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SNOW FREE LAND SURFACE ALBEDO PRODUCTS FROM OCM2 SENSOR DATA

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S D A P S A

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Introduction

Albedo is a key parameter that is widely used in land- surface energy balance studies, mid- to long-term weather prediction and global climate change investigation. Surface albedo is the ratio of upwelling radiant energy relative to the down-welling irradiance incident upon a surface. As albedo quantifies the capacity of surface to reflect solar radiation it is one of the main driving factors of the energy balance and interaction between land surface and atmosphere. The most relevant albedo quantity for applications related to the energy budget refers to the total short-wave broad-band interval comprising the visible and near infrared wavelength ranges where the solar down-welling radiation dominates. Satellite remote sensing represents the best way to compile such consistent albedo characterizations.

This document describes the Oceansat-2 Land surface Albedo Products version 1.0 derived from the data acquired by Ocean Color Monitor (OCM2) sensor. This is a value added product from OCM2 whose spectral bands are originally designed for ocean color retrieval applications. There are two land surface albedo products, namely board band (0.3-3 µm) albedo and visible albedo (0.3- 0.7µm) both of which are 15 days composite product. Since OCM bands saturate for snow, permanent snow regions are masked in the product. In this document, a brief processing scheme for realizing the land surface albedo products at a spatial resolution of 1km (1080m to be precise) is presented.

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-Vis Albedo conversion rule : Vis Albedo = DN/500(in float)
- DN – BB Albedo conversion rule : BB Albedo = DN/500(in float)
- Usable range of DN : 0 – 200
- Masked Label values : 250 (clouds and cloud shadow)
- Permanent Snow region : 240
- Image background : 255 (outside country boundary)

File Naming Convention

Image file naming convention contains the following information:

- Sensor name
- Product name
- Month of reference

- Year of reference
- Version number

Examples: ocm2_albedo_jan2013_v01_01.tif and ocm2_valbedo_jan2013_v01_01.tif

Data Processing

OCM2 Level-1C imagery has been used to generate fortnightly composites of snow free land surface albedo products. Data preprocessing for generating the albedo products involves following steps: 1) precision correction of images, 2) image-based atmospheric correction to realize surface reflectance 3) sun and view angle effect corrections across the image swath, 4) cloud and cloud shadow masking 5) conversion of spectral albedo to broad band albedo, 6) compositing of images 7) generation of image mosaics.

Narrowband to Broadband Albedo Conversion

The Broadband (BB) surface albedo is determined for the entire short-wave range (0.3-3μm), satellite sensors provide only filtered albedo for some narrow spectral regions. If a surface is assumed to be Lambertian, the retrieved surface reflectance of different spectral bands is equivalent to surface spectral albedo. The broadband surface albedo is calculated form narrowband satellite data by integrating band reflectances across the short wave spectrum(Masahiro Tasumi,2008 et. al) as given in eq (1).

$$\alpha = \sum_{b=1}^{8} \left[\rho_b \bullet w_b \right] \qquad \text{----------- (1)}$$

Where ρ_b is the surface reflectance of band b (b=1, 2…8 for OCM2 sensor) and w_b is the weighting coefficient representing the fraction of at surface solar radiation occurring within the spectral range represented by a specific band as given in eq. (2)

$$w_b = \frac{\int_{LW_b}^{UW_b} R_\lambda \, d\lambda}{\int_{0.3}^{4.0} R_\lambda \, d\lambda} \qquad \text{----------- (2)}$$

Where R_λ is the at-surface spectral hemispherical solar radiation for wavelength λ and UW_b and LW_b are the upper and lower wavelength bounds for band b.

The weighting coefficients were computed with the inclusion of all wavelength regions that occurs between sensor bands. Broad band albedo was computed for the region 0.3- 3 µm and the visible albedo was computed for the region 0.3-0.7 µm. The regions between satellite bands were arbitrarily divided between band edges as shown in Table1 below.

Band	OCM2 Band limit	Applied low and up bounds for BB Albedo	Applied low and up bounds for Vis Albedo
1	0.403-0.429	0.3-0.43	0.3-0.429
2	0.429-0.455	0.43-0.46	0.429-0.465
3	0.478-0.5	0.46-0.5	0.465-0.5
4	0.5-0.524	0.5-0.53	0.5-0.535
5	0.545-0.569	0.53-0.588	0.535-0.588
6	0.606-0.633	0.588-0.68	0.588-0.7
7	0.725-0.763	0.68-0.8	NA
8	0.843-0.89	0.8-3.0	NA

Table1. OCM2 Band Widths and Ranges for lower and upper wavelength bounds

The weights for the conversion of spectral albedo to broad band and visible albedo were computed using 6S atmospheric correction code (Wenjinh Zhao, 2000 et. al,) .Snapshots of the pseudo color BB albedo and visible albedo images for the month Jan2013 is shown in Fig.1. The color map that is used to generate the pseudo color is shown in Fig. 2.

