National Report for the 9th WMO/UNEP Ozone Research Managers Meeting, 14 – 16 May 2014, Geneva, Switzerland, Belarus

As a result of the government reorganization, the Ministry of Education of Belarus is now in charge of ozone monitoring procedures, whereas the international cooperation is assigned to the Ministry of Environmental Protection and Natural Resources.

Following Belarus' accession to the Customs Union, all legislative acts (laws, decisions, instructions) regarding ODS circulation, certification, and custom charges have been formulated and submitted to the authorities of Russian Federation and Kazakhstan aiming to be unified in future. The relevant changes and additions to the ozone layer protection laws should be adopted by our legislative body this summer.

1. MONITORING ACTIVITIES

Belarus continues to design instrumentation as well as develop monitoring, calibration procedures and the archiving of stratospheric & tropospheric ozone, nitrogen dioxide, aerosols, surface UV radiation data and vertical lidar profiles of stratospheric & tropospheric ozone and aerosols.

1.1. Measurements of total ozone (TO) and UV radiation

The monitoring of TO has been maintained in the Republic of Belarus since 1998. Main measurements are taken at the Minsk Ozone Station (Minsk, 27.469E, 53.833N) having № 354 in the WMO international network.

During the period of 1998 to 2002, TO measurements were performed employing the "direct-sun" and "zenith-sky" procedures by means of an ozonometer PION designed at NOMREC.

Since 2006, column ozone values have been retrieved using the Stamnes procedure from spectral irradiance measurements made with the spectroradiometer PION-UV.

The network of TO measurements sites has been enlarging since 2011. Currently, the measurements are also taken at the BSU biological station (the Naroch lake) and at the Gomel state university. As a net ozonometer, one uses a fully automated PION-F double-channel filter photometer.

Since 2006, applying PION-UV and M124-M instruments, the regular TO and UV radiation measurements have been conducted at the time of seasonal Belarusian Antarctic Expeditions in the region of Enderby Land (Antarctica).

NOMREC possesses a full database on TO monitoring in the atmosphere over the territory of Belarus for the period of 1998 – 2014. Also, NOMREC has the database of surface solar UV radiation spectra as well as doses of various biological effects for the territory of Belarus covering the period of 2001-2014.

1.2. Total nitrogen dioxide measurements

Monitoring of nitrogen dioxide has been performed at the Minsk Ozone Station since 2007. In 2009-2010, the nitrogen dioxide column values were measured with a new DOAS zenith-sky system constructed on the base of the Oriel-260 spectrometer. The measurement procedure included the nitrogen dioxide column retrieval technique elaborated at the Obukhov Institute of the Atmosphere Physics (Russia).

A new MAX-DOAS measurement device on the base of Oriel-257 spectrometer has been used for a number of short-term intercomparison measurement campaigns for retrieval of vertical nitrogen dioxide concentration profiles in several sites in Belarus (Minsk, Naroch National Park), Germany (during the calibration procedure in Max Planck Institute for Chemistry, Mainz), and Antarctica.

1.3. Surface ozone monitoring

Measurements of surface ozone concentration have been carried out since 2004 at the Minsk Ozone Station and Berezina National Park EMEP station employing DOAS instrument TRIO-1 which has passed standard certifications in the Belarus State Institute of Metrology. The absolute error did not exceed ±1.45 ppb in the ozone concentration range of 0-200 ppb.

For surface ozone monitoring, a TEI 49C ozone analyser has also been employed particularly for calibration. A compact device to measure the surface ozone concentration is originated at NOMREC and based on a new type of semiconductor nickel oxide sensor.

