4 December

Zhang, Qingyuan, et al. "Estimation of crop gross primary production (GPP): fAPAR chl versus MOD15A2 FPAR." ***Remote Sensing of Environment*** **153 (2014): 1-6.**

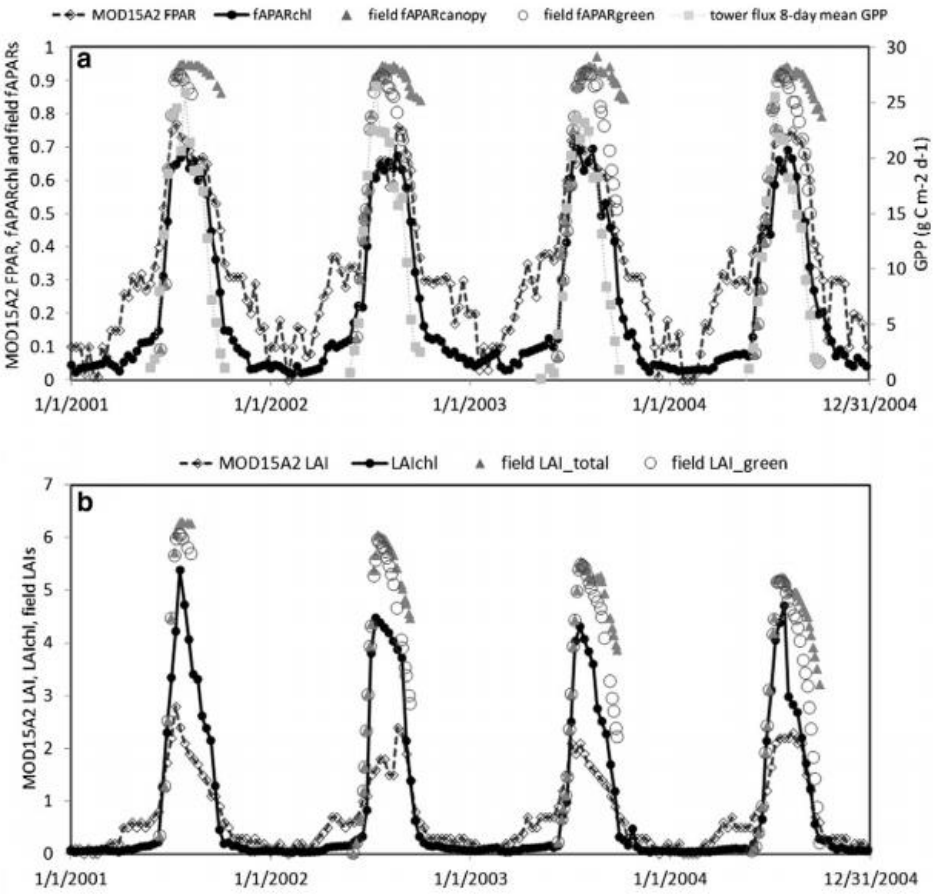

Fig. 1. The seasonal dynamics at US-NE1 during 2001–2004 for: (a) MOD15A2 FPAR, $fAPAR_{chl}$, field $fAPAR_{canopy}$, field $fAPAR_{green}$, and the tower flux 8-day mean daily GPP; and (b) MOD15A2 LAI, retrieved LAI_{chl}, field LAI_{total} and field LAI_{green}.

This paper also compared field measurement with satellite data. I saw fPAR result. It is interesting. Because this paper divide fPAR into 4 phase, canopy, green, chlorophyll. MODIS satellite underestimated fPAR and LAI. The value is similar with fPARchl. I guess this situation is same with our case. I will try to get fPARgreen, fPARchl and model fPAR, which is derived from vegetation index. And then comparing with SIF. It should be interesting topic!

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3 December

Casanova, D., Epema, G. F., & Goudriaan, J. (1998). Monitoring rice reflectance at field level for estimating biomass and LAI. ***Field Crops Research*****,** ***55*****(1), 83-92.**

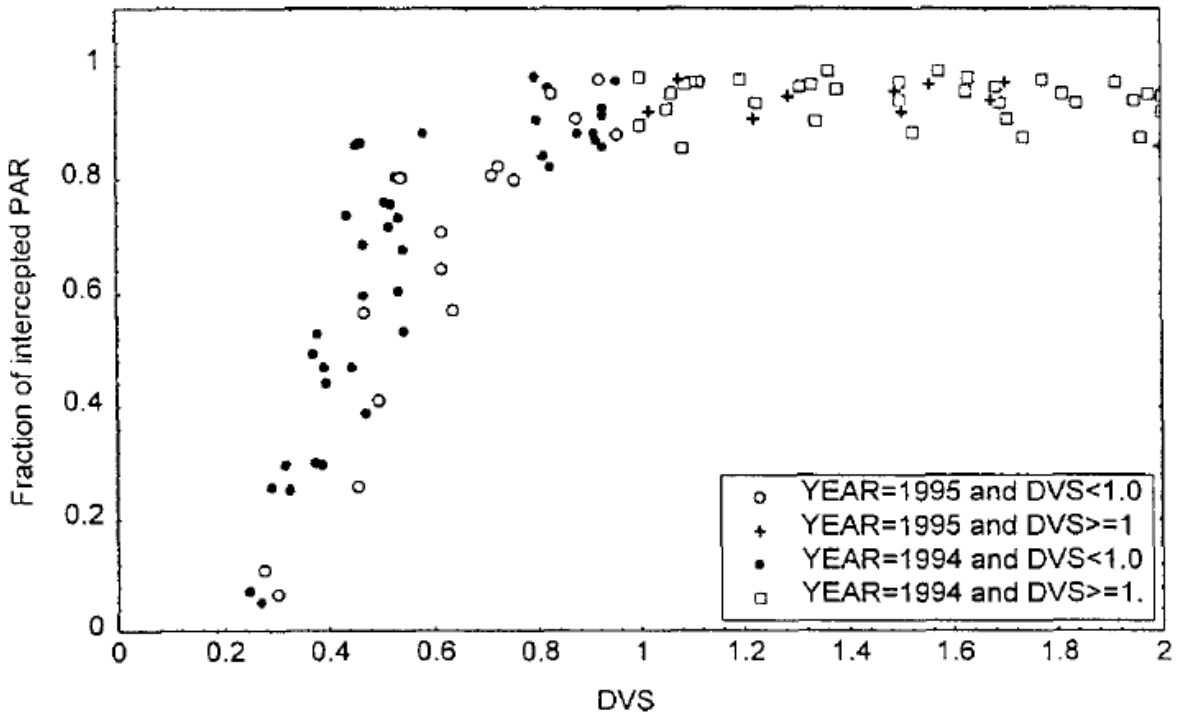

Fig. 2. The progress of f_{PAR} with crop development stage.

After I read this paper, I could convince my fPAR result is reliable one more time. This paper tried to estimate LAI from fPAR data. I saw the formula which how they did estimate fPAR, it seems they assume that transmittance is fPAR. That means their fraction of intercepted PAR is same with our method of estimating fPAR data. And this paper said "During the rice growing season, fPAR increased from 0 (at seeding) to a maximum at flowering stage LAI max. During the post-heading period fPAR is assumed constant (ca.94%)." The fPAR can be constant even though the NDVI is dropped in the rice paddy.

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2 December

Evaluation of optical satellite remote sensing for rice paddy phenology in monsoon Asia using a continuous in situ dataset

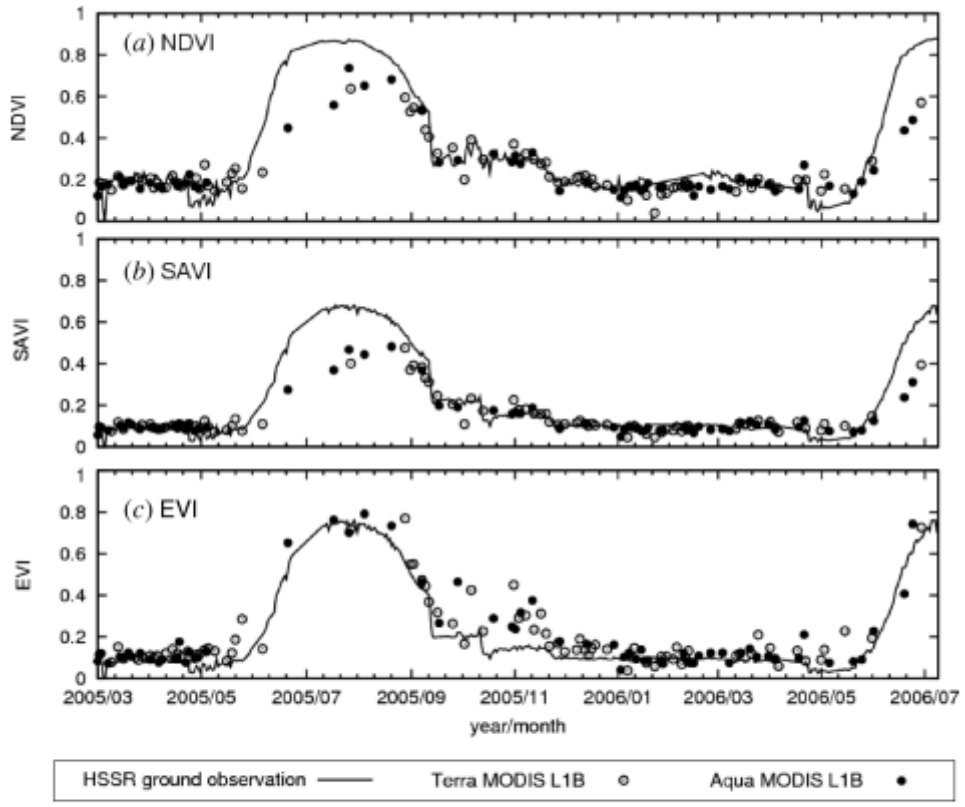

Figure 5. Time-series for (*a*) Normalized Difference Vegetation Index (NDVI), (*b*) Seasonally Adjusted Vegetation Index (SAVI) and (*c*) Enhanced Vegetation Index (EVI) derived from the *in situ* Hemisphere Radiometer (HSSR) observation (daily mean) and from Terra/Aqua MODIS L1B daily data. MODIS data with poor quality from the MOD09 QC flag and with sensor zenith angles more than 40° were removed.

The paper compared field spectral reflectance with satellite data. This paper shows that the magnitude of in situ based vegetation indices were well reproduced by the original MODIS data (L1B) rather than the atmospherically corrected MODIS data (MOD09). EVI, derived from MODIS L1B data, was the best combination of VI and data processing in terms of the agreement with the in situ data in most periods. And this paper mention data fusion (Terra and Aqua) provide more accuracy result to monitoring phenology of rice.

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1 December

Cheng, Q. (2008). Validation and Correction of MOD15-LAI using In Situ Rice LAI in Southern China. *Communications in soil science and plant analysis*, *39*(11-12), 1658-1669.

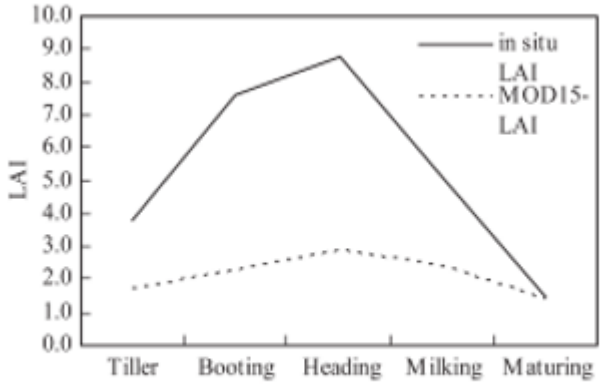

Figure 4. Variation of MOD15-LAI and in situ LAI with time (Yongfeng village).

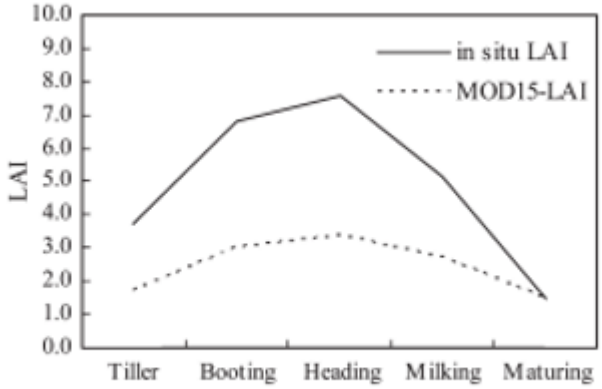

Figure 5. Variation of MOD15-LAI and in situ LAI with time (Mojiatang village).

This paper compared in-situ LAI data with MODIS satellite. This paper shows same with our data. MODIS data shows underestimate than in situ LAI. In this reason, they made corrected MODIS LAI. However, they result showed that different phenological type of rice has different linear relationship. They said “For a homogeneous (within class) site, where the scales of class and region account for most of the spatial variation, a sampling strategy should focus more on using accurate land cover maps and selection of regions.”

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4 November

Liu, Y., Wu, C., Peng, D., Xu, S., Gonsamo, A., Jassal, R. S., ... & Chen, J. M. (2016). Improved modeling of land surface phenology using MODIS land surface reflectance and temperature at evergreen needleleaf forests of central North America. *Remote Sensing of Environment*, *176*, 152-162.

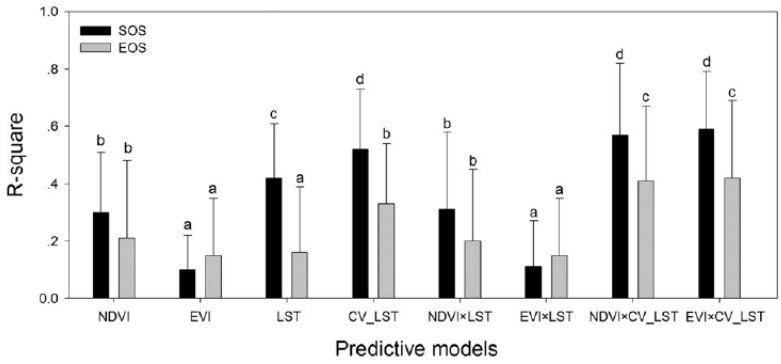

Fig. 9. Analysis of variance (ANOVA) technique using Duncan's multiple range test on the R-square between the start and end of growing season (SOS and EOS) using different predictive models. Different letters indicate significant level at $p = 0.05$.

This paper purpose is comparing near surface data and satellite data with temperature. This paper found that single VI neither NOVI nor EVI, was not able to accurately predict SOS and EOS because of the low intra-annual variations of canopy greenness for the needle leaf or conifer forests. Additional validation at phenocam, land surface monitoring also demonstrated the usefulness of the model. I think I can cite this paper in conclusion. Also I found very interesting sentence. "White et al., (2014) showed that EVI derived from Landsat TM data provided better SOS estimates than that of NDVI in deciduous forests, possibly because of EVI being less sensitivie to high biomass than NDVI." I will study more how NDVI and EVI different.

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3 November

Petach, A. R., Toomey, M., Aubrecht, D. M., & Richardson, A. D. (2014). Monitoring vegetation phenology using an infrared-enabled security camera. *Agricultural and Forest Meteorology*, *195*, 143-151.

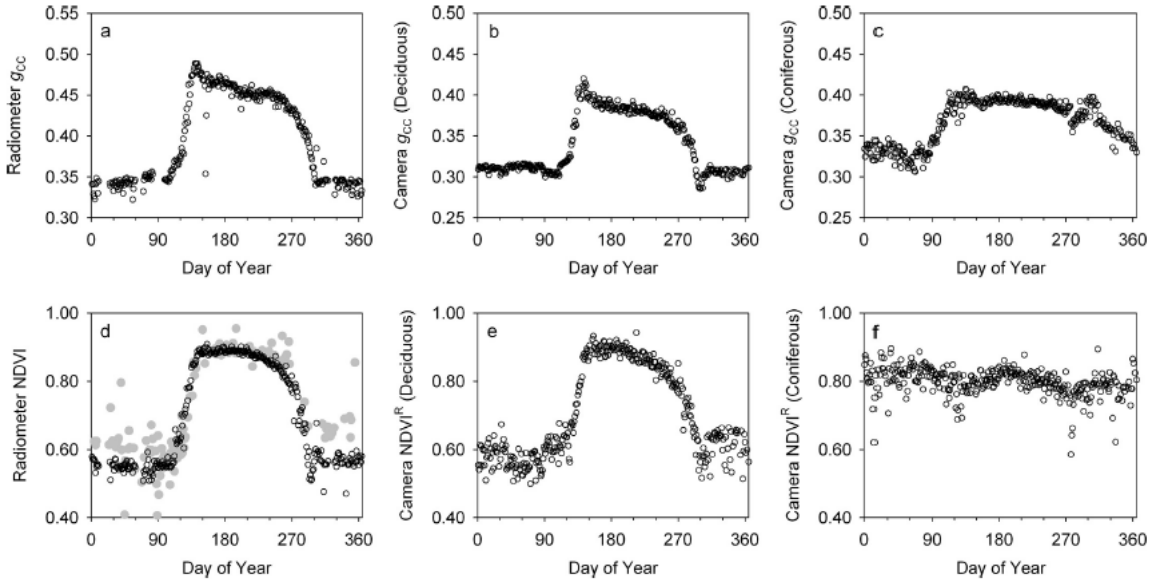

Fig. 5. Time series of daily means (calculated for PPFD $\geq 200\,\mu mol\,m^{-2}\,s^{-1}$) of vegetation indices calculated from radiometric instruments (a and d) and digital camera imagery, analyzed separately for deciduous (b and e) and coniferous (c and f) regions of interest, from instruments mounted on the Harvard Forest Barn Tower. In (d), the gray filled circles are the mean value of MODIS NDVI from a 3×3 window centered on the tower pixel. g_{CC} is the green chromatic coordinate, NDVI is the normalized difference vegetation index.

This paper developed NDVI camera using infrared filter. NDVI camera means camera also can capture plant physiology easily. However, this paper mentioned the NDVI camera's advantage. Camera cannot record reflectance value. That means it need to addition calibration with other radiometric sensors. And NDVI camera cannot solve the fundamental advantage of camera which is the band wavelength is huge and it is hard to change or obtain suitable wavelength.

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2 November

Bauer, Jan, et al. "On the potential of Wireless Sensor Networks for the in-situ assessment of crop leaf area index." *Computers and Electronics in Agriculture*128 (2016): 149-159.

Table 2
Performance of related approaches.