Compositing of Albedo Images

The objective of compositing is to maximize the clear sky pixels for the calculation of albedo. Clouds tends to increase the signal received at the satellite level, selecting smallest value will tend to minimize the impact of undetected clouds. Also cloud shadow on the other hand tries to minimize the value received signal. Hence to arrive at clear sky pixels in the 15-day composite image, we have opted second minimum albedo compositing criteria for the temporal scenes with the assumption that cloud shadow pixel exists at most once during a compositing period (15 days).

Products horizontal Accuracy

Geometric accuracy of the snow free land surface albedo products is better than 500 m.

Thematic Mapping Accuracy

BB albedo and visible products derived from OCM2 data were validated using MODIS albedo products. OCM albedo products (at 360 m) were resampled to 500m to compare with MCD43A3 16 day composite products. MODIS actual sky albedo is determined by interpolation between black sky and white sky albedo as a function of diffuse sky light. Figure 3 shows the correlation plot for four months data between the OCM2 and MOD43 BB products. A good overall correlation between these products is noticed ($R^2 \sim 0.90$). Figure 4 shows the correlation plot for four months data between the OCM2 and MOD43 visible albedo products. Overall correlation of more than 0.96 is observed.

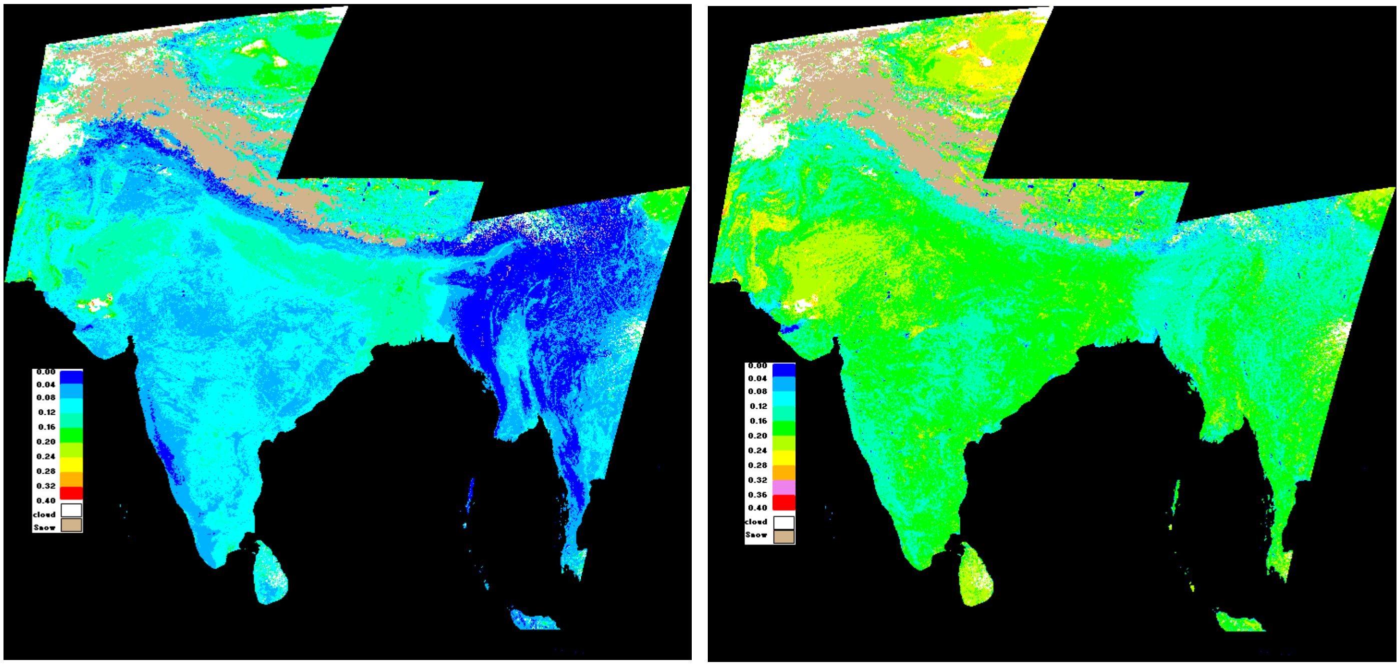

Figure 1. Pesudo color Albedo images for jan'13 . Left image is the visible albedo and right image is BB albedo. Cloud and cloud shadow are masked and white in color. Permanent snow regions are given tan color

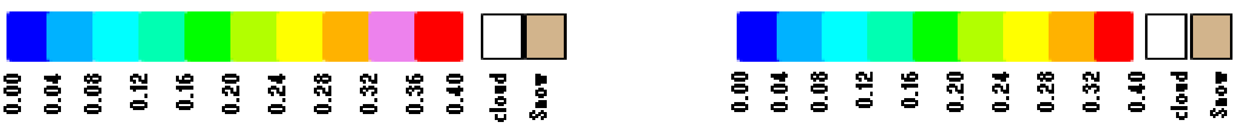

Figure 2. Color Map used to generate the pseudo color. Left one is for visible albedo and the right one is for BB albedo

