STRUCTURE OF THE FIELD OF REFLECTED SOLAR RADIATION IN THE VISIBLE REGION OF THE SPECTRUM FROM INTERKOSMOS-21" SATELLITE DATA

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The statistical characteristics of the spectral structure of the reflected radiation in the region 0.415—0.822 μm *are studied. The data were obtained above some regions of the USSR from Interkosmos-21 satellite with the help of the correlation method.*

The variations of the spectral brightness of the surface-atmosphere system are quite significant, even under conditions of high atmospheric transmission, and they are of a random character.[1,2] Statistical methods must be employed to study the spectral structure of the solar radiation field of this system.

Some possibilities in this direction are provided by measurements of the spectral brightness in the band $\lambda = 0.415$–0.822 μm, which were obtained from the Interkosmos-21 satellite with the help of the correlation method instrumentation. The spectra of the reflected solar radiation above some sections of the Azerbaidzhan SSR, Georgian SSR, the Krasnoyarsk Krai, and the Pacific Ocean were analyzed.

To study the statistical characteristics of the brightnesses $J_i(\lambda_k)$, regarded as 13-dimensional random vectors ($k = 1, 2, \ldots, 13$ and $i = 1, 2, \ldots, N$, where N is the number of realizations of the vector, which ranged from 43 to 64 for the regions studied), aside from the average spectral distributions of the brightness $\bar{J}(\lambda_k)$ and the standard deviations $\sigma_J(\lambda_k)$, the autocorrelation matrices $B_{JJ}(\lambda_k, \lambda_1)$ and the correlation coefficients $R_{JJ}(\lambda_k, \lambda_1) = B_{JJ}(\lambda_k, \lambda_1)/\sigma_J(\lambda_k)\sigma_J(\lambda_1)$ were calculated for each region.

Figure 1 shows the average distributions of the brightness $\bar{J}(\lambda_k)$ and the standard deviations $\sigma_J(\lambda_k)$. As one can see from the figure the spectral behavior of $\bar{J}$ above dry land differs substantially from that above water. The spectral behavior of $\bar{J}$ is almost identical for the regions of dry land studied and has one deep minimum in the region of the absorption band of molecular oxygen $\lambda = 0.76$ μm. The standard deviations $\sigma_J(\lambda_k)$ for the brightness are equal, on the average, to 30% above dry land and reach 70% above the sea surface. The fact that the variance of the variations of $J_1(\lambda_k)$ here is two times greater than the variance above dry land indicates that the variations in the aerosol above the Pacific Ocean are significant.

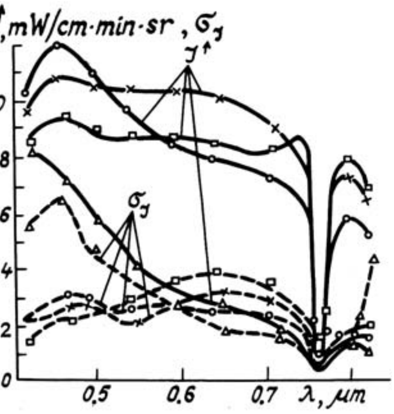

FIG. 1. The average spectral distribution of the brightness $\bar{J}(\lambda_k)$ *of the surface-atmosphere system (solid lines) and the standard deviation* $\sigma_J(\lambda_k)$: ○ – *Krasnoyarsk;* □ – *Georgian SSR;* × – *Azerbaĭdzhan SSR;* △ – *Pacific Ocean.*

Figure 2 shows the coefficients of the correlation matrix $R_{JJ}(\lambda_k, \lambda_1)$. One can see that the characteristic regions are reflected in these matrices. For example, for the Azerbaĭdzhan SSR, the Georgian SSR, and Krasnoyarsk Krai the correlation drops in the region $\lambda = 0.700$ μm of the spectrum $\lambda = 0.500$–0.550 μm are attributable to absorption by molecular oxygen and the low spectral sensitivity of the instrument in the region of 0.794 μm.

The matrix for the Pacific Ocean shows that the overall degree of correlation at the wavelength $\lambda = 0.415$ μm is significantly distinguished from other wavelengths by its low values. The reflection coefficients of water for wavelengths in the range $\lambda < 0.500$ μm increase and therefore the contribution of reflection becomes equal to that of scattering. This explains the low values of R_{JJ} at the wavelength $\lambda = 0.415$ μm for the Pacific Ocean.

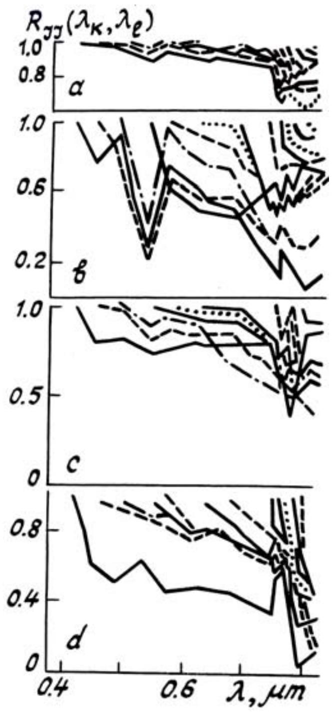

FIG. 2. The correlation coefficients $R_{JJ}(\lambda_k, \lambda_1)$. a — Krasnoyarsk; b — Azerbaĭdzhan SSR; c — Georgian SSR; d — Pacific Ocean.

The effect of the underlying surface on the redistribution of the roles of scattering and attenuation of the upgoing radiation is ultimately manifested correlation couplings for a given level of measurements and the existence of extrema in separate spectral intervals.

An idea of the structure of the information contained in the variations of the spectra of reflected radiation can be obtained from an analysis of the eigenvectors $\varphi_m(\lambda_k)$ as well as the eigenvalues μ_m (Ref. 3). Analysis of these characteristics shows that $\varphi_1(\lambda_k)$ is positive throughout the entire spectrum and reflects primarily the spectral behavior of the variance of the brightness while $\varphi_2(\lambda_k)$ and $\varphi_3(\lambda_k)$ pass through zero once or twice. Moreover, in all cases, the second eigenvector crosses the axis near $\lambda_k \sim 0.48$–0.55 μm. For the Pacific Ocean, as compared with the cases of the Azerbaidzhan SSR, the Georgian SSR, and Krasnoyarsk Krai, $\varphi_2(\lambda_k)$ changes places with $\varphi_3(\lambda_k)$; this can be explained by the sharp minimum for water at $\lambda \approx 0.4$ μm and the virtual vanishing in the region $\lambda > 0.55$ μm.

In all regions studied the first three eigenvectors describe the main features of the distribution of the radiation fluxes over the spectrum and make it possible to represent the measured brightness spectra with an error of 15–20%, while the first five vectors give an error of 7–10%.

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