A Big Data Approach for Situation-Aware correction and estimation of NDVI, based on Landsat8 OLI/TIRS (Surface Reflectance) time series data

*Ananjay Kumar Singh[1], Durga Toshniwal[1]

1. Indian Institute of Technology Roorkee

The Landsat8 Surface Reflectance Higher-Level Data provided by USGS corrected from medium resolution MODIS Terra /Aqua Satellites data, contain Cloud QA, CFmask, CFmask Cloud Confidence and Interpolation Flag bands corresponding to prior single Quality Assessment(QA) Band of OLI/TIRS data. These corrected band data, when used for deriving vegetation indices such as Normalized Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI), Soil Adjusted Vegetation Index (SAVI) still exposes limitations in presence of atmospheric artifacts such as aerosol, cloud, cirrus cloud etc. The effect of occlusion by these artifacts imposes an important challenge for estimation of accurate vegetation indices, adequately affecting application areas such as digital precision agriculture: Where recommendation applications developed for farmers largely depend on these indices(e.g. Spatio-temporal irrigation recommendations to farmers based on NDVI based estimation of crop evapotranspiration - ETc). Our approach corrects the surface reflectance band values in the case of occlusion by cloud and other artifacts, defusing Spatio-temporal correlations and regressions. The Big Data process pipeline consisting correlation and regression techniques developed on Apache Spark can easily scale for large data sets including many tiles(scenes) and over widened time-scale.

Keywords: Normalized Difference Vegetation Index (NDVI), Situation-Aware, Big Data, Apache Spark, Landsat8

Rice Crop Monitoring by using Multiple Satellite Sensors

*Kei Oyoshi[1], Shinichi Sobue[1]

1. Japan Aerospace Exploration Agency

Rapid population and economic growth, and the increase in extreme weather events, are destabilizing global food security. In Asia, rice is a staple cereal crop, and the continent accounts for about 90% of global rice production and consumption. The Group on Earth Observations (GEO) Global Agricultural Monitoring (GLAM) was launched in 2011 to utilize remote sensing tools to enhance crop production projections in order to promote food security and foster sustainable economic growth. Asia-Rice Crop Estimation & Monitoring (Asia-RiCE) is a component of GEOGLAM, and aims to use remote sensing tools to develop rice-related information such as maps of paddy fields, rice growing conditions, yield, and production. Rice is mainly cultivated in the rainy season, and the high density of cloud cover during that season limits the observations that can be made from space using only optical sensors. In contrast, Synthetic Aperture Radar (SAR) is a robust tool because it penetrates cloud cover; however, the revisit frequency of a single SAR satellite is limited, making it difficult to capture the complicated rice crop calendar in Asia. In this research, SAR data (ALOS-2 PALSAR-2 etc.), and optical global imager data (MODIS) were utilized to monitor rice crops in Asia. Rice crop growth can be estimated from backscattering coefficient measured by ALOS-2 or vegetation index such as NDVI or EVI by MODIS. In addition, microwave radiometer (AMSR2) was also used to identify surface water condition because AMSR2 36.5GHz data has high sensitivity to water, and it can penetrate cloud and capture surface water condition on a 2-3 days basis with 10 km spatial resolution. The integrated use of these satellite data enables us to capture rice growing and surface water condition during whole rice cropping cycle consists of planting, vegetative, reproductive, ripening, harvesting, and fallow seasons. These information can improve our ability to estimate rice crop yield/production and quantify the carbon or water balance in paddy fields and the methane emission from paddy fields.

