

The Chlorophyll Carotenoid Index (CCI) as an indicator of photosynthetic (GPP) phenology

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The problem with evergreen ecosystems...

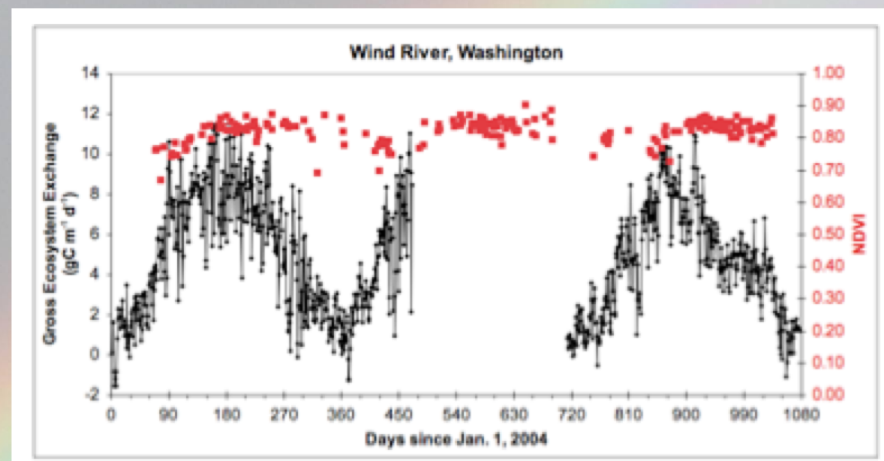
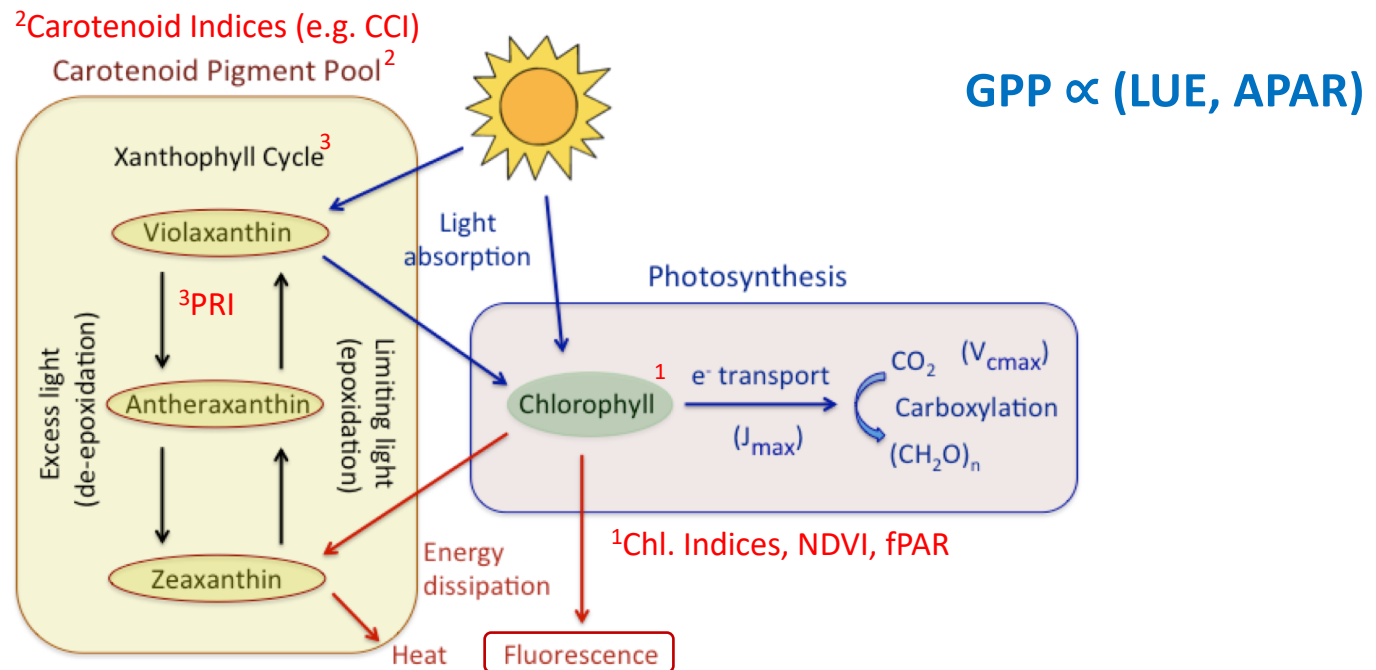


Fig. courtesy Fred Huemrich

Western Peatlands, Alberta, Canada

Photosynthetic Light Regulation



Gamon 2015 *Biogeosciences* 12: 4509-4523.



