P5.21 LAND SURFACE ALBEDO, NADIR BRDF−ADJUSTED REFLECTANCE, AND BRDF PRODUCTS FROM THE MODERATE RESOLUTION IMAGING SPECTRORADIOMETER (MODIS)

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1. INTRODUCTION

Provisional albedo, bidirectional reflectance and nadir surface reflectance products of the Earth's land surfaces from the MODerate resolution Imaging Spectro−radiometer (MODIS) on board NASA's Terra spacecraft have been available from the EROS Data Center (EDC) since November 2000. Atmospherically corrected, cloud cleared, surface reflectances are used to produce 1km gridded MODIS Bidirectional Reflectance Distribution Function (BRDF), Nadir BRDF−Adjusted surface Reflectance (NBAR), and Albedo Products (MOD43B1, MOD43B3 and MOD43B4) every 16 days (Lucht et al., 2000). The operational MODIS BRDF/Albedo algorithm relies on multidate surface reflectance data and a semiempirical kernel−driven BRDF model (RossThickLiSparseReciprocal) to determine a global set of parameters describing the BRDF of the land surface. These one kilometer gridded parameters are then used to determine both global directional hemispherical reflectance (direct beam or "black sky albedo" at local solar noon), and bihemispherical reflectance (diffuse or "white−sky albedo") for the first seven spectral bands of MODIS and three broad bands of interest to modelers. The parameters are also used to obtain the Nadir BRDF−Adjusted surface Reflectances (NBAR) for the seven spectral bands (at the mean solar zenith angle of the period). The quality of these products is currently being evaluated by the MODIS science team and validation scientists.

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2. PROTOTYPING with AVHRR

Prior to launch, the operational MODIS BRDF/Albedo algorithm was tested with multidate AVHRR data to see if consistent BRDF parameters and albedos could be produced that reflected the true phenological cycles of the underlying surface. A sequence of over 4 months of daily AVHRR data of New England from July to October 1995 were used for this prototyping exercise. The daily data were broken into 16 day periods, and laboriously calibrated, geolocated, and cloud cleared following the methods described in (d'Entremont et al.,1999). The data were then atmospherically corrected using the 6S code (Vermote et al,1997a;b) with standard atmospheres and visibility information from the eleven meteorological stations in the region. The data were finally transformed into the ISG projection and formatted to simulate a MODIS input tile (with, of course, only the two solar spectral channels that are available from the AVHRR). BRDF parameters were retrieved for each pixel in the scene and used to obtain albedo and nadir reflectance measures. The resulting red and NIR spectral white−sky albedos obtained over the latter portion of the period are displayed in Figure 1. Over the summer months, the values remained fairly consistent with higher NIR (and lower red) albedos occurring over the forested portions of Vermont, New Hampshire and New York and lower NIR (and higher red) spectral values occurring over the urban and suburban areas. However, a change is seen sweeping over the scenes as autumn (late September) approaches, with the northern areas producing increased red spectral albedos as the deciduous forests senesce into a typically spectacular New

England fall with peak colors on October 8th and then abruptly changing to high red (and low NIR) values as the region experiences leaf drop a week later.

3. OPERATIONAL MODIS PRODUCTS

As MODIS Terra operationally captured the New England autumn September − October 2000, a companion series of white−sky albedo images were produced (Figure 2). During this period, the data products were available to the public as beta products. A full aerosol correction was not yet being applied to the data and a uniform default optical depth was used globally. Despite these obvious limitations, Figure 2 indicates that the MODIS derived albedos captured the senescence of the predominantly deciduous and mixed forests of the region. Foliage color peaked on October 20th in 2000 and leaf drop had occurred by October 26th (slightly later than in 1995). Note the slightly higher albedo values (~5%) which are attributed to the poor aerosol correction used with the MODIS beta products and the differences in channel width between MODIS and AVHRR.

