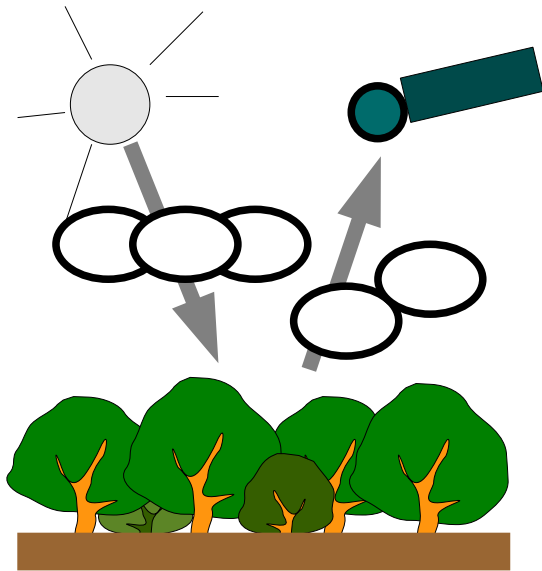# "*Phenological Eyes Network* (*PEN*)"
Long-term ground validation of satellite remote sensing of ecosystems.

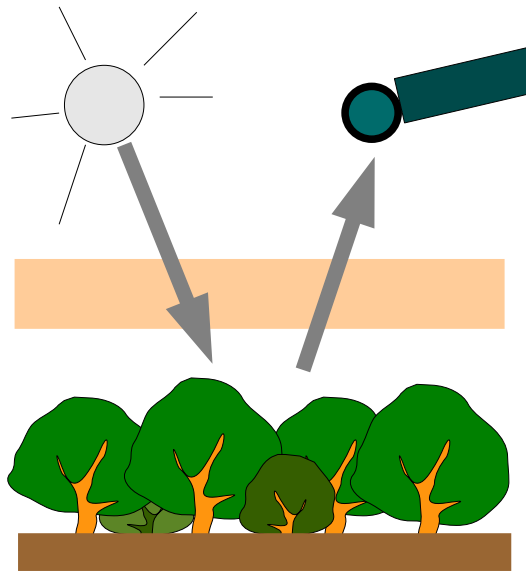Kenlo Nishida Nasahara (Univ. Tsukuba; JAXA)
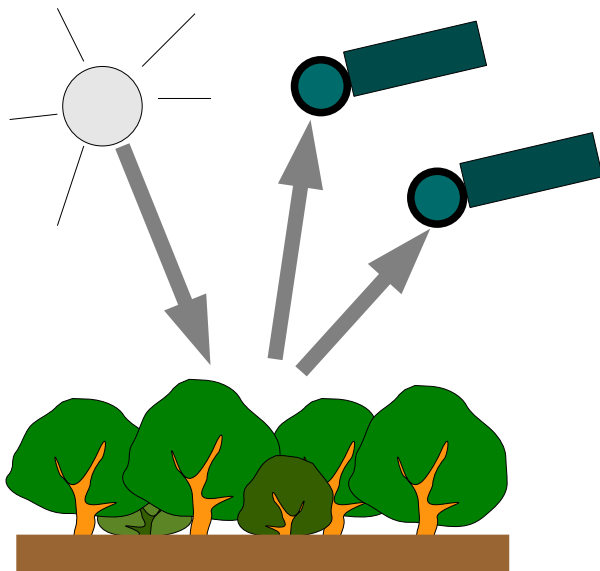Satoshi Tsuchida (AIST)
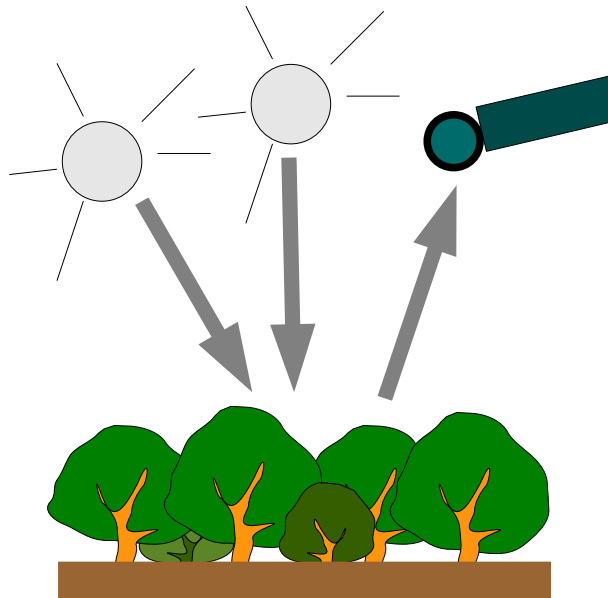Takeshi Motohka (Univ. Tsukuba)

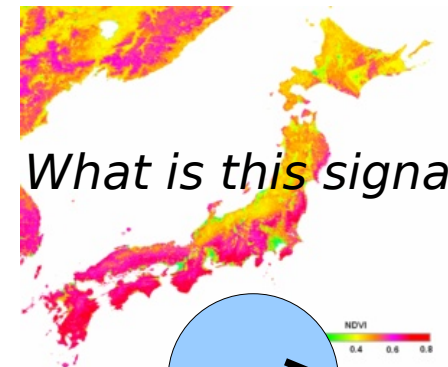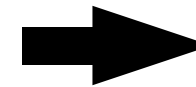# Noise factors for satellite data
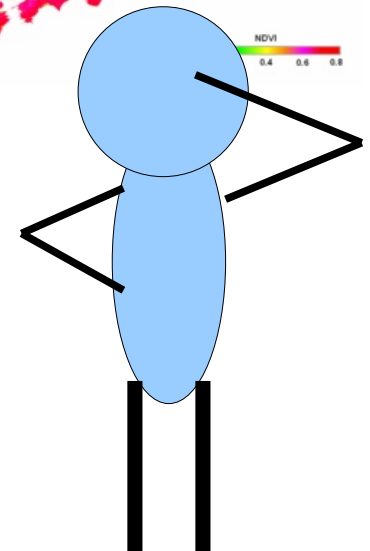
clouds!

aerosols!

