

KMA updates since CGMS-52 and report on the medium to long-term future plans on Earth observation

Presented to CGMS-53 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) since 2019.

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 in weather forecast. The new retrieval with AI technique has been also tried to overcome the limitation of GEO observation and in-situ measurements.

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 **began in April** of this year as the start of a seven-year development journey.

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). It is currently operating only communication mission, which are scheduled to continue until around 2027.
- **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.

	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

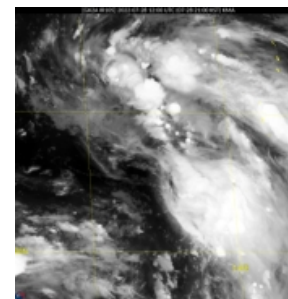
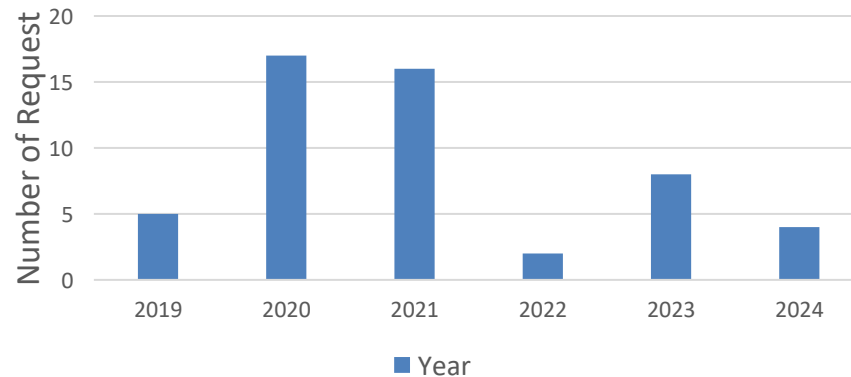
GOCI-II: Geostationary Ocean Color Imager-II; **GEMS**: Geo. Environmental Monitoring Spectrometer

CURRENT GEO SATELLITES – New Observation and Data Service

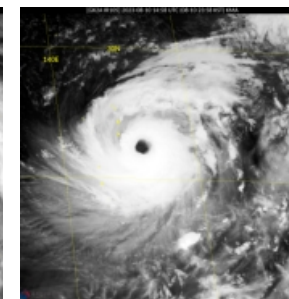
➤ GK2A Request-based Rapid Scan Observation since Feb. 2021

- 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)

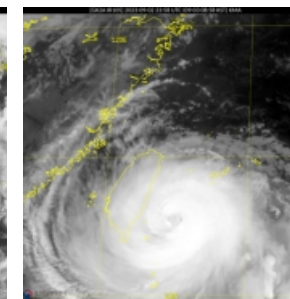
GK2A Rapid Scan Request



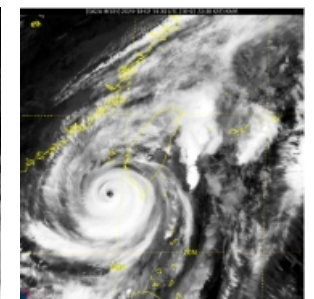
Tropical Cyclone (DOKSURI)
(2023.07.28 12:00UTC)



Typhoon (LAN)
(2023.08.10 14:58UTC)



Typhoon (HAIKUI)
(2023.09.02 23:58UTC)



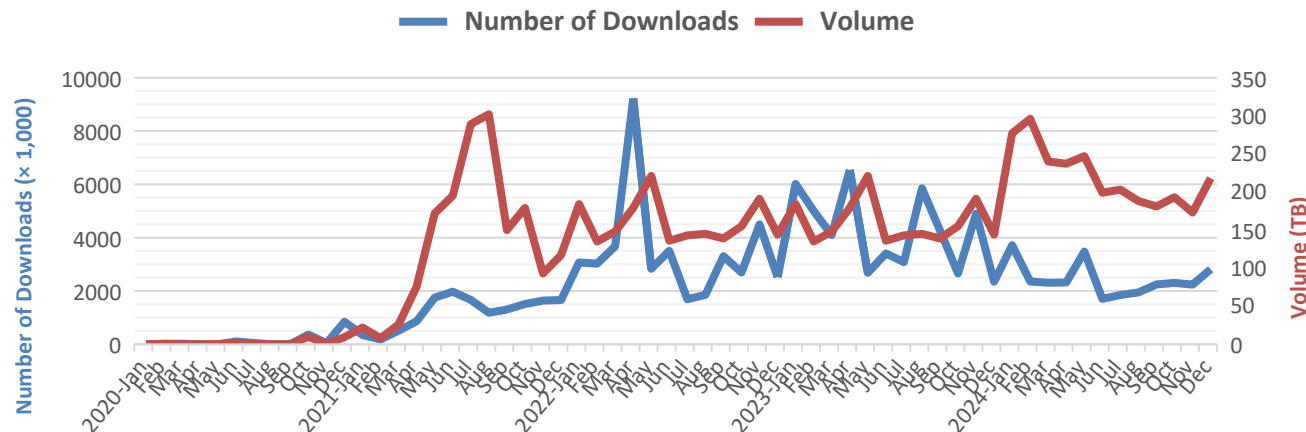
Typhoon (KRATHON)
2024.10.02 14:30UTC)

