DEVELOPMENT OF MTSAT DATA PROCESSING, DISTRIBUTION AND VISUALIZATION SYSTEM ON WWW

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ABSTRACT

Abstract: This research focuses on a network based data distribution and visualization system of Multi-functional Tranport SATellite (MTSAT). Institute of Industrial Science (IIS) and Institute of Earthquake Research Institute (ERI) both at University of Tokyo have been receiving, processing, archiving and distributing of MTSAT imagery with a direct receiving of High Rate Information Transmit (HRIT) since October 2006. A software package, `mtsatgeo`, is developed including radiometric correction, geometric correction and spatial subset, and they are available on a web-based data distribution and processing service accessed at `http://webgms.iis.u-tokyo.ac.jp/`.

***Keywords*:** mtsatgeo, YUV model, precise geometric correction

1 INTRODUCTION

1.1 Backgrounds

Multi-purpose Transmission SATellite (MTSAT) is Japanese weather satellite for geosynchronous orbit. MTSAT is a three-axis stabilized spacecraft and carries both a meteorological mission and an aeronautical communications mission. The Japan Meteorological Agency (JMA) contracted for MTSAT as a successor to GMS-5, in cooperation with the Civil Aviation Bureau (CAB), of the Ministry of Transport of Japan (JMA, 2003).

Geostationary satellites such as Meteosat, GMS and Geostationary Operational Environmental Satellite (GOES) were designed for meteorological applications. As a consequence, the onboard sensors have very low geometric, radiometric and spectral resolution. Despite these characteristics, during recent years, several studies have used geostationary satellite data for land surface remote sensing application. In most of them, these data have been used to retrieve geophysical parameters used as an input for models GMS data and are very effective to detect burned areas in different tropical environments as well (Boschetti, *et al.*, 2003).

MTSAT breaks through limitations of earlier three-axis stabilized GEO instruments with significant improvements in many areas, including spatial sampling, radiometric sensitivity, calibration and performance around local midnight (Puschell *et al.*, 2003). The process for the automatic detection of Landmarks and Earth Edges has been working operationally for many months on MTSAT-1R. The ability to use these data as the basis to determine the satellite orbit and attitude has also been demonstrated (Milnes, 2006). In this sense, it is necessary to have a continuous accurate and timely determination of the satellite orbit and attitude in order to perform geometric correction of Earth images acquired by geostationary meteorological satellites.

1.2 Objective

This research focuses on a network based data processing, distribution and visualization of MTSAT data. Data processing includes radiometric correction, geometric correction and spatial subset, and it is developed as a software package, `mtsatgeo`.

2 METHODOLOGY

2.1 Data receiving, processing and archiving

MTSAT High Rate Information Transmit (HRIT) data have been received at a direct broadcasting system at Yayoi research campus of University of Tokyo since October 2006. They are transfered to an archiving system at Komaba research campus of University of Tokyo in a near-real time fashion. MTSAT HRIT products were calibrated to a top-of-atmosphere (TOA) reflectance or brightness temperatures for further processing. A set of processing were carried out using a web-based data processing system equipped with a direct broadcasting of MTSAT HRIT [1].

2.2 A package software `mtsatgeo`

A series of pre-processing includes radiometric correction, precise geometric correction, map projection conversion and spatial subset and they are developed as a package software `mtsatgeo` freely available at our website along with MTSAT HRIT data. A precise geometric correction is carried out by using a template matching technique with shore lines and digital elevation models(Takeuchi *et al.*). An evaluation of it is explained at the latter part of this article. A map projection conversion is applied from Normalized Geostationary Projection (NGP) to a plate caree projection (lat-lon system) as shown in Figure 1.

[1] A web-based MTSAT processing system (http://webgms.iis.u-tokyo.ac.jp/)

2.3 A WWW-based data distribution system

A series of pre-processing and distribution is applied to a WWW-based data distribution system. Figure 2 shows a WWW interface of WebGMS system[2]. This system enables us to promote the data integration system along with NOAA AVHRR[3], Aqua/Terra MODIS[4] and MTSAT HRIT. A line up of satellite data series are processed and transfered to Earthquake Research Institute, University of Tokyo to monitor active volcanic activities over East Asia[5], National Institute of Informatics to monitor typhoon and flooding[6], Center for Remote Sensing, Chiba University, Kochi University for weather forcasting[7].

