CGMS-34, JMA-WP-07

Prepared by JMA
Agenda Item: II/2
Discussed in WG II

MONITORING WEB PAGE OF MTSAT-1R NAVIGATION AND CALIBRATION

The quality of HRIT imagery data observed by MTSAT-1R is available at the Web page of MSC (http://mscweb.kishou.go.jp/monitoring/mtsat_monit.html). Information presented on the Web page is navigation status evaluated by a landmark analysis method, and calibration status regarding the infrared channels evaluated by brightness temperature comparison between MTSAT-1R and the NOAA satellites. This working paper introduces the Web page, and the methods to generate the information shown on the page.

MONITORING WEB PAGE OF MTSAT-1R NAVIGATION AND CALIBRATION

1. INTRODUCTION

The quality of HRIT imagery data observed by the Multi-Functional Transport Satellite 1R (MTSAT-1R) is available at the Web page of the Meteorological Satellite Center at: http://mscweb.kishou.go.jp/monitoring/mtsat_monit.html.

The object of the Web page is to enhance the usability of MTSAT-1R image by providing users with referential information. The Web page is accessible without any restriction via the Internet.

The Web page presents accuracy information on navigation and calibration. The navigation information consists of the evaluation of MTSAT-1R image location accuracy by a landmark analysis method. The calibration information consists of the comparison of infrared images between MTSAT-1R and the Polar Operational Environmental Satellites, NOAA.

2. NAVIGATION INFORMATION

In order to provide the users of MTSAT-1R imagery data with its navigation information, image location error is estimated by landmark analysis. The location error is diagnosed by comparison between the landmark coastline positions of MTSAT-1R images and those of a reference map. Median, contrast conversion and Laplacian filters are applied on the image in advance of the comparison to enhance contrast between land and sea, and to remove cloud contamination. Subsequently, a vector representing a positioning departure between the filtered image and the reference map is measured by cross correlation procedure. No rotational misalignment is taken into account. This landmark analysis is operationally conducted for MTSAT-1R IR1 and IR4 images. A vector computed by the landmark evaluation contains both an image registration error and a landmark analysis error. Since the landmark analysis error can be assumed to have no bias, averaging some computed error vectors is expected to retrieve image registration error.

Figure 1 shows a Web page displaying landmark analysis for all MTSAT-1R HRIT images over the last one month. On this page, users can see location error vectors computed for each image by specifying a date and time. The vectors are emphatically drawn with reference vectors, which represent one infrared pixel length, printed outside the image. This landmark analysis image is posted about 10 minutes after each observation on a real-time basis.

Figure 2 shows a Web page displaying the temporal variation of the image location error vectors over the last two weeks. On this page, users can see the recent trend and alteration of the HRIT navigation accuracy. The location error vector plotted here is the regional average of the error vectors computed by the landmark analysis. The vector is displayed in a vertical and a horizontal component, a magnitude, and a direction. Currently, the averaged location error vectors of 16 regions can be monitored. The location error map on this Web page is also updated about 10 minutes after each observation on a real-time basis.

