

Detailed Reports on the Validation of the SGLI Products

2. Land Products

2. Validation Results of Land Products

2.1 Evaluation Summary

Product	Release threshold	Standard accuracy	Target accuracy	Status*1	Evaluation Methods
Precise geometric correction	<1 pixel	<0.5 pixel	<0.25 pixel	◎	Evaluation of geolocation accuracies with GCPs prepared using AVNIR-2 data.
Atmospheric corrected reflectance (incl. cloud detection)	0.3 (<=443nm), 0.2 (>443nm) (scene)	0.1 (<=443nm), 0.05 (>443nm) (scene)	0.05 (<=443nm), 0.025 (>443nm) (scene)	○	Comparison with in-situ observed reflectance.
Vegetation index	Grass:25% (scene), forest:20% (scene)	Grass:20% (scene), forest:15% (scene)	Grass:10% (scene), forest:10% (scene)	○	Comparison with in-situ observation and other satellite data.
Above-ground biomass	Grass:50%, forest: 100%	Grass:30%, forest:50%	Grass:10%, forest:20%	○	Comparison with in-situ observation (incl. the data from the literatures).
Vegetation roughness index	Grass & forest: 40% (scene)	Grass & forest:20% (scene)	Grass & forest:10% (scene)	○	Comparison with other satellite data.
Shadow index	Grass & forest: 30% (scene)	Grass & forest:20% (scene)	Grass & forest:10% (scene)	○	Comparison with in-situ observations.
fAPAR	Grass:50%, forest: 50%	Grass:30%, forest:20%	Grass:20%, forest:10%	○	Comparison with in-situ observation and other satellite data.
Leaf area index	Grass:50%, forest: 50%	Grass:30%, forest:30%	Grass:20%, forest:20%	○	Comparison with in-situ observation and other satellite data.
Surface temperature	<3.0 K (scene)	<2.5 K (scene)	<1.5 K (scene)	○	Comparison with in-situ observation and other satellite data.

*1 Symbols denote as follows; ○: the release threshold achieved, ◎: the standard accuracy achieved, ☆: the target accuracy achieved.

2. Validation Results of Land Products

2.2 (a) Precise geometrically corrected Top-of-Atmosphere (TOA) radiance (LTOA)

Validation Method:

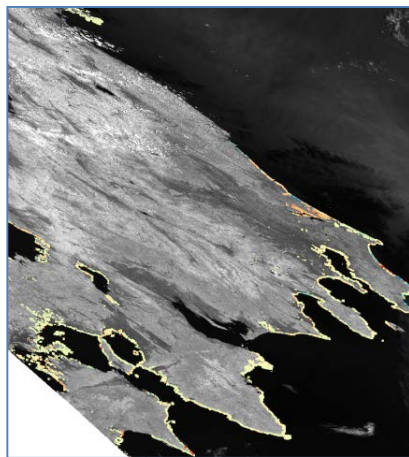
- The geometric accuracies were evaluated by automatic matching of SGLI VN11 for VNR and SW3 for IRS at 250 m resolution with AVNIR-2 ortho-corrected mosaic data around Japan islands.
- The accuracies of POL bands were evaluated as registration errors relative to the VNR band that were resampled to 1 km resolution by averaging.
- Evaluation method is quadratic curve fitting of cross-correlation coefficients (considering pixel locking correction)

Validation data and condition, period etc.

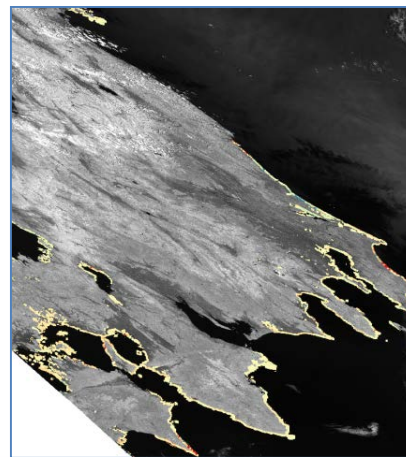
- Reference data: ortho-corrected mosaic of AVNIR-2 with less cloud covers as shown below*1
GC1SG1_20180625D01D_T0529_L2SG_LTOAQ_0006.h5
- Dependence of geometric errors on altitude was evaluated for confirming the accuracies of the ortho-corrected images

*1) Overall geometric accuracies of LTOA depend also on those of L1B. Regarding the geometric accuracies of L1B, please refer to the “geometric correction” on the SGLI calibration pages.

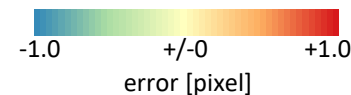
Target Image example: GC1SG1_20180625D01D_T0529_L2SG_LTOAQ_0104.h5



Horizontal (X)



Vertical (Y)

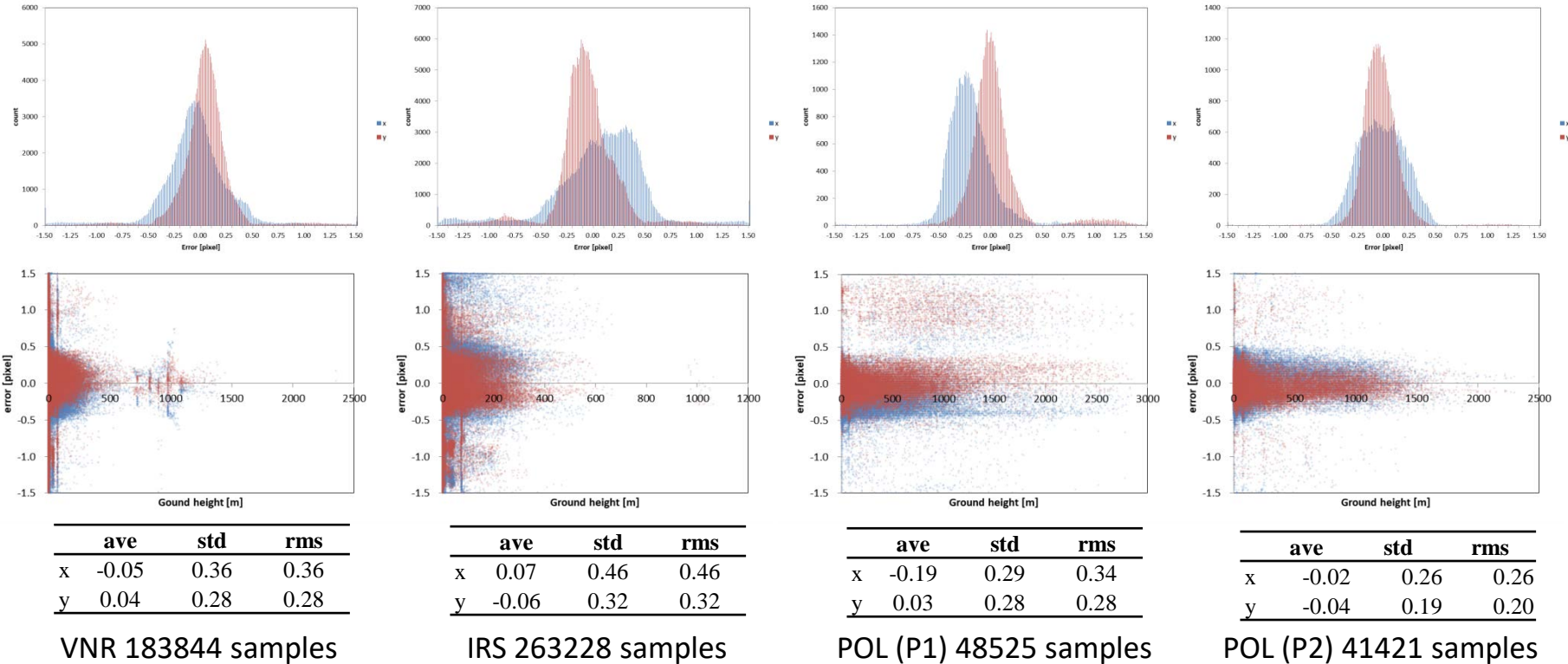


Distribution of geolocation error between
SGLI/Lt_VN11 and AVNIR-2/Band4

2. Validation Results of Land Products

2.2 (a) Precise geometrically corrected Top-of-Atmosphere (TOA) radiance (LTOA)

Validation Results: Histograms (upper), altitude dependences (middle), statistics (lower) of estimated geometric errors



Note: There is no systematic error depending on altitude, indicating that the ortho-correction works well.

Estimated errors	Release threshold	Standard accuracy	Target accuracy
< 0.36 (VNR) < 0.46 (IRS) < 0.34 (POL)	< 1.0 pixel	< 0.5 pixel	<0.25pixel

Release threshold & Standard accuracy are achieved

2. Validation Results of Land Products

2.2 (b) Atmospherically corrected reflectance (RSRF)

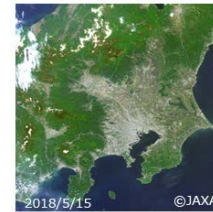
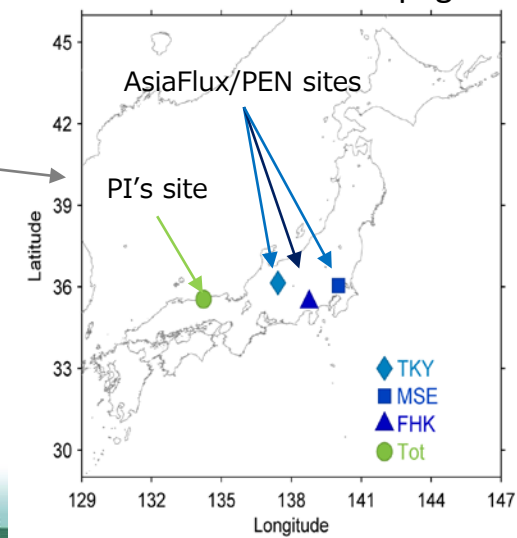
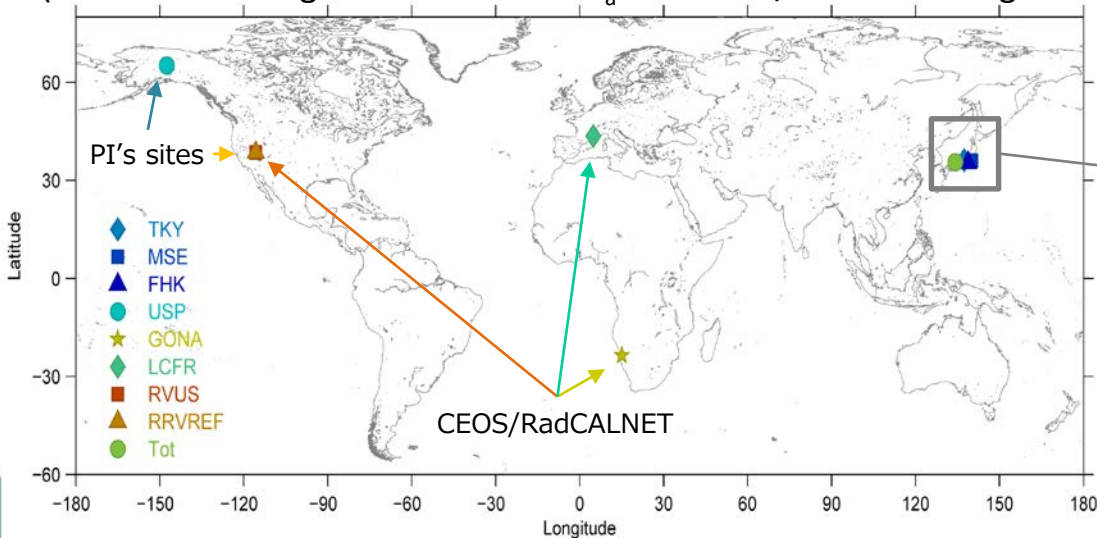
Validation Method:

- Accuracy targets were defined as RMSE of the reflectances acquired at the ground surface with moderate reflectance of around 0.2 at solar zenith angles SZA less than 30 degrees. In addition, the release threshold is defined as the value acquired at the condition of aerosol optical depth AOT (at the wavelength of 500 nm) less than 0.25.
- In-situ measured reflectances simultaneously acquired with the SGLI observations were used for evaluating RMSE. (Relative errors for the reflectance of 0.2 were also evaluated for comparison).

