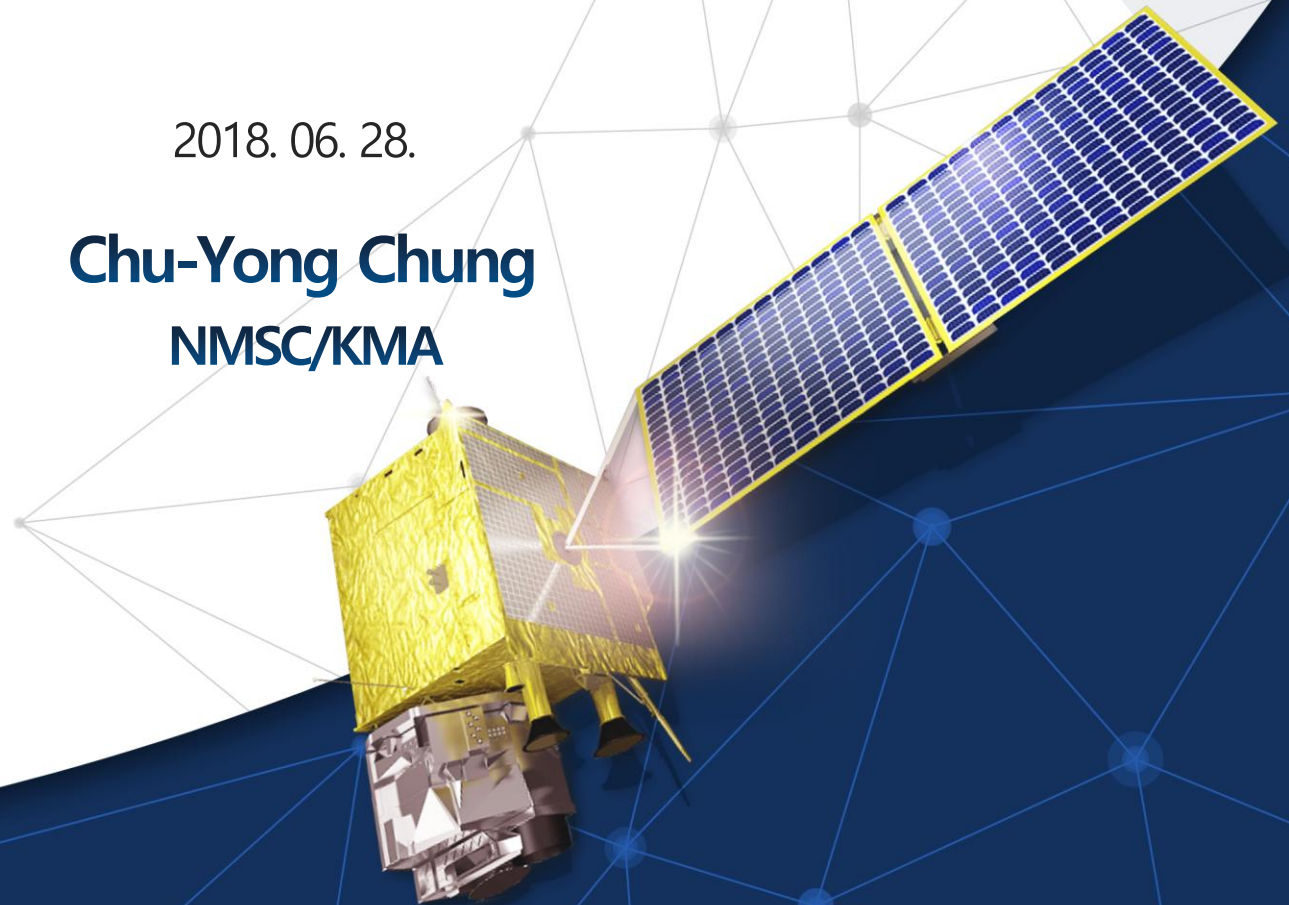


Surface Products of GK-2A Satellite

2018. 06. 28.

Chu-Yong Chung
NMSC/KMA



Surface Products of GK-2A

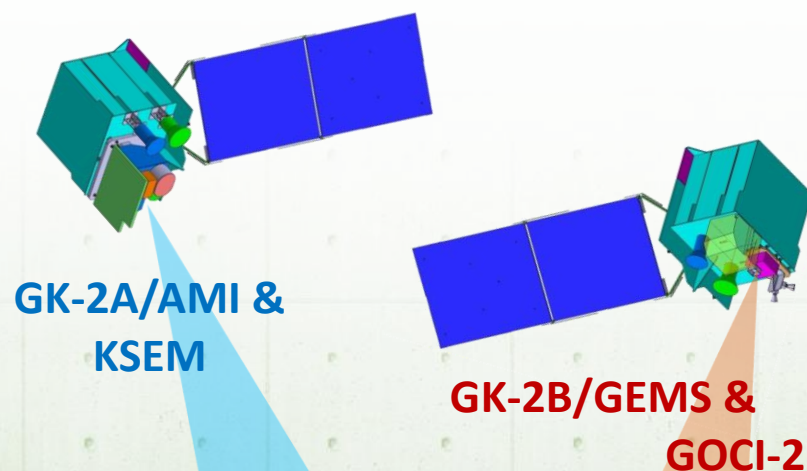
CONTENTS

Chapter I	GK-2A Program
Chapter II	& Applications
Chapter III	Surface Products
Chapter IV	Summary
Chapter V	Related Posters

I

GK-2A Program (Geo-KOMPSAT)

01 ▶ Overview of GK-2A & GK-2B



Launch: Nov. 2018

Launch: 2nd Half 2019

● Specifications

	GK-2A	GK-2B	
Payload	AMI	GOCI-2	GEMS
Lifetime	10 years		
Location	36,000 km over equator at 128.2° E		
Channels	16	13	1000
Wavelength range	0.4 – 13.3 μm	375 - 860 nm	300-500 nm
Spatial resolution	0.5 & 1 km (Vis) 2 km (IR)	250 m@ eq 1 km (FD)	7 x 8 km ² @ Seoul 3.5x8 km ² (aerosol)
Temporal resolution	10 min (FD)	1 hour	1 hour

AMI: Advanced Meteorological Imager

KSEM: Korean Space wEather Monitor

GOCI-2: Geostationary Ocean Color Imager-2

GEMS: Geostationary Environmental Monitoring Sensor

02 ▶ Channel Characteristics of AMI

AMI(Advanced Meteorological Imager)

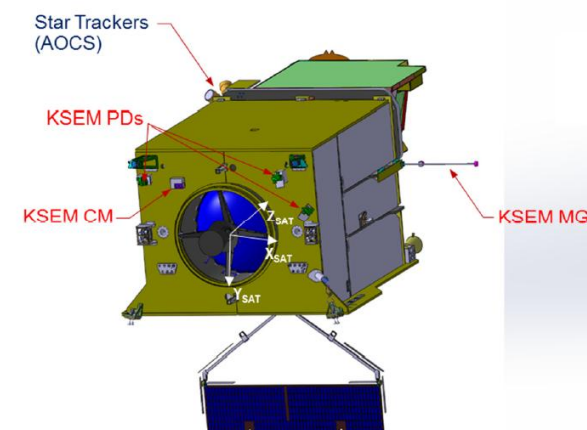
Center wavelength (μm)			
AMI (Resolution)		ABI	AHI
★ 1 blue	0.47 (1km)	0.47	0.46
★ 2 green	0.511 (1km)		0.51
★ 3 red	0.64 (0.5km)	0.64	0.64
4	0.856 (1km)	0.865	0.86
★ 5	1.38 (2km)	1.378	
★ 6	1.61 (2km)	1.61	1.6
		2.25	2.3
7	3.830 (2km)	3.90	3.9
8	6.241 (2km)	6.185	6.2
9	6.952 (2km)	6.95	7.0
10	7.344 (2km)	7.34	7.3
11	8.592 (2km)	8.50	8.6
12	9.625 (2km)	9.61	9.6
13	10.403 (2km)	10.35	10.4
14	11.212 (2km)	11.2	11.2
15	12.364 (2km)	12.3	12.3
16	13.31 (2km)	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

