Armenia
Republic of Belarus
Russian Federation

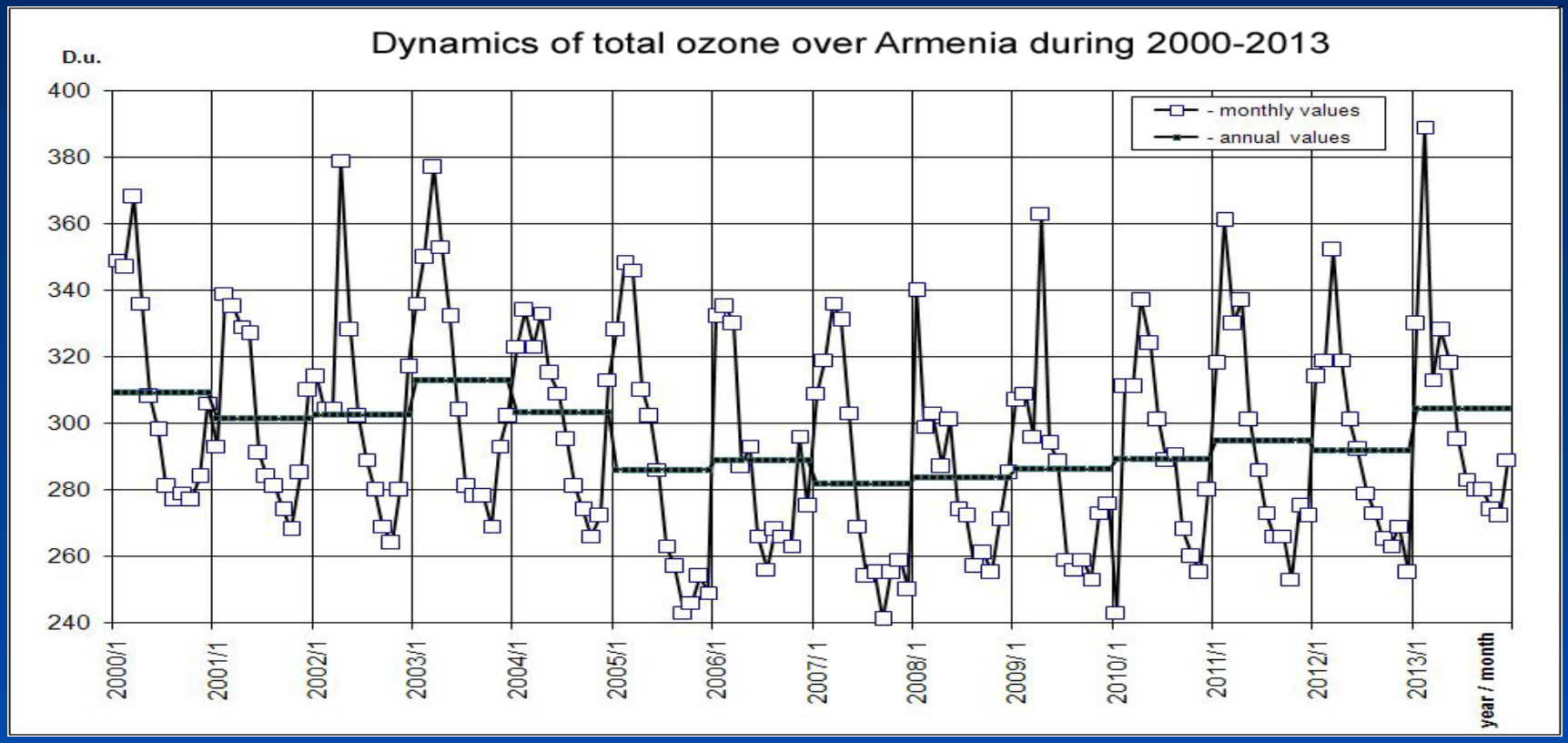
Federal service for hydrometeorology and environmental monitoring
Dr. Yu.A. Borisov

ARMENIA

- **OBSERVATIONAL ACTIVITIES**
- The GAW regional station #410 Amberd from 2000 carries out the regularly measurements of total ozone. The station is equipped by Dobson spectrophotometer D-044 (Fig.1).
- Location: 40.38N, 44.25E, 2070 a.s.l.
- The begun in 1990 measurements of total ozone on the local network ozone-observing station Arabkir in city Yerevan are continued. The station is equipped by filter ozonometer M-124.
- Location: 40.20N, 44.50E, 1113 a.s.l.

Figure 1. GAW regional station #410 Amberd.

Some results of carried out on Dobson-station measurements



The results of measurements showed, that during 2007-2013 the average increase of total ozone is observed

on 1.3% per year for annual values,
on 0.2% per year for spring months,
on 0.8% per year for summer months,
on 1.6% per year for autumn months,
on 3.2% per year for winter months.

THEORY, MODELLING, AND OTHER RESEARCH

- Using the constructed early computer model of solar radiation transfer in atmosphere and of its distribution on the territory of Armenia and estimations of climatic parameters of solar radiation on the territory of Armenia are created the references books.
- The comparative analysis of modern results of total ozone measurement at stations "Arabkir" (ozonemeter M-124) and "Amberd" (Dobson spectrophotometer) with the purpose to find correction of algorithm of calibration of filter-ozonometers, connected with aging of filters, is continued.
- The studies of connection between changes of total ozone, ultraviolet radiation and the morbidity of population by skin cancer for different regions of country were initiated and are continued now.