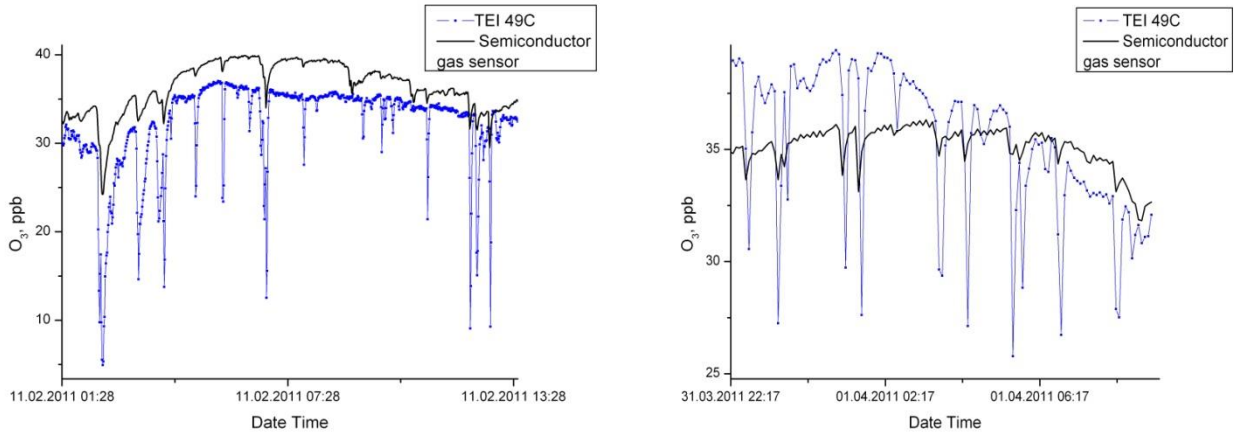

Fig. 1: Falls in surface ozone concentrations

At the location of the Minsk Ozone Station, one has observed the effect of non-periodic short-term deep surface ozone falls (for a few minutes time, see fig. 1). The phenomenon has been detected by instruments of the various types. The fall depth depends on the instrument time constant. The problem needs further analysis and discussion.

Department of Hydrometeorology has recently created a complex network of observational sites for the atmospheric air quality on the territory of Belarus. Ozone, some of its precursors as well as aerosol particles are among atmosphere pollutants being controlled at the sites. In particular, Minsk has 4 such points located in city

areas differing in air pollution level.

1.4. Profile measurements of ozone and aerosols

The atmosphere monitoring has been conducted at B.I. Stepanov Institute of Physics, National Academy of Sciences of Belarus since 1985.

In 2007-2014, two wavelength (355 and 532 nm) lidar measurements of stratospheric aerosol parameters were performed as well as ozone concentration profiles (266 nm).

A type of lidar system was developed using the transmitter at the wavelength 281.7 nm on the base of solid-state stimulated Raman scattering converter. The system provides measurements of ozone concentration in a layer of 1 – 10 km.

1.5. Calibration activity

Spectral irradiance calibrations of PION-UV and other instruments in a spectral range of 285-450 nm were regularly carried out at the NOMREC site with a 300 W tungsten band-lamp certified by the Russian National Standard Agency. T

Total ozone instruments were calibrated using a WMO regional standard (Dobson N108 spectrophotometer) in Voeikov Main Geophysical Observatory (MGO), St. Petersburg, Russia. The last calibration was performed in July, 2013.

On a regular basis, one also uses a special technique originated specifically at NOMREC for checking and recalibration of total ozone instruments at the operational sites.

In summer 2013, the MAX-DOAS measuring system of NO_2 profiles participated in the MAD-CAT intercalibration and intercomparison campaign at the Max Planck Institute for Chemistry, Mainz, Germany.

2. OBSERVATION RESULTS AND ANALYSIS

In accordance with the analysis of total ozone data at Minsk (53.83 N, 27.47 E) for the periods of 1979-1992 and 1996-2012, besides a reduction in multi-year averages of monthly average values of total ozone, one has revealed a shift in the annual total ozone maximum from April to March (fig. 2). This is due to the changing of circulation processes in the atmosphere.

Substantial efforts have been taken to assign this fact to the circulation processes in the northern hemisphere. Analysis has shown that this dependence is most clearly revealed if comparing to the circulation processes described by Dzezrdzeevsky. Matching a number of days with different types of meridional circulation and TO average monthly values demonstrates an existing for several years link between these quantities. One may assume that the shift in the annual maximum is due to the changes in troposphere circulation, that is intensification of the meridional northern circulation in March and intensification of the meridional southern circulation in April (fig. 3).