Approach	Tech.	Species	r^2	Reference	LAI range	n
Ryu et al. (2012)	DHP	Trees	0.94	LAI-2000	0.26–0.9[a]	7[b]
Confalonieri et al. (2013)	DHP	Rice	0.97	Destructive	0.25–6.1	6
Francone et al. (2014)	DHP	Grass	0.86	AccuPAR	1.1–4.1[a]	21
		Maize	0.92	AccuPAR	0.25–6.0[a]	22
		Reed	0.88	AccuPAR	0.2–7.7[a]	24
Qu et al. (2014b)	WSN	Maize	0.27–0.97	LAI-2000	1.6–4.2[a]	4–6
		Maize	Avg. 0.43	LAI-2000	1.6–4.2[a]	24
Bauer et al. (2014)	WSN	Shrubs	0.90	LAI-2200[c]	0.32–5.71	27
		Shrubs	0.85	LAI-2200[d]	0.86–5.16	31

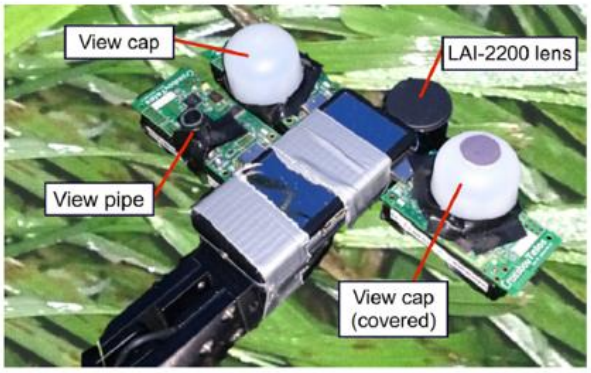

Fig. 5. Measurement set-up used for the comparative analysis of indirect LAI estimation using WSN devices with different approaches (view pipe, view cap, and view cover) versus the LAI-2200.

Strength of this paper are 1) they used WRS for measuring LAI of crop. 2) they compared between novel sensor with LAI-2200 at same location. 3) they used diffuser and filter to get high quality result. And he made one more table for comparing others paper which compared LAI-2200 with their new sensor. I thought this table provides us to get information easily.

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1 November

Yamaguchi, D. P., Nakaji, T., Hiura, T., & Hikosaka, K. (2016). Effects of seasonal change and experimental warming on the temperature dependence of photosynthesis in the canopy leaves of Quercus serrata.

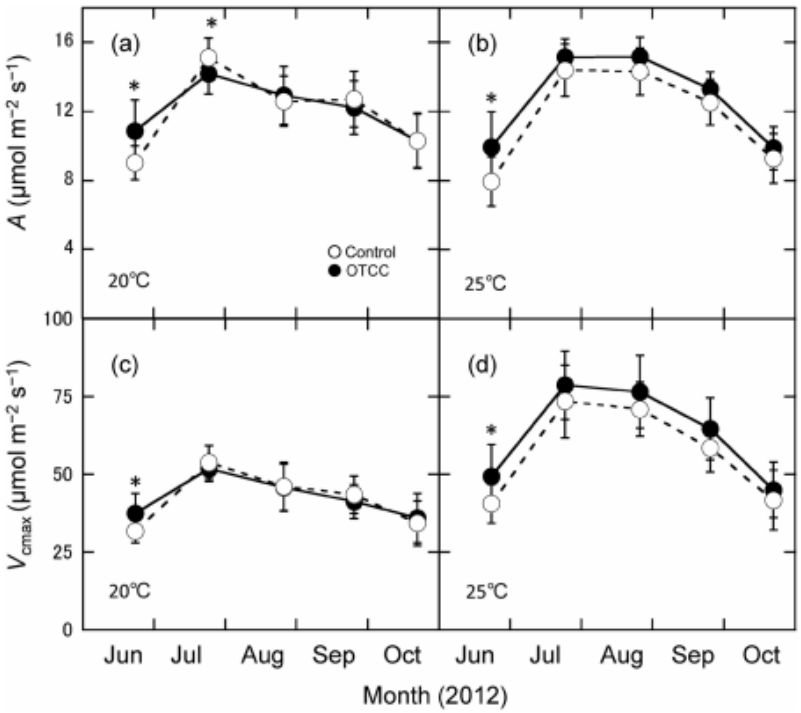

Figure 3. Seasonal changes in CO_2 assimilation rate (A) and apparent maximum RuBP carboxylation rate (V_{cmax}) at 20 °C (a and c), and A and V_{cmax} at 25 °C (b and d) in canopy leaves of *Q. serrata* in 2012. Leaves were exposed to either naturally changing temperature conditions (control: white circles) or experimental warming with an OTCC (black circles) (means ± standard deviation, $n = 12$). Trees are incorporated as a random factor. Asterisks indicate significant differences between treatments at $P < 0.05$ (GLMM).

I found very interesting paper. This paper focused on Quercus serrata, which is marcescent species and dominant of GDK site. The figure showed VC max increasing a lot in higher temperature condition. I found that Leaf Area Index and Growing season length well not matched with GPP. So I think that we should measure ability of photosynthesis at leaf level. This figure provides evidence to interpret why GPP was higher regardless LAI, and GSL didn't different.

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4 October

Florian A. Busch and Rowan F.sage. "The sensitivity of photosynthesis to O2 and CO2 concentration identifies strong Rubisco control above the thermal optimum". ***New pythologist (2016)***

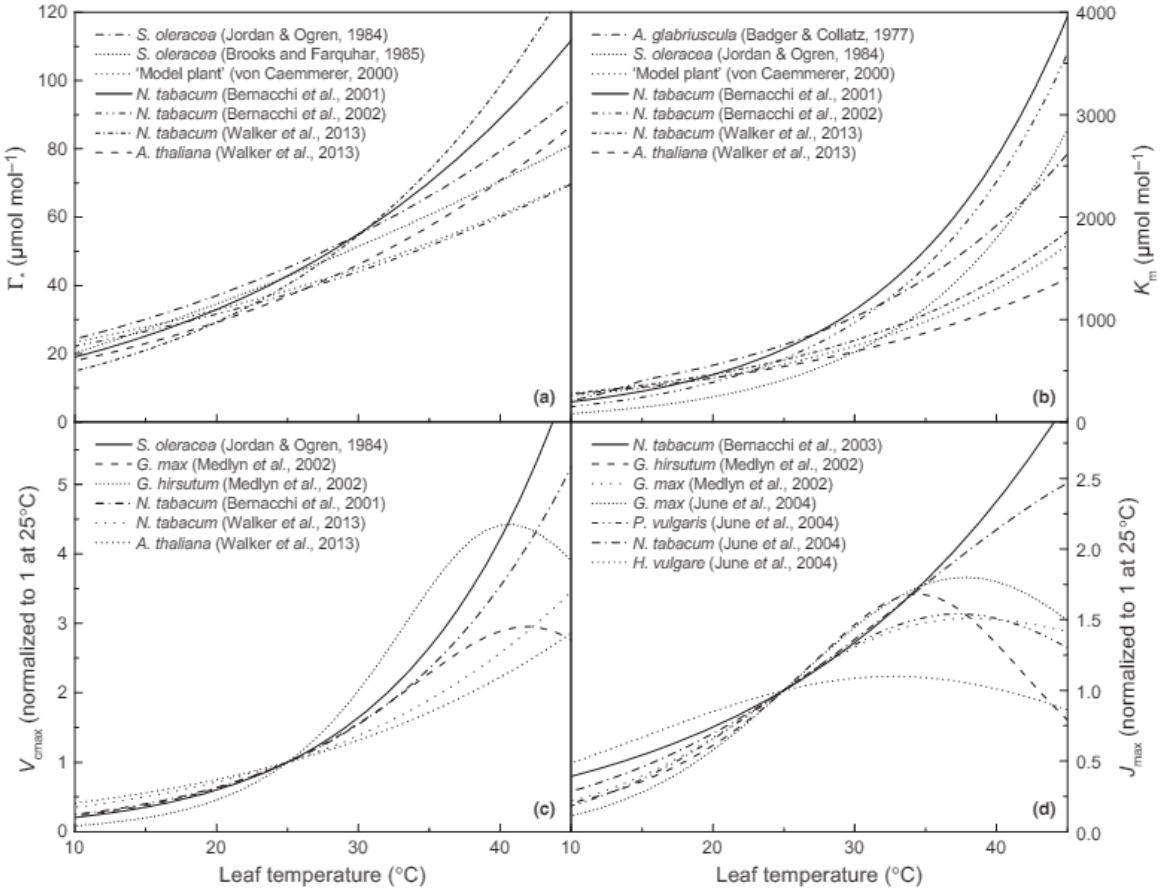

Fig. 1 Variability of temperature responses of some commonly used parameters of the Farquhar, von Caemmerer and Berry (FvCB) model. (a) CO_2 compensation point in the absence of mitochondrial respiration (Γ*); (b) Michaelis–Menten constant of Rubisco for CO_2 in the presence of O_2 ($K_m = K_c (1 + O/K_o)$). The temperature responses of both Γ* and K_m are derived from either *in vitro* (Badger & Collatz, 1977; Jordan & Ogren, 1984) or *in vivo* (Brooks & Farquhar, 1985; von Caemmerer, 2000; Bernacchi *et al.*, 2001; Bernacchi *et al.*, 2002; Walker *et al.*, 2013) measurements of Rubisco kinetics. (c, d) V_{cmax} (c) and J_{max} (d) of a selection of herbaceous plants. Some authors describe the temperature response of these parameters with an Arrhenius-type equation, while others use a peaked function.

When I used LI-6400, It is hard to match relative humidity. Because Li-6400 cannot adjust humidity automatically and Rice paddy is rapidly increasing humidity in the noontime because of irrigation water. In this reasons, we controlled leaf temperature for match relative humidity at every times. However, this paper said Vcmax relative with leaf temperature (show figure, Ylabel is normalized value). So It should be affect 5% (but different species shows different increasing rate). That means, if we want to compare annual variations, we should match temperature with in every year.

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3 October

Majasalmi, Titta, Miina Rautiainen, and Pauline Stenberg. "Modeled and measured fPAR in a boreal forest: Validation and application of a new model." *Agricultural and Forest Meteorology* 189 (2014): 118-124.

This paper compared field measured fPAR with a model. Application of the model to simulate diurnal and seasonal values of fPAR for the study stands indicated that the ratio of direct-to-total incident radiation and LAI are the key factors behind the

magnitude and variation of stand-level fPAR values. however, I think the leaf angle also important factor. because if leaf angle is erectophile, the transmittance should be large. In the starting season of rice paddy, It is erectophile. but, end of season, leaf angle is clumped. And I think this figure is something wrong. because if the diffuse condition, the value should be similar with 60~90 SZA in sunny day.

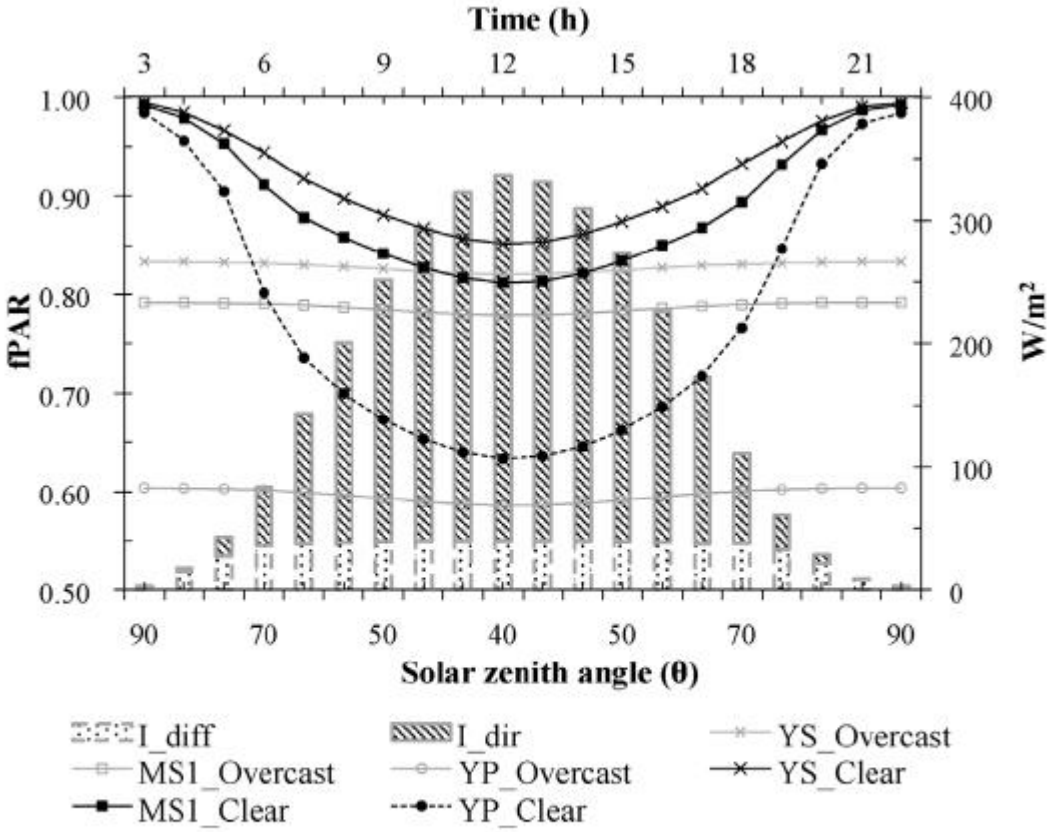

Fig. 4. The modeled diurnal courses of fPAR in three coniferous stands (YP, YS, MS1, see Table 1) during clear and overcast days. The incident sky irradiance is shown on the secondary *y*-axis.

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2 October

Schwartz, Mark D., and Bradley C. Reed. "Surface phenology and satellite sensor-derived onset of greenness: an initial comparison." ***International Journal of Remote Sensing*** **20.17 (1999): 3451-3457.**

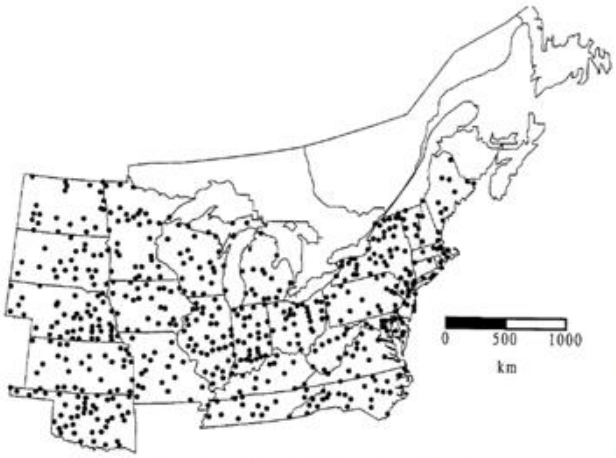

Figure 1. Location of Historical Climatology Network stations.

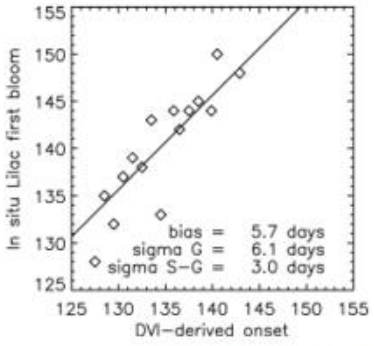

Fig. 2. Comparison between the onset dates derived from the AVHRR DVI time series and the ground observations of Lilac at the Norfolk site [42° N; 73.2° W]. The plain line is not the best fit but has a slope of 1 and is adjusted for the bias between the spaceborne estimates and ground observations. The Knyazikhin et al. (1999) classification indicates a dominance of Broadleaf Forests in this area (93%).

For find the paper which is compared satellite data with ground-based data, I searched and found this paper. After read this paper, I was shocked. Because there is already some network system since 1995. Now days, I tried to find network system, which is monitoring phenology. HCN has monitor phenology or other factors at variation reason during long period. And this paper also tried to compare satellite data and in-situ data. This paper mentioned satellite could detect onset of understory like Ryu et al., 2014. However, It is hard to find a paper which compare in-situ spectral data with satellite.

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1 October

Richardson, Andrew D., Stephen Klosterman, and Michael Toomey. "Near-surface sensor-derived phenology." *Phenology: An Integrative Environmental Science*. Springer Netherlands, 2013. 413-430.

Table 22.1 Pros and cons of different approaches to monitoring phenology

Approach	Pros	Cons
Direct field observations	Ability to characterize specific phenophases (e.g., budburst, flowering) Can observe individual plants Can focus on species of interest	Spatial coverage typically limited Temporal resolution of observations often inadequate (≈ weekly) Time consuming if a population or ecosystem is to be adequately sampled Potential for observer bias, subjectivity
Satellite remote sensing	Yields seasonal trajectory of "greenness" Provides spatial integration across pixel (10–1,000 m) Offers global coverage	Tradeoffs between spatial and temporal resolution Cloud cover may obscure land surface Atmospheric corrections are required and may be uncertain
Near-surface remote sensing	Yields quantitative (seasonal trajectory of "greenness") or categorical (visual assessment of specific phenophases) data on phenology Opportunity for spatial integration across instrument footprint or to focus on individual organisms (spatial scale ≈ 1–100 m) Continuous in time (data collected at time interval of minutes to hours) Potential to separate structure (leaf area) and function (photosynthetic capacity) Relatively inexpensive (many options in $100–$5,000 price range)	Instrument footprint may not represent larger areas (ecosystem to region) Some infrastructure required (e.g., structure for mounting, data logging equipment or Internet connectivity) Instruments may fail (lightning strikes, extreme heat/cold, rodents like to chew cables, etc.); large data gaps are possible if instruments are not monitored regularly

I think this paper is key paper about near surface sensing. The paper well-organized what is different between remote sensing with near surface remote sensing. And well reported camera, broad bend spectrometer and other things. This paper showed near surface remote sensing is important because It can detect field issue which satellite cannot detect. I'm really want to write about review paper of near surface sensing like this for exponential technology.

