

New Era of Air Quality Monitoring from Space

Geostationary Environment Monitoring Spectrometer (GEMS)

Level-2 Status – Presenting author: Heesung Chong (Yonsei Univ.)



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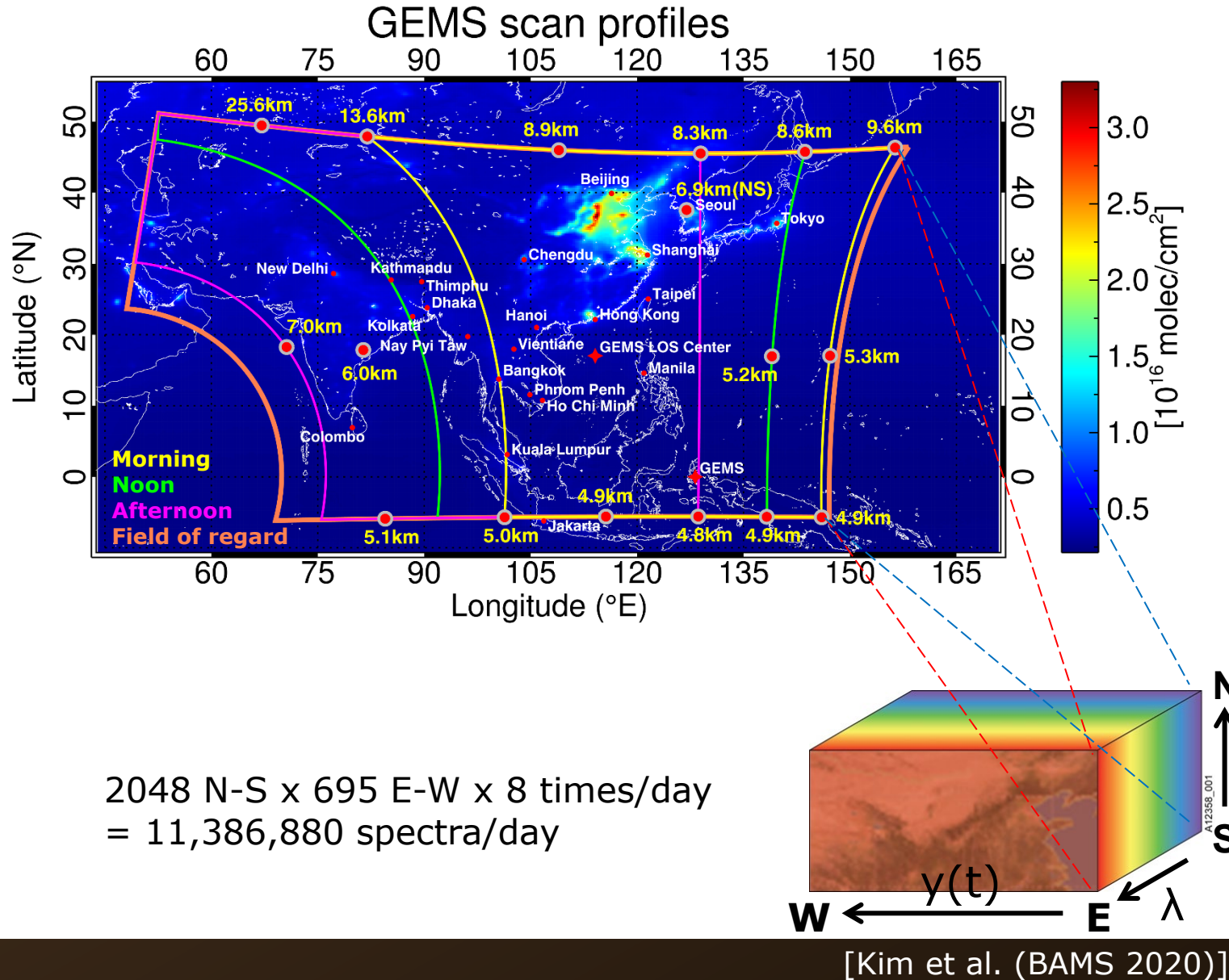


GK-2B launch: 2020.02.19 (Korea Standard Time)

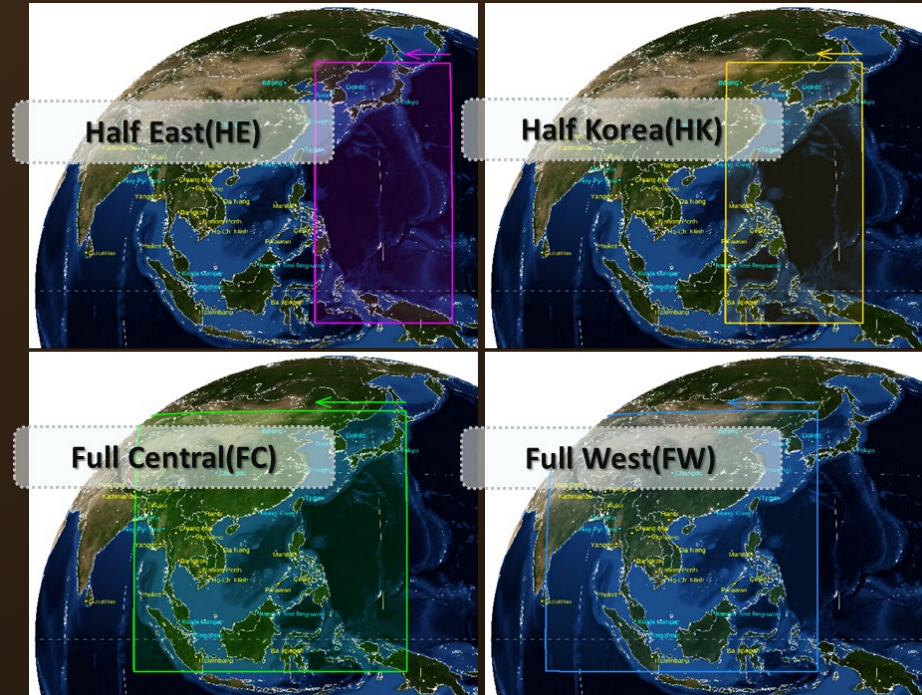
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GEMS E-W scan scenario



Updated scan profiles



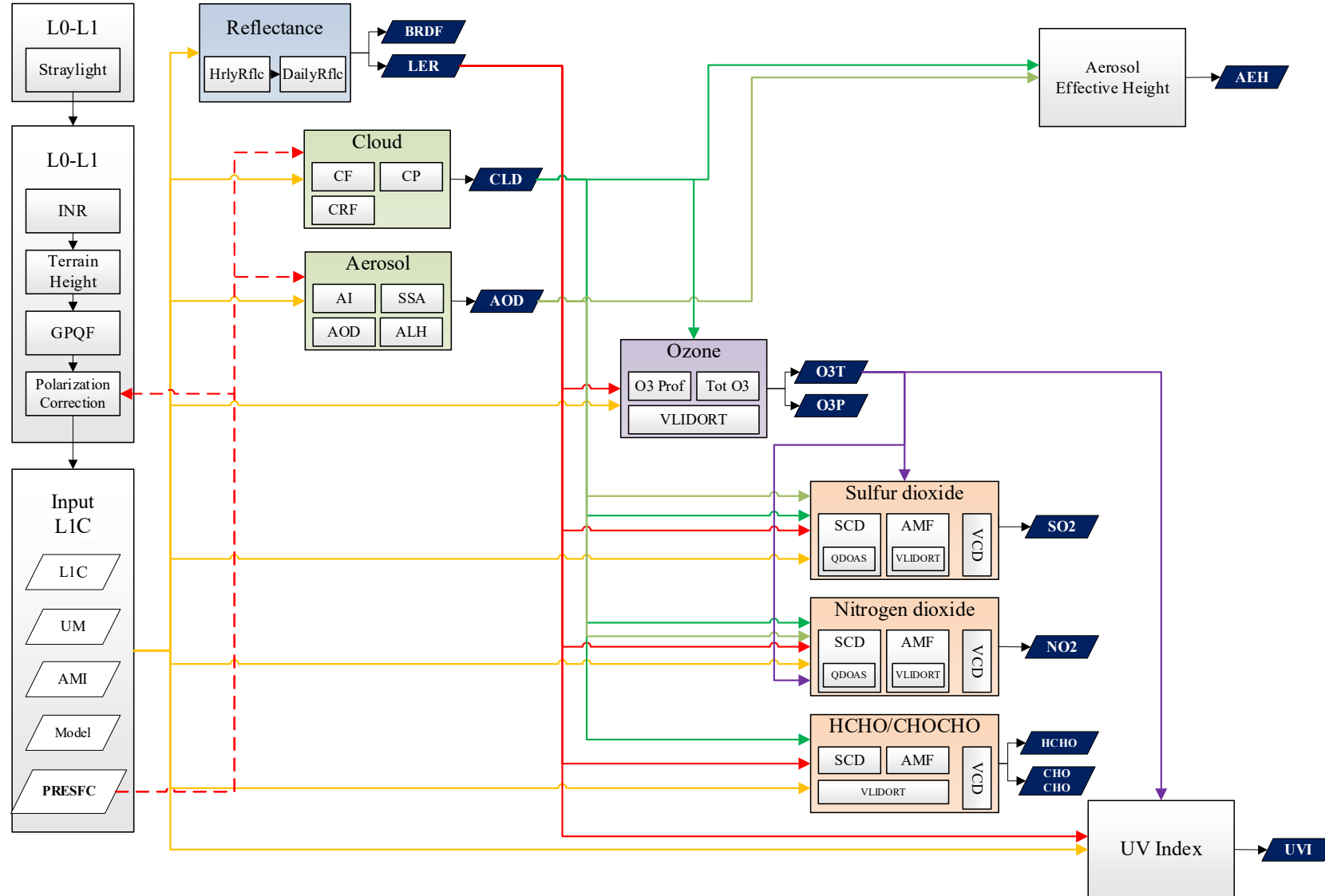
[Courtesy of NIER]

