The COMS Measurements of Sea Surface Temperature at KMA

Jae-gwan Kim, Chul-kyu Park, Chu-yong Chung, and Seon-kyun Baek

National Meteorological Satellite Center of KMA

National Meteorological Satellite Center, 64-18 Guam-gil, Gwanghyewon-myeon, Jincheon-gun, Chungbuk, 365-831, Republic of Korea

KimJGwan@korea.kr

Ⅰ. Introduction

National Meteorological Satellite Center (NMSC) of Korea Meteorological Administration (KMA) has been operating the first Korean meteorological geostationary satellite, COMS officially since 2011. KMA developed sixteen baseline meteorological products of the COMS observation data including sea surface temperature (SST) and they have been generated via COMS Meteorological Data Processing System (CMDPS). NMSC evaluated the accuracy and performance of SST product and tried to improve it. The COMS SST product retrieved with Multi-Channel SST algorithm. We tried to reduce biases in comparison with in-situ data and other satellite data using modification of regression coefficients in algorithm for numerical weather prediction.

Ⅱ. COMS and CMDPS

The COMS is the first multi-purpose geostationary satellite for Korea in the application of meteorology, ocean, and communication. MI is imager on board COMS.

▣ COMS: Communication, Ocean, and Meteorological Satellite

- Launch date: June 27th, 2010
- Operation Orbit: 128.2E / 35,800 km above the Equator
- S/C Stabilization: 3-axis
- Multiple Payloads: MI, GOCI, Ka-band Transponders

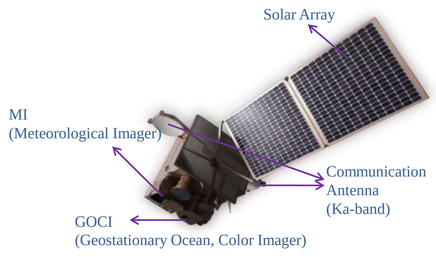

Figure 1. Structure and name of each parts of the COMS

▣ MI: Meteorological Imager

- Multispectral imaging radiometer
- 1 visible and 4 infrared channels

Table 1. Specification of the COMS MI channels

Channel Number	Channel Full Width at Half Maximum (μm)		Spatial Resolution Half-Amplitude (IFOV in μrad) (km)	Required Range of Measurement	End Use
	Lower	Upper			
VIS	0.55	0.80	28 (1km)	0-115%(Albedo)	Cloud Cover
SWIR	3.5	4.0	112 (4km)	4-350K	Night Cloud
WV	6.5	7.0	112 (4km)	4-330K	Water Vapor
IR1	10.3	11.3	112 (4km)	4-330K	Cloud and Surface Temperature
IR2	11.5	12.5	112 (4km)	4-330K	Cloud and Surface Temperature

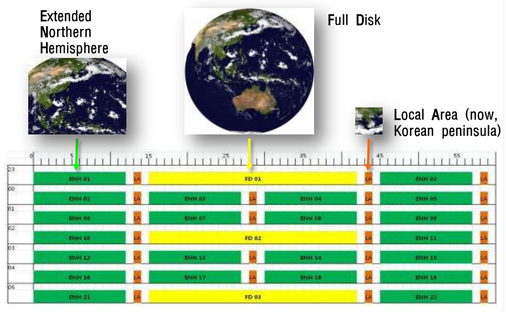

Figure 2. Observation schedule and mode

▣ CMDPS: COMS Meteorological Data Processing System

- L2 data processing system installed at ground station in NMSC
- CMDPS has produced 16 baseline products from the COMS MI observation

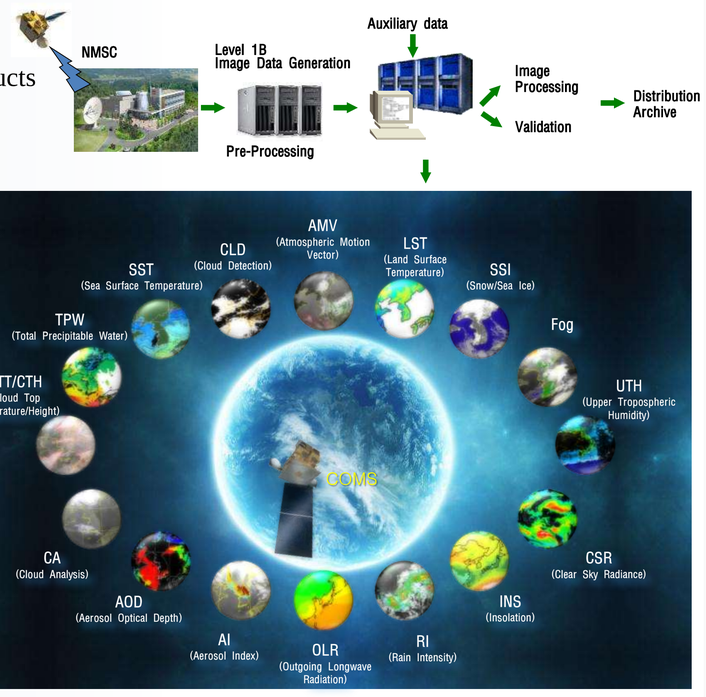

Figure 3. 16 baseline products of the COMS MI

Ⅲ. COMS SST

KMA uses MCSST method to derive COMS SST in operation and different coefficient sets are used for daytime and nighttime.

