Status report on the current and future satellite systems by KMA

Presented to CGMS-51 plenary session, agenda item 2

Dohyeong Kim

Coordination Group for Meteorological Satellites

Korea Meteorological Administration

CGMS

Executive summary

The KMA has been operating GEO-KOMPSAT-2A (GK2A, meteorological and space weather mission; AMI and KSEM) since July 25, 2019.

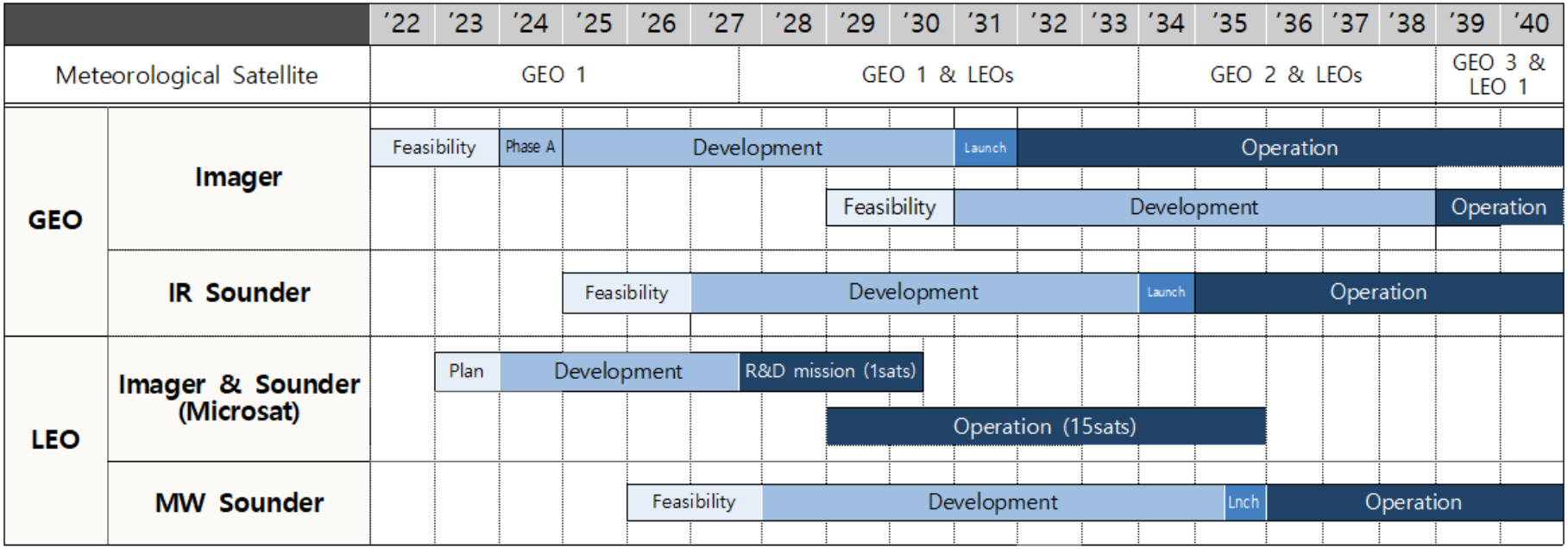
The GEO-KOMPSAT-2B (GK2B) for the oceanic and environmental mission payload, GOCI-II and GEMS, respectively, has been operational since October of 2020.

KMA is trying a new approach to support weather forecast such as fog detection for road hazard weather service, simulated satellite images for nowcasting and very short-term forecasting, dust peak height, AI-based proxy radar data, and drought monitoring data using GK2A and GK2B, and so on.

The Follow-ons of both GK2A and GK2B are in phase of feasibility study. And KMA is also preparing meteorological microsat for the future, now in conceptual study.

Overview - Planning of KMA satellite systems

KMA's Roadmap for Meteorological Satellite by 2040



Coordination Group for Meteorological Satellites

Korea Meteorological Administration

CGMS

CURRENT GEO SATELLITES

- **COMS** Meteorological mission (MI) was ended at 31 March 2020 and after one year Ocean Monitoring mission (GOCI) was also ended (31 March 2021).
- **GK2A**, which has two payloads AMI and KSEM, has been operational since 25 July 2019 and will continue to provide observational data until the end of 2029.
- **GK2B**, which has two payloads GOCI-II and GEMS, has been operational since October 2020.
- KMA is implementing the feasibility study to prepare for the follow-on of GK2A satellite in 2022~2023.
- Ministry of Oceans and Fisheries (MOF) and Ministry of Environment (ME) have implemented the conceptual studies of the follow-on of GK2B satellite.

