(updated on 06-Jun-2012)

VEGETATION FRACTION (VF) AND NORMALIZED DIFFERENCE VEGETATION INDEX (NDVI) PRODUCTS BY USING OCM2 SENSOR DATA

FOR BHUVAN NOEDA

S D A P S A

NATIONAL REMOTE SENSING CENTRE

Introduction

Vegetation fraction (VF) is defined as the percentage or fraction of occupation of vegetation canopy in a given ground area in vertical projection. It is popularly treated as a comprehensive quantitative index in forest management and vegetation communities to monitor respective land cover conditions. Field measurement approach has been the traditional method of estimating the vegetation fraction; however, the reliability of such measurements for the vegetation fractional coverage is questionable, besides the high cost. To overcome these, satellite based data are strongly pursued recently.

This document describes briefly monthly Vegetation Fraction (VF) Products realized by using Oceansat-2 Ocean Color Monitor (OCM2) sensor. This is a value added product from OCM2 whose spectral bands are originally designed for ocean color retrieval applications. However, the two-day repetivity with a wide swath of 1420 km and high radiometric resolution of 12 bits per pixel from the OCM2 sensor can provide useful information for agricultural applications. In this document, a brief processing scheme for realizing the VF products at a spatial resolution of 1km (1080m to be precise) is presented. Since the NDVI is an intermediate product generated for the VF products realization, this data is also provided as a product for a given month.

Products Formats Specification

- Image File Format : Geo TIFF
- Projection : Geographic coordinates (Lat., Long.)
- Datum : WGS-84
- Spatial Resolution : 1080m (0.01017 deg)
- Radiometric resolution : 8 bits per pixel
- Correction Level : precision corrected
- Number of bands : 1
- DN-VF conversion rule : VF = (0.5 × DN) (in %)
- DN ï NDVI conversion rule : NDVI = (0.005 × DN) (in float)
- Usable range of DN : 0 ï 200
- Masked Label values : 250 (clouds) and
  240 (NDVI less than 0)
- Image background : 255

File Naming Convention

Image file naming convention contains the following information

- Sensor name
- Product name
- Month of reference
- Year of reference
- Version number

- Sub version number

Examples: ocm2_vf_oct2011_v01_02.tif and ocm2_ndvi_oct2011_v01_02.tif

Features Included in Version v01_02

- Inclusion of Negative NDVI values
- Cloud separation
- Expansion of geographical area (Inclusion of Neighboring countries)

Ocean Color Monitor Sensor

The Oceansat-2 mission was envisaged as the continuity service provider to IRS-P4 data users. Oceansat-2 has onboard 3 payloads, namely, OCM2, Ku-band Scatterometer and ROSA (developed by the Italian Space Agency, ASI). Oceansat-2 was launched into a near polar sun-synchronous orbit of 720 km altitude. The local time of pass is 12 noon + 10 minutes. The OCM2 is an 8-band multi spectral camera operating in the Visible-Near IR Spectral range. This camera provides an Instantaneous Geometric Field of View of 360 m covering a swath width of 1420 km. This wide swath enables the OCM2 to provide a repetivity of 2 days for any given area. For further details, please refer to webpage http://www.nrsc.gov.in and further following links >> Satellite Data/Mapping and >> Missions.

Data Processing

OCM2 Level-1C imagery has been obtained to generate a monthly product. To make genuine representation of the vegetation growth, selection of datasets was ordered and processed for dates of passes around middle of the month. Accordingly, day 15th of each month +/- 3 (4) days were first checked for cloud free conditions up to 99% to select scenes to cover the country boundary. Leaving the monsoon period (June-September), monthly products are realized by following this selection approach. Two steps of data processing are involved: 1) Data preprocessing to prepare the base data, and 2) Generation of intermediate NDVI imagery to realize finally VF products.

Data preprocessing for generating the VF products involves following steps: 1) precision correction of images, 2) cloud masking, 3) sun and view angle effect corrections across the image swath, 4) atmospheric correction to realize top-of-atmospheric reflectance product, 5) generation of image mosaics, and 6) generation NDVI images.

