

KMA updates since CGMS-51 and report on the medium to long-term future plans on Earth observation

Presented to CGMS-52 plenary session, agenda item 3

Executive summary

KMA operates GEO-KOMPSAT-2A (GK2A) equipped with meteorological payload, Advanced Meteorological Imager (AMI) and space weather payload, Korea Space wEather Monitor (KSEM).

The GEO-KOMPSAT-2B (GK2B) for the oceanic and environmental mission and equipped with Geostationary Ocean Colour Imager-II (GOCI-II) and Geostationary Environment Monitoring Spectrometer (GEMS) is also operational, and data have been released since 2021.

KMA is also working to strengthen the usability of satellite data not only in weather forecast but also in climate monitoring with new approach. The new retrieval with GK2A data such as AI-based Convective Initiation (CI) detection, AI-based Proxy Radar, Satellite-based Insolation and Ultraviolet (UV) Index, Flash Drought, and so on.

KMA expanded GK2A Marine Weather Broadcast Service to provide various digital marine weather information with emergency message of urgent weather to Asia-Pacific region.

KMA's third meteorological satellite GEO-KOMPSAT-5 (GK5) program has got government approval and are preparing to begin the project.

CURRENT GEO SATELLITES

- **COMS** Meteorological mission (MI) was ended on 1st April 2020 and after one year Ocean Monitoring mission (GOCI) was also ended (1st April 2021).
- **GK2A** for the meteorological mission using AMI and for the space weather mission using KSEM is operational since 25th July 2019.
- **GK2B** for the ocean observation mission using GOCI-II and for the environmental mission using GEMS is also operational and derived products have released since the 2nd half of 2021.

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
COMS (GK1) (MI, GOCI)	Mission completed for MI & GOCI									
GK2A (AMI, KSEM)	In-operation (weather & space weather)									
GK2B (GOCI-II, GEMS)	In-operation (ocean & environment)									

MI: Meteorological Imager; **GOCI:** Geostationary Ocean Color Imager

AMI: Advanced Meteorological Imager; **KSEM:** Korean Space wEather Monitor

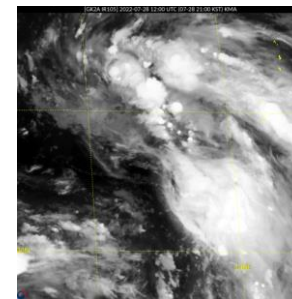
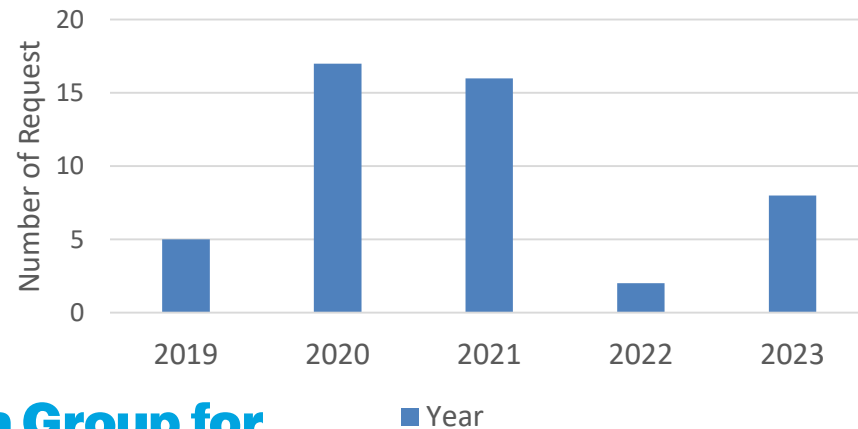
GOCI-II: Geostationary Ocean Color Imager-II; **GEMS:** Geo. Environmental Monitoring Spectrometer

CURRENT GEO SATELLITES – New Observation and Data Service

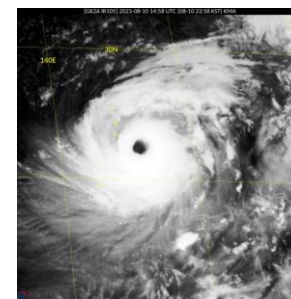
➤ GK2A Request-based Rapid Scan Observation since Feb. 2021

