Microwave Unmixing With Video Segmentation for Inferring Broadleaf and Needleleaf Brightness Temperatures and Abundances From Mixed Forest Observations

Passive microwave sensors have better capability of penetrating forest layers to obtain more information from forest canopy and ground surface. For forest management, it is useful to study passive microwave signals from forests. Passive microwave sensors can detect signals from needleleaf, broadleaf, and mixed forests. The observed brightness temperature of a mixed forest can be approximated by a linear combination of the needleleaf and broadleaf brightness temperatures weighted by their respective abundances. For a mixed forest observed by an N-band microwave radiometer with horizontal and vertical polarizations, there are 2 N observed brightness temperatures. It is desirable to infer 4 N + 2 unknowns: 2 N broadleaf brightness temperatures, 2 N needleleaf brightness temperatures, 1 broadleaf abundance, and 1 needleleaf abundance. This is a challenging underdetermined problem. In this paper, we devise a novel method that combines microwave unmixing with video segmentation for inferring broadleaf and needleleaf brightness temperatures and abundances from mixed forests. We propose an improved Otsu method for video segmentation to infer broadleaf and needleleaf abundances. The brightness temperatures of needleleaf and broadleaf trees can then be solved by the nonnegative least squares solution. For our mixed forest unmixing problem, it turns out that the ordinary least squares solution yields the desired positive brightness temperatures. The experimental results demonstrate that the proposed method is able to unmix broadleaf and needleleaf brightness temperatures and abundances well. The absolute differences between the reconstructed and observed brightness temperatures of the mixed forest are well within 1 K.