Geophysical Research Abstracts
Vol. 17, EGU2015-9200, 2015
EGU General Assembly 2015

Towards Estimating Water Stress through Leaf and Canopy Water Content Derived from Optical and Thermal Hyperspectral Data

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A competition for available (drinkable) water has arisen. This competition originated due to increasing global population and the respective needs of this population. The water demand for human consumption and irrigation of food producing crops and biofuel related vegetation, has led to early indication of drought as a key issue in many studies. However, while drought monitoring systems might provide some reasonable predictions, at the time of visible symptoms of plant stress, a plant may already be critically affected. Consequently, pre-symptomatic non-destructive monitoring of plants is needed. In many studies of plant stress, this is performed by examining internal plant physiology through existing remote sensing techniques, with varying applications. However, a uniform remote sensing method for identifying early plant stress under drought conditions is still developing.

In some instances, observations of vegetation water content are used to assess the impact of soil water deficit on the health of a plant or canopy. When considering water content as an indicator of water stress in a plant, this comments not only on the condition of the plant itself, but also provides indicators of photosynthetic activity and the susceptibility to drought.

Several indices of canopy health currently exists (NDVI, DVI, SAVI, etc.) using optical and near infrared reflectance bands. However, these are considered inadequate for vegetation health investigations because such semi-empirical models result in less accuracy for canopy measurements. In response, a large amount of research has been conducted to estimate canopy health directly from considering the full spectral behaviour. In these studies , the canopy reflectance has been coupled to leaf parameters, by using coupling leaf radiative transfer models (RTM), such as PROSPECT, to a canopy RTM such as SAIL. The major shortcomings of these researches is that they have been conducted primarily for optical remote sensing. Recently, PROSPECT-VISIR, an extended version of the PROSPECT model has been developed, extending the range to 5.7μm. However, this model is yet to be validated other than in the original publication.

The goal of this research is to examine the biophysical property of leaf and canopy water content as an indicator of plant health through analysis of leaf spectra in the optical and thermal range. The MIDAC FTIR (3 - 20μm) and ASD spectrometer (0.35 – 2.5μm) were used to measure the thermal and optical ranges, respectively, of individual leaf spectra. A relationship between the measured spectra and leaf water content is to be analyzed. In addition, the PROPSECT-VISIR model is to be utilized along with SAIL to analyze the applications of the spectra in radiation transfer models, and to validate the recent PROSPECT-VISIR model.