TOWARDS SPECTRO-DIRECTIONAL PRIOR INFORMATION - CASE STUDY ON AN ALFALFA CANOPY OBSERVED DURING DAISEX 99

Gabriela Schaeppman-Strub (1, 2a) gschaepp@geo.unizh.ch, Michael Schaeppman (2b), Y. Knyazikhin (3), K.I. Itten (1)

ABSTRACT

Multiparameter ground based spectroradiometer measurements are a tool to generate BRDF a priori knowledge for improving the retrieval of surface bidirectional reflectance and spectral albedo from satellite data. This study presents the analysis of directional spectrometer data acquired on an agricultural test-site during DAISEX’99 (ESA Contract No. 13390/NL/GD), an airborne imaging spectrometer campaign to substantiate the retrieval of geometrobiophysical variables [1]. The objectives of this contribution is a quality assessment and analysis of ground-based directional observations and corresponding simulated data, linking measured directional reflectance factors (HDRF) to canopy BRDF models for the derivation of biophysical parameters. Presented results are a contribution to the generation of a reliable database of spectral a priori BRDF knowledge by demonstrating methods to verify observed directional vegetation data, with special emphasis on the spectral dimension of the reflectance.

METHODS

PREPROCESSING (HDRF, BHR, ANIF

DATA SET

FIELD MEASUREMENTS (FIGOS)

EXAMPLE OF ANIF

RESULTS

VARIATION OF DIURNAL HDRF DATA

Figure 1: Anisotropy factors (ANIF

VARIATION OF DIURNAL NADIR OBSERVATIONS

Figure 4: Differences between the nadir HDRF around solar noon (SZ = 17º) and nadir view HDRFs at different Sun zenith angle throughout the day, normalised by the solar noon HDRF (left: observed data, right: simulated data). The relative HDRF deviations are wavelength dependent and considerably larger in the visible wavelength region with less reflectance values. In the visible wavelength region, HDRF data are up to 40% below solar noon measurements. Modelled HDRF deviations are much smaller, within 20% of the reference noon reflectance value (which partly might be an artifact of the model version used for this study). These results illustrate the necessity of taking into account the Sun angle geometry for field spectrometer measurements and vicarious calibration purposes.

PROSPECT (2) / SAILH (6) SIMULATIONS

To establish a reference for the measured Alfalfa HDRF data, leaf optical properties and canopy reflectance were modeled using PROSPECT (2) and SAILH (6), in a modified version. (Main modifications of the original code include the parametrization of the elliptical distribution, with average leaf angle and eccentricity as driving parameters, whereas eccentricity is coupled to the average leaf angle. Thus, the model needs only the average leaf angle as an input parameter. This modification has been performed by F. Baret, INRA, France, 1998.) Vegetation parameters required by PROSPECT and SAILH are determined from field measurements or literature (N = 1.8, Cab = 41.4ug/cm2, Cw = 0.022, Cm = 0.004g/cm2, brown pigment = 0.1, LAI = 5, average leaf angle = 50º, hot spot parameter = 0.657). The required soil reflectance was measured during the field campaign. Using optical depth derived from Sun photometer data, the ratio of the diffuse and total irradiance is modeled for each hemisphere using MODTRAN4.

For the geometry (illumination and view angle) of each goniometer measurement, a run of the modified SAILH is performed, providing the HDRF. The view angles in the hot spot region are excluded from the measured data set to omit unrealistic simulations, too.

ANALYSIS

• Statistical analysis of diurnal HDRF revealing additional information contained in spec-

• Variation of nadir observations during the day showing the relevance of simultaneous

• Analysis of diurnal spectral albedo changes for observed and simulated data.

• Analysis of wavelength dependent effects of BHR/HDRF.

• Inversion of AMBRELS model (MODOS) to calculate isotropic, volumetric (Ross/Thick) and geometric (LITe010) kernel values for the generation of a priori BRDF knowledge.

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DIURNAL ALBEDO VARIATION

- Variations of observed and simulated Alfalfa HDRF data are in the same range and both clearly exceed spectrometer measurement uncertainties (Figure 5).
- Spectral albedo derived from measured (left) and simulated (right) Alfalfa hemispherical bidirectional reflectance factors. Spectral albedo derived from measured data exhibit a larger variation than HDRF data derived from simulated data. The coefficients of the red band show a lower absolute variation and mostly lie within the joint probability density function as derived by Li et al., 2001 [3], from 73 BRDF data sets. Negative weights can be observed for measured vegetation reflectances in the NIR wavelength range, indicating the need for further examination.

ANISOTROPY FACTORS

- The measurements substantiate that the albedo has an increasing value with the solar zenith angle (Figure 5), and shows a pronounced asymmetry with respect to solar noon.
- The characterization of the vegetation category throughout the day, i.e., for model driving parameters such as leaf area index and leaf angle, is a prerequisite for further studies.
- For upcoming analysis of wavelength dependent effects for different Sun zenith angles, the influence of the diffuse fraction of the irradiance on measured HDRF data has to be investigated. Laboratory measurements with the FIGOS and joint outdoor observations will enable to quantify the effects caused by diffuse irradiance.
- More studies on BRDF a priori knowledge are limited to a few spectral bands. There is a need of analyzing the spectral dynamics of BRDF effects, providing additional soft-bound knowledge in the spectral dimension.

REFERENCES AND ABBREVIATIONS

3. Li, X.W., F. Gao, J.D. Wang, and A. Strahler, A Priori Knowledge Accumulation and Its Application to Linear BRDF Model Version Used in This Study, and Thus Is Under Discussion.

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