Current Status and Future Plan of KMA Satellite Program

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Contents

1. Current Status of COMS
2. Utilization of COMS data
3. Plan for Geo-KOMPSAT-2A
Current Status of COMS
COMS Program

COMS is the first multi-purpose geostationary satellite for Korea in the application of Meteorology, Ocean and Communication

- Meteorological Mission: Continuous Observation to support weather forecasting and early detection of severe weather phenomena
- Development period: 2003 - 2010 (8 yrs)
- Orbit: 128.2°E over equator (36,000 km)
- Design life: 7 years
- Launch: June 2010
- Operation: April 2011 ~
COMS Ground Segment

COMS

HRIT/LRIT

MDUS/SDUS

User Agencies

NWP

KMA

KARI

(Korea Aerospace Research Institute)

Internet

End User

HRIT (High Rate Information Transmission)
LRIT (Low Rate Information Transmission)
Observation Schedule for COMS

- FD every 3 hour
- ENH every 15 min
- KPeninsular 8 times an hour
- Every 30 min → 15 min
  Early detection of severe weather

COMS VIS 2014. 3. 24 23:45 UTC[02. 14 08:45 KST] KMA
COMS MI Schedule Modification for Satellite Operation

- Station keeping: 2 times/week (N-S(TUE), E-W(THR))
- House keeping: 2 times/day (06:45 15:21 UTC)
- Albedo monitoring: 1 time/day (Around 21:35 UTC)
- Dark image observation: 1 time/3 months
- Moon observation: 1 time/month
Result of COMS Data Service (via COMS)

- Average of COMS data services for HRIT: 99.31% (April 2011 ~ August 2014)
  - COMS HRIT Services : 104,851/105,023 (April 2011 ~ August 2014, for 40 months)
COMS Data Services

Service via COMS (HRIT/LRIT)
- Asia-Pacific region covering 30 nations with 2.2 billion people
- 10 domestic stations and several foreign stations are operating
  KMA supports some foreign stations via ODA

Service via FTP
- Domestic
  - 21 domestic KMA-related organizations such as the military, broadcasting companies, disaster prevention centers and local government
- International
  - EUMETSAT, CIMSS(US), Hongkong (on progress) etc.

Service via Internet
- NMSC provides COMS Level 1B data of all five channels and Level 2 products to users by posting the processed data on NMSC Website
WELCOME TO THE DCPC NMSC PORTAL

As a WMO Information System, DCPC NMSC is operating by the National Meteorological Satellite Center. The DCPC NMSC will provide the COMS (Communication, Ocean and Meteorological Satellite) Level 1, 2:
- Metadata search on the satellite data and satellite data HTTP, FTP, EMAIL through providing services.
- Satellite data provided basic data (Level1), product data (Level2).

Meteorological missions of COMS:
- Continuous monitoring of imagery and extracting of meteorological products.
- Early detection of severe weather phenomena.
- Monitoring of climate change and atmospheric environment.

Basic 5 channels:

Visible
- Wavelength: 0.67 μm
- Spatial Resolution: 1Km
- Weekly cloud imagery, Asian dust, forest fire, fog observation, atmospheric motion vector.

Infrared1
- Wavelength: 10.8 μm
- Spatial Resolution: 4Km
- Cloud information, sea surface temperature, Asian dust observation.

Infrared2
- Wavelength: 12.0 μm
- Spatial Resolution: 4Km
- Cloud information, sea surface temperature, Asian dust observation.

Shortwave Infrared
- Wavelength: 3.7 μm
- Spatial Resolution: 4Km
- Night fog & low-level clouds, forest fire detection, land surface temperature.

Water vapor
- Wavelength: 8.7 μm
- Spatial Resolution: 4Km
- Observation of mid and upper atmospheric humidity & upper atmospheric motions.

What's New:

- OBS_COMS_V1L2_TPW_HDF_ENH
- OBS_COMS_V1L2_CSR_R1_HDF_ENH
- OBS_COMS_V1L2_CSR_R2_HDF_F
- OBS_COMS_V1L2_CSR_R2_HDF_ENH
- OBS_COMS_V1L2_CSR_SWIR_HDF_ENH
Cooperation with Asian-Pacific Countries

- **Project**: Establishment of receiving and analysis system of COMS
- **Targets**: Sri Lanka (‘10~’12), Philippines (‘13~’14), Laos (‘13~’14)
- **Contents**: Receiving system (H/W, S/W)
  - Operational monitoring and analysis system
  - Technological support & Training
International Conference