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

Coordination Group for Meteorological Satellites

Korea Meteorological Administration

CGMS

CURRENT GEO SATELLITES – New Observation and Data Service

GK2A Request-based Rapid Scan Observation since Feb. 2021

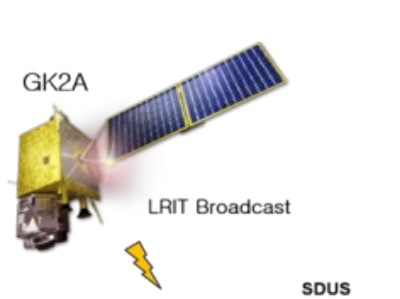
- Global users in GK2A coverage can request **Target Area Observation** for their own purpose via KMA rapid scan request webpage (http://datasvc.nmsc.kma.go.kr/datasvc/html/special/specialReqMain.do)
  - Target Area Observation: 1,000 x 1,000 km^2 every 2 minutes
- Portal on the RA II WIGOS Project website 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)

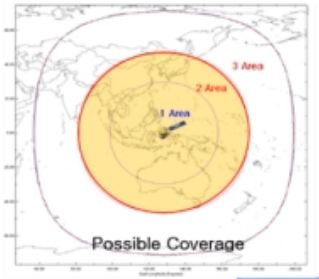
GK2A Open API data service since Nov. 2020

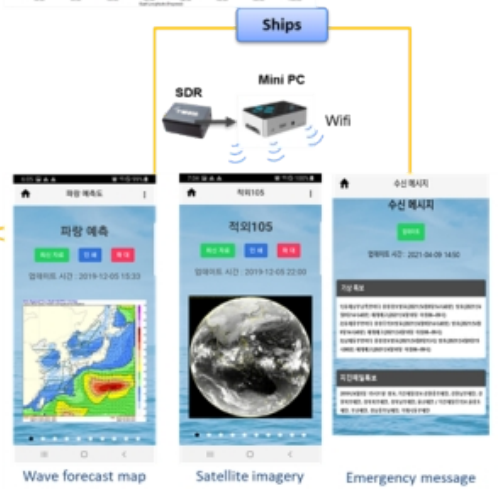
- **Open API data service** is available to agency, company, academia and individual that want to use the GK2A data.
  - user application form posted on NMSC website (http://nmsc.kma.go.kr/enhome, kmasod@korea.kr)

CURRENT GEO SATELLITES – Marine weather broadcast service

- KMA has operated **GK2A marine weather broadcast service via SDUS** since July 23, 2020
  - This is high-quality digital marine weather information service using antenna and reception system connects with smartphone and tablet for ships and remote area within RA-II and RA-V regions
  - The information includes
    - GK2A satellite images
    - surface and wave analysis and forecast charts
    - Emergency message : severe weather and disaster information such as typhoon, storm, earthquake and tsunami warning

