Geophysical Research Abstracts
Vol. 17, EGU2015-10700, 2015
EGU General Assembly 2015

Characterization of forest litter horizons through full-wave inversion of ground-penetrating radar data

Frédéric André (1), Mathieu Jonard (1), François Jonard (2), and Sébastien Lambot (1)

(1) Université catholique de Louvain, Earth and Life Institute, Environmental Sciences, Louvain-la-Neuve, Belgium (frederic.andre@uclouvain.be), (2) Forschungszentrum Jülich, Institute for Bio- and Geosciences, Jülich, Germany

Decomposing litter accumulated at the soil surface in forest ecosystems play a major role in a series of ecosystem processes (soil carbon sequestration, nutrient release through decomposition, water retention, buffering of soil temperature variations, tree regeneration, population dynamics of ground vegetation and soil fauna, ...). Besides, the presence of litter is acknowledged to influence remote sensing radar data over forested areas and accurate quantification of litter radiative properties is essential for proper processing of these data. In these respects, ground-penetrating radar (GPR) presents particular interests, potentially allowing for fast and non-invasive characterization of organic layers with fine spatial and/or temporal resolutions as well as for providing detailed information on litter electrical properties which are required for modeling either active or passive microwave remote sensing data.

We designed an experiment in order to analyze the backscattering from forest litter horizons and to investigate the potentialities of GPR for retrieving the physical properties of these horizons. For that purpose, we used an ultrawide band radar system connected to a transmitting and receiving horn antenna. The GPR data were processed resorting to full-wave inversion of the signal, through which antenna effects are accounted for. In a first step, GPR data were acquired over artificially reconstructed layers of three different beech litter types (i.e. (i) recently fallen litter with easily discernible plant organs (OL layer), (ii) fragmented litter in partial decomposition without entire plant organs (OF layer) and (iii) combination of OL and OF litter layers) and considering in each case a range of layer thicknesses. In a second step, so as to validate the adopted methodology in real natural conditions, GPR measurements were performed in situ along a transect crossing a wide range of litter properties in terms of thickness and composition through stands of various tree species. Results from the controlled experiment demonstrated the ability of GPR to reconstruct litter horizons, showing close correspondence between inversely estimated and measured litter layer thicknesses and providing reliable estimates of litter electromagnetic properties. This experiment also highlighted the necessity of considering scattering and dielectric losses occurring within litter for proper modeling of the GPR signal, which was accounted for through frequency dependence of an effective electrical conductivity of the litter. Similar findings emerged from the in situ experiment, though somewhat lower agreement was observed between estimated and reference layer thickness values. These results show great promise for the use of GPR for non-invasive characterization of forest litter.

Index Terms: Ground-penetrating radar (GPR), forest litter, frequency dependence, scattering

Reference:
André F., Jonard M., Lambot S., 2015. Non-invasive forest litter characterization using full-wave inversion of microwave radar data, IEEE Transactions on Geoscience and Remote Sensing, 53(2), 828–840.