The temporal scale research of MODIS albedo product authenticity verification

Yongxing Cao[1], Zhihang Xue[1], Hui Cheng[2], Yajv Xiong[2], Yunping Chen[2], Ling Tong[2]

[1] Electric Power Research Institute of Sichuan, Chengdu, China
[2] University of Electronic Science and Technology of China, Chengdu, China

E-mail: xyj0943@163.com

Abstract. This study introduces a method that normalizes the inversed ETM+ albedo to the local solar noon albedo for the temporal scale of the MODIS albedo validation. Firstly, the statistical relation model between the surface albedo and the solar elevation angle was set up, and then deducing relationship between ETM+ albedo and the solar elevation angle, so the ETM+ albedo at local solar noon could be got. Secondly, the ground measurement albedo at the local solar noon was used to assess the inversed ETM+ albedo and the normalized albedo. The experiment results show that the method can effectively improve the accuracy of product certification.

1. Introduction

In remote sensing products, land surface albedo is one of the most important parameters to evaluate the earth's energy budget. Albedo is defined as the ratio of outgoing to incoming radiation at the Earth's surface. In order to understand and characterize the fluxes of energy at the Earth's surface, albedo must be known as accurately as possible [1].With the launch of the Moderate Resolution Imaging Spectrometer (MODIS) instrument aboard the NASA Terra platform in December 1999, a new capability for deriving moderate resolution estimates of broadband albedo was initiated [2]. Validating these land surface products is important because their accuracy is critical to the scientific community for various applications. Any feedback from the validation activity will also help improve the generation of these products [3].

The traditional validation method assesses the uncertainties of the albedo product by comparing it with field measurements [4-5]. However, the result of this method is suspicious because MODIS pixels cover larger areas than in situ measurements [6-7]. In order to reduce the effect of the scale

mismatch, we use the ETM+ as the medial data in the validation procedure. But the ETM+ and MODIS are not synchronous at temporal scale. In the former validation the main concern is the spatial scale, The MODIS albedo products represent albedo at the local solar noon and the inversed ETM+ albedo products represent albedo the satellite passby. The abledo is changed in one day from dawn to dark as the solar elevation angle changed [8]. So normalizing the inversed ETM+ albedo to the local solar noon albedo is a necessary method to reduce the error in the validation procedure.

In this study the MODIS albedo productions are MCD43B3, the medium resolution image are ETM+ and the ground measurement albedo are from Surface Radiation Budget Network Goodwin Creek, MS station.

2. Methods

In general the Land surface albedo changes accompanying with the solar elevation [8]. The Land surface albedo are showing U-shaped distribution in one day. The Figure 1 shows the albedo variations and the solar elevation angle variations from 9:00 am to 6:00 pm in one day. There is a large different between the albedo at the local solar noon and albedo at dawn or dark. If the Landsat-7 satellite passby at the dawn or dark, the error will be great.

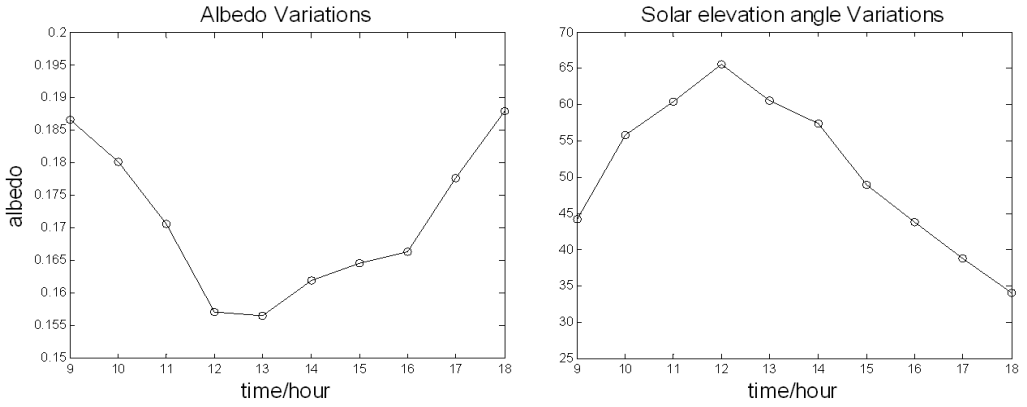

Figure 1. The albedo variations (left) and the solar elevation angle variations (right) in one day.