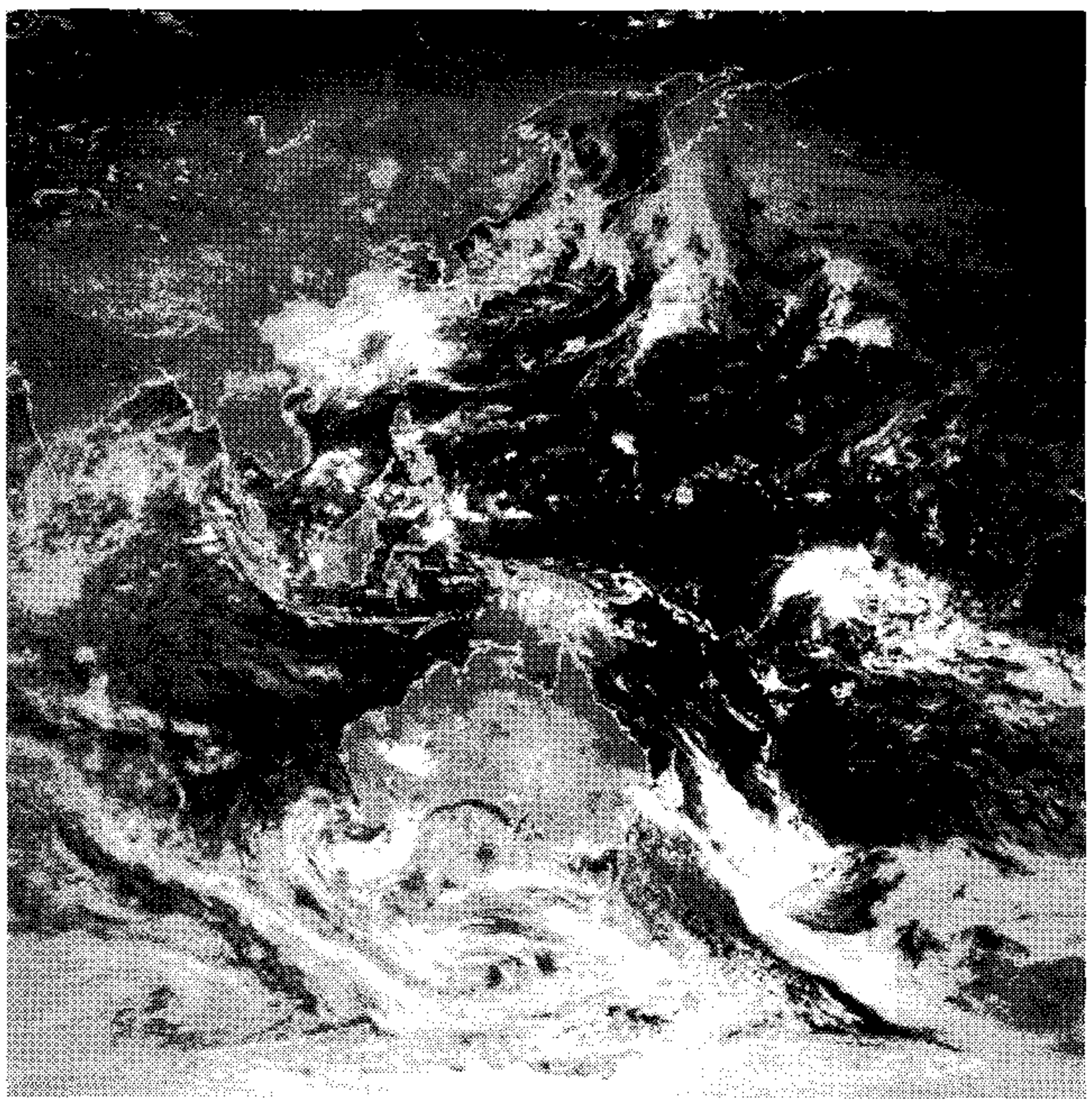


Figure 1: MTSAT image overlayed with shore lines over Pacific Asian region.

3 RESULTS AND DISCUSSIONS

3.1 Pseud-color visualization by color data conversion

Figure 3 shows quick look images of visible, thermal infrared and water vapor channels in gray scale. A pseud-color visualization was carried out on visible channel in 1 kilometer by color data conversion technique to give better visual interpretation.

