A PARAMETERIZED MICROWAVE MODEL FOR SHORT VEGETATION LAYER

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1 INTRODUCTION

Most of the existing microwave models [1][2][3][4][5] for vegetation are based upon an intuitive understanding of the relative importance of different vegetation components. It sums up these important contributions from various components which can be treated as a collection of randomly distributed discrete scatterers assuming average sizes and shapes. For example, the canopy of a broadleaf forest can be modelled as a discrete inhomogeneous medium which is made up of disks (leaves) and cylinders (branches) [2][3] of different size, while the canopy of a conifer forest can be modelled as a mixture of different sized needles (leaves) and cylinders (branches) [2][3]. Then, by assuming the vegetation layer above a rough ground surface, total emissivity or brightness temperature can be obtained based on an iterative solution of the radiative transfer equation.

The zeroth-order solution of the radiative transfer equation [6], i.e. the ω-τ model, is simple and easily to be obtained, which can be well used under lower frequency and sparser vegetation covered area. However, it cannot predict emission very well when the vegetation volume scattering albedo and optical depth are large. It commonly under estimate vegetation emission signals. As to the first-order solution of the radiative transfer equation [7], since it takes volume scattering into account, it better describes the scattering mechanism within the vegetation and thus can be used under higher frequency for denser vegetation. But it is complex and computationally intensive. Thus, it is meaningful to develop a vegetation model which is not only as simple as the zeroth-order ω-τ model, but also considers the volume scattering.

2 METHOD

In this study, a parameterized microwave model for short vegetation layer has been developed based on the first-order solution of the radiative transfer equation which contains five parts. The first three parts are same as in the ω-τ model, i.e. (1) the direct, upward, self-emitted contribution of the vegetation layer; (2) the direct soil emission attenuated by passage through the vegetation and (3) the downward, self-emitted energy of the vegetation that is reflected by the soil surface. It should be noted that, although the third term appeared in the zeroth and first solution are with the same physical meaning, they have different computation formulations. The other two parts are concerned with the volume scattering within the vegetation. They are (4) the vegetation signal scattered by the vegetation scatterers once and (5) the ground signal scattered by the vegetation scatterers once. It has been proved in our work that the third, the fourth and the fifth term of the first-order solution are directly related to the third, the first and the second term in the zeroth-order solution respectively. Thus, the relationship between them could be accurately described and the first-order solution could be expressed only with the single scattering albedo and the optical depth of the vegetation layer, as well as the ground surface emissivity.

The parameterized procedure will be realized through the following steps:

1) The Generally Rayleigh Gans Approximation method [8][10] will be used to simulate disk-shaped leaves [11] and needle-shaped leaves [12] with different sizes and water content.
2) The Infinite Length Approximation method [9][10] will be used to simulate cylindrical objects like twigs and branches with different sized and water content.
3) The Advance Integrated Equation Model [13] will be used to simulate ground under different surface roughness and soil moisture.
4) The total emissivities as well as each component of them will be computed respectively by the zeroth-order solution and the first-order solution of the radiative transfer equation.
5) Regression will be applied to the corresponding terms and the parameterized model will be set up.

3 RESULTS

Results show that the RMSE between simulations from the first-order solution of the radiative transfer model and the paramterized model is very low (about 0.003 or so) and the R-square is comparably very high (more than 0.99). It implies that the first-order solution of radiative transfer model has been well parameterized. Furthermore, the parameterized model is very practicable and applicable with its simple form.

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