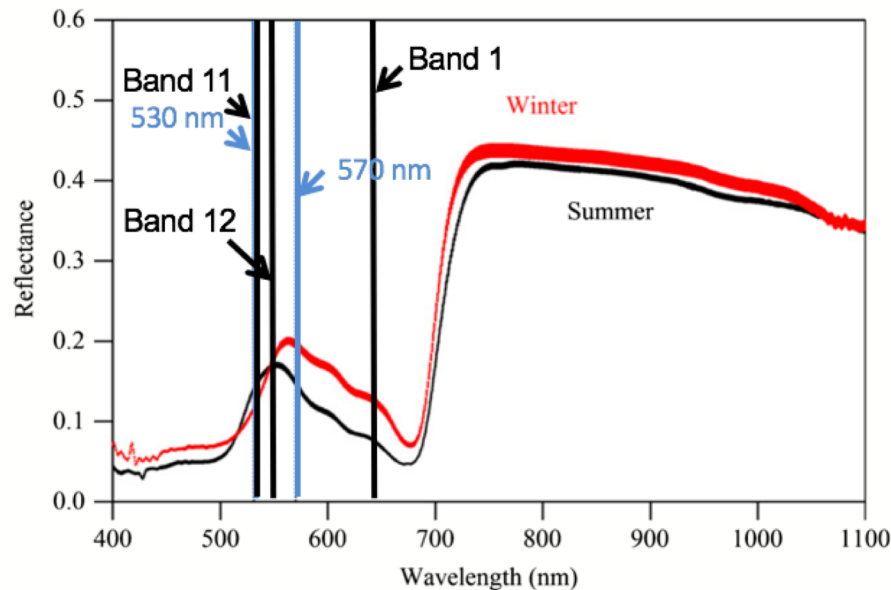
Leaf reflectance sampling

Leaf & Canopy Reflectance (Pine)



Canopy reflectance sampling

Seasonal change in conifer needle reflectance



Photochemical Reflectance Index:

$$PRI = \frac{(R_{531} - R_{570})}{(R_{531} + R_{570})}$$

Diurnal
Time
Scale

Chlorophyll:Carotenoid Index:

