PHOTOMETRIC CORRECTION OF THERMAL DATA FROM THE DIVINER LUNAR RADIOMETER.

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Introduction: The Diviner Lunar Radiometer (Diviner) on the Lunar Reconnaissance Orbiter (LRO) has mapped lunar silicate mineralogy using three narrowband channels centered near 8 µm, which locate the emissivity maximum known as the Christiansen Feature (CF) [1]. Diviner also has four broadband channels extending into the thermal infrared (13-23, 26-41, 50-100, 100-400 µm). This region contains additional spectral features, including bending and rotational vibrational modes, some of the Reststrahlen bands, and transparency features, which can be used in conjunction with the CF position to enable more robust compositional identification [2].

Before these long wavelength spectral features can be used for compositional identification, Diviner thermal data requires a correction for photometric effects that vary between measurements [3,4]. Previous work [4] has demonstrated the pronounced decrease of radiance values with increasing incidence angles due to the difference in total irradiance of the surface at high latitudes and times of day far from equatorial noon. Although the published CF data includes a photometric correction, the broadband thermal data also requires a correction to compare directly data from various lunar locations with different illumination conditions.

Our goal for this work is to create a correction for the Diviner thermal channels that (a) has the minimum number of parameters required to correct the data, and (b) is applicable to as much of the Moon as possible. This will ensure that compositional investigations that utilize the thermal channels can be directly compared with each other.

Data and Methods: We have adopted a model that involves applying two successive cosine fits to a broadly representative dataset in uncorrected radiance and normalized radiance spaces [5]. To apply the correction, mapped data from an area of interest is normalized by the value of the generic normalized radiance fit at an optimal incidence angle (0° in this version of the correction). This process shifts high incidence data towards the same radiance as low incidence data, yielding a corrected dataset with a more symmetrical normal distribution (Figure 1).

To test this model, several test datasets have been created for sites that vary in latitude (equatorial to +/- ~50° N), composition (highlands and mare), and degree of large scale topography (nearly featureless 1x1 degree sites and crater sites up to 8x8 degrees). We performed a comprehensive analysis of the possible combinations of datasets, and determined that an optimal input dataset for the fitting routine would combine data from various latitudes to accommodate the inherent yet complementary variation in data density across incidence angles between low and high latitudes. We then used this data set for the fit in the correction applied to the Diviner Channel 6 map of King Crater in

Results and Discussion: Figures 1 and 2 demonstrate both the quantitative and visual improvement of

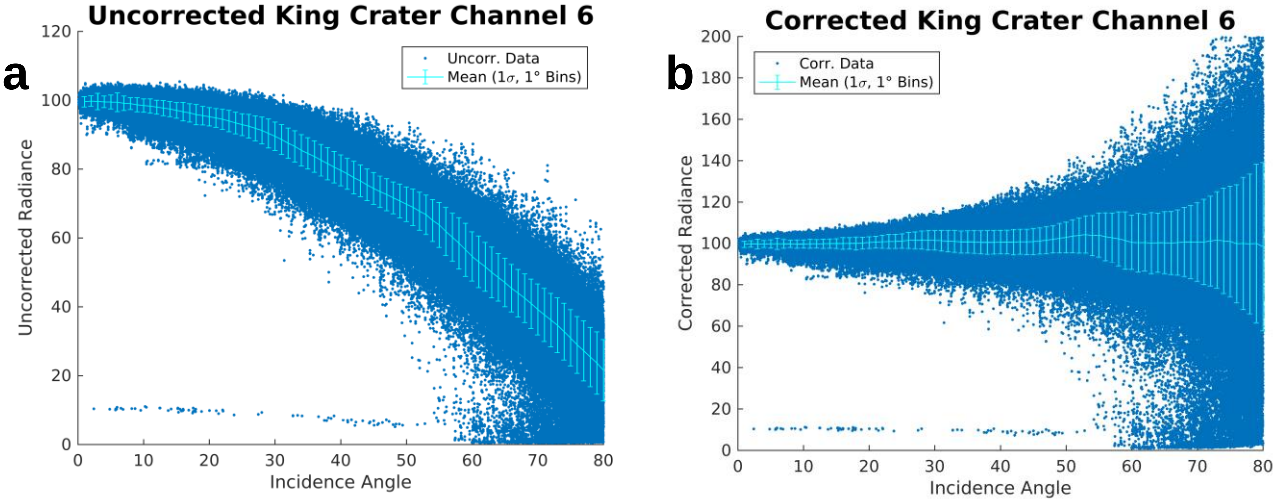

Figure 1: Plots of uncorrected (a) and corrected (b) Diviner thermal data from a 4x4 degree scene centered on an equatorial highlands crater (King, 3-7 degrees N, 119-123 degrees E). The correction normalizes the uncorrected data against a curve fitted to a generic normalized radiance dataset that is representative of the scene.

