STUDIES OF CARBON DIOXIDE, METHANE AND CARBON MONOXIDE VARIATIONS IN THE AIR NEAR THE GROUND AND IN THE ATMOSPHERIC COLUMN IN THE EUROPEAN TERRITORY OF RUSSIA (MOSCOW REGION)

F.V. Kashin[1], Yu.I. Baranov[1], P.P. Tans[2], and T.J. Conway[2]

[1]*State Institution SPA "Typhoon", 82 Lenin Ave., Obninsk, Kaluga Region, 249038, Russia; +7(08439)71449, Fax: +7(08439)40910, E-mail: kashin@typhoon.obninsk.ru*
[2]*NOAA Climate Monitoring and Diagnostics Laboratory, 325 Broadway, Boulder, CO 80305, USA; 303-497-6681, Fax: 303-497-6290, E-mail: Thomas J. Conway@noaa.gov*

ABSTRACT
The results of atmospheric CO_2, CH_4 and CO measurements are presented. The measurements were made in air samples collected at heights of 4, 25, 100, 200 and 300 m above ground, and in the atmospheric column in Obninsk, Russia (55.11 N, 36.57 E, 183 m asl).

INTRODUCTION
The method applied at the stations for CO_2, CH_4 and CO content monitoring in the atmosphere is based on the estimation of a gas concentration in an air sample taken near the ground. The spectroscopic method is used for determining CO_2, CH_4 and CO contents in the atmospheric column from the solar radiation spectra. The application of these two kinds of data gives a possibility to investigate the peculiarities of CO_2, CH_4 and CO propagation in the atmosphere vertically from the sources located on the ground. Therefore, for a more detailed investigation of spatio-temporal variability of CO_2, CH_4 and CO joint measurements of their contents in the atmospheric column have been started from the High Meteorological Mast (HMM) at heights of 4, 25, 100, 200 and 300 m.

INSTRUMENTATION AND METHOD
The instrumentation complex used for the measurements of CO_2, CH_4 and CO contents in the atmospheric column consists of a system tracking the Sun and an automatically controlled spectrometer. The measurement method is based on the registration of solar radiation spectra in the spectral ranges including the oscillation-rotation absorption bands of CO_2, CH_4 and CO and on the determination according to them of the atmospheric transmission function. The dependence of the transmission function is calculated with the use of spectrum fine structure parameters from the HITRAN-04 database, vertical profiles of pressure, temperature, humidity, concentrations of CO_2, CH_4 and CO. The spectrometer has the spectral resolution of (0.2 – 0.4) cm^{-1} in the operation range of (2000 – 5000) cm^{-1}. The analysis of air samples is made at the instrumentation complex comprising a Fourier spectrometer with a spectral resolution of 0.5 cm^{-1}, a multipass optical cell and a system for sample preparation. The multipass optical cell provides an absorbing layer of 30 m at the base length of 1 m and the operation volume of 0.012 m^3. The technological gas system is used for air pumping and pumping out and for temperature and pressure control. The concentrations of CO_2, CH_4 and CO are determined at comparing the experimental spectrum presenting a radiation spectrum absorbed by an air sample in the multipass optical cell and with a modeled one calculated over the parameters of spectral lines from the HITRAN-04 database.

MEASUREMENT RESULTS
A direct comparison of the results of CO_2, CH_4 and CO measurements in the atmospheric column and in the air near the ground is impossible because the first results characterize total contents and the second ones concern concentrations in an air sample. Therefore total contents of the gases were recalculated as mean height-averaged concentrations under the condition that CO_2, CH_4 and CO are vertically uniformly mixed.

Fig. 1 gives CO_2, CH_4 and CO concentrations obtained from the measurement results made in the atmospheric column and in the air near the ground at a height of 4 m. The comparison has shown that:

- seasonal variations of CO_2 in the atmospheric column differ both in amplitude and phase from CO_2 seasonal variations in the air near the ground that depend on the ground-based sources and sinks of carbon dioxide;
- seasonal variations of CH_4 and CO in the atmospheric column and in the air near the ground coincide in phase as the source of these gases is their interaction with the hydroxyl in the troposphere;
- for CO_2 and CH_4 concentrations an agreement is seen in the atmospheric column and in their minimal values in the air near the ground;

- a discrepancy in phases of CO_2 seasonal variations and of CO amplitude seasonal variations is determined by the character of a vertical distribution of theses gases in the atmosphere, that is confirmed by the data in Fig. 2, where the results of CO_2, CH_4 and CO concentration measurements made at heights of 4, 25, 100, 200 and 300 m are given.