4. SUMMARY

While the results discussed are only from a small regional study, they are representative of the temporal consistency of the MODIS BRDF/Albedo products. Six months worth of Nadir BRDF−Adjusted Reflectances have already been used to produce the first provisional MODIS Land Cover product (Friedl et al., 2000). Furthermore, the BRDF/Albedo global products from November 2000 onward are currently being reprocessed to obtain a consistent year running from November 2000 through October 2001. This will allow us to more accurately capture annual phenological cycles across the globe and monitor the greenup and the senescence of various deciduous vegetation canopies. Active field validation programs are currently underway at the Beltsville Agricultural Research Center (BARC) in Maryland, at the Barton Bendish agricultural site in East Anglia, at the Mongu, Zambia woodland site and the Skukuza, South Africa savanna site (both part of the Southern African Regional Science Initiative − SAFARI), and at the Liangchen, Shunyi and Yucheng agricultural sites in China.

5. REFERENCES

d'Entremont, R. E., C. L. Barker Schaaf, W. Lucht, and A. H. Strahler, 1999: Retrieval of red spectral albedo and bidirectional reflectance using AVHRR HRPT and GOES satellite observations of the New England region, J. Geophys. Res., **D−104**, 6229−6239.

Friedl, M., Muchoney, D., McIver, D., Gao, F., Hodges, J., and Strahler, A., 2000: Characterization of North American Land Cover from NOAA−AVHRR Data Using the EOS− MODIS Land Cover Classification Algorithm. Geophys. Res. Let., **27**, 977−980.

Lucht, W., C.B. Schaaf, and A.H. Strahler, 2000: An Algorithm for the retrieval of albedo from space using semiempirical BRDF models, IEEE Trans.Geosci. Remote Sens., **38,** 977−998.

Vermote, E. F., N. El Saleous, C. O. Justice, Y. F. Kaufman, J. L. Privette, L. Remer, J. C. Roger, and D. Tanre, 1997a:, Atmospheric correction of visible to middle infrared EOS−MODIS data over land surfaces: Background, operational algorithm, and validation, J. Geophys. Res., **D−102**, 17131−17141.

Vermote, E. F., D. Tanre, J. L. Deuze, M. Herman, and J. J. Morcrette, Second simulation of the satellite signal in the solar spectrum: an overview,1997b: IEEE Trans. Geosci. Remote Sens., **35**, 675−686.

