The development of Microwave Vegetation Index for future SMOS applications

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Abstract—Monitoring global vegetation can be of importance in understanding land surface processes and their interactions with the atmosphere, biogeochemical cycle, and primary productivity. The normalized difference vegetation index (NDVI) derived from optical satellite sensors and mainly dependent on the green leaf material of the vegetation cover. For microwave derived vegetation indexes, Becker and Choudhury proposed the normalized microwave polarization difference index (MPDI) for a given frequency. Recently, the microwave emissivity difference vegetation index (EDVI) was developed for dense forest conditions using 19 GHz and 37 GHz observations. Ideally, we would like the vegetation index derived from satellite measurements to be independent of background soil and atmospheric conditions and to be only dependent on the vegetation properties. At low frequencies, the atmospheric effects are expected to be much less than at higher frequencies. The Soil Moisture and Ocean Salinity (SMOS) mission is currently under preparation with a launch in 2009. It will provide global microwave brightness temperature observations at L-band, in dual polarization and a range of viewing angles.

The microwave emission signals at low frequencies can typically be described by the $\omega$-$\tau$ model that is derived from a 0th-order radiative transfer solution and the atmospheric effects are expected to be much less. At the passive microwave footprint scale, the observed vegetation canopy signals represent the overall effect of the mixture of different vegetation canopy types present. For minimizing the effect of soil emission signals, we generated a simulated multi-angular surface emission database at L-band using the surface emission model – Advanced Integral Equation Model. This database included a wide range of the volumetric soil moisture and surface roughness.

In this study we developed a new microwave vegetation index using L-band
observations. The basis of the approach is that the bare surface emission signals of a surface for two adjacent view angles are highly correlated and can be well described by linear function with a coefficient that only depends on the pair of view angles to be used. We demonstrated that MVI is positively correlated to LAI and that it is affected not only by the vegetation properties but also the surface physical temperature. To evaluate the microwave vegetation index, we compared MVI with the LAI measurements derived from BARC for the year 1980. Comparisons of the vegetation index and LAI showed that the general distribution and the change patterns of the MVI are consistent with those of LAI derived by the optical sensor. However, their range of values in a region and responses to time change can be significantly different. These variations are associated with land cover type and are due to the differences in sensitivity of optical and microwave observations to different parts of vegetation canopy. Further studies utilizing modeling and field verifications are needed for the quantitative descriptions on how to retrieve soil moisture minimizing the vegetation effects and how to derive the important useful vegetation parameters such as biomass or other properties.

Keywords: Passive Microwave; Vegetation Index; SMOS; L-B and