Validation data and condition etc.:

- In-situ data measured within the time window of 1-1.5 hours at the sites shown in the figure below (for the period during Jan. 24 to Sep. 28, 2018)
- All the SGLI channels except for VN07 and VN10 (saturated at land areas) and SW02 (water vapor absorption channel) were evaluated.
- The data of pixels at $AOT > 0.8$ and/or with cloudy or cloud shadow flags were eliminated.

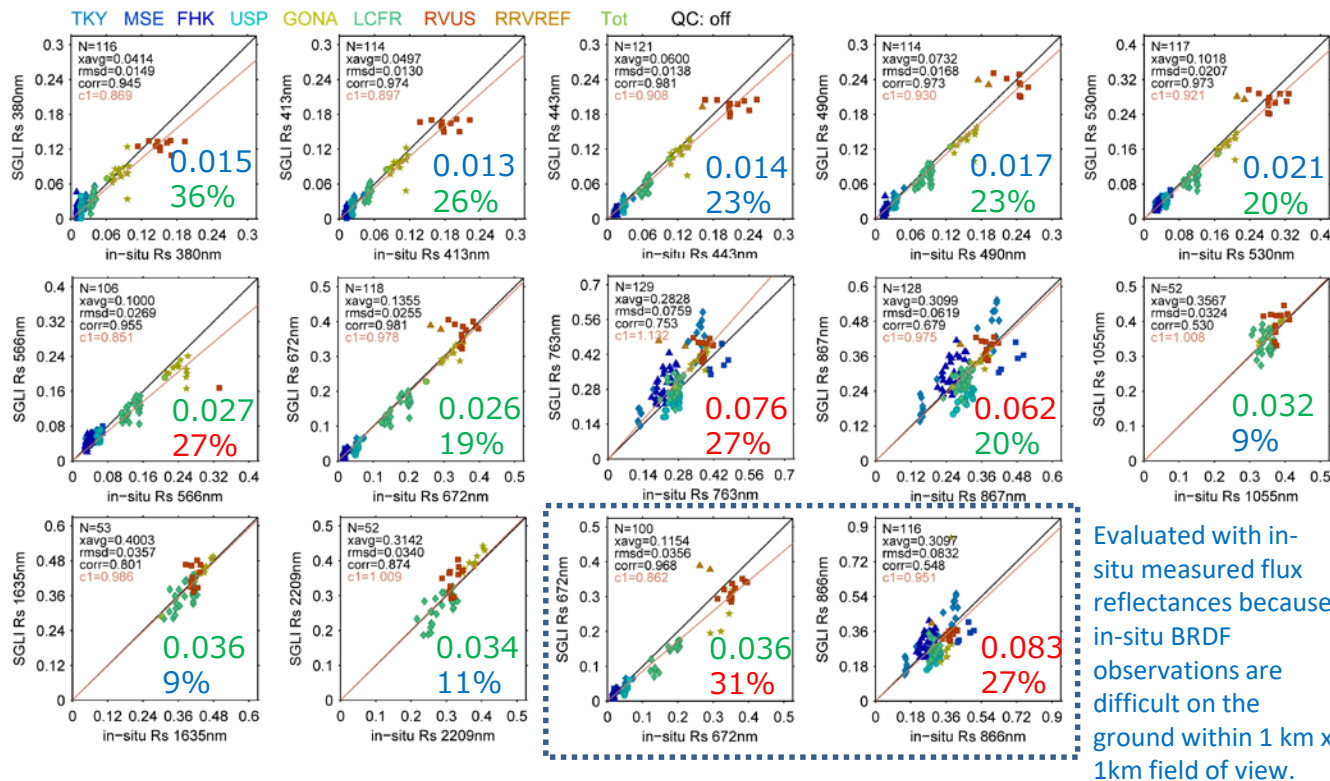
(There is no change at conditions of $\tau_a \leq 0.25$ and/or $SZA \leq 30\text{deg}$. See the table shown on the next page)



2. Validation Results of Land Products

2.2 (b) Atmospherically corrected reflectance (RSRF)

Validation Results:



RMS differences due to QC types

band	left fig.	sza<30	aot<0.25	Both
N=	52-116	21-65	44-92	16-43
VN01	0.015	0.016	0.014	0.014
VN02	0.013	0.013	0.013	0.011
VN03	0.014	0.014	0.014	0.012
VN04	0.017	0.014	0.018	0.013
VN05	0.021	0.019	0.021	0.018
VN06	0.027	0.031	0.029	0.034
VN08	0.026	0.019	0.027	0.017
VN09	0.076	0.085	0.078	0.086
VN11	0.062	0.065	0.056	0.060
SW01	0.032	0.031	0.030	0.029
SW03	0.036	0.040	0.033	0.036
SW04	0.034	0.038	0.032	0.034
PI01	0.036	0.026	0.040	0.026
PI02	0.083	0.068	0.087	0.067

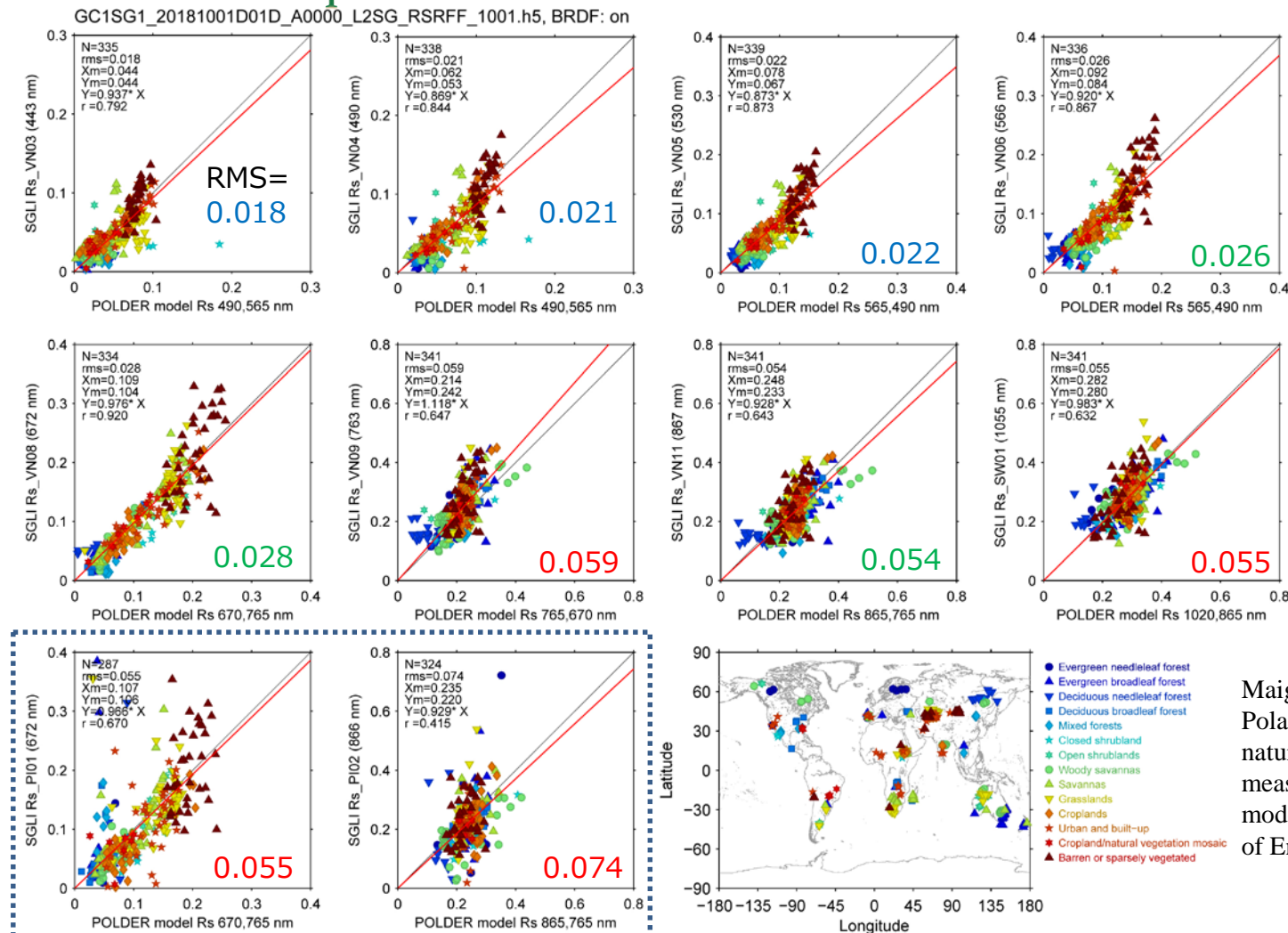
Estimated errors	Release threshold	Standard accuracy	Target accuracy
0.019(<=443nm) 0.084(>443nm)	0.3 (<=443nm) →150% 0.2 (>443nm) →100%	0.1 (<=443nm) →50% 0.05 (>443nm) →25%	0.05 (<=443nm) →25% 0.025 (>443nm) →13%

Release threshold is achieved

Relative errors estimated for the reflectance of 0.2

2.2 (b) Atmospherically corrected reflectance (RSRF)

