擬似的多方向観測データを用いた針葉樹林・広葉樹林の特徴抽出

Differences between needle-leaves forest and broad-leaves forest from pseudo multidirectional observation data

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Abstract

Forest classes for global land cover data is important for global environmental studies. However, it is difficult to correctly classify needle-leaves forest and broad-leaves forest using phenology information extracted from observation data as a nadir view. In this study, we attempted to differentiate needle-leaves and broad-leaves forests using MOD09GA and MYD09GA. To produce pseudo multidirectional satellite data, we selected several days of data with scanning widths overlapping along the crosstrack direction. We used the pseudo multidirectional data sets to study reflectance on four bands, as well as the variation with solar zenith and relative azimuth for NDVI (Normalized Difference Vegetation Index) and GVI (the green chlorophyll index). Data selection followed criteria aimed to reduce as much as possible the influence of viewing direction and terrain conditions. We found that NDVI and GVI change depending on the solar zenith and relative azimuth. Using data in limited ranges of solar zenith and relative azimuth, it was not possible to clearly show differences between the characteristics of needle-leaves forest and broad-leaves forest from pseudo multidirectional observation data. However, we found differences for both NDVI and GVI between nadir and slant data depending on the surface state of the forest.

Pseudo multidirectional data sets

Used data and Selecting of scenes as Nadir and Slant

- Used data : MOD09GA (MODIS/Terra Surface Reflectance Daily L2G Global 1km and 500m) and MYD09GA (MODIS/Aqua Surface Reflectance Daily L2G Global 1km and 500m) SIN Grid V006, in 2010 year.
  - sur_refl_b01: 500m Surface Reflectance Band 1 (620-670 nm), sur_refl_b02: 500m Surface Reflectance Band 2 (841-876 nm), sur_refl_b03: 500m Surface Reflectance Band 3 (459-479 nm), sur_refl_b04: 500m Surface Reflectance Band 4 (545-565 nm), Solar zenith, Solar azimuth, Sensor zenith, Sensor azimuth.
  - For multidirectional nadir and slant data, data of several days with scanning widths overlapping along the cross-track direction were selected (See Figure 1).
    <Critaria> Nadir : 0°< sensor zenith < 10°, Slant : 45°<= sensor zenith < 55°, Cloud state : Clear, land/water flag : land
- Sample areas : Sample sites with flat ground were selected from FLUXNET sites and field surveys. Number of sites selected are eight EN sites, two DN sites, four EB sites, four DB sites, and two MIX sites. Each site is the same forest type spreads within a radius of 500 m from the center-of-site area.

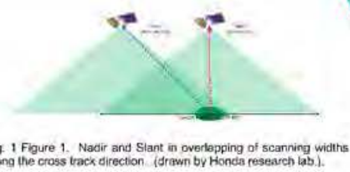

Fig. 1 Figure 1. Nadir and Slant in overlapping of scanning widths along the cross track direction. (drawn by Honda research lab.).

Data-process for nadir and slant (produced by Chiba Univ. Honda Lab.)

Nadir and slant data sets were produced by compositing a 15-day cycle as one scene as, with size 2400 × 2400 pixels. Values of reflectance data on four bands, zenith and azimuth for sun and sensor were populated for each pixel meeting the cloud state and land/water flag requirements cited above, otherwise, the pixel was filled with null data.

Data-process for analysis

- In each sample site, scenes were selected for which every data subset exists in both the nadir and slant files.
- To study the relationship between nadir and slant data, we calculated vegetation indices NDVI(Normalized Difference Vegetation Index) and GVI (the green chlorophyll index) as follows.
  $NDVI = (NIR-Red)/(NIR+Red)$, $GVI = NIR/Green-1$
- To avoid the influence of thin clouds, we used data with NDVI > 0.7 for both nadir and slant data.
- To study reflectance affected by solar azimuth and sensor azimuth, relative azimuth was calculated from zero to 180 degree by the difference between sun azimuth and sensor azimuth (See Figure 2).
  Solar azimuth and sensor azimuth of MODIS products have values in the −180.00 to 180.00 degrees range.

