SURFACE OZONE IN KIEV

A.V.Shavrina[1], I.A.Mikulskaya[2], S.I.Kiforenko[3], O.B.Blum[4], V.A.Sheminova[5], A.A.Veles[6]

[1] Main Astronomical Observatory of National Academy of Sciences of Ukraine, Kiev, Ukraine, *shavrina@mao.kiev.ua*
[2] MNUTS IT and C, National Academy of Scinces and Ministry of Education and Science of Ukraine, Kiev, Ukraine, *lutmail@ukr.net*
[3] MNUTS IT and C, National Academy of Scinces and Ministry of Education and Science of Ukraine, Kiev, Ukraine
[4] Botanic garden National Academy of Scinces of Ukraine, Kiev, Ukraine
[5] Main Astronomical Observatory of National Academy of Sciences of Ukraine, Kiev, Ukraine, *shem@mao.kiev.ua*
[6] Main Astronomical Observatory of National Academy of Sciences of Ukraine, Kiev, Ukraine, *veles@mao.kiev.ua*

ABSTRACT. The study of total ozone over Kiev and its concentration changes with height in the troposphere has been made on the base of ground-based observations with the infrared Fourier-spectrometer in the Main Astronomical Observatory of National Academy of Sciences of Ukraine (MAO NASU) as part of ESA-NIVR-KNMI project no 2907 "OMI validation by ground based remote sensing: ozone columns and atmospheric profiles "(2005-2008) [1,2,4]. Ground-level ozone in Kiev for an episode of its high concentrations in August 2000 was also simulated with the model of urban air pollution UAM-V [5,6]. In 2008 the satellite data Aura-OMI on profiles of ozone in the atmosphere OMO3PR became available (*http://disc.sci.gsfc.nasa.gov/Aura/data-holdings/OMI/ omo3pr_v003.shtml*). They include ozone content in the lower layer of the atmosphere, beginning from 2005, which can be used to evaluate the ground-level ozone in all cities of Ukraine. The comparison of the data of ozone air pollution in Kiev (ozone - the pollutant of the first class of danger) and medical statistics data of of respiratory system (RS) diseases of the city population was carried out with the package "Statistica". A regression analysis, prognostic regression modelling, and retrospective prognosis of the epidemiological situation with respect to RS pathologies in Kiev in 2000-2006 were performed.

Key words: Stars: He-weak: magnetic field; stars: individual: HD182255, 3 Vul

Introduction

The study of total ozone over Kiev and changes of its concentrations with altitude in the troposphere has been made on the basis of ground-based observations of the infrared Fourier spectrometer of the Main Astronomical Observatory of National Academy of Sciences of Ukraine (MAO NASU) as part of ESA-NIVR-KNMI project no 2907 "OMI validation by ground based remote sensing: ozone columns and atmospheric profiles "(2005-2008 years) [1,2,4]. It was also modeled ground-level ozone in Kiev for an episode of its high content in August 2000 [5,6] using a model of urban air pollution UAM-V. Ground-level ozone is a secondary pollutant which is highly toxic to humans and all living matter. It is formed by photochemical reactions of precursor substances, emissions, mainly from vehicle exhausts and large technology companies, and, indeed, is an indicator of anthropogenic pollution of the studied areas. As chemical and toxic substance ozone has been well studied. As for its effect on human health, the residents of modern cities, then, unlike the U.S. and Europe, in Ukraine this question is only beginning to be studied. At the same time, it is here that this problem requires the most careful study: firstly, because of the complexities of economic, medical and environmental conditions prevailing in recent years, and secondly, because we observe an intense transformation of cities into a modern metropolis with a huge park of vehicles. This phenomenon, from many points of view, the new has not yet been studied, including in health and ecological aspects.

