

**KMA REPORT ON THE STATUS OF CURRENT AND FUTURE SATELLITE**  
In response to CGMS action/recommendation

COMS (128.2°E) MI is currently operational and data are distributed via landline and satellite over Western Pacific region, and COMS GOCI over East Asian region.

The progress of the development of GEO-KOMPSAT-2A (meteorological mission) and -2B (ocean and environmental mission) scheduled to be launched in November of 2018 and 2nd half of 2019, respectively.

\*COMS : Communication, Ocean and Meteorological Satellite

\*GOCI : Geostationary Ocean Colour Imager

\*KARI : Korea Aerospace Research Institute

## Report on the status of current and future satellite systems

### 1 INTRODUCTION

COMS (Communication, Ocean, and Meteorological Satellite), the first Korean geostationary meteorological satellite, was launched successfully on June 27<sup>th</sup>, 2010 and has been operating at a longitude of 128.2°E since April 1<sup>st</sup>, 2011.

### 2 CURRENT SATELLITE SYSTEMS

| Sector       | Satellite in Orbit<br>P=pre-operational<br>Op=operational<br>B=back-up<br>L=limited availability | Operator   | Location | Launch date | Details on near real time access to L0/L1 data (Link) | Environmental payload and status   |
|--------------|--|------------|----------|-------------|---|--|
| West Pacific | COMS (Op)  | KMA, KIOST | 128.2°E  | 26/06/2010  | HRIT specification<br>LRIT specification              | 5-channel VIS/IR Meteorological Imager (MI), Geostationary Ocean Colour Imager (GOCI) Direct Broadcast via HRIT/LRIT |

## 2.1 Status of current GEO satellite systems

### 2.1.1 Mission objectives, payload/instruments, products

COMS meteorological mission is performed by MI (Meteorological Imager) with one visible channel and four infrared channels (Table 2.1).

The COMS MI observation data are disseminated to M/SDUS (Medium/Small Scale Data Utilization Stations) users in H/LRIT (High/Low Rate Information Transmission) formats within 15 minutes after the end of image scanning. Also, we provide high quality COMS MI level 1B data through land-based network via NMSC (National Meteorological Satellite Center) website (<http://nmssc.kma.go.kr/jsp/homepage/eng/main.do>) and FTP.

In this report, we introduce the current status and future plans of COMS MI operation performance and data services.

Table 2.1 : The channels of COMS/MI

| Channel | Wavelength<br>( $\mu\text{m}$ ) | Spatial Resolution<br>(km) |
|---------|---------------------------------|----------------------------|
| VIS     | 0.675                           | 1 x 1                      |
| SWIR    | 3.75                            | 4 x 4                      |
| WV      | 6.75                            | 4 x 4                      |
| IR1     | 10.8                            | 4 x 4                      |
| IR2     | 12.0                            | 4 x 4                      |

VIS: Visible

SWIR: Shortwave Infrared

WV: Water Vapor

IR: Infrared

The GOCI has 500m×500m pixel resolution (GSD) and a coverage area of 2,500km×2,500km covering Korea, Japan, the eastern coast of China, GOCI can acquire 16 slot images and compose one complete image of the GOCI coverage area at a center of 36°N and 130°E as shown in Figure 2.1. In addition, Table 2.2 presents the general specification of GOCI, which has an operational life of 7.7 years, and GOCI receives images eight times a day in hourly intervals from 00:15 GMT to 07:45 GMT.

Table 2.2: General Characteristics of COMS/GOCI

| GOCI on COMS                  |   |
|-------------------------------|---|
| Volume Size(mm <sup>3</sup> ) | 1,000 x 760 x 896                                       |
| Weight                        | < 83.3 kg   |
| Power                         | < 125 W   |
| Digitization                  | 12 bits   |
| Resolution (GSD)              | 500 m @ point of 130°E, 36°N                            |
| Observation Period            | 1 hour ( 8 times earth observation per 1 day )          |
| Field of regard               | Local Area<br>(2,500 km x 2,500km, Center: 130°E, 36°N) |
| Mission Life Time             | 7.7 years   |

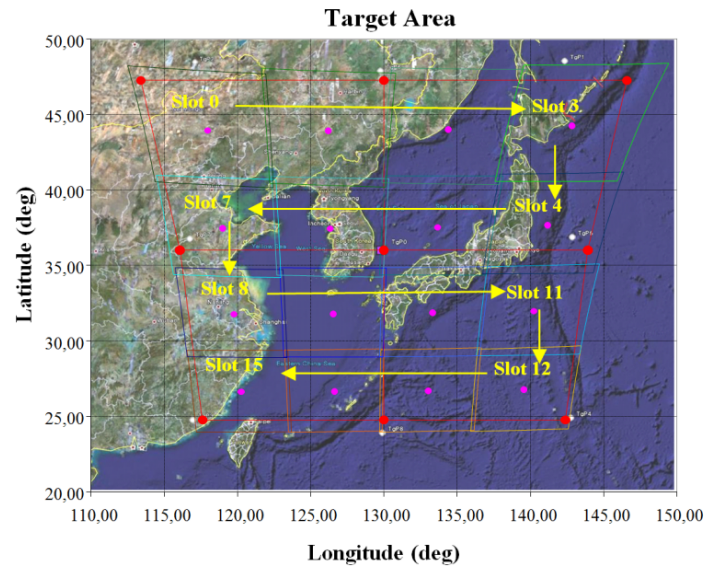


Figure 2.1: The target area of GOCI

### 2.1.2 Status of spacecraft

Since April 2011, the COMS mission is under the normal operation 24 hours a day 365days a year. The normal operation of the COMS is conducted by the Korea Aerospace Research Institute (KARI) using the Satellite Ground Control System (SGCS) in the Satellite Operation Center (SOC) of the KARI.