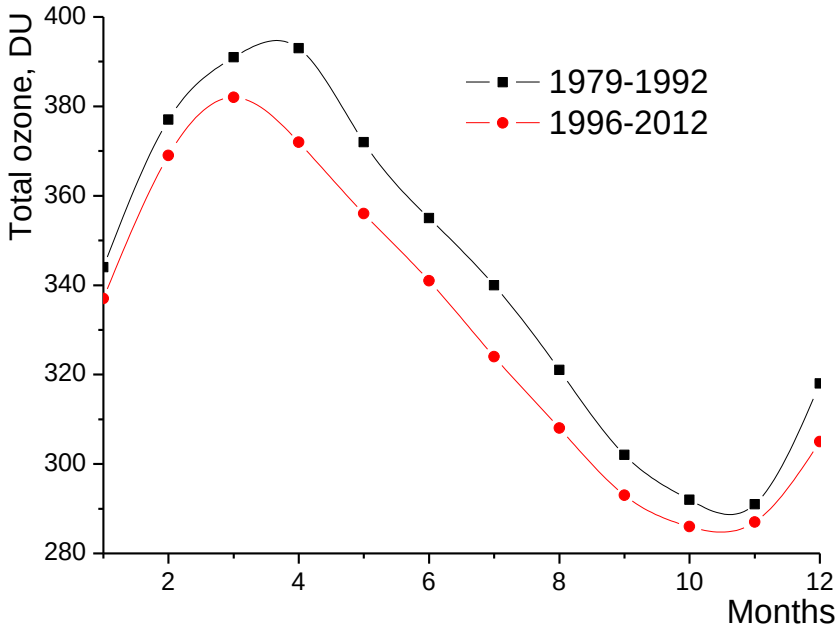

Fig. 2: Multi-year averages of monthly average values of total ozone for the periods of 1979-1992, and 1996-2012.

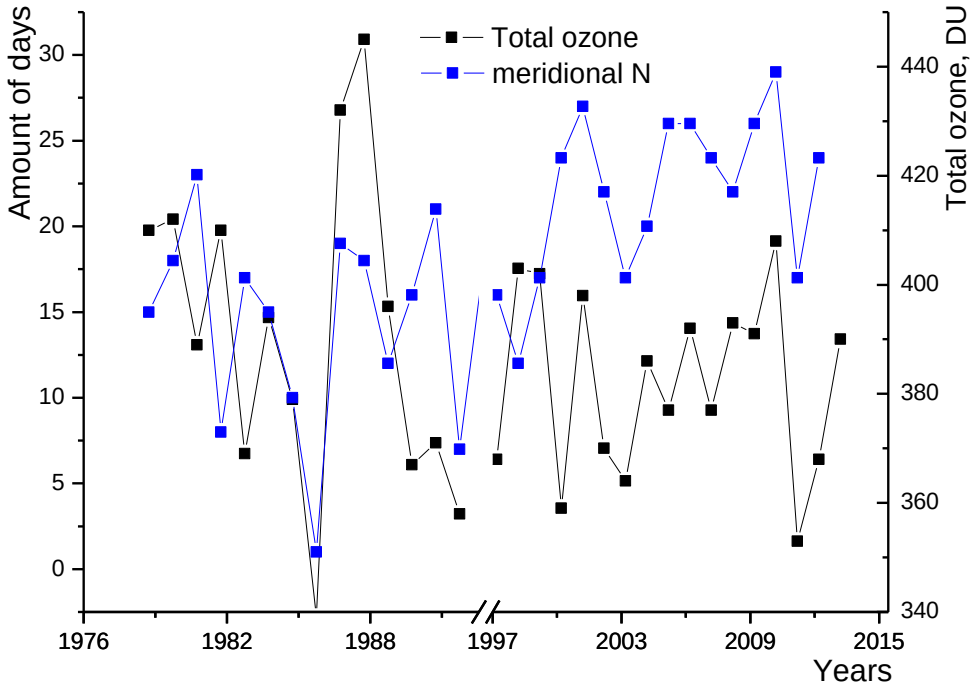

Fig. 3: Average monthly values of TO and a number of days with the meridional northern circulation in March for the periods of 1979-1992 and 1996-2012.