GEMS baseline products

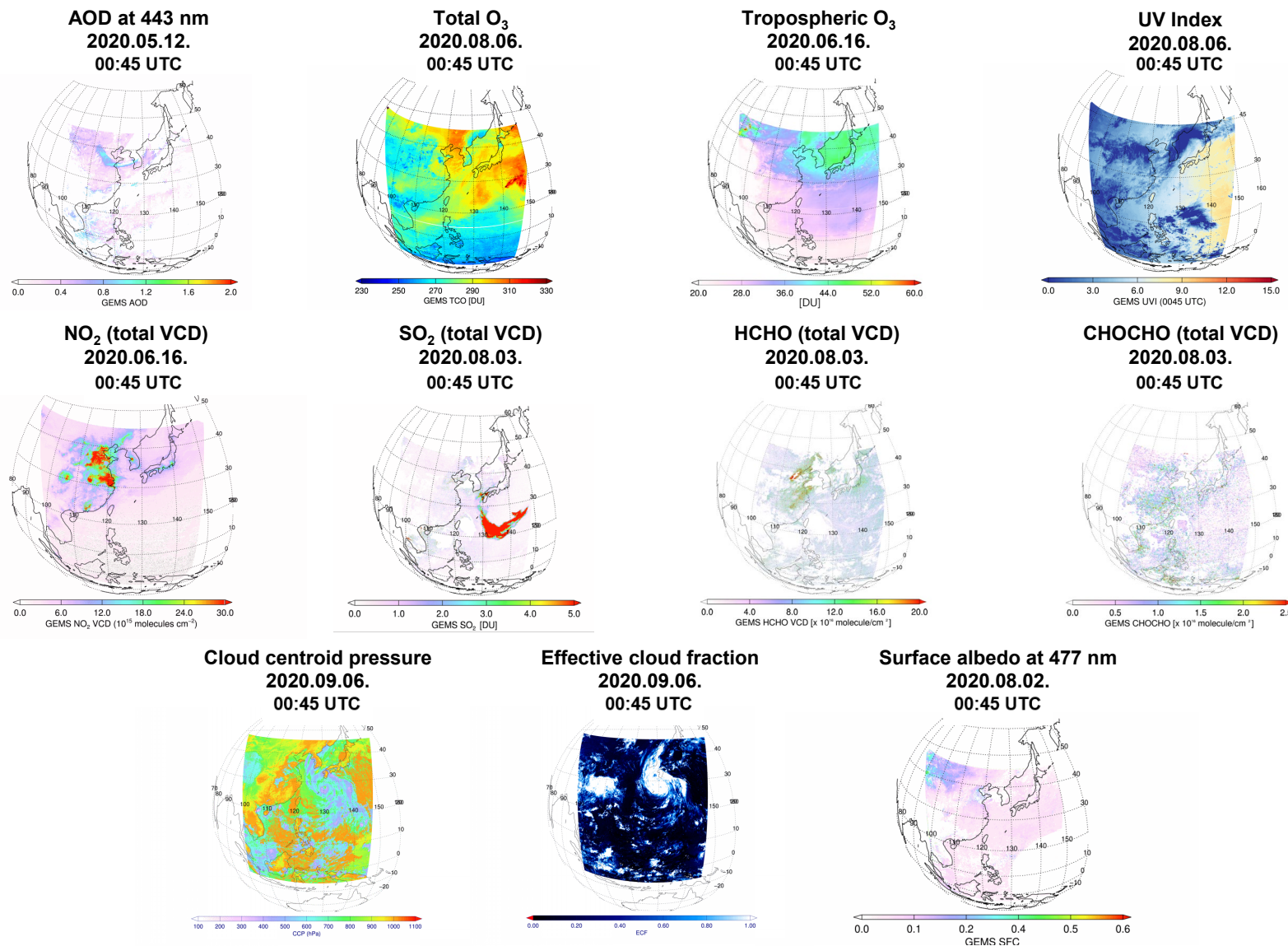


No.	Product	Importance	Min	Max	Nominal	Accuracy	Wavelengths (nm)	Spat. Resol. (km ²) @ Seoul	SZA (deg)	Algorithm
3	Trop. O₃ Strat. O₃ Total O₃	Oxidant Pollutant O ₃ layer	20 DU 180 DU 200 DU	50 DU 450 DU 500 DU	30 DU 270 DU 3000 DU	20% 5% 3%	300-340 317.5, 331.2, 340, 380	7 x 8	<70	OE TOMS
4	AOD AI SSA AEH	Air quality Climate Public health	0 -7 0.82 0 km	3.6 7 0.99 6 km	0.54 0.35 0.90 1.19 km	20% or 0.1@ 400nm (for AOD)	354, 388, 412, 443, 477, 490	3.5 x 8	<70	LUT, OE LUT LUT, OE O ₂ -O ₂
1	HCHO	VOC proxy	8x10 ⁴ cm ⁻²	6.2x10 ¹⁶ cm ⁻²	5x10 ¹⁵ cm ⁻²	1x10 ¹⁶ cm ⁻²	328.5-356.5	7 x 8 x 4 pixels	<50	DF
1	CHOCHO		1x10 ¹⁴ cm ⁻²	1x10 ¹⁵ cm ⁻²	5x10 ¹⁴ cm ⁻²	1x10 ¹⁵ cm ⁻²	435-461	7 x 8 x 4 pixels	<50	DF
2	Trop. NO₂ Strat. NO₂	O ₃ & aerosol precursor	1x10 ¹³ cm ⁻²	4x10 ¹⁷ cm ⁻²	1x10 ¹⁴ cm ⁻²	1x10 ¹⁵ cm ⁻²	432-450	7 x 8 x 2 pixels	<70	DOAS
1	SO₂	Aerosol precursor Volcano	8x10 ¹⁵ cm ⁻² 0 DU	4x10 ¹⁷ cm ⁻² 100 DU	1x10 ¹⁴ cm ⁻² -	1x10 ¹⁶ cm ⁻² -	310-326 310-340	7 x 8 x 4 pixels x 3 hours	<50	Hybrid (DOAS- PCA)
4	UVI Vita. D UVI DNA UVI Plant UVI	Public health	0	15	-	-	354	7 x 8	<70	LUT
1	Surface prop. (LER, BRDF)	Retrieval environment	0	1	-	-	300-500	3.5 x 8	<70	Multi-λ, Min reflectivity
3	ECF CCP CRF	Retrieval Climate	0 100 hPa 0	1 1013 hPa 1	- - -	5% 5% -	300-500 477 -	7 x 8	<70	O ₂ -O ₂

