

CAPTURE OF YELLOW DUST BLOW BY MODIS DATA

Jie Song

Tokyo University of Information Sciences
1200-2 yatou-cho, Wakaba-ku, Chiba, 265-8501 Japan
songjie@eastbridge.co.jp

JongGeol Park

Tokyo University of Information Sciences
1200-2 yatou-cho, Wakaba-ku, Chiba, 265-8501 Japan
amon@rsch.tuis.ac.jp

Yoshizumi Yasuda

Tokyo University of Information Sciences
1200-2 yatou-cho, Wakaba-ku, Chiba, 265-8501 Japan
yasuda@rsch.tuis.ac.jp

Abstract: Large plumes of yellow sand or yellow dust blow out over the Sea of Japan and the Japanese archipelago from mainland of China. In this study, the methodology to capture the perspective on the large Yellow dust storm by using MODIS data is discussed. As the typical image of yellow sand, MODIS data obtained of April 8, 2002 were used in this study.

Keywords: MODIS, YDI, AVI, Yellow sand

1. Introduction

Every year from March to April, it was observed that the yellow sand, which occurred from inland of China continent, flies to the North Pacific archipelago and the west coast of America in addition to East Asia area. The Meteorological Agency observed yellow sand in the ground in 123 spots in the whole country. As a result, it was observed that a lot of yellow sand in the year 2002 appeared more than year 1967. It was observed that 1141 times from January to November, 2002. Yellow sand was observed at a wide area of western Japan 6 years ago on November 12, 2002. In the year 2002 the characteristic of yellow sand in Northern Japan, were particularly observed repeatedly in each place in Hokkaido in addition to West Japan, an area of Japan Sea side. However, about yellow sand, it is not still understand the development source, development condition of yellow sand, blowing path and quantity of blown yellow sand. Observation done on yellow sand is a method to use sampling network of yellow sand in ground. This satellite observation method is advantageous for it can easily cover a wide area. It was suggested by Asian dust indexes (ADI) to use a near infrared

band and aerosol water vapor index (AVI) to derive thermal infrared. A method by AVI to use two thermal infrared bands is not only yellow sand but also to the desert detected with yellow sand area. In addition, it is pointed out that it is hard to detect yellow sand mixed in clouds. Because ADI is intended for area of the sea it can not be applied in the land area. The true color display of MODIS can easily see the Brown yellow sand. The absorption effect of yellow sand in blue band so it makes yellow sand looks like yellow or brown. It is thought that it can extract yellow sand area with such characteristic. In this case it is necessary to confirm whether suspended matter area of yellow drained detected from desert area and Chang Jiang or the Yellow River resembling the spectrum. It is suggested that an index be calculated by the use of blue band and green band MODIS. The result of the use of the two thermal infrared band of NOAA-AVHRR and method of MODIS was compared.

2. A method of yellow sand extraction by MODIS data

2.1) True-color display

Because of the absorption band of yellow sand is blue, it is effective, and it displays the true-color three bands of MODIS 1(red), 4(green) and 3(blue) by detecting yellow sand when RGB is displayed. As a result, the distribution of state of yellow sand can easily be seen by the naked eye.

2.2) Detection of yellow sand area

2.2.1) In the case of reflectance

In figure 1, x axis is from visible band to short wavelength infrared band of MODIS. y axis is a ratio of reflective value

when it is observed from the satellite. In figure 1, when each substance is compared to band4 (green) and band3 (blue), band3 (blue) is bigger. According to this the quantity of backward scattering of atmosphere in a blue band is bigger than the green band. In spectrum, the yellow sand area of the ratio reflective index of blue band and green band shown in yellow line is lower than the other thing (vegetation or desert). Ratio of blue band and green band can separate the yellow sand area from the other area. Figure 2 is scatter diagram of a reflective index of a sample area. The x axis is band3(blue) and y axis is band4(green) of MODIS. From figure 2, yellow sand can be separated by line from other things such as vegetation and Cloud.

