MONITORING OF THE EARTH'S ATMOSPHERE AT THE TERSKOL OBSERVATORY: CURRENT STATUS AND PROSPECTS

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Continuous high-frequency (every minute) automatic measurements of surface ozone concentrations have been made at the high-altitude Terskol Observatory (on the slope of Elbrus mountain, the Northern Caucasus) since 2003. We present the main experimental results including seasonal variations and the main factors affecting ozone levels. Ozone concentrations in air at Terskol Peak (3100 m above sea level) show a distinct seasonal cycle with the highest concentrations during spring–summer period and a peak amplitude of about 85 ppbv. In autumn–winter period, the daily maximum ozone concentrations are typically around 40 ppbv.

INTRODUCTION

The state of the atmosphere, changing its composition and the cycling of elements within the Earth system has a great influence on the global environment. Today, no region of the Earth's atmosphere is unaffected by anthropogenic pollution. The monitoring of the atmosphere, in particular, of its lowest level, the troposphere, is of increasing importance. Ozone is the main product of complex photochemical processes in the lower atmosphere involving oxides of nitrogen and volatile organic compounds as precursors of ozone formation. To improve our understanding of how the troposphere and stratosphere are coupled and to obtain a wide picture of the present-day state of the atmosphere in the Northern Hemisphere, it is necessary to provide data sets of the spatial and temporal variations of gases in the ambient air focusing especially on processes which can cause increased ozone concentrations, namely, transboundary transport, stratospheric intrusions, horizontal advection of polluted air, and in-situ production of ozone due to local emissions. Special interest must be taken for study of the exchange of ozone between the atmospheric boundary layer and the free troposphere basing on measurements at high-altitude stations.

THE AIR MONITORING STATION AT TERSKOL PEAK

The primary focus of our activities is to develop a regular station in southeastern Europe for monitoring of variations of ozone, its precursors, and other atmospheric gases and particles. The station at Terskol Peak has some advantages, namely: 1) high-altitude position (3100 m above sea level); 2) availability of optical telescopes to control the atmosphere by astronomical techniques; 3) availability of provisions for data distribution via modem and/or computer networks.

Presently, the site is equipped with the DASIBI 1008 U.V. Photometric Ozone Analyzer, which runs continuously. The data observed are transferred together with the meteodata to the data analyse centre in Kyiv. A NO/NOx Analyzer as well as a VOC Analyzer has been ordered to be installed in the winter of 2004–2005.

The future activities planned for the environmental station Terskol are as follows:

- assimilation of ground-based and satellite data to determine the nature and magnitude of processes contributing to the problem of the stratosphere-troposphere exchange and intercontinental transport, and the extent of photochemical processing of pollution in the free troposphere;
- experimental and theoretical study of the impact of emissions from the continents on the composition of the atmosphere in southeastern Europe including the impact on air quality and on climate;
- participation in global ground-based experiments to investigate the composition of the global troposphere.

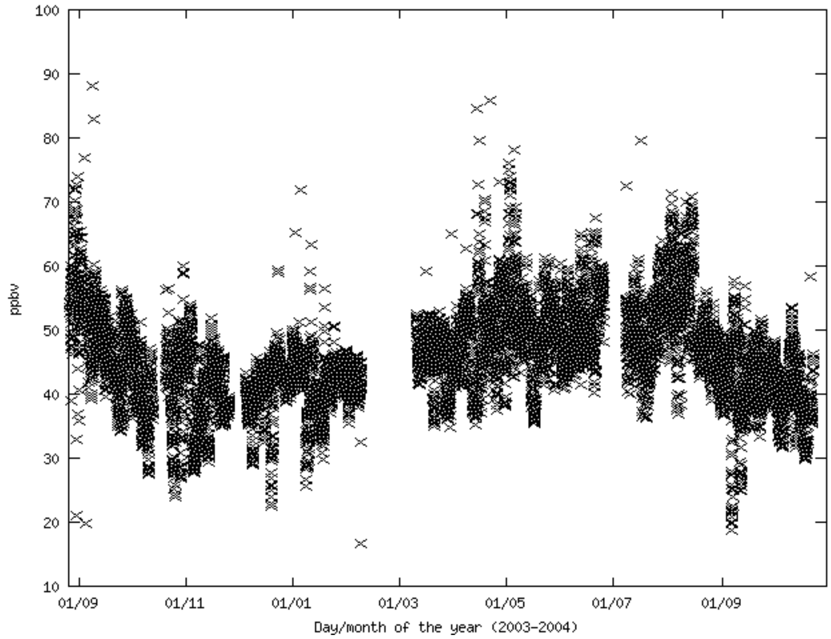

Figure 1. Seasonal variability of ground-level ozone concentrations at Terskol Peak

