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AN ANALYTICAL APPROACH TO TREAT THE BIDIRECTIONAL REFLECTANCE DISTRIBUTION FUNCTION OF THE RICE CROP

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ABSTRACT

Since May, 1982, we have been employing GSFC Mark-II Three Band Hand-Held Radiometer to study the temporal spectral characteristics of the rice crop. The spectral properties of the paddy are characterized by the Bidirectional Reflectance Distribution Function, or BRDF. The preliminary results were summarized by Chen et al (1982). It was found that at some instances, the variations of the bidirectional reflectance for different view angles are comparable to those due to temporal variations over the crop calendar. Furthermore, during the period between active tillering and heading, the BRDF exhibited strong anisotropy for large solar zenith angles. The bidirectional reflectance showed a minimum when the sensor was vertically looking downward and increased with increasing view angles with respect to the vertical direction. In other words, the BRDF depicted a "V" shape distribution.

Several models have been developed in the past, to understand the spectral properties of the crops and woods (Allen and Richardson, 1968; Suits, 1972 and Smith and Oliver, 1972, etc.). It appears that none of the models is adequate to describe the geometrical features of the paddy during the period of active tillering and heading, when the BRDF shows strong anisotropy. A Monte Carlo simulation model developed by Wang and Chen (1983) seems to be able to produce the "V" shaped distribution.

Starting from a microscopic point of view, we propose an analytical approach to treat the BRDF of the rice crop. It is suggested that the BRDF can be decomposed into two components, called "reflectance map" and "effective leaf area map". In a viewer-oriented coordinate system, the "reflectance map" is reconstructed by the knowing optical properties of each small elements of the rice canopy. The optical properties are characterized by its surface normal vector and the phase function of the surface material. The reflectance map is, therefore, a function of the radiation source and the phase function of the rice canopy. The "effective leaf area map" on the other hand, is determined by the geometrical orientation of the leaves with respect to the sensor. By solving the solutions for the "reflectance map" and "effective leaf area map", we are able to reproduce the "V" shaped BRDF. Our approach is particularly useful during the active tillering period when the leaves won't cast shadow on one another. An attempt is being made to compare our results with those obtained by Monte Carlo simulation.