4th December

Sakowska, K.; Gianelle, D.; Zaldei, A.; MacArthur, A.; Carotenuto, F.; Miglietta, F.; Zampedri, R.; Cavagna, M.; Vescovo, L. WhiteRef: A New Tower-Based Hyperspectral System for Continuous Reflectance Measurements. *Sensors* 2015, *15*, 1088-1105.

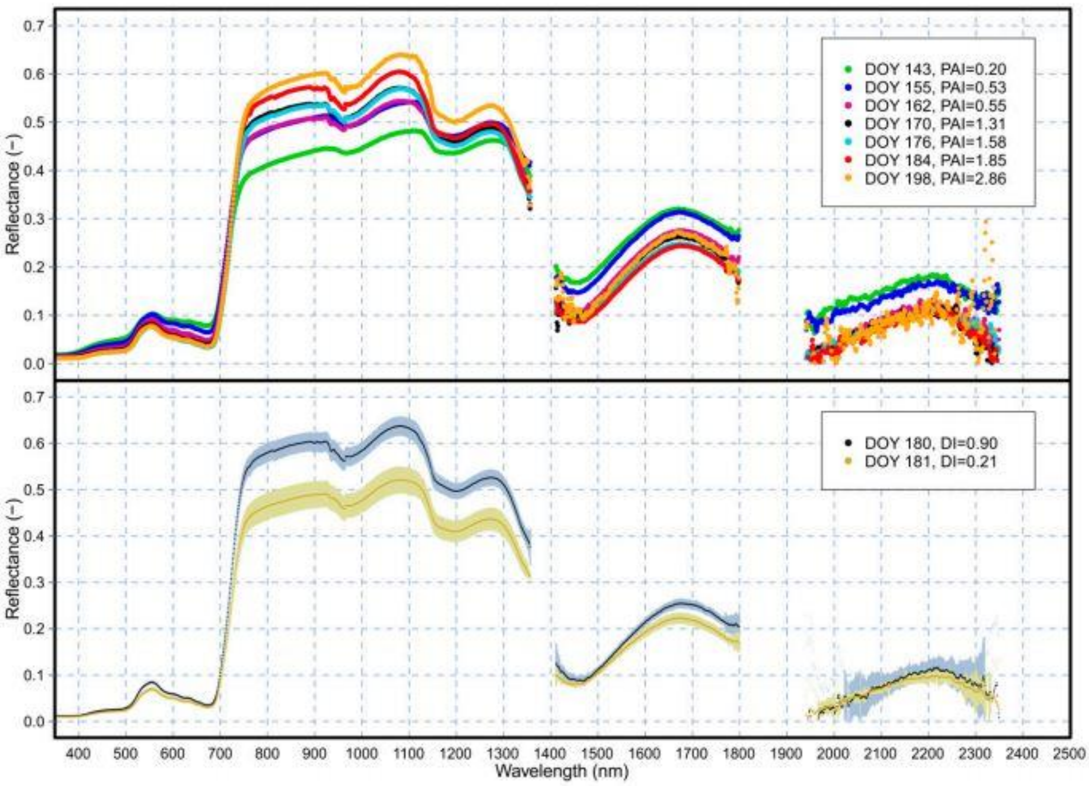


Figure 6. Upper: example of reflectance (daily average) trends starting from DOY 143 until DOY 198, with different Plant Area Index (PAI) values ranging from 0.20 to 2.86 ($m^2 \cdot m^{-2}$). **Lower**: reflectance under sunny (DOY 181; Diffusion Index—DI = 0.21 (−)) and cloudy conditions (DOY 180; DI = 0.90 (−)). Error bars in the lower panel represent standard deviation.

I think this paper will be useful to explain why NIRvP showed a linear relationship with GPP. In case of the diffuse sky condition, the LUEp shows higher value compared to clear day. In the case of NIR reflectance, it also showed higher value because "canopy reflectance was significantly increased in the NIR when the DI values were higher since cloudy conditions increased the canopy NIR scattering." I think it is quite interesting and this variation of NIR reflectance is related to fesc. SIFyield showed relatively consistent but the fesc are sensitive to sky condition, so SIF showed high correlated to GPP.

3rd December

Karkauskaite, P.; Tagesson, T.; Fensholt, R. Evaluation of the Plant Phenology Index (PPI), NDVI and EVI for Start-of-Season Trend Analysis of the Northern Hemisphere Boreal Zone. *Remote Sens.* 2017, *9*, 485.

Table 1. Average ± one standard deviation Plant Phenology Index (PPI) start of season (SOS) dates for different land cover types (Figure 1) and the relative difference (in Julian days) in SOS to the Normalized Difference Vegetation Index (NDVI) and the Enhanced Vegetation Index (EVI).

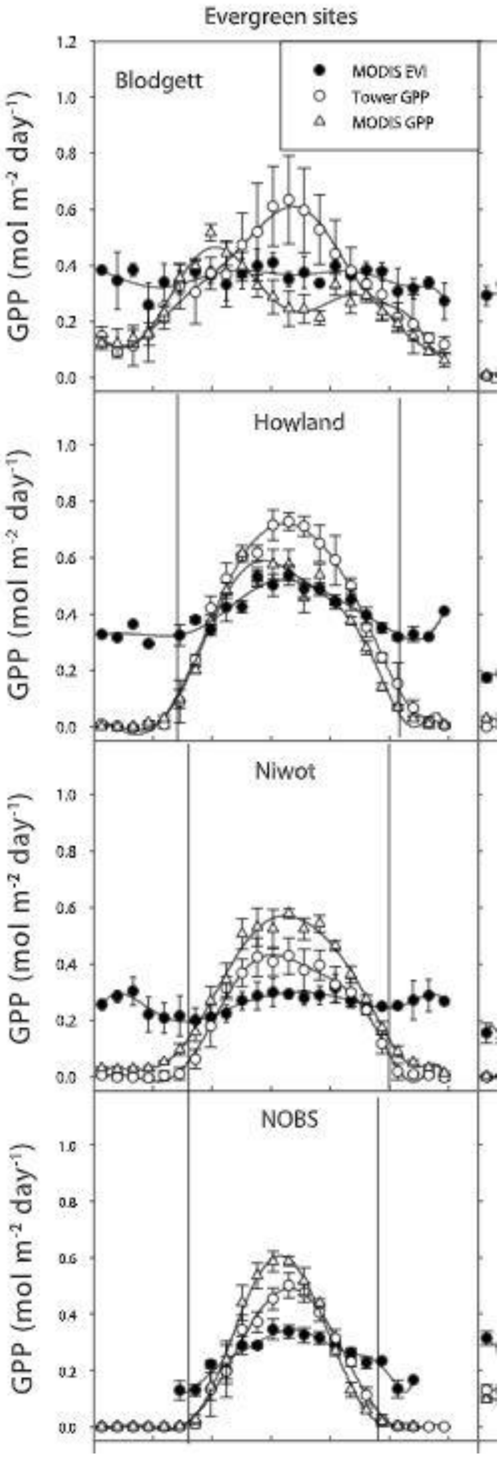
IGBP [1] Land Cover Class	PPI (Date)	NDVI (ΔDays)	EVI (ΔDays)
Evergreen Needleleaf forest	24 May ± 10	−16 ± 13	−7 ± 8
Deciduous Needleleaf forest	26 May ± 5	−15 ± 5	−13 ± 5
Deciduous Broadleaf forest	1 May ± 10	−16 ± 10	5 ± 9
Mixed forest	22 May ± 7	−20 ± 13	−8 ± 7
Open shrublands	2 June ± 8	9 ± 9	11 ± 9
Woody savannas	3 June ± 8	4 ± 10	5 ± 6
Savannas	4 June ± 8	−15 ± 10	−2 ± 7
Grasslands	26 May ± 15	10 ± 19	9 ± 16
Permanent wetlands	29 May ± 10	−42 ± 11	−34 ± 13
Croplands	27 May ± 11	−21 ± 8	−14 ± 6
Cropland/Natural vegetation	20 May ± 10	−20 ± 10	−12 ± 7
All	29 May ± 9	−13 ± 11	−6 ± 9

[1] International Geosphere-Biosphere Programme.

I think this paper also could be used to explain why the traditional vegetation indices are not working well in ENF site. They presented a new vegetation index (Plant phenology index, PPI). I think there is no result about that phenology from NIRvP before, so it also could be published with simple idea and data set.

2nd December

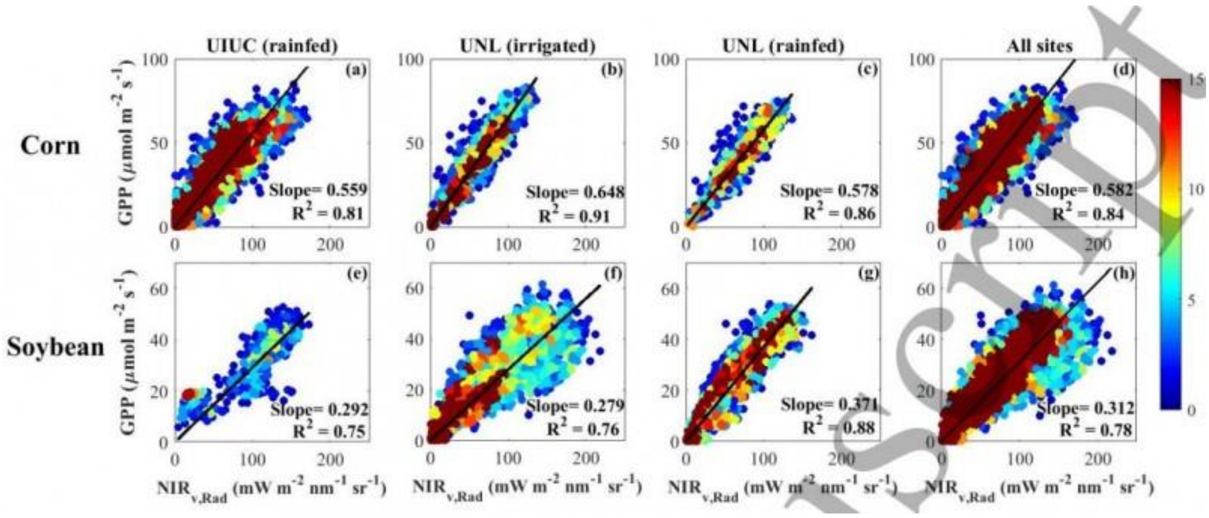
Sims, D. A., et al. (2006), On the use of MODIS EVI to assess gross primary productivity of North American ecosystems, *J. Geophys. Res.*, 111, G04015, doi:10.1029/2006JG000162.



I think this paper is useful to write the introduction part because this paper presented the EVI is not very working well in ENF site.

1st December

Genghong, W. et al., 2019. Radiance-based NIR_v as a proxy for GPP of corn and soybean. Environmental Research Letters.



I think this paper is really similar to Ben's manuscript. Many trends are going to NIRvP to estimate GPP. I think it will be really nice tool to estimate GPP because it showed a linear relationship and easy to calculate using reflectance and radiance.

4th November

Cazzaniga, S, Kim, M, Bellamoli, F, et al. Photosystem II antenna complexes CP26 and CP29 are essential for nonphotochemical quenching in *Chlamydomonas reinhardtii*. *Plant Cell Environ*. 2019; 1– 14. https://doi.org/10.1111/pce.13680

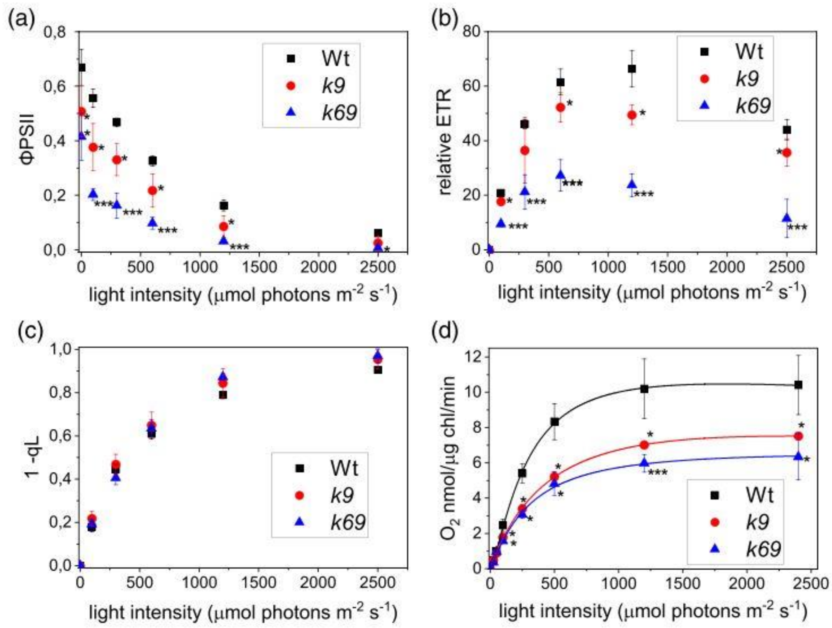


FIGURE 3 Characterization of the photosynthetic electron flow. Dependence of the (a) PSII operating efficiency (ΦPSII), (b) relative electron transport rate (ETR), (c) 1-qL (estimates the fraction of PSII centres with reduced Q_A), and (d) photosynthetic O_2 evolution on actinic light intensity for wild type (Wt, black), *k9* (red), and *k69* (blue). Net photosynthetic rate data were fitted with Hill equation. Data are expressed as mean ± *SD*. *n* > 3. All data were collected from algae grown in high salts at 100-µmol photons m^{-2} s^{-1}. *Values that are significantly different (Student's *t* test, *P* < 0.05) from Wt. **Data that are significantly different between *k6* and *k69*

I could not fully understand this paper but it seems really interesting because we could see the which proteins are related to NPQ cycle. That means we could test that "what is the exact meaning of fluorescence in leaf-level." I saw several scientists said that SIF is just leaked when plants do photosynthesis. but I think "Nature doesn't do anything meaningless." The mutant experiment is will be useful to test it.

3rd November

Blondeel, H., Perring, M.P., Depauw, L., De Lombaerde, E., Landuyt, D., De Frenne, P. and Verheyen, K. (2019), Light and warming drive forest understorey community development in different environments. Glob Change Biol. Accepted Author Manuscript. doi:[10.1111/gcb.14955](https://doi.org/10.1111/gcb.14955)

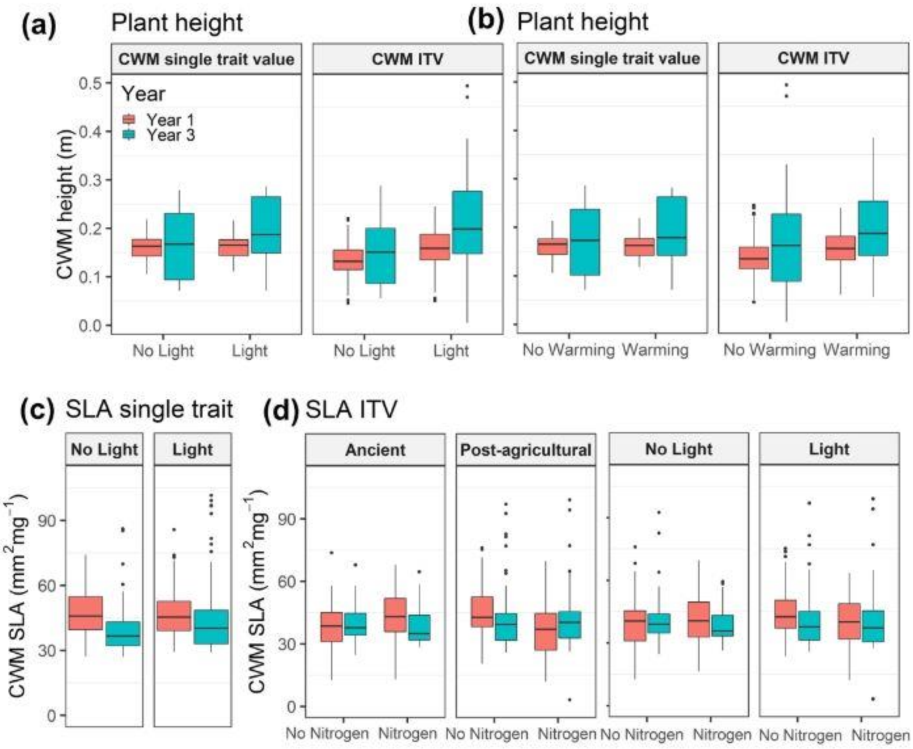


Figure 4: Community plant height consistently responds to light addition and warming due to species reordering, while SLA response changes with intraspecific trait variation (ITV). The boxplots on the interquartile range of CWM trait values are illustrations to the significant terms ($p<0.05$) from Fig. 3. We found the same significant effects of light (A), and warming (B) on plant height regardless of whether ITV was taken into account. CWM SLA responded to light in a single-species single-trait approach, but driven by some outliers (C). CWM SLA response becomes more variable when ITV is considered (D) as the effect of N addition depends on the land-use history and on light availability.

To me, this paper is quite hard to understand, but I think it is useful to know which variables affect the understory phenology. The authors measured plant height, specific leaf area (SLA), and species cover over the course of three growing seasons. Increasing light availability followed by warming reordered species towards a taller herb community, with limited effects of N enrichment or the forest land-use history. Two-way interactions between treatments and incorporating intraspecific trait variation (ITV) did not yield additional inference on community height change. Contrastingly, community SLA differed when considering ITV along with species reordering, which highlights ITV's importance for understanding leaf morphology responses to nutrient enrichment in dark conditions

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2nd November

Lu, Y., & Lu, R. (2020). Enhancing chlorophyll fluorescence imaging under structured illumination with automatic vignetting correction for detection of chilling injury in cucumbers. *Computers and Electronics in Agriculture*, *168*, 105145.

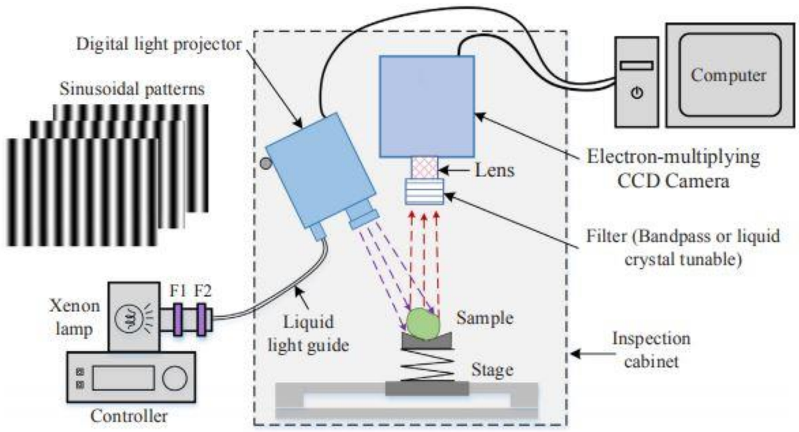

Fig. 1. Schematic of a chlorophyll fluorescence imaging system under sinusoidally-modulated structured illumination for chilling injury detection of cucumbers, where F1 and F2 represent a bandpass (400 ± 70 nm) filter and a lowpass (< 470 nm) filter, respectively.

This paper tried to build chlorophyll fluorescence imaging system under sinusoidally-modulated structured illumination. This paper used cut-off filter and band-pass filter to make the specific incoming light and measuring outgoing light. This system is working inside of lab but we could build the leaf-level measurement system outside.