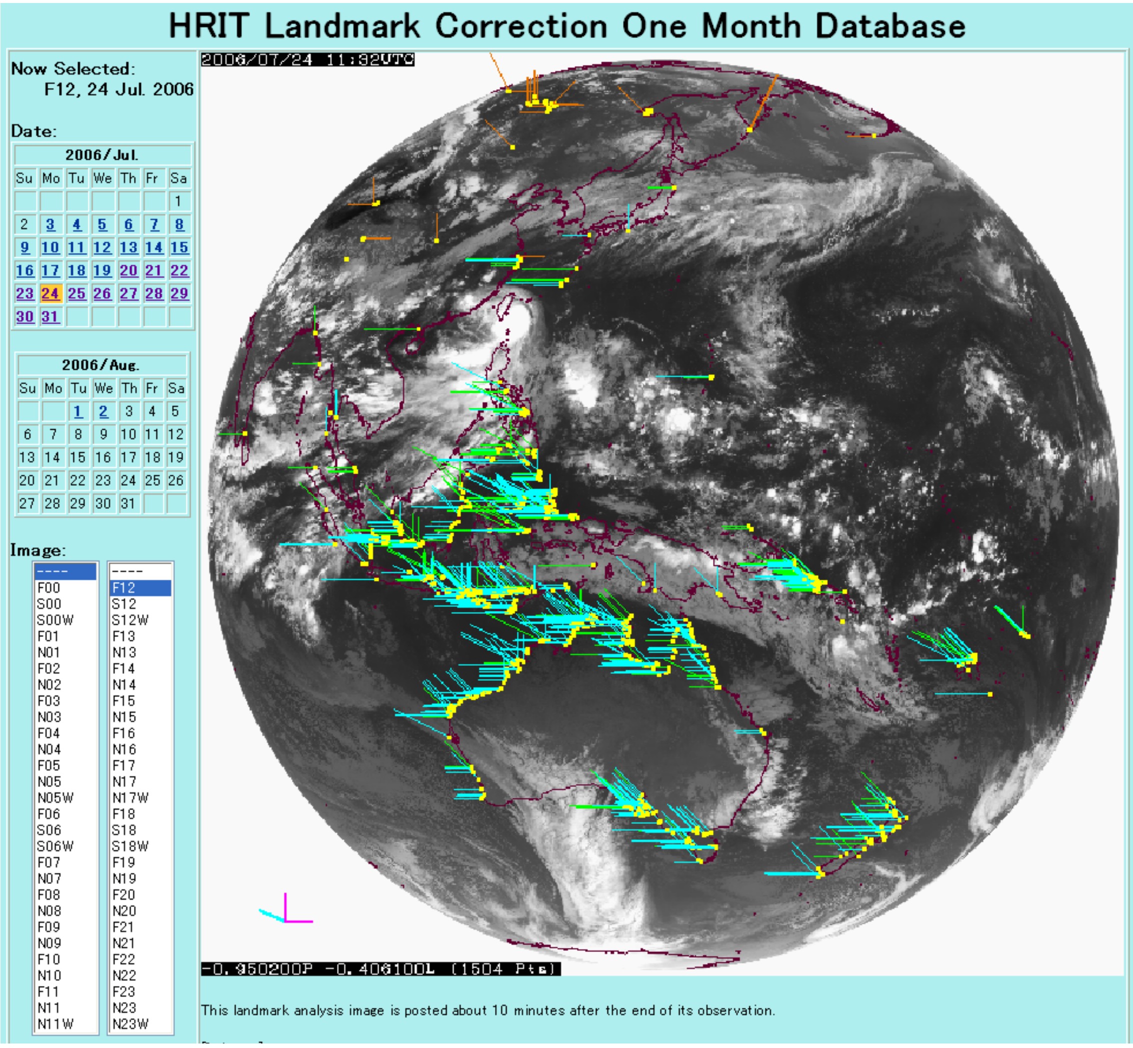

Figure 1 Web page to display the location error map of MTSAT-1R HRIT imagery data evaluated by a landmark analysis method. Analysis result for each image over the last one month can be displayed. The yellow points represent landmark points, and the lines represent the image location error vectors. They suggest that the image should be shifted from a yellow point to the other end of the line to correct the location error. The cyan, green and orange lines indicate the results of the comparison between an IR1 image and a reference map, an IR4 image and the reference map, and an IR1 image and the IR1 image corrected by the landmark analysis 3 hours before, respectively. The purple lines on the bottom left are reference vectors showing one infrared pixel length of the HRIT imagery data, which is equivalent to 4 km around the sub satellite point. The cyan line attached to the purple lines shows the average of all the error vectors.

