PHOTOSYNTHETICALLY ACTIVE RADIATION IN MOLDOVA

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Abstract

Variability of the Photosynthetically Active Radiation (PAR) measured at the ground-based solar radiation monitoring station at the Chisinau site from 2004 to 2006 is analyzed. Series of days with observations for clear sky conditions was selected from the original PAR and solar radiation datasets to study relationship between PAR and global, diffuse and direct solar irradiance, and to evaluate conversion factor for converting PAR values measured with specific PAR sensor from photosynthetic photon flux to PAR in energy units. This selection is necessary to neglect the influence of cloudiness upon the measured data. There was proposed a simple power type relationship approximating diurnal variability of PAR and depending on aerosol optical depth. There was demonstrated strong positive correlation between daily totals of PAR and global solar radiation both for clear sky and all-sky conditions, and respective linear equations between these parameters are proposed. Monthly mean values of daily ratios of PAR and global solar radiation for all-sky conditions show distinct seasonal variation with large values observed during cloudy months specific to fall and winter seasons. It is attributed to predominant absorption of solar radiation on aerosols, gases and in clouds occurring outside of PAR spectral domain. For very clear days of observations the growth of daily mean ratio of PAR and solar irradiance was due to increase of aerosol optical depth. There was supposed a simple linear relationship for evaluation of incoming PAR through direct and diffuse solar radiation by applying specific weighting coefficients. For all-sky and for clear sky conditions weighting coefficients amount to ~0.46 and ~0.59, respectively. Analysis of radiometric data acquired during one of the clearest day in time series of observation gives conversion factor which amounts to ~4.65.

1. Introduction

Photosynthetically Active Radiation (PAR) holds the spectral domain in visible spectrum from 400 to 700 nm and it consists of 44% to 56% from total downwelling shortwave (300-4000 nm) solar radiation reaching the Earth's surface. At the same time, PAR represents vitally important part: it is a critical forcing of photosynthesis. Many ecosystem models calculate biomass accumulation by taking into account incident PAR. It is a key variable applied in almost all terrestrial ecosystem models: in models assessing vegetation primary productivity, in carbon cycle models, models of terrestrial biogeochemistry. PAR is used to initiate, calibrate, and validate these models. In this connection, surface-based measurements of incident PAR are considered basic along with PAR products generated from satellites and also to be used in validation of satellite measurements. The purpose of the present work consists in analysis of variability of global downwelling PAR onto the horizontal plane measured at the ground-based solar radiation monitoring station in Chisinau. This paper compares values of global PAR in units of photosynthetic photon flux calculated with using spectral model the

Simple Model of the Atmospheric Radiative Transfer of Sunshine (SMARTS2) [1] and acquired from ground measurements of PAR. Aerosol optical properties retrieved from simultaneous sunphotometry measurements are used as input parameters in solar flux modeling. Suitable relation between PAR and diffuse and direct solar radiation fluxes for clear sky and all-sky conditions will be derived from datasets acquired from 2004 to 2006. Estimations of conversion factor between PAR in photosynthetic photon flux and in energy flux units for clear sky conditions will be made.

2. Experimental setup and measurement approach

PAR measurements have been made with a PAR Lite quantum sensor (Kipp&Zonen) that is a component of the radiometric complex. Quantum sensor measures a part of global horizontal downwelling solar radiation (in photosynthetic photon flux unit, μmol $m^{-2}s^{-1}$) in spectral domain from 400 nm to 700 nm active in photosynthesis. Two CM-11 solar sensors (Kipp&Zonen) were used to measure global and diffuse solar radiation in spectral range 308-2800 nm. Automatic sun tracker 2AP-BD equipped with the Shading Ball Assembly was used to carry out direct and diffuse solar radiation measurements with CH-1 and CM-11 sensors, respectively. PAR Lite and CM-11 sensors for global solar radiation are located at the stationary platform of the radiometric complex. Quantum sensor, CH-1 and two CM-11 solar sensors are scanned at 1Hz rate followed by 1-minute averaging and storing of readings in a CR-10X datalogger with memory module SM4M. Radiometric complex is placed at the ground solar radiation monitoring station on the rooftop of the Institute of Applied Physics building, located at the South-West of the Chisinau city (φ_o=47.0013°N, λ_o=28.8156°E, h=205 m a.s.l) [2, 3]. Supplemental main surface meteorological elements were obtained from measurements at the nearly collocated meteorological station AWS Minimet (Skye Instruments). Meteorological sensors are scanned at 0.1Hz rate with subsequent 5-minute averaging and storing of readings in DataHog2 datalogger.