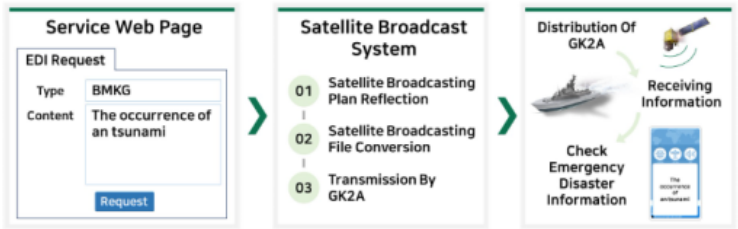






Marine weather broadcast service screen example

Request procedure for users of RA-II and RA-V



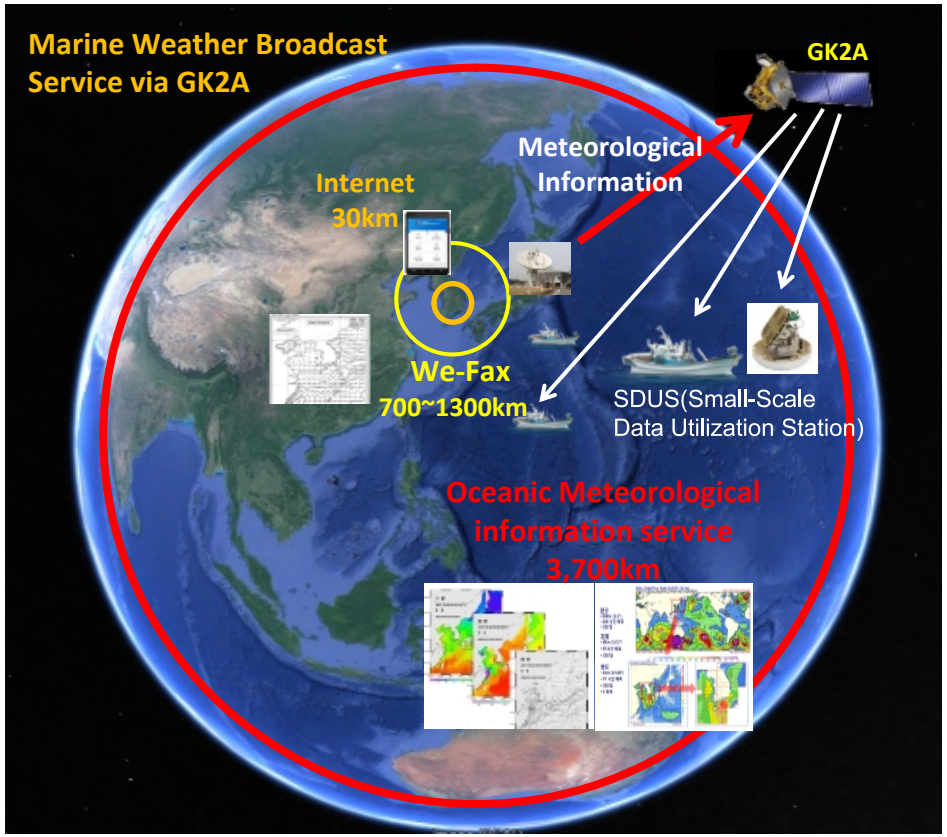
Coordination Group for Meteorological Satellites

Korea Meteorological Administration

CGMS

CURRENT GEO SATELLITES – Marine weather broadcast service

- KMA has operated **GK2A marine weather broadcast service via SDUS** since July 23, 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

❖ Service website opened in 2022

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

❖ As for the RA II Pilot project, KMA will cooperate with BMKG Indonesia for the international service

