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A Growing and Global Fine-Root Trait Database: Current Coverage and Scientific Applications

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Fine roots are the most active and dynamic portion to the belowground plant system. Fine roots supply plants with nutrients and water critical for growth and represent a significant sink for plant carbohydrates associated with their production and respiration. Despite clear relationships to plant nutrient, water, and carbon cycling, fine roots continue to be one of the most poorly understood components of terrestrial ecosystems. This then strongly limits our ability to model plant growth and forecast future changes in plant productivity. Poor understanding of fine-root systems is primarily due to limited availability of fine-root data as well as difficulties comparing existing root trait data due to inconsistent measurement protocols.

We address the above limitations with the development of the Fine-Root Ecology Database (*FRED*), which serves as a database to house and organize root trait data and facilitate meaningful comparisons of data obtained using comparable methods. *FRED* also captures relevant ancillary data at both the species and site levels to facilitate tests of trait variation across species and climate. FRED currently houses over 70,000 root trait observations collected from ~800 data sources covering over 550 root trait and ancillary trait categories. These data include observations in all globally-relevant plant biomes and higher plant types. *FRED* is now publicly available without restriction at http://roots.ornl.gov and gives researchers and modelers a powerful tool to assess fine-root traits in a data-rich environment.

We are leveraging *FRED* to initiate two projects that address gaps in our scientific understanding of fine-root processes in the terrestrial biosphere. Our first analysis uses *FRED* data to inform the ACME Land Model (version 0) and test model sensitivities to changes in root related parameters, including novel model conceptualization of root phenology. Overall, changes in fine-root longevity, C/N ratio, root/leaf allocation ratio, and root phenology had the greatest effects on modeled forest growth in the five evergreen, needleleaf forests examined in this exercise. Importantly, capturing interactive effects, and not just main effects, proved to be key in understanding model responses. Our second analysis applies an advanced gap-filling algorithm combined with analysis of trait relationships to assess broad inter-plant and cross biome patterns in belowground plant strategies. Moving forward, we are using *FRED* to highlight trait types and geographic regions that warrant targeted field campaigns to capture data needed to enhance our broad understanding of fine-root traits and the role they play in defining a belowground and whole-plant growth strategy.