Retrieving leaf area index and fraction of absorbed photosynthetically active radiation using GCOM-C/SGLI data

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The Japan Aerospace Exploration Agency (JAXA) will launch the Global Change Observation Mission - Climate (GCOM-C) satellite. We developed the algorithms for retrieving the Leaf Area Index (LAI) and the fraction of Absorbed Photosynthetically Active Radiation (fAPAR), which will be produced and distributed as one of the GCOM-C standard land products by JAXA. In this document, we introduce the methods for retrieving them.

LAI and fAPAR were estimated based on the look-up tables showing the relationships between Normalized Difference Vegetation Index (NDVI) data and the LAI or fAPAR. They were retrieved by comparing the values of multi-angle NDVIs derived from satellite and from the look-up tables for each sun and satellite geometries. The multidirectional observation capability is one of the feature of the Second generation GLobal Imager (SGLI) onboard the GCOM-C satellite. The look-up tables were produced for each solar and view zenith angles and relative azimuth angle. The relationships among LAI, fAPAR and multi-angle NDVIs were estimated for 6 kinds of land cover types. They were adjusted to fit with the collected in-situ reference data. The data from several databases such as VALERI and BIGFOOT were used as in-situ reference data.

The relationships among LAI, fAPAR and NDVIs were simulated using a radiative transfer simulator, the Forest Light Environmental Simulator (FLiES) [1]. It simulates radiative transfers in the forests and grasslands based on the Monte Carlo method. The inputs of the FLiES were the reflectance and the transmittance of canopy leaves and understory vegetation, the reflectance of stems and soils, the leaf area density (LAD) of tree canopies, the non-photosynthetic bark area density (BAD) of trees, and the forest landscape data. The forest landscape data were the total number of trees, the geometric shapes of the trees, and the positions, radius and the heights of the trees.

The accuracy of the retrieved LAI and fAPAR will be assessed using the in-situ observation data which will be collected at several sites on global after the launch of the GCOM-C satellite. In this research, the MODIS reflectance data were used for the satellite data for producing the look-up tables, because the GCOM-C satellite has not been launched yet. The look-up tables will be revised to fit with the SGLI data after the launch of the GCOM-C satellite.

[1] H. Kobayashi *et al.*, A coupled 1-D atmosphere and 3-D canopy radiative transfer model for canopy reflectance, light environment, and photosynthesis simulation in a heterogeneous landscape, *Remote Sensing of Environment*, **112** (2008), 173-185.

Keywords: LAI, fAPAR, NDVI, MODIS

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Atmospheric Correction Inter-comparison Exercise (ACIX)

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The free and open data access policy to Landsat-8 (L-8) and Sentinel-2 (S-2) satellite imagery has encouraged the development of atmospheric correction (AC) approaches for generating Bottom-of-Atmosphere (BOA) products. Several entities have started to generate (or plan to generate in the short term) BOA reflectance products at global scale for L-8 and S-2 missions. To this end, the European Space Agency (ESA) and National Aeronautics and Space Administration (NASA) have initiated an exercise on the inter-comparison of the available AC processors. The results of the exercise are expected to point out the strengths and weaknesses, as well as communalities and discrepancies of various AC processors, in order to suggest and define ways for their further improvement.
In particular, 11 atmospheric processors from five different countries participate in ACIX with the aim to inter-compare their performance when applied to L-8 and S-2 data. All the processors should be operational without requiring parametrization when applied on different areas. A protocol describing in details the inter-comparison metrics and the test dataset based on the AERONET sites has been agreed unanimously during the 1st ACIX workshop in June 2016. In particular, a basic and an advanced run of each of the processor were requested in the frame of ACIX, with the aim to draw robust and reliable conclusions on the processors’ performance. The basic run includes the correction of Rayleigh and aerosol scattering, gas absorption and adjacency effects (only for the processors, it could not be omitted). In the optional run, the participating teams can include all the corrections involved in their AC approaches. The protocol also describes the comparison metrics of the aerosol optical thickness and water vapour products of the processors with the corresponding AERONET measurements. Moreover, concerning the surface reflectances, the inter-comparison among the processors is defined, as well as the comparison with the MODIS surface reflectance and with a reference surface reflectance product. Such a reference product will be obtained using the AERONET characterization of the aerosol (size distribution and refractive indices) and an accurate radiative transfer code. The inter-comparison outcomes will be presented and discussed among the ACIX participants in the 2nd ACIX workshop, which will be held on 11-12 April 2017 (ESRIN/ESA). The proposed presentation is an opportunity for the user community to be informed about the ACIX results and conclusions.

