Development of Global land cover classification algorithms and validation methods

全球土地被覆分類アルゴリズムと分類精度検証方法の開発

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Tasks of GCOM-C1 (FY2013)

- Development of the classification method for broadleaf forest and needleleaf forest using multi-direction satellite data
  - Study the differences between needleleaf and broadleaf trees using multi-direction data of ALOS/PRISM
- Development of validation methods for global land cover products
  - Produce validation data sets with reliable accuracy using SACLA data sets
  - Produce validation data sets for low resolution data using middle high resolution satellite data sets (ALOS/AVNIR-2).

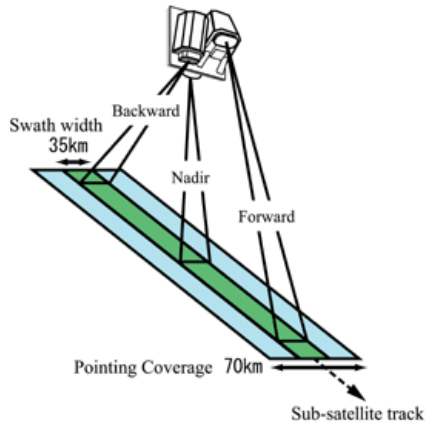
The characteristic differences between needleleaf and broadleaf trees using multi-direction data of ALOS/PRISM

- The aim of this study is developing an classification method for broadleaf forest and needleleaf forest using multi-direction satellite data
  - Distinguish differences in shape of a canopy of forests using multi-direction data
  - Study about characteristic differences among needleleaf and broadleaf trees using multi-directional data of ALOS/PRISM.

PRISM Characteristics

Number of Bands	1 (Panchromatic)
Wavelength	0.52 to 0.77 micrometers
Number of Optics	3 (Nadir; Forward; Backward)
Base-to-Height ratio	1.0 (between Forward and Backward view)
Spatial Resolution	2.5m (at Nadir)
Swath Width	70km (Nadir only) / 35km (Triplet mode)
S/N	>70
MTF	>0.2
Number of Detectors	28000 / band (Swath Width 70km) 14000 / band (Swath Width 35km)
Pointing Angle	-1.5 to +1.5 degrees (Triplet Mode, Cross-track direction)
Bit Length	8 bits

Note: PRISM cannot observe areas beyond 82 degrees south and north latitude.



Characteristic of sample

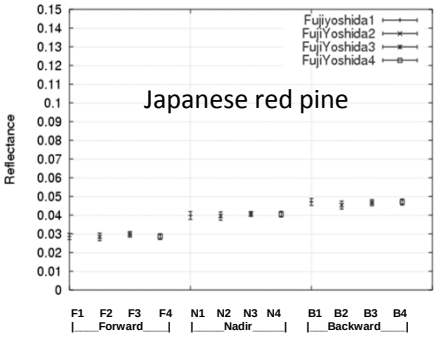
- Selecting sample points from Fluxnet（http://fluxnet.ornl.gov/）
- Land of sample point is relatively flat surface
- Measured under same illumination condition (Principal plane)
- Use scenes of only summer season (High vegetation condition)

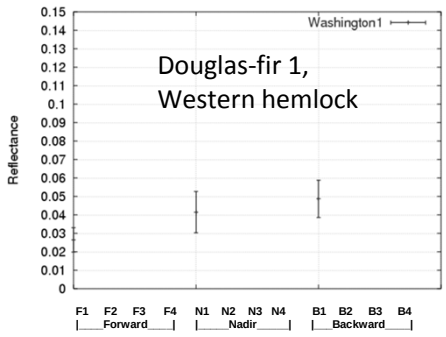
Vegetation	Location	Species	SunZenith(PRISM)	Sun azimuth(PRISM)
Evergreen Needleleaf tree	Fujiyoshida	Japanese red pine	69.18	134.47
	USA/Washington	Douglas-fir , Western hemlock	64.3	145.64
	USA/Oregon	Douglas-fir	56.8	151.16
	USA/Maine	Red spruce, Eastern hemlock	64.22	143.51
Deciduous Needleleaf tree	Fuji Hokuroku	Japanese larch forest	69.18	134.47
Evergreen Broadleaf tree	Brazil	Macaranduba,Jatoba, brazilnut,Taxi	54.98	43.99
Deciduous Broadleaf tree	USA/Wisconsin	Sugar maple	56.33	152.09
	USA/Ohio	Northern red oak,White oak	51.64	155.14
	USA/Tennessee	Oak/Hickory	64.56	136.69

