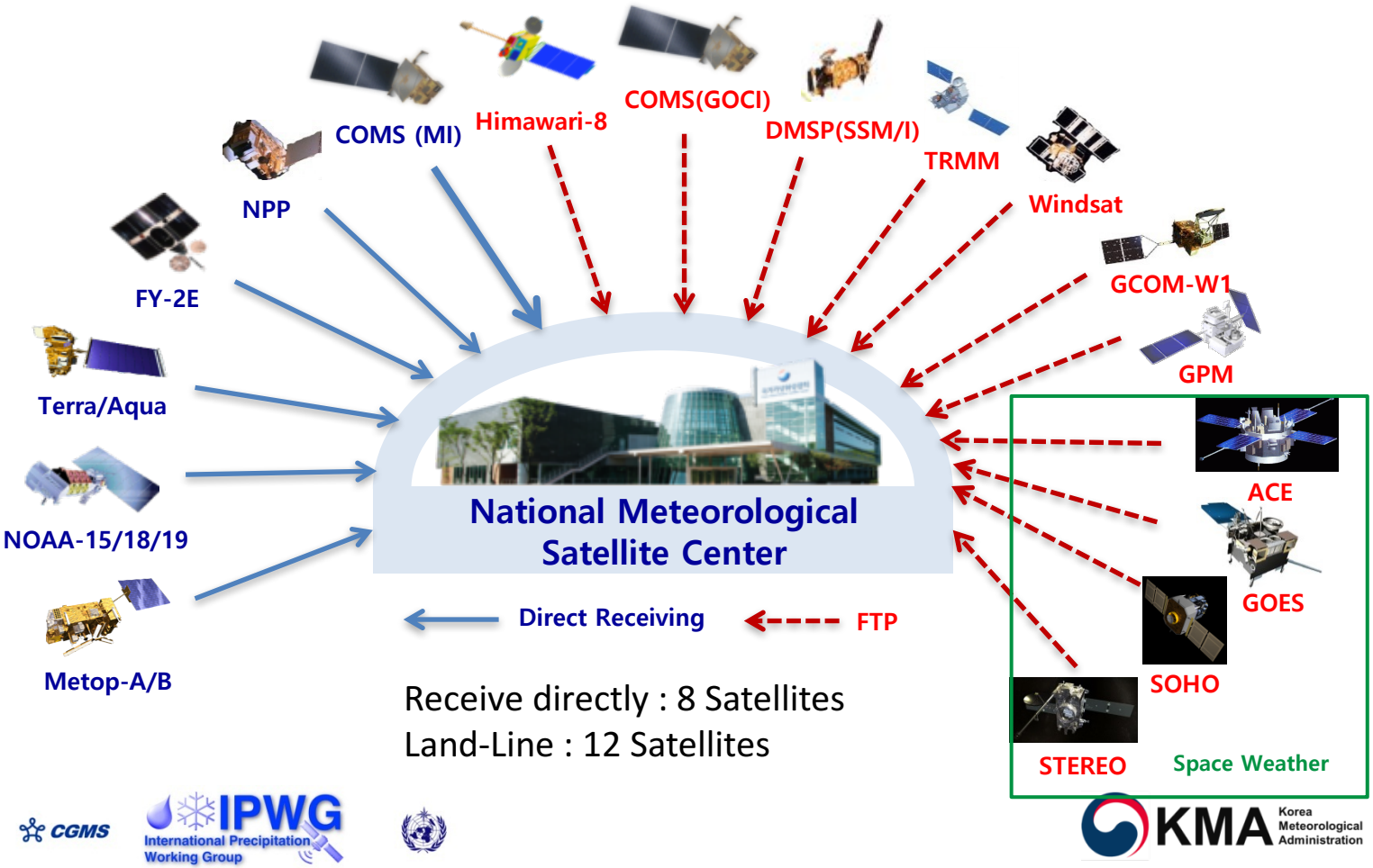
Planning for next generation geostationary satellites (GK-2A) of Korea Meteorological Administration (KMA)

Yunbok Lee & Geun-Hyeok Ryu

CGMS IPWG International Precipitation Working Group KMA Korea Meteorological Administration