1st November

Zhaohui Li, Qian Zhang, Ji Li, Xi Yang, Yunfei Wu, Zhaoying Zhang, Songhan Wang, Hezhou Wang, Yongguang Zhang, Solar-induced chlorophyll fluorescence and its link to canopy photosynthesis in maize from continuous ground measurements, Remote Sensing of Environment, Volume 236, 2020, 111420, ISSN 0034-4257,

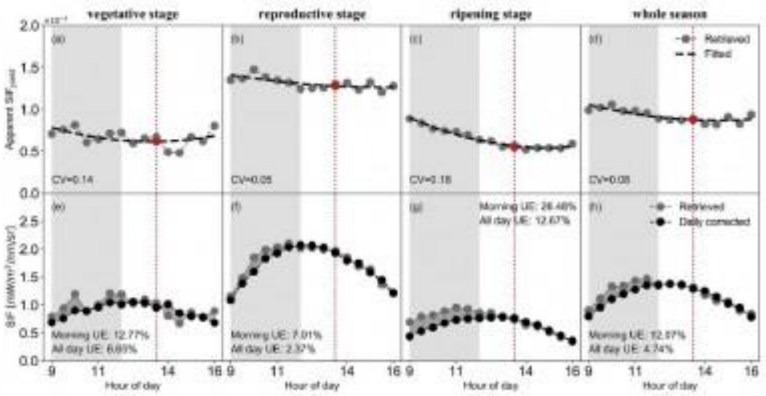

Fig. 4. Diurnal patterns of apparent SIF_{yield} (i.e. SIF/PAR) under clear-sky conditions during three growth stages and whole season (a–d). Corresponding diurnal patterns of retrieved SIF (gray line) and daily corrected SIF (black line) using retrieved SIF_{yield} at 13:30 (i.e. the overpass time of OCO-2) in three growth stages and whole season (e–h). The gray shaded region between the two lines in (e–h) is the difference between retrieved SIF and corrected SIF. The dashed gray line is the quadratic fitted line of diurnal apparent SIF_{yield}. The vertical dashed red line represents the time of 13:30. The red dot is the point of intersection of the vertical dashed line and fitted line, representing the fitted apparent SIF_{yield} value at 13:30 which was used for upscaling in this study. CV is the coefficient of variance. All day UE and Morning UE represent the amount of underestimations for the whole day and in the morning, respectively. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

When we have a meeting with Nanjing Univ folks, we shared this result. After reading this paper, I am curious about the seasonal variation of SIF yield in their site. However, I am not sure this variation is affected by SIF measurement or Fesc. I think they should check the Fesc and applied it for calculating SIFyield. In addition, in this paper, the authors showed the weird diurnal pattern and they said it might be come from variance reasons. 1) Chlorophyll contents or absorption 2) SIF emission 3) scattering and re-absorption.

4th October

Louis, J., Ounis, A., Ducruet, J. M., Evain, S., Laurila, T., Thum, T., ... & Moya, I. (2005). Remote sensing of sunlight-induced chlorophyll fluorescence and reflectance of Scots pine in the boreal forest during spring recovery. *Remote sensing of environment*, *96*(1), 37-48.

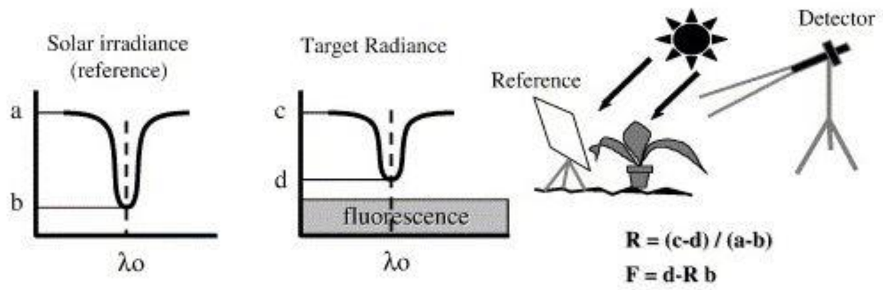

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Fig. 1. Fraunhofer Line Discriminator principle. The method is based on the partial in-filling of the absorption band by the sun-induced emission of the luminescent target. *R* and *F* are the calculated reflectance and stationary fluorescence flux.

Download : Download full-size image

Fig. 2. Photograph of the Passive Multi-Wavelength Fluorescence Detector (PMFD).

The authors developed a Passive Multi-wavelength fluorescence Detector (PMFM) and tried to monitor SIF continuously. I think I have to make the strength of 4S clearly because they already developed the sensor which can monitor SIF continuously.

3rd October

Kebabian, P. L., Theisen, A. F., Kallelis, S., & Freedman, A. (1999). A passive two-band sensor of sunlight-excited plant fluorescence. *Review of Scientific Instruments*, *70*(11), 4386-4393.

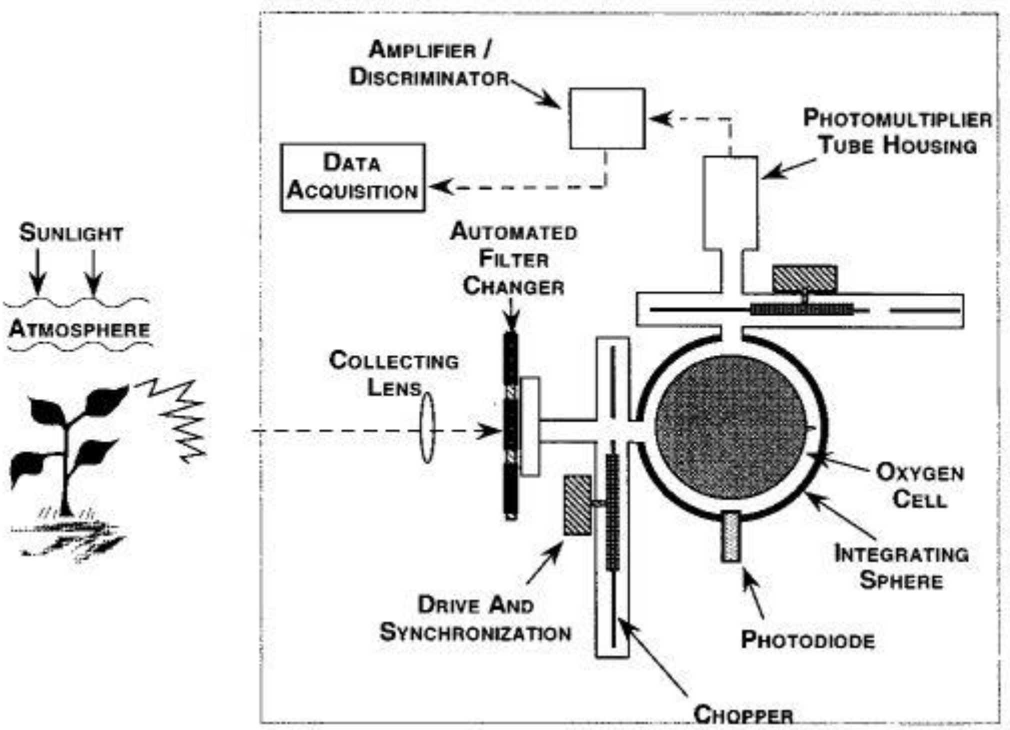

FIG. 2. Schematic diagram of the plant fluorescence sensor.

This paper showed the structure of filter-based SIF sensor first time. Very interesting and smart system. They already presented automated filter changer and collecting lens. This paper was published in 1999!

2nd October

Carter, G. A., Jones, J. H., Mitchell, R. J., & Brewer, C. H. (1996). Detection of solar-excited chlorophyll a fluorescence and leaf photosynthetic capacity using a Fraunhofer line radiometer. *Remote Sensing of Environment*, *55*(1), 89-92.

Table 1. Responses to Photosystem II Inhibition by DCMU of Solar-Excited Chlorophyll *a* Fluorescence (*F*, Relative Units) and Leaf Reflectance (*R*, %) at 687 nm, Net Photosynthetic Rate (*A*, μmol m^{-2} s^{-1}), Stomatal Conductance to Water Vapor Diffusion (*g*, mol m^{-2} s^{-1}), and Leaf Internal CO_2 Concentration (C_i, μmol mol^{-1})[a]

		F	R	A	g	C_i
			20 April			
Grape	Control	0.71 (0.05)	7.3 (1.0)	4.6 (0.8)	0.06 (0.02)	179 (6)
	DCMU	0.70 (0.06)	8.8* (1.7)	9.0* (5.3)	0.16* (0.12)	178 (14)
Palm	Control	0.67 (0.09)	12.7 (1.5)	8.2 (1.3)	0.16 (0.04)	215 (16)
	DCMU	0.81* (0.07)	13.0 (1.7)	12.4* (3.5)	0.28* (0.12)	215 (4)
			21 April			
Grape	Control	0.75 (0.07)	10.2 (1.2)	8.6 (1.3)	0.18 (0.01)	222 (8)
	DCMU	0.70 (0.04)	10.2 (1.2)	2.2* (3.7)	0.11* (0.04)	308* (47)
Palm	Control	0.71 (0.04)	8.3 (1.5)	8.7 (2.0)	0.24 (0.05)	248 (13)
	DCMU	0.84* (0.06)	10.2* (1.0)	0.8* (0.6)	0.11* (0.01)	339* (31)

[a] Measurements on 20 April began 18 h after DCMU was applied on 19 April. A mean ($n = 6$) denoted by (*) was significantly different from the corresponding control mean ($p = 0.05$) according to a two-tailed *t*-test (critical $t = 2.45$). Standard deviations are shown in parentheses to the right of each mean.

Crazy, they start to measure SIF by using filter system from 1996! Also, they used DCMU treatment. What's new in my research compare to this paper? I think science has been improved and this idea and thinking could come true.

1st October

Stoertz, G. E., Hemphill, W. R., and Markle, D. A. (1969), Airborne fluorometer applicable to marine and estuarine studies, J. Marine Tech. Soc. 3:11-26.

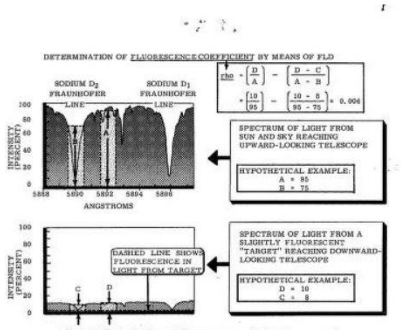

Figure 2. Determination of fluorescence coefficient by means of FLD

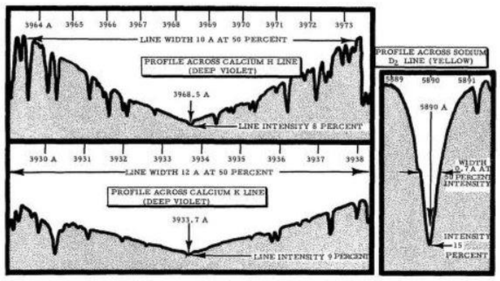

Figure 3. Profiles across the sodium D_2, calcium H, and calcium K Fraunhofer lines

I think this paper is first paper which monitors fluorescence from the earth. I know there are previous studies to measure lunar lumination, but this paper tried to capture fluorescence from earth. So Interesting.

4th September

Rossini, M., Nedbal, L., Guanter, L., Ač, A., Alonso, L., Burkart, A., ... & Hanus, J. (2015). Red and far red Sun-induced chlorophyll fluorescence as a measure of plant photosynthesis. *Geophysical research letters*, *42*(6), 1632-1639.

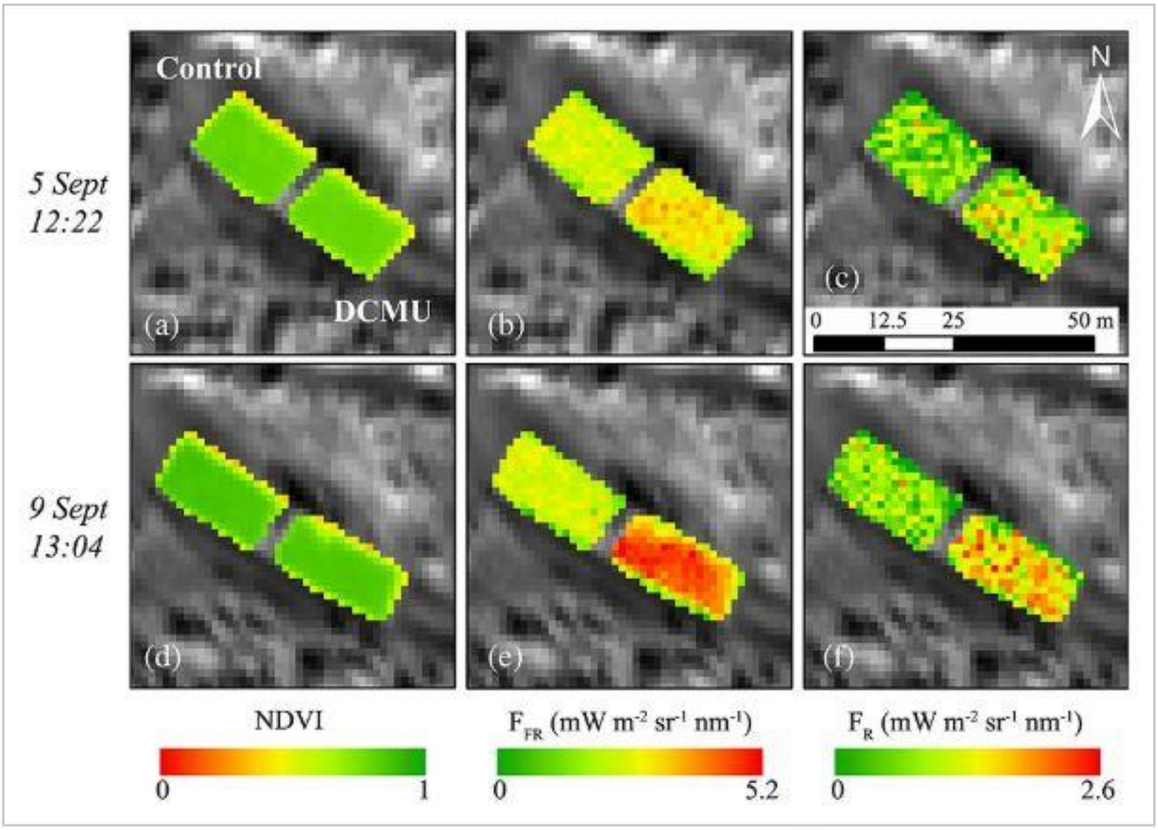

Figure 2

Open in figure viewer | PowerPoint

Control (left) and DCMU-treated (right) grass plots in airborne images. (a, d) Normalized difference vegetation index (NDVI). (b, e) Far red chlorophyll fluorescence (F_{FR}). (c, f) Red chlorophyll fluorescence emission (F_R). The dates and hours (CEST) on the left indicate the data acquisition time.

This paper showed how to evaluate our SIF retrieval is correct or not. In this paper, the authors used DCMU to test SIF. In addition, this paper well described what is the DCMU and how it works in the plant cell.

3rd September

Berry, Z. C. and Goldsmith, G. R. (2019), Diffuse light and wetting differentially affect tropical tree leaf photosynthesis. New Phytol. doi:10.1111/nph.16121

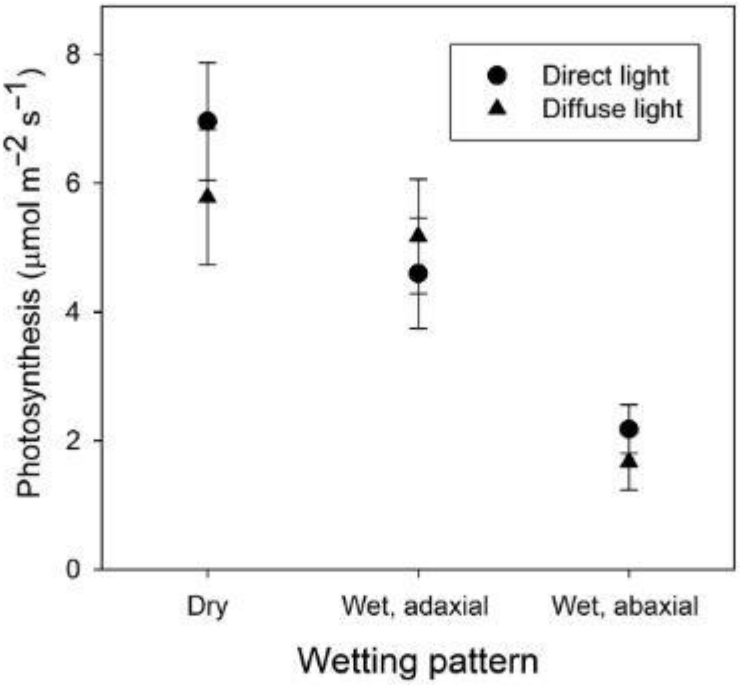

Fig. 4 Photosynthetic rates for subcanopy leaves of *Ocotea tonduzii* when dry, wet on the adaxial surface (top of leaf), and wet on the abaxial surface (bottom of leaf). Leaves were located 5–10 m off the ground under a closed canopy. Measurements were taken under both direct (circles) and diffuse (triangles) light conditions. Data are means of five individuals per treatment ± SE.

In this paper, they showed the diffue light and weeting condition could affect the tropical leaf-level photosynthesis. The authors measured the effects of diffuse light and leaf wetting on photosynthesis in canopy species from a tropical montane cloud forest using a modified gas exchange setup. The authors demonstrated significant variation in species-level response to light quality independent of light intensity. Some species demonstrated 100% higher rates of photosynthesis in diffuse light, and others had 15% greater photosynthesis in direct light. Even at lower light intensities, diffuse light photosynthesis was equal to that under direct light conditions. Leaf wetting generally led to decreased photosynthesis, particularly when the leaf surface with stomata became wet; however, there was significant variation across species.Ultimately, the autrhors demonstrated that ecosystem photosynthesis is significantly altered in response to environmental conditions that are ubiquitous. Our results help to explain the observation that net ecosystem exchange can increase in cloudy conditions and can improve the representation of these processes in Earth systems models under projected scenarios of global climate change.

2nd September

Wahl, M.S.; Wilhelmsen, Ø.; Hjelme, D.R. Addressing Challenges in Fabricating Reflection-Based Fiber Optic Interferometers. *Sensors* 2019, *19*, 4030.

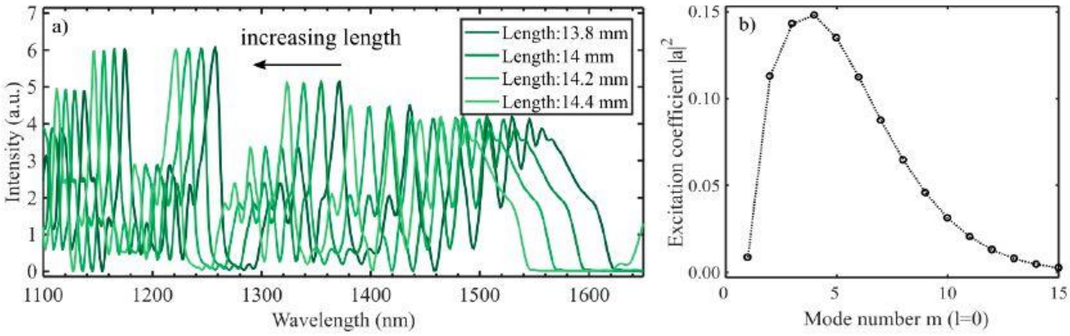

Figure 3. (**a**) Spectra of coreless interferometers with different lengths that have a perfect cleave. The spectrum sensitivity to the length of the interferometer is 60 nm/mm at around 1500 nm. (**b**) Excitation coefficients for the radial modes ($l = 0$) at the single mode fiber (SMF)-CL fiber interface. The excitation of the hybrid modes is calculated individually, however, only the sum of the square magnitude is plotted for each value of l.

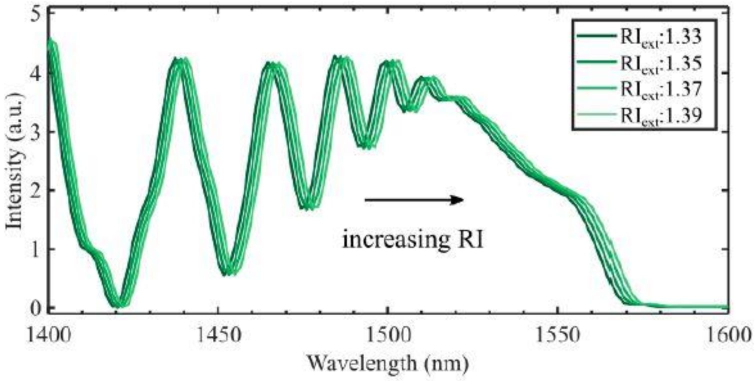

Figure 4. Refractive index sensitivity for a 14.2 mm CL fiber with a perfect cleave (zero degrees). The resulting sensitivity is 65.5 nm/RIU at 1550 nm.