▣ COMS SST Algorithm: MCSST (Multi-Channel Sea Surface Temperature)

- Retrieval Formula

$$MCSST = a_1 T_{IR1} + a_2 (T_{IR1} - T_{IR2}) + a_3 (T_{IR1} - T_{IR2})(sec\theta - 1) + a_4$$

Where, a_1, a_2, a_3, a_4 : SST retrieval coefficients

T_{IR1}, T_{IR2} : Brightness temperature of IR1 and IR2 channels

θ : Satellite zenith angle

- Flow chart of calculation

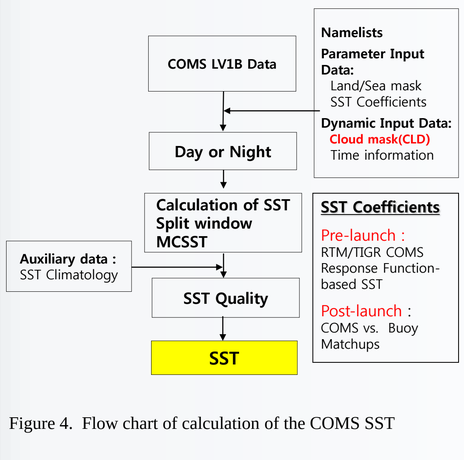

Figure 4. Flow chart of calculation of the COMS SST

- SST Quality Control

SST gross test: $-5 < SST < 37$

SST climatology test: using NASA JPL 9km pathfinder SST DB

$-5 \leq SST - SST_{clim} \leq 5$

Thin cirrus test: If $T_{ir1} < 20$, $T_{ir1} - T_{ir2} < 0.032 \times (T_{ir1})2 + 0.0996 \times T_{ir1} + 1.6071$

If $T_{ir1} \geq 20$, $T_{ir1} - T_{ir2} < 6$

SST spatial uniformity test:

remove SST if around 3×3 pixels' std > 1 & SST < $SST_{avg(3\times3)}$

Temporal uniformity test: remove if previous 10day composite SST – SST < 1.5K

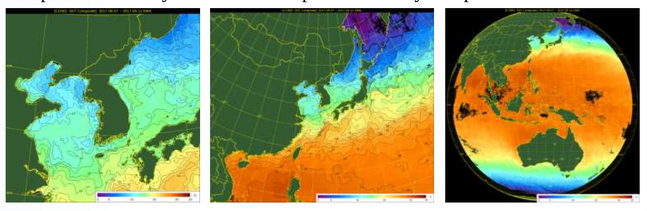

Figure 5. COMS SST 5days composite image of Korea peninsula, east Asia, and full disk each (CMDPS has been producing1day and 10days composite images, too.)

Ⅳ. Improvement Test with Evaluation of SST Coefficients

▣ Coefficients for MCSST

- We evaluated the coefficients of MCSST to determinate the best coefficient for sea of east Asia.
- Essential Climate Variables (ECVs) coefficient used with GSICS correction of LV1B data.
- First Guess (FG) extracted from OSTIA. And the coefficients are as follows (See Table 2);

Table 2. MCSST coefficients for COMS SST

Coefficient	Day/Night	a1	a2	a3	a4	Remarks
Global	Day	0.985098	2.338343	0.545135	-0.321399	Sampling time: 2011. Domain: Full Disk
	Night	0.975640	2.496965	0.353631	-0.031189	
Local	Day	0.981226	2.350931	0.348782	-0.262010	Sampling time: 2011. Domain: East Asia
	Night	1.001531	2.513783	0.160822	-0.813652	
ECVs	Day	0.923391	2.476857	-0.048561	1.458838	Sampling time: 2011. ~ 2015. Domain: Full Disk
	Night	0.931688	2.647177	-0.000013	1.457544	
FG_OSTIA	Day	0.803549	0.093898	-0.022592	4.443756	Sampling time: 2011. ~ 2015. Domain: Full Disk
	Night	0.812352	0.085826	-0.000004	4.658588	

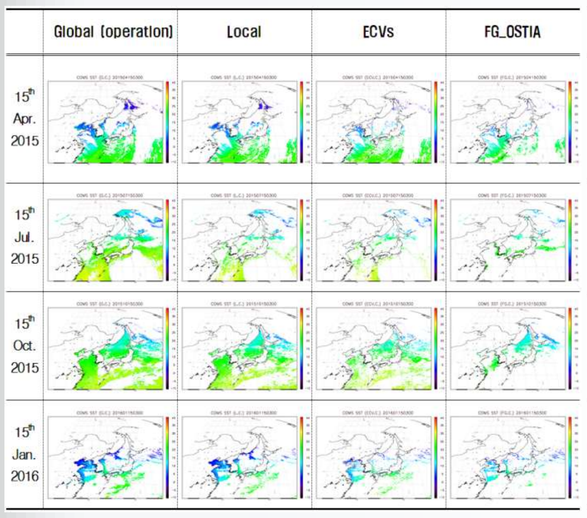

Figure 6. COMS SST image comparison among coefficients (Day time)

