



OPERATIONAL SEA SURFACE TEMPERATURE RETRIEVAL USING GK-2A OF KMA

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Abstract

The GEO-KOMPSAT-2A (GK-2A), the 2nd geostationary meteorological satellite of the South Korea, was launched on December 4th, 2018. National Meteorological Satellite Center (NMSC) of the Korea Meteorological Administration (KMA) developed Sea Surface Temperature (SST) retrieval algorithm with Himawari-8 and tuned with GK-2A data during the In-Orbit Test (IOT) period. The SST algorithm is based on Multi-band SST (MSST) with 4 infrared channels. The SST was verified with in-situ data and the bias and RMSE are less than 0.1 degree and 0.5 degree in Celsius, respectively. For the contingency plan, other algorithms are also prepared, which are hybrid-SST, Non-Linear SST, and Multi-Channel SST. As the SST observed by imager sensor works only on cloud free area, the GK-2A SST is composited with 1day, 5days, and 10days to fill the void area on the ocean. In addition, SST data from several satellites are blended to produce a multi-sensor SST every day. These composite and blended SST data are verified with OSTIA data. The SST products has been serviced operationally in KMA since March of 2020.

I. Introduction to GK-2A

The GK-2A is the 2nd geostationary meteorological satellite of Korea. AMI is imager on board GK-2A.

GK-2A: GEO-KOMPSAT-2A (Geostationary Earth Orbit - Korea Multi-Purpose Satellite - 2A)

- Launch date/Operation: December 4th, 2018 (UTC) / July 2019
- Operation Orbit: 128.2E / 35,800 km above the Equator
- Multiple Payloads: AMI, KSEM

AMI: Advanced Meteorological Imager

- Observation mode:

Full Disk (Full Disk) + 5 ELA (Extended Local Area) + 5 LA (Local Area)

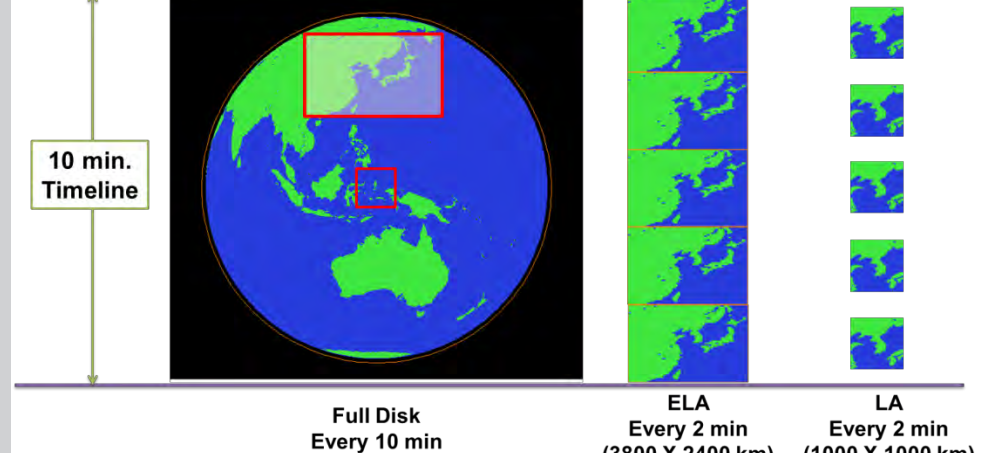


Figure 2. Observation mode of the GK-2A AMI

- 16 Channels:

Table 1. GK-2A AMI channel information comparison with GOES-16/ABI and with Himawari-8/AHI

Channel	Resolution	Wavelength	ABI	AHI
1 (blue)	0.47 (1km)	0.47	0.47	0.46
2 (green)	0.511 (1km)	0.511	0.511	0.51
3 (red)	0.64 (0.3km)	0.64	0.64	0.64
4	0.955 (1km)	0.955	0.955	0.95
5	1.38 (2km)	1.378	1.378	1.37
6	1.61 (2km)	1.61	1.61	1.6
7	3.830 (2km)	2.25	2.25	2.3
8	6.241 (2km)	3.90	3.90	3.9
9	6.852 (2km)	6.185	6.185	6.2
10	7.344 (2km)	6.95	6.95	7.0
11	8.592 (2km)	7.34	7.34	7.3
12	9.625 (2km)	8.50	8.50	8.6
13	10.403 (2km)	9.61	9.61	9.6
14	11.212 (2km)	11.2	11.2	11.2
15	12.364 (2km)	12.3	12.3	12.3
16	13.31 (2km)	13.3	13.3	13.3