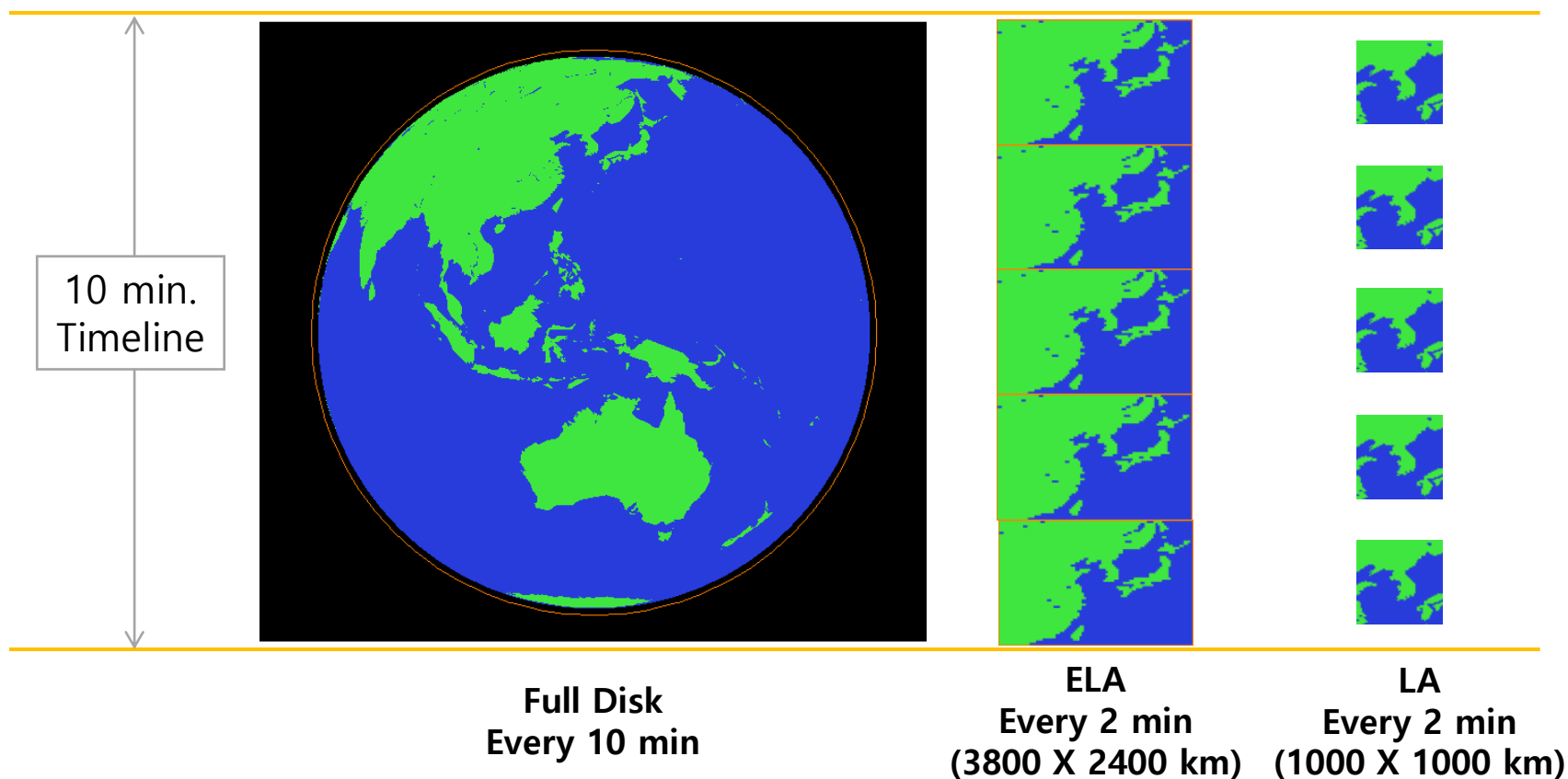


KSEM(Korea Space wEather Monitor)

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

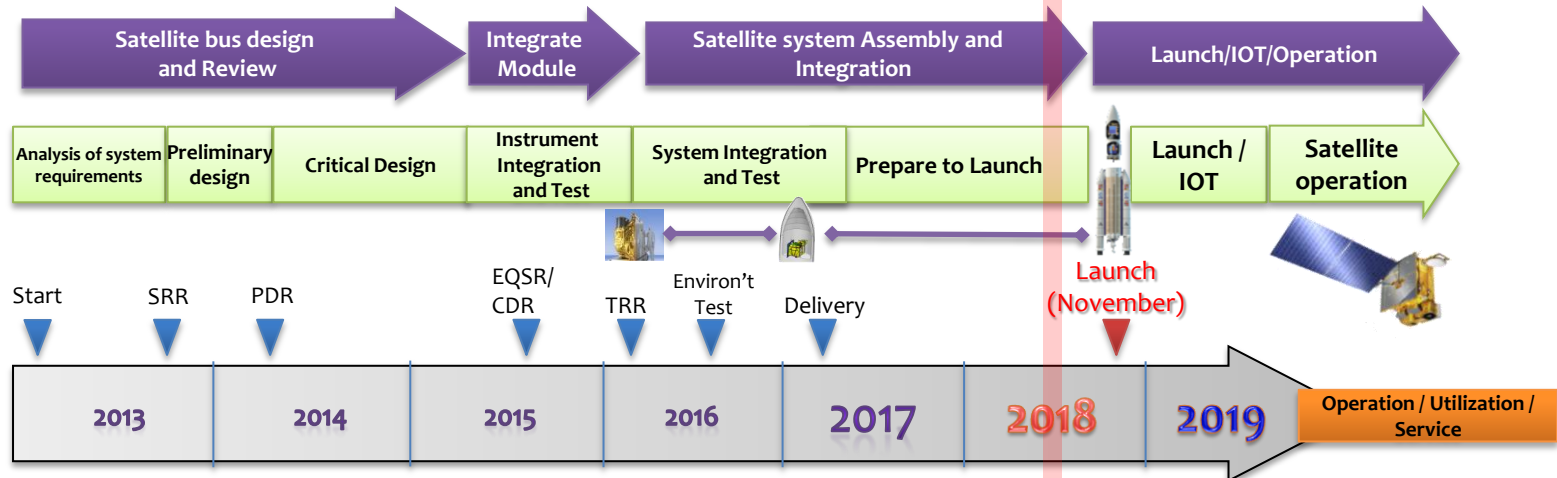
03 ▶ AMI Observation Schedule

- Full Disk
- Extended Local Area(ELA) : 3800 X 2900 km² (EW X NS)
- LA 1000 X 1000 km²



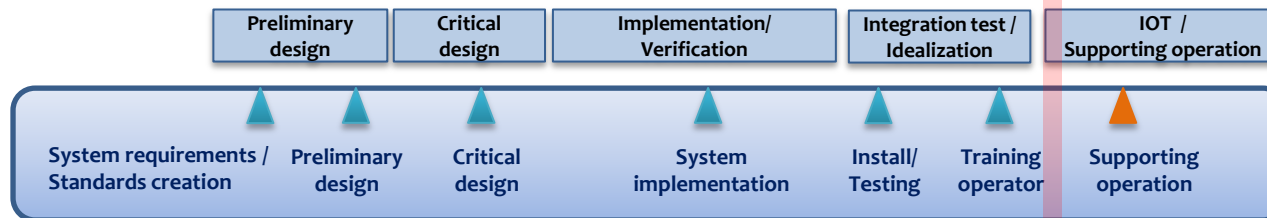
04 ▶ Milestone of GK-2A

PAYLOAD AND SATELLITE

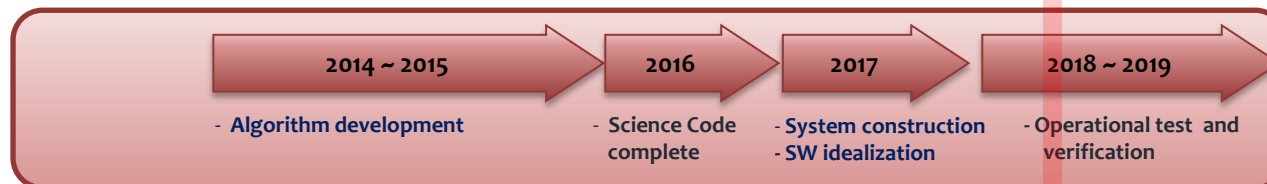


GROUND SEGMENT

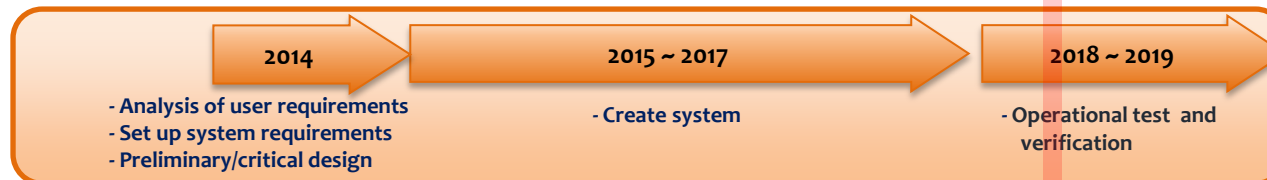
DATA RECEIVING AND PROCESSING SYSTEM



SCIENCE ALGORITHMS



APPLICATION AND SERVICE SYSTEM



II

Geophysical Products and Applications

01 ▶ GK-2A/AMI 52 Geophysical Products

	Scene & Surface Analysis	Cloud & Precipitation	Aerosol & Radiation	Atmospheric condition & Aviation
Primary Products (23)	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 Phase	Asian Dust Optical Depth	Instability Index
	Sea Surface Temperature	Rainfall Rate	Volcanic Ash Detection, Height & Mass	Convective Initiation
	Land Surface Temperature		Radiance	Total Ozone
Secondary Products (29)	Surface Emissivity	Cloud Type	Aerosol Particle Size	Total Precipitable Water
	Surface Albedo	Cloud Amount	Visibility	Clear Sky Turbulence
	Fire Detection	Cloud Optical Depth	Downward SW Radiation (SFC)	SO ₂ Detection
	Vegetation Index	Cloud Effective Radius	Reflected SW Radiation (TOA)	Overshooting Top Detection
	Vegetation Green Fraction	Cloud Liquid Water Path	Absorbed SW Radiation (SFC)	Aircraft Icing
	Snow Depth	Cloud Ice Water Path	Upward LW Radiation (TOA)	
	Ocean Current	Cloud Layer/Height	Downward LW Radiation (SFC)	
		Rainfall Potential	Upward LW Radiation (SFC)	
		Probability of Rainfall		

01 ▶ GK-2A/AMI 52 Geophysical Products

❖ Algorithm Improvement

- To improve the algorithm reliability, KMA performs in-depth review meetings together with the International Review Team (7 international experts).