Comparison with BRDF models of POLDER



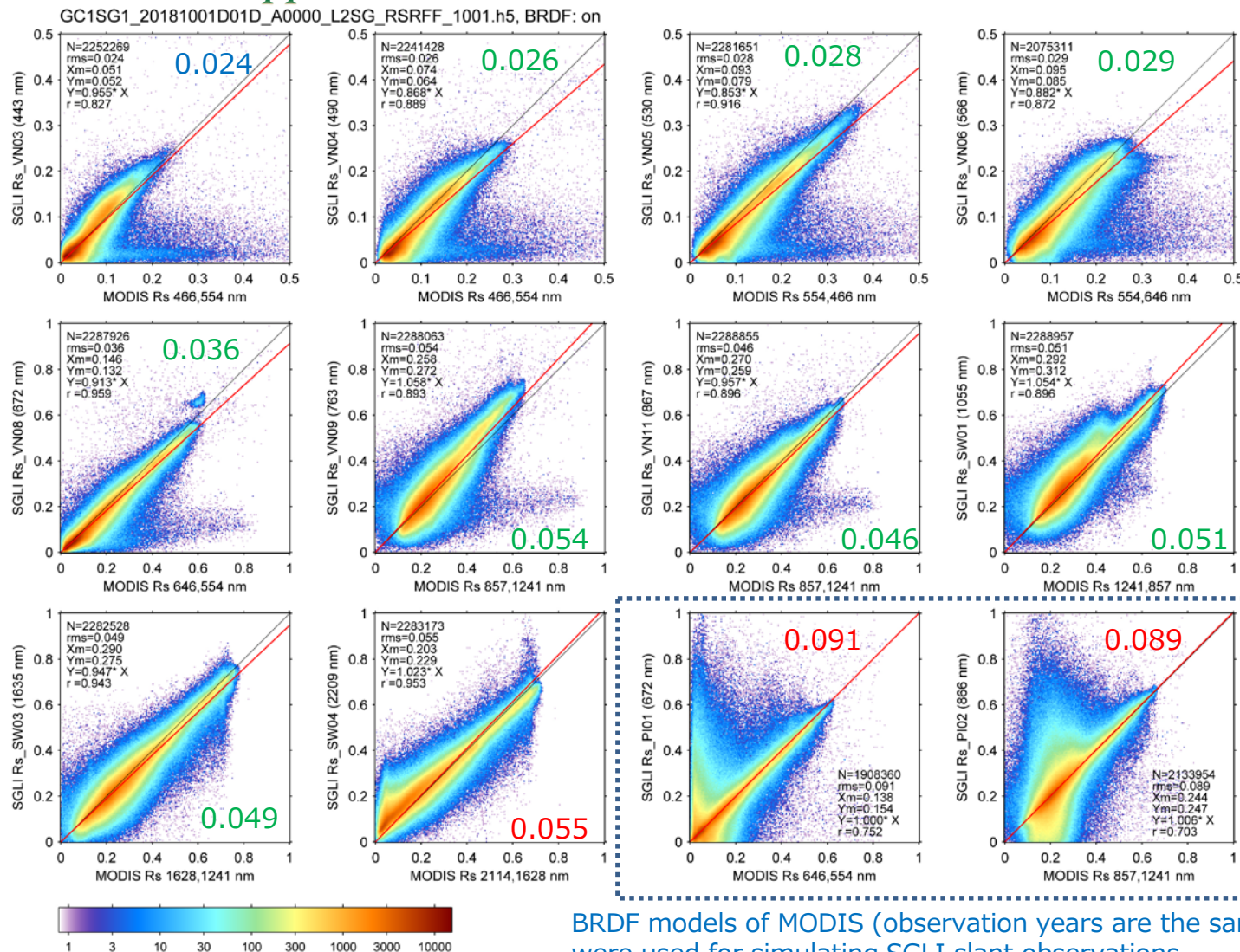
Maignan, F., et al.,
Polarized reflectances of
natural surfaces: Spaceborne
measurements and analytical
modeling, Remote Sensing
of Environment (2009)

BRDF models of POLDER (observation years are different)
were used for simulating SGLI slant observations

- ✓ BRDF models of POLDER are derived for land cover classes with relatively homogeneous surface.
- ✓ The differences in center wavelengths of SGLI and POLDER were corrected by interpolation.
- ✓ SGLI-derived reflectances are consistent well with those of POLDER except at bare land.

2.2 (b) Atmospherically corrected reflectance (RSRF)

Supplemental evaluations for slant observations



BRDF models of MODIS (observation years are the same) were used for simulating SGLI slant observations

- ✓ Comparison with MODIS-derived global BRDF products.
- ✓ The differences in center wavelengths of SGLI and MODIS were corrected by interpolation.
- ✓ **SGLI-derived reflectances are consistent well with that of MODIS within the same orders of RMS for in-situ observation.**
- ✓ **Peak and frequency were consistent well with those of MODIS with relatively large variances of slant observation bands** (*possibly due to the difference in the direction of slant observation path. That is, the line of sight of SGLI is along track whereas that of MODIS is cross-track.)

2. Validation Results of Land Products

2.2 (c) Vegetation indices (VGI: NDVI, EVI)

Validation Method:

- Comparisons of SGLI-derived VGIs with those derived from in-situ observed spectral reflectances*¹ were made for forest and grass areas.
*¹: Comparisons were made only for the sites with a homogeneous land cover class (LCC) within one pixel (250mx250m) of SGLI after checking the homogeneity of LCC with high resolution satellite imagery
- As a supplemental evaluation, comparison with other satellite products (MODIS Terra 16-days composites [MOD13Q1]) was also made.

Validation data and condition etc.:

- Sky-camera data were used to eliminate cloud contaminated SGLI data.
- For the in-situ sites with less observation data within the validation periods (Baganuul, BayanUnjuul, Watarase, Teshio, Lambir) 10-day composite of SGLI data was compared with in-situ data assuming that there is no change in VGIs during the composite period.
- Because there are few in-situ data for grass land, the data at Mase (LCC: Paddy) acquired during July 1st to August 30th were used for the ground truth of grass land.
- Comparisons with other satellite products were made for a date within the composite period of each products.

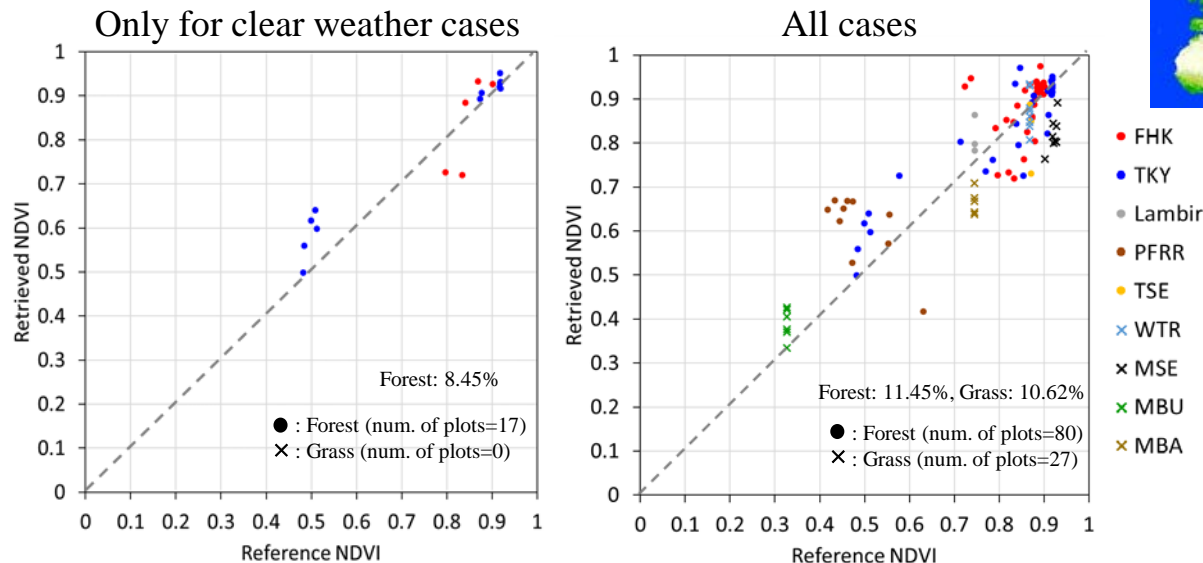
Validation period:

- August 22nd to October 30th 2018 for all the sites.
- April 21st to July 31st 2018 for Takayama (TKY), Fuhihokuroku (FHK) Watarase (WTR), Mase (MSE).
- The in-situ data during the period with solar zenith angle larger than 70 degree for Poker Flat Research Range (PFRR) were eliminated.
- The data on August 29, 30, and 31 were used for the comparison with MODIS products.

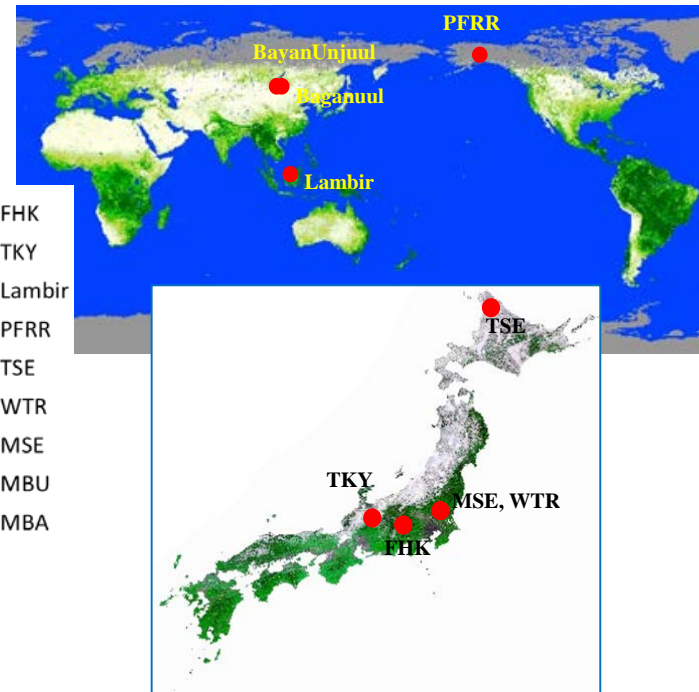
2. Validation Results of Land Products

2.2 (c) Vegetation indices (VGI: NDVI)

Validation Results (vs. in-situ observation):



Location of in-situ sites



Estimated errors	Release threshold	Standard accuracy	Target accuracy
8 (11 ^{*1}) % 11 ^{*1} %	20% (Forest) scene, 25% (Grass) scene	15% (Forest) scene, 20% (Grass) scene	10% (Forest) scene, 10% (Grass) scene

^{*1} Evaluated errors using all the data including potentially cloud contaminated ones

Release threshold & Standard accuracy are achieved

(Remarks: The standard accuracy are achieved even using possibly cloud contaminated data.
Currently there are few in-situ data for grass land.)

2. Validation Results of Land Products

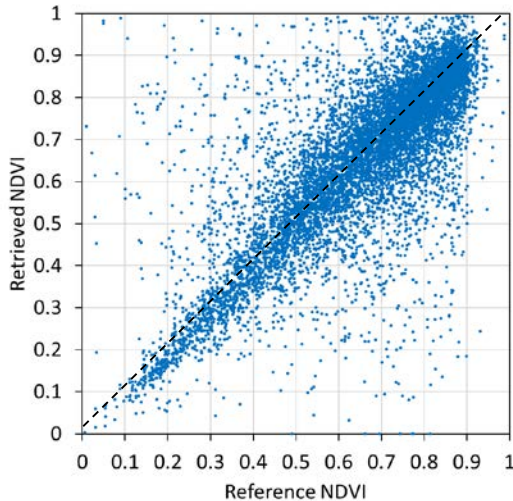
2.2 (c) Vegetation indices (VGI: NDVI)

Validation Results (vs. other satellite product of NDVI):