Keywords: rice paddy, SAR, Microwave radiometer, Optical sensor

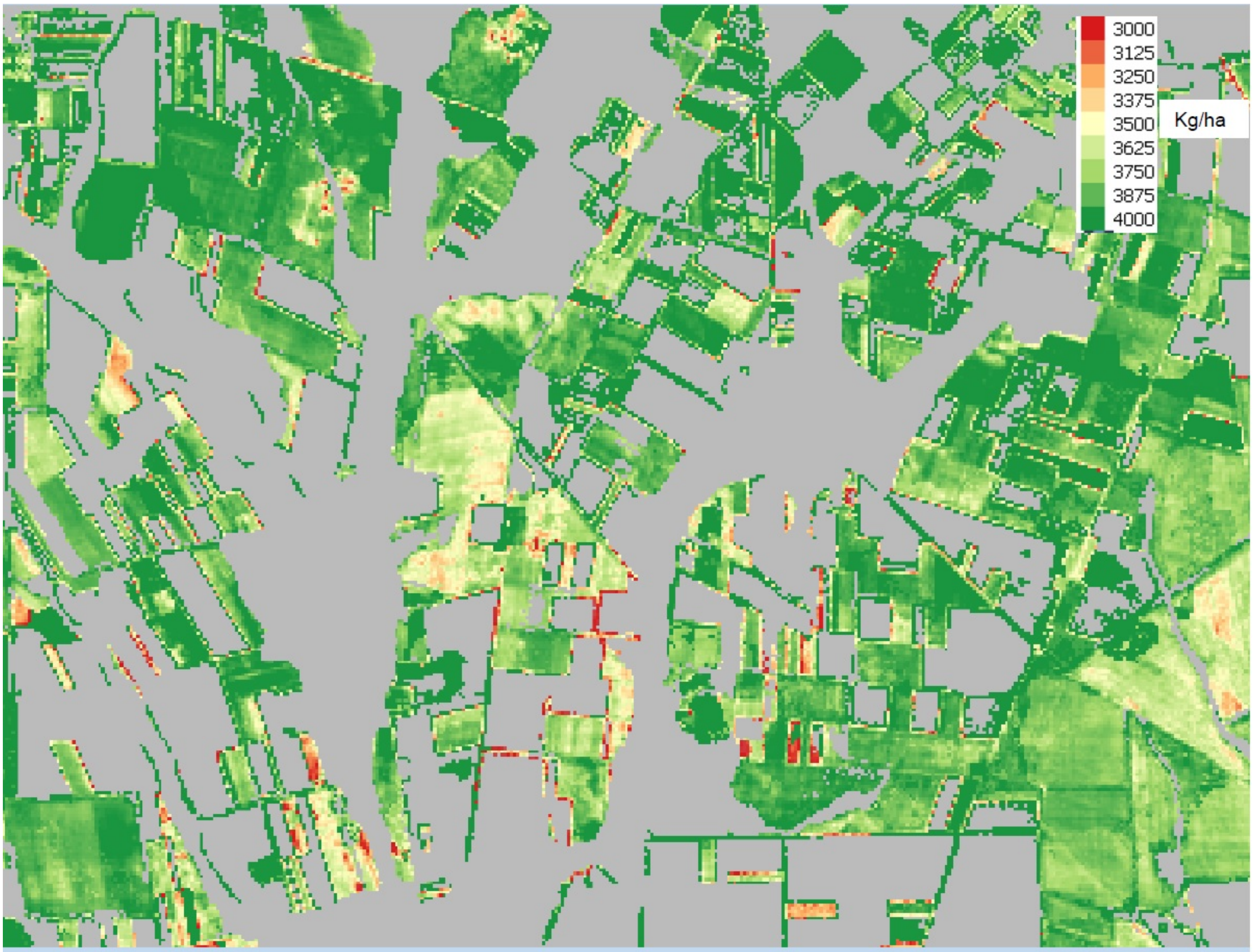
Crop mapping and crop production estimation using multi-source remote sensing data

*Sergii Skakun[1,2], Jean-Claude Roger[1,2], Belen Franch[1,2], Eric Vermote[2], Christopher Justice[1]