Optical and microphysical characteristics of aerosols, such as AOD $\tau_a(\lambda)$, Angstrom exponent α, single scattering albedo ω_o, asymmetry parameter g_a, complex refractive index, volume size distribution, etc. in a column of atmosphere are derived from the sun and sky spectral radiance measurements at eight wavelengths λ =340, 380, 440, 500, 670, 875, 940 and 1020 nm that have been made with using of a precision sunphotometer Cimel CE-318. Measurements were fulfilled for clear sky and broken cloud conditions simultaneously with solar radiation measurements at the radiometric complex. Data processing was made with using an effective cloud screening [4] and retrieving algorithms [5, 6]. Technical specifications of sunphotometer, measurement sequences, and technique for retrieving of aerosol optical characteristics, data processing, and accuracy of measurements are described in detail in [3, 6, 7, 8]. Sunphotometer operates at the ground solar radiation monitoring station and measurements are fulfilled within the frames of the AERONET program [7, 9] under supervision of the NASA/Goddard Space Flight Center.

3. Data and analysis

Time-series of PAR and global, diffuse, and direct solar radiation datasets used in this study have been acquired from continuous observations at the ground station in Chisinau for the period from January 2004 to December 2006. Time-series represents as a set of radiometric data with 1-minute averaging of readings acquired at 1 Hz rate from each of the solar sensors. Hourly, daily, and monthly totals and respective averaged values are derived from the original solar radiation dataset. Daily mean values of aerosol optical characteristics retrieved from AERONET databases with Level 1.5 and 2.0 v. 2 [7,9] and main meteorological elements from ground weather station are supplementary data. These data will be utilized as input parameters in modeling of incoming solar radiation with using the Simple Model of the Atmospheric Radiative Transfer of Sunshine (SMARTS2) software v. 2.9.5 developed by C. Gueymard [1, 10, 11]. PAR and solar radiation datasets acquired during the period of observation from 2004 to 2006 were divided in two groups of datasets characterized by two specific sky conditions: clear sky and all-sky conditions, consisting of 66 and 1110 days of observations. Day with a clear sky condition is defined as a day with cloudiness < 1/10 and the clearest day is identified as fair cloudless day having low value of AOD.

Daily variation of 1-minute averages of PAR (in photosynthetic photon flux unit, μmol $m^{-2}s^{-1}$) measured during one of the clearest days, on July 20, 2006, in time series of observations at the Chisinau site is shown in Figure 1. This day was selected to make comparison of measured PAR values with the calculated ones for clear sky conditions.

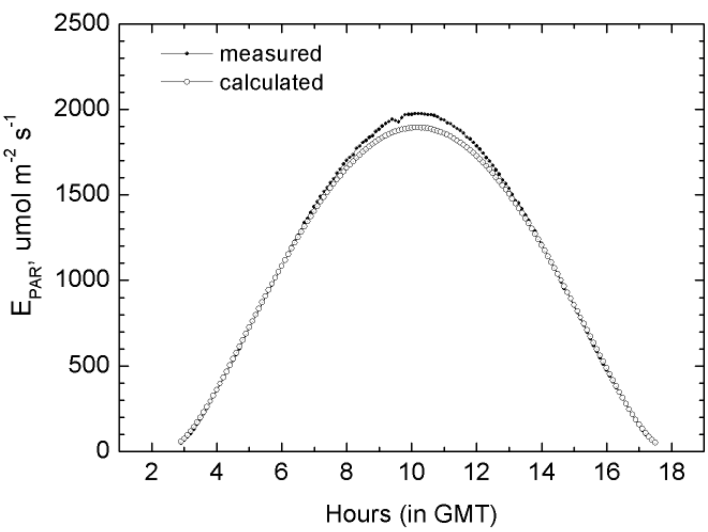

Figure 1. Diurnal variation of 1-minute averages of PAR E_{PAR} (in μmol m^{-2} s^{-1}) for clear sky conditions measured at the Chisinau site on July 20, 2006 and respective PAR values calculated with using SMARTS code v. 2.9.5 [10].