Data reporting

- Monthly results of measurements of total ozone at station Amberd are regularly submitted in the WOUDC.

- On the basis of results of measurements of total ozone on stations Amberd and Arabkir is continued the creation of local computer bank.

Information to the public

- Using the forecasts of total ozone distribution above northern hemisphere from WMO/GAW ozone mapping program and forecasts of cloudiness with use of the model of solar irradiation are developed the daily maps of forecasts of distribution of UV Indexes on the territory of Armenia. The estimations and forecasts of UV indexes for mostly inhabited areas of Armenia are calculated according to "UV Index for Public" (COST-713 Action UVB Forecasting) and are included in the weather forecasts for dissemination to the public via mass media.

PROJECTS AND COLLABORATION

- On created on the Dobson-station Amberd the first-level station EMEP are continued works for measurements of concentrations of pollution in precipitations and of solid particles in air, also of SO_2, NO_x and surface ozone O_3.

FUTURE PLANS

- Regular measurements of ozone with distribution of the received results will be continued.
- Efforts for the organisation of regular measurements of ultra-violet radiation will be undertaken.
- The results of modeling of a climatic regime of UV irradiation will be used for development of results begun in [1] research of vulnerability of health of the village and urban population to increase of ultraviolet radiation and the influence on vulnerability of height of location in all regions of territory of Armenia. The research is based on long-term statistics on morbidity of the population of Armenia by skin cancer and on results of total ozone measurements.

NEEDS AND RECOMMENDATIONS

- **Needs:**
- **to use the capacities of weather station Amberd, which allow implementation of international projects for monitoring of solar radiation and vertical distribution of ozone, lidar observations, aerosol transfer and transboundary air pollution in region of South Caucasus.**

- **The recommendations:**
- **periodically to organize DQ Workshops, similar WMO/ UNEP Dobson Data Quality Workshop Hradec Kralove, Czech Republic, February 14-18, 2011.**
- **enabling for ozone-experts from developing countries of short-term practice in leading scientific centres of the world for improving of their scientific and technical potential.**

Belarus

A universal ultraviolet solar spectrophotometer-ozonometer PION operating at the NOMREC Ozone Station

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

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

An automatic ultraviolet spectroradiometer PION-UV at the NOMREC Ozone Station

NOMREC

Belarus

MONITORING ACTIVITIES

Measurements of total ozone (TO) and UV radiation

All instruments used for monitoring activities are originally designed and tested at NOMREC

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

Belarus

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.

Belarus

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.

All-weather net photometer PION-F is intended to automatically measure spectral irradiance

PION-F photometer operating at the Naroch Biological Station

The instrument uses filters with a half-width of ≈ 20 nm and transmission maxima of 293 and 326 nm. The measurements are taken every 30 sec during a light day in the automated mode. A djurnal data file is formed by an objective computer at the end of day.

Belarus

Total nitrogen dioxide measurements

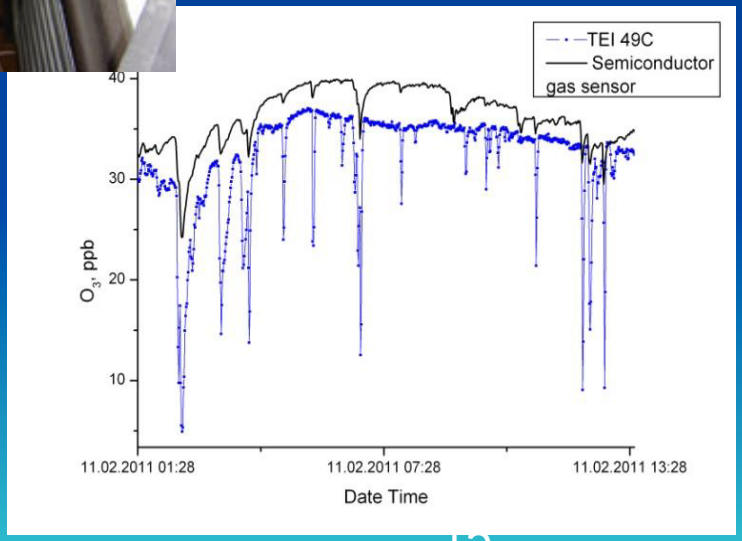
- **Monitoring of nitrogen dioxide has been performed at the Minsk Ozone Station since 2007. In 2009-2010, the nitrogen dioxide column values were measured with a new DOAS zenith-sky system**

Belarus

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.

DOAS Instrument with Zero Path TrIO-1



At the location of the Minsk Ozone Station, one has observed the effect of non-periodic short-term deep surface ozone falls. The phenomenon has been detected by instruments of the various types.

