Development of new global surface type maps from VIIRS data

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Introduction

Accurate representation of terrestrial surface types or land cover at regional to global scales is an important element for a wide range of applications, such as land surface parameterization, modeling of biogeochemical cycles, and carbon cycle studies. Global surface type map is also a core input for National Weather Service’s (NWS) Numerical Weather Prediction (NWP) models, and could be used in other weather, climate, hydrology and ecology models. The National Oceanic and Atmospheric Administration (NOAA) Joint Polar Satellite System (JPSS) land surface type team has been generating global surface type classification maps using global observations acquired by the Visible Infrared Imaging Radiometer Suite (VIIRS) onboard the Suomi National Polar-Orbiting Partnership (S-NPP) satellite launched on 28 October 2011. The newest VIIRS surface type map with the 17-class International Geosphere-Biosphere Program (IGBP) classification scheme was created from 2014 VIIRS surface reflectance data using the support vector machines algorithm. Other legends are also covered in this study. More details and data access: http://vet.geog.umd.edu/st/

Objectives

Introduce the methods and results of IGBP legend global surface type map from VIIRS data. In addition, introduce a 20-type global surface type map required by the NCEP. For retrieval of leaf area index, a 6-type biome global surface type map is also presented.

Methods

- VIIRS surface reflectance data (swath)
- Gridding
  - Gridded surface reflectance data
- Compositing
  - Global composites (daily)
  - Global composites (32-day)
- Metrics generation
  - Annual metrics (global)
  - Other surface type products
  - Error matrix of estimated area proportions (in percentage).
- Viirs ST IP product
- Decision tree
- Support vector machines (SVM)
- Validation data
- Training sample

Advantages of SVM: Noise resistant, more accurate. Optimal boundary (hyperplane) used, can handle very complicated classifications.

We have classified 2012, 2014 and 2015 S-NPP annual metrics using the SVM algorithm in parallel to create the GST. Annual metrics used in the classification are listed as below:

<table>
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<tr>
<th>x is the band in annual metrics:</th>
<th>m1, m2, m3, m4, m5, m7, m8, m10, m11</th>
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Surface type change

Land surface type changes, which are typically caused by flooding, burning, deforestation, reforestation, or urbanization, occur frequently around the world. Although some of these changes take place over a multi-year timescale, others may take place in just a few days. While the VIIRS annual global surface type product may not capture the short term surface type changes, it may illustrate their consequences by detecting burn scars or flooded areas. An example of large scale surface type changes is the consequence of the Kim fire of 2013 in California. The GST products generated with 2012 and 2014 VIIRS data demonstrated that the region marked with the red polygon in the enlarged areas in the middle of the figure shown below has surface type change from Woody Savannas to Shrubland.

2012 surface type

The fire caused the surface type changes from woody savannas to open shrubland

2015 S-NPP GST SVM classification result in IGBP

The S-NPP global surface type IGBP map has been extensively validated using high resolution imagers. The error matrix is described as follows:

Error matrix of estimated area proportions (in percentage). Overall accuracy is 78.5 ± 0.6%.

Globally, around 6600 validation points are visually validated against high resolution images retrieved from Google Earth in an integrated validation platform. The detailed validation process and results have been published, see references section for more information.

20-type surface type for NCEP

Specific users may require different classification legend other than IGBP. For example, the National Centers for Environment Prediction (NCEP) needs a 20-type global surface type classification map, which consists of the abovementioned 17-type IGBP map plus three additional tundra types.

In this study, three tundra classes extracted from other sources were combined to the S-NPP VIIRS IGBP surface type data, and the 20-type surface type is generated.

Global surface type classification map for NCEP with 20 types.

The tundra types are derived directly from MODIS global land cover data and other ancillary data. In future development, other more accurate data source, such as USGS high resolution maps, and other data sources, such as ecoregions maps will be used to enhance the mapping results.

Biome surface type

Surface type in IGBP legend is required by the JPSS program, but other legend system, such as biome classification scheme is also desired by some researchers. For example, the retrieval of LAI and IPAR requires a biome surface type classification based on their canopy structures, in which biome types are defined: 0: water; 1: Grasses/Cereal Crop; 2: Shrub; 3: Broadleaf crop; 4: Savanna; 5: Broadleaf forest; 6: Needleleaf forest; 7: Unvegetated; 8: Urban. Most biome types could be obtained by converting IGBP types in a look-up-table (LUT), but the separation of cereal crops and broadleaf crops were conducted by a secondary SVM classification.

In the LUT, World Wildlife Fund (WWF) global biome map is used to separate mixed forest. To separate two different crop types from IGBP crop types (12, 14), additional training samples for different agriculture type was used, which was provided by the System for Terrestrial Ecosystem Parameterization (STEP) dataset.

The biome surface type map was generated using a SVM-biome LUT plus a second SVM classification to further separate cereal crops and broadleaf crops. Validation in progress.

References


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