BLUE REFLECTANCES CONTRAST OF MODIS IMAGERY: IMPLICATION FOR DUST AND BIOMASS BURNED SMOKE DETECTION

Ronggao Liu[1] *and Yang Liu*[1,2]

[1]Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing, 100101, China
[2]Graduate University of the Chinese Academy of Sciences, Beijing, 100049, China

1. INTRODUCTION

Dust and biomass burned smoke have strong absorption effects on visible and ultraviolet wavelengths which is important for understanding of the Earth radiative budget and small-scale temperature changes. Several dust/smoke detection algorithms as well as products have been developed using satellite observations on visible or ultraviolet channels. It has been demonstrated that the spectral radiance contrast between the 340nm and the 380nm UV channels is very sensitive to absorbing aerosols, especially for desert-mineral dust and smoke. Using these wavelengths, an absorbing aerosol index dataset from the Nimbus-7 Total Ozone Mapping Spectrometer (TOMS) instrument has been produced that provides a long-term record of tropospheric absorbing aerosols over land and ocean [1, 2]. Chiapello et al. [3] developed a similar aerosol index for the detection of mineral dust based on the spectral contrast between the two ultraviolet TOMS channels.

In this presentation, we evaluate the capability of the two blue bands apparent reflectance difference (BRD) of the channel 3(469nm) and 8 (415nm) to identify dust and biomass burned smoke over land and ocean, which is applied to detect atmospheric dust storms several major dust source regions, including the Gobi Desert, the Red Sea, as well as fire smoke in Southeastern Siberia.

2. METHOD

Terra MODIS 1B data over china from 2000 to 2008 were statistically analyzed the BRD distribution of dust and non-dust pixels. The Thermal Infrared Integrated Dust Index (TIIDI) algorithm [4] was applied to MODIS 1B dataset to detect dust pixels which were analyzed the BRD distribution of dust. To retrieve the BRD distribution of non-dust pixels, it was assumed that there is at least one non-dust day in a continuous 10-day time period. All MODIS 1B dataset were gridded and composed to 10-day apparent reflectance by using the minimum selection of blue band apparent reflectance. This composite reflectance would be considered as non-dust apparent reflectances which were analyzed the BRD distribution of non-dust. The results suggest that the BRD of dust and non-dust surface has a normal distribution, with a range of -0.05-0.005 for non-dust and -0.25-0.23 for dust. More than 90% of non-dust BRD is negative. In contrast, most dust pixels have positive BRD. The BRD threshold zero of

MODIS data can differentiate biomass burned smoke and dust from other phenomena. Generally, R3-R8>0 for heavy dust and smoke, while R3-R8 <0 for clouds, surface and haze.

3. EXAMPLES

Several examples of dust storm and biomass burned smoke are used to evaluate the performance of BRD.

3.1 Dust Detection using BRD

The largest sources of atmospheric dust are located in the northern hemisphere, mainly in a belt that extends from the west coast of North Africa, through the Middle East, into Central and South Asia, to China [5]. The "Blue Contrast" dust detection algorithm is applied to detect atmospheric dust storms by using MODIS data over these major dust sources regions.

A dust storm event over the Gobi Desert is applied as an example. The Gobi Desert, located east of the Tarim Basin on the Mongolian Plateau, is a major source of Chinese dust [5]. Figure 1(a) depicts a dust storm in northern China and southern Mongolia using true-color image from the Terra/MODIS captured on March 15, 2002. The dust storm whipped up sand in the Gobi Desert, and the dust cloud curls downwind to the northeast. Aerial dust covers most of the image. Figure 1(b) shows the MODIS BRD image corresponding to Figure 1(a). It can be seen that MODIS BRD can distinguish between sand/dust and land/cloud. Figure 1(c) shows the retrieved AOD map. The BRD image has the same spatial pattern as the AOD distribution. The high BRD area coincides with that of the high AOD, except for the region contaminated by the cloud. A comparison of Figure 2a and 2b shows the benefit of the BRD map over true color images for identifying heavy dust plumes.

