GCOM-C WS（Jan. 16 2014 Tokyo）

JAXA 宇宙航空研究開発機構 Japan Aerospace Exploration Agency

JAMSTEC

International Arctic Research Center IARC University of Alaska Fairbanks

JAMSTEC-IARC Collaboration Study JICS

GRENE 北極気候変動研究事業

Phenological Eyes Network (PEN)

- Ground-based Measurement for Remote Sensing Studies -

Investigation of carbon cycle of vegetation in cold districts through collaboration of SGLI and in-situ observations (PI #121)

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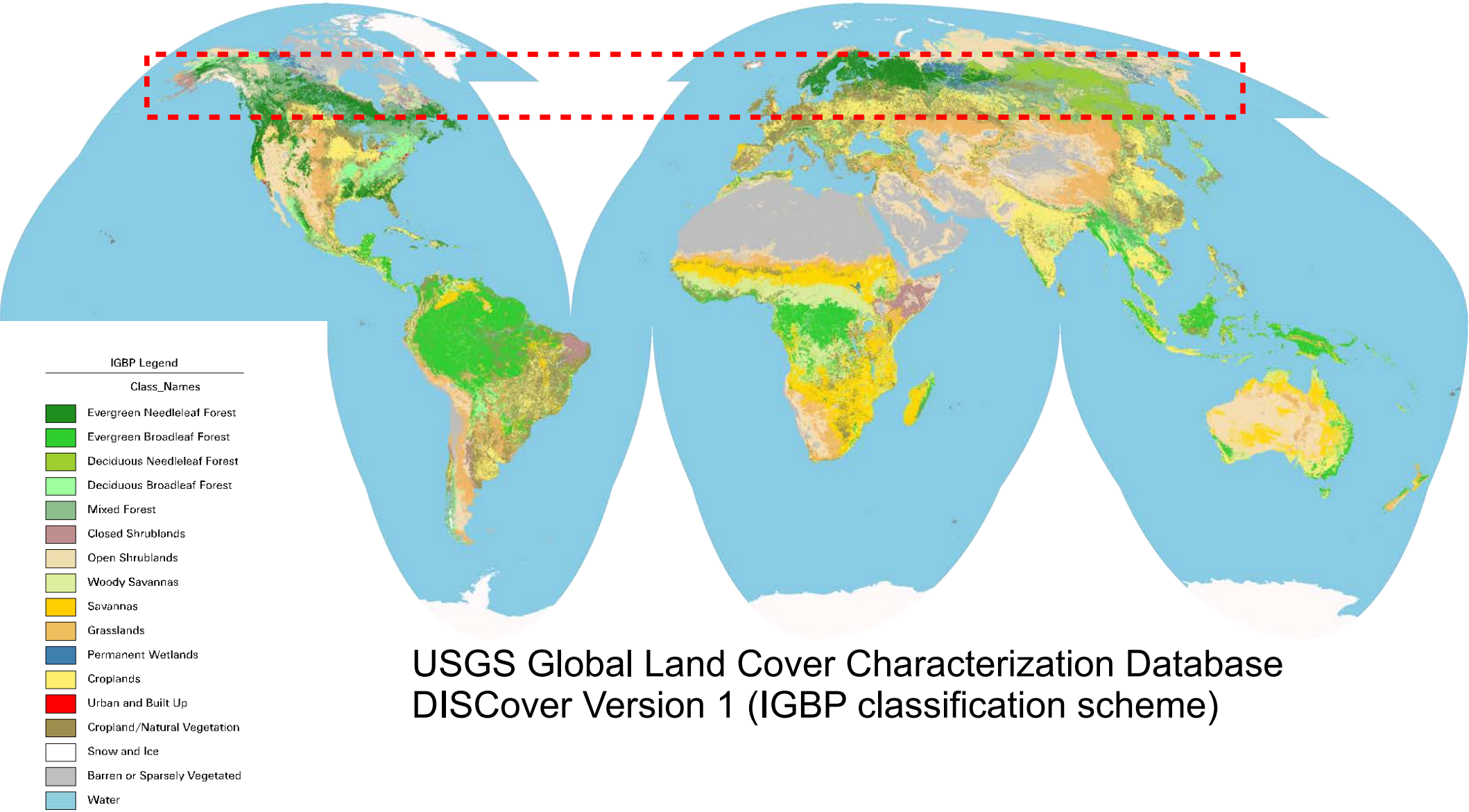
[3] International Arctic Research Center, University of Alaska Fairbanks

[4] Hydrospheric Atmospheric Research Center, Nagoya University

JAXA GCOM-C RA

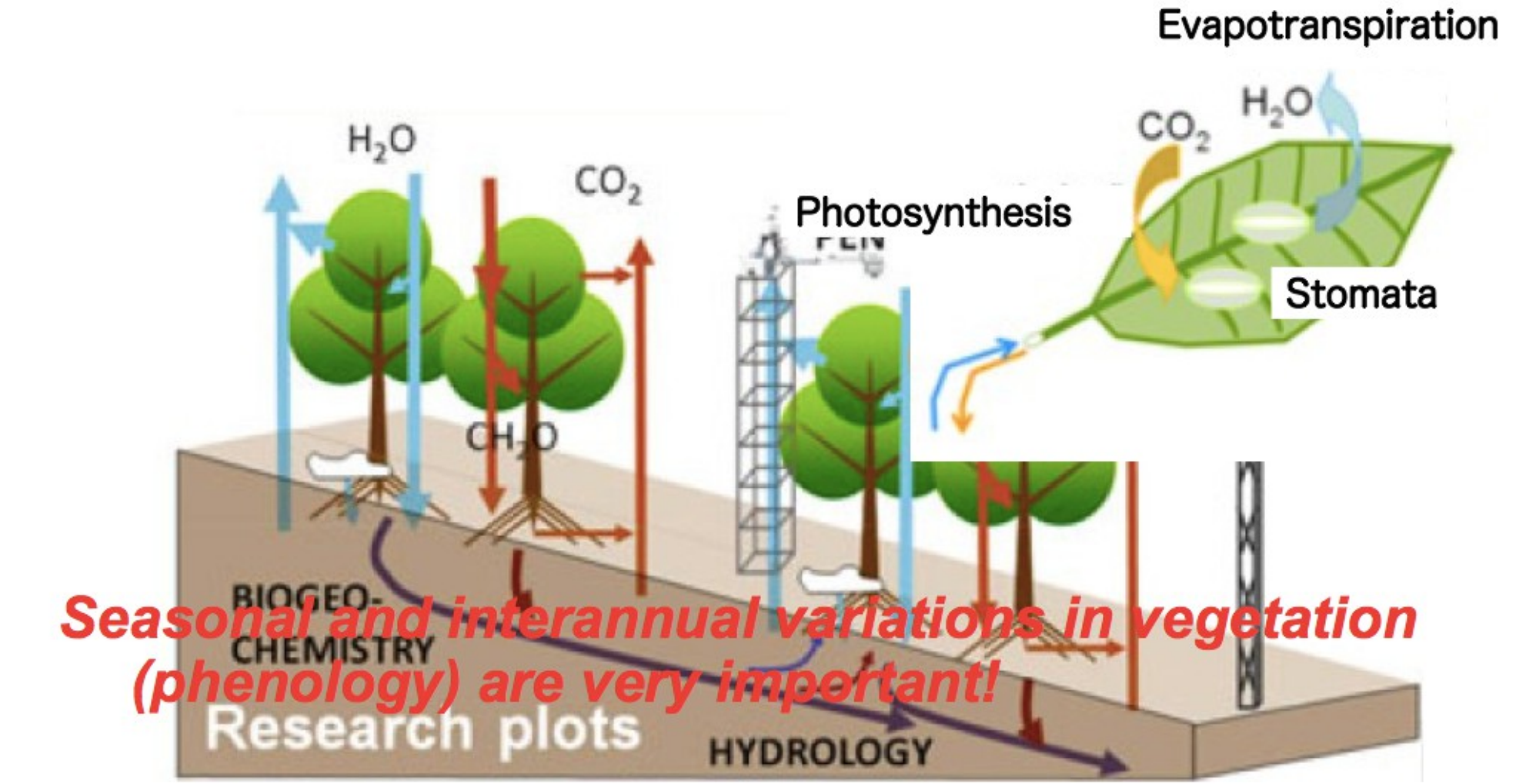
JAMSTEC-IARC Collaboration Study (JICS) GRENE-TEA

Evergreen and deciduous needleleaf forests are widely distributed across cool-temperate and boreal regions.



USGS Global Land Cover Characterization Database
DISCover Version 1 (IGBP classification scheme)

Seasonal and interannual variations in carbon, water, and energy cycles are affected by those in photosynthesis and evapotranspiration under the meteorological and climate changes.

