THE MOON - NATURAL STANDARD FOR CALIBRATION OF THE
VISIBLE AND INFRARED IMAGES OF THE EARTH; S.G.Pugacheva1,
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The method where the Moon is used as a standard of calibration of spectrophotometric
under-satellite observations is presented. Observations are produced by the satellite (GOMS),
which was placed on geostationary orbit in October 1994 for meteorological forecasting and
monitoring of the Earth's environment [1]. A calibration is based on measurements made
by Saary and Shorthill [2] by means of scanning an illuminated lunar disk in the visible
(0.45 microns) and in the infrared (10-12 microns) wavelengths during a lunation.

The intensity scattering of the lunar surface in visible and infrared spectrum is constant and
it is not change in space during time. Radiative lunar surface can be easily described in the form
of analytical dependences, that allow to transform brightness and temperature values to any angle
parameters of observation and illumination. Procedure of the calibration is based on the
comparison between of signal voltages of the scan image and computer data base, which
includes spectrophotometric measurements of the photometric brightness and infrared brightness
temperature of a large amount of separate spots on the lunar surface.

The computer data base is constructed in the form of logical structure of the relational
type and includes the information about 3000 lunar sites, brightness and temperature surface
which were measured during lunation for 23 phase angles. The image of the Moon in the
visible and IR spectrum on the IBM PC screen may be reproduced by an automatic
programs for the calibration and normalization of the photometrical measurements of
terrestrial natural objects. The algorithm of the programs systematizes the information by
specific regional parameter, it is necessary for estimation the shortage of the informative
numerical data in the comparative matrix "parameter - object".

Numerical models of visible and infrared radiation of the lunar surface were investigated to
transform brightness and temperature measurements to any angle parameters. The Akimov's
theoretical model of radiation scattering of lunar surface [3] was chosen for calibration of the
observed signal in the visible region of spectrum. The relationship for current brightness is
following: 

\[ B = kA b(G, W, L), \]

where \( A \) is brightness of surface for phase angle \(-20^{\circ}\), constant \( k \) is
calculated a least squares for approximating phase curve to values of the data base, \( b(G, W, L) \)
is photometric function, which is a function of phase angle \( G \), luminance latitude \( W \), and
luminance longitude \( L \). The photometric function may be written in the general form:

\[ b(G, W, L) = \cos[\pi(L-G)/2]/[\pi-G])][\cos(G/2)/\cos(L)] \]

Observed signals in the infrared region of spectrum are calibrated by method approximation
of the dependence between brightness temperature and angle parameters. The least-squares fit of
the measurement data to phase function brightness temperature was accomplished by
trigonometric polynomial:

\[ T = T(A, r)[q\cos(i)+p\cos(i)\sin(G-18)+d\cos(G+10)+262], \]

where \( T(A, r) \) is temperature of the subsolar point, which depends on the albedo \( A \), \( r \) is
distance between the Sun and the Moon, \( G \) is phase angle, \( i \) is incidence angle, constants \( q, p, d \)
are the best fit values to phase function temperature for each site of the lunar surface.
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Theoretical brightness and temperature values were calculated by means of given equations and were compared with numerical values data base. These equations provide good fit of most of measurements. The analytical fit with brightness correction is accurate to better than 5%. Measurements of the temperature give of 1.5K in agreement with analytical infrared data. The infrared image of the Earth transmitted in working spectrum diapason 10.5-12.5 micron by geostationary satellite (GOMS) is shown in the Figure 1. The bright (in infrared view) object above limb of the Earth is the Moon. The lunar phase is between first quarter and waxing gibbous.

Fig. 1