TOR station for environmental monitoring

Arshinov, Mikhail, Arshinova, V., Belan, Boris, Davydov, Denis, Kovalevskii, Valentin, et al.

Mikhail Yu. Arshinov, V. G. Arshinova, Boris D. Belan, Denis K. Davydov, Valentin K. Kovalevskii, Aleksandr P. Plotnikov, Evgenii V. Pokrovskii, T. M. Rasskazchikova, D. V. Simonenkov, Tatyana K. Sklyadneva, Gennadii N. Tolmachev, "TOR station for environmental monitoring," Proc. SPIE 3105, Chemical, Biochemical and Environmental Fiber Sensors IX, (30 May 1997); doi: 10.1117/12.276173

SPIE.

Event: Environmental Sensing III, 1997, Munich, Germany

TOR-station for the environmental monitoring

M.Yu.Arshinov, V.G.Arshinova, B.D.Belan, D.K.Davydov, V.K.Kovalevskii,
A.P.Plotnikov, E.V. Pokrovskii, T.M.Rasskazchikova
D.V. Simonenkov, T.K.Sklyadneva and G.N. Tolmachev
Institute of Atmospheric Optics,
Siberian Branch of the Russian Academy of Sciences, Tomsk

ABSTRACT

In December 1992 a station for atmospheric observations has been put into operation at the Institute of Atmospheric Optics within the frameworks of the program of ecological monitoring of Siberia. The station provides for acquiring data on gas and aerosol composition of the atmosphere, on meteorological quantities, and the background of gamma radiation. The station operates day and night and the whole year round. All the measurement procedures are fully automated. Readouts from the measuring devices are performed every hour 10 minutes averaged. In addition, synoptic information is also received at the station. Periodically gas chromatographic analysis is being done to determine concentrations of hydrocarbons from the methane row. Occasionally, chemical composition of suspended matter is determined relative to 39 ingredients. The station is located to the north-east of Tomsk, Akademgorodok. Therefore sometimes it measures air mass coming from Tomsk down town area and some times the air mass from rural areas. As a result information obtained at this station should be typical for recreation zones around Tomsk.

Keywords: monitoring, environmental, aerosol, meteorological parameters, TOR-station

INTRODUCTION

The problem of study of climatic factors and their variability is of particular interest when studying the spatiotemporal dynamics of meteorological parameters, gas and aerosol components of air over extended period. The above-mentioned parameters mainly determine the radiation regime of the atmosphere. At the available network of stations for monitoring, the meteorological values are monitored according to the programs confirmed by the World Meteorological Organization.

The problem of monitoring of gases and aerosols has not yet been solved. On the one hand, for this purpose we have no mass inexpensive measuring instruments. On the other hand, educational institutions do not train workers in this field. As a result of which, in the field of atmospheric Sciences the data on gases and aerosol do not occupy a proper place.

Since 1991 the Institute of Atmospheric Optics (SB RAS) has become a coexecutor of the project TOR (Tropospheric Ozone Research) of the programme EUROTRAC (European Experiment on the Transport and Transformation of Environmentally Relevant Trace Constituents in the Troposphere over Europe). The city of Tomsk has been chosen as a reference point for researchers from Europe due to its geographic position, especially the fact that Tomsk is located in the boreal forest zone.

The TOR-project research programme proposes to organize the stations for monitoring of ozone and ozone cycle components.

In 1993 the station for ozone monitoring has been constructed at the Institute of Atmospheric Optics. The station is located in the north-eastern outskirts of the Tomsk Akademgorodok and, depending on wind direction, the measurements can be carried out both under background conditions and under conditions of the industrial centre influence. This paper describes the above-mentioned station and the results obtained during its work. This station is named as the TOR-Station.

1. SPECIFICATIONS OF THE TOR–STATION

The station for measurement of the atmospheric aerosol parameters, meteorological values and some gases has been put into operation at the end of December, 1992 and since that moment has been persistently operating. The schematic diagram of the station is shown in Fig. 1, specifications are given in Table I.

Table 1.