The COMS spacecraft is currently under normal operation without any problem to support the meteorological observation mission and the ocean monitoring mission.

### 2.1.3 Impact on spacecraft due to space weather

#### Space weather related spacecraft anomalies (Items in bold are required)

There was the interruption of COMS MI imaging from Feb. 10, 2018 20:44 (UTC) to Feb. 14, 2016 07:40 (UTC), which is due to the SET (Single Event Transient : A glitch caused by single event effect, which travels through combinational logic and is captured into storage element). During that period, there was no significant space weather event detected. The high energy particle flux was under 2.05 pfu at the energy above 2MeV and under 0.13 pfu at the particles with the energy above 10MeV. However, on-board FDIR (Fault Detection Isolation and Recovery) system indicated that an SET was recorded at the time of the problem. Hence SCU reset on SCU A and reconfiguration to SCU B were happened with MI stop imaging during COMS recovering period.

*Source: Recommendations for Contents of Anomaly Database for Correlation with Space Weather Phenomena, P. O'Brien, J.E. Mazur, T. Guild, November 2011, AEROSPACE Report No.TOR-2011(3903)-5.*

| 1. Date and Universal Time of the anomaly | 2. Fully specified location of the anomaly (spacecraft location) | 3. Velocity or orbital elements at time of the anomaly | 4. Eclipse state of the vehicle (full, penumbra, partial, none) | 5. Vector to Sun in spacecraft coordinates | 6. Velocity vector of spacecraft in spacecraft coordinates | 7. Initial guess at type of anomaly (See taxonomy below) | 8. Estimated confidence of that guess | 9. Anomaly category (e.g., affected system or kind of disruption) | 10. Vehicle identity | 11. Notes (e.g. unusual operational states or recent changes to operations (recent commands, attitude scheme, etc.) |
|---|--|--|---|--|--|--|---------------------------------------|---|----------------------|---|
| 2018-02-10 20:44(UTC)                     | 128.2°E over the equator   | GEO  | none  | -  | -  | SET  | SET                                   | Interruption in imaging   | COMS                 | Daytime normal operation , no severe impact by space weather expected at all  |

#### Taxonomy of Satellite Anomalies Caused by In Situ Charged Particle Environment (to be used for column 7):

##### 1. Electrostatic discharge (charging)

###### 1.1 Surface charging

###### 1.1.1 Plasma sheet (subauroral)

###### 1.1.2 Auroral

###### 1.2 Internal charging

##### 2.2 Heavy ions

###### 2.2.1 Galactic Cosmic Rays

###### 2.2.2 Solar energetic particles

###### 2.2.3 Geomagnetically trapped heavy ions

##### 3. Total Dose



- 1.2.1 Subsurface charging (e.g., beneath blanket)
- 1.2.2 Deep charging (e.g., inside a box)
- 2. Single-Event Effects
  - 2.1 Protons
    - 2.1.1 Solar proton event
    - 2.1.2 Geomagnetically trapped protons

- 3.1 Long-term dose accumulation (multiple causes combined)
- 3.2 Short-term (days or less) dose accumulation
  - 3.2.1 Solar protons
  - 3.2.2 Geomagnetically trapped protons
  - 3.2.3 Geomagnetically trapped electrons

### 2.1.4 Ground segment matters

The success rate of MI H/LRIT broadcast can be the standard of operation and real-time data service. We analysed the success rate from April 1, 2011 to March 31, 2018. The success of broadcast means that MI H/LRIT image data dissemination is completed within 15 minutes after the end of image scanning.

- Period: 04.01. 2011 ~ 03.31. 2018 (84 months)
- Success rate of broadcast: 97.62 % (209,877/214,987)

The broadcast failure cases were caused by ground system anomaly such as antenna and pre-processing system faults.

### 2.1.5 Data transmission

The observed meteorological data by COMS MI are broadcast to medium/small-scale data utilization stations (MDUS/SDUSs) after being converted into HRIT (High Rate Information Transmission) and LRIT (Low Rate Information Transmission) formats (Table 2.3). We provide the H/LRIT services free of charge and transmit encrypted data to identify the users of H/LRIT. The domestic and foreign MDUS/SDUSs that wish to use our services should make a formal application using the procedures outlined on the website of the National Meteorological Satellite Center (<http://nmssc.kma.go.kr/jsp/homepage/eng/contents/etc/member.jsp>). The technical documentations to learn about the application procedures for becoming a user station and the means to decrypt the encrypted data are posted on the website.



Figure 2.2: Concept of MI H/LRIT direct broadcasting

Currently, the FD and ENH images are broadcasted in both H/LRIT and three kinds of level 2 meteorological products images (cloud top temperature (CTT), cloud top pressure (CTP), cloud top height (CTH)) and GOCI images are broadcast in only LRIT. Figure 2.3 shows H/LRIT dissemination schedule which has officially carried out since April 1<sup>st</sup>, 2011.