We followed an idea proposed by (Kittler *et al.*, 1985) to generate a pseud-color image from a gray-scale visible image by using a color composite information with the other image sources. In this study, YUV image conversion technique was applied to convert RGB image composite and `netpbm` software was used to carry it out. It is widely used

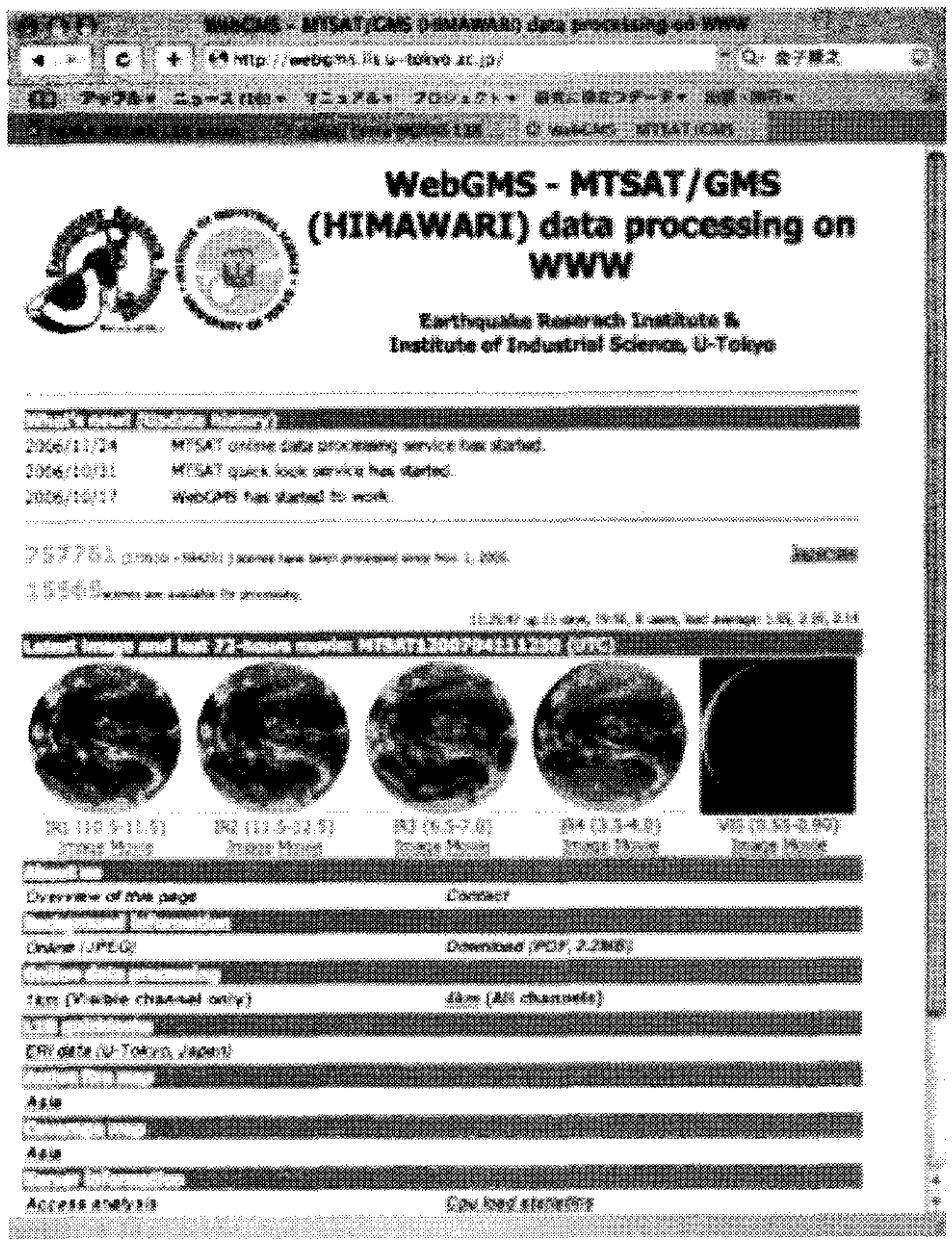


Figure 2: WWW interface of WebGMS (`http://webgms.iis.u-tokyo.ac.jp/`).

in a color television image format (NTSC) and the relationship between YUV and RGB is represented as follows;