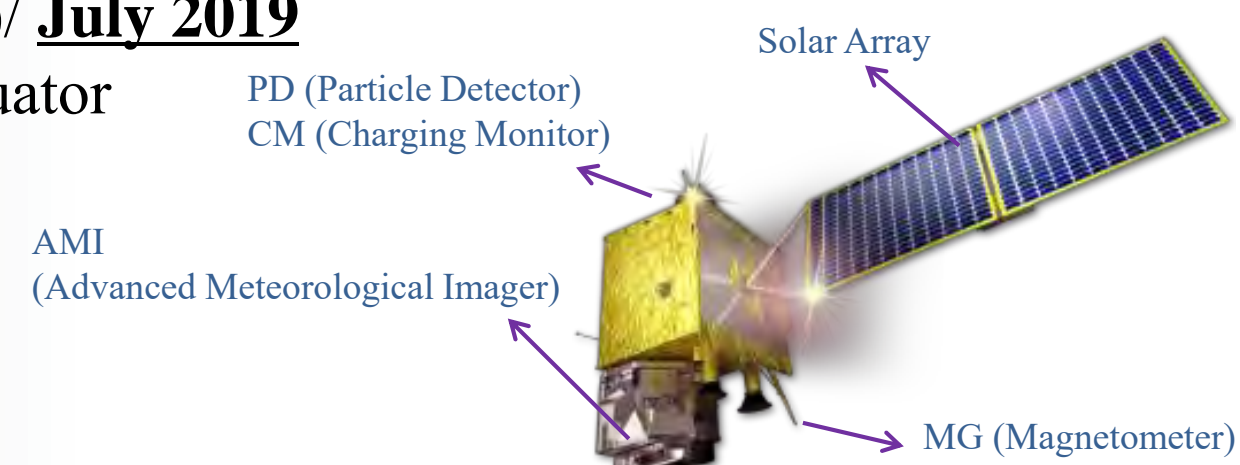


Figure 1. Structure and payloads of the GK-2A

KSEM: Korea Space Weather Monitor

- Sensors: Particle Detector, Charging Monitor, Magnetometer

GK-2A Meteorological Data (L2+)