Device	Parameter measured	Range	Error, %	Time constant, s
GIAM–15 gas analyser	CO, mg/m^3	0.1...100	5	1
GIAM–15 gas analyser	CO_2, ppm	1...1000	10	1
Ozonometer 3–02 P	O_3, μg/m^3	1...1000	15	1
R-310-11	NO_2, μg/m^3 NO, μg/m^3	1..100 1..100	20 20	1 1
Aerosol counter AZ-5	N(r), cm^{-3} 12 channels	0...1000 0.4...10.0 μm	20	1
Diffusion spectrometer of aerosols	N(r), cm^{-3} 8 channels	0...200.000 2...200 nm	25	5min
Meteorological system	t, °C f, % d, deg V, m/s	–50...+50 10...100 0...360 0...40	0.1°C 7 10 10	1 1 s...5 min 1 1
Photoelectric nephelometer	a (0.55 μm)	0.001...1 km	7	1
Mercury gas analyser	gamma background, μR/h	1...1000	30	1
Piranometer M-115M	Total solar radiation W/m^2	0...1368	10	1
Balansometer M-10M	Radiation balance W/m^2	0...800	10	1
Soil temperature meter M-54-2	t, °C	–50...+50	0.3°C	1

As is seen from Fig. 1, the station consists of 7 measuring units. The information from the units is recorded at the computer, where the data are normalized and recorded to a magnetic data medium.

Since all the meters, being the part of the station, are contact, the control system is one of the units of the station intended for turning on the flow stimulators of the gas analyser, aspiration devices of meteorological system, switching of measuring and calibration regimes of the devices. Switching on and off of the system occurs based on the corresponding computer command.

The work of the station is organized as follows. During 10 minutes before the measurement the control system brings into operation the flow stimulators and aspiration units of devices for scavenging the supply service lines. Then the calibration characteristics are taken. The measurement process after carrying out the above preparative operations continues during 10 minutes. At the same time, a reading of each parameter with 1 Hz frequency is taken. The final result, recorded by a computer, is obtained by averaging of 600 values and calculating the root-mean-square deviation on their basis for every measured value. This is necessary for control of serviceability of

primary converters (zero drift, bridge unbalance, and so on). The measured at the station characteristics, recording ranges and measurement errors are given in Table I. Except for those, several gases are investigated using the chromatographic technique, synoptic information is constantly received via radiochannels.

The measurement of the values enumerated in Table I is carried out every hour over day. The station operates in this mode since December, 1992 to the present day.

The output data from the station are registered in the special database, which except for the measurement results includes also synoptic information of observation periods using the technique previously developed by the authors.