- Global users in GK2A coverage can request **Target Area Observation** for their own purpose via **KMA rapid scan request webpage** (<https://datasvc.nmsc.kma.go.kr/datasvc/html/special/specialReqMain.do>)
 - Target Area Observation: 1,000 x 1,000 km² every 2 minutes
- Portal on the **RA II WIGOS Project website** of the request-based high frequency regional observation launched by CMA, JMA and KMA is also available
 - (https://www.jma.go.jp/jma/jma-eng/satellite/ra2wigosproject/ra2wigosproject-intro_en_jma.html#request)

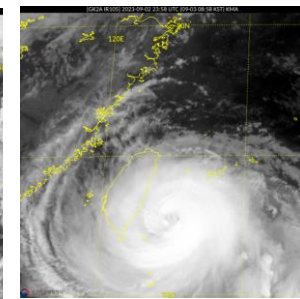
GK2A Rapid Scan Request



Tropical Cyclone (DOKSURI)
(2023.07.28 12:00UTC)



Typhoon (LAN)
(2023.08.10 14:58UTC)



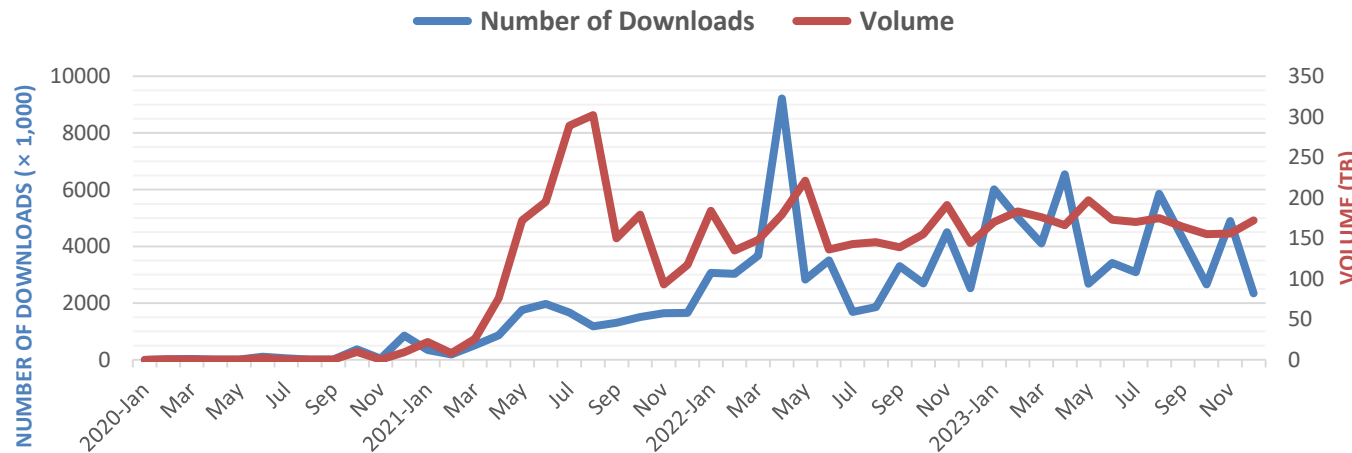
Typhoon (HAIKU)
(2023.09.02 23:58UTC)

CURRENT GEO SATELLITES – New Observation and Data Service

➤ GK2A Open API data service since Nov. 2020

- **Open API data service** is available to agency, company, academia and individual that want to use the GK2A data.
 - user application form posted on **NMSC** website (<https://nmsc.kma.go.kr/enhome>, kmasod@korea.kr)
 - (Domestic) **KMA** API hub website (<https://apihub.kma.go.kr>)

