

Geostationary Environmental Monitoring Spectrometer (GEMS)

Overview and Current status

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Environmental Satellite Center (ESC)

NIER, Republic of KOREA

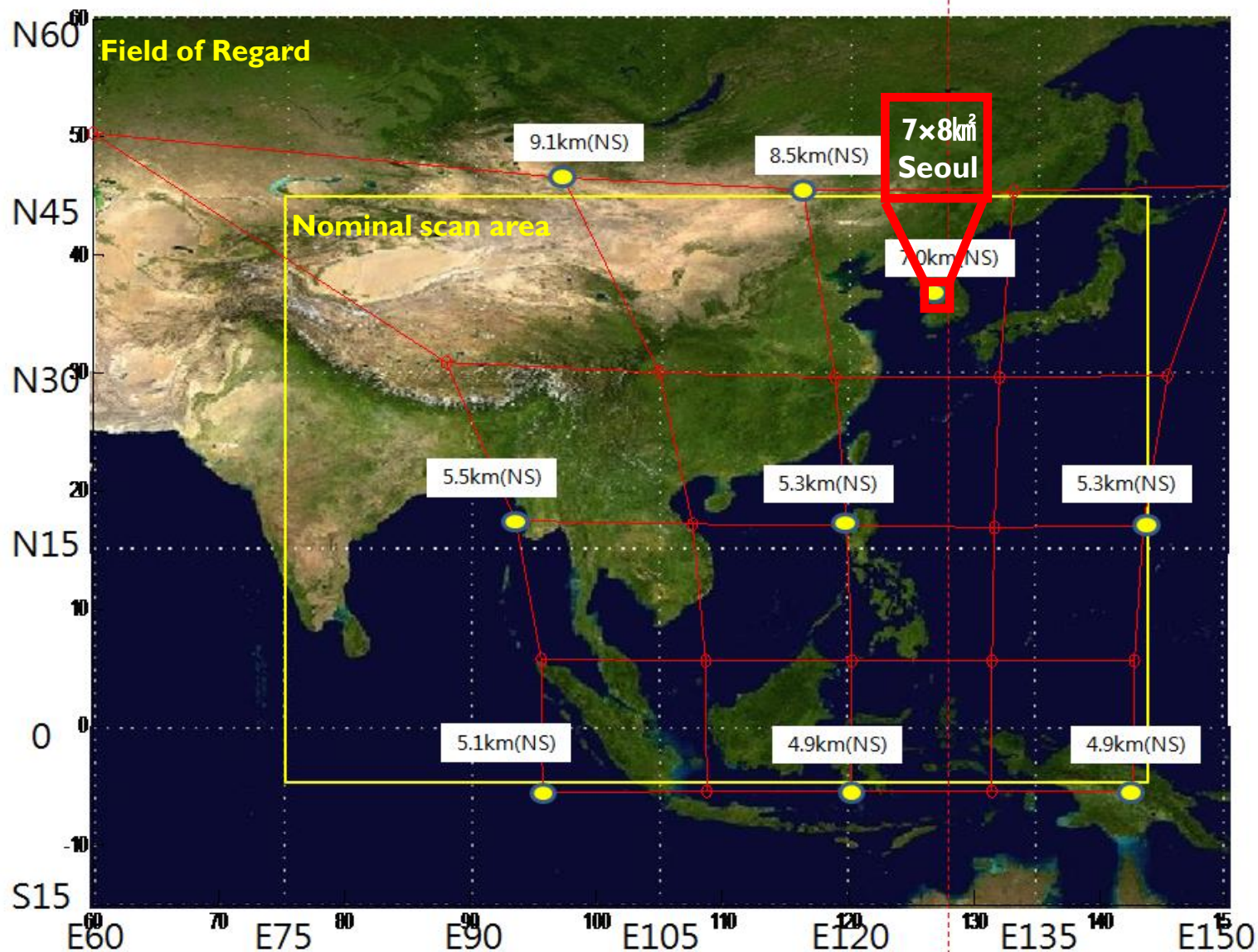
Successful GK-2B Satellite launch!

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GEMS Overview

Target center : 120E, 17N

S/L: 128.2E



Monitoring Items

O₃, SO₂, NO₂, HCHO, CHOCHO, and aerosol, etc.