Falls in surface ozone concentrations

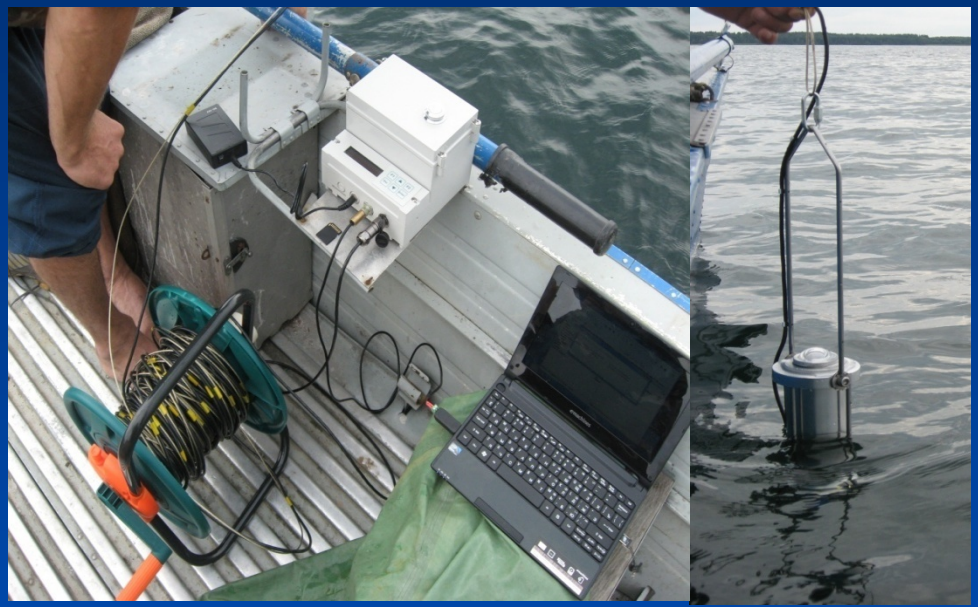
Profile measurements of ozone and other gases

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

Lidar station at Institute of Physics of National Academy of Sciences (IPNAS) , Minsk

Belarus

A submersible spectrometer has been designed to study solar UV radiation propagation in the aqueous medium up to a depth of 20 m.



A submersible PION-F photometer

Device characteristics:

Supply voltage: 10-15 V

Power: 10 W

Time of autonomous work with a standard li-ion accumalator of 5600 mAh : 4 hours.

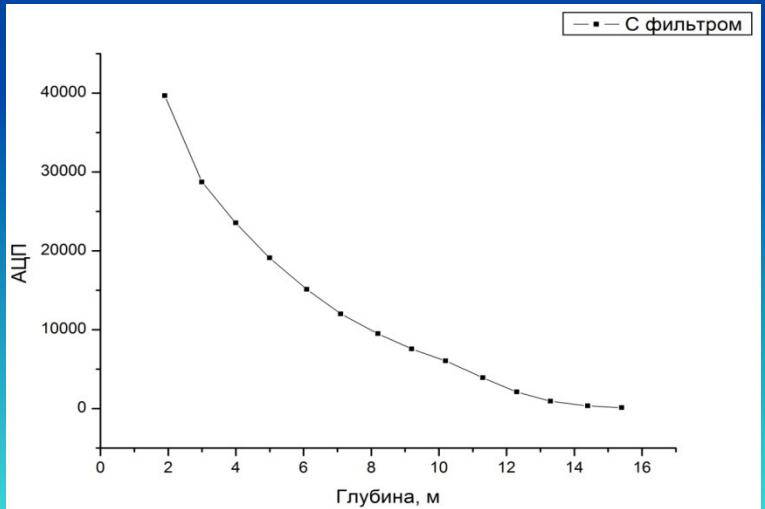
Maximum depth of submersion: 30 m

An error in depth determination: ±5 cm

Spectral range: 285-400 nmи or 285-315 nm.

Operating temperature range: 0 ..+30 °C

Measuremnt results storing: flash-card of 2 GB capacity

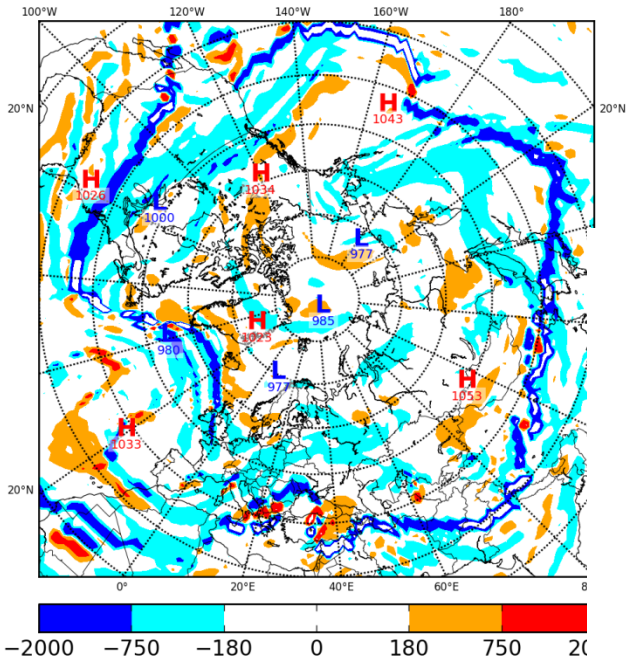


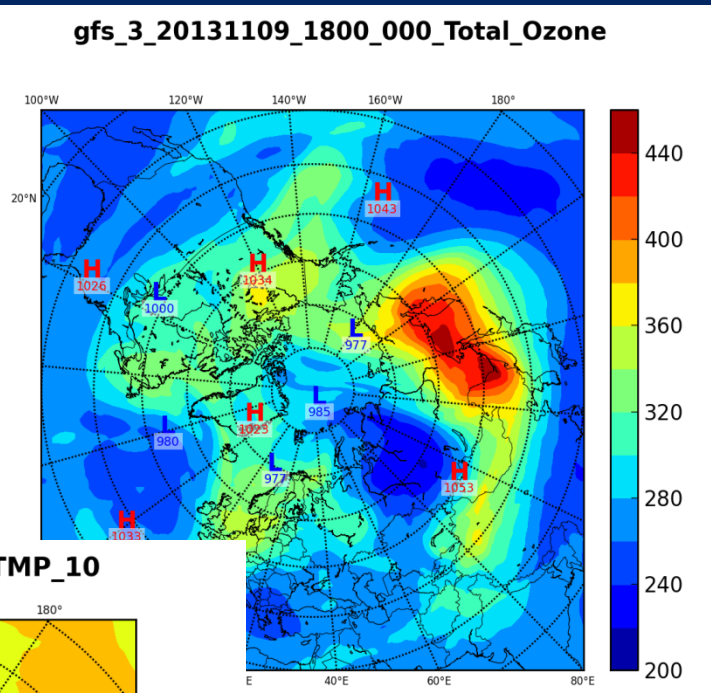
Results of measurements
in a spectral range of 285-315 nm.

