ESTIMATION OF PIXEL-BASED VISIBLE/NIR BAND RATIO FOR HIGH RESOLUTION AEROSOL RETRIEVAL FROM MODIS IMAGERY

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1. INTRODUCTION

Aerosols are important components of the earth-atmosphere system, which affect climate system, plant photosynthesis, and hydrologic cycle by scattering and absorbing the incoming radiation from the sun, modifying the magnitude and directionality of the downwelling radiation and influencing cloud formation and albedo[1-6]. Epidemiological studies have also shown that small particles in the air, while be inhaled, can penetrate in the lung and cause many adverse health effects [7]. Aerosols, especially dust, are a key contribution to the transportation of nutrients elements to forest and ocean ecosystem and mitigate the function of arid rain [8, 9]. Despite the important role that aerosols play in the earth-atmosphere system, they remain a major uncertainty in modeling, simulation and analysis. This is in part due to the lack of accurate and repetitive observations at global scales since the residence time of aerosols in the atmosphere is short and their distribution and composition are highly variable.

Satellite remote sensing offers a viable means for routinely measuring aerosols over very large areas. Several routinely measuring aerosol products from remote sensing data have been provided to public user, such as those from TOMS, AVHRR and MODIS [10-12]. The signal of satellite is the mixture of earth surface and atmosphere. Retrievals of aerosol properties over ocean from many satellite data have been successful, but it is still a challenge over land to separate the contribution of aerosol from that of land surface reflectance. There are mainly two approaches to estimate aerosol properties over land from single scene satellite data, one is dark-object-based method that is only suitable for dark land surface. Another is multi-temporal composite method which assume the land surface reflectance remain unchanged in several days and the composite data of these days can represent the land surface reflectance in clear-sky condition. This method has been successfully used to estimate aerosol properties in bright land surfaces. However, sometimes it is difficult to find a clear-sky day in composite period, especially in urban region.

In this paper, the pixel-based visible/NIR ratios are determined using ten years' MODIS data. This method assumes that the visible/NIR ratio remains unchanged in same site in same season. For multi-temporal cloudless land pixels, the maximum 65% and the minimum 5% apparent reflectance of blue band pixels are discarded, the

mean value of the rest pixels considered as the ratio of the pixel. After estimation of the ratio of per pixels, the aerosol thickness can be derived from the satellite observation and the geometrical condition.

2. METHOD

It has been demonstrated that the visible/NIR band ratio is stable in certain period [13, 14]. The dark object method assumes the visible/NIR ratio is global constant. For example, MODIS aerosol retrieval algorithm assumes that the land surface reflectance of Blue (B3) and Red (B1) channels can be estimated from the 2.1 μm channel (B7):

$$\rho_{B3} = 0.25\rho_{B7} \qquad \rho_{B1} = 0.50\rho_{B7}$$

However, the visible/NIR ratio is different with land surface, especially the ratio usually grow for brighter, especially artificial surfaces. For example, the ratio in urban area is larger than other surface [15, 16]. Therefore, the pixel-based ratios will improve the aerosol retrieval.

We assume the visible/NIR ratios only depend on the land character and the vegetation coverage. That is, the ratio is constant in a site with same season. The ten years' data in same season is used to estimate the ratio.

In this presentation, the following steps are taken to get the pixel-based visible/NIR ratio.

(1) The pixels in MODIS MOD02 1km files are flagged that cloud, snow/ice. Because the MODIS cloud mask product, MOD35, sometimes failed in sand area, especially in winter. A new mask algorithm is taken to flag them.

(2) The bands 1, 3 and 7 of clear pixels in all MODIS MOD02 1km files during 2000-2009 were corrected for Rayleigh effects;

(3) A the data are gridded to Albers projection with 1km × 1km;

(4) Collecting all ratio in same site and same season, eliminate the 80% maximum value and 5% minimum value, the rest 15% ratio value are averaged as the ratio of this pixel;

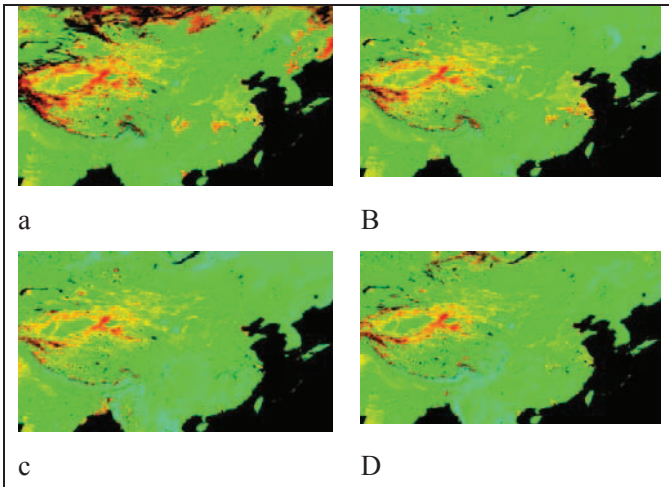
(5) All the pixel is written to HDF format file as the pixel-based ratio database;

(6) Aerosol retrieved based on this ratio database.