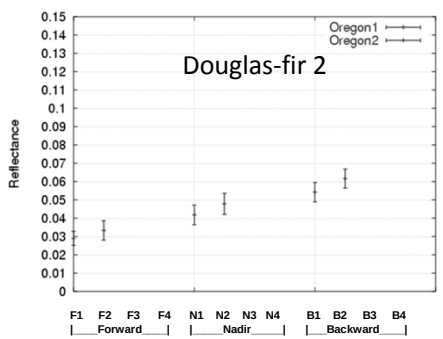
Average and standard deviation of PRISM reflectance (Forward, Nadir, backward) for each sample area (1 blocks size : 20pixel x 20pixel)

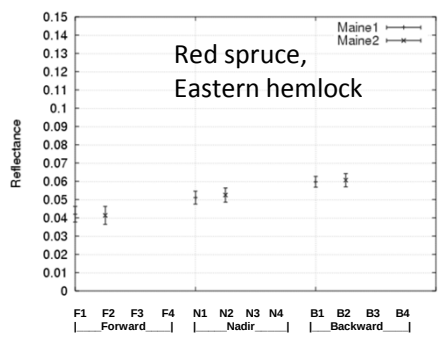
Average of PRISM forward・nadir・backward (Needleleaf and Broadleaf tree)

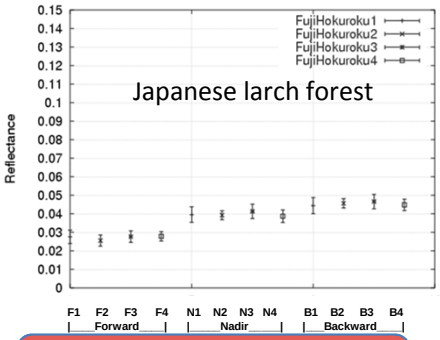
Needleleaf tree







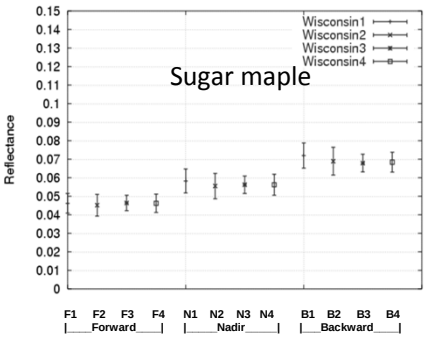


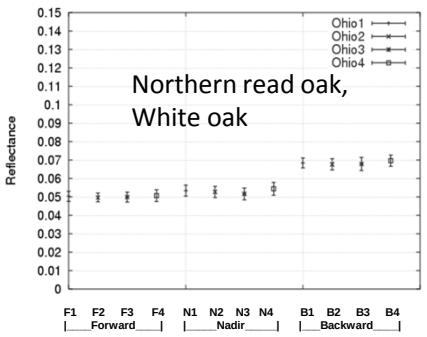


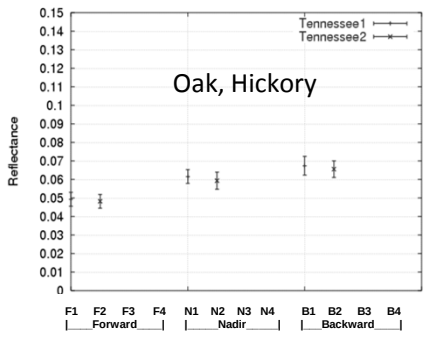
Both Neadleleaf tree and Broadleaf tree

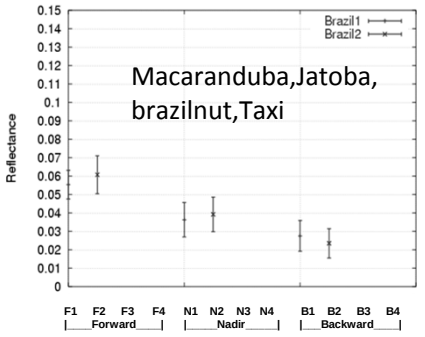
Northern hemisphere : **Forward** ＜ **Nadir** ＜ **Backward**
Southern hemisphere : **Backward** ＜ **Nadir** ＜ **Forward**