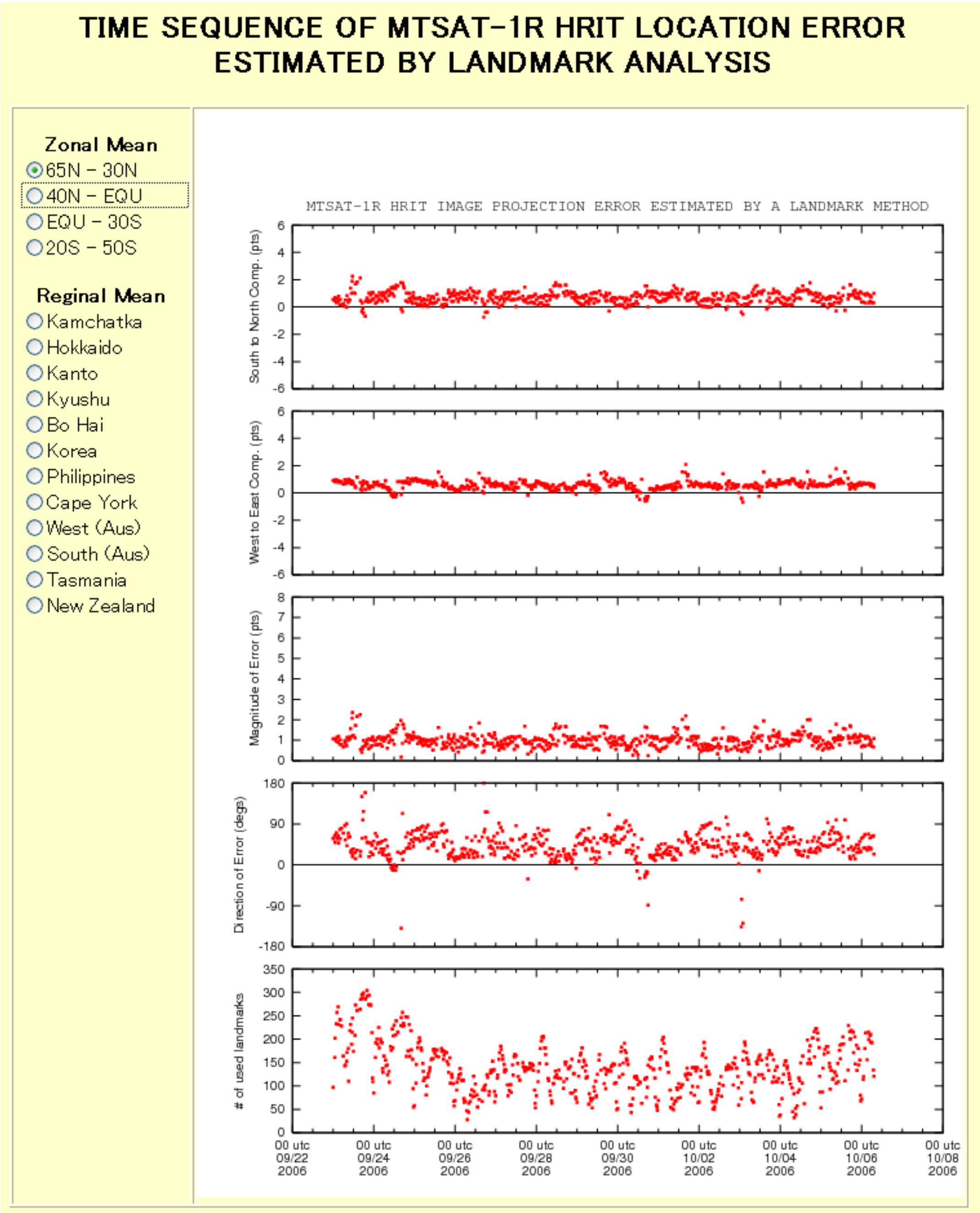

Figure 2 Web page to display the temporal trend of MTSAT-1R HRIT image location error. The regional averages of the error vectors shown in Figure 1 are plotted. Each point corresponds to one image. The error vector is decomposed into the north-south component (top chart, positive for image shifting northward), the east-west component (second chart, positive for image shifting eastward), the magnitude (third chart), and the direction (fourth chart, positive for clockwise rotation from north). The unit of the top three charts is one infrared pixel length, and the unit of the direction is degree. The last chart shows the number of the error vectors obtained by the landmark analysis and used to compute their average over the region.

3. CALIBRATION INFORMATION

In order to provide the users of MTSAT-1R imagery data with its calibration status, brightness temperature comparisons between MTSAT-1R and AVHRR aboard the NOAA satellites are operationally conducted once a day. The comparisons are performed for the infrared channels between MTSAT-1R IR1 and AVHRR channel 4, IR2 and channel 5, and IR4 and channel 3B, respectively. Figure 3 shows the comparison of the spectral response functions between these channels. The data used in the comparisons are MTSAT-1R HRIT data and AVHRR GAC data obtained from the ftp server of NOAA/NESDIS via the Internet.