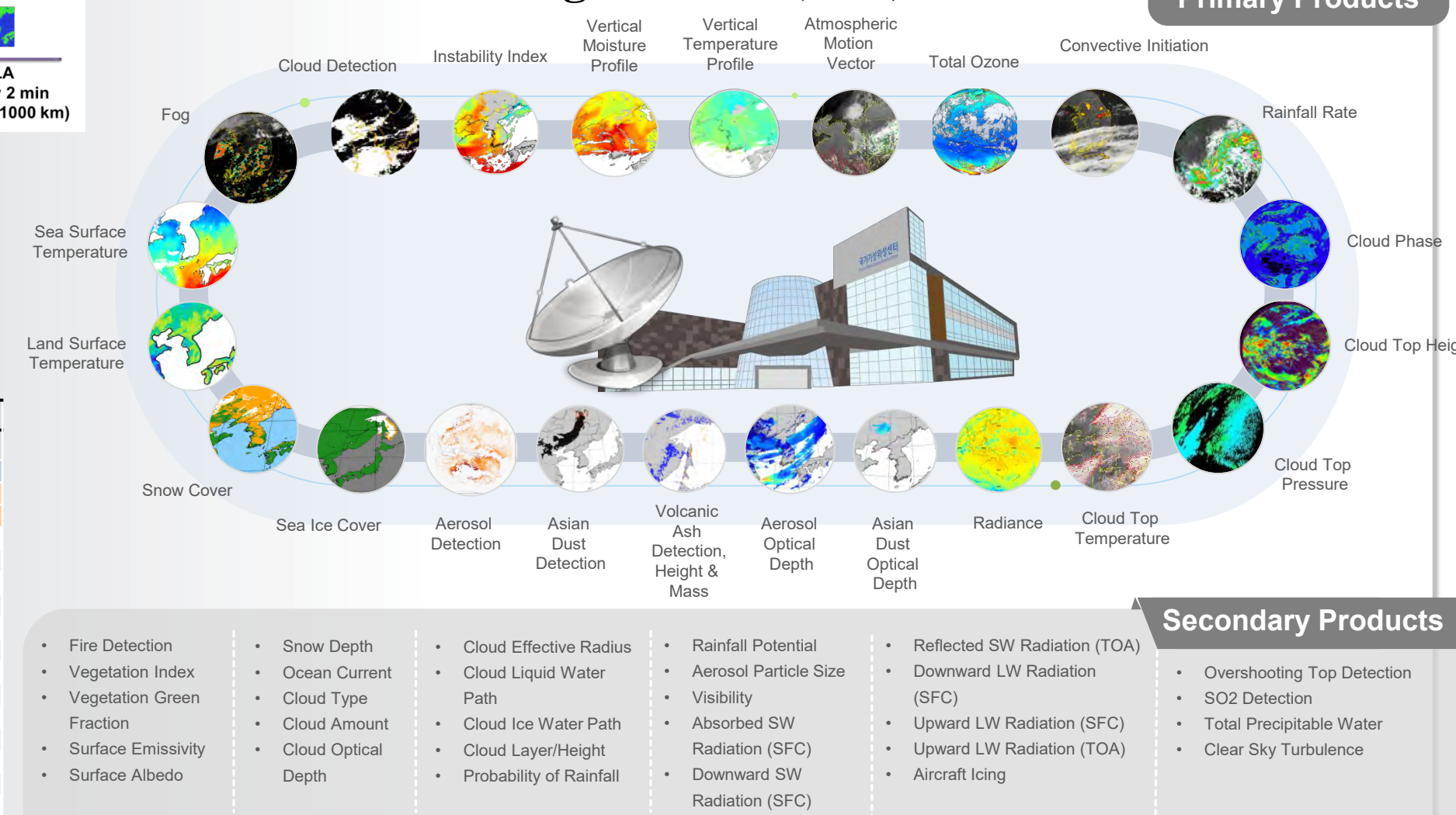


Figure 3. 52 meteorological products of the GK-2A AMI

II. GK-2A SST

KMA has developed SST algorithm for the GK-2A using 4 infrared channels (Multi-band algorithm). The GK-2A SST data has been officially serviced since March 2020.

GK-2A SST Algorithm: Multi-band SST (a priority)

- Prepared 3 backup algorithms for contingency
- 4 SST Retrieval Formulas

MCSST Algorithm (Ch. 13 & 15)

NLSST Algorithm (Ch. 13 & 15)

Hybrid Algorithm (Ch. 13 & 15)

Multi-band Algorithm (Ch. 11, 13, 14, & 15)

SST Quality Controls

After Cloud Mask, SST Range Test / RTM Test / Static SST Test / Adaptive Test / Uniformity Test for non-cloudy pixels