Computer modeling was fulfilled with using SMARTS code (for clear sky conditions only). Aerosol optical properties and main surface meteorological elements were utilized as input data. Datasets were retrieved from spectral measurements of the direct sun and diffuse sky radiance with sun photometer Cimel CE-318 at the Chisinau site and meteorological observations at the MiniMet weather station, collocated near the radiometric complex and sun photometer. All input datasets are represented as daily means of respective values and are referred to as optical and meteorological data. Aerosol model is composed on the basis of the optical characteristics derived from AOD measurements at the Chisinau site. Quality assured optical data are retrieved from AERONET database [9]. Optical data consist of daily means of AOD $<\tau_{a,500}>_d=0.064$, two values of the Angstrom wavelength exponent $<\alpha>_d$ for wavelengths $\lambda<500$ nm, $<\alpha_1>_d=1.550$ and for $\lambda>500$ nm, $<\alpha_2>_d=1.382$, and spectrally averaged aerosol single scattering albedo $<\omega_o>_\lambda$ $=0.921$ and asymmetry parameter $<g_a>_\lambda=0.650$. Meteorological data consist of surface mean pressure $<p_a>_d=997.3$ mb, relative humidity RH=61.8%, mean air temperature at the site level $<t>_d=20.2$°C, column ozone abundance (measured at the site with the hand-held Microtops ozonometer) $<X_o>_d=0.3245$ atm·cm, or 324.5 DU. Type of air pollution was selected through the level of concentrations of the 10 gaseous pollutants possibly typical for urban conditions and it was accepted as “moderate pollution”. This specific criterion of pollution is taken into account among other input requirements assigned by algorithm of the SMARTS code in order to consider separate gaseous absorption calculations for tropospheric gases concentrated in a pollution layer. Pollution layer is assumed to be 1-km thick above the Earth’s surface and well-mixed. Calculated curve of daily variation of the PAR shows good resemblance with the measured one (see Figure 1), thereby confirming the adequate model forming the basis of the SMARTS2 code for solar radiation computation.

In clear sky conditions, when the influence of clouds upon the solar radiation attenuation is neglected, variation of 1-minute averages of PAR E_{PAR} versus solar zenith angle (SZA) θ_o may be approximated with simple power type relationship, given as $E_{PAR} \sim (\cos\theta_o)^\beta$ for $25° < \theta_o < 75°$. It is expected that coefficient β is influenced by aerosols and depends on aerosol optical depth $\tau_a(\lambda)$. For example, in the case of selected two clearest days of July 20, 2006 and July 21, 2004 from the original series of observations, respective coefficients β of power approximation are equal to β =1.25 at $<\tau_a(500)>_d$= 0.064 and β =1.30 at $<\tau_a(500)>_d$= 0.169. In the last case the day was characterized as having clear sky conditions but with higher value of AOD (or higher turbidity of the atmosphere). Dependence of the coefficient β on aerosol optical depth $\tau_a(\lambda)$ requires studying in detail in a separate article. Seasonal variation of monthly totals $Q_{PAR,M}$ of PAR measured for all-sky conditions at the Chisinau site from 2004 to 2006 reveals distinct maximum in summer (June-July) and minimum in winter (December) for each of the years (see Figure 2). Multiyear averages of monthly totals $Q_{PAR,M}$ of PAR for this period of observations amount to ~1.55 kmol m^{-2} and 0.21 kmol m^{-2}, respectively. Yearly totals $Q_{PAR,Y}$ of PAR are equal to ~10.03, 9.83, and 9.78 kmol m^{-2} for 2004, 2005, and 2006. Statistical analysis of the data acquired from 2004 to 2006 gives the linear relationship between daily totals of PAR Q_{PAR} and global solar radiation Q_{gl}. There is demonstrated the strong positive correlation with value of R^2~0.998 between Q_{gl} and Q_{PAR} for days both with clear and all sky conditions (see Figure 3). The best fit lines for scatterplots are given by linear expression: $Q_{PAR}=a_1+a_2\cdot Q_{gl}$, where $a_{1,2}$ are the coefficients derived from regression analysis, which amount to a_1= -1.359, a_2=2.157 for clear sky and to a_1=0.379, a_2=2.117 for all-sky conditions. Monthly mean values of $<Q_{PAR}/Q_{gl}>_M$ ratios (subscript "M" out of brackets corresponds to monthly averaging) are derived from the ratios of the daily