3. RESULTS

3.1 The visible/NIR ratio distribution in China

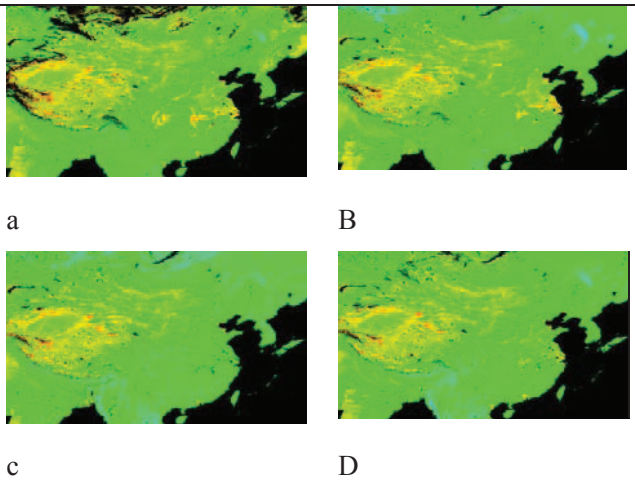
The Band3/Band7 and Band1/Band7 are estimated in China. Figure 1a, 1b, 1c and 1d are the Band3/Band7 ratio distribution on four seasons. Figure 2a, 2b, 2c and 2d are the Band1/Band7 ratio distribution. These figures show that spatial divergences of visible/VIR ratio distribution are large in China. And the urban site is obviously larger than other surfaces. The agricultural lands have large different in season with the vegetation coverage change.



a B

c D

Figure 1. Band3/Band7 ratio distribution



a B

c D

Figure 2. Band1/Band7 ratio distribution

3.2 Aerosol retrieval and validation

These pixel-based visible/NIR ratios were used to retrieve aerosol from MODIS data. Figure 3 is the aerosol retrieved from single granule file of MOD02. Figure 4 is the retrieved aerosol from 2004 whole year to compare with the AERONET measurements.

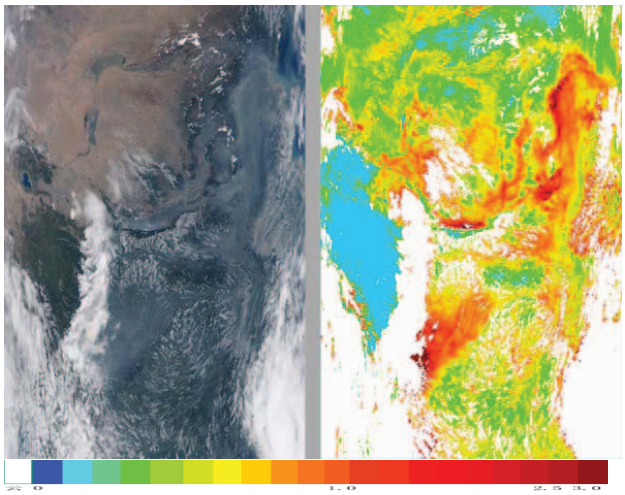


Figure 3 The Aerosol retrieval from MODIS 1km granule

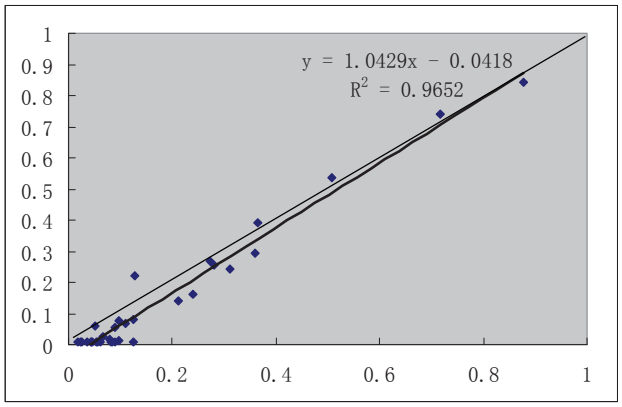


Figure 4 Validation of Aerosol in Beijing AERONET site

5. ACKNOWLEDGMENT

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