



# Incidence Angle Dependency of Leaf Vegetation Indices from Hyperspectral Lidar Measurements

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## Abstract:

We have studied the effect of incidence angle on the spectral content of leaf measurements from hyperspectral light detection and ranging (lidar) data. New results obtained for different ornamental plant leaves indicate that their backscatter properties do not follow the Lambert scattering law, especially in the visible wavelength range: specular reflections were observed near the normal incidence. Also the vegetation spectral indices, such as normalized difference vegetation index (NDVI), or even the simple ratios may change with the laser incidence angle to the target. The reason for this is the difference in their backscatter vs. intensity behaviour between visible and near-infrared (NIR) wavelengths. In comparison with earlier results it turns out that this phenomenon seems to depend on the internal structure and surface properties of leaves. Further information on the extent and role of this effect for different leaves is needed, but our results indicate that the nature of laser reflection in tree canopies may vary between species. The calibration of hyperspectral lidar vegetation reflectance measurements must be further studied by rigorous experiments and modelling.