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Tracking isoprene emissions using a simple spectral index: The influence of constitutive and facultative changes in leaf phyto-pigments

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Isoprene is the most dominant biogenic volatile organic compound (BVOC) emitted by plants. Perturbations to isoprene emissions are likely to have an important influence on regional climates and feedbacks to global climate. However, there is little quantitative understanding of the mechanisms controlling patterns of emissions over long timescales and across regions, making modelling emissions challenging. A simple spectral index, (the photochemical reflectance index; PRI), through its relationship with light use efficiency (LUE) and xanthophyll cycle activity, has recently been shown to hold potential for tracking isoprene emissions from vegetation (Peñuelas et al. 2013). However, both PRI and isoprene emissions can also be influenced by slower constitutive changes in leaf carotenoid pigment concentrations. Our aim was to clarify the physiological mechanisms behind the PRI-isoprene relationship by considering the influences of both constitutive differences in pigment concentrations, and facultative differences in xanthophyll pigment conversions, on isoprene emissions and the PRI reflectance signal. We exposed saplings of the tree species Salix viminalis (Dwarf Willow), to a range of modified light environments and determined the relationships between PRI, isoprene emissions, photosynthetic rates and phyto-pigments. Acclimation of the plants resulted in differences in pigment concentrations, isoprene emissions and PRI. Changes in carotenoid concentration were significantly correlated with both isoprene emissions and PRI. The results suggest that knowledge regarding how isoprene emissions are affected by longer term changes in total carotenoid concentrations and shorter term dynamic adjustments of LUE is required to facilitate wider interpretation of PRI for synoptic emission monitoring.

References

Peñuelas J, Marino G, Llusia J, Morfopoulos C, Farre-Armengol G and Filella I (2013) Photochemical reflectance index as an indirect estimator of foliar isoprenoid emissions at the ecosystem level. Nature Communications 4:2604.