

*How to link multiple super sites for integration of satellite and ground observations  
-from the view point of plant phenology-*



Shin Nagai



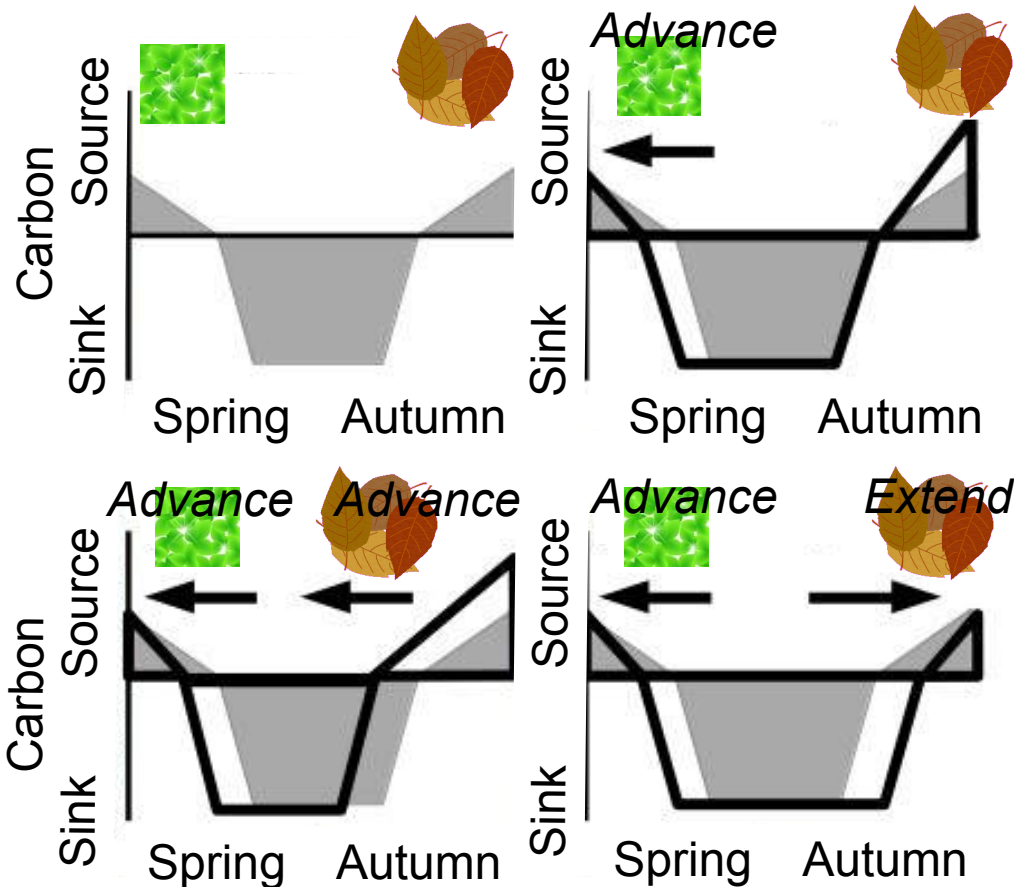
**JAMSTEC** 国立研究開発法人  
海洋研究開発機構  
JAPAN AGENCY FOR MARINE-EARTH SCIENCE AND TECHNOLOGY

Plant phenology (e.g. timing of flowering, leaf-flush, and leaf-fall) is important to evaluate spatio-temporal variability of ecosystem functions and service under climate change.

## Function of photosynthesis & Regulating services

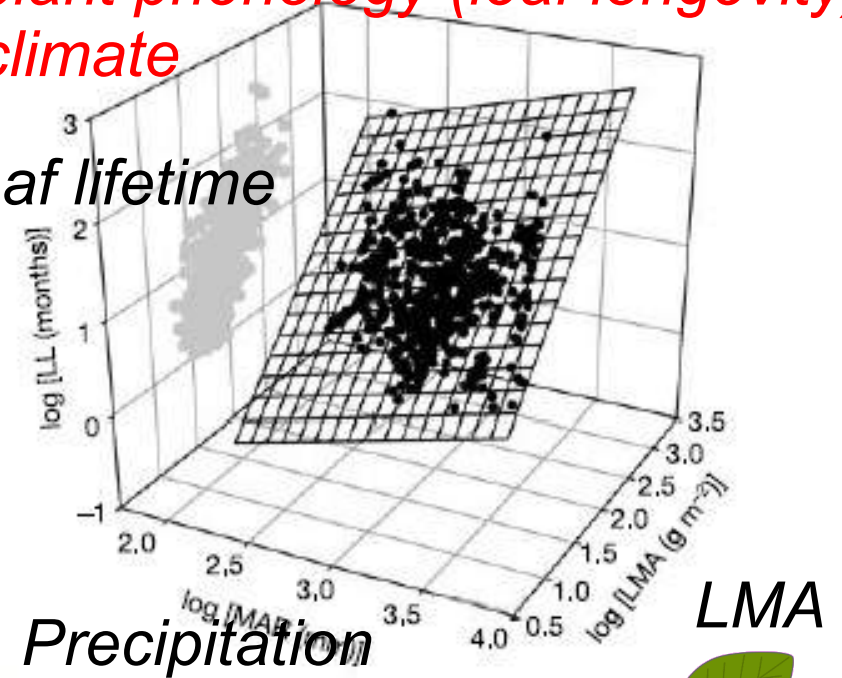
### Carbon cycle

Normal case



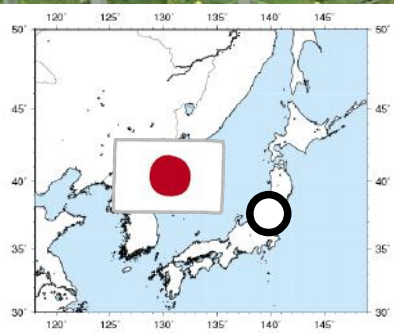
Photosynthetic capacity–leaf trait  
 –plant phenology (leaf longevity)  
 –climate

Leaf lifetime



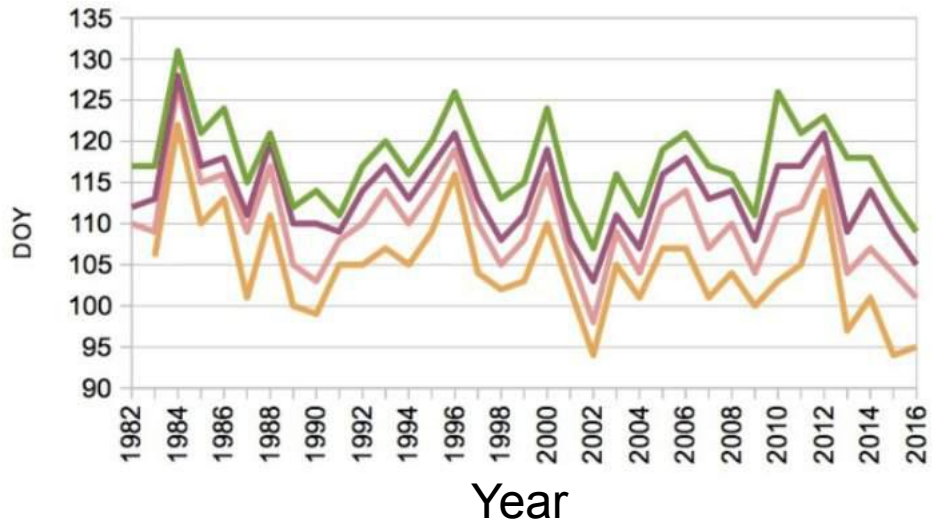
**Figure 4** LL as a function of precipitation (MA and MAR (all axes are  $\log_{10}$ -scaled)). The 3D LL–LMA cloud of points is spread along a sloping surface. The slope is steeper in the LMA dimension than in the rainfall dimension, reflecting the higher partial regression coefficient for LMA (1.23 versus 0.47). Both coefficients were highly significant in a multiple regression ( $P < 0.0001$ ;  $r^2 = 0.51$ ; data for 678 species from 51 sites).

# Cultural services



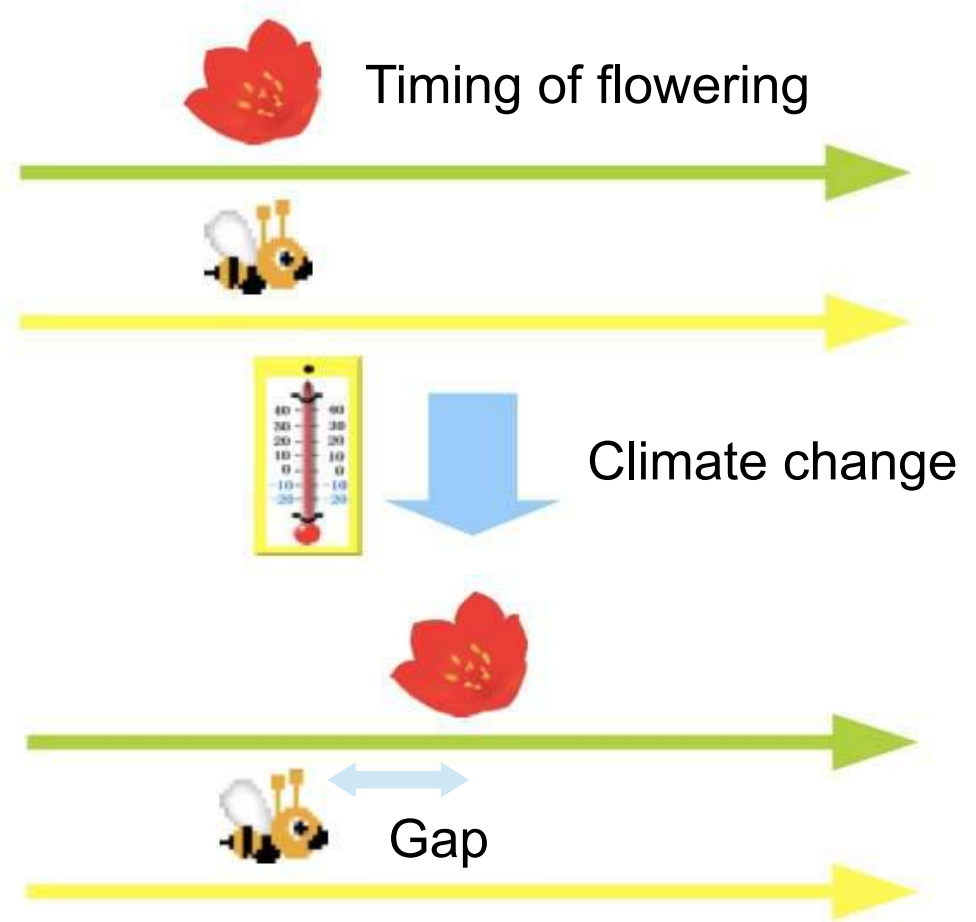
10<sup>th</sup> Apr. 2016

Miharu, Fukushima



# Risk of lossing biodiversity

## Phenological mismatch



- Flowering
- Full-blooming
- Scattering
- Tree in leaf

[<http://www.town.miharu.fukushima.jp/soshiki/7/01takizakura-01-0201kako.html>]  
 [<http://www.town.miharu.fukushima.jp/soshiki/7/takizakura0417.html>]