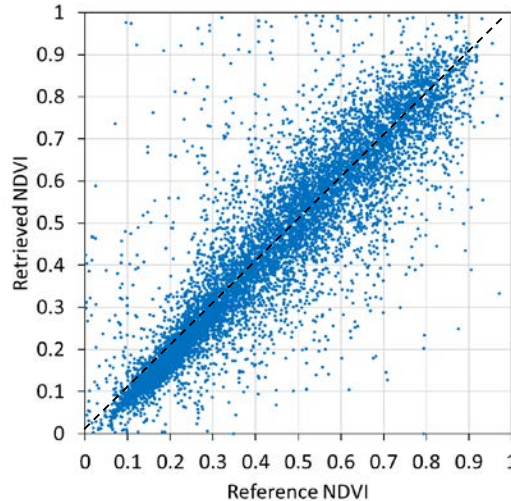
MOD13Q1

Forest

Grass



• num. of plots=9997

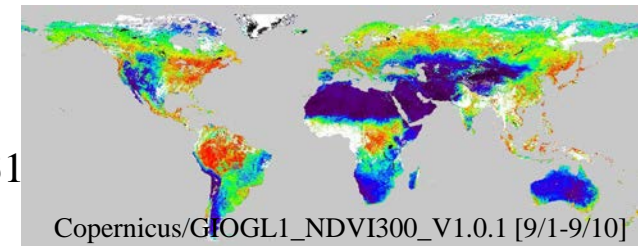
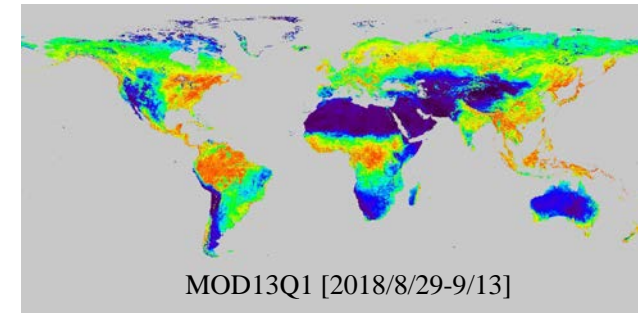
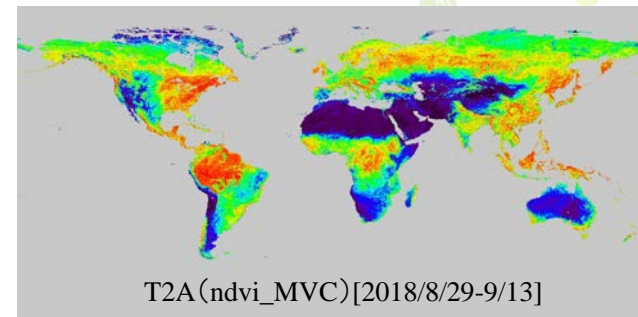


• num. of plots=10225

MOD13Q1: Aug.29-Sep.12 [16-day composites] vs. SGLI: Aug. 29, 30,31

Forest: GlobCover's forest class

Grass: GlobCover's grass, sparse vegetation, farm classes



Estimated errors	Release threshold	Standard accuracy	Target accuracy
19 % 24 %	20% (Forest) scene, 25% (Grass) scene	15% (Forest) scene, 20% (Grass) scene	10% (Forest) scene, 10% (Grass) scene

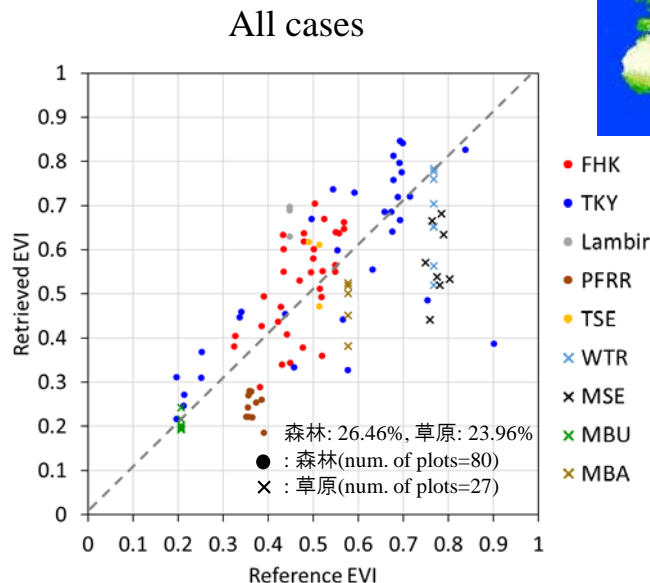
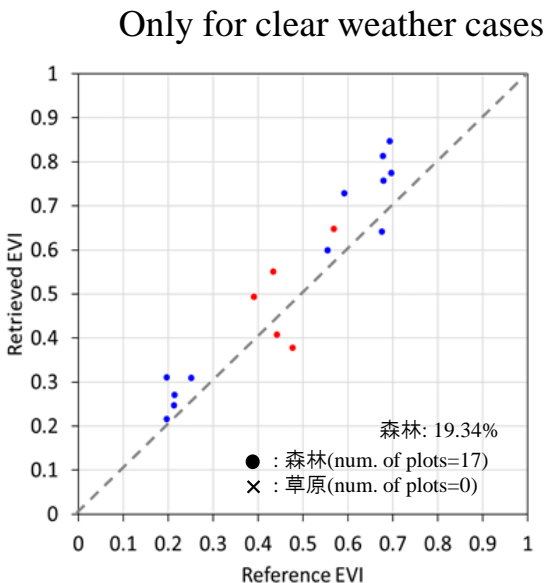
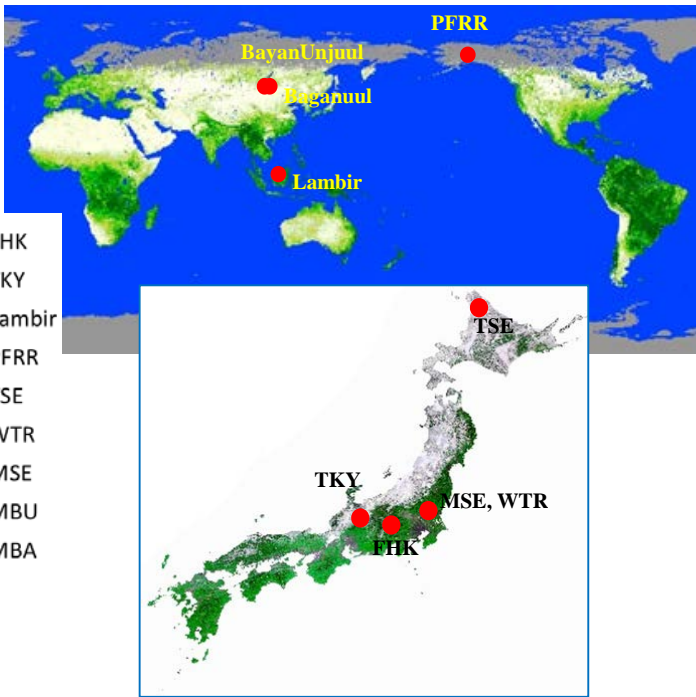
Release threshold is achieved (vs. other satellite products)

2. Validation Results of Land Products

2.2 (c) Vegetation indices (VGI: EVI)

Validation Results (vs. in-situ observation):

Location of in-situ sites



Estimated errors	Release threshold	Standard accuracy	Target accuracy
19(26 ^{*1}) % 24 ^{*1} %	20% (Forest) scene, 25% (Grass) scene	15% (Forest) scene, 20% (Grass) scene	10% (Forest) scene, 10% (Grass) scene

^{*1} Evaluated errors using all the data including potentially cloud contaminated ones

Release threshold & Standard accuracy are achieved

(Remarks: The standard accuracy are achieved even using possibly cloud contaminated data.
Currently there are few in-situ data for grass land.)

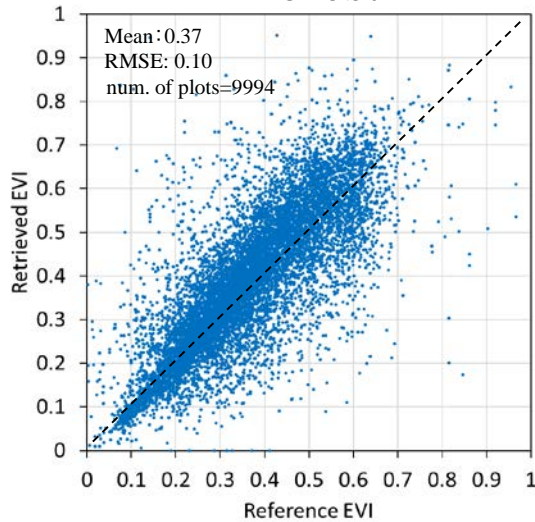
2. Validation Results of Land Products

2.2 (c) Vegetation indices (VGI: EVI)

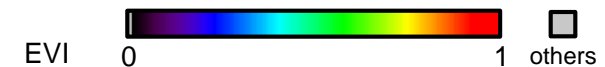
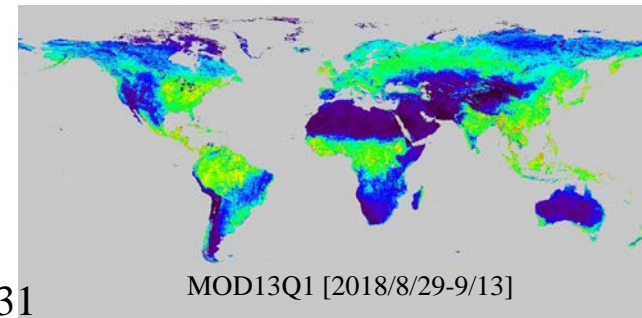
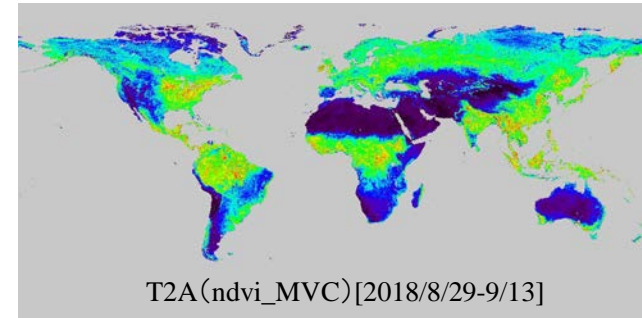
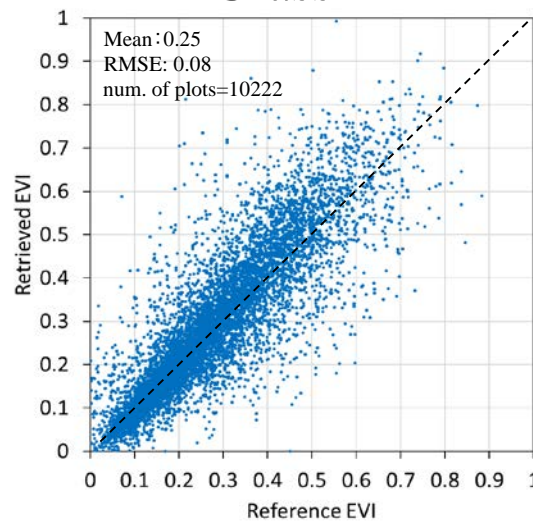
Validation Results*1 (vs. other satellite product of EVI):

MOD13Q1

Forest



Grass



MOD13Q1: Aug.29-Sep.12 [16-day composites] vs. SGLI: Aug. 29, 30,31

Forest: GlobCover's forest class

Grass: GlobCover's grass, sparse vegetation, farm classes

*1 These are supplemental results because EVI depends on satellite zenith angle and weather condition etc.

2. Validation Results of Land Products

2.2 (d) Above-ground biomass (AGB)

Validation Method:

- Comparisons of SGLI-derived AGBs with those derived from in-situ observations were made for forest and grass areas.
- As supplemental data for the in-situ reference, AGB obtained from FOS data (<http://forest-observation-system.net/>) were used.
- As a supplemental evaluation, comparison with other satellite products (Global Forest Biomass Map by WUR, GlobalBiomassCarbon2000, GlobBiomass) was also made.