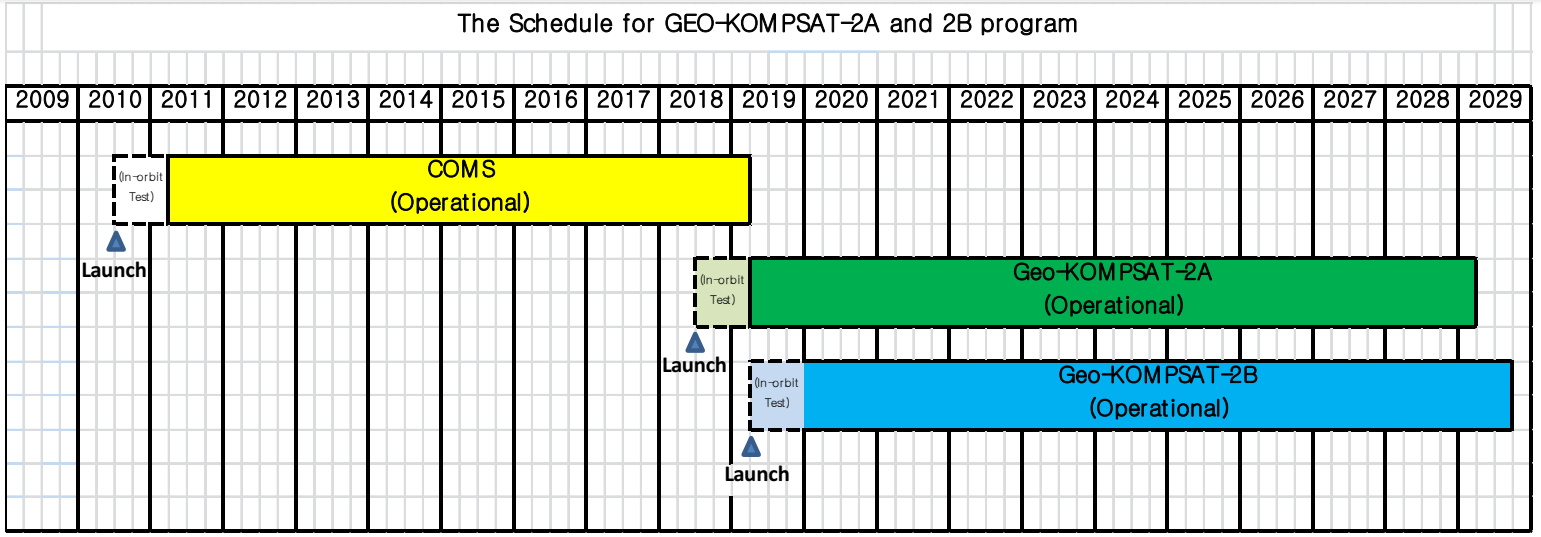
NMSC Goal

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



GEO-KOMPSAT-2 program

Sector	Satellite in Orbit	Operator	Location	Launch date	Payloads
West Pacific	GEO-KOMPSAT-2A (GK-2A)	KMA	128.2°E	05/2018	Advanced Meteorological Imager (AMI) Korea Space wEather Monitoring payload (KSEM)
	GEO-KOMPSAT-2B (GK-2B)	MOF (Ministry of Ocean and Fisheries) ME (Ministry of Environment)	128.2°E	03/2019	Advanced Geostationary Ocean Colour Imager(GOCI-II) Geostationary Environmental Monitoring Spectrometer(GEMS)



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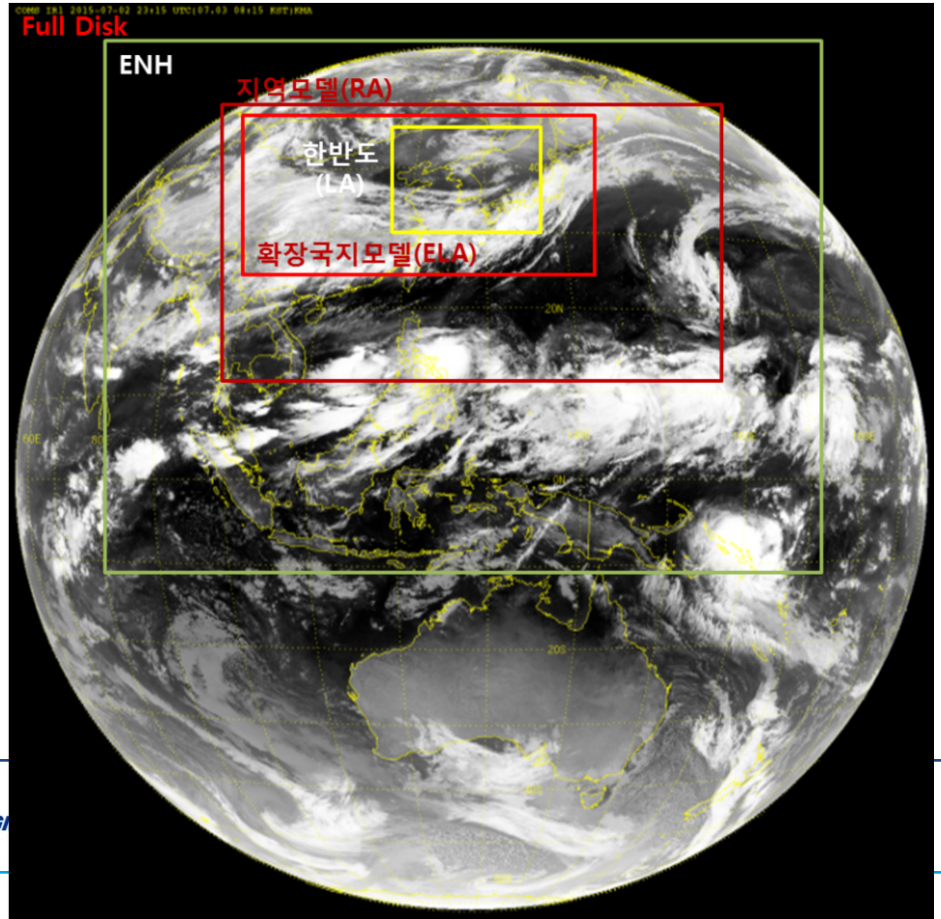
GEO-KOMPSAT-2A AMI(Advanced Meteorological Imager)

- Multi-channel capacity: 16 channels
- Temporal resolution: within 10 minutes for Full Disk observation
- Flexibility for the regional area selection and scheduling
- Lifetime of meteorological mission: 10 years