# To observe spatio-temporal variability of plant phenology, remote and non-destructive sensing is very useful!!

← Plot

1-10m



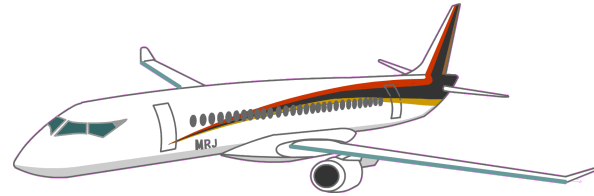
Spatial scale

100-1000m



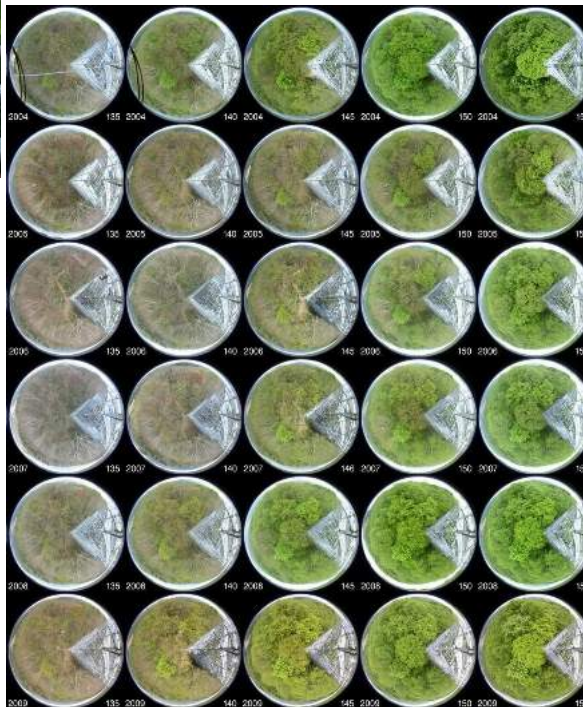
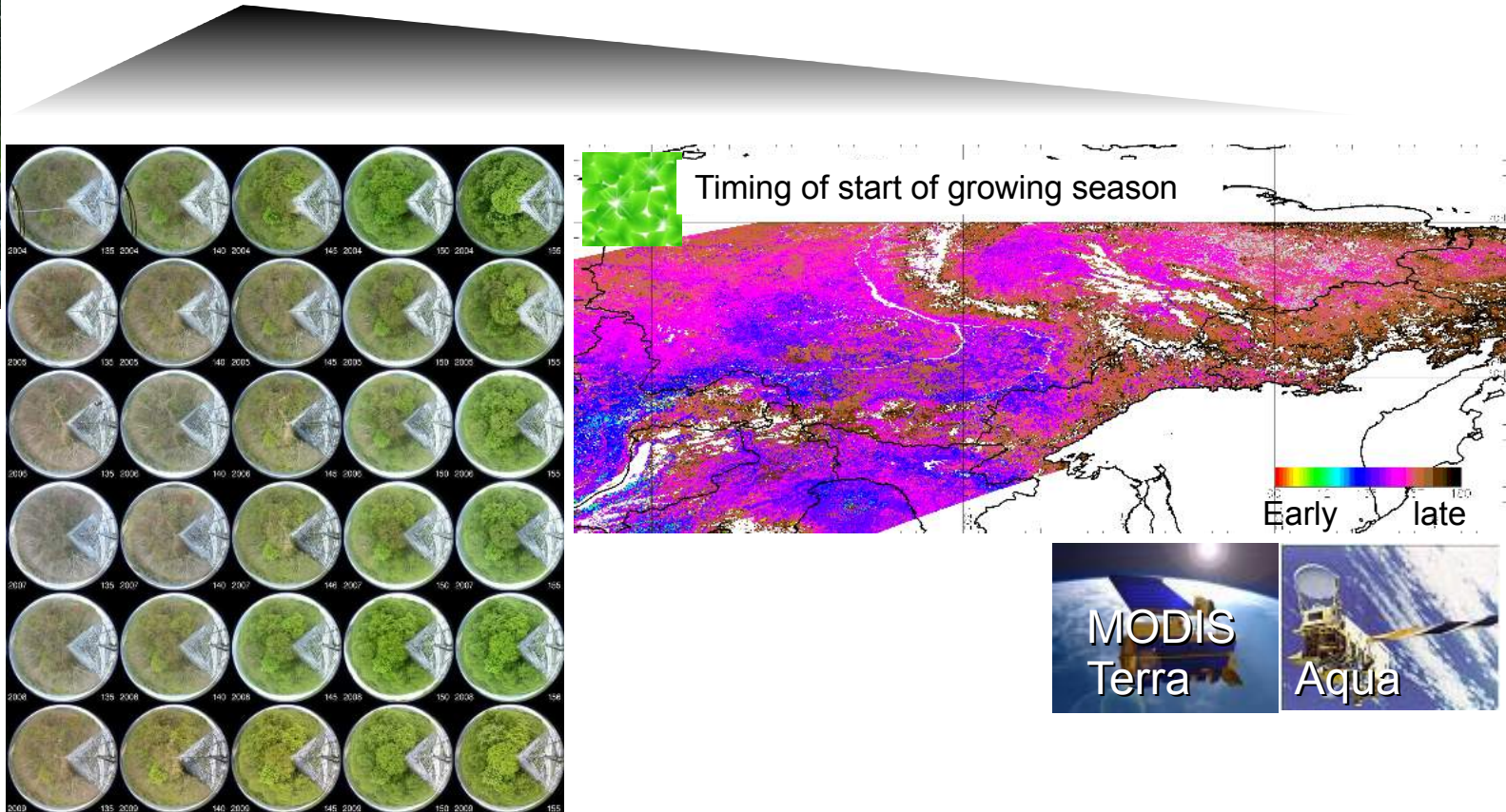
1-100km