I could not fully understand this paper, but I think we could get the hint for wavelength shift in CRK QEpro. According to this paper, the experimental results showed the variability in the spectrums produced from a set of sensors with different cleave angles. Some peaks showed a consistent increase in intensity for larger cleave angles, whereas other showed a decrease. The length accuracy of the experimental setup was found to be ±100 μm based on the results from the simulations, which gave an estimated sensitivity to the interferometer length of 60 nm/mm. The refractive index sensitivity was estimated to be 65.5 nm/RIU. According to the simulations, the end-face cleave angle has the largest impact on the spectrum, attributed to the wide distribution of optical power in the cross-section. That means split fiber system could make the wavelength shift if there is mismatched the centor of the fiber.

1st September

Wong, C. Y., D'Odorico, P., Bhathena, Y., Arain, M. A., & Ensminger, I. (2019). Carotenoid based vegetation indices for accurate monitoring of

the phenology of photosynthesis at the leaf-scale in deciduous and evergreen trees. ***Remote Sensing of Environment*****, *233*, 111407.**

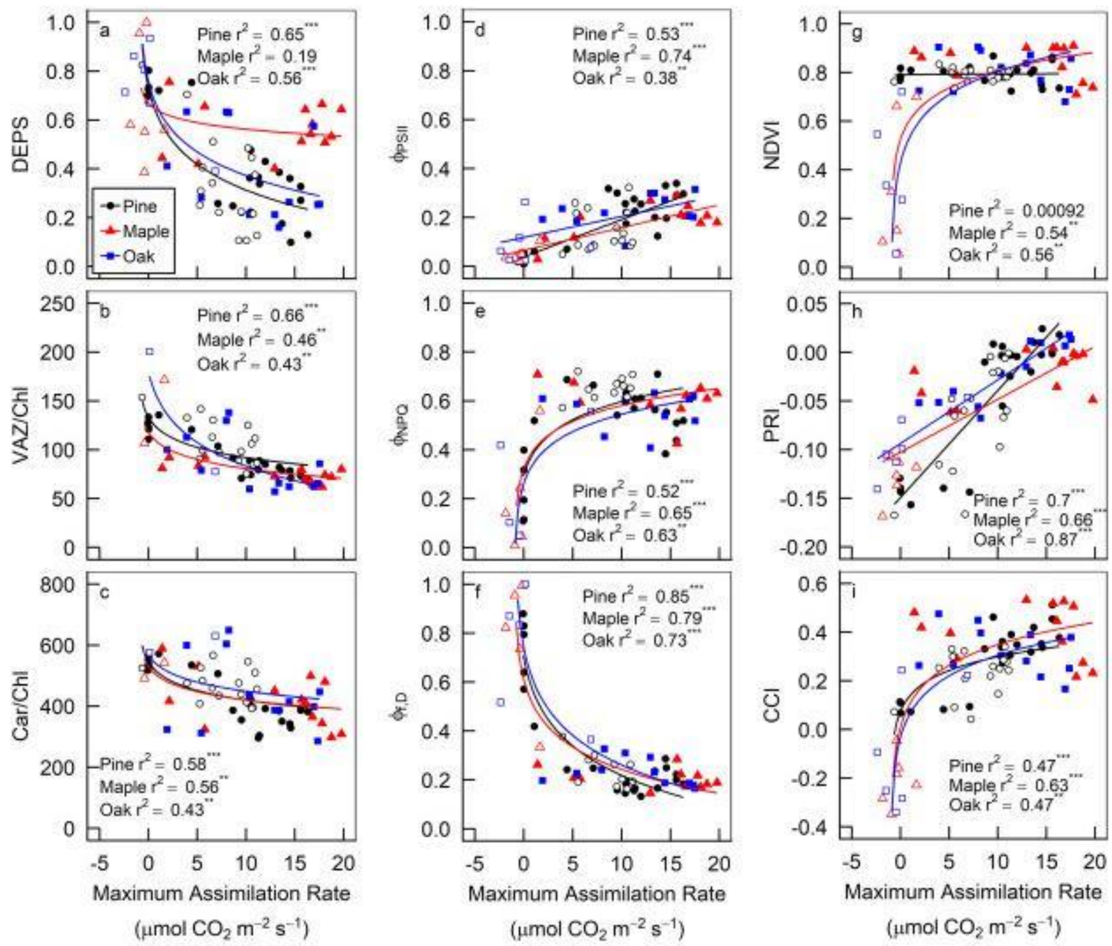

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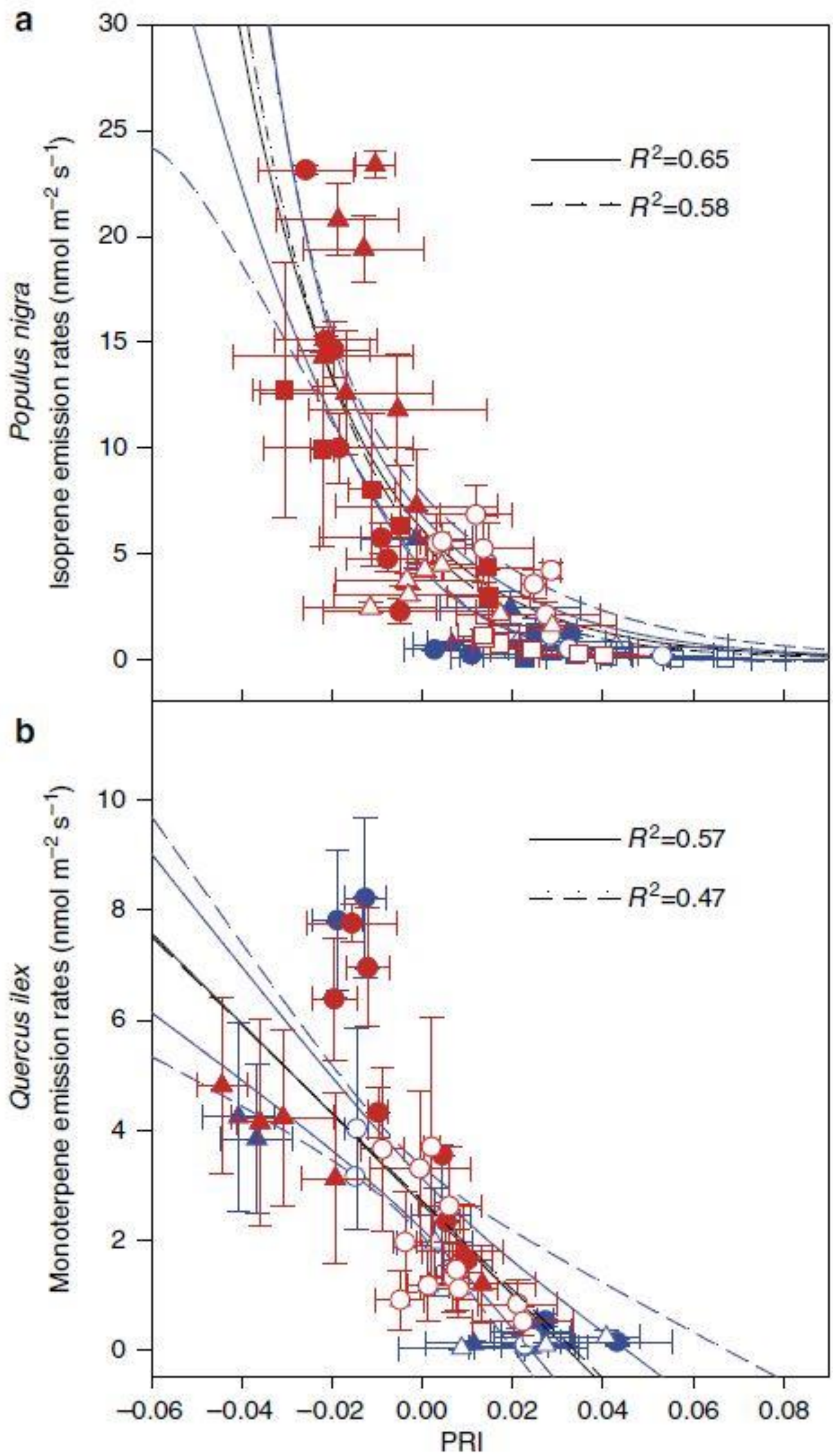
Fig. 7. Relationship between leaf-scale maximum assimilation rate (A_{max}) and (a) de-epoxidation state of the xanthophyll cycle (DEPS), (b) xanthophyll pool on a chlorophyll basis (VAZ/Chl), (c) total carotenoids on a chlorophyll basis (Car/Chl), (d) the fraction of absorbed light used for photochemistry (ϕ_{PSII}), (e) the fraction of absorbed light quenched via dynamic NPQ (ϕ_{NPQ}), and (f) the fraction of absorbed light quenched via sustained NPQ ($\phi_{f,D}$), (g) NDVI,

One of my favourite author published another paper. The authors measured leaf-scale NDVI, PRI and CCI and checked which index could tract phenology of photosynthesis. This paper highlighted that 1) NDVI poorly represents photosynthetic phenology and activity in conifers. 2) PRI and CCI detect carotenoid pigment composition regulating photosynthetic activity. 3) PRI and CCI represent photosynthetic phenology in deciduous and evergreen trees.

4th August

Penuelas, J., Marino, G., LLusia, J., Morfopoulos, C., Farré-Armengol, G., & Filella, I. (2013). Photochemical reflectance index as an indirect estimator of foliar isoprenoid emissions at the ecosystem level. *Nature communications*, *4*, 2604.



I attended Ulo's presentation and I found that isoprenoid emissions are related to plant stress such as drought, heat, insect, etc.. Therefore, I think there should be relationships between BVOCs and vegetation indices such as PRI or SIF because these VIs also showed response to plant stress. Ulo recommends this paper and there was high relationship between PRI and isoprenoid emission. I think it will be interesting topic between SIF and isoprenoid. BVOC also related stress and GPP and SIF also does. I will check the TNF data.

3rd August

Hovi, A., Forsström, P., Mõttus, M., & Rautiainen, M. (2017). Evaluation of accuracy and practical applicability of methods for measuring leaf reflectance and transmittance spectra. *Remote Sensing*, *10*(1), 25.

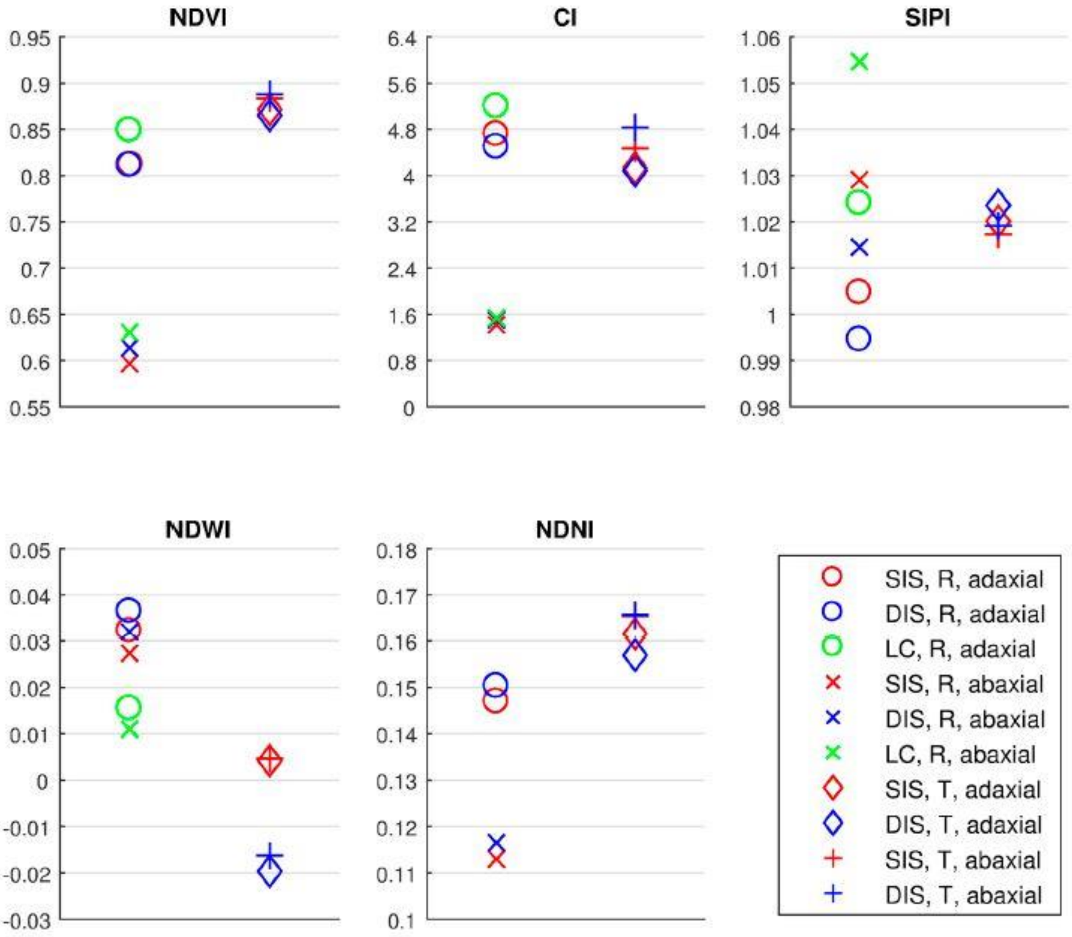


Figure 6. Dependence of spectral indices of birch leaves on measurement method, measured quantity (reflectance or transmittance), and leaf side. The values shown are mean values of indices calculated from the measured spectra (18 spectra per method). SIS = single integrating sphere, DIS = double integrating sphere, LC = leaf clip, R = reflectance, T = transmittance.

I did not consider the structure of ASD leaf clip tool before. However, when I check it nowadays, there is some issues which could affect leaf reflectance or transmittance values. In this paper, the authors compared a single integrating sphere, a small double integrating sphere and a leaf clip. The results were interesting because The systematic difference in mean reflectance spectra between single and double integrating spheres was only minor (average relative difference of 1%), whereas a large difference (14%) was observed in transmittance. Reflectance measured with leaf clip was on average 14% higher compared to a single integrating sphere.

2nd August

Mora, C., Rollins, R. L., Taladay, K., Kantar, M. B., Chock, M. K., Shimada, M., & Franklin, E. C. (2018). Bitcoin emissions alone could push global warming above 2 C. *Nature Climate Change*, *8*(11), 931.

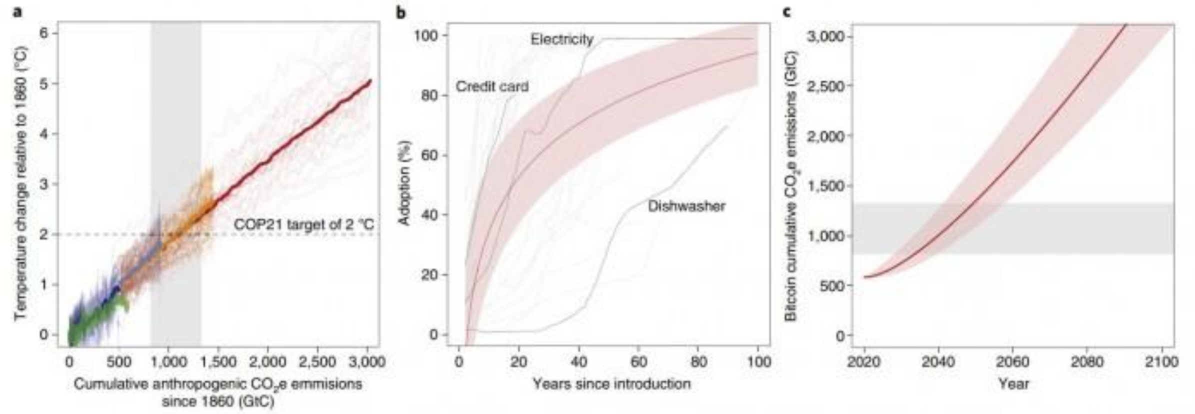


Fig. 1 | Carbon emissions from projected Bitcoin usage. a, Current and projected trends in global average temperature as a function of cumulative man-made carbon emissions. Narrow lines depict the projections of individual ESMs, while the thick lines indicate the multimodel median. The dashed line represents the COP 21 target of 2 °C global warming, and the grey shaded area represents the CO_2e emissions among ESMs at which such a threshold is crossed (values are for the 5th and 95th percentiles of all model projections). **b**, Trends in the adoption of broadly used technologies. Data are available for the United States, and used here as a reference. The red shaded area indicates the margins of the upper and lower quantiles, and the red line is the median tendency among technologies (see Methods). Grey lines indicate trends for each of the technologies (see Methods). **c**, Cumulative emissions from Bitcoin usage under the average growth rate of technologies that have been broadly adopted as shown in **b**. The grey shaded area indicates the carbon emissions above which warming exceeds 2 °C.

I think the idea of this paper is really interesting. This paper said, "Bitcoin is a decentralized cashless payment system introduced in early 2009, and it is now accepted by over 100,000 merchants and vendors worldwide and the correcting Bitcoin could affect the carbon emission by consuming electricity." I think this paper really has nice idea about connection between life and science. I am not sure their analysis is scientific right but their idea is cool.

1st August

Zeng, Y., Badgley, G., Dechant, B., Ryu, Y., Chen, M., & Berry, J. A. (2019). A practical approach for estimating the escape ratio of near-infrared solar-induced chlorophyll fluorescence. *Remote Sensing of Environment*, 111209.

Together with our assumption that $\omega_N = 1$, we can then rewrite Eq. (10) to read:

$$f_N^{esc} \approx \frac{NIR_V}{fPAR}, \quad (12)$$

which is both computationally tractable and easily estimated from existing *in situ* and remote sensing measurements. A more detailed derivation relating f^{esc} of SIF to f^{esc} of NIR reflectance is presented in the Appendix.

I think this paper is a key paper about the fraction of photons that escape from the canopy. In this paper, the authors propose an approach for estimating the fraction of total emitted near-infrared SIF photons that escape the canopy by combining the near-infrared reflectance of vegetation and the fraction of absorbed photosynthetically active radiation, two widely available remote sensing products. In this paper showed that correcting for the escape ratio of SIF using NIRV provides robust estimates of the total emitted SIF, providing for the possibility of studying physiological variations of fluorescence yield at the global scale.

4th July

Do all chlorophyll fluorescence emission wavelengths capture the spring recovery of photosynthesis in boreal evergreen foliage?