Broadleaf tree









Ratio of Forward to Backward

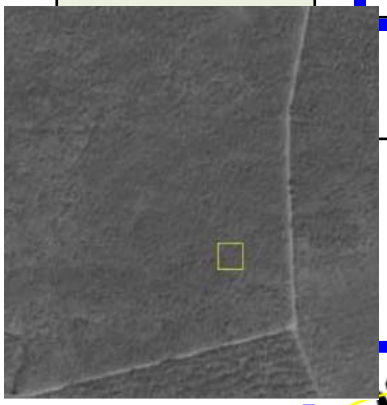
Needleleaf tree					
Species (Location)	Red spruce, Eastern hemlock (USA/Maine)	Red pine (Fujiyoshida)	Japanese larch forest (FujiHokuroku)	Douglas-fir (USA/Oregon)	Douglas-fir , Western hemlock (USA/Washington)
Average	1.518	1.601	1.730	2.087	2.130
Standard deviation	0.276	0.160	0.342	0.543	0.811

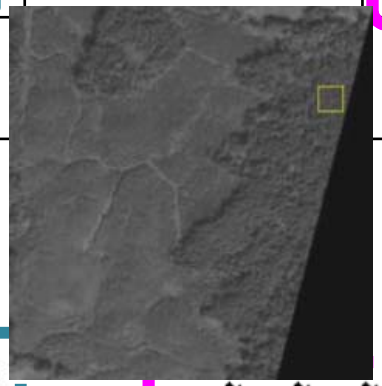
Broadleaf tree				
Species (Location)	Oak/Hickory (USA/Tennessee)	Northern red oak, White oak (USA/Ohio)	Sugar maple (USA/Wisconsin)	Macaranduba, Jatoba, brazilnut, Taxi (Brazil)
Average	1.314	1.390	1.543	2.651
Standard deviation	0.151	0.151	0.284	8.341

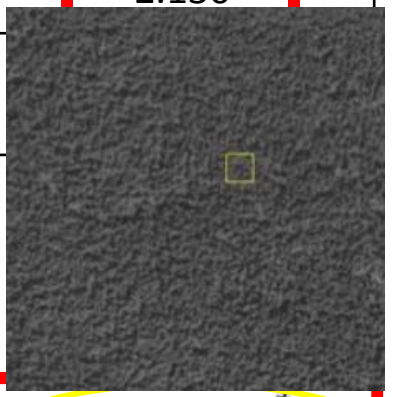
Needleleaf tree > Broadleaf tree

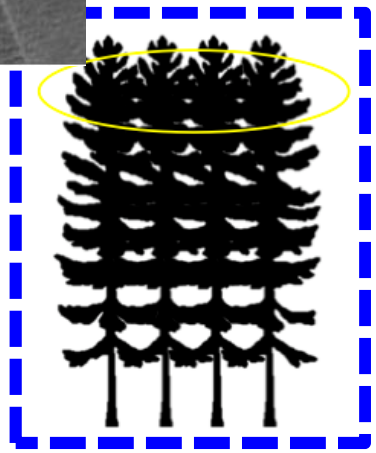
Differences in shape of canopy of trees

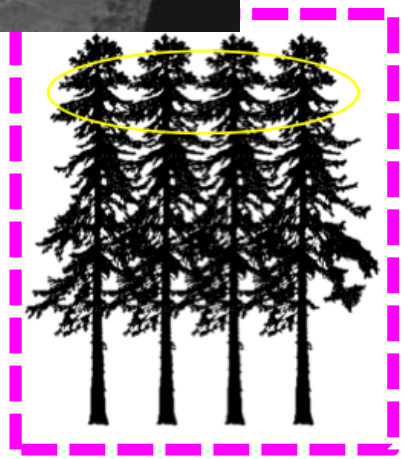
Needleleaf tree					
Species (Location)	Red spruce(41%), Eastern hemlock (USA/Maine)	Red pine (Fujiyoshida)	Japanese larch forest (FujiHokuroku)	Douglas-fir (USA/Oregon)	Douglas-fir , Western hemlock (USA/Washington)
Average	1.518	1.601	1.730	2.087	2.130
	0.276	0.160		0.543	

