GROUND-BASED SOLAR RADIATION MONITORING STATION AT THE KISHINEV SITE: STRUCTURE AND OPERATION

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The problem concerning the influence of the radiative factors upon the circulation of the atmosphere and related with further climatic changes holds a prominent place in studying of the global atmospheric processes and energy balance of the atmosphere. Solar radiation reaching our atmosphere interacts with aerosol particles and gases in too involved forms and finally resulting in absorbing and scattering of solar radiation. Each of components has a specific influence upon the radiation exchange and interaction processes. In this connection ground-based solar radiation monitoring networks of stations are of a particular interest to obtain an exhaustive and reliable continuous flow of information about the resulting radiation field on the earth surface.

In 2003, for the first time in Moldova it was established ground-based solar radiation monitoring station. This solar radiation station in Kishinev (φ=47.0013°N, λ=28.8156°E, h=205 m a.s.l.) was registered in Global Atmosphere Watch Station Information System (GAW SIS) as a Regional fixed station in WMO RA VI – Europe. Station is placed in an urban environment at the Kishinev site on the base of the Institute of Applied Physics. The station consists of multifunctional radiometric complex, ozonometer, automatic weather station, Sunphotometer Cimel CE-318, and PC local network. Radiometric complex includes solar radiation sensors, stationary and moving platforms, and data logger. Complex is intended to carry out long-term continuous monitoring of radiative properties of atmosphere and to acquire datasets on broadband solar radiation (global, diffuse and direct components) ranged from UV-B to IR and atmospheric longwave radiation. The set of solar and atmospheric radiation sensors gives us the opportunity to cover wide wavelength region (more than two decades) from 280 nm up to 42 μm. This range is divided into the six partially overlapping broadband sub-intervals according to the spectral sensitivity of each sensor: UV-B, UV-A, Photosynthetically Active Radiation (PAR), pyranometers for solar and pyrgeometer for atmospheric radiation. Datalogger CR10X with multiplexer provides acquiring readings from each of sensors with 1Hz, processing and logging with 1-minute interval in the built-in memory module. Stationary platform is applied to carry out global component of solar and atmospheric radiation. Moving platform is based on the precise active solar tracker 2AP BD and it is used to measure diffuse and direct components of broadband solar radiation. PC from local network is used to communicate with datalogger, to make remote control and setup of the radiometric complex, to download data from datalogger memory module to hard drive, to process data and their archiving. Measurements of the total column ozone content are regularly fulfilled with the MICROTOPS II Ozonemeter at the station. Measurements of direct solar UV radiances are carried out for fixed channels at λ=305, 312 and 320 nm. Total ozone content in column of the atmosphere is derived from two ratios for pairs of wavelengths from the UV spectral range: 305nm/312nm and 312nm/320nm. Regular measurements of the direct sun radiance and sky radiance in the almucantar and principal planes are carried out with sunphotometer Cimel CE-318 at the Kishinev site. These measurements are fulfilled within the framework of the international Aerosol Robotic Network (AERONET) programme, managed by NASA/GSFC. Kishinev site was included into the AERONET globally distributed network. Column-integrated volume size distribution functions, single scattering albedo, spectral aerosol optical depth (AOD), scattering phase function, and complex refractive index of aerosol matter were retrieved from the solar and sky radiance measurements made with Sunphotometer for seven fixed wavelength channels at λ=340, 380, 440, 500, 650, 870 and 1020 nm. Channel at 940 nm is used to measure precipitable water. Results obtained with the sunphotometer represent a valuable supplement to the datasets with solar radiation measurements made with the multifunctional radiometric complex. Solar radiation data are supplied with the main meteorological elements such as air temperature, relative humidity, atmospheric pressure, wind mean velocity and direction, and solar irradiances in spectral wavelength ranges 280-315 nm and 400-1100 nm, which are continuously measured with the automatic meteorological station MiniMet. Data from datalogger at the weather station MiniMet are transferred to the remote PC for processing and archiving.