Aircraft

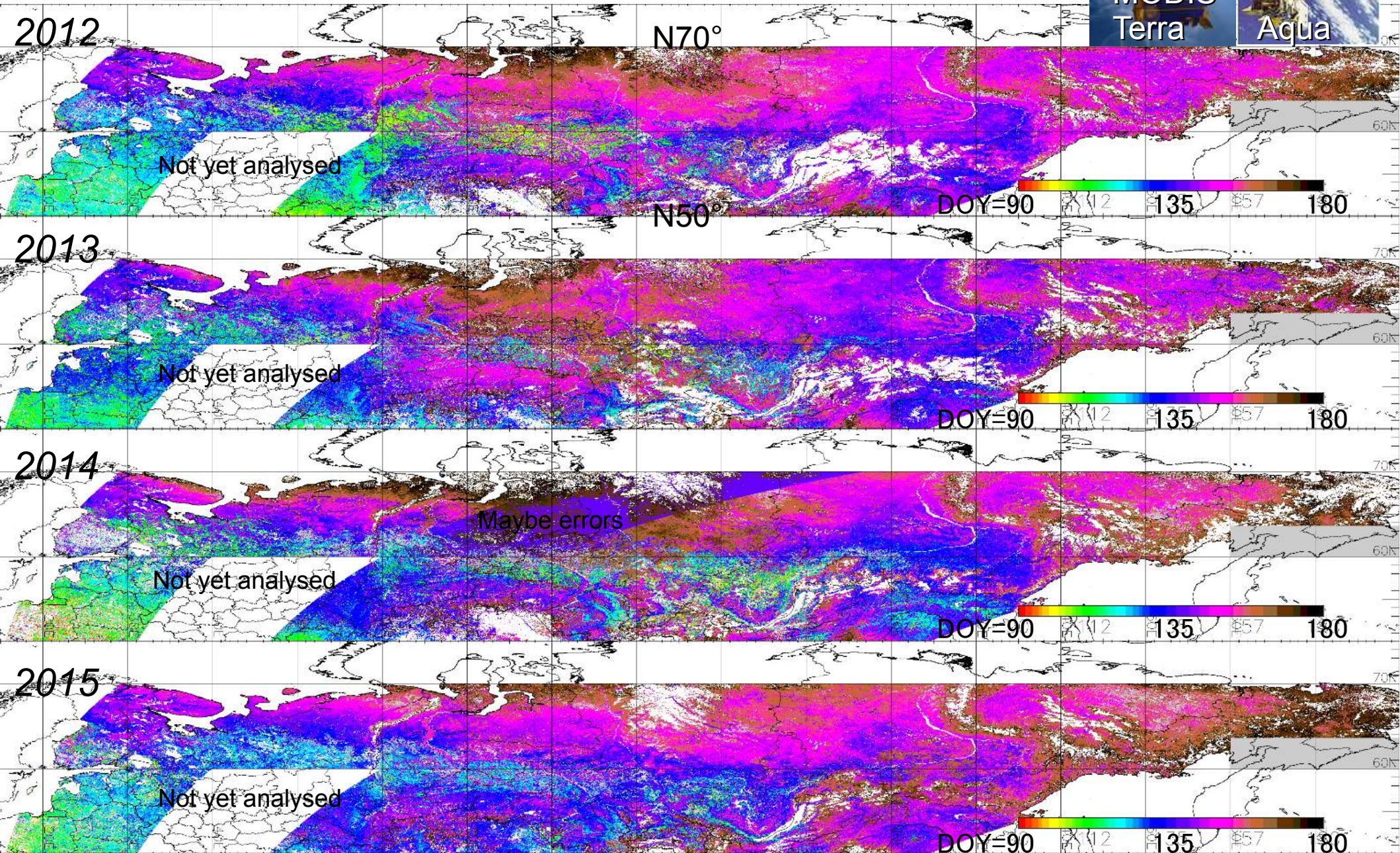


Wide area →

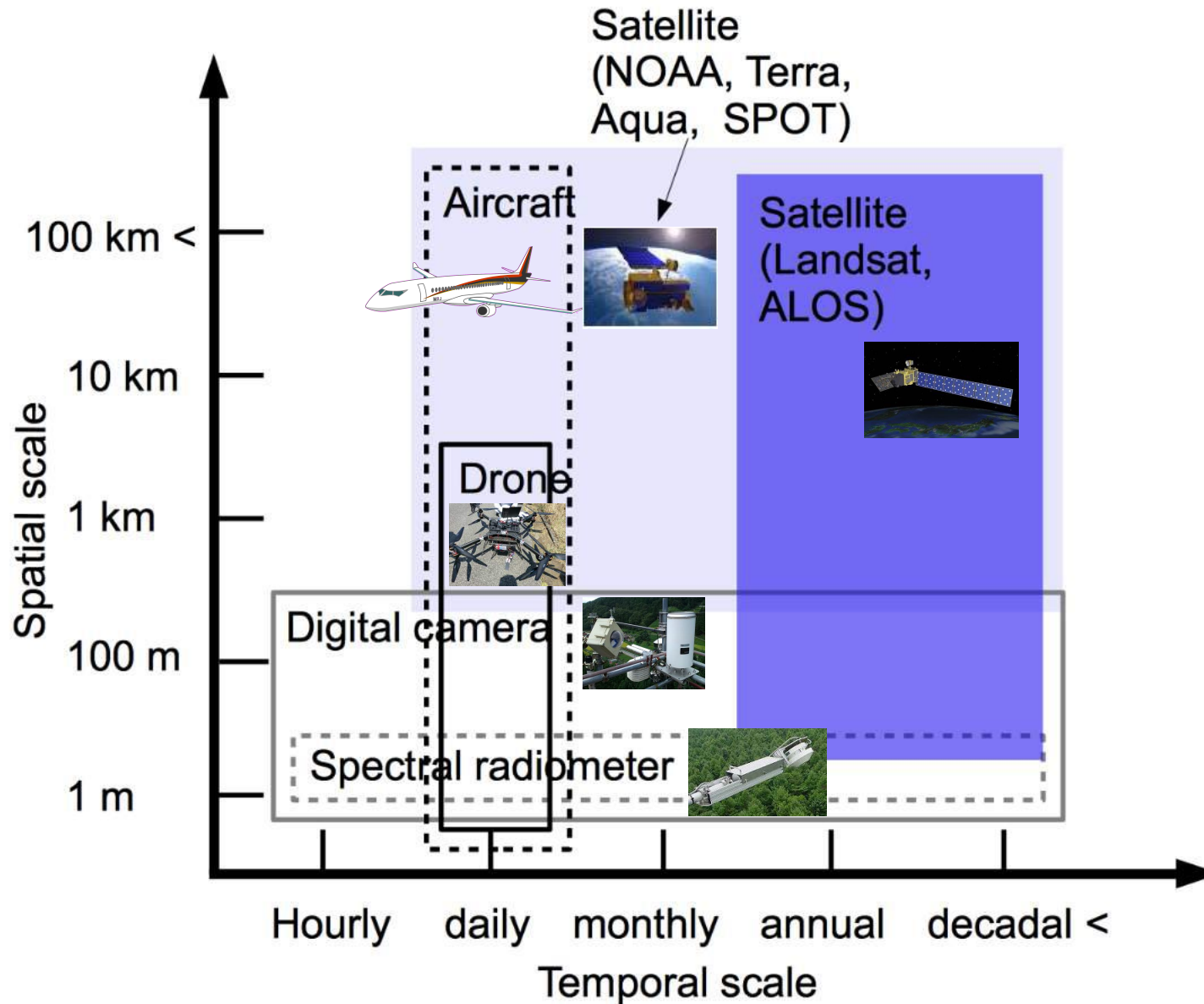
global



# Spatio-temporal variability of the timing of start of growing season by analysing MODIS/Terra&Aqua-observed daily GRVI (500m res.)



**Unavoidable important issue:  
spatial and temporal gaps among multiple sensors  
mounted on multiple platforms.**



# Global phenology observation networks by using time-lapse cameras

インターネット自然研究所 **Web Camera Images of National Parks and Wildlife in Japan**

Phenological Eyes Network (PEN)  
 フュノロジカル・アイズ・ネットワーク  
 — Connecting Satellite Remote Sensing to the Ground-Level Ecosystems —  
 pen-mi@asi.go.jp  
 What does PEN stand for?  
 English / MPEG animation / gallery / open documents / closed documents / presentation list /  
 Leaflet: PDF / PPT / JPEG (page1, page2, page3, page4)  
 Review article in AsiaFlux Newsletter (2007)

PhenoCam - Site Map  
 About Gallery Map FAQ Tools Data Site Table Education  
 Welcome, Guest (login)  
 All Active Inactive

<http://www.sizenken.bioidic.go.jp/index.php>  
<http://www.pheno-eye.org>

<https://phenocam.sr.unh.edu/webcam/>

**Phenological Eyes Network**

**PhenoCam**

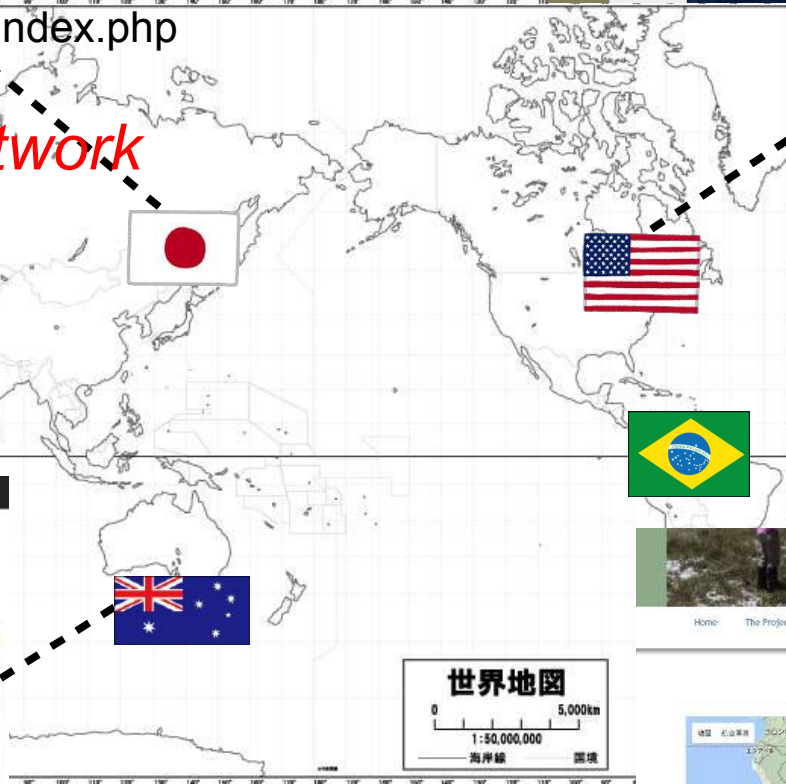
**Australian Phenocam Network**

**e-phenology**

Australian Phenocam Network Sites Point Clouds About



Home The Project PhenoCam Network Research Group Publications Gallery Media Resources Sponsors Contact

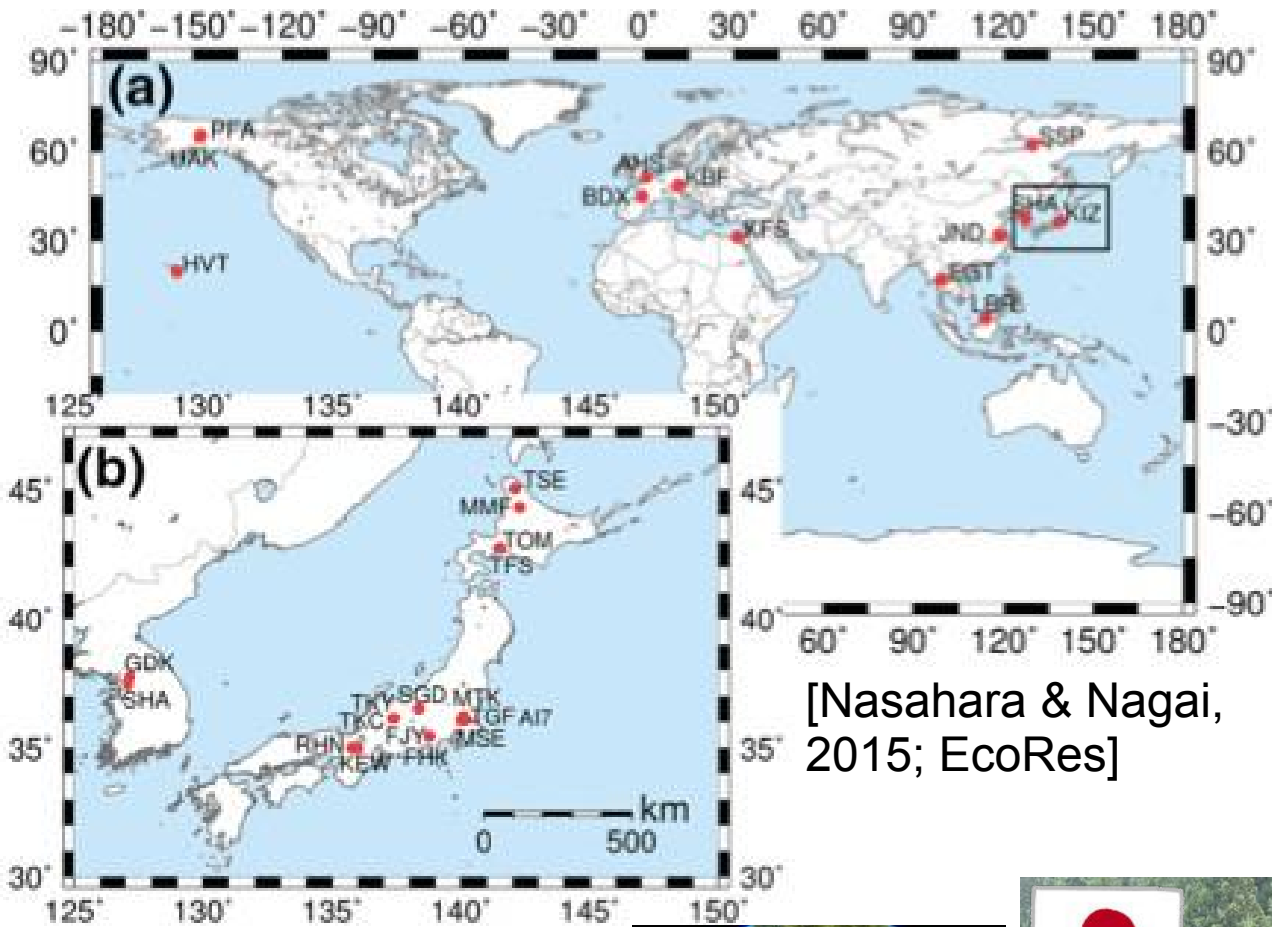


← <https://phenocam.org.au/>  
 → <http://www.recod.ic.unicamp.br/ephenology/client/index.html#/>

PhenoCam Network Gallery

The e-phenology project has several towers arranged in different regions of Brazil. In order to analyse the different biomes and phenology of the plants present in these regions. In this section we present the location of each tower. As some towers are in nearby regions, you need to zoom in on the map. However, it can be observed in the map of Brazil that the towers are located in different regions and arranged over great distances. The towers of the project are: Cerrada Core, Atlantic Rain Forest, Cerrada PEG, Amazon Forest, Caatinga, EE Itaipava and Serra Cipo. It is important to mention that the Serra Cipo presents a set of towers arranged in different areas of this region. You can click on each location's mark of the map to open tower details, or simply click on the Images below to perform this action.