❖ Product Validation

- Primary products have been validated on several cases or some periods for evaluating product maturity using Himawari-8/AHI data as a proxy data
- Secondary products were just validated under the initial stage of algorithm development

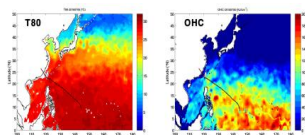
❖ User Readiness and Training

- **Monitoring Testbed System** using related GK-2A products such as T/q profile, instability index, total precipitable water, convective initiation, aerosol detection, etc.
- **Feedbacks from users** such as forecasters of local weather offices inside the KMA
- **Training** of how to utilize and analyze GK-2A meteorological products

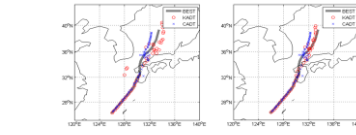
02 ▶ Applications of satellite products

- For maximizing the usability of the GK-2A observations and the products
- **“By the additional use of all available data”** including GK-2A(B), LEO products, ground observations, NWP

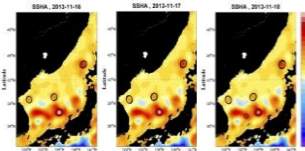
Typhoon/Ocean



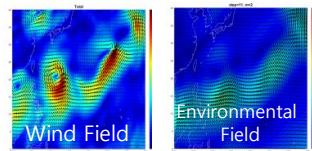
Estimating cyclone



Objective and automatic technique to analyze tropical cyclone (TC) information

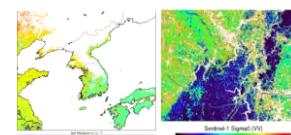


Satellite-based ocean environment monitoring and analysis

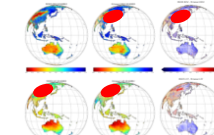


Sea surface wind and 3-D wind field analysis

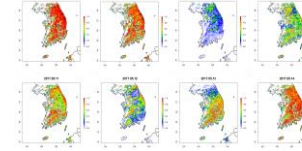
Surface/Hydrology



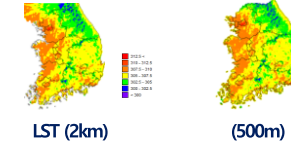
Soil moisture & flood



Drought

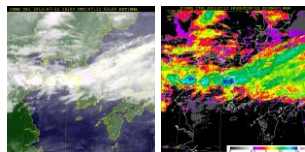


Forest Fire

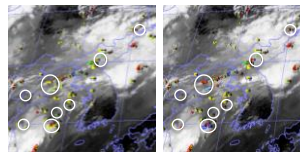


Blending, Downscaling, Validation Strategy

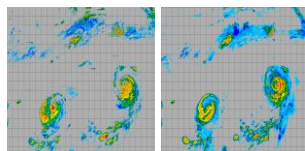
Nowcasting



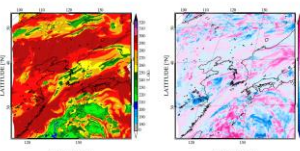
Satellite-based objective cloud analysis



Convective analysis

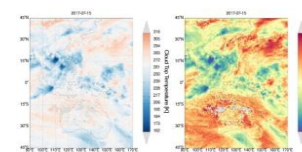


Multi-satellite sensor precipitation merging and analysis

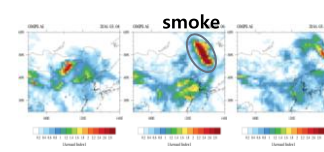


Improvement satellite production technology

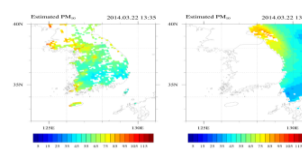
Climate/Environment



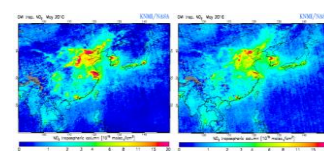
Climate change and environmental meteorological monitoring plan



Environmental Meteorological monitoring and analysis technology development plan



Dust (peak height/concentration)



Research on satellite data utilization meteorological prediction model

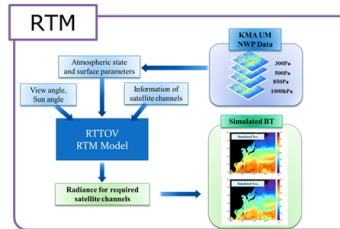
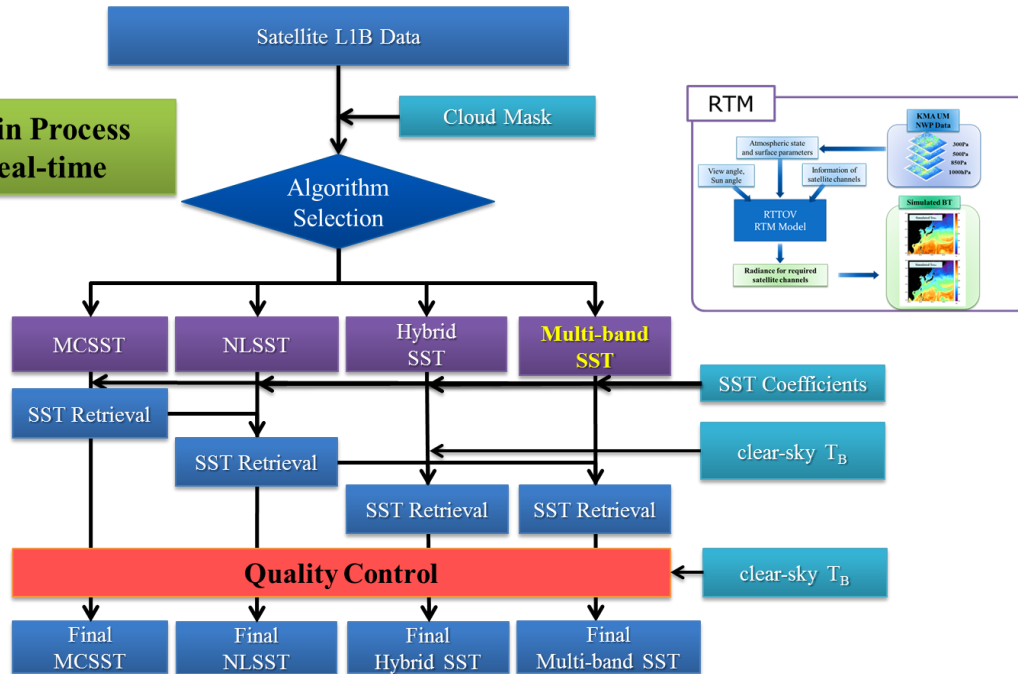
III

Surface Products

01 Major Features of the GK-2A surface products

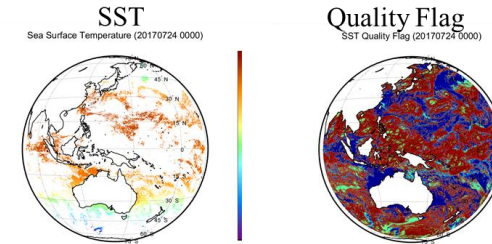
- Sea surface temperature

Main Process Real-time



Post Process

Level 2

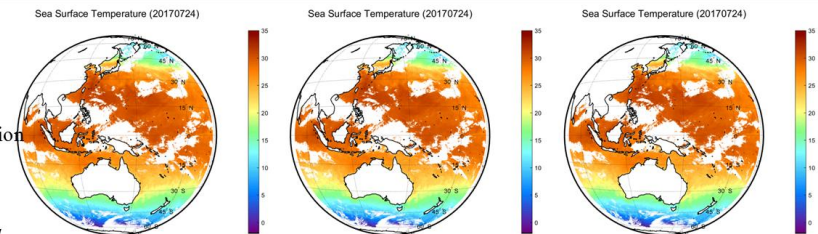


Level 3

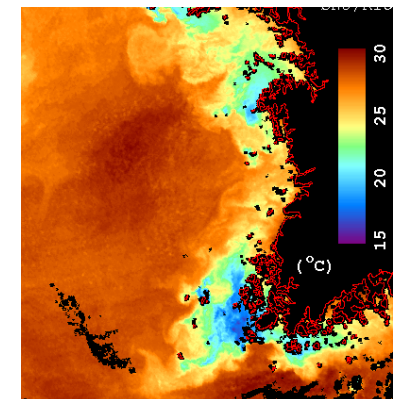
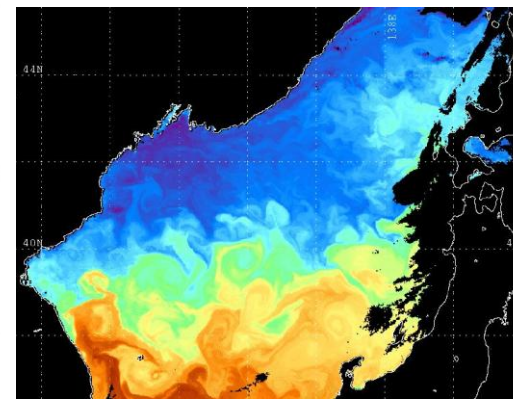
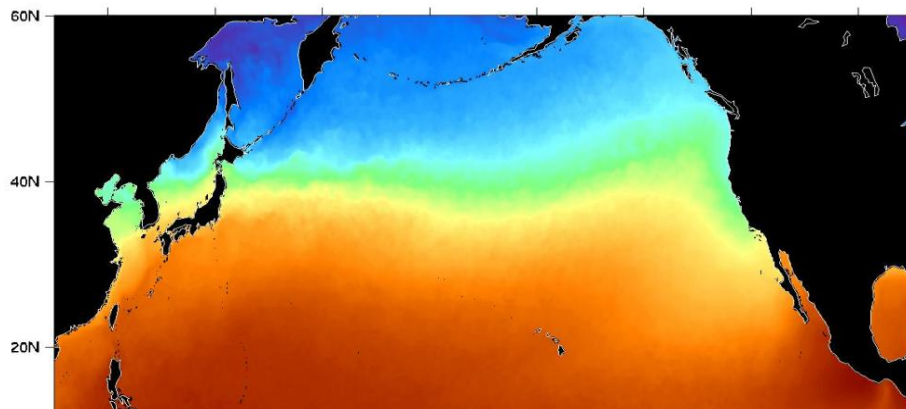
Daily SST Composite