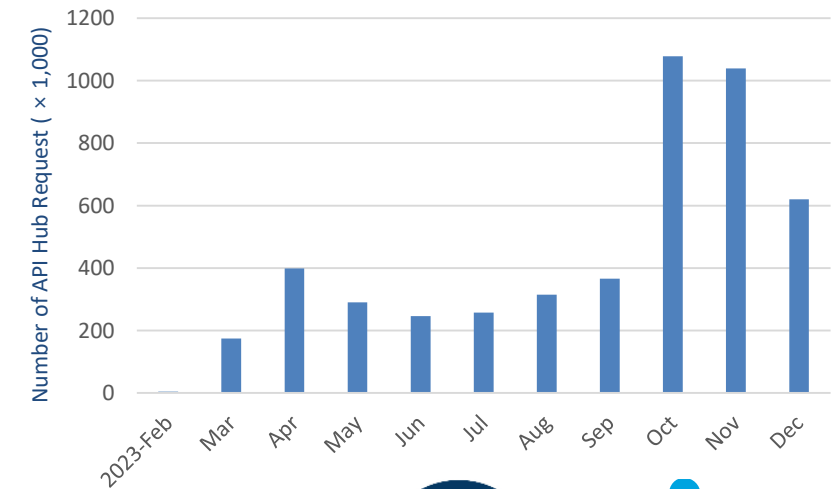
GK2A Data OpenAPI Service



↑ NMSC Open API service begin

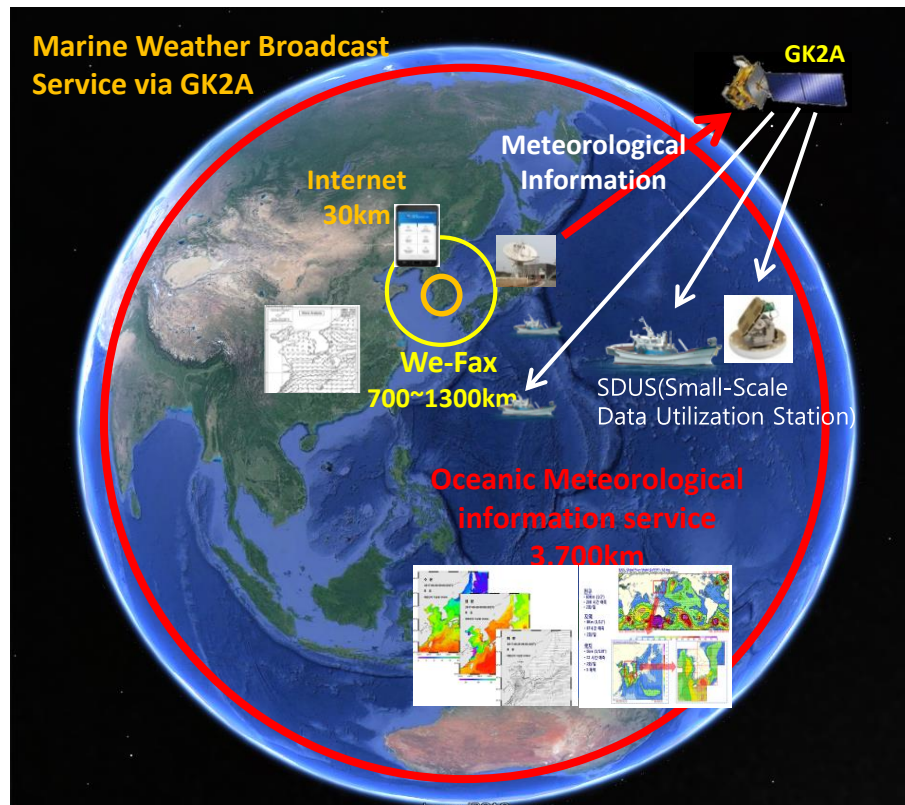
↑ KMA Open API service begin

KMA's API Service for GK2A Data (2023)



CURRENT GEO SATELLITES – Marine Weather Broadcast Service

➤ GK2A Marine Weather Broadcast Service using SDUS since 23 July 2020



❖ Advantages of broadcasting using GK2A

- Wide service area including Western Pacific, Oceania, and Indian Ocean
- Various display media available such as PC monitor, tablet, mobile, etc.
- Large capacity and variety of information over 360/day with image, text, etc.
- Sending urgent information by alarming and pop-up message

❖ Expand the service to Asia-Pacific region from domestic users as a pilot project (RA-II-17-I-PP-1) of WMO ET-SOA

- In 2021, Submitted project proposal in RA II-17
- In 2022, Development of web page for the Emergency message request service (Korean/English)
- In 2023, Start the international broadcast service for Emergency message of urgent weather
- In 2025, KMA will support the construction of a reception system (SDUS) in the Philippines through ODA