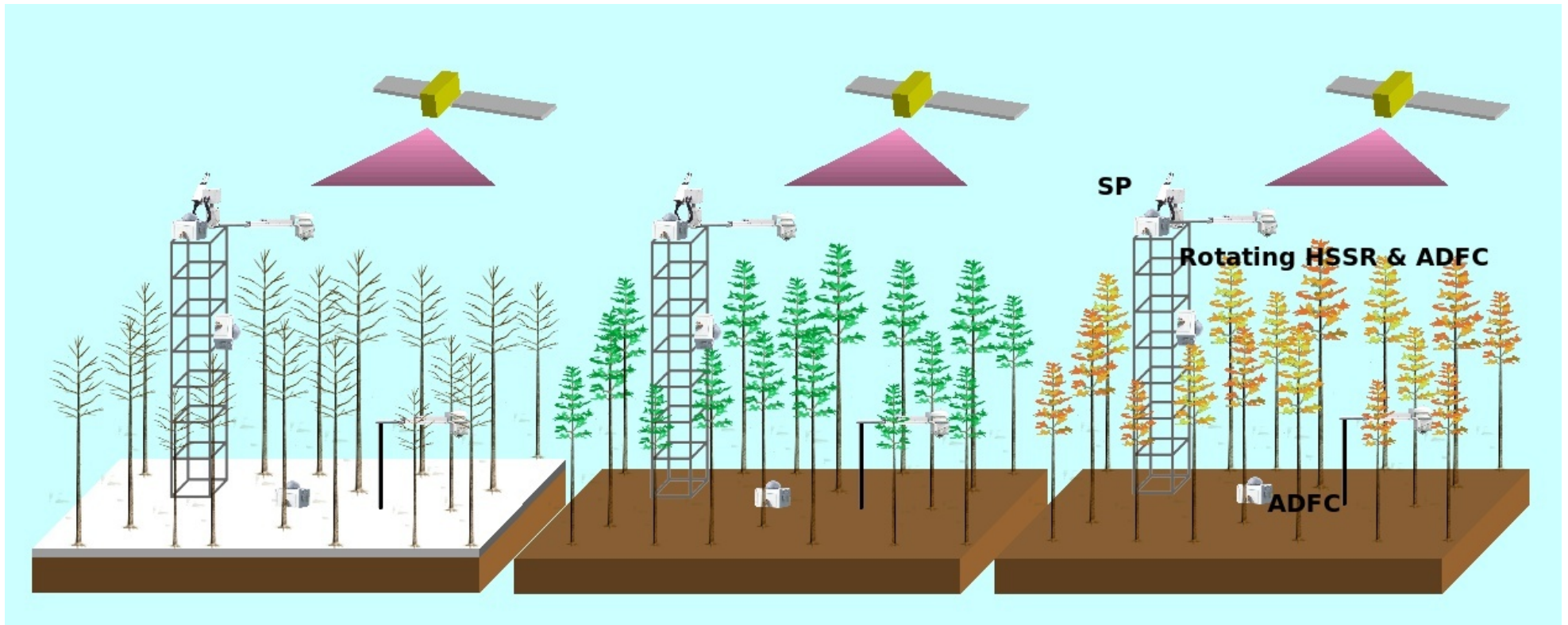Different view angle!

Different sun angle!

What is this signal?

We need "Ground truth" for ecology remote sensing.

Long-term … Because ecosystem is always changing!
Multiple-site … Because there are many types of ecosystems!
Hyper-spectrum … Because there are many satellite sensors!
Biophysical … Because we want to estimate LAI, NPP, GPP, etc.

||

"Phenological Eyes Network (PEN)"

Since 2003

PEN Sites

Sugadaira 菅平
(Univ. Tsukuba)

Grassland

Takayama 高山
(Gifu Univ. & AIST)

Deciduous Broadleaf
Forest

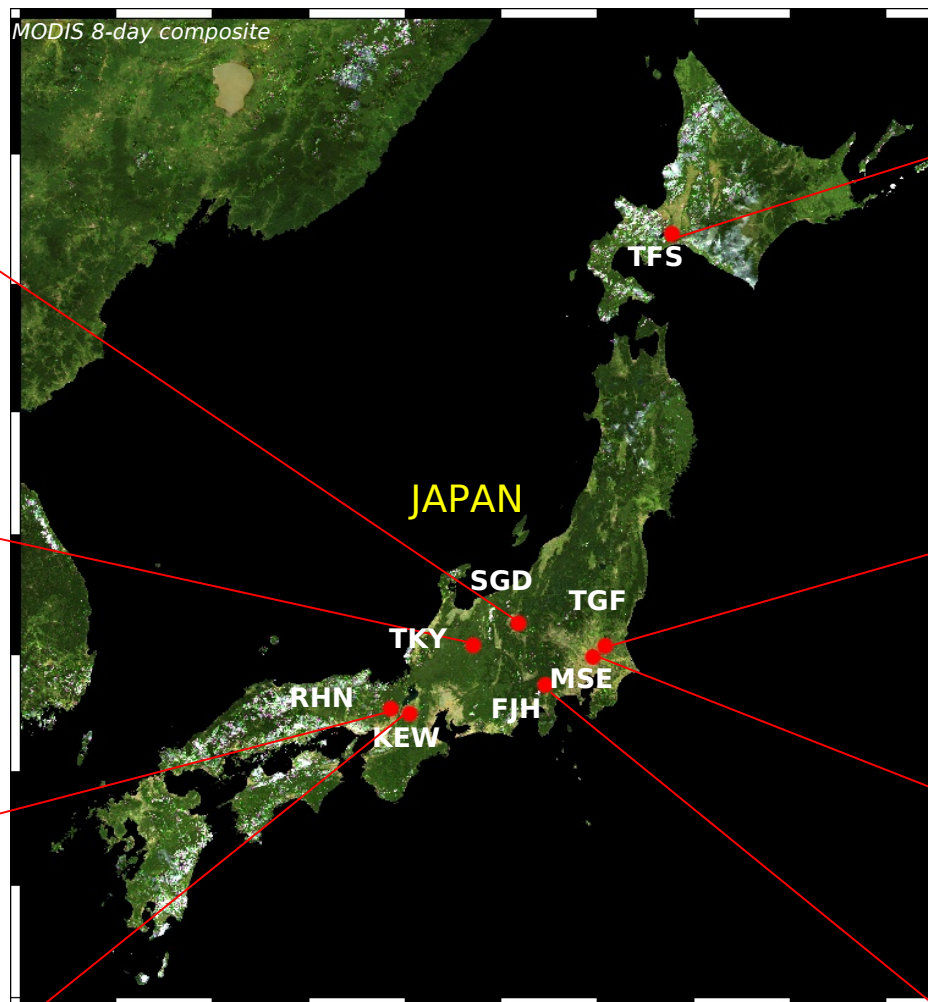**Research Institute for
Humanity and Nature ***

Urban

Kiryu 桐生
(Kyoto Univ.)

