GOES-9 IMAGER DATA ANLYSIS
FOR THE PREPRATION OF THE COMS MI OPERATION

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ABSTRACT:

The ITT Industry's Commercial Advanced Geo-Imager (CAGI) which is a recurrent version of imagers used in the GOES series was selected as the COMS Meteorological Imager (MI). The ITT Imager can conduct some special observation such as the space look, blackbody observation, and star sensing regularly or irregularly for its radiometric quality control. Because the GOES-9 which uses an ITT Imager has become operational over the Western Pacific and Eastern Asia positioned at 155 degrees East, the reception of the GOES-9 data is available in Korea.

As a step of preparing the COMS MI operation, we conduct the analysis of the GOES-9 imager raw data and operation procedures and compare them with contents of the ITT Imager's manual.

KEY WORDS: COMS, MI, Operation, GOES, ITT Imager.

1. INTRODUCTION

The COMS Meteorological Imager (MI), one of three payloads mounted on the COMS, is a multi-spectral two axis radiometer and has a mission of providing the imagery and radiometric information of the Earth's surface and cloud cover. The ITT's Commercial Advanced Geo-Imager (CAGI) which is a recurrent version of imagers used in the GOES series was selected as the COMS MI manufacture.

The ITT Imager can conduct some special observation such as the space look and blackbody observation automatically or manually for radiometric quality control. It can also perform the star sensing and IMC coefficient uploading for geometric quality control. These observations will be also considered for the COMS operation.

The COMS MI will be operated with the basement on the regular observation schedule but it will have to accomplish the special observation which is an irregular observation targeted on small area for the server weather prediction. Besides that, MI requires various observation modes such as full disk, hemisphere and small area observation.

The GOES-9 satellite from which Korea Aerospace Research Institute (KARI) is receiving GVAR data also uses the same ITT imager. Lots of studies have been doing about the GVAR data, GOES' user dissemination data. Together this, the analysis of the raw data of GOES-9 will be a great reference for the MI operation.

KARI is providing GOES-9 images with real-time Internet service using Meteorological Sensor Ingest System(MESIS) developed for GOES-9 data ingest and processing in house. But to receive the raw data of GOES-9 in a condition of 10-6 Bit Error Rate (BER) needs over 22.66 dB/K which matches to the 13 M antenna receiving system in SRMO (Satellite Radio Monitoring Center) in ICheon.

As a step of preparing the COMS MI operation, we conduct the analysis of the ITT imager raw data and operation procedures and compared them with contents of the ITT imager's manual.

2. ITT IMAGER

2.1 Scan Mode

The ITT Imager can provide two modes of scanning, scan clamp mode and space clamp mode. The major difference is the E-W dimension of the scanned area.

For full disk or a sector of the earth having full E-W (hemisphere) observation as shown in Figure 1, scan clamp mode is available. As this mode can acquire space look at every scan line, it does not have additional space look and has the best conditions for radiometric accuracy.

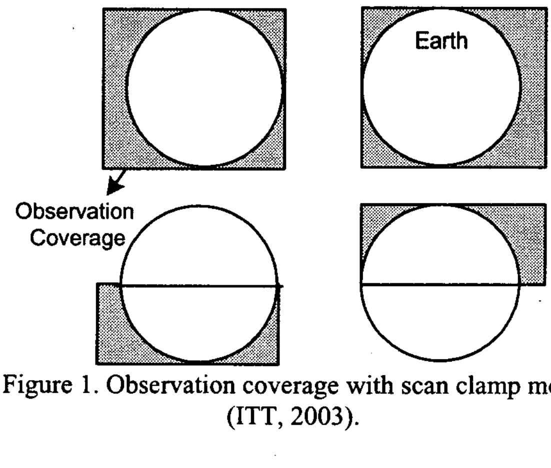

Figure 1. Observation coverage with scan clamp mode (ITT, 2003).

For small area or a part of the earth have partial E-W observation, space clamp mode is needed as shown in Figure 2. In this mode, the scan has restrictions on size or location to get the space look. Therefore it interrupts the scan process every 9.2 or 36.6 seconds to get space look for radiometric calibration of IR channels (ITT, 2003).