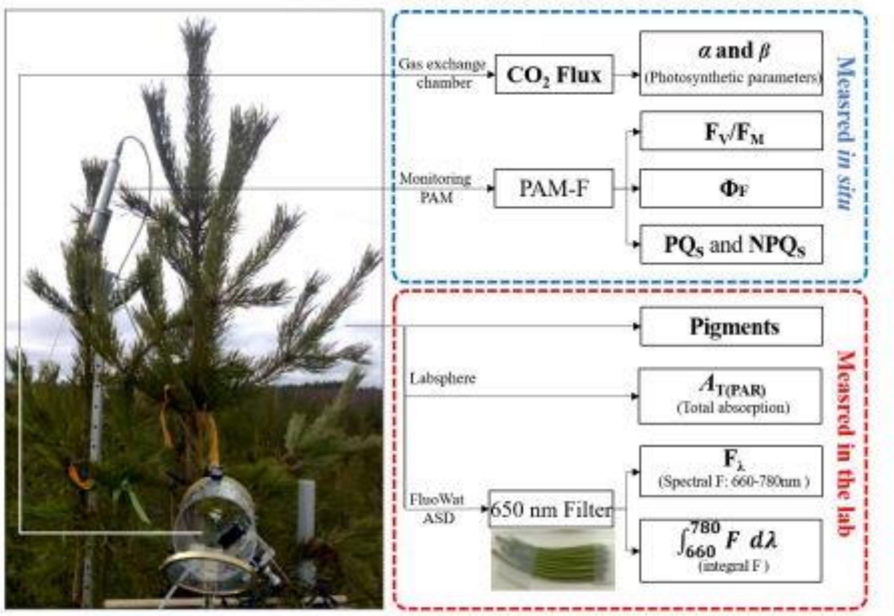
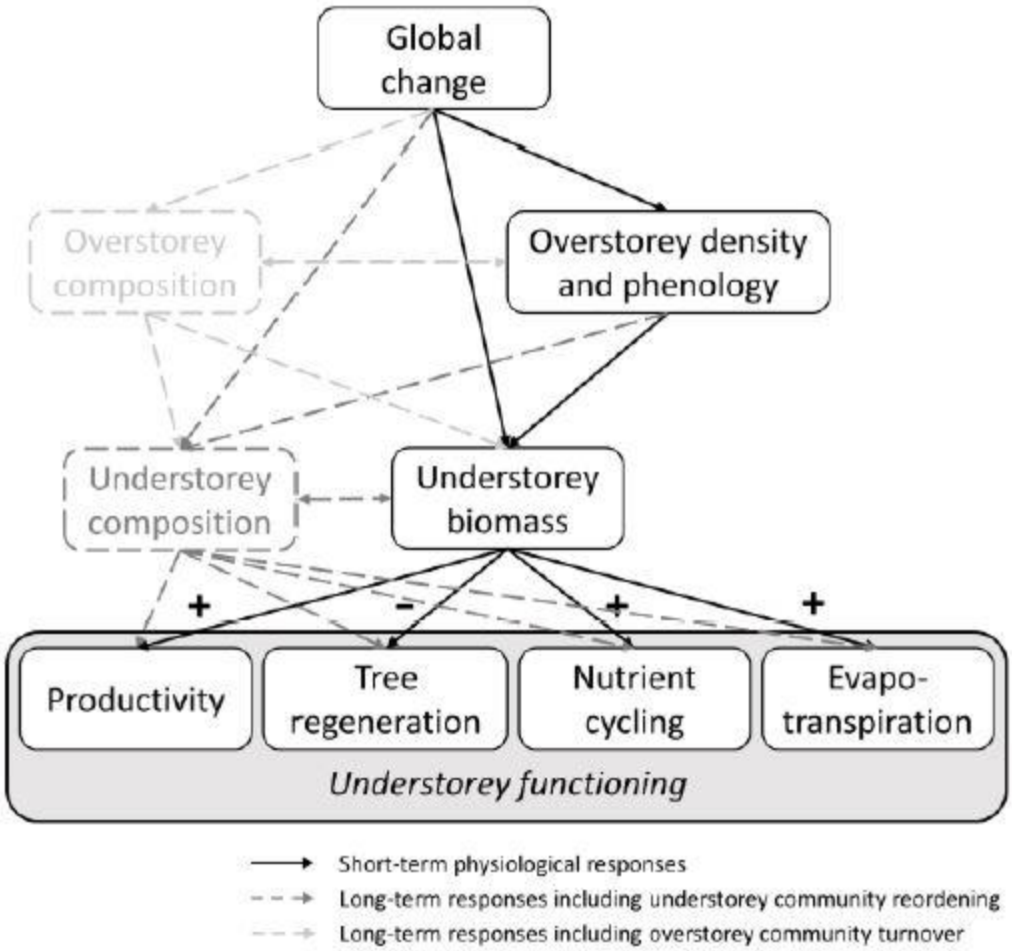


Fig. 1. Measurement rationale during the spring recovery of 2015 in *Pinus sylvestris*.

I think this paper is really interested in because they measure the seasonal spectral shape of ChlF. Their species is different but I think it will be useful to understand our data set. This paper present seasonal ChlF variation in the red and far-red wavelengths, which was strongly correlated with NPQs, carotenoid content and photosynthesis but not with PAR absorption. In addition, they investigated if red and far-red wavelengths of ChlF were equally positioned to capture the spring recovery of photosynthesis. To do so they combined long-term and continuous in situ measurements of gas exchange, and PAM ChlF with repeated measurements of foliar pigment content, leaf total PAR absorption and spectral ChlF, spanning the full dynamic range of variation in photosynthetic capacity of Scots pine needles: They demonstrated that red and far-red ChlF emission wavelengths were able to transmit the optical signature of the spring.

3rd July

Landuyt, D. , De Lombaerde, E. , Perring, M. P., Hertzog, L. R., Ampoorter, E. , Maes, S. L., De Frenne, P. , Ma, S. , Proesmans, W. , Blondeel, H. , Sercu, B. K., Wang, B. , Wasof, S. and Verheyen, K. (2019), The functional role of temperate forest understorey vegetation in a changing world. Glob Change Biol. Accepted Author Manuscript.



I think this paper will be a really good reference paper for my understory research. In the introduction, actually, I need the reference materials. In this paper also focused on temperate forest site and understory. I really like this paper! In this paper said, the understory could affect the overstory density and phenology. In addition, the understory effect could need to understand productivity, tree regeneration, nutrient cycling and evapotranspiration. The authors said global change drivers could change understory function and growing conditions. I will check this paper reference and I will add discussion parts to show why our satellite-based phenology have a potential disadvantage.

2nd July

Du, S., Liu, L., Liu, X., Guo, J., Hu, J., Wang, S., & Zhang, Y. (2019). SIFSpec: Measuring Solar-Induced Chlorophyll Fluorescence Observations for Remote Sensing of Photosynthesis. *Sensors*, *19*(13), 3009.

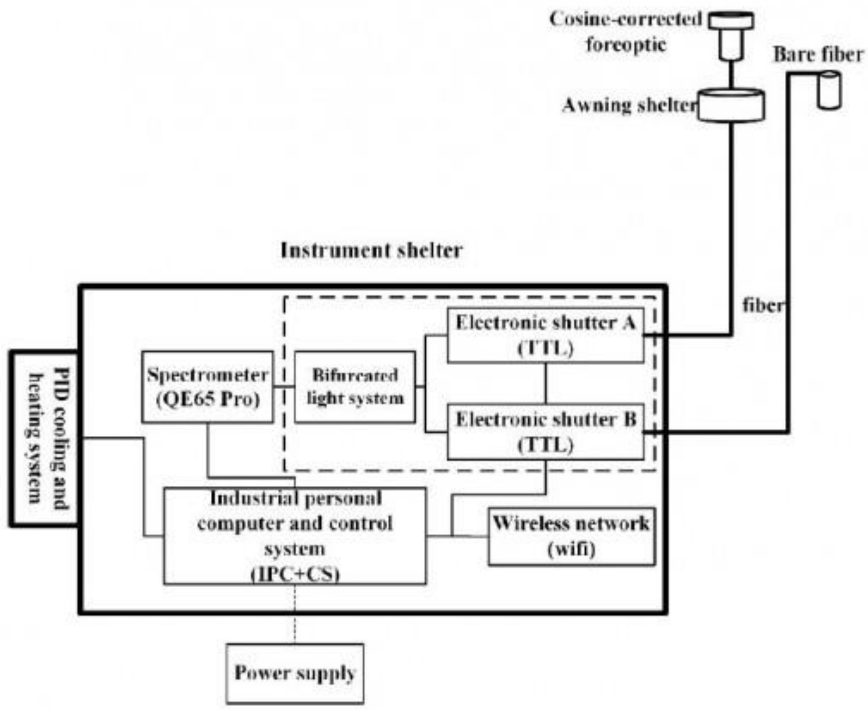


Figure 1. Schematic diagram of the configuration of the solar-induced chlorophyll fluorescence (SIF) measurement (SIFSpec) system. TTL and IPC indicate the electronic shutter and the industrial personal computer, respectively.

Again, a new SIF observation system. Actually, I could not see something new compare to Photospec, Fluospec, FAME and FLoX system. However, I think I can check the reference papers and introduction for 4S-SIF. In addition, this paper shows the hysterysis diurnal pattern. I am not sure that comes from the NPQ effect. It looks like a tilted sensor pattern.

1st July

Havaux, M., Gruszecki, W. I., Dupont, I., & Leblanc, R. M. (1991). Increased heat emission and its relationship to the xanthophyll cycle in pea leaves exposed to strong light stress. *Journal of Photochemistry and Photobiology B: Biology*, *8*(4), 361-370.

Abstract

In vivo thermal energy dissipation was photoacoustically monitored in pea leaves before and after strong light treatment. Concomitant with the conversion of the carotenoid violaxanthin into zeaxanthin, a marked increase in the heat emission signal was observed in the light-stressed leaves. However, when the xanthophyll cycle was blocked by dithiothreitol, the photothermal signal still increased, indicating that there was no causal relationship between these two phenomena. Increased heat emission was shown to result from pigment uncoupling, which caused the inhibition of the energy transfer from carotenoids to chlorophylls. It was also observed that the maintenance of a very low zeaxanthin level by dithiothreitol led to an increase in both the oxygen evolution and the photothermal components of the photoacoustic signal in control leaves and to a strong increase in lipid degradation in light-stressed leaves. These results may suggest that a possible function of the xanthophyll cycle is to provide an accessory pigment (violaxanthin) in weak light and to furnish the lipid matrix of the thylakoid membranes with an efficient photoprotector (zeaxanthin) in strong light.

I am curious about the relationship between heat emission and xanthophyll cycle because when I read such a study about photoprotection, they always mention the heat emission and xanthophyll cycle. I think this paper is good enough to solve my question. This paper said there is no direct relationship between heat emission and the xanthophyll cycle. However, some paper said the Zeaxanthin affect the lipid-protein formation and it will affect the heat emission. In this paper said "For the light conditions used in this study, the xanthophyll cycle is not directly involved in the increase in the photoacoustically monitored thermal deactivation of excited pigments. This effect appears to be caused by a loss of energy transfer from carotenoids to Chl a. Although this work only deals with strong light treatments, it seems that the situation is more complex than that presented in recent papers."

4th June

Pastore, M. A., Lee, T. D., Hobbie, S. E., & Reich, P. B. (2019). Strong photosynthetic acclimation and enhanced water-use efficiency in grassland functional groups persist over 21 years of CO 2 enrichment, independent of nitrogen supply. *Global change biology*.

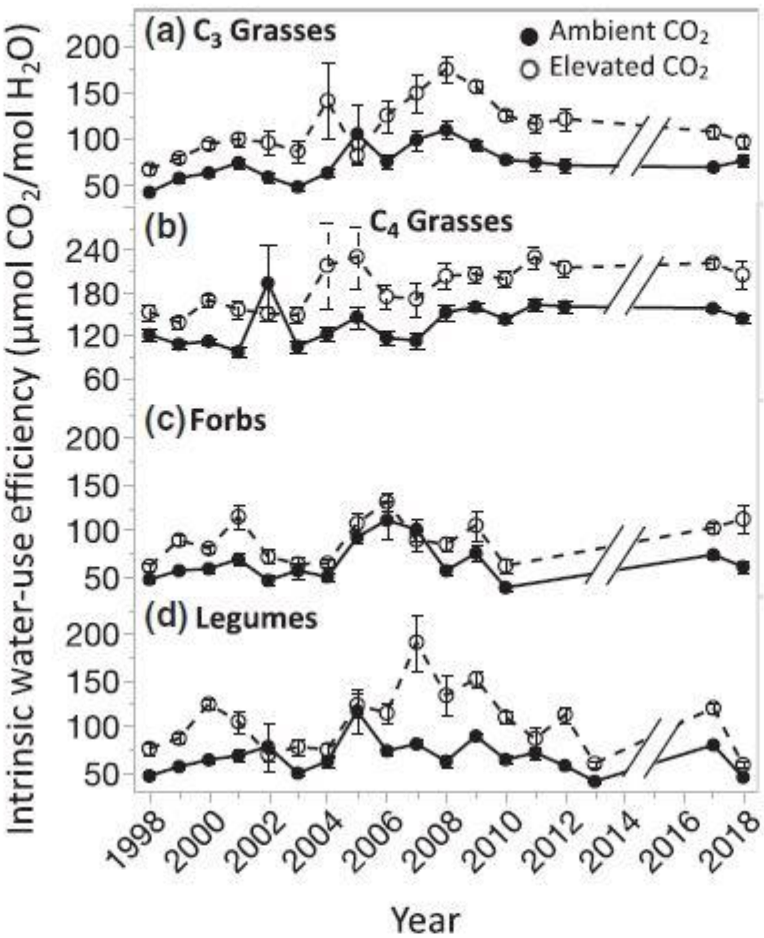


FIGURE 6 Mean intrinsic water-use efficiency in (a) C_3 grasses, (b) C_4 grasses, (c) forbs, and (d) legumes grown at ambient (closed circles) or elevated (open circles) CO_2 over 21 years. Data for each FG are pooled across species and N treatments. See Table 1 for statistics. Dashes indicate a gap in years of data collection, not an axis break. Error bars represent standard error. Note that the range of the *Y*-axis is larger for "b"

This paper is quite interesting because 1) they used the long term-FACE measurement data 2) There was no N treatment effect. They results imply that "enhanced nitrogen supply will not necessarily diminish photosynthetic acclimation to eCO2 in nitrogen-limited system." That means the increased WUE can plant survive in the drought region. Then my question is that plant can acclimate well in drought region in the future? Because we know there is CO2 fertilization effect in the world and precipitation also changing in a different region.

3rd June

Kim, J. J., Allison, L. K., & Andrew, T. L. (2019). Vapor-printed polymer electrodes for long-term, on-demand health monitoring. *Science advances*, *5*(3), eaaw0463.

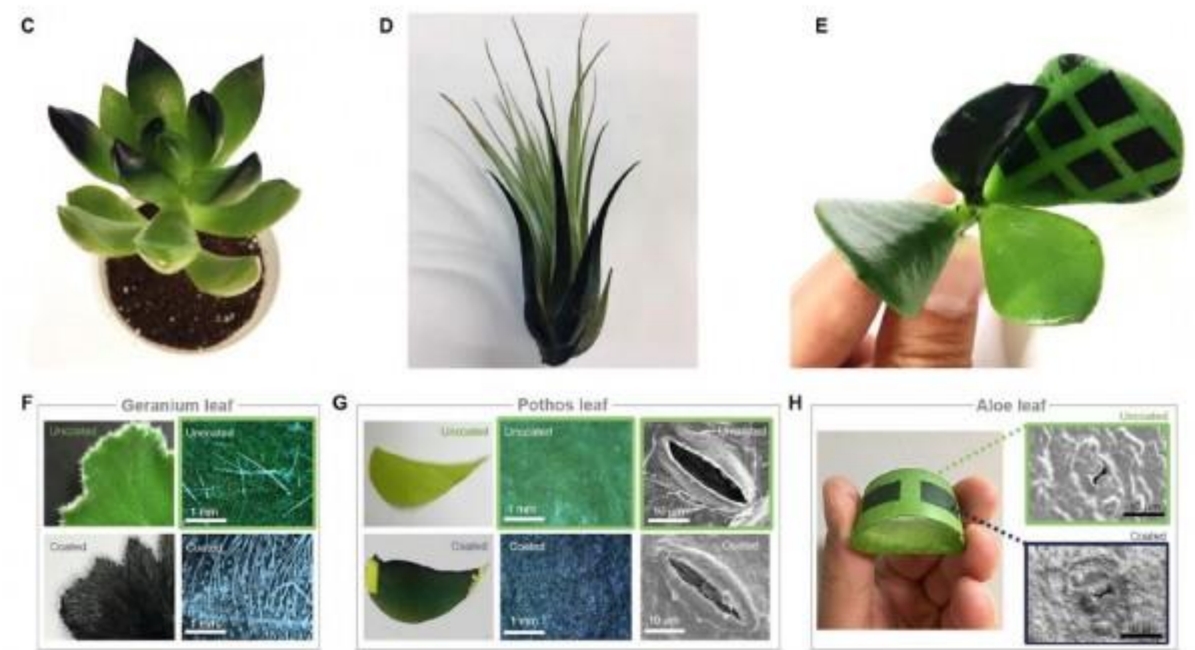


Fig. 1. Vapor printing polymer films on plant matter. (**A**) Process for vapor coating live plants with functional polymer films. (**B**) Oxidative polymerization reaction that occurs in the low-pressure reactor and structure of the conducting polymer coating, PProDOT-Cl, used in this work. (**C**) Stonecrop with the tips of selected leaves coated with PProDOT-Cl. (**D**) Air plant with the exposed surfaces of the outermost leaves coated with PProDOT-Cl. (**E**) Jade plant cutting coated with a PProDOT-Cl electrode pattern achieved using a polyimide tape mask placed on one leaf. (**F**) Digital photographs (left) and optical micrographs (right) of pristine and PProDOT-Cl–coated geranium leaves. (**G**) Digital photographs (left) and optical micrographs (center) of pristine and PProDOT-Cl–coated pothos leaves and scanning electron micrographs (SEMs; right) of a pristine and polymer-coated pothos stoma. (**H**) A digital photograph (left) of a cut aloe leaf vapor-coated with a PProDOT-Cl electrode pattern and SEMs (right) of a pristine and polymer-coated aloe stoma. Note that the gel inside a cut aloe leaf is preserved after vapor coating.

I think this paper is very interesting. The basic idea of this paper is using Inbody system to monitor plant health. I could not fully understand the detail part but If we use this system to estimate plant physiology, it will be really interesting. I think this idea should be useful to my other idea (Estimate CI using photodiode system).

2nd June

Chang, Q., Xiao, X., Jiao, W., Wu, X., Doughty, R., Wang, J., ... & Qin, Y. (2019). Assessing consistency of spring phenology of snow-covered forests as estimated by vegetation indices, gross primary production, and solar-induced chlorophyll fluorescence. *Agricultural and Forest Meteorology*, *275*, 305-316.

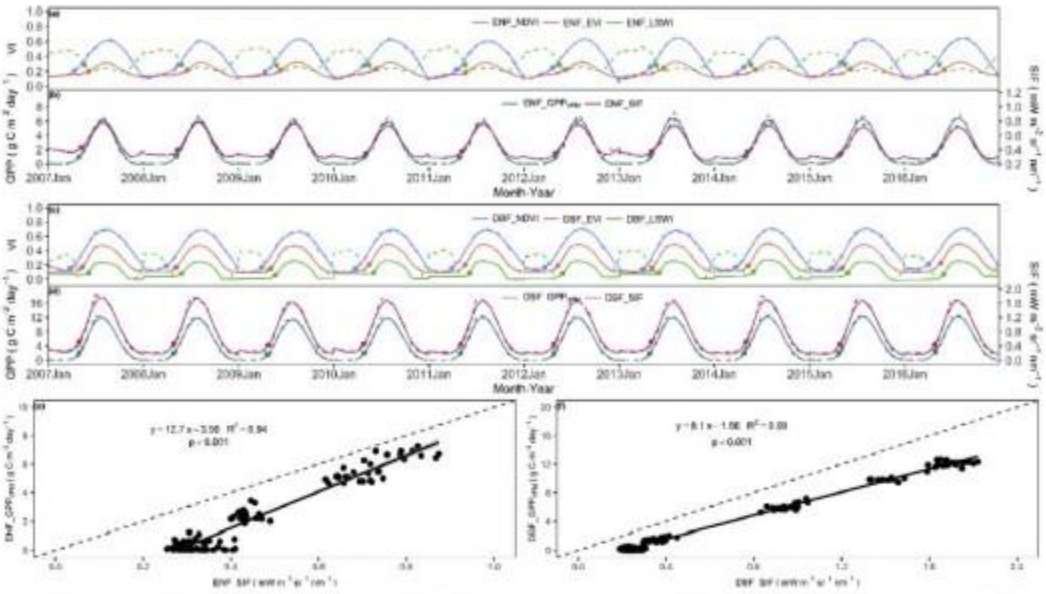


Fig. 4. The seasonal dynamics and interannual variation of average NDVI, EVI, LSWI, GPP_{VPM}, and GOME-2 SIF of all the snow covered ENF (a, b) and DBF (c, d) gridcells (0.5°) as well as the relationships between GPP_{VPM} and SIF for snow-covered ENF (e) and DBF (f) during 2007–2016 in northern mid- to high-latitudes. Points represent the start of the growing season (SOS) for each year.