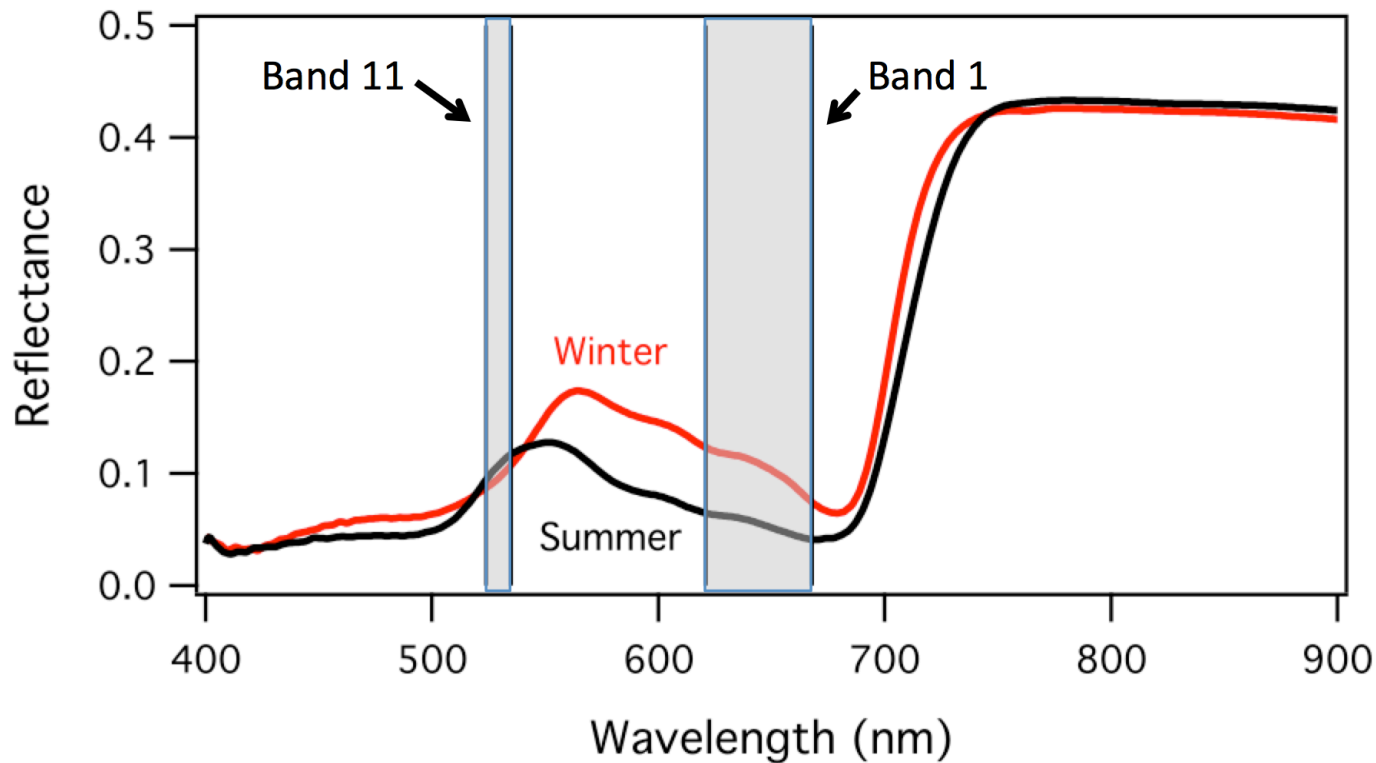
$$CCI = \frac{(\text{Band 11} - \text{Band 1})}{(\text{Band 11} + \text{Band 1})}$$

Seasonal
Time
Scale

Can new “pigment indices” from MODIS ocean and terrestrial bands monitor “invisible” photosynthetic phenology (ϵ) in evergreens?

Adapted from Wong & Gamon 2015

Seasonal reflectance changes for evergreen conifers



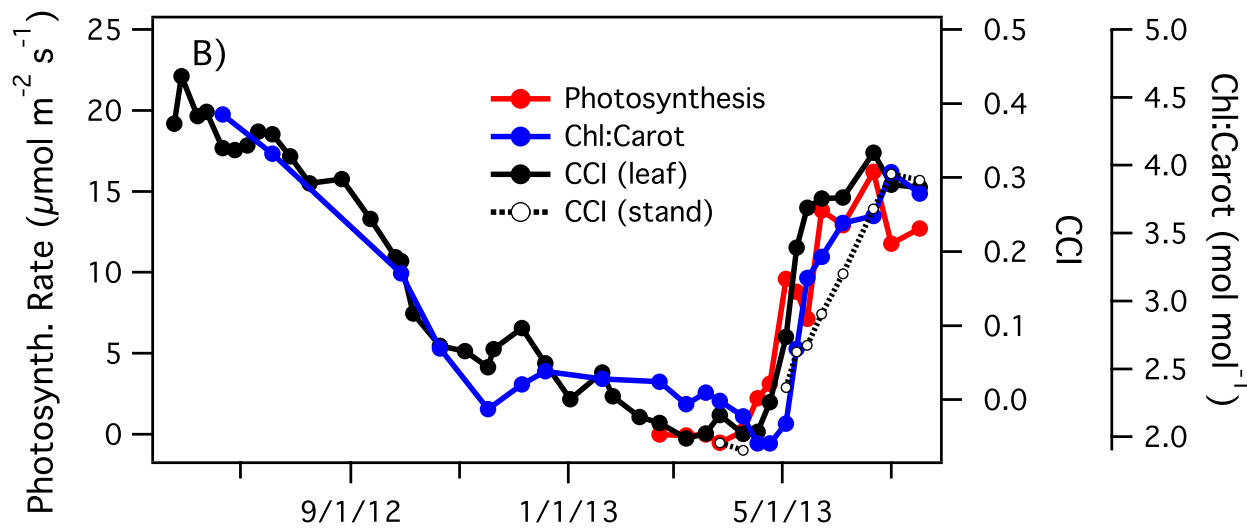
Chlorophyll:Carotenoid Index:

$$CCI = \frac{\text{Band 11} - \text{Band 1}}{\text{Band 11} + \text{Band 1}}$$

→ MODIS Collection 6 allows calculation of CCI (a.k.a. "MODIS PRI")

Gamon et al. (2016) PNAS, 113 (46), 13087-13092

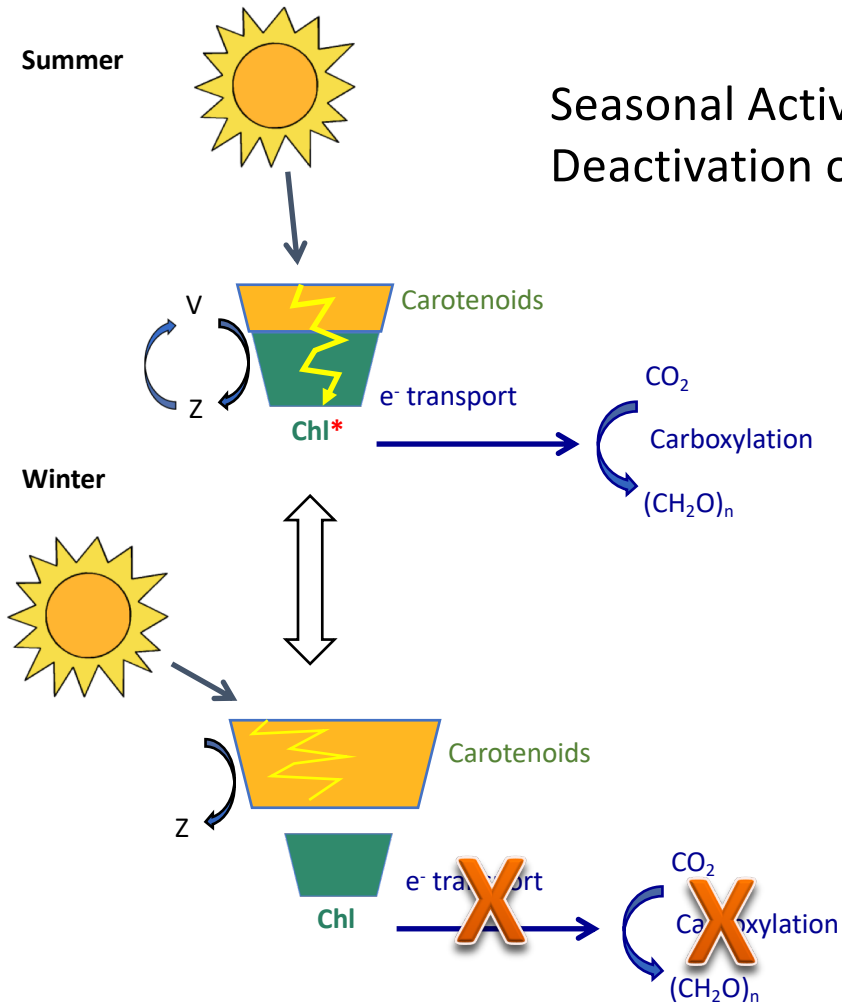
Chlorophyll/Carotenoid Index (CCI) tracks changes in pigments and photosynthetic activity

