Unmanned Aerial Vehicles for leaf angles

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Leaf angle distribution (LAD) is an important parameter affecting the interaction of sunlight and forest canopies [1]. But, difficulty in measuring LAD has limited exploration of its species-specific ecological variability [2]. To evaluate whether digital photographs from unmanned aerial vehicles (UAVs) could be used to measure LAD, we directly compared UAV-based measurements of leaf angle against those made from conventional leveled digital photographs taken from towers, ladders, buildings, or poles [3]. We used two different UAV and camera systems, and found that both systems provided statistically similar results to the conventional measurements of LAD on five broadleaf tree species in the hemiboreal region of Europe and North America. In addition to overcoming challenges of UAV airspace regulation and piloting within complex forest canopies, we recommend potential users of this method should identify, minimize, and correct for any image distortion effects created by their UAV and camera system. With these considerations in mind, UAVs can be used to measure LAD in virtually any broadleaf forest environment, which opens the possibility for obtaining accurate, species-specific information on the variability of LAD through time and along environmental gradients.

References

[1] G.G. McMillen, and J.H. McClendon, "Leaf angle: an adaptive feature of sun and shade leaves," *Botanical Gazette*, vol. 140, pp. 437–442, 1979.

[2] J. Pisek, O. Sonnentag, A.D. Richardson, and M. Mõttus, "Is the spherical leaf inclination angle distribution a valid assumption for temperate and boreal broadleaf tree species?" *Agricultural and Forest Meteorology*, vol. 169, pp. 186-194, 2013.

[3] Y. Ryu, O. Sonnentag, T. Nilson, R. Vargas, H. Kobayashi, R. Wenk, and D. Baldocchi, "How to quantify tree leaf area index in a heterogenous savanna ecosystem: a multi-instrument and multimodel approach," *Agricultural and Forest Meteorology*, vol. 150, pp. 63-76, 2010.