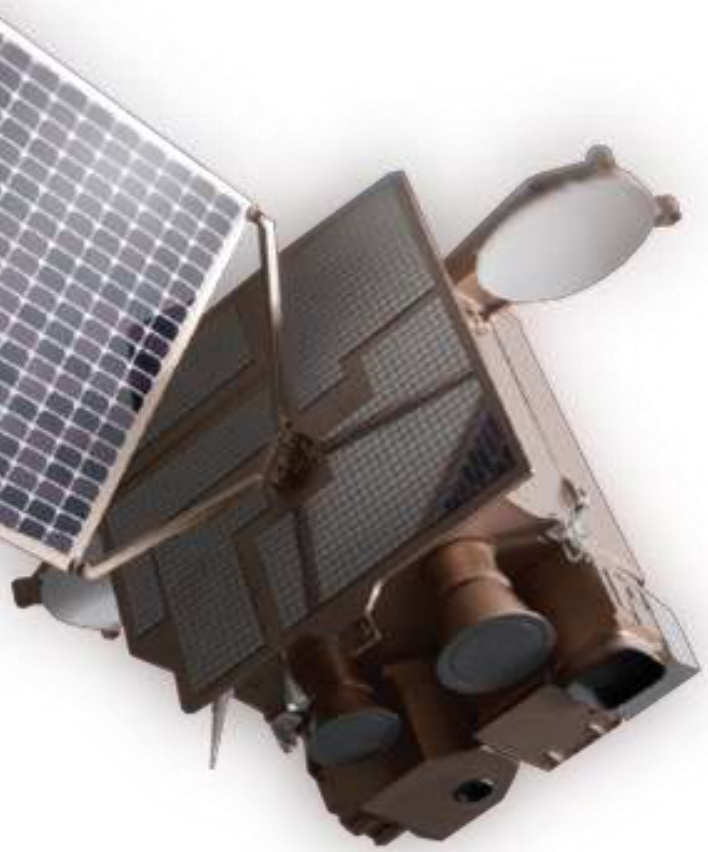
Introduction of KMA/NMSC and its calibration activities

5 September 2016

Dohyeong Kim
KMA



KMA/NMSC and Current Satellite

General information of KMA/NMSC

History of KMA

➔ Founded as the Central Meteorological Office in 1949

➔ Promoted to the Korea Meteorological Administration in 1990

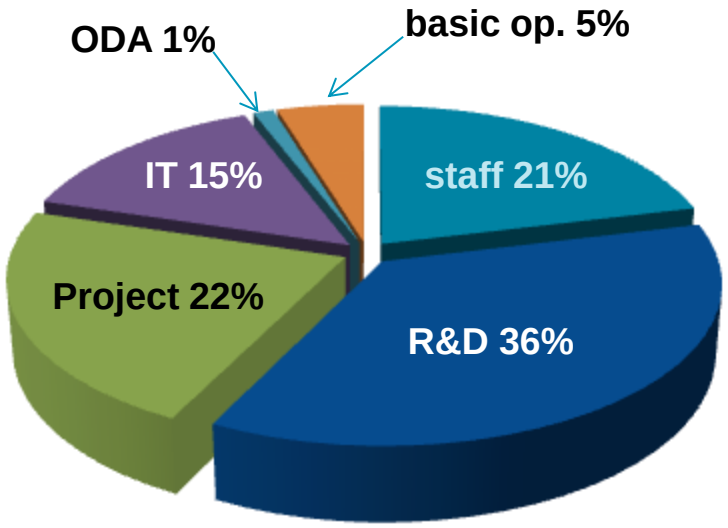
➔ Promoted to the rank of Vice Minister in 2005

Staff (NMSC/KMA)

✓ 49 / 1,340 employees in total

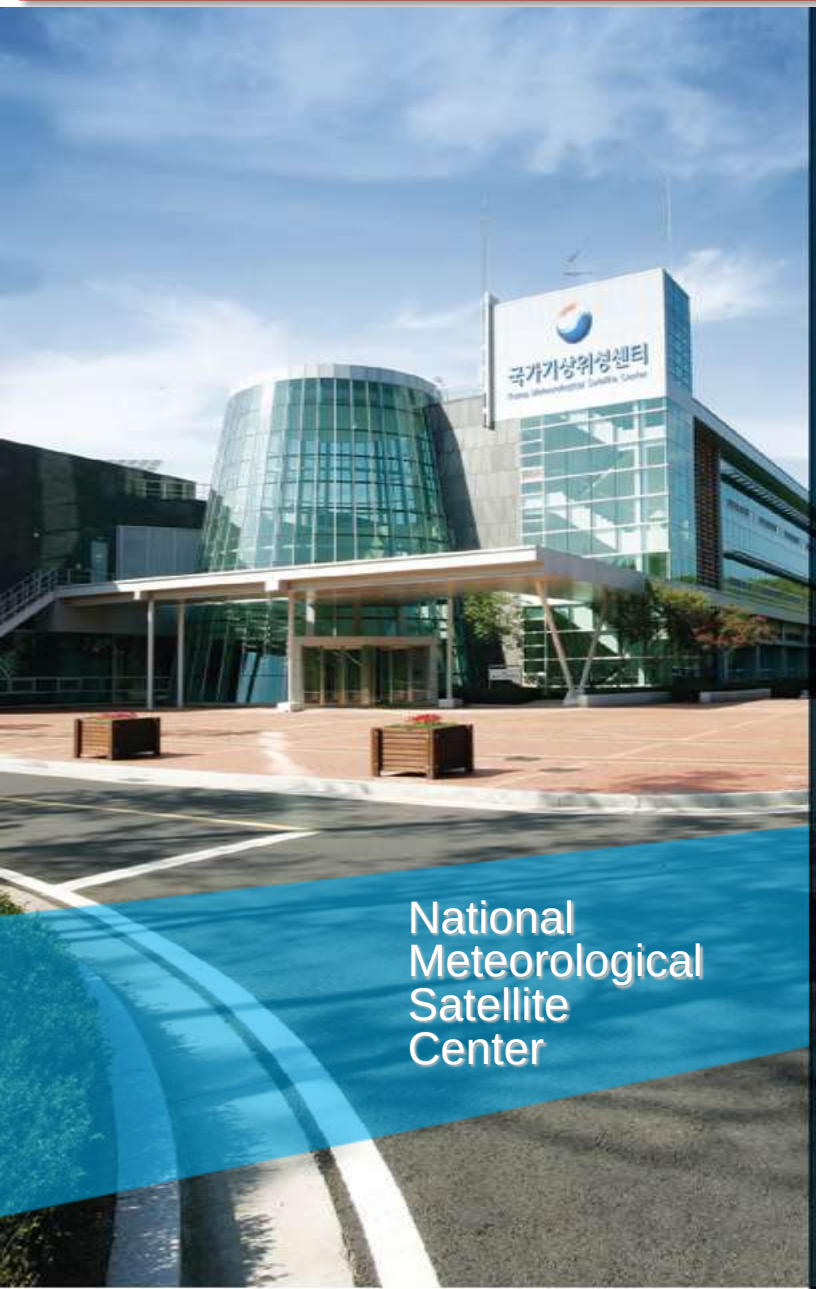
Budget (NMSC/KMA)

✓ 78 / 402 M as of 2016 (19%)



NMSC

KMA



1 Building for NMSC

- Area: 33,058m²
- Construction : 2005~2008

2 Organization & Personnel

- 3 divisions & 1 Team (Satellite Planning, Satellite Operation, Satellite Analysis division + Satellite Development team) with more than 120 staffs and researchers