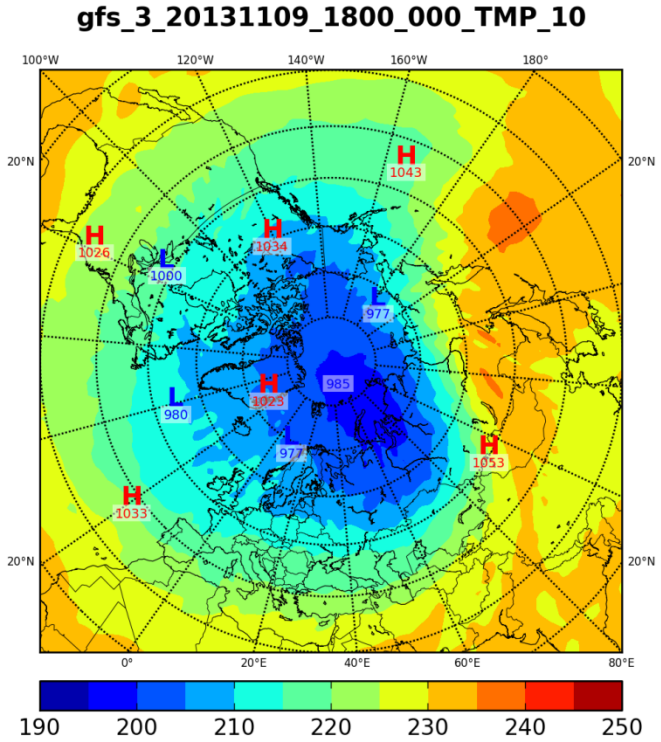
NMREC Belarus

Theory and modelling

The event of SSW in Siberia







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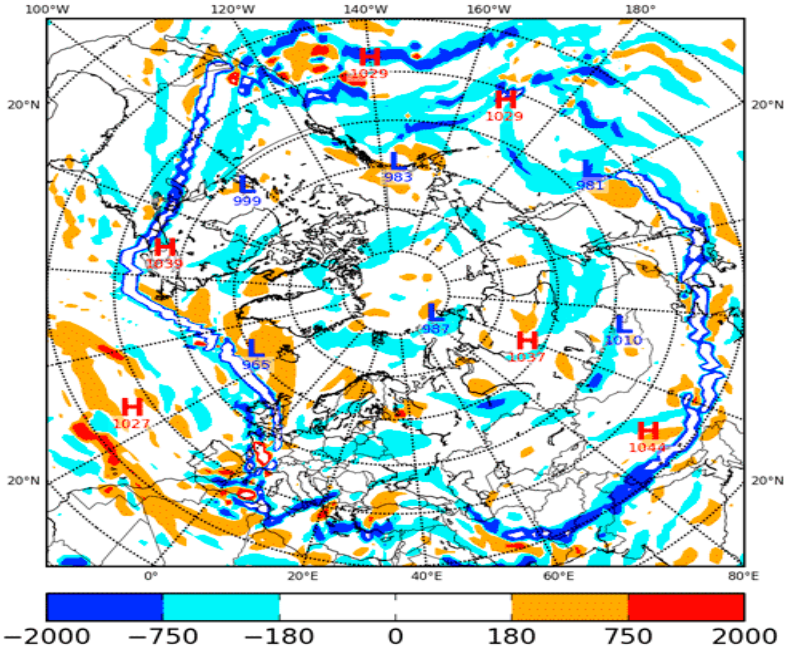

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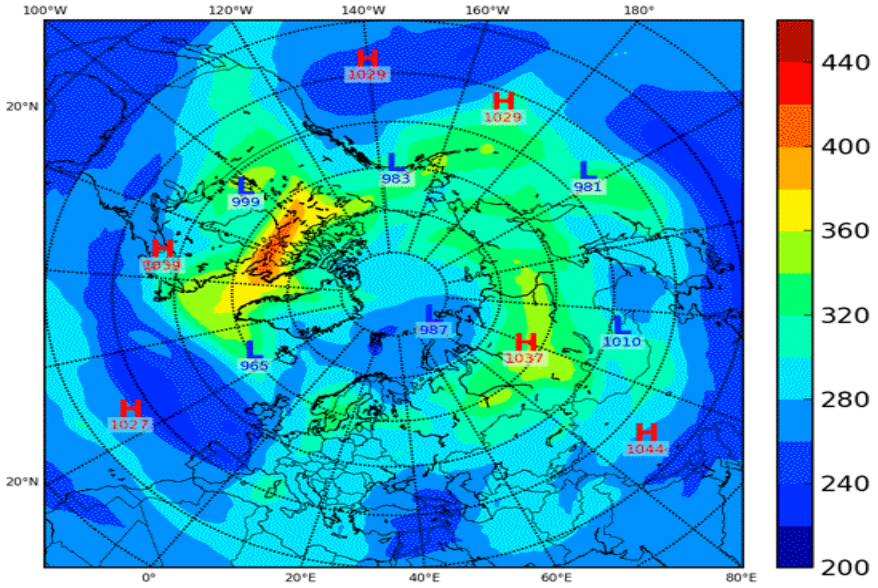