In this paper, the authors we evaluated the consistency of the start of the growing season (SOS) in spring for snow-covered evergreen needleleaf forests (ENF) and deciduous broadleaf forests (DBF) using three vegetation indices, *in-situ* GPP data from the eddy covariance flux towers (GPP_{EC}), GPP data from the Vegetation Photosynthesis Model (GPP_{VPM}), and SIF data from the GOME-2. Results showed that SOS_{NDVI} dates were much earlier than SOS dates from EVI (SOS_{EVI}), land surface water index (LSWI) (SOS_{LSWI}), GPP (SOS_{GPP}; $SOS_{GPP\text{-}EC}$, SOS_{GPP_VPM}) and SIF (SOS_{SIF}) for both snow-covered evergreen needleleaf forest (ENF) and deciduous broadleaf forest (DBF). From this paper, we could see that GPP and SIF shows similar SOS and I like this sentence "It is critical that future studies utilize SIF and reflectance data with high spatial and temporal resolution so that we can reach a greater understanding about the phenology worldwide."

1st June

Raczka, B., Porcar-Castell, A., Magney, T., Lee, J. E., Köhler, P., Frankenberg, C., et al (2019). Sustained Non-Photochemical Quenching Shapes the Seasonal Pattern of Solar- Induced Fluorescence at a High-Elevation Evergreen Forest. *Journal of Geophysical Research: Biogeosciences*, 124.

2006). For example, a de-epoxidation reaction converts violaxanthin to zeaxanthin, where the zeaxanthin mediates heat dissipation. This increases NPQ (Jahns & Holzwarth, 2012) thereby decreasing the likelihood of photosystem damage. This type of regulation of the xanthophyll cycle occurs relatively quickly (minutes to hours) and reverses during the night, hence is referred to as reversible NPQ (Porcar-Castell, 2011).

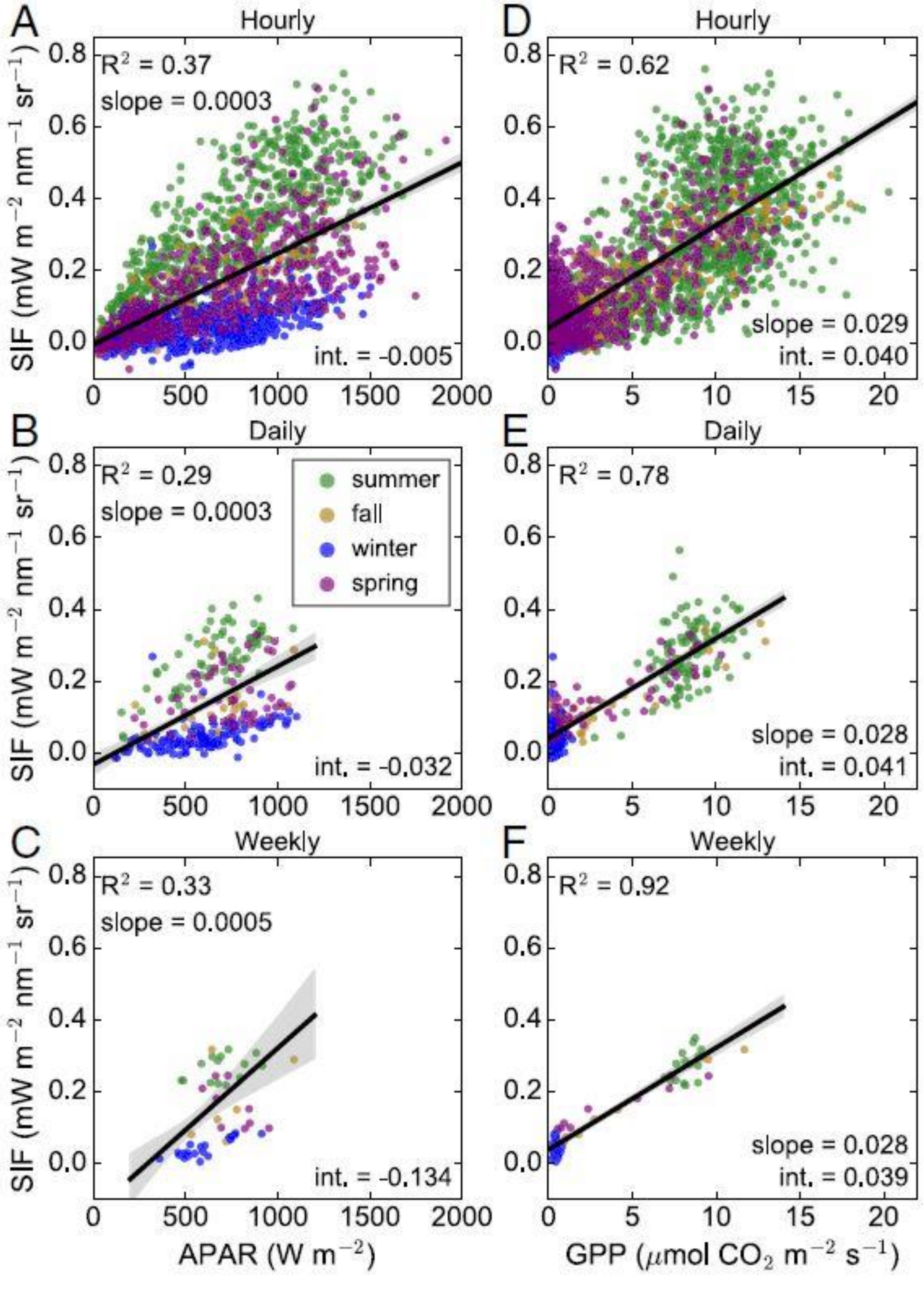
An important component of fluorescence models is the empirical relationship between light saturation (fraction of absorbed light not used for photosynthesis) and reversible NPQ (e.g. Flexas et al., 2002). A technique using weak pulse amplitude modulated light that induces active fluorescence emission from plants (PAM fluorometry) has been used for decades to quantify this light saturation versus NPQ relationship (Baker, 2008; Porcar-Castell, 2011; van der Tol et al., 2014). Much less research, however, has been devoted to quantifying slower changes in NPQ (e.g. days to months) referred to as sustained NPQ (Demmig-Adams & Adams, 2006; Porcar-Castell, 2011).

Sustained NPQ is an important regulator of light energy for species that maintain leaf area year round (e.g. temperate, boreal evergreen) (Miguez et al., 2015; Porcar-Castell, 2011; Verhoeven, 2014). Unlike the reversible NPQ component, sustained NPQ varies on longer time frames (days, months; Porcar-Castell, 2011) and provides an important outlet for energy during winter dormancy, when photosynthesis is negligible (Bowling et al., 2018; Ensminger et al., 2004). Sustained NPQ is associated with a sustained accumulation of zeaxanthin, but

Now, I think I can see the way to develop my paper for ENF site. To understand SIF, vegetation photosynthesis in evergreen needleleaf forest, there are big topics: 1) Relationship between PRI, NPQ from PAM, and leaf level pigment. 2) relationship between GPP and SIF with leaf level to canopy level. 3) Canopy level SIF yield and leaf level SIF yield. This paper focused on sustained NPQ. There are two NPQ (sustained NPQ and reversible NPQ) according to this paper. I think this paper used to much empirical method but I should consider sustained NPQ later.

4th May

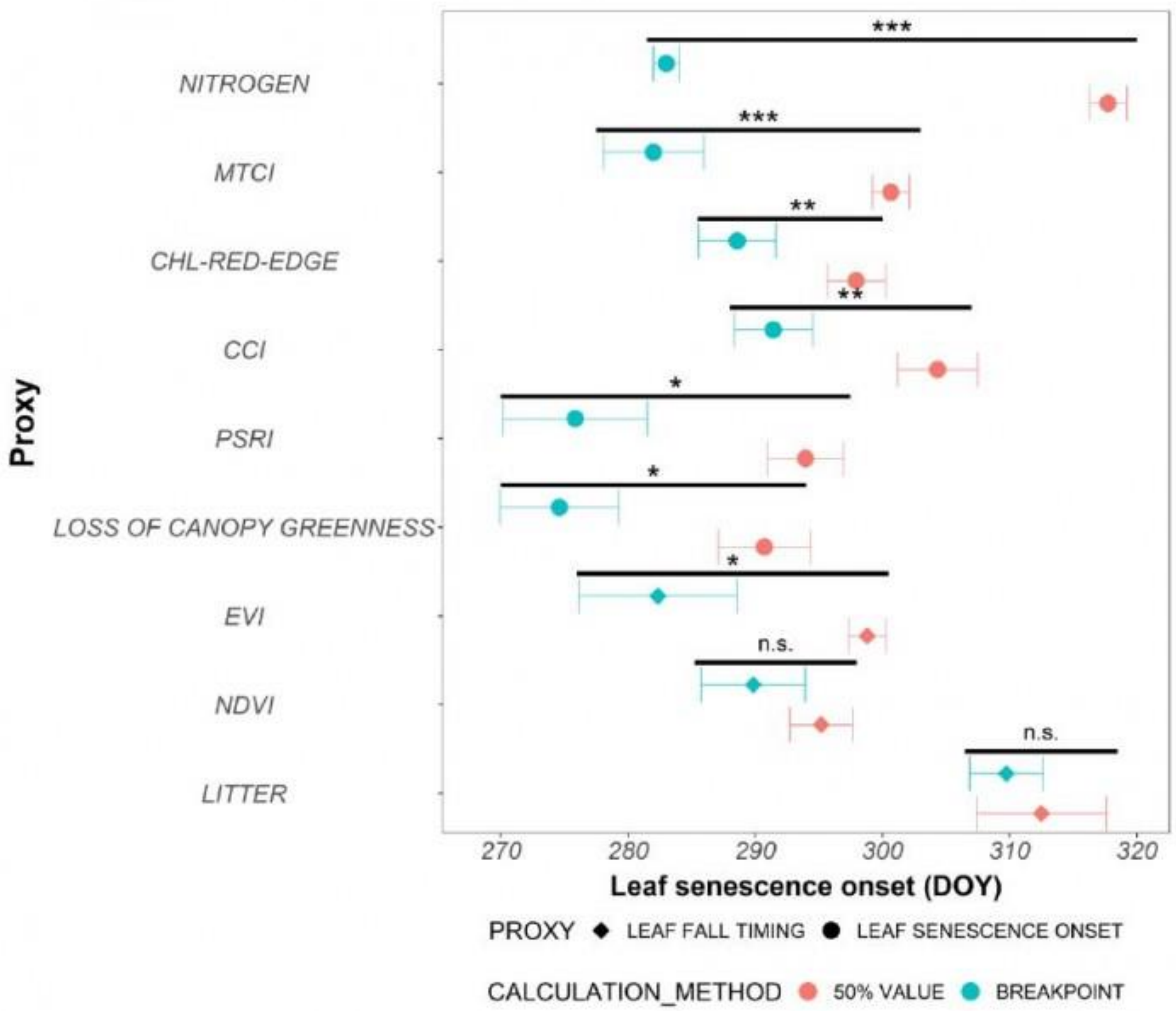
Magney, T. S., Bowling, D. R., Logan, B. A., Grossmann, K., Stutz, J., Blanken, P. D., ... & Lopez, S. (2019). Mechanistic evidence for tracking the seasonality of photosynthesis with solar-induced fluorescence. *Proceedings of the National Academy of Sciences*, *116*(24), 11640-11645.



I think this paper will be Key paper for my SIF in evergreen needleleaf forest site. Actually, I think there is no impressive result for me because we already know that the relationship between SIF, GPP and APAR in ENF. I think I should find the research gap from this paper and prepare the new things. I think 1) They did not show the relationship between PRI or CCI and SIF yield. 2) There SIF-GPP relationship is non-linear but they did not emphasize these things. 3) I should use PAM data to explain NPQ and PS2.

3rd May

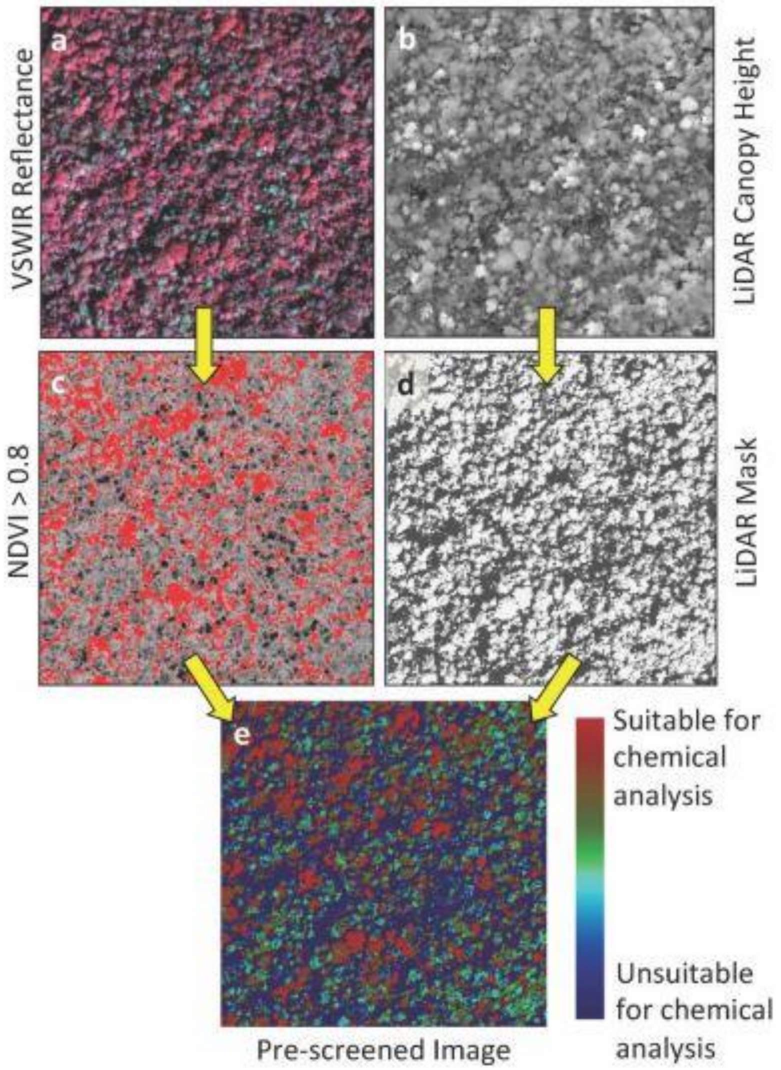
Mariën, B. , Balzarolo, M. , Dox, I. , Leys, S. , Marchand, L. J., Geron, C. , Portillo-Estrada, M. , AbdElgawad, H. , Asard, H. and Campioli, M. (2019), Detecting the onset of autumn leaf senescence in deciduous forest trees of the temperate zone. New Phytol. Accepted Author Manuscript.



I think this paper was really well organized about leaf senescence. The highlight is that CCI was good for indicate leaf senescence onset and each index showed that different leaf senescence onset. I like these two sentences as follows: 1) "The likely explanation is that in 2018 many leaves were damaged or fallen earlier than usual due to the severe drought and extreme temperatures in early summer. This process is called ‘accelerated leaf senescence’ and it is substantially different than the autumn senescence studied here as it does not involve leaf nutrient relocation, but just leaf damage and death (Gunthardt-Goerg & Vollenweider, 2007; Estiarte & Penuelas, 2015). The leaves that were measured with the chlorophyll content meter in 2018 were likely healthy leaves which followed the normal cues for onset of the autumn senescence process. Therefore, it appears that the loss of canopy greenness proxy should not be used when trees are subjected to severe stress (e.g. extreme drought, heat haves, pests) which cause substantial accelerated leaf senescence." 2) "Finally, our study showed that field proxies based on leaf litter introduce a systematic time lag compared to the proxies of leaf senescence onset (three to four weeks) and remote sensing proxies related to leaf fall such as EVI and NDVI (two to four weeks)."

2nd May

Asner, G. P., Anderson, C. B., Martin, R. E., Tupayachi, R., Knapp, D. E., & Sinca, F. (2015). Landscape biogeochemistry reflected in shifting distributions of chemical traits in the Amazon forest canopy. *Nature Geoscience*, *8*(7), 567.

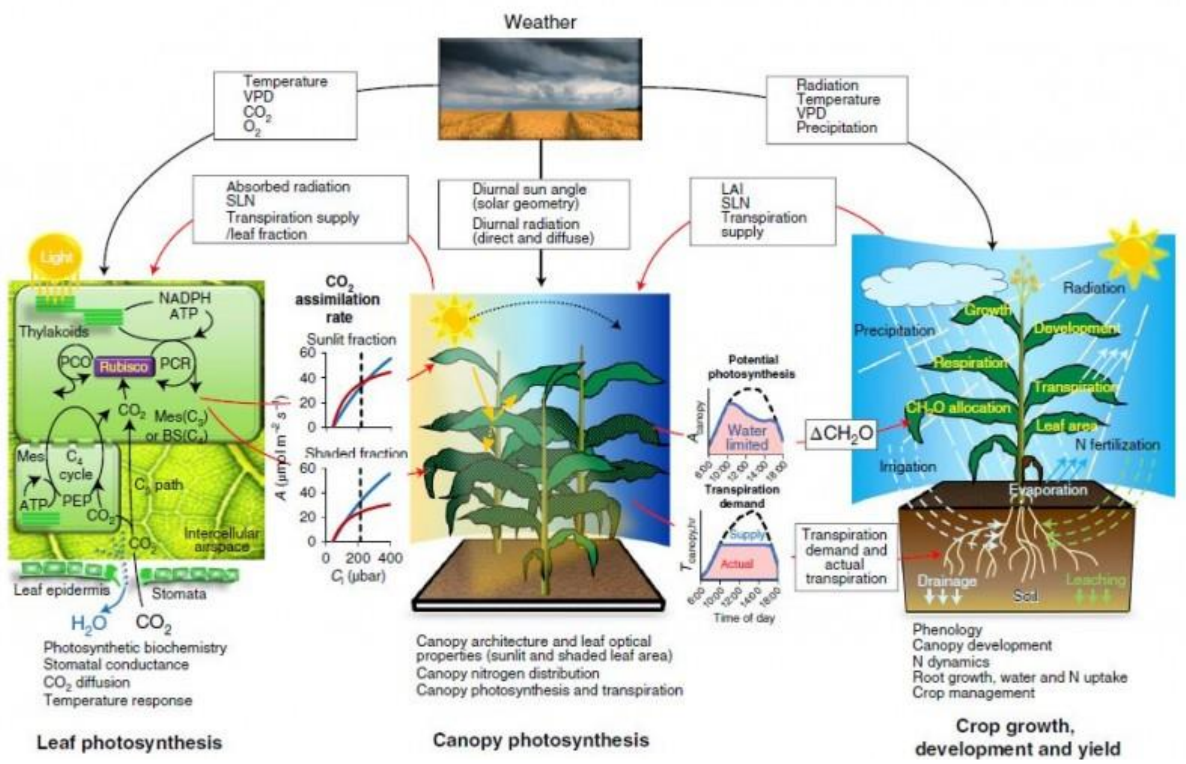


Supplementary Fig. 5. Schematic of the spectroscopic and LiDAR data fusion approach. Pre-screening of (a) High-fidelity Imaging Spectrometer (HiFIS) data using (b) embedded Light Detection and Ranging (LiDAR) data. (c) A minimum Normalized Difference Vegetation Index (NDVI) threshold of 0.8 ensures sufficient foliar cover in each analysis pixel. (d) Combining LiDAR and solar-viewing geometry, a mask is generated to remove pixels in shade, and ground and water surfaces. (e) The resulting suitability image provides candidate pixels for chemometric analysis. Within each 1-ha grid cell, HiFIS pixels that fall in the top 50% of the suitability index are analyzed.

In this paper, the author used airborne laser-guided imaging spectroscopy to develop maps of 16 forest canopy traits, throughout four large landscapes that harbour three common forest community types on the Madre de Dios and Tambopata rivers in southwestern Amazonia. I think this paper will be a sort of key paper for the urban project. However, I am curious that why they set the NDVI threshold at 0.8 points. I mean If we set the orbitary NDVI threshold, then we only choose specific species and only can choose extremely green canopy. I think the result, which is processes of nutrient deposition and depletion drive increasing phosphorus limitation, and a corresponding increase in plant defence, in an eastward direction from the base of the Andes into the Amazon Basin, was interesting.