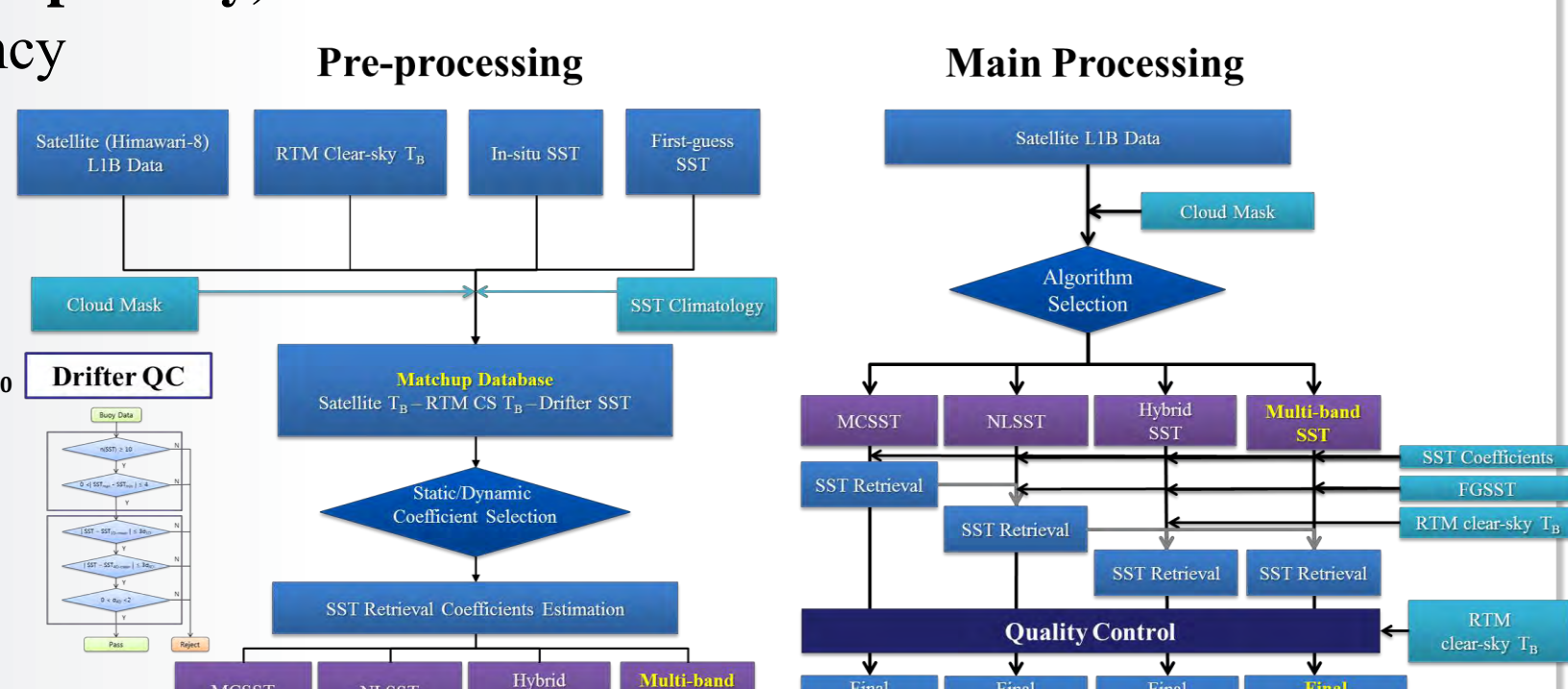


Figure 4. Flow diagram of algorithm of the GK-2A SST

GK-2A SST Products

- Temporal/Spatial resolution: 10 minutes / 2km
- Observation Mode: Full Disk, East Asia, Local Area (Korean Peninsula)
- Composite SST: 1 day, 5 days, 10 days

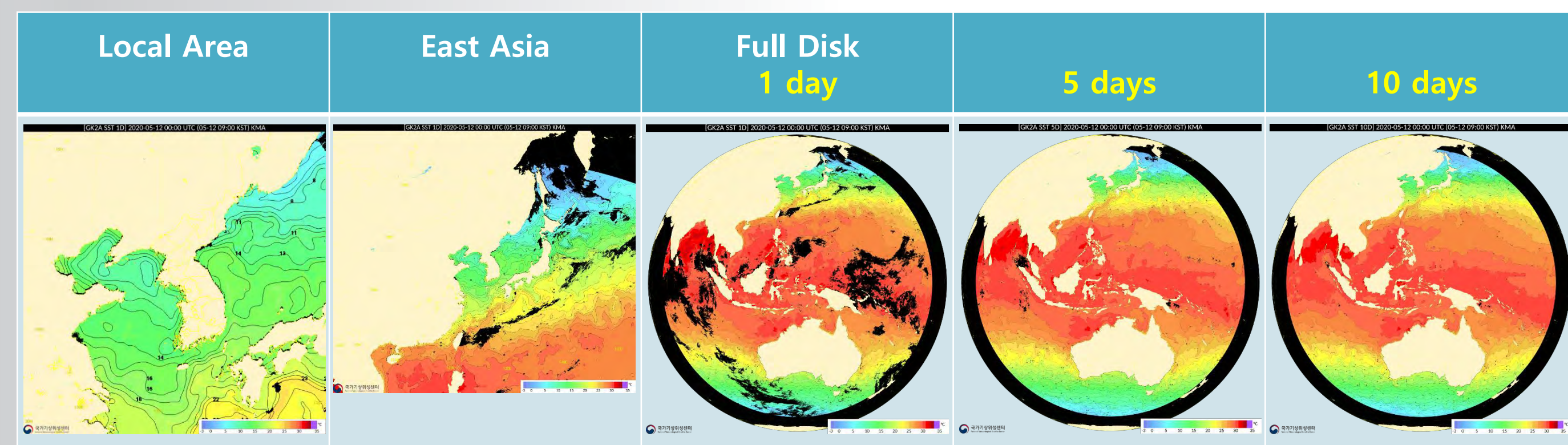


Figure 5. GK-2A SST images classified in observation mode and composite days

KMA also produces composite SST data to fill in the gaps in the observed data. SST values are only produced within 65 degrees of the satellite viewing angle.