Coordination Group for Meteorological Satellites

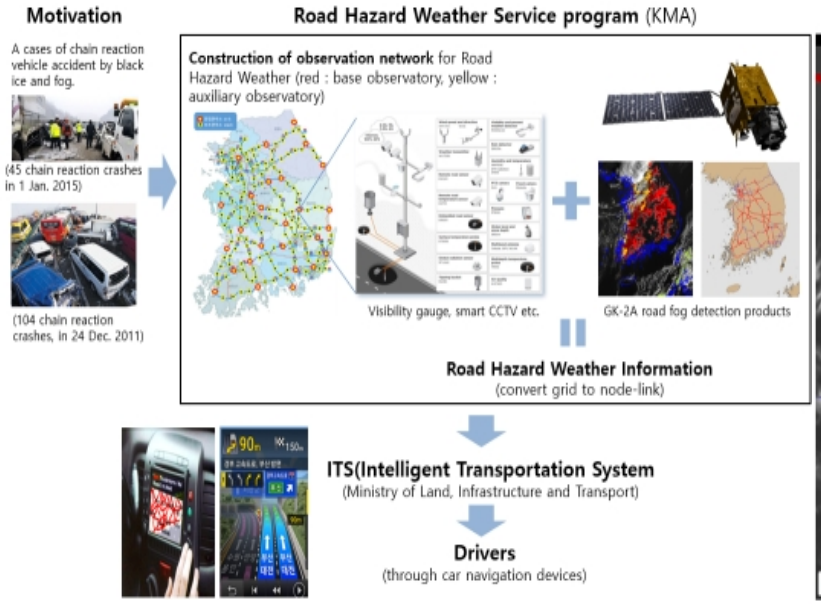
Korea Meteorological Administration

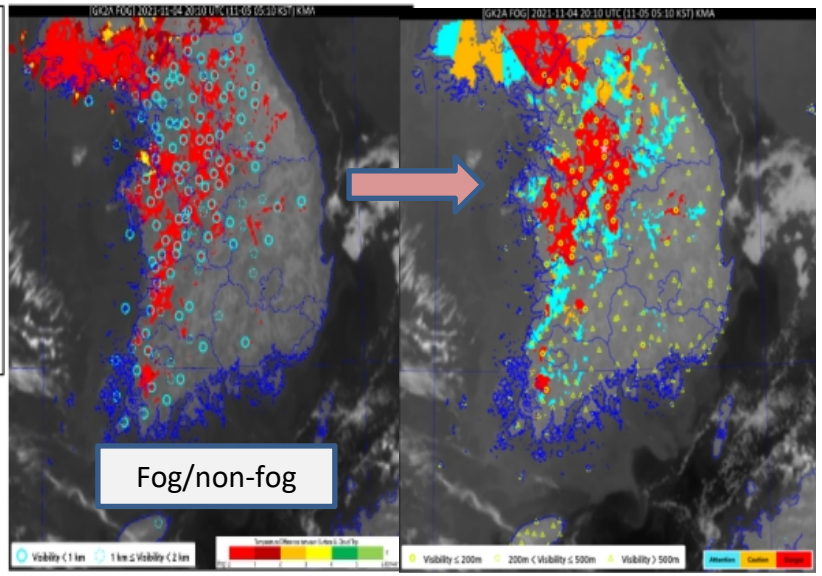
CGMS

New approach for users and AI application for weather support

GK2A fog for road hazard weather service

- For supporting road hazard weather service, GK2A fog is classified into 3 types ; Attention, Caution, Danger according to ranges of visibility which is estimated by regression formula with ground measurement gages.
- This service will be provided to drivers through mobile navigation etc. with integrated information with objective analysis of ground gauges, CCTV derived data as well as GK2A fog from July of 2023.





Attention
Vis. < 1km

Caution
0.2km < Vis. < 0.5km

Danger
Vis. < 0.2km

Coordination Group for Meteorological Satellites

Korea Meteorological Administration

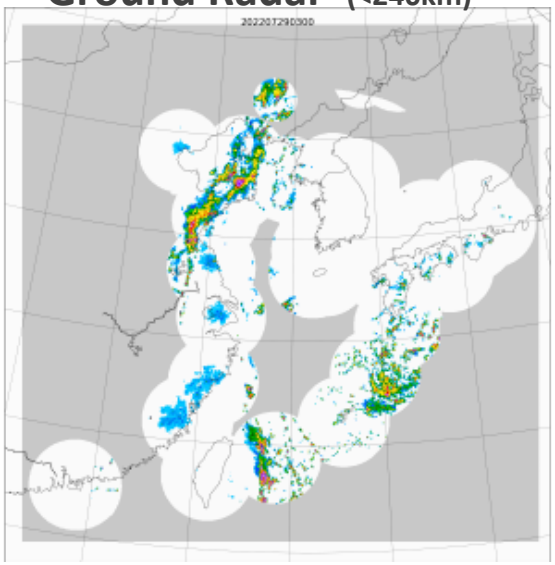
CGMS

New approach for users and AI application for weather support

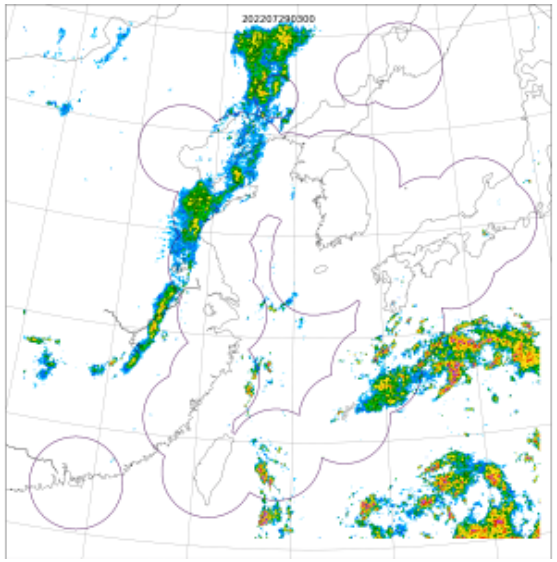
AI based proxy radar from GK2A/AMI data in East Asian region

- No radar observation in western and southern part of Korea as shown in below figure which is very significant area for monitoring severe weather such as typhoon or developed convective clouds crossing this area.
- 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.

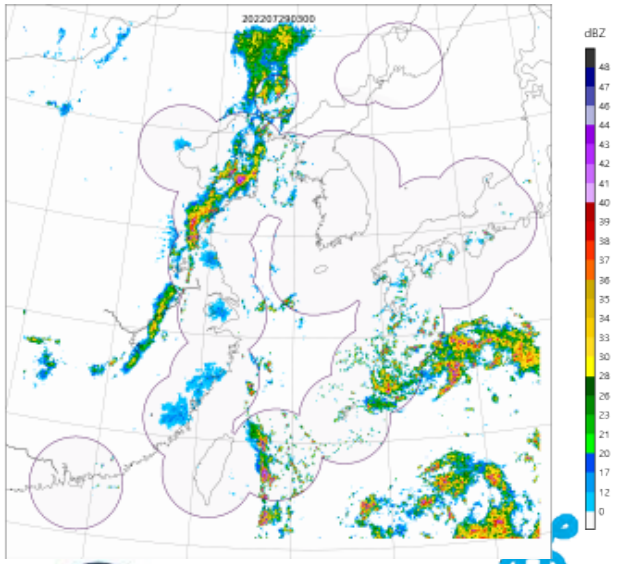
Composited Ground Radar (<240km)