Table 2.3: Classification of H/LRIT

| Classification         | HRIT   | LRIT     |
|------------------------|--------|----------|
| Data Transmission Rate | 3 Mbps | 512 kbps |

|              |  |  |
|--------------|--|--|
| Data Types   | MI image<br>Alpha numeric text<br>Encryption key message | MI image<br>Alpha numeric text<br>Encryption key message<br>GOCI image<br>Satellite meteorological products(Cloud Top Temperature, Cloud Top Pressure, Cloud Top Height) |
| Image mode   | FD, ENH  | FD, ENH  |
| User Station | MDUS   | SDUS   |

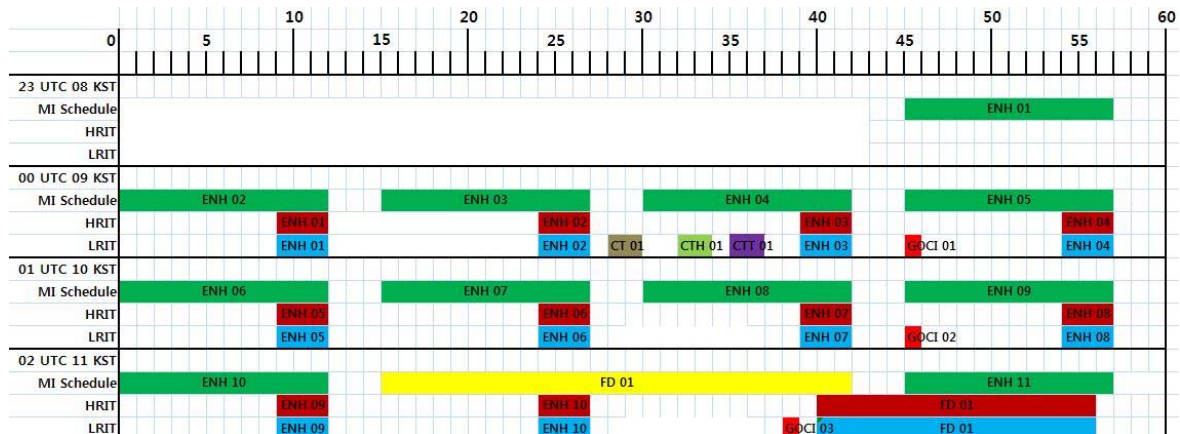


Figure 2.3: Sample of COMS MI H/LRIT dissemination schedule

The MOF issued the GOCI data distribution policy as the Minister's instruction. In the instruction, GOCI data can be distributed free of charge only for public/research purposes. But it takes payments for special request and commercial use. The intellectual property of both GOCI and GOCI data is belonged to the MOF and the re-distribution to third parties of distributed data is limited. The standard products passed the calibration and validation is only distributable on website or on the file transfer service. A distribution is based on this instruction.

The GOCI data has been provided as HDF-EOS5 (He5) format using the orthographic map projection. For a stable distribution service of GOCI data, various systems were installed in KOSC. KOSC developed GOCI Data Distribution System (GDDS) and a website (<http://kosc.kiost.ac>) to distribute geo-corrected satellite data and browsing image. GDDS has been distributed GOCI data to the users since April 2011 on this website restrictively. Some of GOCI level 2 data (Chl, TSS, CDOM, Lw, nLw) are available and GDPS for user can be downloaded in the web site.

All what users to do is to access to web server for the data searching. User can search data as specified date and sensor. Basic selected options are including sensor name, time, date1, date2 and amount of clouds, searching area and each products of each sensor in advanced selections. The function of cart and saving condition is added for user's convenience. User can download the searched/requested data from the data server through download component.

Data distribution for dedicated institution is performed by FTP push method. There are 16 domestic institutions which are getting the GOCI data through the FTP service



from KOSC. Interested in using the FTP service, an institution, who wants to receive the satellite data in near-real time, can fill out an application and send it to KOSC. But the institution should prepare the FTP system for receiving the data. It is just to minimize inconvenience of users by avoiding overloading the KOSC system. If there is no problem on the application through the review, KOSC will announce the start date to you by e-mail. Then the data will be sent from KOSC FTP to your system and the report on the transmission also sent you every day by e-mail. The report includes the result and information of the provided data. If there is any missed data, re-transmission can be required.

## 2.1.6 Projects, services

### (1) Service via Satellite

Please refer to 2.1.5.

### (2) Service via Landline

The NMSC provides COMS level 1B data of all five channels and level 2 products to users by posting the processed data on NMSC website

(<http://nmisc.kma.go.kr/jsp/eng/contents/main/main.jsp>). All registered members of the website can log on, search, and download those data up to 3GB and 500 files for one time request. Here is the list of COMS meteorological products open to users.