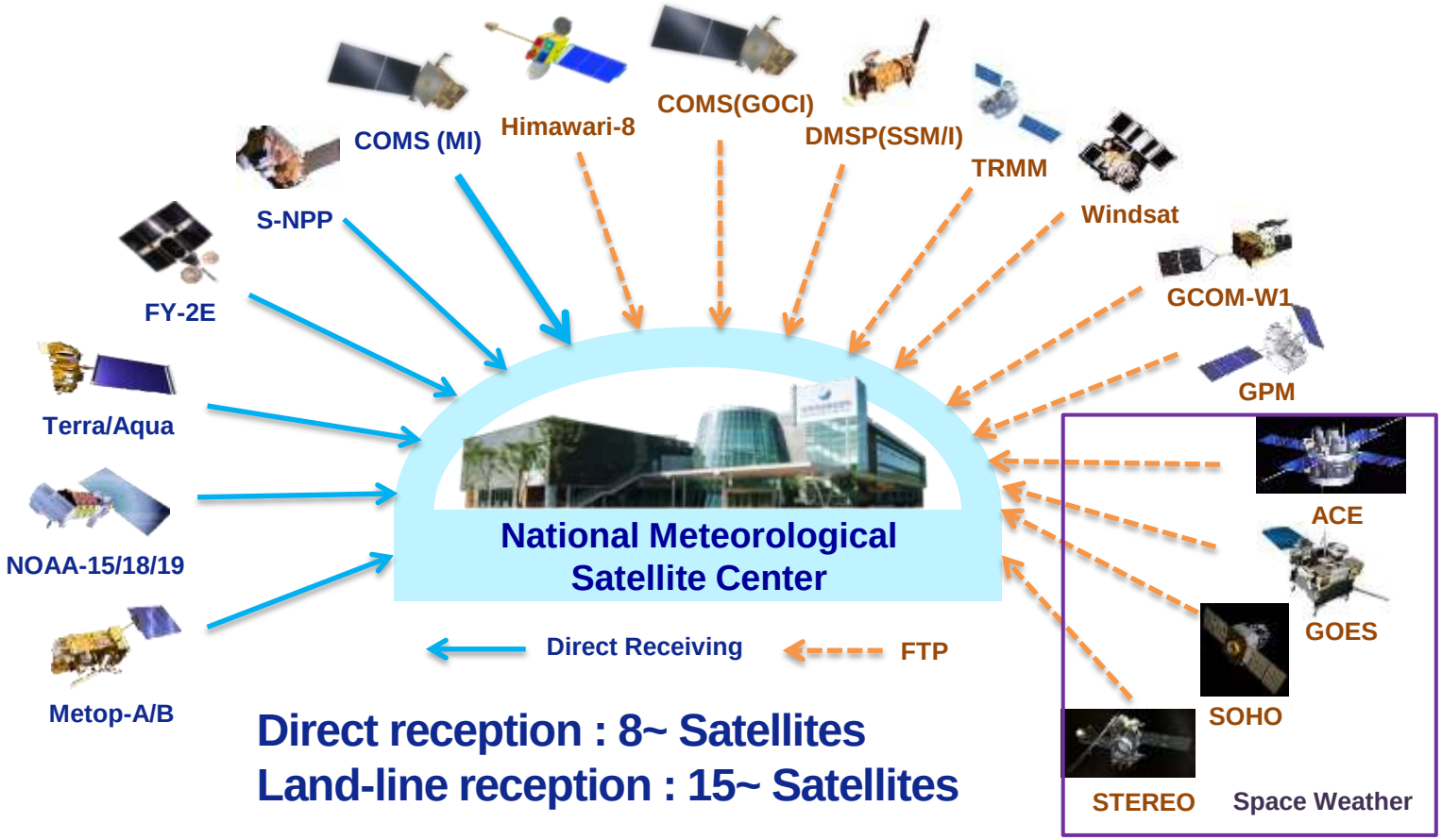
3 Major duties

- Meteorological Satellite Development & Operation
- Satellite Data Application
  Data Reception/Processing/Analysis/ Distribution for Users
- International and Domestic Cooperation regarding Meteorological Satellite

NMSC Goal (I)

KMA

- To **operate timely** COMS (GK-1), to gather reliable satellite data on weather and climate and to **deliver** them to other Agencies and countries

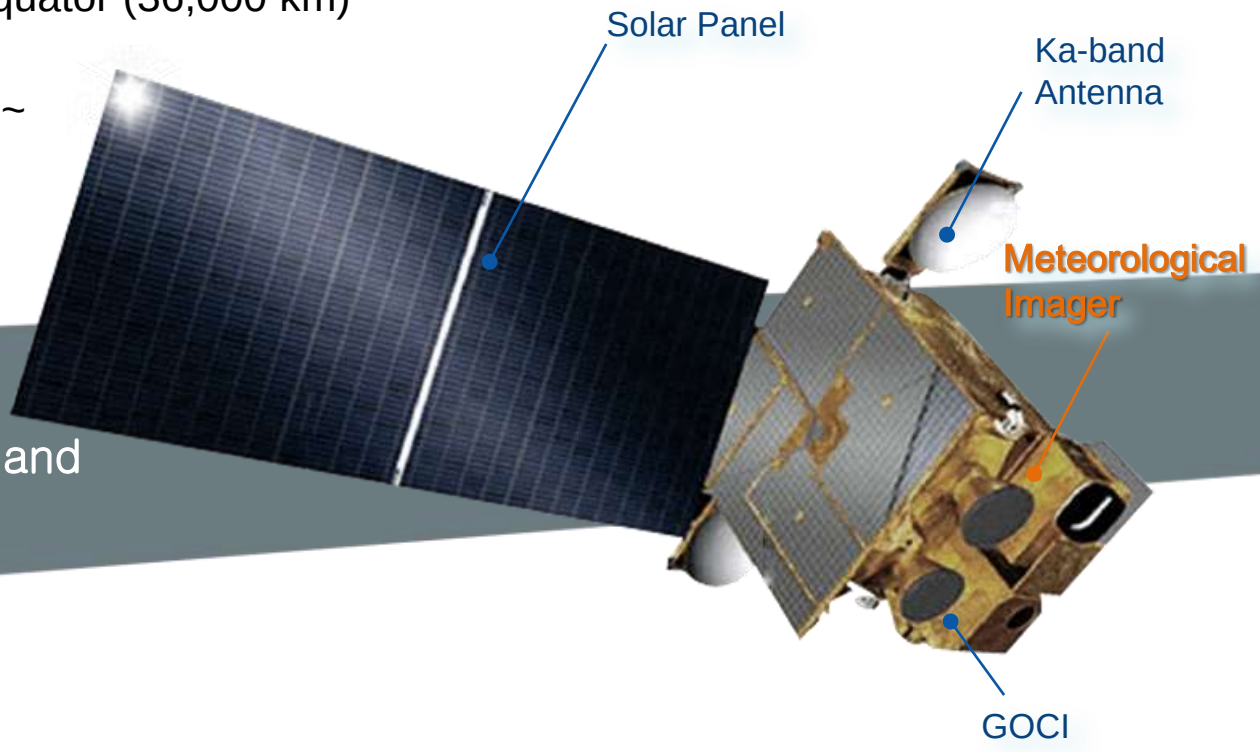


COMS

COMS(GK-1) is the first multi-purpose geostationary satellite for Korea in the application of Meteorology, Ocean and Communication

Meteorological Mission : Continuous Observation to support weather forecasting and early detection of severe weather phenomena

Period : 2003 - 2010 (8 yrs)
Orbit : 128.2˚E over equator (36,000 km)
Design life : 7 years
Operation : April 2011 ~



Communication, Ocean and Meteorological Satellite

COMS Dissemination

KMA

COMS

HRIT/LRIT

Raw data

HRIT/LRIT

NMSC

MDUS
(Korea 6, Foreign: 7)

AFUS(Guam), Taiwan, Sri Lanka, Laos, Philippines, Australia, Japan

SDUS
(Korea 5, Foreign: 6)

Japan(JAMSTEC, Nippon Hakuyo Electronics, KaiyoMaru, Univ of Tokyo), Thailand, Vietnam

FTP

Real time

Korea(24) : Agencies

Foreign(3) :
Univ of Wisconsin(SSEC Data Center)
Univ of Colorado(CIRA)
Hong Kong Meteo Agency

DCPC

Internet

Korea

Foreign Country

HRIT(High Rate Information Transmission)

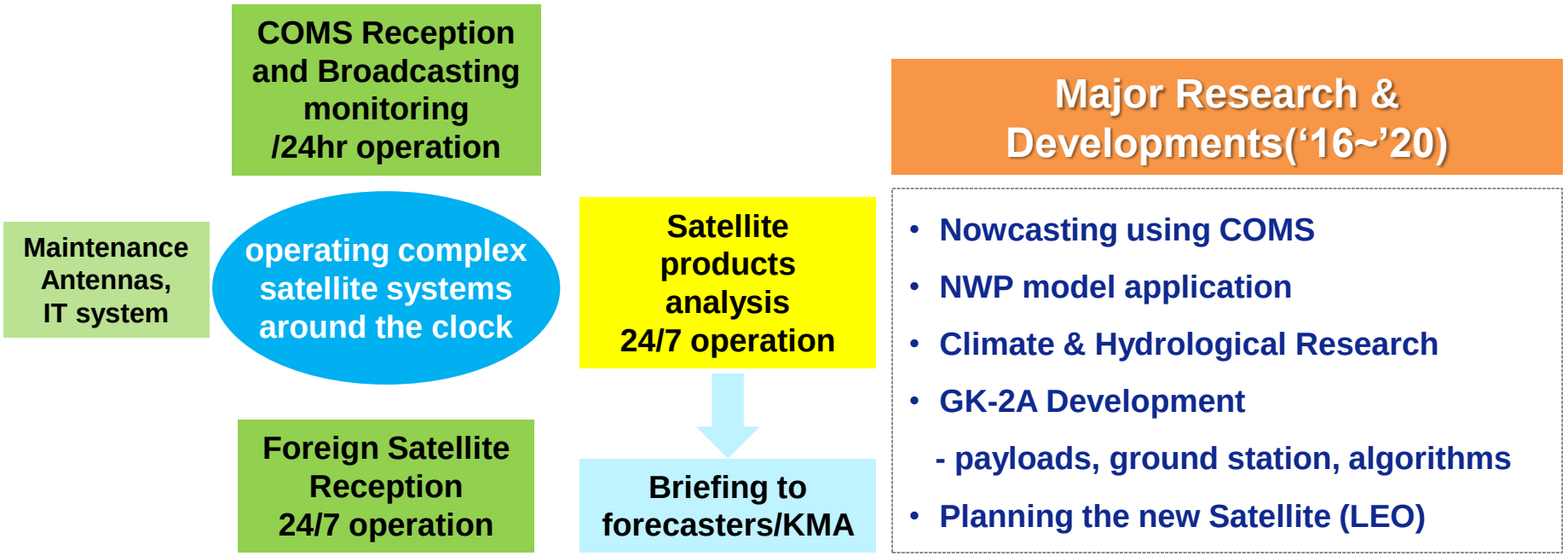
LRIT (Low Rate Information Transmission)