❖ Service website opened in 2022

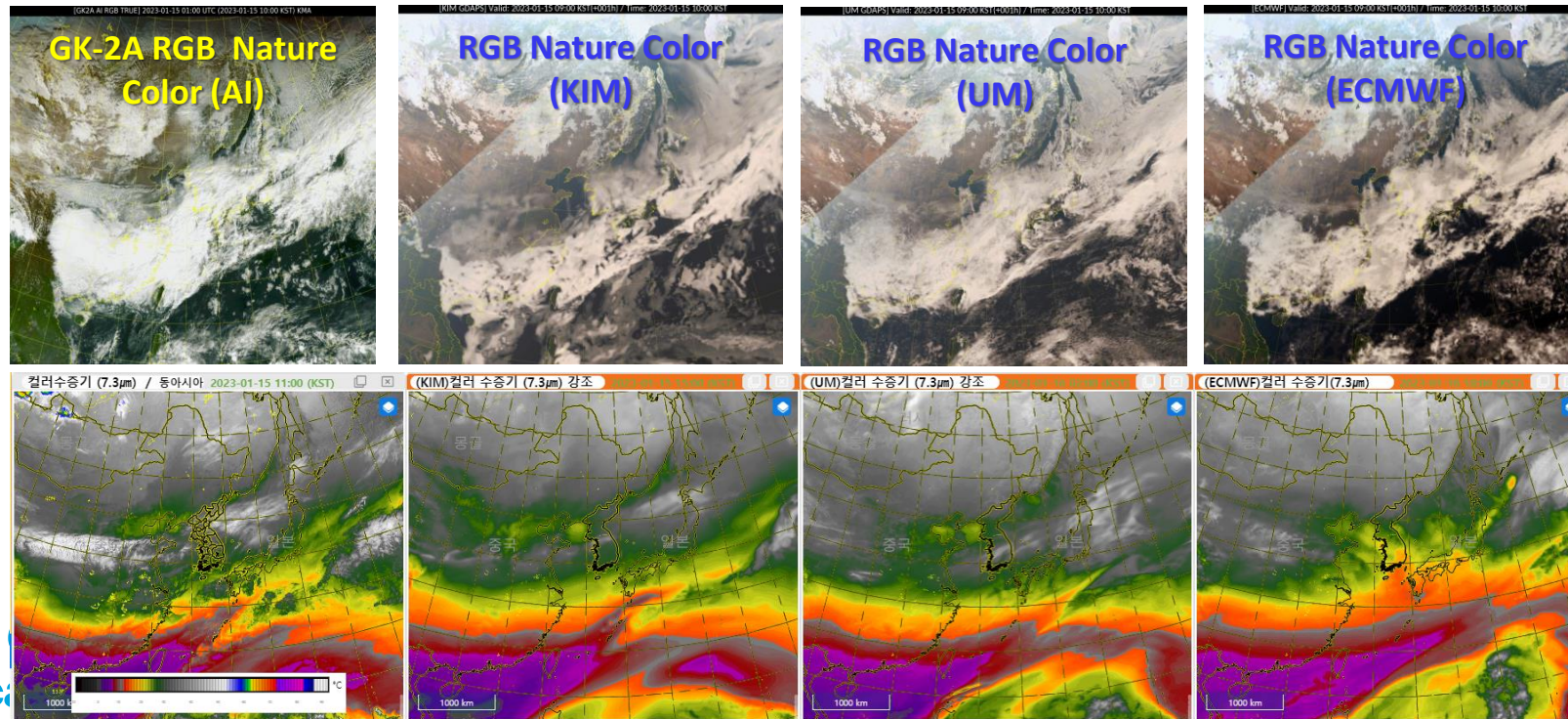
<http://datasvc.nmsc.kma.go.kr/datasvc/html/egmsg/introEgmsg.do>

CURRENT GEO SATELLITES – GK2A Products and its application

➤ Monitoring and Warning of Extreme Weather (Satellite Images Simulation)

❖ Performance evaluation of NWP model comparing simulated image and satellite observation

- KMA has generated model-simulated satellite images of Infrared(IR), Water Vapor(WV), Visible(VIS) and Nature Color RGB to utilize in Now-casting and Very Short-Range Forecasting for GK2A
- By comparing satellite observations and simulation, forecasters can be guided as to which model is closer to the real weather phenomenon.