Mission Duration

10 Years

Spectrum/ Spectral Resolution

300 – 500 nm / 0.6 nm

Spatial Resolution

7 km (3.5) × 8 km @Seoul

Observation cycle

8 times / day

Spatial Coverage

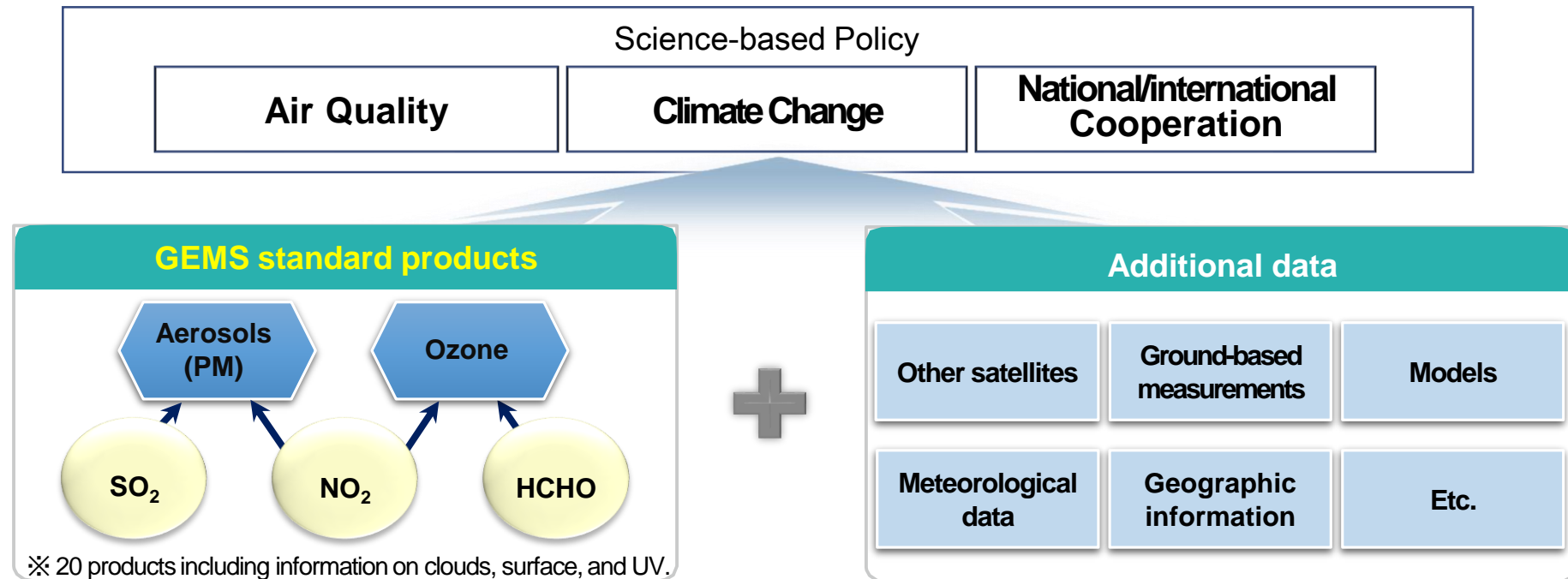
5,000 km × 5,000 km
(5 °S – 45 °N, 75 °E – 145 °E)