COMS Products

KMA

16 Baseline Products : Development (2003-2010) and operation (2011~)

NMSC Goal (II)



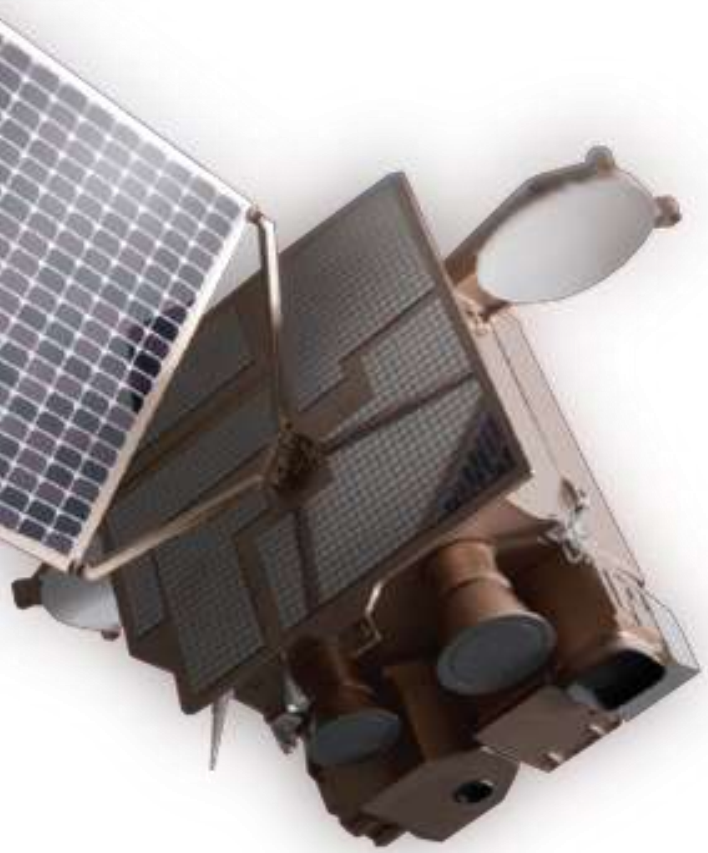
- **To develop a broad range of products from the satellite observations based on innovative algorithms** for timely warning and support public and private decision making for our social and economic wellbeing **as a science-based services agency.**

COMS Applications

KMA

Computation Sources	Applications
Cloud detection, Clear sky radiance, Rainfall intensity	Weather and numerical forecast
Atmospheric motion vector	Numerical forecast
Sea surface temperature	Numerical forecast & climate monitoring, ocean
Land surface temperature	Numerical forecast & climate monitoring
Sea Ice/Snow detection	Numerical forecast & climate monitoring, Asian dust prediction
Insolation	Agricultural meteorology, climate research
Upper tropospheric humidity, Total precipitable water, Cloud analysis, Cloud top temperatures & heights, Outgoing long wave radiation	Numerical forecast & climate monitoring
Fog	Aviation meteorology
Aerosol index	Asian dust forecast & environment monitoring
Aerosol optical depth	Asian dust forecast, environment monitoring, & climate research

KMA

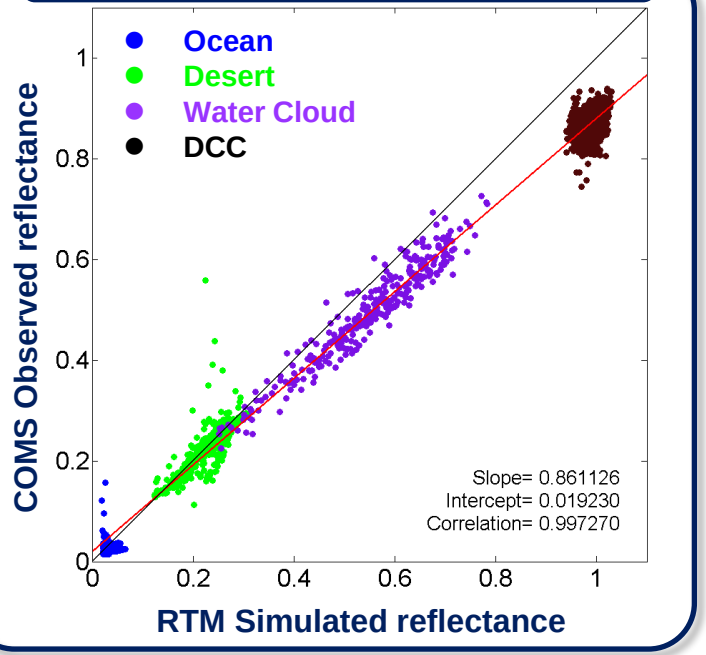


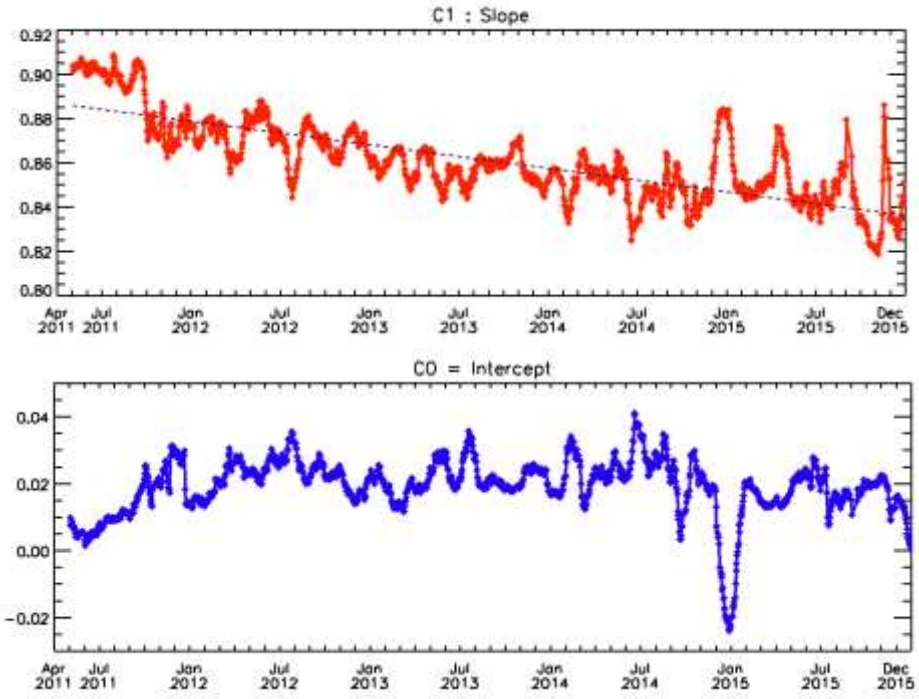
KMA/NMSC Calibration Activities

GSICS Activities of KMA(VIS)

- Vicarious calibration for visible channel using 5 targets.
  - Ocean, Desert, Water Cloud, Deep Convective Cloud (DCC) and Moon
- Monitoring the **slope** changes from the four targets
- The slope is obtained using 30 days average.

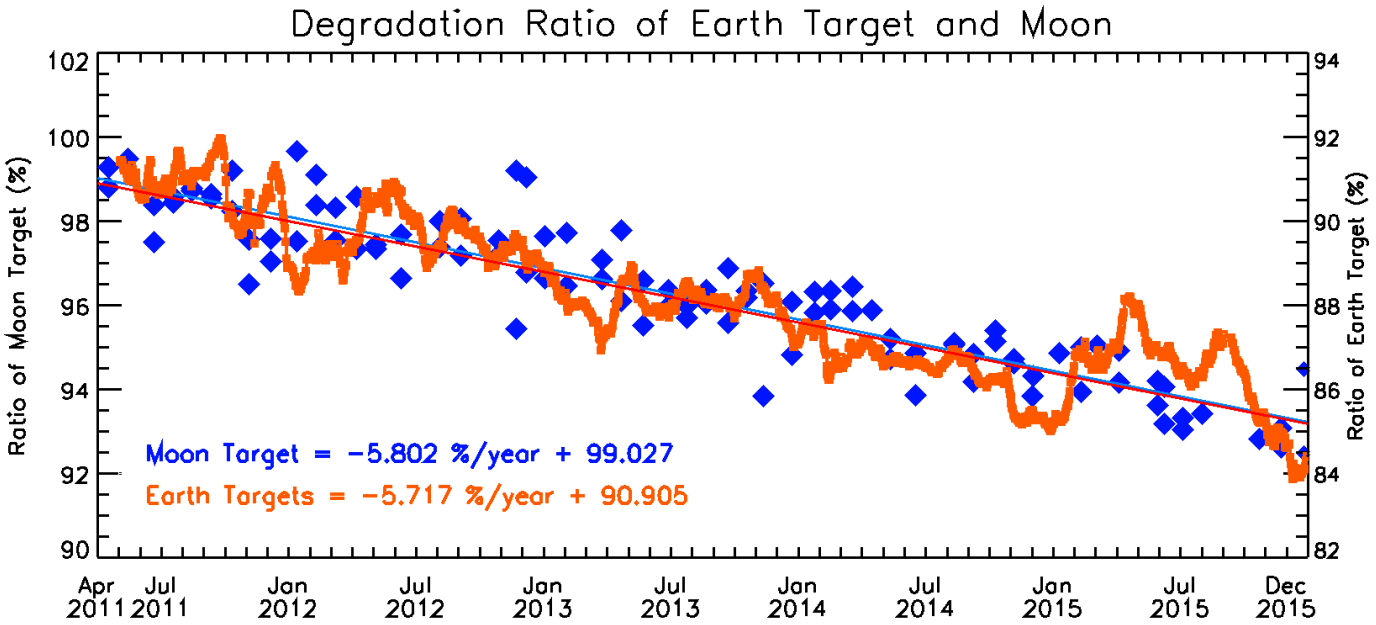
2011. 04 – 2015. 12





GSICS Activities of KMA(VIS)