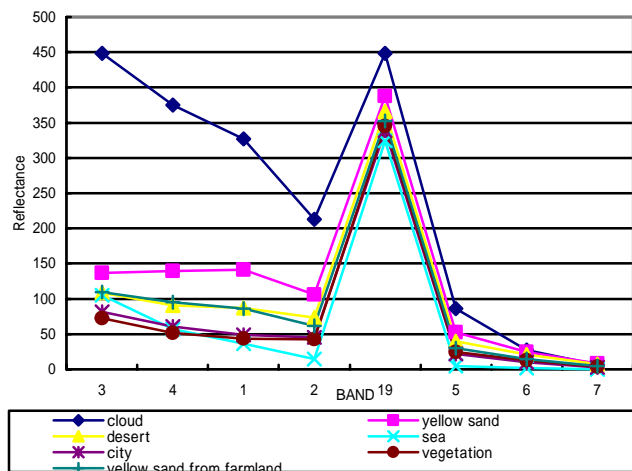


Fig. 1. Reflectance data

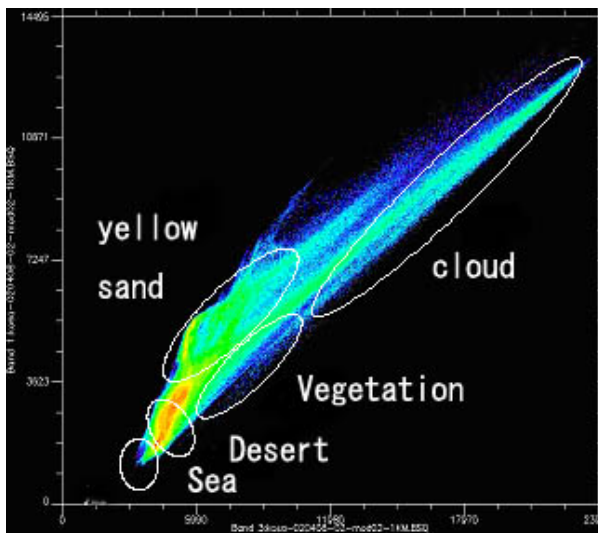


Fig. 2. scatter diagram (band3 and band4)

The line from the starting point has an angle of 45 degrees. The slope is decided by the ratio of blue and green or the normalized difference ratio of blue and green. The YDI (Yellow Dust Index) in this research is defined as follows.

$$YDI(B3,1) = (B3 - B1) / (B3 + B1) \quad \text{by Terra/MODIS}$$

$$YDI(B4,3) = (B4 - B3) / (B4 + B3) \quad \text{by Terra/MODIS}$$

The use of band19 (915 μm to 965 μm) which has water vapor characteristic will emphasize the aerosol. It may be useful method to separate yellow sand.

2.2.2) In the case of emissivity

The difference in image was made by band31 and band32 of Terra/MODIS. Band31 and band 32 is the brightness temperature data. The difference image is the simulation of AVI method. Because discriminate of cloud and soil dust is possible in AVI analysis, it can detect distribution of yellow sand. The AVI which has a thermal infrared band of NOAA/AVHRR data (band4, band 5) is use for yellow sand detection method

$$AVI = ch4 - ch5$$

$$Ch4 : AVHRR-4 \quad (10.3\mu m \sim 11.3\mu m)$$

$$Ch5 : AVHRR-5 \quad (11.5\mu m \sim 12.5\mu m)$$

In this research, AVI was determined as follows.

$$AVI = ch32 - ch31 \quad \text{by Terra/MODIS}$$

$$Ch31 : \text{MODIS バンド 31} \quad (10.780\mu m \sim 11.280\mu m)$$

$$Ch32 : \text{MODIS バンド 32} \quad (11.770\mu m \sim 12.270\mu m)$$

In addition, band27, band28 and band29 were effective to observe water vapor and aerosol and also effective method to separate yellow sand.

3 . Data and Experiment

3.1) Data

The MODIS data used for extraction are as follows.

April 8, 2002 02:43:44 (GMT)

The yellow sand flies from north of Mongolia and passes to the direction of Manchurian and then to Beijing. Dairen city is covered with yellow sand completely. Part of the yellow sand flies from Nakhodka to the direction of Hokkaido.

November 11, 2002 02:37:19 (GMT)

Sand storm occurred on the 10th in Inner Mongolia, China which was caused by the yellow sand that was mixed in the air current. On the 11th, the temperature was lower and the wind was strong so the sand storm became yellow sand. According to the expert of a meteorological observatory in China, a sandstorm to occur in early winter is said to be unusual. Yellow sand was observed by a wide range in Western Japan in November 12, 2002 which the same occurred 6 years ago.

3.2) Detection of yellow sand by YDI method

The sea, vegetation, desert and cloud are Negative value of YDI. Thin yellow sand and yellow sand becomes positive value of YDI. To separate desert and yellow sand the YDI value is 0.0026 because the desert spectrum resembles the yellow sand. It is possible to distinguish yellow sand from

other areas.