Proxy Radar



Ground radar + Proxy radar



Coordination Group for Meteorological Satellites

Korea Meteorological Administration

CGMS

New approach for users and AI application for weather support

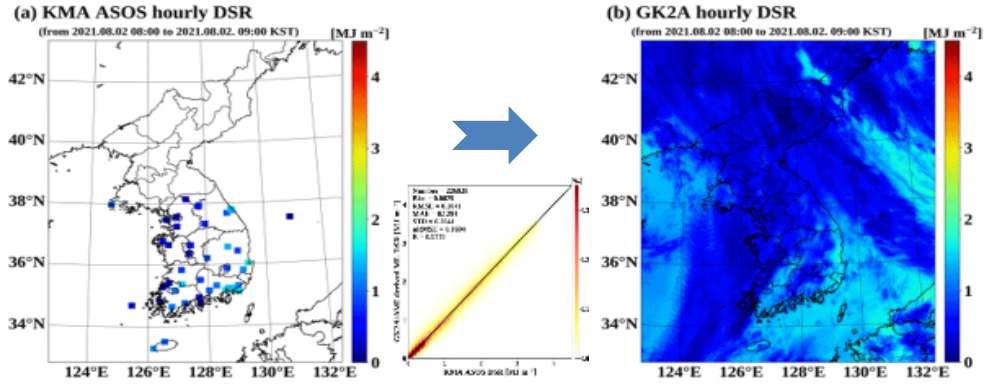
AI based GK2A/AMI Surface Solar Irradiation (SSI) for Climate Application

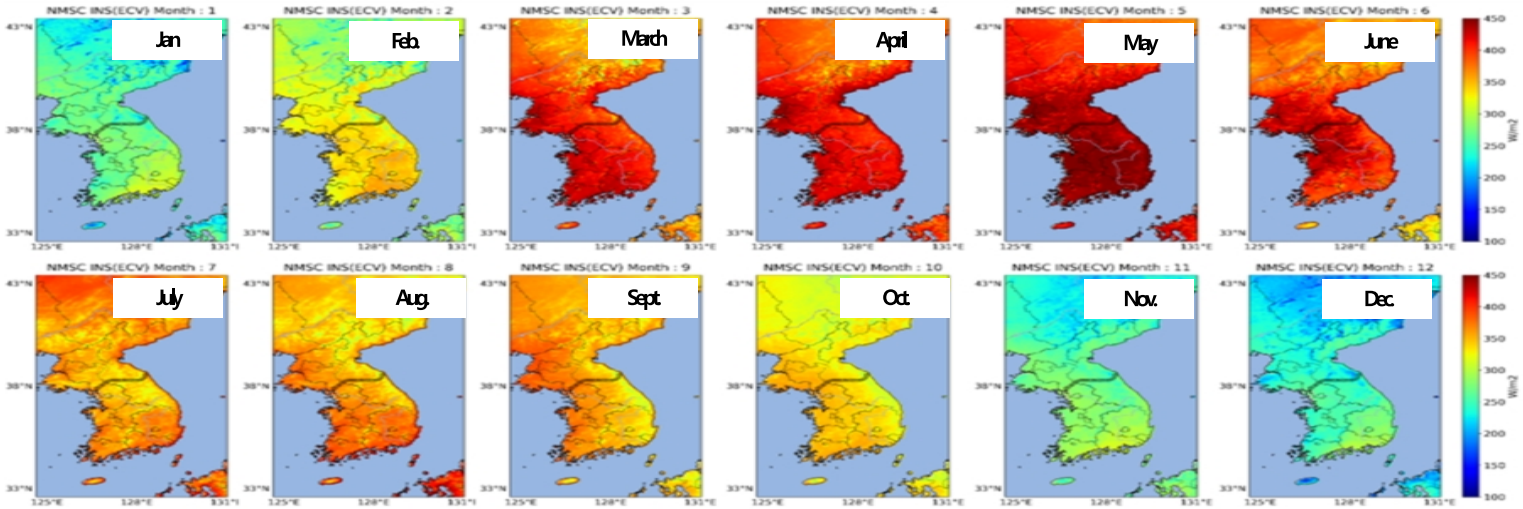
* Method: Convolutional Neural Network (CNN)

- GK2A SSI retrieval developed
  - Using AI/CNN technique with training downward shortwave radiation (DSR) comparison between ground point (ASOS) data and GK2A observation data