Results of measurements of the solar radiation, total column ozone content in the column of atmosphere and column-integrated aerosol optical properties are originally presented for the Kishinev site of observation for the period from October 2003 to June 2005. Time series of the monthly totals of global and diffuse components of the solar radiation (308 – 2800 nm) and UV-B (280-315 nm) erythemally weighted radiation data show distinct seasonal variation with maximum and minimum values recorded at summer and autumn months, respectively. The absolute value of any registered monthly totals is influenced by meteorological conditions (mainly by cloudiness) during the observation period and the height of the Sun variation. Minimum and maximum values both for global and diffuse components of solar radiation correspond to winter and summer solar solstice. To show relative range of variability of the measured components of solar radiation, these values are presented below for the period of observation during of year 2004, for example, daily mean totals of global components of UV-B erythemally weighted radiation and solar radiation varied from 0.33 kJ/m^2 (in winter) to 4.82 kJ/m^2 (in summer), and from 3.4 MJ/m^2 (in winter) to 24.77 MJ/m^2 (in summer), respectively. The mean ratio of diffuse component divided to global component for UV-B radiation ranged from 0.70 to 0.91, and mean ratio of these components for solar radiation varied from 0.36 to 0.78, respectively. In both cases high values of ratio are mainly attributed to the meteorological conditions (cloudy or overcast) and these values were observed in winter. Totals of sunshine duration for this period varied from ~ 40 hours (in January) to ~ 259 hours (in July) and number of overcast days ranged from 22 (in January) to 2 (in July).

Monthly mean values of the total column ozone content retrieved from direct solar radiance measurements at three wavelengths in the UV-B region are presented. These values clearly indicate the presence of tendency of the seasonal variation of ozone content in atmospheric column. Maximum and minimum values of ozone content were observed in spring and autumn months, respectively, due to the global circulation of atmosphere. At the same time, some anomalous high and low values of the ozone content were observed from July 2003 through June 2005. For example, on December 12, 2004 the total ozone content in column of atmosphere reached its maximum value of 411 D.U. and on October 31, 2004 ozone content reached its minimum value ~252 D.U. Daily mean value of ozone content for this period of observation was ~342 D.U. Mutli-year (1978-2005) statistics on daily mean values of total ozone content retrieved from measurements made by using the EP TOMS satellite platform reveals following extreme values (maximum and minimum): ~ 532 D.U. and ~ 203 D.U. observed on March 3, 1988 and December 1, 1999, respectively. It should be noted that such extreme low values of ozone content in both cases may be attributed to the ozone 'mini-holes' originated and evolved above the territory of the Europe. Multi-year mean value of ozone content for this region amounts of ~343 D.U.. Analysis of multi-year statistics for the period of 26 years of observations from EP TOMS showed that decreasing of the total column ozone content over the territory of Moldova amounts of ~ 9 D.U./decade.

Climatology of aerosol optical depth τ_a (for cloudless atmosphere) measured from 1999 to 2000 at the Kishinev site is presented. Multi-annual monthly mean of AOD τ_a (500) at λ=500 nm shows high values: τ_a=0.31 (in April) and τ_a=0.38 (in August). Multi-annual annual mean value of AOD for Moldova amounts of τ_a=0.23±0.08. It should be also noted that winter season is characterized by high transparency of the atmosphere with low value of AOD τ_a=0.15, but summer season may be characterized as having conditions with more turbid atmosphere with AOD τ_a =0.30. In Moldova winter and late autumn months may be characterized as months with low values of AOD τ_a (500) <0.2, and spring and summer months may be characterized as months with large aerosol loading and having AOD ranged from 0.2 to 0.4.

Spectral variation of the multi-annual annual mean values of AOD $\tau_a(\lambda)$, measured at the Kishinev site, shows distinct power dependence versus of wavelength and it may be approximated with following relationship, $\tau_a(\lambda) \sim \lambda^{\alpha}$, where α= -1.31.

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