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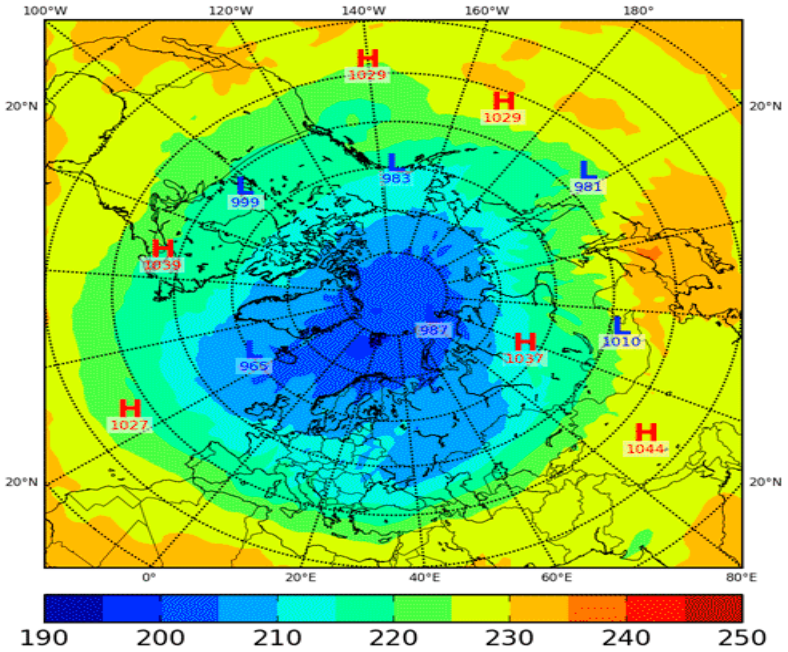


Total Ozone Observational Activities

THE MINISTRY OF NATURAL RESOURCES AND ECOLOGY OF THE RUSSIAN FEDERATION

Federal service for hydrometeorology and environmental monitoring (Roshydromet)

Main Geophysical Observatory (MGO)

(filter M-124 network instruments)
- maintenance (tech. assistance)
- measurement assurance (metrology)
- methodology assurance

M – 124 Ozone network stations
are subordinated to Federal Service

Central Aerological Observatory (CAO)

- archiving the column ozone data
- accomplishing quality assurance of the data
- daily monitoring and analysis of the ozone fields using M-124 network data and Dobson, Brewer, SAOZ and available s/c ozone data.

Reference points
Dobson
Brewer
SAOZ

WMO World Ozone and UV Center

Russian Academy of Science

OBSERVATIONAL ACTIVITIES

- Total ozone measurements
- Vertical profile measurements
- Surface ozone observations.