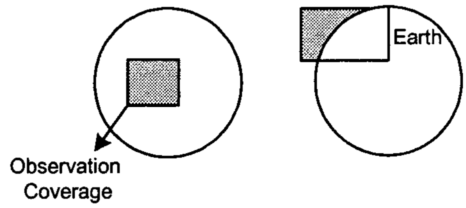

Figure 2. Possible observation coverage with space clamp mode (ITT, 2003).

2.2 Wideband Data Format

The wideband data format of ITT imager is consisted of active scan format for radiometric data and scan reversal format for auxiliary data such as space look, telemetry, and electronic calibration data. There're five kinds of block which consist of active scan and scan reversal format are as following:

- Active scan
- Telemetry
- Header or trailer
- E-cal
- Fill

They can be classified with the data block ID (DBID). The data discrimination for GOES-9 raw data analysis also conducted with basement on the DBID in this paper.

Though ITT Imager's manual (ITT, 2003) says that there're three redundant DBID per data block against data loss, we could find the redundant DBID were empty in the real GOES-9 raw data.

2.3 Operation for Radiometric Quality

2.3.1 Space Look and Blackbody Observation

Before the launch of every satellite, the radiometric calibration equation and some coefficients are characterized through the pre-launch calibration. The satellite can be revealed into the space environment, the change of calibration equation can be needed after launch. For inferring calibration slope, the data acquired at the blackbody observation are used and the data from the space looks are used to infer the calibration intercepts (Weinreb, 1997).

Because the temperature on three-stabilized satellites such as GOES and COMS can be changed by tens of degrees K diurnally, the frequent data collection of radiometric calibration is needed. For this, the space look can be occur every 2.2 (full disk), 9.2 or 36.6 seconds (small region). The pre-clamp (space-look before scan reversal) and post-clamp (space-look after scan reversal data) are acquired to reduce drifts which can occur between any two space-looks.

The blackbody observation is required every 19.4 or 30 minutes by automatic process or commands from ground. Detailed observation procedure, necessary commands, and needed time are described in reference materials (ITT, 2003) and (Weinreb, 1997).

2.4 Operation for Geometric Quality

2.4.1 Star Sensing

Because star sensing is the highest priority activity, it can occur within any frame. In the event that the space look or blackbody time-out occurs during star sequence, the space look is inhibited and occurs after the return to initial location.

To maintain location accuracy, GOES image navigation and registration(INR) system is deployed star sensing. When the time and location of a star is predicted, the imager points that location and the scan stopped. Selection of time and location for star sense must consider the processing scenario. While the imager are remained at the observation location with the star sequence mode, the imager will return to the initial scan location with the star sensing mode.

2.4.2 Image Motion Compensation

The ITT imager can provide the on-board processing by uploading Image Motion Compensation (IMC) coefficients to the satellite. IMC coefficients describe the orbit and attitude perturbation that can be predicted on next day. This is the key characteristic of GOES INR system which performs the on-board processing by correcting imager's pointing to null effects of the orbit and the attitude perturbation by using IMC coefficients uploaded from the ground system.

2.4.3 Special Observation

In addition to the star sensing for the location data, the small area observation is possible to conduct special observation when the observation area is covered with cloud and lack of possible landmarks. With observing parts out of interested observation region, we can acquire enough land-marks information. Though it is not the unique characteristics of ITT imager and one of operation policies, this kind of special observation can be considered for geometric data quality control.

3. ANALYSIS OF GOES-9 DATA

GOES-9 has become the operational meteorological satellite over the Western Pacific and Eastern Asia, positioned at 155 degrees East, by replacing the Japan Meteorological Agency's GMS-5 since 22 May 2003. The user dissemination data of GOES system is GVAR (GOES Variable data transmission format) and LRIT (Low Rate Information Transmission).

GOES-9 is operating with basement on the regular observation schedule. The full disk observation is performed once every hour and twice with 6 hour interval.

Besides the full disk observation, the small full disk and PAC-9 observation are also performed (http://www.ssd.noaa.gov).