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

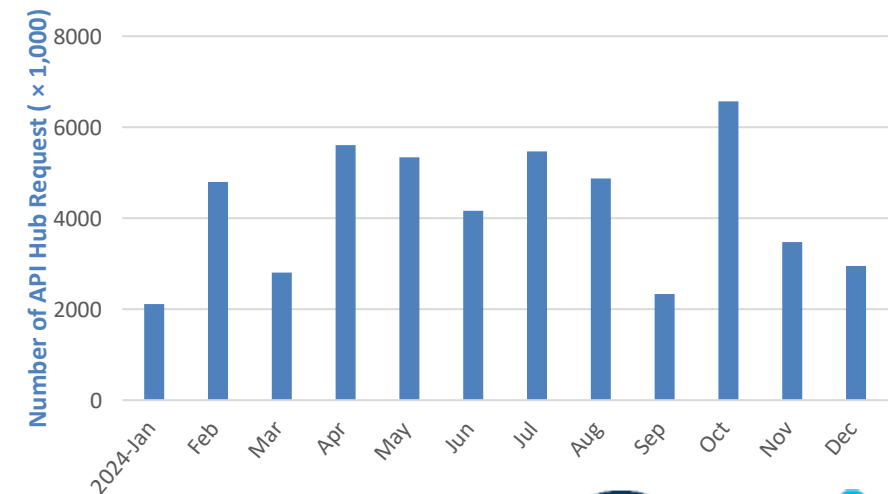


↑ NMSC Open API service begin

↑ KMA Open API service begin

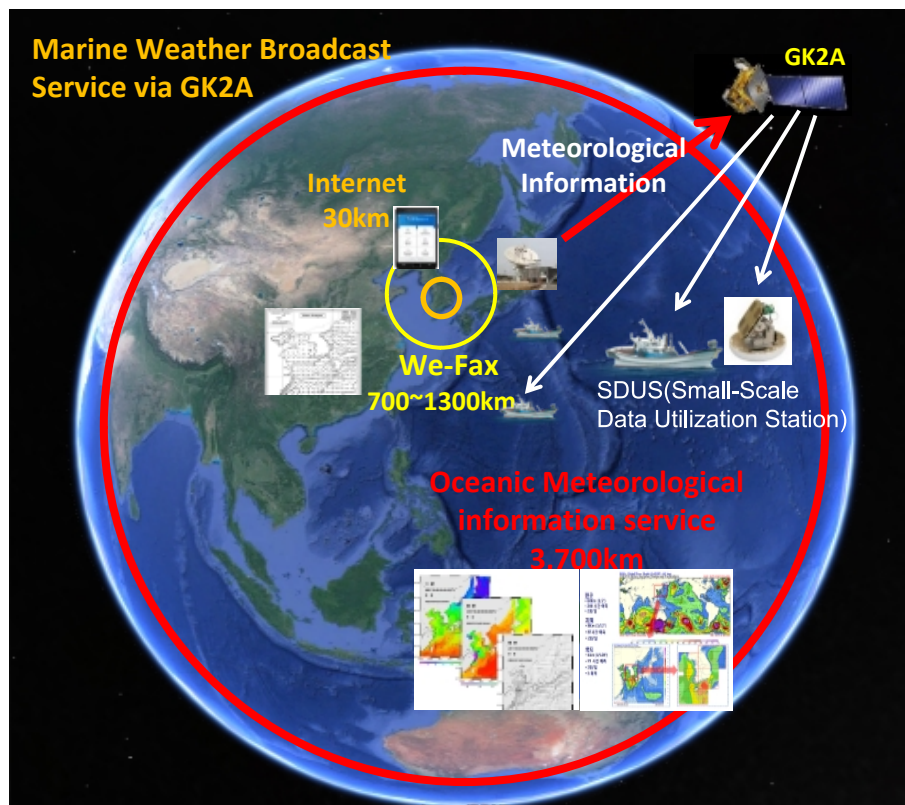
Coordination Group for Meteorological Satellites