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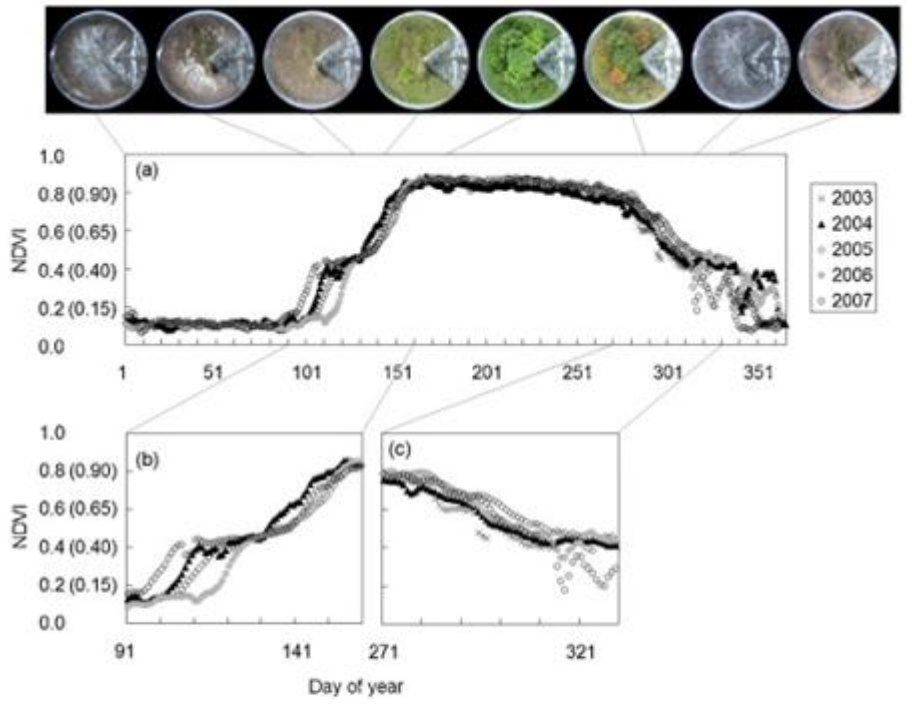
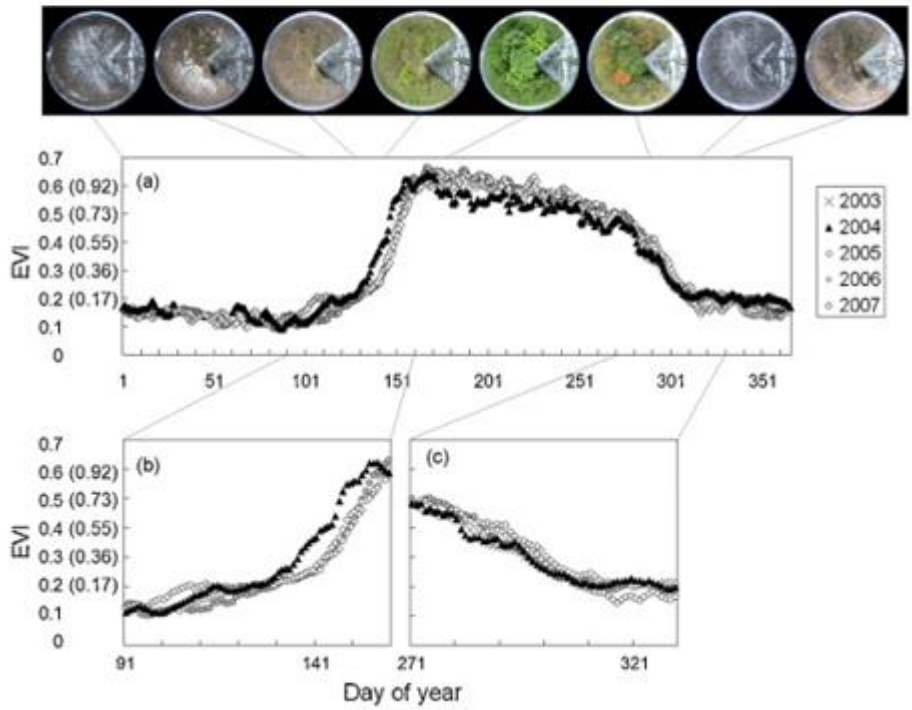
4 September

Nagai, Shin, et al. "Field experiments to test the use of the normalized-difference vegetation index for phenology detection." *Agricultural and forest meteorology* 150.2 (2010): 152-160.





This paper defined that the timing of leaf expansion and defoliation using the normalized-difference vegetation index (NDVI). There are two method, *Criterion 1*: They defined the day with the maximum rate of NDVI growth as the onset of leaf expansion, and the day with the maximum rate of NDVI reduction as the offset of defoliation. The other one is *Criterion 2*: They defined the date when a specific NDVI value (the reference NDVI value) was obtained as the onset of leaf expansion, and the day when the reference NDVI value was obtained as the offset of defoliation. And this paper said NDVI should satisfy follows; (1) NDVI should exhibit a monotonous

increase or decrease (monotonicity). (2) The relationship between NDVI and the forest canopy's status should be unique (uniqueness). (3) The method is robust against the systematic noise (bias) (robustness).

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3 September

Kawashima, Shigeto, and Makoto Nakatani. "An algorithm for estimating chlorophyll content in leaves using a video camera." ***Annals of Botany*** **81.1 (1998): 49-54.**

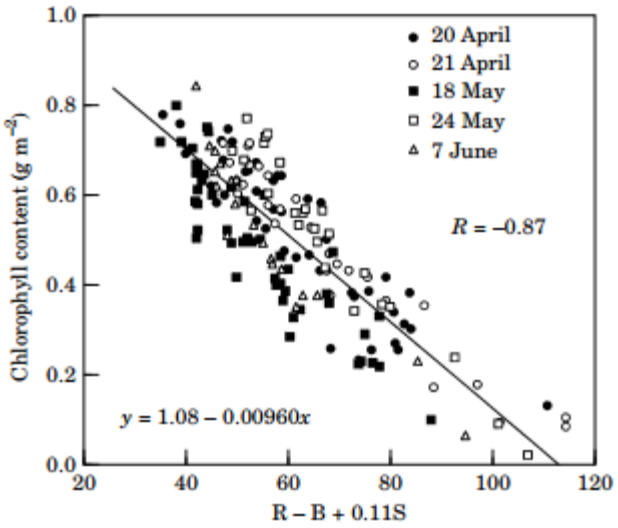

FIG. 5. The relationship between (R–B) + 0·11S and chlorophyll content. The correlation coefficient is −0·87, with all data obtained under different conditions.

They tried to measure chlorophyll contents using a video camera. They made novel formula. however, This paper reported camera's limitation. First, A video camera is sensitive in the visible range and has no channel specialized to the near-infrared. Second, special features are included by each manufacturer for the specific characteristics of automatic exposure. This paper said this limits may become problematic for the improvement of the estimation accuracy.

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2 September

Bauer, Jan, et al. "On the potential of Wireless Sensor Networks for the in-field assessment of bio-physical **crop parameters."** ***Local Computer Networks Workshops (LCN Workshops), 2014 IEEE 39th Conference on*****. IEEE, 2014**

(a) Pair setting with one TelosB on a tripod above and a second one below the canopy (red ellipse) deployed in a wheat field.

(b) Setting for the direct comparison of WSN versus conventional hardware using a TelosB mounted on the LAI-2200 wand.

Fig. 2. Measurement setups used for indirect LAI estimation.

This paper used commercial off-the-shelf (COTS) sensor nodes for the indirect and nondestructive LAI estimation are described. This sensor is also WSN. And it has good relation with LAI-2200. This paper focused on LAI-2200 lens because different footprint makes different results. I have to define that how to measure LAI using 4S. And also I have to try using this sensor.

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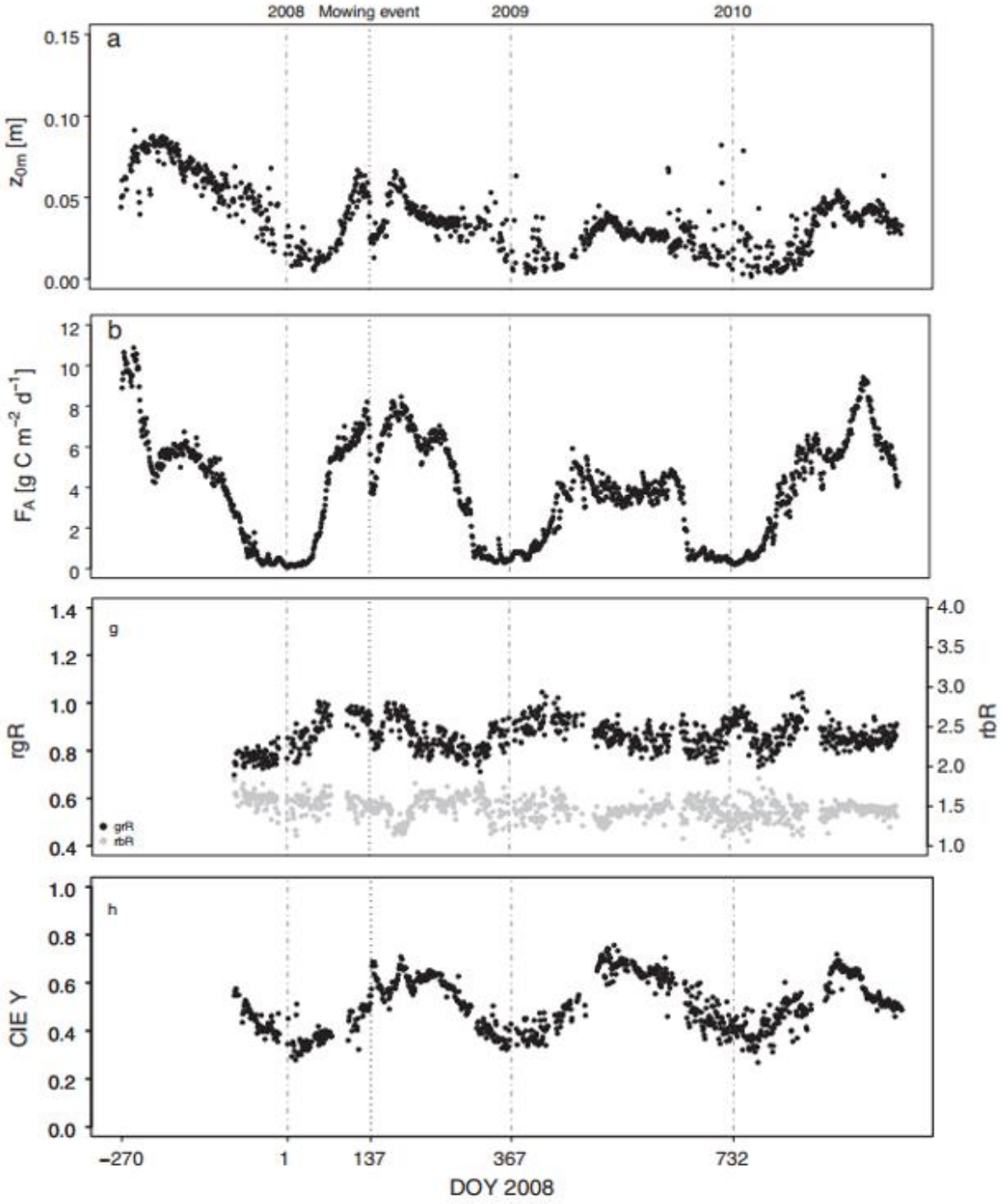
1 September

Sonnentag, O., et al. "Tracking the structural and functional development of a perennial pepperweed (Lepidium latifolium L.) infestation using a multi-year archive of webcam imagery and eddy covariance measurements." ***Agricultural and Forest Meteorology*** **151.7 (2011): 916-926.**



This paper calculated CIE Y from pepperweed RGB brightness levels in relation to hypothetical horizontal reference RGB brightness levels. So this paper found that high accuracy value to understand changing carbon flux. That mean's camera could capture the development of function. However, this paper method only suit for pepperweed. If there are lots of species, I guess that it is hard to know. In this reasons, we have to combine the spectrometer and camera for monitor structural and functional developing.

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4 August

Morisette, Jeffrey T., et al. "Tracking the rhythm of the seasons in the face of global change: phenological research in the 21st century." *Frontiers in Ecology and the Environment* 7.5 (2009): 253-260.

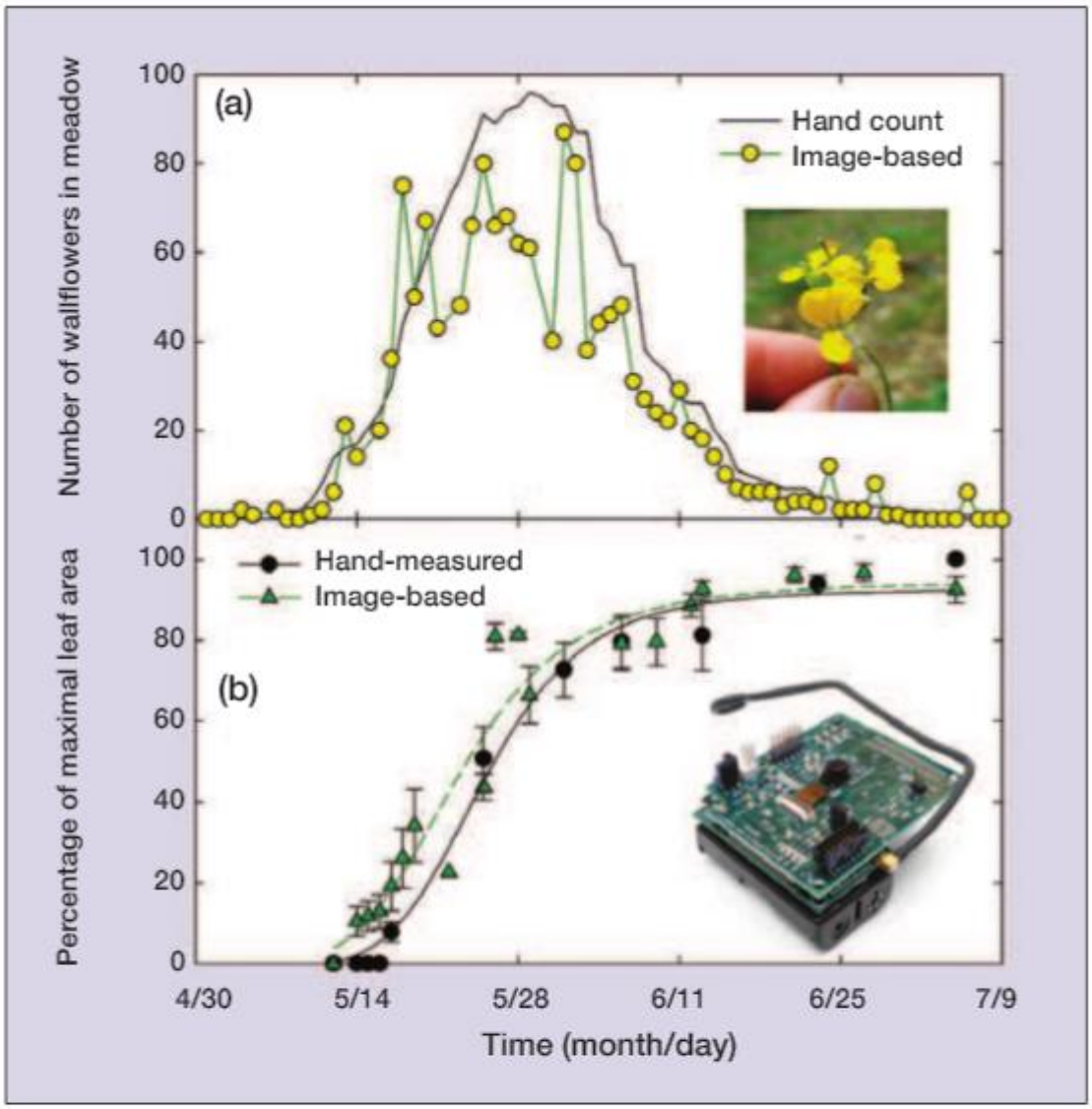

Figure 3. *Examples of (a) automatically identifying and counting individual flowers from images captured in a 5000-m^2 field with a pan-tilt-zoom camera and (b) calculating leaf areas of rhododendron in a temperate forest using a camera on a mobile platform. Inset in (b) is an example of a small, wireless, battery-powered camera that can be networked for automated image retrieval (http://research.cens.ucla.edu).*

This paper mentioned that the automatically identifying and counting is already developed before. This paper said Center for Embedded Networked Sensing, CENS

could automate discovery of phenological events using imagery has recently been successful through a combination of low-level, robust image analysis with more complex machine learning algorithms. Therefore, I think that best advantage of 4S is not automatically analysis system. I think the advantage is combined and analysis it-self. And this paper mention that a large scale has big uncertainty.

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3 August

Vitoria, Angela Pierre, et al. "Using leaf δ 13 C and photosynthetic parameters to understand acclimation to irradiance and leaf age effects during tropical forest regeneration." *Forest Ecology and Management* 379 (2016): 50-60.