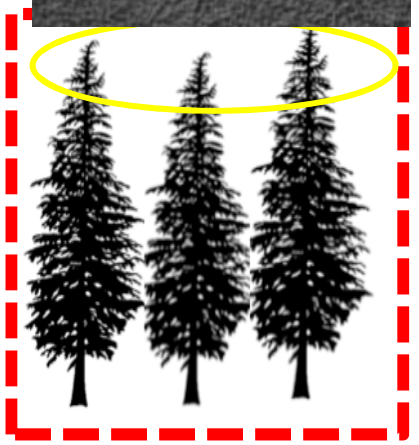












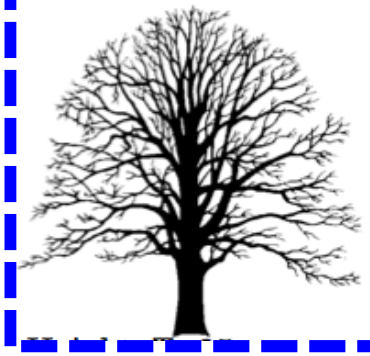
With the spread crown and dense trees, the shape of canopy is low roughness

With the conical crown of needleleaf tree, the shape of canopy is high roughness

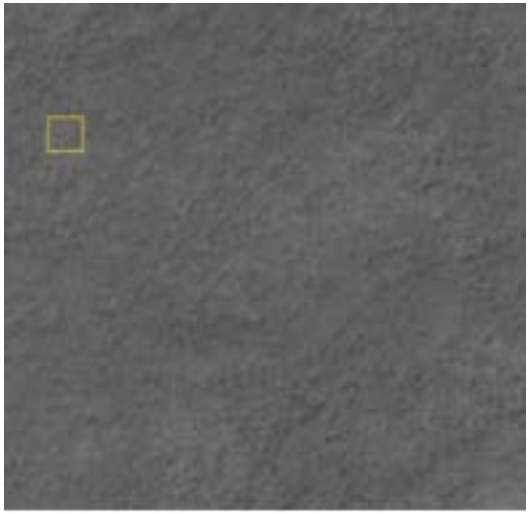
Differences in shape of canopy of trees

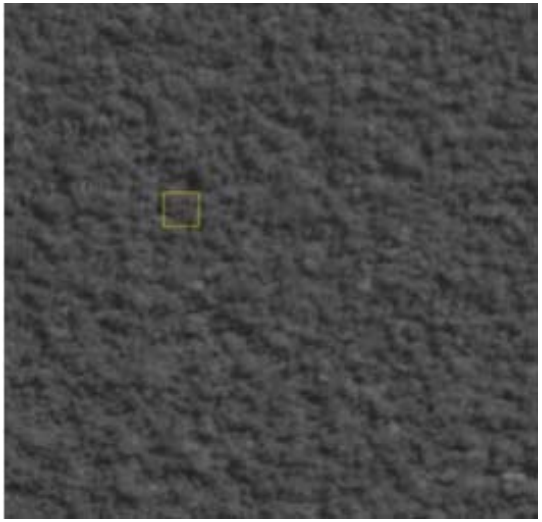
The crown spread of Oak is large, the shape of canopy is low roughness

	USA/Tennessee）	（USA/Ohio）	ugar maple （USA/Wisconsin）	Macaranduba, Jatoba, brazilnut, Taxi （Brazil）
	1.314	1.390	1.543	2.651
	0.151	0.151	0.284	8.341



With many tall trees forming a multi-layer canopy of tropical forest ,the shape of canopy is high roughness





The classification applicability of forests using multi-direction data

- Distinguish differences in shape of a canopy using multi-direction data

- The shape of canopy is related to species, ages, forming layer of forest canopy and etc.

- Need to collect training data from various forest types, and develop the method of classification between needleleaf forest and broadleaf forest using multi-direction satellite data

Validation data for global land cover products - data with reliable accuracy using SACLA -

- Produce validation data sets with reliable accuracy using SACLA data sets

SACLA: several persons determined the class item of the site by watching photos on Degree Confluence Project (DCP) web site (provided by Dr. Sasai)

- Merit

  Collect validation data around the world

- Demerit

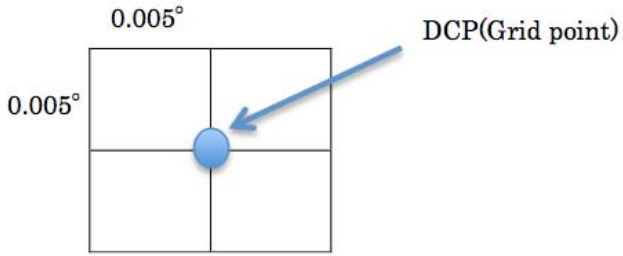
  Accuracy is not high since there are less information to determine a class.

