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Impact of physiology, structure and BRDF in hyperspectral time series of a Citrus orchard

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Monitoring of plant production systems using remote sensing requires an understanding of the mechanisms in which physiological and structural changes as well as the quality and direction of incident light alter the measured canopy reflectance. Due to the evergreen nature of Citrus, the benefits of year-round monitoring of spectral changes are counterweighted by more subtle changes and seasonal trends than in other perennials.

This study presents the results of a 14 months field measurement campaign in a commercial Citrus sinensis 'Midknight Valencia' orchard in Wellington, Western Cape Province, South-Africa. Hyperspectral data were collected of canopy and leaf reflectance (350 – 2500 nm) of 16 representative trees at monthly intervals and supplemented with local climatology, orchard management records, sap stream, water potential and leaf and soil nutrient analysis. The aim of this research is to translate spectral changes and trends at the leaf and at canopy levels into physiological processes such as plant nutrient and carbohydrate balances and stress responses. Specific research questions include the spectral detection of flowering (date of anthesis, flowering intensity), fruit drop, fruit number and coloration, vegetative flushes, leaf senescence and drop and pruning. Attention is paid to the detection and the impact of sunburn (photo-damage). In order to separate physiological and structural changes from changes caused by seasonal changes in solar elevation during measurement time (bidirectional reflectance) a normalization function is constructed using simulated and measured data. Additional research is done to up-scale measurements from tree level to orchard level, which includes the tree variability, the influence of soil and weeds and different amounts of shading.