



## **Extracting vertical foliage profiles of individual Eucalypt trees using last significant return airborne laser altimetry and on-site photography**

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A method for the estimation of leaf area index, apparent foliage profile and total leaf area of trees from the last significant returns of airborne laser altimetry is presented, and tested, showing the growth of ten individual Eucalypt trees in New South Wales, Australia over a period of five years. Two airborne laser altimetry data sets were acquired, November 2006 and September 2011. These were analysed to estimate the apparent foliage profiles of the ten identified trees. The results were compared to four sets of on-site photographs - aerial photography acquired in 2006 at the same time as the LiDAR acquisitions, ground-acquired photographs taken in 2007 by the GoogleEarth Streetview programme, and by the authors in 2010 and 2011 during site visits. The aerial photography is used to estimate tree height by shadow length, and the ground-acquired photographs are analysed to estimate overall leaf area index, apparent foliage profile, and total leaf area per tree. These results are compared to the 2006 and 2011 estimates based on the laser altimetry. In all but one case an increase in leaf area index is seen overall; a mean increase of 55%, breaking down as 33% increase in the taller, older trees and 77% for the shorter, younger trees. Structural changes in the apparent foliage profiles of the trees are evident, most clearly in the maturing of shorter, younger trees. Total tree leaf area change, due to the conflation of leaf area index increase and planimetric expansion of the canopies, was found to be strongly dependent on the size of the trees in 2006, with smaller, younger trees increasing foliage area by up to a factor of ten, and taller, more mature trees increasing by only a factor of two.