Ground based SSI measurement (KMA ASOS)
- Spatial resolution : about 67 km x 67 km

AI generated 1hr accumulated SSI
- Spatial resolution : 2 km x 2 km





Annual SSI distribution (Monthly value)

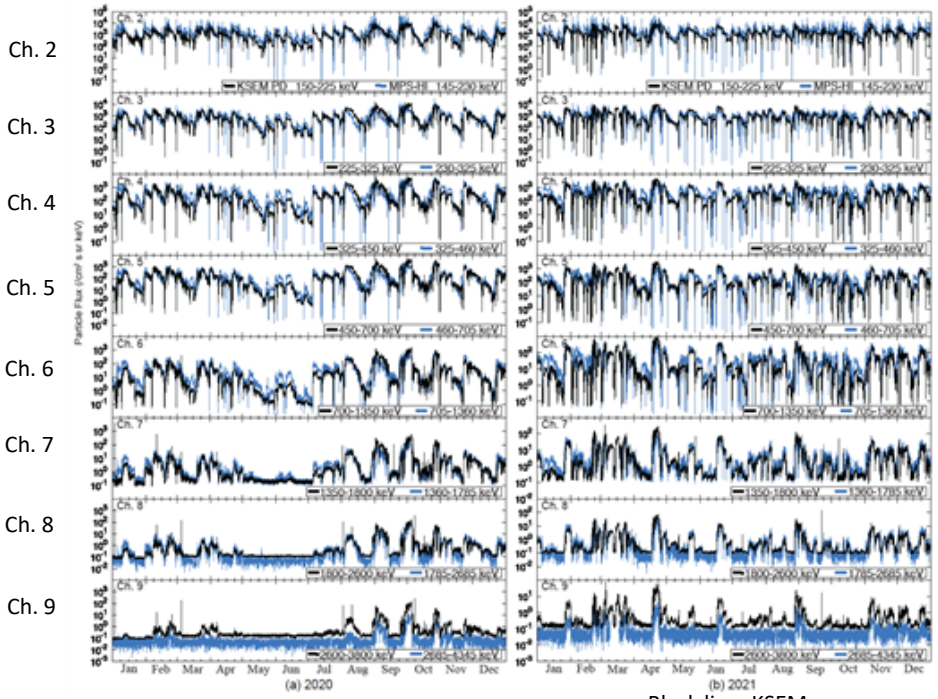
Coordination Group for Meteorological Satellites

Korea Meteorological Administration

CGMS

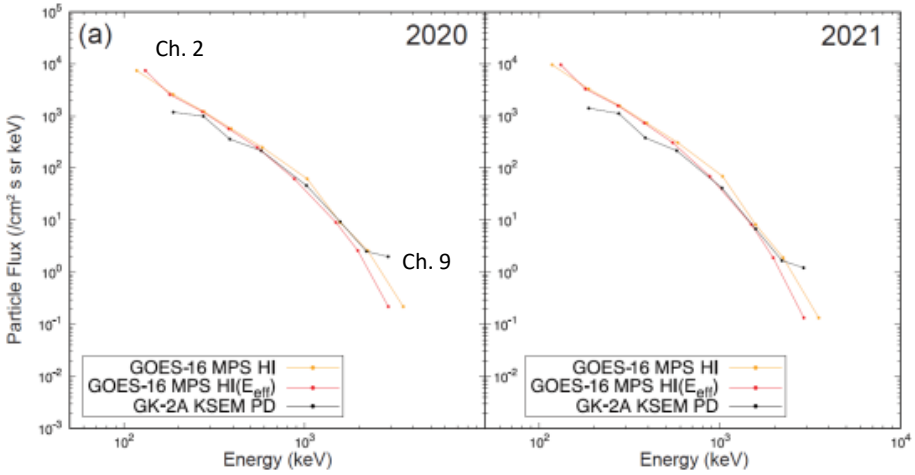
Korean Space wEather Monitor onboard GK2A

- The GK2A's space weather payload, KSEM consists of Particle Detector (PD), Magnetometer (MG), and Charging Monitor (CM).
- KMA analysed electron particle flux inter-comparison between GK2A/KSEM PD and GOES-R/MPS-HI data for 2 years (2020-2021). As a result, overall response of KSEM PD and MPS-HI to the electron flux detection phases show a good correspondence