- period: 2011.04 ~ 2015.12
- degradation: **5.717%** (**1.204%**/year) from **4 targets on the Earth**
  : Desert, Ocean, Water Cloud, DCC
  5.802% (**1.221%**/year) from **the Moon targets** **using GIRO_V1.0.0**



- Lunar calibration by collaborate with **EUMETSAT**
- DCC method by collaborated with **NASA**

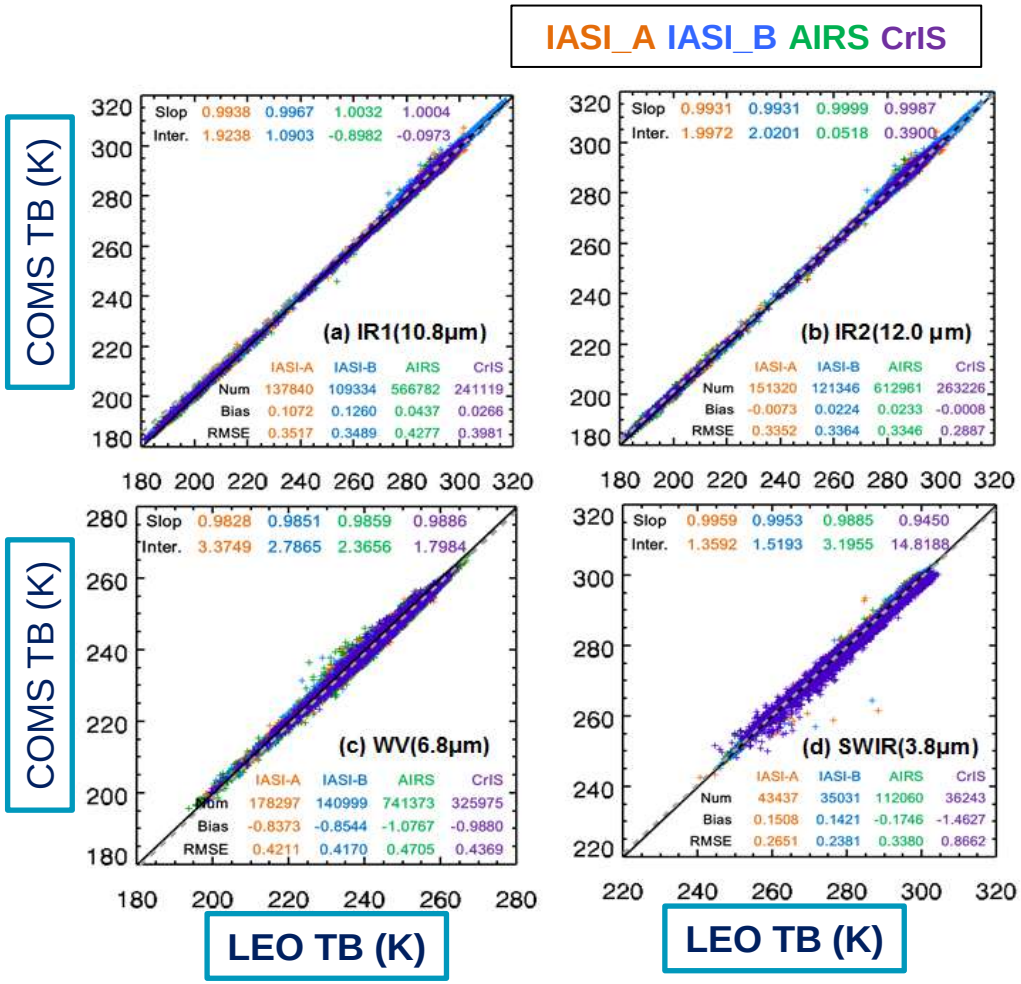
GSICS Activities of KMA(IR)

Preparation for the demonstration phase for COMS IR calibration

– GEO-LEO Inter-calibration (IASI, AIRS and CrIS)

- Period : AIRS, IASI-A(April 2011 - Dec. 2015), IASI-B(Aug. 2013 - Dec. 2015), CrIS(Jan. 2014 - Dec. 2015)

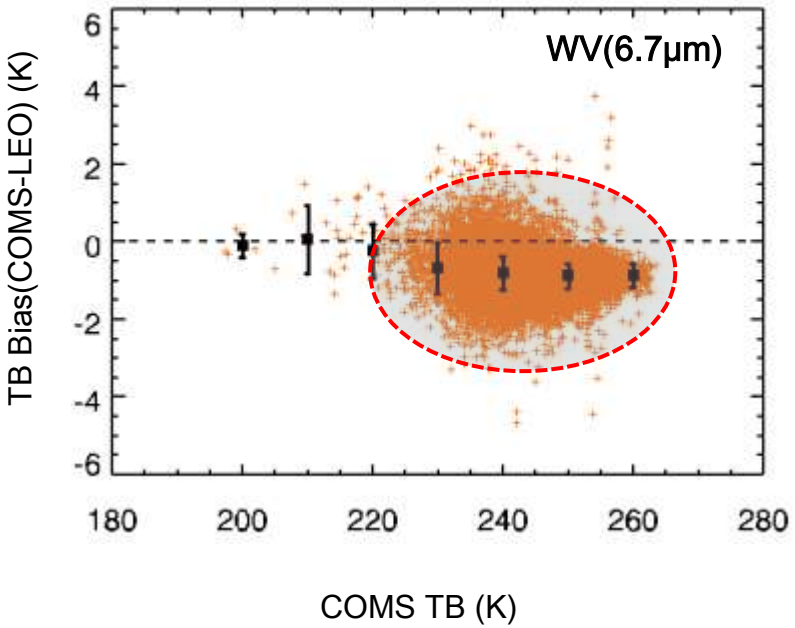
IASI_A IASI_B AIRS CrIS



		IASI_A	IASI_B	AIRS	CrIS
IR1	Number	137840	109334	566782	241119
	Bias	**0.1072**	**0.1260**	**0.0437**	**0.0266**
	RMSE	0.3517	0.3489	0.4277	0.3981
IR2	Number	151320	121346	612961	263226
	Bias	**-0.0073**	**0.0224**	**0.0233**	**-0.0008**
	RMSE	0.3352	0.3364	0.3346	0.2887
IR3 (WV)	Number	178297	140999	741373	325975
	Bias	**-0.8373**	**-0.8544**	**-1.0767**	**-0.9880**
	RMSE	0.4211	0.4170	0.4705	0.4369
IR4 (SWIR)	Number	43437	35031	112060	36243
	Bias	**0.1508**	**0.1421**	**-0.1746**	**-1.4627**
	RMSE	0.2651	0.2381	0.3380	0.8662

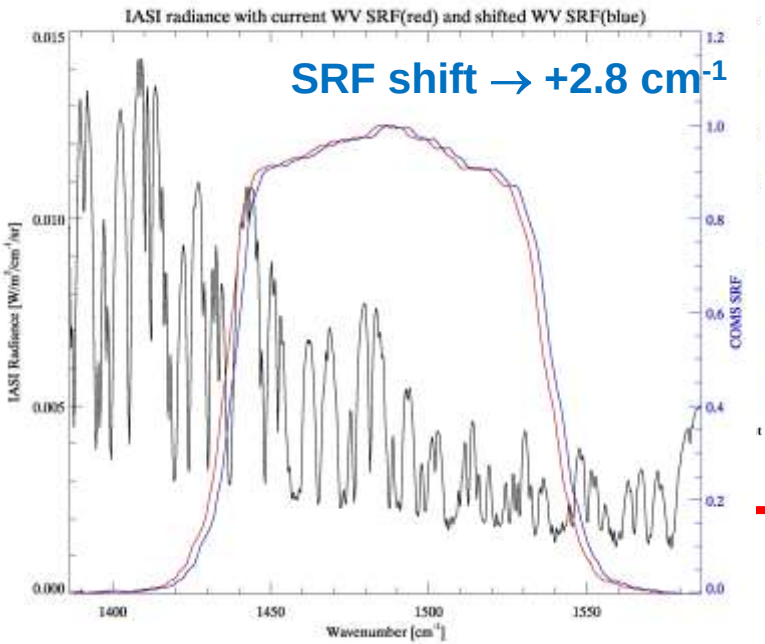
GSICS Activities of KMA(IR)

- Currently, check the **trend of TB bias for WV**
- Large **negative** bias for **warm temperature**
- Period: Jan. 2014 - Dec. 2014