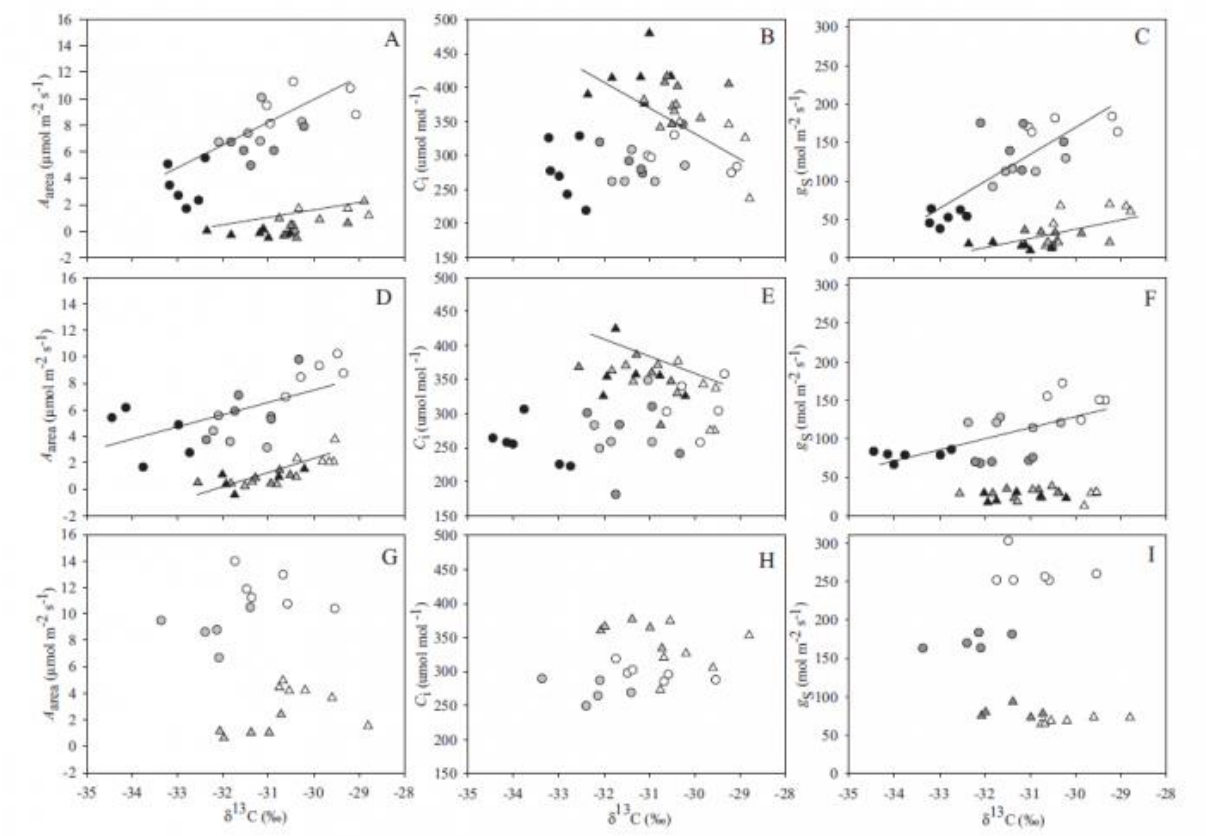
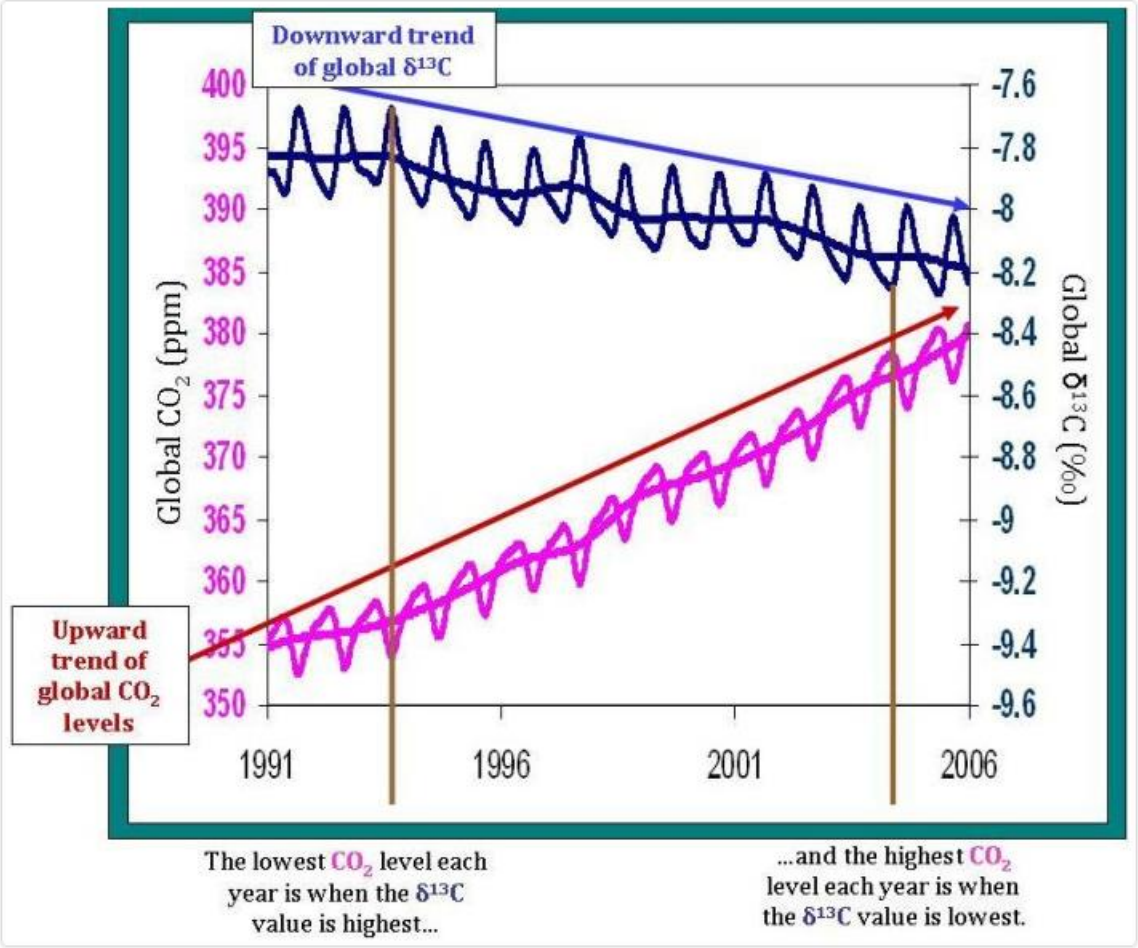


Fig. 4. Relationship between leaf carbon isotope composition (δ^{13}C, ‰) and photosynthetic rate per area (A_{area}, μmol m^{-2} s^{-1}, left column), internal CO_2 concentration (C_i, μmol mol^{-1}, middle column), and stomatal conductance (g_S, mol m^{-2} s^{-1}, right column) for young (triangles) and mature (circles) leaves of *Siparuna guianensis* (A, B and C), *Xylopia sericea* (D, E and F), and *Byrsonima sericea* (G, H and I) in four sites in União Biological Reserve, Brazil, in November 2014. Black: forest (9 μmol m^{-2} s^{-1}), dark grey: US 1 (85 μmol m^{-2} s^{-1}), light grey: US 2 (230 μmol m^{-2} s^{-1}), and white: US 3 (550 μmol m^{-2} s^{-1}). US: understory. Line indicates significant correlations ($P \leq 0.05$). n: 5–6.

This paper highlights are delta C13 in young leaves is controlled by imported C, stomatal control and carboxylation. And photosynthetic performance is a strong determinant of leaf delta C13 in regenerating forest. Last Increases in irradiance and leaf age increase carbon assimilation and leaf delta C 13. Delta C 13=12 per mil means that the sample was analyzed against a reference material and found to be 12 molecules per thousand more abundant. And I attached on more figure. I searched this figure in NOAA web-site. It was so interesting.



A comparison of global total atmospheric carbon dioxide trends and global $\delta^{13}C$ trends both annually and seasonally.

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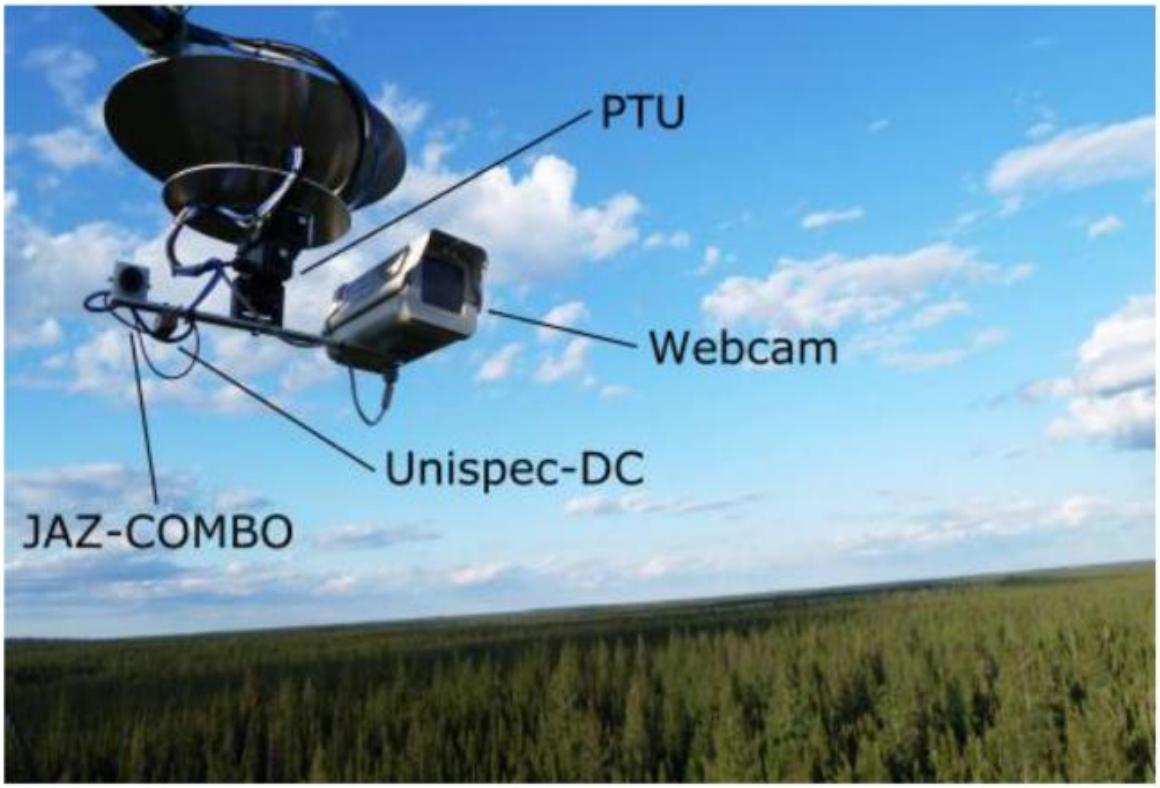
2 August

Tortini, R., Hilker, T., Coops, N.C. and Nesic, Z., 2015. Technological advancement in tower-based canopy reflectance monitoring: The AMSPEC-III system. Sensors, 15(12): 32020-32030

Figure 1. *In situ* photograph of the third generation Automated Multiangular SPectro-radiometer for Estimation of Canopy reflectance system (AMSPEC-III) taken at the Southern Old Black Spruce (SOBS) site.



This paper already combined JAZ hyper-spectrometer and webcam. Unispec-DC is also spectrometer (Let's search) however, as i know, the price of hyper-spectrometer is quite expensive and this system used to use data logger for monitor phenology. but this system could observe 360 degrees within the scene. very interesting and I can see how many they effort.

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1 August

Garrity, Steven R., Lee A. Vierling, and Keith Bickford. "A simple filtered photodiode instrument for continuous measurement of narrowband NDVI and PRI over vegetated canopies." ***Agricultural and Forest Meteorology*** **150.3 (2010): 489-496.**

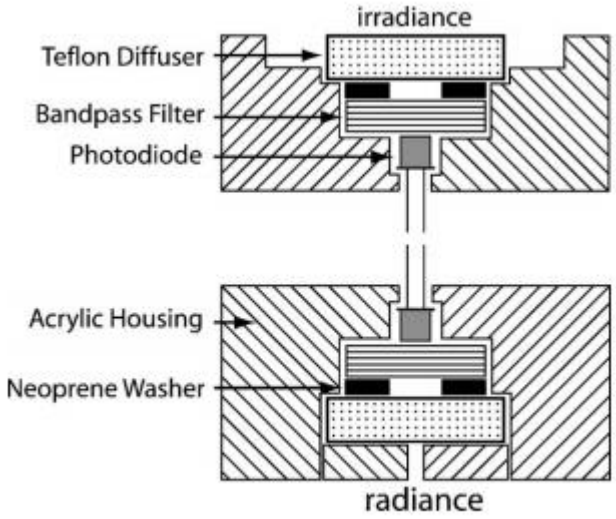

Fig. 5. Housing schematic for QuadPod irradiance and radiance sensor heads.

This paper used a photodiode and filter for estimate NDVI and PRI. I was very surprised. Because this paper already used filter and tried to observe using radiance and irradiance. If we use this method, I think we can measure SIF signal using 4S-LED. If we get a good quality filter, we can do that !

————————————————————————————

4 July

Ferrández-Pastor, Francisco Javier, et al. "Developing Ubiquitous Sensor Network Platform Using Internet of Things: Application in Precision Agriculture." *Sensors* 16.7 (2016): 1141.

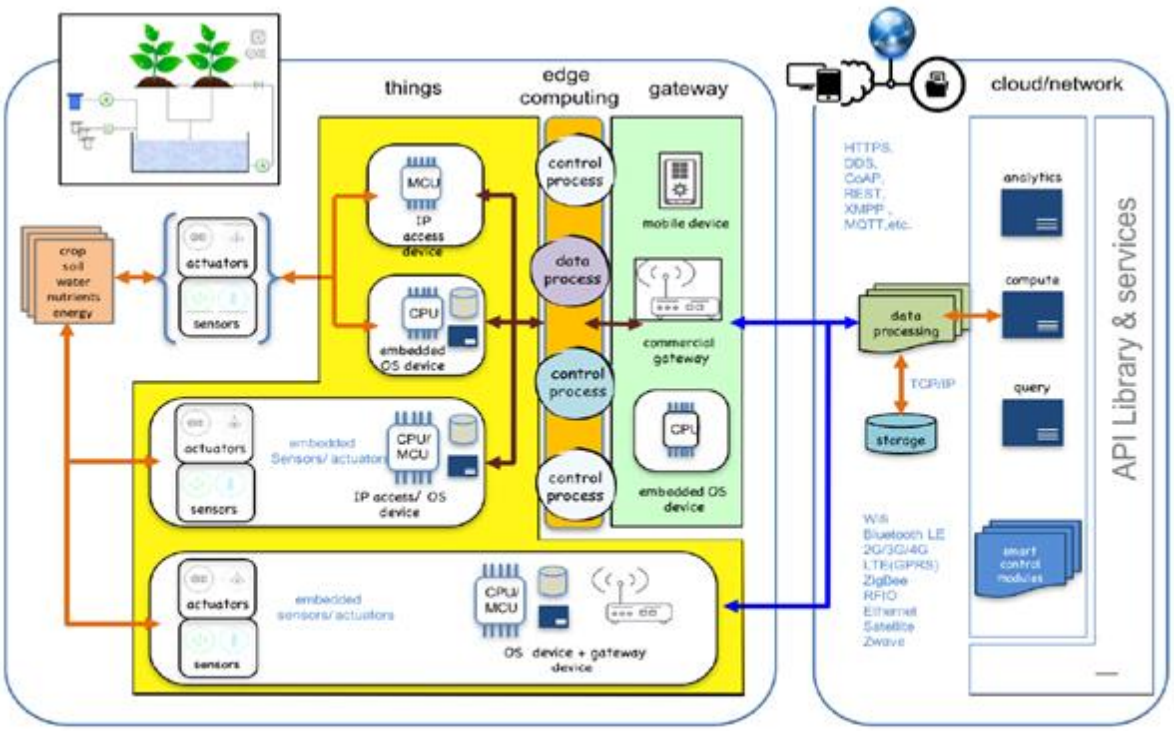

Figure 4. IoT ecosystem developed. Sensors, actuators and IP access devices make up the ubiquitous thing layer.

Shit! This paper is very similar with 4S paper. This paper emphasis edge computing which can analysis data at each node. Actually, I think 4S has strong point out to automatic analysis. However, this paper already explains about it detail. But in my case, I used Arduino and LED. And the purpose is different. 4S purpose focus on environmental factor. And target journal is AFM. Then I have to make strong purpose. What's new? So what?

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3 July

Flexas, Jaume, et al. "Analysis of leakage in IRGA's leaf chambers of open gas exchange systems: quantification and its effects in photosynthesis parameterization." *Journal of Experimental Botany* 58.6 (2007): 1533-1543.

This paper mention leakage in IRGA's quantification and its effects in photosynthesis parameterization.

When I read this paper, I focused on stomatal conductance. When stomatal conductance is very low, the influence of cuticular conductance may impair the estimation of Ci using the typical procedures.

And this paper mention 'edge' effect. leaf chambers usually enclose a small leaf surface(2–6 cm2) surrounded by gaskets of a certain width, the illuminated

photosynthesizing leaf area is always surrounded by an area darkened by gaskets, which respires and thus affects the measurement of the photosynthetic flux. And leaf temperature makes significant errors in the estimation of stomatal conductance. Stomatal conductance can be overestimated by 20-60%, especially when Gs values are low, as under stress conditions.

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2 July

Bater, Christopher W., et al. "Design and installation of a camera network across an elevation gradient for habitat assessment." ***Instrumentation Science and Technology*** **39.3 (2011): 231-247.**

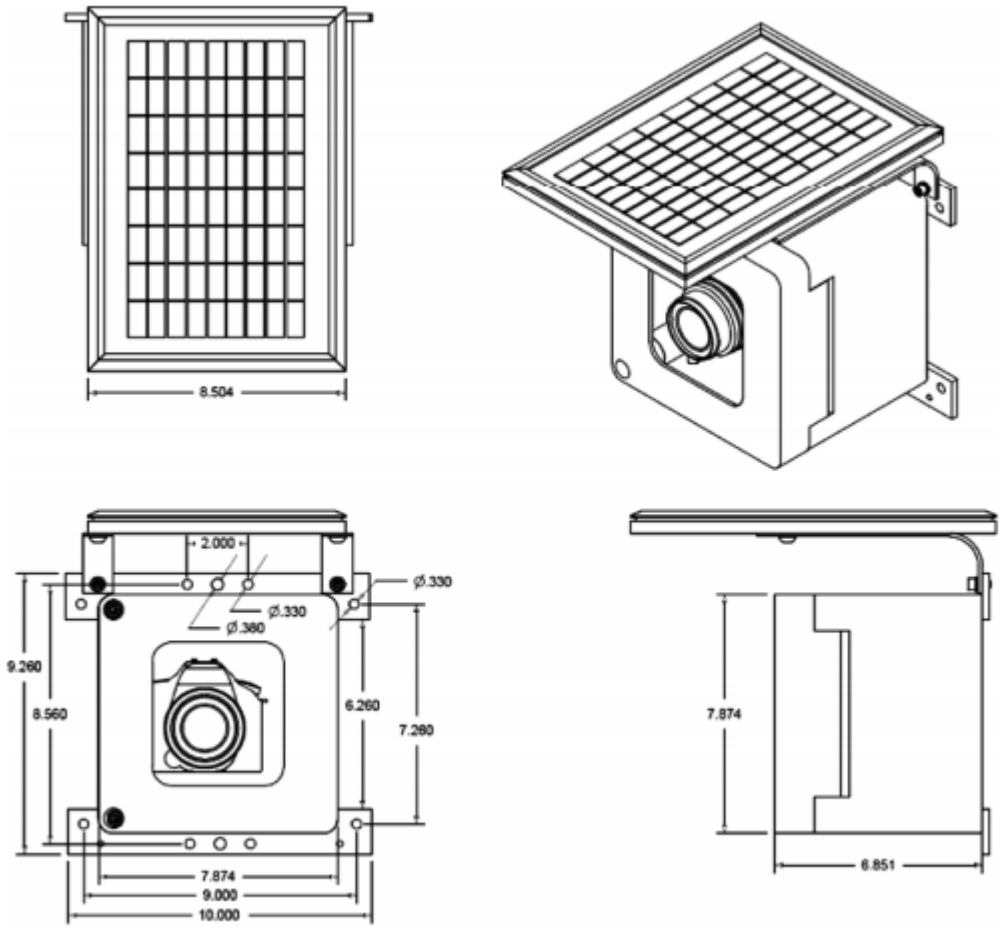

FIGURE 1 Diagram of the Harbortronics time-lapse camera package. The units consist of a Pentax DSLR slaved to an intervelometer, both of which are powered by a lithium ion battery and solar panel.

Why my research is important? What is different? How can I describe my logic? I read this paper for my 4S manuscript. In this paper, the author makes camera package (Camera + solar pennel). And this paper published 2011. The 5 years ago. I think advantage of 4S is “man-power is used only when necessary.” And “low-cost network system.” I must emphasis these two contents in the paper.

