RETRIEVAL OF SOIL MOISTURE UNDER VEGETATION USING POLARIMETRIC SCATTERING CUBES

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1. INTRODUCTION

Soil moisture, a medium for interaction between atmosphere and land surface, plays an important role in understanding the global climate system. In the literature, many researchers have tried to invert soil moisture from polarimetric radar backscattering cross section as in [1], and each algorithm works reasonably well for bare surface. However, it is very important to extend the algorithm to vegetated terrain since more than 76% of the total land surface is covered by some vegetation [2][3]. Radar backscattering from bare surface is relatively simple so that it can be characterized by only soil moisture and roughness. On the other hand, the existence of vegetation makes it complicated with greater number of scattering mechanisms. For example, scattering from grassland may consist of not only scattering from ground but also ones from grass-blades and interaction between grasses and ground. In this context, it is straightforward to explore a possibility to combine model-based polarimetric decomposition technique which might be able to estimate correct portion of ground scattering component.

2. INVERSION ALGORITHM WITH MODEL-BASED POLARIMETRIC DECOMPOSITION

Let us consider radar backscattering cross section from simple grassland as

$$\sigma_{total} = \sigma_{volume} + \sigma_{ground} + \sigma_{\mathrm{interaction}} + \sigma_{\mathrm{reminder}}, \tag{1}$$

where the remainder term can be considered as a term which expresses any scattering mechanisms other than volume, ground and interaction between them[4]. The co-polarized ground scattering component can be expressed as follows.

$$\sigma_{ground}^{xx} = \sigma_{bare}^{xx} \exp\left(-2\alpha_{xx} H / \cos\theta_i\right) \qquad x = h, v, \tag{2}$$

where α_{xx}, H, and θ_i are an attenuation ratio, layer height and incidence angle respectively. The expression clearly tells us that the scattering from grassland is decreased depending upon an amount of vegetation. In another word, even though we would be able to perfectly decompose the observation into those scattering mechanisms in the right portion, the estimated ground scattering component is already attenuated by the vegetation. Now let us try to apply this attenuated ground scattering term to conventional soil moisture inversion algorithm proposed by Dubois *et al*. [5]. According to [1], the dielectric constant is estimated as follows.

$$\hat{\varepsilon}_{bare} = 3.55\left\{14\log\left(\frac{\sigma_{vv}}{\sigma_{hh}}\right) + 3\log\sigma_{hh}\right\} + 18.44 \tag{3}$$

where we assume that θ_i = 40 degrees and wavelength is 24 cm (L-band) for SMAP [6]. By simply plugging (2) into (3), the estimated dielectric constant based on natural logarithm can be expressed as

$$\hat{\varepsilon}_v^{\ln} = \hat{\varepsilon}_{bare}^{\ln} - 3.55\cdot 2\{14(\alpha_{vv} - \alpha_{hh}) + 3\alpha_{hh}\}H/\cos\theta_i \ . \tag{4}$$

Assuming $\alpha_{vv}=\alpha_{hh}$ in which the second term in the right-hand side is always negative, you can easily recognize that the obtained dielectric constant might be *negative*!

3. POLARIMETRIC SCATTERING CUBES

As shown in the previous section, the idea to combine model-based decomposition with soil moisture inversion algorithm for bare surface should not be a way to choose because estimated ground scattering is already attenuated, and it is extremely difficult to estimate the ratio without any *a priori* knowledge. In our presentation, a brand-new inversion technique with polarimetric scattering cubes based on a forward scattering model will be introduced. We will also show examples of this technique for various amounts of vegetation and compare the results to previous technique.

4. REFERENCES

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