-Black line: KSEM
-Blue line: GOES-R/MPS-HI

Spectral energy distribution



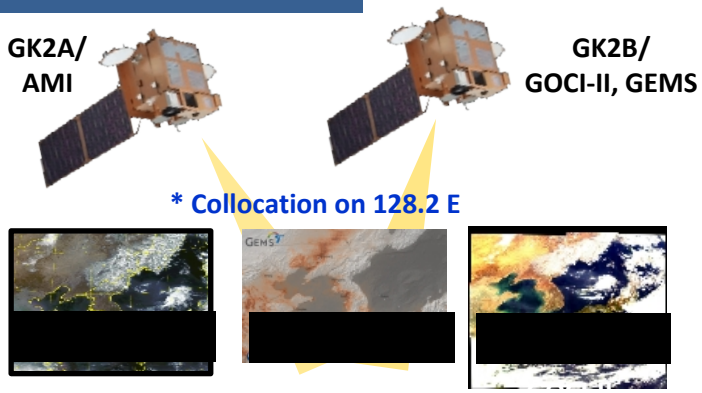
Coordination Group for Meteorological Satellites

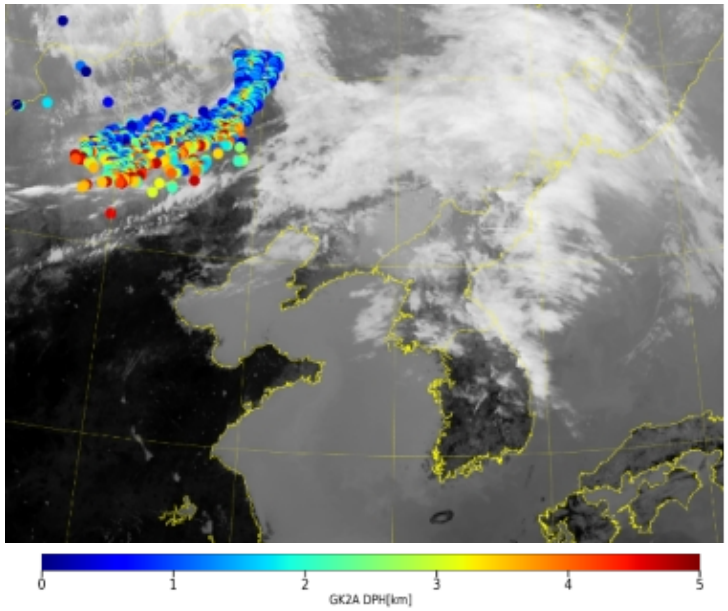
Korea Meteorological Administration

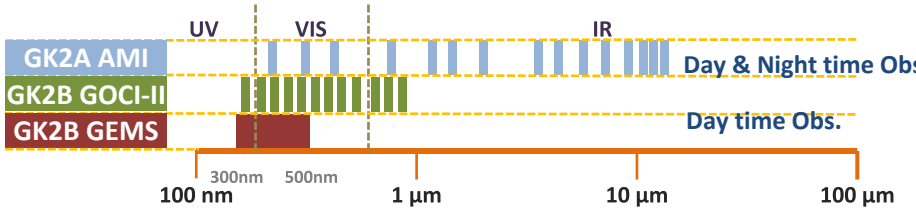
CGMS

Collaboration Between GK2A and GK2B

- Dust Peak Height retrieval developed using GK2A and GK2B data
  - GK2A AMI: CLD, ADPS, AOD
  - GK2B GEMS: L1C, Irradiance, Reflectance



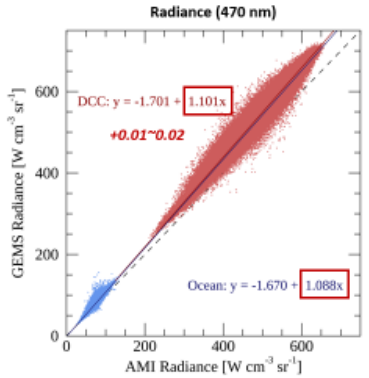


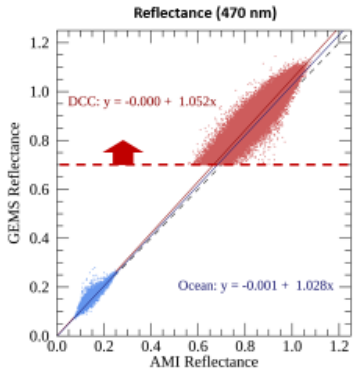


GEO-GEO comparison (GEMS vs. AMI)

❖ Scene dependence: vicarious targets

Threshold	DCC	Ocean
$R_{754\,nm}$	> 0.85	< 0.30
$TB_{10.4\,\mu m}$	< 210 K	> 290 K
$\sigma(R_{470\,nm})$	< 0.03	< 0.003
$\sigma(t, R_{470\,nm})$		< 0.02