1st May

Wu, A., Hammer, G. L., Doherty, A., von Caemmerer, S., & Farquhar, G. D. (2019). Quantifying impacts of enhancing photosynthesis on crop yield. *Nature plants*, 5(4), 380.



In this study, a cross-scale model connecting leaf photosynthesis and field crop performance was developed to provide the capacity to assess and guide photosynthetic manipulation efforts targeting crop yield improvement. I know in our lab, we develope the BESS-rice. In this paper, they used APSIM model to calculate the root : shoot ratio. I'm wondering what is really new in this paper because APSIM model was developed in ~2014. In addition, I am curious that why Vcmax and Jmax show a big difference in their output.

4th April

Laskin, D. N., McDermid, G. J., Nielsen, S. E., Marshall, S. J., Roberts, D. R., & Montaghi, A. (2019). Advances in phenology are conserved across scale in present and future climates. *Nature Climate Change*, 9(5), 419.

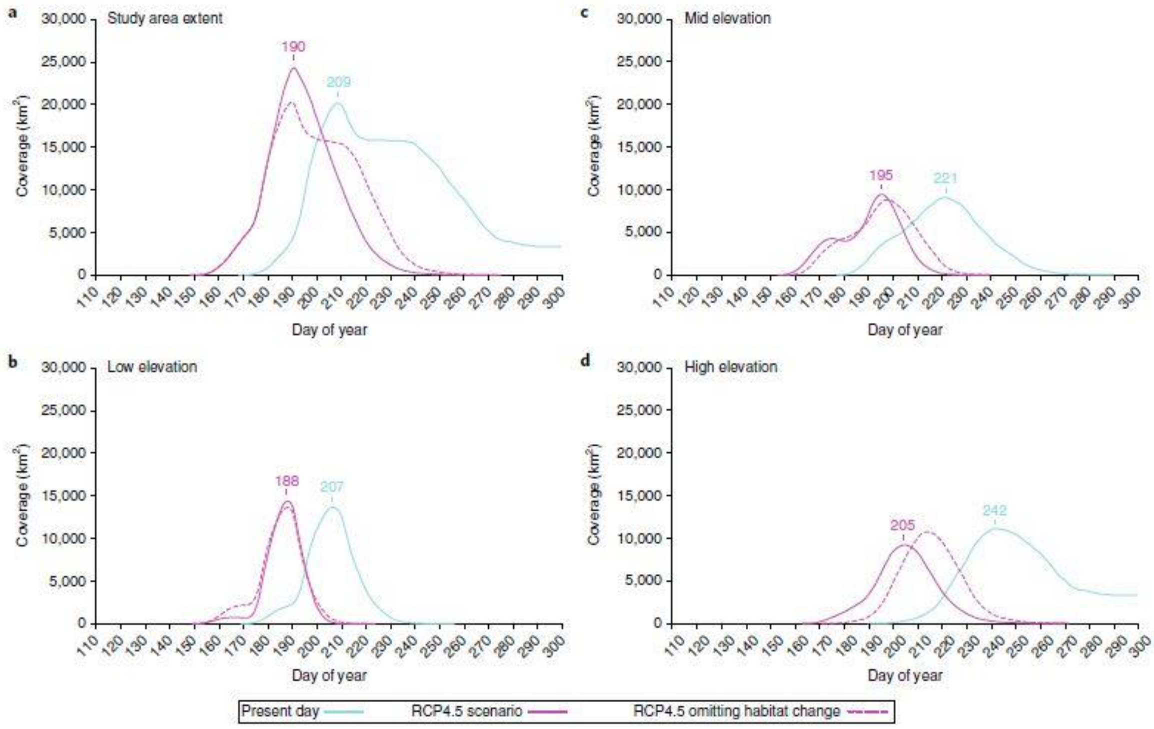


Fig. 5 | Seasonal spatial coverage of ripe fruit for the present day and the RCP4.5 warming scenario. Curves illustrate the area (in km^2) of the landscape covered by fully ripe *S. canadensis* fruit throughout the growing season and the timing (day of year highlighted) of peak coverage for the present day and the RCP4.5 scenario assuming no change in the extent of *S. canadensis* habitat in the future (dotted line). **a–d**, The seasonal spatial coverage of ripe fruit across the study area (**a**), and for spatially equal tertile elevation ranges to exemplify differences in the regional effect of climate warming: low(<1,232 m; **b**), mid (1,233–1,561 m; **c**) and high (>1,562 m; **d**).

This paper was talking about warming temperatures at understory vegetation. They address the challenge of observing phenological dynamics in the understory by exploiting the physiological relationship between plant phenology and temperature accumulation, a horticultural principle we show to be preserved across spatial scales through a combination of field and growth chamber observations. They developed their own model to estimate understory temperature. I think this paper emphasizes their model too much but it is quite interesting to estimate the understory temperature. My question was why high elevation is more sensitive to the temperature than low elevation.

3rd April

Gu, L., Han, J., Wood, J. D., Chang, C. Y. Y., & Sun, Y. (2019). Sun-induced Chl fluorescence and its importance for biophysical modeling of photosynthesis based on light reactions. *New Phytologist*, 1.

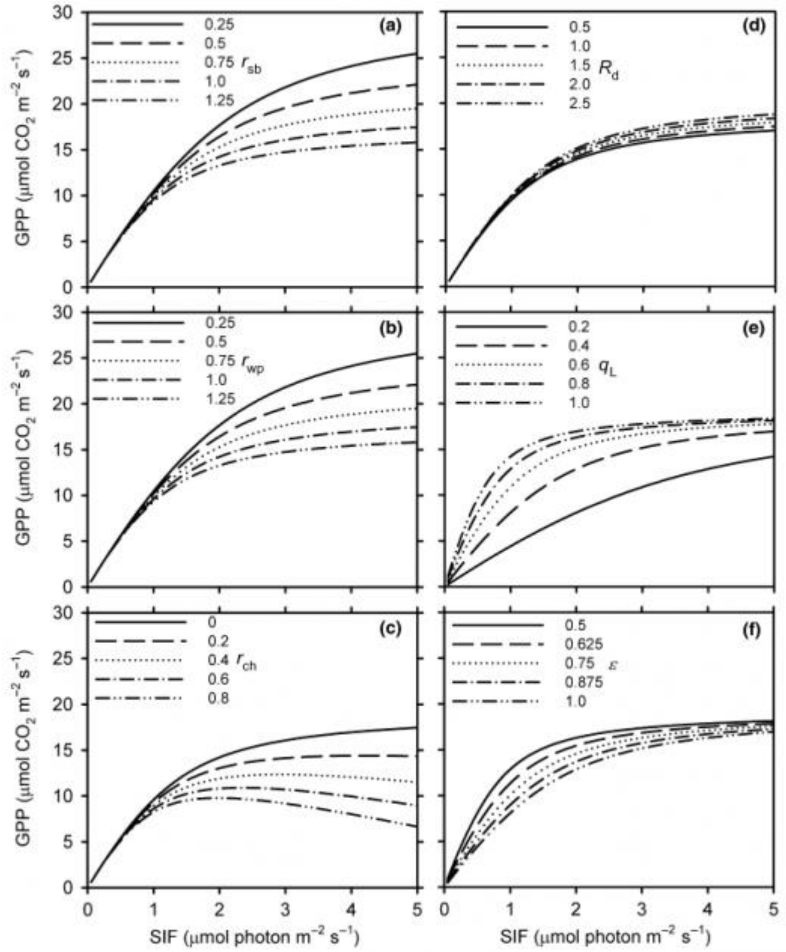


Fig. 2 Simulated variations of gross primary production (GPP) as a function sun-induced Chl fluorescence observed at the top of the canopy for multiple values of r_{sb} (a), r_{wp} (b), r_{ch} (c), R_d (d), q_L (e) and ε (f) for C_3 species with Eqns 21 and 24. For each plot, only one parameter is varied while the other parameters are fixed. Unless specified otherwise as in the plots, the parameters take the following values: $r_{sb} = 1$ Pa μmol^{-1} m^2 s, $r_{wp} = 1$ Pa μmol^{-1} m^2 s, $r_{ch} = 0$ Pa μmol^{-1} m^2 s, $R_d = 1$ μmol m^{-2} s^{-1}, $q_L = 0.5$, $\varepsilon = 0.8$, $\Gamma^* = 3.75$ Pa, $k_{DF} = 19$, $\Phi_{PSIImax} = 0.83$ and $C_a = 40$ Pa. These values are chosen for their representativeness (von Caemmerer, 2000; Papageorgiou & Govindjee, 2004; van der Tol *et al.*, 2014). See Supporting Information Notes S2 for definitions of symbols.

In this paper, the authors really well organized SIF and GPP relationship. They make the theory equation and the equation show that, although SIF is dynamical as complex as photosynthesis, the measured SIF simplifies photosynthetic modeling from the perspective of light reactions by integrating over the dynamic complexities of photosynthesis. Here, the SIF-photosynthesis relationship is nonlinear. I fully agree with this part. In this paper, I think they really well solve the relationship between GPP and SIF using methodological formula. They said this is because photosynthesis saturates at high light whereas SIF has a stronger tendency to keep increasing, as fluorescence quantum yield has a relatively muted sensitivity to light levels.

2nd April

Stocker, B. D., Zscheischler, J., Keenan, T. F., Prentice, I. C., Seneviratne, S. I., & Peñuelas, J. (2019). Drought impacts on terrestrial primary production underestimated by satellite monitoring. *Nature Geoscience*, 1.

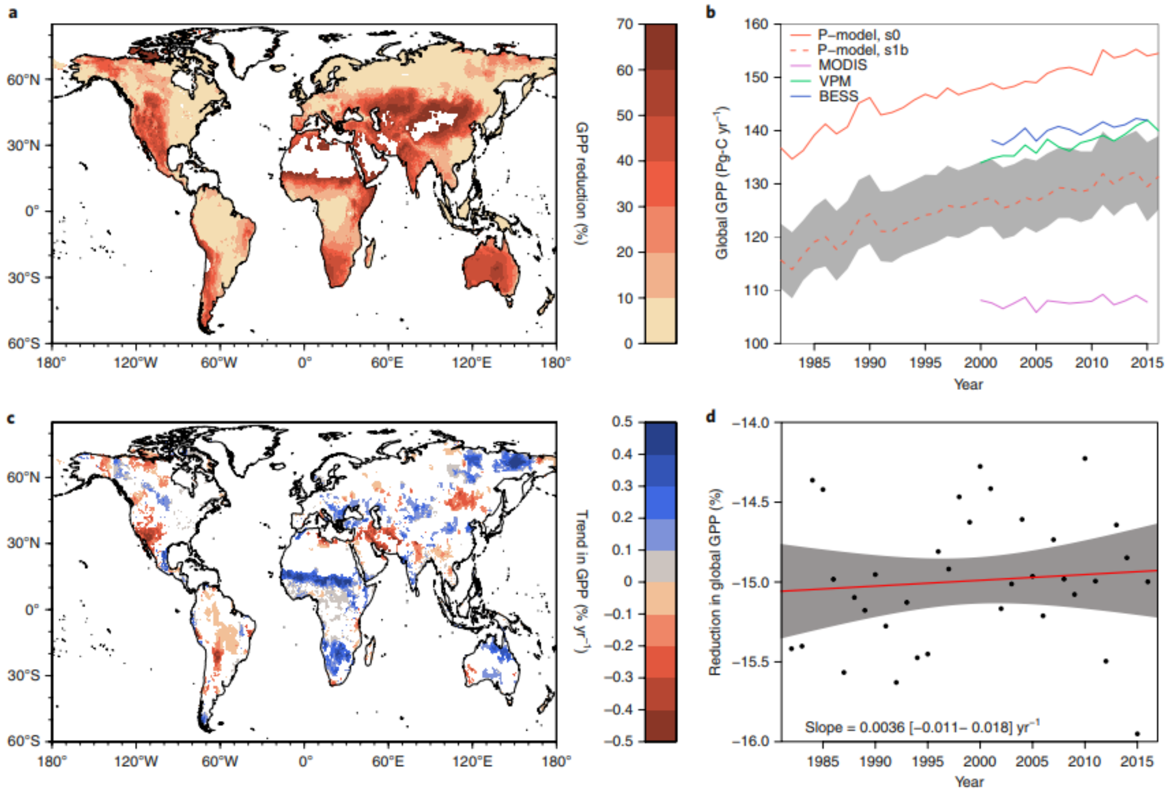


Fig. 2 | Effect of soil moisture limitation on GPP. a, GPP reduction due to the effects of soil moisture, calculated as the difference in the mean for 1982–2016 from simulations s0 and s1b. **b**, Time series of global GPP from different RS models. The grey envelope represents the range of simulations s1a and s1c. **c**, Trend in soil moisture impacts on GPP, calculated as the linear trend in the percentage difference in annual GPP from simulations s0 and s1b, covering 1982–2016. Blank gridcells indicate no significant trend, red shades indicate a trend towards stronger GPP reductions by soil moisture effects. **d**, Percentage difference in global annual GPP from simulations s0 and s1b. The linear regression is plotted as the red line, with the shaded envelope indicating the 95% confidence interval; the slope with its 95% confidence interval are also given.

This paper said that the drawbacks of the widely used remote sensing-based GPP estimates and highlight the contrasting results of increased drought stress over the last few decades. they have demonstrated that soil moisture is an important forcing of primary production and carbon cycle variability of global plants that can not be replaced by information on the atmospheric drying and should be considered in estimates by satellite data.

1st April

Song, X. P., Hansen, M. C., Stehman, S. V., Potapov, P. V., Tyukavina, A., Vermote, E. F., & Townshend, J. R. (2018). Global land change from 1982 to 2016. *Nature*, *560*(7720), 639.

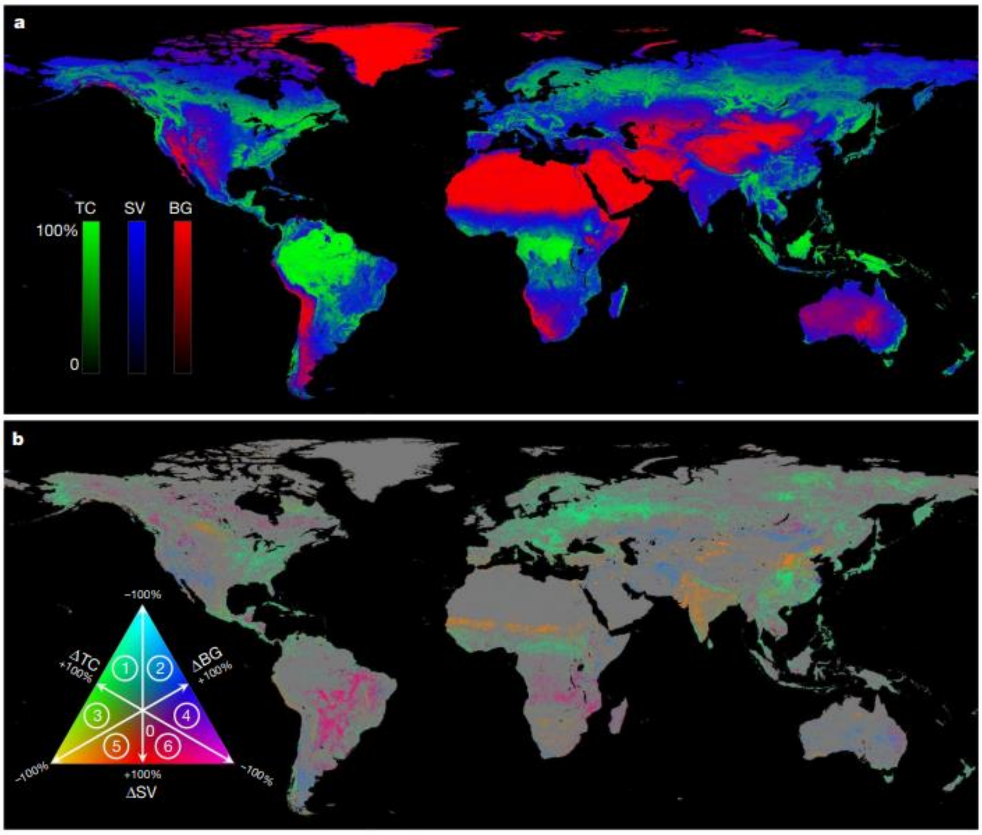
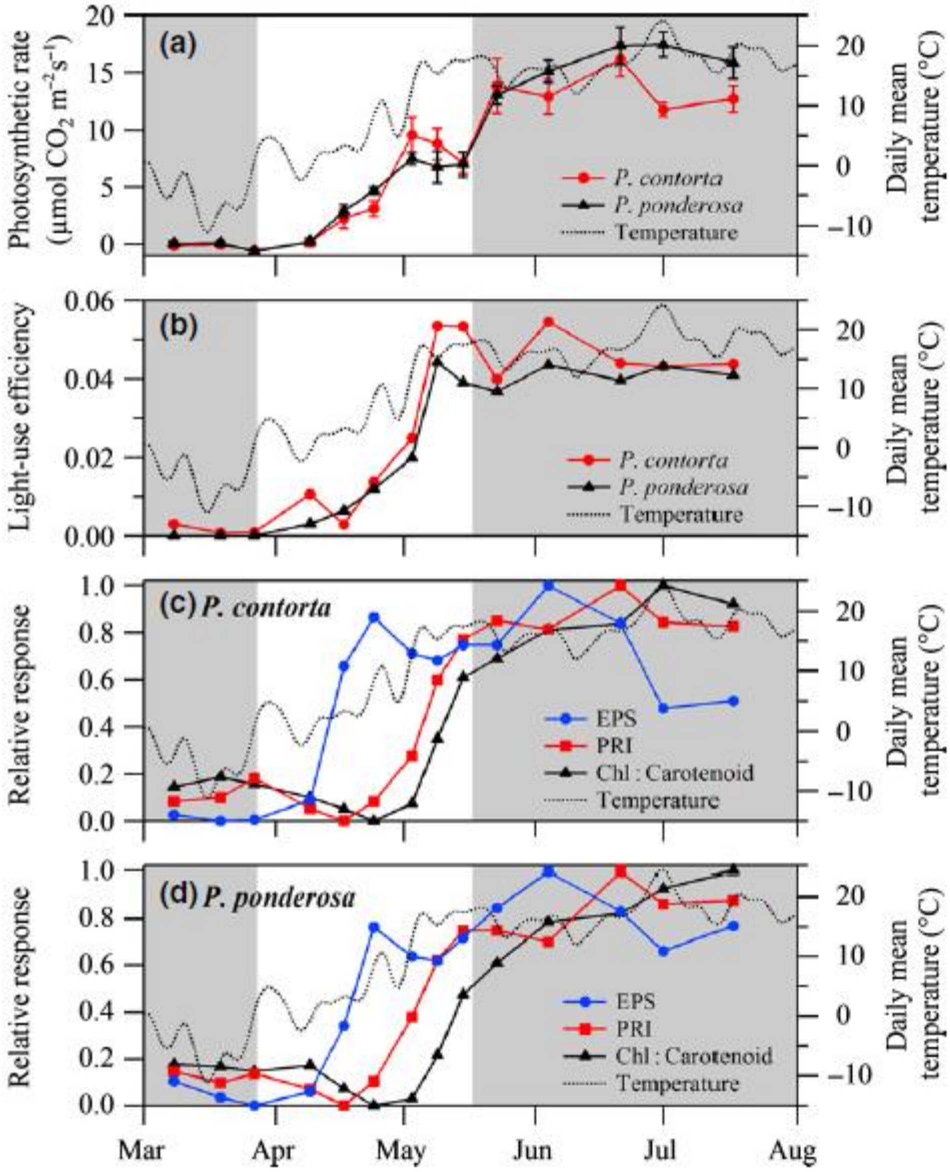


Fig. 1 | A satellite-based record of global TC, SV and BG cover from 1982 to 2016. a, Mean annual estimates. **b**, Long-term change estimates. Both mean and change estimates are expressed as per cent of pixel area at 0.05° × 0.05° spatial resolution. Pixels showing a statistically significant trend ($n = 35$, two-sided Mann–Kendall test, $P < 0.05$) in either TC, SV or BG are depicted on the change map. Circled numbers in the colour legend denote dominant change directions: 1, TC gain with SV loss; 2, BG gain with SV loss; 3, TC gain with BG loss; 4, BG gain with TC loss; 5, SV gain with BG loss; and 6, SV gain with TC loss.

