

Development of MTSAT Data Processing and Distribution System on WWW

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Abstract

This research focuses on a network based data distribution and visualization system of Multi-functional Transport 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/>.

Key Words: HRIT, mtsatgeo, YUV model

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 Objectives of this study

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. System Configuration

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 transferred 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 (A web-based MTSAT processing system, <http://webgms.iis.u-tokyo.ac.jp/>).

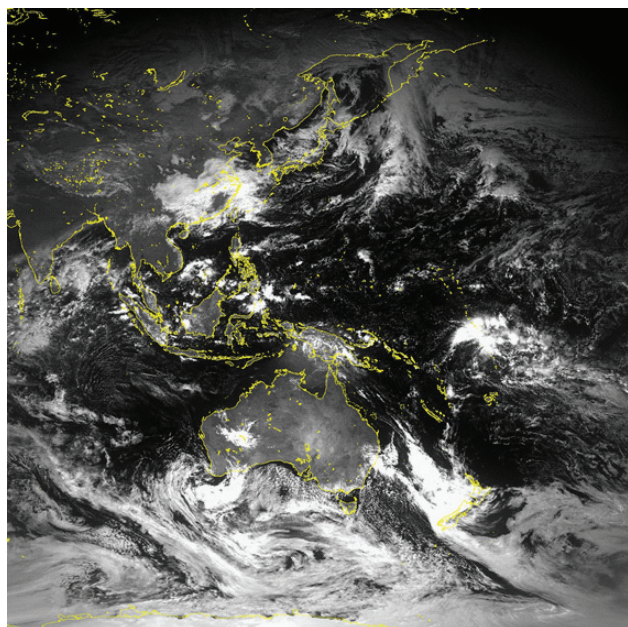


Figure 1: Geo-rectified MTSAT image with coastal line over Asia Pacific region (70E-150W, 70N-70S).

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 shorelines 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 (grid lat-lon system) as shown in Figure 1.

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. This system enables us to promote the data integration system along with NOAA AVHRR (<http://webpanda.iis.u-tokyo.ac.jp/>), Aqua/Terra MODIS (<http://webmodis.iis.u-tokyo.ac.jp/>) and MTSAT HRIT. A line up of satellite data series are processed and transferred to Earthquake Research Institute, University of Tokyo to monitor active volcanic activities over East Asia (<http://vrsserv.eri.u-tokyo.ac.jp/>), National Institute of

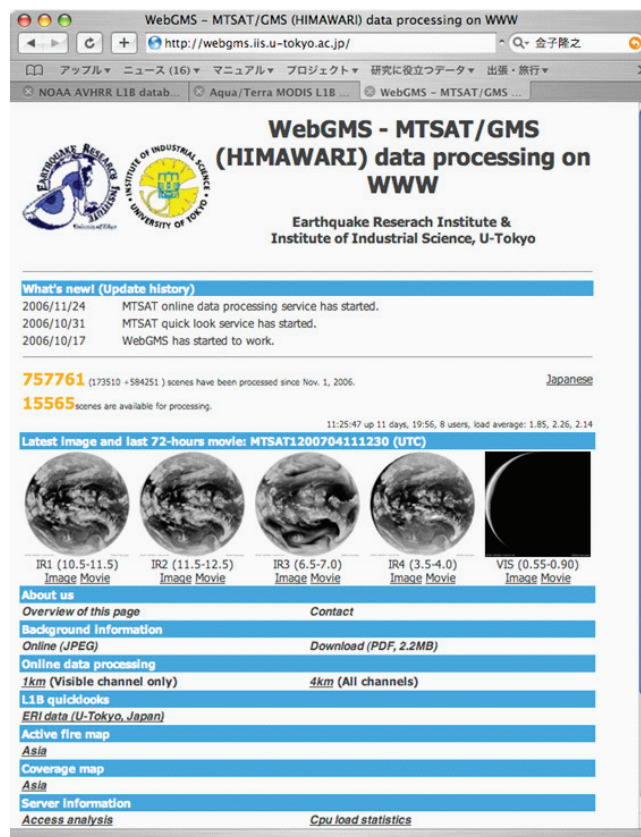


Figure 2: A WWW interface of WebGMS system

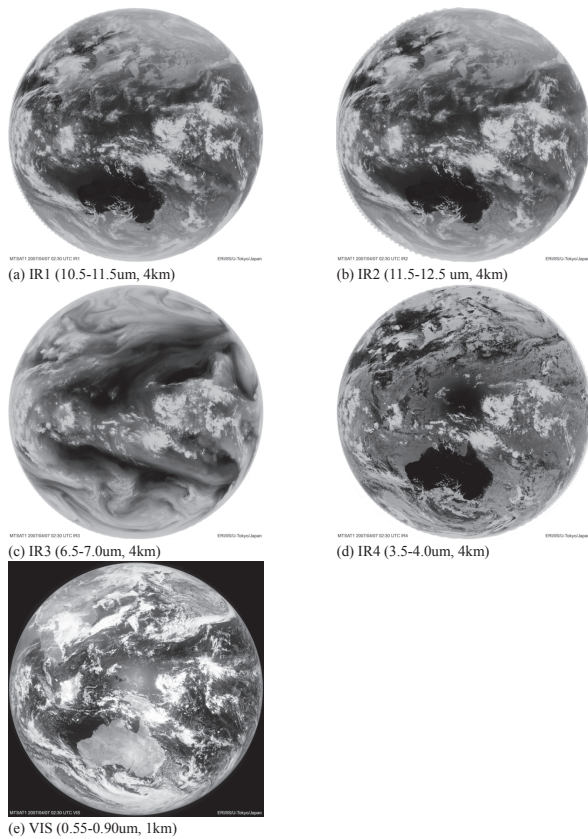


Figure 3: Gray scale visualization of MTSAT imagery.