KMA's API Hub Satellite Data Service (2024)



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 590/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
- **KMA will continue to expand efforts to support the construction of a reception system (SDUS) in near ocean region**

❖ Service website opened in 2022

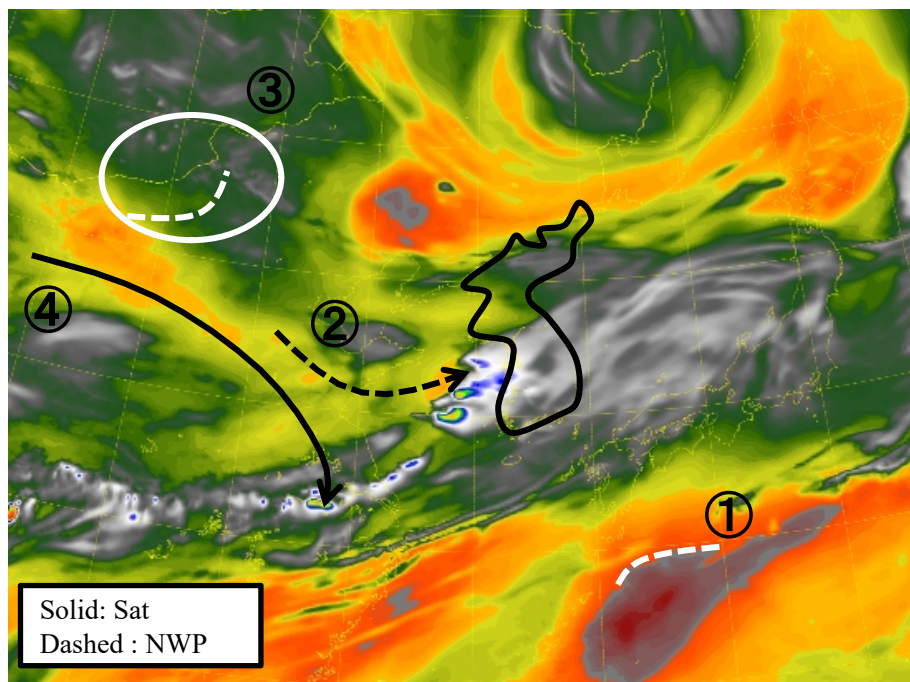
<https://datasvc.nmsc.kma.go.kr/datasvc/html/egmsg/introEgmsg.do>

CURRENT GEO SATELLITES – GK2A Products and its application

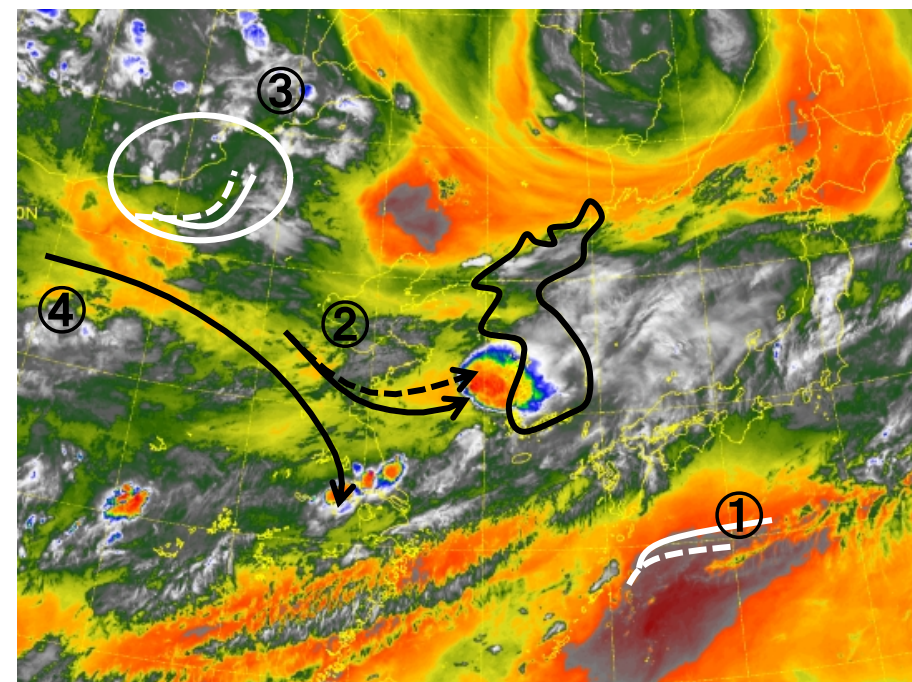
➤ Analysis of dry regions based on GK2A water vapor Imagery