1. University of Maryland College Park, 2. NASA Goddard Space Flight Center

Remote sensing data from space is the essential source of information for enabling continous monitoring and quantification of crop state at global and regional scales. Crop mapping, state assessment, area estimation, yield forecasting and eventually crop production estimation are the main tasks being addressed within the Group on Earth Observation (GEO) Global Agricultire Monitoring Initiative (GEOGLAM). Efficiency of agriculture monitoring can be improved when heterogeneous multi-source remote sensing datasets are exploited. Here, we present several case studies of utilizing MODIS, Landsat-8 and Sentinel-2 data along with meteorological data for winter wheat yield forecasting, mapping and area estimation. Historical coarse spatial resolution data, such as MODIS, VIIRS and AVHRR, can provide daily global observations that coupled with statistical data on crop yield can enable the development of empirical models for timely yield forecasting at national level. With the availability of high-temporal and high spatial resolution Landsat-8 and Sentinel-2A imagery, course resolution empirical yield models can be downscaled to provide yield estimates at regional and field scale. In particular, we present the case study of downscaling the MODIS CMG based generalized winter wheat yield forecasting model to high spatial resolution data sets, namely harmonized Landsat-8 –Sentinel-2A surface reflectance product (HLS). Since the yield model requires corresponding in season crop masks, we propose an automatic approach to extract winter crop maps from MODIS NDVI and MERRA2 derived growing degree days (GDD) using the Gaussian mixture model (GMM). Validation for the state of Kansas (US) and Ukraine showed that the approach can provide accuracies > 90% without using reference (ground truth) data sets. Another application of yearly derived winter crop maps is their use for stratification purposes within area frame sampling for crop area estimation. In particular, one can simulate the dependence of error (coefficient of variation) on the number of samples and strata size. This approach was used for estimating the area of winter crops in Ukraine for 2013-2016. The GMM-GDD approach is further extended for HLS data to provide automatic winter crop mapping at 30 m resolution for crop yield model and area estimation.

Keywords: agriculture, crop mapping, crop yield, MODIS, Landsat-8, Sentinel-2



Winter wheat yield map derived from Landsat-8

Evaluation of The Landsat-8/Sentienl-2 Land Surface Reflectance

*Jean-Claude Roger[1,2], Eric Vermote[2], Sergii Skakun[1,2], Belen Franch[1,2], Brent Holben[3], Christopher Justice[1]

1. Department of Geographical Sciences, University of Maryland, College Park, MD, USA, 2. Terrestrial Information System Branch-Code 619, NASA/GSFC, Greenbelt, MD, USA, 3. Biospheric Science Branch-Code 618, NASA/GSFC, Greenbelt, MD, USA

The land surface reflectance is a fundamental climate data record at the basis of the derivation of other climate data records (Albedo, LAI/Fpar, Vegetation indices) and has been recognized as a key parameter in the understanding of the land-surface-climate processes. Here, we present the validation of the Land surface reflectance used for Landsat-8 and Sentinel-2 data. This methodology uses the 6SV Code and data from the AERONET network.
The first part was to define a protocol to use the AERONET data. To correctly take into account the aerosol model, we used the aerosol microphysical properties provided by the AERONET network including size-distribution ($\%C_f$, $\%C_c$, r_f, r_c, σ_r, σ_c), complex refractive indices and sphericity. Over the 670 available AERONET sites, we selected 230 sites with sufficient data. To be useful for validation, the aerosol model should be readily available anytime, which is rarely the case. We then used regressions for each microphysical parameter using the aerosol optical thickness at 440nm and the *Angström* coefficient as parameters. Comparisons with the AERONET dataset give good APU (Accuracy-Precision-Uncertainties) for each parameter.
The second part of the study relies on the theoretical land surface retrieval. We generated TOA synthetic data using aerosol models from AERONET and determined APU on the surface reflectance retrieval while applying the Landsat-8 and Sentinel-2 Atmospheric correction software. Over 250 AERONET sites, the global uncertainties are for MODIS band 1 (red) is always lower than 0.0015 (when surface reflectance is > 0.04). This very good result shows the validity of our reference. Then, we used this reference for validating the Landsat-8 and Sentinel-2 surface reflectance products. The overall accuracy clearly reaches specifications.
Finally, we will present an error budget of the surface reflectance retrieval. Indeed, to better understand how to improve the methodology, we defined an exhaustive error budget. We included all inputs i.e. sensor, calibration, aerosol properties, atmospheric conditions… This latter work provides a lot of information, such as the aerosol optical thickness obviously drives the uncertainties of the retrieval, the absorption and the volume concentration of the fine aerosol mode have an important impact as well…