Multi-sensor SST (MSST) with GK-2A

- In addition, KMA has been producing blending SST retrieval using multi-sensor data as well as GK-2A.

Table 2. Multi-sensors for MSST

SST	GK2A (AMI)	NOAA-18/19 (AVHRR)	GCOM-W1 (AMSR2)	GPM (GMI)	In-situ (Buoy)
Resolution	2km	1km or 4km	25km	25km	≥ 13°C

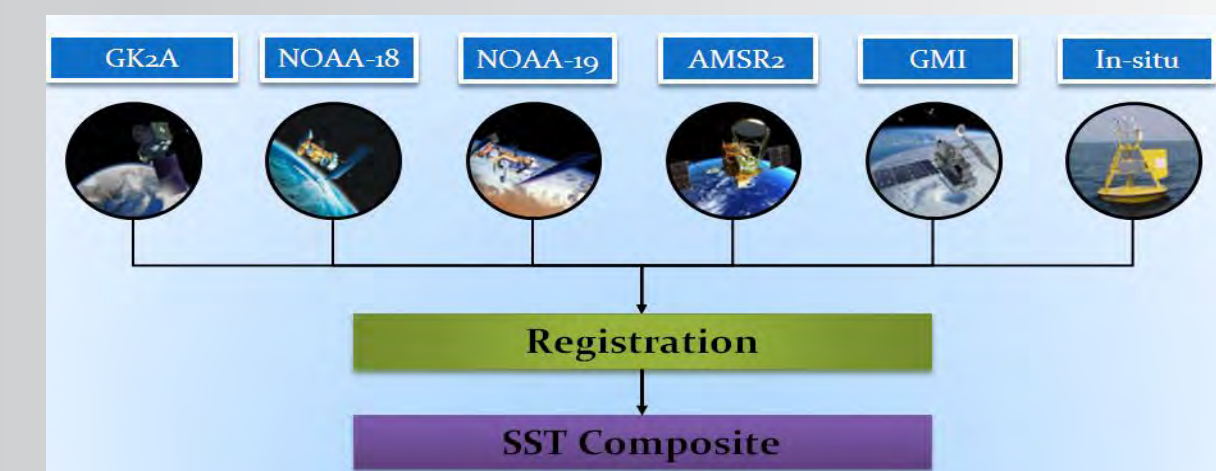


Figure 6. Flow diagram of algorithm of the GK-2A MSST

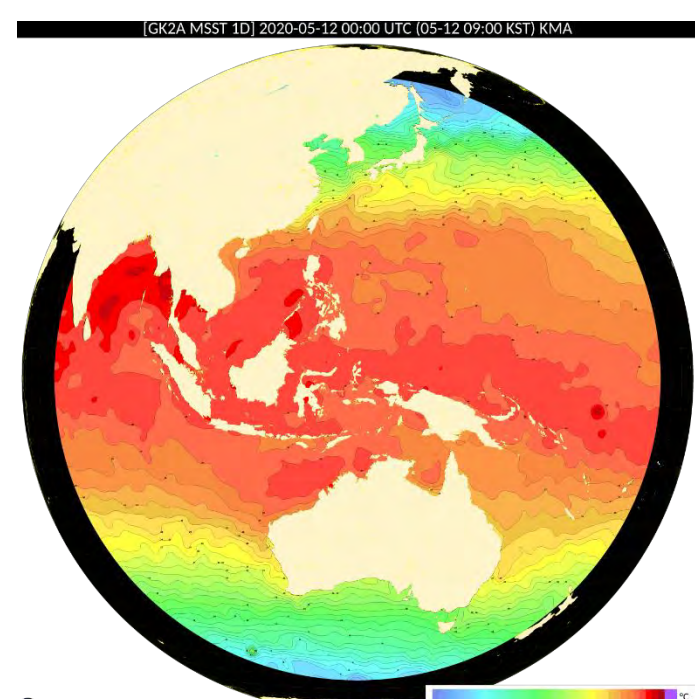


Figure 7. Sample image of GK-2A MSST

III. Preliminary Results of GK-2A SST

KMA verified the developed SST by comparing it with buoy data. In addition, KMA used Operational Sea Surface Temperature and Sea Ice Analysis (OSTIA) data to evaluate the GK-2A MSST validation. The preliminary results are as follows.