❖ Diagnosis of Discrepancy between satellite water vapor imagery(Observed) and Numerical Model(Simulated) in Dry regions

- Morning, July 10 from July 9 : Anticyclonic flow(①) in the south region to northeastern gap in real, Dry zone due to cyclonic flow over the Yellow Sea (②) in the southern region
- Afternoon of July 10: Anticyclonic flow(①, Northern Pacific High, mT) in the south region to northeastern gap, Dry zone due to Mongolian low pressure system (③) to the southeastward region with a distinct boundary



July 9, 21KST – Simulated WV(7.3 um) Enhanced Image (NWP)

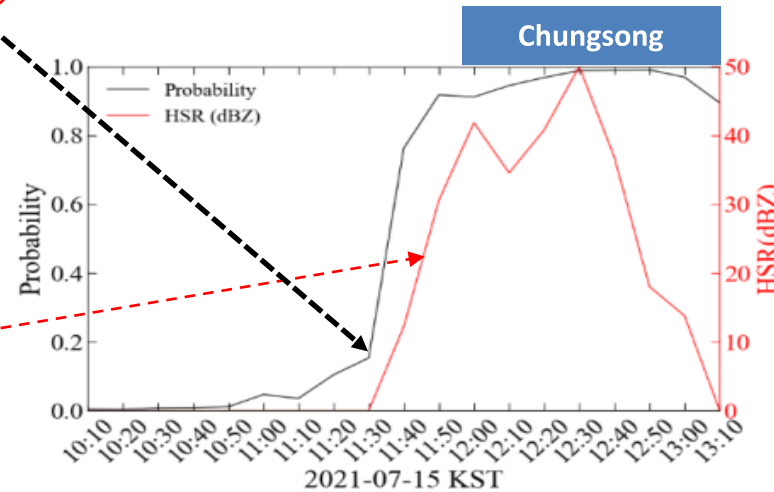
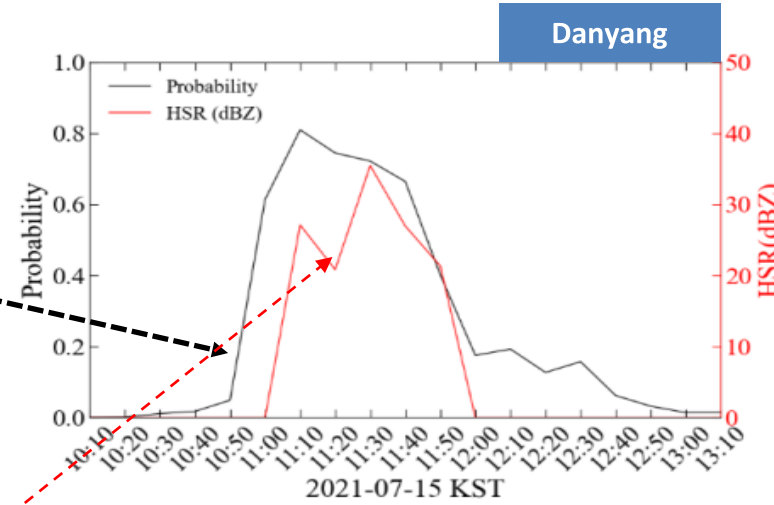
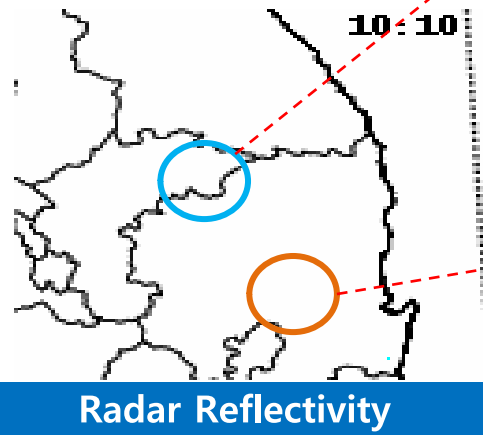
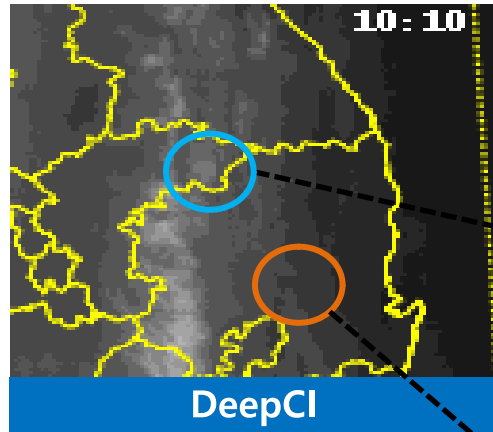