the radiance data after using the correction. The correction makes several compositionally discrete regions in Figure 2 visible. Improved visual quality at high spatial resolution is necessary for locating features to use in spectral analysis and compositional mapping. These tasks are aided by comparison to visible wavelength imagery such as LROC NAC or to other compositional mapping products, including the Diviner CF dataset.

The correction mechanism illustrated in Figure 1 works sufficiently well on most of the test sites investigated so far. Refining the generic fits derived from these sites by adding additional data to the fit inputs will help us expand the correction to a wider variety of spatial regions. Accounting for extrinsic illumination conditions and spatially variable data density may further improve the correction by reducing the orbit-to-orbit variation remaining in images after they are processed with the current correction. Future work will involve validating the applicability of our generic corrections to the wide variety of environments found on the lunar surface and working to eliminate the orbit-to-orbit variation still visible in the corrected data.

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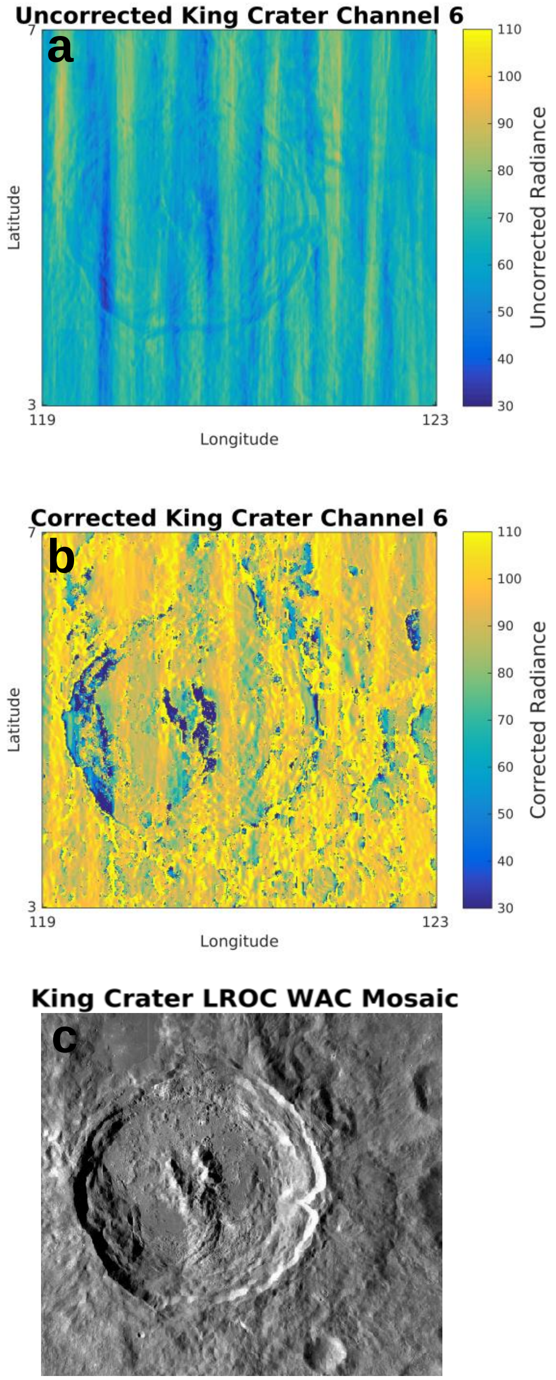

Figure 2: Maps of uncorrected (a) and corrected (b) Diviner channel 6 radiance data for King crater, with an LROC WAC mosaic (c) of the same site for reference. The correction enables us to distinguish several features on the surface not visible in the uncorrected data, including the central peak and crater floor of King, as well as features and textures in the surrounding highlands, including small craters and other structures.