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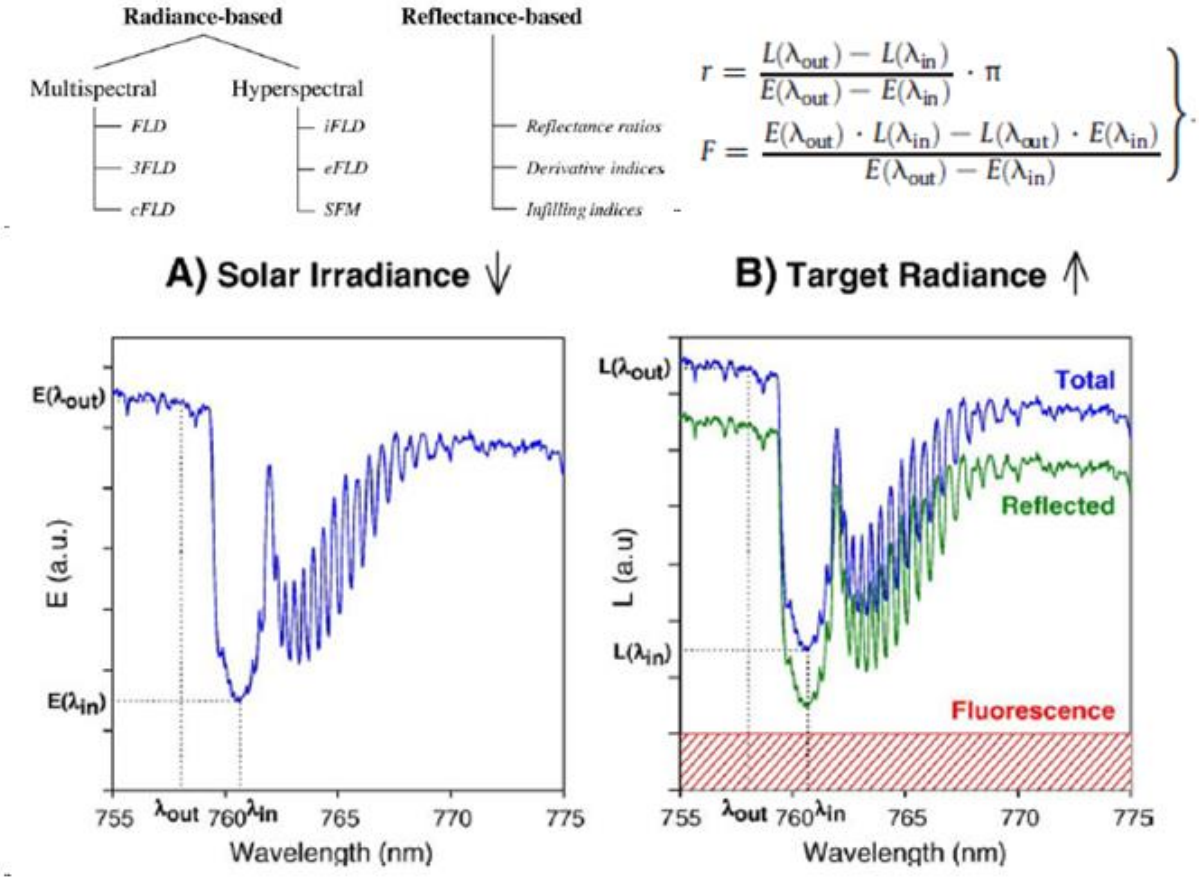
1 July

Meroni, M., et al. "Remote sensing of solar-induced chlorophyll fluorescence: Review of methods and applications." ***Remote Sensing of Environment*** **113.10 (2009): 2037-2051.**



I think this paper is a key about Sun Induced Fluorescence (SIF). Because this paper well mention that concept of SIF and compared each other papers. This paper reported advantage of SIF is offered by solar–induced Chl fluorescence (F) which is emitted by the photosynthetic machinery itself and which can provide an early and more direct approach for diagnosis of the actual functional status of vegetation. And this paper also described how to estimate SIF using spectrometer. I focused Fraunhofer Line Depth (FLD) method. However, this method has limitation. The weakness of this approach lies in the assumption of constant r and F, which has been questioned by several authors.

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4 June

Huete, A. R., R. D. Jackson, and D. F. Post. "Spectral response of a plant canopy with different soil backgrounds." *Remote sensing of environment* 17.1 (1985): 37-53.

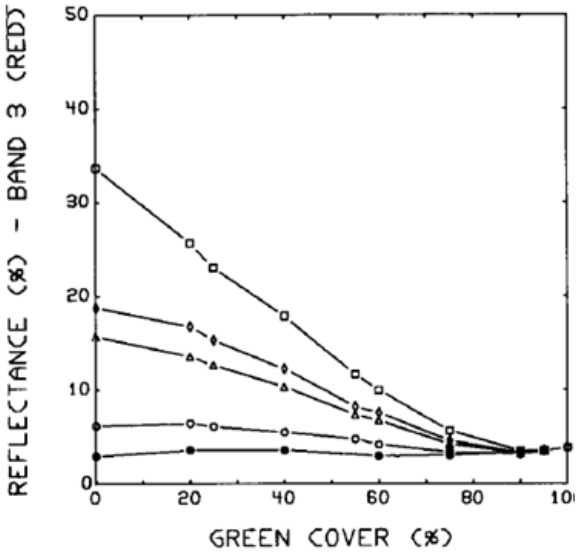

FIGURE 1. Relationship between composite red reflectance and green canopy cover for one wet and four dry soil backgrounds: (□) Superstition sand (dry); (◇) Avondale loam (dry); (△) Whitehouse-B SCL (dry); (○) Cloversprings loam (dry); (●) Cloversprings loam (wet).

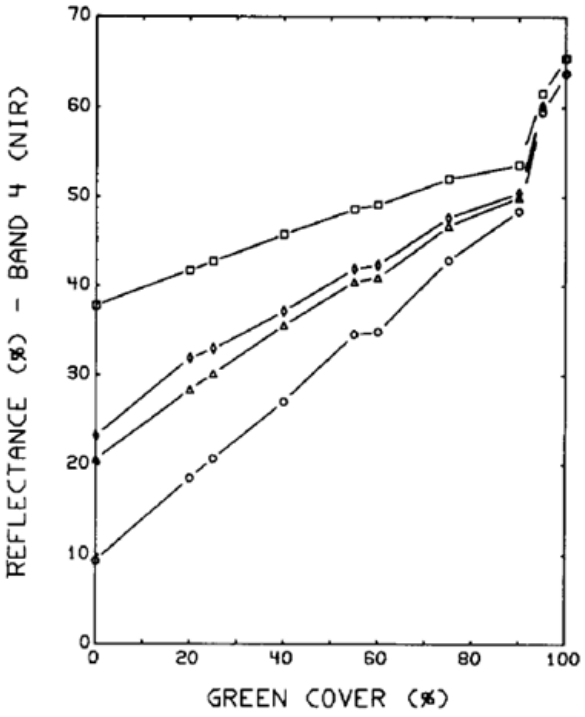

FIGURE 2. Relationship between composite near-infrared reflectance and green canopy cover for four dry soil backgrounds: (□) Superstition sand (dry); (◇) Avondale loam (dry); (△) Whitehouse-B SCL (dry); (○) Cloversprings loam (dry).

This paper is very interesting. I think this paper is key information about spectral response of a plant canopy with background. This paper tested changing green cover on the difference type of background. This paper said “Both a soil brightness and a soil spectral effect were found to influence greenness measures, not only at low vegetation densities but also at canopy covers approaching 75%.” When I read this paper, we could make topic background, which do photosynthesis, influence optical reflectance.

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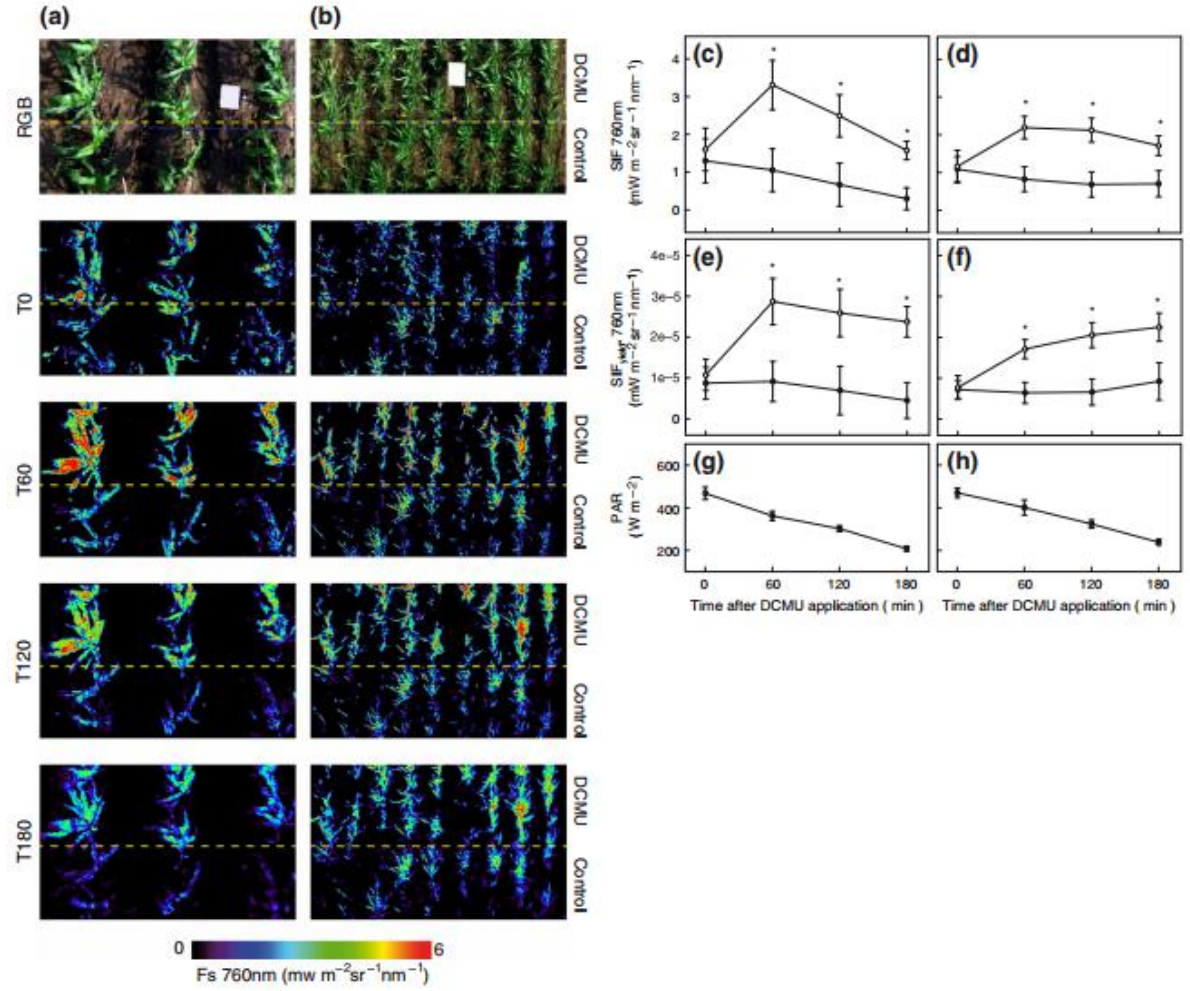
3 June

Pinto, Francisco, et al. "Sun-induced chlorophyll fluorescence from high-resolution imaging spectroscopy data to quantify spatio-temporal patterns of photosynthetic function in crop canopies." *Plant, cell & environment* (2016).



I read this paper, I got an idea that when I tried to get SIF signal using hyper spectral imager, I missed one thing. SIF is a very sensitivity signal. So if took a photo with long length, It had huge uncertainty because of atmosphere resistor. So if I want to take signal I have to take a photo within a small plot. And white reference would be installed next to a plant. This paper experimented that treated plants with DCMU. DCMU has been widely reported to increase the fluorescence level because of its blocking action in the electron transport chain. In the future, I want to test one of a experiment like this one, makes a different condition.

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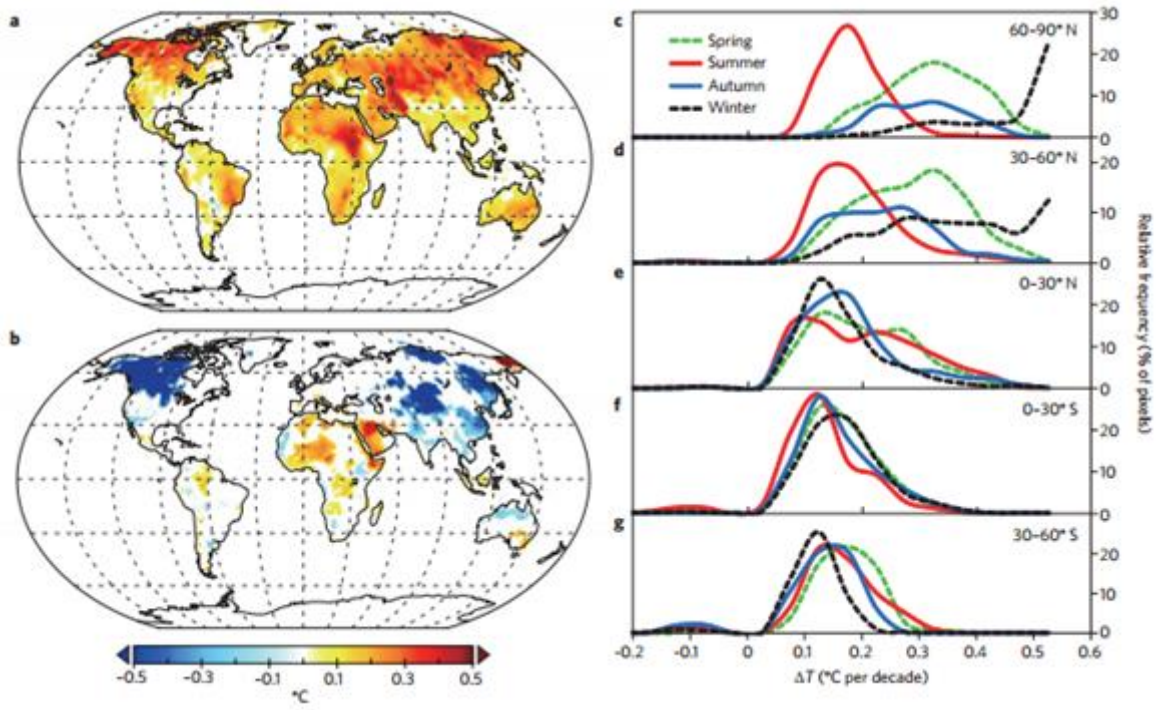
2 June

Xia, J. Y., et al. "Terrestrial carbon cycle affected by non-uniform climate warming." (2014).



When I read this paper, it is interesting that different latitude and longitude has non-uniform trend in diurnal temperature change. Also it is quite interesting north part is more dynamic change than south part. In global scale also has various direction to response with temperature. north part of globe seems dynamic changing than south part. That means boreal forest will be changing fester to forest. I thought that even global scale has different pattern within each part. So in local scale also has different response to changing temperature. this paper mention “Autumn warming seems to be more important for enhancing litter decomposition and has no clear influence on photosynthesis.” The reason why the photoperiod limitation during this season. So my next paper of the week is “Photoperiodic regulation of the seasonal pattern of photosynthetic capacity and the implications for carbon cycling “

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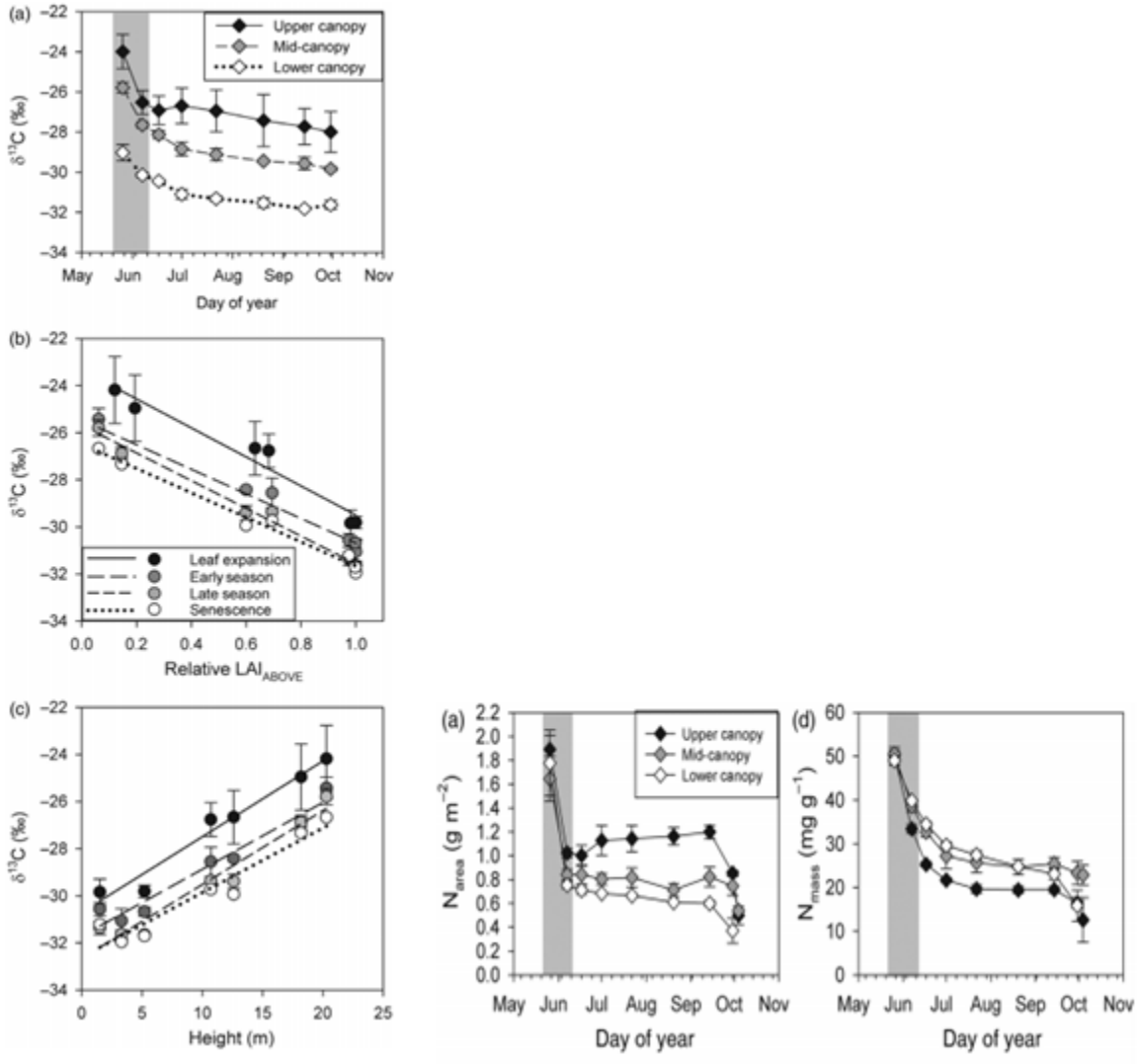
1 June

How vertical patterns in leaf traits shift seasonally and the implications for modeling canopy photosynthesis in a temperate deciduous forest, Adam P. Coble (2016), Tree physiology

This is very very interesting paper. Because I learned delta C13 at class. I read this paper after taking class, I can understand easily. Delta C13 related with drought and canopy height. And I convinced that the area of N and mass of N is quite different. Because height canopy has thick leaf. I really enjoyed this paper’s figure.