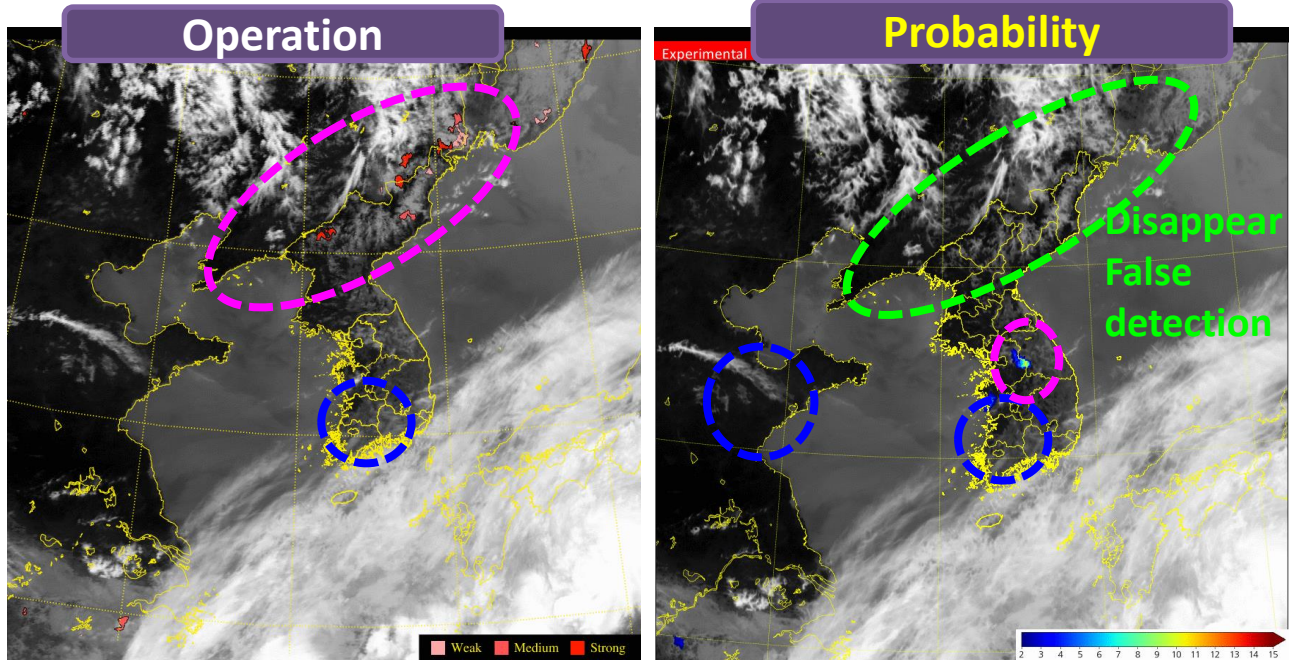


CURRENT GEO SATELLITES – GK2A Products and its application

➤ Monitoring and Warning of Extreme Weather (CI detection)

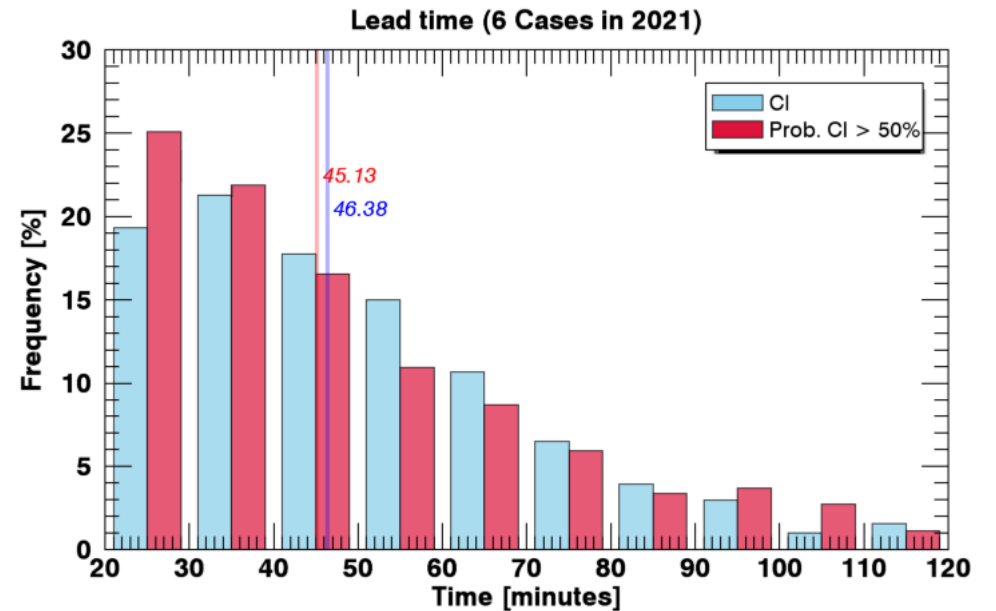
❖ Convective Initiation(CI)