GEMS algorithm flow chart



GEMS baseline products

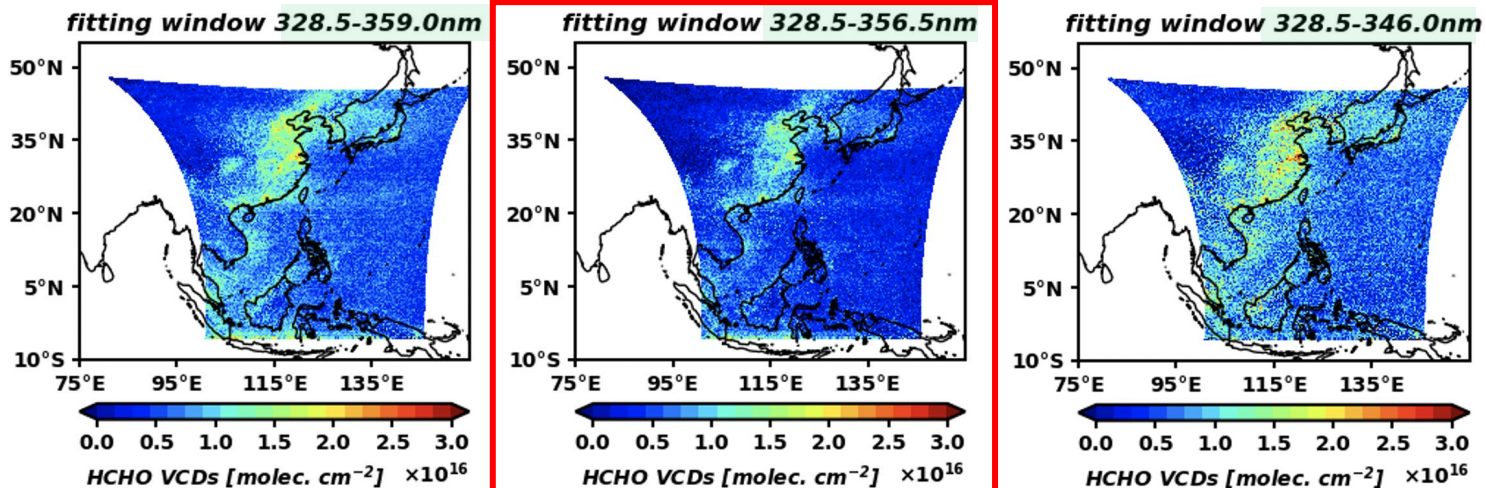


Algorithm tests during IOT

<Adjusting spectral fit setting>

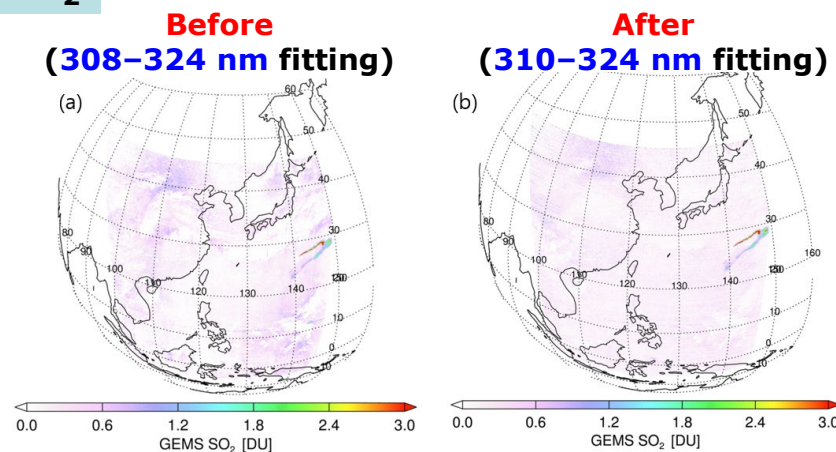
HCHO

2020.08.01 ~ 2020.08.31 12:45 KST
Scan type = Nominal **selected**



- ✓ The suitability of fitting windows was examined considering noise, bias, and capability of source detection.

SO₂

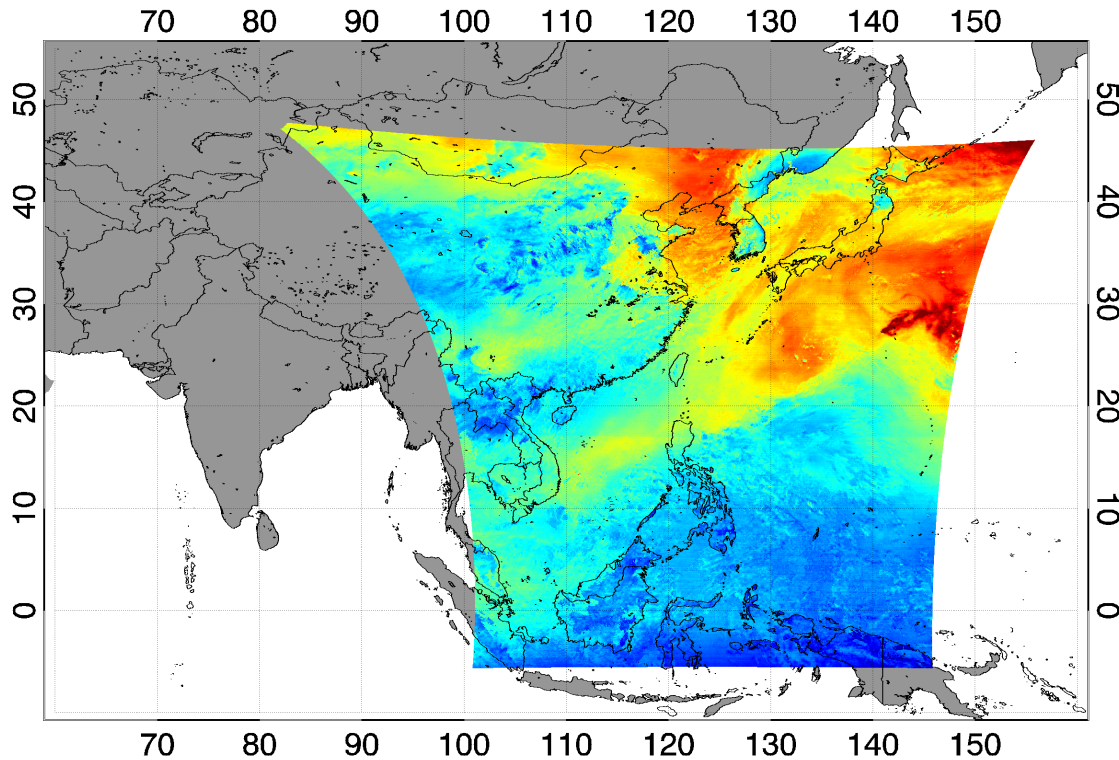


- ✓ Changed fitting window: 308-324 nm → 310-324 nm
- ✓ The number of principal components (PCs) are adjusted.
- ✓ Modified clean sector selection method

Early results: O₃

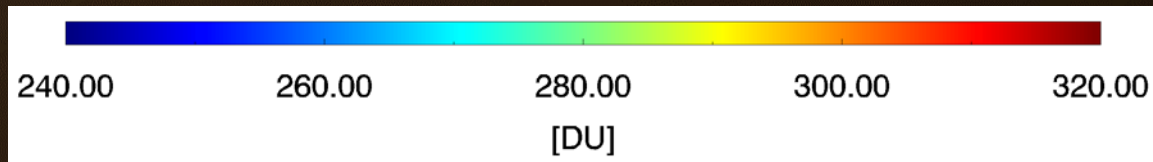
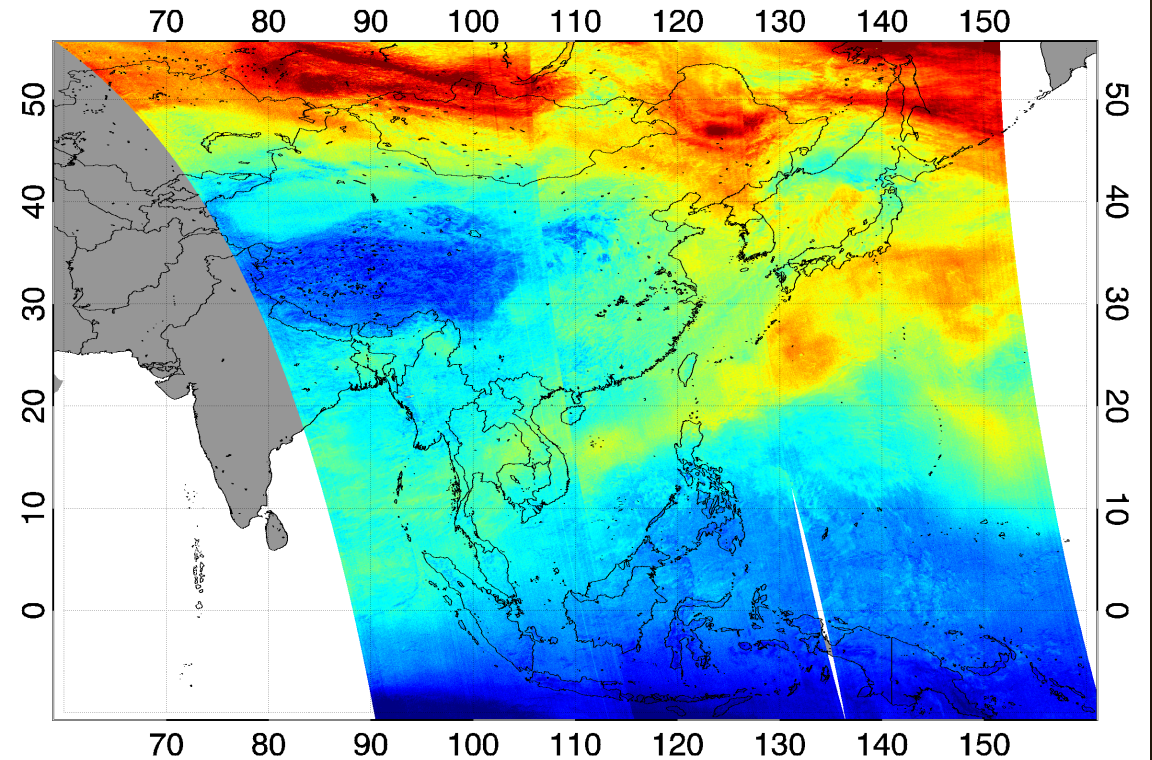
GEMS