5-day SST Composite

10-day SST Composite

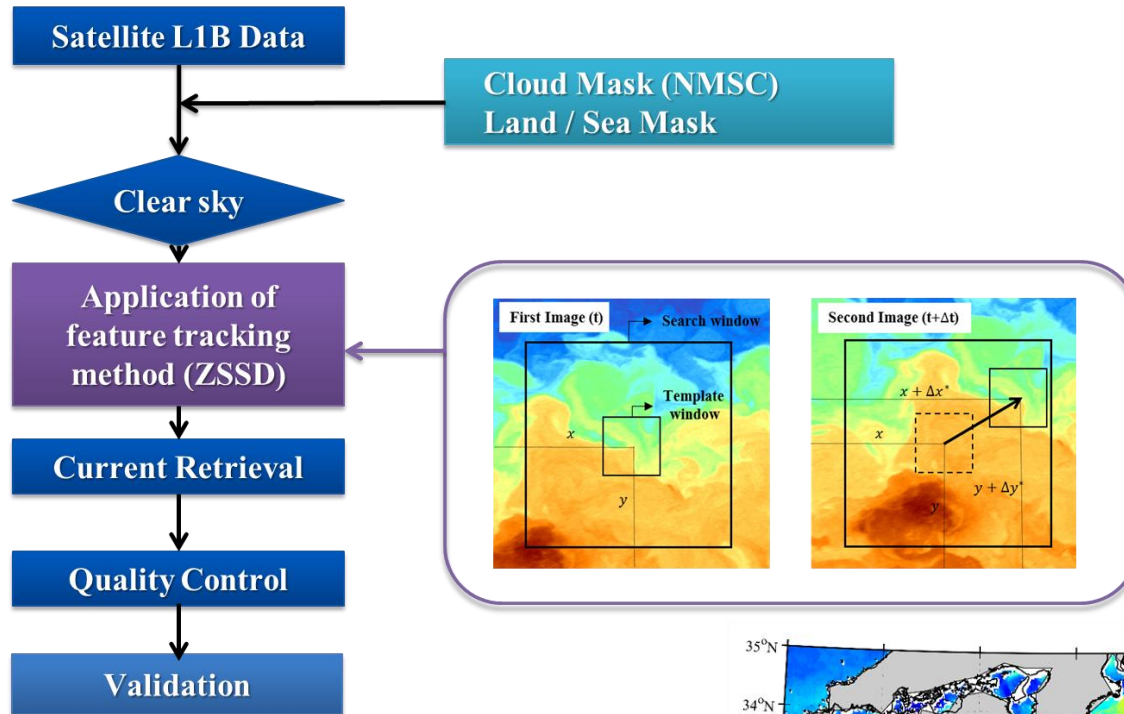


- SST & QC flag information
- 3 SST Composite files
GK-2A Data only
- 1, 5, 10 days
- July 24 – August 7, 2017
- Poor Coverage due to Clouds



02 Major Features of the GK-2A surface products

- Sea surface current



SSD method, 3 hour time interval for optimal pattern tracking

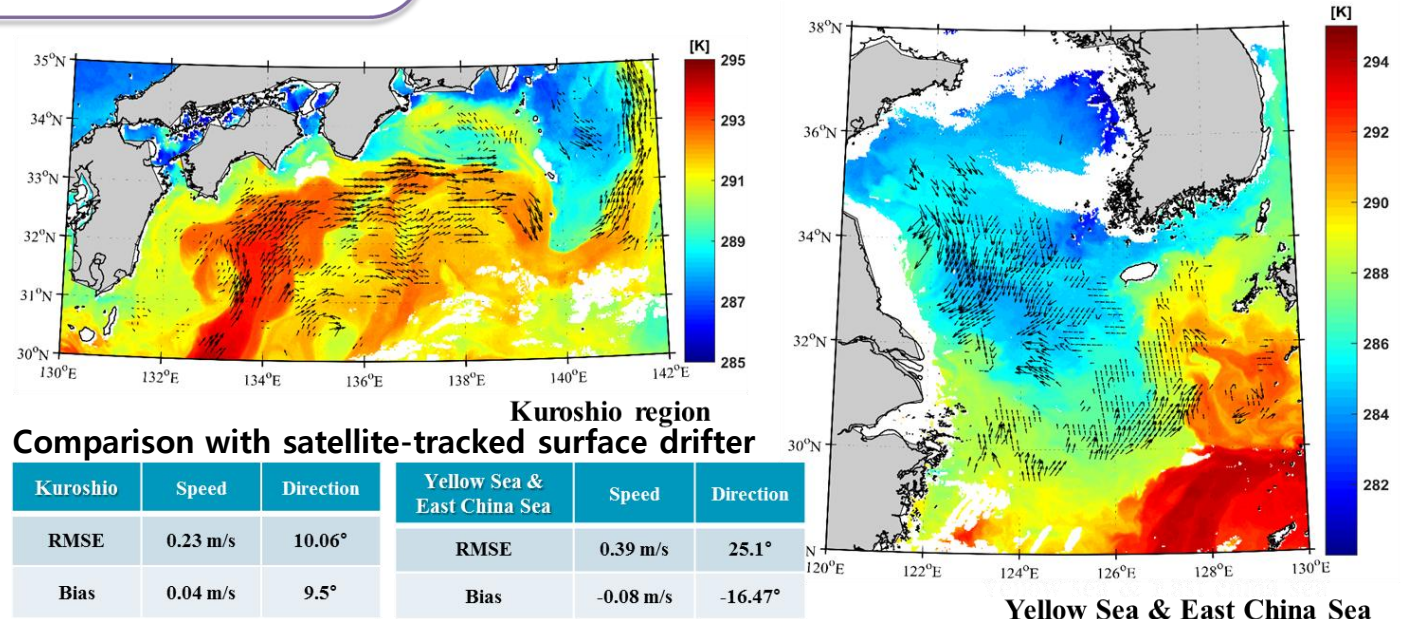
- Using two successive images
 - Maximum Cross Correlation (MCC)
 - Inverse Method
 - Zero-mean Sum of Absolute Differences (ZSAD)
 - Zero-mean Sum of Square Differences (ZSSD)

$$MCC(x + \Delta x, y + \Delta y) = \frac{\sum_{i=-N}^N \sum_{j=-N}^N [I_t(x + i, y + j) - \bar{I}_t] \times [I_{t+\Delta t}(x + \Delta x + i, y + \Delta y + j) - \bar{I}_{t+\Delta t}]}{\sqrt{\sum_{i=-N}^N \sum_{j=-N}^N [I_t(x + i, y + j) - \bar{I}_t]^2} \sqrt{\sum_{i=-N}^N \sum_{j=-N}^N [I_{t+\Delta t}(x + \Delta x + i, y + \Delta y + j) - \bar{I}_{t+\Delta t}]^2}}$$

$$\text{Inverse Method} \quad \sum_{ij} \left| \frac{\partial T}{\partial t} + u \cdot \nabla T - S \right|_{ij}^2 + \alpha^2 \sum_{ij} |\nabla \cdot u|_{ij}^2 + \beta^2 \sum_{ij} |u|_{ij}^2 + \gamma^2 \sum_{ij} |\nabla \times u|_{ij}^2$$