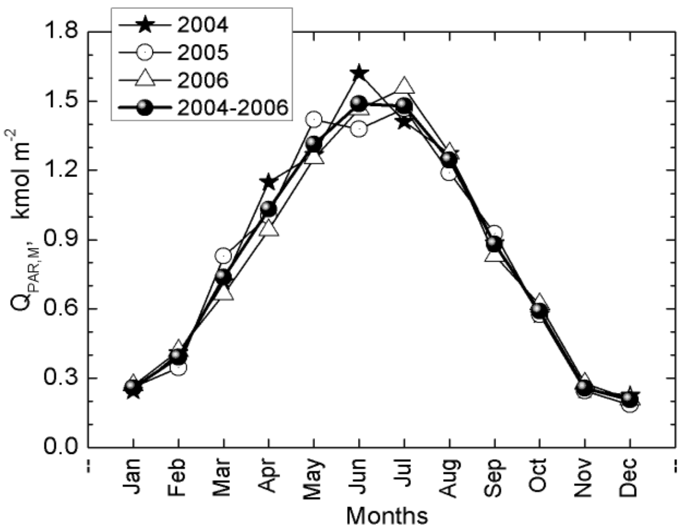

Figure 2. Seasonal variation of monthly totals $Q_{PAR,M}$ of PAR measured for all sky conditions at the Chisinau site from 2004 to 2006.

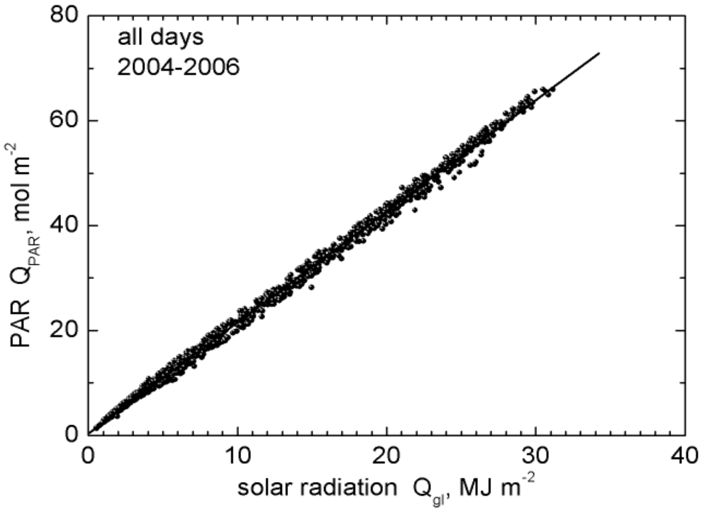

Figure 3. Scatterplot of global daily totals Q_{PAR} of PAR versus global daily totals Q_{gl} of solar radiation measured for all sky conditions at the Chisinau site from 2004 to 2006.

totals of PAR Q_{PAR} and global solar radiation Q_{gl} for all sky conditions. Variability of $<Q_{PAR}/Q_{gl}>_M$ ratios is shown in Figure 4 for each of the years and for the overall period from 2004 to 2006. Table 1 provides yearly means $<Q_{PAR}/Q_{gl}>_Y$ of daily total ratios for these years (subscript "Y" corresponds to yearly averaging). The end of fall, winter and beginning of spring (fall-win-spr) in Moldova are considered as seasons with prevailing cloudy and very cloudy skies; and spring, summer and beginning of fall (spr-sum-fall) are characterized as seasons with less cloudiness and having a large number of days with clear and almost clear sky conditions. There is observed the increase of $<Q_{PAR}/Q_{gl}>_M$ ratio for cloudy sky during cold periods (fall-win-spr) and decrease for less cloudy and cloudless skies during warm periods (spr-sum-fall). Table 2 provides seasonal means $<Q_{PAR}/Q_{gl}>_s$ of daily ratios of PAR and global solar radiation for 2004-2006 (subscript "s" corresponds to seasonal averaging).

Table 1. Yearly means $<Q_{PAR}/Q_{gl}>_Y$ of daily total ratios of PAR and global solar radiation for all-sky conditions (subscript "Y" corresponds to yearly averaging).

Year	2004	2005	2006	2004-2006
$<Q_{PAR}/Q_{gl}>_Y$, mol MJ^{-1}	2.230±0.152	2.174±0.140	2.190±0.153	2.198±0.150

Table 2. Seasonal means $<Q_{PAR}/Q_{gl}>_s$ of daily total ratios of PAR and global solar radiation for all- sky conditions for 2004-2006 (subscript "s" corresponds to seasonal averaging).

Season	winter	spring	summer	fall
$<Q_{PAR}/Q_{gl}>_s$, mol MJ^{-1}	2.260±0.207	2.193±0.141	2.174±0.064	2.166±0.136

Taking into consideration that spectral sensitivity of the CM11 sensor ranges up to 2800 nm, the variability of Q_{PAR}/Q_{gl} may be attributed to the absorption of solar radiation in IR region of spectrum (for cloudy and overcast conditions), where absorption of solar radiation is sufficiently large in comparison with the absorption in PAR spectral domain. Another reason of the Q_{PAR}/Q_{gl} ratio variability may be related to the selective absorption due to presence of aerosols (smoke, haze) in the atmosphere. Daily mean statistics on the basis of dataset for clear sky conditions only for the period from 2004 to 2006 gives the averaged value of daily Q_{PAR}/Q_{gl} ratios which amounts to $<Q_{PAR}/Q_{gl}>$=2.064±0.062 mol MJ^{-1}. It is clearly seen that higher values of daily ratios occurring in cold and cloudy seasons may be related to the absorption of solar radiation in clouds and hazes during the long-term cloudy sky conditions.