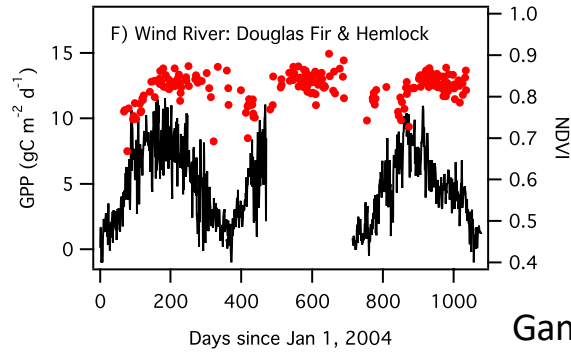
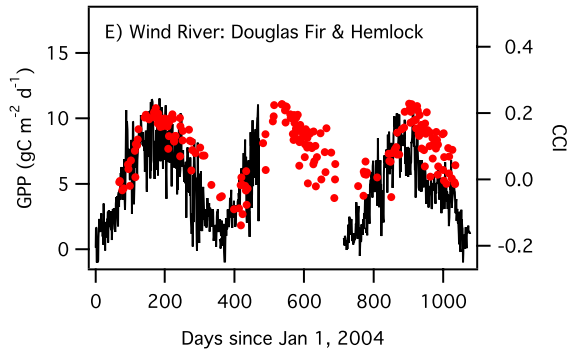
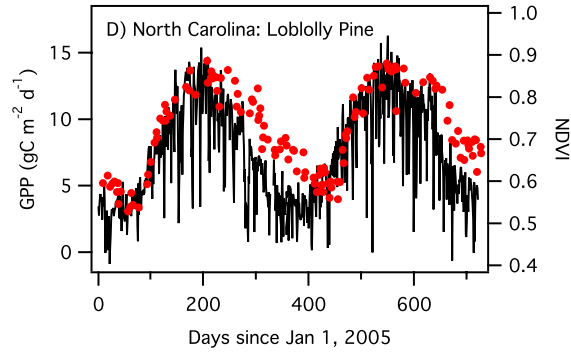
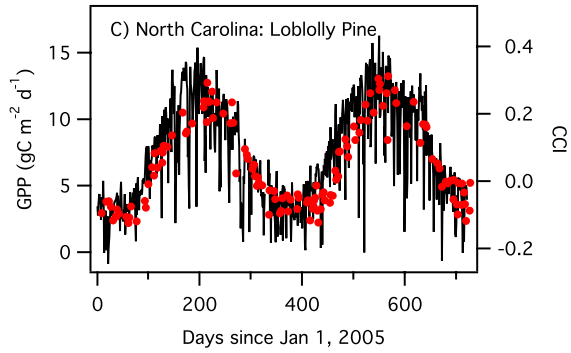
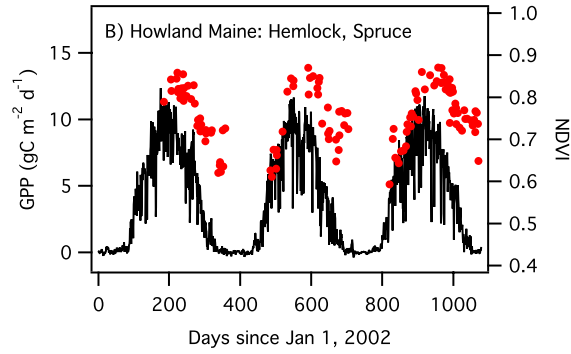
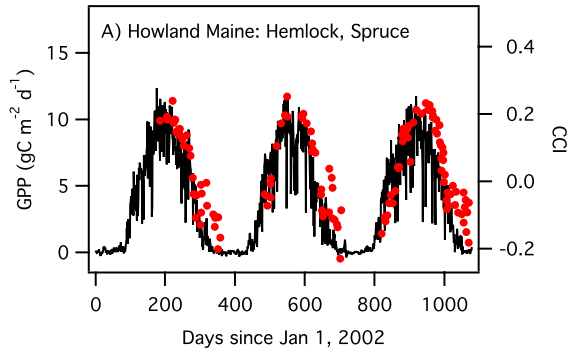
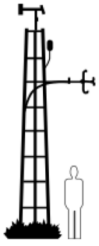