Table 2.4: The list of COMS MI products

| No. | Products                                      | Resolution | Period                     | Start Date of Service |
|-----|---|------------|----------------------------|-----------------------|
| 1   | Cloud analysis (cloud type, phase and amount) | 4 km       | 15 min.                    | 1 Apr. 2011           |
| 2   | Cloud top pressure/temperature/height         | 4 km       | 15 min.                    |                       |
| 3   | Atmospheric Motion Vector (AMV)               | 64 km      | 1 hour                     |                       |
| 4   | Cloud detection                               | 4 km       | 15 min.                    |                       |
| 5   | Fog   | 4 km       | 15 min.                    |                       |
| 6   | Aerosol index (AI)                            | 4 km       | 15 min.                    |                       |
| 7   | Sea surface temperature (SST)                 | 4 km       | 1-, 5-, 10-day composition | 10 Aug. 2011          |
| 8   | Rain intensity (RI)                           | 4 km       | 15 min.                    |                       |
| 9   | Outgoing longwave radiation (OLR)             | 4 km       | 1 day                      |                       |
| 10  | Upper tropospheric humidity (UTH)             | 36 km      | 15 min.                    |                       |
| 11  | Land Surface Temperature                      | 4 km       | 15 min.                    | 10 Feb. 2012          |
| 12  | Snow and Sea Ice                              | 4 km       | 1 day/8 day                |                       |
| 13  | Total Precipitation                           | 4 km       | 15 min.                    |                       |
| 14  | Clear Sky Radiance                            | 28 km      | 15 min.                    |                       |

Currently near real-time FTP service of COMS HRIT data is only open to organizations which has MOU conclusion for data exchange with NMSC such as NESDIS, EUMETSAT. Last seven days of COMS HRIT data are stored in FTP disk, so the authorised organization can get those data via land-based network once they get FTP account of it.

Contact information for request FTP account: [kmasod@korea.kr](mailto:kmasod@korea.kr)

### (3) DCPC-NMSC

As a part of WIS DCPC project lead by WMO, NMSC accomplished the construction of DCPC-NMSC and started normal operation on 29<sup>th</sup> March 2013 for providing COMS meteorological data as below list.

- All five channels level 1B in binary and graphic file format
- Eleven level 2 products in binary and graphic file format as below:
  - (1) Cloud detection
  - (2) Land surface temperature
  - (3) Total precipitable water
  - (4) Cloud analysis (cloud top temperature/pressure/height, cloud type, cloud amount, cloud phase, cloud optical thickness)
  - (5) Fog
  - (6) Rainfall Intensity
  - (7) Atmospheric motion vector
  - (8) Sea surface temperature
  - (9) Sea ice/snow cover detection
  - (10) Outgoing longwave radiance
  - (11) Clear Sky Radiance

The registered user can search, access, download the COMS meteorological data on this user portal web address : <http://dcpc.nmsc.kma.go.kr>



Figure 2.4: Main page of DCPC-NMSC website

### **2.1.7 User statistics**

#### **(1) Domestic**

NMSC provides COMS data to 19 domestic KMA-related via FTP in real time such as the military, broadcasting companies, disaster prevention centers, and local governments. To receive COMS L/HRIT data, 12 MDUSs and 6 have been installing at 13 organizations: Air Force, National Fisheries Research and Develop Institute, Korea Meteorological Industry Promotion Agency, Seoul Emergency Management Center, National Science Museum and so on since 2011. To get COMS data via Internet, around 1,100 members are registered on NMSC website until end of May2017.

#### **(2) International**

Currently, 15 MDUSs and 10 SDUSs have been installed at 25 foreign organizations since 2011 including Air Force weather Agency of US(Guam and Okinawa), Department of Meteorology of Sri Lanka, Hongkong Observatory, Laos Department of Meteorology and Hydrology, Central Weather Bureau of Taiwan, Japan Agency Marine-Earth Sciences and Technology, Chulalongkorn University in Thailand, Vietnamese Air Force and Air Defence and so on.

For ODA (Official Development Assistance) activities, KMA had supported COMS receiving, processing systems and education program for the Philippines being managed by KOICA (Korea International Cooperation Agency) for two years from 2014 as a follow-up project for Sri Lanka which was accomplished in 2012. Now KMA is preparing to extend this kind of project to Asian user countries for GEO-KOMPSAT-2A.

### 3 FUTURE SATELLITE SYSTEMS

| Sector       | Satellite in Orbit<br>P=pre-operational<br>Op=operational<br>B=back-up<br>L=limited availability | Operator   | Location | Launch date    | Details on near real time access to L0/L1 data (Link) | Environmental payload and status  |
|--------------|--|--|----------|----------------|---|---|
| West Pacific | GEO-KOMPSAT-2A(P)  | KMA  | 128.2°E  | November, 2018 |   | Advanced Meteorological Imager (AMI), Space Environmental monitoring payload Direct broadcast via UHRIT/HRIT/LRIT |
|              | GEO-KOMPSAT-2B(P)  | MOF( Ministry of Oceans and Fisheries),<br>ME(Ministry of Environment) | 128.2°E  | October, 2019  |   | Advanced Geostationary Ocean Colour Imager(GOCI-II), Geostationary Environmental Monitoring Spectrometer(GEMS)    |

### 3.1 Status of future GEO satellite systems

GEO-KOMPSAT-2 program had been started under the cooperation with Ministry of Science, ICT and Future Planning (MSIP), Ministry of Oceans and Fisheries (MOF), and Ministry of Environment (ME) of Korean government, and kicked off in the middle of 2012.

The GEO-KOMPSAT-2 consists of a pair of satellites for multi-purpose. One (GEO-KOMPSAT-2A) is for meteorological dedicated satellite with the space weather as a piggyback mission. The other (GEO-KOMPSAT-2B) is for ocean and environmental missions. Ocean mission is to monitor the ocean colour using an advanced Geostationary Ocean Colour Imager (GOCI) continuously. The environmental mission is to monitor atmospheric environments globally with the first payload carried on the geostationary satellite. The GEO-KOMPSAT-2A and -2B satellites will be launched in November 2018, and 2nd half of 2019, respectively.