*PEN (Phenological Eyes Network) (<http://www.pheno-eye.org>)*



[Nasahara & Nagai, 2015; EcoRes]



*Deciduous coniferous (larch) forest*



*Evergreen broad-leaved forest*



*Deciduous broad-leaved forest*



*Deciduous coniferous (larch) forest*

2011 251



*Evergreen coniferous forest*

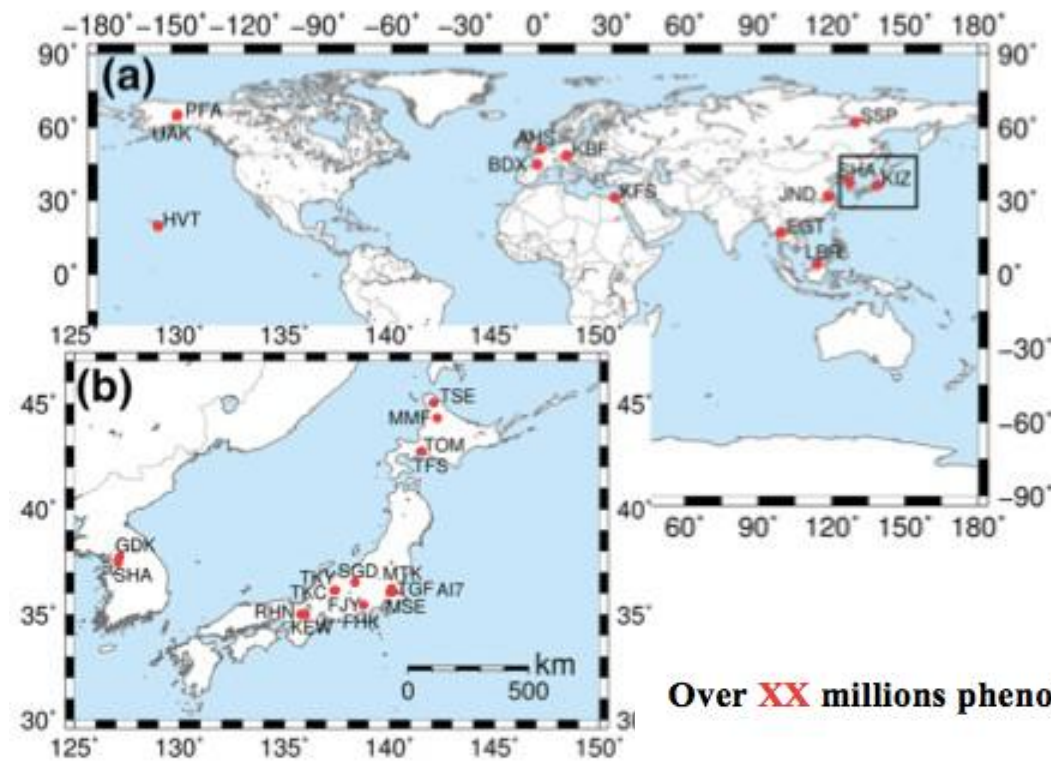


*Oil palm plantation*



*Now, we are preparing data paper of phenology and sky images in 28 sites.*

Will be submitted to Ecological Research

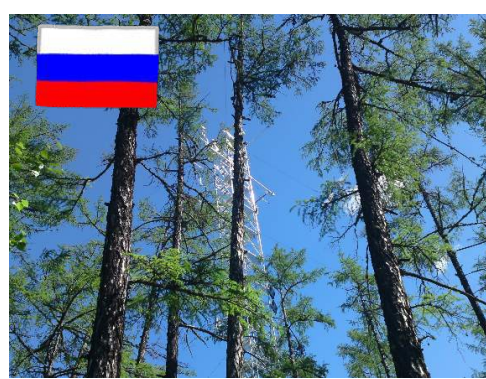


Over **XX** millions phenology and sky images in 28 various ecosystem sites ranging from

### Arctic to tropic regions: the Phenological Eyes Network

Shin Nagai<sup>1</sup>, Tomoko Akitsu<sup>2</sup>, Taku M Saitoh<sup>3</sup>, Robert C Busey<sup>4</sup>, Karibu Fukuzawa<sup>5</sup>, Yoshiaki Honda<sup>6</sup>, Tomoaki Ichie<sup>7</sup>, Reiko Ide<sup>8</sup>, Hiroki Ikawa<sup>9</sup>, Akira Iwasaki<sup>10</sup>, Koki Iwao<sup>11</sup>, Koji Kajiwara<sup>6</sup>, Sinkyu Kang<sup>12</sup>, Yongwon Kim<sup>4</sup>, Kho Lip Khoon<sup>13</sup>, Alexander V Kononov<sup>14</sup>, Yoshiko Kosugi<sup>15</sup>, Takahisa Maeda<sup>16</sup>, Masayuki Matsuoka<sup>7</sup>, Trofim C Maximov<sup>14</sup>, Annette Menzel<sup>17&18</sup>, Tomoaki Miura<sup>19</sup>, Toshie Mizunuma<sup>20</sup>, Tomoki Morozumi<sup>21</sup>, Takeshi Motohka<sup>22</sup>, Hiroyuki Muraoka<sup>3</sup>, Hirohiko Nagano<sup>4</sup>, Taro Nakai<sup>23</sup>, Tasuro Nakaji<sup>24</sup>, Hiroyuki Oguma<sup>8</sup>, Takeshi Ohta<sup>25</sup>, Keisuke Ono<sup>9</sup>, Petrov E Roman<sup>14</sup>, Runi Anak Sylvester Punga<sup>26</sup>, Christian Schunk<sup>17</sup>, Seikoh Sekikawa<sup>27</sup>, Yowhan Son<sup>28</sup>, Atsuko Sugimoto<sup>29</sup>, Rikie Suzuki<sup>1</sup>, Kentaro Takagi<sup>30</sup>, Satoru Takanashi<sup>31</sup>, Shunsuke Tei<sup>29</sup>, Satoshi Tsuchida<sup>11</sup>, Hirokazu Yamamoto<sup>11</sup>, Eri Yamasaki<sup>32</sup>, Megumi Yamashita<sup>33</sup>, Tae Kyung Yoon<sup>34</sup>, Mitsunori Yoshimura<sup>35</sup>, Shinpei Yoshitake<sup>3</sup>, Matthew Wilkinson<sup>36</sup>, Lisa Wingate<sup>37</sup>, Kenlo Nishida Nasahara<sup>2</sup>