Evergreen Needleleaf
Forest

MODIS 8-day composite

JAPAN

SGD

TGF

TKY

RHN

MSE

KEW

FJH

TFS

Tomakomai 苫小牧*
(NIES)

Deciduous Needleleaf
Forest

**Terrestrial Environment
Research Center**
(Univ. of Tsukuba)

Grassland

Mase 真瀬
(NIAES)

Rice Paddy Field

Fuji Hokuroku
富士北麓
(NIES)

Deciduous Needleleaf
Forest

Most of the PEN sites are located at the AsiaFlux sites. AsiaFlux is a monitoring network of carbon, water and energy fluxes between ecosystems and the atmosphere.
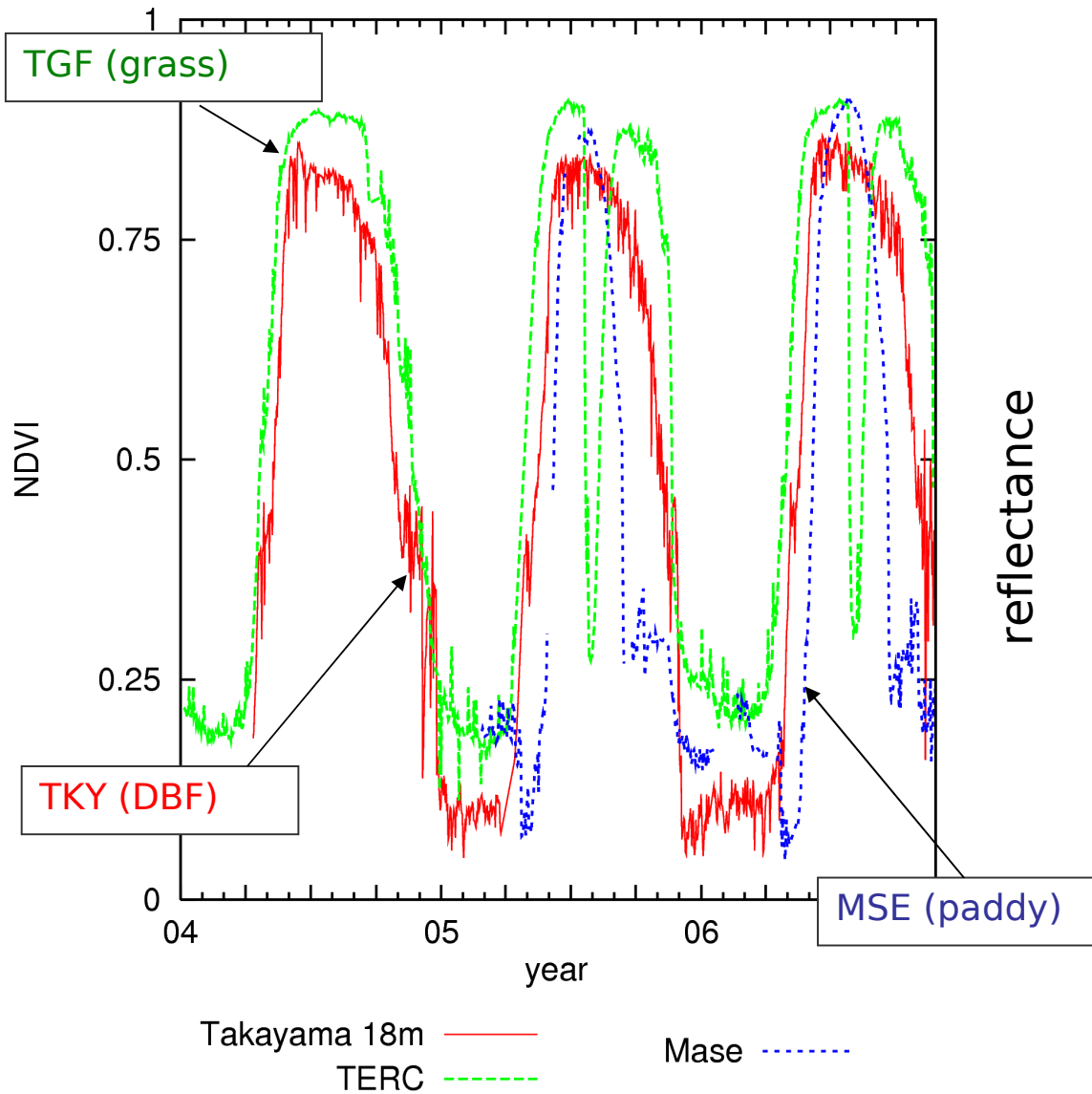
* TFS and RHN stopped operation in September, 2004 and February 2006, respectively.
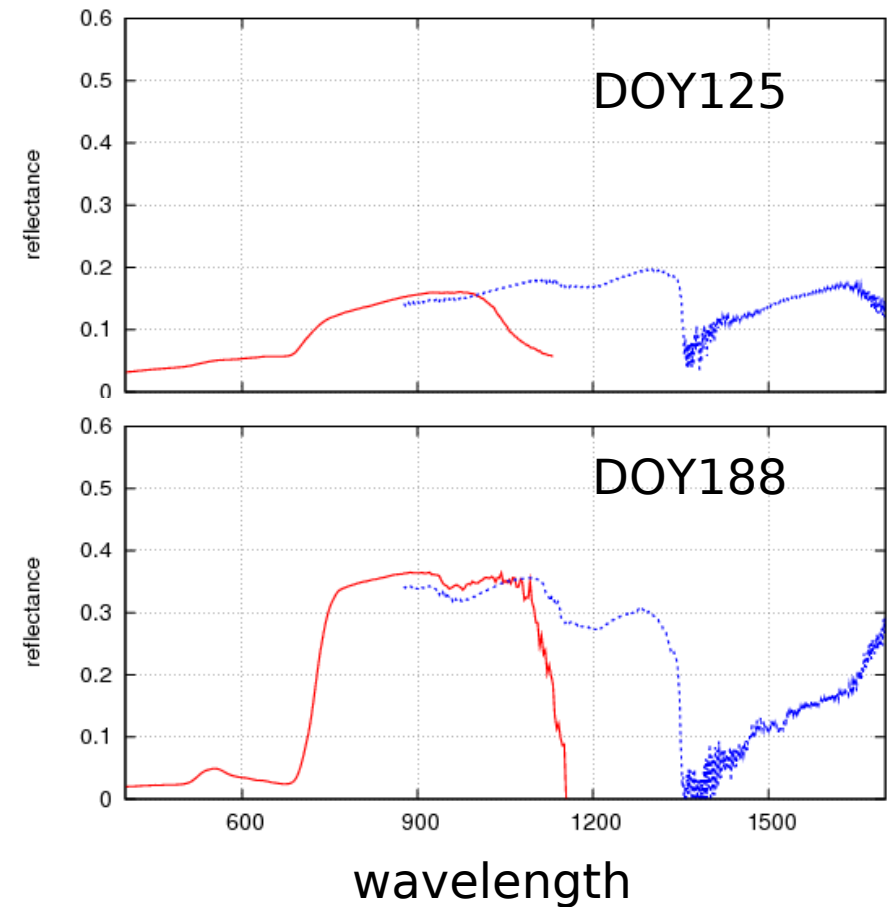
PEN Device: HSSR