◆ WMO RA II Pilot Project Virtual Laboratory (VLab) High Profile Training Event
  ▪ 4~6 October, 2012 (3days) / NMSC

◆ The 2nd Meeting of the Coordination group of the RA II Pilot Project
  ▪ 8 October, 2012 / Suite Hotel, Jeju Island, Korea

◆ The 3rd Asia-Oceania Met. Sat. Users’ Conference
  ▪ 29~12 October 2012 / Suite Hotel, Jeju Island, Korea

◆ The 19th International TOVS Study Conference
  ▪ 26 March ~ 1 April, 2014 / Lotte Hotel, Jeju Island, Korea
Utilization of COMS Data
COMS Data Products

◆ 16 Baseline Products: Development (2003-2010) and operation (2011~)

- SST (Sea Surface Temperature)
- CLD (Cloud Detection)
- AMV (Atmospheric Motion Vector)
- LST (Land Surface Temperature)
- SSI (Snow/Sea Ice)
- TPW (Total Precipitable Water)
- CTT/CTH (Cloud Top Temperature/Height)
- CA (Cloud Analysis)
- AOD (Aerosol Optical Depth)
- AI (Aerosol Index)
- OLR (Outgoing Longwave Radiation)
- RI (Rainfall Intensity)
- UTH (Upper Tropospheric Humidity)
- CSR (Clear Sky Radiance)
- INS (Insolation)
<table>
<thead>
<tr>
<th>Group</th>
<th>Product Name</th>
<th>Area</th>
<th>Alg. Dev.</th>
<th>Remarks</th>
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</thead>
<tbody>
<tr>
<td><strong>Scene Analysis</strong></td>
<td><strong>Cloud Detection (CLD)</strong></td>
<td>FD / ENH / LA</td>
<td>NIMR</td>
<td>Apr 2011</td>
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<tr>
<td></td>
<td><strong>Fog Detection (FOG)</strong></td>
<td>East Asia</td>
<td>NIMR</td>
<td>Apr 2011</td>
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<td><strong>Snow/Sea Ice (SSI)</strong></td>
<td>FD / ENH + comp.</td>
<td>NIMR</td>
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<td>East Asia</td>
<td>Pusan NU</td>
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<td><strong>Aerosol Optical Depth (AOD)</strong></td>
<td>East Asia</td>
<td>YSU</td>
<td>Jan 2012</td>
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<td><strong>Cloud Type (CT)</strong></td>
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<td><strong>Cloud Phase (CP)</strong></td>
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<td><strong>Cloud Optical Thickness (COT)</strong></td>
<td>FD / ENH / LA</td>
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<td><strong>Cloud Top Temp./Height (CTTH)</strong></td>
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<td>SNU</td>
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<td><strong>Rainfall Intensity (RI)</strong></td>
<td>East Asia / LA</td>
<td>Kangnung NU</td>
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<td><strong>Total Precipitable Water (TPW)</strong></td>
<td>East Asia</td>
<td>Kyoungpook NU</td>
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<td><strong>Surface Information</strong></td>
<td><strong>Sea Surface Temperature (SST)</strong></td>
<td>FD / ENH + comp.</td>
<td>SNU</td>
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<td><strong>Land Surface Temperature (LST)</strong></td>
<td>East Asia</td>
<td>Kongju NU</td>
<td>Jan 2012</td>
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<tr>
<td><strong>Radiation Information</strong></td>
<td><strong>Clear Sky Radiance (CSR)</strong></td>
<td>FD / ENH</td>
<td>NIMR</td>
<td>Jan 2012</td>
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<td></td>
<td><strong>Insolation (INS)</strong></td>
<td>FD / ENH</td>
<td>Pukyoung NU</td>
<td>Jan 2012</td>
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<td><strong>Outgoing Longwave Radiation (OLR)</strong></td>
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<td>SNU</td>
<td>Aug 2011</td>
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<td><strong>Wind</strong></td>
<td><strong>Atmospheric Motion Vector (AMV)</strong></td>
<td>Enhanced Northern Hemi.</td>
<td>NIMR</td>
<td>Apr 2011</td>
</tr>
</tbody>
</table>
COMS data quality monitoring

Algorithm improvement from feedback and continuous effort for user satisfaction through the COMS data quality monitoring and evaluation in real time.
Utilization (1/2)

COMS Composite Images

Global Satellite Composite Image

Disaster Mitigation

Short-term / Nowcasting
Utilization (2/2)