3. SCIENTIFIC ACTIVITIES

3.1. Engineering development

The work is continued to modernize an M124 filter ozonometer. As a result, we have a final modification of M124.

A double-channel filter photometer PION-F has been devised to measure levels and doses of the biologically active surface solar UV radiation (CIE bioeffect). Both instruments can be used at the sites where previous generation of M124 devices was exploited. NOMREC can organize modernization and recalibration of the existing observational M124 network in cooperation with Voeikov MGO (St. Petersburg, Russia).

The construction of the PION-F has no moving elements. PION-F is designed for all-weather application in a completely automated mode. Systems of the photometer spectral selection are similar to the M124 filter systems, but radiation registration is realized from a hemisphere in two measuring channels simultaneously. To enhance sensitivity of the system and reduce a stray exposure, a solar-blind PMT has been used in the device.

An automated complex system including a base unit of the biologically active UV radiation meter, a sensor of the total radiation, and a FAR sensor has been created on the basis of the PION-F photometer.

A submersible device has been specifically engineered to study solar UV radiation propagation in the aqueous medium up to a depth of 20 m. The instrument is equipped with a surface unit enabling to measure both radiation levels at different depths and water transparency.

A MAX-DOAS measuring system of atmospheric NO_2 slant column densities is designed on the basis of an Oriel-257 spectrometer.

A small-sized model of a tropospheric lidar and the mobile monitoring system of ice and snow cover condition have been developed.

Within the framework of the National Antarctic program, two filter ozonometers M124-M and the spectroradiometer PION-UV have been specifically modified to be used in polar areas of the Earth.

3.2. Theory and modelling

Some developments have been made advancing the measurement procedure as well as the Stamnes ozone retrieval technique.

Following the analysis of possibilities for various techniques of TO measurement, one has defined that the errors of direct-sun measurements are comparable to those of zenith measurements in the order of magnitude at large solar zenith angles. Meanwhile, stability of zenith measurements if considering the atmospheric variations is essentially higher. Moreover, the best ratio between signal levels and stability of the TO retrieval algorithm is achieved while registering a signal by a cosine input device in the specially selected spectral intervals.

Also, some efforts have been undertaken in the field of modelling studies of stratospheric ozone layer processes. In particular, a mesoscale atmospheric model has been used to simulate dynamical processes of local ozone anomalies formation, evolution, and decay. Apart from that, a project is currently underway dealing with

ozone-climate connections, namely, the ozone mechanism of solar activity influences on mesosphere-stratosphere-troposphere coupling.

4. DISSEMINATION OF RESULTS

The data derived by the NOMREC along with the data collected at the B.I. Stepanov Institute of Physics are submitted to and archived in the database of the National Environmental Monitoring System (NEMS). At the moment we still have problems with submitting our data to WOUDC.

4.1. Information to the Public

Mapping and UV Index forecast generated specifically for different regions have been realized since 2006.

The UV Index short-term forecast made for the Belarus territory is submitted to the National news agency BelTA on a daily basis.

These data are also available on the NOMREC site at http://ozone.bsu.by and on the official site of the National Hydrometeorogical Agency of Belarus at http://www.pogoda.by.

4.2. Projects and collaboration

Presently, we have four active projects at NOMREC:

1. Within the NEMS Ozone Monitoring Program, we have plans to expand our network to six observation stations in Belarus instead of existing three ones to meet the recommendations of the 8th ORM.
2. As part of the National Space Research Program of Belarus, we implement the project on ozone-climate interactions.
3. Within the National Environmental Program, we have a special project aimed at estimating a climatic average of stratospheric and surface ozone.
4. A separate research project on atmospheric modelling for the purposes of numerical weather prediction, regional climate forecasting and stratosphere-troposphere interactions.

At B.I. Stepanov Institute of Physics, two project are currently implemented dealing with lidar development for measurements of ozone and aerosols in the troposphere and the stratosphere, respectively.

Furthermore, B.I. Stepanov Institute of Physics and NOMREC have corresponding projects in the National Antarctic Program of Belarus related to atmospheric research. A permanent ozone station in Antarctica is about to be established in the nearest future.

Also, it is planned to intensify research activities in the field of ozone-climate connections in the framework of the National Climatic Program of Belarus starting the next year.

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