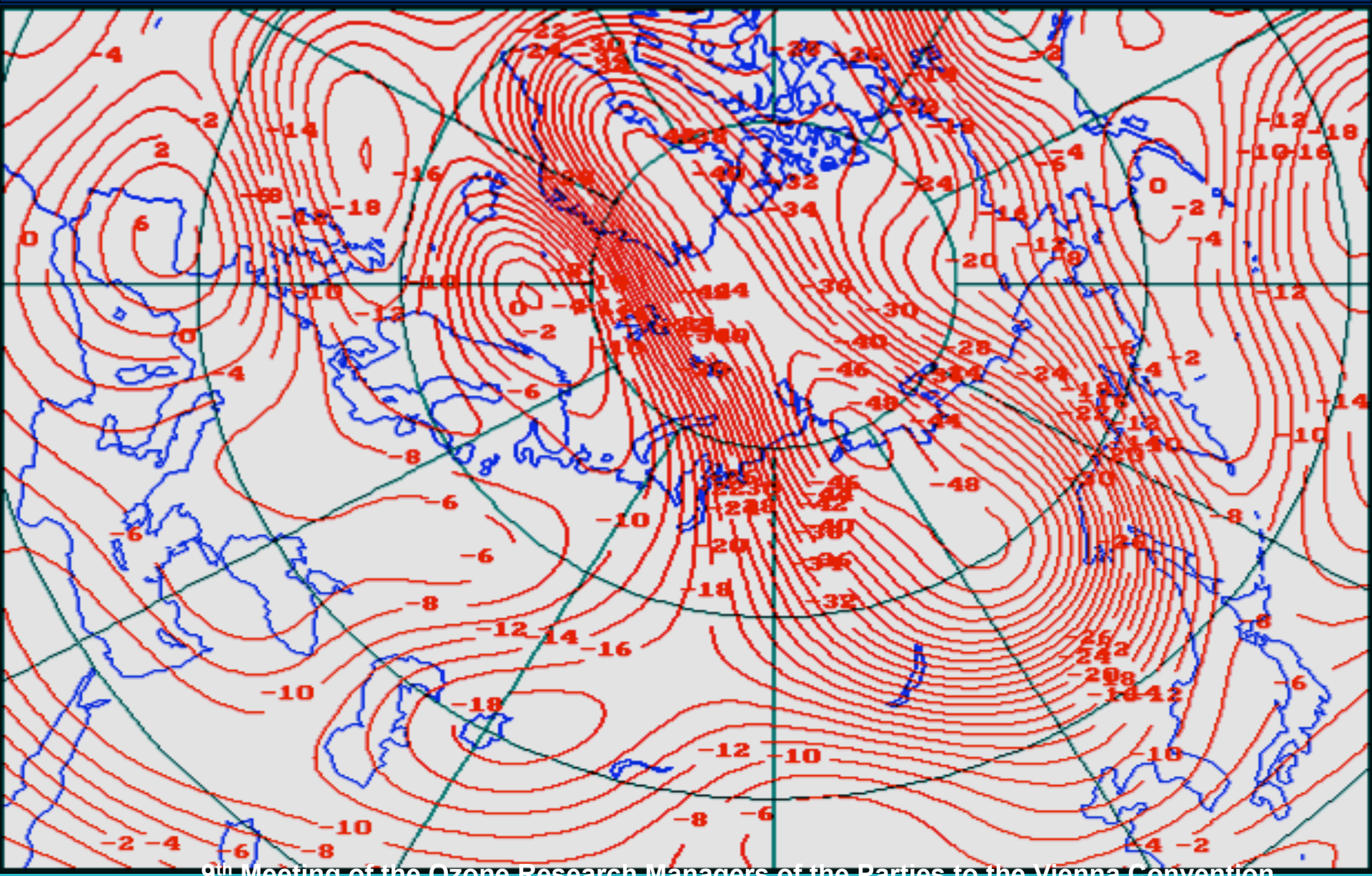
Column ozone measurements

- Daily measurements are made by ozone network of Roshydromet service using filter instruments M-124
- Roshydromet and RAS reference ozone points using Dobson (2), Brewer (5) and SAOZ (6) instruments

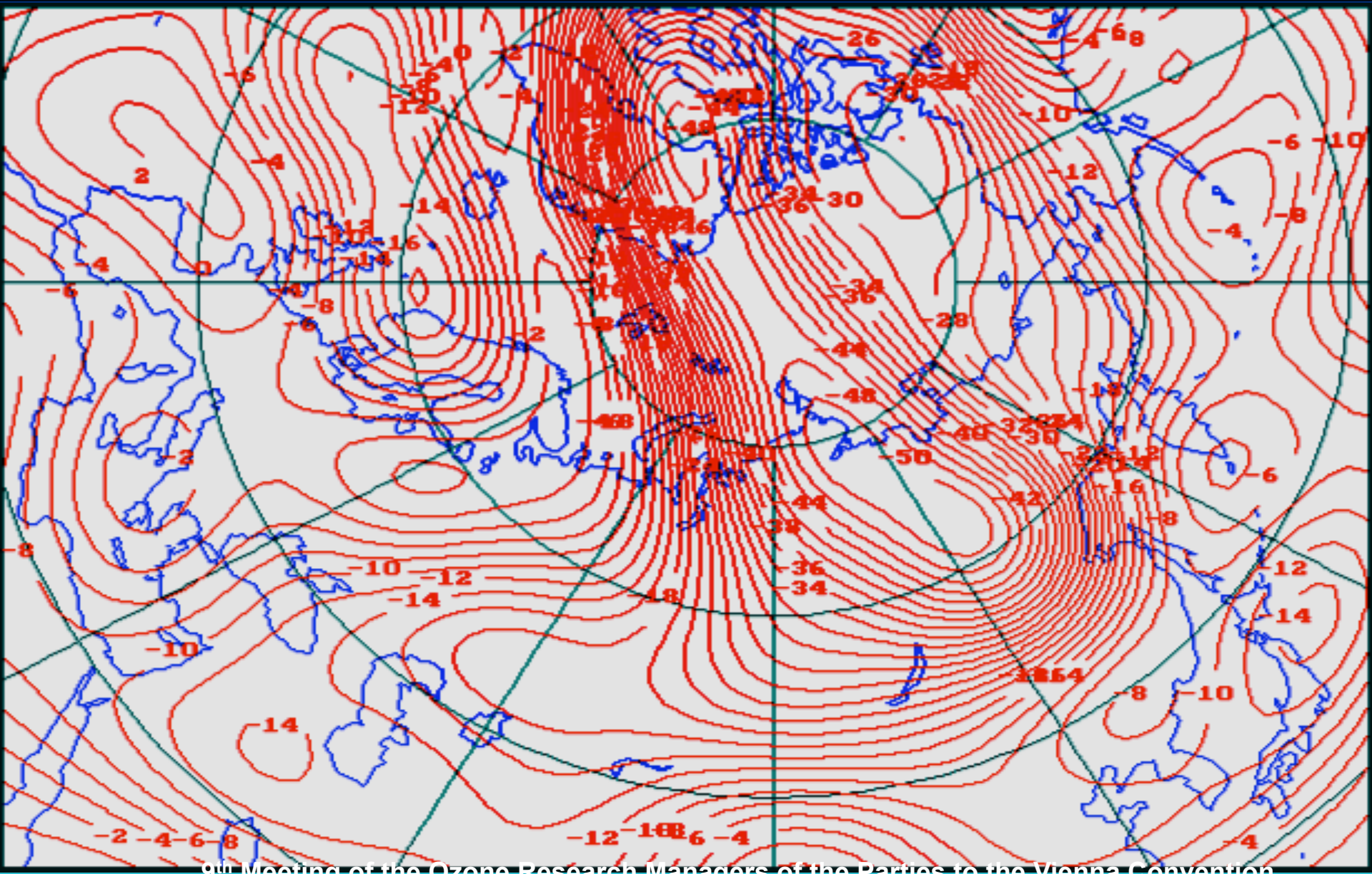
Column ozone measurements 2011-2013

Column ozone measurements 2011-2013

Column ozone deviation, % 22 March, 2011



Column ozone deviation, % 21 March, 2011



Profile measurements of ozone and other gases variables relevant to ozone loss

- During 2011 and 2012 spring seasons, several measurements of ozone vertical profiles were made by Roshydromet in the frame of international cooperations using ozone sondes at Salekhard station (67N, 67E); the data is available at NDACC server (http://www.ndacc.org/).

