Laser technology measures biomass in world's largest trees

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The technique, published in *Scientific Reports*, offers unprecedented insights into the 3-D structure of trees, helping scientists to estimate how much carbon they absorb and how they might respond to climate change.

Professor Mat Disney (UCL Geography), lead author on the study, said: "Large trees are disproportionately important in terms of their above ground biomass (AGB) and carbon storage, as well as their wider impact on ecosystem structure. They are also very hard to measure and so tend to be underrepresented in measurements and models of AGB.

"We show the first detailed 3-D terrestrial laser scanning (TLS) estimates of the volume and AGB of large coastal redwood trees (Sequoia sempervirens) from three sites in Northern California, representing some of the highest biomass ecosystems on Earth."

The research contributes to an aspect of climate change research with increasing focus.

Professor Disney add: "Big questions within climate science in response to rising CO2 levels are whether and where more trees should be planted and how best to conserve existing forests. In order to answer these questions, scientists first need to understand how much carbon is stored in different tree species."

Estimating the size and mass of very large trees is an extremely difficult task. Previously, trees could only be weighed by cutting them down or by using other indirect methods such as remote sensing or scaling up from manual measurements of trunk diameter, both of which have potentially large margins of error.

Working with colleagues at NASA, and with support from the NASA Carbon Monitoring System programme, the researchers used ground-based laser measurements to create detailed 3-D maps of the redwoods. NASA's new space laser mission, GEDI, is mapping forest carbon from space, and the GEDI team are using Professor Disney's work to test and improve the models they use to do this.

The trees scanned include the 88-metre tall Colonel Armstrong tree, with a diameter-at-breast height of 3.39 m, which they estimate weighs around 110 tons, the equivalent of almost 10 double-decker buses.

The researchers compared the TLS estimates with other methods and found that their estimates correlated with those of 3-D crown mapping, a technique pioneered by American botanist Stephen C. Sillett that involves expert climbers scaling giant redwoods to manually record fine details about their height and mass.

Professor Disney's team found that their AGB estimates agreed to within 2% of the records from crown mapping. Crucially, they also found that both these 3-D methods show that these large trees are more than 30% heavier than current estimates from more indirect methods.

The researchers recommend that laser technology and 3-D crown mapping could be used to provide complementary, independent 3-D measures.

Assistant Professor Laura Duncanson (NASA Earth Sciences & University of Maryland), last author on the study and member of the NASA GEDI science team, said: "Estimating the biomass of large trees is critical to quantifying their importance to the carbon cycle, particularly in Earth's most carbon rich forests. This exciting proof of concept study demonstrates the potential for using this new technology on giant trees—our next step will be to extend this application to a global scale in the hopes of improving GEDI's biomass estimates in carbon dense forests around the world."

More information: New 3D measurements of large redwood trees for biomass and structure, *Scientific Reports* (2020). DOI: 10.1038/s41598-020-73733-6

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