- Modified: 1 hour cumulative probability CI
 - Less false detection in the North Korea



	POD	FAR	Mean lead time
Previous CI	54.17%	72.84%	46.38 min
Modified CI > 50%	58.62% (4.45%p↑)	63.79% (9.05%p↓)	45.13 min (1.24min↓)

Lead Time Detection



CURRENT GEO SATELLITES – GK2A Products and its application

➤ Application of AI technology

✓ Fill the gap of conventional observational network around the Korea peninsula and improve the quality of satellite geophysical data

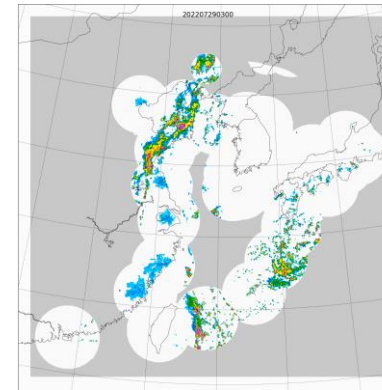
❖ Proxy Radar using GK2A data

- Proxy radar is estimated from GK2A data by using AI technique (Pix2Pix(CGAN)) for no ground radar observation and provided to forecaster every 10 minutes.

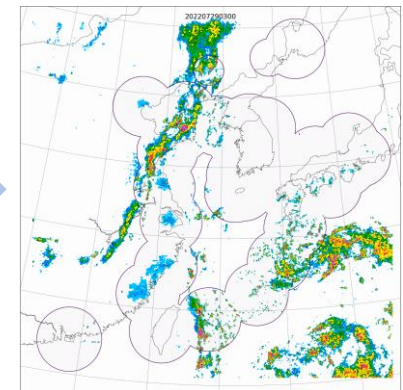
❖ Public Service of UV Index

- For the KMA's UV index forecast, the ground UV observation data was replaced with AI-based GK2A UV Index product with 2km spatial resolution and 30-minute temporal resolution

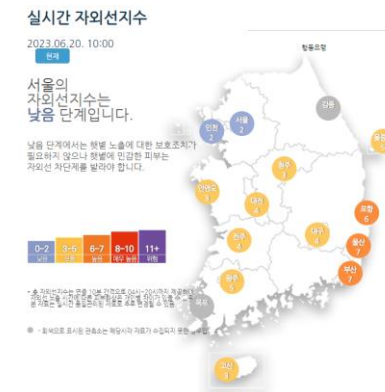
KMA+CMA+JMA Radar



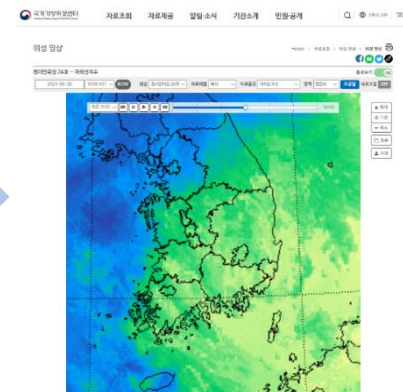
Radar + Proxy radar



Ground-based network (15 stations)



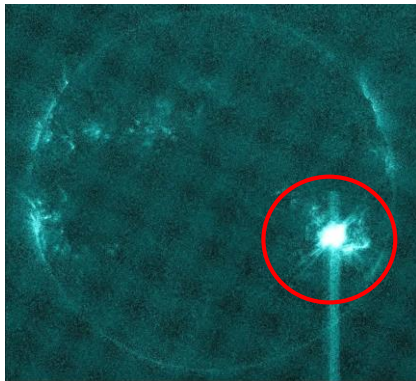
AI-based GK2A UV Index



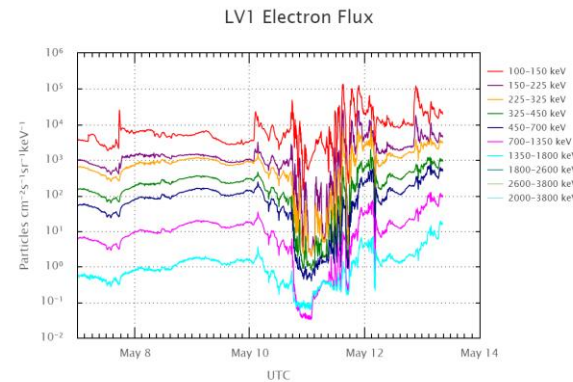
CURRENT GEO SATELLITES – Space weather monitoring using GK2A

