

# Automated scene-derived normalization of spectral imagery for subpixel classification

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## ABSTRACT

Changing illumination and atmospheric conditions hamper the automated analysis of spectral imagery. Applied Analysis Inc. developed an Environmental Correction module as part of its *Subpixel Classifier* software. This module derives atmospheric and sun angle correction factors directly from an image without the use of predictive models. Subpixel occurrences of dark and bright surface features are used to characterize atmospheric radiance, atmospheric attenuation and sensor transfer functions. A significant component of each pixel used to derive this information can be unwanted surface reflectance from sun glint, sky illumination, or other solar-illuminated terrain materials. These spectral contributions distort the accurate assessment of atmospheric radiance, atmospheric attenuation and sensor transfer functions. By working at a subpixel level, the *Subpixel Classifier* software is able to more accurately derive these factors, resulting in improved environmental correction.

**Keywords:** Subpixel, multispectral, hyperspectral, normalization, atmospheric correction

## 1. INTRODUCTION

The automated detection of materials of interest using satellite and airborne multispectral and hyperspectral sensors has had mixed success. One of the principal factors that has limited algorithm performance in the past has been inadequate calibration for atmospheric, illumination, and sensor characteristics. The digital number value of an image pixel in band  $n$ ,  $DN(n)$ , can be related to the apparent reflectance characteristics of the material in the pixel field of view,  $R(n)$ , by the relation

$$DN(n) = O(n) + G(n) \times (\text{Sun}(n,i) \times T_S(n) + \text{Sky}(n) \times T_A(n)) \times R(n). \quad (1)$$

Here  $O(n)$  and  $G(n)$  are the bandpass-integrated sensor offset and gain factors in band  $n$ , respectively.  $O(n)$  and  $G(n)$  include the integrated contributions of all the sensor optical elements and electronics, as well ground processing calibrations applied to the raw data.  $A(n)$  is the bandpass-integrated atmospherically scattered solar radiance in the direction of the sensor for band  $n$ . This term includes both molecular and particulate (haze) scattering.  $\text{Sun}(n)$  is the bandpass-integrated incident solar radiance at the top of the atmosphere in band  $n$  and sun angle  $i$ , and  $T_S(n)$  is the bandpass-integrated atmospheric attenuation along the paths of solar incidence and reflection toward the sensor in band  $n$ .  $T_S(n)$  includes attenuation by both absorption and scattering along a heterogeneous path.  $\text{Sky}(n)$  is the bandpass-integrated hemispherical sky radiance, and  $T_A(n)$  is the bandpass-integrated and hemispherically integrated atmospheric attenuation of the sky radiance.  $R(n)$  includes reflectance contributions from all materials, exclusive of those included in  $A(n)$ , at their respective terrain angles in the pixel field of view.

Attempts at modeling these terms, using codes like MODTRAN, have met with mixed success due to the complexity of each of the terms and the frequent lack of sufficient information about