There are two kinds of comparisons performed. One is the brightness temperature comparison over clear sky and ocean to evaluate calibration difference between the two satellites over high temperature region. The other is the comparison over smooth cloud top to evaluate calibration difference over lower temperature region. Table 1 shows conditions to choose pixels to be compared. Since the variation of observed brightness temperatures over cloud is very large, the uniformity check is effective to reject cloud pixels in the comparison over clear sky and ocean. The uniformity check inspects each pixel whether the maximum brightness temperature difference between the pixel and its surrounding 5 by 5 pixels is within 0.2 degrees. In the smooth cloud top comparison, the criterion of the uniformity check is mitigated to within 3 degrees, while the criterion of observing time difference is restricted to within 5 minutes. In both comparisons, the difference of secant of satellite zenith angles is limited to within 0.03 to decrease the difference of radiative path lengths from surface or cloud top to the two satellites and make their atmospheric effects comparable.

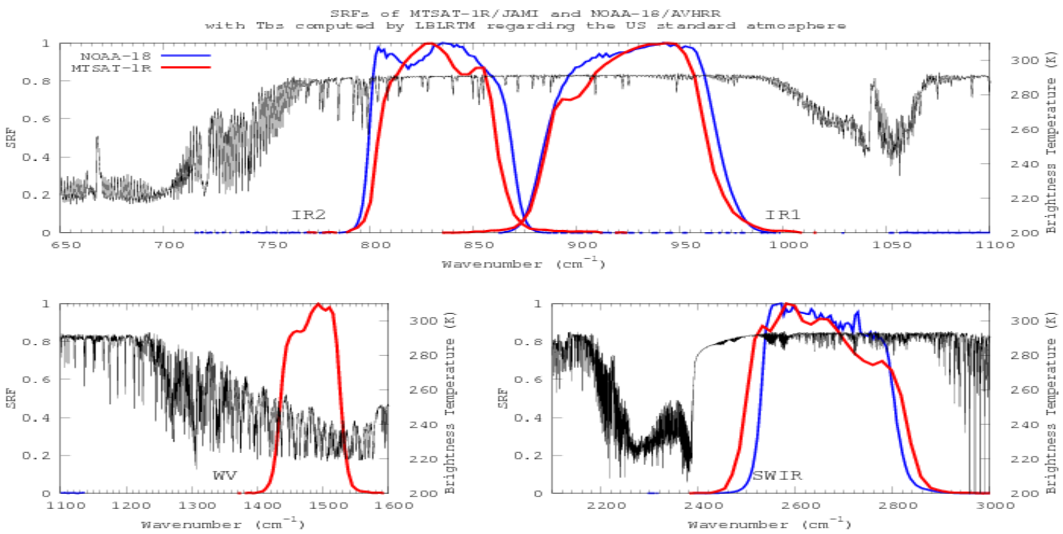

Figure 3 Spectral response functions of MTSAT-1R infrared channels (red lines) with those of NOAA-18 AVHRR infrared channels (blue lines). The MTSAT-1R IR1, IR2 and IR4 (SWIR) channels correspond to the AVHRR channel 4, 5 and 3B, respectively. The black thin lines show brightness temperatures computed by the line-by-line radiative transfer model LBLRTM with the HITRAN2000 line parameter database regarding the U.S. standard atmosphere.

Figure 4 shows a Web page displaying the brightness temperature comparison over clear sky and ocean. On this page, users can see images simultaneously observed by the two satellites and their brightness temperature difference. Users can change the graph by specifying a NOAA satellite, a date, a channel, and a match-up condition. The comparison is performed once a day and the images are posted at 23:15 UTC. Due to the delay of GAC data acquisition, the comparison is applied to images observed a day before.