<Information of the web >
- Visit season
- Some photos (East,West,North,South)
- Description of the way of visiting to the point

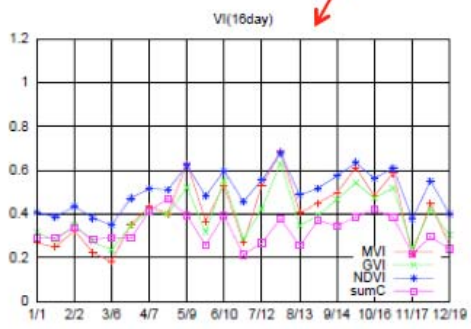
Degree Confluence Project (DCP)
http://confluence.org/index.php

Produce validation data sets with reliable accuracy using SACLA data sets

- Confirm four pixels, corresponding to a size of SGLI, centered on the DCP(grid point) using the following three check points by several persons.
  - ✓ Check Photos and descriptions on Degree Confluence Project (DCP) web site
  - ✓ See the surrounding area using Google Earth
  - ✓ Check the seasonal change characteristic of the site using Vegetation Index and spectral reflectances



Google Earth



VI of MODIS(2007)

- Problems
  - ✓ Difficult to distinguish between forests with accuracy
  - ✓ Difficult to distinguish between openshrub and grassland covered with low vegetation
  - ✓ Difficult to determine the class item of a mixel land cover

In IGBP classes, cropland/natural vegetation mosaic is only mixel land cover type.

Validation data for global land cover products - expanding point data of field survey -

- In a location having no view from standing place such as forest, validation data collected by field survey may be low accuracy with a size according to low resolution satellite data

- Produce validation data sets for low resolution data with middle high resolution satellite data sets such as ALOS/AVNIR-2, Landsat8
  - ✓ Use middle high resolution satellite data sets (ALOS/AVNIR-2)
  - ✓ Analyze the land cover characteristic of well-known site using some index values (Vegetation Index, UPDM coefficients)
    - Calculate the average and the standard deviation of area (250mx250m) centered on the field point.
    - Determine the condition of the land cover by the data distribution
  - ✓ Distinguish pixels satisfying the condition from area(1kmx1km) centered on the field point
  - ✓ Determine the location for the validation data using the occurrence ratio(70%) of the class with a size according to low resolution (SGLI)

Determine the location for the validation data using occurren

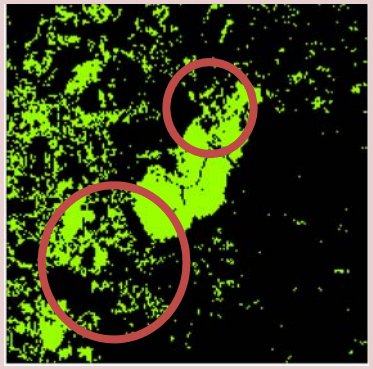
Data : ALOS/AVNIR-2 produced by JAXA/EORC D
Wakakusayama(Nara) : Grassland
Distinguish using MVIUPD of November

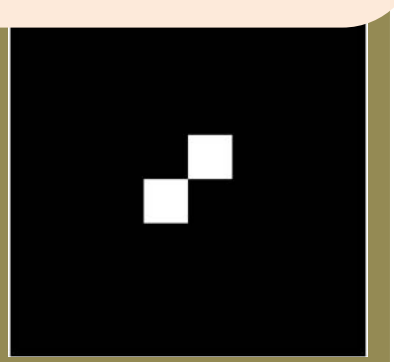
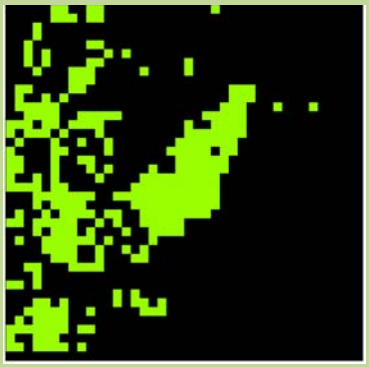
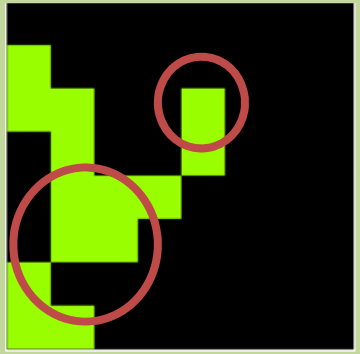
In the circle, there are many evergreen trees (high values) and shops(low values).