Informatics to monitor typhoon (<http://www.digital-typhoon.org/>) and Kochi University for weather forecasting (<http://weather.is.kochi-u.ac.jp/>).

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

$$Y = 0.299R + 0.587G + 0.114B \quad (1)$$

$$U = B - Y \quad (2)$$

$$V = R - Y \quad (3)$$

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;

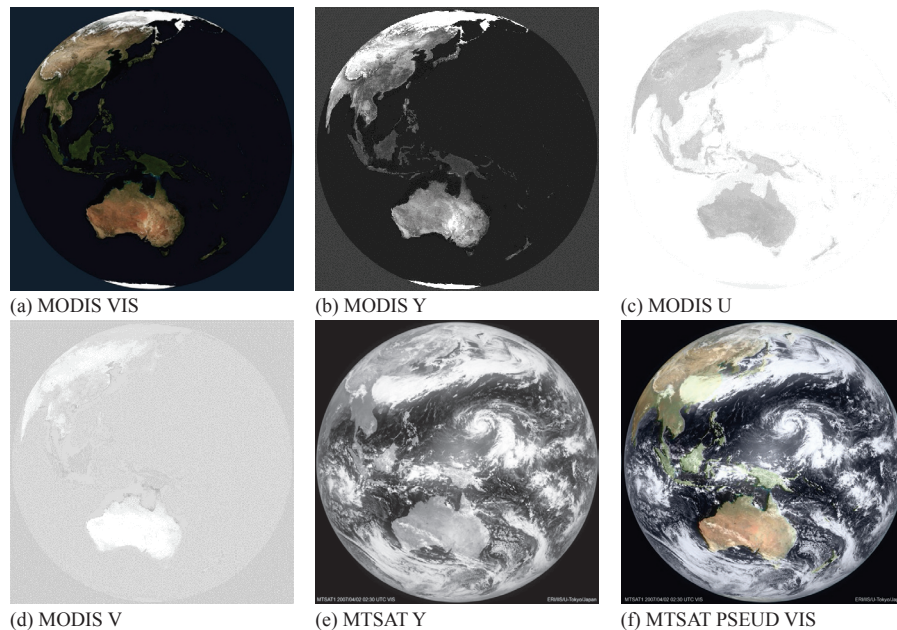


Figure 4: Pseud color composite of MTSAT imagery integrated with MODIS YUV color model.

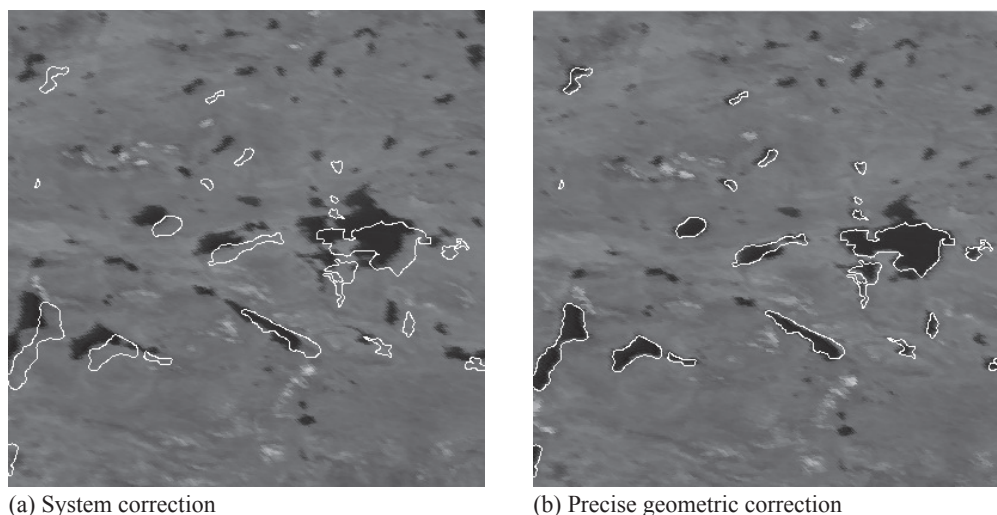


Figure 5. Comparing MTSAT subset scene of system correction (as shown (a)) with that of precise geometric correction (as shown (b)) overlaid with coastal lines. A coverage over 400×400 km² is centered around (32.0N, 88.0E) over Himalaya lake zones elevated up to 4,600 meters high above the sea level.

1. A cloud-free MODIS visible images are obtained (Figure 4-(a)) and RGB image composite is converted to YUV by using equations (2) (Figure 4 (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))

3.2 Precise geometric correction

Figure 5 compares MTSAT subset scene of system correction with that of precise geometric correction overlaid with coastal lines. A coverage over 400×400 km² 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 coastal 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 <http://webgms.iis.u-tokyo.ac.jp/>.

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