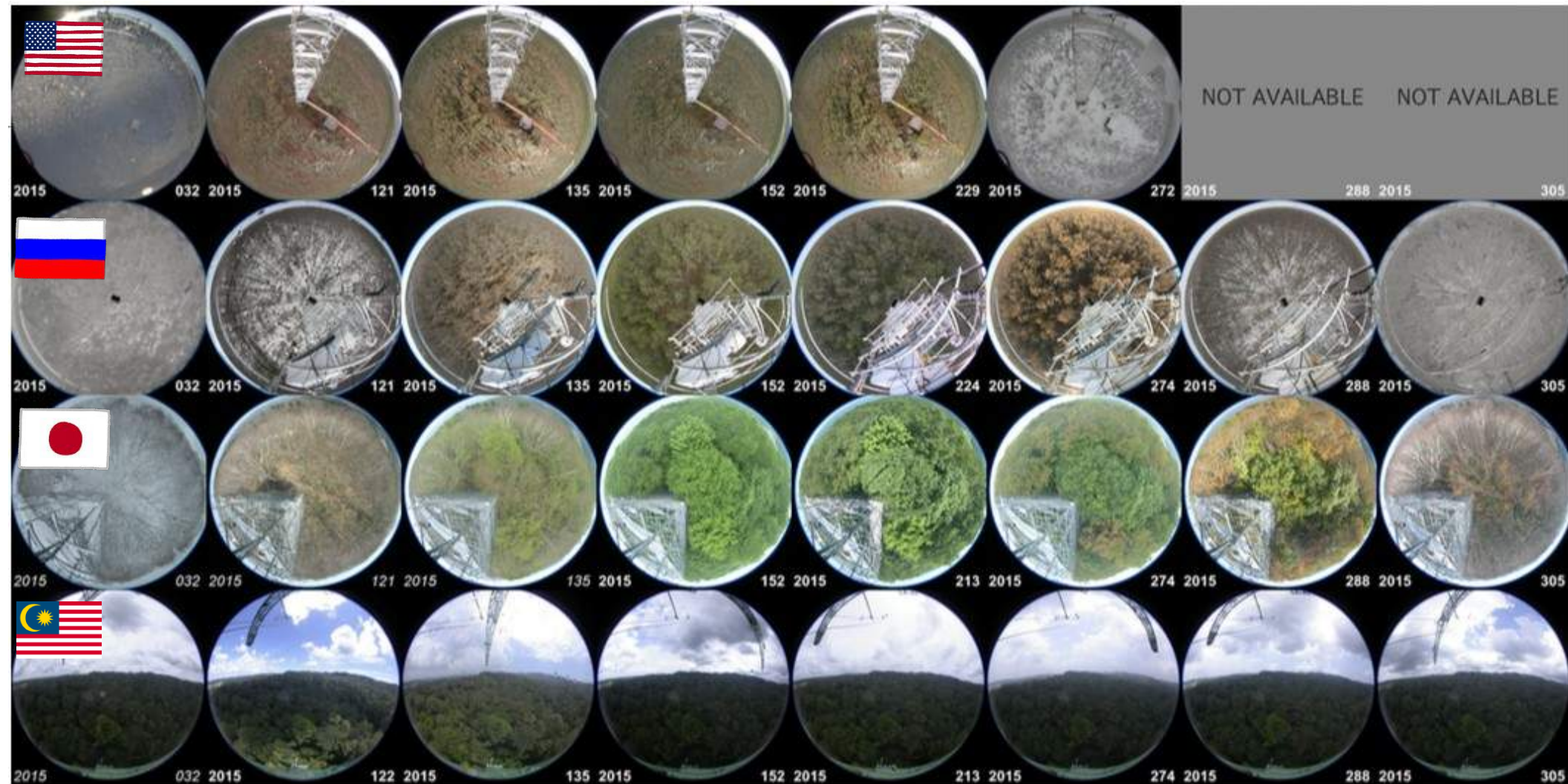


*Evergreen coniferous forest*

*Deciduous coniferous forest*

*Deciduous broad-leaved forest*

*Evergreen broad-leaved forest*



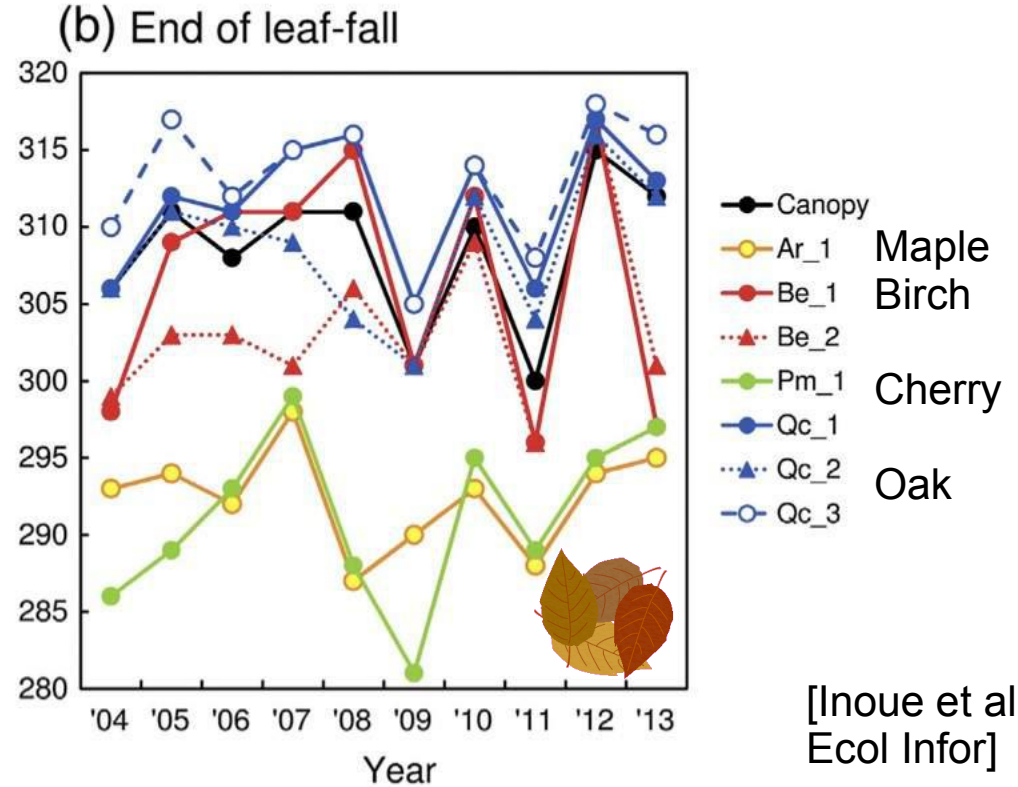
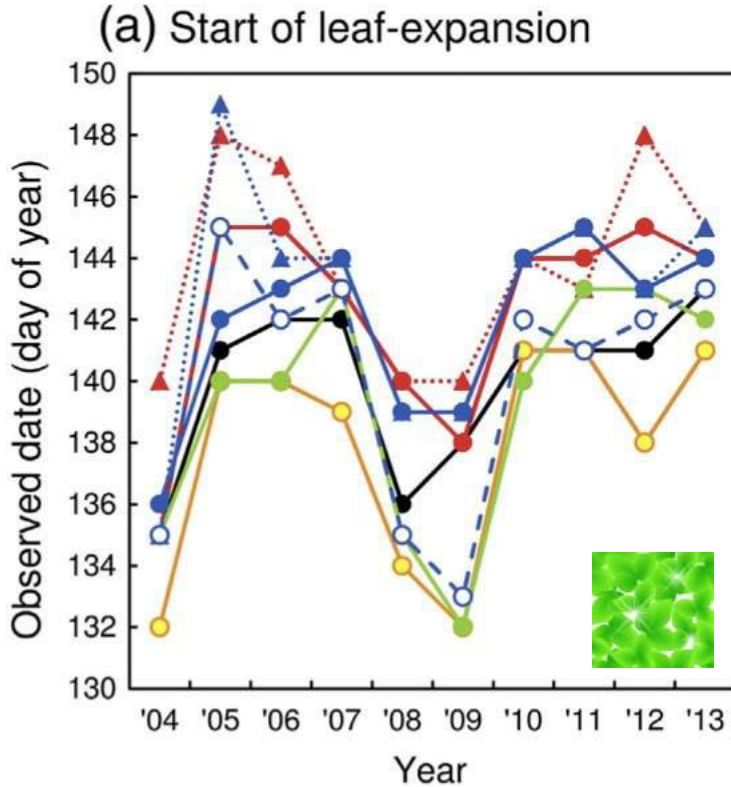
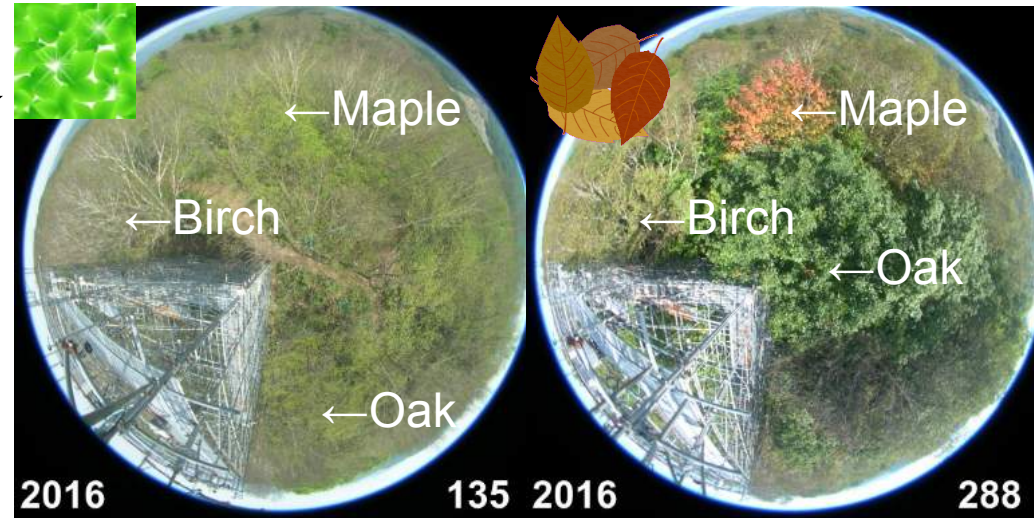
# Year-to-year variability of the timing of leaf-flush and leaf-fall for various tree species



Takayama site

**Dominant species**  
 Overstorey: birch, oak  
 Understorey: maple

**Leaf longevity (leafy period) is important!!**



- Canopy
- Ar\_1 Maple
- Be\_1 Birch
- Be\_2
- Pm\_1 Cherry
- Qc\_1
- Qc\_2 Oak
- Qc\_3

[Inoue et al. 2014, Ecol Infor]

# Detection of characteristics of tree phenology in a tropical rain forest, Borneo by using the red, green, and blue digital numbers



By Wikipedia

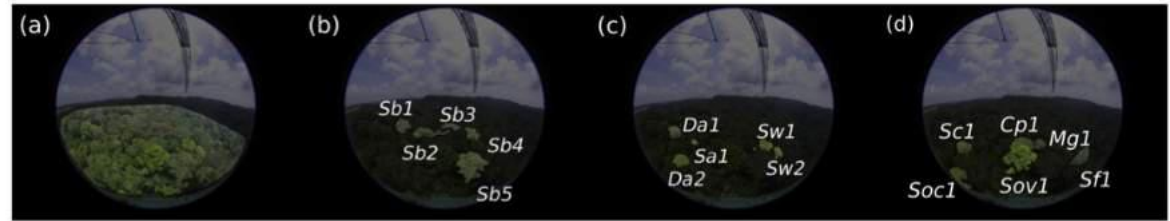
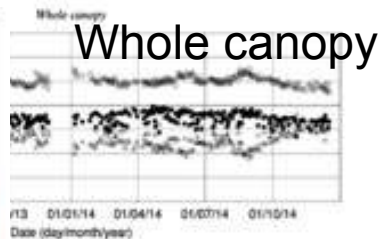
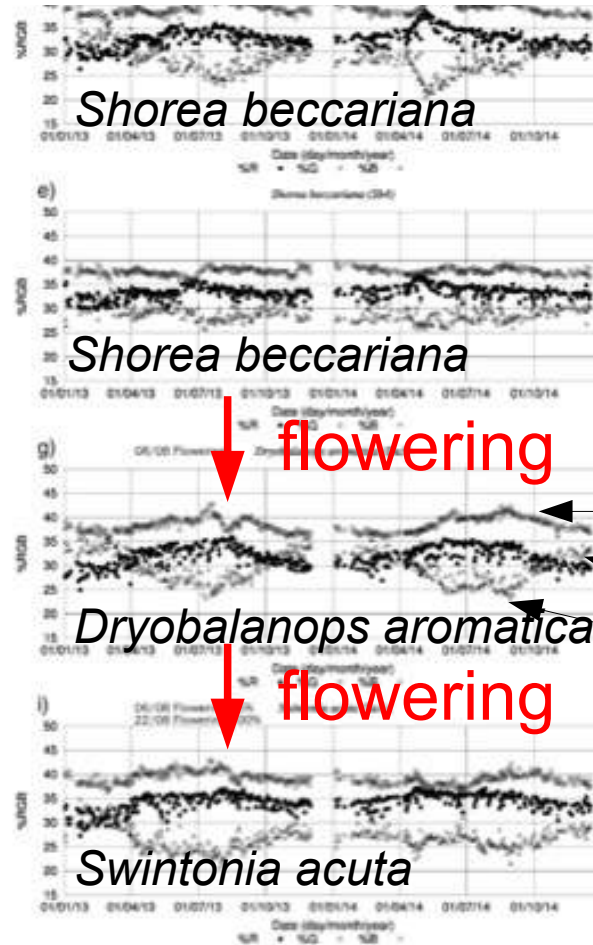
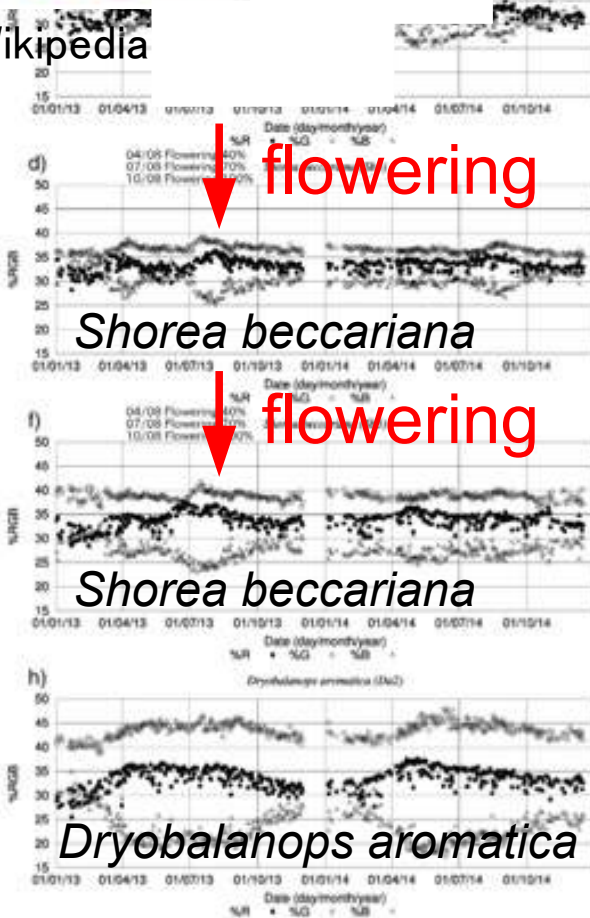


Fig. 1. Photographs of the canopy areas (highlighted) that were analyzed for the %RGB, HSL (hue, saturation, and lightness), and GEI values (see text for explanations). (a) Whole canopy; (b) five *Shorea beccariana* trees (Sb1–Sb5); (c) two *Dryobalanops aromatica* (Da1 and Da2), one *Swintonia acuta* (Sa1), and two *Swintonia* sp. (Sw1 and Sw2); (d) one *Shorea* sp. cf. *ovata* (Sov1), one *Shorea ochracea* (Soc1), one *Swintonia foxworthyi* (Sf1), one *Shorea curtisii* (Sc1), one *Ctenolophon parvifolius* (Cp1), and one *Myristica gigantea* (Mg1).