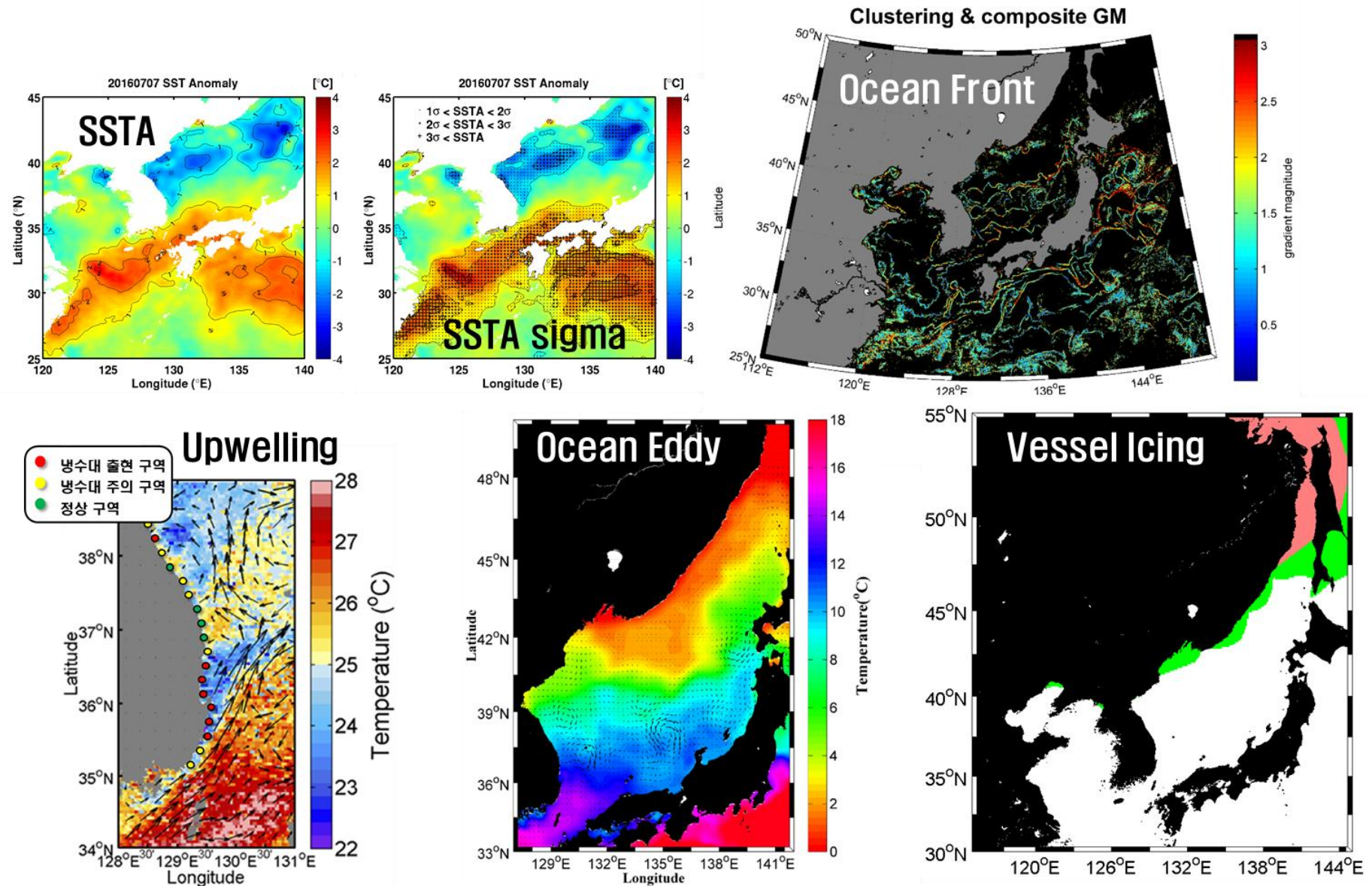
$$SAD(x + \Delta x, y + \Delta y) = \sum_{i=-N}^N \sum_{j=-N}^N |I_t(x + i, y + j) - \bar{I}_t| - |I_{t+\Delta t}(x + \Delta x + i, y + \Delta y + j) - \bar{I}_{t+\Delta t}|$$

$$SSD(x + \Delta x, y + \Delta y) = \sum_{i=-N}^N \sum_{j=-N}^N [I_t(x + i, y + j) - \bar{I}_t] - [I_{t+\Delta t}(x + \Delta x + i, y + \Delta y + j) - \bar{I}_{t+\Delta t}]^2$$



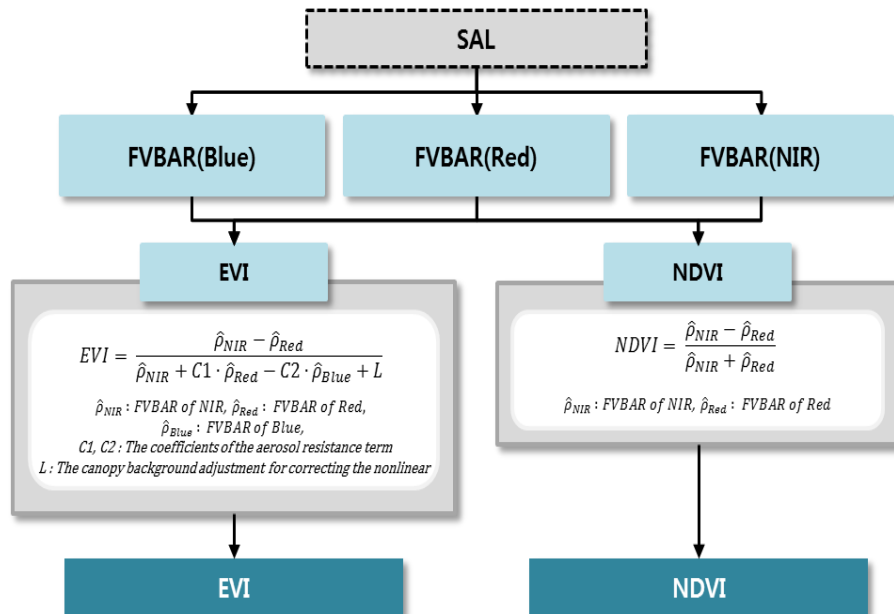
03 Major Features of the GK-2A surface products