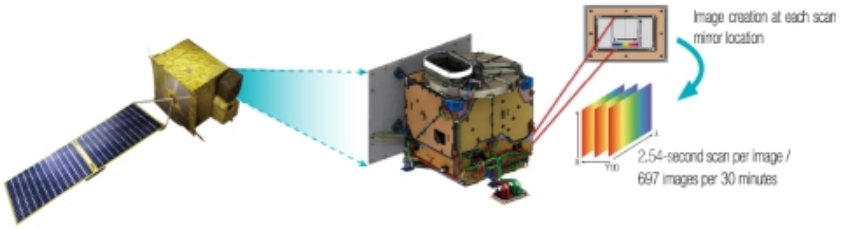




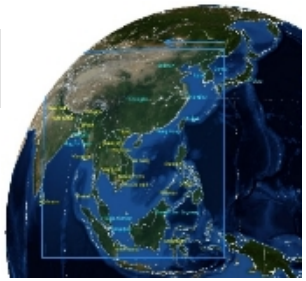
2023 GSICS Annual Meeting (Feb. 2023/USA)

Issues in GK2B GEMS & GOCI-II

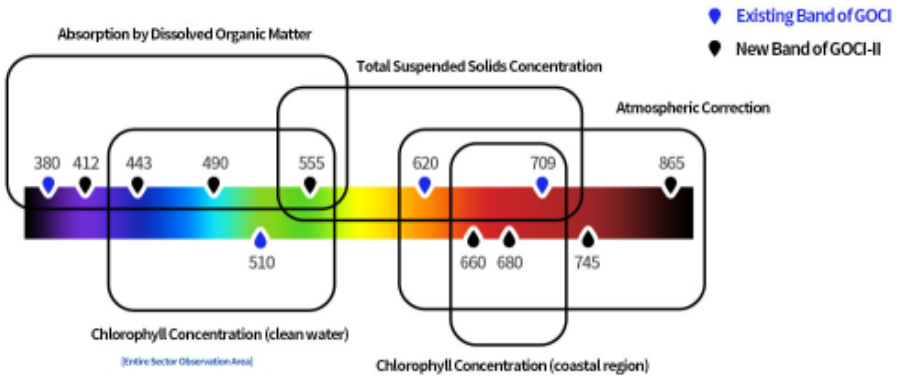
GK2B GEMS (environmental monitoring sensor)

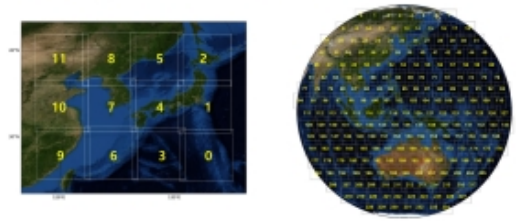


Scan Area



GK2B GOCI-II (ocean color imager)

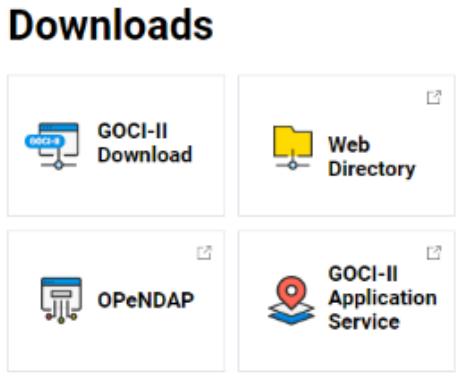




Observation Slot Image Order
- Regional & Entire Sector

- GK2B GEMS L2 21 products service since Nov. 2022
  - Environmental Satellite Center in National Institute of Environmental Research
  - http://nesc.nier.go.kr/en/html/index.do

- GK2B GOCI-II data downloads way 4 types since Nov. 2022
  - National Ocean Satellite Center
  - http://www.nosc.go.kr/eng/main.do



Coordination Group for Meteorological Satellites

Korea Meteorological Administration

CGMS

FUTURE GEO SATELLITES – The GK2A follow-on program

- The KMA GEO satellite program will continue based on CGMS baseline and WIGOS vision 2040.
  - VIS/IR Imager, hyperspectral sounder, space weather mission

    ※ Space weather payloads: Proton/Electron Detector, Satellite Charging Monitor, Magnetometer

- KMA's long-term satellite development plan (2023) introduced **the multi-GEO program**; one is Imager and another is Hyperspectral IR Sounder.
  - To consider **GXI** with 18 channels as the GEO imager FO program
  - The impact studies on KMA weather forecast performance of the GEO sounder is underway collaborating with NWP center

Coordination Group for Meteorological Satellites

Korea Meteorological Administration

CGMS

Thank you!