An image based atmospheric correction was chosen, primarily to generate the required inputs from image itself, rather than from other sources and computationally intensive radiative transfer model. The OCM2 sensor being a large swath imaging system has the bi-directional effect and

hence is to be corrected. Cloud screening is essential for the proper utilization of satellite data in the remote sensing of vegetative parameter. Cloud mask algorithm was based on the threshold method using radiance values of bands B1, B3 and B7 bands of the OCM2 sensor. Cloud will reflect part of the incoming solar radiation leading to an increase in the radiance as observed by the sensor in all the bands. The thresholds used to classify a pixel to be cloudy were B1 > 13.8, B3 > 8 and B7 > 14.5 respectively. The algorithm cloud easily screen thick cloud pixel but some of the very thin clouds were identified as clear sky pixels. The Normalized Difference Vegetation Index (NDVI) was computed with NIR (OCM2-B8) and Red (OCM2-B6) bands Top of Atmosphere reflectance data:

$$NDVI = \frac{\rho_{NIR} - \rho_R}{\rho_{NIR} + \rho_R} = \frac{\rho_{B8} - \rho_{B6}}{\rho_{B8} + \rho_{B6}}$$

OCM2_NDVI products are at 4-byte float value. In the NDVI product, all pixels with values less than or equal to zero were brought to zero to enhance the variation in vegetation more predominantly.

For estimation of the VF, the mosaic-pixel model suggested by Zu Liang et al. (http://www.isprs.org/proceedings/XXXVII/congress/8_pdf/10_WG-VIII-10/12.pdf) is carried out. The present study attempts to estimate the vegetation fraction only for highly vegetated parts (identified from Land Use Land Cover map) of the country. In the non-vegetation cover area, the vegetation fraction is zero. The vegetation fraction is given by