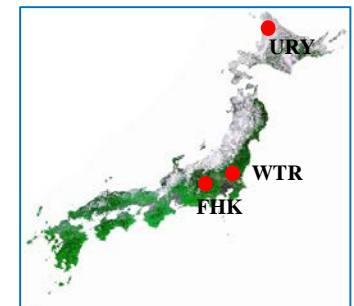
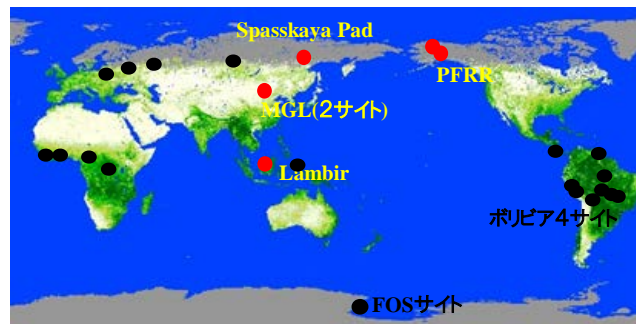
Validation data and condition etc.:

- One-month averages of SGLI AGB data were compared with in-situ data assuming that there is no change in AGBs during one-month.
- The pixels with bit-flags of low quality and probably cloudy were eliminated.
- Before the comparison with SGLI-derived AGBs, the quality of AGB data from FOS were checked and filtered in order to ensure that the value of AGB does not change even in the SGLI's spatial resolution.
- Comparison with other satellite products was made based on image appearance.

Validation period:

- August 23nd to September 25th 2018.

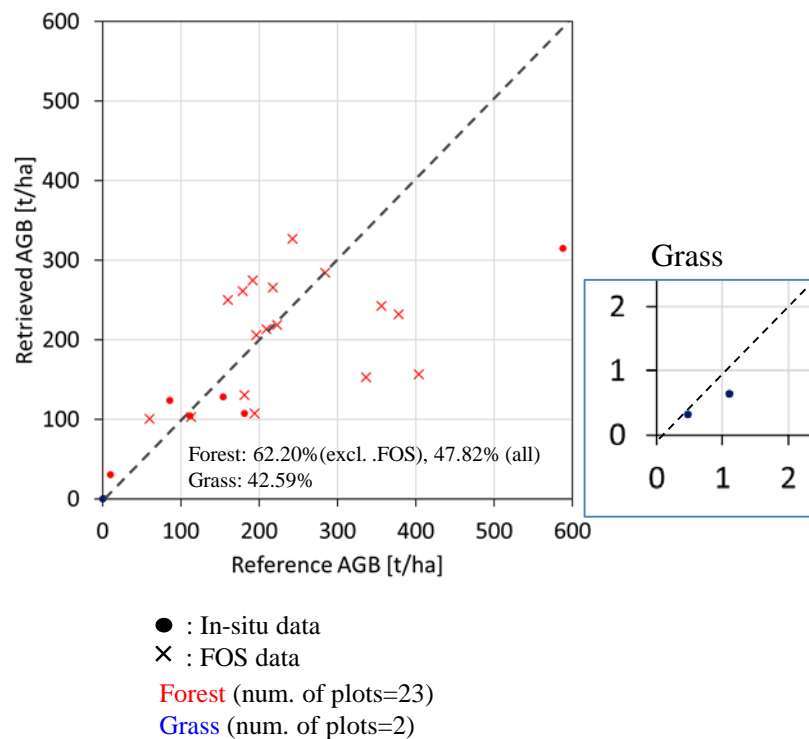
Location of in-situ sites



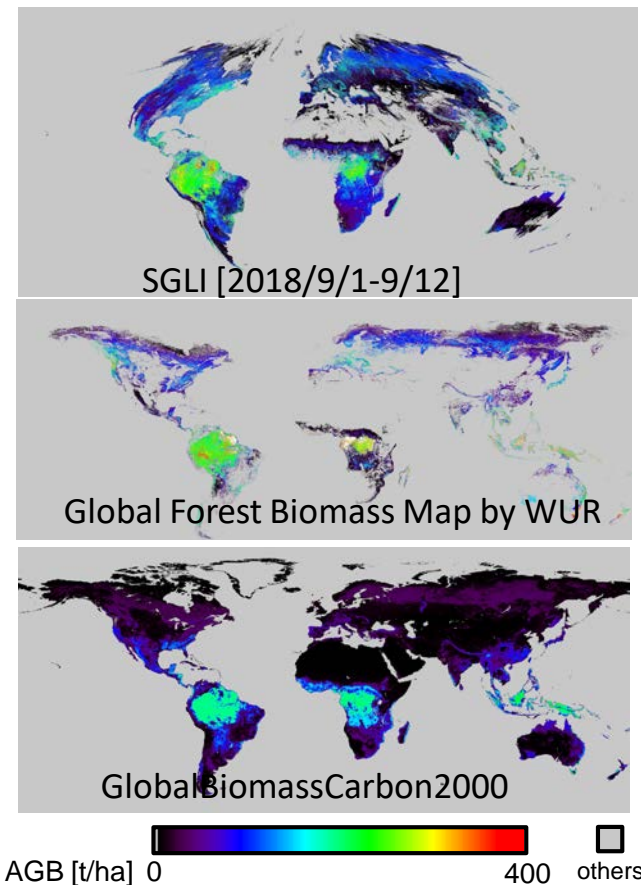
2. Validation Results of Land Products

2.2 (d) Above-ground biomass (AGB)

Validation Results:



Comparison with other satellite products



Estimated errors	Release threshold	Standard accuracy	Target accuracy
48 (62 ^{*1})% 43 %	100% (Forest), 50% (Grass)	50% (Forest), 30% (Grass)	20% (Forest), 10% (Grass)

*1 Results excluding FOS data

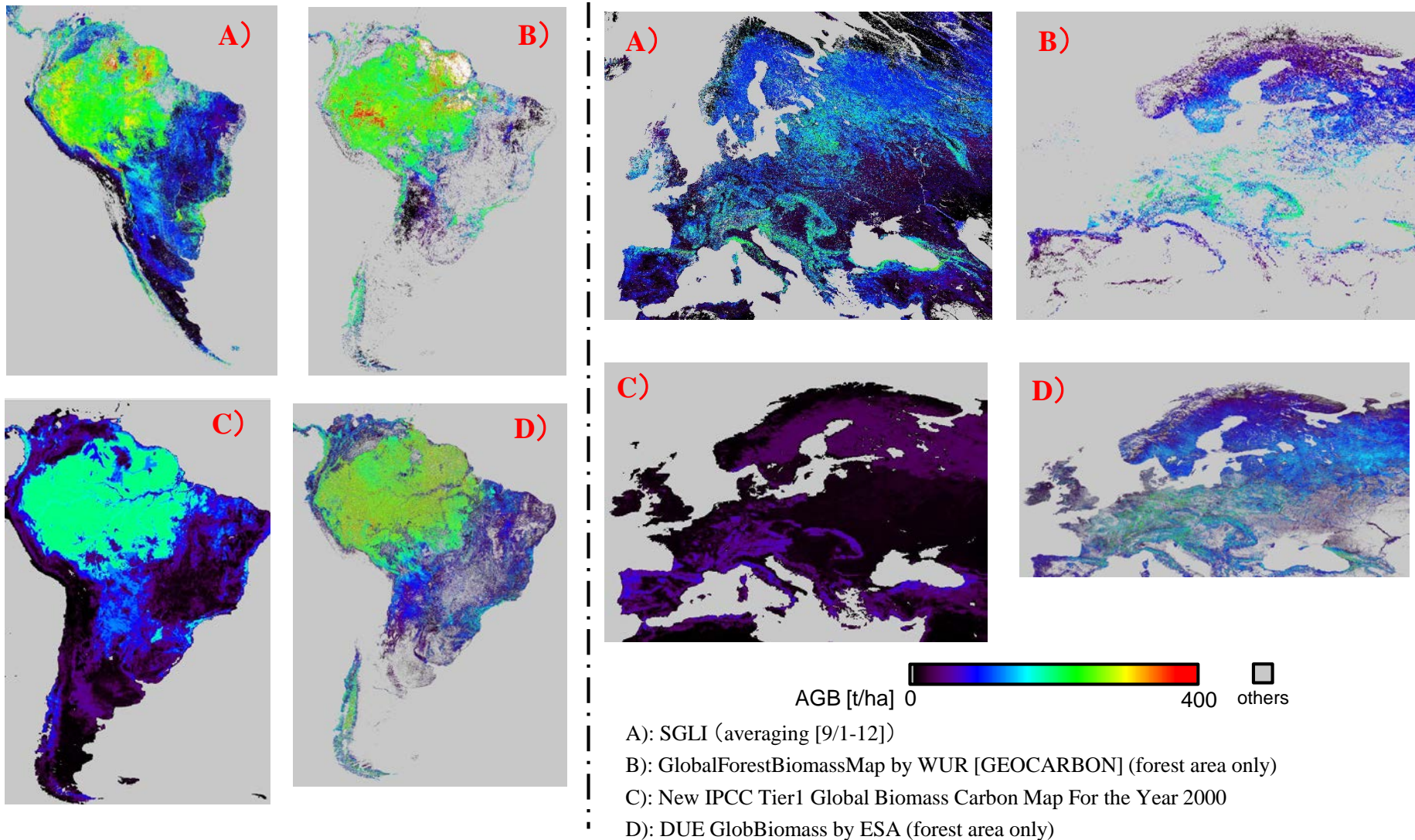
Release threshold is achieved

2. Validation Results of Land Products

2.2 (d) Above-ground biomass (AGB)

Validation Results (cont.):

Comparison with other satellite-derived AGB products



2. Validation Results of Land Products

2.2 (e) Vegetation roughness index (VRI)

Validation Method:

- Comparisons of SGLI-derived VRIs with those derived from in-situ observed directional reflectances were made for forest and grass areas.
- Due to the bad weather in 2018, there are no in-situ data obtained under clear sky conditions. That is why the comparisons were made with in-situ data obtained under cloudy conditions and other satellite products.

Validation data and condition etc.:

- In-situ VRIs were first derived from reflectances observed at the same geometric conditions as SGLI observations using the same equation defined in the SGLI algorithm, and then compared with SGLI-derived VRIs.
- The pixels with bit-flags of low quality were eliminated.
- Due to the bad weather in 2018, evaluations were made using only the data shown below;
 - Simulated VRIs derived from MODIS/BRDF product (MCD43A1) acquired on October 28, 2018 using only the reflectances at the same geometric conditions as those of SGLI.
 - In-situ derived VRIs calculated from BRDF data acquired at Watarase on May 21, 2018 under cloudy conditions (Only the SGLI and in-situ data with the same sensor zenith angle of within ± 5 degree were used for comparison).

Validation period:

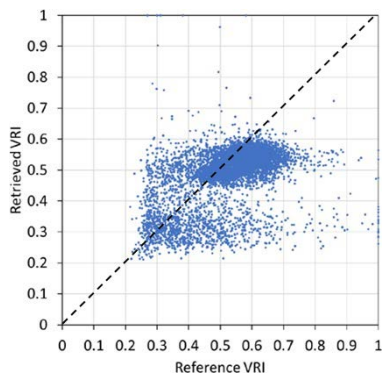
- October 28th, November 3rd 2018 (vs. MCD43A).
- May 1st to June 10th 2018 (vs. Watarase).

