QOS2016-355, 2016
Quadrennial Ozone Symposium of the International Ozone Commission

Independent remote system to monitor ozone layer state and measure active biological erythema dose of ultraviolet radiation

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Studying the ozone layer state and the levels of surface UV radiation in the Antarctic region is of great interest. At the same time, conducting research in Antarctica means that spectral instruments have to meet some specific requirements. First of all, one needs to ensure the measurements at significant solar zenith angles (SZA> 60°) and high values of the underlying surface albedo.

Our experimental and simulation result clearly indicates that, at the significant SZA and high surface albedo, techniques for determining the parameters of the atmosphere (e.g., TO) based on the analysis of the spectra of scattered radiation have significant advantages over methods employing direct radiation spectra.

In this paper we present an experimental model of independent automated remote system for monitoring the ozone layer state and measuring the dose of active biological ultraviolet radiation using a filter photometer determining the integrated irradiance spectra of the total (direct + diffuse) solar radiation. This is device for monitoring of the total ozone as well as CIE doses. It includes a double-channel photometer and solar panel. The system is fully independent and does not require external power supply and communication with the computer for data storage and processing.

An important feature of the photometer's spectral characteristics is that the shape of the short-wave filter (with a teflon cosine collector) in the 290 - 320 nm spectral region highly reproduces the "Erythema" spectrum curve.

Therefore, a short-channel signal may after calibration be used as a value of the CIE biological effect. Thus, to determine the UV index, one employs the intensity measured in a short channel (295 nm). While calculating the TO, the ratio of the intensities of the two channels 290-320, and 305-345 nm is used.

To derive the TO, modernization of Stamnes technique has been made allowing to substantially increase the accuracy of the method (<3%) by means of on-line use of real data on cloud cover conditions, aerosol parameters and characteristics of the underlying surface.

The measurement results are transmitted via GSM network to a remote server enabling to monitor the state of the ozone layer in the online mode. The use of modern electronic base has allowed achieving high energy efficiency of the device, for example, power consumption in a sleeping mode is only 13 mWt.

Independence of the system and use of the GSM network for data transmission enable to locate the photometer virtually at any point having cellular communication coverage.

In case the GSM network cannot be exploited (for example, measurements are taken in Antarctica), the photometer provides an alternative wireless communication channel on a frequency of 433MHz and with a maximum range of 1 km. Here the data are transmitted to a PC or a laptop.

The results of field tests of the instrument during the seasonal Belarusian Antarctic Expedition (BAE) of 2015-2016 at the Station of Gora Vechernyaya (Enderby Land, Antarctica) are discussed.