Ocean Meteorology

Climate/Environment Monitoring

Hydrological Application

Agriculture
QPE (Quantitative Precipitation Estimates) from COMS

QPE from Tb_IR & Rain rate_MW

\[ \text{Tb}_{\text{IR}} + \text{RR}_{\text{SSM/I}} = \text{COMS RI} \]

QPE from Tb_IR, WV & Rain rate_Radar

\[ \text{Tb}_{\text{IR}}, \text{Tb}_{\text{WV}} + \text{RR}_{\text{Radar}} = \text{COMS CRR} \]
QPE (Quantitative Precipitation Estimates) from GEO(COMS)

Heavy rain monitoring from COMS Rainfall Intensity: Aug 29, 2013
Nowcasting & Short-range Weather Forecasting

Integration of COMS data with ground-based observation data

- Infrared image
- Infrared image + AWS
- Infrared image + Radar
Tropical Cyclone Analysis

To find the center position of TC using RGB products

- RGB convective cloud product
- Conventional IR Image

2013 24th Typhoon ‘DANAS’
(2013. 10. 06. 10:45UTC)
Tropical Cyclone Analysis

Derivation of Sea Surface Wind from MW data regardless of rain condition

- GCOM-W1 AMSR2
  - launched in May, 2012

<table>
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<tr>
<th>Band [GHz]</th>
<th>Polarization</th>
<th>Spatial Resolution (3-dB footprint size) [km x km]</th>
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<tr>
<td>6.93</td>
<td>V, H</td>
<td>62 x 35</td>
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<td>7.3</td>
<td>V, H</td>
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<td>10.65</td>
<td>V, H</td>
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<td>18.7</td>
<td>V, H</td>
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<td>23.8</td>
<td>V</td>
<td>19 x 11</td>
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<tr>
<td>36.5</td>
<td>V, H</td>
<td>12 x 7</td>
</tr>
<tr>
<td>89.0</td>
<td>V, H</td>
<td>5 x 3</td>
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</table>
Tropical Cyclone Analysis

Derivation of Sea Surface Wind from MW data regardless of rain condition

- Obs. Wind vs Retrieved Wind
- Retrieved Wind from 6.9GHz
- Retrieved Wind from 36.5GHz
Development of techniques for supporting numerical weather prediction (1/2)

- Development of techniques for supporting NWP
  - COMS products quality management (AMV, sea ice, snow etc.)
  - NWP sensitivity test
  - Analysis of characteristic of satellite data utilized in NWP
  - Improving RTM simulation

Accuracy is Maximized in East Asia area

1% accuracy improvement of NWP through COMS AMV assimilation
Development of techniques for supporting numerical weather prediction (2/2)

◆ COMS Clear Sky Radiance (CSR)

- 500 GPH RMSE difference between Cntl and COMS CSR
- Impact study for COMS CSR assimilation (2.6% improved)
Aviation Met. Services

Development of turbulence & icing area analysis based on COMS data
Aviation meteorological information to KAMA

- Turbulence, Flight Icing
- Convective Initiation, Tracking of convective cloud
- Asian dust storm, Volcanic Ash

* Flight Icing
  COMS Icing (19:45 UTC 2 Sep. 2013)

* Turbulence
  COMS IR (17:45 UTC 18 May 2013)
Space Weather Services

- Development of public warning system & prediction model for the space weather services
- Space environment sensor to be installed on GEO-KOMPSAT-2A
Space Weather Forecast & Warning service and Monitoring System from KMA

◆ Space Weather Forecast & Warning
  • KSEM on GK-2A, Aviation weather in polar airways, Ionospheric weather
◆ Building space weather monitoring system
  • Development of integrated space weather prediction model
  • Development of techniques for space weather forecast and warning
  • Building integrated space weather operation system, etc
Plan of Geo-KOMPSAT-2A
Development of the next COMS

Development of the geostationary multi-purpose satellite based on the National Space Development Plan. Next Meteorological Satellite is planned to be launched in 2018 time frame.