- LPI RAS and Institute of Applied Optics RAS measuring ozone profiles using microwave (142.2 GHz) radiometers (Solomonov et al., 2012).

- IOA RAS conducted the regular observations of ozone, nitrogen dioxide and aerosol profiles using lidar.

- The first TO measurements from the Russian geostationary weather satellite Elektro-L have been obtained (Kramchaninova and Uspensky, 2013).

UV measurements

- The Lomonosov Moscow state University continue monitoring of the surface UV radiation using the UVB-1 1YES pyranometer since 1989.
- The Brewer instruments located at the Yakutsk, Obninsk, Kislovodsk (since 1989) and Dolgoprudny (2014) were calibrated to measure the spectral distribution of the surface UV radiation.

Calibration activities

- The MGO of Roshydromet provides calibration of ozonometers M-124. TO reference is provided by Dobson spectrophotometer No.108, which, in turn, once in 4 years undergoes intercalibration procedure at the WMO European Calibration Center. Since 1988, the deviation of Dobson No.108 TO measurements from the WMO reference values has not exceeded 1%. The calibration of the M-124 instruments are made with a period no more then 2 years.
- Brewer spectrophotometers operated in Obninsk, Kislovodsk, and Tomsk, were last calibrated in 2012.

Regular TO measurement quality control

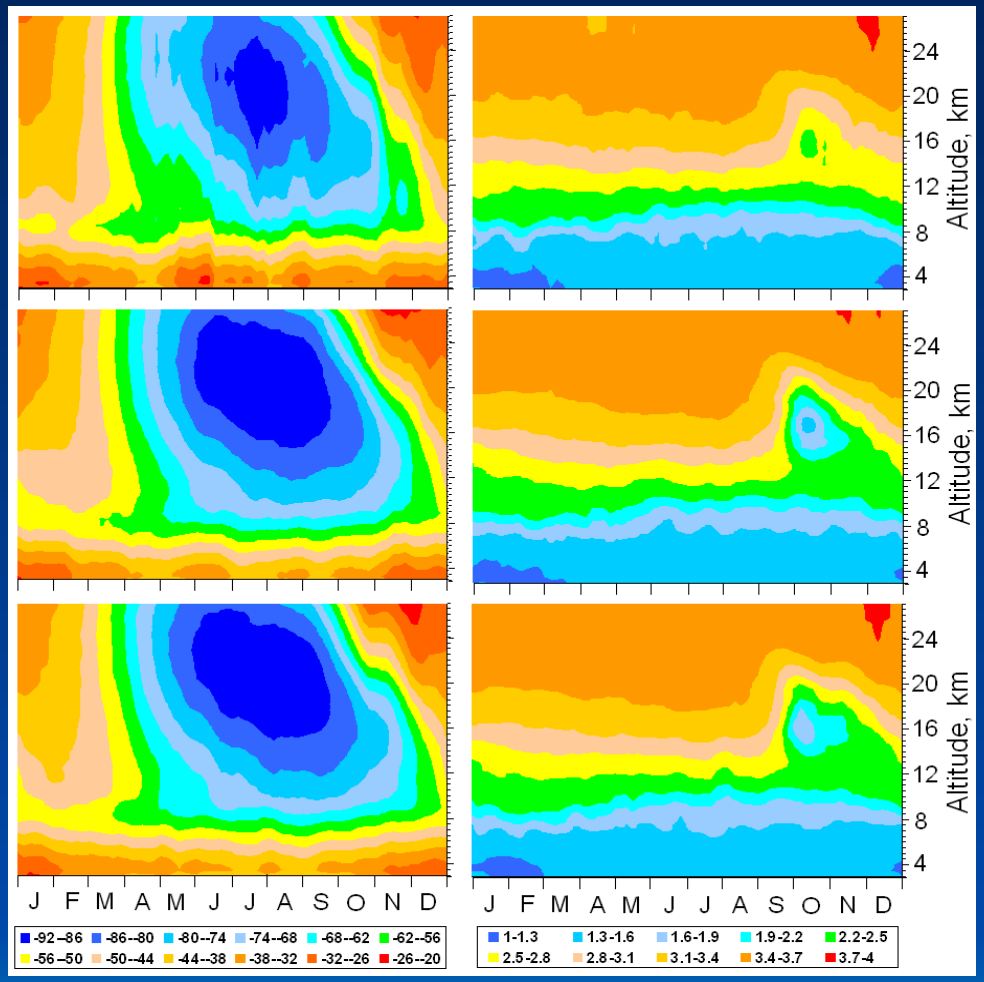
- **TO measurement scale stability is maintained through regular calibration of M-124 ozonometers at MGO and monthly ozonometer intercomparison at the stations.** Each station has got 3 instruments – operational, back-up, and reserve.
- **The MGO provides continuous control of measurement quality and performance of M-124. Ozonometers with considerable changes in measurement scale are replaced ahead of the schedule time, and undergo calibration.**

Ozone measurements in troposphere

- The regular measurements of surface ozone are continued at the Kislovodsk, Moscow, Dolgoprudny, Lovozero and Tomsk stations.