Gamon et al. (2016) PNAS, 113 (46), 13087-13092

Extreme cold

Seasonal Activation and Deactivation of Photosynthesis

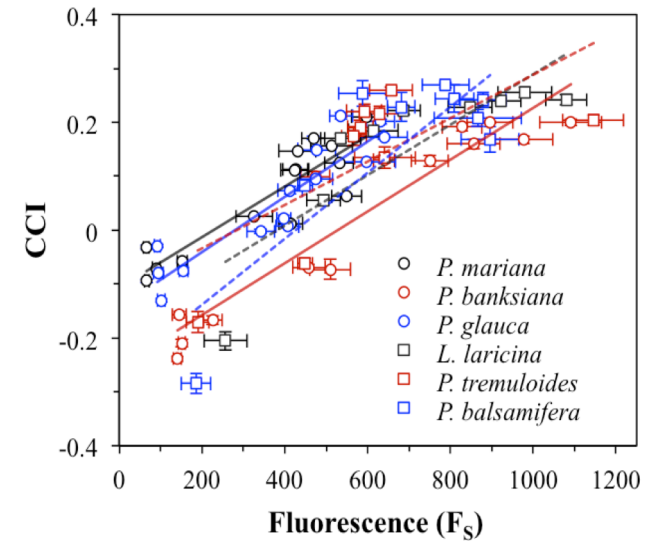
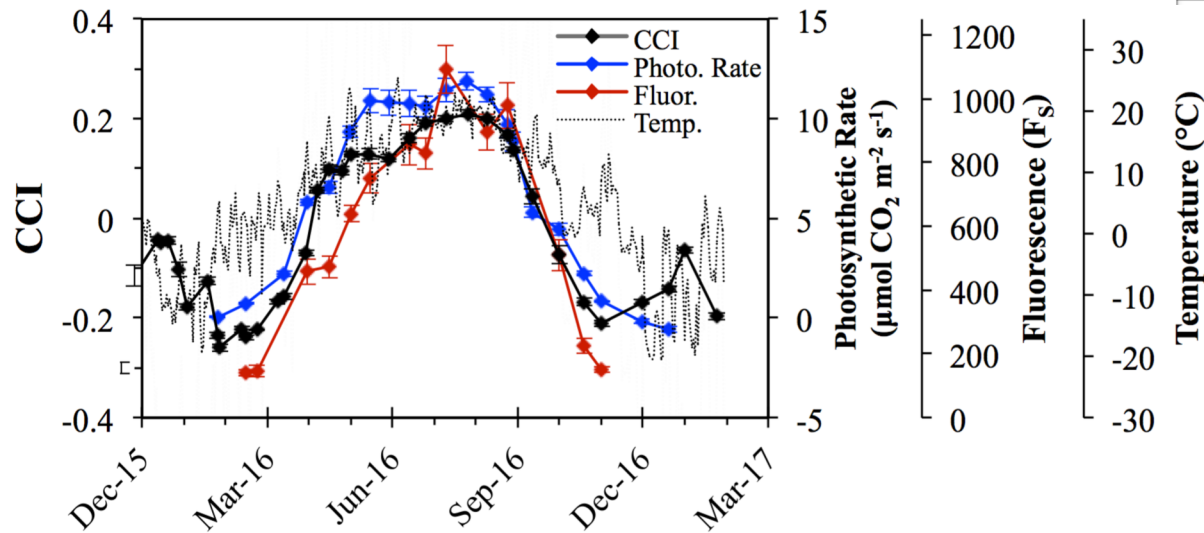
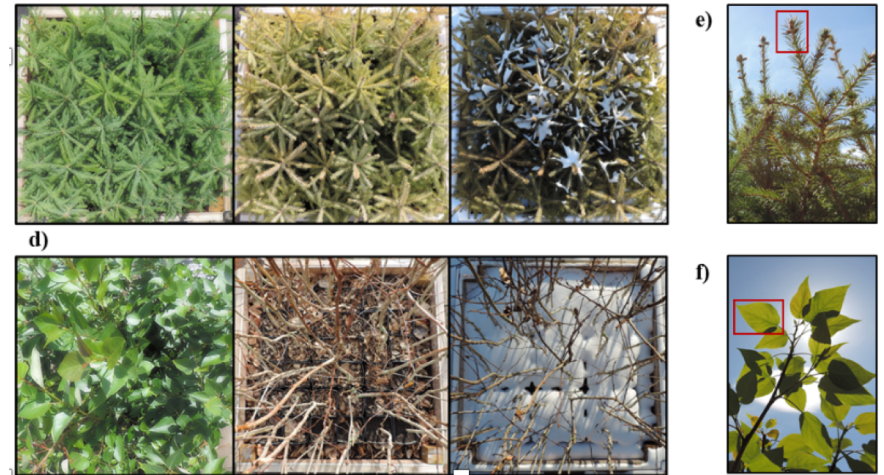