$$VF = \frac{NDVI - NDVI_0}{NDVI_\infty - NDVI_0}$$

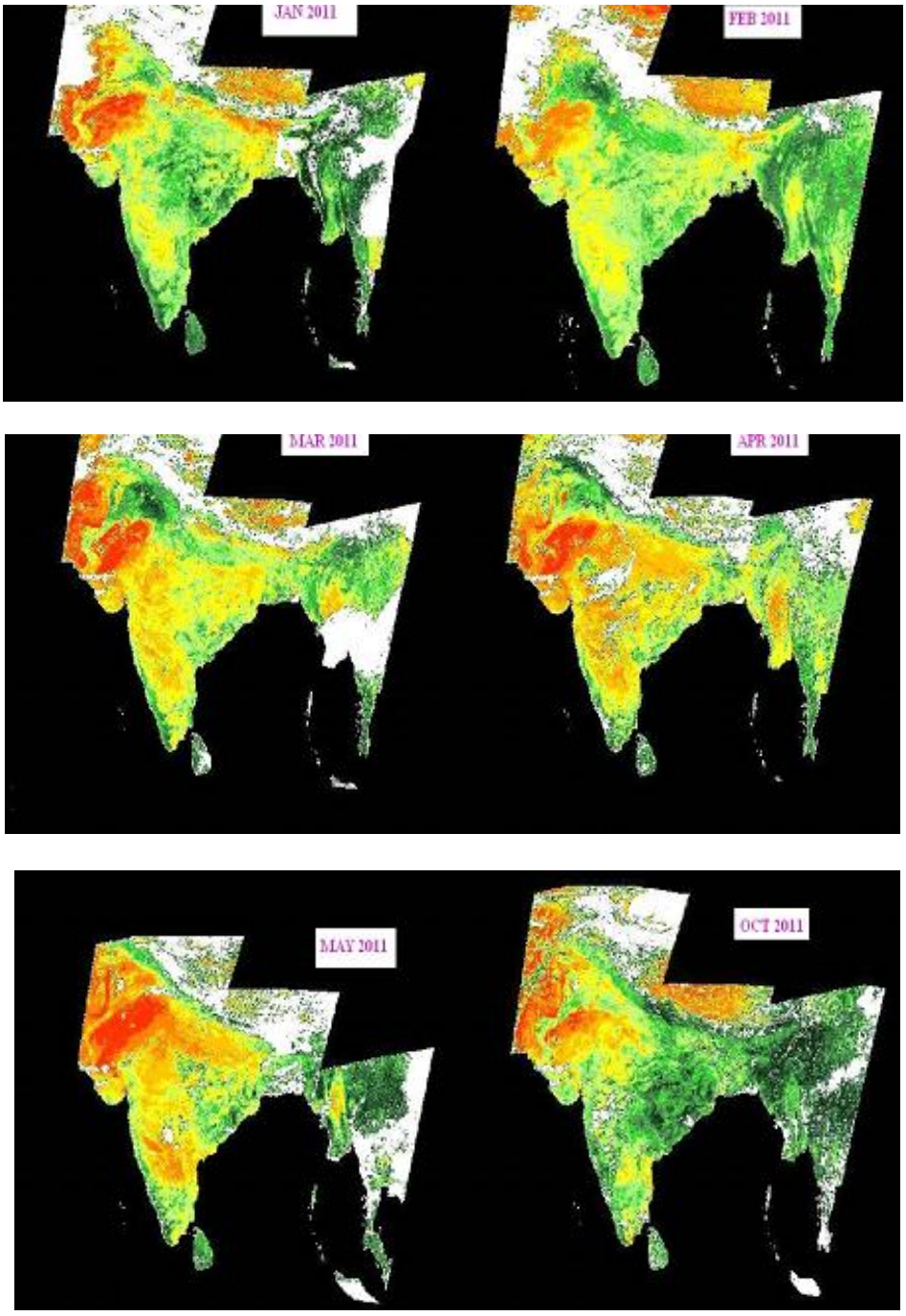
The NDVI is usually sensitive to vegetation. However, NDVI of some special features will be similar to that of vegetation. It is difficult to identify vegetation and non-vegetation areas by using only the NDVI data, and land cover classification map is needed. Land use/land cover (LULC) classification map is used to delineate vegetation areas from the non-vegetated ones. LULC map was available for the entire country at a scale of 1:250, 000. This map can be downloaded from NRSC BHUVAN webpage (http://www.bhuvan.nrsc.gov.in). Using this LULC map a mask was generated to reflect the regions falling into the Kharif, Rabi, Zaid, Double/Triple cropping, Grassland and Shifting cultivation patterns. The mask was laid on each of the the NDVI images to identify the pixels falling into these regions. Histogram of these pixels values was used to determine $NDVI_o$ and $NDVI_\infty$ for each image, taking care to avoid contaminated pixels by leaving 1% into consideration on either ends of the histogram. The vegetation fraction is calculated for all pixels using the global minimum and maximum value obtained from vegetated area. An image mosaic of the VF products for the year 2011 is shown in Figure 1.

Products horizontal Accuracy

Geometric accuracy of the VF and NDVI products is better than 500 m.

Thematic Mapping Accuracy

Though elaborate comparison was not made so far with ground measured vegetation indices, a comparison is made with reference to NDVI products from MODIS sensor data by visually identifying common regions of the images. Mean values of these regions are considered for analysis. Figure 2 shows the correlation plot for three months data between the OCM2 and MODIS products. A good overall correlation between these products is noticed (R^2 = 0.980). The root mean square error (RMSE) between these products is found to be 0.0278, with an overall variation of the OCM2 NDVI products with respect to MODIS NDVI data of about 5.2%.