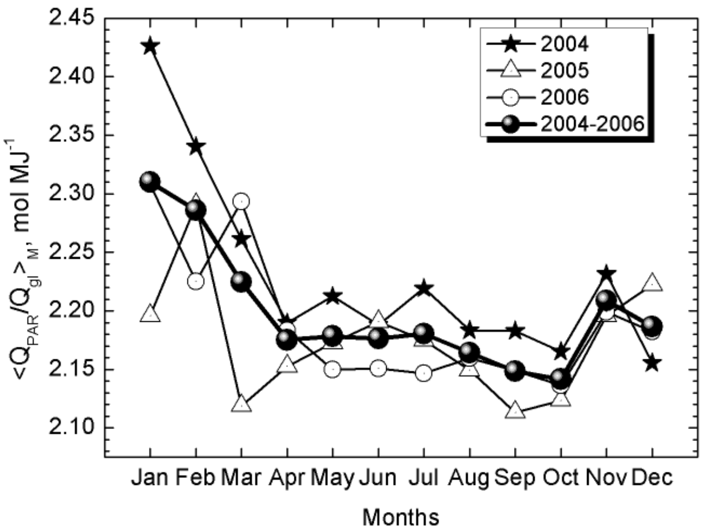

Figure 4. Seasonal variation of monthly mean values of daily ratios $<Q_{PAR}/Q_{gl}>_M$ of PAR and solar radiation for all sky conditions at the Chisinau site from 2004 to 2006 (subscript "M" corresponds to monthly averaging).

In general, for evaluation of the ratio of PAR and solar radiation, the following expression is introduced: $\varphi = F_{PAR}/F_{gl}$, where F represents the irradiances E_k or daily totals Q_k, with subscripts k={PAR, gl} attributed to PAR and global solar radiation. At the top of the atmosphere evaluation of irradiances E_k or daily totals Q_k may be simply done by making the integration over two spectral domains, PAR (400-700 nm) and global solar (CM-11 solar sensor, 308-2800 nm) radiation. Extraterrestrial solar spectral irradiance distribution is used to estimate PAR and solar radiation within respective wavelength ranges [11]. At the top of the atmosphere value of Q_{PAR}/Q_{gl} ratio is equal to 1.848 mol MJ^{-1} (for PAR in photon flux density units, μmol m^{-2} s^{-1}) or 0.41 (for PAR in energy units, Wm^{-2}). For evaluation of φ variability at the Earth's surface one should take into account such factors as scattering and absorption of radiation due to aerosols, absorption of radiation by gases, multiple scattering of radiation in atmosphere (on aerosols and clouds), and surface reflectance. For clear sky conditions these evaluations may be done by using SMARTS code [1, 10]. From the series of days with clear sky conditions there were selected three clearest cloudless days with low values of AOD $<\tau_{a,500}>_d$ ranged from 0.06 to 0.17. These values of AOD are typical of low aerosol loading of the atmosphere. Table 3 provides daily means $<E_{PAR}/E_{gl}>_d$ of ratios of PAR and solar irradiance E_k with 1-minute averages and respective aerosol optical depth $<\tau_{a,500}>_d$ values retrieved from simultaneous AOD observations during these three clear days at the Chisinau ground station. It is clearly seen that increase of $<\tau_{a,500}>_d$ results in growth of daily means $<E_{PAR}/E_{gl}>_d$ ratio of PAR and solar irradiance.

Table 3. Variability of daily means $<\varphi>_d=<E_{PAR}/E_{gl}>_d$ ratios of PAR and solar irradiance versus aerosol optical depth $<\tau_{a,500}>_d$ for very clear days of observations at the Chisinau ground station from 2004 to 2006 (subscript "d" corresponds to daily averaging).