**Top Level Improvement**

- # of Channels: 5 ➔ 16
- Resolution (temporal): 30 ➔ 10 min
- Resolution (spatial): 4 ➔ 2km
Geo-KOMPSAT-2 Program

→ GK-2A for the next generation Meteorological Imager and SWx monitoring
→ GK-2B for the Ocean Color and Atmospheric Trace Gas monitoring

Meteorological Sensor
Space weather Sensor
Geo-KOMPSAT-2A

KMA

Geo-KOMPSAT-2B
Ocean / Environmental Sensor

2012 ~ 2017 (6 years)

Ground Segment
Data Processing System
**AMI (Geo-KOMPSAT-2A)**

- **AMI (Advanced Meteorological Imager)**
  - 16 spectral bands

<table>
<thead>
<tr>
<th>Channel</th>
<th>Band name</th>
<th>wavelength (µm)</th>
<th>resolution (km)</th>
<th>SNR</th>
<th>NEdT(K) (240/300K)</th>
<th>Radiometric Accuracy</th>
<th>Wavelength (µm)</th>
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<td>1</td>
<td>VIS0.4</td>
<td>0.47</td>
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<td>5%</td>
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<td>2</td>
<td>VIS0.5</td>
<td>0.51</td>
<td>1</td>
<td>250</td>
<td></td>
<td>5%</td>
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<td>3</td>
<td>VIS0.6</td>
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<td>0.675</td>
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<td>4</td>
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<td>0.856</td>
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<td>5</td>
<td>NIR1.3</td>
<td>1.378</td>
<td>2</td>
<td>300</td>
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<td>5%</td>
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<tr>
<td>6</td>
<td>NIR1.6</td>
<td>1.61</td>
<td>2</td>
<td>300</td>
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<td>5%</td>
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<tr>
<td>7</td>
<td>IR3.8</td>
<td>3.9</td>
<td>2</td>
<td></td>
<td>3/0.2</td>
<td>1K</td>
<td>3.75</td>
<td>4</td>
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<td>8</td>
<td>IR6.3</td>
<td>6.185</td>
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<td>0.4/0.1</td>
<td>1K</td>
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<tr>
<td>9</td>
<td>IR6.9</td>
<td>6.95</td>
<td>2</td>
<td></td>
<td>0.37/0.1</td>
<td>1K</td>
<td>6.75</td>
<td>4</td>
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<td>12.0</td>
<td>4</td>
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<td>16</td>
<td>IR13.3</td>
<td>13.3</td>
<td>2</td>
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<td>0.48/0.3</td>
<td>1.1K</td>
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KSEM (Korean Space Environmental Monitor)

◆ KSEM specification

<table>
<thead>
<tr>
<th>Sensor Unit</th>
<th>Measurement Range</th>
<th>Accuracy</th>
<th>Time Resolution</th>
<th>Remark</th>
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<tbody>
<tr>
<td>PD</td>
<td>100KeV ~ 2MeV</td>
<td>&lt;30%(ΔE/E)</td>
<td>0.33s</td>
<td>6 measurement direction</td>
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<tr>
<td>MG</td>
<td>-350nT ~ +350nT</td>
<td>&lt;1nT</td>
<td>&lt;0.1s</td>
<td>Boom type</td>
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<tr>
<td>CM</td>
<td>-3pA/cm² ~ +3pA/cm²</td>
<td>&lt;0.01 pA/cm²</td>
<td>&lt; 1s</td>
<td>-</td>
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</table>

Particle detector (3ea)  Magnetic field sensor(2ea)  Charging Monitor(1ea)
Development of GK-2A Ground Segment
Development of GK-2A Ground Segment

Outline

- Development of GeoKOMPSAT-2A ground segment
  - Develop Level 2 products algorithms
  - Develop integrated analysis and application facilities
  - Develop meteorological/space weather data processing system
  - Establish satellite control system
  - Develop data management and service system
  - Integration test & normal operation preparation
- Period: 2014 ~ 2019 (6yrs)

Mission

- Enhancing forecast/climate monitoring based on high resolution measurements
- Generation of the baseline meteorological products, and application to hydrology, agriculture, disaster mitigation etc.
- Dissemination of GK-2A data via satellite broadcast system, LRIT/HRIT/UHRIT
- Supporting satellite operation with space weather monitoring
## Development of GK-2A Meteorological Products