Aims and objectives

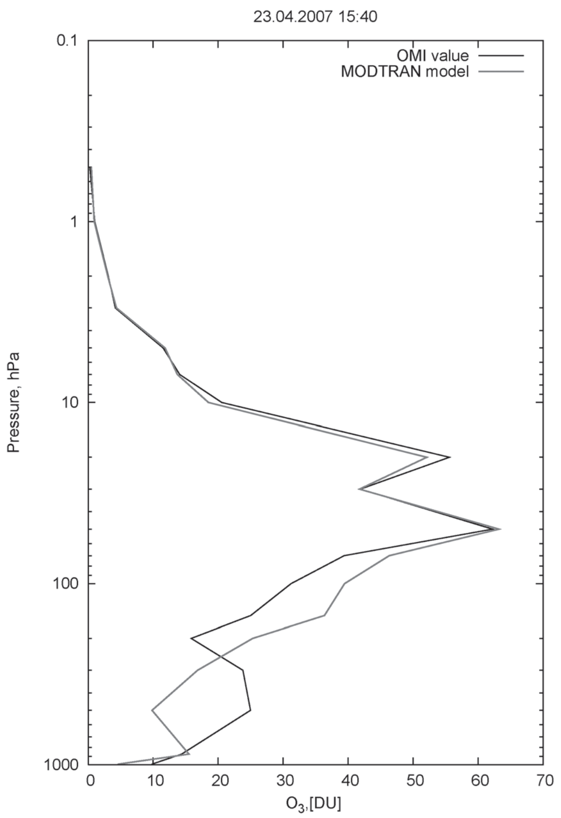
The main purpose of this study - to perform a retrospective study of the influence of ozone on the health of Kiev city population, from 2000 until the present time. It is known that the primary target of ozone impact on human health is the respiratory system (RS), as well as health in general. The aim of this work is to create a database on the problem of ozone in Kiev and to carry out on its basis the necessary epidemiological and theoretical studies to predict the ozone impact on the respiratory system of the city population. It is also expected to use the results of epidemiological studies to assess the risk of harmful effects of ozone on the health of the inhabitants of Kiev and other cities in Ukraine, both at the population and individual (personal) level.

Materials and methods

To carry out this work, we asked for medical statistics regarding the RS diseases of the population of 14 districts of Kyiv. We select 12 indicators for determining the general and primary morbidity of the population by ozone depending RS pathologies for the period 2000-2006. The data obtained related to five socio-age groups of Kiev residents: children, adolescents, adults of working age and pensioners. Data of averaged maximum ozone pollution for 14 districts of Kiev, as well as in Kiev as a whole for the "ozone episode" in August 2000, calculated from the results of urban ozone modelling with UAM-V. for surface layer of the atmosphere over the city [5,6], Fig. 1. The model UAM-V takes into account the following factors: topography of the city, weather conditions, intensity of solar radiation, the number of point and area sources of industrial emissions to the atmosphere, the number of vehicles in the city, the speed and temporal loading of traffic. In 2008, the satellite data Aura-OMI on ozone profiles in the atmosphere OMO3PR (*http://disc.sci.gsfc.nasa.gov/Aura/data-holdings/OMI/ omo3pr_v003.shtml*), became available which include the ozone concentration in the lower layer of the atmosphere since 2005. We performed a comparison of these data with ozone profiles obtained by us from observations with the infrared Fourier spectrometer and the modelling with program MODTRAN4 [1,2]. The first comparison of our profile for the April 23, 2007 showed a significant difference with the profile of the Aura-OMI in the tropospheric part of the profile, Fig. 1a. However, the data OMI of version 2009 agree well with our profile for the same date, Fig.1b. This gives grounds for using OMI data in assessing the ground-level ozone concentrations in all major cities of Ukraine.

Epidemiological study of the SVD diseases for population of Kiev (2000)

The first epidemiological study on the problem of surface ozone in Ukraine was carried out by us with the modelling results of ozone episode of 2000 [3]. At that time the administrative structure of Kiev was comprised of 14 districts, each of which was served by a network of district clinics delivering statistics data to the Kiev centre for medical statistics "Medinstat". This made possible to carry out a full statistical comparison of district averaged RS indicators for city's population and averaged maximal district ozone concentrations calculated from ozone modelling (Fig. 2). The correlation study showed that the socio-aged group "adults", counting more than 70% of the Kiev population, has statistically significant relationships (r > 55) for indicators "respiratory diseases" and "pneumonia". Socio-aged group "children" shows statistically significant relationship in terms of "asthmatic bronchitis" (r = 0,66).



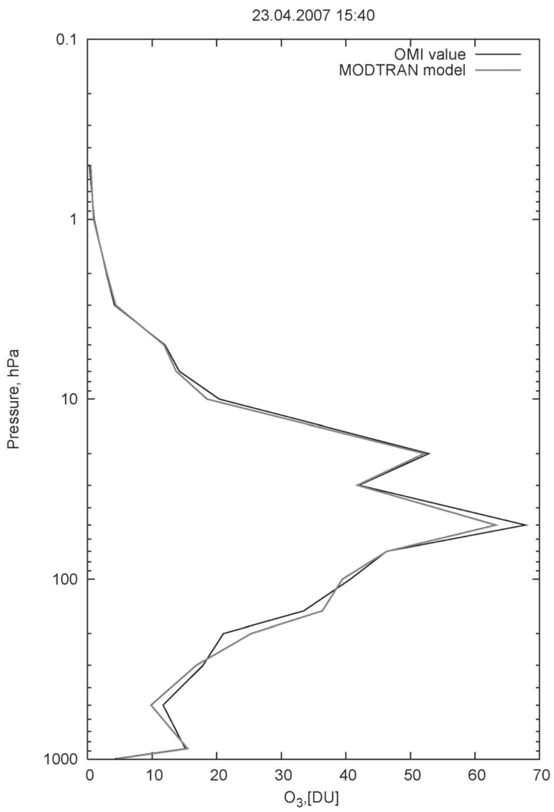


Figure 1: Comparison of our retrieved atmospheric ozone profile with the OMI data (OMO3PR):
a) OMI data of version 2008, b) OMI data of version 2009