Date	July 20, 2006	May 30, 2005	July 21, 2004
$<\tau_{a,500}>_d$	0.064	0.108	0.169
$<\varphi>_d$, mol MJ^{-1}	2.116	2.157	2.180

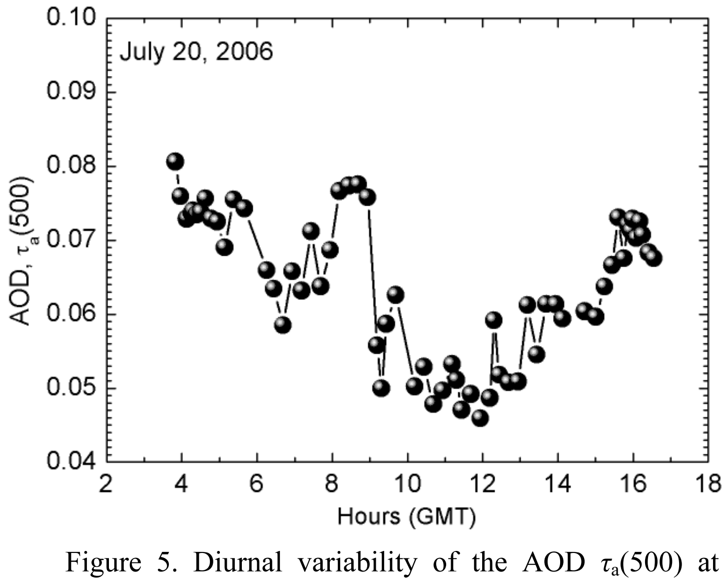

Figure 5. Diurnal variability of the AOD $\tau_a(500)$ at λ=500 nm observed at the Chisinau ground station on July 20, 2006. Daily mean value of aerosol optical depth was equal to $<\tau_a(500)>_d=0.064\pm0.009$.

In order to study daily variability of $\varphi=E_{PAR}/E_{gl}$ ratio of PAR and solar irradiance there was chosen daily dataset with measured irradiances with 1-minute averaging for one of the clearest days - July 20, 2006 in the time series of observations characterized with the lowest value of daily mean AOD $<\tau_{a,500}>_d=0.064\pm0.009$. Daily AOD $\tau_{a,500}$ reveals different change during morning and afternoon hours (see Figure 5) and respective linear regression equations are given as $\varphi=2.182 - 0.001\,\theta_o$ for morning hours and $\varphi=2.201 - 0.002\,\theta_o$ for afternoon hours, for solar zenith angles $26° < \theta_o < 75°$. Observations at solar zenith angles $\theta_o>75°$ are not taken into account due to large measurement errors. At the same time, dependence of daily variability of AOD on solar zenith angle is expressed as $\tau_{a,500} \sim \theta_o$ and it may be approximated with linear relationships given as $\tau_{a,500}=0.056+2.539\cdot10^{-4}\,\theta_o$

for morning hours and $\tau_{a,500}$=0.036+4.569·10^{-4} θ_o for afternoon hours. Diurnal variability of φ and best fit lines of data approximations for morning and afternoon hours are shown in Figure 6. At the surface φ is expected to be a little higher due to the selective absorption of solar radiation by gases and aerosols in the atmosphere, this predominantly occurs outside of the PAR spectral domain. Evaluation of daily (monthly) totals of PAR Q_{PAR} (in energy units, Wm^{-2}) may be fulfilled by applying simple relation between respective daily (monthly) totals of direct Q_{dir} and diffuse Q_{dif} solar radiation as follows $Q_{PAR}=(1-\rho_k)\cdot Q_{dir}+\alpha_k\cdot Q_{dif}$, where ρ_k is the coefficient derived from the respective PAR and solar radiation total values Q_{PAR}, and Q_{dir} and Q_{dif} measured with sensors PAR Lite, CH-1 and CM11; subscript k = "d" or "M" refers to daily and monthly totals, respectively.

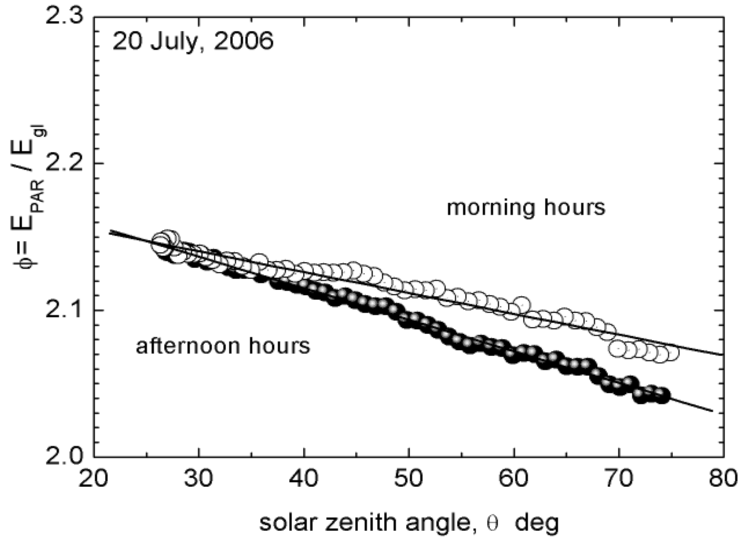

Figure 6. Diurnal variability of $\varphi=E_{PAR}/E_{gl}$ ratios in the course of morning and afternoon hours versus solar zenith angle θ_o at the Chisinau ground station during one of the clearest day on July 20, 2006.