- The most long run measurements of tropospheric ozone are at the mountain scientific station Kislovodsk (2070 m above sea level) since March 1989.

RESULTS FROM OBSEVATION AND ANALYSIS TOTAL OZONE



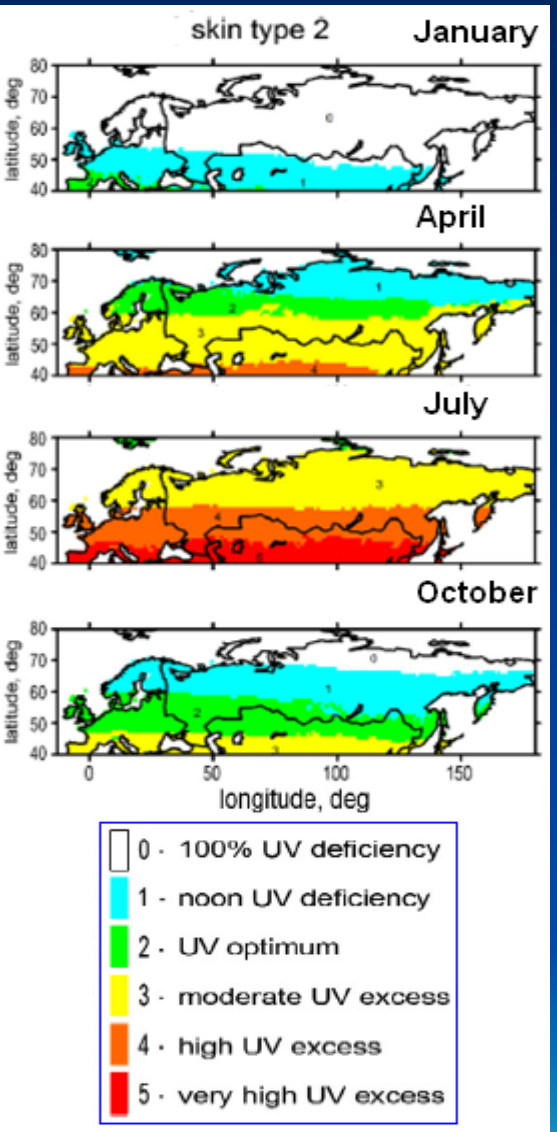
Mean annual variation of temperature (°C; left) and common logarithm of ozone mixing ration (billion^{-1}; right) at different heights H (km) over NOAA South Pole station, based on ozone sounding data: during 1986-1990 (top)., 1996-2000 (middle), 2006-2010 (bottom) (Zvyagintsev et al., 2012).

RESULTS FROM OBSEVATION AND ANALYSIS

Column ozone

Some publications are devoted to the investigation of an unprecedented deep and long-term 2011 anomaly in the high-latitude Northern. It is shown, in particular, that the anomaly accompanies with very low temperatures that persisted for a record-long time in that region, with the lower stratosphere temperatures exceeding those characteristic of the Antarctic ozone hole by nearly 10°C. Nevertheless, Northern Hemisphere stations did not observed any local minimum in the vertical distribution of ozone mixing ratio at 15-20 km that is representative for the Antarctic ozone hole.

RESULTS FROM OBSEVATION AND ANALYSIS



. Examples of the spatial distribution of UV resources for the 2nd skin type under typical cloud conditions in January, April, July, and October. Based on the data from (Chubarova and Zhdanova, 2013).

The influence of different factors (sun elevation, total ozone, surface albedo, optical properties of aerosols and clouds) on two types of biologically active UV radiation – the one causing erythema (erythema-weighted) and the other producing vitamin D – was studied. A new classification of UV-resources was proposed which helped to estimate the natural areas with UV-deficiency, UV-excess, and UV-optimum for human health in Eurasia. This classification takes into account aerosol distribution, surface albedo, and total ozone for different seasons. In particular, it is shown that UV-irradiance in Europe is more comfortable that in Asia, while the largest part of Russia suffers from UV deficiency during cold seasons.

(Chubarova, 2012, 2013; Zhdanova and Chubarova, 2013)

DATA REPORTING

The data from routine TO observations on the M-124 network are transmitted to the Hydrometeorological Center of Russia, CAO, and MGO daily. CAO archives the data, performs their primary quality control, and transmits them to the WOUDC. This data, together with that from other countries, is employed by the WOUDC for operational imaging of TO fields (http://woudc.org/). Also, CAO performs operational mapping of TO distribution over Russia, reveals anomalies and analyzes the reasons for their formation.

At the MGO the TO data undergo more thorough quality control, which enables assessing the performance of instruments, data correction. After QA control the results are transmited to the WOUDC.

The WOUDC also regularly receives TO and UV data measured with Brewer spectrophotometers at Kislovodsk, Obninsk, and Tomsk stations.

Total ozone and NO_2 measurements on the territory of Russia using SAOZ are made at 6 high-latitude stations: Anadyr (64°N, 177°E), Zhigansk (67°N, 123°E), Irkutsk (52°N, 104°E), Salekhard (67°N, 67°E), Dolgoprudny (56°N, 37°E), Murmansk (68N°., 33°E.).