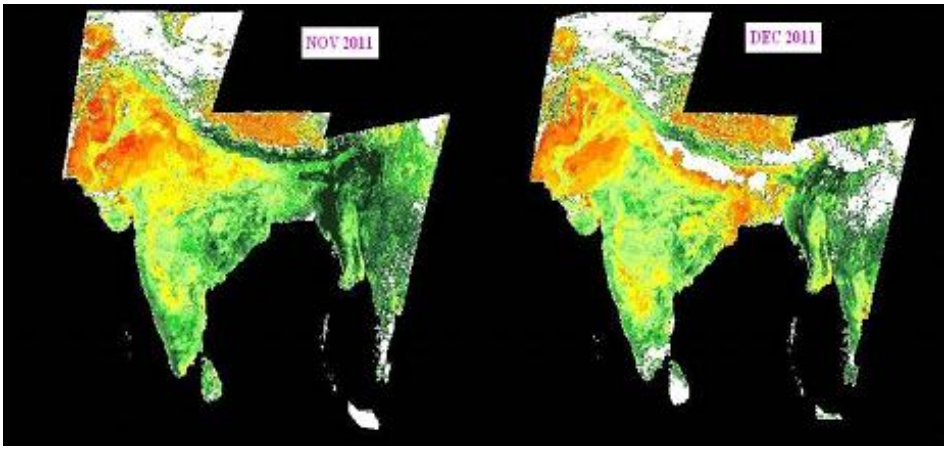


Figure 1. Vegetation fraction maps for the year 2011 by using OCM2 imagery. Here ñredòindicates low and ñgreenòindicates high vegetation fraction values.

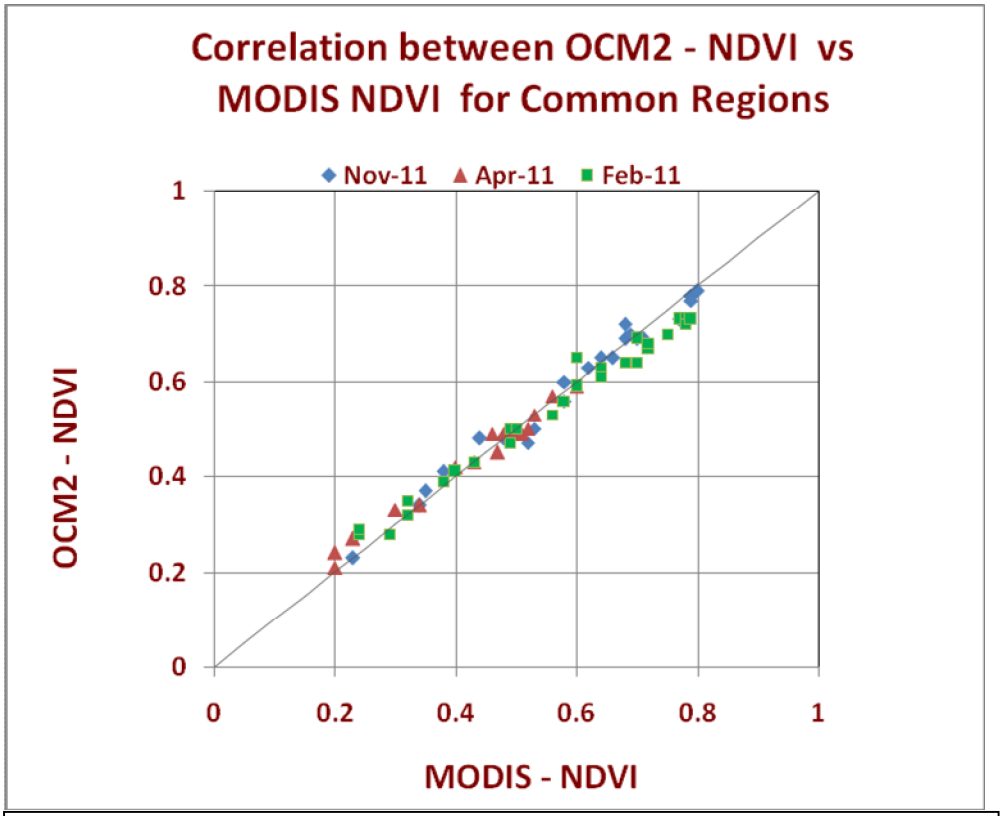


Figure 2 Comparative analysis from common regions of OCM2 NDVI and MODIS NDVI products. The diagonal solid line shows the ideal curve (y=x).