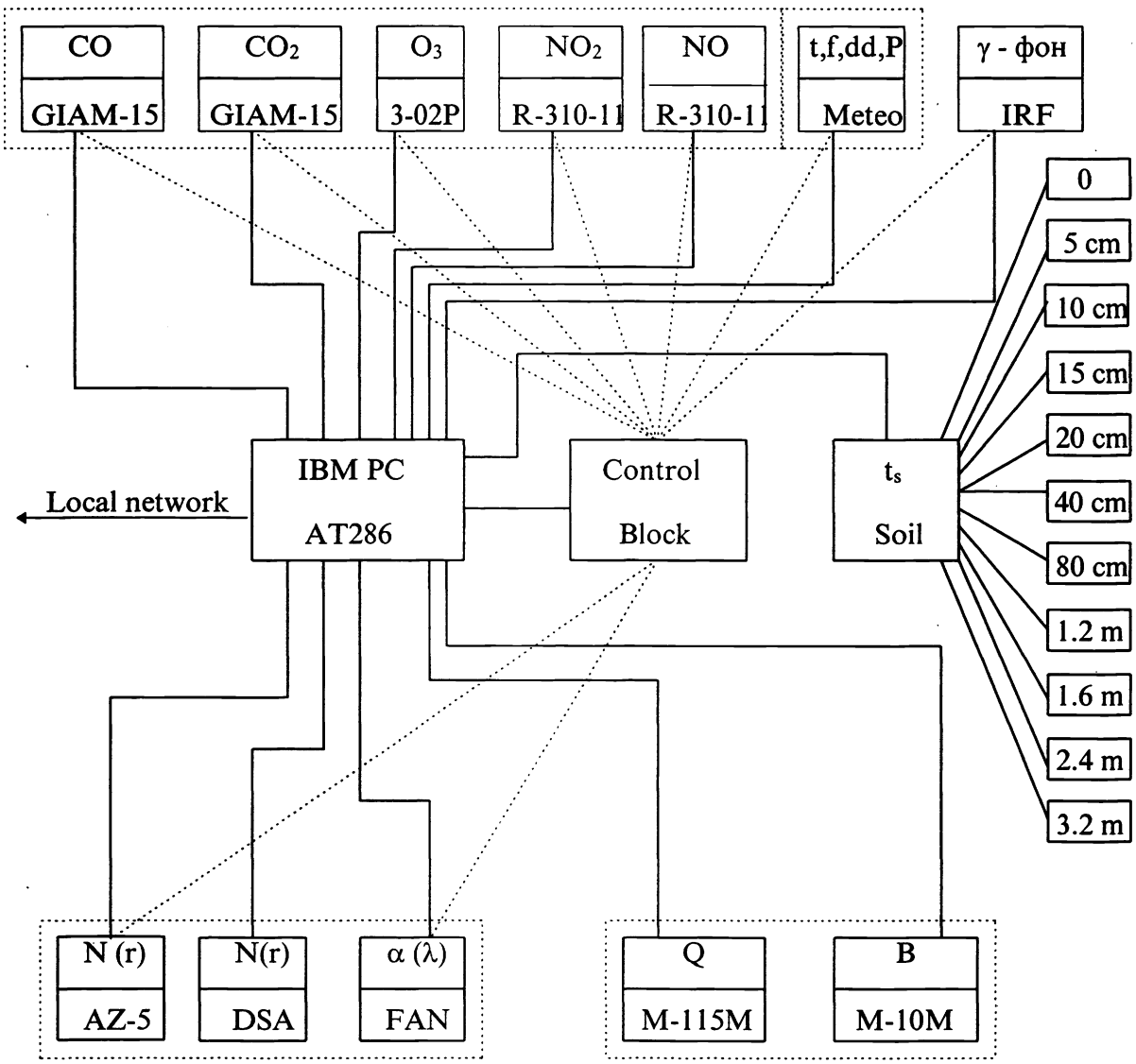

Fig.1. Structure of the TOR-station.

2. GEOGRAPHIC POSITION OF THE STATION

The geographic position of the station for monitoring of atmospheric parameters is of great practical importance since it determines the representativity of the data obtained. The TOR project proposes the research into ozone both in the background and in the industrial regions.
At the south-west northward wind the TOR–station is affected by the air passing through the Tomsk territory. It is evident that in this case the results of measurements are affected by the presence of motor transport exhausts and industrial emissions.

At the wind from north-east to south, the air comes to the TOR–station from the background regions made up of forests. At the same time, there are no any factories at the territory of settlements located in the above-mentioned sector.

The TOR-station is arranged in a building of the high-altitude lidar sensing station of the Institute of Atmospheric Optics (SB RAS) located at the north-eastern periphery of Tomsk Akademgorodok. There are no enterprises and highways adjacent to the station that excludes the presence of gas and aerosol local sources. There are some small forest areas of broad-leaved trees and conifers around the station, the ground is covered with grass.

The meteorological sensors of the station are located as follows. The temperature and humidity data units are mounted at the rod placed at 12 m distance from the building, at 15 m altitude from the Earth's surface. The data unit of wind velocity and direction is mounted at the 10 m height meteorological mast at the building roof, so that it appears to be located higher than the trees surrounding the station. The air intake pipes for gas analysers and aerosol devices are made of Teflon tube and are placed on the outside. The air intake is performed at 15 m altitude. Thus we consider that the station building does not affect largely the unit readings. Nowadays in the framework of State Scientific Technical Programme "Sibir'" the work is proceeding on organizing the climate-ecological monitoring of Siberia. The goal and the problem of this monitoring are in close agreement with the EUROTRAC Programme. Therefore, the TOR-station described here fit naturally into its system. However, this monitoring requires the preparation of a large number of such stations.

In conclusion it should be noted that the present paper describes only the first phase of the TOR-station project. In what follows we would like to enlarge the set of measured values at the station described. The measurements should be performed in two directions by means of inclusion direct and total solar radiation, radiation balance, to be measured with data units and also a diffusion battery. This will make it possible to extend the measured particle size range (up to 2 nm) and thus to study the processes of gas–aerosol transformation. The work is in progress on extension of operation of the station for chromatographic determination of ozone cycle gas concentration as well as gases of anthropogenic origin.