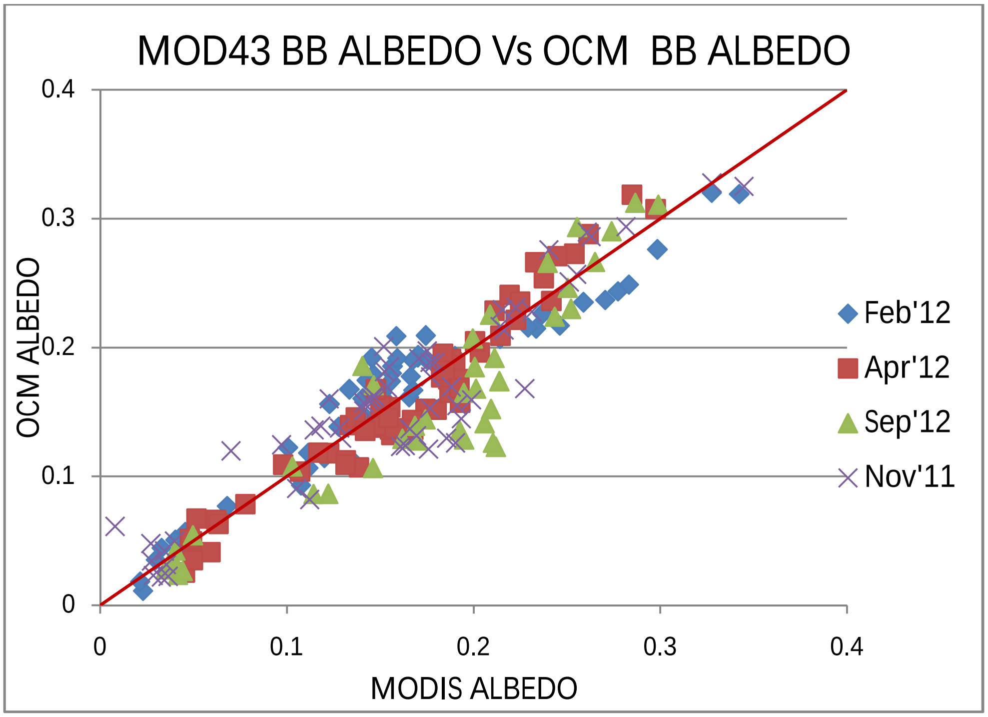

Figure 3 Comparative analysis from common regions of OCM2 BB albedo with MCD43 albedo products. The diagonal solid line shows the ideal curve (y=x).

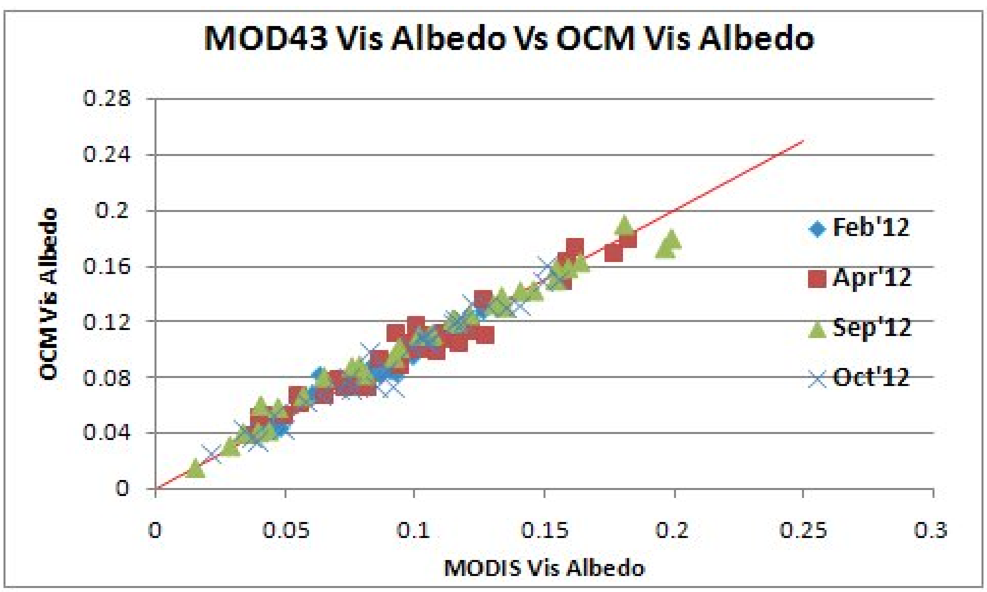

Figure 4 Comparative analysis from common regions of OCM2 visible albedo with MCD43 visible albedo products. The diagonal solid line shows the ideal curve (y=x).

References

1. Masahiro Tasumi, Richard G. Allen and Ricardo Trezza (2008). “At-Surface Reflectance and Albedo from Satellite for Operational Calculation of Land Surface Energy Balance.” Journal of Hydrologic Enginerring vol.13(2) pp.51-63.

2. Wenjing Zhao, Masayuki Tamura and Hidenori Takahashi (2000). “Atmospheric and Spectral Correction for estimating surface albedo from satellite data using 6S code. ‘ Remote Sensing of Environment Vol..76 pp.202-212.