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UPDATED SURFACE SPECTRAL REFLECTANCE MODELS COMPATIBLE WITH CURRENT GLOBAL LAND COVER CLASSIFICATIONS

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1. INTRODUCTION

Information on the spectral characteristics of the earth surface at a global scale is needed in a wide range of applications dealing with the disposition of radiant energy in the atmosphere and at the surface. In the past, such information has been synthesized from ground measurements, model outputs, and limited satellite observations. In this paper, an attempt is being made to use a comprehensive data set of satellite observations at high spatial resolution in two channels of the AVHRR, to update existing spectral reflectance reference models and make them compatible with recent land classifications.

2. DATA USED

Use was made of the NOAA National Environmental Satellite Data and Information Service Global Vegetation Index (GVI) monthly mean global data set for 1985-1987,1989-1991, (Gutman and Ignatov, 1998) and the ASTER Spectral Library data, to update spectral reference reflectance models initially proposed by Briegleb et al. (1985) for the spectral intervals of 0.2-0.5, 0.5-0.7, 0.7-1.3, 1.3-4 μm. The GVI data provide clear sky AVHRR channel 1 and channel 2 reflectances at the top of the atmosphere at 0.144-degree latitude-longitude grids (Csiszar and Gutman, 1999).

3. METHODOLOGY

The TOA reflectance data were corrected for atmospheric influences using the SBDART radiative transfer model to compute spherical and planar reflectances and transmittances for climatological atmospheric conditions of water vapor, ozone and solar zenith angle, and the data are referenced to a solar zenith angle of 60 degrees. Specifically, the following formula is used as a theoretical basis for the atmospheric correction:

$$A_s = \frac{R^* - R(\mu_0)}{TT(\mu_0) + (R^* - R(\mu_0))R}$$

Where:

μ_0 is the cosine of solar zenith angle,
A_s is the surface albedo,
R^* is the TOA reflectance,
$R(\mu_0)$ is the planar reflectivity,
$T(\mu_0)$ is the planar transmissivity,
R is the spherical reflectivity,
T is the spherical transmissivity.

The spherical and planar reflectivity and transmissivity for both channels are calculated with the SBDART radiative transfer model (Ricchiazzi et al., 1998). As input parameters, total precipitable water, ozone, solar geometry, surface elevation and albedo are needed. We use GVI solar zenith angle, TOVS precipitable water, and TOMS ozone for the same period as that of the albedo data to obtain climatologically mean atmospheric conditions. Topography data are taken from a global digital elevation model GTOPO30. Simulations of atmospheric influences are performed globally with these mean profiles and dark surface and AVHRR channel 1 and channel 2 response functions, over a 1x1 degree grid for each month. In order to obtain spherical reflectivity and transmissivity we use the diffusivity approximation. In order to compare albedo from different latitudinal belts all data are converted to the same solar zenith angle of 60^o.

The monthly values of reflectances corrected for atmosphere and for solar zenith angle are regressed against vegetation fractional coverage of each surface type as available from the Global Land Cover product as derived at the University of Maryland, Department of Geography, using the NASA/NOAA Pathfinder Land data set at 8 km resolution for 1981-1994 (Hansen et al., 2000). We assume linear dependence between surface albedo and the reference albedo of each surface type:

$$alb = \sum_{i=1}^{n} st(i)\, a(i)$$

where

alb is the surface albedo,
st(i) is vegetation fractional coverage of surface type *i,*
a(i) is the reference albedo of surface type i,

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n is the number of surface types (14 for UMD classification).

Seasonality in the reference model was also introduced as the reflectance models were derived separately for each month. Examples for an Evergreen Broadleaf Forest and an Evergreen Needle leaf Forest are shown in Figures 1 and 2.

The reference reflectance models proposed in this study should be applicable as input parameters in radiative transfer models, in studies concerned with Earth and atmosphere energy balance, and spectral properties of the surface.

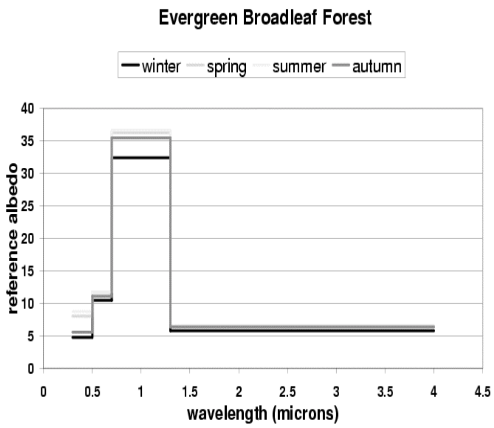

Figure 1.

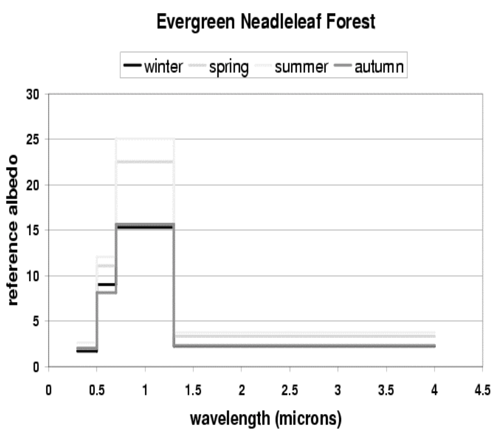

Figure 2.

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