IASI WV SRF +2.8 cm^{-1} shift

- For estimated shift of the SRF center position, match the band averaged radiance from IASI and COMS/MI radiance
- SRF shift : 2.79±1.73 cm^{-1}
- Period: April. 2011 - Jan.2012 (16 different days including four seasons)



< Two Methods>

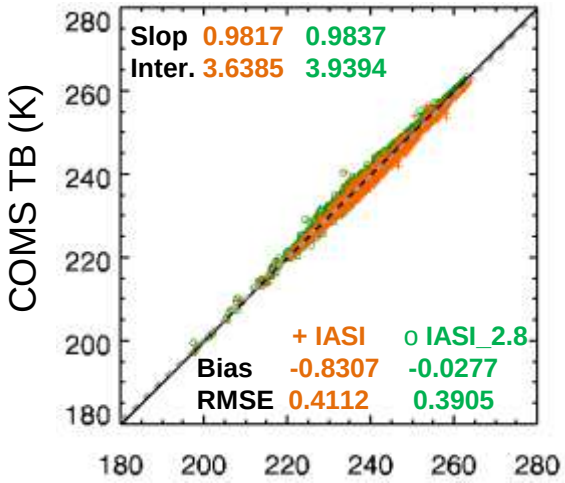
1) Original MI + IASI(SRF shifted by +2.8cm^{-1} shift)

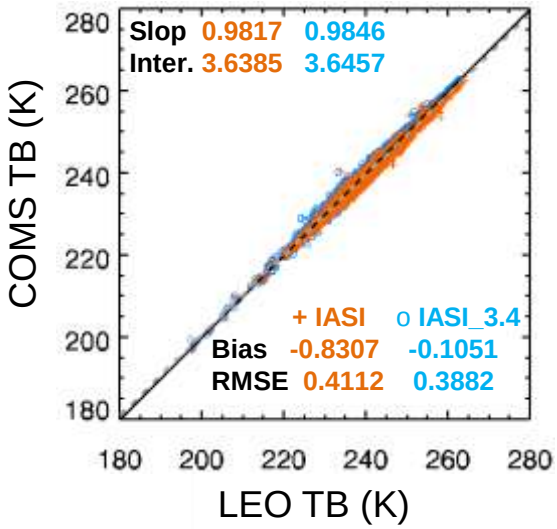
2) (SRF) Corrected MI + IASI(SRF shifted by +3.4cm^{-1} shift)

*Refrence: Myoung-Hwan Ahn, Su Jeong Lee, Dohyeong Kim “Estimation of uncertainties in the spectral response function of the water vapor channel of a meteorological imager”, Proc. SPIE, 2015

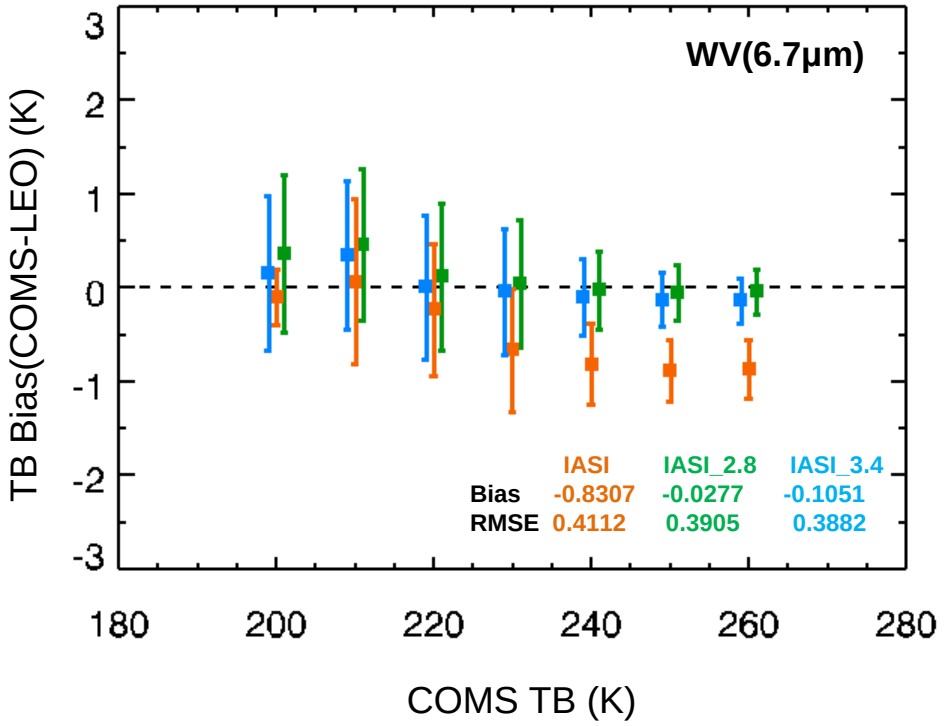
GSICS Activities of KMA(IR)

- **Result** of IASI SRF shift and check the **TB bias and trend of TB bias for WVIR**
- Period: Jan. 01.2014 - Dec.12.2014



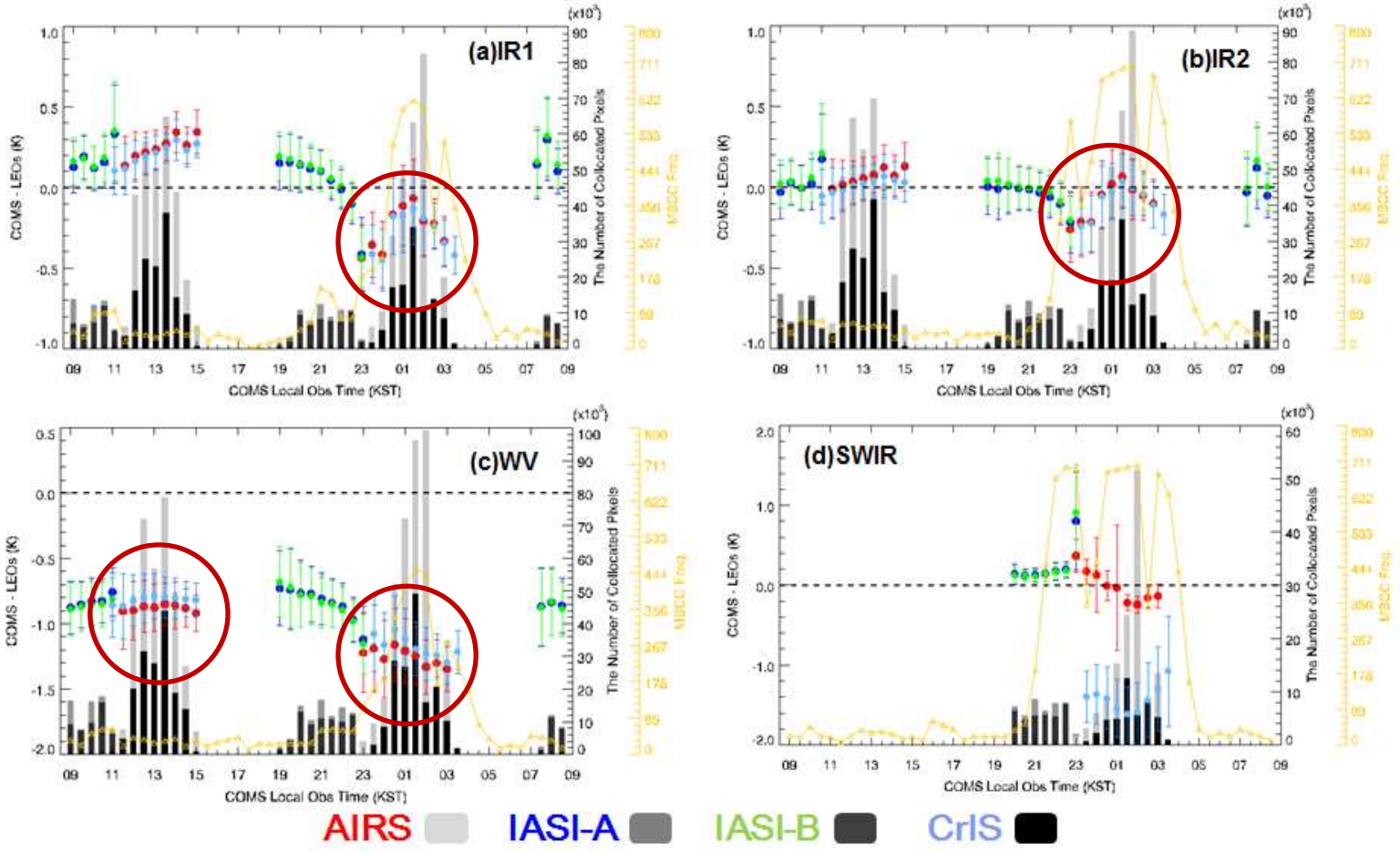


IASI : Original MI + Original IASI
IASI_2.8 : Original MI + IASI SRF shifted by +2.8cm^{-1}
IASI_3.4 : MI corrected + IASI SRF shifted by +3.4cm^{-1}



