OUTGOING SHORTWAVE RADIATION OVER THE PACIFIC OCEAN: "INTERKOSMOS-21" SATELLITE DATA MODEL

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Data on the spectral brightness B_λ of the "ocean-atmosphere" system over the Pacific Ocean in the 0°–30° N latitude belt are statistically processed. The dependence of B_λ on the atmospheric optical mass and the wavelength in the spectral region 0.4–0.8 μm is proposed. The data are compared with the analogous model for the Atlantic Ocean in the 0°–30° N latitude belt.

The results of processing the measurements of outgoing radiation brightness in the "atmosphere–ocean" system obtained over the Atlantic Ocean were presented in Ref. 1. In this paper the results of processing the analogous spectral brightness measurements B_λ in the system "ocean–atmosphere" obtained over the equatorial region of the Pacific Ocean in the 0–30° N latitude belt are reported.

The measurements were performed for one and a half years (1981–1982) onboard the satellite "Interkosmos–21". The readings were taken during continuous sounding along the flight path with sighting on nadir. The satellite flight height was 500–600 km, the field of view of the spectrometer was ~1°, and the total error for B_λ measurements was ~3%.

The brightness of the outgoing radiation in the "ocean-atmosphere" system was measured in 13 spectral channels of visible spectral region (0.415–0.823 μm).

Approximately 68,000 data points were statistically processed in the 0°–30° N latitude belt over the Pacific Ocean. They were classified by seasons and six solar zenith angle ranges $Z_\odot$: 0°–30°, 30°–60°, 60°–75°, 75°–80°, 80°–85°, and 85°–90°. For the above–indicated data sets the statistical characteristics were obtained as well as the sample of measurements corresponding to the cloudless conditions was formed. The number of measurements under cloudless conditions was about 7570. The insignificant seasonal variations in the spectral brightness, substantially not more than 30%, were pointed out for the region of the Pacific Ocean in the 0°–30° N latitude belt, therefore hereafter all the data were processed without any regard for seasonal dependences.

In contrast to Ref. 1, in analyzing the data on B_λ, measurements performed over the Pacific Ocean, the data obtained for the solar zenith angles in the 0°–30°, where additional fluxes of outgoing radiation caused by the specular reflection from the sea surface are possible, were ignored. Thus, the data of processing the measurements performed over the Pacific Ocean are more representative in comparison with the data of analogous processing the measurements performed over the Atlantic Ocean, for which the solar zenith angles $Z_\odot$ in the 0°–30° were not segregated.

The purpose of this paper is to retrieve the dependence of spectral brightness $\bar{B}_\lambda$ of outgoing radiation in the "ocean–atmosphere" system on the optical mass of the atmosphere $m_\odot$ (which depends on the solar zenith angle $Z_\odot$) and light wavelength λ under cloudless conditions.

An analysis of the $\bar{B}_\lambda$ dependences showed their fit by the function of the form

$$\bar{B}_\lambda = \beta_0(m_\odot + 1)^{\beta_1}. \quad (1)$$

The regression coefficients β_0 and β_1 were retrieved using the least–squares technique with the subsequent refinement of LST estimates. The calculated correlation coefficients in all the spectral channels confirmed their high level (0.86–0.99). The correlation coefficients were tested for statistical significance using the r–criterion.

The study of spectral variation in β_1 showed its characteristic linear dependence on the wavelength (in Ref. 1 such a dependence was not observed),

$$\beta_1 = 1.48\,\lambda - 1.57 \quad (2)$$

with the correlation coefficient $R = 0.98$. The confidence levels for the regression coefficients of Eq. (2) are equal to 1.48 ± 0.33 and 1.57 ± 0.22 provided regression $\lambda = 0.3$.

Spectral behavior of the regression coefficient β_0 was represented in the form

$$\beta_0 = (a/\lambda^4 + c)S_{\odot\lambda}, \quad (3)$$

where $E = \pi S_{\odot\lambda}$ is the spectral solar constant. The regression coefficients are retrieved using the nonlinear least–squares technique and are equal to $a = 0.008 \pm 0.001$ and $c = 0.002 \pm 0.008$ provided $\alpha = 0{,}3$. The relative rms error of fitting for all the wavelengths is equal to ~5% with the exception of the band of absorption by molecular oxygen. In this spectral region the correction factor r_λ is introduced whose values are presented in the table.