Table 1. Conditions of the brightness temperature comparisons

Comparison	Clear sky and ocean	Smooth cloud top
Domain	30 N to 30 S Ocean	30 N to 30 S
Position	Difference of observing positions between MTSAT-1R and NOAA < 3 km	Same as left
Time	Difference of observing times < 30 minutes	Difference of observing times < 5 minutes
Satellite zenith angle (SZA)	Difference of secant SZAs < 0.03	Same as left
Uniformity check	| Tb(target) – Tb(5x5 surrounding pixels) | < 0.2 K for MTSAT-1R IR1 and AVHRR Ch. 4	| Tb(target) – Tb(5x5 surrounding pixels) | < 3 K for MTSAT-1R IR1 and AVHRR Ch. 4
Tb range	None	Tb < 260 K for MTSAT-1R IR1 and AVHRR Ch. 4

Note: The spatial resolution of GAC data is about 4 km, which is similar to MTSAT-1R HRIT data around the MTSAT-1R sub satellite point.

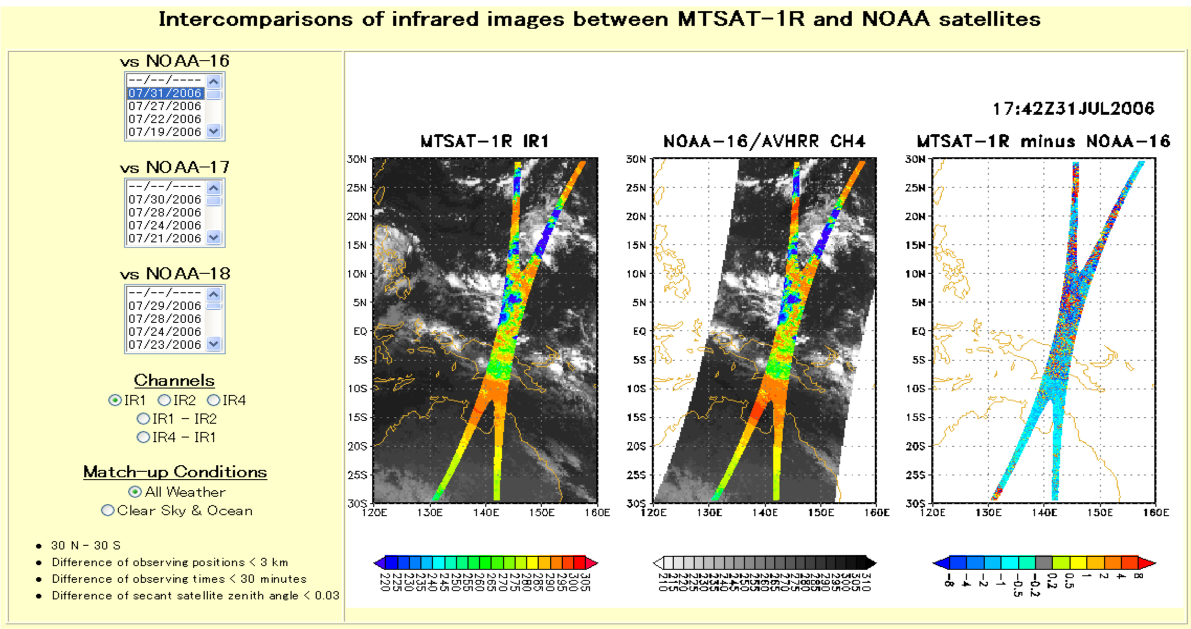

Figure 4 Web page to display the brightness temperature images of MTSAT-1R (left), NOAA/AVHRR (center). The right image shows the differences of brightness temperatures between the two images. By changing the match-up conditions, it can display brightness temperature comparison only over clear sky and ocean (right).

Figure 5 shows a Web page displaying the one-month statistics of the brightness temperature comparison over clear sky and ocean. On this page, users can see the calibration difference between the two satellites in scatter diagrams and statistic scores. Users can specify a NOAA satellite, its orbit either ascending or descending, and comparing channels. The charts on this page are updated on the 4th of every month.

There is a similar Web page, which shows the brightness temperature comparison over smooth cloud top.

