Geophysical Research Abstracts, Vol. 7, 01506, 2005
SRef-ID: 1607-7962/gra/EGU05-A-01506

Possibilities to retrieve temperature profiles from ground-based spectrometric measurements

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The temperature is one of the main parameters, which describe the physical conditions of the atmosphere. The ground-based temperature and the vertical temperature profile are connected with the atmospheric dynamics and the climatic changes, which influence the coefficients of a number of chemical reactions in the atmosphere, the trace gases content and the solar radiation absorption.

To determine the atmospheric temperature profile, balloon, satellite or lidar measurements are usually used, which are costly.

The ground-based spectrometric measurements afford opportunities to obtain information for the atmospheric parameters, including the temperature and its change with the height. Up to now methods for temperature profile retrieval using ground-based measurements have not been developed. The creation of such a method would be a contribution to the atmospheric studies because of the importance of the temperature, and the cheaper implementation of the needed measurements as well.

The purpose of this work is to get up the development of a method for determining temperature profiles in the troposphere, using detailed absorption spectra of the A and b bands of the atmospheric system of O_2. It is based on the non-linear system equations for the equivalent widths of the rotational O_2 lines resolving. First, theoretical computations are performed to model the O_2 absorption. Plan-parallel atmosphere, divided into layers with equal thickness, is presumed. The obtained equations for the

equivalent widths in both cases - of weak and strong absorption, are linearized and the systems are resolved towards the temperature in the separate layers, using an iteration method.

The solution stability is studied with respect to the deviation of the input initial temperature values from the real ones, as well as with respect to the error in determining the equivalent widths. A way for separation of the rotational lines is examined, and the errors due to the lines' superposition are obtained, using the theoretical computations. The temperature dependence is studied and a procedure to eliminate these errors, based on their theoretical values, is developed. The application limits of the weak and strong absorption equations for A and b bands of O_2 are studied, and the advantages and shortcomings of the use of each of these processes in the computations, are discussed.

The real equivalent widths are computed way using the intensity of the rotational lines, determined from the measured spectra. These values are to be used to resolve the inverse problem for the temperature profile restoration. The method needs a further development. The creation of such a method would allow obtaining the temperature profile over the measurement place at each time as well as using it for other investigations and prognoses.