Geophysical Research Abstracts,
Vol. 10, EGU2008-A-00099, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-00099
EGU General Assembly 2008

Soil reflectance modeling and spectral mixture analysis: a solution for the mixed pixel problem in orchards?

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The sub-pixel spectral contribution of background soils and shadows hampers the accurate site-specific monitoring of agricultural crop characteristics from aerial or satellite images. To address this problem, the present study integrates measured in situ and hyperspectral data in an alternative unmixing algorithm. The proposed algorithm, referred to as Soil Modeling Mixture Analysis (SMMA), joins a soil reflectance model and a traditional unmixing algorithm and as such opens up the opportunity to simultaneously extract the sub-pixel spatial extent of crops as well as its pure spectral information. The performance of the algorithm was evaluated using a generalized soil reflectance model with moisture content and texture class as main input parameters. The model was calibrated for five different soil types (i.e., variable in texture, bulk density, organic matter content, etc.) collected from different citrus orchards in the West-Cape province, South Africa. Synthetic mixtures - compiled from in situ measured hyperspectral bare soil and citrus tree canopy spectra - were decomposed and the sub-pixel crop cover fractions ($R^2 > 0.94$, RMSE < 0.03) and pure vegetation signals (average extraction error$_{350-2500nm}$= 0.017, RMSE = 0.02) were adequately extracted from the mixtures.