HemiSpherical Spectro-Radiometer
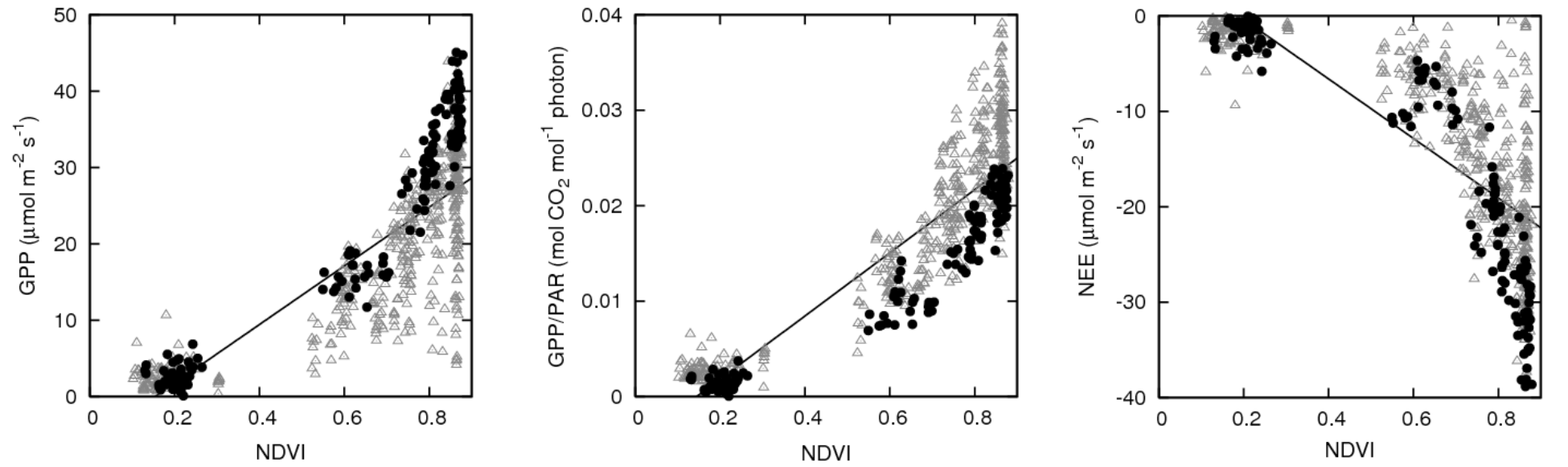
Ground measured NDVI at PEN site

TGF (grass)

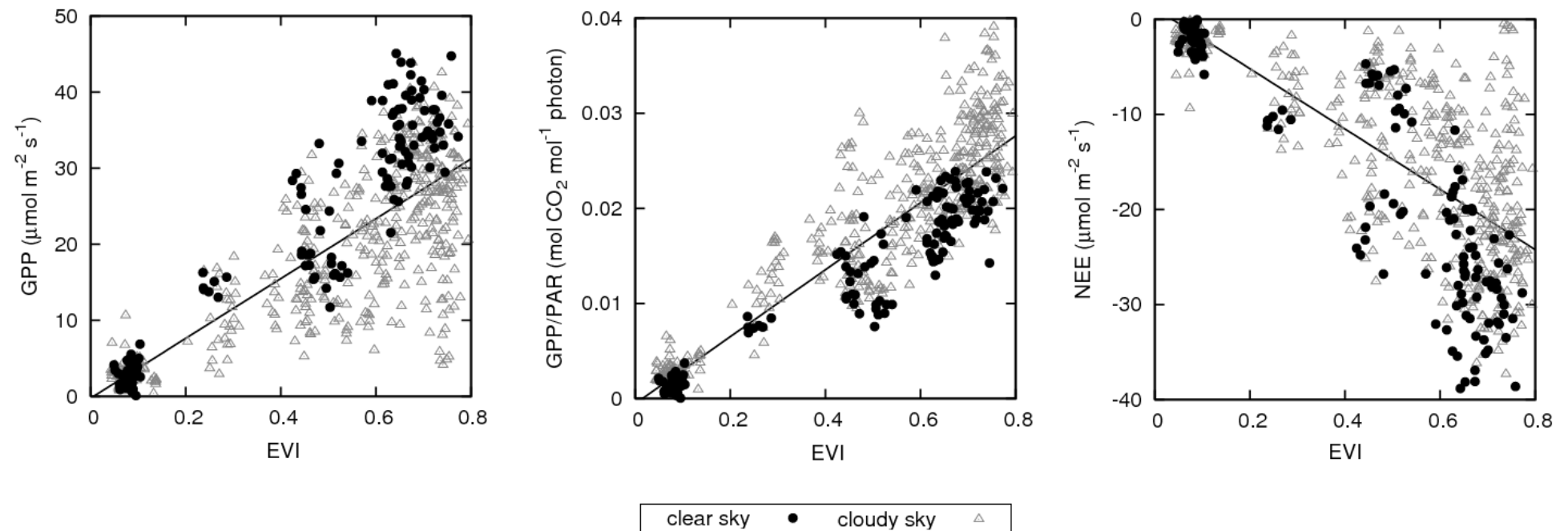TKY (DBF)