➤ GK2A Measurements on 2024-May Event of Solar Activity

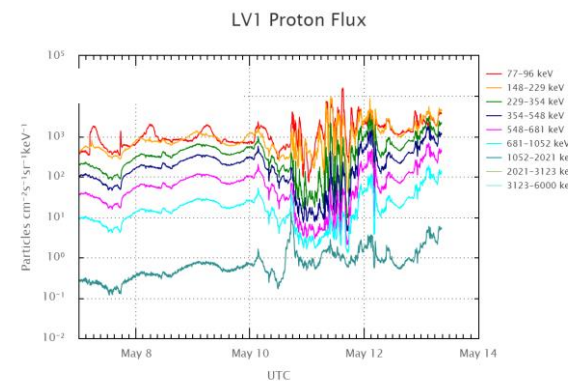
- ❖ Multiple strong solar flares CMEs had occurred in Active Region 6334 on the sun's surface in May 2024.
- ❖ GK2A KSEM (electrons and protons, a magnetometer) data detected the effect of CME passages.
 - When the magnetopause contracted within the geostationary orbit, a sharp decreases in electron flux was observed.
 - All components of the magnetic field experienced intense disturbance.
 - No significant changes were observed in the charging monitor data, likely because the electron flux itself did not increase significantly.
- ❖ There were no confirmed issues on data measurement and the operation of GK2A related to this event.