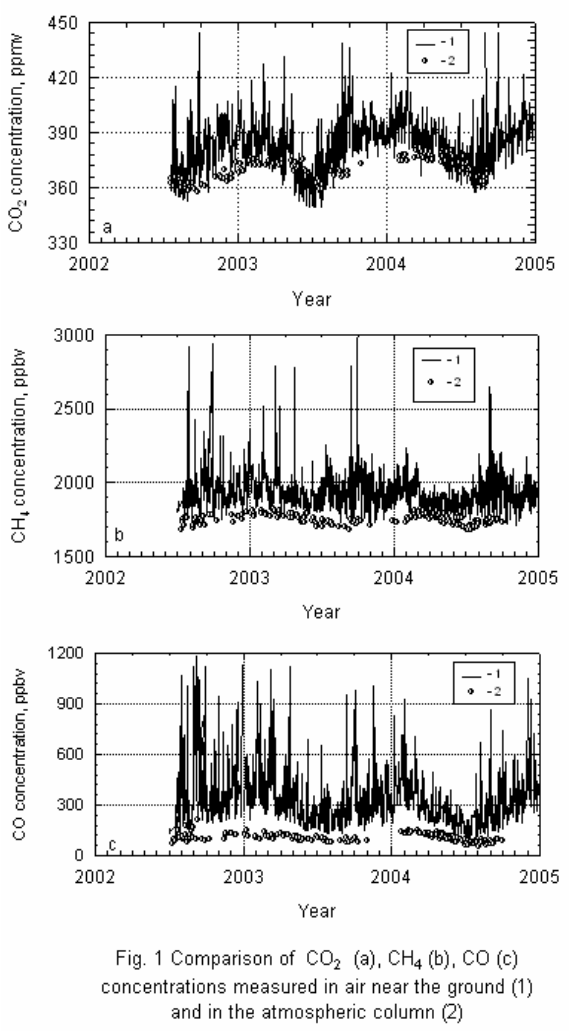

Fig. 1 Comparison of CO_2 (a), CH_4 (b), CO (c) concentrations measured in air near the ground (1) and in the atmospheric column (2)

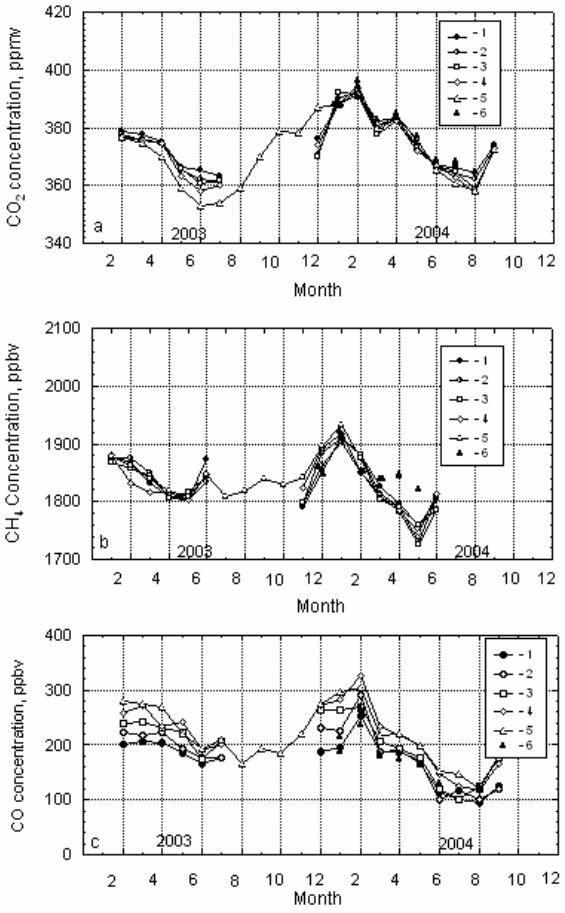

Fig. 2 Seasonal variations of CO2 (a), CH4 (b), CO (c) at heights of 300 m (1), 200 m (2), 100 m (3), 25 m (4), 4 m (5), CMDL-300 m (6)

Fig. 2 also gives concentrations of CO_2, CH_4 and CO at a height of 300 m obtained from the results of analysis of air samples made at the CMDL.

CONCLUSIONS

The results obtained demonstrate that for the investigations of CO_2, CH_4 and CO contents in the continental conditions the measurements of these gas constituents in the atmospheric column are reasonable.

ACKNOWLEDGEMENTS

The studies are carried out under a financial support of the CRDF (Grant RG1-2374-OB-02) and RFBR (Grant 03-05-65038).