**Characteristic of responsiveness of phenology to climate change among species is important!!**



$$\begin{aligned} &G/(R+G+B) \\ &R/(R+G+B) \\ &B/(R+G+B) \end{aligned}$$

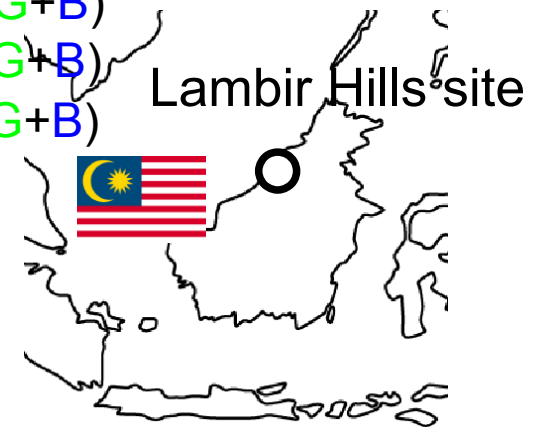
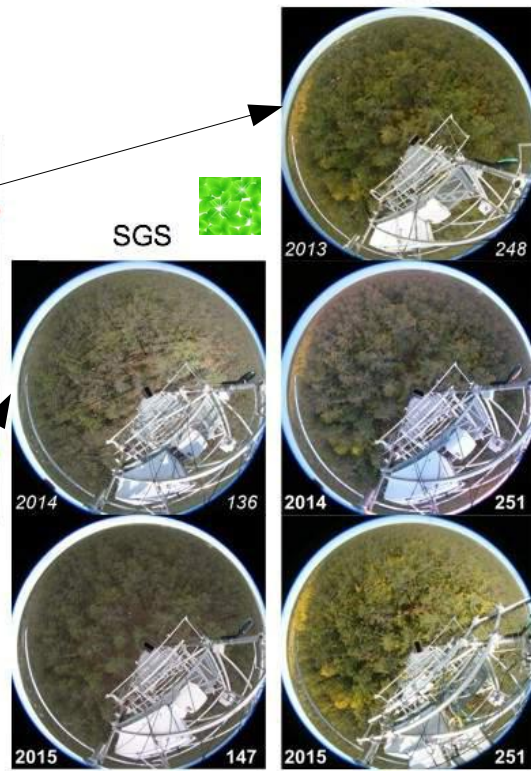
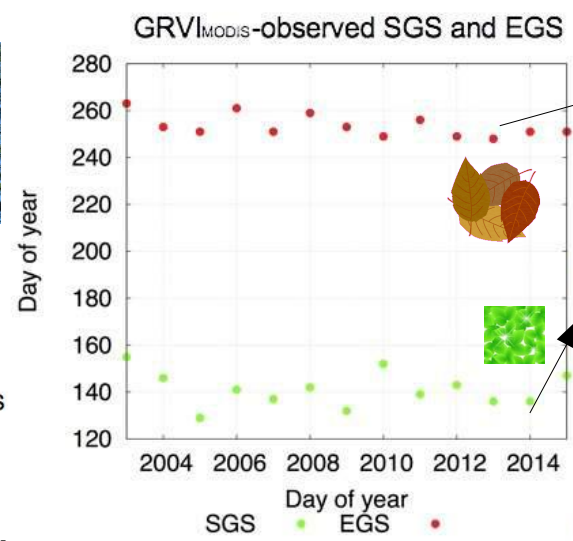
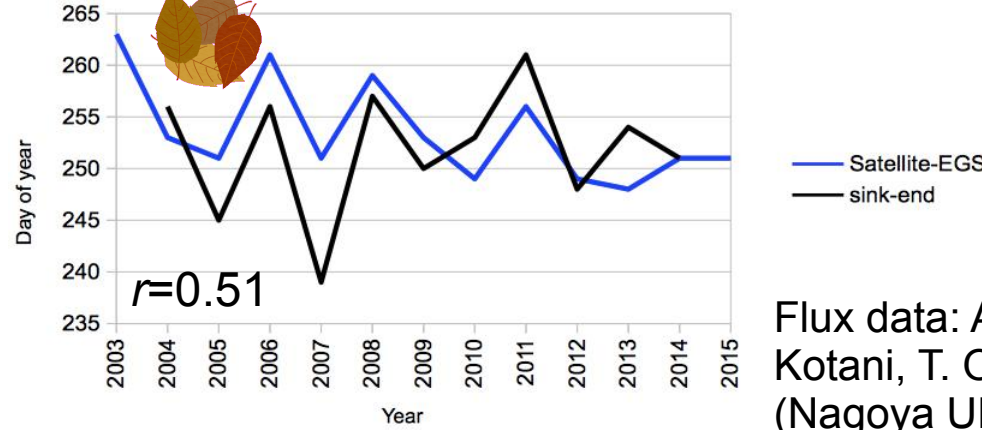
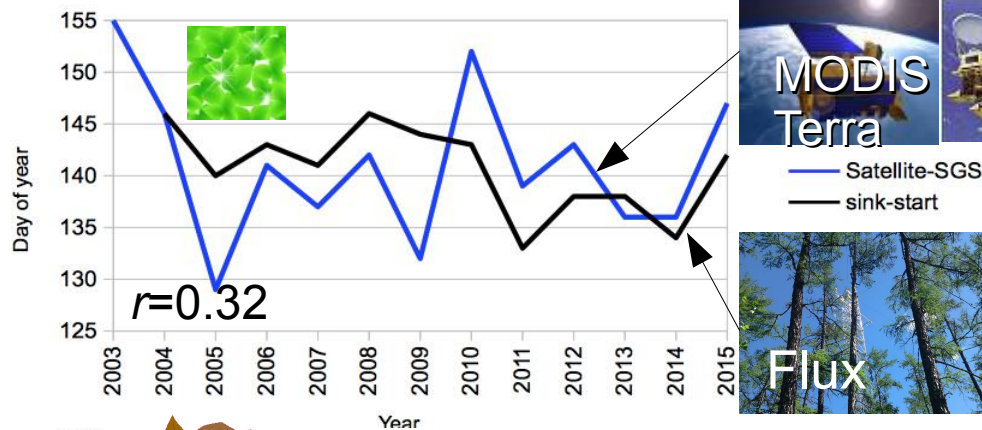
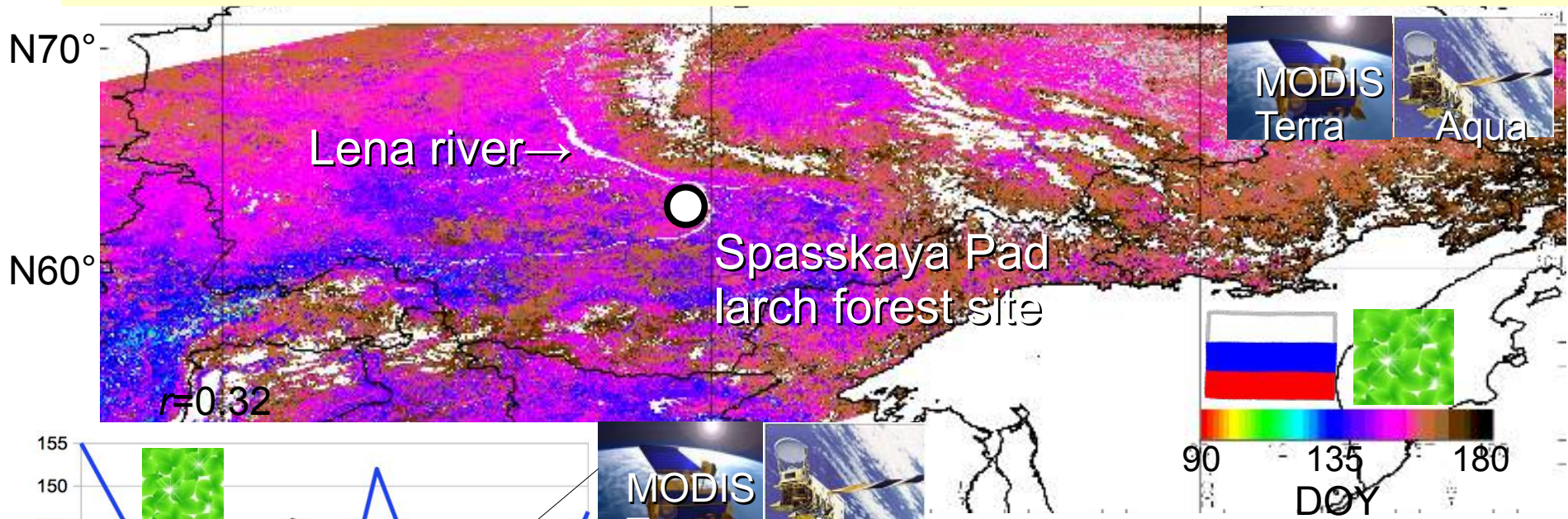


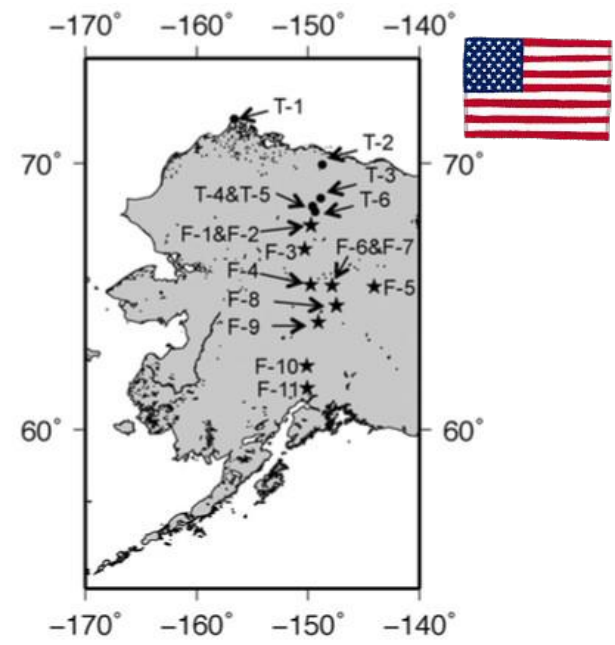
Fig. 4. Temporal patterns in %R, %G, and %B based on  $DN_{red}$  values extracted from phenological images (after exclusion of low-visibility images) of (a) the whole canopy and (b–q) individual trees of each species. During late July 2013 and late August 2013, trees Sb3, Sb5, Da1, Sa1, Sw1, and Sw2 flowered. Dates of the flowering phenology of these individuals are shown at the top of the graphs (T. Itioka et al., unpublished data). The flowering of Da1 was confirmed from a photograph taken on 8 August 2013 (Yayoi Takeuchi, NIES, unpublished data).

# Validation of satellite-based timing of start (SGS) and end of growing season (EGS) (res.: 500 m) in Eastern Siberia



Flux data: A. Kotani, T. Ohta (Nagoya UNIV.)

# Multiple time-lapse digital camera sites along latitudinal gradient for validation of satellite-based growing season



Geographical distribution of the time-lapse camera locations. Black circles are camera sites and the stars are forest sites. Full site names are provided in Table 1. Some camera images for individual sites are provided in the supplemental figure.