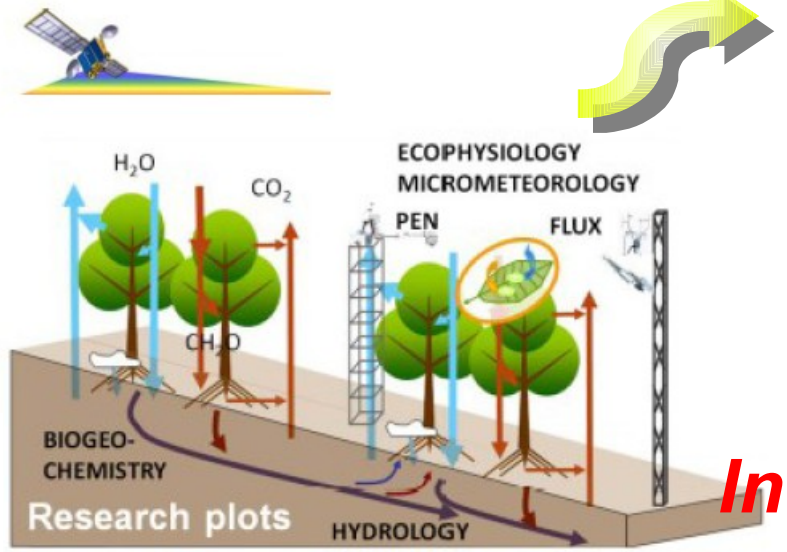


[Muraoka et al., 2012. in Biodiversity Observation Network in Asia-Pacific region: Towards further development of monitoring activities, Springer]

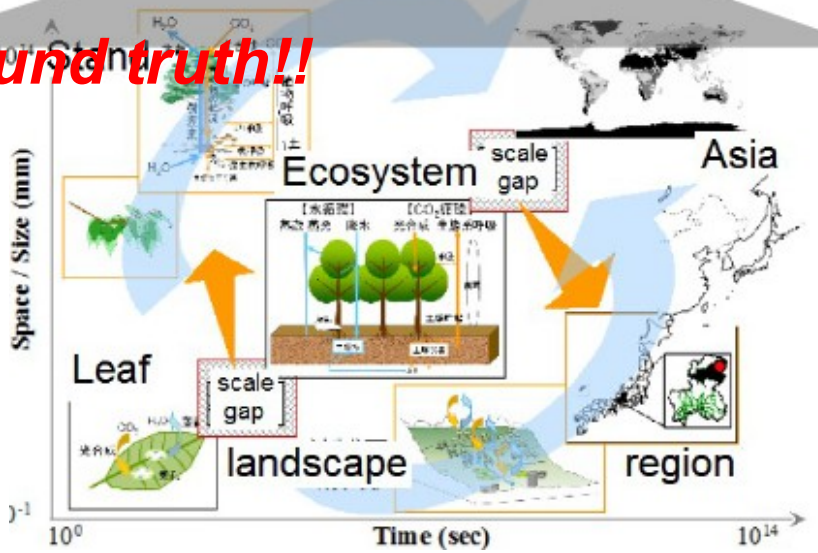
To accurately evaluate the spatio-temporal variability of ecosystem functions and service under rapid meteorological and climate changes, general, global, long-term, and comprehensive phenological observations are required.

At super sites,

Scaling up based on ground truth!!



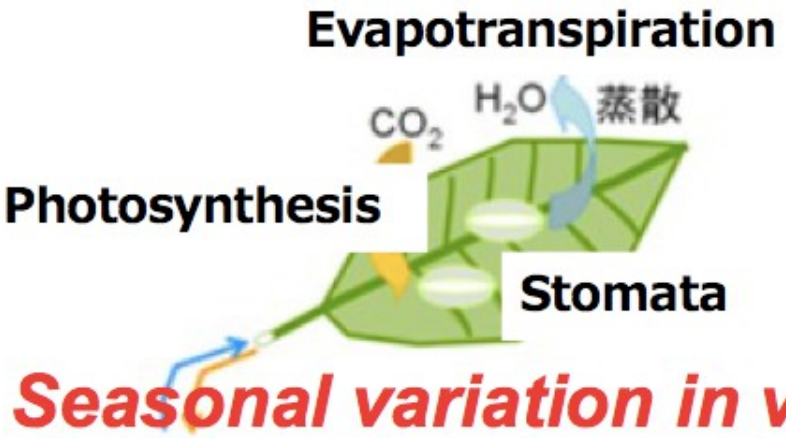
[Muraoka et al. 2012 AP-BON book]



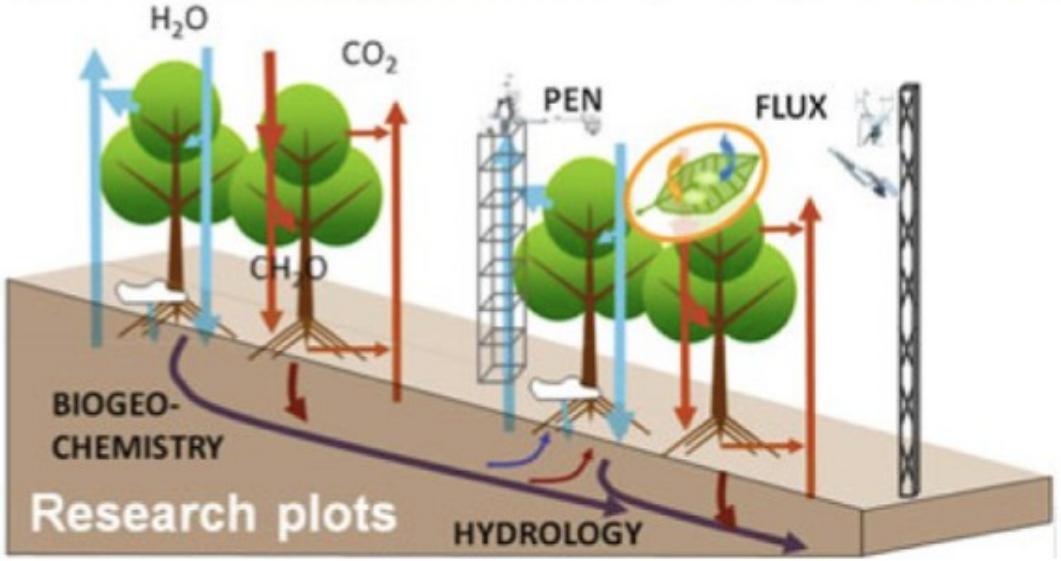
Integration of in situ and satellite observations is important!!

Why are phenological observations important?

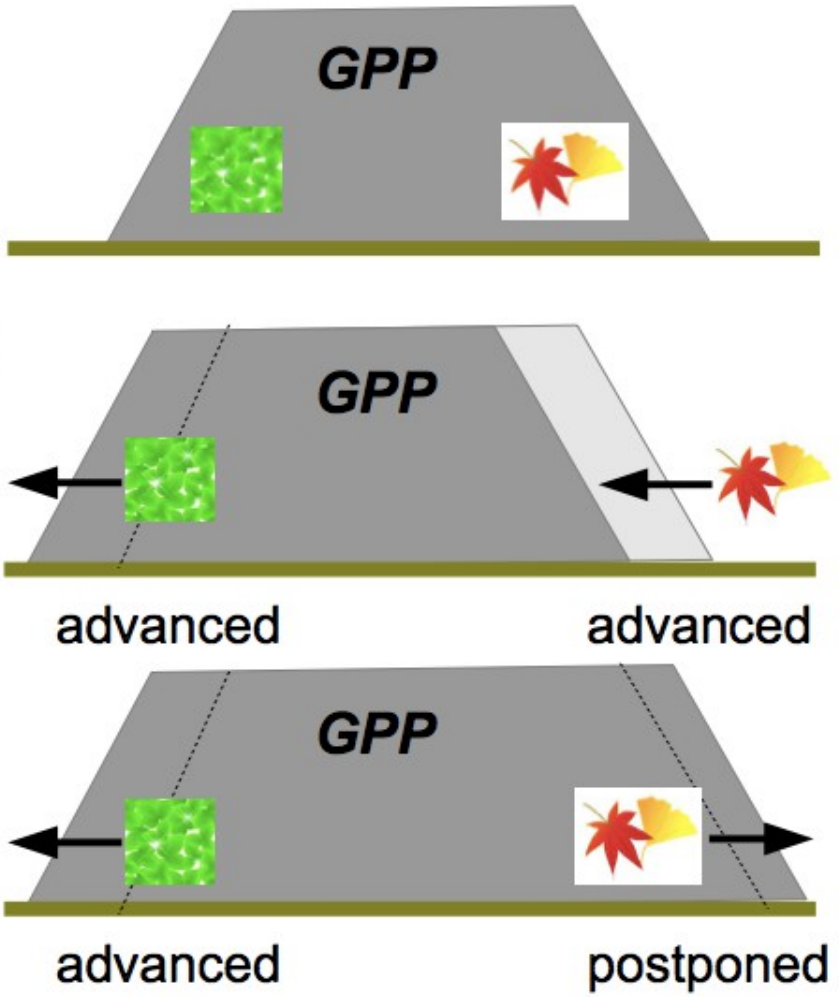
Interannual variations of growing season may affect the yearly gross primarily production (GPP).



Seasonal variation in vegetation (phenology) is very important!



[Muraoka et al. 2012]



[Richardson et al. 2012]

Why are phenological observations important?

Spatio-temporal characteristics of leaf lifetime correlate with leaf traits (e.g. size, thickness, strength, nitrogen), photosynthetic properties and climatatic condition.