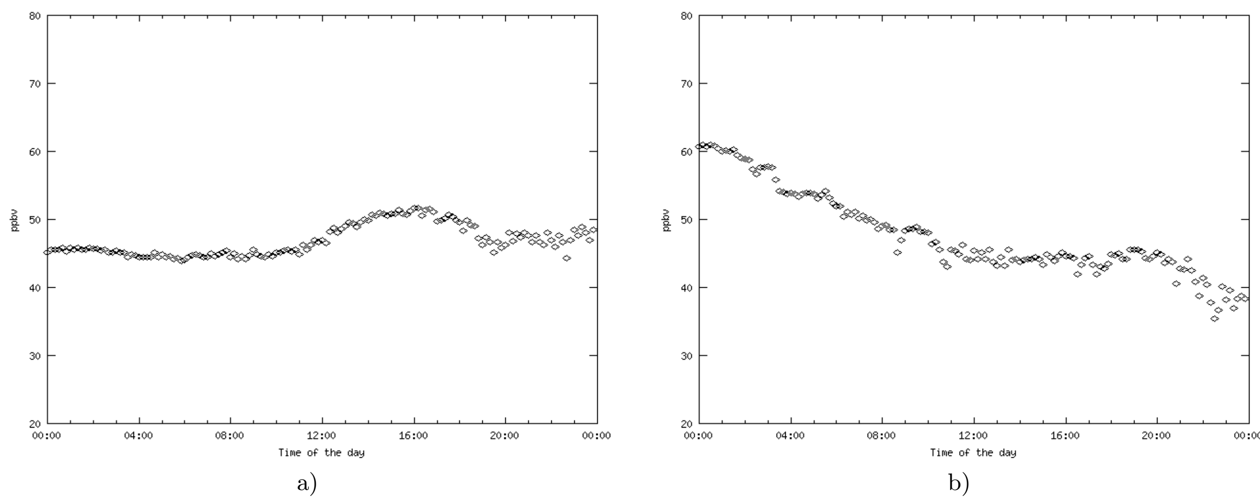

Figure 2. Daily variability of ground-level ozone concentrations at Terskol Peak measured on: (a) March 15, 2004; (b) April 30, 2004

The measurements required for most objectives can be realized using present-day capabilities of the Terskol Observatory as well as the instruments to be installed in the near future. Working in conjunction with the European stations, observations at this point provide the basic grid for an effective environmental control. The involvement of astronomical techniques will help to put the atmospheric study on a higher level, when not only ground-level measurements of air pollution are made but the total ozone and other gases abundances are determined from spectrophotometric UV observations of the Sun as well. Such determinations were made at the Terskol Observatory by the end of the 1990s [1], and work is underway to use these data for comparison with those derived with the aid of Dobson spectrophotometres.

The station Terskol was chosen in 2004 as a regional station for a Russian environmental monitoring program, which is aimed to contribute to the realization of the WMO Global Atmospheric Watch in Russia. This is the largest project on environmental research ever carried out over the giant territory of Russian Federation.

With very carefully designed programmes, sufficient redundancy measurements, and careful investigator analysis of the resulting data, promising results are expected after 1–2 years.

RESULTS AND DISCUSSION

Since the summer of 2003, precise ground-level ozone concentration measurements (every-minute volume mixing ratios) have been carried out at the Terskol Observatory. The analyses of the data sets obtained in 2003–2004 were focused on investigation of seasonal variability and trends of surface ozone. It was taken into consideration that ozone at Terskol Peak cannot be emitted into the ambient air anthropogenically or formed chemically because of the poorly inhabited area as well the absence of significant precursors emissions, only naturally, for example, through stratospheric-tropospheric exchange [3].

The surface ozone concentrations at Terskol Peak are mainly influenced by:

– meteorological phenomena (visibility, relative humidity, wind direction, etc.);

– intrusion of stratospheric ozone;

– vertical transport of polluted air masses from the valley.

The ozone concentrations at Terskol Peak are similar to concentrations observed on Jungfraujoch (3650 m above sea level, Alps) with roughly 40 ppbv in winter and 55 ppbv in summer [2]. Figure 1 shows the general features of seasonal variations, which are characterized by a spring-summer maximum with occurrences of ozone episodes up to 90 ppbv and autumn/winter minimum. The variability of hourly O_3 concentrations observed during different days is related to variations of meteorological conditions as shown in Fig. 2 ((a) by nice weather conditions, (b) by strong wind).

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[2] *Prevot A. S. H., Weber R. O., Dommen J., et al.* Ozone and vertical transport in southern Switzerland // Proc. from the EUROTRAC-2 Symposium 2002 / Eds P. M. Midgley, M. Reuther.–Weikersheim: Margraf Verlag, 2002.–P. 100–103.

[3] *Stohl A., Wernli H., James P., et al.* A new perspective of stratosphere–troposphere exchange // Bull. Amer. Meteor. Soc.–2003.–**84**, N 11.–P. 1565–1573.