This paper showed that contrary to the prevailing view that forest area has declined globally. This overall net gain is the result of a net loss in the tropics being outweighed by a net gain in the extratropics. Global bare ground cover has decreased by 1.16 million km2 (−3.1%), most notably in agricultural regions in Asia. Of all land changes, 60% are associated with direct human activities and 40% with indirect drivers such as climate change. Land-use change exhibits regional dominance, including tropical deforestation and agricultural expansion, temperate reforestation or afforestation, cropland intensification and urbanization. From this paper, the human activities have a dominant role in agricultural and urban landscapes, and that most of the maps presented here constitute to vegetation and its dynamics. I think that human activity will no longer have much impact on land use in the future because a lot of progress has been made. So my questions is which component will have the greatest impact on land use especially vegetation in the future? (e.g. Still human activity, Co2 fetilization, temperature, rainfall, insect, PAR …)

4th March

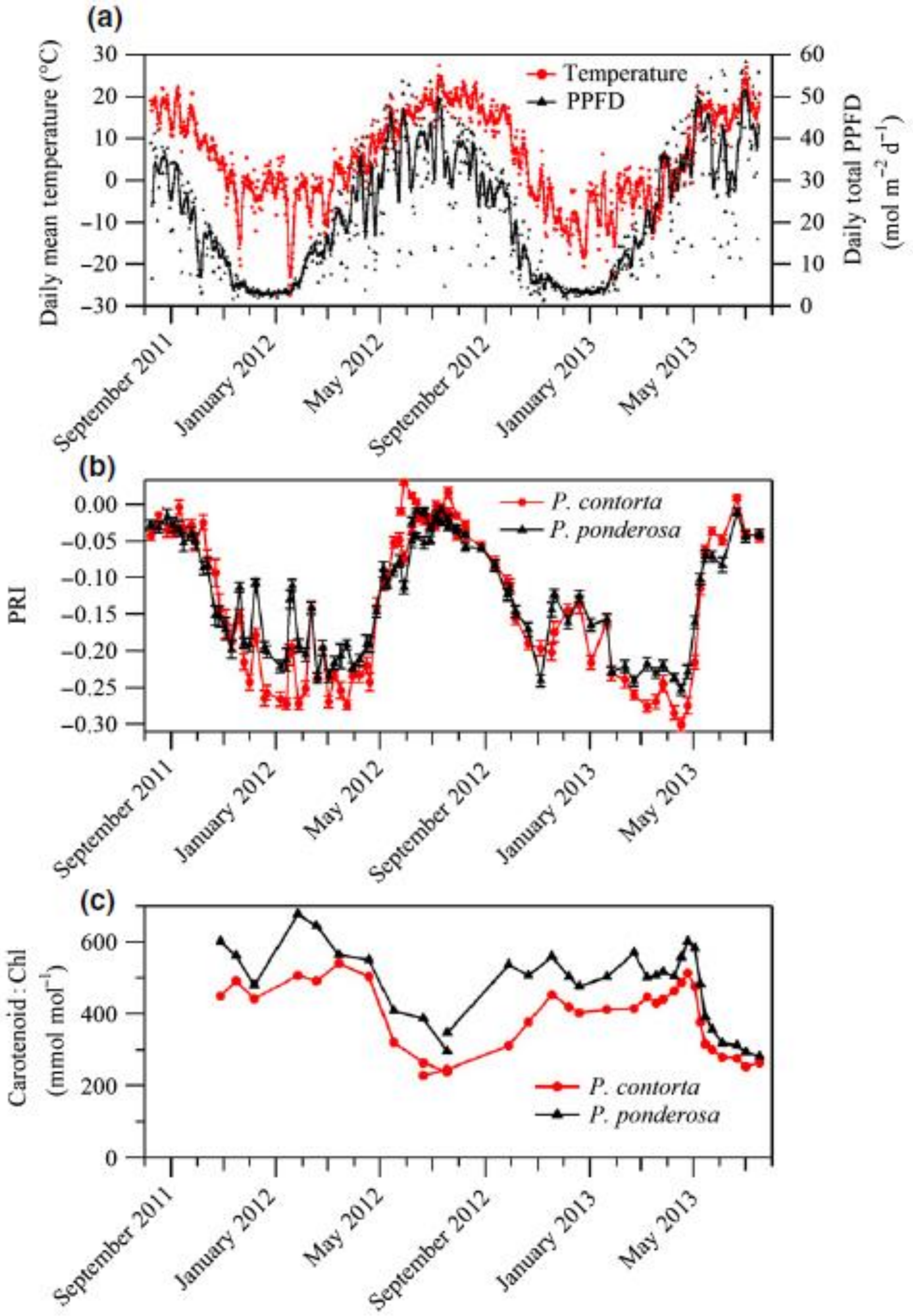
Wong, C. Y., & Gamon, J. A. (2015). The photochemical reflectance index provides an optical indicator of spring photosynthetic activation in evergreen conifers. *New Phytologist*, *206*(1), 196-208.



I think this paper also really KEY paper for understanding PRI in evergreen forest site. PRI, electron transport rate, pigment levels, light-use efficiency and photosynthesis all exhibited striking seasonal changes, with varying kinetics and strengths of correlation, which were used to evaluate the mechanisms and timing of spring activation. PRI and pigment pools were closely timed with photosynthetic reactivation measured by gas exchange. The PRI provided a clear optical indicator of spring photosynthetic activation that was detectable at leaf and stand scales in conifers. The authors propose that PRI might provide a useful metric of effective growing season length amenable to remote sensing and could improve remote-sensing-driven models of carbon uptake in evergreen ecosystems.

3rd March

Wong, C. Y., & Gamon, J. A. (2015). Three causes of variation in the photochemical reflectance index (PRI) in evergreen conifers. *New Phytologist*, *206*(1), 187-195.



This paper is really KEY paper for PRI in evergreen needle leaf forest site. PRI was affected by three distinct processes operating over different timescales and exhibiting contrasting spectral responses. Over the 2 yr study period, the greatest

change in PRI resulted from seasonally changing carotenoid : Chl pigment ratios, followed by a previously unreported shifting leaf albedo during periods of deep cold. Remarkably, the smallest change was attributable to the xanthophyll cycle. To properly distinguish these three effects, interpretation of PRI must consider temporal context,
physiological responses to evolving environmental conditions, and spectral response. The author said "Consideration of the separate mechanisms affecting PRI over different timescales could greatly improve efforts to monitor changing photosynthetic activity using optical remote sensing."

2nd March

Zarco-Tejada, P. J., Berni, J. A., Suárez, L., Sepulcre-Cantó, G., Morales, F., & Miller, J. R. (2009). Imaging chlorophyll fluorescence with an airborne narrow-band multispectral camera for vegetation stress detection. *Remote Sensing of Environment*, *113*(6), 1262-1275.

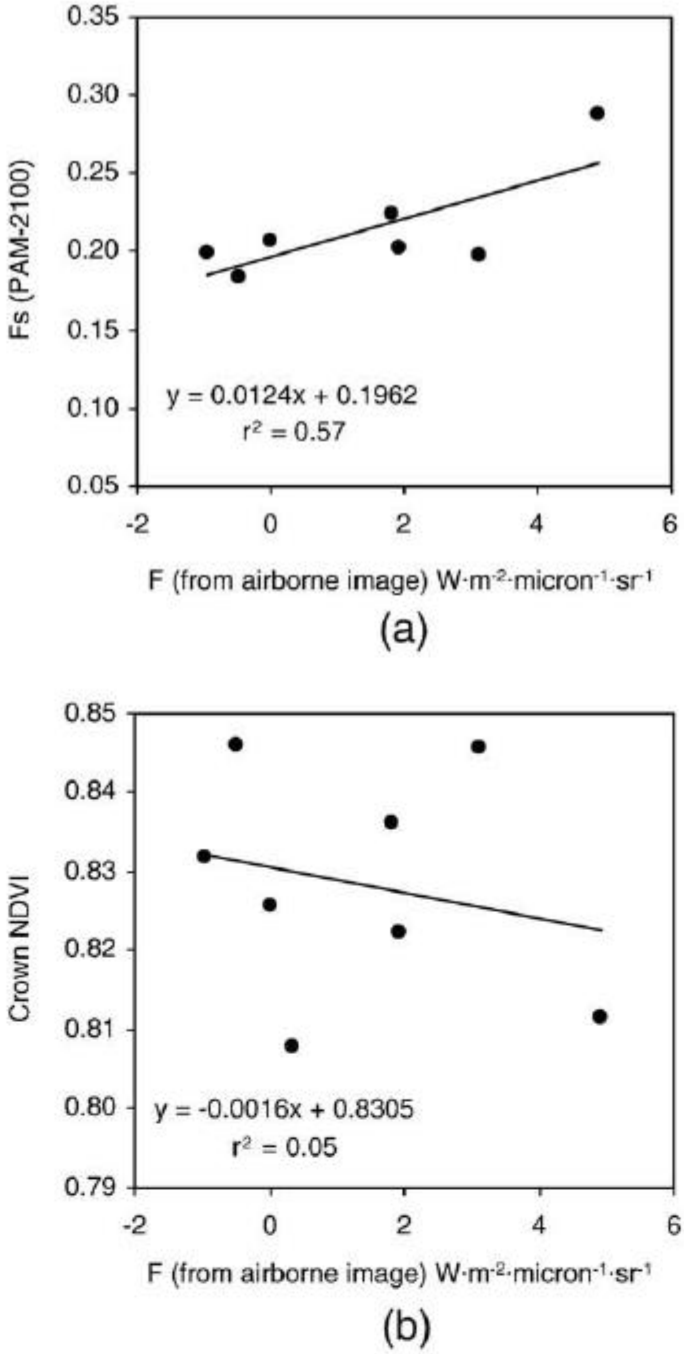


Fig. 11. Relationship obtained between ground-truth *Fs* (PAM-2100) and fluorescence extracted from the airborne image using the *in-filling* method in a water stress experiment conducted on an olive orchard (a); crown NDVI showed no relationship with crown fluorescence extracted from the imagery (b) to dismiss structural effects on the fluorescence retrieval.

I think this paper is unique because they used the narrow filter to monitor fluorescence. They made a custom filter which is 1nm FWHM filters in the 757 and 760 nm bands, and four 10nm FWHM band in the 400-80 nm spectral region. However, this paper did not show how they did a geometric calibration and temperature response curve. I hope I can find a hint from this paper!

1st March

Ryu, Y., Jiang, C., Kobayashi, H., & Detto, M. (2018). MODIS-derived global land products of shortwave radiation and diffuse and total photosynthetically active radiation at 5 km resolution from 2000. *Remote Sensing of Environment*, *204*, 812-825.

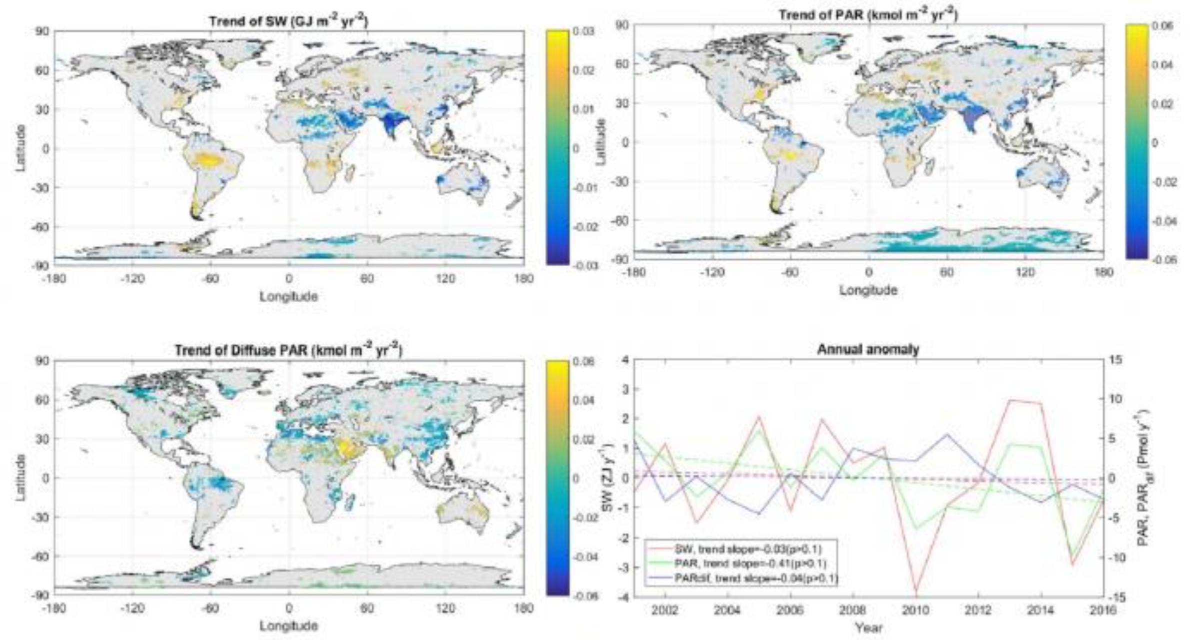


Fig. 7. Trend maps of shortwave (SW; upper left), photosynthetically active radiation (PAR; upper right), diffuse PAR (PAR_{dif}; lower left), and annual anomalies of the three radiation variables (lower right) between 2001 and 2016. Trends were computed by least squares linear fitting, and their significance ($p < 0.1$) was determined by the Mann–Kendall non-parametric test. Only significant pixels appeared.

This paper develops the BESS SW, PAR and PARdif products over the global land surface a 5km resolution with 4-day intervals 2000 – 2016. I think the strength of this paper is that the combination of atmospheric radiative transfer model and an artificial neural network (ANN) to compute SW, PAR and PARdif. I think the method part is interesting because they used model and machine learning simultaneously. The result was quite interesting because the trend of PAR is not that significantly changing over the 16 years. I think this is meaningful because we know that the global temperature is increasing especially the artic region. The increased temperature triggers that survival of plant in arctic region easily. However, I think there should be the limitation in the future because they need time to adjust low PAR condition which is not increasing compare to temperature. I am curious that future plant physiology model considers this issue!

4th February

Daumard, F., Champagne, S., Fournier, A., Goulas, Y., Ounis, A., Hanocq, J. F., & Moya, I. (2010). A field platform for continuous

measurement of canopy fluorescence. *IEEE Transactions on geoscience and Remote Sensing*, *48*(9), 3358-3368.

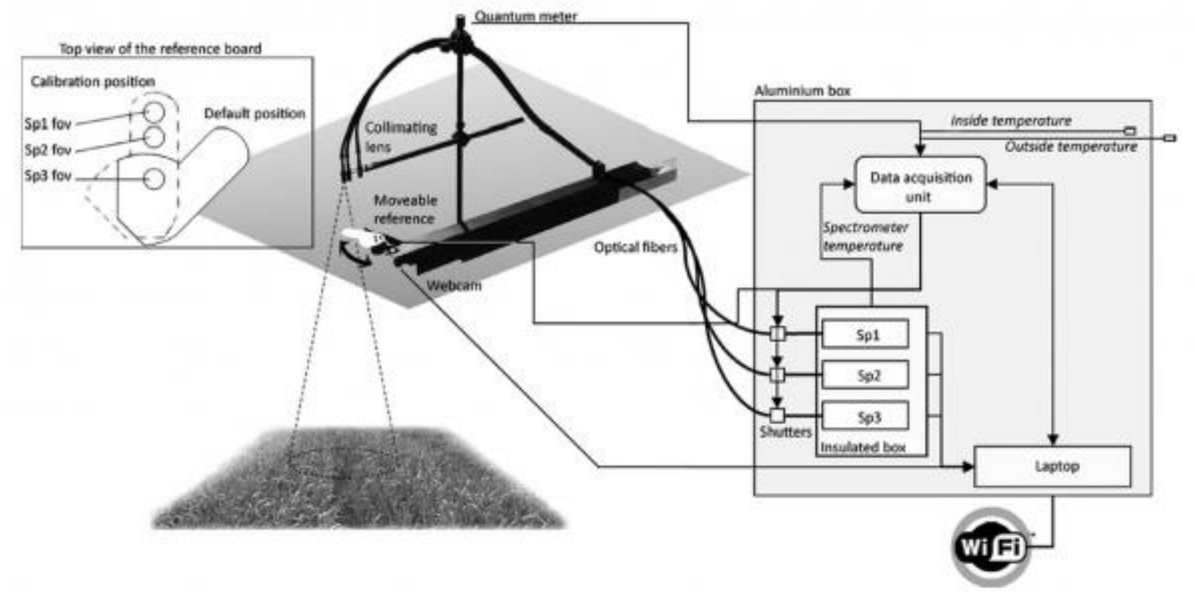


Fig. 2. TriFLEX instrument. Sp1 is a broad band spectrometer (300–900 nm, FWHM ~2 nm). Sp2 and Sp3 are two identical spectrometers (630–815 nm, FWHM ~0.5nm). Sp2 acquires the radiance from the vegetation, and Sp3 acquires the irradiance by continuously measuring the radiance from a reference board (see Sp3 FOV on the top left caption). A laptop controls the three spectrometers. It also controls the optical shutters, the reference board rotation, and the acquisition of several environment parameters through the data acquisition unit (Agilent 34970A). The reference board can be rotated from default position to the calibration position (see top left caption) for cross-calibration purposes.

This paper presents a field platform for continuous measurement of fluorescence at the canopy level. A new fully automatic instrument, called TriFLEX, has been installed. However, I think it was shocked because they used automatic movement arm to measure white reference. I am not sure it is okay because white reference especially Teflon show dependent to incoming light angle and it should be easy to durty in the field. However, I think this system was novel at that time.

3rd February

Yang, X., Shi, H., Stovall, A., Guan, K., Miao, G., Zhang, Y., ... & Lee, J. E. (2018). FluoSpec 2—An Automated Field Spectroscopy System to Monitor Canopy Solar-Induced Fluorescence. *Sensors*, *18*(7), 2063.

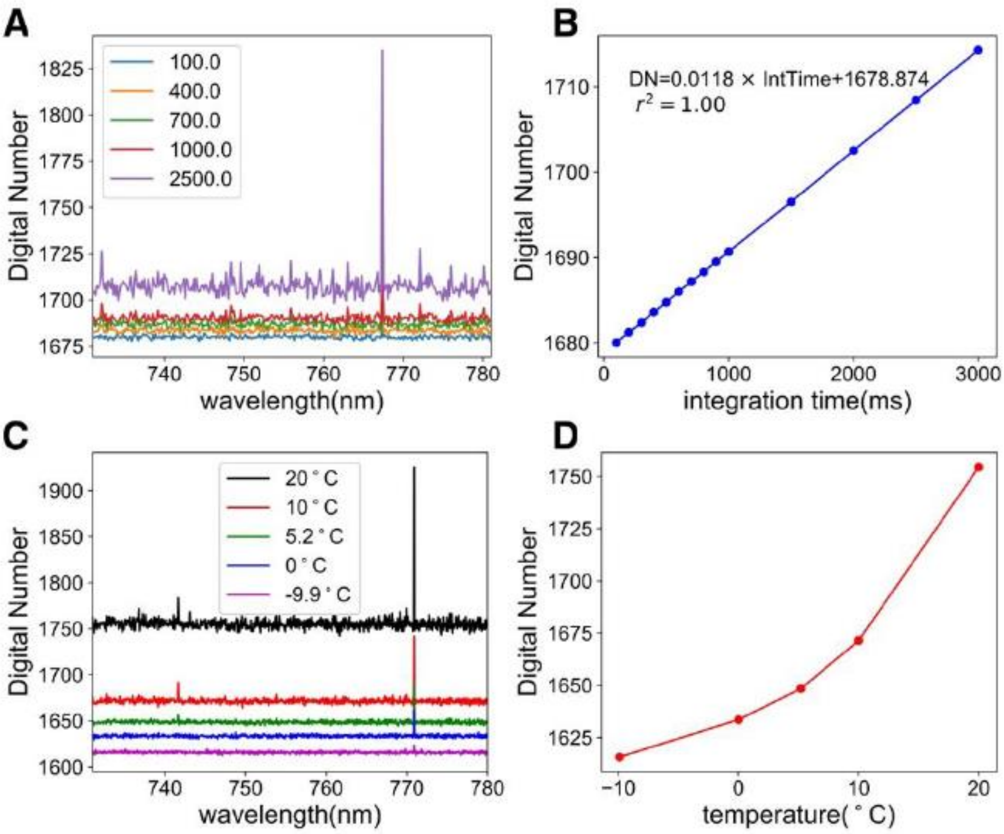


Figure 4. (A) Dark current under various integration times (100 ms, 400 ms, 700 ms, 1000 ms, and 2500 ms). (B) The relationship between integration time and the dark current. (C) Dark current collected at different TEC temperatures. (D) Non-linear relationship between temperature and dark current, indicating the importance of keeping a stable detector temperature.