In this study we set up the statistical relation model between the surface albedo and the solar elevation angle, and then deducing relationship between ETM+ albedo and the solar elevation angle, so we can get the ETM+ albedo at local solar noon. The relationship between albedo and the solar elevation angles are usually given by Partridge. The Formula:

$$\alpha_s = \alpha_0 + (1-\alpha_0)e^{-k\zeta} \quad (1)$$

There the α_s is the surface reflectance and the ζ is the solar elevation angle, the α_0 is the surface reflectance of the height solar elevation angle (at the local noon), the k is the fitting coefficient. The formula is not suit for all conditions, so we simplify the formula to a new one, and give the right at noon solar elevation angle the right k. The formula:

$$\alpha_s = \alpha_0 e^{k/\xi} \quad (2)$$

Here we set up regression relation model in different at noon solar elevation angle. After we get the coefficient *k*, we deduce the albedo at local solar noon.

$$\alpha_o = \alpha_s e^{-k/\xi} \quad (3)$$

Here the α_s is the ETM+ albedo when the Landsat-7 pass-by, the ς is the solar elevation angle, the α_o is the albedo at local solar noon.

Table 1. Coefficient values under different angles in regression formula.

ζ	k	Rlated coefficient	STD	Samples
ζ <=35	3.329	0.832	0.010	43
35< ζ =<55	4.247	0.857	0.006	37
55< ζ =<75	5.832	0.846	0.012	45
ζ >75	6.556	0.876	0.011	45

3. Results & Discussion

Finally, we use the ground measurement albedo at the local solar noon to assess the inversed ETM+ albedo and the normalized albedo. There we take 10 samples in different senson; the solar elevation angle will be cover the whole range. The Figure 2 is the result of the assessment.

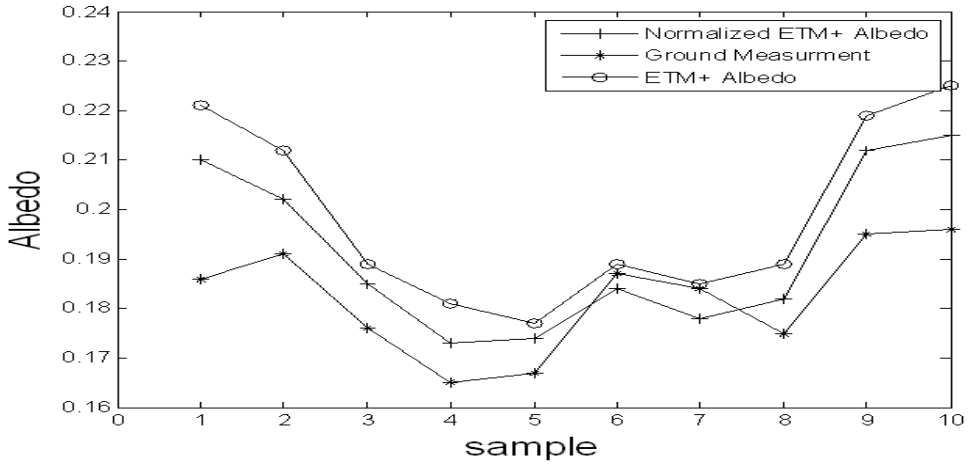

Figure 2. Comparison of normalized albedo and the original inversed albedo and the ground measurement albedo.

In the chart the normalized ETM+ albedo more close to the ground measurement albedo, the inverted albedo when the satellite passby are always large than the real at the local solar noon albedo. So only the normalized ETM+ albedo can represent the at local solar noon albedo, using this albedo will access the MODIS at local solar noon albedo production accurately.

The Figure 3 is the result of the comparison of normalized albedo and the original inversed albedo and the MODIS albedo.

