Tracing the de-epoxidation reaction of the xanthophyll cycle in natural beech leaves using hyperspectral reflectance

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The epoxidation state of the xanthophyll cycle pigments (EPS) is a useful measure of short-term changes in photosynthetic light-use efficiency and it is suggested as the best indicator for evaluating the state of xanthophyll cycles (Gamon et al. 1990). In order to calculate EPS, we have to measure the concentrations of the three xanthophyll cycle pigments (violaxanthin (V), antheraxanthin (A) and zeaxanthin (Z)) using high performance liquid chromatography (HPLC) (Thayer and Bjorkman 1990). However, its application is restricted to leaf scale and it is difficult to expand into large-scale monitoring.
On the other hand, remote sensing is one of the alternative strategies and the hyperspectral index, photochemical reflectance index (PRI) has been applied for evaluating light use efficiency in the previous studies (Filella et al. 2009; Gamon et al. 1992; Gamon et al. 1997; Sha et al. 2014; Stagakis et al. 2014). However, few studies have paid attention to the differences between sunlit and shaded leaves of deciduous plants and the relationship between PRI and photosynthetic light use efficiency is weak for deciduous species (Nichol et al. 2000).
In this study, we explored the ability of PRI to trace EPS based on a series of experiments with only light stress and inhibited treatments. Furthermore, the novel hyperspectral indices, a differential type of index using reflectance derivatives at 677 and 803 nm, was developed.
Results revealed that PRI had low correlations with the EPS of deciduous leaves, especially for sunlit leaves. On the other hand, the newly proposed index was applicable for both. Furthermore, it was applicable for various conditions generated by the inhibitor experiments or the samples obtained from other deciduous species (*Lindera umbellate*, *Clethra barbinervis*, *Viburnum furcatum*, *Eleutherococcus sciadophylloides*, *Quercus crispula* and *Acer japonicum*).

Keywords: EPS, hyperspectral reflectance, xanthophyll cycle

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