Average is obtained by canceling each others.

True color image

10m/pix



Occurrence Ratio: 80%		
Average		

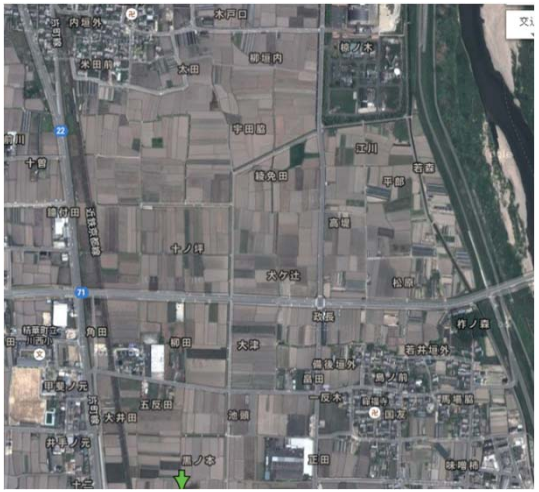
The validation data using occurrence ratio

Paddy land condition :

0.6965826 < MVIUPD of August<0.923086 && -0.09328418 < MVIUPD of May < 0.2798525

Distinguish paddy area with a size according to a low resolution pixel (250m) in which occurrence ratio is 70%

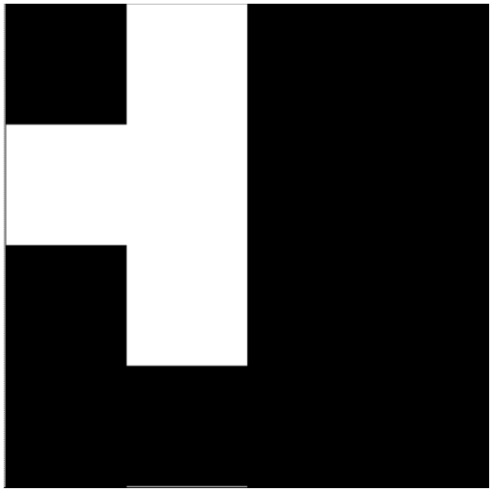
Seika-cho in Kyoto Pref.



Google Maps

White pixels are paddy area

resolution size: 10m



resolution size: 250m

The validation data using occurrence ratio

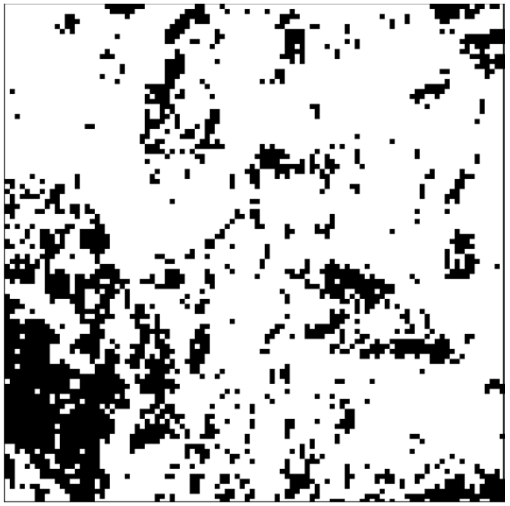
Evergreen Needleleaf forest condition : 0.8998 < MVIUPD of November <1.0086

Distinguish evergreen needleleaf trees area with a size according to a low resolution pixel (250m) in which occurrence ratio is 70%

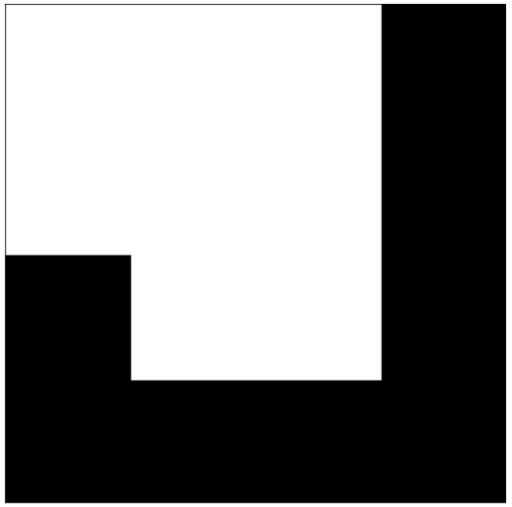
Totsukawamua in Nara Pref.