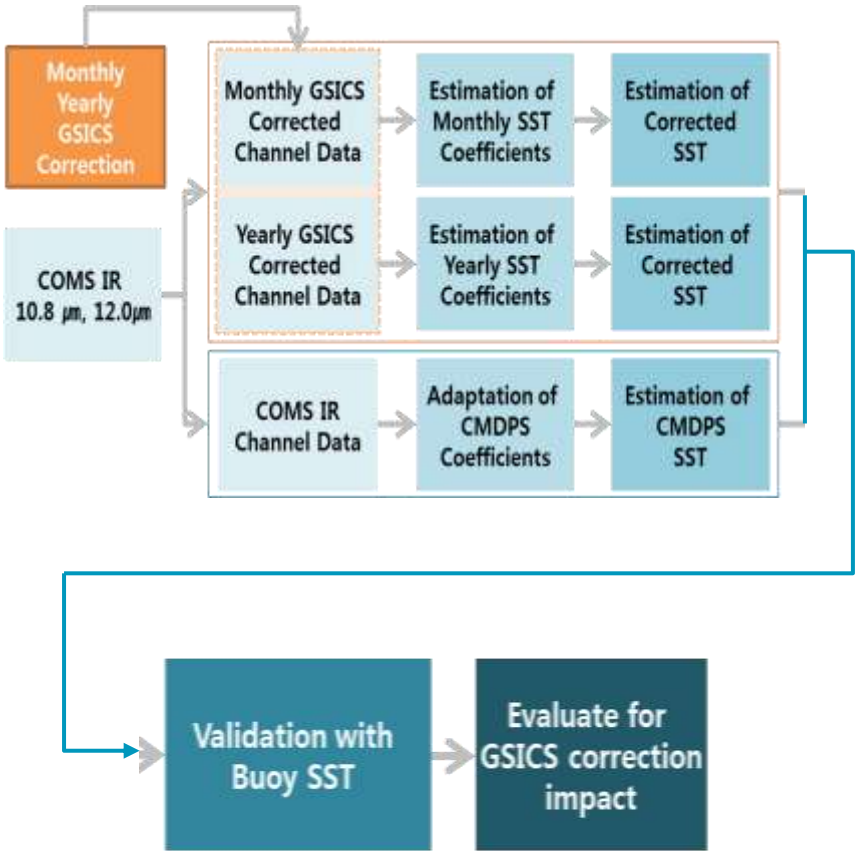
GSICS Activities of KMA(IR)

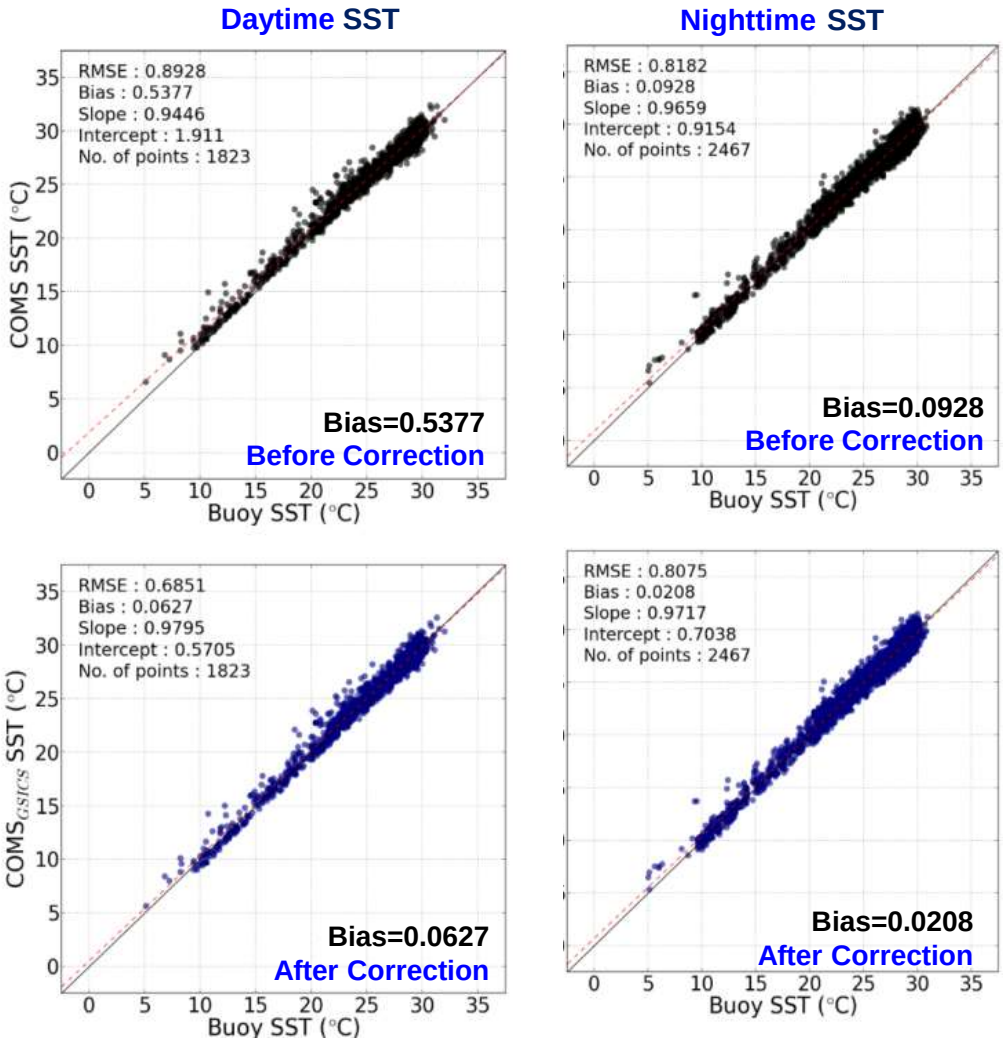
- **Diurnal variation** of **TB bias** (COMS-LEO)
- Period : AIRS, IASI-A(April 2011 - Dec. 2015), IASI-B(Aug. 2013 - Dec. 2015), CrIS(Jan. 2014 - Dec. 2015)



Collaboration with NOAA/NESDIS for diurnal variation due to mid-night effect

Application of GSICS correction to SST





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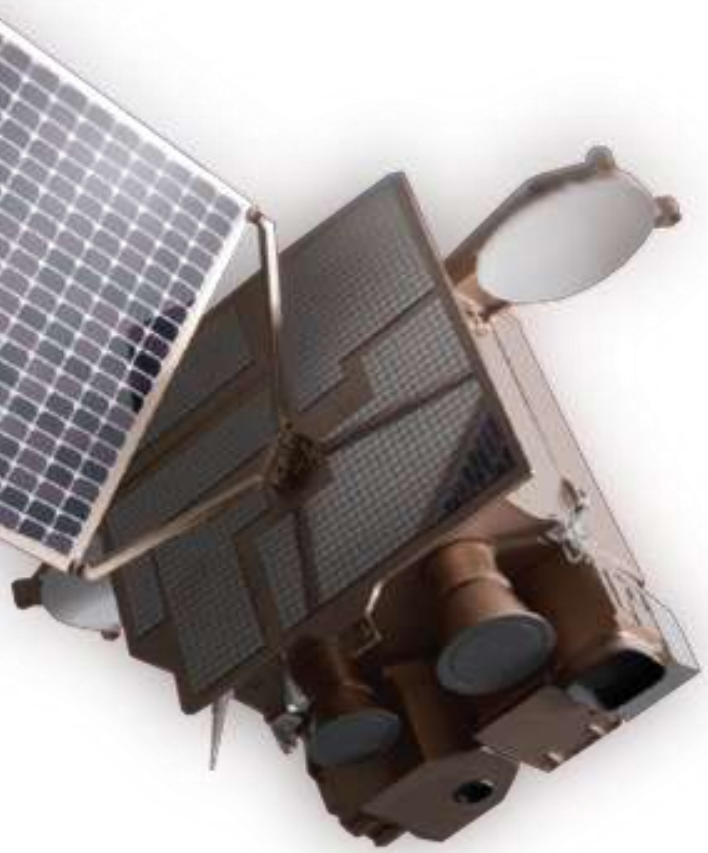


Development of New Satellites (GK-2A & LEO)

Geo-KOMPSAT-2A's Payloads 2012~2018(7years)

KMA

AMI(Advanced Meteorological Imager)