- Ocean monitoring products

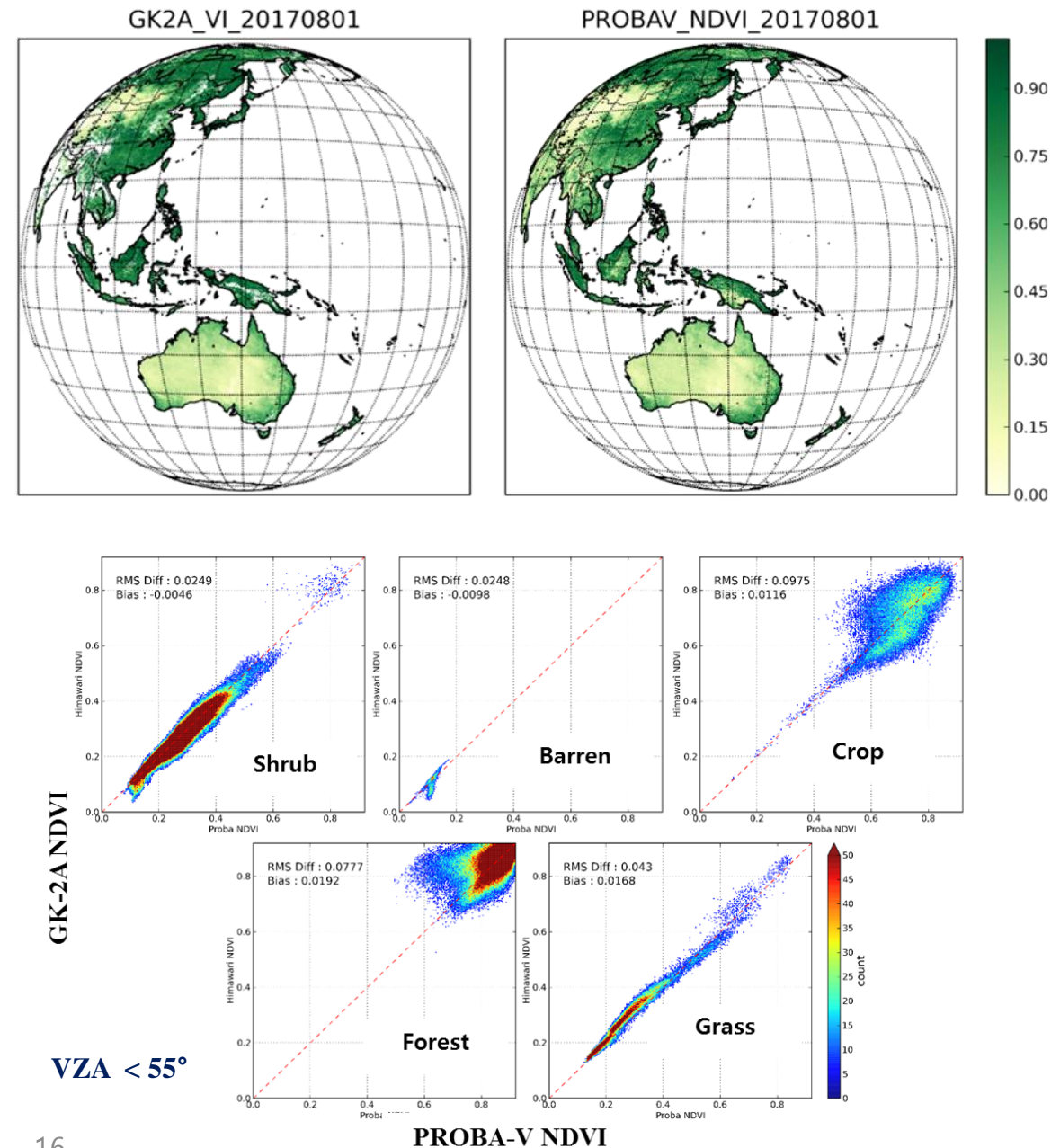


P10. Four potential observations of Ocean Environment Changes using GK-2A

04 Major Features of the GK-2A surface products - Vegetation Index



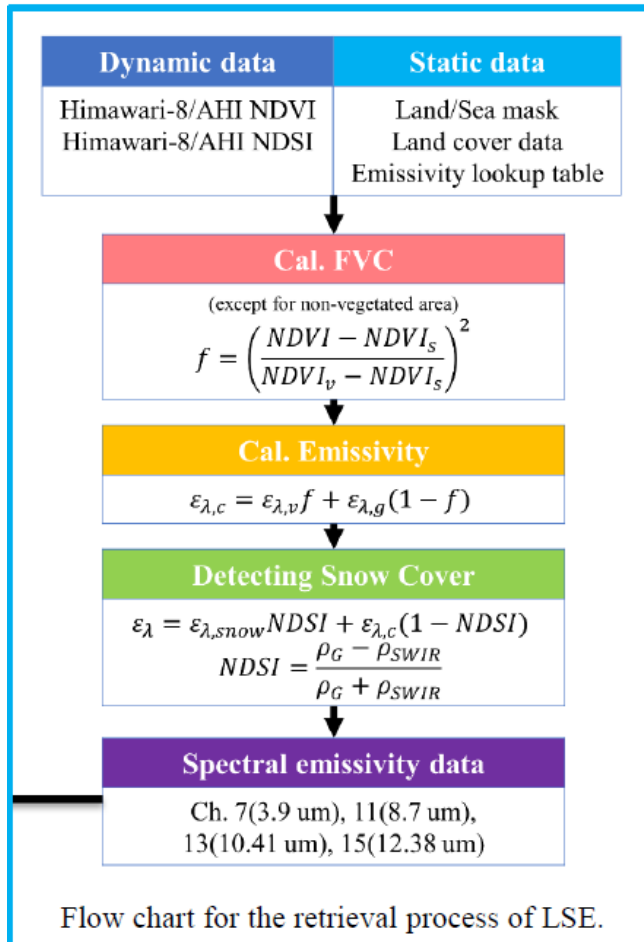
* FVBAR : Fixed Viewing BRDF Adjusted Reflectance



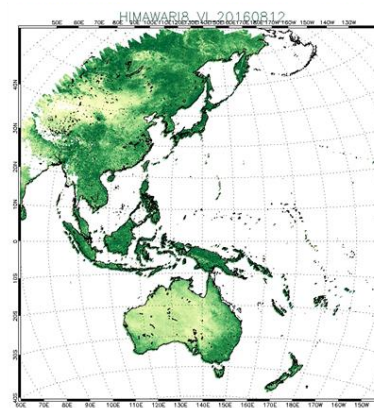
P7. Estimation of Land Surface Albedo from Himawari-8/AHI data

05 Major Features of the GK-2A surface products

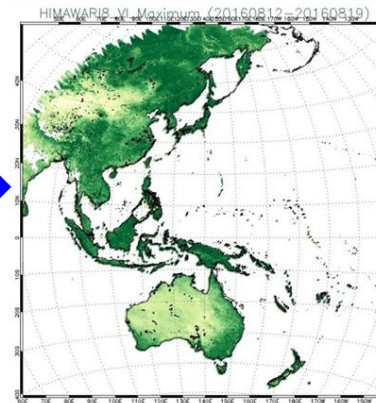
- Land surface emissivity



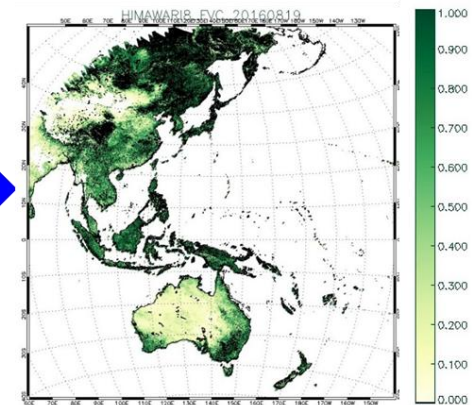
Himawari-8 VI(20160812~19)



Maximum Value of NDVI

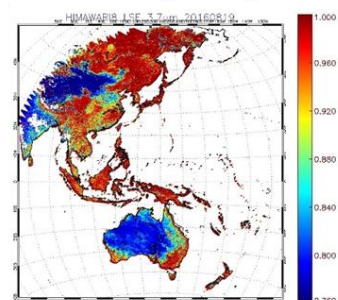


Calculate FVC

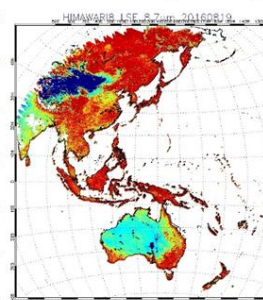


Consider Snow cover & calculate LSE using LUT

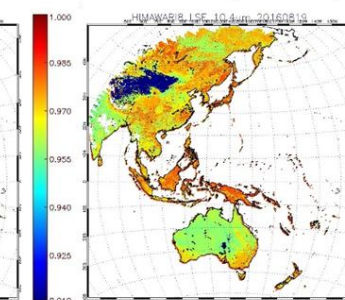
Ch. 7 (3.7 um)



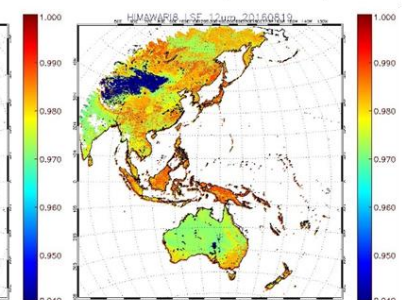
Ch. 11 (8.7 um)



Ch. 13 (10.4 um)



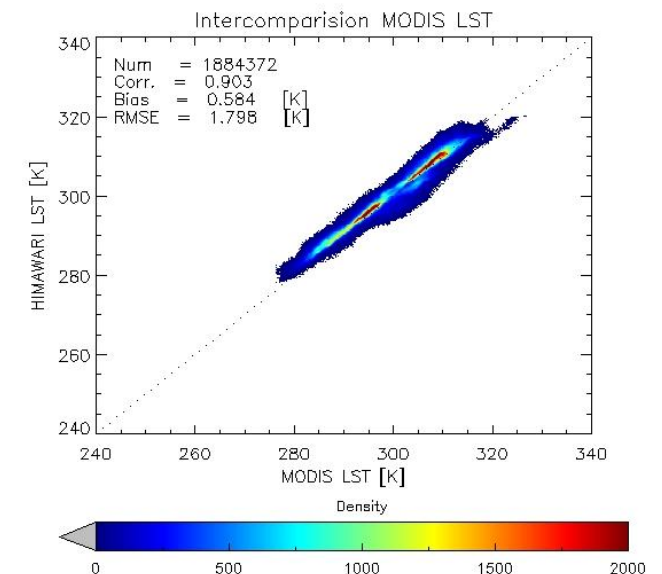
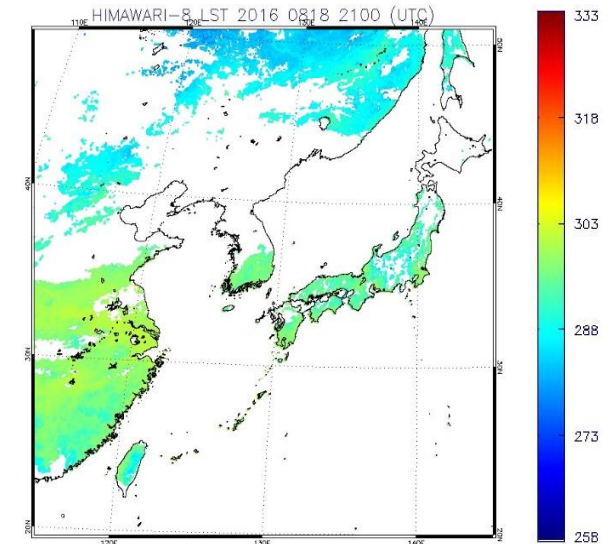
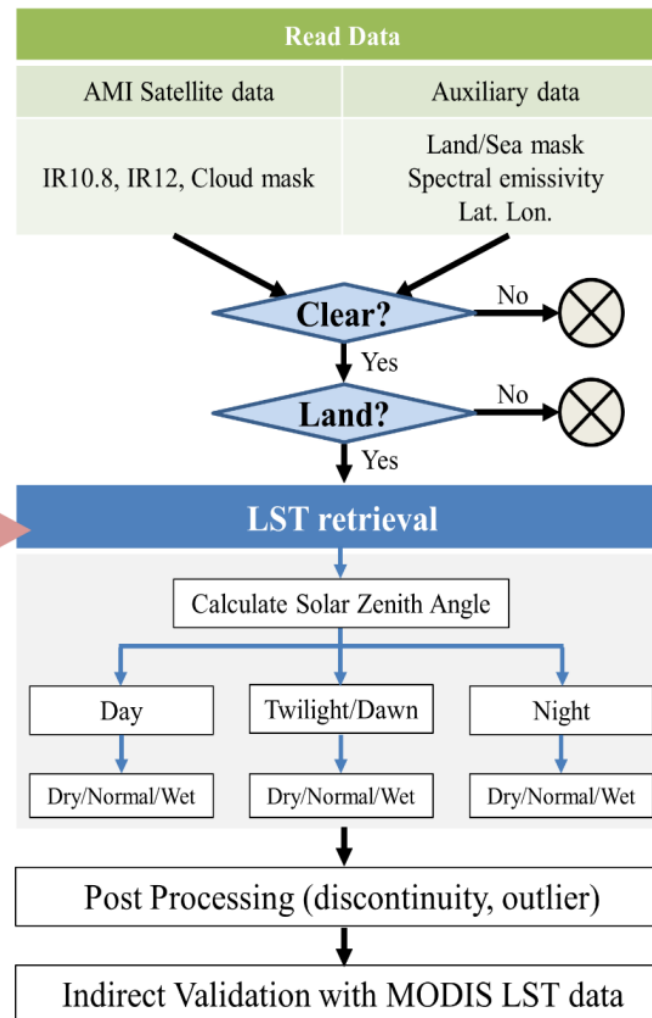
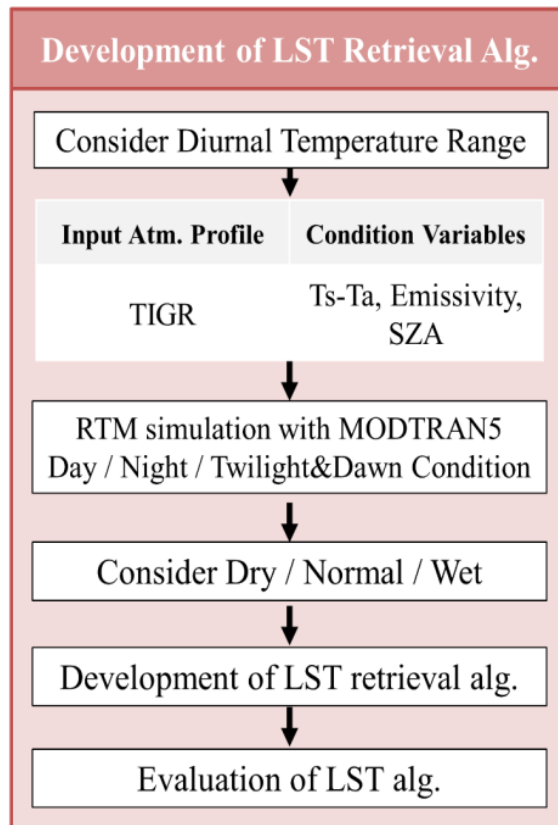
Ch. 15 (12.3 um)



