AN ILLUMINATION CORRECTION ALGORITHM ON LANDSAT-TM DATA

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Illumination correction, also known as topographic correction or topographic normalization, refers to the compensation of the solar irradiance to minimize the variability of observed reflectance for similar targets due to topography and BRDF effects. This is an important step in pre-processing high-resolution remote sensing data. Varying illumination conditions lead to significant changes in the spectral characteristics of a pixel, even in the absence of variations in land cover type or condition. There are several existing illumination correction algorithms for Landsat-TM data. The surface reflectance is a corrected for illumination using a function of the cosine of the solar incidence angle, or Illumination Condition (IL):

$$IL = \cos Z \bullet \cos S + \sin Z \bullet \sin S \bullet \cos(\phi_z - \phi_S)$$

Where Z is the solar zenith angle, S is the slope angle. ϕ_z is the solar azimuth angle, and ϕ_S is the aspect angle of the incline surface.

Two illumination corrections algorithms are widely used, the cosine model $L_H = L_i(\frac{\cos Z}{IL})$, and the C model $L_H(\lambda) = L_i(\lambda)\frac{\cos Z + c}{IL + c}$, described in [1]. Where L_H is the reflectance on flat surface, L_i is the reflectance on incline surface, *c* is the ratio of the slope and intercept of the linear regression:

$$L_i(\lambda) = a \bullet IL + b \quad (1)$$

Several studies have reported that the cosine model overcorrects the surface reflectance, especially in low IL regions [2][3][4]. The C model can avoid the overcorrection to some degree, but in our test cases there is still a significant overcorrection in the shorter wavelengths. Spectrally, both methods perform better for the near-infrared band than visible bands. The overcorrection in visible bands with low IL is significant (Fig. 1), because of the larger amount of atmospheric scatter.

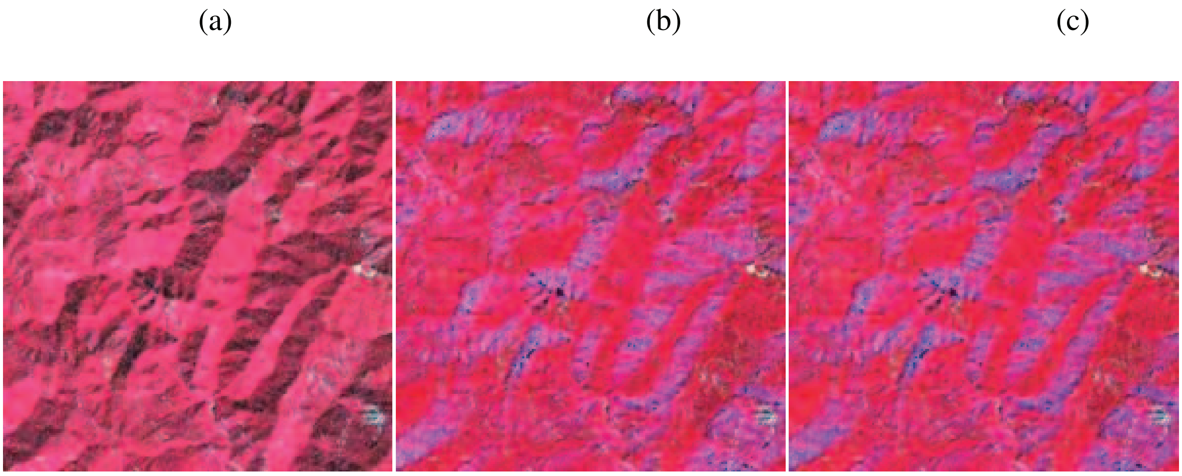

Fig. 1. Landsat images of (a) original data, (b) corrected by cosine model, and (c) corrected by c-model. The RGB composite is using near-infrared, red, and green bands respectively.

After correction by these methods, the spectral characteristics for the low IL regions change significantly. This reduces the usability of the corrected image in subsequent studies. The primary reason for this overcorrection is that both models ignore the effect of diffuse radiation.

Our new approach uses an empirical method to remove the dependency of surface reflectance on the illumination condition. In this procedure, the relative spectral difference among pixels stays unchanged. The equation is $L_H(\lambda) = L_i(\lambda) - (a * IL + b)$, where a and b are from Eq. (1). The preliminary result shows that the corrected image preserves spectral relationships within the image (Fig. 2).

Fig. 2. The illumination corrected Landsat image. The RGB composite is using near-infrared, red, and green bands respectively.

We will further improve the algorithm by quantitatively estimating and minimizing the impact of diffuse radiation in the correction process. The goal of this study is to produce illumination corrected Landsat-TM data with the quality needed for more accurate forest change detection [5][6] in the Landsat Ecosystem Disturbance Analysis Adaptive Processing System (LEDAPS) [7][8]. We will compare the forest change detection accuracies with and without illuminate corrected.

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