#### 3.1.1 Mission objectives, spacecraft, payload/instruments, products

##### Observation mission

The Advanced Meteorological Imager, the payload for meteorological mission of GEO-KOMPSAT-2A, is comparable to those of the ABI and AHI imager on board Himawari-8/9 and GOES-R. The detailed specification of AMI is as follows:

- Multi-channel capacity: 16 channels (4 visible, 2 near-infrared and 10 infrared channels)
- High spatial resolution: 0.5-1.0 km for visible and 2 km for infrared channels
- Fast imaging: within 10 minutes for Full Disk observation
- Flexibility for the regional area selection and scheduling

The channel characterizations of the AMI are summarized in Table 3.1.

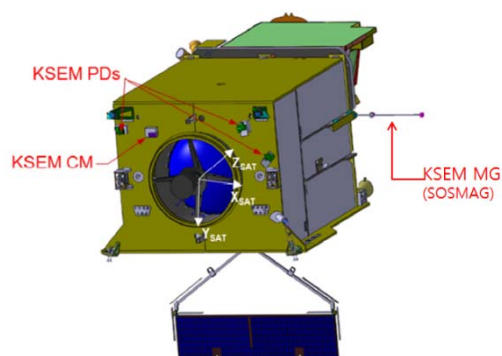
Table 3.1: Channel characterizations of the AMI for the GEO-KOMPSAT-2A satellite

| Bands |        | Center Wavelength (measured, $\mu\text{m}$ ) | Band Width (Measured, $\mu\text{m}$ ) | Resolution (km) | SNR | NE $\Delta$ T(K) (240/300K) | Radiometric Accuracy |
|-------|--------|--|---------------------------------------|-----------------|-----|-----------------------------|----------------------|
| VNIR  | VIS0.4 | 0.4702                                       | 0.0408                                | 1               | 250 |                             | 5%                   |
|       | VIS0.5 | 0.5086                                       | 0.0291                                | 1               | 250 |                             | 5%                   |
|       | VIS0.6 | 0.6394                                       | 0.0808                                | 0.5             | 120 |                             | 5%                   |
|       | VIS0.8 | 0.8630                                       | 0.0344                                | 1               | 210 |                             | 5%                   |
|       | NIR1.3 | 1.3740                                       | 0.0155                                | 2               | 300 |                             | 5%                   |
|       | NIR1.6 | 1.6092                                       | 0.0410                                | 2               | 300 |                             | 5%                   |
| MWIR  | IR3.8  | 3.8316                                       | 0.1912                                | 2               |     | 3/0.2                       | 1K                   |
|       | IR6.3  | 6.2104                                       | 0.8397                                | 2               |     | 0.4/0.1                     | 1K                   |
|       | IR6.9  | 6.9413                                       | 0.4004                                | 2               |     | 0.37/0.1                    | 1K                   |
|       | IR7.3  | 7.3266                                       | 0.1823                                | 2               |     | 0.35/0.12                   | 1K                   |
|       | IR8.7  | 8.5881                                       | 0.3552                                | 2               |     | 0.27/0.1                    | 1K                   |
| LWIR  | IR9.6  | 9.6210                                       | 0.3789                                | 2               |     | 0.35/0.15                   | 1K                   |
|       | IR10.5 | 10.3539                                      | 0.4683                                | 2               |     | 0.4/0.2                     | 1K                   |

|  |        |         |        |   |  |          |      |
|--|--------|---------|--------|---|--|----------|------|
|  | IR11.2 | 11.2285 | 0.6636 | 2 |  | 0.19/0.1 | 1K   |
|  | IR12.3 | 12.3651 | 1.1072 | 2 |  | 0.35/0.2 | 1.1K |
|  | IR13.3 | 13.2870 | 0.5566 | 2 |  | 0.48/0.3 | 1.1K |

※ SNR@100% albedo, NEdT@240/300K, calibration accuracy@100% albedo/300K

KMA in coordination with KARI and KHU (KyungHee University) completed two major milestones of KSEM by successfully completing Critical Design Review (CDR) on October 2015, respectively. KSEM will be in operation over local time of the Korean Peninsular from 2018 and consists of particle detector (PD), a set of dual magnetometers (MAG), and a spacecraft charging monitor (CM). The energetic particle detectors simultaneously measure the population of charged particles in the energy range of at least 100 keV ~ 2 MeV for electrons and 100 keV ~ 20 MeV for



protons, respectively, over the six viewing angles. The dual magnetometer samples variations of low frequency magnetic fields at two different locations on a deployable boom to accurately measure the Earth's magnetic fields by separating the spacecraft contribution. The spacecraft charging monitor measures integrated fluxes of electrons above ~ 1 MeV that is crucial for the satellite operation. KSEM specification is as follows:

| Sensor                     | Requirements   | Application Field   |
|----------------------------|--|---|
| Particle Detector          | <ul style="list-style-type: none"> <li>- Electron energy range : ~100keV ~ 2 MeV</li> <li>- Angular Resolution (pitch angle): 60° at least</li> </ul>                      | Global Electron Distribution<br>Particles distribution on geostationary |
| Magnetometer               | <ul style="list-style-type: none"> <li>- Measurement range : <math>\pm 64,000\text{nT}</math> (in 3 axes)</li> <li>- Field resolution : 1nT at least (on orbit)</li> </ul> | Prediction for Dst and Kp Index   |
| Satellite Charging Monitor | <ul style="list-style-type: none"> <li>- Current range: <math>\pm 3\text{pA/cm}^2</math></li> <li>- Measurement resolution : 0.001pA/cm<sup>2</sup></li> </ul>             | Satellite Charging Index  |

