GLOBAL COLOR AND ALBEDO VARIATIONS ON TRITON; A. S. McEwen, U.S. Geological Survey, Flagstaff, AZ 86001

Among the images returned by Voyager 2 are full-disk color sequences of Triton acquired at low phases angles (11°-39°) and at various rotational longitudes during the approach to Neptune [1]. These data have been used to model Triton's photometric function and to produce multispectral mosaics covering the region from about latitude -90° to +30°. Images acquired through all six narrow-angle camera spectral filters were included: OR (0.59 μm), GR (0.56 μm), BL (0.48 μm), CL (0.47 μm), VI (0.41 μm), and UV (0.34 μm). The spectral response from each bandpass has a half-width at half-height of about 0.03-0.04 μm except that of the CL filter, which has half-width of about 0.14 μm. Ten six-filter sets of approach images were chosen for this study.

Processing steps were as follows: (1) radiometric calibration, yielding image intensities proportional to the brightness relative to that of a Lambert surface illuminated normally (R); (2) geometric control using preliminary control points, limb fits, and tie points; (3) transformation of each frame to an Orthographic projection centered on the average subspacecraft latitude and longitude for each color set; (4) noise removal through principal-component transformation, filtering of higher principal components (where noise was concentrated), and the inverse transformation; (5) geometric transformation to Simple Cylindrical projections at a scale of 0.25 degrees/pixel; (6) photometric-function fits (see below); (7) application of photometric function to correct images to normal albedo; (8) trimming of overlapping images to preserve only the data of highest resolution in each filter; (9) mosaicking; (10) seam removal; (11) reprojection of mosaics to Polar Stereographic projections; and (12) production of hemispheric albedo images for radiative equilibrium models.

The color mosaics in Polar Stereographic projection provide a spectacular view of Triton's south polar cap and bright fringe. The spectral units and variability on Triton will be described in this poster.

Preliminary modeling with the photometric function of Hapke indicated that the macroscopic roughness parameter for Triton is near zero [1]. Also, because the lowest phase angle is 11°, the opposition effect is not observed, and the backscatter function is not needed to fit the data. Therefore, a simplified version of Hapke's equation with the Henyey-Greenstein phase function ($P(\alpha)$) was chosen:

$$R = w/4\ u_o/(u + u_o)\ [P(\alpha) + H(u)H(u_o) - 1],$$

where w is single-scattering albedo, u is the cosine of the emission angle, and u_o is the cosine of the illumination angle. The phase function is

$$P(\alpha) = [1-g^2]/[1+g^2+2g\cos(\alpha)]^{3/2},$$

where g is a parameter that varies from -1 to +1 and α is the phase angle. The H functions are

$$H(x) = [1+2x]/[1+2x(1-w')^{1/2}]$$

where w' is normally taken as the single-scattering albedo. However, by making w' an independent parameter, the fits to the Triton data were significantly improved.

Ratios of Simple Cylindrical images (of the same filter but with different subsolar and subspacecraft positions) were made to test for variations in photometric properties of different surface units. In the absence of different photometric units, the ratios should be smooth functions of u and u_o, whereas distinct photometric units should form discrete patches of relatively high or low ratio values. The ratios are largely smooth functions of u and u_o, but a few slightly anomalous patches are seen in the south polar region. More pronounced anomalies are apparent in images with phase angles greater than 40°, but these images have not been incorporated into the multispectral mosaics. Hence, global average values for g and w' appear to be adequate for the low-phase dataset.

Solutions for g and w' were derived for each filter by finding those values of g and w' that resulted in the smallest mean deviation between corresponding pixels in the simple cylindrical format (weighted by the cosine of the latitude to normalize by surface area). With this method, systematic variations in surface albedo (such as relatively dark surface units near the equator) will not bias the results. The results in all six filters were very near (within 0.01) -0.28 for g and 0.96 for w'. To see if these results apply to higher phase angles, six CL-filter images with phase angles of 63° to 79° were included in the CL solution; the results were identical. At phase angles near 140°, however, Triton becomes more forward scattering, especially at shorter wavelengths, most likely because of scattering by the atmosphere and airborne eruption plumes [1].

Images of hemispheric albedo (A_θ) have been produced through numerical integration of the scattering function over a hemisphere of emission. A_θ varies with illumination angle; for Triton's average surface, A_θ varies from 0.63 at normal illumination to 0.84 at an illumination angle of 80°. Triton's frost temperature is expected to be maintained near a global mean temperature through contact with the atmospheric vapor, which covers the satellite at nearly constant pressure [2]. The global mean temperature in radiative equilibrium is given by $T = [(1-A_\beta)F_o/4\sigma]^{1/4}$, where A_β is the bolometric hemispheric albedo, F_o is the incident solar flux (1.5 W/m^2), and σ is the Stefan-Boltzmann constant. Triton's global average A_θ (at 30° illumination angle) in the GR filter is 0.66, and, if we assume that this is an adequate estimate of A_β, the predicted temperature is 39°K, in excellent agreement with the Voyager IRIS measurement of 38°K (with possible errors of +3° and -4°) [3].

[1] Smith, B. A., et al., 1989, Voyager 2 at Neptune: Imaging science results. Science 246, 1422-1449. [2] Ingersoll, A. P., A post-Voyager study of the dynamics of Triton's atmosphere. submitted to Nature. [3] Conrath, B., et al., 1989, Infrared observations of the Neptunian System. Science 246, 1454-1459.