MSE (paddy)

NDVI

year

Takayama 18m

TERC

Mase

reflectance spectrum (TKY)

DOY125

DOY188

reflectance

wavelength

Spectral index vs. Carbon flux

MSE (paddy)

Flux data: courtesy of NIAES group (A. Miyata)

(a) NDVI

(b) EVI

clear sky ● cloudy sky △

PRI ... photochemical reflectance index

MSE (paddy)

Flux data: courtesy of NIAES group (A. Miyata)
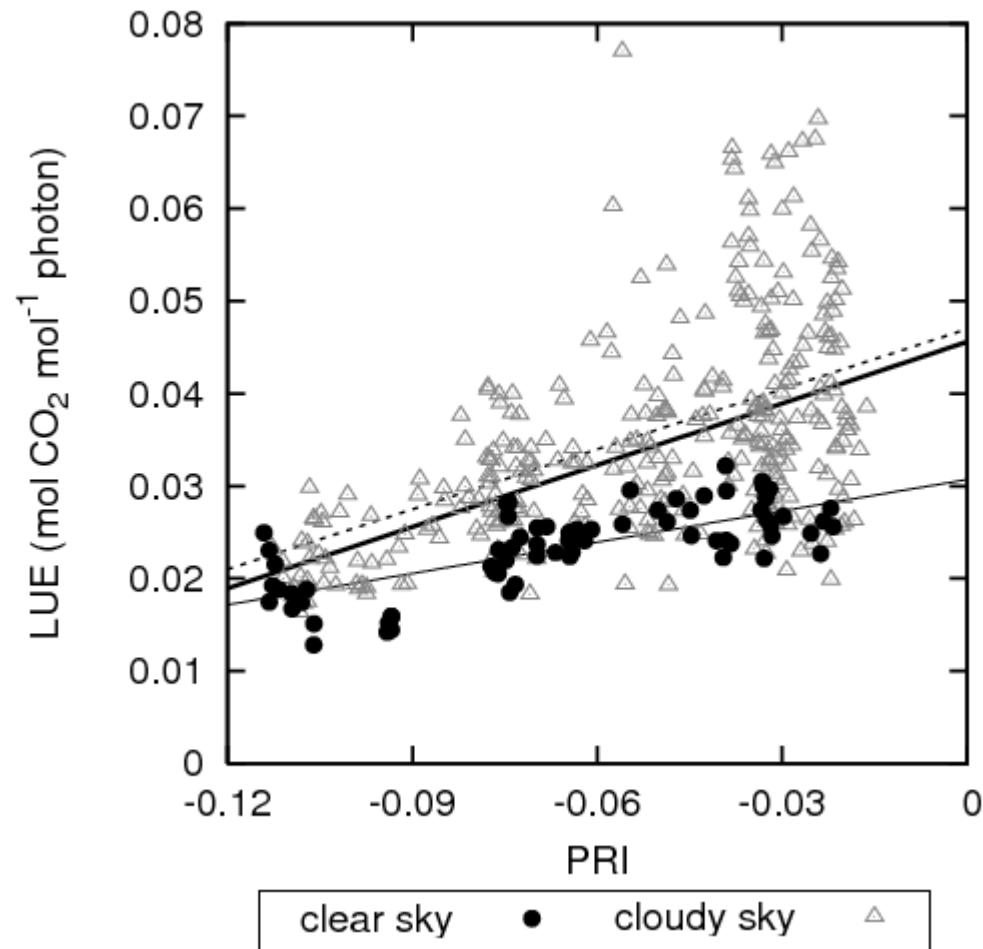
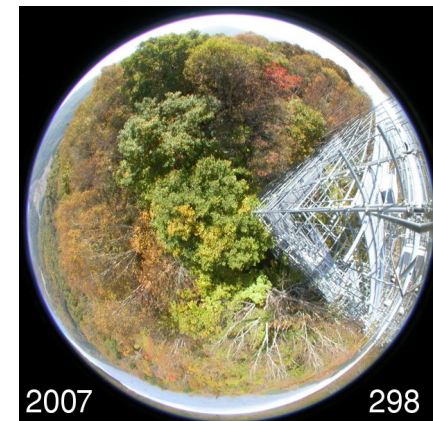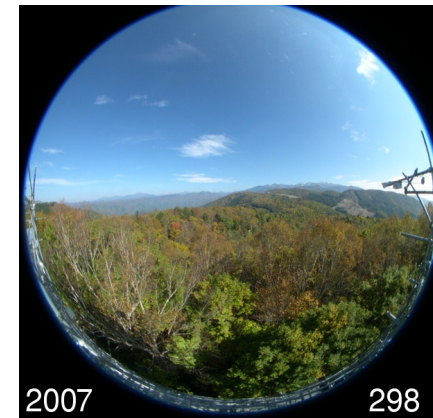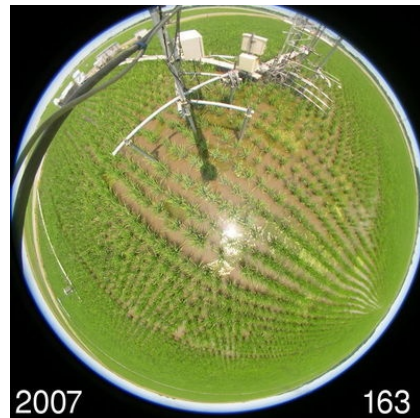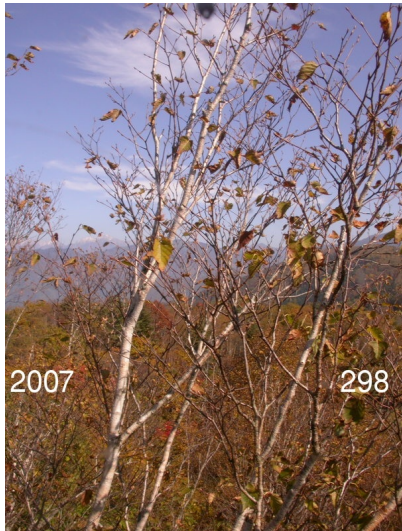| VI	Sky condition	LUE		
		r^2	A	B
PRI	All condition	0.212	0.223	0.0456
	Clear sky	0.517	0.113	0.0307
	Cloudy sky	0.184	0.217	0.0470