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

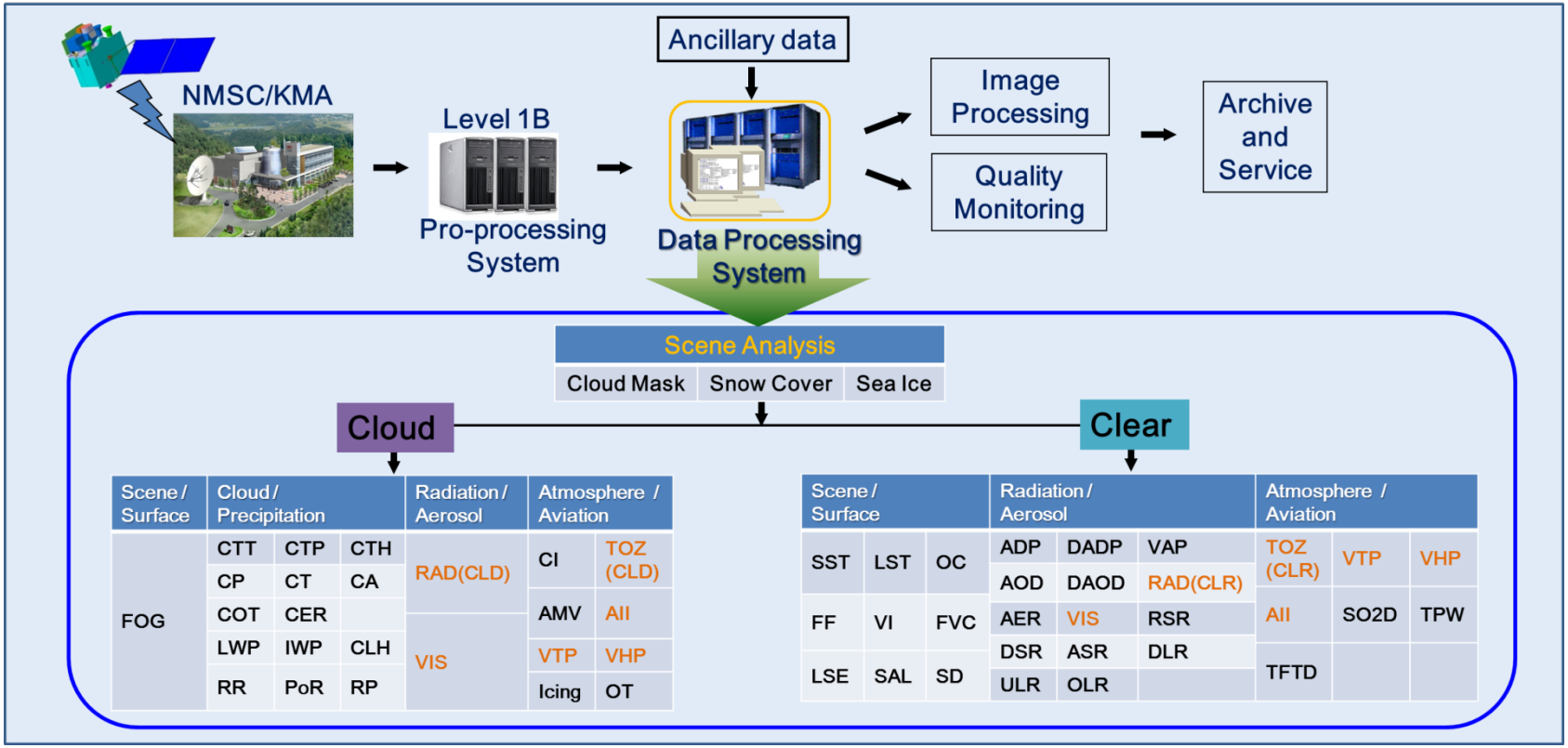
Observation Area and Schedule

- Full Disk
- Regional Area(RA) : 6200 X 5900 km (EW X NS) (TBD)
- Extended Local Area(ELA) : 4300 X 2900 km (EW X NS) (TBD)
  - Plan 1: Full Disk (1) + ELA (4) / 10 minutes
  - Plan 2 : Full disk (1) + RA (2) / 10 minutes



Meteorological products

- The algorithm prototype of 23 (primary) products have developed by 4 algorithm groups and 29 (secondary) products will be developed by the end of 2016
- MODIS, SEVIERI, COMS, and AHI data are used as proxies to evaluate each algorithm



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)	

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52 Meteorological Products

- Development Schedule(2014~2018)
  - 2014-2016 : Algorithm Development
  - 2017-2018 : Validation and Integration of Algorithm for Operation

- 4 Algorithm Groups
  - **Cloud and Precipitation**
  - **Scene analysis and Surface information**
  - **Radiation and Aerosol**
  - **Atmosphere and Aviation**

- Goal & Strategy
  - **"more accurate, consistent, reliable" meteorological products**
  - "optimal estimation" for consistency within products
  - "artificial intelligence" for improvement of some products accuracy
  - "algorithm test-bed" for optimizing scientific algorithm to operation system
  - "international review team" for improvement of the algorithm development

Application areas

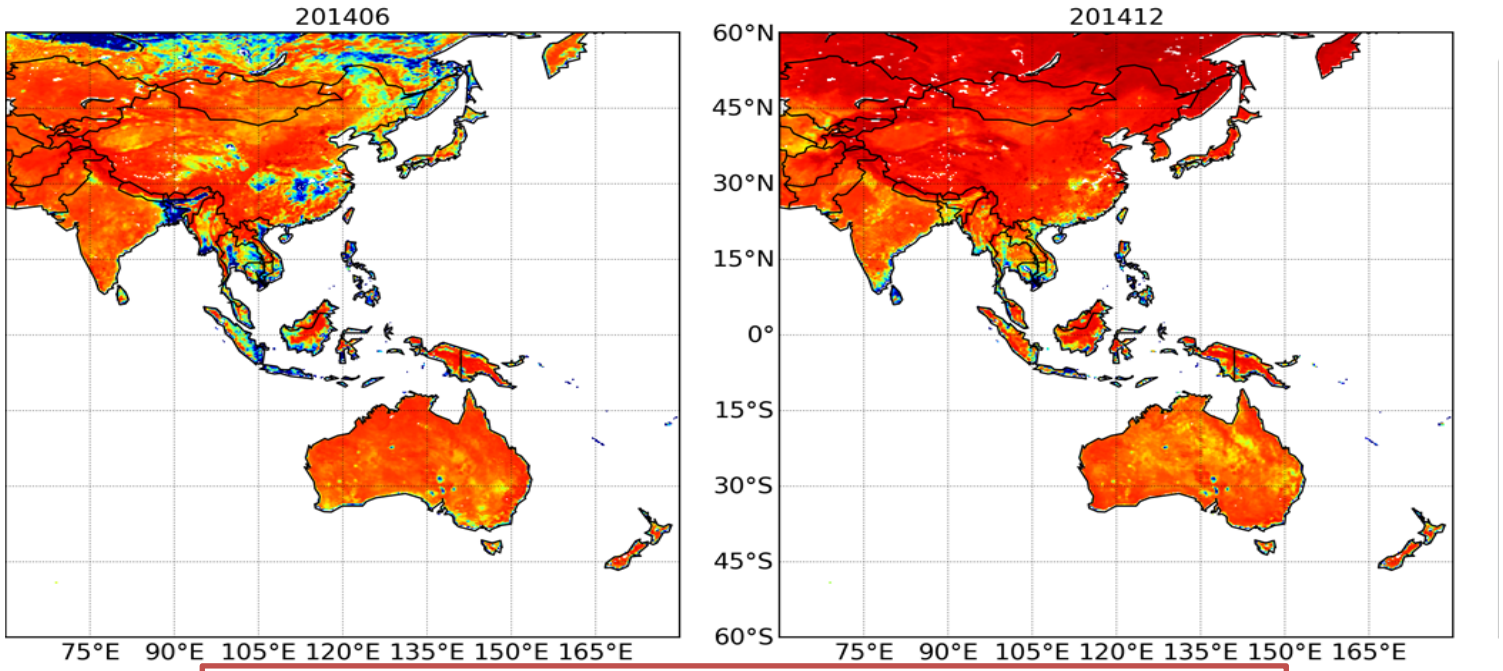
- To be designed to maximize the utilization of the satellite products for forecasters and NWP

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	
Hydrology & SFC	Soil moisture, Drought and Floods, Fire detection 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, Volcanic Ash	