GK-2A SST Evaluation

- Validation data: Drifter Buoy
- Period: Aug. 2019 ~ Feb. 2020
- Validation Area: Full Disk
- Statistical Results

Table 3. Preliminary validation results of GK-2A SST

Product	Temperature Range	Requirements	Validation Results
SST	270 ~ 313 K (-3~40 °C)	RMSE : 0.7 K Bias : ± 0.2 K	RMSE : 0.51 K Bias : - 0.05 K

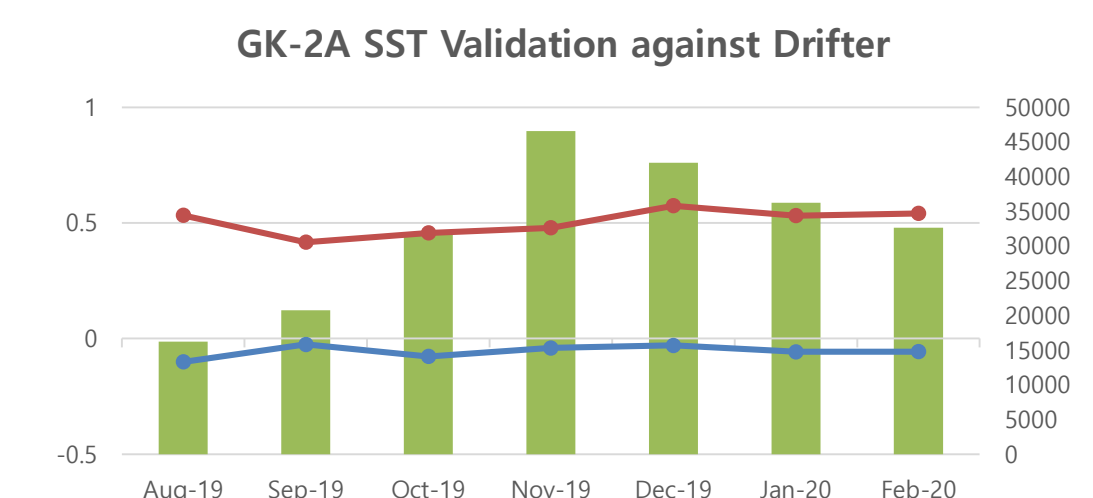


Figure 8. GK-2A SST validation results from Aug. 2019 to Feb. 2020

As a result of verifying GK-2A SST by comparing drifter buoy data from Aug. 2019 to Feb. 2020, bias was -0.05 K and RMSE was 0.51 K. And the results are good matches to the requirements.

GK-2A MSST Evaluation

- Validation data: OSTIA
- Period: Aug. 2019 ~ Feb. 2020
- Validation Area: Full Disk
- Statistical Results

Table 4. Preliminary validation results of GK-2A MSST

Product	Temperature Range	Validation Results	Validation Results (After Nov. 2019)
MSST	270 ~ 313 K (-3~40 °C)	RMSE : 0.67 K Bias : - 0.00 K	RMSE : 0.50 K Bias : - 0.02 K

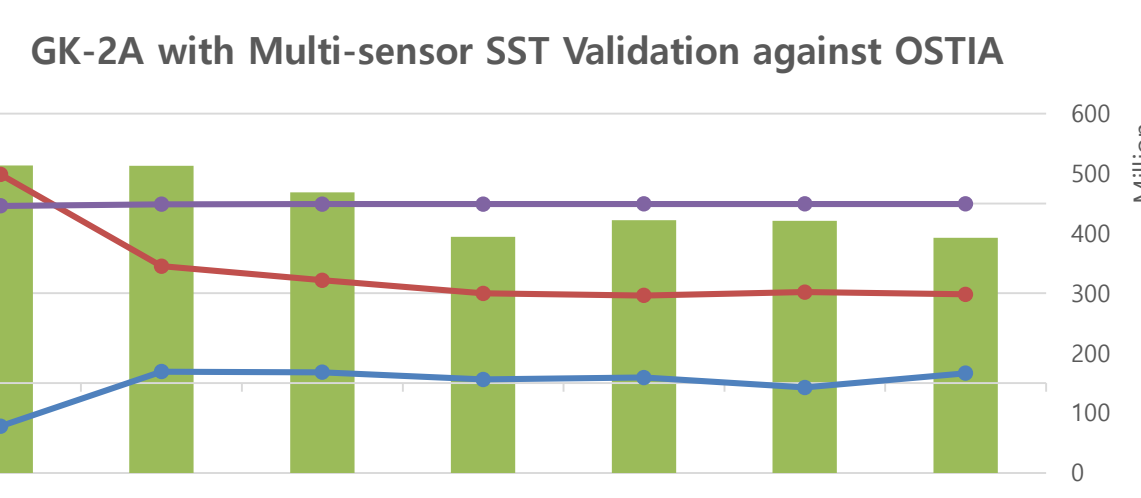


Figure 9. GK-2A MSST validation results from Aug. 2019 to Feb. 2020

The MSST algorithm has been improved since Oct. 23rd 2019.