06 Major Features of the GK-2A surface products

- Land surface temperature

$$LST = c + a_1 T_{IR1} + a_2 \Delta T + a_3 \Delta T^2 + a_4 (\sec \theta - 1) + a_5 (1 - \varepsilon) + a_6 \Delta \varepsilon$$

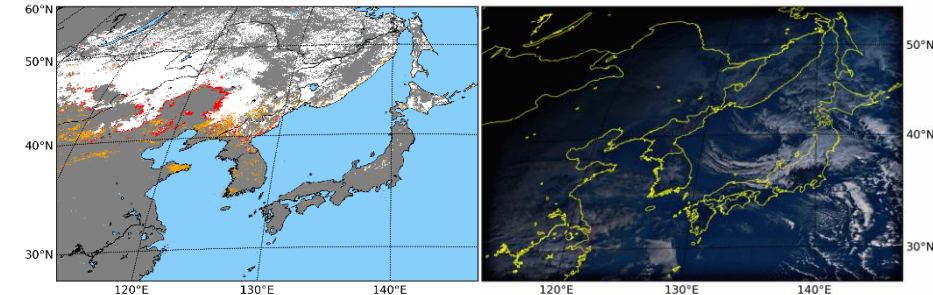


07 Major Features of the GK-2A surface products

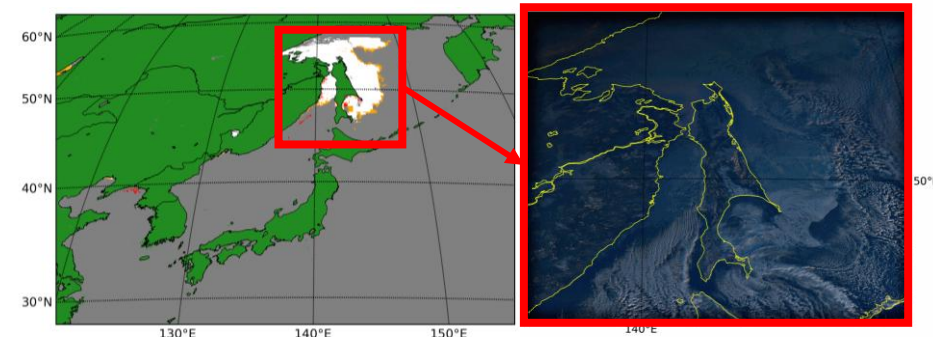
- Snow / Sea Ice

Validation vs. NOAA GMASI product

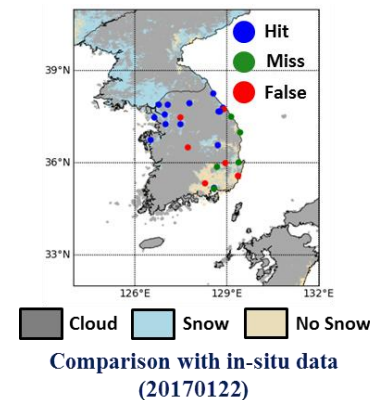
20170104 (POD : 94.82, FAR : 10.76)



20170105 (FAR : 13.45)

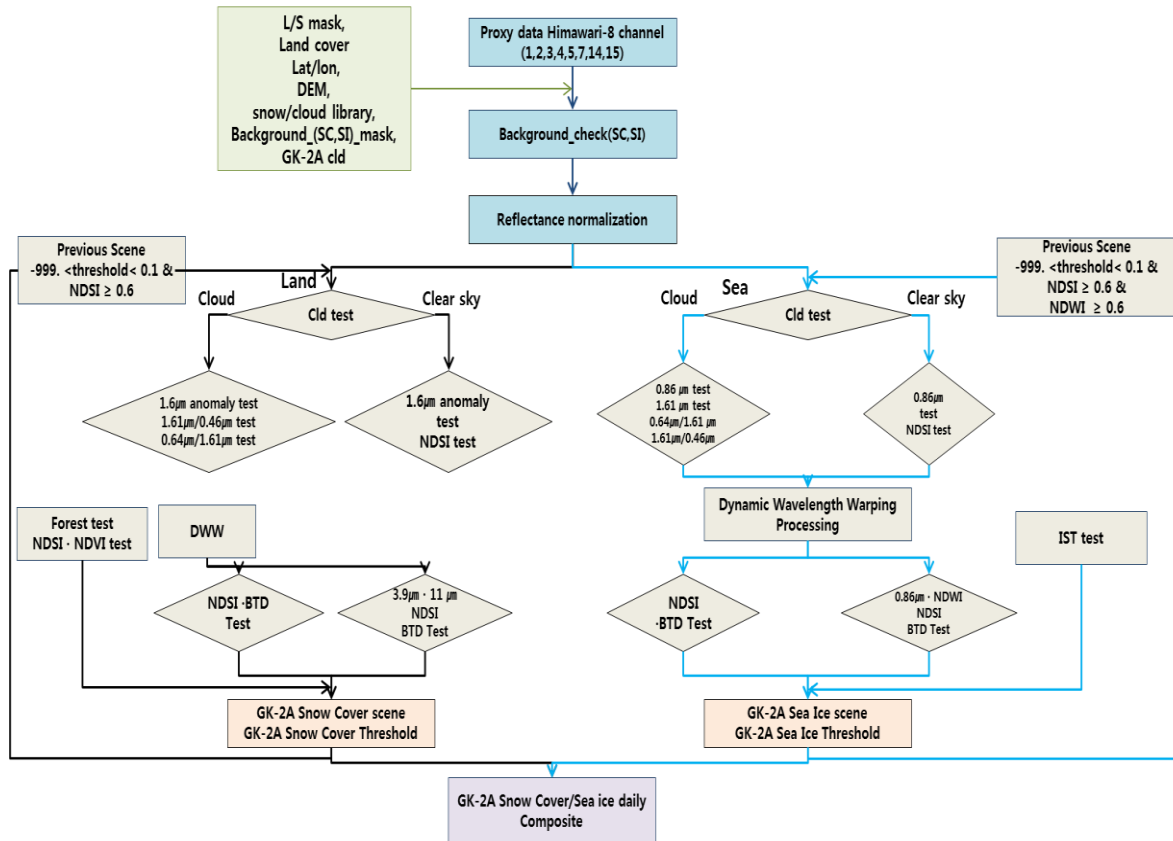


■ No data ■ Land ■ Hit ■ False ■ Miss



KMA surface snow obs. data
- 130 points, 21-24 Jan. 2017

➔ POD : 94.11%, FAR : 57.89%



P5. The Snow/Sea-Ice detection based on Dynamic Wavelength Warping method using Himawari-8/AHI data