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<thead>
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<tr>
<td>Cloud detection</td>
<td>Cloud Top Temperature</td>
<td>Aerosol Detection</td>
<td>Atmospheric Motion Vector</td>
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<td>Snow Cover</td>
<td>Cloud Top Pressure</td>
<td>Aerosol Optical Depth</td>
<td>Vertical Temperature Profile</td>
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<tr>
<td>Sea Ice Cover</td>
<td>Cloud Top Height</td>
<td>Asian Dust Detection</td>
<td>Vertical Moisture Profile</td>
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<td>Fog</td>
<td>Cloud Type</td>
<td>Asian Dust Optical Depth</td>
<td>Stability Index</td>
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<td>Cloud Phase</td>
<td>Aerosol Particle Size</td>
<td>Total Precipitable Water</td>
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<td>Land Surface Temperature</td>
<td>Cloud Amount</td>
<td>Volcanic Ash Detection and Height</td>
<td>Tropopause Folding Turbulence</td>
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<td>Surface Emissivity</td>
<td>Cloud Optical Depth</td>
<td>Visibility</td>
<td>Total Ozone</td>
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<td>Surface Albedo</td>
<td>Cloud Effective Radius</td>
<td>Radiances</td>
<td>SO₂ Detection</td>
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<td>Fire Detection</td>
<td>Cloud Liquid Water Path</td>
<td>Downward SW Radiation (SFC)</td>
<td>Convective Initiation</td>
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<tr>
<td>Vegetation Index</td>
<td>Cloud Ice Water Path</td>
<td>Reflected SW Radiation (TOA)</td>
<td>Overshooting Top Detection</td>
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<td>Vegetation Green Fraction</td>
<td>Cloud Layer/Height</td>
<td>Absorbed SW Radiation (SFC)</td>
<td>Aircraft Icing</td>
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<td>Rainfall Rate</td>
<td>Upward LW Radiation (TOA)</td>
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<td>Rainfall Potential</td>
<td>Downward LW Radiation (SFC)</td>
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<td>Probability of Rainfall</td>
<td>Upward LW Radiation (SFC)</td>
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<td>Forecast support(21)</td>
<td>Analysis support(19)</td>
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<tr>
<td><strong>Typhoon</strong></td>
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<tr>
<td>Center position</td>
<td>Objective analysis</td>
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<td>Intensity &amp; Central pressure</td>
<td>Objective prediction</td>
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<td>Max. wind speed &amp; Radius of 15m/s WS</td>
<td>Real-time analysis of severe weather</td>
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<td>Development &amp; Weakening condition</td>
<td>Typhoon conceptual model</td>
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<tr>
<td>Yellow dust analysis</td>
<td>Flood analysis</td>
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<tr>
<td>Convective cloud analysis</td>
<td>Heavy snow analysis</td>
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<tr>
<td>Severe weather analysis</td>
<td>Aerosol analysis</td>
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<tr>
<td><strong>Aviation</strong></td>
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<tr>
<td>Air-route cloud analysis</td>
<td>Smog analysis</td>
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<tr>
<td>Turbulence analysis</td>
<td>Fog analysis</td>
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<tr>
<td>Aircraft icing analysis</td>
<td>Time series analysis</td>
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<tr>
<td>Volcanic Ash analysis</td>
<td>Spatial analysis</td>
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<tr>
<td>SST analysis</td>
<td>Down-scaling analysis</td>
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<tr>
<td><strong>Marine Weather</strong></td>
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<tr>
<td>Ocean current analysis</td>
<td>Sat. Data composition &amp; analysis</td>
<td></td>
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<tr>
<td>Sea fog analysis</td>
<td>Composition into uniform space-time grid</td>
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<tr>
<td>Sea ice analysis</td>
<td>Data quality analysis</td>
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<tr>
<td><strong>Numerical Weather Prediction</strong></td>
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<tr>
<td>Predicted image products</td>
<td>Data monitoring tech.</td>
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<tr>
<td>Error analysis of NWP input data</td>
<td></td>
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<tr>
<td>Forecast Sensitivity Test</td>
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</tbody>
</table>
Development of data processing and application technique

◆ Production of various products
  - Support for quantitative data extraction
    - Rainfall
    - TPW
    - Greenhouse gases
    - Wildfire
    - SST
    - Sea surface wind
    - Insolation
    - Upward radiation
    - AMV

◆ Support for integrated forecast analysis by using various application technique
  - Black and White image
  - Detection of yellow dust/fog by using RGB composite image
    - Color composition
    - Yellow dust
    - COMS
    - GEO-KOMPSAT-2A
  - Fog
    - Color composition
    - Black and White image
    - Color image
COMS MI vs. GEO-KOMPSAT-2A AMI

**4 times** spatial resolution

<table>
<thead>
<tr>
<th>COMS</th>
<th>Geo-KOMPSAT-2A</th>
</tr>
</thead>
<tbody>
<tr>
<td>VI 1km</td>
<td>VI 0.5~1km</td>
</tr>
<tr>
<td>IR 4km</td>
<td>IR 2km</td>
</tr>
</tbody>
</table>

