IMPROVE PERFORMANCE OF AQUA BAND 6

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ABSTRACT: The Moderate Resolution Imaging Spectroradiometer (MODIS) is a key research instrument for the NASA Earth Observing System (EOS) mission. It was successfully launched onboard the Terra satellite in December 1999 and Aqua satellite in May 2002. Both MODIS instruments have been working well except that detectors in Aqua MODIS band 6 (1.628–1.652 m) are either nonfunctional or noisy. This has been a serious problem for MODIS snow detection and cloud classification, which use band 6 as a primarily data. The main objective of this research is to improve performance of Aqua MODIS band 6 by replace nonfunctional or noisy Aqua band 6 detectors with transformed Aqua band 7 by using polynomial fitting

1 INTRODUCTION

The Moderate Resolution Imaging Spectroradiometer (MODIS) aboard Terra and Aqua platforms is a key research instrument for NASA Earth Observing System (EOS) mission (Barnes 1993, Wang 2006). MODIS sensor has 36 spectral bands covering wavelengths in visible (VIS), near infrared (NIR), short- and midwave infrared (SMIR), and longwave infrared (LWIR). It has three different nadir ground spatial resolution: 0.25 km (band 1-2), 0.5 km (band 3-7), and 1 km (band 8-36). In the along track direction, there are 40 detectors per band from band 1-2 , 20 detectors per band for band 3-7, and 10 detectors per band for band 8-36. MODIS uses a double-sided scan mirror that views onboard calibrators and the earth scene at 20.3 rpm.

The Aqua MODIS instrument has been performing well since its launch with the exception of band 6 (1.628 – 1.652 um). Aqua MODIS band 6 has 15 out of 20 of the accompanying detectors that are either non-functional or noisy (Salomonson 2006, Wang 2006). This is a serious problem for MODIS cloud overlap detection and snow products, which use band 6 as a primarily input.

To continue monitoring snow coverage, MODIS scientists have been using Aqua MODIS band 7 (2.105 – 2.155 um) in replacement for MODIS band 6. Salomonson 2006 and Wang 2006 mention that there is a fairly high correlation between the reflectance of MODIS band 6 and band 7. However the snow reflectance is typically a few percent lower in band 7 than in band 6 (Wang 2006). This difference results in subtle changes in the ability to detect snow and cloud in some situations (Hall 2005).

The objective of this paper is to retrieve Aqua MODIS band 6 based on the relationship between Aqua MODIS band 6 and band 7.

2 METHODS

2.1 Data Collection

In this research, Aqua MODIS data was obtained from the Institute of Industrial Science (IIS), University of Tokyo. The original level 0 data are converted to level1b data by SEADAS software. Level1b data is in HDF-EOS format, which is standard data format of Terra and Aqua MODIS sensors. MODIS data are in the form of 12-bit precision brightness counts and coded to

a 16-bit scale. MODIS images are freely available on the URL http://webmodis.iis.u-tokyo.ac.jp/

2.2 Data processing

To detect noisy detectors, MODIS data is separated into 10 subimages due to the MODIS `s 10-row detector scan. The first line of the original image is assumed to be the first detector and so on. Fig. 1 shows the ten detector subimages separated from Aqua MODIS band 6 taken in April 1, 2006 06:08 GMT. Each detector subimage has 400 pixels by 400 pixels and has been enhanced by histogram equalization. From Fig. 1, it can be seen that Aqua MODIS band 6 has its non-functional detectors on third, sixth, seventh, and ninth. Fig. 1 c, f, g, and i show non-functional detector's images which has 65528 DN as their value.

For retrieving of non-functional detectors, the retrieving algorithm use a gray-level transformation at each pixel of the non-functional detectors in the Aqua MODIS band 6 images. Polynomial regression was used to quantify the relationship between Aqua MODIS band 6 and 7. The gray scale transformation is obtain by using quadratic polynomial fitting of the portion of the image enclosed by a rectangular window surrounding the pixel being processed. Wang, 2006 selected quadratic polynomials for analysis according to high correlation coefficients. The steps involved in Aqua band 6 retrieving algorithm are first to find the relation between Aqua band 7 's pixel and Aqua band 6 's functional pixel of the rectangular region surrounding the pixel being processed. From this local relation, a quadratic polynomial equation is then determined. The polynomial equation transform Aqua MODIS band 7 to Aqua MODIS band 6 that determines the gray-level values of the center pixel. The rectangular window is then slid over to the next pixel and the above procedure is repeated.