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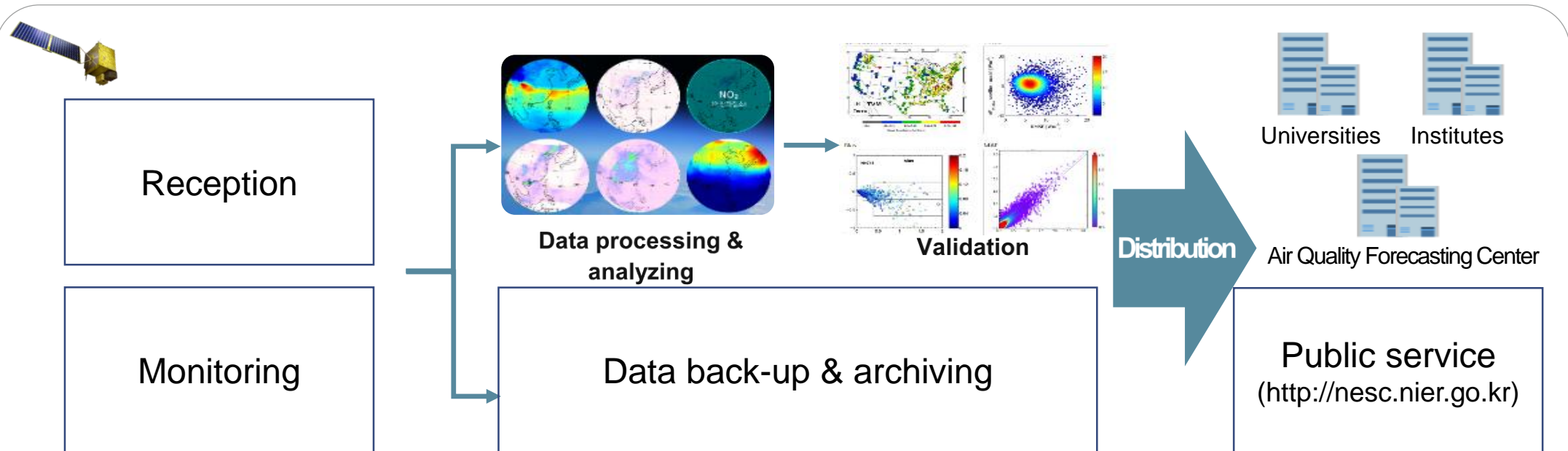
GEMS Overview

GEMS Mission

- To provide observations of tropospheric composition over Asia at high spatial and temporal resolution
 - ☞ To contribute to the establishment and implementation of a science-based policy on air quality



Roles of GEMS Ground Station



A non-stop 24/7 operating ground station

Archiving of all data received and produced in main storage

Real-time data acquisition and near-real-time data distribution

Construction of a back-up system for data reliability

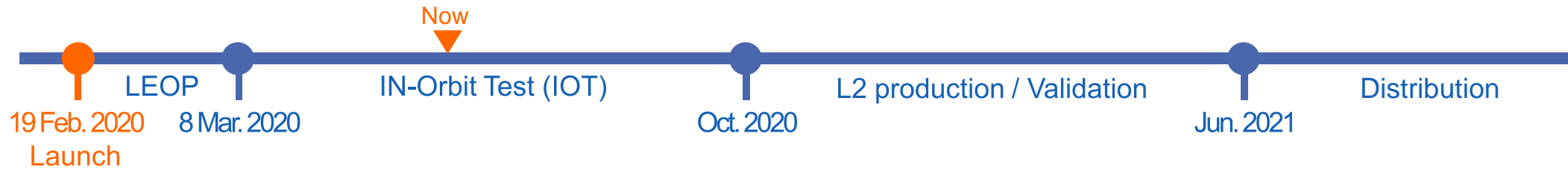
Operating for 10 years, which is the designed duration of GK2B

Achieving 99% or higher operational availability for high-speed processing and customized services