In abstract, the author said "there are few automated systems that allow for unattended observations over months to years.". I agree with this part but I think the reason why there are only a few systems is they usually used spectrometer system. In addition, this paper showed the TEC with dark current DN values. I like this paper and this paper will be used for the advantage of 4S.

2nd February

Moya, I., Camenen, L., Evain, S., Goulas, Y., Cerovic, Z. G., Latouche, G., ... & Ounis, A. (2004). A new instrument for passive remote sensing: 1. Measurements of sunlight-induced chlorophyll fluorescence. *Remote Sensing of Environment*, *91*(2), 186-197.

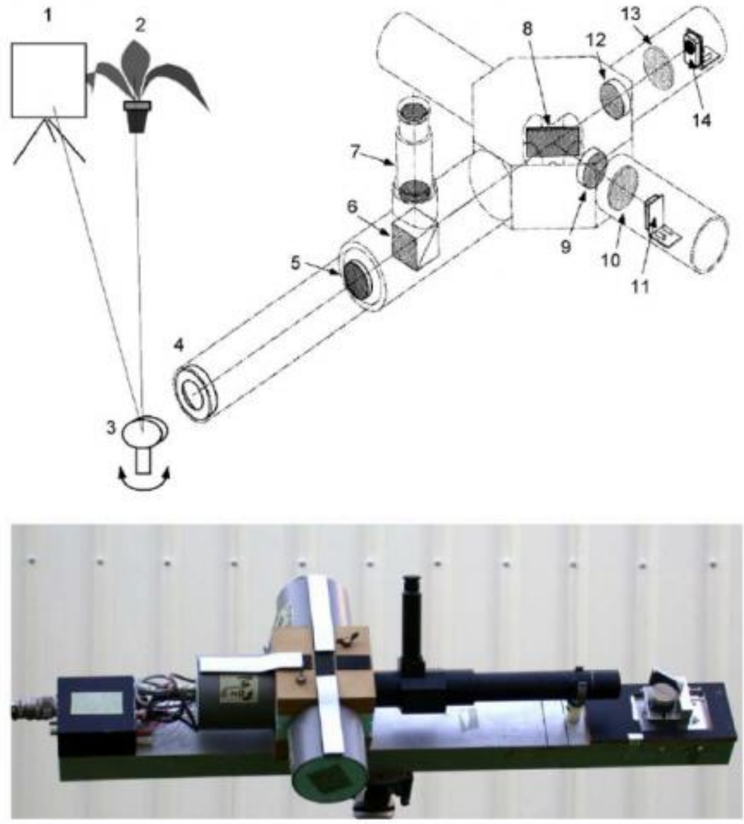


Fig. 3. Top: Components of the Chl fluorescence detector for passive fluorescence measurements in the oxygen absorption band, at 760 nm. 1, reference; 2, target; 3, chopped mirror; 4, field stop; 5, high pass filter; 6, polarization cube; 7, view finder; 8, beam splitter; 9, interference filter (758.5 nm); 10 and 13, lenses; 11 and 14, photodiodes; 12, interference filter (760.5 nm). Bottom: Photograph of the instrument. The length is about 90 cm and the weight 3 kg.

I like this paper because this paper tried to extract SIF by using photodiode and filters. An instrument measuring the in-filling of the atmospheric oxygen absorption band at 760 nm by chlorophyll fluorescence has been designed and constructed. It was surprising to me because this system reported in 2004. I think this paper will be cited in my 4S-SIF paper.

1st February

Nichol, C. J., Drolet, G., Porcar-Castell, A., Wade, T., Sabater, N., Middleton, E. M., ... & Atherton, J. (2019). Diurnal and Seasonal Solar Induced Chlorophyll Fluorescence and Photosynthesis in a Boreal Scots Pine Canopy. *Remote Sensing*, *11*(3), 273.

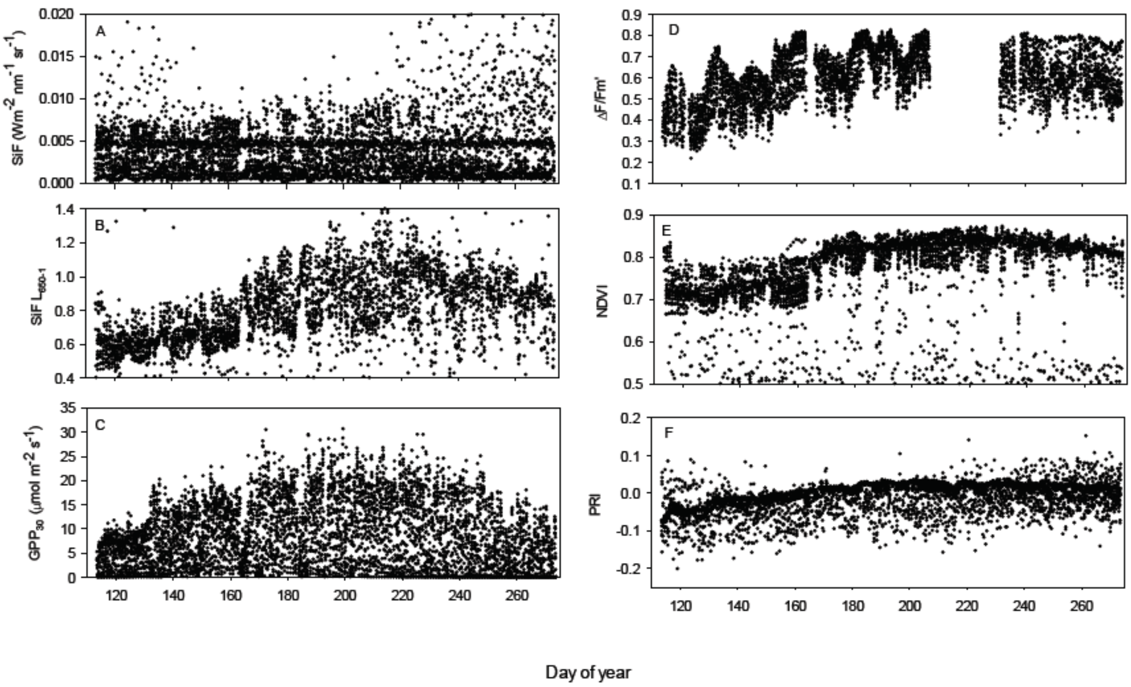


Figure 3. Complete (day and night, all sky conditions) time series of instantaneous observations of (**A**) SiF and (**B**) $SiF\ L_{650}{}^{-1}$, both without correction for structural effects and centered on the flux data acquisitions, (**C**) 30 min means of gross primary productivity (GPP) calculated from the flux tower eddy covariance data, (**D**) effective quantum yield ($\Delta F/F_m{}'$) measured by the PAM system, (**E**) the normalized difference vegetation index (NDVI), and (**F**) the photochemical reflectance index (PRI), both measured by the Skye sensors mounted on the SMEAR II tall tower. A malfunction of the PAM system resulted in a gap in the $\Delta F/F_m{}'$ time series between days of the year 207 and 231.

The main point of this paper is that "In the present study, however, we found only a very weak correlation between SiF and GPP, and SiF L650 and LUE for the canopy component of an evergreen Scots pine forest." However, it is hard to understand their data to me because 1) In their previous paper, there is wavelength shift definitely. So, I think it is none-sense use to FLD method to extract SIF. 2) The magnitude is really weird. If I change w to mw, then the value is 5mW m-2 nm-1. In the ENF site, Fesc is lower than rice paddy, so ideally the magnitude should be smaller than 5mW m-2 nm-1. 3) In the seasonal pattern, what is the linear pattern near 0.005?

4th January

Ryu, Y., Berry, J. A., & Baldocchi, D. D. (2019). What is global photosynthesis? History, uncertainties and opportunities. *Remote Sensing of Environment*, *223*, 95-114.

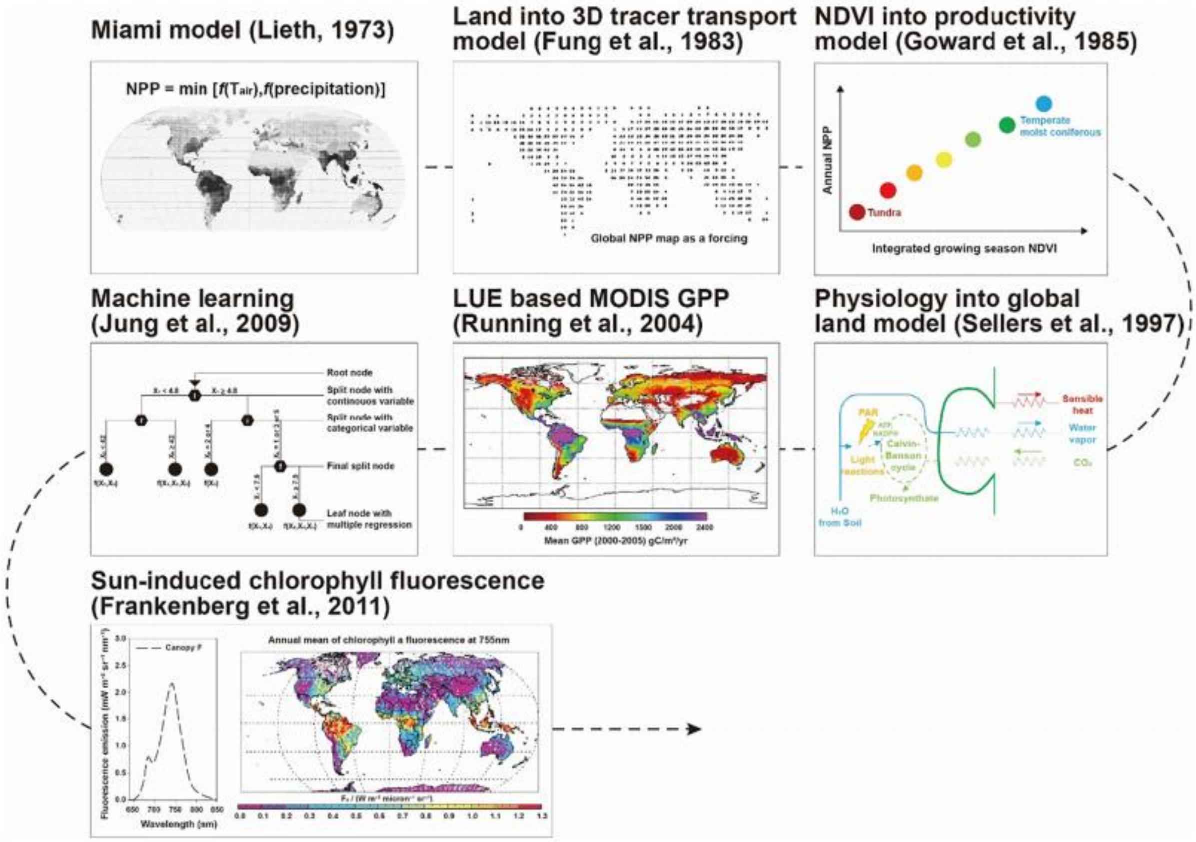


Fig. 2. Milestone works in global photosynthesis estimates. All figures were redrawn or reprocessed.

I think this paper well organized that how quantizing global terrestrial photosynthesis has been done.

3rd January

Zhang, Y., Guanter, **L., Berry, J. A., van der Tol, C., Yang, X., Tang, J., & Zhang, F. (2016). Model-based analysis of the relationship between sun-induced chlorophyll fluorescence and gross primary production for remote sensing applications. *Remote sensing of environment*, *187*, 145-155.**

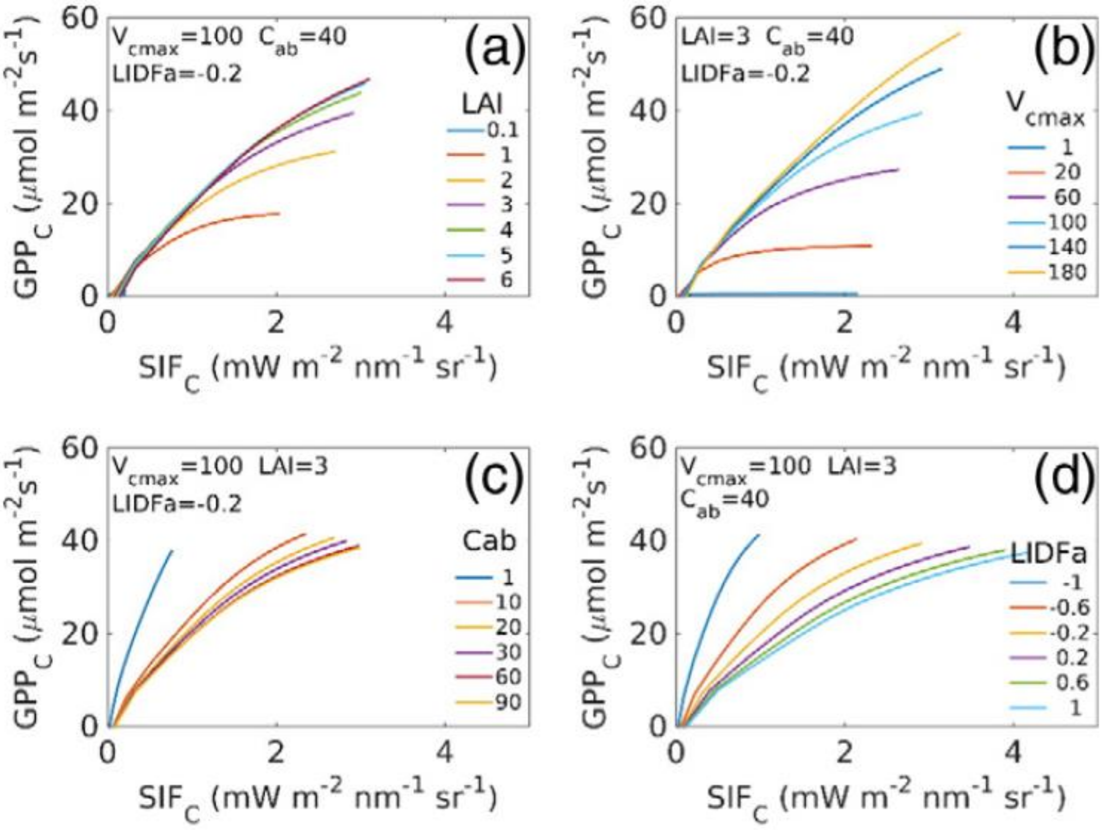


Fig. 7. The sensitivity of the relationship between hourly GPP and SIF at 740 nm to LAI (a), V_{cmax} (b), C_{ab} (c), and LIDFa (d) at the canopy level for a C3 plant from simulations. The radiation (Rin) is from 100 to 1200 W m^{-2}.

I think this paper is well organized SIF-GPP-APAR relationship with SCOPE model. Especially, I like the non-linear relationship between SIF and GPP. The authors present a model-based analysis of the relationship between SIF and GPP across scales for diverse vegetation types and a range of meteorological conditions, with the ultimate focus on reproducing the environmental conditions during remote sensing measurements. The coupled fluorescence-photosynthesis model SCOPE is used to simulate GPP and SIF at both leaf and canopy levels for 13 flux sites. Analyses were conducted to investigate the effects of temporal scaling, canopy structure, overpass time, and spectral domain on the relationship between SIF and GPP. The simulated SIF is highly non-linear with GPP at the leaf level and instantaneous time scale and tends to linearize when scaling to the canopy level and daily to seasonal. These relationships are consistent across a wide range of vegetation types. The relationship between SIF and GPP is primarily driven by absorbed photosynthetically active radiation (APAR), especially at the seasonal scale, although the photosynthetic efficiency also contributes to strengthening the link between them.

2nd January

Porcar-Castell, A. (2011). A high-resolution portrait of the annual dynamics of photochemical and non-photochemical quenching in needles of Pinus sylvestris. *Physiologia Plantarum*, *143*(2), 139-153.

Fig. 1. A *MONI*-head measuring ChlF from Scots pine needles in a top canopy shoot. With the help of the custom-made supports, *MONI*-head and needles remain in exactly the same position relative to each other throughout the year.

I should master this paper because I also want to install the MONI-PAM sensor at evergreen needleleaf forest site. After reading this paper, I send email to Albert about installation "I wonder if I should use black foam and a plate to exclude possible fluorescence from the background. I am a bit confused about this because you used the black materials in your 2007 year paper, but you did not use it in the more recent paper (2011) anymore. I think the black materials should be better to exclude possible fluorescence from the background, but in this case, the leaf temperature could be artificially increased and the light environment of the needles changed. " He gave me the answer. In this paper, NPQ was drastically enhanced during winter via the accumulation of sustained NPQ in a process regulated by air temperature. Reversible NPQ retained some functionality even at temperatures well below zero and was not inhibited by the presence of sustained NPQ per se but by low temperatures alone.

1st January

Dong, T., Liu, J., Shang, J., Qian, B., Ma, B., Kovacs, J. M., ... & Shi, Y. (2019). Assessment of red-edge vegetation indices for crop leaf area index estimation. *Remote Sensing of Environment*, *222*, 133-143.

Table 2. Vegetation indices selected in this study; NIR, RE, RED and GREEN represent the surface reflectance of near infrared, red-edge, red and green bands of RapidEye image, respectively.

Index	Name	Formula	References
Visible reflectance based VIs			
NDVI	Normalized difference vegetation index	$(NIR - RED)/(NIR + RED)$	Rouse Jr et al. (1974)
CI_{green}	Chlorophyll index -Green	$NIR/GREEN - 1$	Gitelson et al. (2003)
MTVI2	Modified triangular vegetation index 2	$\frac{1.5[1.2(NIR-GREEN)-2.5(RED-GREEN)]}{\sqrt{(2NIR+1)^2-(6NIR-5\sqrt{RED})-0.5}}$	Haboudane et al. (2004)
EVI2	Two-band enhanced vegetation index	$\frac{2.5(NIR-RED)}{(NIR+2.4RED+1)}$	Jiang et al. (2008)
Red-edge reflectance based VIs			
$NDVI_{RE}$	Red-edge normalized difference vegetation index	$(NIR - RE)/(NIR + RE)$	Gitelson and Merzlyak (1994)
CI_{RE}	Chlorophyll index Red-edge	$NIR/RE - 1$	Gitelson et al. (2003)
MSR_{RE}	Modified simple ratio Red-edge	$(NIR/RE - 1)/\sqrt{NIR/RE + 1}$	Wu et al. (2008)

This paper showed a well-made table. I like it. This study explores the potential of vegetation indices (VIs) for crop leaf area index (LAI) estimation, with a focus on comparing red-edge reflectance based (RE-based) and the visible reflectance based (VIS-based) VIs. Seven VIs were derived from multi-temporal RapidEye images to correlate with LAI of two crop species having contrasting leaf structures and canopy architectures: Results showed that crop-specific regression models were much closer to a generic regression model using the RE-based VIs than using the VIS-based VIs. Furthermore, the joint posterior probability distribution of the K_{VI} and VI_{∞} of the RE-based VIs tended to converge for the two crops. This suggests that the RE-based VIs are not as sensitive to canopy structure, e.g., the average leaf angle (ALA), as the VIS-based VIs. This is also demonstrated by the sensitivity analyses using both PROSAIL simulations and field measurements.