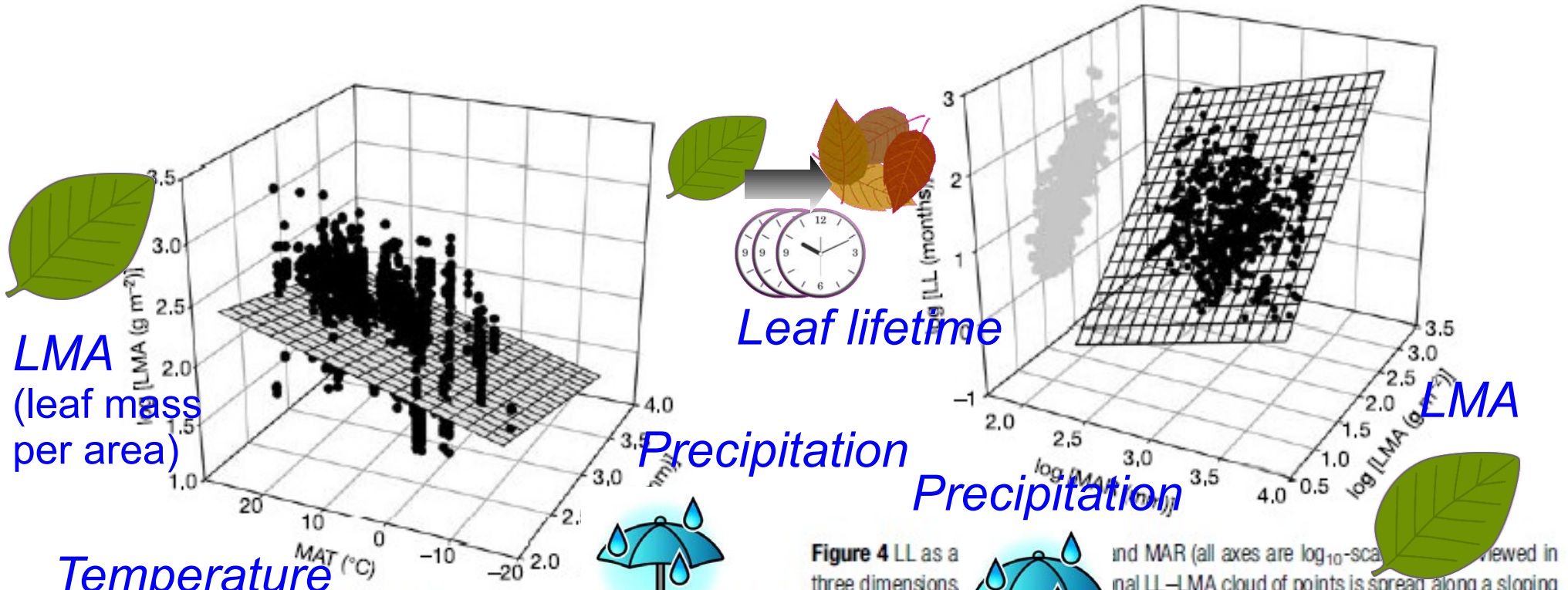


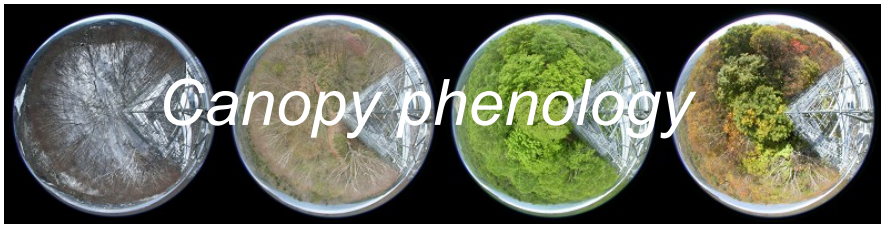
Figure 3 LMA as a function of MAT and MAR at the study sites (ecies from 163 sites; rainfall and L $_{10}$-scaled). The coefficients for MAT and log rainfall were highly significant ple regression (both $P < 0.0001$; further details given in Supplementary Infor

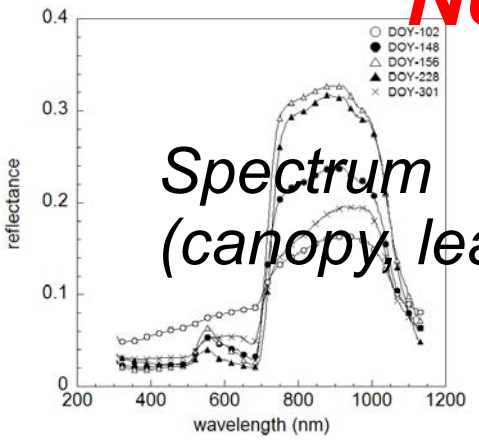
Figure 4 LL as a nd MAR (all axes are $\log_{10}$-sca iewed in three dimensions, nal LL–LMA cloud of points is spread along a sloping surface. The slop s steeper in the LMA dimension than in the rainfall dimension, reflect tial regression coefficient for LMA (1.23 versus 0.47). Both coefficients were highly significant in a multiple regression ($P < 0.0001$; $r^2 = 0.51$; data for 678 species from 51 sites).

[Wright et al. 2004 Nature]

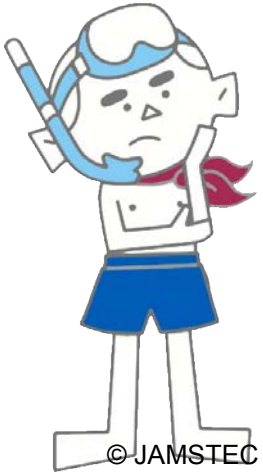
However, from the in situ ecological research view point, the satellite remote-sensing approach has not been sufficiently tested and validated by the ground-truthing.

In situ





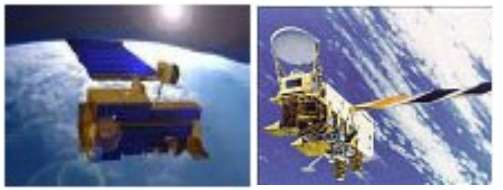
Spectrum (canopy, leaf)

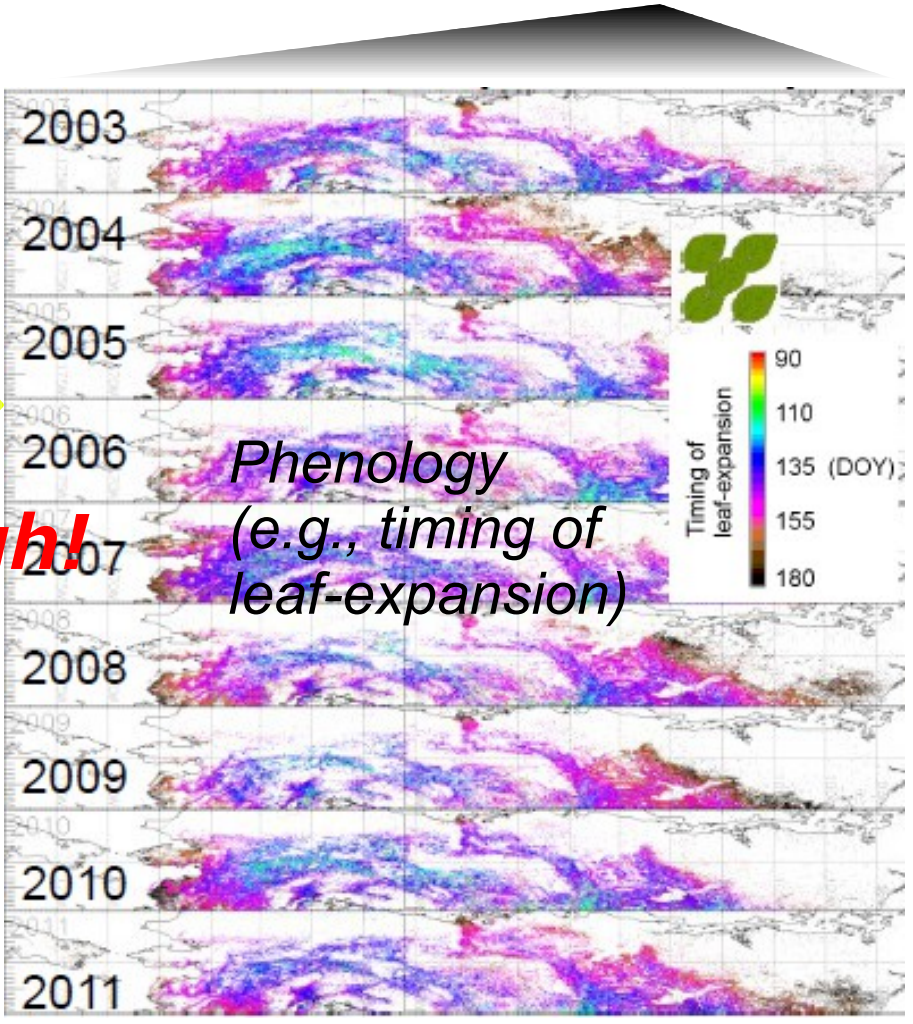


v.s.

Not enough!

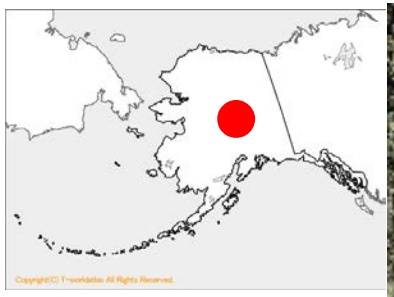
Satellite



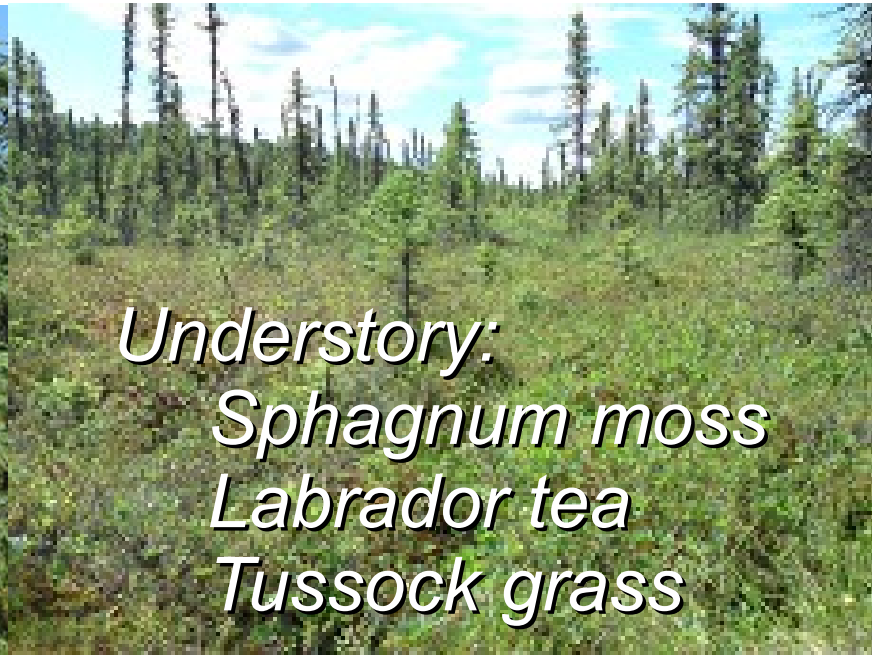


Phenology (e.g., timing of leaf-expansion)