2. Validation Results of Land Products

2.2 (e) Vegetation roughness index (VRI)

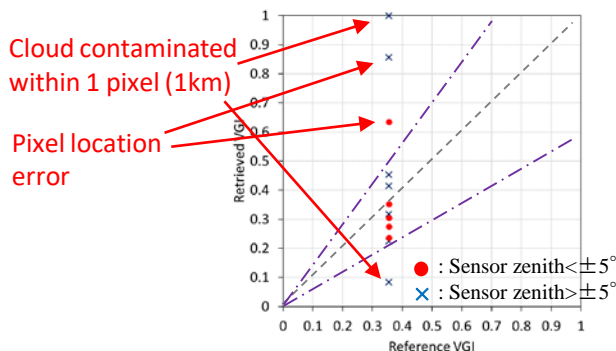
Validation Results:

Comparison with VRIs derived from MCD43A1



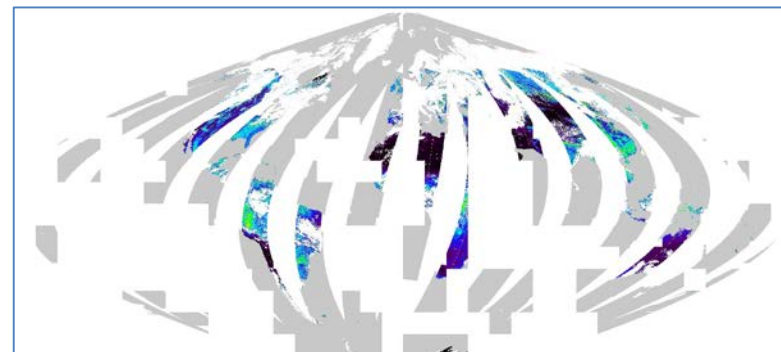
Sites for comparison

Comparison with in-situ derived VRIs at Watarase under cloudy condition

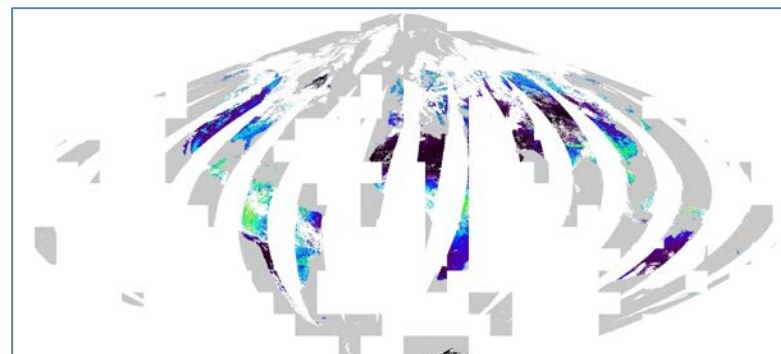


--- : Release threshold

*By eliminating the pixels with cloud contamination and/or pixel location errors, the estimated errors become 23.26% (below the release threshold).



SGLI/VRI [2018/10/28]



MCD43A1/VRI

*The error pixels of SGLI data were eliminated in the comparison.



Estimated errors	Release threshold	Standard accuracy	Target accuracy
21 ^{*1} , 23 ^{*2} %	40% (Forest, Grass) Scene	20% (Forest, Grass) Scene	10% (Forest, Grass) Scene

^{*1} Results compared with MCD43A1 data, ^{*2} Result compared with in-situ data at Watarase under cloudy condition.

Release threshold is achieved

2. Validation Results of Land Products

2.2 (f) Shadow index (SDI)

Validation Method:

- Comparisons of SGLI-derived SDIs with those derived from in-situ observation data were made for forest and grass areas.

Validation data and condition etc.:

- First, direct solar radiation for each SGLI scene was simulated using the Numerical digital surface model (DSM)*¹ (spatial resolution of approx. 50 cm) provided from USGS 3 Dimensional Elevation Programme (3DEP). Second, the areas with zero solar radiation were identified as shadow and integrated to calculate the areal fraction of shadow within one pixel of SGLI. Then, the areal fraction was used as ground truth.

*1: The DSM was derived from lidar observation data obtained from 2015 to 2018.

- Only the pixels meeting the following conditions were used for validation;
 - NDVI > 0.65
 - The pixel is not adjacent to cloudy pixels
 - Satellite zenith angle < 8 deg.

Data for validation

Validation period:

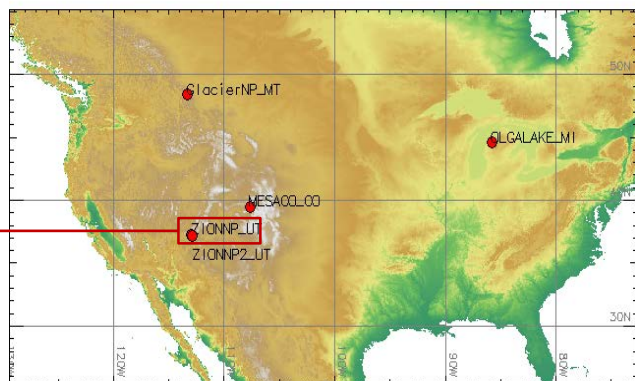
- June to October 2018

Name	SGLI TILE	Rows x cols	Date of SGLI obs. (# of scenes)
WalnutGulch, AZ	V05H08	27 x 76	2018/08/25 – 09/24 (2)
Mesa, CO	V05H09	12 x 10	2018/06/18 – 09/24 (10)
Olgalake, MI	V04H11	18 x 32	2018/06/02 – 10/16 (18)
Glacier NP., MT	V04H10	35 x 60	2018/06/05 – 09/20 (17)
Zion NP., UT	V05H09	17 x 14	2018/06/02 – 09/27 (6)
Zion NP. 2, UT	V05H09	26 x 35	2018/06/02 – 09/27 (6)

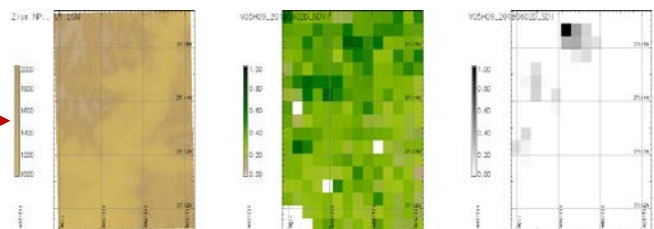
2. Validation Results of Land Products

2.2 (f) Shadow index (SDI)

Validation Results:



Location of validation sites

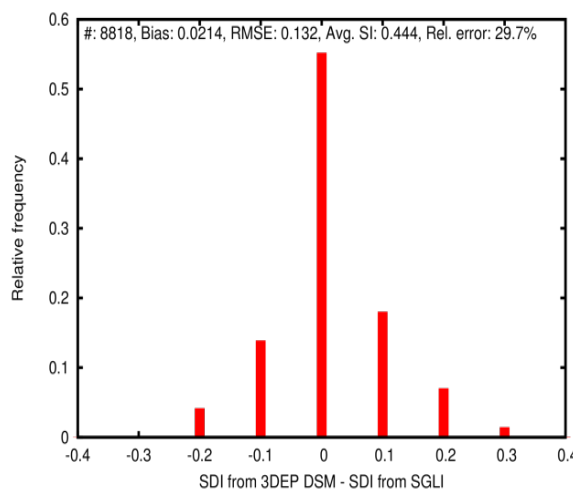


DSM (left), NDVI (mid), and SDI (right) at Zion NP site

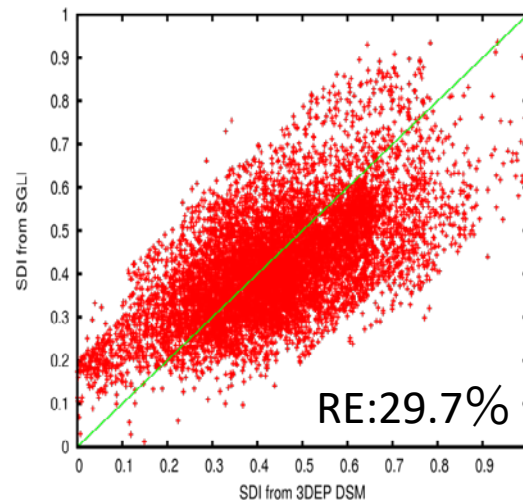


0 200 400 600 800 1000

Simulated direct solar radiation (W/m^2)



Frequency distribution of the differences between in-situ and SGLI data



Comparison results

Estimated errors	Release threshold	Standard accuracy	Target accuracy
30%	Grass, Forest: 30%	Grass, Forest: 20%	Grass, Forest: 10%

Release threshold is achieved

2. Validation Results of Land Products

2.2 (g) Fraction of absorbed PAR (FAPAR)

Validation Method:

- Comparisons of SGLI-derived FAPARs with those derived from in-situ observation data (PAR meter and spectroradiometer) were made for forest and grass areas.
- As supplemental data for the in-situ reference, FAPARs obtained from other satellite products (Copernicus/GIOGL1_FAPAR) and those obtained from the literatures published in the past were used.

Validation data and condition etc.:

- Ten-day averages of SGLI FAPAR data were compared with in-situ data assuming that there is no change in FAPARs during ten days.
- Comparisons of SGLI-FAPARs with other satellite products were made for same composite periods and with the same definition of FAPAR that is the sum of the green FAPARs derived for the upper and lower layers.
- Discrimination of forest and grass was done using an existed land cover map (GlobCover).
- When comparing SGLI-FAPARs with in-situ derived ones which include the effects of stems and branches, SGLI-FAPARs were converted to the ones with the same definition as the in-situ data and then compared.
- When the temporal period of data acquisition were different between SGLI-FAPARs and in-situ derived ones including those from the past literatures, the temporal consistency of FAPAR was confirmed using SGLI-NDVI and other satellite products.

Validation period:

- Sep. 1st to 12th 2018 (vs. GIOGL1_FAPAR).
- Sep. 1st to 10th*1 2018 (vs. in-situ data and literatures).
- Apr. 21st to Jul. 31st 2018 (vs. in-situ data obtained at Fujihokuroku (FHK), Watarase (WTR), Takayama (TKY), Fujiyoshida (FJY)).

*1 When there is no SGLI-derived FAPARs during the period, SGLI data of 10-day before and after the period were used for comparison. Temporal consistency of FAPAR during the comparison period was confirmed using NDVI and other satellite-derived LAIs.