TABLE I. Relative rms error of fit δB_λ (Eq. 4), spectral brightness variability coefficients obtained from satellite data, values of the correction factor r_λ.

λ, μm	0.415	0.449	0.483	0.534	0.569	0.621	0.676	0.758	0.761	0.763	0.767	0.794	0.823
δB_λ, %	12	17	15	15	33	29	21	23	26	18	25	24	19
K_λ, %	26	26	29	35	40	45	49	43	69	62	44	71	64
r_λ	1.0	1,0	1.0	1.0	1.0	1.0	1.0	1.0	0.29	0.49	0.82	1.0	1.0
$S_{\odot\lambda}$,mW/ar·cm²/μm	54,78	63.28	63.28	60.10	58.66	53.79	47.40	39.63	39.15	38.93	38.36	36.92	33.90

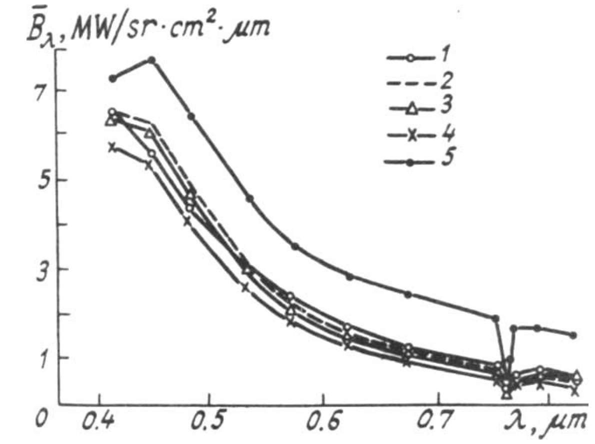

FIG. 1. Average spectral distribution of brightness in the system "ocean–atmosphere". 1) calculational results according to Eq. (4) obtained for the Pacific Ocean ($z_\odot$ = 43.8°). Experimental data obtained for the Pacific Ocean: 2) spring ($z_\odot$ = 45.3), 3) summer ($z_\odot$ = 43.8°), 4) autumn ($z_\odot$ = 37.9), and 5) calculational results from Eq. (5) of Ref. 1 for the Atlantic Ocean ($z_\odot$ = 43.8°).

Taking into account the above facts, the dependence of the outgoing radiation brightness B_λ in the "ocean-atmosphere" system on λ and the solar zenith angle $Z_\odot$ (or $m_\odot$) may be represented by the following statistically retrieved relation:

$$B_\lambda / S_{0\lambda} = \left(\frac{0.008}{\lambda^4} + 0.002\right) r_\lambda \left(m_\odot + 1\right)^{1.48\,\lambda - 1.57}. \quad (4)$$

The relative rms error of experimental data fit $\delta\bar{B}_\lambda$ by Eq. (4) is listed in the table for α = 0.3, where the coefficients for spectral brightness variations obtained from the satellite data are also given.

The calculational results from Eq. (4) are shown in Fig. 1 (curve 1) for $z_\odot$ = 43.8°. The average data of the direct measurements of $\bar{B}_\lambda$ for three seasons are also presented there.

As can be seen from the figure, the proposed relation fits well the experimental data. The calculational results of outgoing radiation spectrum observed over the Atlantic Ocean in the of 0–30°N latitude belt, which were obtained according to Eq. (5) of Ref. 1 are also shown in this figure (curve 5). The average absolute values of the spectral brightness of outgoing radiation in the "ocean-atmosphere" system obtained over the Atlantic Ocean are higher then $\bar{B}_\lambda$ measured at the same time by the same equipment over the Pacific Ocean in the 0–30°N latitude belt. The difference between them is slightly dependent on the wavelength, this fact may be associated with the presence of the coarse fraction of an aerosol over the equatorial Atlantic (provided the same type of underlying surface), that results in nonselective light scattering.

The relations obtained in this paper and in Ref. 1 should be regarded as the statistical model for outgoing short-wave radiation over the equatorial regions of the Pacific and the Atlantic Oceans.

REFERENCES

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