Evergreen needleleaf forest: Poker Flat Research Site (Alaska)

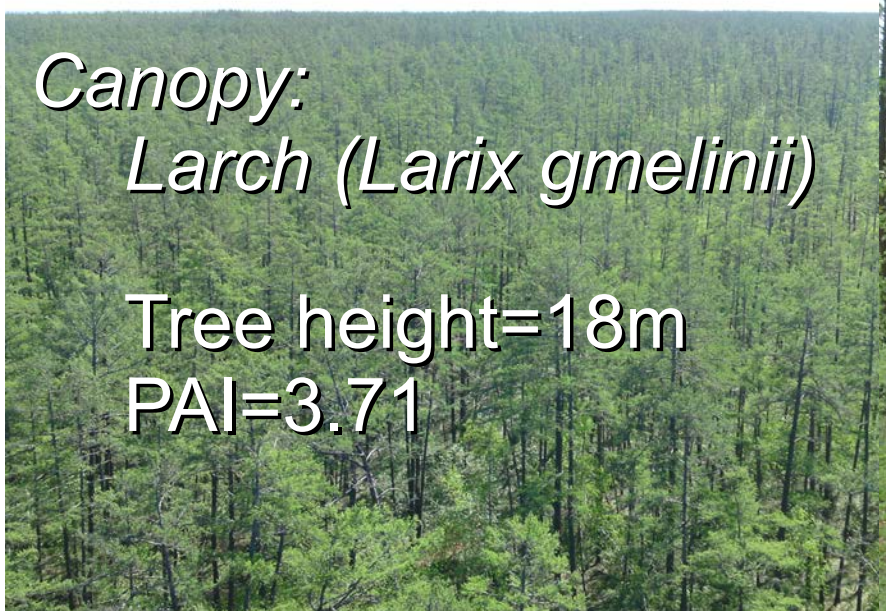


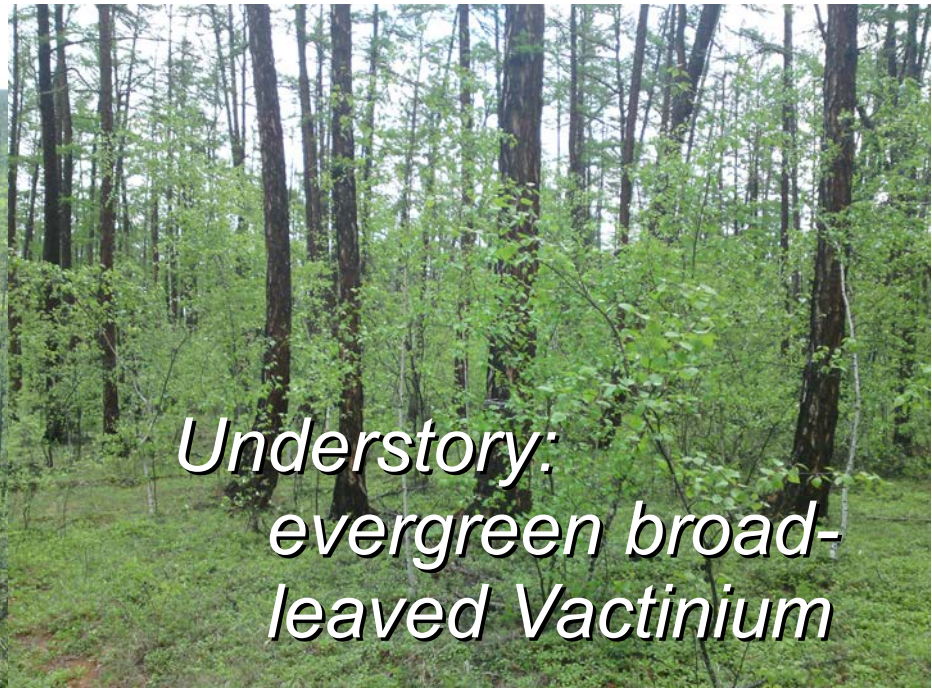
65°07' 24”N,
147°29' 14"W,
250 m a.s.l.



Deciduous needleleaf forest: Spasskaya Pad Site (Siberia)

62°15'18"N,
129°37'08"E,
220 m a.s.l.

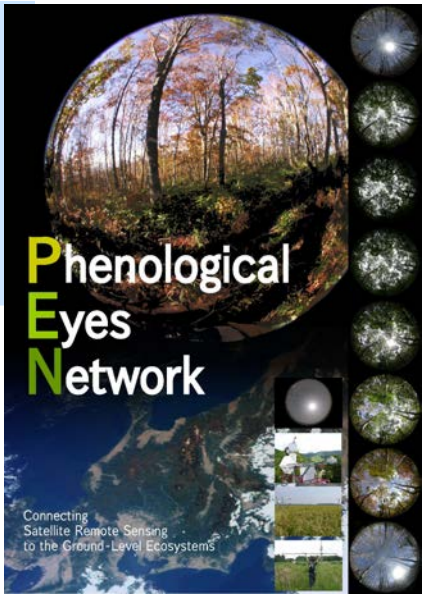


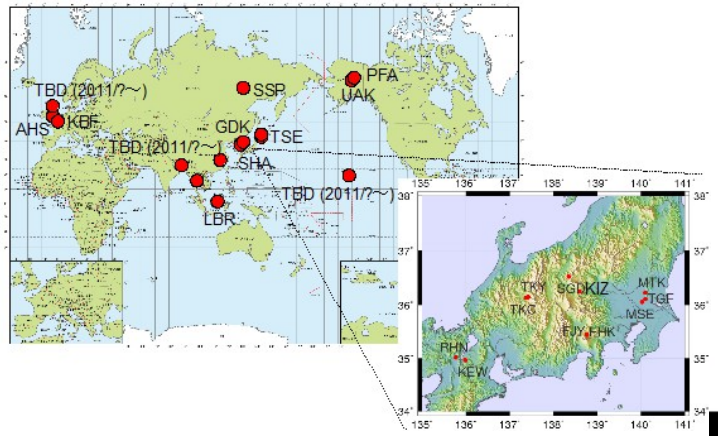


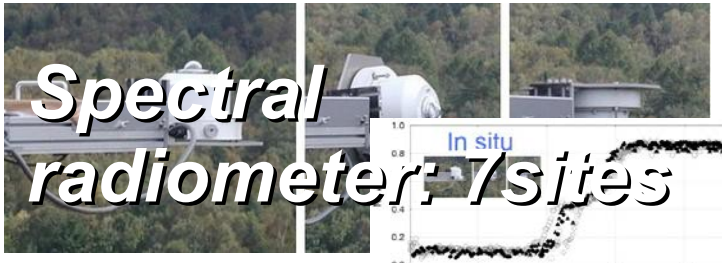

Evergreen needleleaf forest:
Poker Flat Research Site
(Alaska)

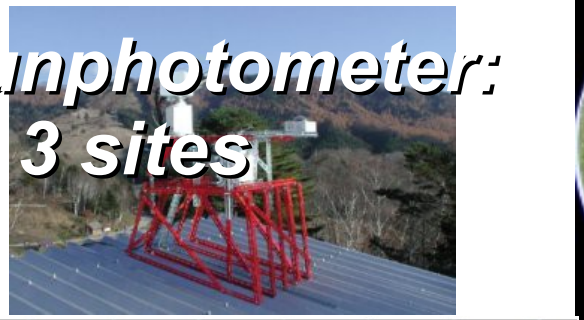

Deciduous needleleaf forest:
Spasskaya Pad Site (Siberia)

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

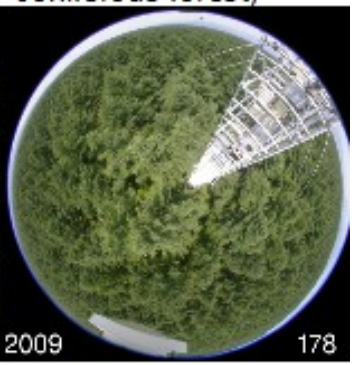




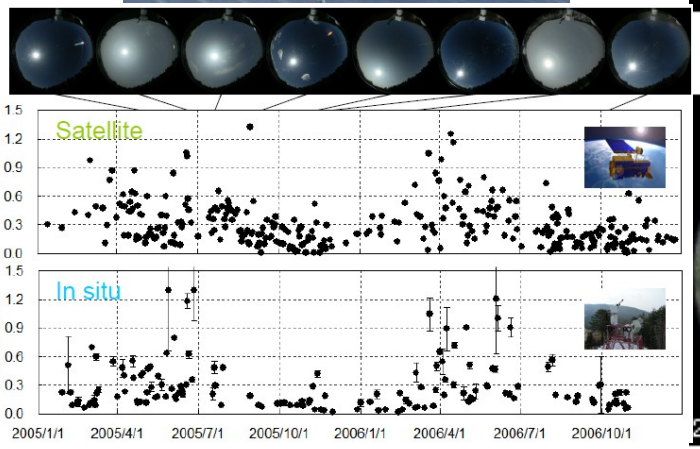


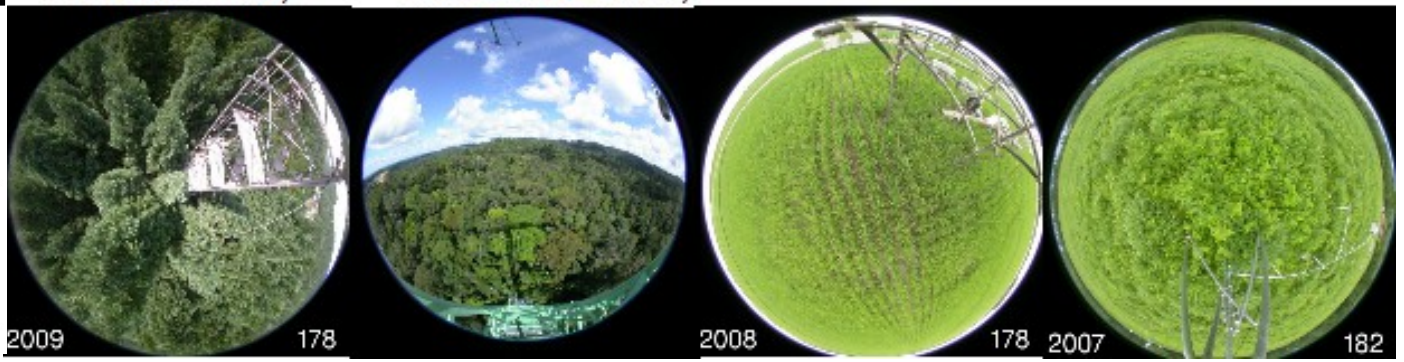


AHF (deciduous broad-leaved forest) TKY (deciduous broad-leaved forest) MTK (mixed forest) FHK (deciduous coniferous forest)