3.2 Biomass Burned Smoke Detection using BRD

Smoke from boreal forest fires is prevalent in eastern Siberian during summer. A forest fire in southeastern Siberia on May 14, 2003, is taken as the first example. Figure 2(a) is the true color image from the Terra MODIS sensor captured on the same day. Several fires occurred and resulted in a thick smoke plume that moved southward. Figure 2(b) shows the MODIS BRD image corresponding to Figure 2(a). It can be seen that the smoke signature is extracted from the MODIS observation. Fires were scattered across the Outer Xing'an Mountains in southeastern Siberia. The wind blew the thick smoke plumes south across the Greater Xing'an Mountains to Heilongjiang province. Cloud in the left of the image is detected. Smoke over snow in the north of the image is enhanced clearly due to the high sensitivity of BRD over bright surface. Figure 2(c) shows the retrieved AOD map in this region. The BRD distribution is consistent with that of AOD. The BRD represents smoke intensity, which facilitates identification of fire location and direction of movement.

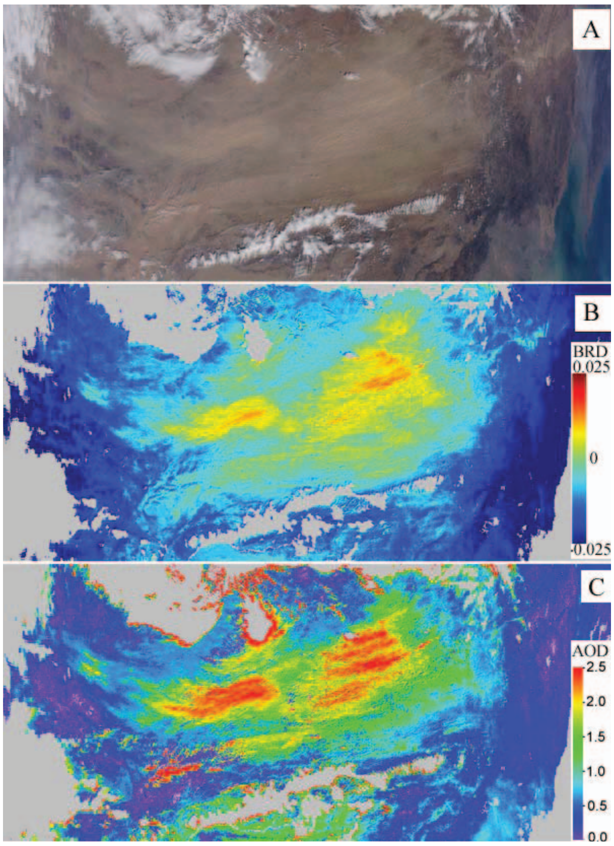

Figure 1. Dust storm in the Gobi Desert, March 15, 2002. (a) Terra MODIS true-color image; (b) Terra MODIS BRD image; (c) AOD map.

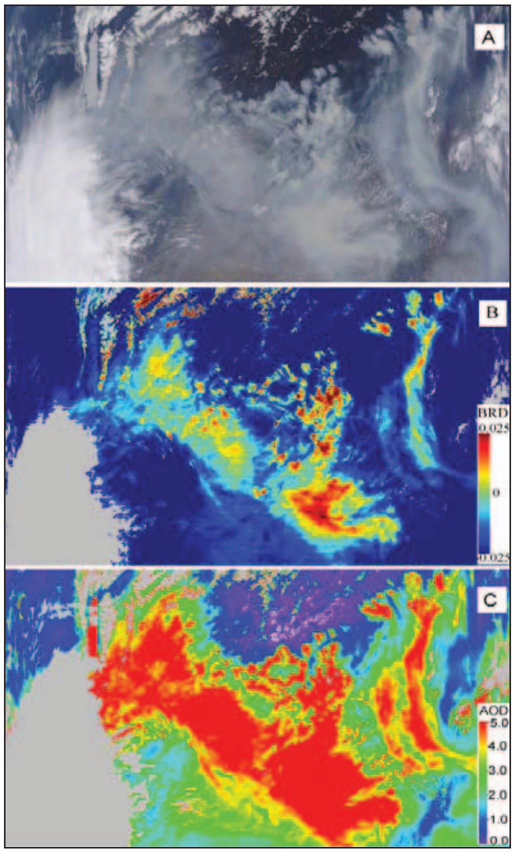

Figure 2. Fire smoke in southeastern Siberia, May 14, 2003. (a) Terra MODIS true-color image. (b) MODIS BRD distribution. (c) AOD map.

5. ACKNOWLEDGMENT

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