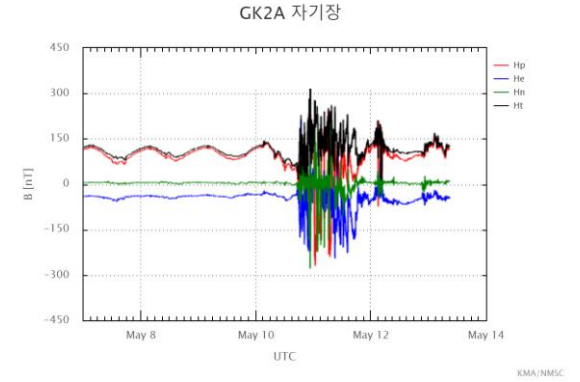
Active Region 3664
and Solar flare



GK2A Electron Flux



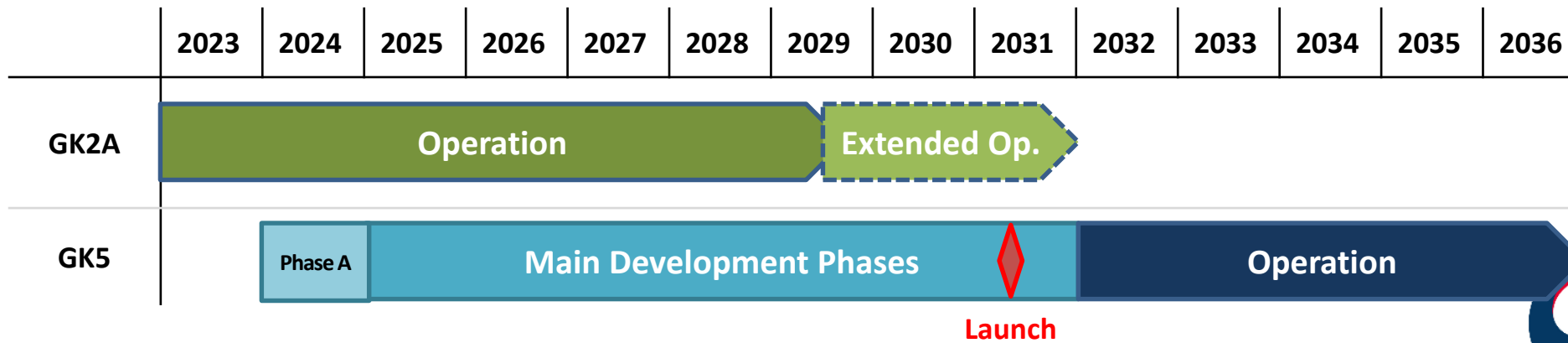
GK2A Proton Flux



GK2A Magnetic Field

FUTURE GEO SATELLITES – The GK2A follow-on satellite, GK5

- The KMA GEO satellite program will continue based on CGMS baseline and WIGOS vision 2040.
 - VIS/NIR/IR Imager, hyperspectral sounder, space weather mission
- GK2A follow-on program (named GEO-KOMPSAT-5, **GK5**) has been **approved by Korean government in May 2024**.
 - Will be the first geostationary satellite developed by a private company in Korea
 - Meteorological Imager: 18 channels for meteorological mission
 - Currently KMA is experimenting to determine the optimal channel (e.g. 0.55, 0.91 um)
 - Space weather payloads: Proton/Electron Detector, Satellite Charging Monitor, Magnetometer (provided by ESA)



FUTURE GEO SATELLITES – The GK2A follow-on satellite, GK5

➤ Comparison of Meteorological Payloads between GK2A and GK5

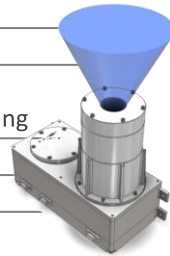
AMI (GK2A)			Imager onboard GK5		Improvement	
Band No.	Wavelength (μm)	GSD (km)	Wavelength (μm)	GSD (km)	Add Channel	GSD
1	0.47	1	0.47	0.5		○
2	0.511	1	0.55	0.5		○
3	0.64	0.5	0.64	0.25		○
4	0.856	1	0.86	1		
5	1.38	2	1.38	2		
6	1.61	2	1.61	1		○
7			2.25	1	○	
8	3.830	2	3.9	1		○
9			5.1	1	○	
10	6.241	2	6.2	2		
11	6.952	2	6.9	1		○
12	7.344	2	7.3	2		
13	8.592	2	8.6	2		
14	9.625	2	9.6	2		
15	10.403	2	10.4	1		○
16	11.212	2	11.2	2		
17	12.364	2	12.4	2		
18	13.31	2	13.3	2		

※ Can be changed during actual development
 - 0.91 um band will be included if 0.55 um band could be replaced

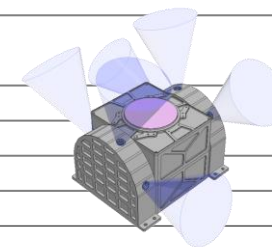
FUTURE GEO SATELLITES – The GK2A follow-on satellite, GK5

Planned Space Weather Payloads (KSEM-II) onboard GK5

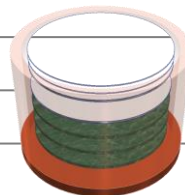
Parameters	Proton Detector
Mission	Measuring and Monitoring of high-energy protons emitted from the Sun
Unit	2 unit
Proton Flux (cm ² s sr keV) ⁻¹	1 ~ >500 MeV : 6 x 10 ² ~ 2 x 10 ⁻³ 80 ~ 500 MeV : 1 ~ 2 x 10 ⁻³
Viewing Angle	30 deg
Products	1min : Proton rate of change 5min : Solar radiation storm warning
Power	< 5W /unit
Mass	< 4kg /unit



Parameters	Electron Detector
Mission	(1) Measuring of electron velocity components in relation to the Earth's magnetic field (2) Effects of internal charging of satellites and warnings
Unit	5 unit
Electron Flux (cm ² s sr keV) ⁻¹	~ 10 ⁶ (@100 MeV)
Viewing Angle	170 deg in YZ
Data Update Time	< 1 sec
Power	< 10W
Mass	< 10kg



Parameters	Satellite Charging Monitor
Mission	Monitoring of satellite charging around satellite operating orbit due to changes in space environment
Unit	3 SURF layer, 1 unit
Measurable Current Range	-3 ~ 3 PA/cm ²
Data Update Time	1sec
Volume	80(Φ) mm x 60(H) mm
Power	1W
Mass	1kg



Parameters	Magnetometer
Mission	Magnetospheric disturbance and solar storm monitoring through 3-axis magnetic field measurement
Magnetic flux density	1.0 nT/Axis
Measuring Period	10 sam
Measurable Range	
Quantization	
Number of Channels	2 (Gate 2)
Resolution	Fluxgate : < 0.220 nT/VHz, Fluxgate : < 0.010 nT/VHz
Power	8.25 W
Mass	Sensor unit 0.1 kg, electronics units 1 kg



To be confirmed after cooperation with ESA

Thank You!