Drought

- Goal : Drought determination using VHI (Vegetation Health Index)
- Procedure
  - Improvement of sensitive variable in order to explain vegetation stress by VHI
  - Considering seasonal and individual vegetation difference with respect to change weight of VHI and TCI (Temperature Condition Index)

❖ *The algorithm will be developed by using both GK2A and GK2B data*



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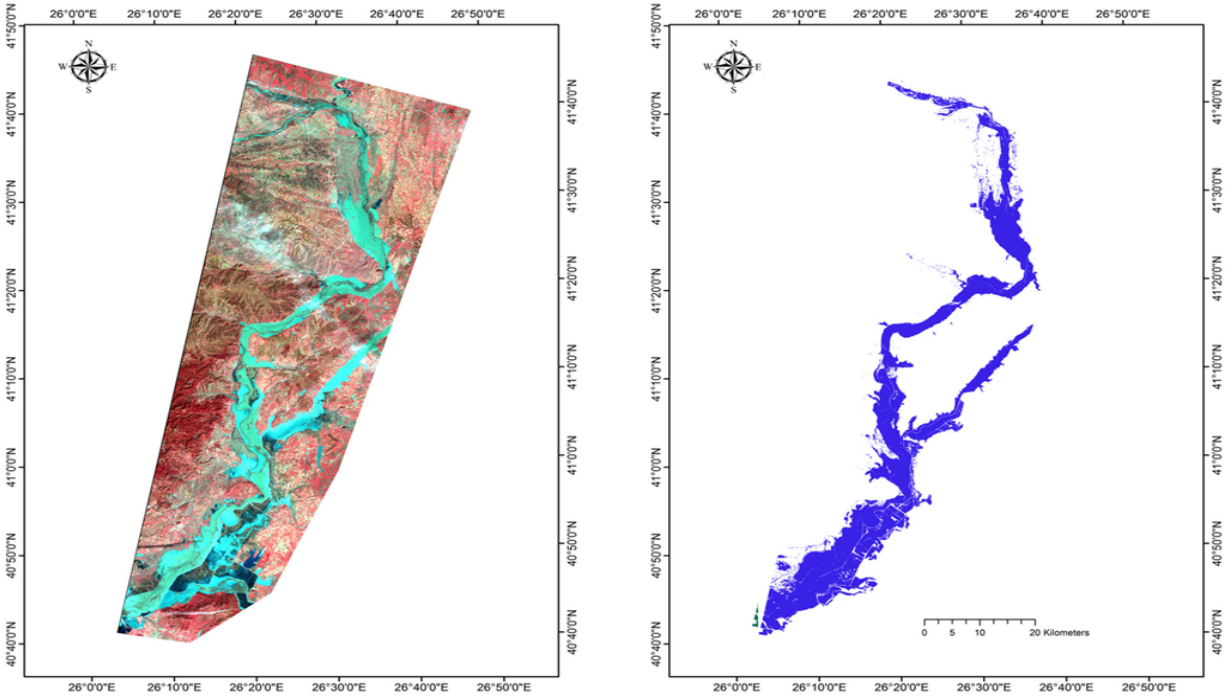
Support Comprehensive Drought information systems of KMA

Flooding

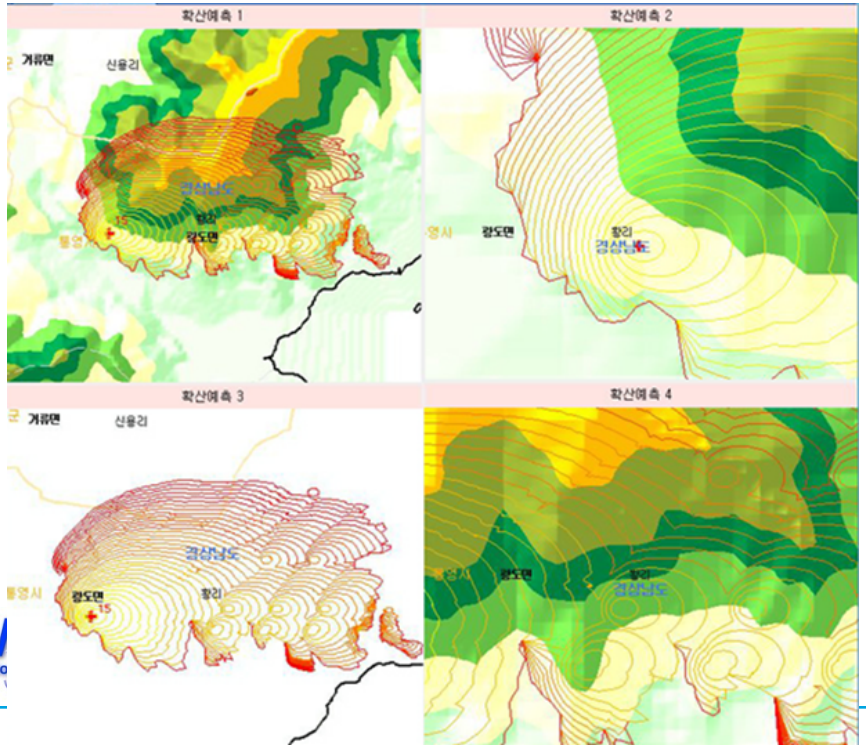
- Goal : Flooding real-time monitoring
- Procedure
  - Using analysis technique development of GK-2A RGB and Reflection



(Left) RGB composite, (right) detection of flooding region on Feb. 19, 2010 from Ireland et al., 2015