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Current Status

IOT schedule and work list



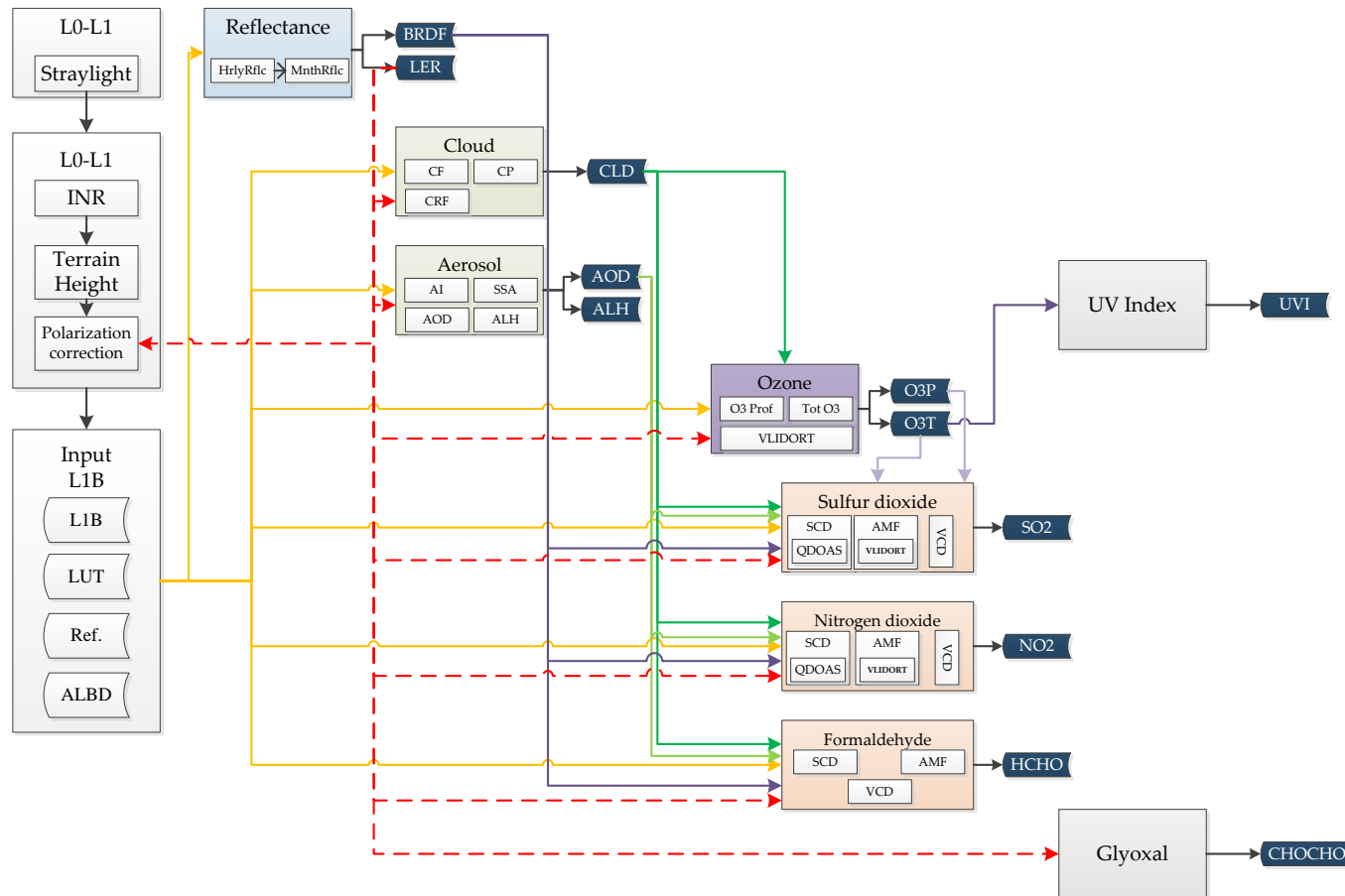
- DPS and INR parameter tuning
- Level 2 retrieval algorithm tuning, improvement, and validation
- Continuous test operation of ground station system
 - ✓ Testing 1st stage and 2nd stage L2 production
 - ✓ Concluding operation concept for L2 processing
- Definition of GEMS quality indicator
- Cross-calibration/validation

