high surface ozone episodes and the stratospheric intrusion events, 2004, Proc. SPIE (in press).*
3. *V.Grigorieva, **S.Kolev**, ; Ts.Gogosheva, B.Petkov, S.Bogdanov, P.Videnov "Surface and Total Ozone Over Bulgaria During Solar Eclipse", Proc. of the EUROTRAC-2 Symposium'2002, Garmisch-Partenkirchen, Germany, P.Midgley (Ed.), Margraf Verlagm Weikersheim 2002.*

4. *V.Grigorieva, **S.Kolev**; "Spring-Time Peculiarities in Ozone Behaviour at the Bulgarian Site", Proc. of the EUROTRAC-2 Symposium'2002, Garmisch-Partenkirchen, Germany, P.Midgley (Ed.), Margraf Verlagm Weikersheim 2002.*
5. *V.Grigorieva, **S.Kolev**, M.Mihalev; "Summer Ozone Episodes at City of Sofia", Proc. of the EUROTRAC-2 Symposium'2000, Garmisch-Partenkirchen, Germany, P.Midgley (Ed.), Springer-Verlag, Heidelberg, 4 page, 2001.*
6. *V.Grigorieva, **S.Kolev** ; "Ozone and Related Species Concentrations at Two Bulgarian Sites", Annual Report, Tropospheric Ozone Research - project, EUROTRAC-2, Munchen, 81- 85, 2000.*
7. *V.Grigorieva, **S.Kolev**, M.Mihalev; "Ozone Air Pollution Over the Balkan Peninsula" Bulg. J. of Physics, 27, 72-75, 2000.*

PROJECTS AND COLLABORATION

National project. Peculiarities in the ozon variations and a study of the proceessess which determine them. ; Project № H3 1406, 2004-2007, funded by the Bulgarian Ministry of Education and Science.

FUTURE PLANS (e.g. new stations, upcoming projects, instrument development)

NIMH would like to to establish a regular station for ozone and UV solar radiation measurements. We are expecting supprot from our ministry and interested parties.

NEEDS AND RECOMMENDATIONS

NIMH needs modern equipments for measuring total column ozone and the ozone profiles, UV solar radiation, NOx profiles.

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