23rd CEReS International Symposium
(2nd Dec. 2015 Chiba)

Chiba University

Phenological Eyes Network (PEN)
- Ground-based Measurement for Remote Sensing Studies -

# USABILITY OF PHENOLOGICAL INFORMATION PUBLISHED ON WEB SITES FOR GROUND-TRUTHING OF SATELLITE REMOTE-SENSING OBSERVATIONS

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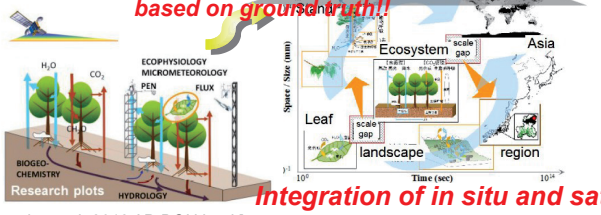
*To accurately evaluate global changes in carbon, water, and energy balances, we require to evaluate the spatio-temporal variability of plant phenology with a high spatiotemporal resolution.*


***At super sites,*** ***Scaling up based on ground truth!!***



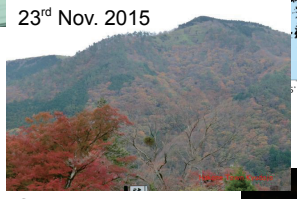

[Muraoka et al. 2012 AP-BON book]

***Integration of in situ and satellite observations is important!!***

17th Nov. 2015

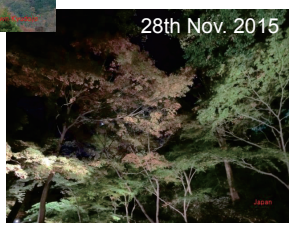
Otsuki, from Super conducting Maglev

23rd Nov. 2015



Gora, Hakone

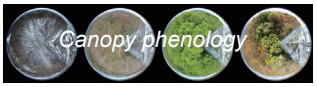
28th Nov. 2015



Rikugien, Tokyo

*From the in situ ecological research view point, satellite remote-sensing approach has not been sufficiently tested and validated by the ground-truthing.*

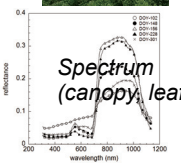
***In situ***



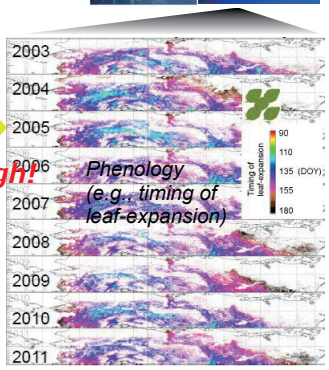


***V.S.***

***Not enough!***

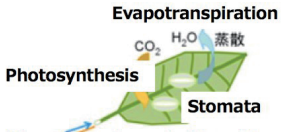




***Satellite***

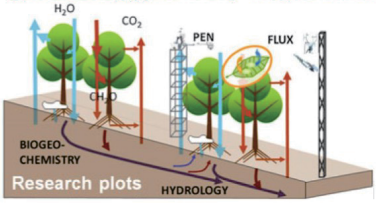




## *Why are phenological observations important?*

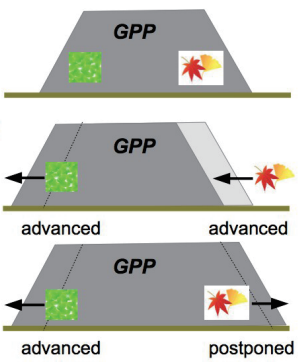
*Interannual variations of growing season may affect the yearly gross primarily production (GPP).*




***Seasonal variation in vegetation (phenology) is very important!***

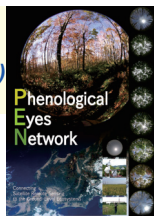


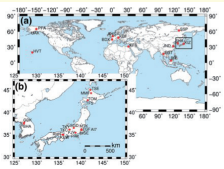

[Muraoka et al. 2012]




[Richardson et al. 2012]

*Global, long-term and continuous camera, spectral radiometer and sunphotometer sites organised by* ***Phenological Eyes Network (PEN)*** *[http://www.pheno-eye.org] since 2003.*