GardenWatchCam (Brinno)



\$200

Satellite:  
Terra MODIS 8-day & SPOT-VEGETATION 10-day NDVI

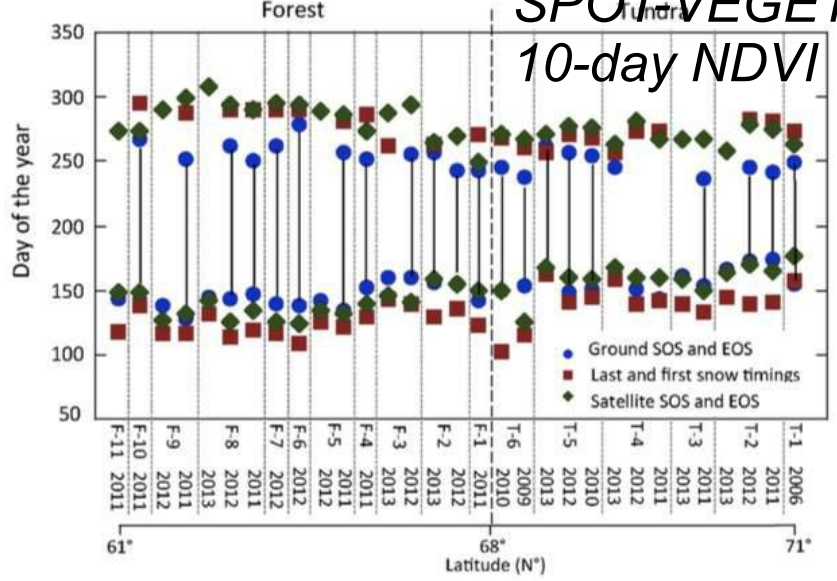
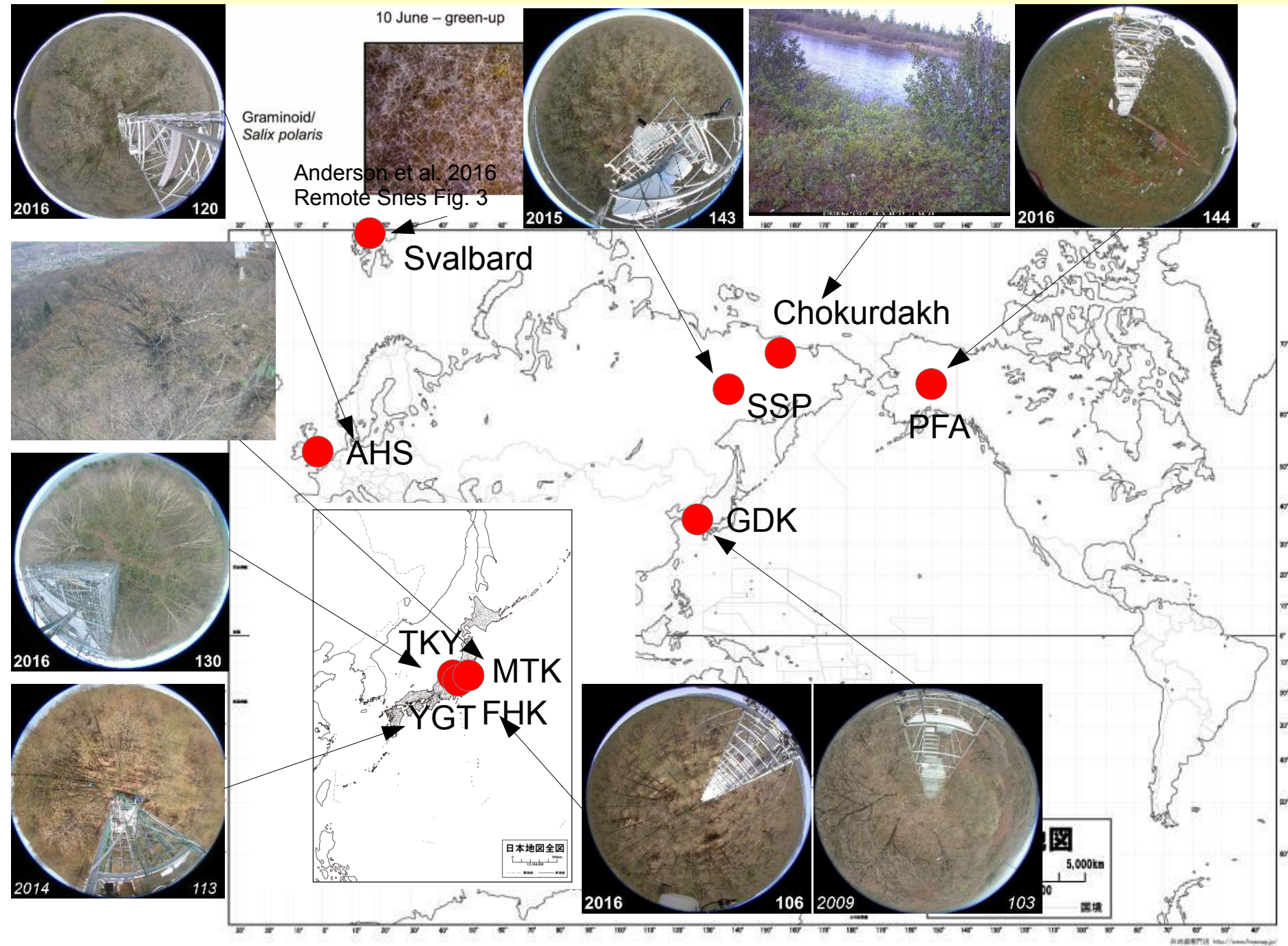


Fig. 4. Summary of the satellite-derived SOS and EOS (green diamond), the last (spring) and first (autumn) snow timings (red rectangle), and the ground-based SOS and EOS (blue circle). The black bars indicate the growing season determined by the ground-based time-lapse cameras. The SOS and EOS are the average of 10 methods derived from two satellite datasets (SPOT-VEGETATION and Terra-MODIS). [Kobayashi et al. 2016, RSE]

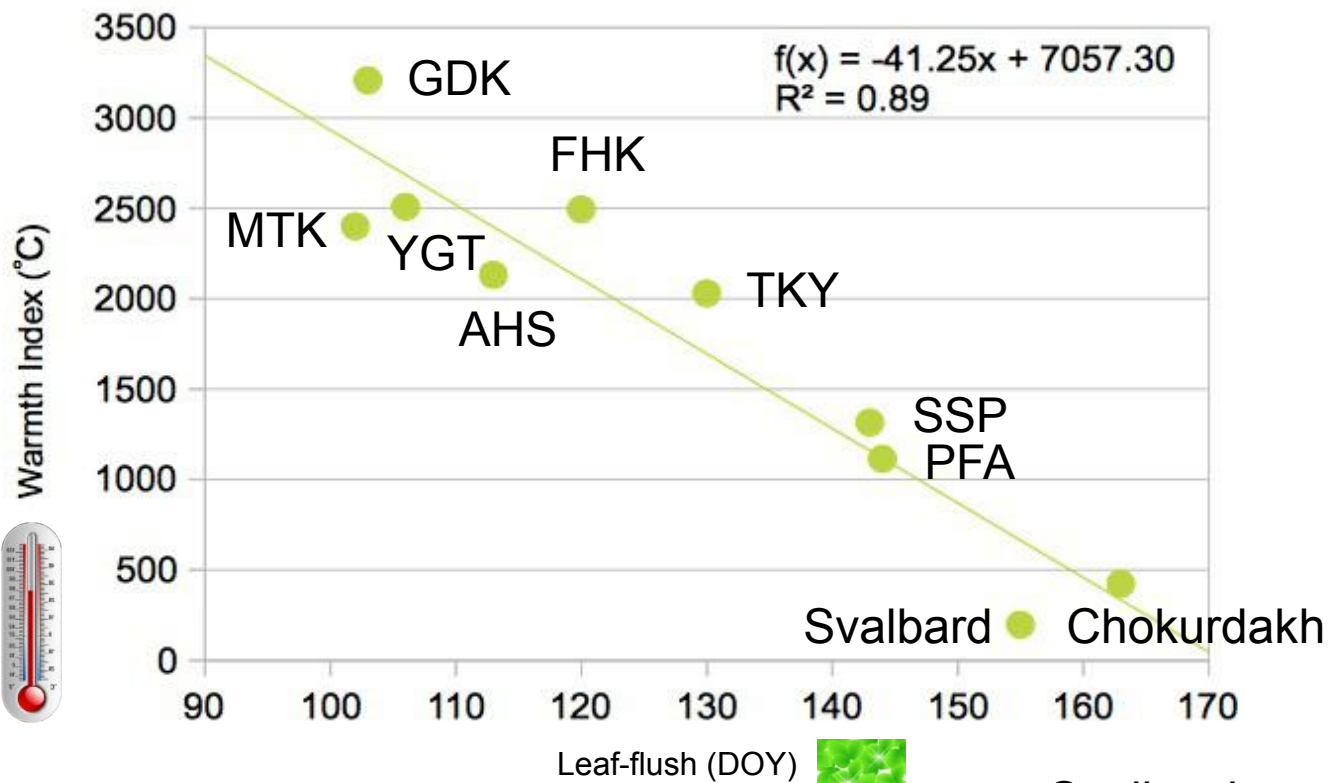
# Examination of spatial characterisitic of the timing of leaf-flush along latitudinal gradient by using phenology images



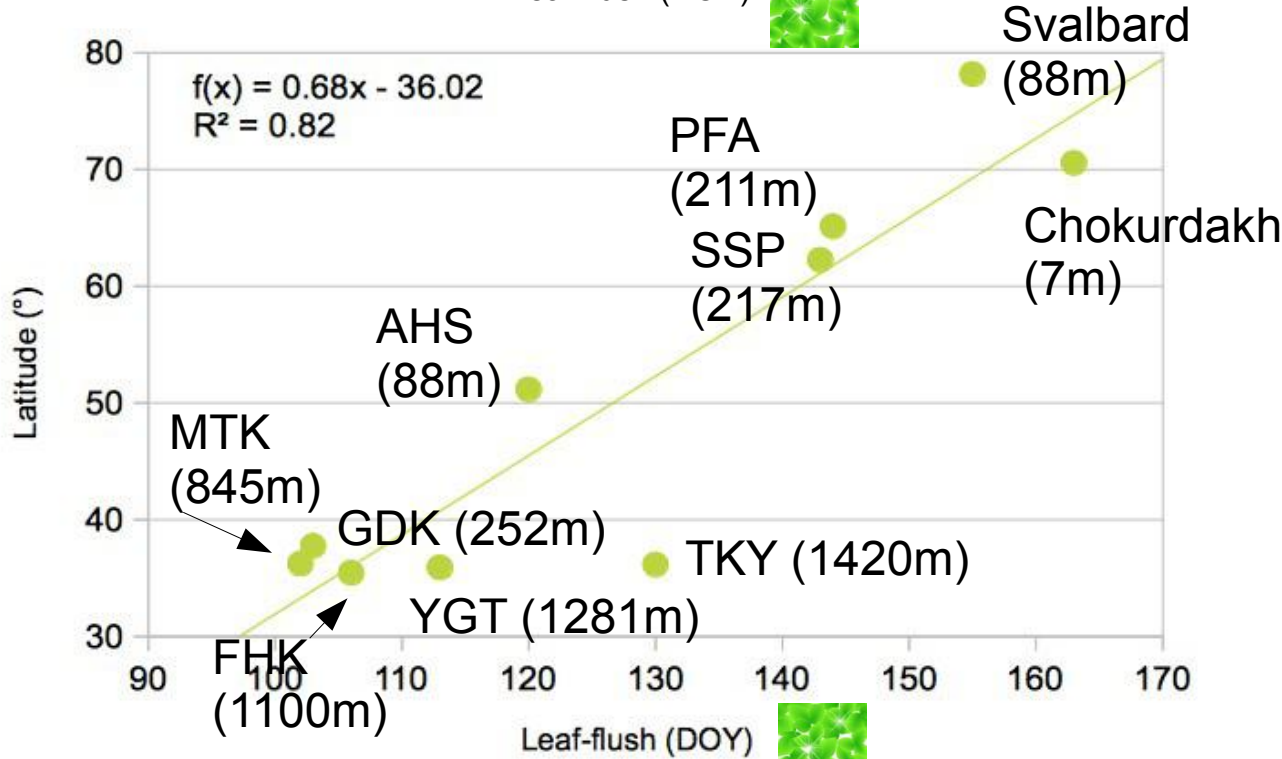
## Warmth index\*–leaf-flush relationship