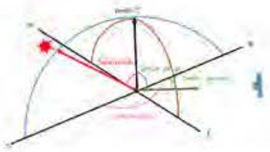

Fig. 2 Relationship between relative azimuth, solar azimuth, and sensor azimuth.

Results

Relationship between relative azimuth and reflectance

Both nadir and slant reflectance change depending on relative azimuth: reflectance decreases as the relative angle approaches 90 degrees.

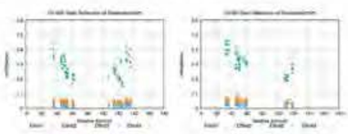

Figure 3. Relationship between reflectance of four bands and relative azimuth.

Both nadir and slant reflectance change depending on solar zenith: reflectance decreases with increasing solar zenith angle.

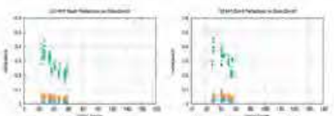

Figure 4. Relationship between reflectance of four bands and solar zenith.

Influence of relative azimuth and solar zenith

Data with a difference between nadir relative azimuth and slant relative azimuth of less than 20 degrees and for which the solar zenith angle of both nadir and slant is less than 30.

- These figures show that NDVI and GVI change depending on relative azimuth.

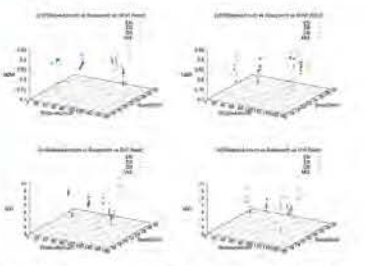

Figure 5. (a1) relationship between NDVI, relative azimuth and solar zenith for nadir, (a2) relationship for slant, (b1) relationship between GVI, relative azimuth and solar zenith for nadir, (b2) relationship for slant.

- Nadir NDVIs have a wider distribution than slant NDVI while they are more similarly distributed for needle-leaves forest.

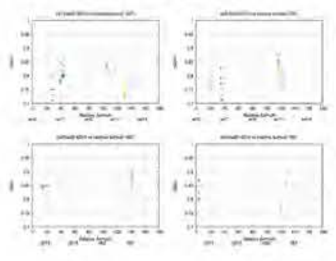

Figure 6. (a1) NDVIs of nadir for needle-leaves forest sample sites, (a2) NDVIs of slant for needle-leaves forest sample sites, (b1) NDVIs of nadir for broad-leaves forest sample sites,(b2) NDVIs of slant for broad-leaves forest sample sites, Relationship between NDVI and relative azimuth for each sample sites of needle-leaves tree and broad-leaves tree.

- Compared to other sites, slant values are somewhat consistently larger than nadir values for sites db2a and en7. Site db2a (deciduous broad-leaves forest) with land covered by oak woodlands. Site en7 (evergreen needle-leaves forest) with land covered by 400–500 years' old western hemlock.

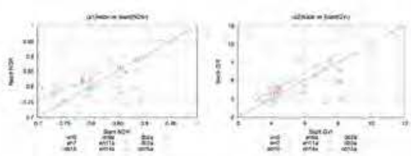

Figure 7. Relationship between nadir and slant (a1) NDVI (a2) GVI, combining needle-leaves forest and broad-leaves forest data.Square marks indicate data with relative azimuth larger than 100 degrees and plus marks indicate data with relative azimuth smaller than 50 degrees.

Conclusions

- We did not find a clear difference between the characteristics of needle-leaves forest and broad-leaves forest, but we found differences for both NDVI and GVI between nadir and slant data depending on the surface state of the forest.
- The number of data points selected following restrictions discussed above for relative azimuth and solar zenith was very small, resulting in 62 EN points, 13 EB points, 11 DB points, and 16 MIX points.
- To further investigate the difference in forest characteristics using multidirectional observation data, it is necessary to increase sample sizes for future studies.

Acknowledgements

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