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4 May

Xiao, Xiangming, et al. "Land surface phenology." *Phenology of ecosystem processes*. Springer New York, 2009. 247-270.

Today I saw profesorXiangming Xiao's lecture. I was very interested in that figure to define rice paddy site. Upon one, LSWI, water index is sometime overcome other vegetation index. That means in that day, farmer plant rice in their own field. I pretty shocked that this method is not complex, very simple. I hope to find that important thing for phenology using easy method.

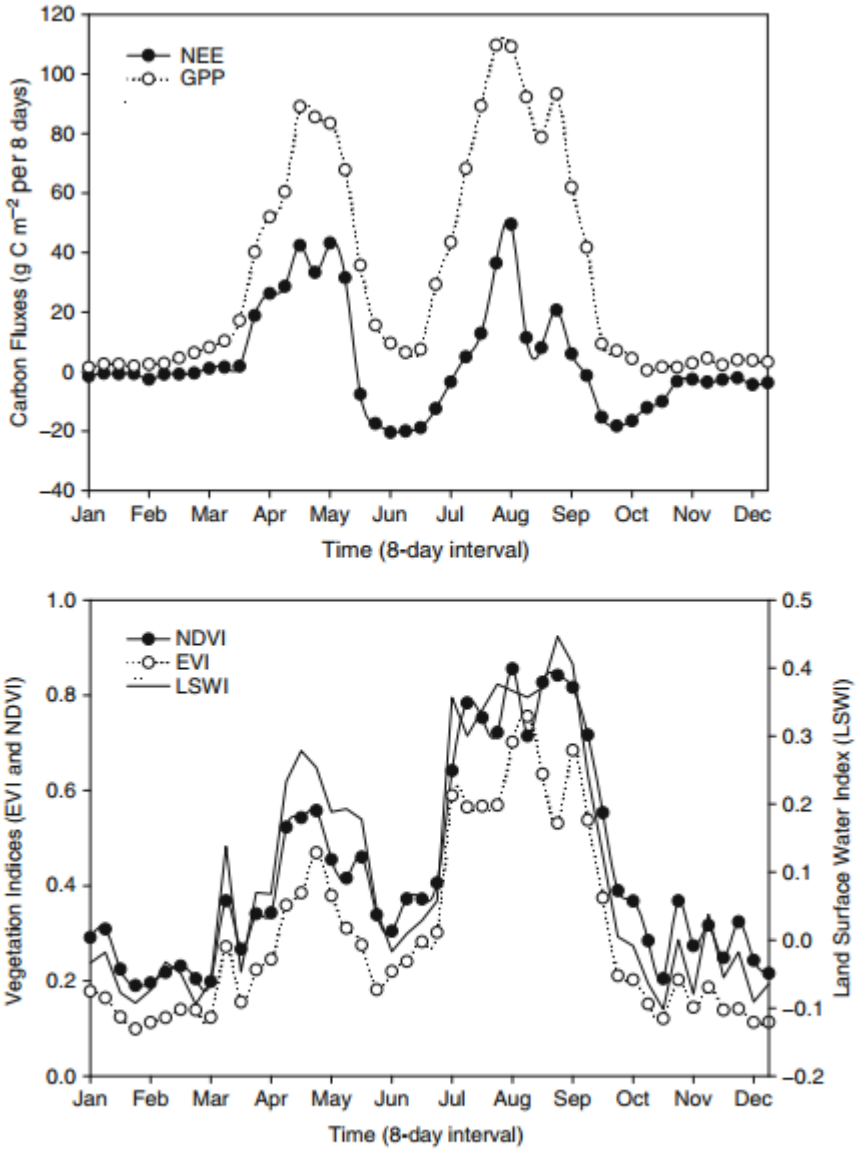

Fig. 5 Seasonal dynamics of net ecosystem exchange (NEE) of CO_2, gross primary production (GPP), Enhanced Vegetation Index (EVI), Normalized Difference Vegetation Index (NDVI), and Land Surface Water Index (LSWI) in 2004 at the eddy flux tower of croplands in Yuchen, Hebei province, China. Here we used 8-day composites of MODIS land surface reflectance product (MOD09A1).

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3 May

Xiao, Xiangming, et al. "Modeling gross primary production of temperate deciduous broadleaf forest using satellite images and climate data." *Remote Sensing of Environment* 91.2 (2004): 256-270.

This paper has interesting figure which is compare NDVI with GPP. I will try same with one. And if I can estimate EVI, I try to compare GPP with EVI. This paper's EVI formula is

$$EVI = 2.5 \times \frac{\rho_{nir} - \rho_{red}}{\rho_{nir} + (6 \times \rho_{red} - 7.5 \times \rho_{blue}) + 1}$$

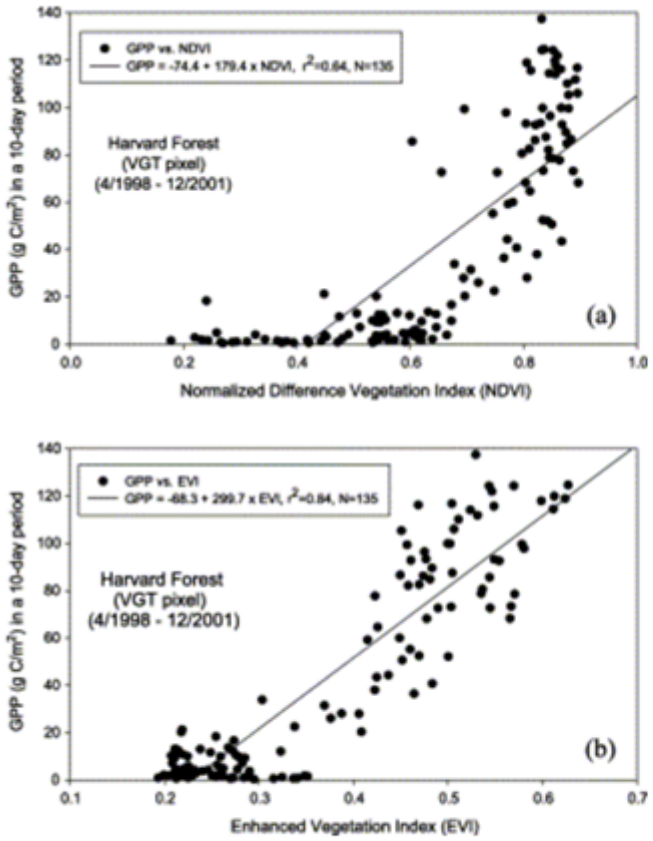

Fig. 4.
Simple linear regression analyses between gross primary production (GPP) of forest and vegetation indices (NDVI, EVI) during 4/1998–12/2001 at Harvard Forest, Massachusetts.

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2 May LED

RayChaudhuri, B., and C. Sen. "Light emitting diode as sensor for miniature multispectral radiometer." *Applied Physics B* 95.1 (2009): 141-144.

This paper mention that function and advantage of LED. This paper mention advantage of LED are follows; LEDs have some technical advantages over photodiodes, like a low cost, small size and sturdiness in outdoor applications. No reverse bias is required in photoconductive mode. Accessories like a filter are not needed for wavelength selectivity. Ambient temperature variation does not seriously affect the sensitivity and the dark current. The limitation of LED the response time, which only affects high-speed switching and is not a factor in a steady radiation measurement.

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1 May

Parker, Geoffrey G., John P. O'Neill, and Daniel Higman. "Vertical profile and canopy organization in a mixed deciduous forest." *Vegetatio* 85.1-2 (1989): 1-11.

This paper analyzes that vertical profile of canopy. This paper seems like song et al,. 2015. However, this paper interesting that the number of species at understory is large. This evidence can explain understory is important. This paper mention that canopy foliar structure has components due to vertical level, seasonal duration, and leaf species.

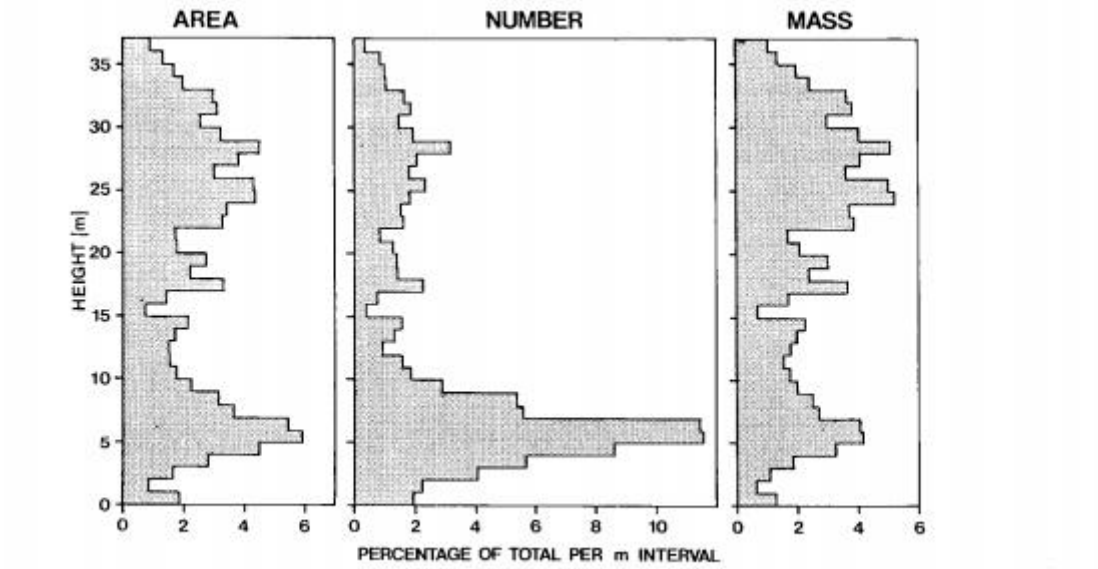

Fig. 4. Comparison of the vertical foliar distribution by leaf area (left panel), number (middle), and mass (right).

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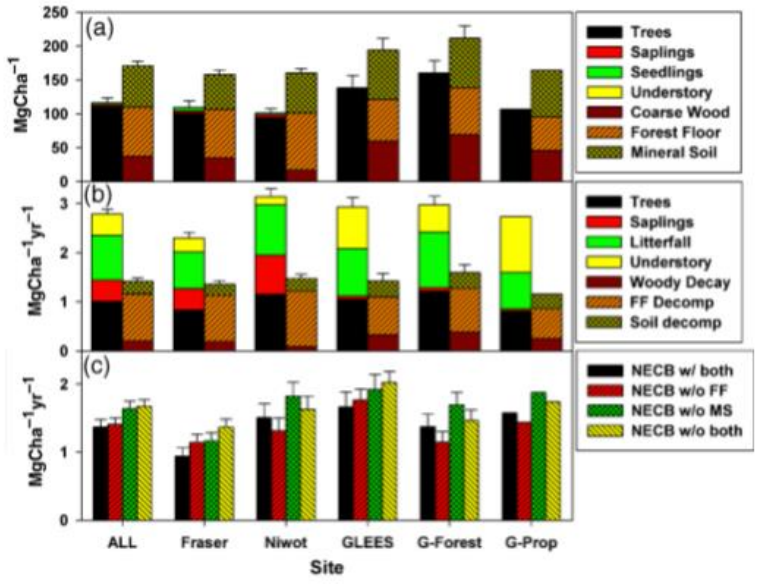
4 April

Bradford, John B., et al. "Tree age**, disturbance history, and carbon stocks and fluxes in subalpine Rocky Mountain forests." *Global change biology* 14.12 (2008): 2882-2897.**

This research analyzes that tree age, the amount of carbon uptake is different between understory and overstory. And upper figure is very interesting because that explain the litterfall has a lot of carbon stock. And some location that there is understory carbon stock is larger than over story. So I should be careful not to fall into a negative and non-helpful emotional state anymore.



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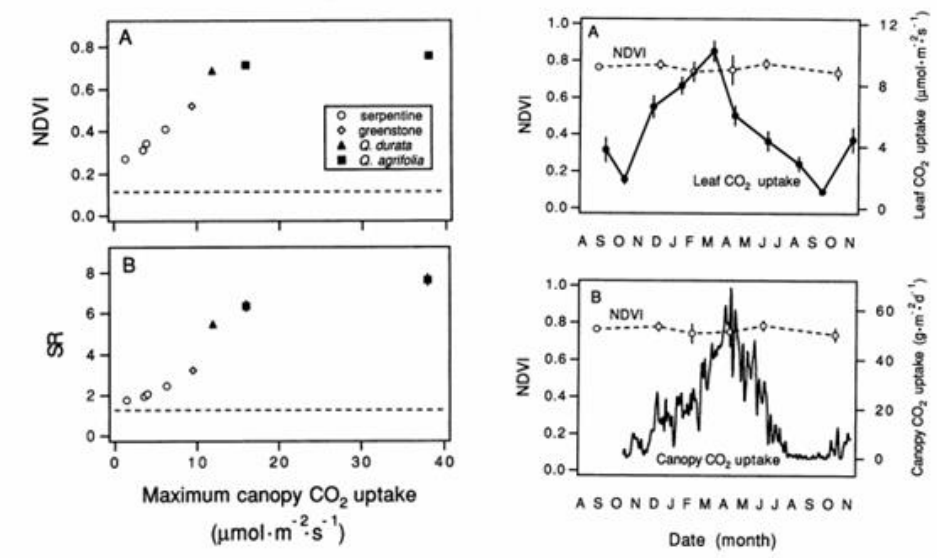
3 April

Gamon, John A., et al. "Relationships between NDVI, canopy structure, and photosynthesis in three Californian vegetation types." *Ecological Applications*(1995): 28-41.

After read this paper, I was surprised about that NDVI shouldn't imply Co2 uptake at sometimes. This paper can answer the question about marcescent's species has a little relationship with NDVI. I saw my data from LED-NDVI sensor. And compared with GPP, It is hard to say top NDVI can't explain the pattern GPP. So I think if the leaf of top dominant species has high NDVI, it doesn't represent it take high Co2 uptake.



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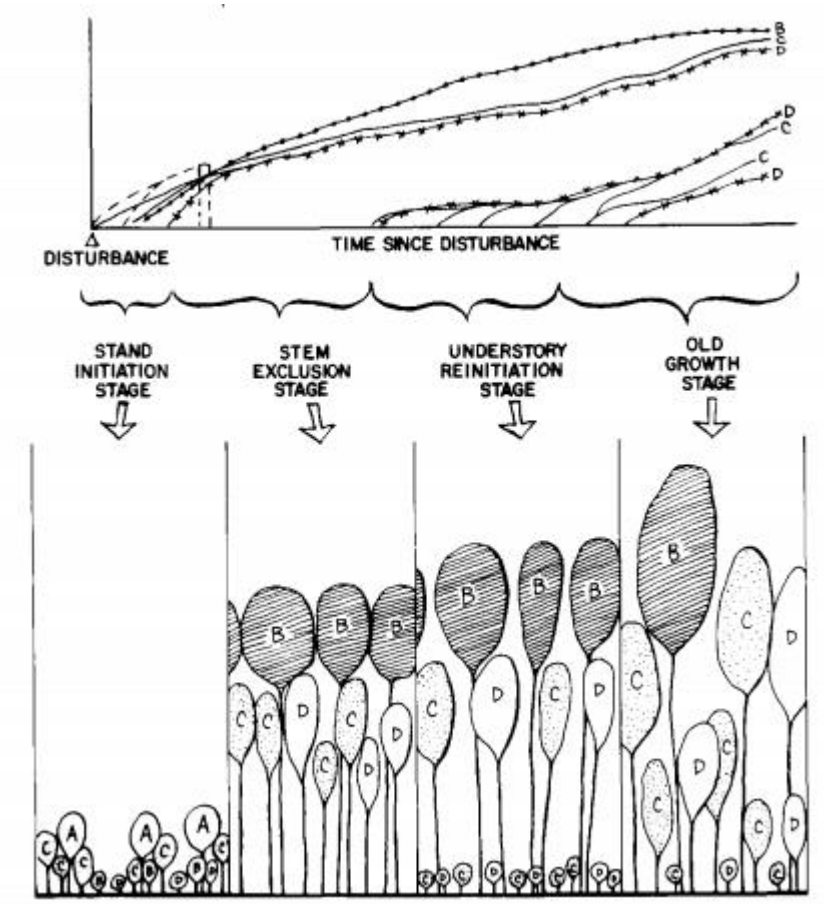
2 April

Oliver, Chadwick Dearing. "Forest development in North America following major disturbances." ***Forest ecology and management*** **3 (1980): 153-168.**

This paper mention about how do forest sturucturesconsist of each component. First stand initiation stage such as Alaska Nome. There is all short canopy. But taking age, there are some tall tree that make shadow. Understory canopy can photosynthesize in the shadow which is made by overstory. After read this paper, I think that Gwangneung forest is old growth stage.Because there are lots of species overstory and understory.



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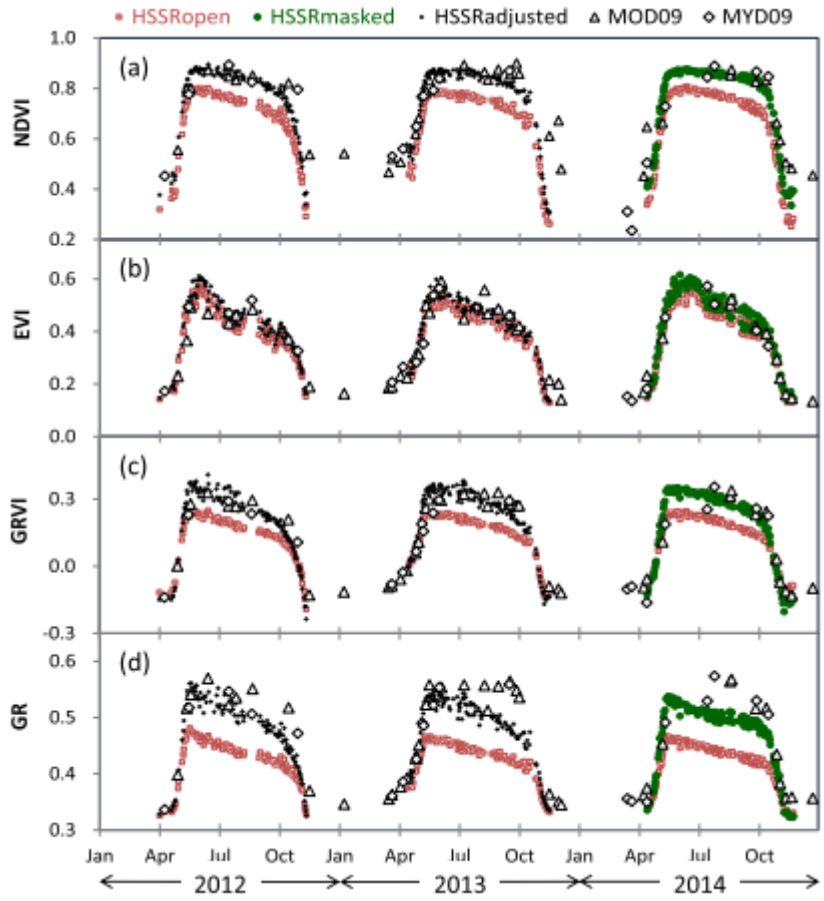
1 April

Development of a masking device to exclude contaminated reflection during tower-based measurements of spectral reflectance from a vegetation canopy

Reiko Ide*, Yasuo Hirose, Hiroyuki Oguma, Nobuko Saigusa

When Isaw this paper, I was very happy. Because this paper used only 3 years. Many people said that the 3 years data is very small. This paper also described that method about Development of a masking device to exclude contaminated reflection during tower-based measurements of spectral reflectance from a vegetation canopy. However, when I read this paper, I got a question about what is different between diffuser and hemispherical. Because our site GDK using diffuser Teflon. But the data got good relationship with MODIS. Then why?