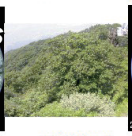


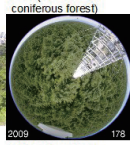




[Nasahara & Nagai, 2015; EcoRes]

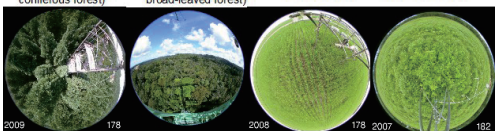
AHF (deciduous broad-leaved forest)
TKY (deciduous broad-leaved forest)
MTK (mixed forest)
FHK (deciduous coniferous forest)

***Sunphotometer: 3 sites***

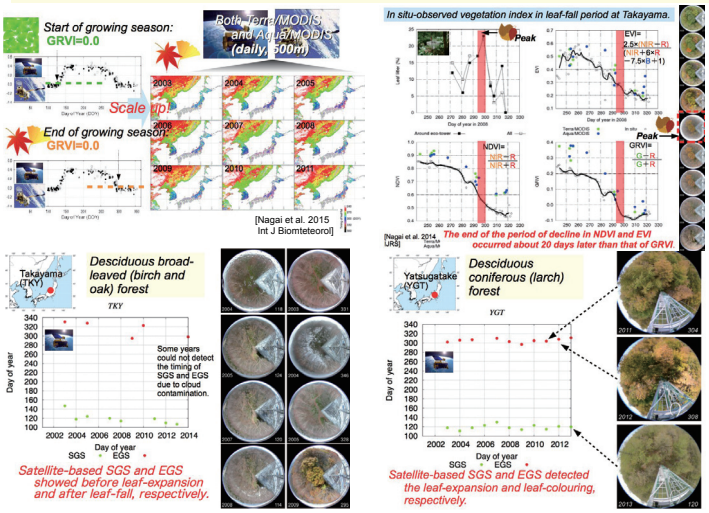





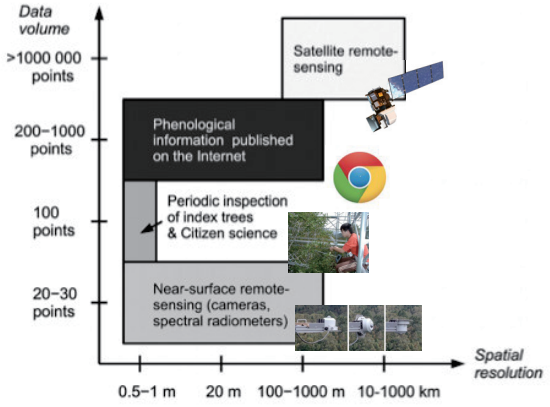

TKC (evergreen coniferous forest)
LBR (evergreen broad-leaved forest)
MSE (paddy)
SGD (grassland)



## Ground-truthing of phenological observations by satellites




## Relationship between the amount and spatial resolution of the available datasets for phenological observations.



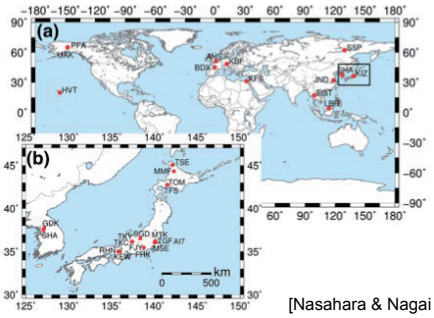

[Nagai et al. In press, Fig. 4: Int J Biometeorol]

## However,

*It is pretty difficult to collect ground-truthing at multiple points in various ecosystem sites.*

*We are not always to obtain the representative of ecosytem site.*

*Global PEN sites*

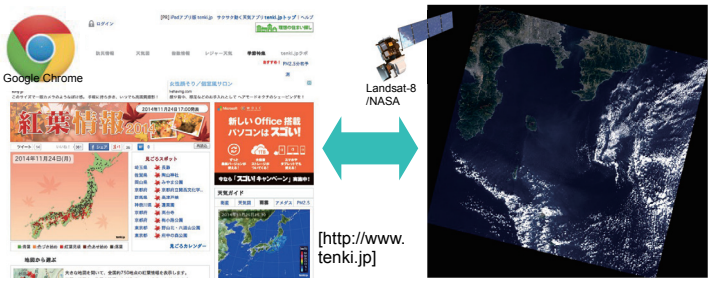



[Nasahara & Nagai 2015 Eco Res]

