ABSTRACT: The temporal and spatial quantification of coarse roots has proven to be one of the most difficult aspects of belowground ecology. Coarse roots play a significant role in belowground carbon cycling and will likely play an increasingly crucial role in belowground carbon sequestration as atmospheric CO₂ levels continue to rise. Ground-penetrating radar (GPR) has been shown to be an effective, nondestructive method of quantifying biomass of coarse roots. GPR propagates electromagnetic waves into the soil, reflecting a portion of the energy back to the surface whenever the waves change speed as a result of contacting a buried object. Despite promising results, this application of GPR is in its infancy, and neither the full potential nor limitations of the technology have been fully evaluated. In this study, we are exploring various scanning protocols and thresholds of application for GPR use across a variety of environmental conditions. We will be conducting experiments in the sandy soils of a sand-hill mixed oak community in Southeastern Virginia, USA as well as shrub-scrub and longleaf pine flatwoods in Florida, USA. Using a 1500 MHz antenna, we have begun testing several scanning protocols involving different scan angles and intervals as well as examining current and potential image processing techniques. We are in the process of establishing correlations between the pixel counts from these different scanning protocols and observed root biomass. The most predictive regression equation will be used at our test site in Southeastern Virginia to measure the effectiveness of GPR in estimating coarse root biomass, in identifying root structures under varying levels of soil moisture and soil composition, in quantifying change in root mass over time, and in determining the effect of root shadowing. These techniques will also be applied to shrub-scrub and longleaf pine flatwoods in Florida in the winter of 2012-2013 as well as to measure legacy effects of raised carbon levels due to an 11-year carbon enrichment experiment at Kennedy Space Center that ended in 2007. This nondestructive method of root quantification could provide a means for rapid and repeatable measurement of belowground structures and as the technique is refined and thresholds are better established, potentially be applied to a wider variety of ecosystems to obtain long-term data on coarse root dynamics.