**4 times** temporal resolution

<table>
<thead>
<tr>
<th>COMS</th>
<th>Geo-KOMPSAT-2A</th>
</tr>
</thead>
<tbody>
<tr>
<td>VI</td>
<td>5 channels</td>
</tr>
<tr>
<td>NIR</td>
<td>10 channels</td>
</tr>
<tr>
<td>IR</td>
<td>4 channels</td>
</tr>
</tbody>
</table>

**3 times** number of channels

<table>
<thead>
<tr>
<th>COMS</th>
<th>Geo-KOMPSAT-2A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 channel (achromatic)</td>
<td>4 channels (color)</td>
</tr>
</tbody>
</table>

**3.5 times** number of products

<table>
<thead>
<tr>
<th>COMS</th>
<th>Geo-KOMPSAT-2A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cloud/Precipitation</td>
<td>16 products</td>
</tr>
<tr>
<td>Radiation/aerosol</td>
<td>52 products</td>
</tr>
<tr>
<td>Atmospheric Motion/Conditions</td>
<td>16 products</td>
</tr>
<tr>
<td>Surface information</td>
<td>11 products</td>
</tr>
</tbody>
</table>
Development of techniques in space weather

◆ Korea Space Environment Monitor (KSEM)
  Measurement of electron on mid energy range and magnetic field

Data
- Time (satellite position)
- Energy channel (electron)
- Particle flux (each direction)
- Magnetic field flux (3-axis)
- Background flux
- Noise
- Payload monitoring data (Voltage, darkcurrent, etc.)

Products (5)
- Real-time high energy particle distribution over the radiation belt
- 3D particle distribution / prediction
- Deep dielectric charging prediction index
- Geomagnetic storm index (2)
Milestone for the Geo-KOMPSAT-2A

PAYLOAD And Satellite

Satellite bus design and Review
Integrate Module
Satellite system integration
Launch/IOT/Operation

Analysis of system requirements
Preliminary design
Critical design
Instrument Integration and test
System Integration and test
Prepare To launch

Start
SRR
PDR
EQSR/CDR
TRR
Environmental Test
Delivery
Launch

2013 2014 2015 2016 2017 2018

GROUND SYSTEM

Operation/Utilization I
Service

Preliminary design
Critical design
Implementation/verification
Integration test/idealization
IOT/Supporting operation

System requirements/Standards creation
Preliminary design
Critical design
System implementation
Install/Testing
Training operator
Launch
Supporting operation

Review and analysis of requirements/standards/design
Selection of TTC and RF production companies
Integration and install TTC system
Install control S/W and interface testing
Training operator
Test operation and verification

2014
-Algorithm development
2015
-Algorithm development II
2016
-Algorithm development complete
2017
-System construction - SW
2018
-Test operation and verification

data receiving and processing system
satellite control system
data processing system
data management and service system

2014
-Analysis of user requirements
-Set up system requirements
-Preliminary/critical design
2015
-Create system
-Verify system
2016
2017
2018
-Test operation and complemen
Plan for LEO Satellite
LEO Meteorological Satellite

Generating numerical model input data
(Cloud, land surface, Ocean, Construction of Atmosphere data)

- Improve weather forecast accuracy
- Standard monitoring of severe weather
- Water control for preparing disaster
- Understanding climate change
- Managing future water resources
- Preparing future climate
- Advanced country of weather observation-contribution to international society, improving global positioning

Monitoring Climate change factor
(sea ice, stratospheric and tropospheric temperature, water cycle factor)

Standard observation of weather factor
(heavy rain, typhoon precipitation, snow cover, strong wind)

Mutual complement Synergy effect

COMS + LEO satellite joint operation system

Observation in all-weather conditions

International Satellite Program (A-train, GPM, etc.)

LEO satellite operation
LEO Satellite development

- **Generic technology research**
  - LEO meteorological satellite instruments technology research
  - LEO meteorological satellite development mid-long term roadmap
  - International technology development cooperation research

- **Secure a budget for LEO satellite**
  - Political and technical validity
  - Economical validity and analysis of benefits
  - Surveying industrial ripple effects and proposing the way of improving manpower

- **Development of the LEO meteorological satellite**
  - Developing instruments of the LEO satellite
  - Satellite bus, system integration and developing testing technique
  - Ground segments development and secure a image quality technique

- **Application of data Utilization plan**
  - Apply to weather, climate, earthquake, volcano, disaster, etc.
  - Data utilization research for global water/climate, etc.
  - Supply standard input data of numerical model
Thank You!