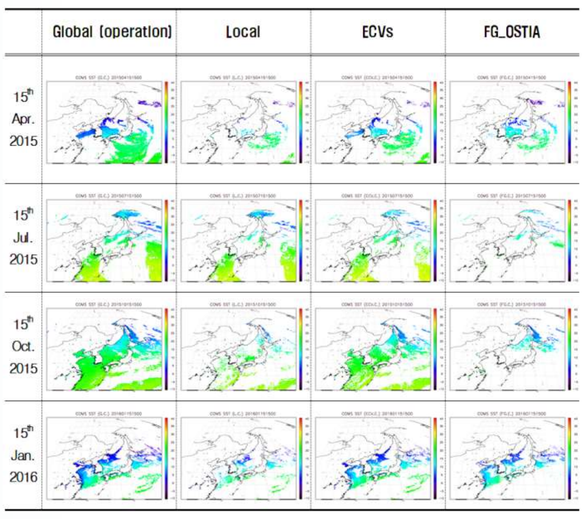

Figure 7. COMS SST image comparison among coefficients (Night time)

▣ Validation Method

- Validation dataset: GTS drift buoy data (spatial colocation: within 5 km, Temporal coincidence: within 30 minutes)
- Validation scores: Correlation coefficient, Bias, and RMSE.
- In the case of ECVs coefficient, Bias and RMSE represented the smallest value among them.

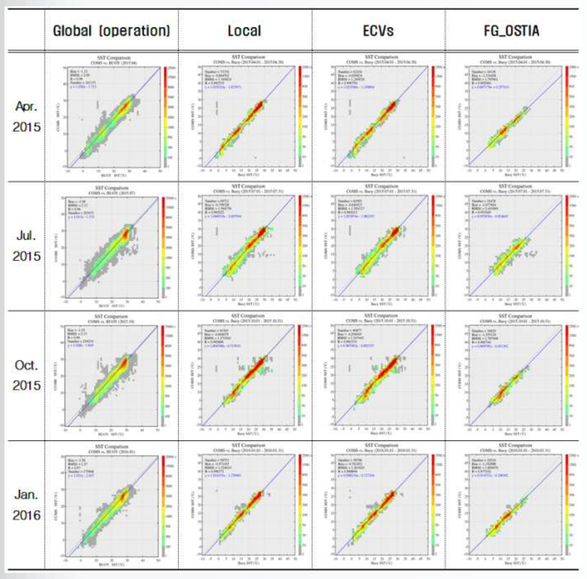

Figure 8. Scatter plots for COMS and buoy colocation dataset (for one month on behalf of each season)

Table 3. Statistical result of COMS vs. buoy each coefficients

		Apr. 2015	Jul. 2015	Oct. 2015	Jan. 2016
Global (operation)	Bias	-1.12	-1.08	-1.16	-1.56
	RMSE	2.00	2.12	2.13	2.27
Local	Bias	-0.88	-0.80	-0.60	-0.97
	RMSE	1.35	1.57	1.28	1.32
ECVs	Bias	-0.66	-0.64	-0.29	-0.76
	RMSE	1.29	1.55	1.25	1.26
FG_OSTIA	Bias	-1.33	-1.68	-1.26	-1.19
	RMSE	1.80	2.40	1.77	1.61

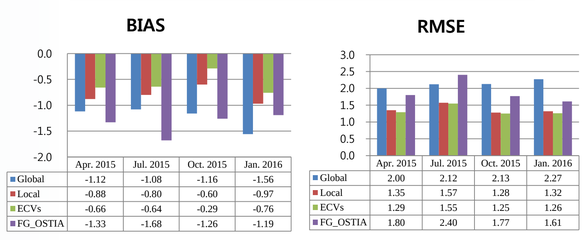

Figure 9. Bias (left) and RMSE (right) comparison of COMS SST against buoy

Ⅴ. Summary and Further Works

▣ National Meteorological Satellite Center of KMA has been operating Korean meteorological imager, MI onboard satellite COMS.
- **One of the 16 baseline products produced via CMDPS, SST using MCSST algorithm with global coefficient in operation in NMSC.**

▣ We evaluated the MCSST coefficients for COMS SST accuracy over east Asian sea (Regional SST) versus in situ data buoy using such as global, local, ECVs, and FG coefficients with GSICS radiance correction.
- **As a result, ECVs coefficient represented the best result (smallest bias around -0.6 K and RMSE around 1.3 K) in comparison with operational global coefficient (bias around -1.2 K and RMSE around 2.1 K).**
- **It is necessary to investigate long-term analysis and to retrieve latest value for coefficients.**

▣ We have plan to retrieve composite SST using various satellite sensor's observation data such as NOAA, AMSR-2, and etc. as well as COMS data for NWP.

▣ KMA is getting ready for launch and operating next meteorological satellite, GeoKOMPSAT-2A, so KMA has been developed SST algorithm using advanced method to do that.

REFERENCES

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