In addition to AMI in GEO-KOMPSAT-2A, Geostationary Ocean Colour Imager-II (GOCI-II) is another payload under the GEO-KOMPSAT-2 program. Korea Institute of Ocean Science & Technology (KIOST), independent national institute established by dedicated law, is responsible for the definition of mission and user requirements, and for the operation of GOCI-II.

GOCI-II is a next generation of GOCI, one of the major payloads in COMS, which is the 1st ocean colour imager in the world operating on the geostationary orbit. GOCI has been developed to provide a monitoring of ocean colour around the Korean Peninsula to detect, monitor, quantify, and predict short term changes of coastal ocean environment for marine science research and application purpose. GOCI-II is expected to have highly enhanced radiometric/geometric performance in comparison with GOCI.

Table 3.2 shows the spectral bands and radiance performance of GOCI-II including the new spectral bands. Additional spectral bands will be expected to perform specific coastal monitoring and application researches as well as more accurate atmospheric correction will be possible in this research area.

Table 3.2: Spectral Bands and Radiance Performance of GOCI-II

| Band | Band Center | Band-width | Nominal Radiance | Maximum Ocean Radiance | Threshold Radiance | Maximum Cloud Radiance | SNR @ nominal radiance |
|------|-------------|------------|------------------|------------------------|--------------------|------------------------|------------------------|
| 1    | 380 nm      | 20 nm      | 93               | 139.5                  | 143.1              | 634.4                  | 998                    |
| 2    | 412 nm      | 20 nm      | 100              | 150.0                  | 152.0              | 601.6                  | 1,050                  |
| 3    | 443 nm      | 20 nm      | 92.5             | 145.8                  | 148.0              | 679.1                  | 1,145                  |
| 4    | 490 nm      | 20 nm      | 72.2             | 115.5                  | 116.0              | 682.1                  | 1,228                  |
| 5    | 510 nm      | 20 nm      | 64.9             | 108.5                  | 122.0              | 665.3                  | 1,180                  |
| 6    | 555 nm      | 20 nm      | 55.3             | 85.2                   | 87.0               | 649.7                  | 1,124                  |
| 7    | 620 nm      | 20 nm      | 53.3             | 64.1                   | 65.5               | 629.5                  | 1,102                  |
| 8    | 660 nm      | 20 nm      | 32.0             | 58.3                   | 61.0               | 589.0                  | 1,060                  |
| 9    | 680 nm      | 10 nm      | 27.1             | 46.2                   | 47.0               | 549.3                  | 914                    |
| 10   | 709 nm      | 10 nm      | 27.7             | 50.6                   | 51.5               | 450.0                  | 914                    |
| 11   | 745 nm      | 20 nm      | 17.7             | 33.0                   | 33.0               | 429.8                  | 903                    |
| 12   | 865 nm      | 40 nm      | 12.0             | 23.4                   | 24.0               | 343.8                  | 788                    |
| 13   | Wideband    |            | -                | -                      | -                  | -                      | -                      |

※ Spectral radiances values are in  $\text{Wm}^{-2}\mu\text{m}^{-1}\text{sr}^{-1}$

GEMS will contribute to the understanding of the globalization of pollution events, source/sink identification, and long-range transport of pollutants and short-lived climate forcers (SLCFs), as a part of the activities of Atmospheric Composition Constellation under the Committee on Earth Observation Satellites (CEOS). This Constellation coordination activity is focused on collaboration to improve and extend data utilization from the planned missions. The missions now funded are: Korea (GEMS), Europe (Sentinel-4), and the US (TEMPO) will enable the “baseline” constellation data products.

GEMS is expected to contribute monitoring air quality and SLCFs including ozone and aerosols in Asia in high temporal and spatial resolution. Using a scanning UV-Visible spectrometer, its observations can contribute to provide a set of tropospheric column products over the Asia-Pacific region at spatial resolution of ~8 km and temporal resolution of 1 hour. Other products include NO<sub>2</sub>, HCHO, SO<sub>2</sub>, and aerosol optical depth.

Table 3.3 shows GEMS requirements for mission success.