3 RESULTS

As an example of the results acquired from our retrieving method, this study selects a whole image data of Aqua MODIS received in April 1, 2006 06:08 GMT (1354 pixels by 4740 pixels). Retrieving result of MODIS images All image groups shown here have been enhanced by histogram equalization. The results show that retrieval algorithm perform well. This keeps data continuity and consistency of Aqua MODIS snow products and cloud classification.

4 CONCLUSION

This letter demonstrated an approach of retrieving Aqua MODIS band 6 using the polynomial relationship between Aqua MODIS bands 6 and 7. This is because MODIS bands 6 and 7 are highly correlated and the relationship is stable. The results show that retrieval algorithm perform well.

Wang 2006 mentioned that the relationship between these two bands depends on many factors, such as land cover types, spectral characteristics, and scan geometry. Retrieval accuracies are functions of surface type, band and sensor viewing geometry, etc. For further understanding of the relationship between MODIS bands 6 and 7, analysis of the retrieval algorithm should account for above factors.

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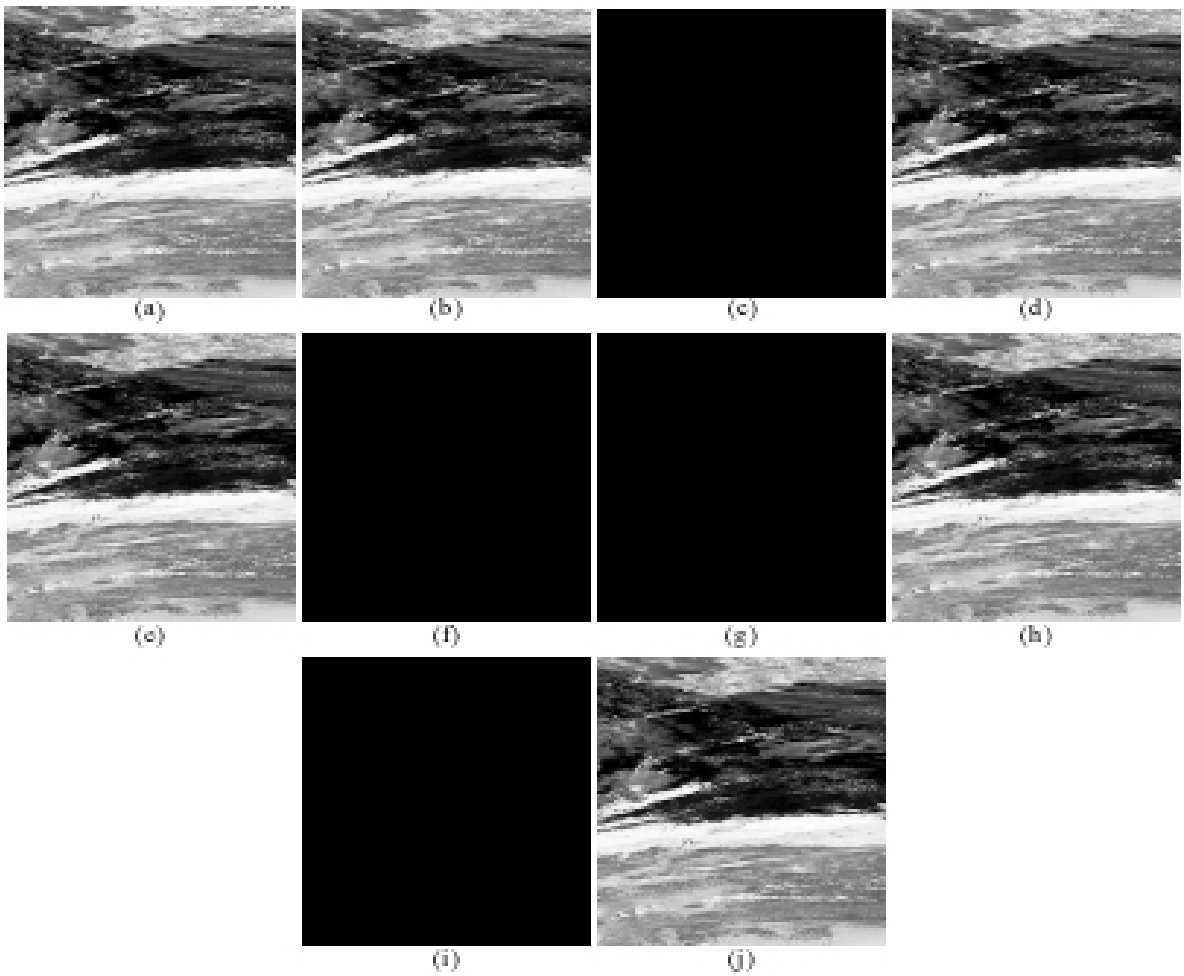
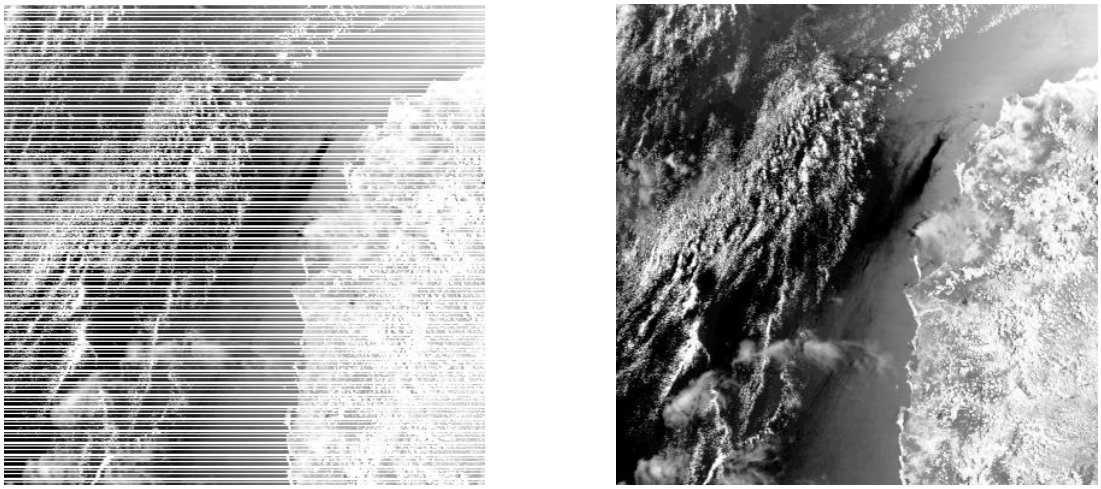
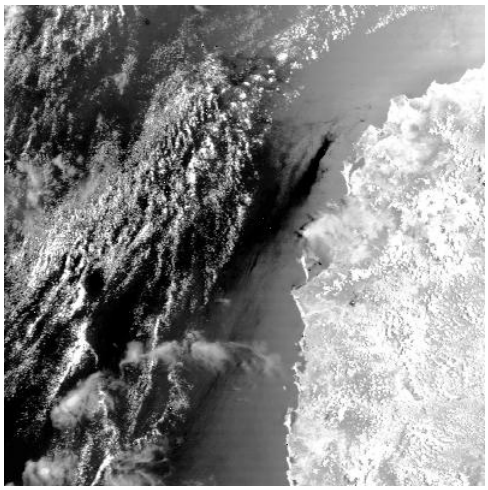


Figure 1: The ten detector subimages separated from Aqua MODIS band 6 taken in April 1, 2006 06:08 GMT. Each detector subimage has 400 pixels by 400 pixels.: (a) 1st detector subimage, (b) 2nd detector subimage, (c) 3rd detector subimage, (d) 4th detector subimage, (e) 5th detector subimage, (f) 6th detector subimage, (g) 7th detector subimage, (h) 8th detector subimage, (i) 9th detector subimage, (j) 10th detector subimage,



(a) (b)



(c)

Figure 2: Aqua MODIS subimage. Area is 400 pixels by 400 pixels (400 km by 400 km). Image was taken in April 1, 2006 06:08 GMT: (a) band 6 before retrieving, (b) band 7, and (c) band 6 after retrieving

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