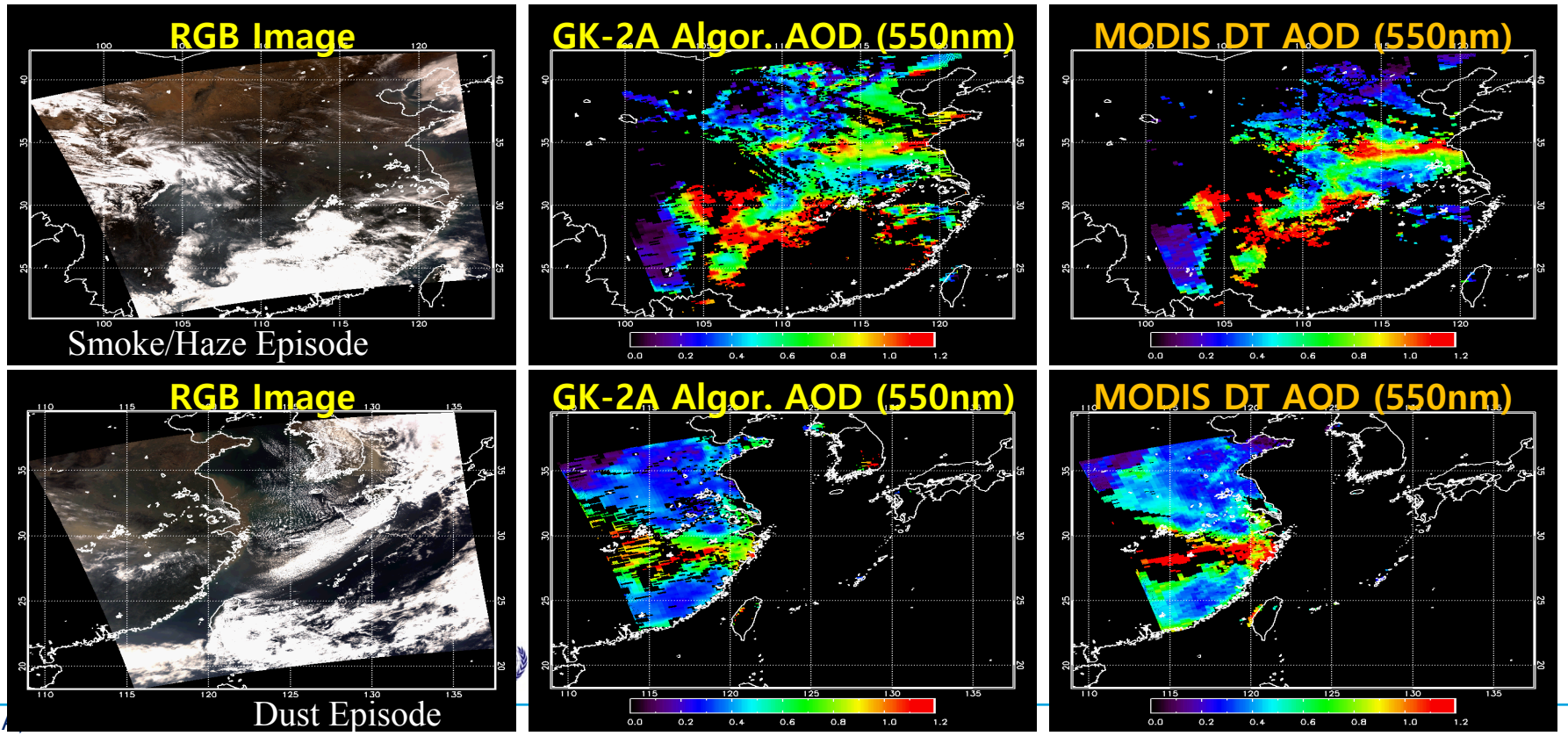
Forest Fire

- Goal : Forest fire detection, vulnerability, damage area
- Procedure
  - FRP(fire radiative power) : fire power and forest map → guess biomass loss → estimate fire emission
  - Vulnerability: Nesterov Index(NI) $NI = \sum_{i=1}^{w}(T_i - Tidew)T_i$
  - Damage area : dNBR = Prefire (NBR) – PostFire (NBR)



Aerosol

- Goal : Aerosol density and height
- Procedure
  - Aerosol height estimated by statistical regression equation model using aerosol optical depth, surface observation, other metrological element
  - Aerosol height algorithm based O4 AMF(air mass factor)

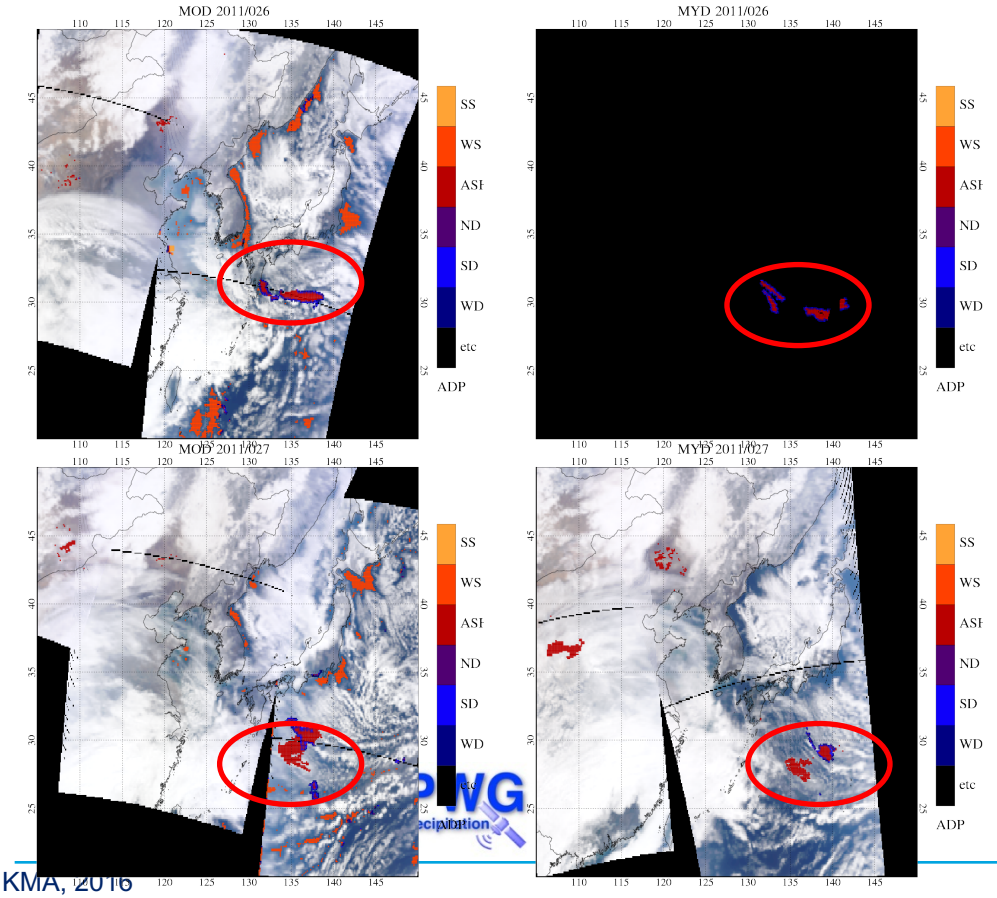


Volcanic Ash

- Goal : Detect volcanic eruption and ash movement
- Procedure

day: $BT_{11}<290$, $BTD_{11\text{-}12}<-0.5$, TVAP > 70, $\rho_{3.9}/\rho_{0.66}>0.6$