Google Maps

White pixels are evergreen needleleaf trees area



resolution size: 10m



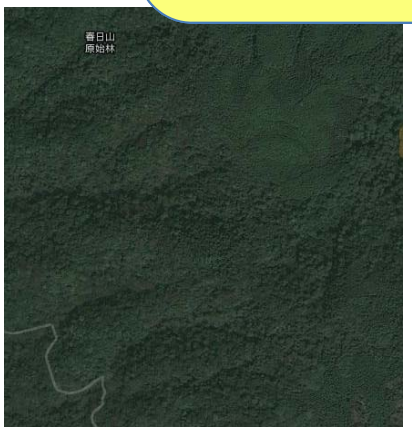
resolution size: 250m

T tio

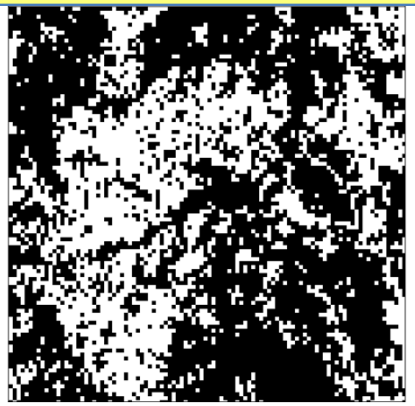
Evergre

KasugaMt

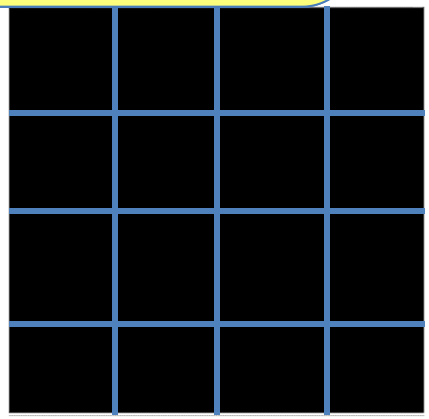
To determine the location of validation data automatically, distinguish that by shifting of 250m from just location according with SGLI.
No pixel distinguished as evergreen broadleaf trees area with a size according to a low resolution pixel (250m) in which occurrence ratio is 70% by shifting of 250m



Google Maps

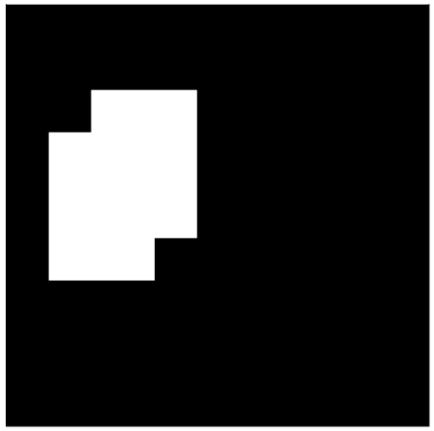


resolution size: 10m



resolution size: 250m

Not to overlook evergreen broadleaf trees area distinguished as data with reliable accuracy, the shifting size is reduced to 100m or 50m.



resolution size: 250m
shifting size : 100m

White Area is evergreen broadleaf trees distinguished with a size according to a low resolution pixel (250m) in which occurrence ratio is 70% by shifting of 100m

Summary

- We can distinguish differences in shape of a canopy using multi-direction data, but the shape of canopy is related to species, ages, forming layer of forest canopy and etc.

  We need to collect training data from various forest types
- Produce validation data sets with reliable accuracy using SACLA data sets
- Produce validation data sets for low resolution data using middle high resolution satellite data sets (ALOS/AVNIR-2).

Future works

- Improve the global land cover algorithm
- Continue to produce the validation data sets using SACLA (including Flux site information)
- Continue to produce the validation data using middle high resolution satellite data sets (ALOS/AVNIR-2, LandSat 8)