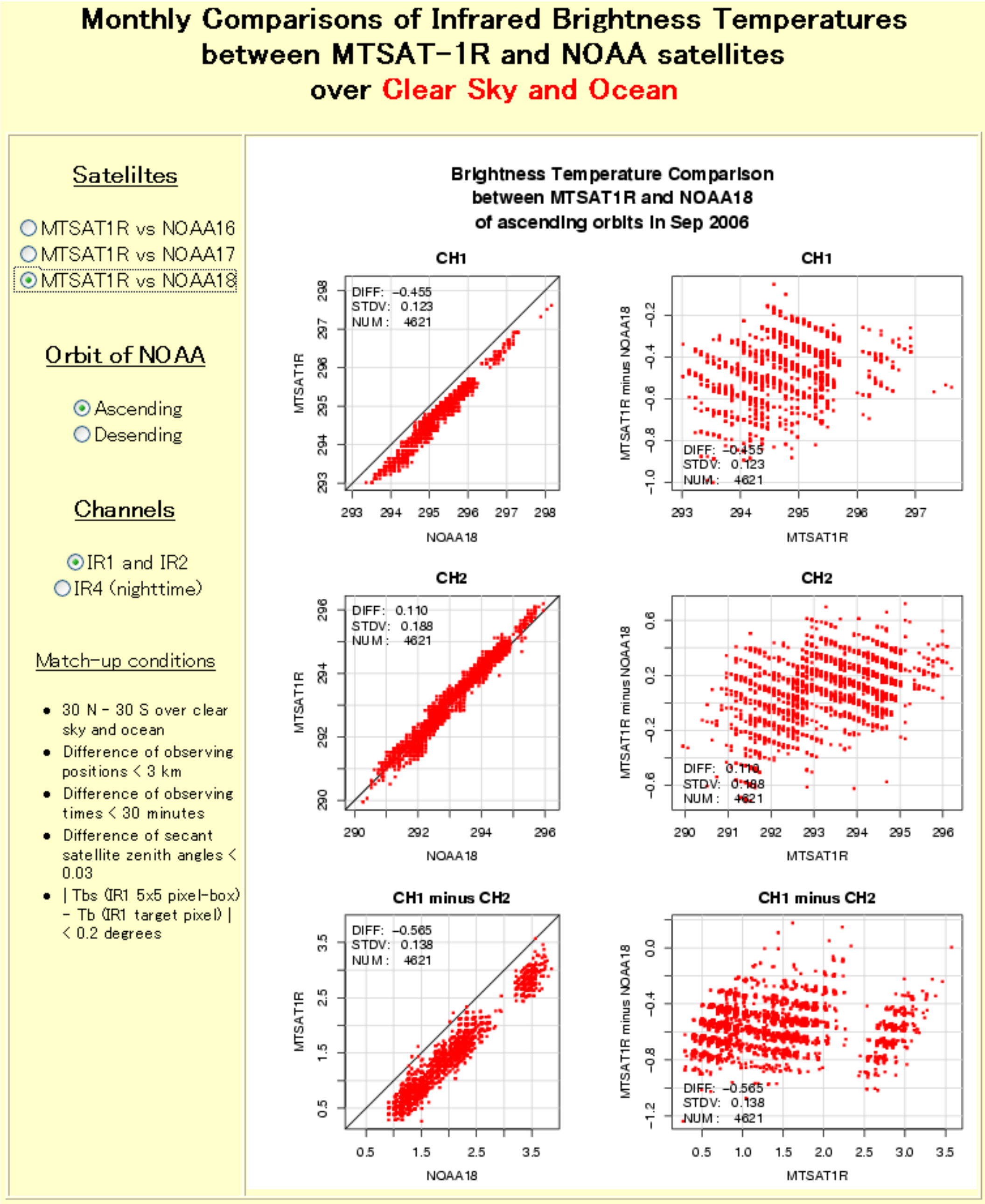

Figure 5 Web page to display one-month statistics of the brightness temperature comparison between MTSAT-1R and NOAA/AVHRR. Users can change the graph by specifying a NOAA satellite, its orbit, and comparing channels.

4. FUTURE PLAN

JMA has a plan to show that the sequence of the location error vectors since the commencement of MTSAT-1R's operation by reprocessing the past observed images. Regarding the calibration information, the validation of other channels, such as MTSAT-1R IR3 (water vapor channel) and VIS (visible channel), is planned. In addition, brightness temperature simulation by a radiative transfer model is planned to be introduced into the comparison scheme.