O₃ total VCD
2020/08/06 00:45 UTC



TROPOMI

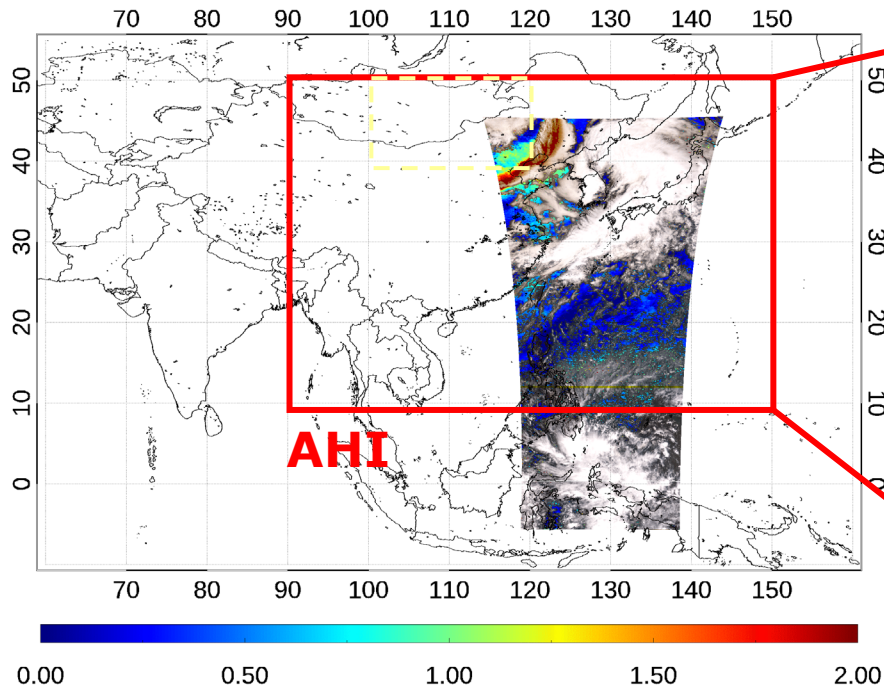
O₃ total VCD
2020/08/06



Early results: Aerosols

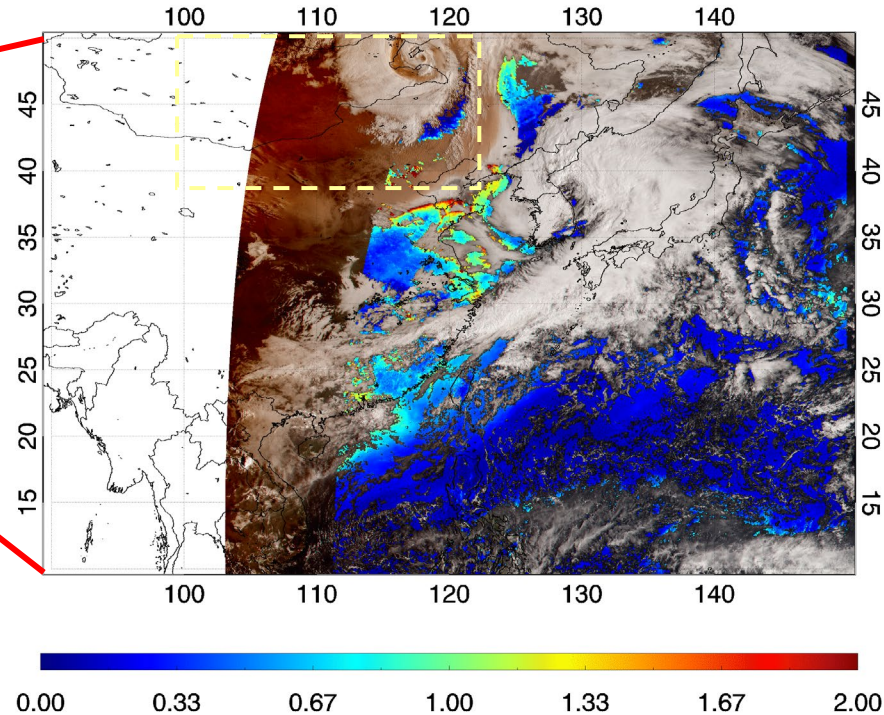
GEMS AOD at 443 nm

AOD at 443 nm
2021/03/28 00:45 UTC



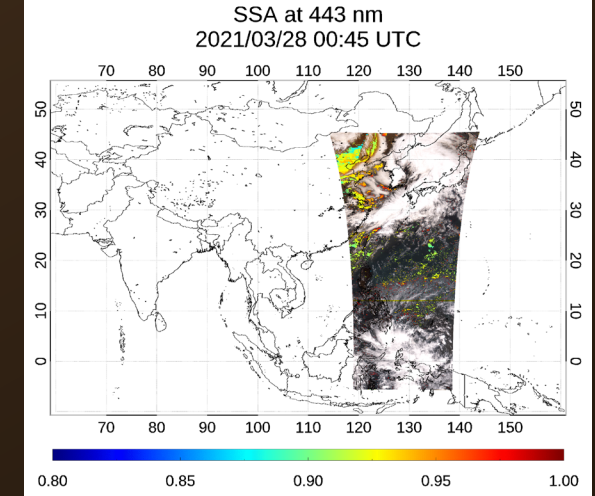
AHI AOD at 550 nm

AHI YAER-AOD_RGB - 202103280000

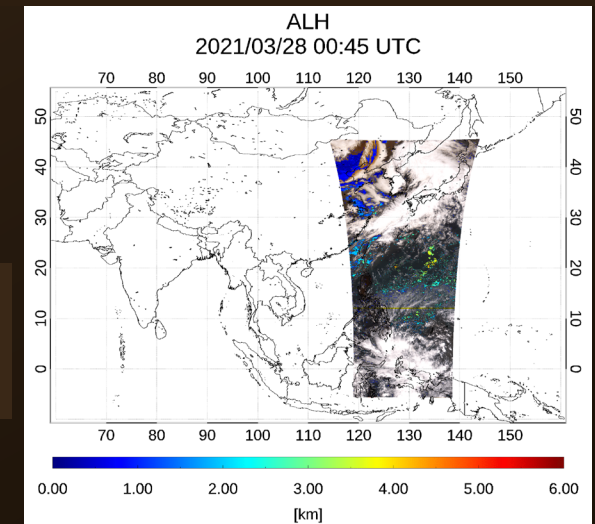


(AOD>0.4)

GEMS SSA at 443 nm



GEMS ALH



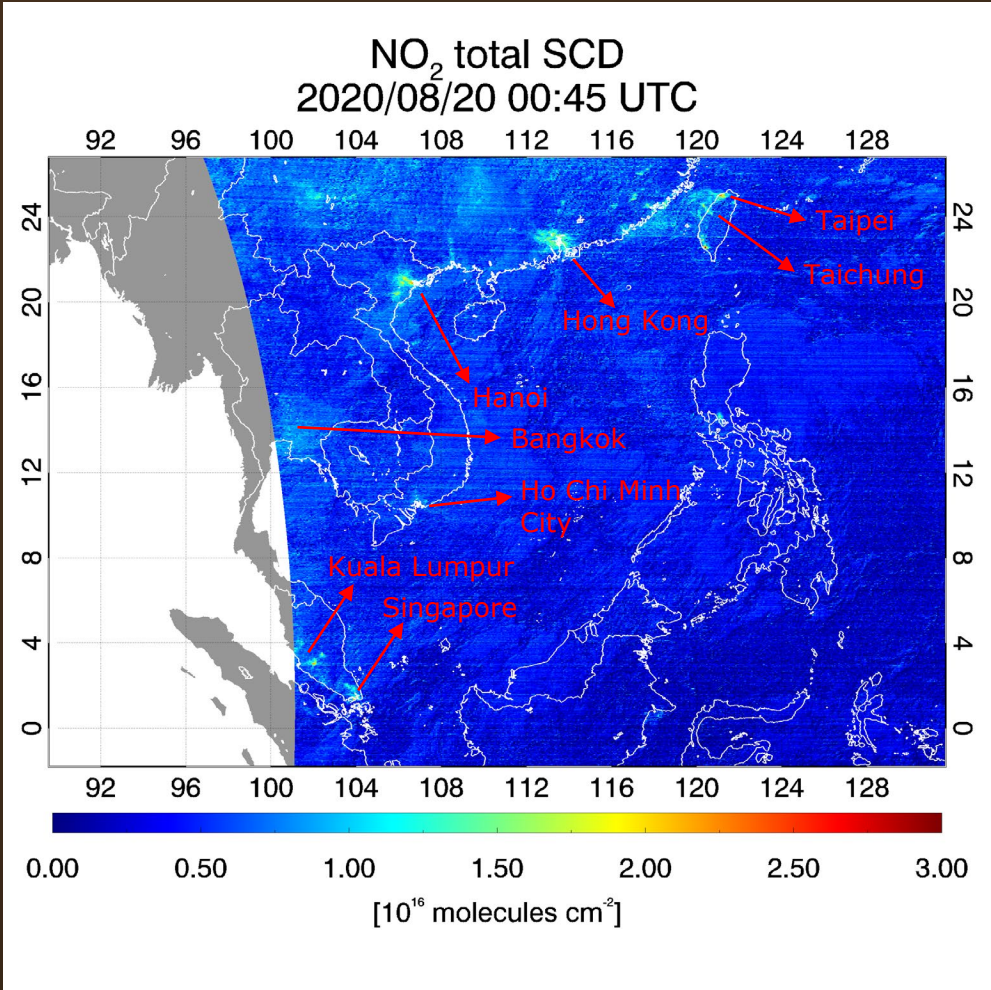
- ✓ Consistent features
- ✓ Retrieval over bright surface