Keywords: Atmospheric correction, validation, land surface reflectance

LANDSAT AND SENTINEL 2A SURFACE ALBEDO ESTIMATION. APPLICATION TO EVAPOTRANSPIRATION RETRIEVAL

*Belen Franch[1], Eric Vermote[2], Andres Santamaria-Artigas[1], Sergii Skakun[1,2], Jean-Claude Roger[1,2]

1. Department of Geographical Sciences, University of Maryland College Park, 2. NASA Goddard Space Flight Center, Code 619

Surface albedo is an essential parameter not only for developing climate models, but also for most energy balance studies. While climate models are usually applied at coarse resolution, the energy balance studies, which are mainly focused on agricultural applications, require a high spatial resolution. The albedo, estimated through the angular integration of the BRDF, requires an appropriate angular sampling of the surface. However, Landsat and Sentinel 2A sampling characteristics, with nearly constant observation geometry and low illumination variation, prevent from deriving a surface albedo product.
In this work we apply an algorithm developed to derive a Landsat and Sentinel 2 surface albedo. It is based on the BRDF parameters estimated from the MODerate Resolution Imaging Spectroradiometer (MODIS) CMG surface reflectance product (M{O,Y}D09) using the VJB method (Vermote et al., 2009). Landsat and Sentinel 2 unsupervised classification images are used to disaggregate the BRDF parameters to their spatial resolution. Using these albedo values with field measurements we apply the S-SEBI method to estimate the evapotranspiration.

Keywords: Landsat, Sentinel 2, Surface albedo, Evapotranspiration

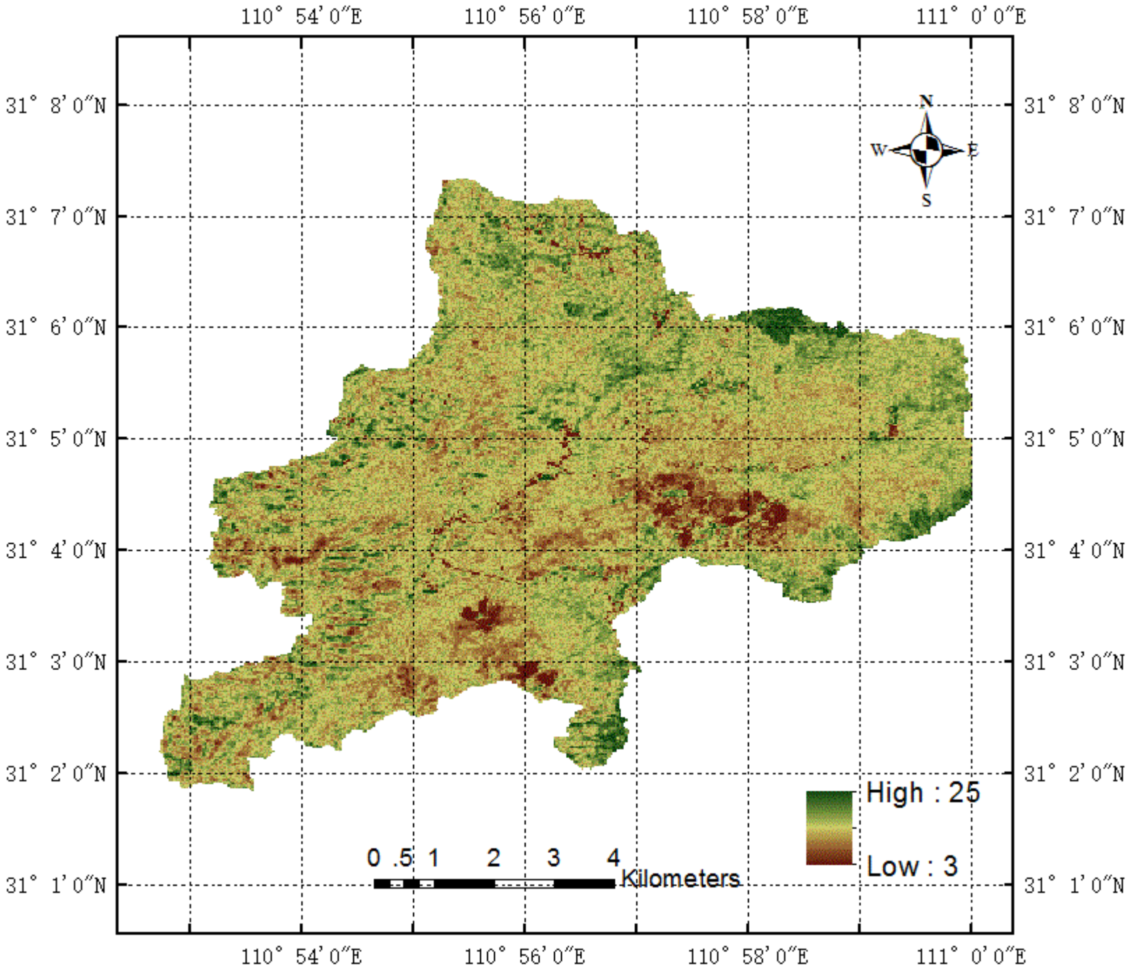
Inversion of forest structure parameters using multi-source remote sensing data