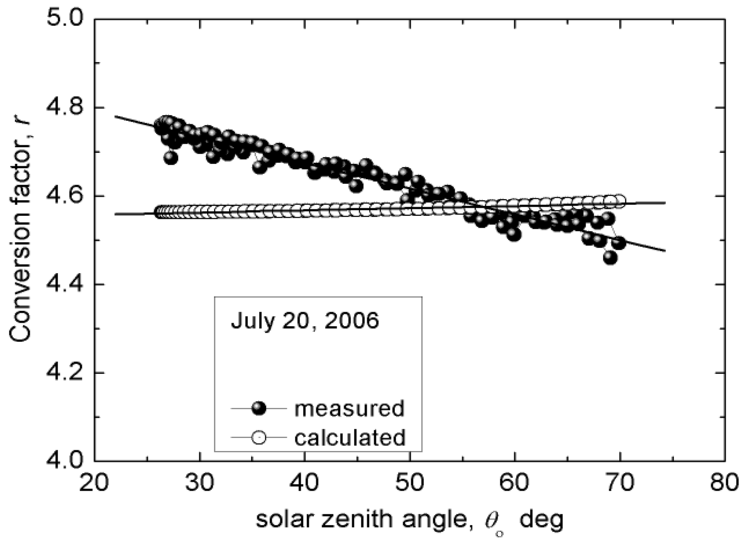

Figure 7. Variability of measured r and calculated r^* conversion factors versus solar zenith angle θ_o. Measurements of PAR radiation were carried out at the Chisinau ground station on July 20, 2006. This day was selected as the clearest one in the time series from 2004 to 2006. Daily mean AOD $<\tau_a(500)>$ at λ=500 nm was equal to 0.064±0.009.

In general, in order to define totals Q_{PAR} in energy units from original values of PAR in photosynthetic photon flux units (mol m^{-2}) measured by PAR Lite sensor, the last one should be divided by conversion factor 4.6. This conversion factor is usually used to convert PAR photosynthetic photon flux to PAR energy units and conversely [12]. Mean value of $<\rho_{d,c}>$ deduced for daily totals of direct Q_{dir} and diffuse Q_{dif} solar radiation for clear sky conditions (subscripts "d, c" denote daily totals for clear sky) for 66 days of observations at the Chisinau ground station from 2004 to 2006 amounts to $<\rho_{d,c}>$=0.59. For all-sky conditions mean values of $<\rho>$ deduced for daily and monthly totals $\{Q_{dir},Q_{dif}\}$ on the basis of time series consisting of 1110 days of observations for 2004-2006 amount to $<\rho_d>$=0.46 and $<\rho_d>$=0.57, respectively (subscripts "d" and "M" correspond to daily and monthly totals for Q_{PAR}, Q_{dir}, and Q_{dif} components). Low value of $<\rho_d>$ may be attributed to significant influence of clouds upon the incoming radiation Q_{dir} and Q_{dif} through the scattering and absorption of solar radiation.

For evaluation of the conversion factor *r* for converting PAR measured by specific PAR sensor from photosynthetic photon flux to PAR in energy units there were chosen data acquired during July 20, 2006, one of the clearest days in the total time series of observations at the Chisinau ground station. This was done to neglect the cloudiness condition influence upon the data of measurements. This selected day was characterized as having nearly uniform aerosol optical properties in the course of observations (see Figure 5) and with very low daily mean AOD $<\tau_a(500)>_d$ at λ=500 nm which was equal to 0.064. Computer modeling of incoming PAR was performed with using SMARTS code [10] and calculated data were applied to derive measured *r* and modeled r^* factors given as $r= E_{\mathrm{PAR,\,f}}/E^*_{\mathrm{PAR,e}}$ and $r^*=E^*_{\mathrm{PAR,f}}/E^*_{\mathrm{PAR,e}}$, where subscripts "f" and "e" denote PAR E_{PAR} expressed in photosynthetic photon flux and in energy units, respectively, and superscript "*" corresponds to calculated value of PAR. Diurnal variation of measured *r* and modeled r^* factors versus solar zenith angle θ_o for $26° < \theta_o < 70°$ is shown in Figure 7. For large solar zenith angles $\theta_o > 70°$ (in early of the morning and late afternoon hours) conversion factor *r* rapidly decreases due to high errors in PAR measuring. The best fit lines are given as r=4.91 –5.8·10^{-3} θ_o and r^*=4.55+4.93·10^{-4} θ_o. Daily mean values of conversion factor are equal to $<r>_d$ =4.65±0.08 and $<r^*>_d$ =4.57±0.01. These values of conversion factor are very close to the one recommended from [12].