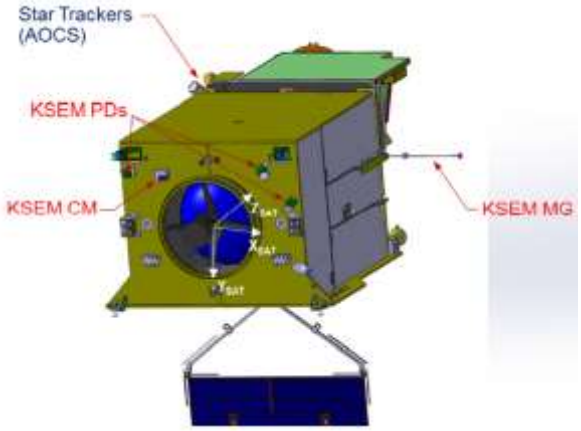
Bands		Center Wavelength		Band Width (Max, um)	Resolution (km)	GOES-R (ABI)	Himawari-8 (AHI)
		Min(um)	Max(um)				
VNIR	VIS0.4	0.431	0.479	0.075	1	0.47	0.46
	VIS0.5	0.5025	0.5175	0.0625	1		0.51
	VIS0.6	0.625	0.66	0.125	0.5	0.64	0.64
	VIS0.8	0.8495	0.8705	0.0875	1	0.865	0.86
	NIR1.3	1.373	1.383	0.03	2	1.378	
	NIR1.6	1.601	1.619	0.075	2	1.61	1.6
	NIR2.2				2	3.35	2.3
MWIR	IR3.8	3.74	3.96	0.5	2	3.90	3.9
	IR6.3	6.061	6.425	1.038	2	6.185	6.2
	IR6.9	6.89	7.01	0.5	2	6.95	7.0
	IR7.3	7.258	7.433	0.688	2	7.34	7.3
	IR8.7	8.44	8.76	0.5	2	8.50	8.6
LWIR	IR9.6	9.543	9.717	0.475	2	9.61	9.6
	IR10.5	10.25	10.61	0.875	2	10.35	10.4
	IR11.2	11.08	11.32	1.0	2	11.2	11.2
	IR12.3	12.15	12.45	1.25	2	12.3	12.3
	IR13.3	13.21	13.39	0.75	2	13.3	13.3

vs. AHI

- addition 1.38 μm (NIR)
- subtraction 2.3 μm (NIR)

1.38 μm : favorable for cirrus cloud detection, cloud type and amount

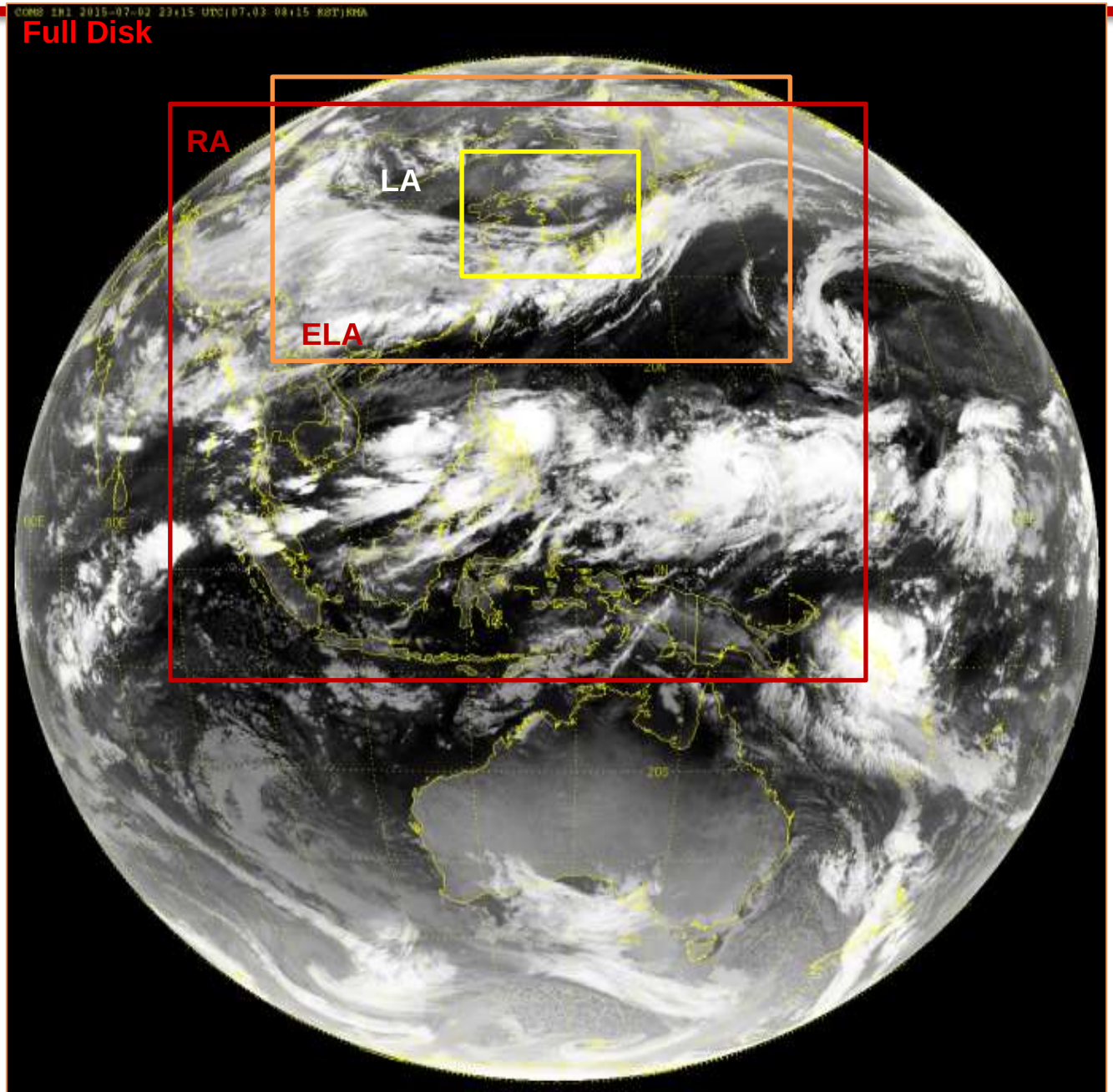
2.3 μm : favorable for Land/cloud Properties



KSEM(Korea Space wEather Monitor)

- PD : Particle Detector
- MG : Magnetometer
- CM : Charging Monitor

Observation Area and Schedule



1. Full Disk
2. RA 6200x5900km
3. ELA 3800x2900km
4. LA 1000x1000km

Detailed 52 Meteorological Products

Scene & Surface Analysis (13)	Cloud & Precipitation (14)	Aerosol & Radiation (14)	Atmospheric condition & Aviation (11)
Cloud detection	**Cloud Top Temperature**	**Aerosol Detection**	**Atmospheric Motion Vector**
Snow Cover	**Cloud Top Pressure**	**Aerosol Optical Depth**	**Vertical Temperature Profile**
Sea Ice Cover	**Cloud Top Height**	**Asian Dust Detection**	**Vertical Moisture Profile**
Fog	Cloud Type	**Asian Dust Optical Depth**	**Stability Index**
Sea Surface Temperature	**Cloud Phase**	Aerosol Particle Size	Total Precipitable Water
Land Surface Temperature	Cloud Amount	**Volcanic Ash Detection and Height**	Tropopause Folding Turbulence
Surface Emissivity	Cloud Optical Depth	Visibility	**Total Ozone**
Surface Albedo	Cloud Effective Radius	**Radiances**	SO_2 Detection
Fire Detection	Cloud Liquid Water Path	Downward SW Radiation (SFC)	**Convective Initiation**
Vegetation Index	Cloud Ice Water Path	Reflected SW Radiation (TOA)	Overshooting Top Detection
Vegetation Green Fraction	Cloud Layer/Height	Absorbed SW Radiation (SFC)	Aircraft Icing
Snow Depth	**Rainfall Rate**	Upward LW Radiation (TOA)	
Current	Rainfall Potential	Downward LW Radiation (SFC)	
	Probability of Rainfall	Upward LW Radiation (SFC)	

- Blue: Primary Products
- Black: Secondary/ancillary

Operational Application using Satellite Products

- To be designed to maximize the utilization of the satellite products for forecasters and NWP
- Recommended using GK-2A and the other satellite data, if necessary NWP and the other ground observation

Areas	Contents	
Nowcasting	• Cloud analysis • Heavy rainfall and snowfall analysis • QPF	
Typhoon & Ocean	Typhoon analysis system based on Satellite SST, red tide, freezing over the ocean 3D Winds analysis	
NWP	Satellite data preprocess for NWP assimilation	
Hydrology & SFC & Verification	Soil moisture, Drought and Floods, Fire Fine Dust analysis Verification, grid and image composite technique	
Climate & Environmental Monitoring	Aerosol concentration, height, vertical distribution Greenhouse gases, atmospheric composition Energy budget, Air Quality model applications	

Data Service Plan : GK-2A

KMA

[Via GK-2A broadcast]

- **Broadcast all 16 channels data (UHRIT)** of meteorological observations
- Maintain **L/HRIT broadcast** corresponding to COMS five channels