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



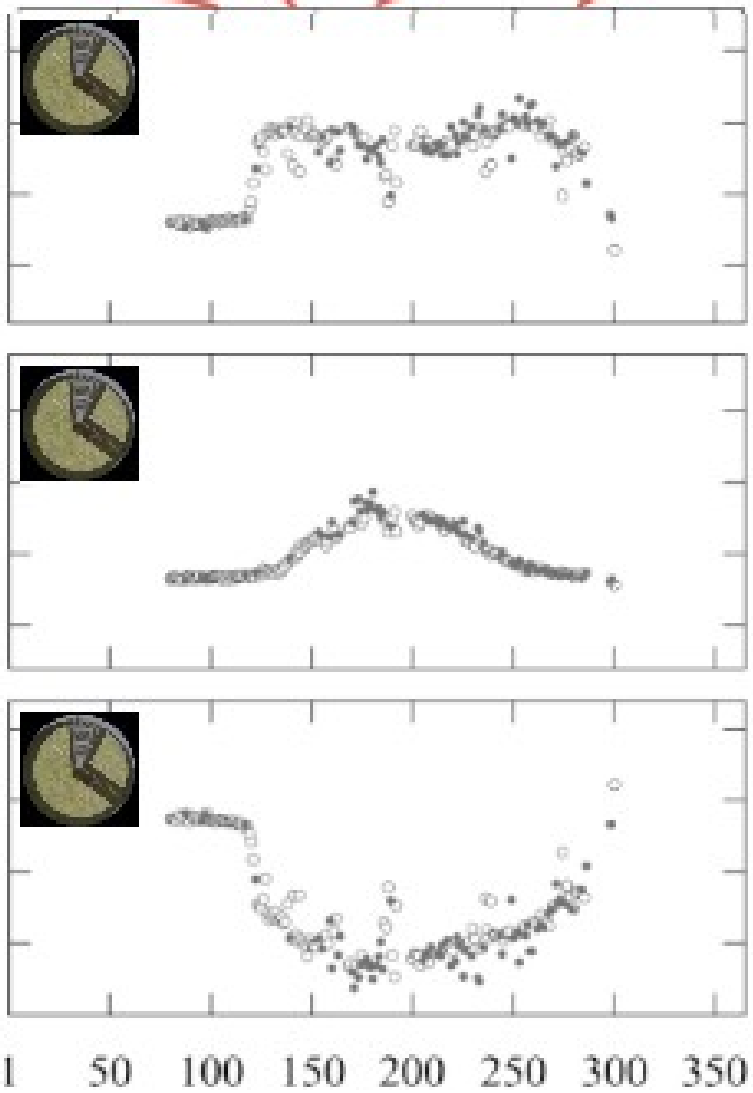


Seasonal patterns of camera-based indices and satellite-observed vegetation indices:

rR= R/(R+G+B)

rG= G/(R+G+B)

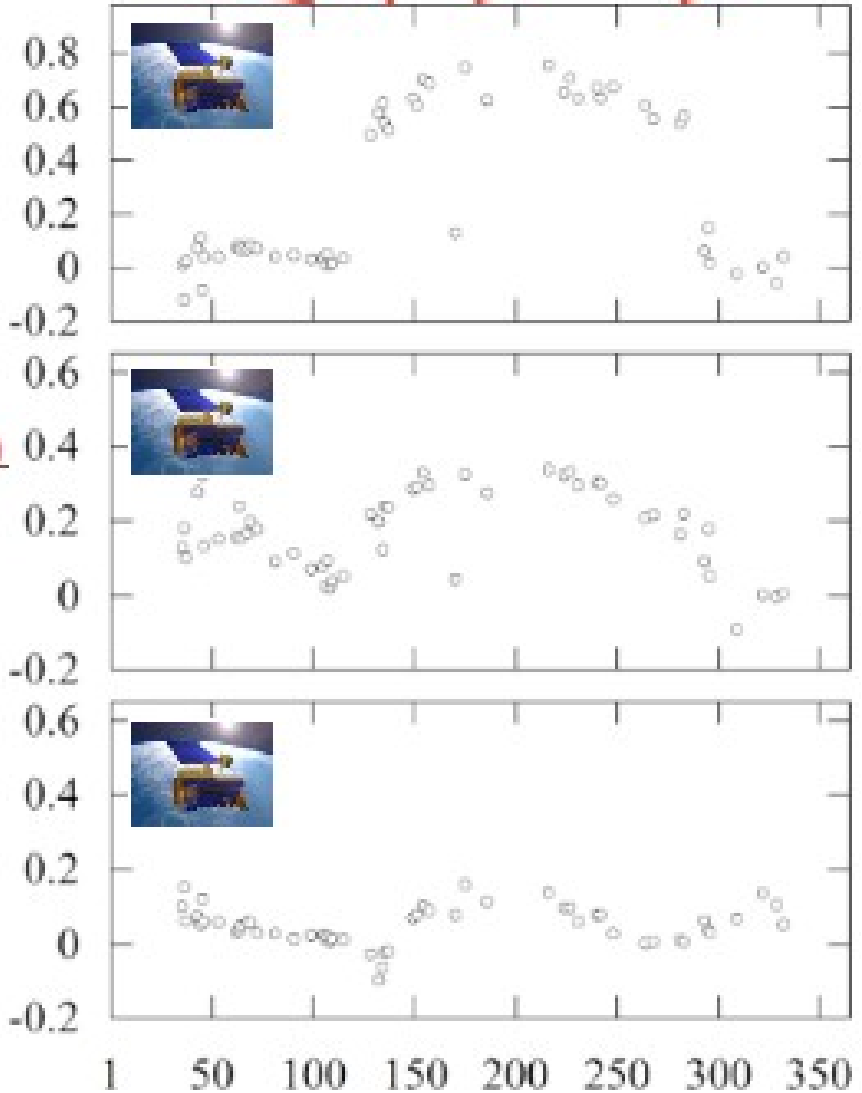
rB= B/(R+G+B)



NDVI= (NIR−R)/(NIR+R)

EVI= 2.5×(NIR−R)/(NIR+6×R−7.5×B+1)

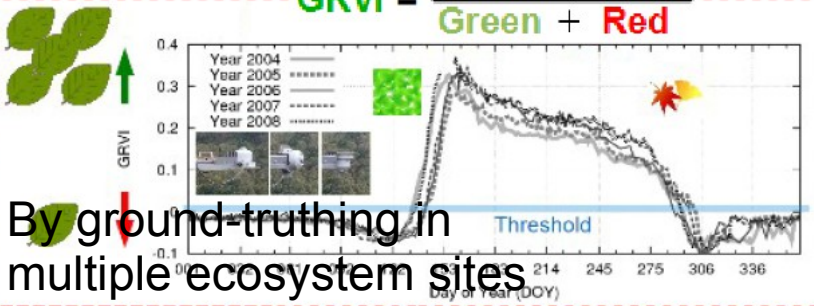
GRVI= (G−R)/(G+R)



○ sunny ● cloudy

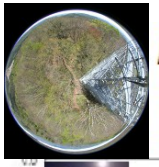
Detection of spatio-temporal variations in the timing of leaf-expansion by using satellite-observed (Terra & Aqua MODIS) vegetation index; GRVI

$$GRVI = \frac{Green - Red}{Green + Red}$$



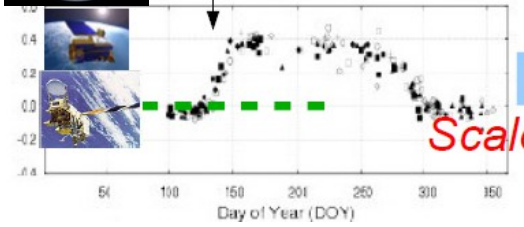
By ground-truthing in multiple ecosystem sites

[Motohka et al. 2010]



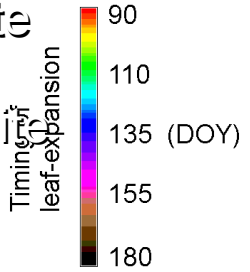
Leaf-expansion:

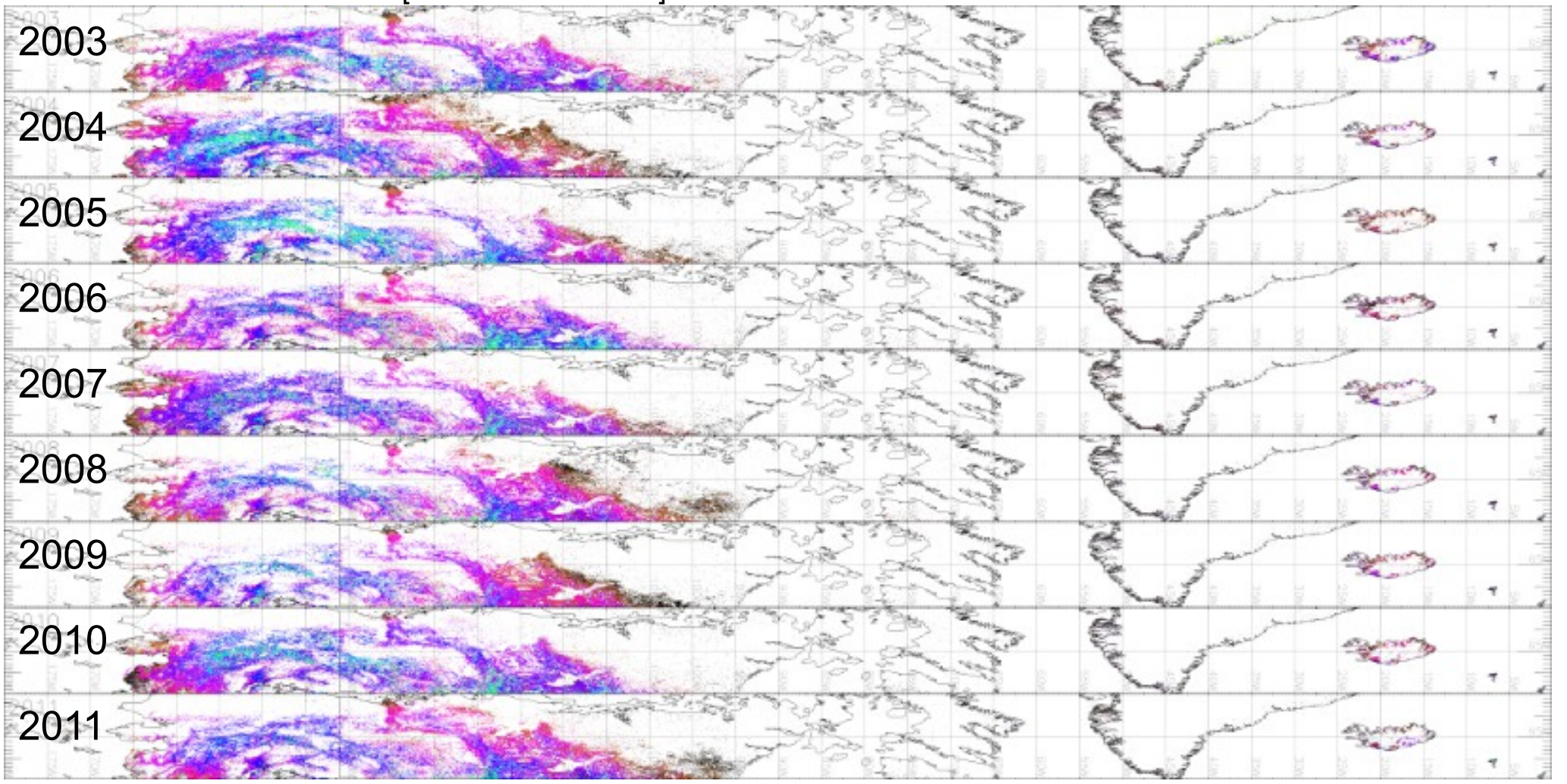
GRVI=0.0



Scale up!

Terra&Aqua MODIS satellite 500x500m 8-day composite

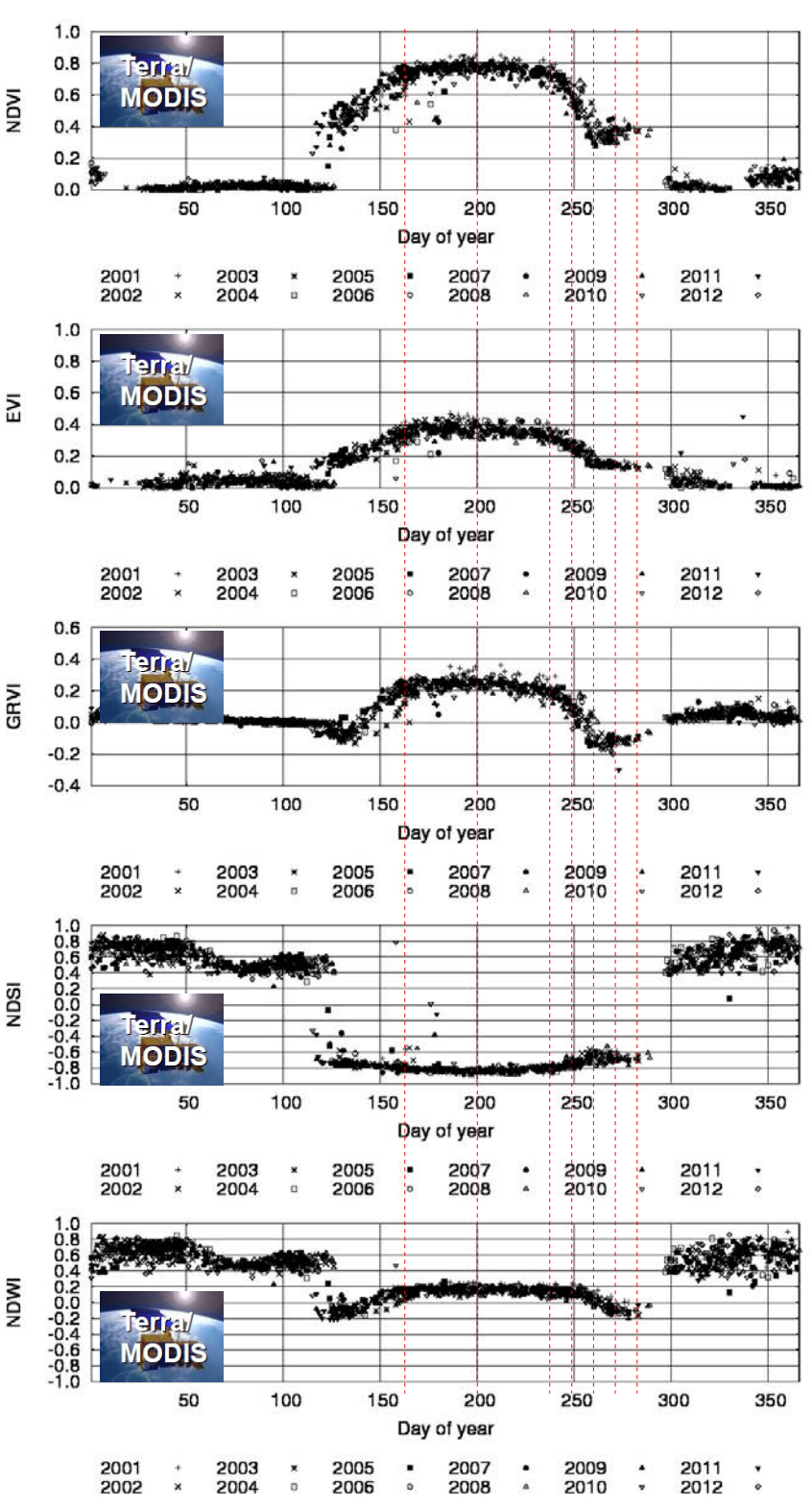


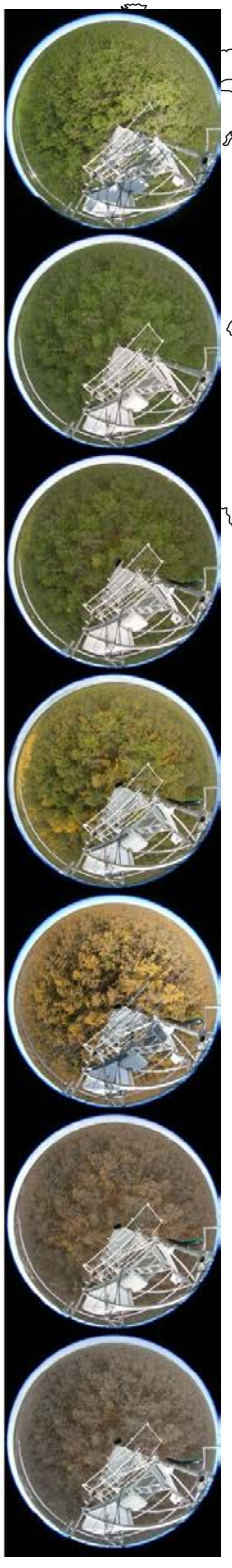


Important finding

Forest structural characteristics, such as canopy openness and seasonal forest-floor changes, should be considered during continuous observations of phenology in boreal forests.