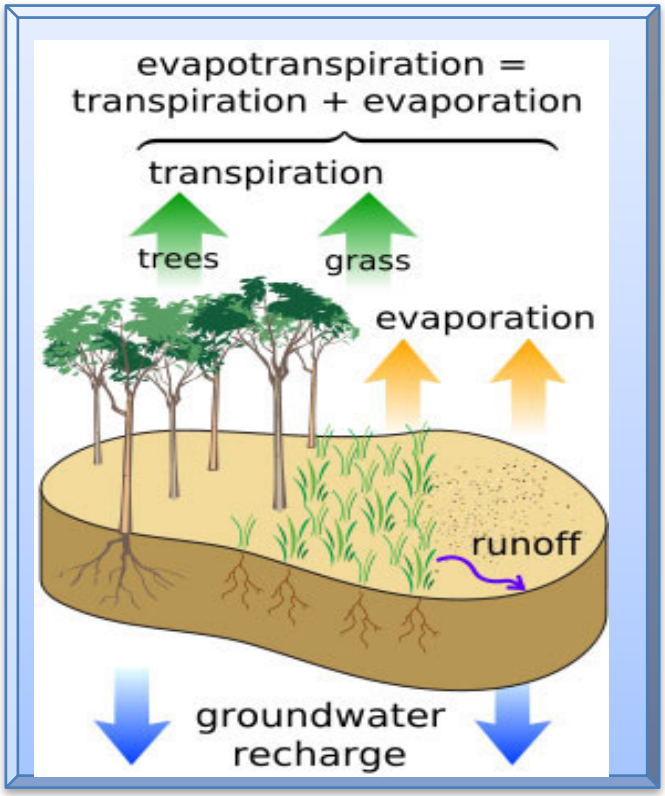
night: $BT_{11}<290$, $BTD_{11\text{-}12}<-0.5$, TVAP > 70 *(Lee et al., 2014, 2015)*



Mt. Shinmoedake eruption, Japan
(26 Jan 2011)

MODIS

Evapotranspiration



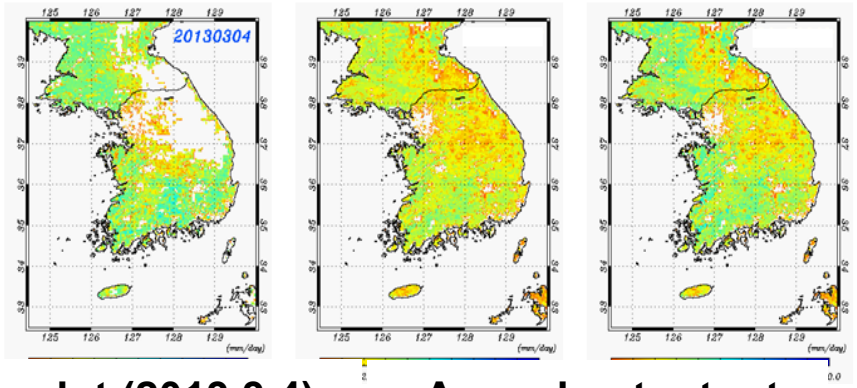
$$Rn = LE + H + G$$

$$\rightarrow LE = Rn - H$$

$$H = \rho \cdot c_p \frac{(Ts - Ta)}{r_a}$$

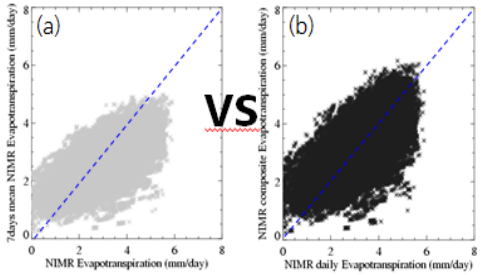
- **Comparison of evapotranspiration**

a) Daily b) 7days(±3) average c) Synthetic daily



- **Scatter plot (2013.3.4)**

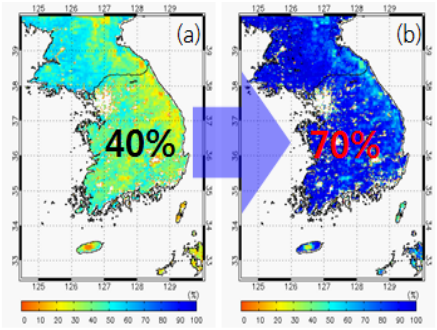
a) 7days(±3) average b) Synthetic daily



	7days(±3) average	Synthetic daily
RMSD	0.928	0.768
Bias	0.574	0.060

- **Annual output rate**

a) daily b) Synthetic daily



Improve the Algorithm with coefficients and input data (2016)

Summary

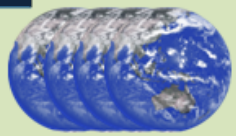
Resolution 4 times

COMS	Geo-KOMPSAT-2A
VIS 1km	VIS 0.5~1km
IR 4km	IR 2km

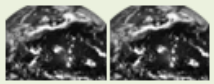
Freq. of obs. 5 times

1 HR

Global 1 time

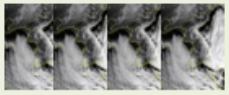


4 FD

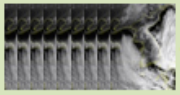


Region 2 times

More than 10 times



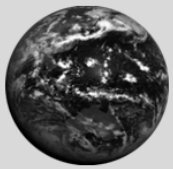
Korea 4 times

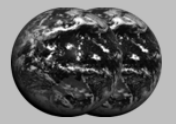


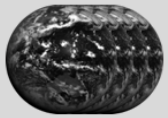
Every 2 minutes

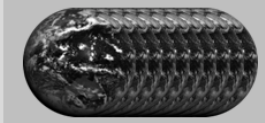
of channels 3 times

	COMS	Geo-KOMPSAT-2A
VIS	1 channel (B/W)	4 channels (colors)
NIR	0	2 channels
IR	4 channels	10 channels
	5 Ch.	16 Ch.