Lim et al. (RS 2018, AMT 2021)

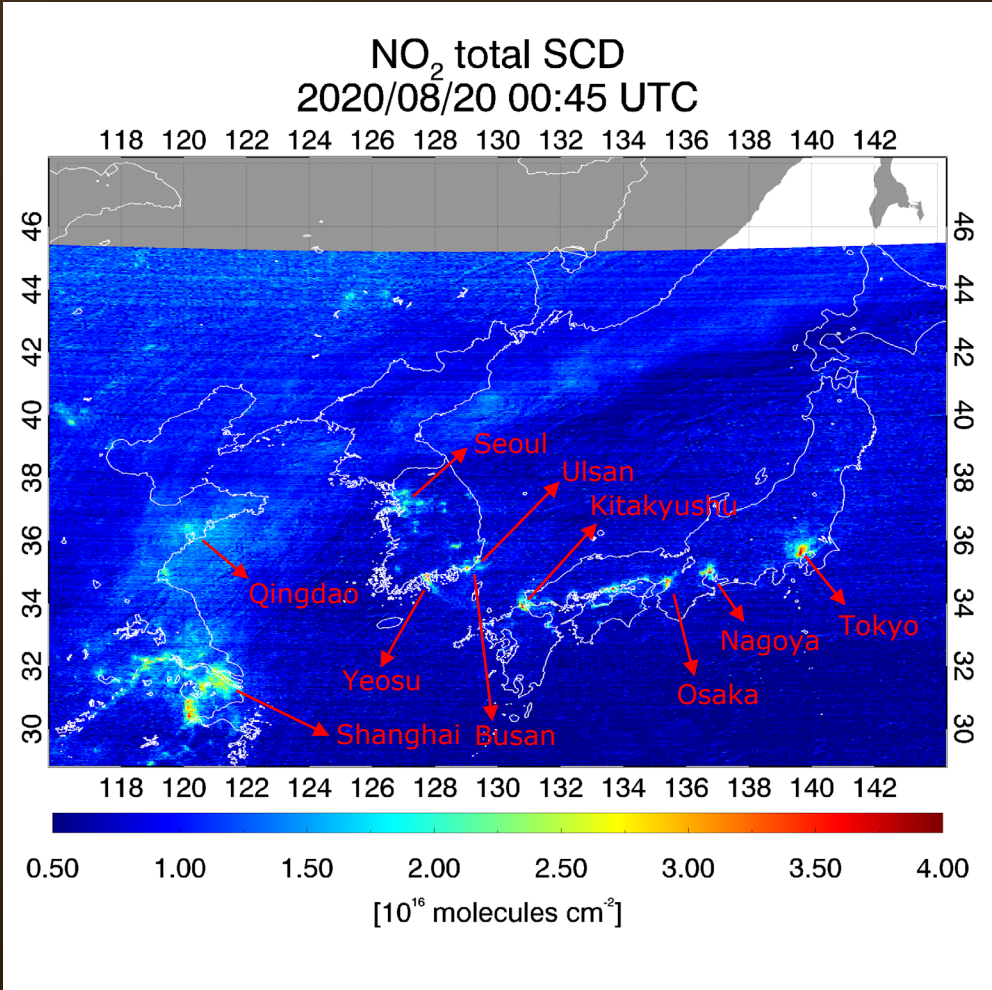
Early results: NO₂



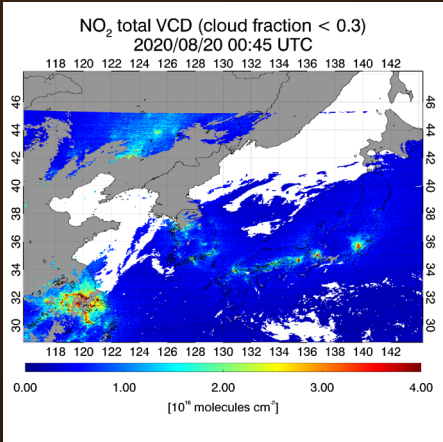
GEMS SCD



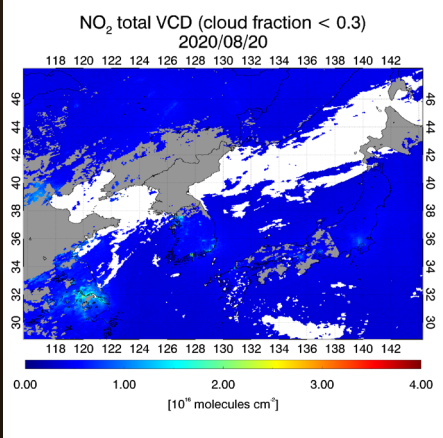
GEMS SCD



GEMS VCD



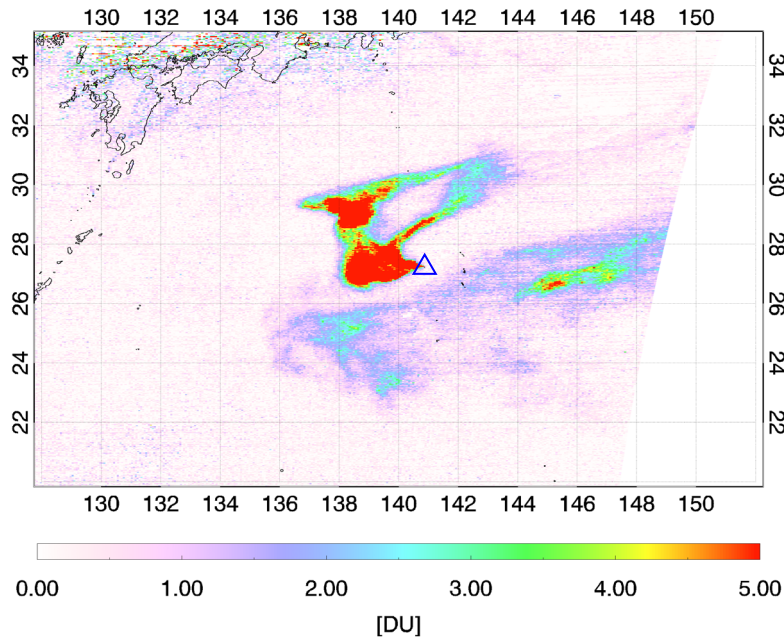
TROPOMI VCD



Early results: SO₂

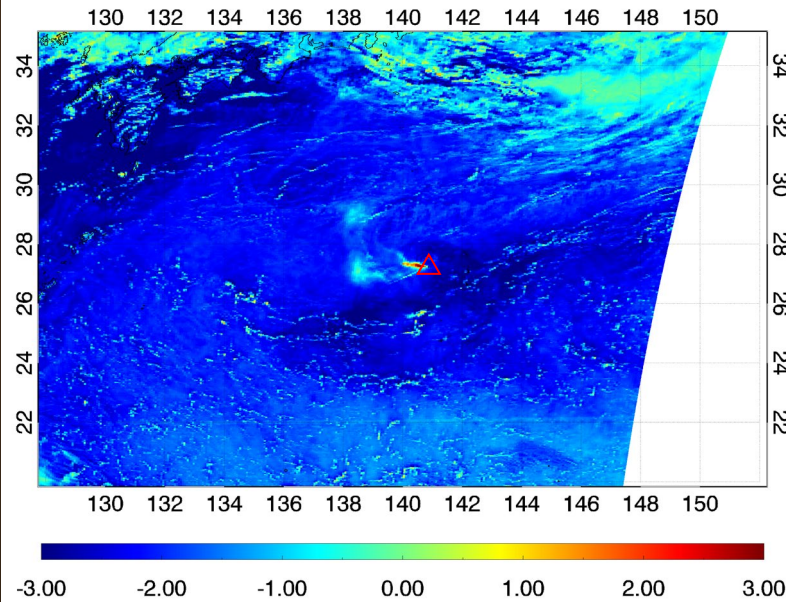
GEMS SO₂

SO₂ total VCD
2020/07/29 01:45 UTC



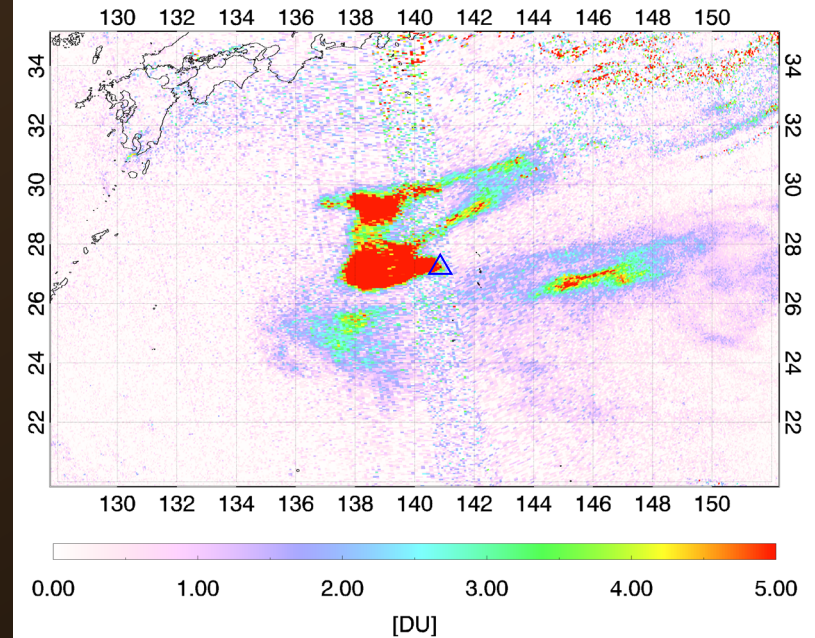
GEMS UV aerosol index

UV aerosol index
2020/07/29 01:45 UTC



TROPOMI SO₂

SO₂ total VCD
2020/07/29

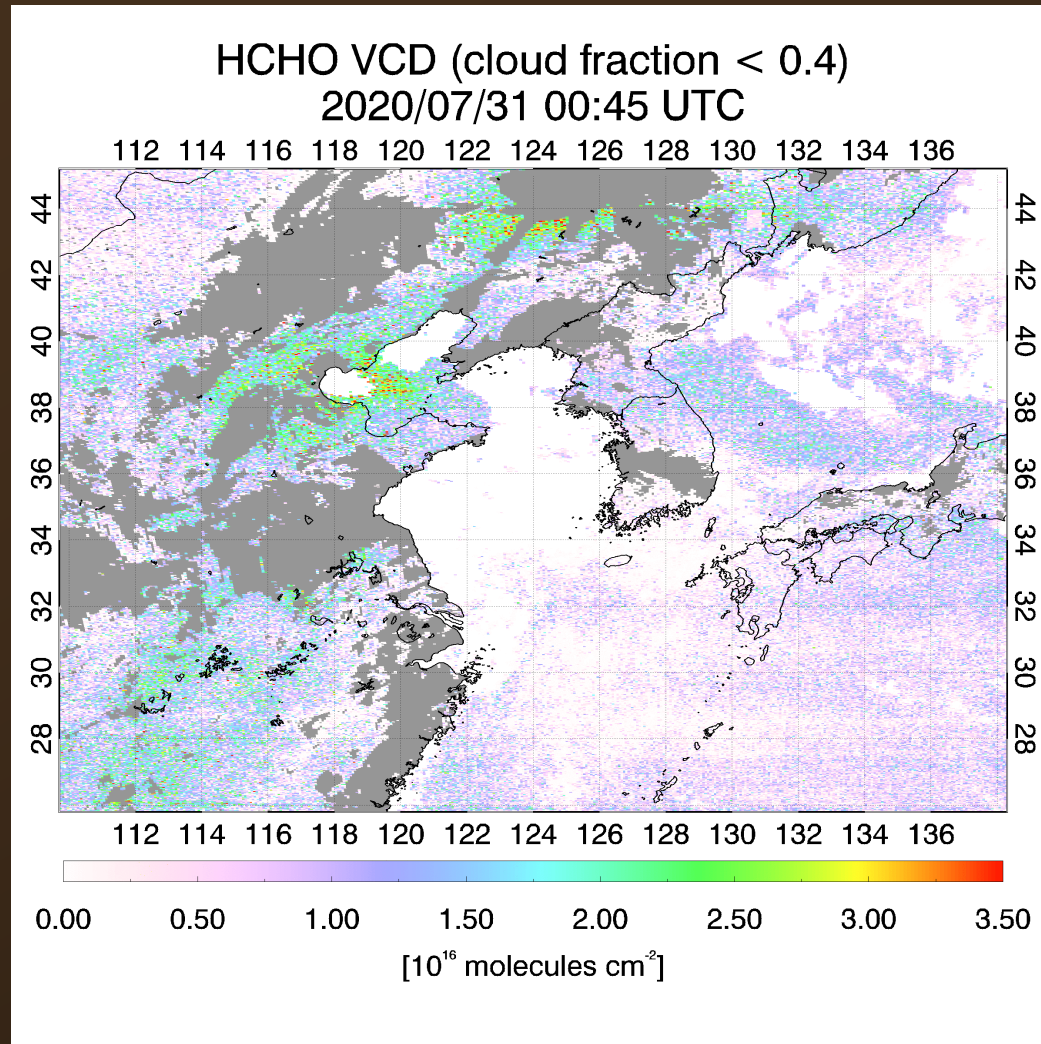


**Volcanic eruption at
Nishinoshima Island, Japan**

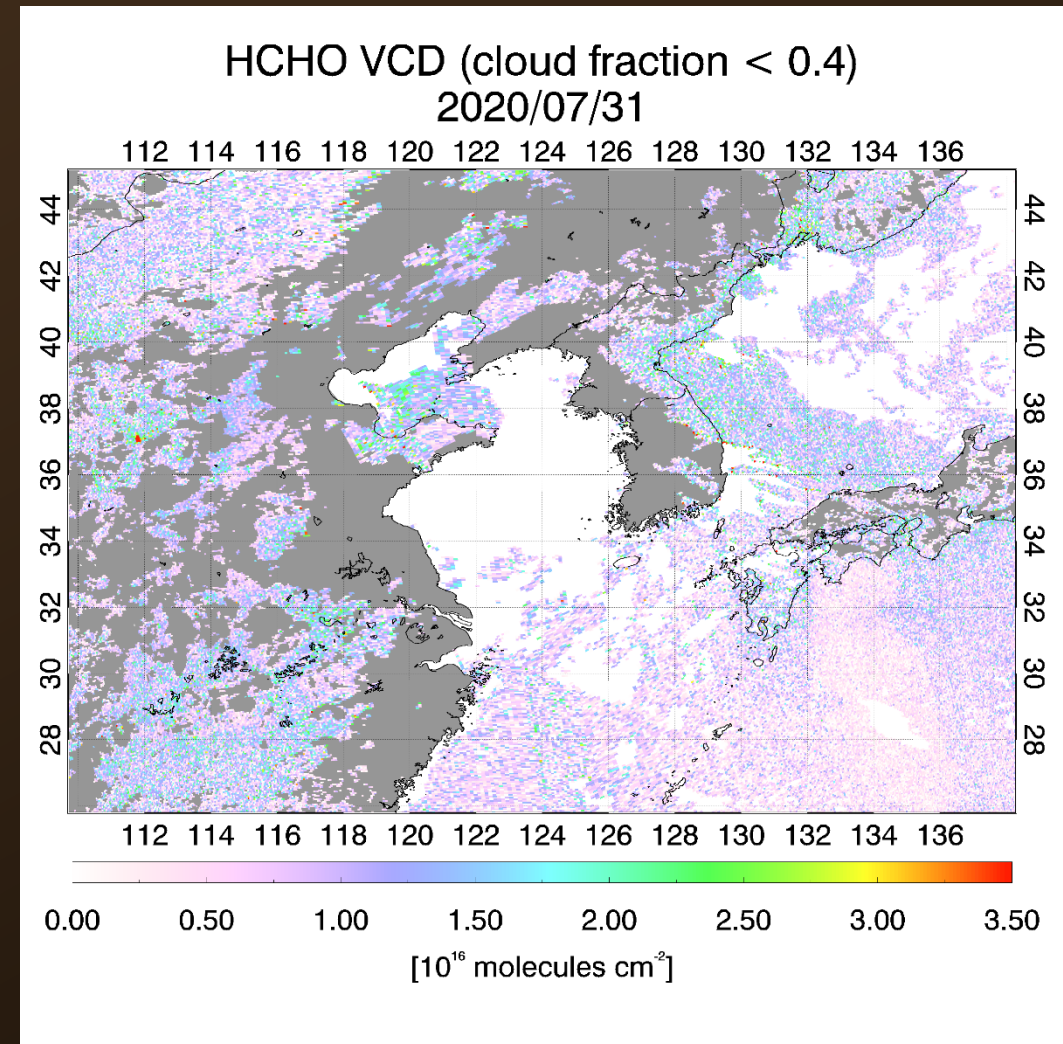


Early results: HCHO

GEMS HCHO

