STATUS OF JAPANESE METEOROLOGICAL SATELLITES AND RECENT ACTIVITIES OF MSC

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Abstract

MTSAT-1R is the current operational Japanese geostationary meteorological satellite located at 140E longitude. The status of MTSAT-1R has been stable since it became operational on 28 June 2005. MTSAT-2, successfully launched on 18 February 2006, is the follow-on satellite to MTSAT-1R. MTSAT-2 will be on standby in orbit in the summer of 2006 and it will take over as the primary operational satellite from MTSAT-1R in about the middle of 2010. JMA (Japan Meteorological Agency) has a tentative plan to launch the follow-on satellite to MTSAT-2 in 2013 hopefully, or by 2015 at the latest.

The Meteorological Satellite Center (MSC) of JMA is responsible for the operation of the MTSAT satellites. MSC activities also include the development of MTSAT products including hourly Atmospheric Motion Vectors (AMVs) and Clear Sky Radiance (CSR) for use in Numerical Weather Prediction (NWP). MSC also receives and processes HRPT data of the polar-orbiting NOAA satellites. MSC has been providing ATOVS data within the AP-RARS (Asia-Pacific Regional ATOVS Retransmission Service) framework since 7 Jun 2006.

1 INTRODUCTION

JMA (Japan Meteorological Agency) has been operating geostationary meteorological satellites for more than two decades. Japanese satellites at 140E longitude have been providing coverage of the Western Pacific region and contributing to the meteorological community. The first Japanese geostationary meteorological satellite was GMS (Geostationary Meteorological Satellite), launched in 1977. Five satellites were launched in the GMS series between 1977 and 1995.

The current series of operational satellites is the MTSAT (Multifunction Transport Satellite) series. MTSAT is the Japanese multi-purpose satellite program with two objectives, aeronautical mission and meteorological mission. The meteorological mission of MTSAT succeeds the observation of GMS. MTSAT-1R, launched on 26 February 2005, is currently the operational satellite at 140E. JAMI (Japanese Advanced Meteorological Imager) on board MTSAT-1R has 5 channels (see Table 1). MTSAT-2, successfully launched on 18 February 2006, is the follow-on satellite to MTSAT-1R. The specifications of MTSAT-2 Imager are the same as of MTSAT-1R JAMI (Table 1).

The Meteorological Satellite Center (MSC) of JMA is responsible for the operation of the MTSAT meteorological mission. MSC activities also include the development of MTSAT products. The recently developed products are hourly Atmospheric Motion Vectors (AMVs) and Clear Sky Radiance (CSR) for use in Numerical Weather Prediction (NWP), and also the dust detection product for atmospheric environment monitoring. MSC supported Japanese Reanalysis Project (JRA-25) and derived AMVs from GMS 3, 4 and 5 with present day algorithms for the reanalysis project (see Sakamoto et al. 2006). MSC also receives and processes HRPT data of the polar-orbiting NOAA satellites (NOAA-17 and NOAA-18 at present). Preparations are currently underway for MetOp direct readout.

The plan of this paper is as follows. Section 2 and 3 report on the status of MTSAT-1R and MTSAT-2 respectively. Section 4 describes our tentative plan for the follow-on satellite to MTSAT-2. Section 5
introduces recent activities of MSC with emphasis on the development of MTSAT-1R products and new data exchange service. Summary follows in section 6.

<table>
<thead>
<tr>
<th>Spectral bands</th>
<th>VIS: 0.55 - 0.90 μm</th>
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<tr>
<td></td>
<td>IR1: 10.3 - 11.3 μm</td>
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<td>IR2: 11.5 - 12.5 μm</td>
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<td></td>
<td>IR3: 6.5 - 7.0 μm</td>
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<td></td>
<td>IR4: 3.5 - 4.0 μm</td>
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<td>Ground resolution at nadir</td>
<td>1 km in VIS, 4 km in infrared channels</td>
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<td>Digitization</td>
<td>10 bits</td>
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Table 1: MTSAT-1R JAMI and MTSAT-2 Imager Characteristics.

1 THE STATUS OF MTSAT-1R

The status of MTSAT-1R operation has been stable since it became operational on 28 June 2005. The status of image navigation and calibration is briefly summarized as follows.

Image navigation

The satellite orbit and attitude has been determined by landmark observations, star observation, and ranging data since May 2006 when the use of star observation data and ranging data was started. It can be expected that the addition of the star and ranging data will improve the accuracy of image navigation. Since image navigation error on the order of one pixel (IR channels) may degrade the quality of the MTSAT-1R products (especially AMVs), several attempts are being made to further improve the accuracy of image navigation.

Calibration

The calibration accuracy has been improved since MTSAT-1R became operational in June 2005. It has been reported that the brightness temperature of IR4 channel (3.8 μm) was around 9 K lower than GOES-9 observation as of summer 2005 (Tahara and Ohkawara 2005). As a result of identifying and correcting the problem, the accuracy of IR4 channel calibration has improved since April 2006. The correction of the remaining bias is now discussed. MSC will start monitoring infrared calibration by comparison with NOAA satellites observations and radiative transfer model simulation in the near future.

Data dissemination

MTSAT-1R has been providing HRIT and LRIT imagery data as well as HiRID and WEFAX since it became operational. HiRID (compatible with S-VISSR data provided by GMS-5) and WEFAX are disseminated to help users transition to new HRIT and LRIT format. It should be noted that the broadcasting service of HiRID and WEFAX will be discontinued at the end of 2007 and only HRIT and LRIT will be disseminated thereafter.