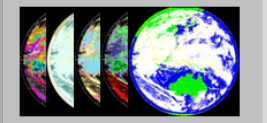


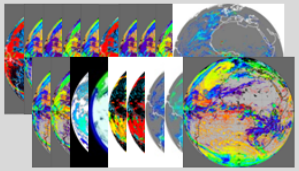


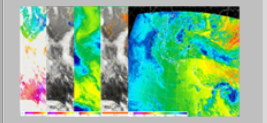


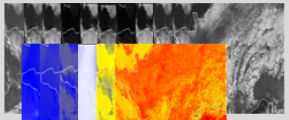
Products 3.5 times

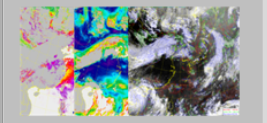
COMS	Geo-KOMPSAT-2A
CLD/Prec.	5->19 types
Rad./Aero.	5->16 types
Atmos. motion	3->6 types
Surface Info.	3->11 types
16 types	52 types

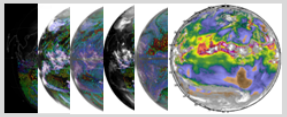


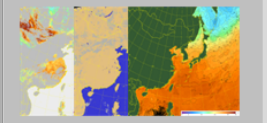


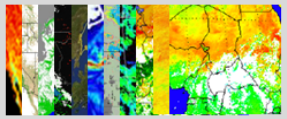












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Thank you

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Acronym

- KIOST : Korea Institute of Ocean Science and Technology (한국해양과학기술원)
- DCPC : Data Collection or Production Centre (slide 3)
- CHL : Chlorophyll (slide 4)
- CDOM : Colored Dissolved Organic Matter (slide 4)
- OBPG : Ocean Biology Processing Group (slide 4)
- UCAR : UCAR - University Corporation for Atmospheric Research (slide 4)
- GNSS-RO : Global Navigation Satellite System-radio occultation (slide 5)
- MODIS : Moderate Resolution Imaging Spectroradiometer (slide 9)
  NOAA Terra, Aqua 위성에 탑재
- SEVERI : Spinning Enhanced Visible and Infrared Imager (slide 9)
  EUMETSAT의 MSG 위성시리즈에 탑재
- AHI : Advanced Himawari Imager (slide 9)
  일본 정지궤도기상위성 Himawari-8/-9에 탑재
- TEMPO : Tropospheric Emissions: Monitoring of Pollution (slide 9)

GEO-KOMPSAT-2A Data Service Plan

[Via GK-2A broadcast]

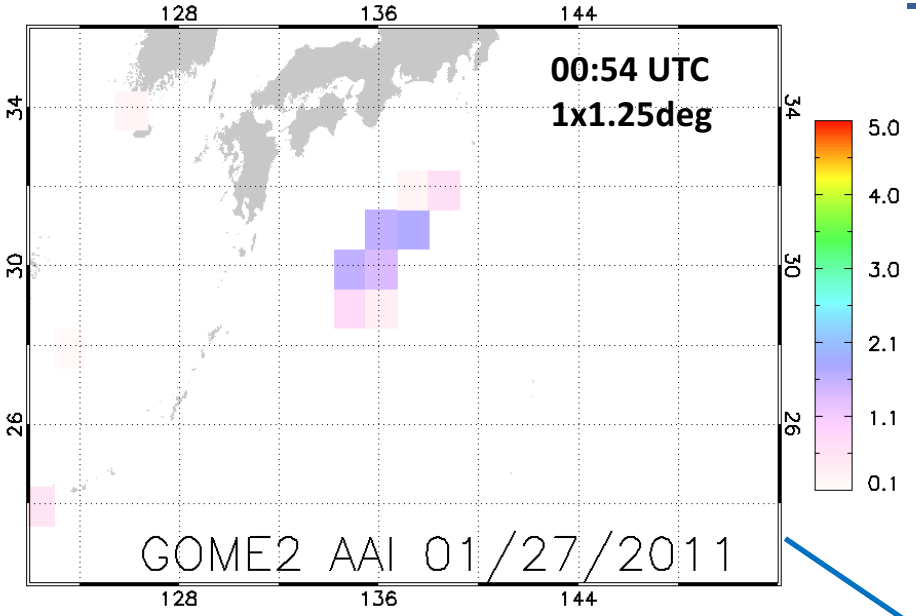
- **Broadcast all 16 channels data (UHRIT)** of meteorological observations
- Maintain **L/HRIT broadcast** corresponding to COMS five channels

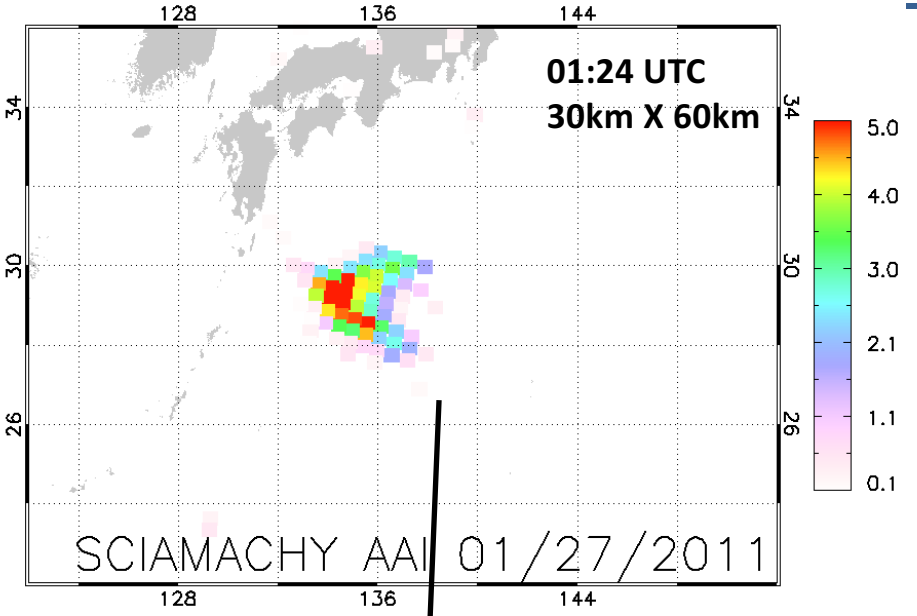
Categories	UHRIT	COMS-like H/LRIT	
Service		HRIT	LRIT
Data Rate	≤ 31 Mbps	3 Mbps	~512 Kbps
Frequencies	Uplink : S-band Downlink : X-band	Uplink : S-band , Downlink : L-band * Same Frequencies band with COMS	
Data Type	AMI Image(16 Ch.) Alphanumeric text Encryption Key Message * Additional info could 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, ENH	FD, ENH
Station	LDUS	MDUS	SDUS