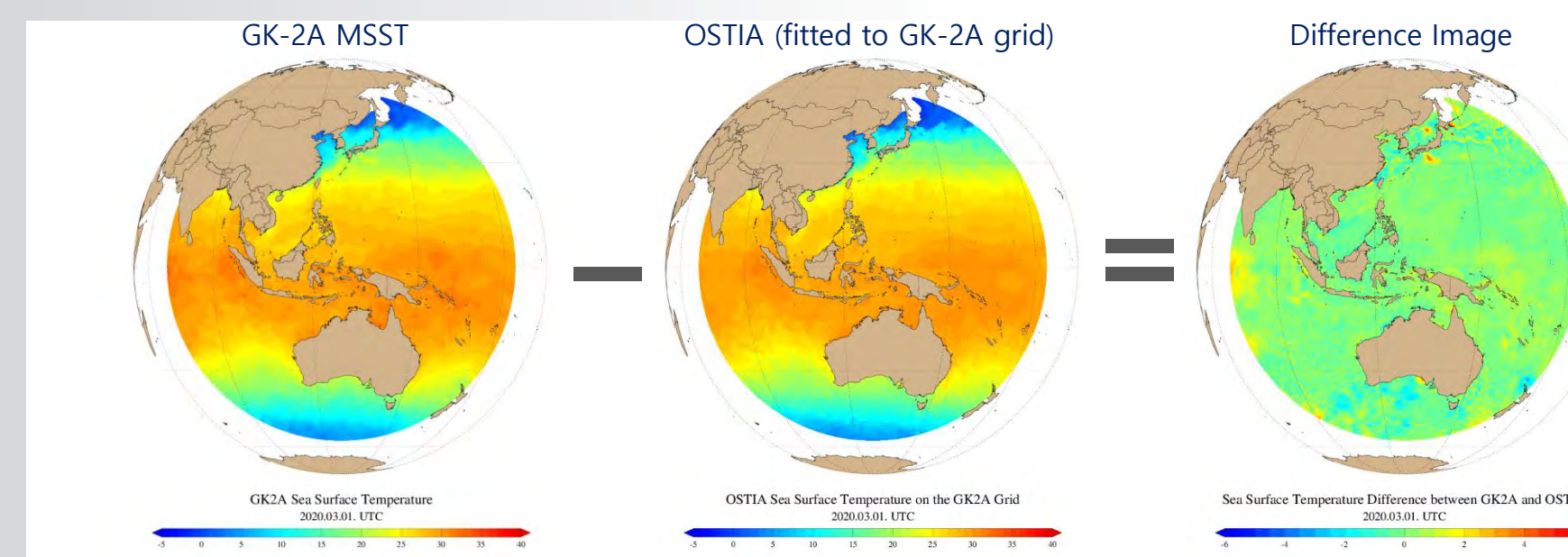


Figure 10. Sample comparison image of GK-2A MSST and OSTIA (Mar. 1st 2020)

As a result of verifying GK-2A MSST by comparing OSTIA data from Aug. 2019 to Feb. 2020, bias was near zero degree and RMSE was 0.67 K. Especially, RMSE was 0.50 K after Nov. 2019. It is because the GK-2A MSST algorithm had improved at Oct. 23rd 2019.