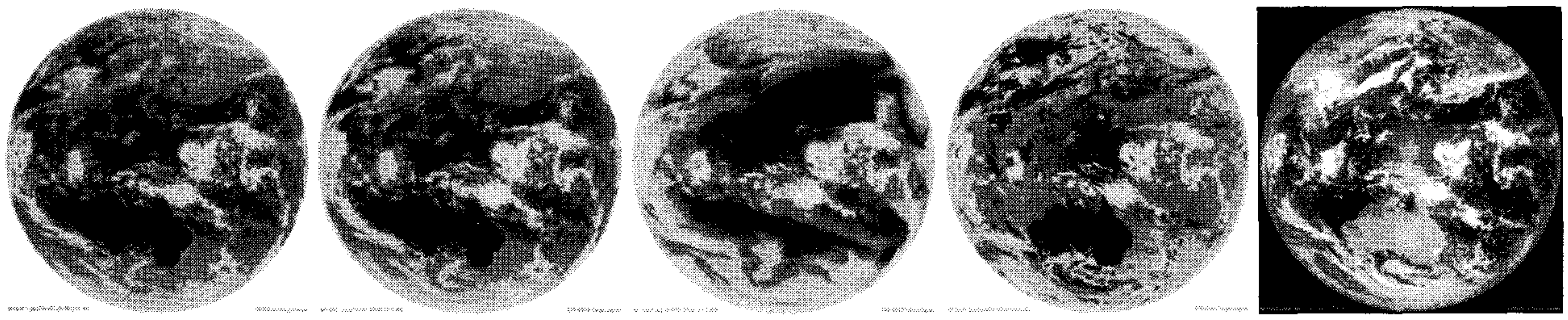
$$Y = 0.299R + 0.587G + 0.114B \quad (1)$$
$$U = B \quad Y \quad (2)$$
$$V = R \quad Y \quad (3)$$

In equations (2), Y corresponds to a brightness, U to blue and V to red in Mansell color system, respectively. YUV conversion was carried out at in three steps as shown below;

1. A cloud-free MODIS visible images are obtained [8] (Figure 4-(a)) and RGB image composite is converted to YUV by using equations (2) (Figure 4 の (b)-(d)).
2. Replace Y component of MODIS (Figure 4-(b)) with a visible image of MTSAT (Figure 4-(e)) then newly generated YUV component is derived.
3. Convert a YUV into RGB by using equations (2) (Figure 4-(f))

Figure 4-(f) shows a pseud-color composite of MTSAT imagery integrated with MODIS YUV color model. An visual interpretation found that a red area is high-colored over desert area such as inner China and central part of Australia, however, over all accuracies seem quite well.

[2] `http://webgms.iis.u-tokyo.ac.jp/`
[3] `http://webpanda.iis.u-tokyo.ac.jp/`
[4] `http://webmodis.iis.u-tokyo.ac.jp/`
[5] `http://vrsserv.eri.u-tokyo.ac.jp/REALVOLC/`
[6] `http://www.digital-typhoon.org/`
[7] `http://weather.is.kochi-u.ac.jp/`
[8] NASA Blue Marble `http://earthobservatory.nasa.gov/`



(a) IR1 (b) IR2 (c) IR3 (d) IR4 (e) VIS

Figure 3: Gray scale visualization of MTSAT imagery.

3.2 Precise geometric correction

Figure 5 compares MTSAT subset scene of system correction with that of precise geometric correction overlaid with shore lines. A coverage over 400 $\times$400 km^2 is centered around (32.0N, 88.0E) over Himalaya lake zones with a elevation 4,600 meters high above the sea level.

Figure 5-(a) shows that a sub-image with a system correction has a gap around 12 kilometers, namely 12 pixels in a image, against shore lines in upper left direction in the scene (north west). This is caused by high elevations over the scene. On the other hand, a sub-image with a precise geometric correction in Figure 5-(b) yields has a good overlay with shore lines by visual interpretation, which results in the importance of a geodetic distortion compensation in high altitude area and off-nadir observation.

4 CONCLUDING REMARKS

This research focused on a network based data processing, distribution and visualization of MTSAT data. Data processing includes radiometric correction, geometric correction and spatial subset, and it was developed as a software package, `mtsatgeo`. They are available on a web-based data distribution and processing service. A method was proposed to generate a pseud-color image from panchromatic data by using MODIS true color composite imagery. As a result, it was found to be very useful for a better visualization interpretation despite its data access limitation on daytime observation only. All of the information related with this research is available at a `http://webgms.iis.u-tokyo.ac.jp/`.