*Mingbo Liu[1], Chunxiang Cao[1], Yongfeng Dang[2]

1. Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences, 2. Academy of Forest Inventory and planning, State Forestry Administration of China

The inversion of forest structure parameters, which are needed in forest management planning, is carried out through the joint use of Sentinel-1A, Sentinel-2A, Landsat-8, GF-2 and field survey data. After atmosphere and terrain correction, Optical bands' reflectance value, intensity of C-band SAR and a series of extracted vegetation index were used in the construction of random forest regression model, terrain factors of slope and aspect were also within consideration. 1 m resolution GF-2 panchromatic imageries were used as the data source of texture analysis and the influences of different size of convolution window were analyzed. We introduce the concept of Normalized Difference Time Index (NDTI) to reflect the impact seasonal changes, which is proved to be an influential variable in our regression model. Through the above work, this article is dedicated to explore the possibility of a practical forest structure remote sensing inversion solution in mountain areas around Three Gorges basin of Yangtze River, which was previously thought as one of two most difficult regions for remote sensing in China.
Vegetation indexes used in this article include Normalized Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI), Soil Adjusted Vegetation Index (SAVI), Modified Soil Adjusted Vegetation Index (MSAVI), Normalized Difference Moisture Index (NDMI). Normalized Difference Time Index is expressed in the following form:
NDTI = (Band X_{summer} –Band X_{winter}) / (Band X_{summer} + Band X_{winter})
Texture factors include Mean, Variance, Homogeneity, Contrast, Dissimilarity, Entropy, Second Moment and Correlation of different convolution window.
The correlation coefficient of the model for average tree height is 0.377, with a standard error of 1.1024 m, for average diameter at breast height(DBH) is 0.422, with a standard error of 1.8684 cm, for volume per hectare is 0.556, with a standard error of 11.8606 m^3/ha.This work is still refining according to the needs of forestry production sector.