Table 3.3: Payload Requirement of GEMS

| Item            | Requirement   |
|-----------------|---|
| Lifetime        | > 10 years after IOT  |
| Reliability     | > 0.85 @ 7 years  |
| Field of regard | > 5,000 km(N/S) × 5,000 km(E/W) N/S: 45°N ~ 5°S, E/W: Selectable between 75°E ~ 145°E |



|                                  |   |
|----------------------------------|---|
| Duty cycle/Imaging time          | 8 images during daytime<br>(30 min imaging + 30 min rest) × 8 times/day                         |
| Ground sampling distance         | < 7 km(N/S) at Seoul GSD area < 56km <sup>2</sup> at Seoul(Aspect ratio shall be less than 1:3) |
| Spectral range                   | 300 nm to 500 nm  |
| Spectral resolution              | < 0.6 nm  |
| Spectral sampling                | < 0.2 nm  |
| Signal-to-noise ratio            | > 720 @ 320 nm<br>> 1500 @ 430 nm   |
| Data quantization                | ≥ 12 bits   |
| MTF (Instrument level)           | > 0.3 in N/S direction @ Nyquist frequency<br>> 0.3 in E/W direction @ Nyquist frequency        |
| Radiometric calibration accuracy | < 4%  |
| Spectral calibration accuracy    | < 0.02 nm   |
| Polarization factor              | < 2% (310-500 nm)<br>No inflection point within 20nm for all wavelength range                   |

The schedule for GEO-KOMPSAT-2A and 2B program is shown in Figure 3.2.

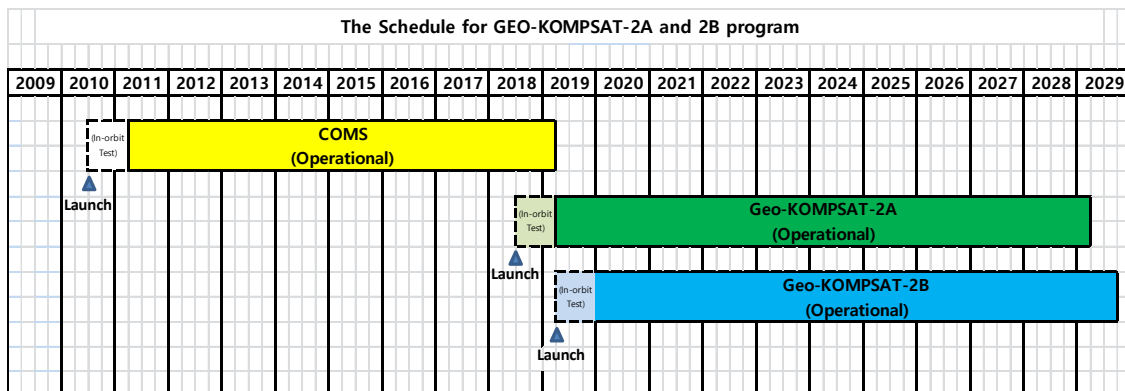


Figure 3.2: Schedule for the GEO-KOMPSAT-2

### 3.1.2 Ground segment matters

In July 2014, NMSC/KMA kicked off the project of ground segment development that will receive data from Geo-KOMPSAT-2A spacecraft, generate real-time Geo-KOMPSAT-2A meteorological/space weather products and disseminate data via Geo-KOMPSAT-2A broadcasting. The top-notch Information & Communication Technologies and scientific capabilities will be applied to handle the vast volume of Geo-KOMPSAT-2A data in real-time manner consistent with user requirements. For non-stop operation and real-time data service, back-up systems will be equipped for all components and the remote data storage concept will be implemented for enhancing data security.



The timeline of Geo-KOMPSAT-2A ground segment development consists of three phases as below:

- Phase 1 (2014~2015) : System Design and Algorithm Development
- Phase 2 (2016~2017) : Implementation and Integration
- Phase 3 (2018~2019) : In-orbit Ground Test and Preparation of Normal Operation

Currently the project is in stage of Phase 3 as scheduled and the Thermal-Vacuum tests for were carried out in May 2018. The Figure 3.3 displays the time schedule of Geo-KOMPSAT-2A ground segment development, which might be modified according to the Geo-KOMPSAT-2A satellite development progress and budgeting for this project.