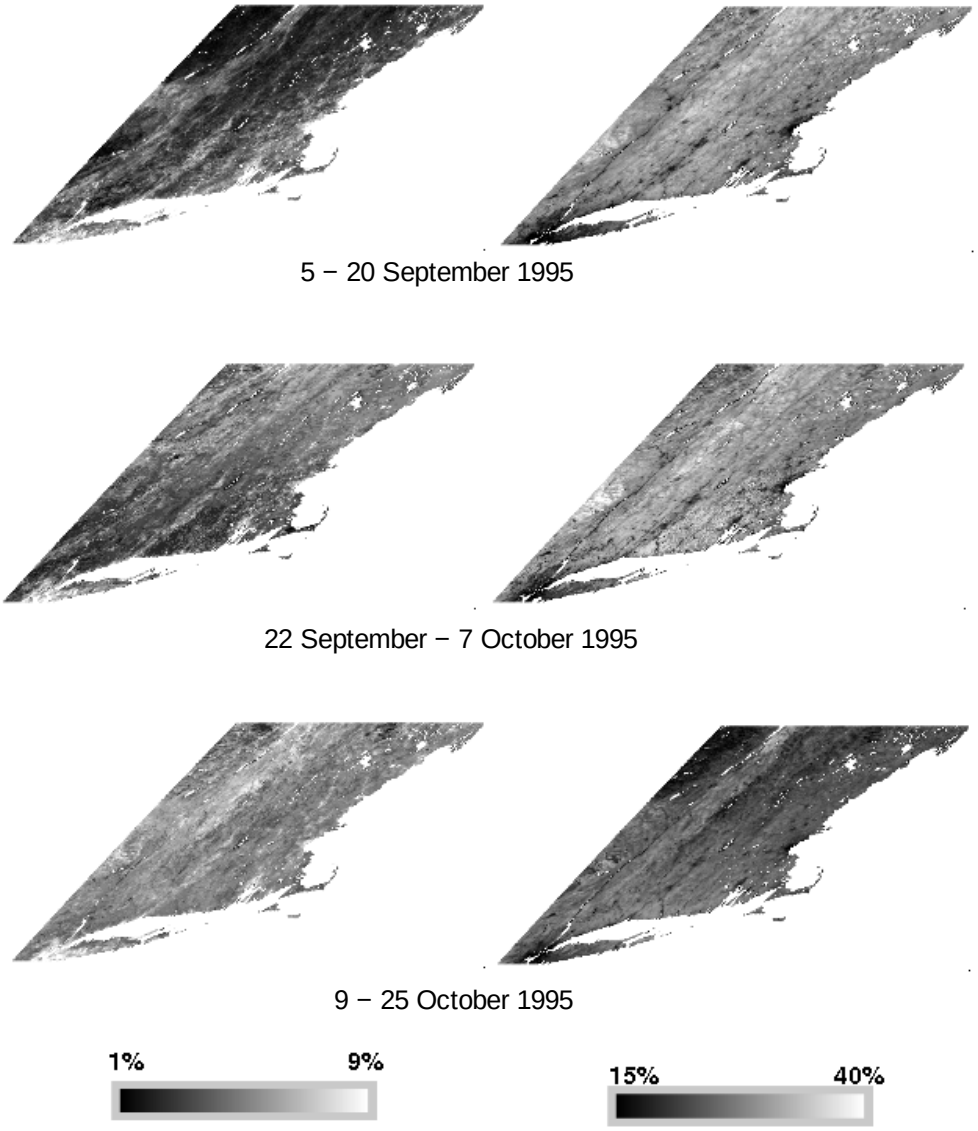
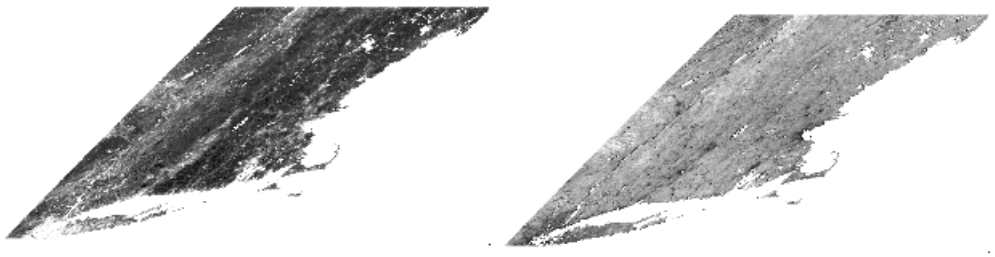
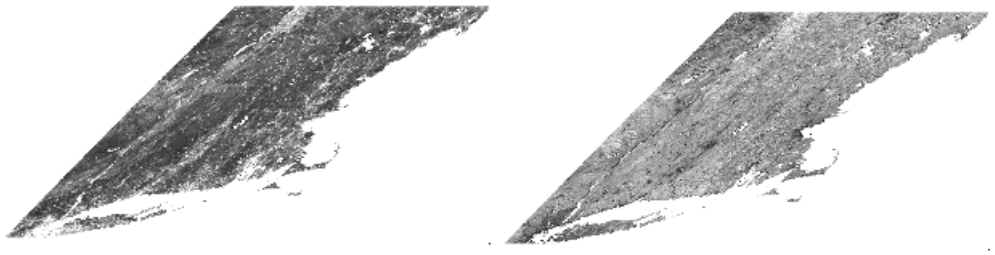


Figure 1. NOAA AVHRR red band (left) and NIR band (right) spectral white−sky albedo for New England during autumn 1995.



5 − 20 September 2000



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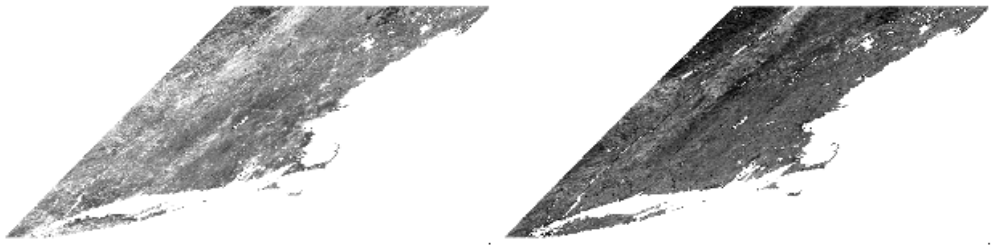

9 − 25 October 2000

Figure 2. Terra MODIS red band (left) and NIR band (right) spectral white−sky albedo for New England during autumn 2000.