Keywords: Forest structure parameters, Multi-source, NDTI, Texture


110° 54′ 0″E
110° 56′ 0″E
110° 58′ 0″E
111° 0′ 0″E
31° 8′ 0″N
31° 7′ 0″N
31° 6′ 0″N
31° 5′ 0″N
31° 4′ 0″N
31° 3′ 0″N
31° 2′ 0″N
31° 1′ 0″N
N
W
E
S
High : 25
Low : 3
0 .5 1 2 3 4
Kilometers

Land cover classification of the Mongolian Plateau using multi-temporal MODIS data

*てむ るん[1]、奈佐原 顕郎[1]、呉 越人[1]
*TEMU LUN[1], KenIo Nasahara[1], Yueren Wu[1]

1. 筑波大学
1. University of Tsukuba

The Mongolian Plateau is part of the Central Asian Plateau and it mainly consists of Inner Mongolia of China and Republic of Mongolia. Previous studies have shown that this region has been experiencing rapid land cover and land use change such as lake shrinkage and land degradation due to human activities and climate change. In this study, we aimed to produce high reliable regional land cover map of the Mongolian Plateau using 500 m resolution multi-temporal MODIS data of 2016. The classification method is as below: First, we implement classification to each scene of the MODIS data of different seasons in year 2016. Second, we integrate these multi-temporal classification results. In the per-scene classification, we conduct a kernel density estimation (KDE), and then use the densities in a Bayesian inference to obtain the class posterior probability. After the multi-temporal per-scene classification, we calculate the classification score by integrating class posterior probabilities in multi-temporal scenes. In addition, we applied night light data such as SUOMI NPP to correctly estimate urban area. Also, digital elevation model data was used for detecting the wrong estimation of water or paddy class which located on the slope of mountain. For validation of the map, we mainly relied on the ground truth photo database which named SACLAJ (Site-based dataset for Assessment of Changing Landcover by JAXA) as well as higher resolution satellite images from ALOS and Landsat-8. Our studies demonstrated that combining such variety of satellite data and ground truth data, we can produce a high reliable regional land cover map which can be used as base input data for other researchers.

キーワード：土地利用、内モンゴル、カーネル密度推定
Keywords: Land use, Inner Mongolia, Kernel density estimation

ALGORITHM DEVELOPMENT AND VALIDATION METHOROLOGY FOR GCOM-C/SGLI AVOBE GROUND BIOMASS PRODUCT

*梶原 康司[1]、本多 嘉明[1]
*Koji Kajiwara[1], Yoshiaki Honda[1]

1. 千葉大学 環境リモートセンシング研究センター
1. Center for Environmental Remote Sensing, Chiva University

Japan Aerospace Exploration Agency (JAXA) will launch new Earth observation satellite GCOM-C in this fiscal year. GCOM-C equips Second-generation Global Land Imager (SGLI) as core sensor. Since SGLI can observe nadir and offnadir angle with along track direction simultaneously, it is expected to retrieve forest Above Ground Biomass (AGB) using bi-directional spectral data.

For the estimation of forest AGB, difference of bi-directional reflectance of each observation angle caused by forest canopy structure will be key information. Authors have been developed basic AGB estimation algorithm for SGLI. This algorithm is based on the empirical model related to the relationship between reflectance shift on the Red-NIR plane for different viewing angle and AGB. Since the algorithm requires the bi-directional reflectance on fixed observation geometry, we have also developed bi-directional reflectance simulator, BiRS, which employ not only sun-target-sensor geometry but also forest structure based on canopy structure model.

In this paper, a preliminary result of ARG estimation using MODIS multipass composite data is described. The preliminary result meets good estimation accuracy on the area that has Biomass validation data. As the result of comparison between NDVI value and normalized AGB shows the fact that NDVI cannot describe forest AGB.

Furthermore, validation plans of SGLI AGB product will be introduced including non-direct AGB measurements using terrestrial / aerial LiDAR and Structure from Motion technology.

キーワード：Second Generation Global Imager (SGLI)、Multi-angular observation、Forest canopy、Biomass Estimation
Keywords: Second Generation Global Imager (SGLI), Multi-angular observation, Forest canopy, Biomass Estimation