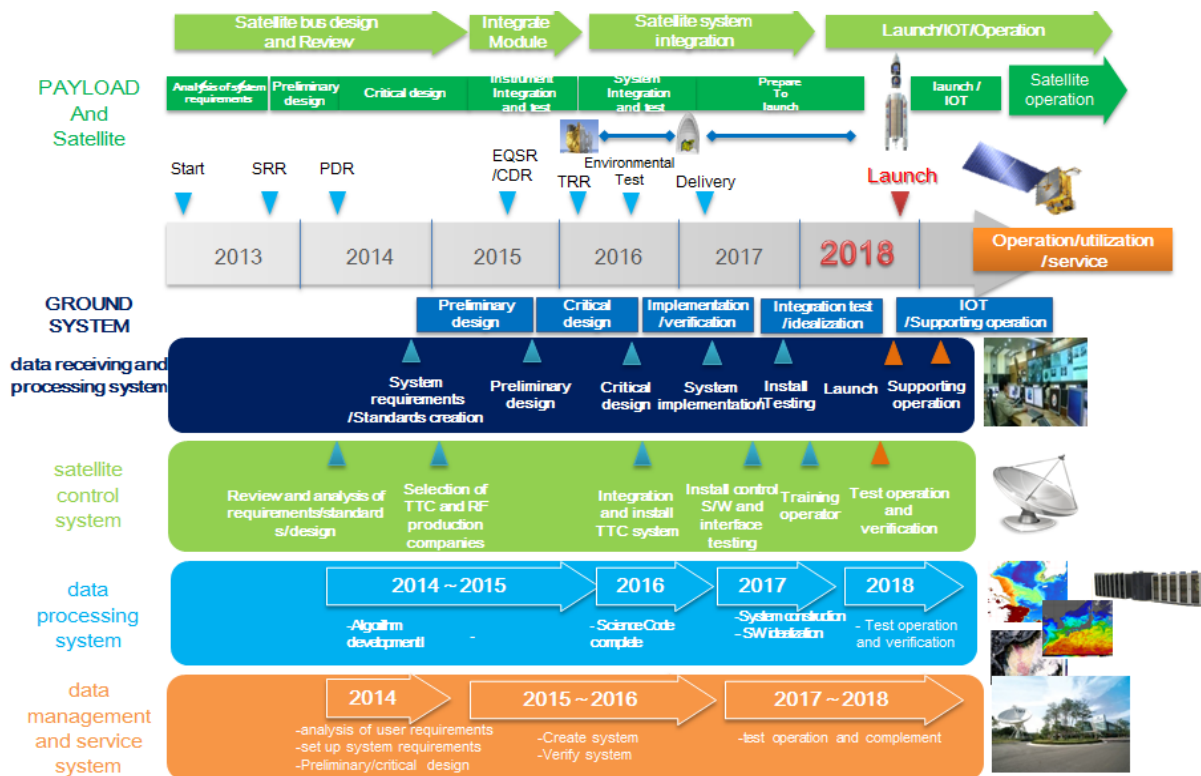


Figure 3.3: Schedule for the space/ground segment development of the GEO-KOMPSAT-2A

Based on 16 channels measurement of Geo-KOMPSAT-2A, 52 kinds of meteorological products in Table 3.4 will be generated and parts of them will be utilized for operation and released to users.

Table 3.4: List of meteorological products for Geo-KOMPSAT-2A

| Scene & Surface Analysis (13) | Cloud & Precipitation (14) | Aerosol & Radiation (14)          | Atmospheric condition & Aviation (11) |
|-------------------------------|----------------------------|-----------------------------------|---------------------------------------|
| Cloud detection               | Cloud Top Temperature      | Aerosol Detection                 | Atmospheric Motion Vector             |
| Snow Cover                    | Cloud Top Pressure         | Aerosol Optical Depth             | Vertical Temperature Profile          |
| Sea Ice Cover                 | Cloud Top Height           | Asian Dust Detection              | Vertical Moisture Profile             |
| Fog                           | Cloud Type                 | Asian Dust Optical Depth          | Stability Index                       |
| Sea Surface Temperature       | Cloud Phase                | Aerosol Particle Size             | Total Precipitable Water              |
| Land Surface Temperature      | Cloud Amount               | Volcanic Ash Detection and Height | Tropopause Folding Turbulence         |
| Surface Emissivity            | Cloud Optical Depth        | Visibility                        | Total Ozone                           |
| Surface Albedo                | Cloud Effective Radius     | Radiances                         | SO <sub>2</sub> Detection             |
| Fire Detection                | Cloud Liquid Water Path    | Downward SW Radiation (SFC)       | Convective Initiation                 |
| Vegetation Index              | Cloud Ice Water Path       | Reflected SW Radiation (TOA)      | Overshooting Top Detection            |
| Vegetation Green Fraction     | Cloud Layer/Height         | Absorbed SW Radiation (SFC)       | Aircraft Icing                        |
| Snow Depth                    | Rainfall Rate              | Upward LW Radiation (TOA)         |                                       |
| Current                       | Rainfall Potential         | Downward LW Radiation (SFC)       |                                       |
|                               | Probability of Rainfall    | Upward LW Radiation (SFC)         |                                       |

### 3.1.3 Data Service

The baseline of data broadcast policy for Geo-KOMPSAT-2A is to disseminate all 16 channels data of meteorological observations in Ultra HRIT (tentatively named as UHRIT) and to maintain H/LRIT broadcast corresponding to COMS five channels.

Below table is the current status of international registration request of frequency for Geo-KOMPSAT-2A which was submitted to International Telecommunication Union (ITU) on June 4<sup>th</sup>, 2012. The uplink/downlink frequency domains for Geo-KOMPSAT-2A mission will be determined afterward within the requested bandwidth of each frequency band.

Table 3.5: International frequency registration request for Geo-KOMPSAT-2A.

| Category | Uplink (MHz)                | Downlink (MHz)                           |
|----------|-----------------------------|--|
| L-Band   | -                           | 1670 ~ 1710<br>( for L/HRIT)             |
| S-Band   | 2025 ~ 2110<br>( for UHRIT) | 2200 ~ 2290<br>(for UHRIT)               |
| X-Band   | 8175 ~ 8215<br>(for UHRIT)  | 7450 ~ 7550<br>(for Sensor Data & UHRIT) |
|          | -                           | 8025 ~ 8400<br>(for Sensor Data & UHRIT) |

For landline service of Geo-KOMPSAT-2A, we are planning two ways to provide the data for domestic and international users in real-time and non-real-time. One way is a real-time service of level 1B similar to Himawaricloud which is being provided by JMA and the other way is a conventional user request based data service via the NMSC website. Those functions will be implemented in timeline scheduled in Figure 3.3.

### **3.2 Status of future LEO satellite systems**

### **3.3 Status of future HEO [or other] satellite systems**

Not applicable

## **4 ACTIONS AND/OR RECOMMENDATIONS FOR CONSIDERATION BY CGMS PLENARY SESSION**

Not applicable

## **5 CONCLUSIONS**