

# KYRGYZ REPUBLIC

## Introduction

During long time the Kyrgyzstan carries out investigations on ozone and concerned problems in the Central Asian region in two directions:

- a complex monitoring of ozone and main greenhouse gases at the station "Issyk-Kul" located on a coast of the high-mountain Issyk-Kul Lake (42.6°N, 77°E, 1640 m a.s.l.);
- a monitoring of tropospheric and stratospheric aerosol at the Lidar station "Teplokljuchenka" located in a southeast part of the Issyk-Kul Lake (42.5°N, 78.4°E, 2200 m a.s.l.).

These stations are located in the mountains of the Northern Tien Shan, have the very favorable conditions for investigations of the above-mentioned problems due to a high transparency of an atmosphere, a lot of sunny days in a year, and also because of absence of sources of anthropogenic pollution. They are unique in the central part of the Eurasian continent. Investigations of ozone layer and stratospheric aerosol changes and their influence on regional climate change are carried out at these stations.

## 1. MONITORING

At present, a complex monitoring of total ozone and atmosphere parameters that may influence an ozone layer state are carried out in Kyrgyzstan.

### 1.1. The ozone&GHG station "Issyk-Kul"

Investigations of atmospheric ozone in Kyrgyzstan were begun at the Kyrgyz State National University in 1978. Different variants of spectral multiwave methods of measurement of the total content of ozone and stratospheric nitrogen dioxide were developed. For realization of these methods the devices were made, and the scientific station "Issyk Kul" was created.

The regular measurements of the total ozone content are carried out at the station since June 1979 (manager V.Semyonov). During the next years the monitoring of a content of a stratospheric nitrogen dioxide (NO<sub>2</sub>), an integrated content of carbon oxide (CO<sub>2</sub>), water vapor (H<sub>2</sub>O) in an atmosphere, and a spectral transparency of an atmosphere in a visible spectrum range of a solar radiation with an estimation of effective parameters of tropospheric aerosol was organized at this station.

For validation of ozone measurements in various years, a comparison of the measurements by the ozonometer at the station with measurements by the national etalon device of Russia (Dobson spectrophotometer #107) and with the data of measurements by the satellite device TOMS was carried out.

Since January 2000, a monitoring of intensity of solar UV radiation at the Earth's surface in 5 bands of a solar spectrum in width of 2 nm being centralized on wave lengths 305.5; 312.5; 320.0; 340.0 and 380 nm was carried out by the device MICROTOPS II. The device registers radiation of a solar disk plus scattered radiation within a solid angle of 2.5 degrees.

### 1.2. The Lidar station "Teplokljuchenka"

A monitoring of tropospheric and stratospheric aerosol by the multiwave lidar is carried out since April 1988 at the Lidar station "Teplokljuchenka" (manager B.Chen).

The lidar can work in two modes:

- Simultaneous registration of intensity of backscattered radiation at three laser wavelengths (355, 532 and 1064 nm) and Raman backscattering by atmospheric nitrogen (387 nm) in analog or photon counting modes of operation;
- Registration of two perpendicular polarization components of backscattered signal at 532 nm wavelength by using of Vollandstone prism as a polarizer.

## 2. RESEARCH

### 2.1. The ozone&GHG station "Issyk-Kul"

Mean monthly total ozone contents ( $X$ ) in an atmosphere over the central part of Eurasia for period of 1979-2001 are presented in Fig.1. A determination error for  $X$  is less than  $\pm 0.5\%$ . The figure also presents the smoothed total ozone content (thick curve) and the linear trend (straight line). During the whole observation period the mean annual ozone content in an atmosphere decreased to about 10.5% (34 DU) with an average rate  $-(0.41 \pm 0.03)\%$  per year.

