A STUDY ON ESTIMATION OF ABOVEGROUND WET BIOMASS BASED ON THE MICROWAVE VEGETATION INDICES

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ABSTRACT

Vegetation biomass is an important parameter in the carbon cycle study. It has been realized that the global carbon cycle is imbalanced in our current monitoring system. This uncertain in the carbon sink is most likely because of the limitation of the existing observation system in detecting woody biomass. Since vegetation biomass is an important indicator of the global carbon pool, the numerous studies have been carried out to estimate above-ground biomass based on active microwave or visible/infrared using remote sensing measurements. However, these methods are nearly all based on empirical relationships between biomass and the measurement signals and affected by the vegetation structure and the components or spectrum parameters of vegetation. Conventional, visible-near infrared, vegetation information are often limited by the effects of atmosphere, background soil conditions, and saturation at high levels of vegetation. These uncertainties have confined their further applications. However, the passive microwave instruments are suitable for monitoring many global land surface parameters. The microwave measurements can penetrate comparative thick vegetation layer providing the capability to estimate above-ground biomass. The signals are sensitive to not only the leafy part of vegetation biomass but also to the woody part of vegetation biomass. Therefore, the passive microwave remote sensing is a promising method in estimating vegetation biomass at global scale.

The technique for deriving passive microwave vegetation indices (MVIs) has been developed by Shi et al. (2008) for data from the Advanced Microwave Scanning Radiometer (AMSR-E) on the Aqua satellite. Using the Advanced Integral Equation Model (AIEM) simulated relationship for bare soil surface emissivity at different frequencies, this technique using the linear relationship between the brightness temperatures observed at two adjacent radiometer frequencies to minimize the surface emission signal and to maximize the vegetation signal when using dual-frequency and dual-polarization radiometer measurements. The results indicate that the MVIs can provide significant new information since the microwave measurements are sensitive not only to the leafy part of vegetation properties but also to the properties of the overall vegetation canopy where the microwave sensor can "see" through. In combination with conventional optical sensor derived

vegetation indices, they provide a possible complementary dataset for monitoring global short vegetation and seasonal phenology from space.

In this study, we take one step further to evaluate the feasibility in deriving vegetation's wet biomass from MVIs. At low frequencies, the quantitative description of MVIs can be derived from the radiative transfer model (the ω-τ model). In this model, the brightness temperature are described as the vegetation fraction cover, the emissivities and physical temperatures of vegetation and soil, the vegetation optical thickness and the single scattering albedo. In considering vegetation effects on microwave signals, we will simulate vegetation with the different vegetation structure types under the AMSR-E sensor configuration. They include:

1. The randomly, vertically, horizontally orientated discs, needles, and short cylinders (leaves and branches) for short vegetations;
2. The above randomly, vertically, and horizontally orientated discs, needles, and short cylinders (leaves and branches) with a long vertical cylinder (trunks) for forest type vegetations.

Through our analyses, we find that vegetation scattering property and structure have a great impact on the quantitative descriptions of the relationships between the vegetation part of the microwave properties at the different frequencies and polarizations. This is because the different vegetation structures can result in the significant differences in its scattering properties. It is the major problem in estimation of vegetation biomass. However, the absorption effect of vegetation canopy is mostly controlled by the total wet biomass since the influence of vegetation structural properties is comparatively small. From above characteristics, we developed a technique to estimate vegetation wet biomass under the AMSR-E sensor configuration. This technique first retrieves the single scattering albedo and the optical thickness with the multi-frequency observations. Then, the estimated above two properties are used to derive the absorption part of the optical thickness. Finally, it can be related to the vegetation wet biomass. We will demonstrate this technique and the field validation in details.