08 Major Features of the GK-2A surface products

- Soil Moisture

● TVDI: Temperature-Vegetation Dryness Index

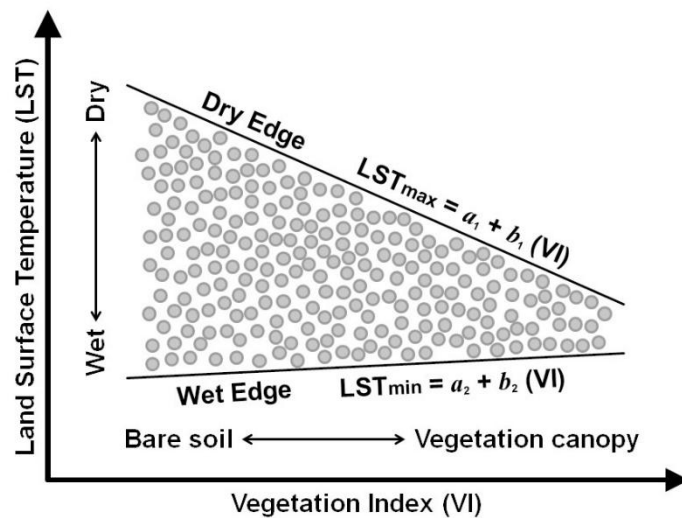
→ Relationship between TVDI and SM

TVDI meaning: 0 (saturated soil) ~ 1 (dry soil)

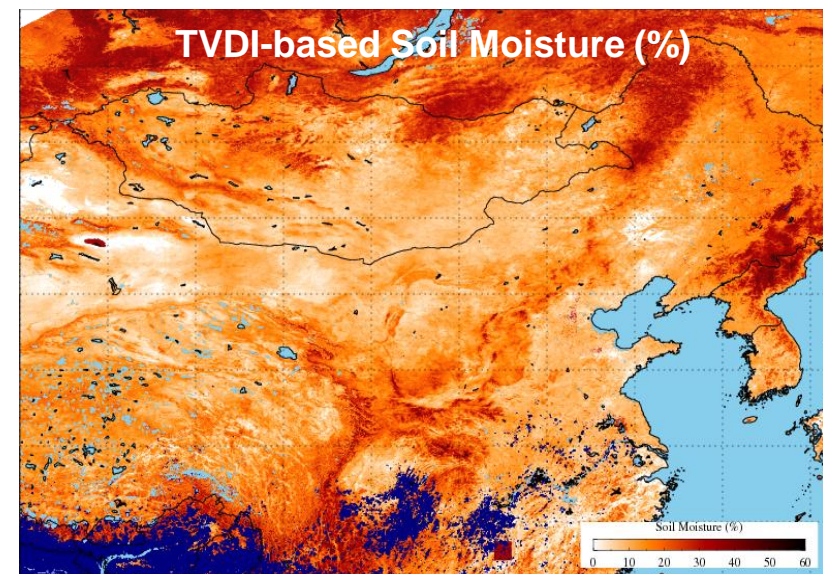
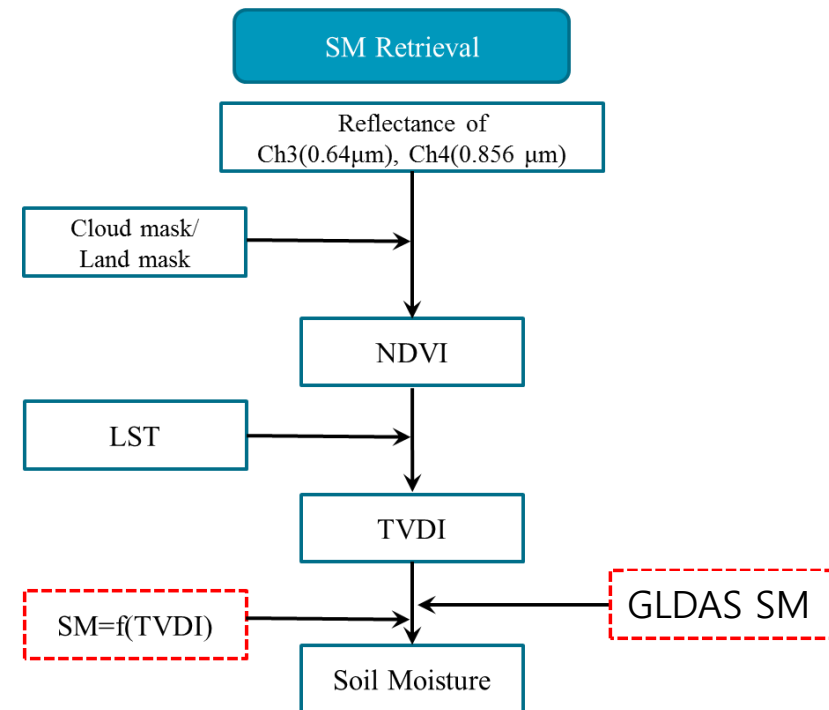
$$TVDI = \frac{(LST - LST_{day_min})}{(LST_{day_max} - LST_{day_min})}$$

$$LST_{max} = a_1 + b_1 (NDVI)$$

$$LST_{min} = a_2 + b_2 (NDVI)$$



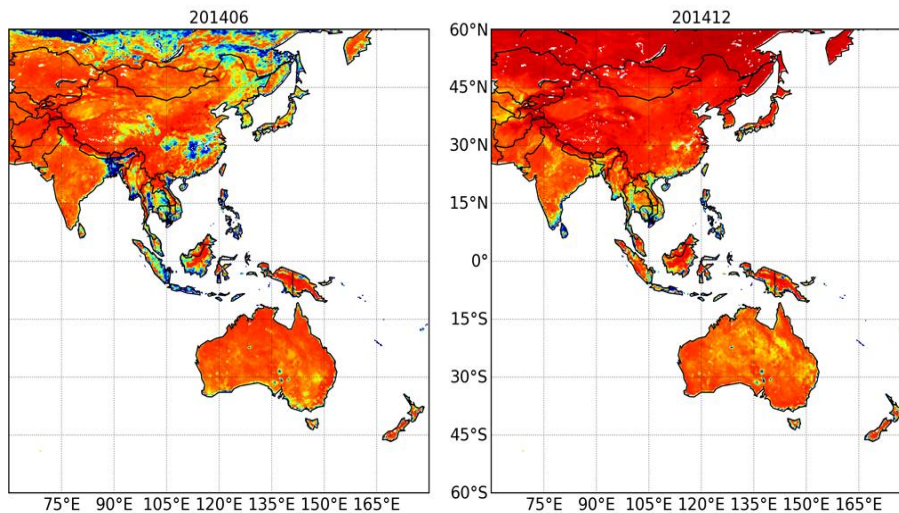
$LST = a + b NDVI$
(an empirical formula: a, b is determined from observation data)



09 Major Features of the GK-2A surface products

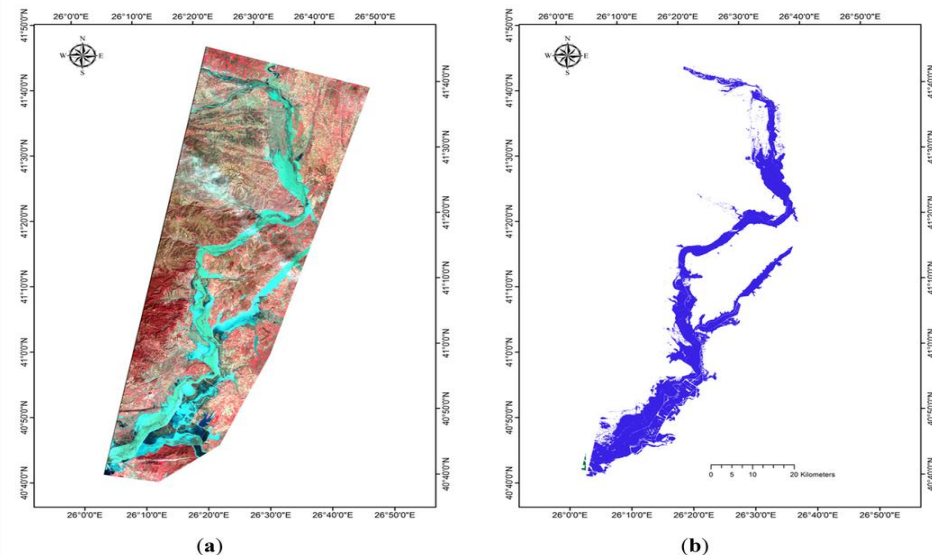
- Drought / Flood

- Drought : 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 VCI and TCI (Temperature Condition Index)



Support Comprehensive Drought information systems of KMA

- Flooding
- 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

IV Summary

01 ▶ Summary and Future Plan

- AMI/GK-2A is under integration phase and will be launched on November, 2018.
- 52 geophysical product algorithm prototypes are prepared and under validation using Himawari-8 data.
- Additional “user-friendly application technique” is being developed.
- Science algorithms and application techniques will be implemented onto ground segment.
- After the launch and IOT, the products are expected to be available from 2020.

Related Posters ▶

- P5. The Snow/Sea-Ice detection based on Dynamic Wavelength Warping method using Himawari-8/AHI data**
- P6. Evaluation of Drought Impact under different agricultural managements in South and North Korea using satellite remote sensing**
- P7. Estimation of Land Surface Albedo from Himawari-8/AHI data**
- P8. Development of Sea Surface Temperature retrieval algorithm for Geo-KOMPSAT-2A/Advanced Meteorological Imager**
- P9. Development of Sea Surface Currents retrieval algorithm for Geo-KOMPSAT-2A/Advanced Meteorological Imager**
- P10. Four potential observations of Ocean Environment Changes using GK-2A**
- P20. development of GK-2A land surface temperature retrieval algorithm using Himawari-8/AHI**

Thank you very much for your attention!