July 9, 21KST – Observed WV(7.3 um) Enhanced Image

CURRENT GEO SATELLITES – GK2A Products and its application

➤ Monitoring and Warning of Extreme Weather : Deeplearning(UNET) based CI (DeepCI)

blue:25%, green:50%, red:75%



- Radar Reflectivity of 35dBZ around 11:30 at Danyang
- Early detection around 10:50 with a 20% probability, Early detection around 11:00 with a 60% probability

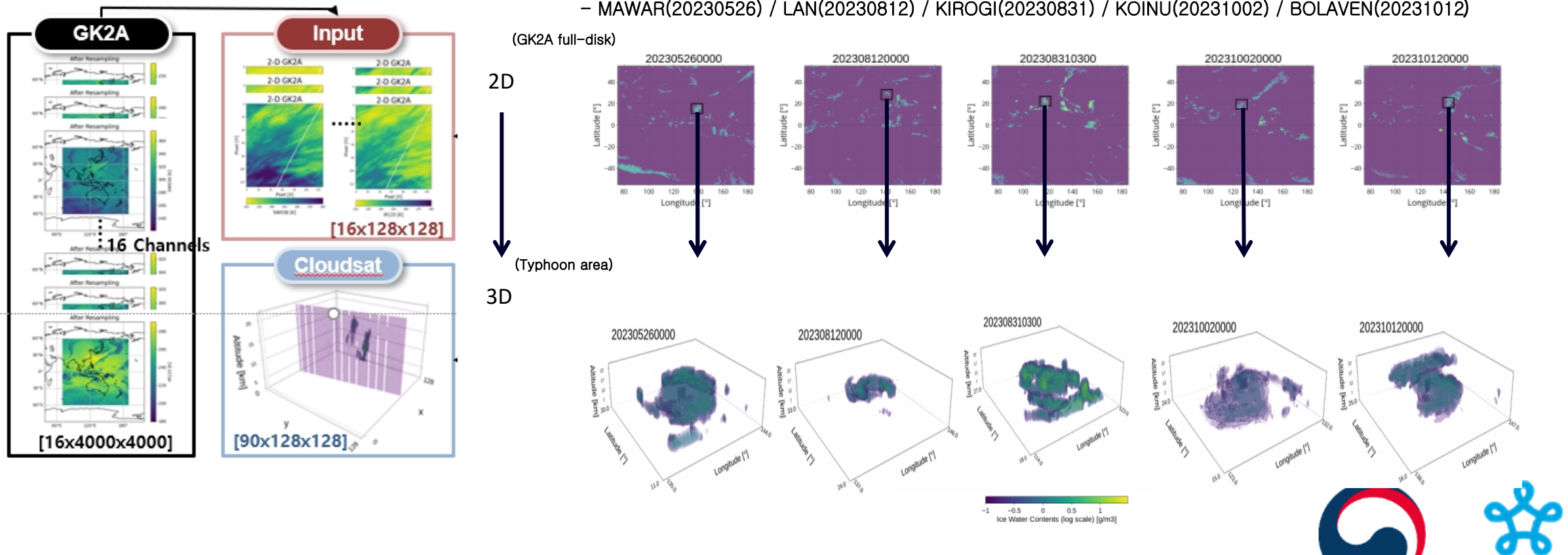
- Radar Reflectivity of 35 dBZ around 11:50 at Chungsong
- Early detection around 11:30 with a 20% probability, Early detection around 11:40 with a 60% probability

	POD	FAR	CSI
CI(Threshold)	9.62%	86.64%	5.93%
CI(Logistic Regression)	17.54%	80.70%	16.48%
CI(Deep Learning)	45.59%	12.36%	42.84%

CURRENT GEO SATELLITES – GK2A Products and its application

➤ Monitoring and Warning of Extreme Weather : AI(Res-UNET) based 3D IWP from 2D GK2A

- 5 typhoon cases selected for 2023.
 - MAWAR(20230526) / LAN(20230812) / KIROGI(20230831) / KOINU(20231002) / BOLAVEN(20231012)



Bruning et al. (2024) presented an artificial intelligence model that derives CloudSat CPR reflectivity profiles from MSG SEVIRI visible and infrared imagery (**2D image → 3D information**). Based on this study, we aim to develop an AI model that directly learns from GK2A visible and infrared imagery to derive vertical hydrometeor data by estimating CloudSat CPR-provided ice water path.