## Material & method:

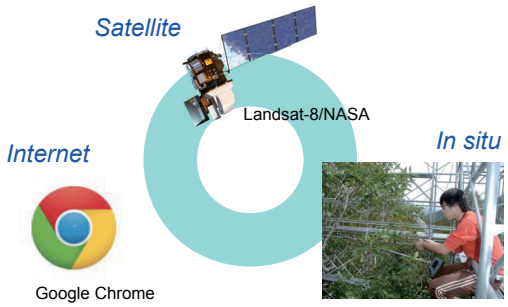
*(1) We collected leaf-coloring information published on the web sites during 21 November 2014 and 25 November 2014 in Kanagawa, Japan.*

*(2) We examined the relationship between leaf-coloring information and Landsat-8/OLI-observed green-red vegetation index (GRVI) on 23 November 2014.*

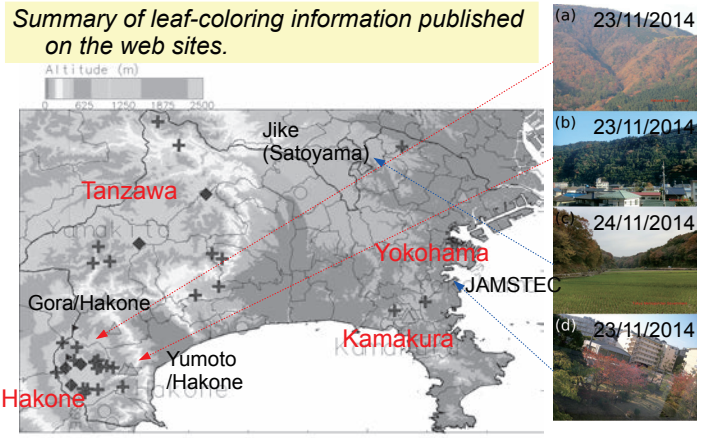



## Aim:

*We evaluated the usability of leaf-coloring information published on the web sites to provide ground-truthing for the mapping of spatio-temporal variability of leaf-coloring phenology by using in situ and satellite remote-sensing data.*




## Summary of leaf-coloring information published on the web sites.




□: green leaves, ○: start of leaf-coloring,
△: pre-peak of leaf-coloring, ×: peak,
◇: post-peak of leaf-coloring, ⚑: leaf-fall

[Nagai et al. 2015 Jpn J Biometeorol]

## Summary of leaf-coloring information published on the web sites

Table 2. Leaf-coloring information available on web sites from 21 and 25 November 2014 in Kanagawa prefecture, Japan

| City | Main reported point, garden, or area | Number of reports | Number of overlapping reports |
|---|---|---|---|
| Hakone | Asinoko (lake), Hakone Museum | 22 | 13 |
| Kamakura | Zuisen-ji (temple), Enkaku-ji (temple) | 10 | 6 |
| Yokohama | Sankeien (garden), Yamashita-Park Avenue | 8 | 4 |
| Yamakita | Tanzawako (lake), Nakagawa Hot Spring | 5 | 5 |
| Isehara | Oyamadera (temple), Oyama-Afuri Shrine | 2 | 3 |
| Yugawara | Ikemine Momiji-no-Sato | 2 | 3 |
| Sagamihara | Mt. Jinba | 2 | 1 |
| Hadano | Kobo-yama (mountain) | 2 | 0 |
| Minami-Ashikaga | Daiyuzan Saijyo-ji (temple) | 1 | 2 |
| Oiso | Prefectural Oiso Jyoyama Park | 1 | 1 |
| Kiyokawa | Miyagaseko (lake) | 1 | 2 |
| Kawasaki | Ikuta-Ryokuchi (park) | 1 | 0 |