Relationship between canopy phenology and satellite-observed vegetation indices in a deciduous coniferous (larch) forest; Spasskaya Pad site in Siberia





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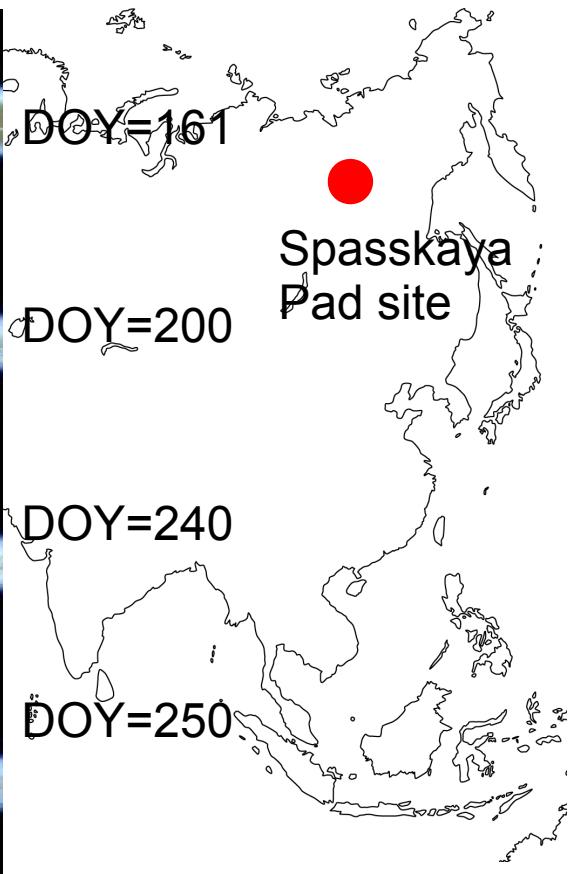
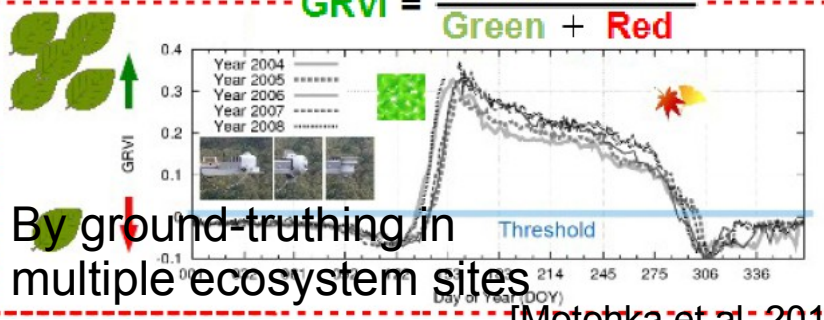


Detection of spatio-temporal variations in the timing of leaf-expansion by using satellite-observed (Terra & Aqua MODIS) vegetation index; GRVI

$$GRVI = \frac{Green - Red}{Green + Red}$$

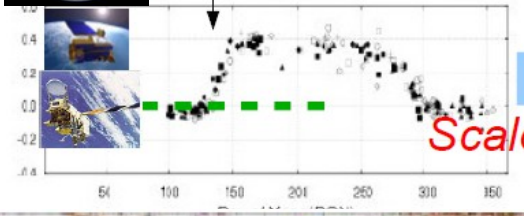


By ground-truthing in multiple ecosystem sites

[Motohka et al. 2010]

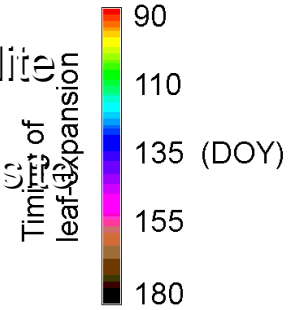
Leaf-expansion:

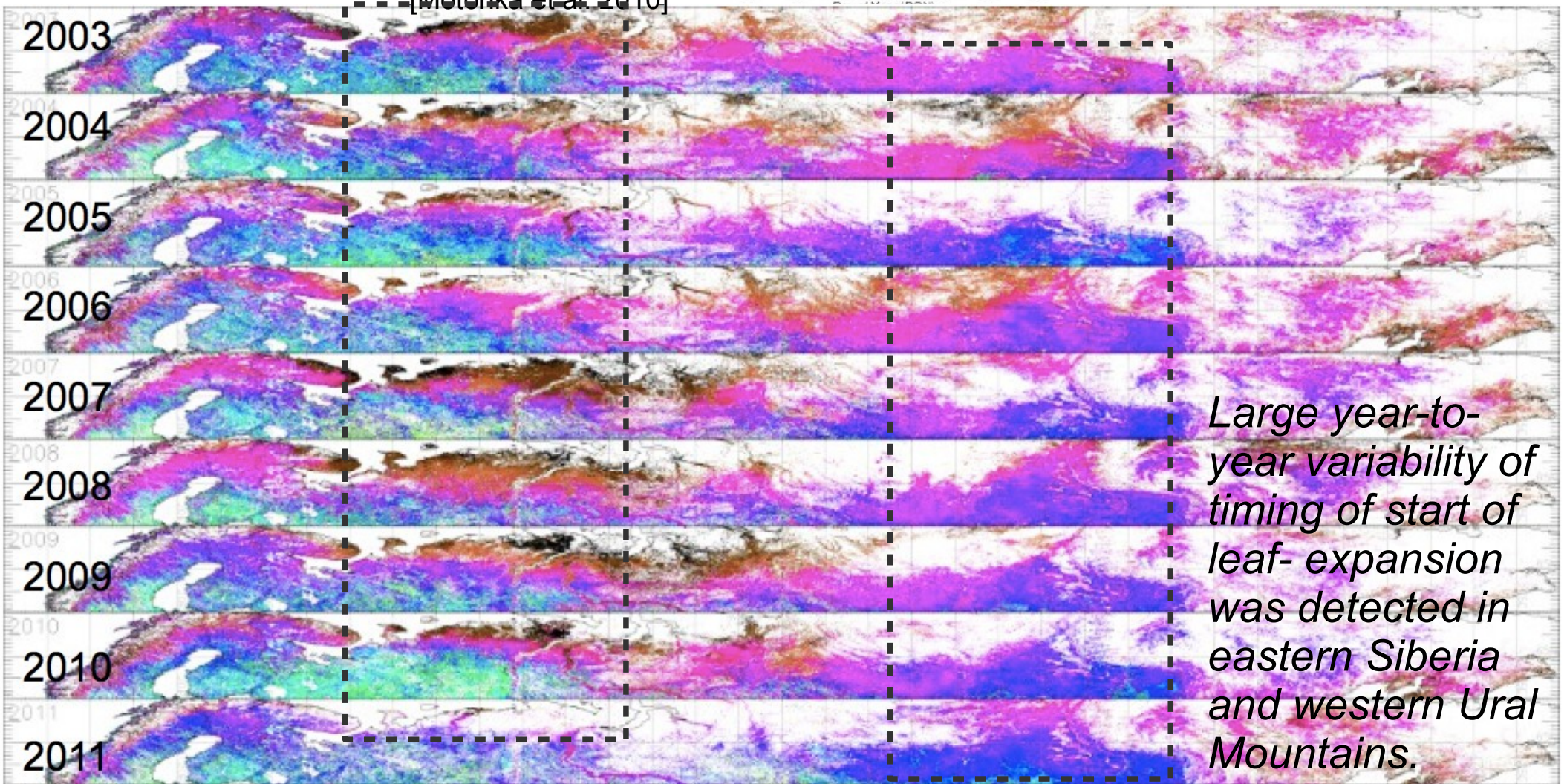
GRVI=0.0



Scale up!

Terra&Aqua MODIS satellite 500x500m 8-day composite



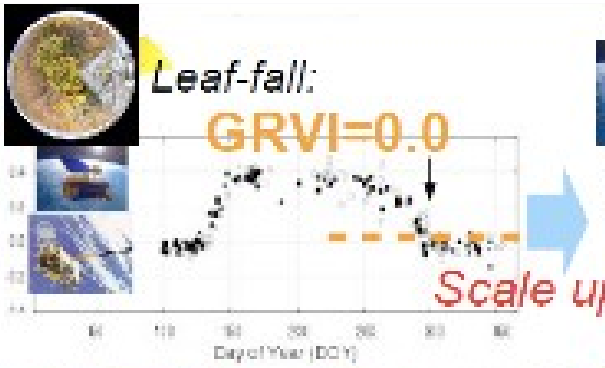


Large year-to-year variability of timing of start of leaf- expansion was detected in eastern Siberia and western Ural Mountains.

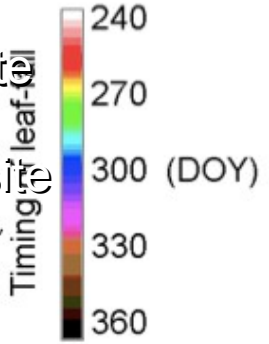
Detection of spatio-temporal variations in the timing of leaf-fall by using satellite-observed (Terra & Aqua MODIS) vegetation index; GRVI

$$GRVI = \frac{Green - Red}{Green + Red}$$

[Motohka et al. 2010]



