3D *in situ* imaging of tree root structure with RF signals: test of the concept

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ABSTRACT: Roots are a tree's main intake path for water and nutrients. Their function and health is directly linked with the overall health of the tree, and structural properties and distribution of vegetation. There is also evidence that a large part of plant competition and collaboration between plants occurs in the root zone, and that dynamic changes in root distribution could be an important signal preceding vegetation changes. Currently, detection of root distribution of mature trees non-destructively is practically impossible in most environments. This is because roots are tightly connected with soil, they can extend unreachable depths, and soil composition strongly affects the resolution of above-ground imaging methods such as ground-penetrating radar (GPR). Therefore, root description is very rudimentary in current plant growth and vegetation models leading to severe uncertainty in predicted vegetation changes and the carbon cycle. We experimentally tested the feasibility of using radio frequency (RF) signals for imaging of tree roots by exploiting the well-established ability of trees to act as efficient RF antennas. RF signals travel in tree stems mostly through the conductive tissue that connects the above and below ground parts. Therefore, a signal induces to the above-ground stem could travel through the root system, and be detectable from above ground revealing the structure of the root system. Our results suggest that this method has potential, but further studies are required for improving the signal-to-noise ratio.