\*Sum of over 5°C in daily mean air temperature until leaf-flush

$$WI = \sum_{t=1}^{D_{SGS}} \max(\text{Temp}_t - 5, 0)$$

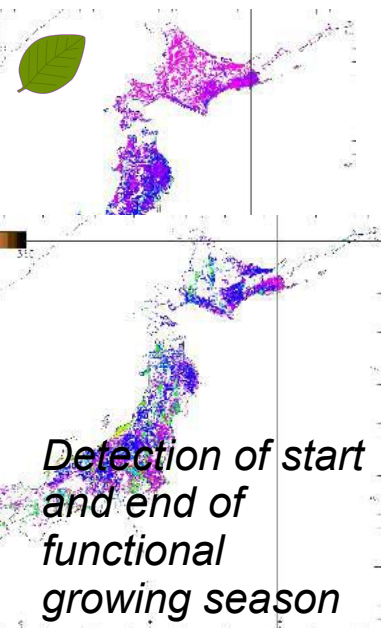


## Latitude–altitude–leaf-flush relationship

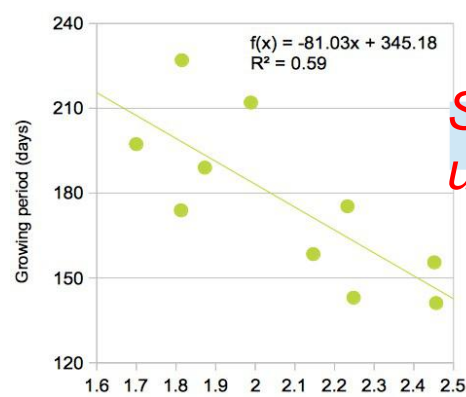




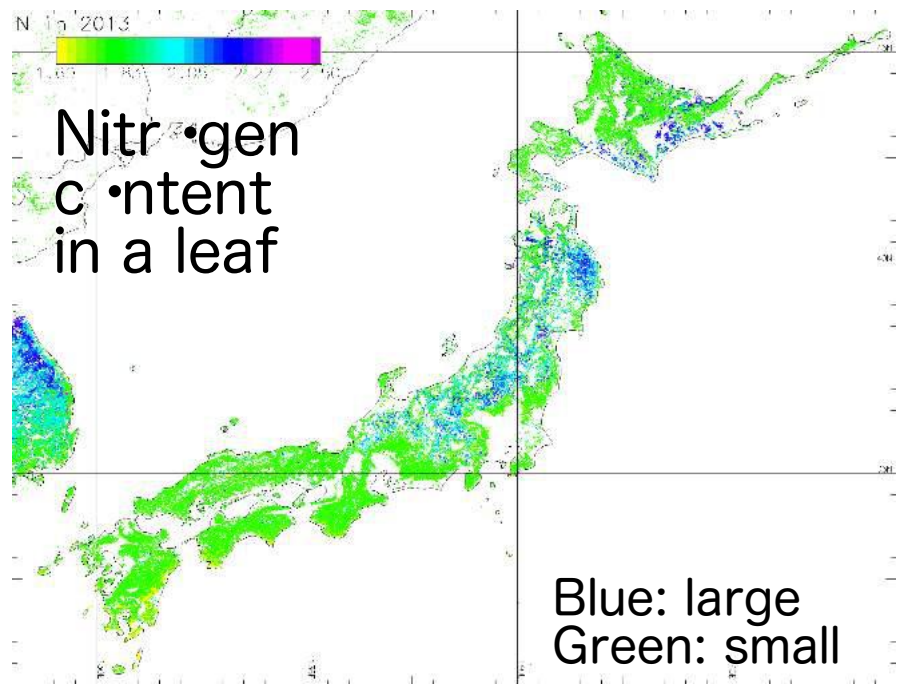
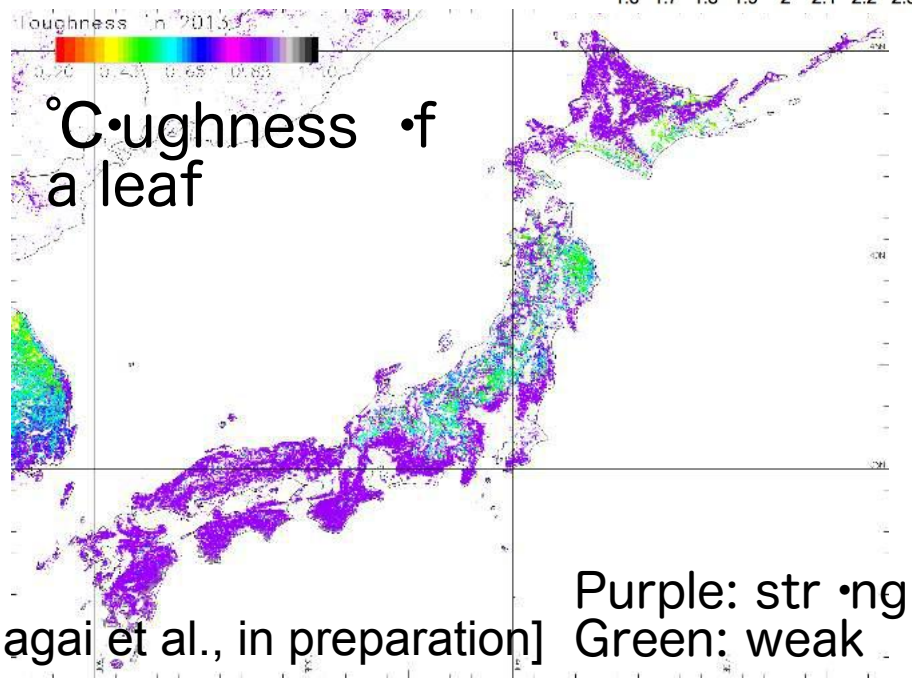
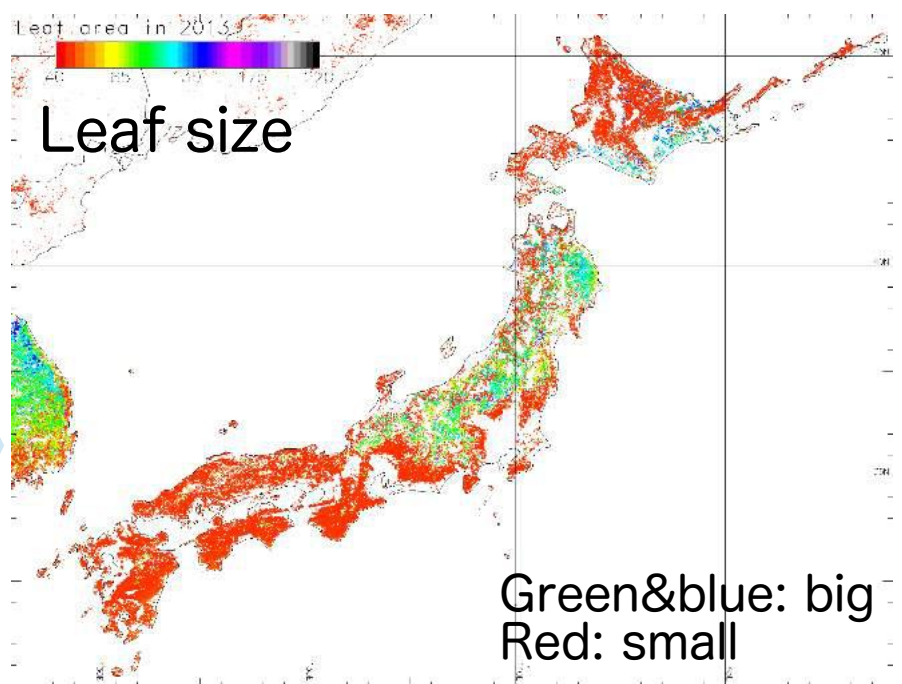
# Evaluation of spatial distribution of leaf traits by analysing satellite-observed functional growing period



Examination of the relationship between in situ-observed leaf trait and satellite-based functional growing period



Scale up!



*We never simultaneously observe high spatial, high temporal, and multi spectral data.*

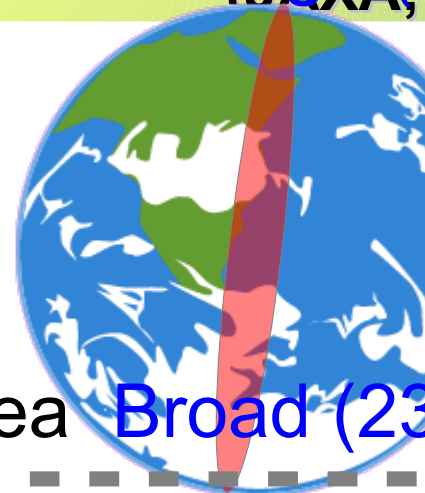
High (10 m) Spatial resolution Low (250 m)



Low (46 days) Temporal resolution High (everyday)



Narrow (70 km) Swath area



Broad (2330 km) Swath area



**Aboveground biomass**  
**Plant functional type (land cover change)**

**Growing season duration**

## Languages Are Still a Major Barrier to Global Science

Tatsuya Amano, Juan P. González-Varo, William J. Sutherland

Published: December 29, 2016 • <https://doi.org/10.1371/journal.pbio.2000933>

### Abstract

While it is recognized that language can pose a barrier to the transfer of scientific knowledge, the convergence on English as the global language of science may suggest that this problem has been resolved. However, our survey searching Google Scholar in 16 languages revealed that 35.6% of 75,513 scientific documents on biodiversity conservation published in 2014 were not in English. Ignoring such non-English knowledge can cause biases in our understanding of study systems. Furthermore, as publication in English has become prevalent, scientific knowledge is often unavailable in local languages. This hinders its use by field practitioners and policy makers for local environmental issues; 54% of protected area directors in Spain identified languages as a barrier. We urge scientific communities to make a more concerted effort to tackle this problem and propose potential approaches both for compiling non-English scientific knowledge effectively and for enhancing the multilingualization of new and existing knowledge available only in English for the users of such knowledge.

**Citation:** Amano T, González-Varo JP, Sutherland WJ (2016) Languages Are Still a Major Barrier to Global Science. PLoS Biol 14(12): e2000933. <https://doi.org/10.1371/journal.pbio.2000933>

**Published:** December 29, 2016

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[Amano et al. 2016]

*“We should publicize Japanese language phenological data in the international research literature so that the data will be more accessible to the international research community.”*

[Nagai et al. 2016; Int J Biometeorol]

*Thank you for your attention and supports!*

- Global Change Observation Mission (GCOM; PI#117) of the JAXA
- Belmont Forum (COPERA)
- ArCS (MEXT)
- RBRC, Gifu University



*Phenological Eyes Network (PEN)*

- Ground-based Measurement for Remote Sensing Studies -