CURRENT GEO SATELLITES – GK2A Products and its application

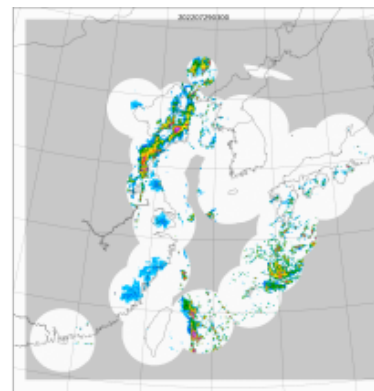
➤ Application of AI technology

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

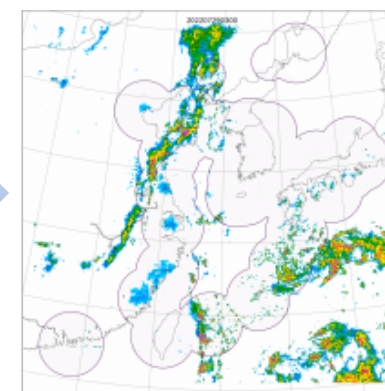
❖ Proxy Radar using GK2A data

- 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.

KMA+CMA+JMA Radar



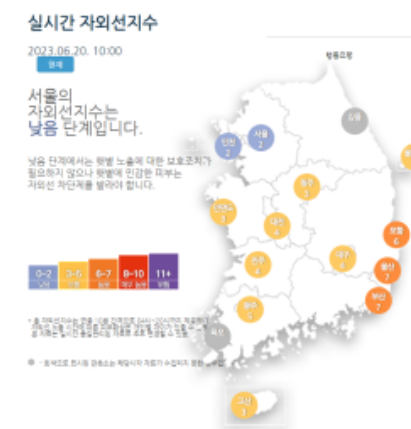
Radar + Proxy radar



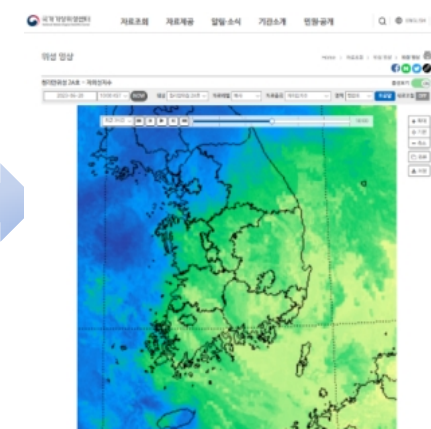
❖ Public Service of UV Index

- 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

Ground-based network (15 stations)