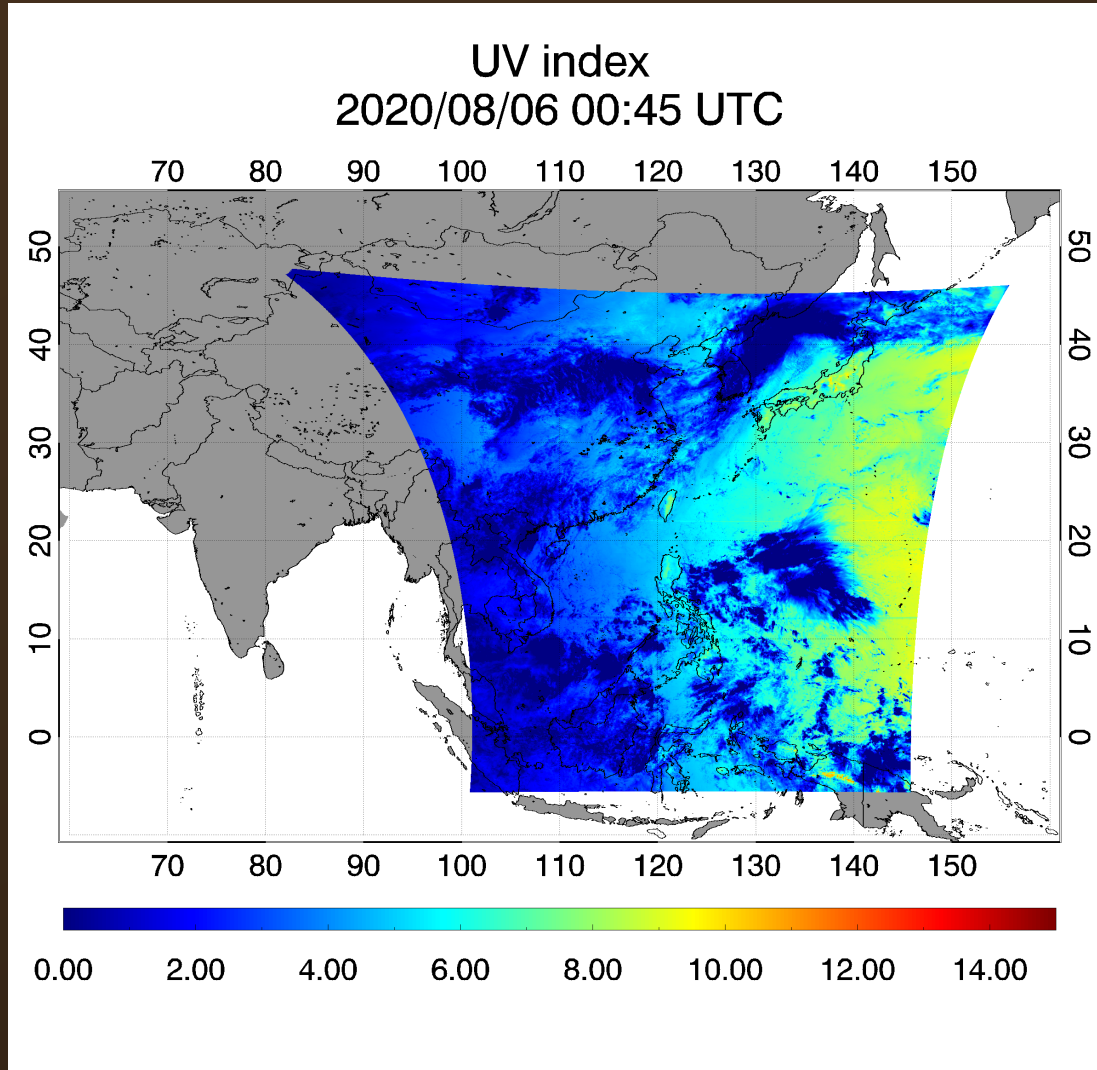


TROPOMI HCHO

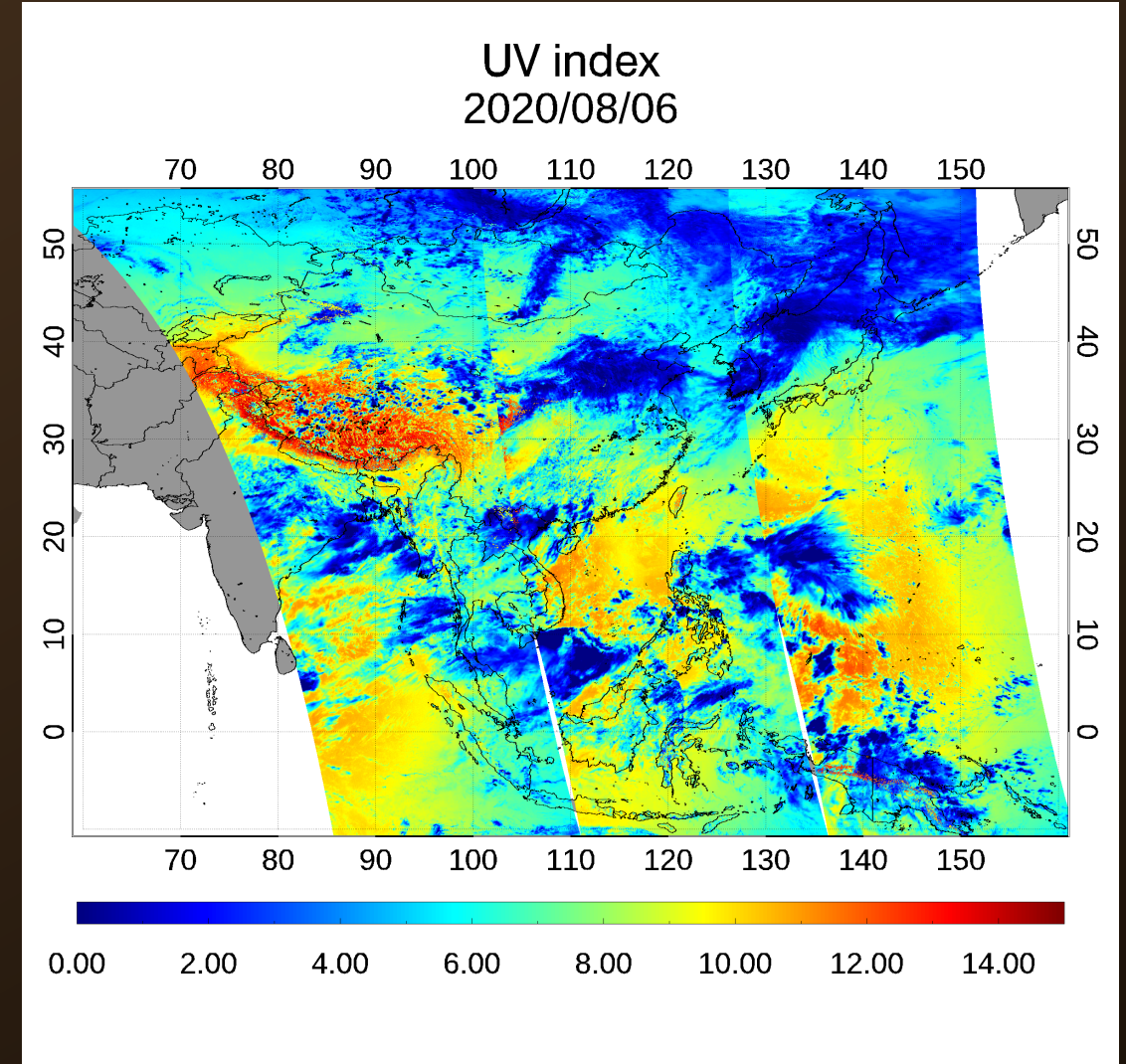


Early results: UV index

GEMS UV index

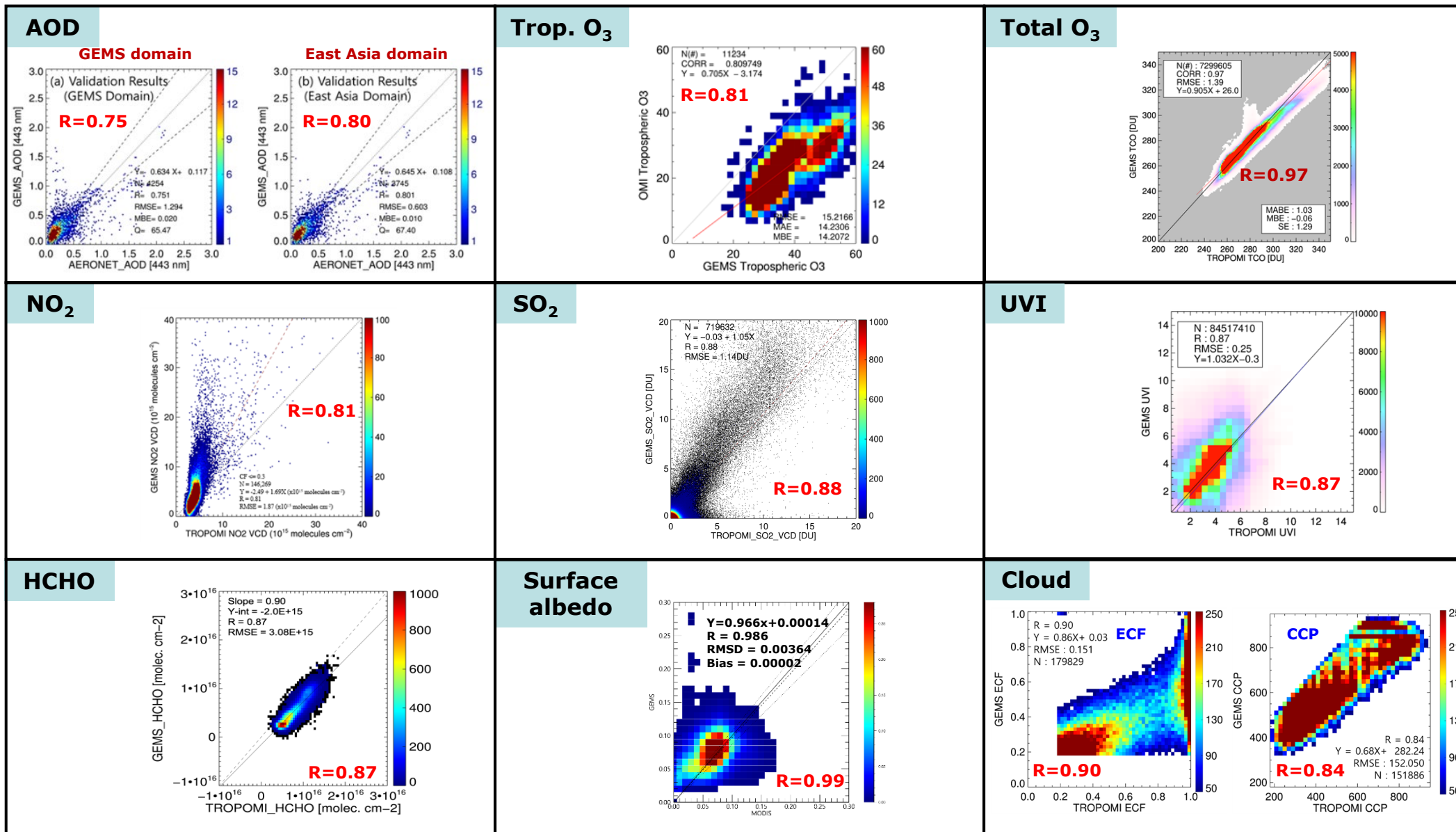


TROPOMI UV index



GEMS validation results

Period : August–October 2020

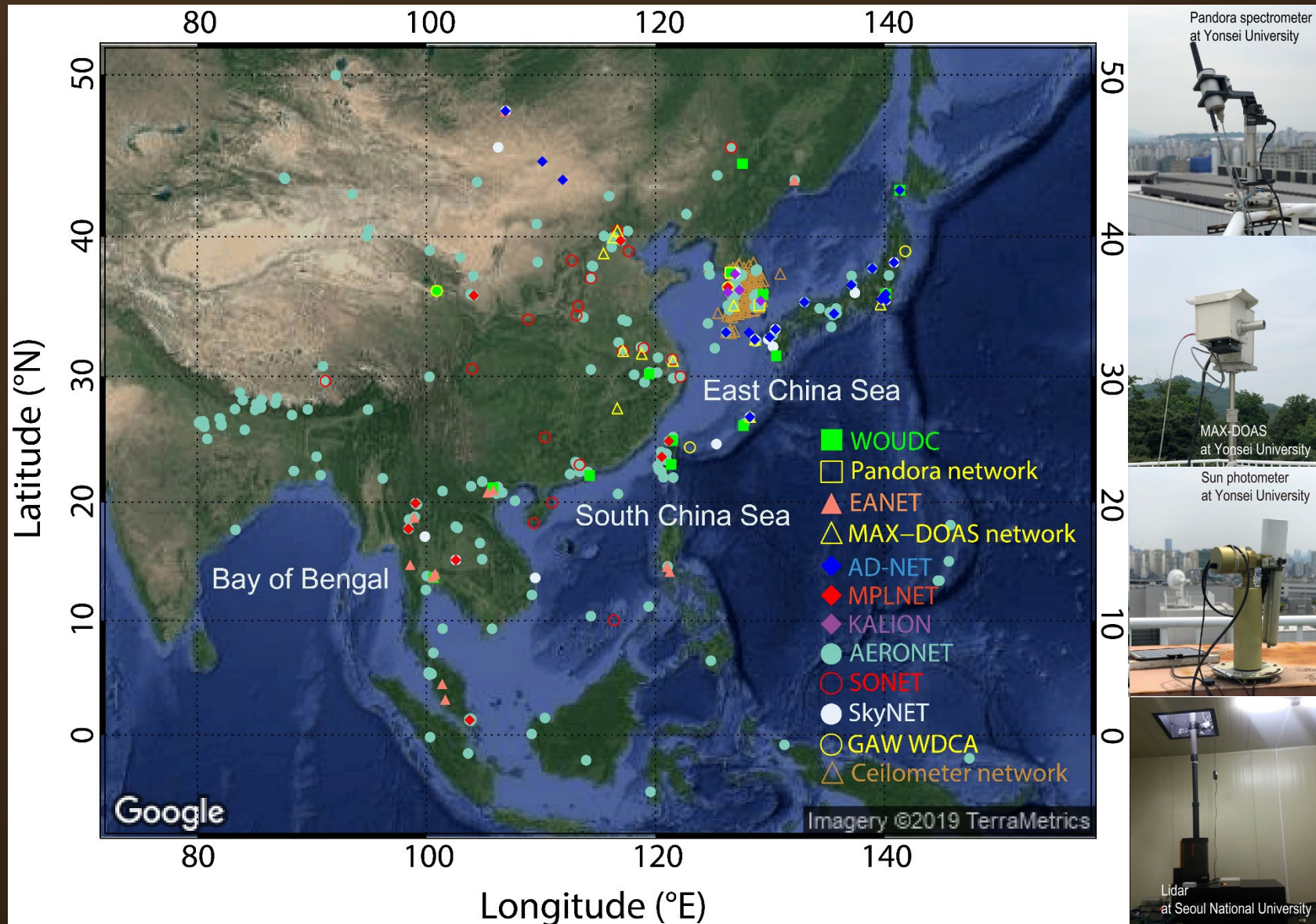


GEMS validation results



Parameter	Goal correlation (R)	Achieved correlation (R)	Slope (a)	Intercept (b)	RMSE	Reference	Region	Period
O ₃ (Trop.)	0.5–0.8	0.81	0.71	-3.17 DU	15.21 DU	OMI	East Asia	2020.08–2020.10
O ₃ (Total)	0.82–0.97	0.89	0.94	24 DU	1.83 DU	Pandora	Busan & Ulsan	2020.08–2020.10
NO ₂	0.80	0.81	1.69	-2.49×10^{15} molec. cm ⁻²	1.87×10^{15} molec.cm ⁻²	TROPOMI	GEMS domain	2020.08–2020.10