PEN Device: ADFC

Automatic Digital Fish-eye Camera）

Nikon CoolPix4500 + fisheye FC-E8

Phenology, LAI, sky condition (cloud cover), snowpacks.
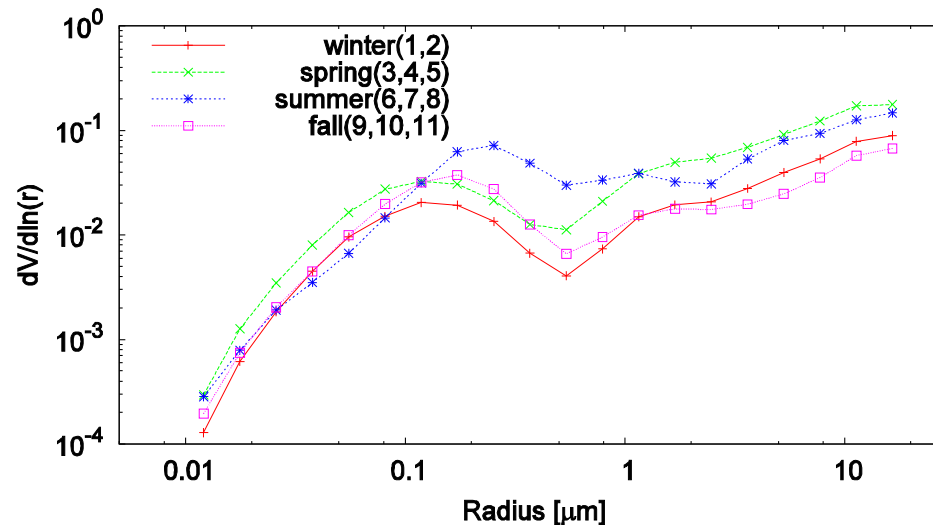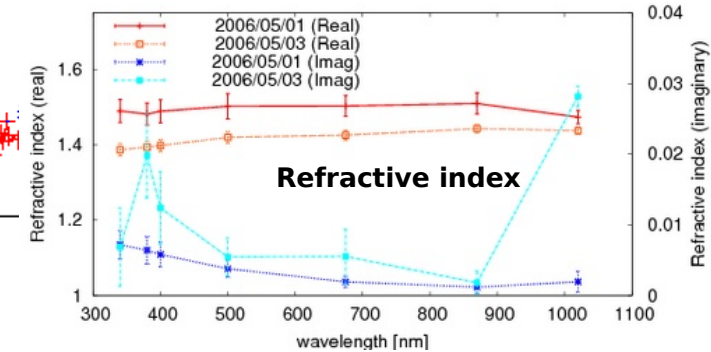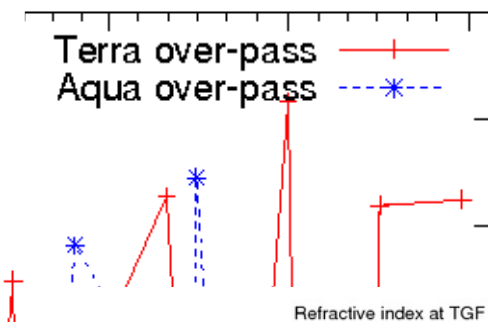
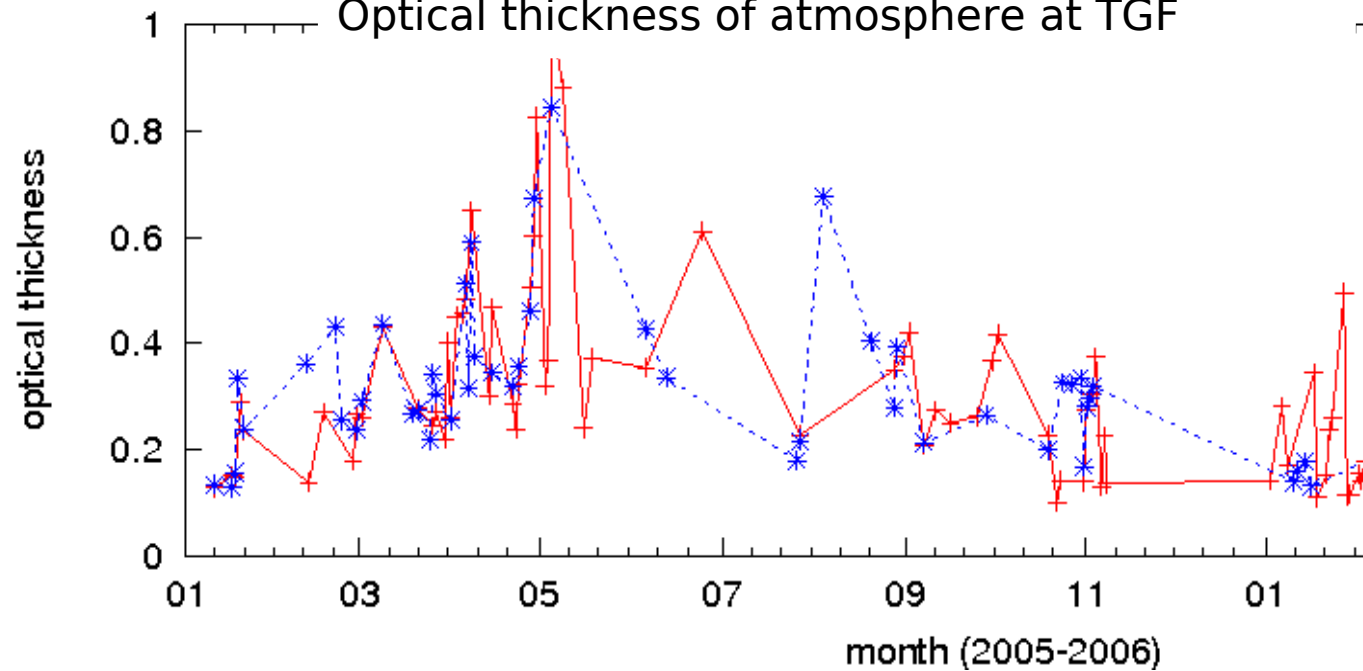11 sites, 34 cameras, 2.3 million digital pictures so far.