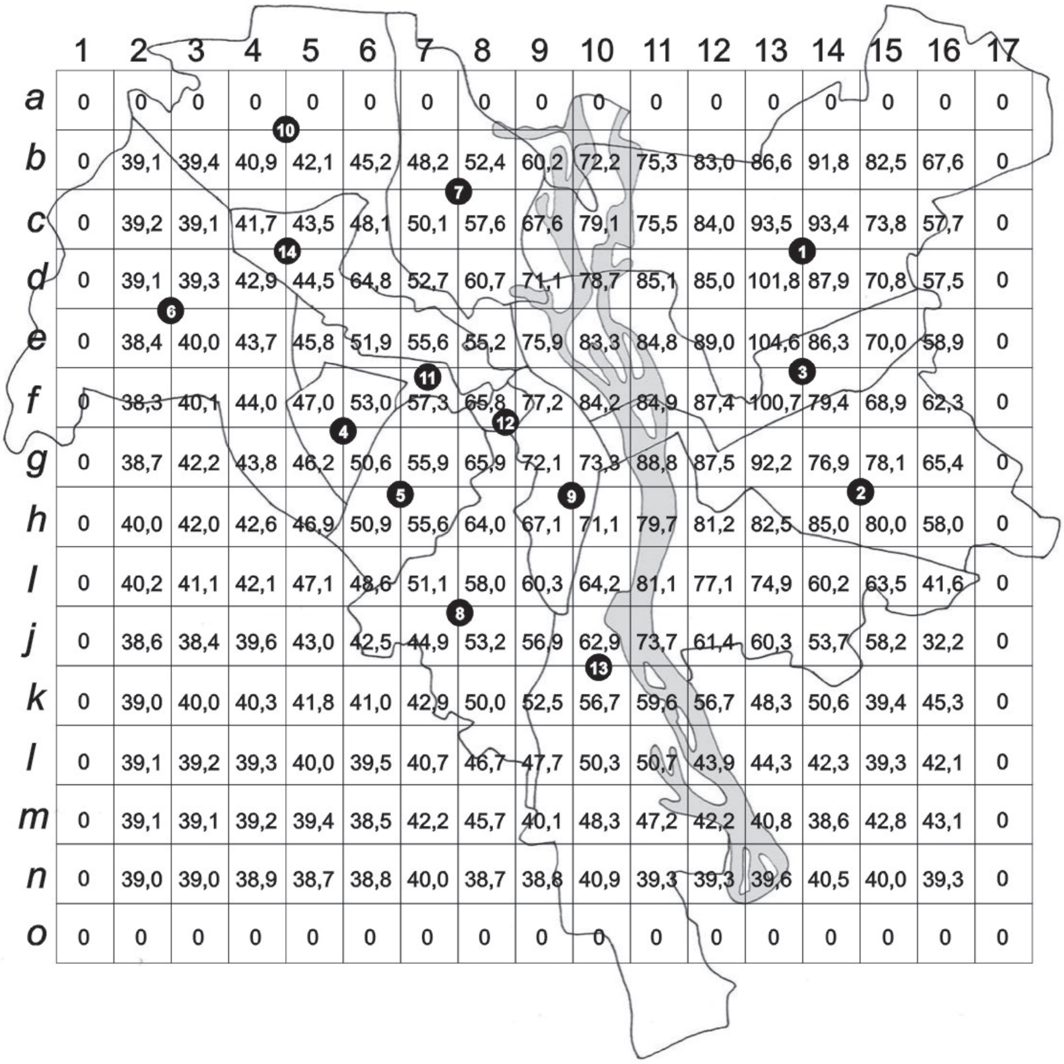


Figure 2: Mean maximal concentrations of ozone in the Kiev areas, calculated from the modelling: 1. Vatutinski district (76 ppb), 2. Darnitski district (71ppb), 3. Dneprovski district (73.3ppb), 4. Zhovtnevyi district (46.2 ppb), 5. Zaliznichnyi district (60 ppb), 6. Leningradski district (38.8 ppb), 7. Minski district (51.9 ppb), 8. Moskovski district (50.3 ppb), 9. Pecherski district (64.1 ppb), 10. Podolski district (46.2 ppb), 11. Radyanski district (52.5 ppb), 12. Starokievski district (61 ppb), 13. Kharkovski district (59.1 ppb), 14. Shevchenkovski district (46.4).