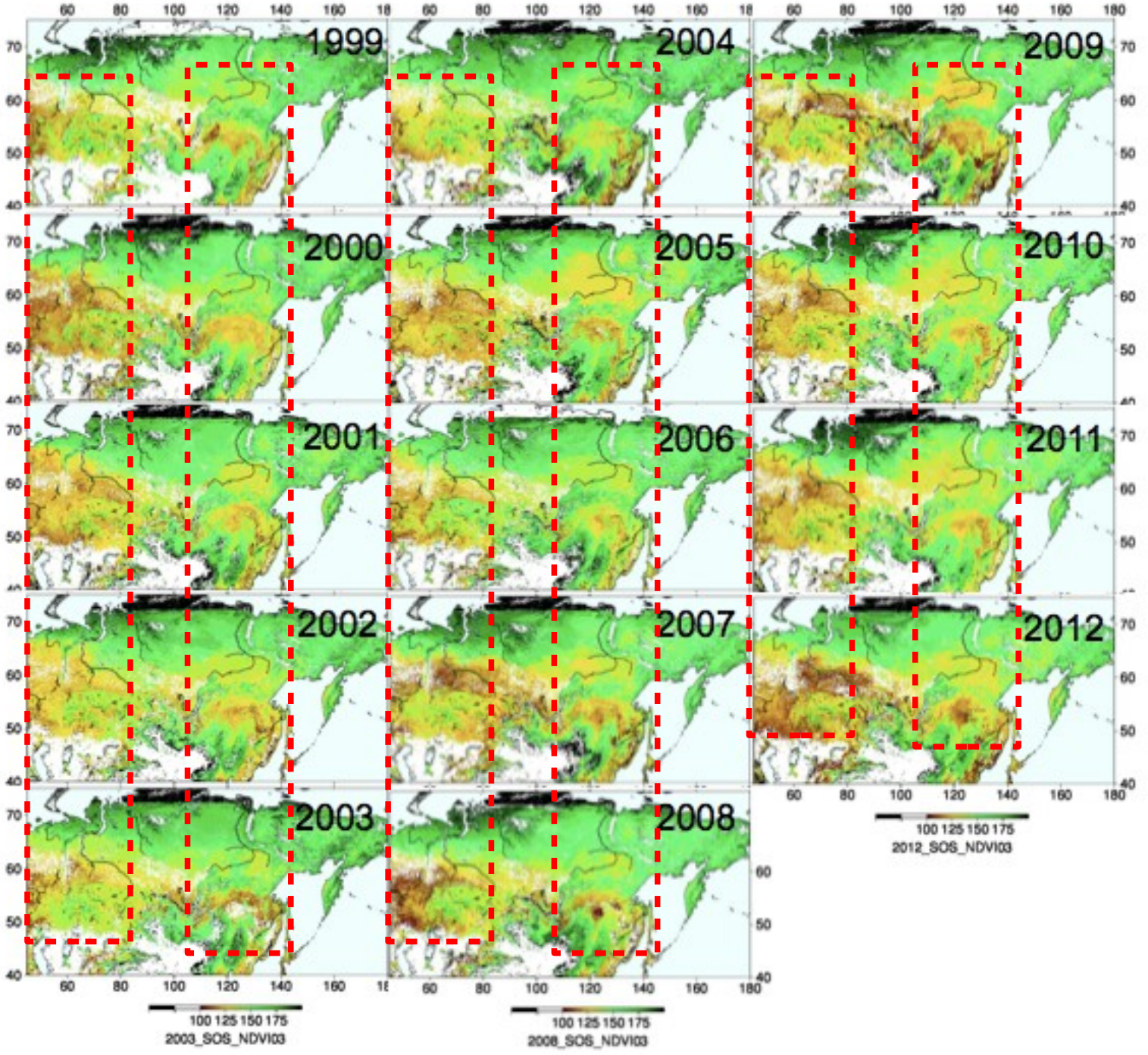
Terra&Aqua MODIS satellite 500x500m 8-day composite



Spring onset derived by the NDVI>0.3 method (SPOT/VEGETATION)

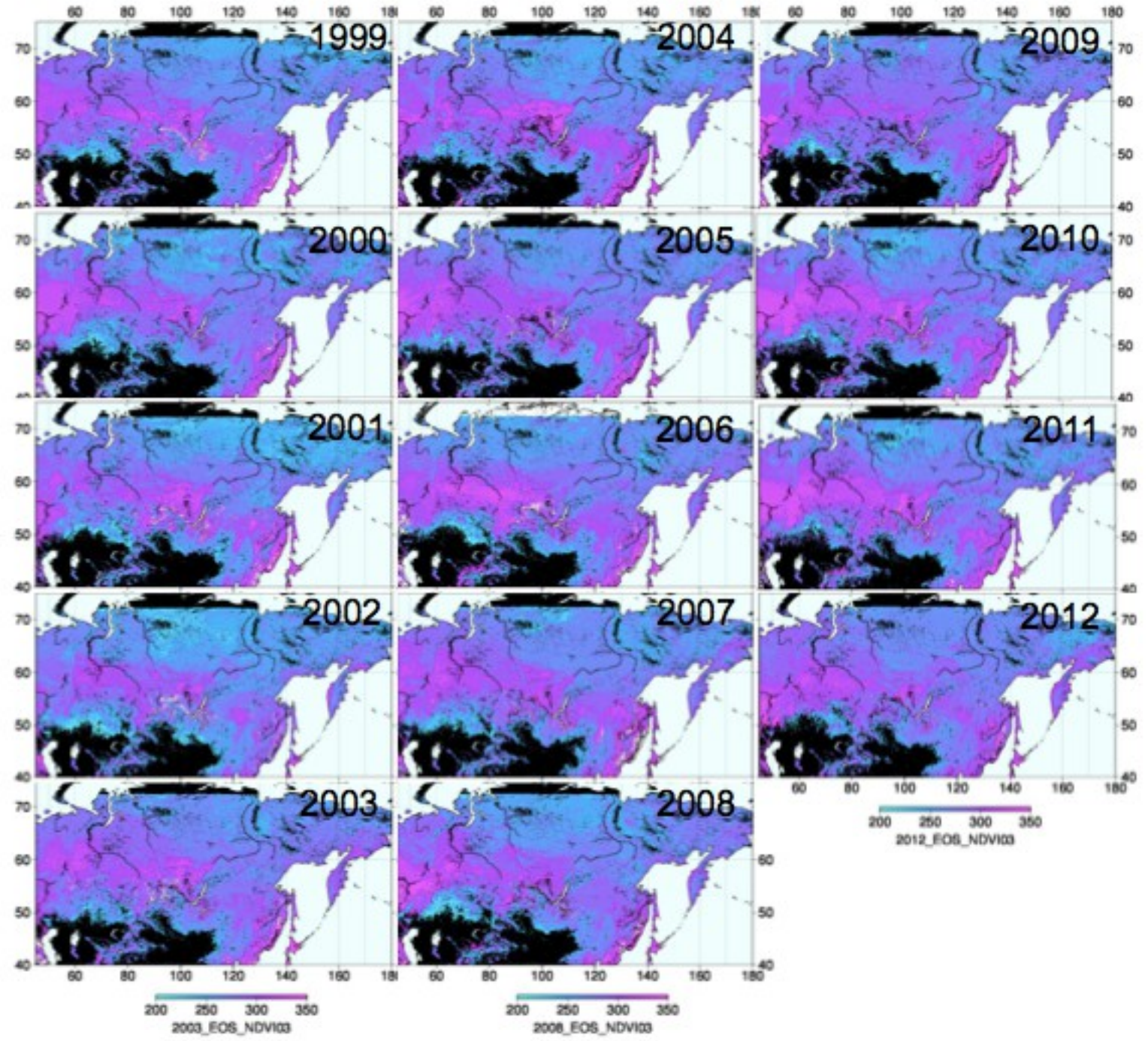
1kmx1km
10-day composite

Large year-to-year variability of timing of start of leaf- expansion was detected in eastern Siberia and western Ural Mountains.



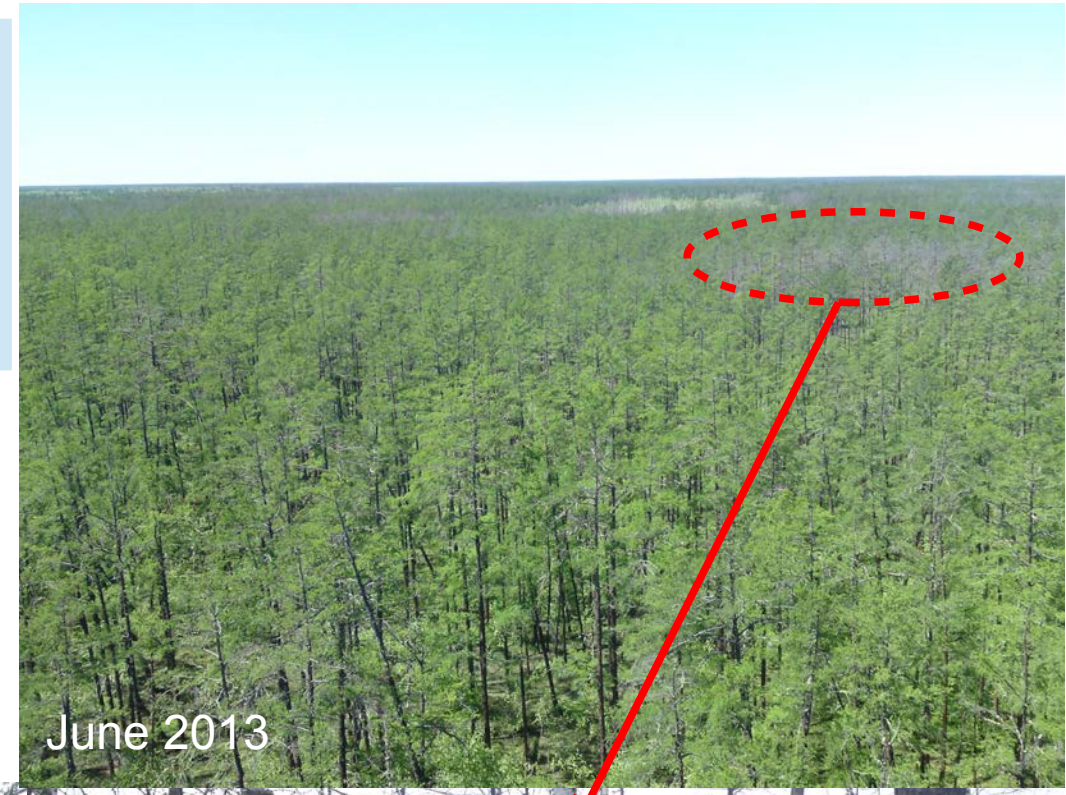
Autumn offset derived by the NDVI>0.3 method (SPOT/VEGETATION)

1kmx1km
10-day composite



Vegetation change is caused by environmental changes (i.e. soil moisture) in Siberia. [Drs. Iijima and Ohta]

Thawing permafrost may affect the spatio-temporal variability of boreal forests ecosystem structures, function and service.



Global warming

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 All PEN members
- Environment or Japan Global Environment Research Fund (S-1) of the Ministry of Environment of Japan
- Japan Society for the Promotion of Science (JSPS) 21st Century COE Program (Satellite Ecology, Gifu University)
- JSPS/NRF/NSFC A3 Foresight Program
- Global Change Observation Mission (GCOM; PI#102, #121) of the JAXA
- JAMSTEC-IARC collaboration (JICC project)
- JSPS Funding Program for Next Generation World-Leading Researchers (NEXT Program)
- CEReS, Chiba University
- UK-Japan collaboration (UK embassy)
- and all PEN members.