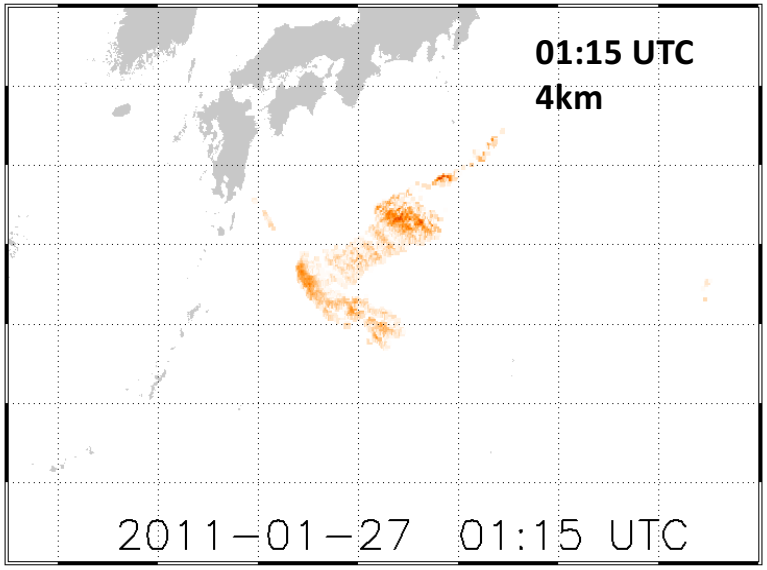
[Via Landline]

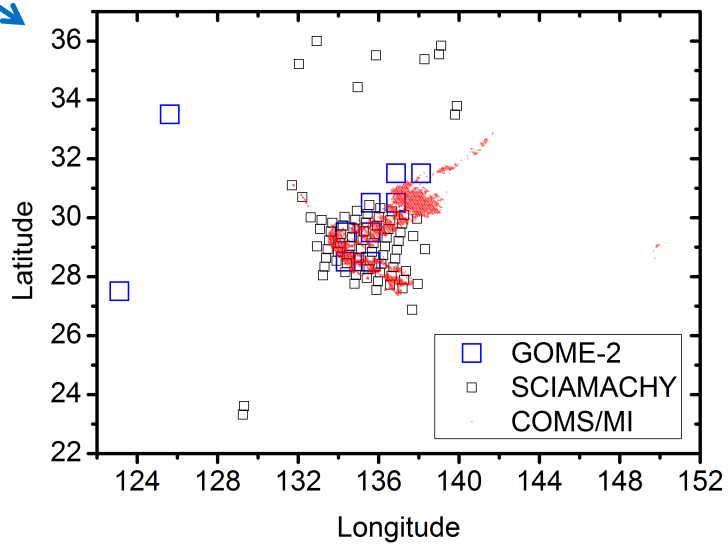
- Cloud service is under development (completed in 2018)
- Renovated web-based service system is under development (completed in 2018)
- GK-2A data also will be available in DCPC-NMSC (http://dcpc.nmsc.kma.go.kr)

Volcanic Ash
Comparisons with other satellite products





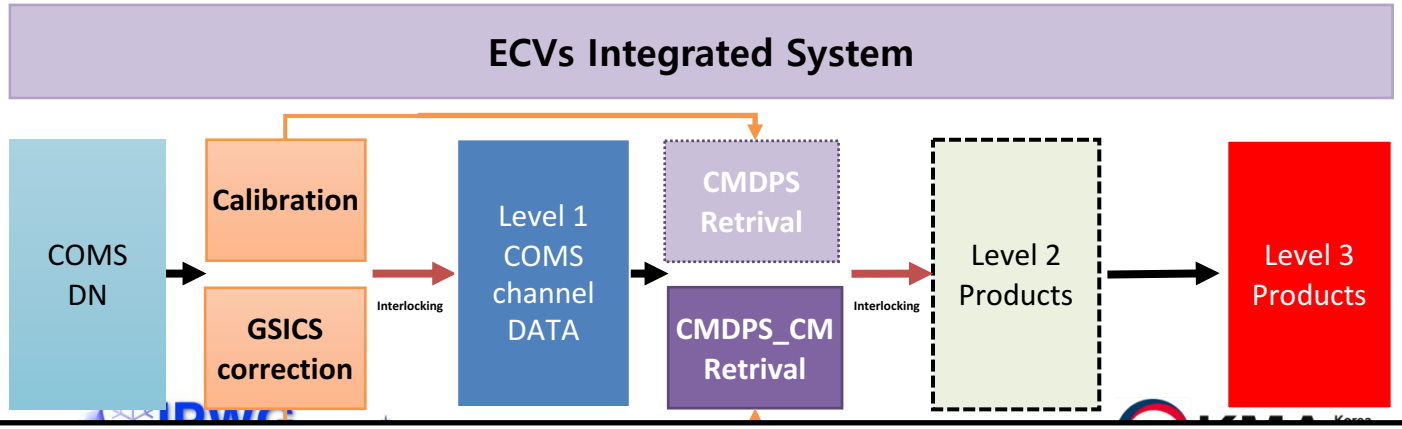




Lee et al (RSE, 2016)

Essential Climate Variables (ECVs)

1. COMS-based ECVs long-term development plan(2011 yr)
   - Content: International trend analysis, COMS-based ECVs definition, selection variables in the second step
2. COMS meteorological variables(L2) production
   - Polar orbiting satellites(MetOp/IASI, Aqua/AIRS) verification system(GSICS), quality control
   - COMs Level2 Production and regular service(Since April, 2011)
3. Domestic and international satellite-based ECVs data sharing and utilization system
   - Objective: long-term securing of donsistent data
   - (2015 yr) Primary ECVs (SST, INS, OLR) L3 unified system development
   - (2016 yr) Second ECVs (Albedo, Precipitation, cloud fraction) Algorithm Improvement



➢ Level 3 : reprocessed through the rough footage, the details check in the calibration process, including spatial information grid-type satellite (composite) output