AI-based GK2A UV Index

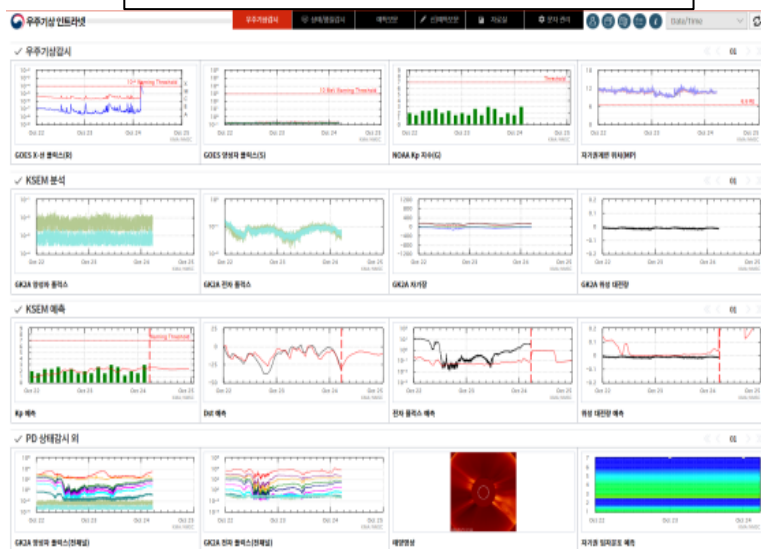


CURRENT GEO SATELLITES – Space weather monitoring using GK2A

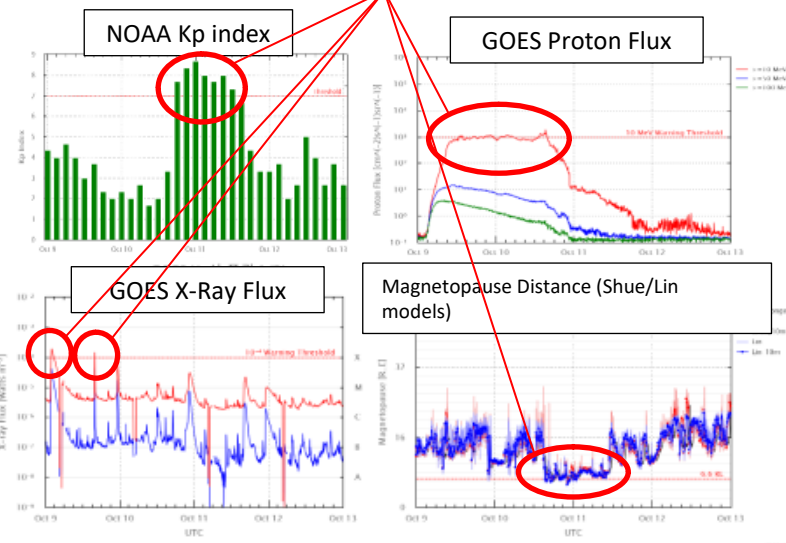
 Space Weather Monitoring

- KMA/NMSC is continuously monitoring various space weather data, including GK2A, GOES, and DSCOVR, and issues warnings when hazardous situations occur.
- An monitoring and alert issuance case for space weather events that occurred between October 9 and 11 due to solar flares and arrival of CMEs.