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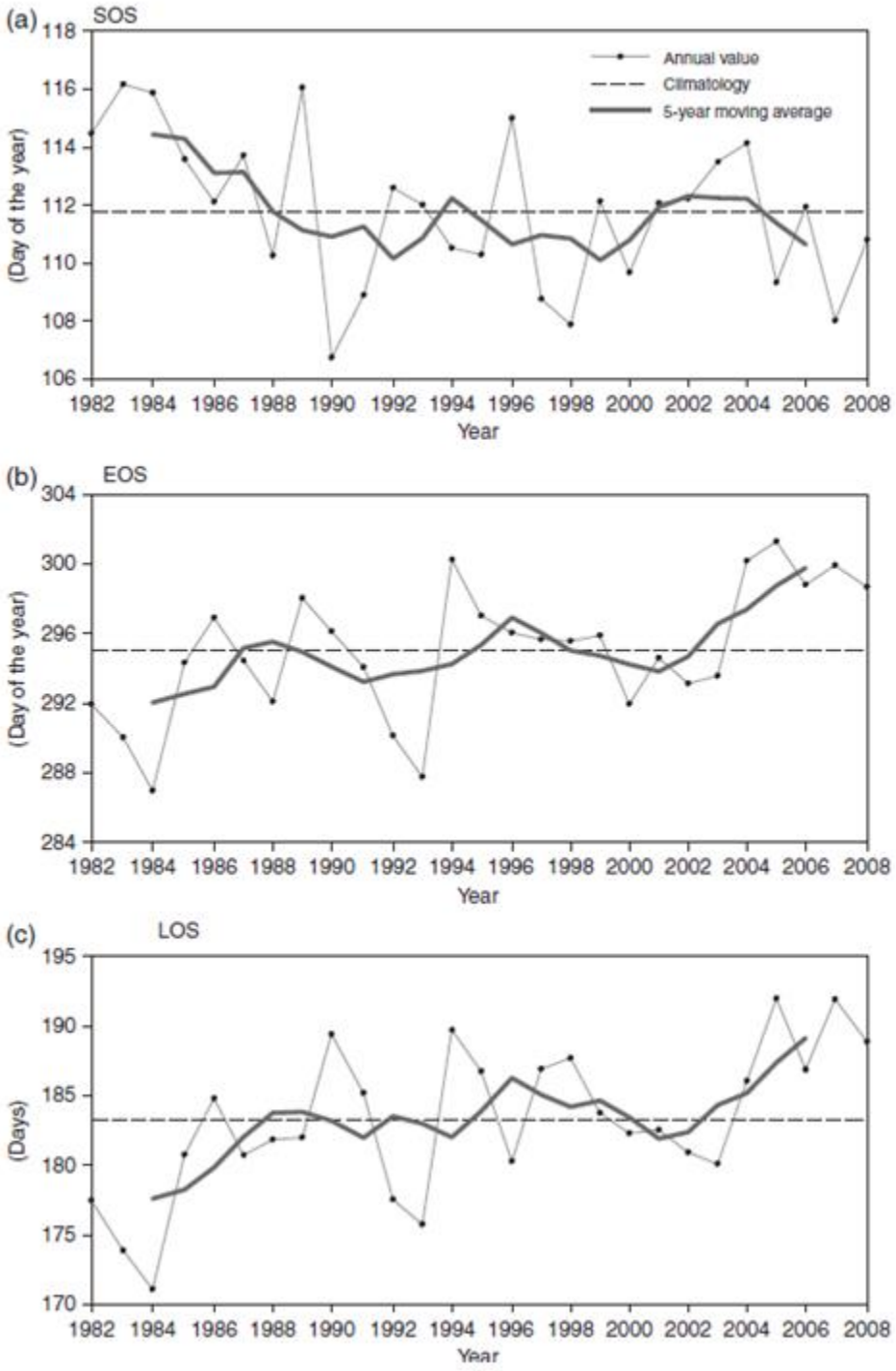
4 March

Jeong, Su-Jong, et al. "Phenology shifts at start vs. end of growing season in temperate vegetation over the Northern Hemisphere for the period 1982–2008."*Global Change Biology* 17.7 (2011): 2385-2399.

This paper compared NDVI with temperature in Northern Hemisphere. This paper used temperature at Jan to April when compare with SOS. and June-September EOS. This paper said higher temperature derived delayed leaf fall.However, my site is different with this one. In the understory, the higher temperature triggered early leaf

fall. What is different? And this paper compare between each continent. I will check a paper which is using climate map



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3 March

Sakai, Toru, et al. "The contribution of gross primary production of understory dwarf bamboo, Sasasenanensis, in a cool-temperate

deciduous broadleaved forest in central Japan." *Forest ecology and management* 236.2 (2006): 259-267.

This paper good mention that important of understory flux. This paper said the contribution of understory species to ecosystem GPP was more than 10%. However, this paper used model, So I'm not sure separating understory and overstory GPP. But this paper very similar with Gwangneung site. I think I will cite this paper. J "Therefore, understory GPP should not be neglected in carbon balance calculations (Kolari et al., 2006). Understory vegetation is as important as overstory trees in determining the sink/source function of forest ecosystems."

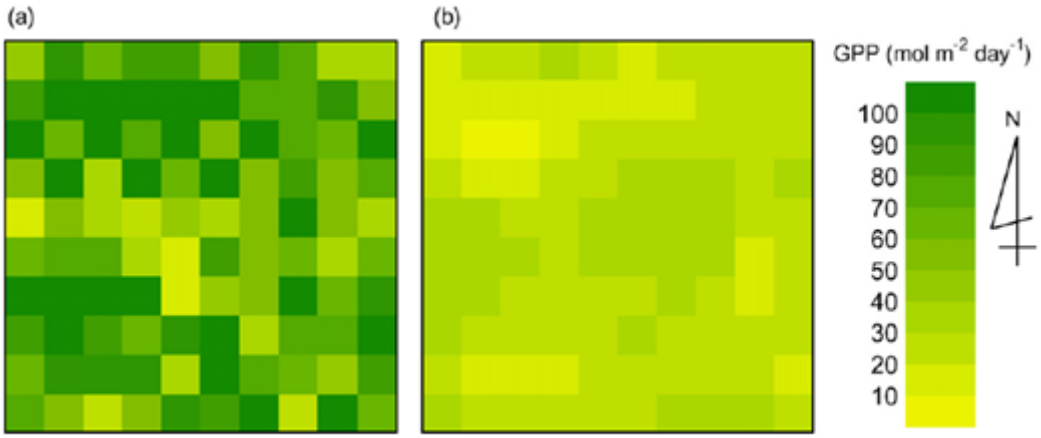

Fig. 6. Distribution of gross primary production (GPP) of (a) overstory; (b) understory species in the 1 ha study site.

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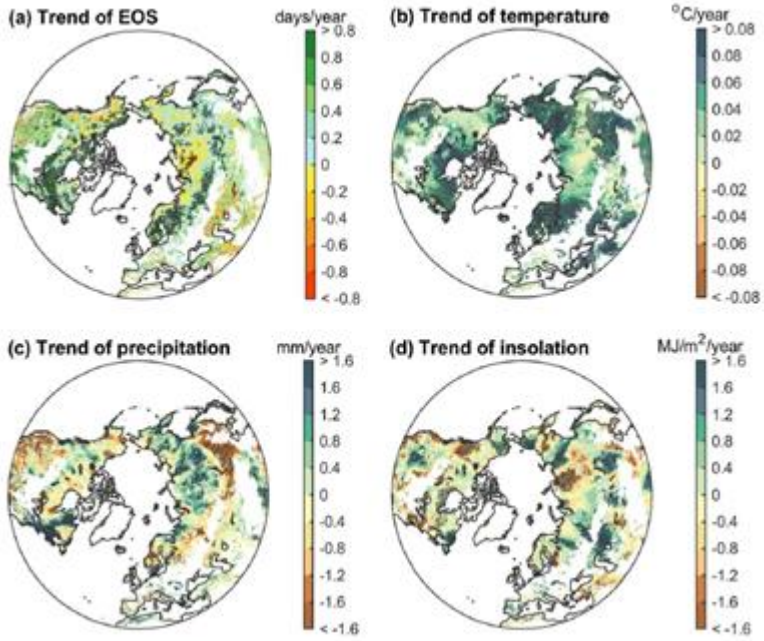
2 March

Liu, Qiang, et al. "Delayed autumn phenology in the Northern Hemisphere is related to change in both climate and spring phenology." *Global Change Biology* (2016).

This paper compare annual temperature and precipitation and insolation with EOS. I think this part is very interesting in this paper.

Multiple mechanisms have been proposed to explain the carryover effects of SOS (i.e. earlier SOS is followed by an earlier date of EOS). 1) The timing of leaf senescence was reported to be constrained by factors associated with leaf traits directly, such as leaf life span (Reich *et al.*, 1992) and programmed cell death (Lim *et al.*, 2007). 2) Earlier spring might lead to soil water loss in the early part of growing season, thereby increasing the prevalence of drought during summer (Buermann*et al.*, 2013) that may subsequently result in earlier leaf senescence. 3) Earlier leaf emergence may increase the risk of being exposed to spring frost (Hufkens*et al.*, 2012), and the outbreak of harmful insects (Jepsen*et al.*, 2011), which may be related to earlier leaf senescence. 4) The correlation between SOS and EOS was also suggested to be related to the limitation in the size of the plants' carbon sink: earlier accumulation of

non-structural carbohydrate in spring might have contributed to the earlier achievement of its maximum carbon content in autumn (Charrier &Améglio, 2011; Fu *et al*., 2014a). Nonetheless, it should be noted that the influence of earlier SOS on the determination of EOS was weaker than climatic variables across all biomes, and even in some areas with deciduous forest, a negative correlation were founded, suggesting more experimental efforts are needed to improve the understanding of the climatic and SOS effects on the EOS phenology process.



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1 March

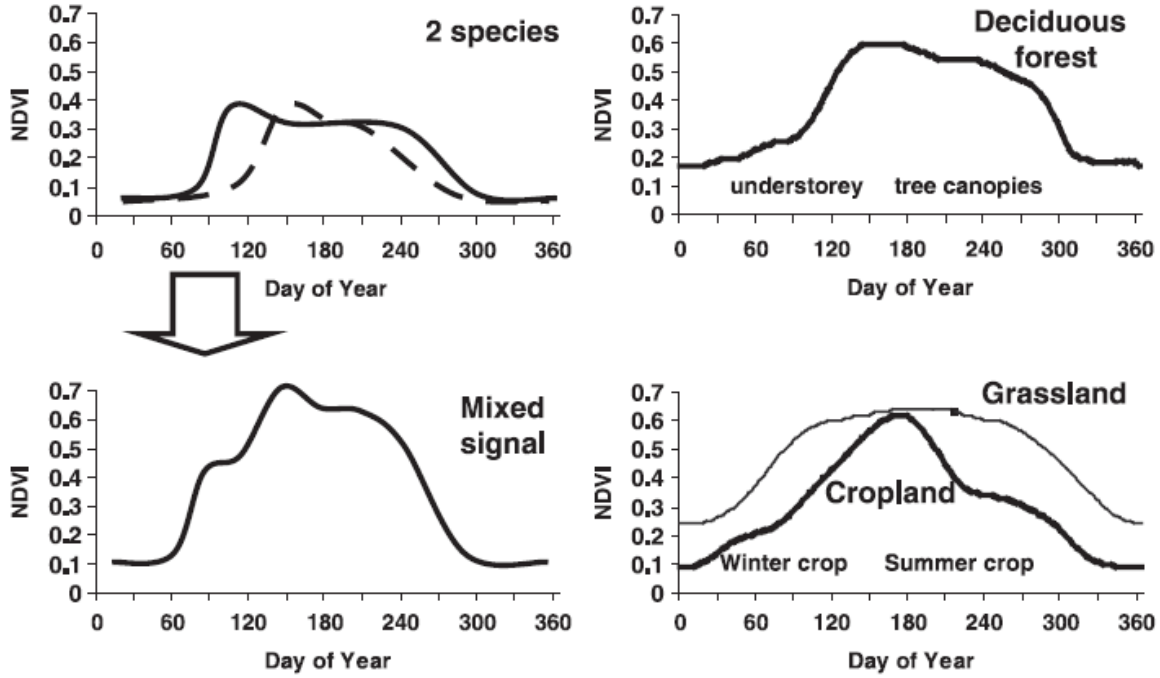
Badeck, Franz-W., et al. "Responses of spring phenology to climate change."*New Phytologist* 162.2 (2004): 295-309.

When I saw this paper, It was very interesting. Because this paper mention that mixed canopy NDVI. I haven't read mixed NDVI.

This paper showed what is different between one specie with more two combined species. "However, this method does not always work: for most deciduous forests in

temperate/boreal zones the satellite first sees the greening of the understorey that occurs several weeks before bud burst of the tree leaves."

Also this paper has some reference about this sentences. I will read them soon!



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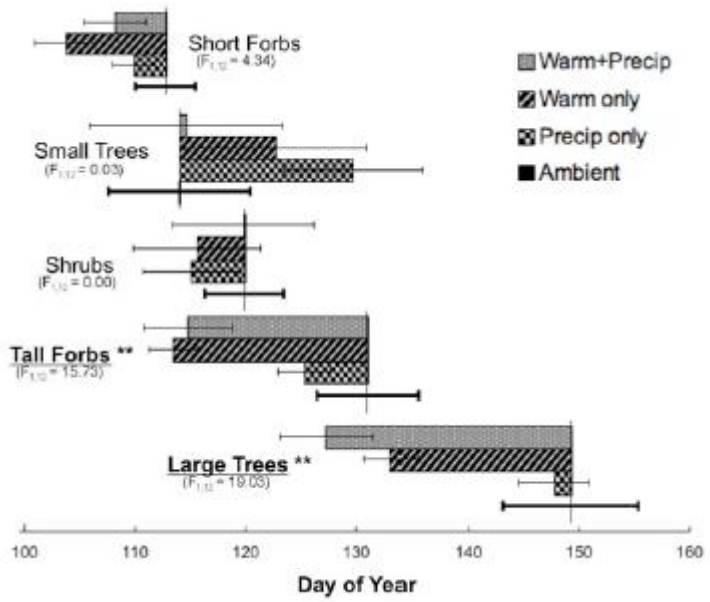
5 February

Rollinson, Christine R., and Margot W. Kaye. "Experimental warming alters spring phenology of certain plant functional groups in an early successional forest community." *Global Change Biology* 18.3 (2012): 1108-1116.

I studied flag which is standard of temperature from this paper. This paper chose FFD. The reasons are following :

Temperature-based growth cues are commonly represented by growing degree-days (GDD); however, we chose to represent spring warming cues with freeze-free days (FFD) because it captures similar spring warming patterns as GDD but also represents early spring chilling cues that often regulate bud burst (Lechowicz 1984, Korner & Balser 2010)

Furthermore, the base temperature for GDD can vary greatly depending on what species is being examined.



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4 February

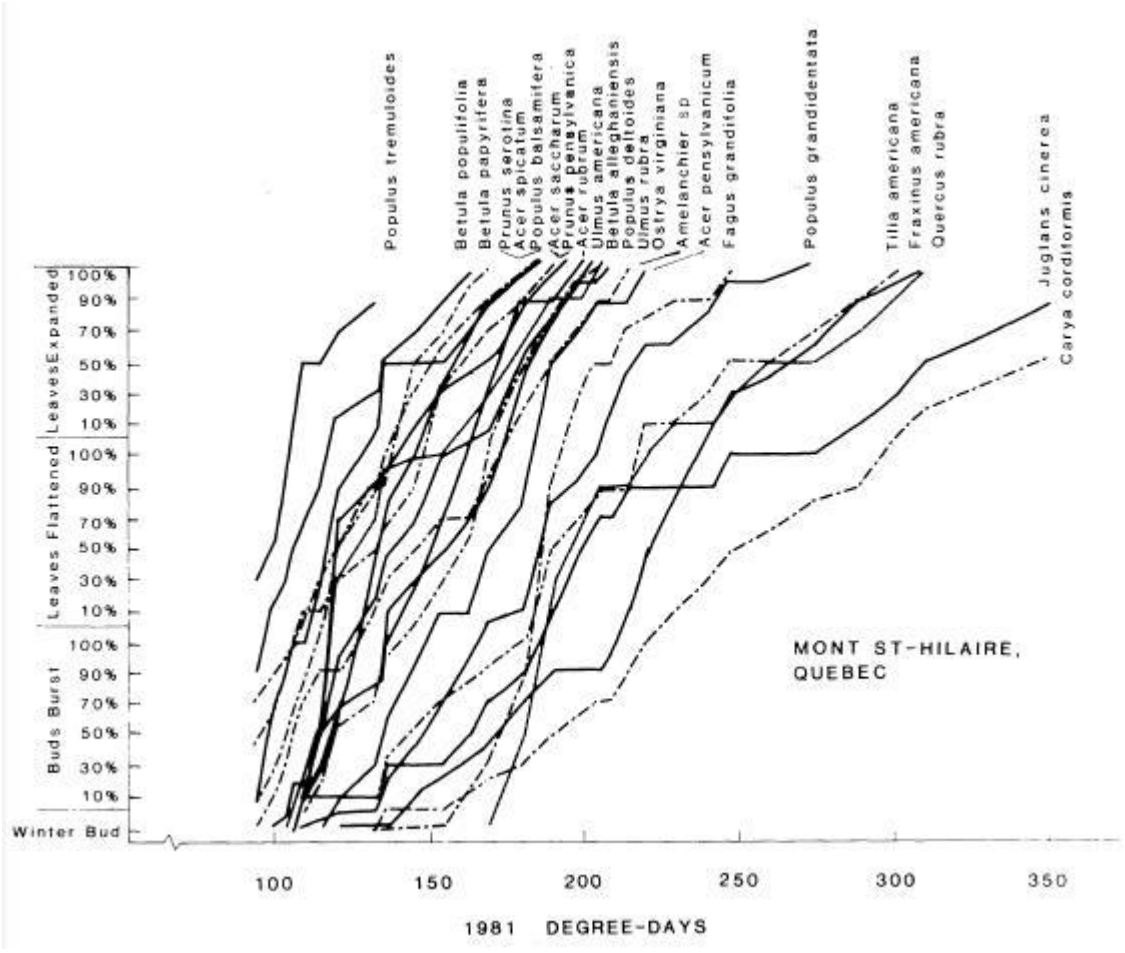
Lechowicz, Martin J. "Why do temperate deciduous trees leaf out at different times? Adaptation and ecology of forest communities." ***The American Naturalist*** **124.6 (1984): 821-842.**

I thought this paper is key about changing phenology. Because It has history and detail.