MODIS CCI tracks GPP in evergreen conifers

Gamon et al. (2016) PNAS, 113 (46), 13087-13092

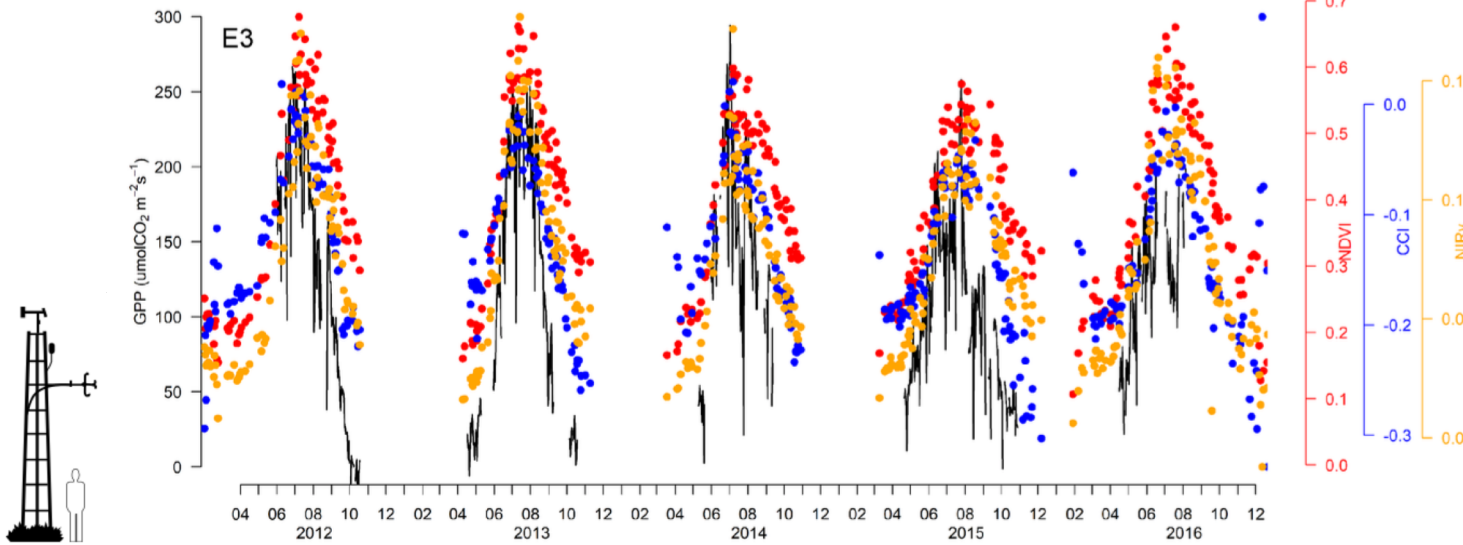
Boreal Tree Experiments (Canada)



→ Chlorophyll/Carotenoid Index (CCI) and Chl Fluorescence both track photosynthesis.