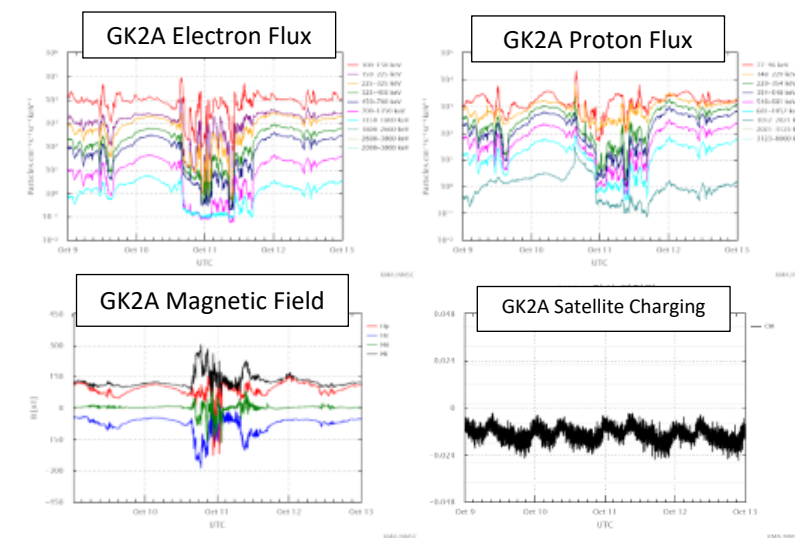
Space Weather Monitoring System



Alert Issued

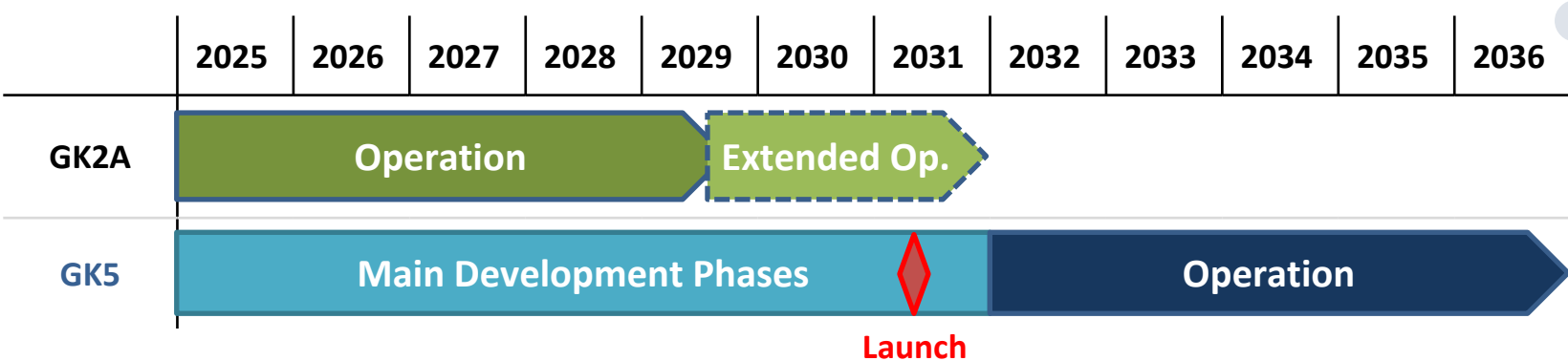


GK2A KSEM Measurements

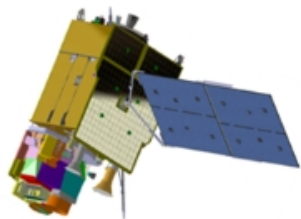


FUTURE GEO SATELLITES – The GK2A follow-on satellite, GK5

- The KMA GEO satellite program will continue based on CGMS baseline and WIGOS vision 2040.
 - VIS/NIR/IR Imager, space weather mission
- GK2A follow-on program (named **GEO-KOMPSAT-5, GK5**) **began in April 2025**.
 - A private company in Korea has been selected for the first time as the main developer of the satellite system
 - Meteorological Imager: 18 channels for meteorological mission
 - Space weather payloads: Proton/Electron Detector, Satellite Charging Monitor, Magnetometer (provided by ESA)



GK5 is scheduled to launch on 2nd Q, 2031



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

➤ Channel Comparison of Meteorological Payloads between GK2A and GK5

Wavelength Range	AMI (GK2A)			Imager onboard GK5		
	Channel No.	Central WL (μm)	Spatial Resolution (km)	Channel No.	Central WL (μm)	Spatial Resolution (km)
VIS/NIR	1	0.47	1	1	0.47	0.5
	2	0.51	1			
	3	0.64	0.5	2	0.64	0.25
	4	0.86	1	3	0.86	0.5
				4	0.91	1
	5	1.38	2	5	1.38	2
	6	1.61	2	6	1.61	1
MWIR				7	2.25	1
	7	3.83	2	8	3.9	1
				9	5.1	1
	8	6.24	2	10	6.2	2
	9	6.95	2	11	6.9	1
	10	7.34	2	12	7.3	2
LWIR	11	8.59	2	13	8.6	2
	12	9.63	2	14	9.6	2
	13	10.40	2	15	10.4	1
	14	11.21	2	16	11.2	2
	15	12.36	2	17	12.4	2
	16	13.31	2	18	13.3	2



Channels improved in spatial resolution

New channel

0.51 μm band will be simulated and produced

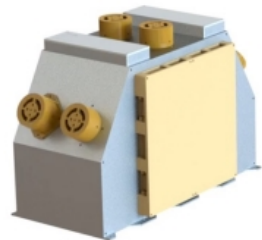
FUTURE GEO SATELLITES – The GK2A follow-on satellite, GK5

➤ Planned Space Weather Payloads (KSEM-II) onboard GK5



High Energy Proton Monitoring Suite	
Components	Key Parameters
HEPT-1 (High Energy Proton Telescope)	Energy Range: 1 ~ 30 MeV Channels: 5 in log-scale GF: 0.15 cm ² ·sr
HEPT-2 (High Energy Proton Telescope)	Energy Range: 30 ~ >500 MeV Channels: 6 in log-scale GF: 2.0 cm ² ·sr

Spacecraft Charging and Radiation Monitoring Suite	
Components	Key Parameters
CM (Charge Monitor)	Range: -3 ~ 3 pA/cm ² Resolution: < 10 fA/cm ²
RM (Radiation Monitor)	Range: 1 ~ 100 krad Resolution: < 10 rad
SESA (Segmented Electro-Static Analyzer)	Range: 10 eV ~ 20 keV $\Delta E/E$: ~0.115

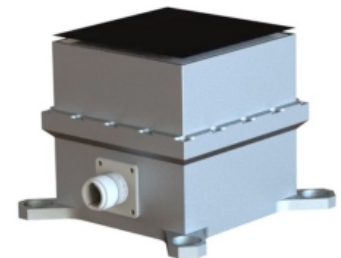


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High Energy Electron Monitoring Suite	
Components	Key Parameters
SED (Semiconductor Electron Detector)	Energy Range: 0.1 ~ 2 MeV Channels: 6 in log-scale GF: 0.032 cm ² ·sr
CED (Cherenkov Electron Detector)	Energy Range: 0.6 ~ 10 MeV Channels: 40 in log-scale GF: 0.032 cm ² ·sr



Solar Activity Monitoring Suite	
Components	Key Parameters
SXRD (Solar X-Ray Detector)	Energy Range: 0.5 ~ 10 keV Wavelength Range: 1.2 ~ 25 Å Resolution: ~ 9% (in energy) X-Ray Sensitivity: 1,000/s/keV



Magnetic Field Monitoring Suite	
Components	Key Parameters
SOSMAG-II (Service Oriented Space Magnetometer)	Range: ±1,000 nT <i>ESA will Provide</i>



Thank You!