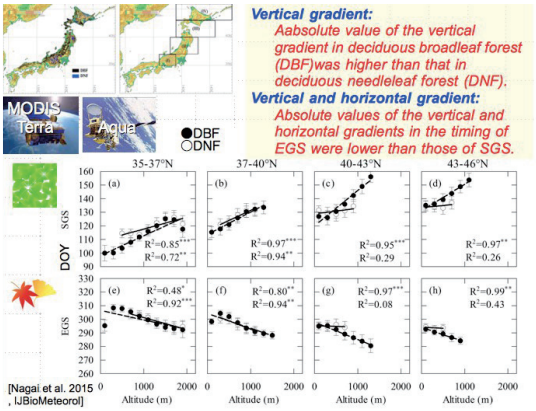
*1st finding:*

*Leaf-coloring information published on the web sites were widely distributed in sights of mountains (Hakone and Tanzawa) and cities (Kamakura and Yokohama).*

[Nagai et al. 2015 Jpn J Biometeorol]

*2nd finding:*

*Leaf-coloring information published on the web sites in multiple points in mountainous region provided useful ground-truthing for satellite remote-sensing along the vertical gradient.*




**Vertical gradient:** *Aabsolute value of the vertical gradient in deciduous broadleaf forest (DBF)was higher than that in deciduous needleleaf forest (DNF).*

**Vertical and horizontal gradient:** *Absolute values of the vertical and horizontal gradients in the timing of EGS were lower than those of SGS.*

[Nagai et al. 2015 , IJBioMeteorol]

## Summary of source of leaf-coloring information on the web sites

Table 3. Source of leaf-coloring information published on web sites from 21 to 25 November 2014

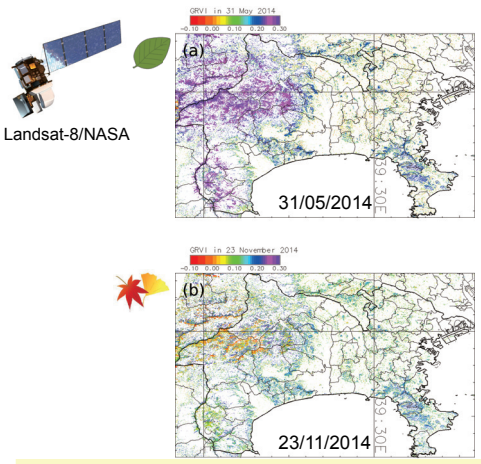
| Source | Name | Web site address | Number of reports |
|---|---|---|---|
| Tourism service | rurubu.com (JTB Publishing) | http://www.rurubu.com/ | 1 |
| Tourism service | Walkerplus (Kadokawa Corporation) | http://www.walkerplus.com/ | 11 |
| Tourism service | jalan.net (Recruit Lifestyle Co., Ltd.) | http://www.jalan.net/ | 1 |
| Meteorological service | tenki.jp (Japan Weather Association) | http://www.tenki.jp/ | 21 |
| Meteorological service | weathernews.jp (Weathernews Inc.) | http://weathernews.jp/ | 14 |
| Park | Prefectural Oiso Jyoyama Park | http://www.kanagawa-park.or.jp/ooisojoyama/ | 1 |
| Park | Sankeien Hoshoukai Foundation | http://www.sankeien.or.jp/ | 1 |
| Park | Yokohama-Ryokuchi Co., Ltd. | http://www.kanagawaparks.com/mitsuike/ | 1 |
| Tourism society | Prefectural Tourist Association | http://www.kanagawa-kankou.or.jp/ | 19 |
| Tourism society | Hakone Tourist Association | http://www.hakone.or.jp/ | 8 |
| Tourism society | Kamakura City Tourist Association | http://www.kamakura-info.jp/ | 7 |
| Tourism society | Minamiashigara City Tourist Association | http://www.mcity-kankokyokai.com/ | 1 |
| City office | Isehara City | http://www.city.isehara.kanagawa.jp/ | 1 |
| Town office | Town Yamakita | http://www.town.yamakita.kanagawa.jp/ | 3 |
| Temple | Enkakuji | http://www.engakuji.or.jp/ | 1 |
| Museum | Hakone Museum of Art | http://www.moaart.or.jp/hakone/ | 1 |