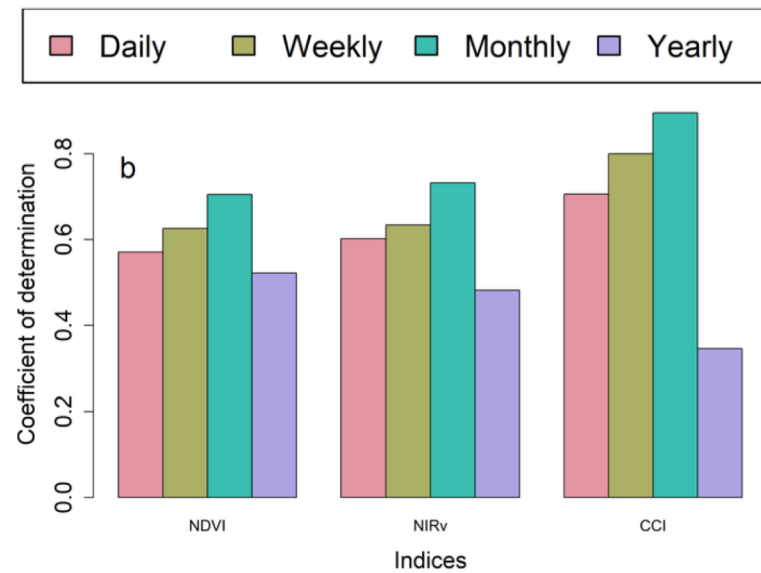
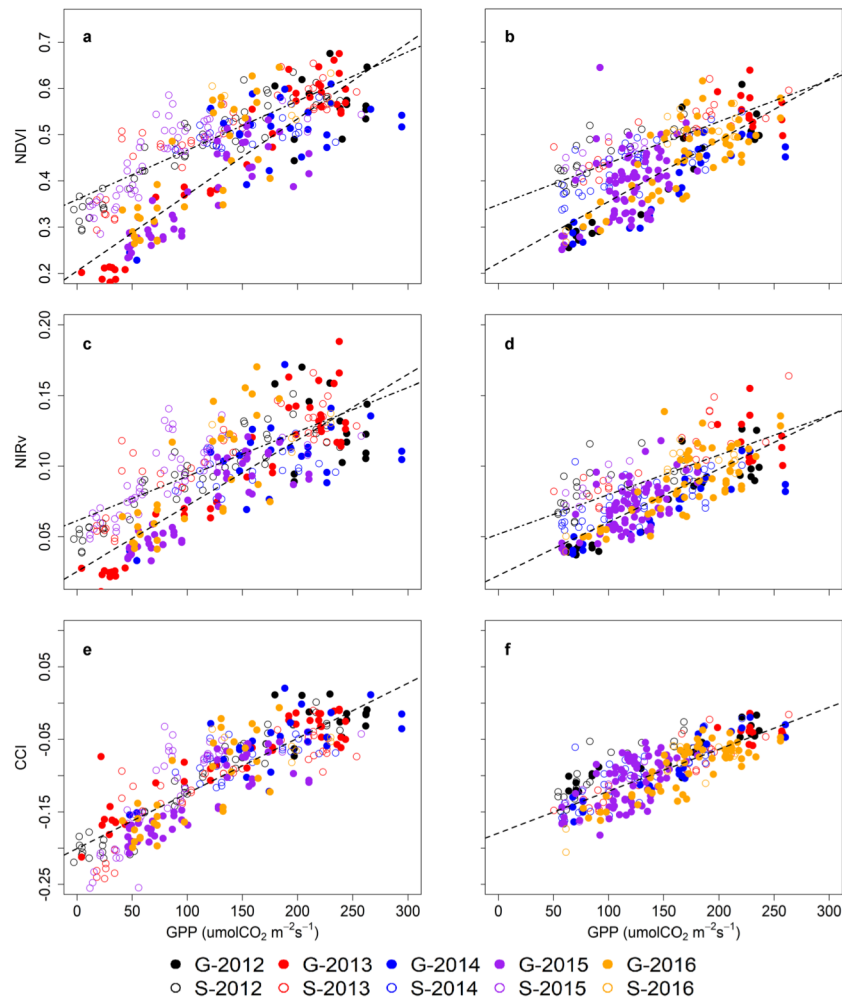


Tracking GPP, CCI, NDVI, and NIRv in prairie



Wang et al. (in preparation)

CCI shows reduced hysteresis and improved correlations with seasonal GPP for grasslands



Wang et al. (in preparation)

Conclusions:

- Chlorophyll/Carotenoid Index (CCI) offers improved tracking of GPP phenology (relative to NDVI, NIRv).
- In evergreens, the strong CCI-GPP relationship is driven by seasonal changes in pigment pool sizes.
- CCI also works as a GPP indicator in deciduous and annual vegetation.
- Seasonal changes in CCI and pigment pools appear to be closely related to chlorophyll fluorescence (and potentially SIF).