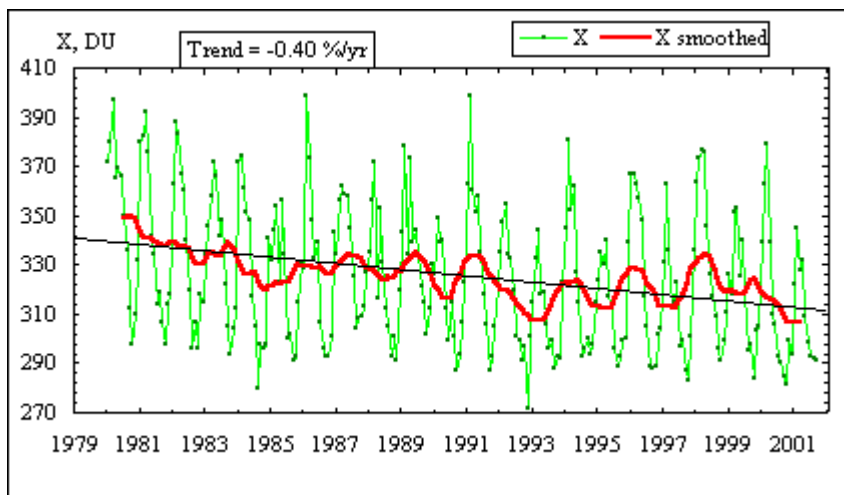


Fig.1. Total ozone content ( $X$ ) in an atmosphere of the Northern Tien Shan.

During the whole measurement period the almost regular quasibiennial oscillations of smoothed  $X$  content with the amplitude of 15 DU were observed. The disturbance of these oscillations regularity took place in the periods of 1980-1983 and 1991-1992.

In different time intervals the real trend of interannual ozone change may significantly differ from the linear trend for all period of observations. After a short period (1993-1998) of restoration of ozone layer with the mean rate 0.6% per year, a further ozone layer depletion with the rate  $-1.5\%$  per year took place during the following period.

The parameters of daily (fast), interdiurnal, seasonal and long-term fluctuations of an ozone layer and stratospheric aerosol above the Northern Tien Shan were determined. It is established that a probable reason of daily (fast) fluctuations are the internal gravitational waves generated by instability of jet flows in troposphere. Interdiurnal changes are connected to displacement of air mass, reorganization of vertical streams in jet flows, and to planetary waves.

It is seen from Fig.1 that during some time periods, along with usual seasonal total ozone variations, considerable "gaps" - negative anomalies of different duration (from several days to several months) - were observed at the station. In their essence these anomalies are regional, local "microholes" in ozone layer similar and equal in size to the anomalies observed over Europe in 1980s.

The parameters of abnormal deviations of ozone and  $\text{NO}_2$  were determined (see Fig.2). These anomalies appear in a phase or in an anti-phase depending on the shape and displacement of the northern circumpolar vortex.

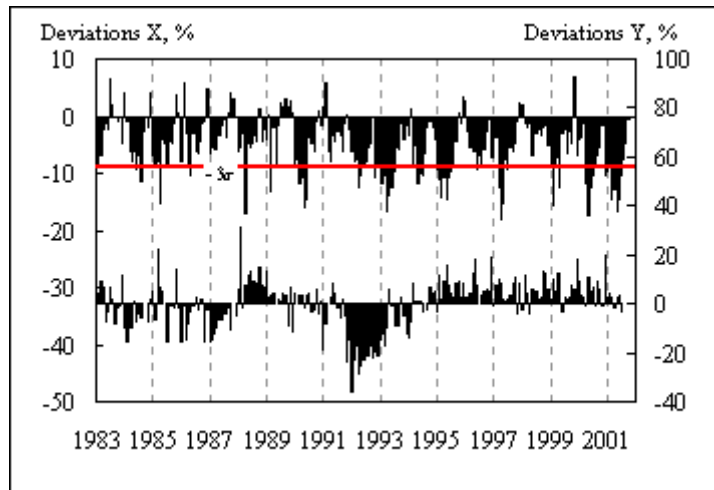


Fig.2. Deviations of total ozone (upper panel) and nitrogen dioxide (lower panel) from a monthly mean at the Issyk-Kul station.

The investigation of influence of solar activity on an ozone layer above the mountain region of the Central Asia was carried out.

## 2.2 The Lidar station “Teplokljuchenska”

The regularities of transformation of an aerosol layer in a stratosphere and its changes in a result of the natural and man-caused accidents, influence of stratospheric aerosol on a radiating and thermal regime of the region were investigated. The model estimations of climatic consequences of natural and anthropogenic changes of a stratospheric aerosol layer were carried out.