1.The time of spring leaf emergence varies consistently among deciduous tree species.

2.leaf out date relative with xylem's diameter. Big diameter has later leaf out date.

3.late-leafing species have narrow vessels.



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3 February

White, Michael A., and Ramakrishna R. Nemani. "Canopy duration has little influence on annual carbon storage in the deciduous broad leaf forest." ***Global change biology*** **9.7 (2003): 967-972.**

This paper's big word of phenology is two. First one is canopy duration which is day from leaf appearance to complete leaf fall. Second one is carbon uptake period integrates the influence of all ecosystem states and processes, was strongly related to NEE. This paper said the canopy duration has little influence on annual carbon storage in the deciduous broad leaf forest. However, they didn't use field data, and I'm not sure that simulator is good correct. However, It was good paper to me. Because this paper is opposite sides of other papers.

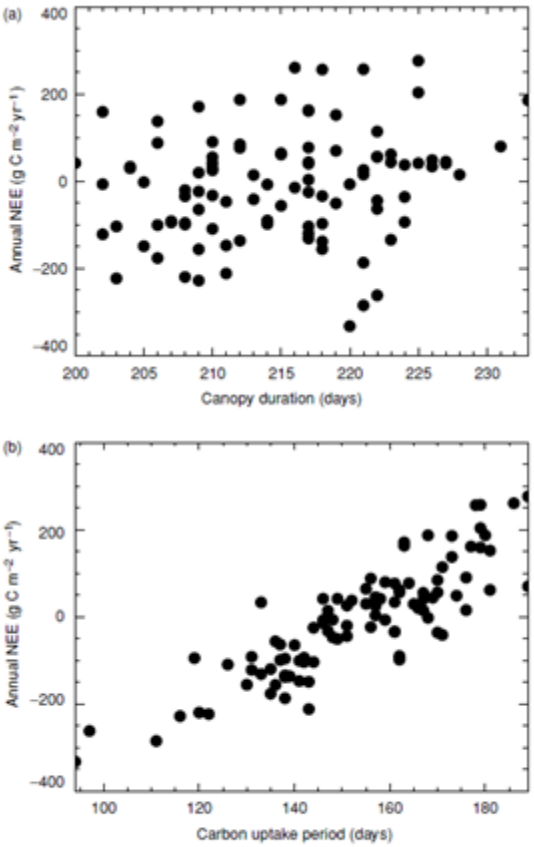

Fig. 1 Scatter plots for a representative 1895–1993 simulation of (a) canopy duration vs NEE and (b) carbon uptake period vs NEE.

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2 February

Zhang, Xiaoyang, et al. "Monitoring vegetation phenology using MODIS."*Remote sensing of environment* 84.3 (2003): 471-475.

I think that I will use this paper's method. They made one equation and fit MODIS result for monitoring phenology. This method can find (1) greenup, the date of onset of photosyntheticactivity; (2) maturity, the date at which plant greenleaf area is maximum; (3) senescence, the date at whichphotosynthetic activity and green leaf area begin to rapidlydecrease; (4) dormancy, the date at which physiologicalactivity becomes near zero. I will use this method with temperature data.

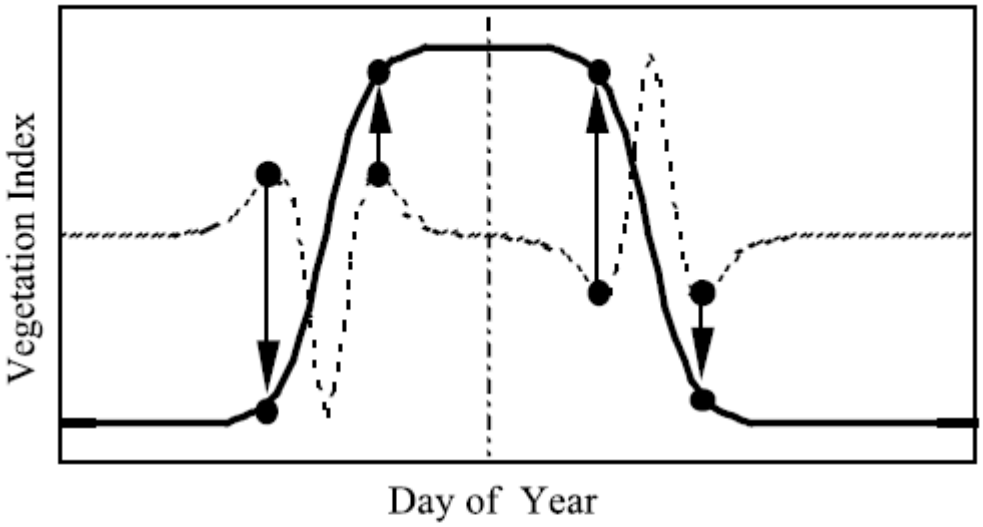

Fig. 2. A schematic showing how transition dates are calculated using minimum and maximum values in the rate of change in curvature. The solid line is an idealized time series of vegetation index data, and the dashed line is the rate of change in curvature from the VI data. The circles indicate transition dates. The extreme values located between each circle indicate the point at which the rate of change in curvature changes sign.

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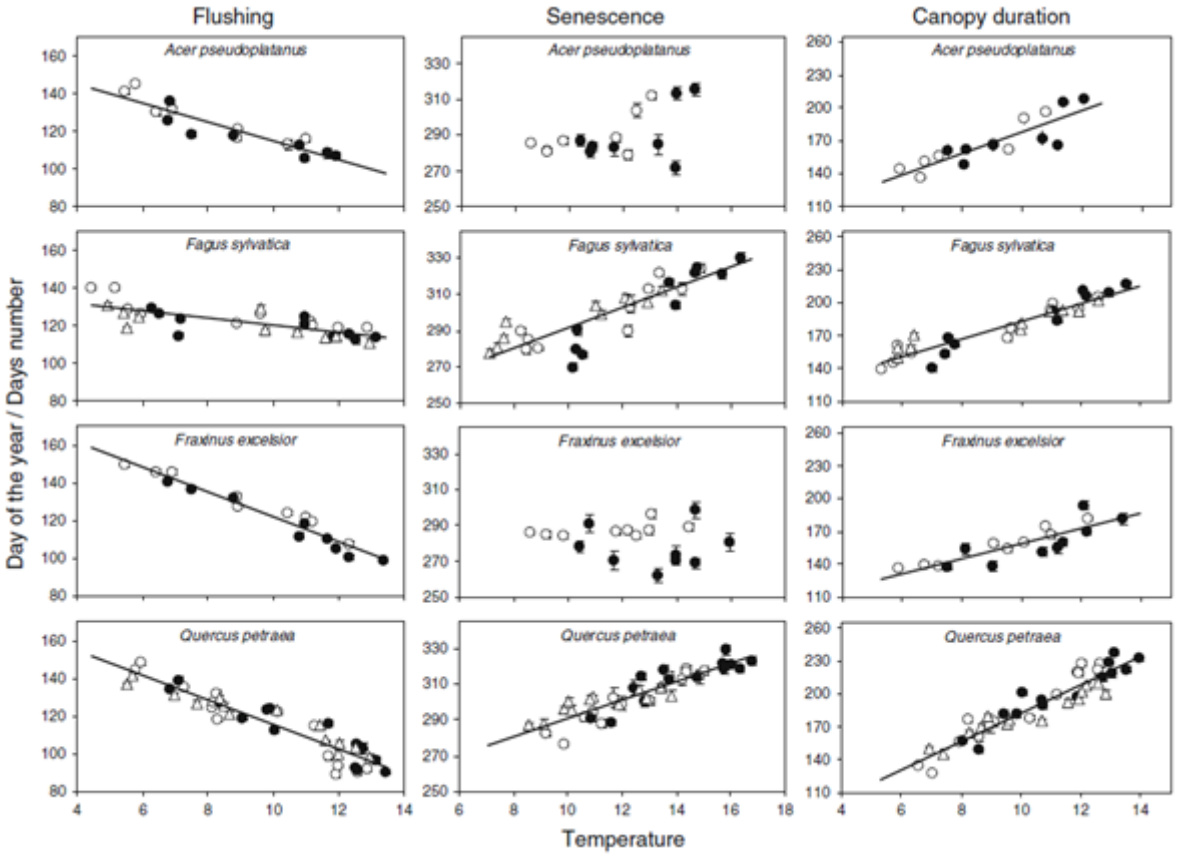
1 February

Vitasse, Yann, et al. "Responses of canopy duration to temperature changes in four temperate tree species: relative contributions of spring and autumn leaf phenology." ***Oecologia*** **161.1 (2009): 187-198**.

This paper mentioned that temperatureand altitude affect canopy duration. High altitude has lower temperature. So they said “Responses of canopy duration to temperature changes in four temperate tree species: relative contributions of spring and autumn leaf phenology”. I will use NDVI vegetation index. I hope it will be different shape between understory and overstory in each year.



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4 January Phenology

Hunter, Alison F., and Martin J. Lechowicz. "Predicting the timing of budburst in temperate trees." *Journal of Applied Ecology* (1992): 597-604.

This paper compared 4 model. spring warming model, chilling model, parallel chilling model, photothermal model. I have to study this four model because all model need to reflect theory. However, the main reason is same. Winter temperature is important in leaf out.

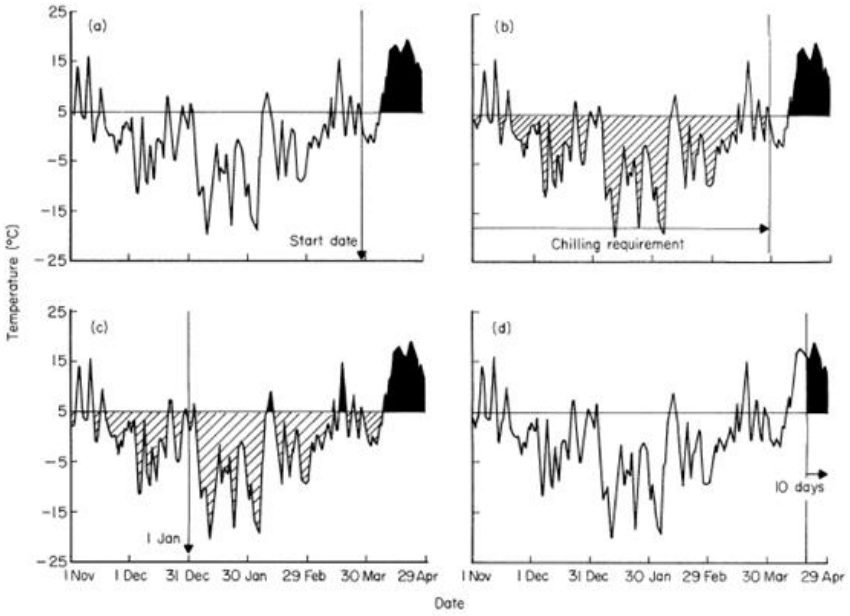

Fig. 1. Determination of the date of budburst by the models. Shaded areas contribute to heat accumulation towards budburst (■) or chilling duration (▨). Vertical lines represent constants in (a) and (c), variables in (b) and (d). (a) The spring warming model assumes a constant degree-day sum to budburst from a constant start date. (b) The sequential chilling model also has a constant degree-day sum to budburst, but the start date varies depending on when the constant chilling requirement is met. (c) The parallel chilling model assumes that there is a variable heat sum to budburst from 1 January which depends upon the chilling duration over the entire winter. (d) In the photothermal model the heat sum to budburst is a variable dependent upon the photoperiod. (Daily mean temperatures from Wauseon, Ohio in 1885–86.)

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3 January Phenology

Morin, Xavier, et al. "Leaf phenology in 22 North American tree species during the 21st century." *Global Change Biology* 15.4 (2009): 961-975.

This paper describethat comparing temperature with leaf unfolding specially chilling period. I thought this sentence is very interesting. “Species with a later phenology may have greater requirements of low temperatures to break dormancy than other species. Under global warming, the requirements for low temperatures are on average fulfilled later, causing a delay in break dormancy. Species with an earlier phenology may have lower chilling requirements so that the warming does not delay breaking dormancy as much as later species, and it accelerates subsequent cell growth, leading, on average, to an advanced leaf unfolding date. “ this means that global climate change doesn’t always affect leaf unfolding earily.

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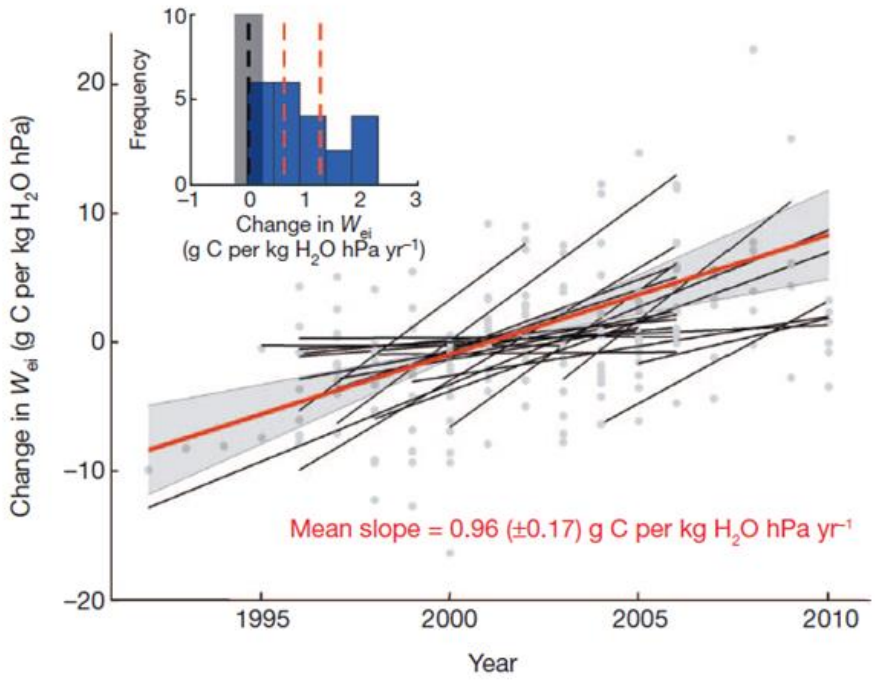
2 January Trend

Increase in forest water-use efficiency as atmospheric carbon dioxide concentrations rise

Trevor F. Keenan, David Y. Hollinger, Gil Bohrer, Danilo Dragoni, J. William Munger, Hans Peter Schmid & Andrew D. Richardson

This study confirm that shift in the carbon- and water-based economics of terrestrial vegetation,which may require a reassessment of the role of stomatal control in regulating interactions between forests and climate change,and a re-evaluation of coupled vegetation–climate models. And this paper used a very simple formula for estimate water use efficiency. And they said that if rising CO2 is the driving factor, then to reproduce the magnitude of the observed trends in Wei,plants would have to partially close their stomata (thereby reducing gs and hence E) to hold Ci at a relatively constant level despite increasing ca concentrations. This was also interested.



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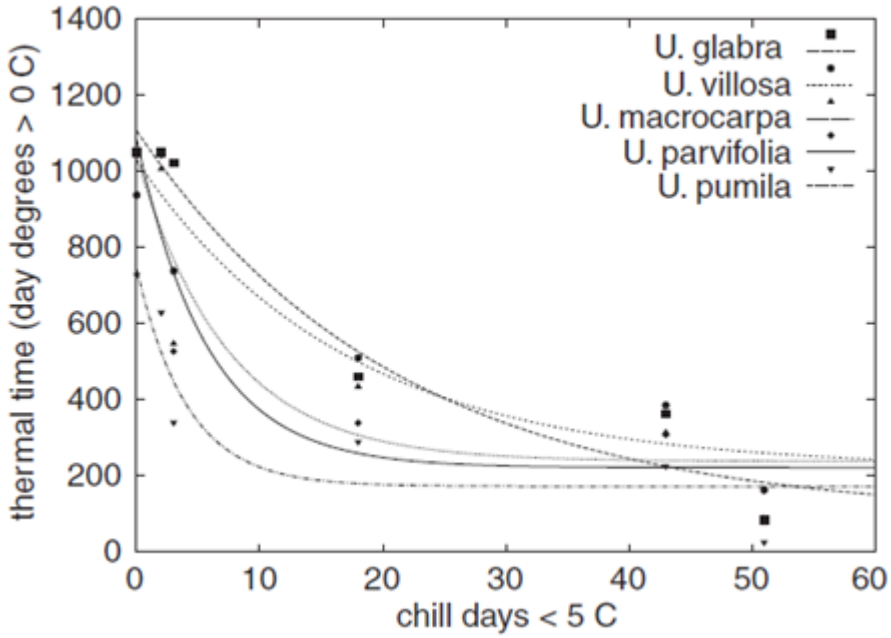
1 January Phenology

Bud dormancy release in elm (Ulmusspp.) clones—a case study of photoperiod and temperature responses

Lusia Ghelardini, Alberto Santini, Sanna Black-Samuelsson, Tor Myking and Mauro Falusi

This paper said the photoperiod and temperature are relative with each other. This figure is very interesting. In this figure, chill days negative relative with thermal time. Important thing is that the variation of each value is effected by species. In this paper's abstract also said that in all the clones except *U. minor*, the observed decrement in thermaltime to bud burst was efficiently explained as an inverse exponential function of the number of chill days ≤5 °C received outdoor in autumn and winter. Endodormancy, as measured by the single-node cuttings test, was weak and short in all the clones. The latter result suggests that correlative inhibitions were largely responsible for preventing bud burst during winter in these elm clones.


thermal time (day degrees > 0 C)
chill days < 5 C
U. glabra
U. villosa
U. macrocarpa
U. parvifolia
U. pumila
0
200
400
600
800
1000
1200
1400
0
10
20
30
40
50
60