2. Validation Results of Land Products

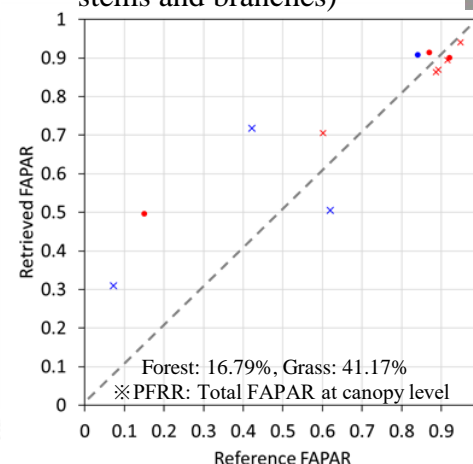
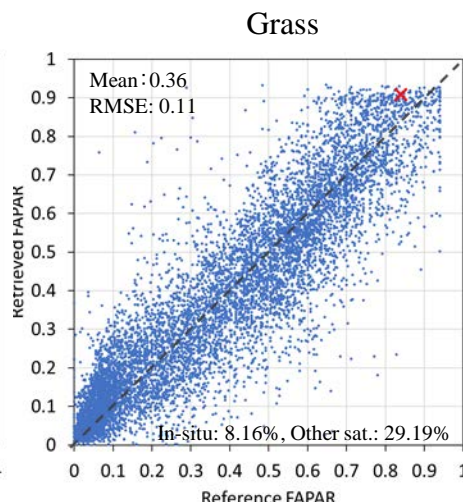
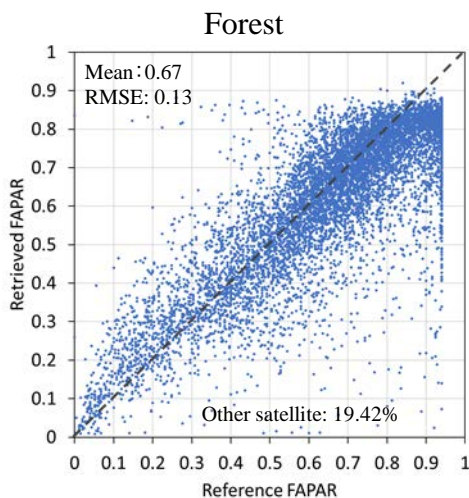
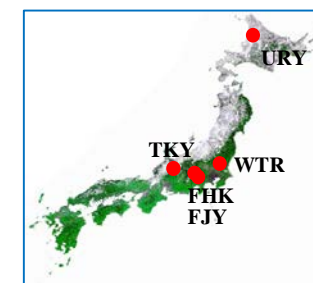
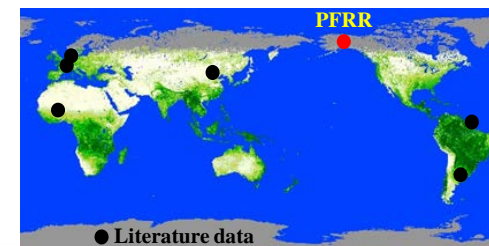
2.2 (g) Fraction of absorbed PAR (FAPAR)

Location of in-situ sites and literatures' sites

Validation Results:

Comparison results for green FAPAR of Upper + Lower layer

Comparison results for total FAPAR (incl. the effects of stems and branches)



● :GEOV (num. of plots=9196)

● :GEOV (num. of plots=8883)
× :In-situ (num. of plots=1)

● : In-situ data
× : Literatures
Forest (num. of plots=8)
Grass (num. of plots=4)

Forest: GlobCover's forest class

Grass: GlobCover's grass, sparse vegetation, crop land classes

Estimated errors	Release threshold	Standard accuracy	Target accuracy
19 (17*1)% 41% [in-situ + literature], 29%[other satellite]	50% (Forest), 50% (Grass)	20% (Forest), 30% (Grass)	10% (Forest), 20% (Grass)

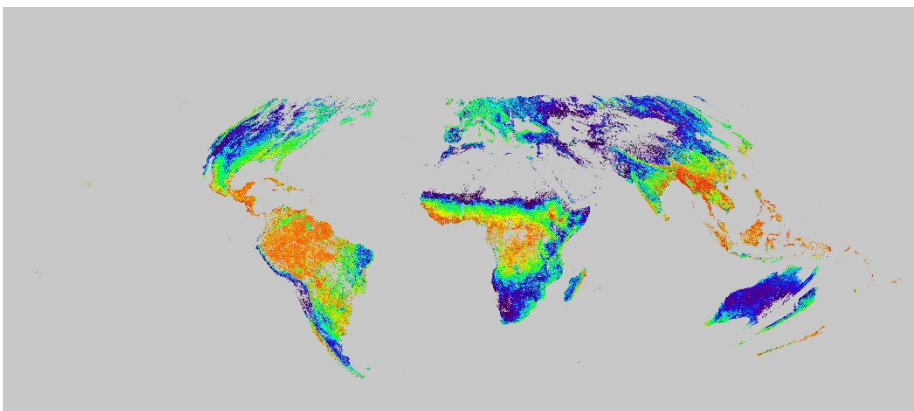
*1 As total FAPAR

Release threshold is achieved

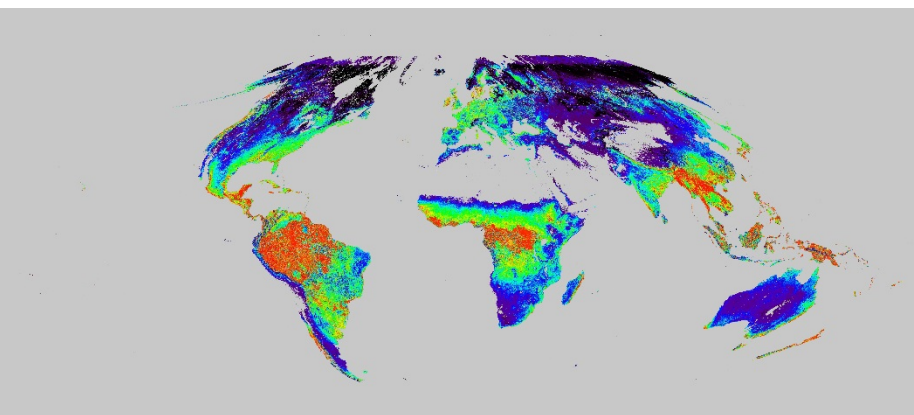
2. Validation Results of Land Products

2.2 (g) Fraction of absorbed PAR (FAPAR)

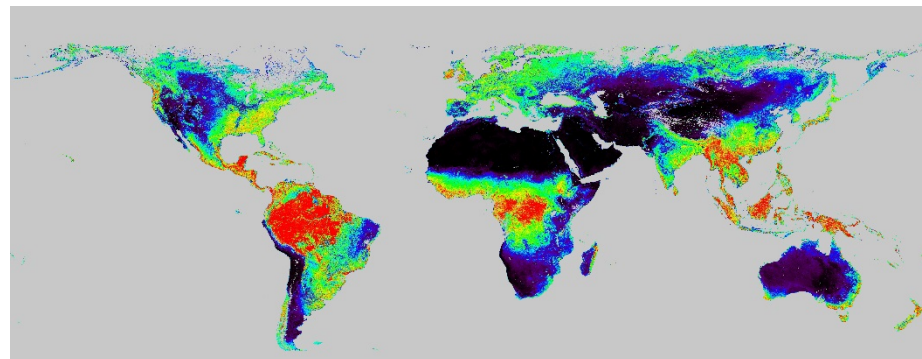
FAPAR retrieved results (Comparison with other satellite products)



T2A(fapar_MVC)[2018/11/1-11/8]



MCD15A2H [2018/11/1-11/8]



Copernicus/GIOGL1_LAI300_V1.0.1 [10/20]

- ✓ MCD15A2H: Nov. 1st-8th [8-days composite with maximum FAPAR, 500m]
- ✓ GIOGL1: Oct. 11th-20th 2018 [10-day composite with MV (vza/sza), 300m]
- Spatial distribution of SGLI (T2A) is consistent with other satellite products.

2. Validation Results of Land Products

2.2 (h) Leaf area index (LAI)

Validation Method:

- Comparisons of SGLI-derived LAIs with those derived from in-situ observation data (LAI-2000 and spectroradiometer) were made for forest and grass areas.
- As supplemental data for the in-situ reference, LAIs obtained from other satellite products (Copernicus/GIOGL1_LAI) and those obtained from the literatures published in the past were used.

Validation data and condition etc.:

- Ten-day averages of SGLI LAI data were compared with in-situ data assuming that there is no change in LAIs during ten days.
- Comparisons of SGLI-LAIs with in-situ data and other satellite products for the confirmation of the release threshold achievement were made for the total LAI (the sum of LAIs of upper layer and that of lower layers), and also for the upper layer LAI as a supplemental data at the present. In future, the achievement of the accuracies for the upper layer LAI is a goal of the SGLI LAI products.
- Discrimination of forest and grass was done using an existed land cover map (GlobCover).
- When comparing SGLI-FAPARS with in-situ derived ones which include the effects of stems and branches, SGLI-FAPARS were converted to the ones with the same definition as the in-situ data and then compared.
- When the temporal period of data acquisition were different between SGLI-FAPARS and in-situ derived ones including those from the past literatures, the temporal consistency of FAPAR was confirmed using SGLI-NDVI and other satellite products.
- In-situ data and other satellite products were used for the total LAI evaluation, and in-situ data and literature data were used for that of upper layer LAI.
- The comparisons with other satellite products were done for the same composition period. When the temporal period of data acquisition were different between SGLI-LAIs and in-situ derived ones including those from the past literatures, the temporal consistency of LAI was confirmed using SGLI-NDVI and other satellite products.

Validation period:

- Sep. 1st to 12th 2018 (vs. GIOGL1_LAI).
- Sep. 1st to 10^{th*1} 2018 (vs. in-situ data and literatures).
- Apr. 21st to Jul. 31st 2018 (vs. in-situ data obtained at Fujihokuroku (FHK), Watarase (WTR)).

*1 When there is no SGLI-derived FAPARS during the period, SGLI data of 10-day before and after the period were used for comparison. Temporal consistency of FAPAR during the comparison period was confirmed using NDVI and other satellite-derived LAIs.

2. Validation Results of Land Products

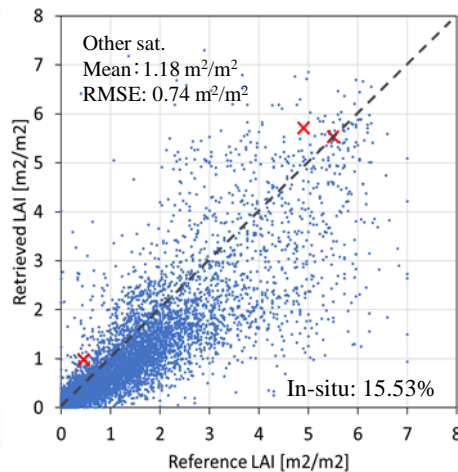
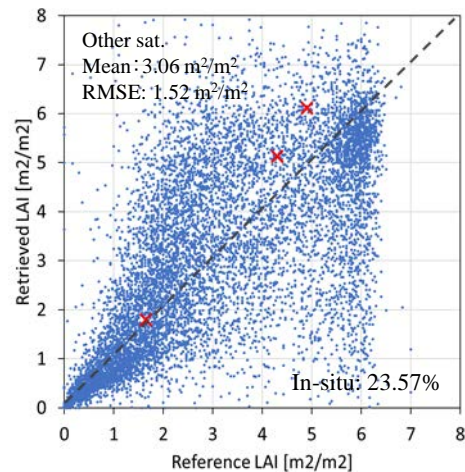
2.2 (h) Leaf area index (LAI)

Validation Results:

Comparison results for LAI of upper and lower layers

Forest

Grass



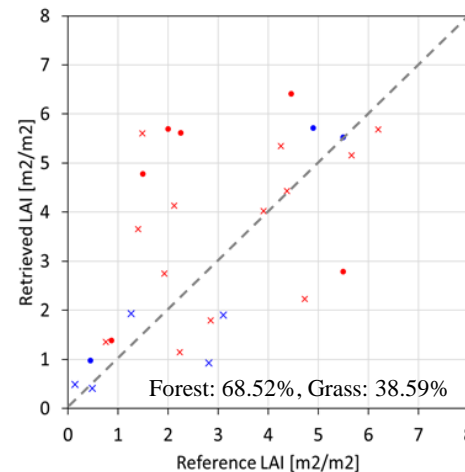
● : GEOV (num. of plots=9199)
× : In-situ (num. of plots=3)

● : GEOV (num. of plots=8889)
× : In-situ (num. of plots=3)