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Current Status

GEMS L2 Algorithm test

< GEMS Baseline Products >

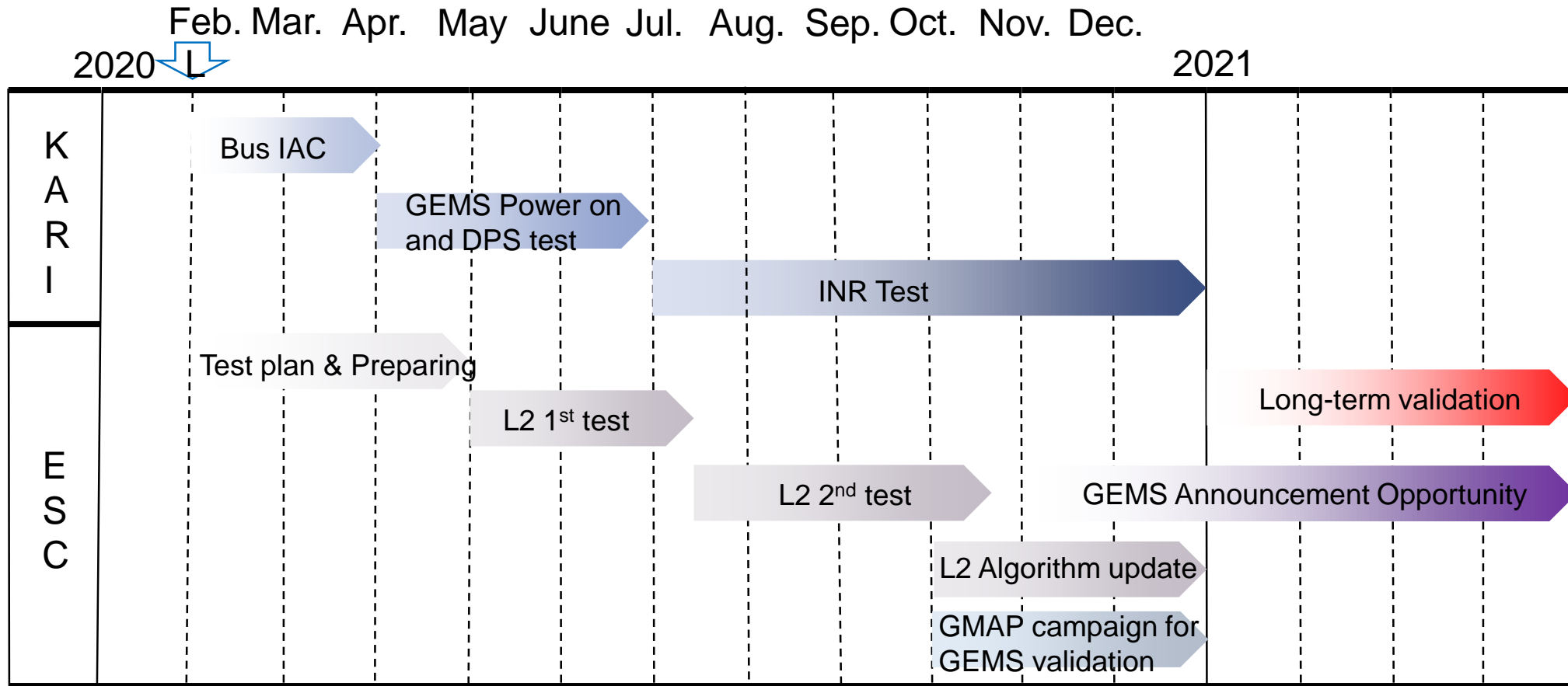


Product	Window (nm)	Spat. Resol. (km ²)@Seoul	Algorithm
NO ₂	425-450	7 x 8 x 2 pixels	DOAS
SO ₂	310-330	7 x 8 x 4 pixels	DOAS + PCA
HCHO	327-357	7 x 8 x 4 pixels	DOAS
CHOCHO	437-452	7 x 8 x 4 pixels	
StratO ₃ TotalO ₃	300-340	7 x 8	OE TOMS
AOD AI SSA AEH	300-500	3.5 x 8	Multi-λ O ₂ O ₂
[Clouds] ECF CCP	300-500	7 x 8	O ₂ O ₂ RRS
Surface Property	300-500	3.5 x 8	Multi-λ
UVI		7 x 8	Multi-λ

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Current Status

GEMS L2 Algorithm test plan during IOT



KARI: Korea aerospace research institute
 ESC: Environmental satellite center
 IAC: Initial activation and check out
 DPS: Data pre-processing sub-system
 INR: Image navigation and registration

L2 1st test: L1B SRF(spectral response function)
 NO₂, Ozone, AOD, surface reflectance
 L2 2nd test: SO₂, HCHO, ozone profile, UVI, cloud

Announcement of Opportunity (AO)

This AO call is

to harness professional knowledge and expertise of experienced scientists to perform validation and accuracy assessment of data and products of GEMS through independent data analysis

1. Evaluation of Level 2 retrieval algorithms
2. Assessment of regional errors and their sources
3. Comparison with other space-borne instruments
4. Comparison with ground-based and/or airborne measurements
5. Comparison of diurnal variations of each atmospheric species between GEMS measurements and modeling results
6. Assessment of the impact of auxiliary data used in product retrieval
7. Analysis of major error sources and error budget
8. Assessment of heterogeneous geographic effects

Product	Importance	Window (nm)	Spatial resolution (km × km) at Seoul	Algorithm	Remark	
NO ₂	Trop	O ₃ /aerosol precursor	432-450	7×8	DOAS	RD-04
	Strat					
SO ₂	Aerosol precursor	310-326	7×8	DOAS-PCA	RD-05	
	volcano	310-340				
HCHO	VOC proxy	328.5-356.5	7×8	DF	RD-06	
CHOCHO		435-461	7×8	DF	RD-07	
O ₃	Trop	300-340	7×8	OE	RD-08	
	Strat	300-340		OE		
	Total	317.5, 331.2, 331.2, 340, 380		TOMS	RD-09	
Aerosol	AOD	Air quality, climate	354, 388, 412, 443, 477, 490	LUT, OE	RD-10	
	UVAI			LUT		
	SSA			LUT, OE		
	AEH			O ₂ -O ₂	RD-11	
Cloud	ECF	300-500	7×8	O ₂ -O ₂	RD-12	
	CCP	477				
	CRF					
Surface reflectivity	Retrieval, environment	300-500	3.5×8	Multi-channel, BRDF	RD-13	
UVI	UVI	Public health	354	7×8	LUT	RD-14
	VitaD					
	DNA					
	Plant					