*Tourism service*

*Meteorological service*

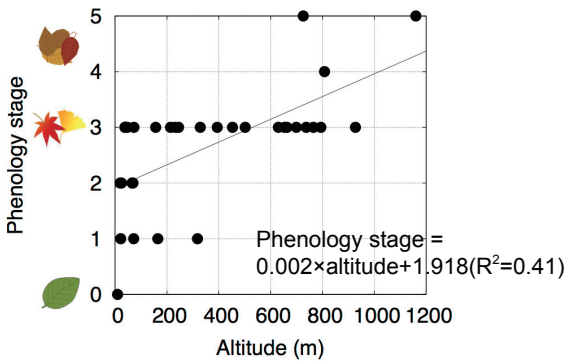
*Tourism society*

[Nagai et al. 2015 Jpn J Biometeorol]



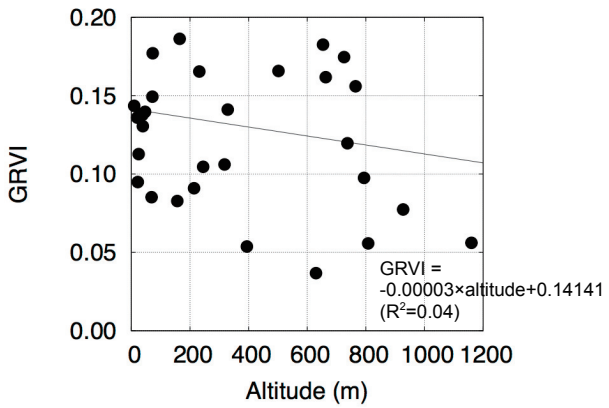

*Spatial distributions of GRVI in deciduous forests on (a) 31st May 2014 and (b) 23rd November 2014. We only colored deciduous forests.*

[Nagai et al. 2015 Jpn J Biometeorol]




*Relationship between altitude and phenology stage (0: green leaves; 1: start of leaf-coloring; 2: pre-peak of leaf-colouring; 3: peak; 4: post-peak of leaf-colouring; 5: leaf-fall) in deciduous forests based on leaf-colouring information published on the web sites.*

[Nagai et al. 2015 Jpn J Biometeorol]

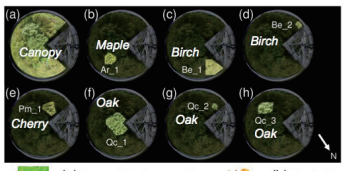



*Relationship between altitude and GRVI in deciduous forests at locations obtained leaf-coloring information on the web sites.*

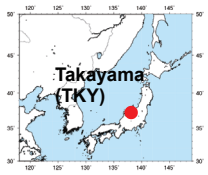
[Nagai et al. 2015 Jpn J Biometeorol]

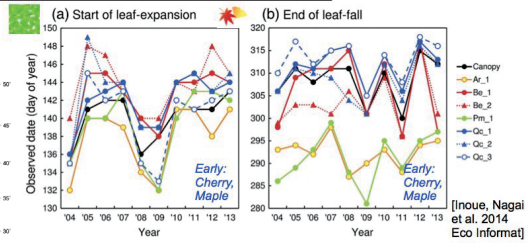
*3rd finding:*

*Leaf-coloring information published on the web sites included the uncertainties due to definition of leaf-coloring phenology, location of reported points, and heterogeneity and footprint of vegetation.*




***Compared with the timing of start of leaf-expansion, year-to-year variability of end of leaf-fall were different among species.***




[Inoue, Nagai et al. 2014 Eco Informat]

## *Thank you for your attention!*

*We are also grateful for many supports by*


- NEON (PhenoCam)
- HyARC, Nagoya University
- KAKENHI (JSPS)
- Hawaii University
- Environment Research and Technology Development Fund (S-9) of the Ministry of the Environment of Japan, and all PEN members
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- GRENE
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- JSPS Funding Program for Next Generation World-Leading Researchers (NEXT Program)
- CEReS, Chiba University
- UK-Japan collaboration (UK embassy)
- and all PEN members.


*Phenological Eyes Network (PEN)*

– Ground-based Measurement for Remote Sensing Studies –