The investigations of influence of sulfuric acid stratospheric aerosol on the general content of ozone were carried out, and preliminary results were obtained.

A comparison of dynamics of the reverse aerosol dispersion coefficient  $F_{\pi\alpha}$  change in the layer 15-30 km with a change of total ozone content shows a presence of the relation between them (see Fig.3). In which connection, this relation is negative as a whole for the analysis period (1988-2000),

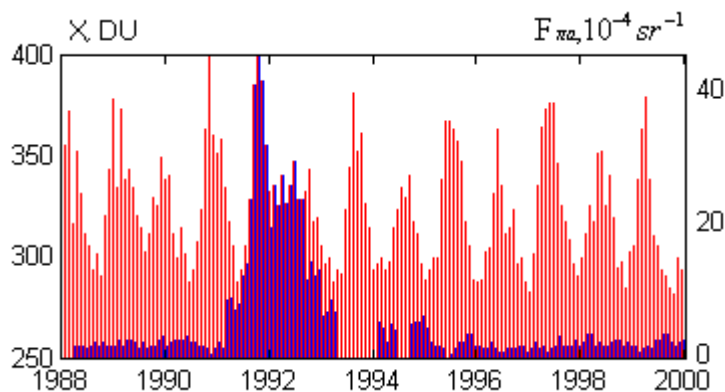


Fig.3. Variation of total ozone content (X) and reverse aerosol dispersion coefficient ( $F_{\pi\alpha}$ ) in the layer 15-30 km.

while it is positive, vice versa, during the periods of atmosphere distortion by natural disasters (convulsion of nature, oil fire, nuclear explosion and others). A presence of such relation cannot be explained by mechanisms of photochemical interaction of ozone with sulfuric acid stratospheric aerosol. Evidently, another physical-chemical mechanism of influence of stratospheric aerosol on ozone layer exists.

### **3. APPLICATIONS**

The results of measurements of ozone obtained at the station "Issyk-Kul" are regularly transmitted to the WMO World Ozone and UV radiation Data Centre (Canada) where it is registered by the number 347.

### **4. PUBLICATIONS**

The results of investigations are being published in national and international journals and proceedings.

### **5. PLANNED RESEARCH ACTIVITIES**

In account of the Decision V/3. Recommendations of the fourth meeting of the Ozone Research Managers, the priority at the above mentioned stations in Kyrgyzstan for the nearest future will be given to investigations of interaction between ozone and climate, between stratospheric aerosol and climate, and influence of sulfuric acid stratospheric aerosol on ozone.

To realize these tasks, it is necessary to carry out:

#### **5.1. Control of ozone layer and solar UV radiation in a mountain region of the Northern Tien Shan:**

- to continue monitoring of ozone, NO<sub>2</sub>, CO<sub>2</sub>, H<sub>2</sub>O and parameters of an atmosphere aerosol at the station "Issyk-Kul". To provide measurements of the ozone vertical profile using the Umkehr technique.
- to establish the ozone lidar for carrying out of probe of a vertical ozone stratification and investigations on influence of stratospheric aerosol on ozone;
- to establish the devices for measurement of other greenhouse gases (CH<sub>4</sub>, N<sub>2</sub>O), tracer gases (SO<sub>2</sub>, CO), total and scattered solar UV radiation at the Earth's surface.

#### **5.2. Investigations:**

- on the basis of the results of measurements of ozone, greenhouse gases and stratospheric aerosol, to carry out investigations of influence of these gases on a climate in the Central Asian region;
- to develop a statistical model of ozone change over a mountain region of the Central Asia for medium-term forecast of ozone layer state;
- to investigate an influence of ozone layer depletion on intensity of solar UV radiation at the Earth's surface in the region of the Issyk-Kul Lake;
- to take part in the international project on validation of measurements of O<sub>3</sub>, NO<sub>2</sub>, CO<sub>2</sub>, H<sub>2</sub>O, N<sub>2</sub>O, CH<sub>4</sub>, CO and parameters of aerosol by the device SCIAMACHY established on the satellite ENVISAT.

### **6. NEED OF SUPPORT**

For solution of above mentioned tasks, improvement and expansion of the base monitoring of ozone and stratospheric aerosol in the Central Asian region, Kyrgyzstan as a developing country needs a financial support from international organizations.

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