SunPhotometer

aerosol particle size at TGF (2005)

Optical thickness of atmosphere at TGF

Refractive index
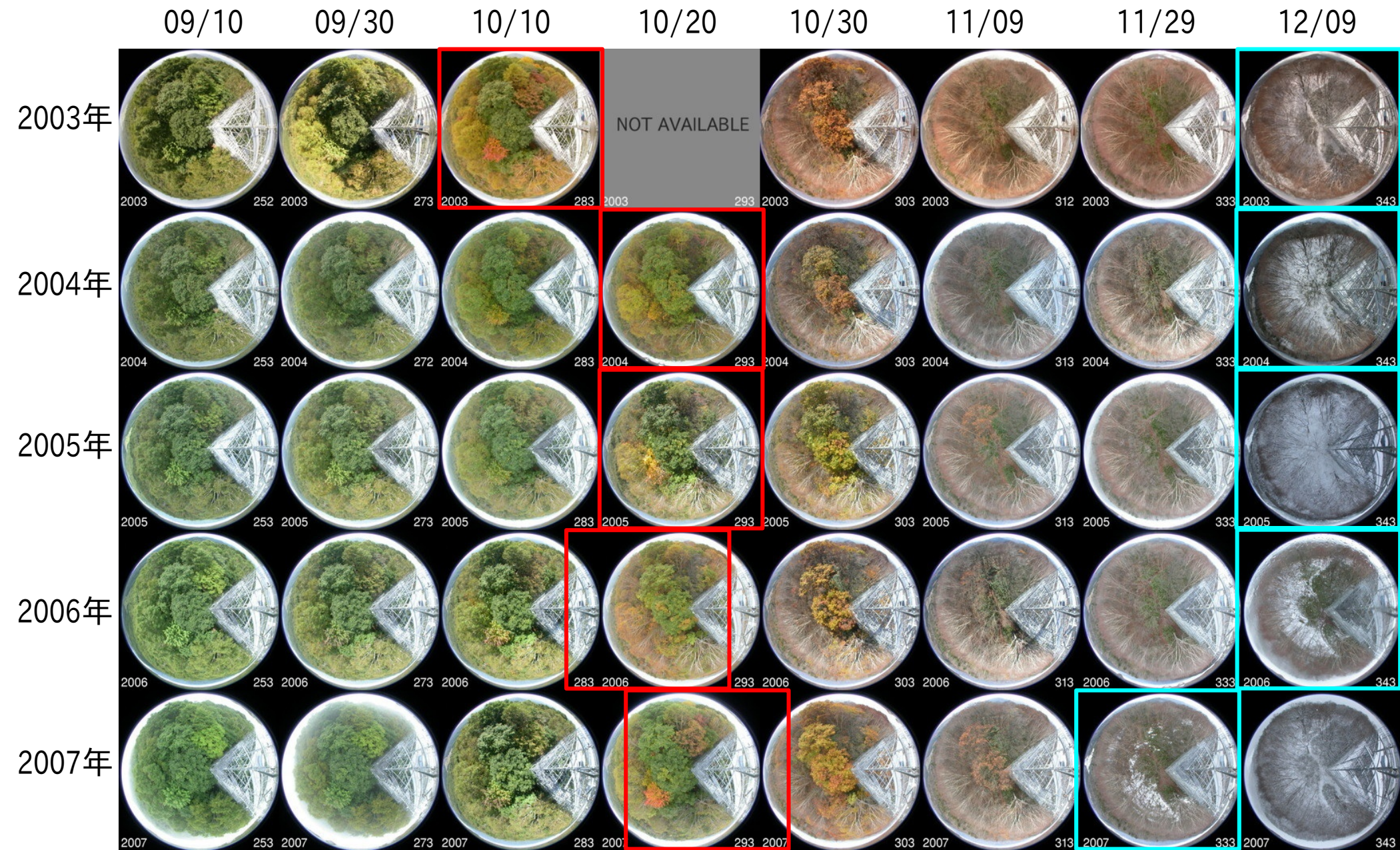
Timing of snow melt and budburst do not correlate.

Autumn phenology （TKY） … 10-day summary

	09/10	09/30	10/10	10/20	10/30	11/09	11/29	12/09
2003年				NOT AVAILABLE				
2004年								
2005年								
2006年								
2007年								

Phenology index

Satellite-based data

Terra MODIS

Year 2001-2006

Spectral vegetation index

$$GRVI = \frac{GREEN - RED}{GREEN + RED}$$

First date of "**GRVI>0.05**" during DOY 0-200

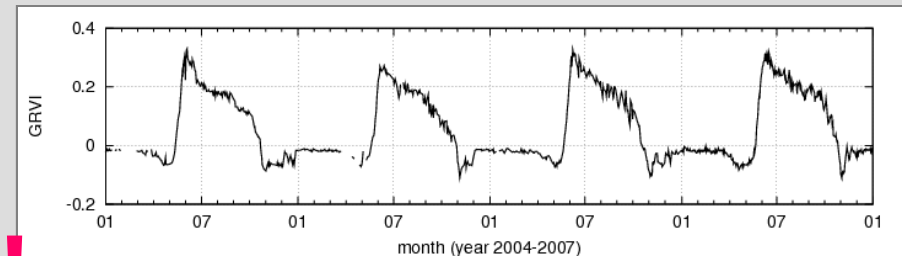First date of "**GRVI<0.05**" during DOY 200-365

Green-up

Autumn coloring

Our Goal !!

