

Non-invasive monitoring of plant root activities in the framework of the Earth's Critical Zone and soil-plant-atmosphere interactions.

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Bio-geophysics is a very broad discipline, including a variety of physical monitoring techniques applied to biological processes. As such, it is inherently very challenging and, at the same time, very promising. A variety of scales are being investigated, from the cellular scale to the ecosystem scale. More relevant to the latter scale is the investigation of the plants root zone, where the majority of mass and (latent) energy balance takes place between the soil and biota and, from there, to the atmosphere. The response of the soil-water-vegetation system and of the Earth's critical zone (from the top of the canopy to the bottom of the shallowest aquifer) to climate and land-use change is crucial for the preservation of essential ecosystem services such as carbon storage, primary productivity, food and materials availability, and water and erosion regulation. In addition, the interaction between atmosphere and land surface is one of the most critical points to be resolved to reduce epistemological uncertainties in atmospheric models, both for numerical weather prediction (NWP) and global and regional climate models (GCMs and RCMs). The use of geophysical techniques in this context provides dense high-resolution spatial information as well as, potentially, high temporal resolution monitoring. Two different viewpoints can be taken in this form of "bio-geophysical" monitoring: on one hand, the physical signals of the biological (e.g. root presence and signals) activity can be directly sought; on the other hand, the effects of biological activity (e.g. root water uptake) can be sensed by the resulting changes of the soil/water system state (especially in terms of moisture content, but also temperature, etc.). Examples of both types of approaches, and links to eco-hydrological modelling, will be presented in this contribution, urging towards a more frequent and more accurate applications of these techniques, particularly for their potential contribution towards a better definition of Land Surface Models, i.e. the bottom, critical, and poorly known boundary condition for atmospheric models.

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