4. Conclusions

Variability of PAR is analyzed on the basis of three year dataset measured at the Chisinau ground solar radiation monitoring station from 2004 to 2006. Radiometric datasets were complemented with aerosol optical properties retrieved from simultaneous spectral measurements of direct solar and diffuse sky radiance with sun photometer. From original PAR and solar radiation datasets there was selected a group of observations for clear sky conditions to study relationship between PAR and global, diffuse and direct solar irradiance, and, finally, to evaluate conversion factor *r* neglecting the influence of cloudiness upon the measurements. Diurnal variability of measured PAR for clear day shows a good agreement with the calculated PAR data from using SMARTS code [10], thereby confirming the applicability of code to be used in modeling and evaluation of the conversion factor *r* for converting PAR radiation measured by specific PAR sensor from photosynthetic photon flux to PAR in energy units. For clear day it was shown that variation of PAR E_{PAR} with 1-minute averages versus solar zenith angle (SZA) θ_o may be approximated with a simple power type relationship, such as $E_{\mathrm{PAR}} \sim (\cos\theta_o)^{\beta}$, for $25°< \theta_o< 75°$ and parameter β depends on aerosol optical depth $\tau_a(\lambda)$. Seasonal variation of monthly totals $Q_{\mathrm{PAR,M}}$ of PAR reveals distinct maximum in summer and minimum in winter months with respective average values of monthly totals ~1.55 kmol m^{-2} and 0.21 kmol m^{-2}. There was observed strong positive correlation between daily totals of PAR Q_{PAR} and global solar radiation Q_{gl} both for clear sky and all-sky conditions. Respective linear equations between these parameters are proposed. Monthly mean values $<Q_{\mathrm{PAR}}/Q_{\mathrm{gl}}>_M$ of daily ratios of PAR and global solar radiation for all sky conditions at the Chisinau station from 2004 to 2006 show seasonal variation with large values observed in more cloudy months (for fall and winter seasons) and it is attributed to predominant absorption of solar radiation on aerosols, gases and in clouds in spectral domain out of the PAR wavelength band. The ratio $<Q_{\mathrm{PAR}}/Q_{\mathrm{gl}}>_M$ ranges from ~2.310 mol MJ^{-1} in January to ~2.149 mol MJ^{-1} in September. For series of days with clear sky conditions for period from 2004 to 2006, ratio $Q_{\mathrm{PAR}}/Q_{\mathrm{gl}}$ amounts on average to 2.064±0.062 mol MJ^{-1}. For very clear days of observations at the Chisinau ground station there was demonstrated growth of Q_{PAR}/Q_{gl} ratio of PAR and global solar irradiance due to increase of aerosol optical depth $\tau_a(\lambda)$. There was supposed a simple linear relationship for evaluation of incoming daily (monthly) totals of PAR Q_{PAR} through the respective daily (monthly) totals of direct Q_{dir} and diffuse Q_{dif} solar radiation applying specific weighting coefficients $<\rho>$. For all-sky conditions mean values of $<\rho>$ for daily and monthly totals of components $\{Q_{PAR}, Q_{dir}, Q_{dif}\}$ amount to $<\rho_d>=0.46$ and $<\rho_M>=0.57$, respectively, and for clear sky conditions for daily totals the weighting coefficient amounts to $<\rho_{d,c}>=0.59$. The difference between these weighting coefficients is attributed to cloudiness influence coupled with absorption and scattering of solar radiation. On the basis of the data acquired during one of the clearest days — July 20, 2006 having nearly uniform aerosol optical properties in the course of observations and low value of daily mean AOD $<\tau_a(500)>_d$ ~0.064, there were derived daily mean values of measured and calculated conversion factors. These factors are equal to $<r>_d$ ~4.65 and $<r^*>_d$ ~4.57, respectively.

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