GEMS cal/val activities timeline

Table 2 illustrates an overview of the timelines of GEMS cal/val activities.

Step	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
GEMS Mission life	→												
Commissioning phase	→												
Exploitation phase			→										
Archive											→		
On-orbit VAL	→												
Reprocessing						→							
Validation (post mortem)											→		
Remark	1 st project		2 nd project		3 rd project		4 th project		5 th project		6 th project		

GEMS AO information can be obtained from <https://nesc.nier.go.kr>

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Activities for GEMS validation

GMAP & SIJAQ

* SIJAQ: Satellite Integrated Joint monitoring of Air Quality

* GMAP: GEMS Map of Air Pollution

Pre-GMAP

~~Apr. – May 2020~~

(delayed due to COVID-19)

1st GMAP

19 Oct. – 27 Nov. 2020
(depending on COVID-19)

2nd GMAP

Oct. – Dec. 2021

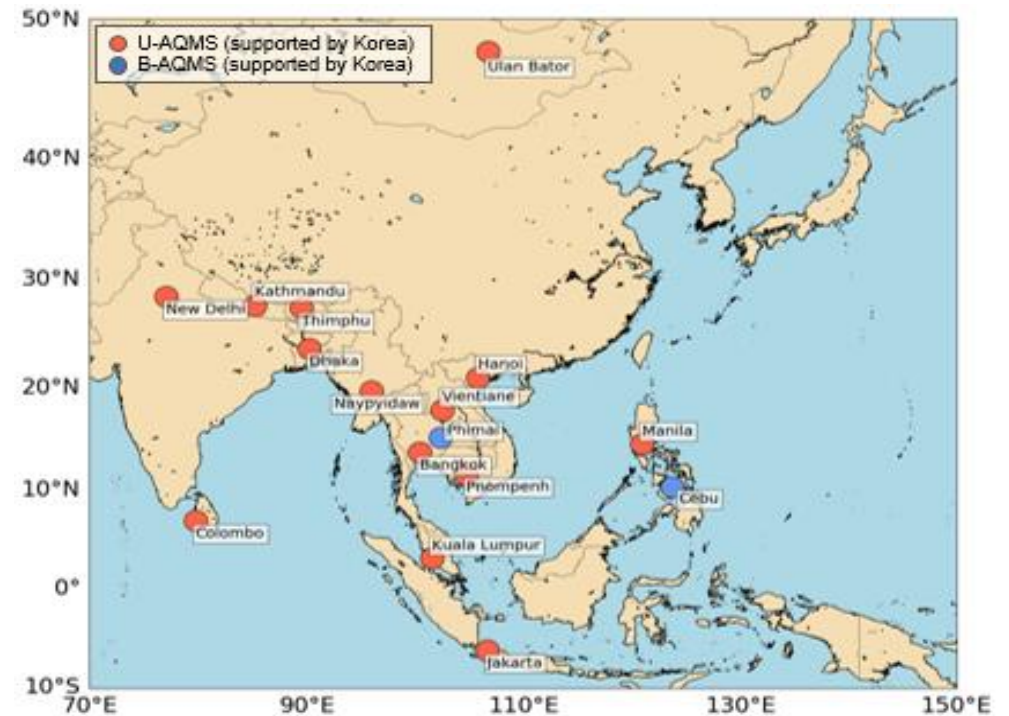
SIJAQ

Oct. 2022 – Jun. 2023

Main campaign

PAN

* Pandora Asia Network

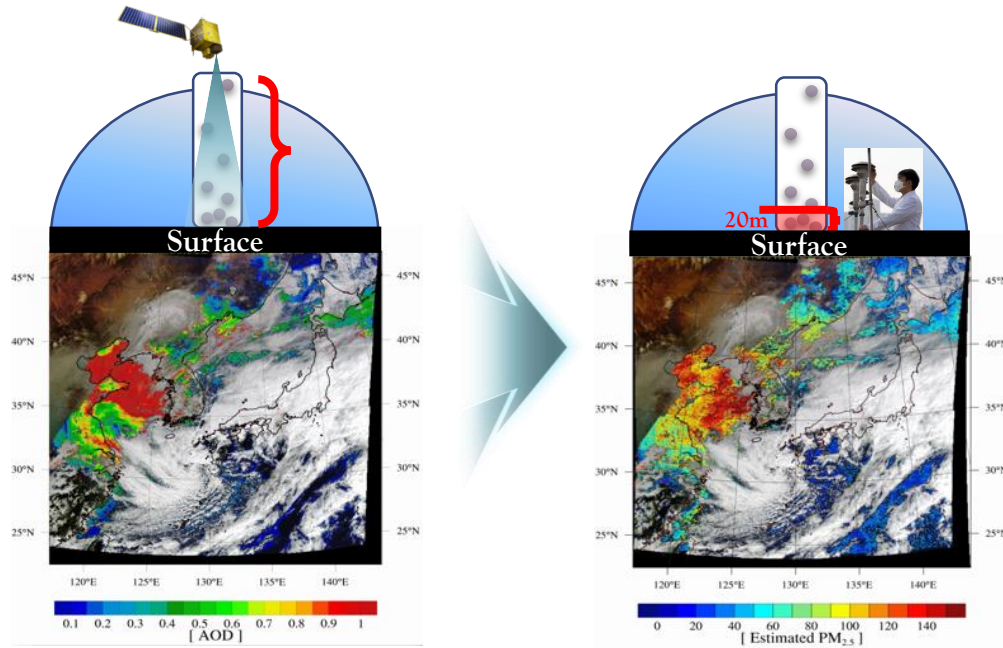


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Current Status

GEMS data application plan

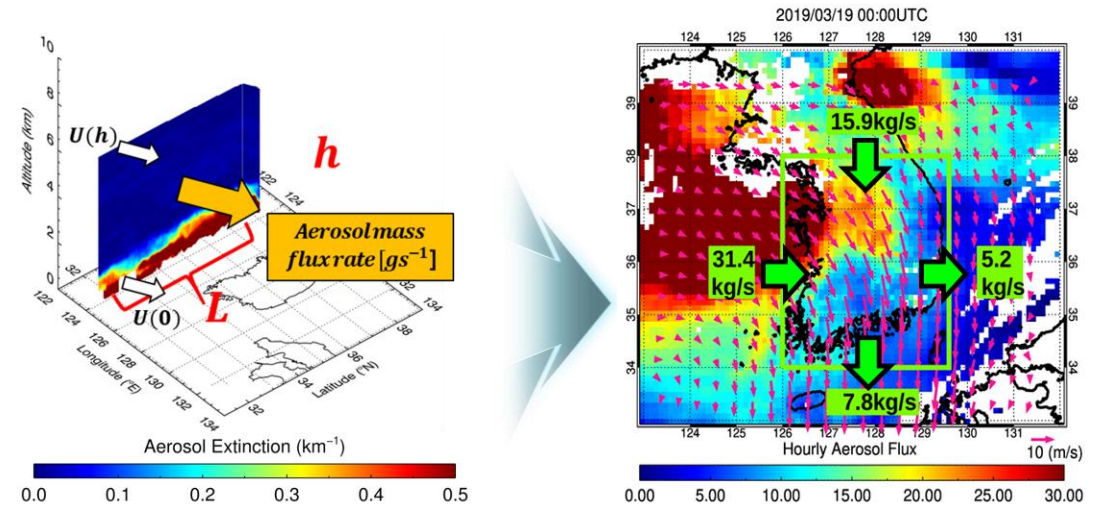
✓ Estimation of ground-level PM concentrations



✓ Data fusion of satellites

✓ Trend and ozone sensitivity analysis

✓ Monitoring of long-range transported air pollutants



✓ Estimation of top-down emissions

✓ Relationship between air pollution and climate change

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Announcements by NIER

- The 11th GEMS workshop is scheduled to be held from 12 to 14 October 2020.
- The 1st GMAP will start on 19 October (to 27 November).

(Depending on COVID 19)

Thank you for your attention !

<http://nesc.nier.go.kr>