Ground-based Data

- continuous and long-term datasets
- multiple biome (forest, grassland, paddy ...)

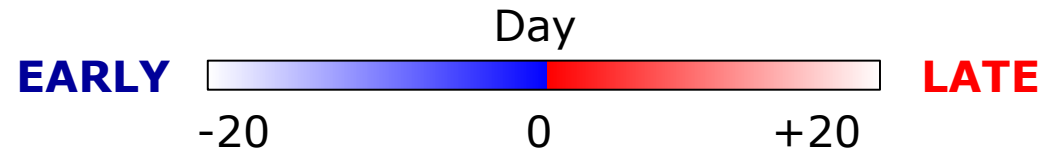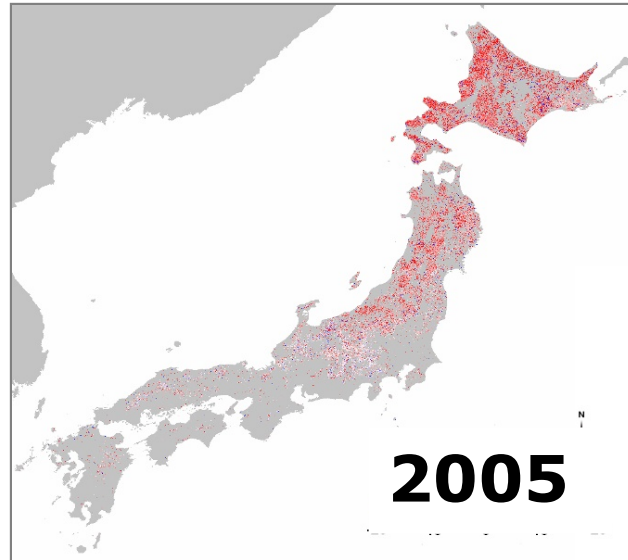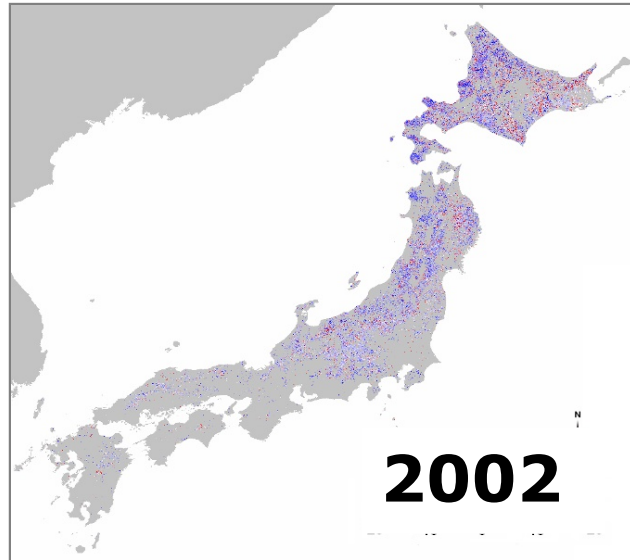### Spectral vegetation index

Check!

Photos (canopy & shoot)
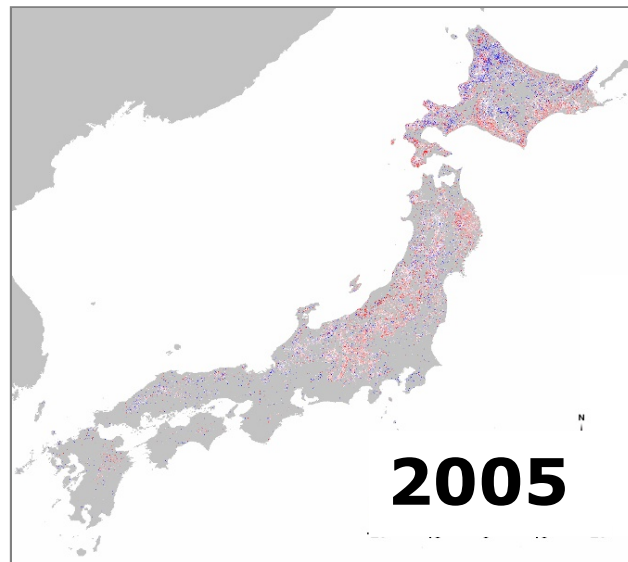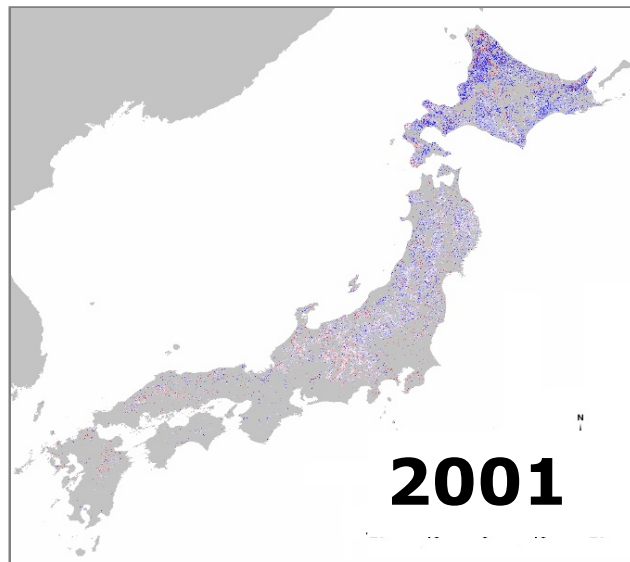
Anomaly of "green-up" and "autumn-coloring" date

"Deciduous Forest" only.

Day

EARLY $\quad$ LATE

-20 $\qquad$ 0 $\qquad$ +20

Green-up

2002

2005

Green-up was
 - early in 2002
 - late in 2005 and 2006

Autumn-coloring

2001

2005

Autumn-coloring was
 - early in 2001
 - late in 2005

However, It was differed greatly from region to region.

Conclusion

Phenological Eyes Network (PEN) is accumulating long-term ground data for ground-truth of satellite remote sensing.

Ground truth by PEN:
 - Cloud-screening
 - Band reflectance, NDVI, EVI.

New algorithms by PEN:
 - phenology detection
 - LAI estimation
 - carbon budget estimation (LUE, GPP)