Forest: GlobCover's forest class

Grass: GlobCover's grass, sparse vegetation, crop land classes

Comparison results for LAI f upper layer

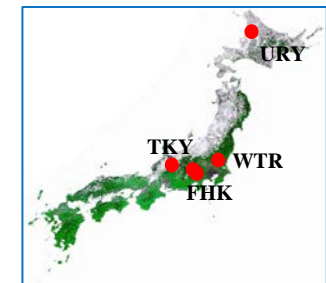
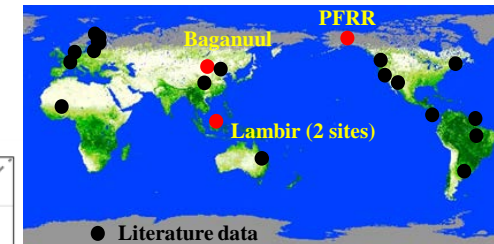


● : In-situ
× : Literature

Forest (num. of plots=19)

Grass (num. of plots=8)

Location of in-situ sites and literatures' sites



Estimated errors	Release threshold	Standard accuracy	Target accuracy
24%(69%* ¹) [in-situ] 39%[in-situ + literature]	50% (Forest), 50% (Grass)	30% (Forest), 30% (Grass)	20% (Forest), 20% (Grass)

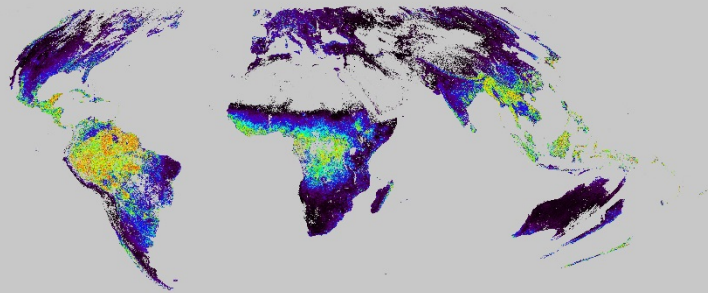
*¹As LAI of upper layer (canopy_LAI)

Release threshold is achieved

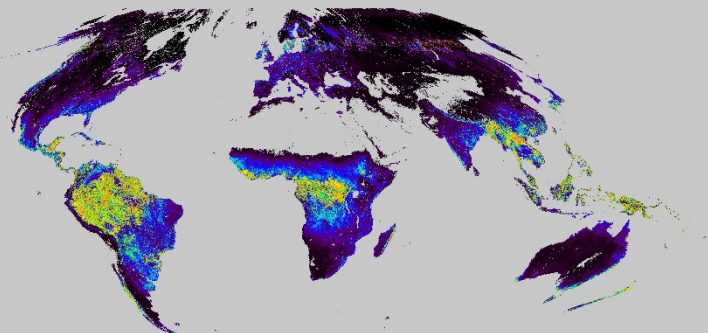
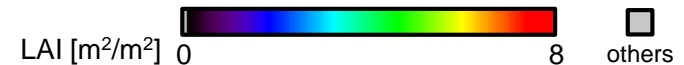
2. Validation Results of Land Products

2.2 (h) Leaf area index (LAI)

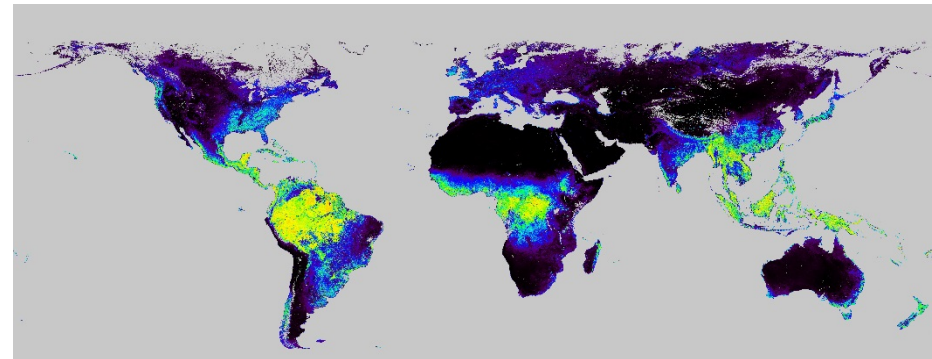
LAI retrieved results (Comparison with other satellite products)



T2A(fapar_MVC)[2018/11/1-11/8]



MCD15A2H [2018/11/1-11/8]



Copernicus/GIOGL1_LAI300_V1.0.1 [10/20]

- ✓ MCD15A2H: Nov. 1st-8th [8-days composite with maximum FAPAR, 500m]
- ✓ GIOGL1: Oct. 11th-20th 2018 [10-day composite with MV (vza/sza), 300m]
- Spatial distribution of SGLI (T2A) is consistent with other satellite products.

2. Validation Results of Land Products

2.2 (i) Land surface temperature (LST)

Validation Method:

- Comparisons of SGLI-derived LSTs with other satellite products (MOD11C1: Daily global product of MODIS) were made using the equation (1) shown below.
- Comparisons of SGLI-derived LSTs with those derived from in-situ observation data (brightness temperature estimated from the data of thermal radiometer at ground sites taking into account the emissivity of the surface) were made using the equation (1).

$$\text{Evaluation variable: } RMSE[K] = \sqrt{\frac{\sum (S(i) - T(i))^2}{N}} \quad (1)$$

N: the number of observation data

S(i): SGLI-derived LST

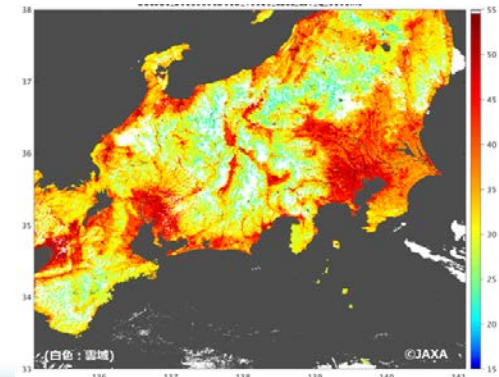
T(i): LST derived from in-situ data

Validation data and condition etc.:

- When comparing with MOD11C1 (pixel size is approx. 5 km), SGLI LST data of 250 m resolution were averaged to have the same pixel size. Other conditions for the comparison are the following;
 - Observation time difference between SGLI and MODIS is less than 10 min.
 - Valid MODIS LST data: the lowest two bits of the MODIS QC flag are '00'.
 - Valid SGLI LST data (see QA flag and Mask_for_statistics of SGLI products)
- In addition, SGLI-derived LST data were compared with in-situ data at Mase and Fujihokuroku (emissivity is assumed to be 0.98 for both sites) which were acquired within the time difference of 15 minutes from the SGLI observations. Other QC conditions for in-situ data are the following;
 - Conversion residuals of SGLI are less than 1 Kelvin.
 - In-situ data are also qualified with the difference of upper and lower radiation fluxes and the variations of the low fluxes within 15 min.

Validation period:

- Aug. 22nd to Sep. 17th 2018 (vs. MOD11C1).
- Mar. 14th to Sep. 28th 2018 (vs. in-situ data).

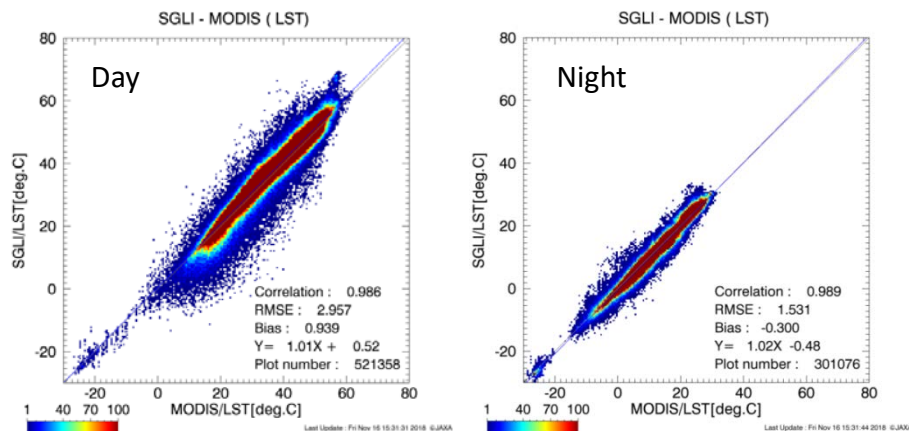


2. Validation Results of Land Products

2.2 (i) Land surface temperature (LST)

Validation Results:

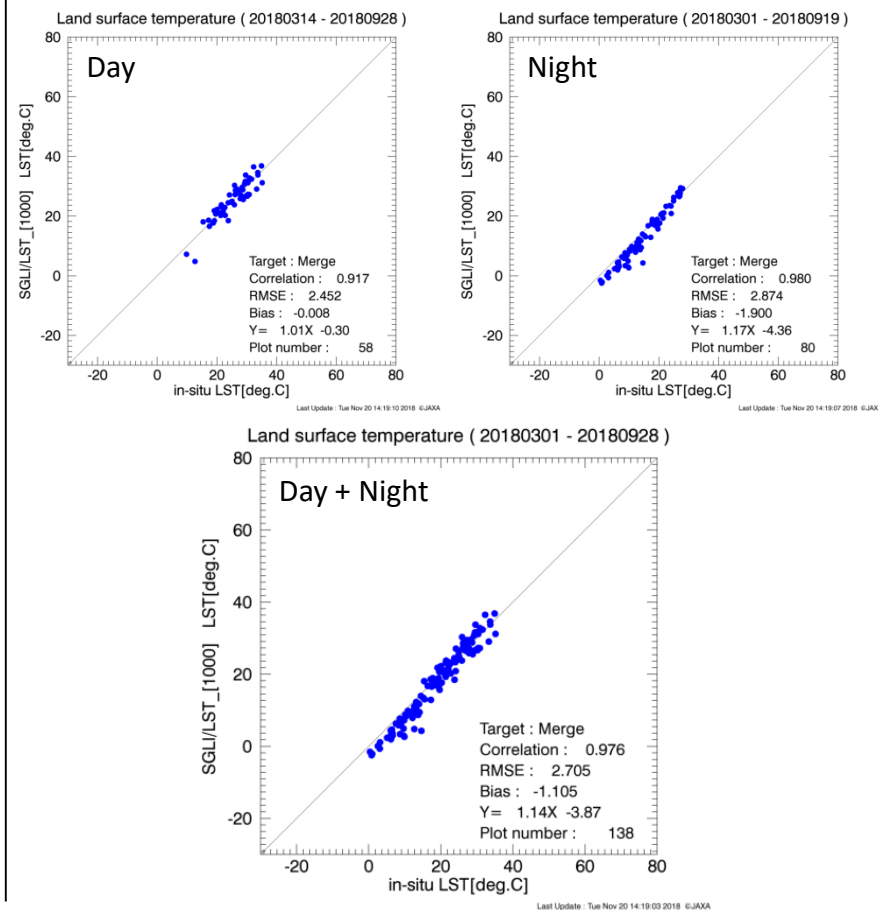
Comparison results with MODIS products (Aug. 27, 2018)



Summary (Aug.22 to Sep.17 2018)

	RMSE Ave. [K]
Day	2.95
Night	2.09
Day + Night	2.52

Comparison results with in-situ data



Estimated errors	Release threshold	Standard accuracy	Target accuracy
2.5 [K]@MODIS 2.7 [K]@in-situ	< 3.0K	< 2.5K	< 1.5K

Release threshold is achieved