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Spatial Representativeness and Scaling of Spectral Vegetation Indices Across Landsat, MODIS, and VIIRS

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A large number of tower sites are equipped with optical sensors, acquiring high-quality, continuous remote sensing data. High-temporal resolution vegetation index (VI) time series data are often derived from these near-surface remote sensing data and used for characterizing seasonal changes in site-level leaf area index and evaluating the quality of satellite products such as land surface phenology or VIs by inter-comparison of their temporal trends. One issue associated with these inter-comparisons is the spatial representativeness of in situ (Tower) VI data. Tower optical sensors’ field-of-views (FOVs) are often smaller than the spatial resolution of coarse resolution satellite sensors, such as Moderate Resolution Imaging Spectroradiometer (MODIS) and Visible Infrared Imaging Radiometer Suite (VIIRS). Likewise, “ratio-based” VIs such as the normalized difference vegetation index (NDVI) are not scale-invariant as they involve a non-linear transformation of band reflectances. In this study, we assessed the spatial representativeness and scaling uncertainty of Tower VI data for their inter-comparisons with MODIS and VIIRS VI time series data. Two contrasting AmeriFlux sites in terms of vegetative cover conditions were selected, for which Landsat Operational Land Imager (OLI) data were obtained along with USGS National Land Cover Data (NLCD). The OLI image data and NLCD land cover data were spatially aggregated to produce VIs and major vegetation cover types, respectively, at various pixel sizes, including Tower ground FOV footprint, 250 m, 375 m, 500 m, 750 m, and 1 km. Several statistical measures were employed to quantify the spatial representativeness of Tower VIs for MODIS and VIIRS pixels and to quantify the magnitude of VI scaling uncertainties across these pixel sizes. Preliminary results of the analysis will be presented.

Keywords: NDVI, EVI, EVI2, scaling uncertainties, spatial representativeness

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A Generic Approach For Inversion And Validation Of Surface Reflectance Over Land: Application To Landsat 8 And Sentinel 2.

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This paper presents a generic approach developed to derive surface reflectance over land from a variety of sensors. This method relies on the inversion of the radiative transfer equation in the Lambertian case, with no adjacency effects, that account for a simplified coupling of the absorption by atmospheric gases and scattering by molecules and aerosols as implemented in the 6SV radiative transfer code. The processing code relies on look-up tables generated by 6SV, for which the accuracy (˜1%) has been well documented in several papers. The code uses ancillary data such as pressure and gas concentrations but relies on a per pixel inversion of the aerosol properties to assure the best possible accuracy for the surface reflectance, as aerosols can be highly variable both in space and time. This new aerosol inversion builds on the extensive dataset acquired by the Terra platform, combining MODIS and MISR to derive an explicit and dynamic map of band ratio’ s between blue and red channels and is a refinement of the operational approach used for MODIS and LANDSAT over the past 15 years. The aerosol inversion is generic and applicable to a variety of sensors. We use this approach to derive Landsat 8 and Sentinel 2 surface reflectance products. We then present the validation approach and results using AERONET data. Finally, we conclude by analyzing the consistency of the time-series of surface reflectance combining both sensors over agricultural areas and exploring the potential application of this new product.

Keywords: radiative transfer, aerosol, surface reflectance

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GEOGLAM Asia-RiCE initiative

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The Asia-RiCE initiative (http://www.asia-rice.org) has been organized to enhance rice production estimates through the use of Earth observation satellites data, and seeks to ensure that Asian rice crops are appropriately represented within GEO Global Agriculture Monitoring (GEO-GLAM) to support FAO Agriculture Market Information System (FAO-AMIS). Asia-RiCE is composed of national teams that are actively contributing to the Crop Monitor for AMIS and developing technical demonstrations of rice crop monitoring activities using both Synthetic Aperture Radar (SAR) data (Radarsat-2 from 2013; Sentinel-1 and ALOS-2 from 2015; TerraSAR-X, Cosmo-SkyMed, RISAT, and others) and optical imagery (such as from MODIS, SPOT-5, Landsat, and Sentinel-2) for 100x100km Technical Demonstration Sites (TDS) as a phase 1 (2013-2015) in Asia. with satellite –based cultivated area and growing stage map.

The Asia-RiCE teams are also developing satellite-based agro-met information for rice crop outlook, crop calendars and damage assessment in cooperation with ASEAN food security information system (AFSIS) for selected countries (currently Indonesia, Thailand, Vietnam, Philippine, and Japan; http://www.afsisnc.org/blog), using JAXA's Satellite-based MonItoring Network system as a contribution to the FAO AMIS outlook (JASMIN) with University of Tokyo (http://suzaku.eorc.jaxa.jp/cgi-bin/gcomw/jasm/jasm_top.cgi).

From 2016 as a phase 2, Asia-RiCE initiative deploy up-scaling activity from a province (100x100km) to major crop areas or entire country to implement operational use for rice crop production information in low Mekong, Vietnam and top 10 provinces in Indonesia using space based technology in cooperation with VAST, VNSC, CESBIO, MOA/Indoensia, LAPAN and JAXA.

This paper reports this year activity of 2016 accomplishment and way forward.

Keywords: GEOGLAM, Asia Rice, ALOS-2, food security

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