3.3) Comparison of YDI method and AVI method

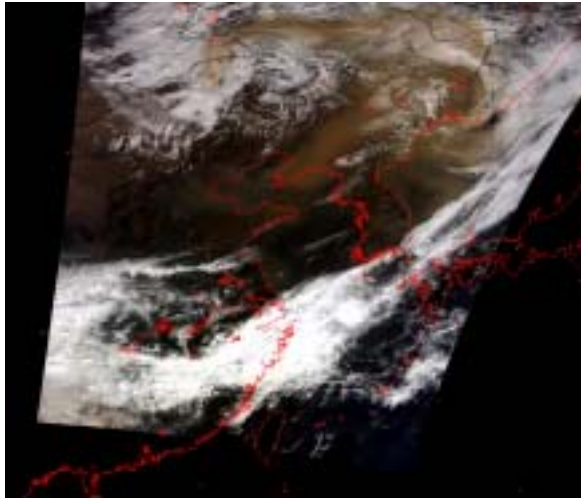


Fig. 3. True-color Image

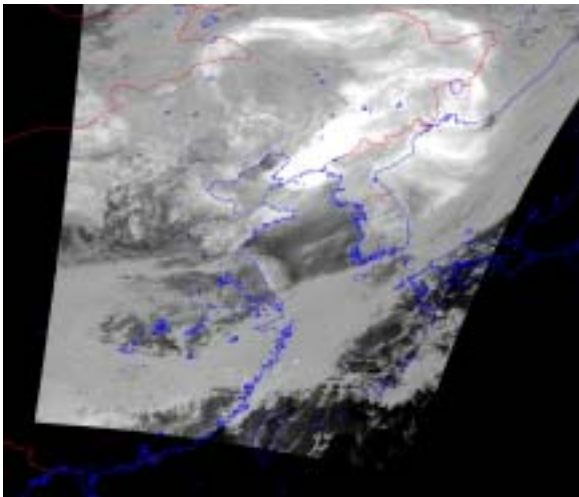


Fig. 4. YDI image

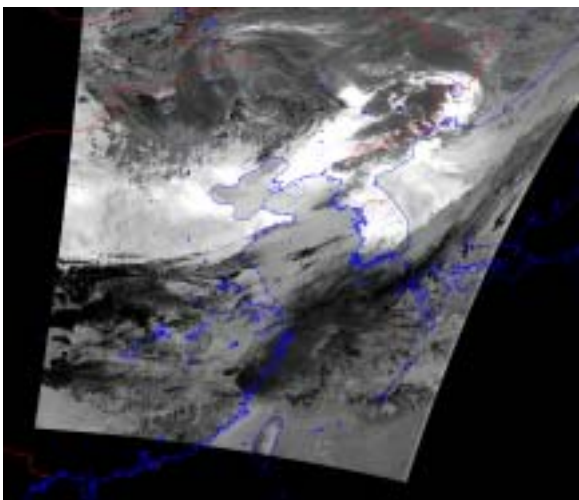


Fig. 5. AVI image

With the true-color image, yellow sand area is clearly extracted (figure 3) Figure 4 is yellow sand area extracted by YDI method. With the true-color image, yellow sand area is

clearly extracted. The result of AVI method is in figure5. The Mixture of a yellow sand and cloud area can not be extracted by AVI method. The extraction of yellow sand image using YDI method is better than AVI. In addition, according to AVI method, the desert area was extracted by yellow sand area.

3.4) Detection of yellow sand by band19 MODIS

With the use of band19 MODIS there is a yellow sand segment extracted from Shanghai area. To confirm, Shanghai area in true-color image is covered with thin cloud.

3.5) Detection of yellow sand by band29 MODIS

As for band29 and band31 Terra/MODIS, they resemble similar characteristic of yellow sand. Therefore band29 and band32 are used to extract yellow sand. As a result, the area of cloud mixed with yellow sand can not be detected the same way as AVI method.

4. Result and discussion

AVI analyzes the difference image of brightness temperature data. Therefore the cloud and soil dust can be detected by the area distribution of yellow sand. YDI method uses R,G,B band which detect yellow sand. It can detect area distribution of yellow sand in YDI method is distinctive. The table1 is the characteristic of YDI and AVI method.

Table1. Characteristics of YDI and AVI

	Desert and Yellow sand	Cloud and Yellow sand	Yellow from Desert	Yellow sand from farmland
AVI	○	×	□	□
YDI	□	□	□	○

□ : Possible

× : Impossible

According to table 1, AVI and YDI has good points and weak points. The AVI weak point is that the area of cloud mixed with yellow sand can not be detected. Tthe YDI weak point is that the thin yellow sand area can not be detected. The future study is to select a band that can extract thin yellow sand.

Acknowledgement

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