3.1 Full Disk Observation

Because of the ITT imager's optical mirror characteristics, the observation data are over-sampled by a factor of 1.75 in east-west direction as shown in Figure 3. The full disk image data are scanned using the scan clamp mode. The Imager performs a space clamp during the turnaround on the same side as the active space look address.

Figure 3. GOES-9 full disk image data of VIS channel

The full disk observation of GOES-9 took for about 28.3 minutes and consisted of following data:

- Blackbody observation 1 time
- Earth observation scan during 26.4 minutes
- Star sensing 2 times

Because the space look in scan clamp mode is inhibited into the Earth observation scan every 2.2 seconds, the space look for radiometric quality control are included in the observation scan data. It is consisted of units of 1 active scan for radiometric data and 1 scan reversal data for changing scanning direction and space look. The above processes were occurred in the time sequence.

3.2 Small Full Disk Observation

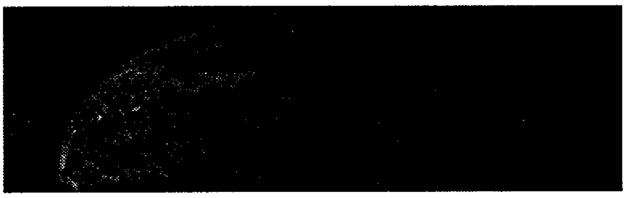

Figure 4. GOES-9 small full disk image data of VIS channel

The small full disk of GOES-9 is also observed in the scan clamp mode and consisted of following data:

- Blackbody observation 1 times
- Earth observation scan during 15.11 minutes
- Star sensing 2 times

Between the above processes, the scan reversal process including space look were observed with a 9.2 second interval and the frequent star sensing was also observed.

3.3 PAC-9 Observation

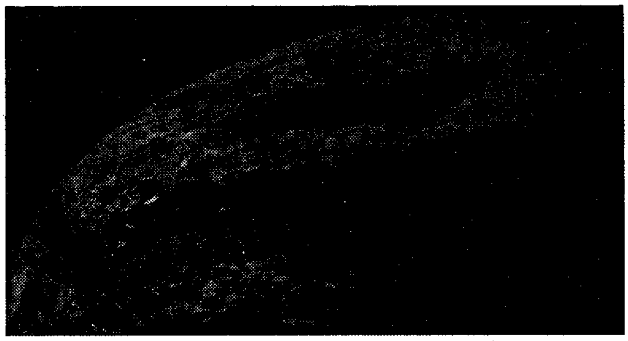

Figure 5. GOES-9 PAC-9 image data of VIS channel

The PAC-9 image data for East Asia are scanned using the space clamp mode and consisted of following data:

- Space look
- Earth observation scan during 9.24 minutes
- Space look

The scan reversal data including the space look are observed before or after of the earth scan. The active scan of Earth observation scan is 2751 blocks, while active scan of the full and small full disk observations were 5209 blocks. There was no star sensing during this PAC-9 observation. But the star sensing scenario can depend on the data quality requirement and operation policy.

4. CONCLUSION

In the ITT Imager manual, scan action progress can be interrupted by a higher priority activity such as star sensing or blackbody observation. But in the real data, we could observe the higher priority activities occurred before or after the scan action. Every observation seemed to be started with the blackbody observation. With the estimation based on the blackbody dwell time in all cases of this test is just 0.2 seconds, the blackbody which occurred before the scan action seems to be one of processes for scan initialization. Actually scan initialization occurs whenever scan system starts new. For a new start, the Scan ON command and Electronics ON command, and Scan Reset pulse commands are needed (ITT, 2003).

With limited number of raw data, the estimated result in this paper might include unexpected errors. In addition, the operation scheme such as the time and frequent number of special observation can be selected with basement on the operation policy and data quality requirement.

But this test can be good opportunities to compare the real data and ideal manual published by the imager company. In this paper, we concentrated on the blackbody observation, space look, and star sensing for ITT Imager's special action for data quality.

But the COMS will have two more payloads, we will have to consider the operation conflicts with other payloads and other operations such as station-keeping manoeuvres and eclipse for routine operation.

With the current design, the image data processing for COMS will be based on ground processing. There is no need to upload the IMC coefficient like GOES system, but we can use this property of ITT Imager for long-term imager pointing maintenance.

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