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Chlorophyll Fluorescence Effects on Vegetation Apparent Reflectance: II. Laboratory and Airborne Canopy-Level Measurements with Hyperspectral Data

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Relationships found between Compact Airborne Spectrographic Imager (CASI) hyperspectral canopy reflectance measurements at laboratory and field levels with PAM-2000 chlorophyll fluorescence data are presented. This is a continuation of the paper where relationships at the leaf level between leaf reflectance and chlorophyll fluorescence were found and demonstrated to be consistent with theory using the Fluorescence-Reflectance-Transmittance (FRT) model. Experiments using the hyperspectral CASI sensor in the laboratory to observe a canopy of maple seedlings are performed as an intermediate step to demonstrate the link between the results at leaf-level and the CASI field canopy levels. Scene observations of the seedlings utilizing a long-pass blocking filter showed that apparent canopy reflectance in the laboratory is affected by changes in fluorescence emissions. A laboratory experiment on seedlings subjected to diurnally induced change shows the strong link between CASI canopy reflectance optical indices in the 680–690-nm region and Fv/Fm dark-adapted chlorophyll fluorescence. Stressed and healthy maple seedlings are used to demonstrate the use of optical indices calculated from the 680–690-nm spectral region to track changes in steady-state fluorescence: the curvature index $R683^2/(R675 \cdot R691)$ and the R685/R655 ratio calculated from the canopy reflectance are related to leaf-measured Ft, Fm′ and ΔF/Fm′ steady-state features, and are in agreement with theoretical simulations using the leaf Fluorescence-Reflectance-Transmittance model. To test these findings in a field setting, airborne field hyperspectral CASI data of 2-m spatial resolution, 7.5-nm spectral resolution, and 72 channels was used, collected in deployments over 12 sites of Acer saccharum *M. in the Algoma Region, Ontario (Canada) in 1997 and 1998. A field sampling campaign was carried out for biochemical contents of leaf chlorophyll and carotenoids, chlorophyll fluorescence, and leaf reflectance and transmittance. Leaf-level relationships obtained between optical indices and physiological indicators were scaled up to canopy level through canopy reflectance models using input model parameters related to the canopy structure and viewing geometry at the time of data acquisition. Results show that scaled-up optical indices in the 680–690-nm region are related to Fv/Fm chlorophyll fluorescence measured in the 20×20-m study sites. Consistency between leaf, laboratory, and field canopy hyperspectral data is shown in this and the previous paper, demonstrating the effect of fluorescence on observations of apparent vegetation reflectance. ©Elsevier Science Inc., 2000*

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INTRODUCTION

The development of remote sensing methods to measure chlorophyll fluorescence is currently receiving much attention [e.g., see *Rem. Sens. Environ.*, Vol. 47 (Jan.