3 THE STATUS OF MTSAT-2

MTSAT-2 has been undergoing in-orbit tests at 145E longitude. In the course of the tests, the back-up module of the S-band telemetry, tracking and command (TTC) receiving system was found to be malfunctioning. However, there will be no crucial effect on operational observation and data dissemination to be conducted. After further tests, MTSAT-2 will be on standby in orbit in the summer of 2006.

The operation as a standby satellite will be going on until 2010 when MTSAT-2 will be the primary operational satellite at 140E longitude and MTSAT-1R will be on standby (Figure 1). MTSAT-2 will provide HRIT and LRIT imagery for the convenience of MTSAT-1R HRIT and LRIT user.
4 THE PLAN OF THE FOLLOW-ON SATELLITE TO MTSAT-2

In order to ensure robust satellite observing system covering the Western Pacific region, JMA has a plan to launch the follow-on satellite to MTSAT-2 as early as possible. The tentative plan is to launch the follow-on satellite in 2013 hopefully, or by 2015 at the latest (Figure 1). Preparatory studies have been conducted to define the specifications of the follow-on satellite by collecting user requirements. JMA will define the specifications in consideration of a CGMS recommendation that all geostationary imagers should be upgraded to at least the level of SEVIRI and all future satellites should carry a hyperspectral IR sounder by the 2015 timeframe.

5 RECENT ACTIVITIES OF MSC

MTSAT-1R products recently developed by MSC

Hourly AMVs are derived from three successive MTSAT-1R images at intervals of 30 minutes. The spatial coverage extends from 0° to 50N and 90E to 170W. The spatial resolution is 0.5° x 0.5°. Two quality indicator flags are included. Operational NWP centers can take advantage of the high temporal resolution of geostationary satellite observations by assimilating the products at times other than 00, 06, 12, and 18 UTC with four-dimensional variational assimilation (4D-Var) systems. JMA plans to use the hourly AMVs in the operational assimilation systems.

Clear Sky Radiance (CSR) provides clear sky information from MTSAT-1R. The water vapor (WV) CSR data give information about the upper tropospheric humidity field. Processing is hourly and up to local zenith angles of 65°. CSR is determined for each 16 x 16 pixel box that corresponds to approximately 60 x 60 km² resolution at the sub-satellite point. For each box, the CSR is calculated by taking the average of the brightness temperatures from the cloud-free pixels. The cloud detection algorithm is based on channel difference and threshold techniques. The CSR data will be provided in BUFR (Binary Universal Form for the Representation of meteorological data). JMA has carried out assimilation experiments with MTSAT-1R WV CSR. JMA has been monitoring the WV CSR data with the operational assimilation suite. The data are not operationally used in the assimilation. Figure 2 shows anomaly correlation of 500 hPa geopotential over the southern hemisphere. Anomaly correlation is a measure of forecast skill. The higher the correlation, the better the forecast skill. There is a positive impact from day seven onward. JMA has a plan for operationally assimilating MTSAT-1R WV CSR in the global 4D-Var system after further pre-operational experiments.
The dust detection product is used for monitoring the dust around Japan (Figure 3). The product is provided as an index that indicates concentrations of dust. The index is derived from two window channels (IR1 and IR2). The dust detection algorithm is based on the difference of sensitivity to the density of air dust between IR1 (10.8μm) and IR2 (12.0μm).

Figure 2: Anomaly correlation (in %) of 500 hPa geopotential for forecasts up to 9 days verified against operational analysis for the experiment with MTSAT-1R WV CSR (red line) versus the control (blue line) over the southern hemisphere (south of 20S). The sample comprised 20 cases from 29 November to 18 December 2005.

Figure 3: The dust index on 8 Apr 2006 at 0300 UTC. The dust index is a parameter that indicates concentrations of dust. The index is calculated from window channels.
AP-RARS

MSC contributes to the implementation of AP-RARS (Asia-Pacific Regional ATOVS Retransmission Service). AP-RARS is ATOVS data exchange between HRPT stations in the Asia-Pacific region. JMA provides ATOVS data received and processed at MSC. The data exchange between Beijing, Melbourne, and Tokyo started on 7 Jun 2006. JMA also plans to exchange HRPT data received at Syowa Station, Antarctica (a Japanese Antarctic Station). The data will be obtained from the National Institute of Polar Research (NIPR) of Japan and processed at MSC. Figure 4 shows coverage of the data received at AP-RARS stations in the Asia-Pacific region. By the implementation of AP-RARS, NWP centers in the region will be able to access all the data in near real time.

Figure 4: Shaded area shows coverage of the data received at AP-RARS stations.

6 SUMMARY

The status of MTSAT-1R operation has been stable and the current issue is to achieve higher quality of the satellite image data. MTSAT-2 has been undergoing in-orbit tests and will be on standby in the summer of 2006. MTSAT-2 will take over as the primary operational satellite from MTSAT-1R in about the middle of 2010. JMA has a tentative plan to launch the follow-on satellite to MTSAT-2 in 2013 (by 2015 at the latest).

MSC has been developing MTSAT-1R products. The hourly AMVs and CSR products for use in Numerical Weather Prediction (NWP) has been developed recently. The assimilation of the hourly AMVs and the CSR is being planned in JMA. MTSAT-1R products also include the dust detection product for atmospheric environment monitoring. JMA started providing ATOVS data received and processed at MSC within the AP-RARS framework. Through the exchange ATOVS data with HRPT stations in the Asia-Pacific region, MSC provides operational NWP centers with near real time access to ATOVS data as much as possible.

REFERENCES
