ANOMALIES OF THE MOON'S THERMAL EMISSION IN THE IR SPECTRAL RANGE (10.5 - 12.5 micron). S. G. Pugacheva. Sternberg State Astronomical Institute, Moscow, 119899, Russia, pugach@sai.msu.ru

Summary: New satellite measurements of the lunar-surface radiation temperature were used to construct the spatial angular function of thermal radiation of the Moon in the infrared (10.5-12.5 micron) spectral range. The basic material for investigations is the scanned cosmic spectrozonal images of the lunar surface transmitted by the first Russian geostationary artificial meteorological satellite "GOMS". The photometric function of thermal radiation of the Moon is plotted as a function of the incidence angle, the reflection angle, and the azimuthal angle between the planes of the incident and reflected rays. A photometric database was created for the brightness and temperature values for 1954 areas of the lunar surface [Pugacheva S.G., Shevchenko V.V., 1999]. In this paper I describe an analytic model for the lunar thermal field, which is realized as an angular function of the thermal infrared radiation emitted by the lunar surface and analyse thermal anomalies of the lunar surface.

Introduction: This satellite was placed in a circular orbit on October 31, 1994, in accordance with the program "Meteorological Service for the Population". The artificial satellite had an onboard television complex (BTVC), whose optical system transmitted real-time digital images of terrestrial clouds, snow cover, and ice cover. With certain geometry of observation and illumination, the lunar disk was seen in the frame of the BVTC objective simultaneously with the Earth's image. The cosmic measurements of the Moon's radiation temperature were constrained by the technical parameters of the BTVC radiometer mounted onboard the "GOMS" artificial satellite. This radiometer measures the heat flux from objects with a brightness temperature of 213--313 K, whereas the lunar-surface radiation temperature at the time of imaging was 250--395 K. To make up for the deficiency in the available data, we used the results of ground-based radiometric measurements of the surface temperature of the Moon performed by Saari and Shorthill (1967). The derivation of an analytic expression for the lunar-surface thermal emission is an important problem of lunar photometry. For this purpose, the parameters of the photometric function were approximated by the regression dependence of radiation temperatures and angular parameters. The analytic expression for the lunar-surface thermal radiation is a trigonometric function whose arguments are the values of the angular parameters i, ε, and A (in degrees). The root-mean-square error in the determination of the radiation temperature is 3% for mare regions and 5% for highland regions [Pugacheva S.G., Shevchenko V.V., 2001].

Discussion: A comparison of the regression dependence with radiation temperatures measured at some points of the lunar surface shows a systematic departure of the measured values from the average values. These deviations, depending on the surface albedo, characterize the photometric inhomogeneity of the lunar surface layer. On the lunar surface four groups of thermal anomalies are chosen: the thermal anomalies at the expense of different heat conduction of the lunar ground, thermal anomalies on the edge of the Moon's limb, "hot spots" - sites of the surface, which area are less than the sanction of the detector, anomalies stipulated by the relief of the surface. The difference in heat conduction of the lunar ground is one of the reasons for thermal anomalies in the mare and craters with dark floors. The difference in temperature of the surface of lunar sites of different heat conduction does not exceed 10_. The thermal anomalies of craters with dark floors are limited to the area of craters and correlate with their diameter. On the surface of the Moon there are plenty of thermal anomalies whose diameter is less than sanction of the detector. On a photograph they appear as isolated points, randomly scattered over the surface. On detail study of large-scale photographs some anomalies are identified with small-sized craters, others with separate clusters of stones. The thermal anomalies as separate "hot spots" are marked at Ocean Procellarum (20E, 55S, six thermal anomalies), Mare Imbrium (35E, 15S, three thermal anomalies), Mare Frigoris (55E, 5N, one thermal anomaly), Mare Crisium (17E, 59N, one thermal anomaly), Mare Humorum (24W, 39S, two thermal anomalies). The formation of the thermal field of the Moon's surface is influenced by relief in a complex manner. These thermal anomalies are observed only in the limited range of phase angles. The difference in temperature of the surface of the thermal anomalies can exceed 20_. Thermal anomalies connected to relief may be related to non-stationary thermal phenomena. The thermal anomalies are dated for such large craters as

Copernicus (9.6N, 19.9W), Tycho (11.3W, 43.1S), Stevinus (54.1E, 32.4S). The anomalies of the largest craters change depending on the conditions of illumination - the thermal spot disintegrate into two opposite anomalies: positive and negative. That is called by irregularities of the relief at the bottom of the crater.

Conclusions: The thermal field of the Moon's surface in the IR infrared spectrum (10.5-12.5 _m) is formed as an outcome of heating of the surface by solar radiation. The temperature of the Moon's surface varies from 400_ to 100_ during a synodic month. The radiation temperature of the surface in regions close to the terminator changes in limits from 250_ up to 300 _. A change of phase of the Moon by one degree increases the radiation temperature by 10_. The differences of temperature of the lunar surface layer indicates the extremely low heat conduction and high porosity of the material. Major factors of the photometric inhomogeneity are strong irregularities of the relief and the varied heat conduction of the lunar ground. The thermal anomalies for highland regions and for mare regions are shown in figure. Contours represent variations of temperature of lunar regolith during lunation (ΔT K).

References: [1] .Pugacheva S.G., Shevchenko V.V. (1999). Astron. Vest., vol.33, no. 1 pp. ,29-35. [2] Pugacheva S.G., Shevchenko V.V. (2001). Astron. Vest., vol.35, no. 3, pp. 199-207. [3] .Saary J.M., Shorthill R.W. (1967). Contractor Report NASA CR-859.186.