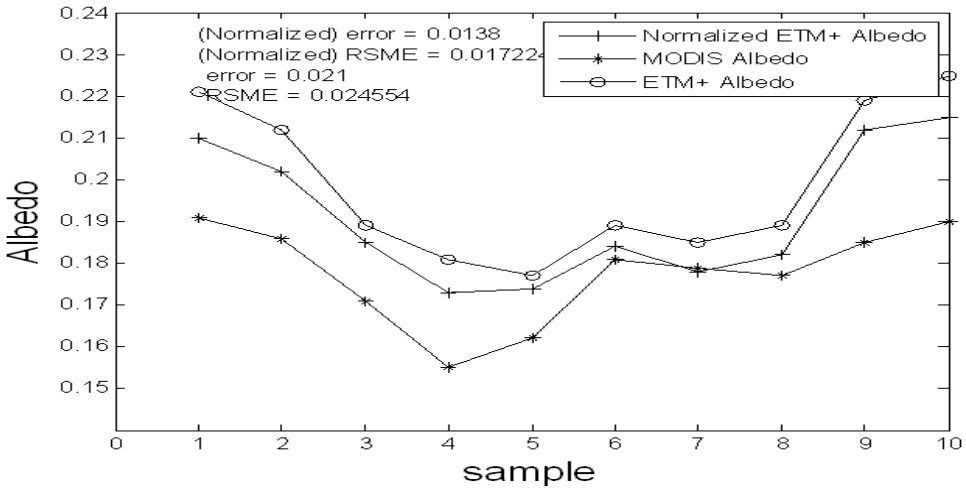

Figure 3. Comparison of normalized albedo and the original inversed albedo and the MODIS albedo.

Using the normalize albedo at local solar noon to access the MODIS albedo the error will be reducing. In this sample the error is reduce 0.0034, about 24% of the error.

4. Conclusions

In this paper, the major concern is the temporal scale of the MODIS albedo validation, According to the ground measurement albedo, we set up the regression model to normalize the ETM+ inversed albedo. The ETM+ albedo is normalized to the local solar noon albedo, it will be the same time as the MODIS albedo production. It will decrease the errors which come from the asynchronous of the two albedo production. The experiment results show that the method can effectively improve the accuracy of product certification.

References

[1] Sellers P J 1992 Remote sensing of the land surface for studies of global change, NASA/GSFC. International Satellite Land Surface Climatology Project Report, Greenbelt, MD, USA.

[2] Schaaf C B, GaoF, Strahler A H, Lucht W, LI X and Privette J 2001 Land surface albedo, nadir BRDF-adjusted reflectance and BRDF product from the Moderate Resolution Imaging Spectroradiometer (MODIS). Proceedings of the 11th Conference on Satellite Meteorology and Oceanography, AMS, Madison, WI, 15–18 October 2001 (Lawrence, KS: Allen Press), pp. 5–21.

[3] Liang S, Fang H, Chen M, Shuey C J, Walthall C, Daughtry C, Morisette J, Schaaf C, and Strahler A 2002 Validating MODIS land surface reflectance and albedo products: Methods and preliminary results, Remote Sens. Environ., 83, 149– 162.

[4] Wang Z, Schaaf C B, Chopping M J, et al 2012 Evaluation of moderate-resolution Imaging Spectroradiometer (MODIS) snow albedo product (MCD43A) over tundra. Remote Sens Environ, 117: 264–280

[5] Peng J J, Liu Q, Wen J G, et al 2014 Multi-scale validation strategy for satellite albedo products and its uncertainty analysis. Science China: Earth Sciences, 45: 66-82

[6] Román M O, Gatebe C K, Shuai Y, et al 2013 Use of in situ and Airborne Multiangle Data to Assess MODIS-and Landsat-Based Estimates of Directional Reflectance and Albedo. Ieee Trans Geosci Remote Sensing, 51: 1393-1404

[7] Wang Z, Schaaf C B, Strahler A H, et al 2014 Evaluation of MODIS albedo product (MCD43A) over grassland, agriculture and forest surface types during dormant and snow-covered periods. Remote Sens Environ, 140: 60-77

[8] Chen J W, Zuo H C, Wang Y, et al 2014 Parameterization scheme about albedo changing with solar altitude angle over different underlying surface in arid areas of Northwest China. Plateau Meteorology, 33(1): 80-88