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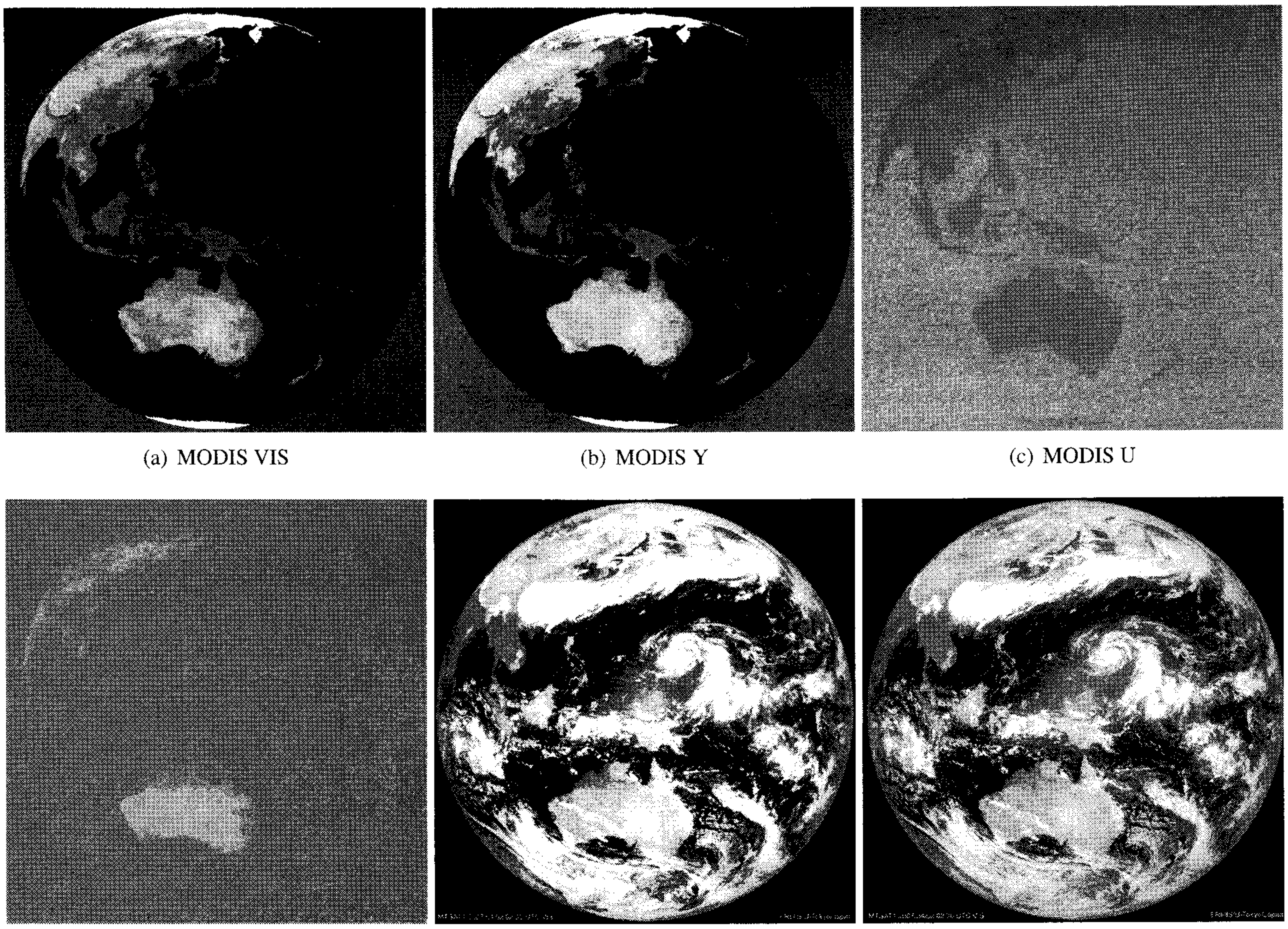
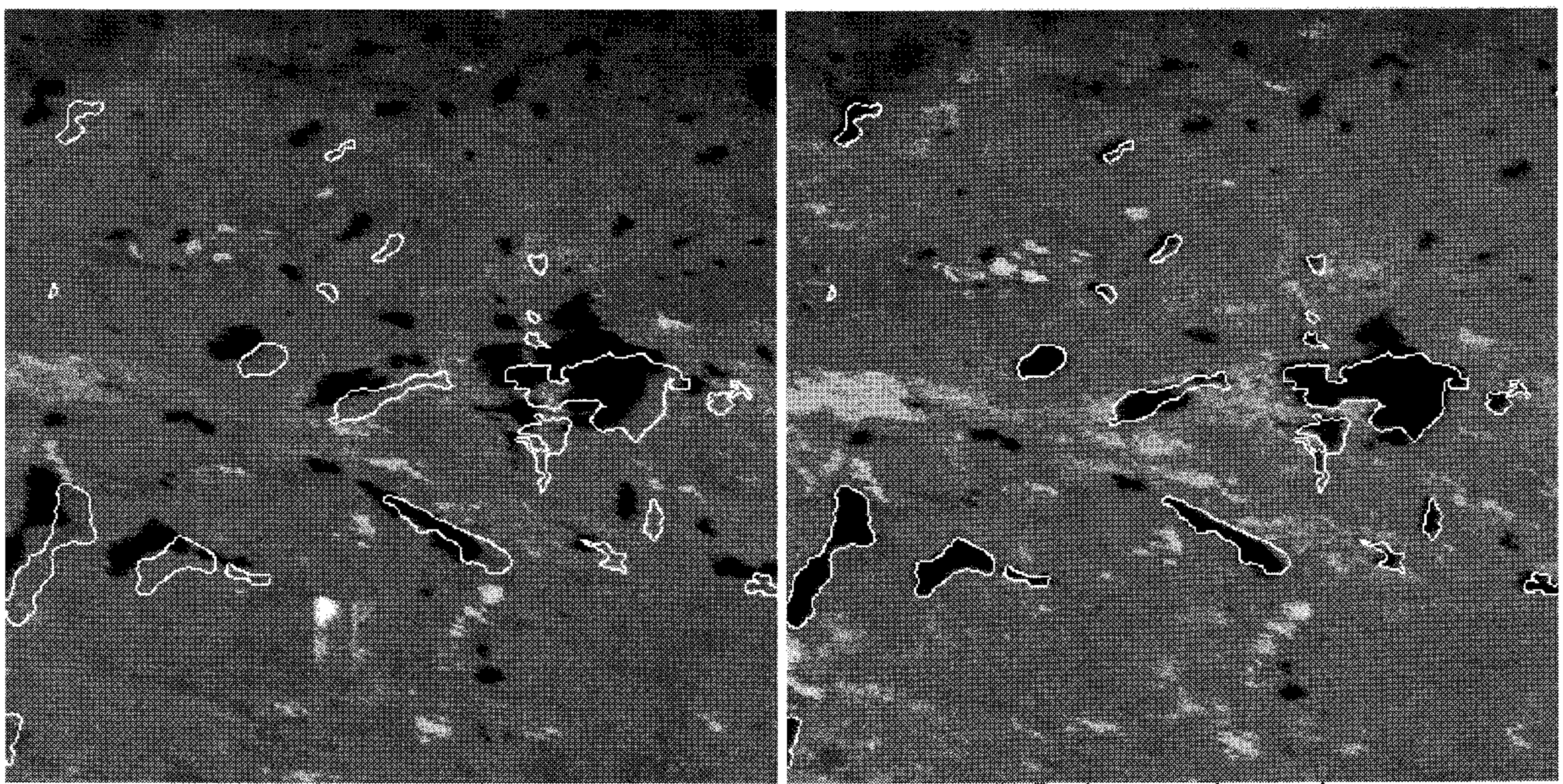


(a) MODIS VIS (b) MODIS Y (c) MODIS U

(d) MODIS V (e) MTSAT VIS (f) MTSAT PSEUD

Figure 4: Pseud color composite of MTSAT imagery integrated with MODIS YUV color model.



(a) System correction (b) Precise geometric correction

Figure 5: Comparing MTSAT subset scene of system correction (as shown (a)) with that of precise geometric correction (as shown (b)) overlaid with shore lines. A coverage over 400×400 km^2 is centered around (32.0N, 88.0E) over Himalaya lake zones elevated up to 4,600 meters high above the sea level.