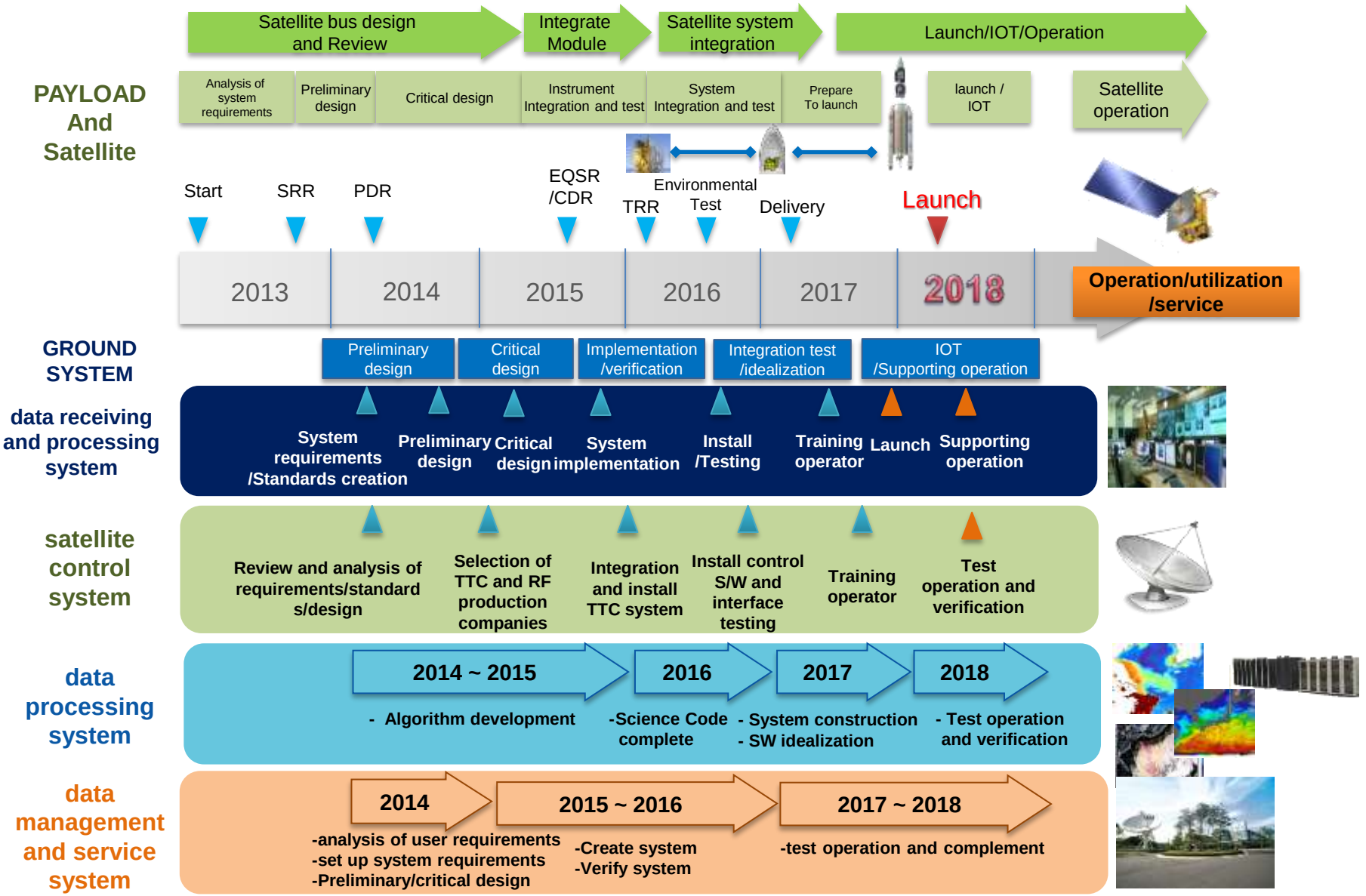
Categories	UHRIT	COMS-like H/LRIT	
Service		HRIT	LRIT
Data Rate	≤ 31 Mbps	3 Mbps	~512 Kbps
Frequencies	Uplink : S-band Downlink : X-band	Uplink : S-band , Downlink : L-band * Same Frequencies band with COMS	
Data Type	AMI Image(16 Ch.) Alphanumeric text Encryption Key Message * Additional info could be added in the future	AMI Image(5 Ch.) Alphanumeric text Encryption Key Message GOCI-II products(TBD)	AMI Image (5 Ch.) Alphanumeric text Encryption Key Message Lv2 products GOCI-II image file
Mode	FD	FD	FD
Station	LDUS	MDUS	SDUS

[Via Landline]

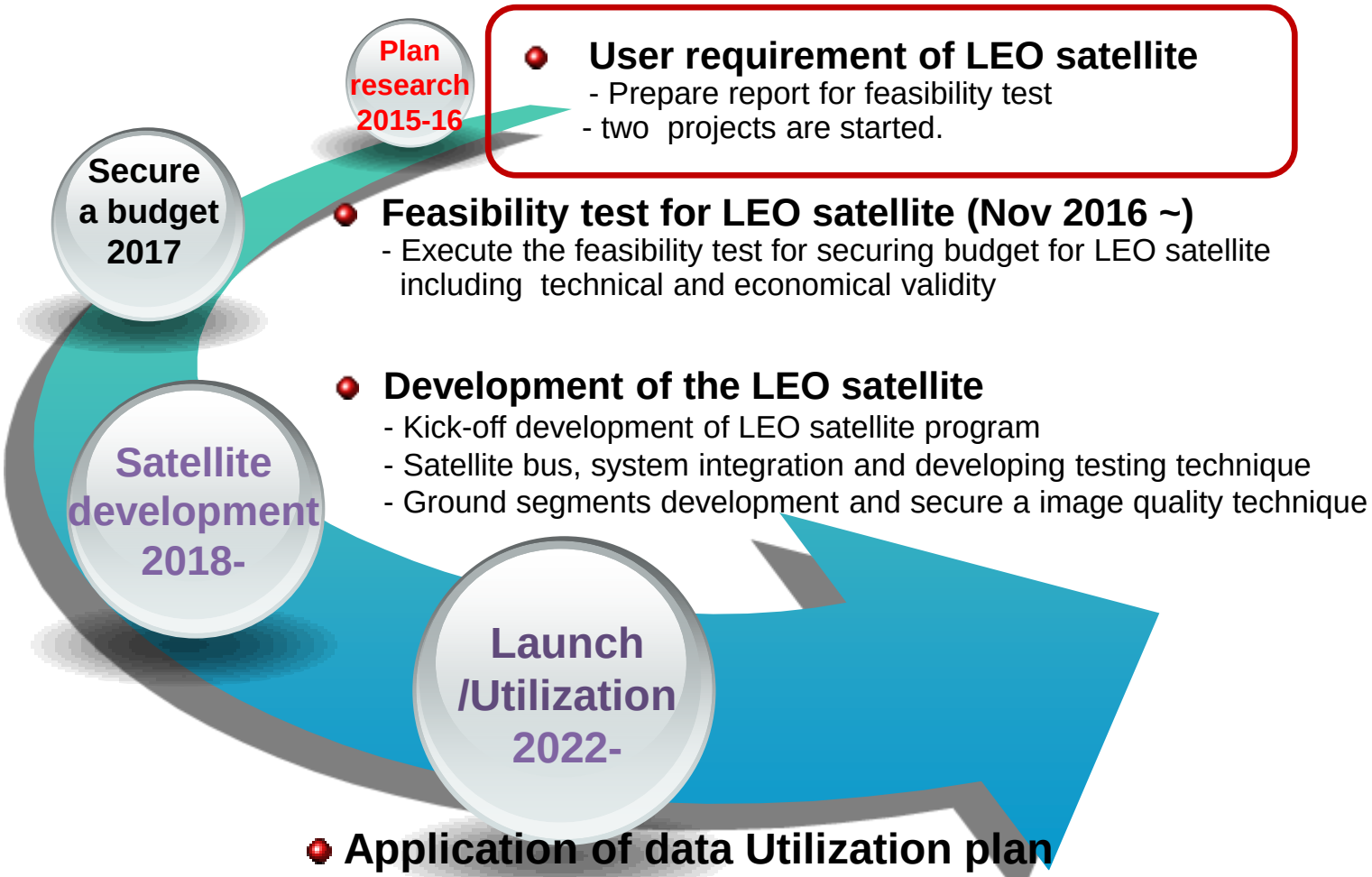
- Cloud service similar to Himawaricloud is under development (completed in 2018)
- Renovated web-based service system is under development (completed in 2018)
- GK-2A data also will be available in DCPC-NMSC (http://dcpc.nmsc.kma.go.kr)

Milestone for the GK-2A

KMA



Future LEO Satellites for Meteorological Use



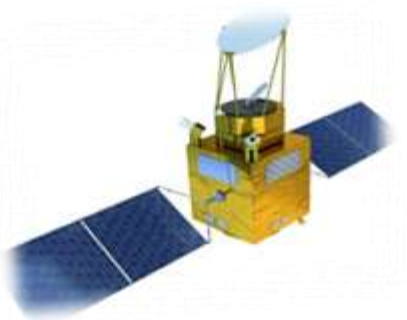
- **User requirement of LEO satellite**
  - Prepare report for feasibility test
  - two projects are started.
- **Feasibility test for LEO satellite (Nov 2016 ~)**
  - Execute the feasibility test for securing budget for LEO satellite including technical and economical validity
- **Development of the LEO satellite**
  - Kick-off development of LEO satellite program
  - Satellite bus, system integration and developing testing technique
  - Ground segments development and secure a image quality technique
- **Application of data Utilization plan**
  - Apply to weather, climate, earthquake, volcano, disaster, etc.
  - Data utilization research for global water/climate, etc.
  - Supply standard input data of numerical model

Preparing Future LEO Satellites

- **Development (plan) : ~ 2022 (or earlier)**
- **Altitude/orbit : 500~900km / Sun-synchronous (TBD), dawn-dusk orbit**
- **Satellite : ~500kg, instrument : ~150kg**
- **Possible Instrument : MW Sounder such as ATMS, AMSU, SSMI**
  : CrIS with limited channels
  : GPM MW Imager

  ~ one or two instrument due to the weight of payloads(~150kg)

  ~ instrument type will be decided for feasibility test
- **International cooperation / joint development for payload and sensors**



THANK YOU!