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Modelling of microwave propagation through sparse media

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1. Abstract

Sensing Earth from space is of great importance for sustainable management and control of natural / urban resources. Among spaceborne remote sensing instruments, microwave systems are particularly attractive since microwaves are independent of day and night-time, can penetrate into soil and vegetation, and are nearly independent on adverse weather conditions. Traditional microwave remote sensing is performed using active radar (in a mono-static active radar mode) or radiometer (passive mode). In active radar mode, a well-defined radio frequency (RF) signal is transmitted to interrogate a target, and a reflected signal (in backscatter direction) is used to characterize the target. While in passive mode, black body microwave radiation from a target is used to classify target characteristics. These two methods are the core systems used for microwave remote sensing and are powerful tools used for gathering data in the Earth science community. Recently, a new methodology known as remote sensing via signal of opportunity (or bistatic passive radar mode) has become more attractive because of its many advantages over the traditional methods of microwave remote sensing. The main principle behind this approach is to receive direct and reflected signals from free illuminators and extract information of the Earth surface by appropriately processing the direct and reflected signal in a bistatic configuration.

Aforementioned microwave sensors are highly sensitive to land surface, vegetation, and hydrological features. However, retrieving biophysical parameters of interest (such as soil moisture and biomass) from microwave measurements is a difficult task due to the complexity of microwave interactions with Earth. Development of physics-based forward models are thus fundamental for a full exploitation of signatures collected by spaceborne missions. The forward models are particularly used to describe the physical processes that determines the instrument product, thereby making retrieval algorithms more reliable. This tutorial will present development of advanced models of emission and (back- and bistatic-) scattering from vegetated media, their validation using accurate and well calibrated experiments, their application in the development of reliable retrieval algorithms. The fundamentals of microwave vegetation modeling using both wave and radiative transfer theories will be presented in a unified fashion that will cover monostatic active radar, bistatic passive radar, and radiometer approaches.