When we select for the study the areas of the city "sleeping" districts with their socio-economic and medico-ecological features, as well as the similar population density (5 000 inhabitants per 1 km^2.) We found in this case the high correlations between ozone cocentrations and RS indicators. For adults they reached values of r = 0,83, for children r = 0,8. Further, with the correlations obtained we carried out the regression analysis of the data and constructed linear regression equation that will predict the RS state for residents of Kiev. Indicators "Respiratory diseases" in adults and "asthmatic bronchitis" in children are based on summer peak concentrations of ozone in their areas. The prediction of the epidemiological situation with respect to RS diseases in Kiev in 2002-2006 was carried out using the data of measurements of the surface ozone at the Botanical Garden, satellite data Aura-OMI, as well as results of surface ozone concentrations modelling for Europe (including Ukraine) performed in the Rhenish Institute for Environment at the University of Cologne (*http://www.eurad.uni - koeln.de/index_e.html*). It was assumed that these data for Kiev characterize the city average concentration of ozone in 2000-2006. On their basis it was forecasted the total number of respiratory diseases (adults) and asthmatic bronchitis (children). The comparison of the results of prediction and health statistics for 2000-2006 (Kiev) showed that forecasts constructed on the modelling results are mainly confirmed. The discrepancy in the values of the indices studied does not exceed 26% (Table). The prognosis based on the satellite Aura-OMI (2005, 2006 years) for the same indicators was close enough to the statistics data.

Table. Surface ozone impact on respiratory diseases of Kiev city population. Comparison of predicted respiratory system diseases in Kiev with the data of medical statistics.

year	2000	2002	2003	2004	2005	2006
Concentr.3(ppb)						
Model O3	56.9	75.0	75.0	55.0	78.5	71.5
Aura-Omi					63.0	61.9
Ozonometer:						
Bot.Garden, GAO	56.9	75.5	71.1	67.9	84.2	77.0, 70.0
Respir. diseases (adults) Med.statistics data (100000 persons)	2996	3236	3534	3391	3561	3600
Prognosis:						
Model O3	2996	3886	3884	2902	3714	3714
deviation		20%	10%	14%	3%	3%
Aura-Omi					3295	3252
deviation					9%	9.6%
Ozonometer:						
Bot.Garden, GAO		3911	3694	3537	4339	3985
deviation		21%	4.5%	4.3%	22%	11%
Asthmatic bronchitis (children) Med.statistics data (1000 persons)		8.75	9.2	7.12	9.2	8.75
Prognosis:						
Model O3		9.7	9.7	9.3	10.1	9.0
deviation		11%	5.4%	24%	11%	3%
Ozonometer:						
Bot.Garden, GAO		11.	9.2	8.8	10.9	9.95
deviation		26%	0.1%	6%	18%	14%

Conclusion

Summing up the results of this work, we should say that the expansion of the database of ground-level ozone pollution for the other cities of Ukraine, as well as statistics on the health of the population of these cities is a necessary condition for the study and solving of the problem of ozone in the Ukraine. Note very high concentrations of ozone in the summer 2010 in Odessa (up to 200 ppb), given by the EURAD modelling in the Rhenish Institute for Environment at the University of Cologne. As a result of this work, it became apparent that the modelling of ground-level ozone in the city should be repeated at least every 3-4 years, taking into account the growth rate of the city, as well as changes in the quantitative characteristics of morbidity by ozone depending RS pathologies. Such studies, combined with satellite data (in particular the Aura-OMI) and modelling of ozone pollution for cities opens up the opportunities for predicting risks of ozone harmful effects on the health of the population of major cities in Ukraine.

Acknowledgements. This work was partially supported by the Space Agency of Ukraine.

Reference

1. Shavrina A.V, Pavlenko Ya.V, Veles, A.A et al.: 2008, *Kosmichna nauka i tehnologiya*, **14**, N 5 , 85.
2. Shavrina A.V Sheminova V.A, Pavlenko Ya.V. et al.: 2010, *Kosmichna nauka i tehnologiya*, **16**, N 4,3.
3. Mykulska I.A., Shavrina A.V., Kiforenko S.I.: 2008, *In Coll. Biomedical information technology in health care,* Kyiv, BMIT-2008, **BMP-2009**, 41.
4. Shavrina A.V., Pavlenko Ya. V., Veles A. et al.: 2007, *J. of Geophys. Res.*, **112**, D24S45.
5. Shavrina A.V., Sosonkin M.G., Veles A.A. et al.: 2008, *Simulation and Assessment of Chemical Processes in a Multiphase Environm.*, Barnes I., Kharytonov, M. M. (Eds.), NATO Science for Peace and Security Series C:Environmental Security. Springer, **XXV**, 345.
6. Shavrina A.V., Veles A.A., Nochvaj V. et al.: 2010, *NewsLetters of the FP7 EC MEGAPOLI Project*, N 8, 31.