Scatter plot series of GK-2A MSST vs. OSTIA

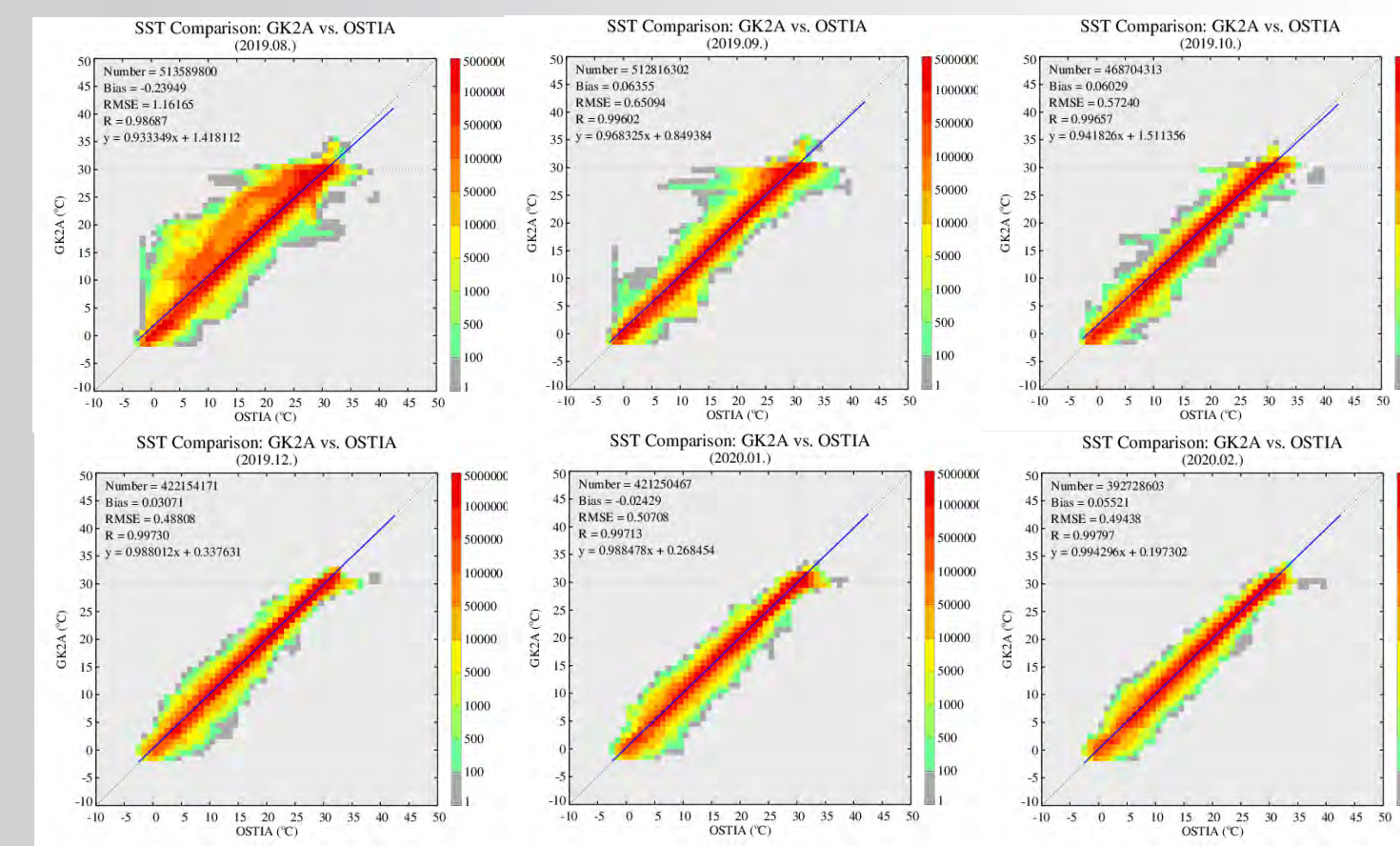


Figure 11. Monthly scatter plot images between GK-2A MSST and OSTIA from Aug. 2019 to Feb. 2020

Statistical difference between GK-2A MSST and OSTIA gradually decreases and appears to stabilize.

IV. Summary and Future Works

National Meteorological Satellite Center (NMSC) of KMA has been operating 2nd geostationary meteorological satellite of Korea, GK-2A since July 2019.

One of the 52 baseline products, SST retrieval also operationally produced using Multi-band (4 band) SST algorithm in NMSC/KMA.

- KMA has three back-up SST algorithms such as MCSST, NLSST, and Hybrid-SST for the contingency situation.
- The bias and RMSE of GK-2A SST products were -0.05 K and 0.51 K respectively against drifter buoy SST data.

In addition, KMA has been developed composite and blending SST to fill in the gaps.

- Multi-sensor blended SST (MSST) obtained microwave data, IR data, and in-situ SST data is produced operationally
- The bias and RMSE of GK-2A MSST were -0.02 K and 0.50 K respectively against OSTIA data.

KMA is preparing to produce Global coverage SST with many of sensors and in-situ data for SST.

KMA plan to further analyze how the accuracy varies in SST with seasonal changes.