SO ₂	0.70	0.88	1.05	-0.03 DU	1.14 DU	TROPOMI	GEMS domain	2020.08–2020.10
HCHO	0.81	0.87	0.90	-2.0×10^{15} molec. cm ⁻²	3.08×10^{15} molec. cm ⁻²	TROPOMI	East Asia	2020.08–2020.10
AOD	0.70	0.75	0.63	0.12	1.29	AERONET	GEMS domain	2020.08–2020.10
UVI	0.86–0.96	0.87	1.03	-0.30	0.25	TROPOMI	GEMS domain	2020.08–2020.10
ECF	0.90	0.90	0.86	0.03	0.15	TROPOMI	GEMS domain	2020.08–2020.10
CCP	0.80	0.84	0.68	282.24 hPa	152 hPa	TROPOMI	GEMS domain	2020.08–2020.10
SFC	0.70–0.91	0.99	0.97	0.0001	0.0036	MODIS	GEMS domain	2020.08–2020.10

GEMS validation network



GEMS images open to the public

NIER website > <https://nesc.nier.go.kr/product/view>

[Courtesy of NIER]

Home / Satellite Data / [Image View](#)

Image View >

Data Download

ATBD

Search Keyword Search

Search Keyword Keyword

Period

Interval 0.5s

Level Select

Product Select

Observation Mode All

UTC / KST UTC

Time 00:00 ~ 24:00

Search

Keyword

Aerosol Optical Depth (443nm)

Total Ozone

EffectiveCloudFraction

Total NO2

PlantResponseIndex

DNA DamageIndex

VitaminDIndex

All All Download Download

GEMS L2_AERAOD 2021-03-28-05:45 UTC (2021-03-28-14:45 KST) FW_DPRO ESC

Aerosol Optical Depth at 443nm

Preliminary

GEMS L2_AERAOD 2021-03-28-05:45 UTC (2021-03-28-14:45 KST) FW_DPRO ESC

Aerosol Optical Depth at 443nm

Preliminary

GEMS images open to the public

Hourly observations are presented in near real time (in a figure form but NOT in a data form).

Image View

AOD 443 nm

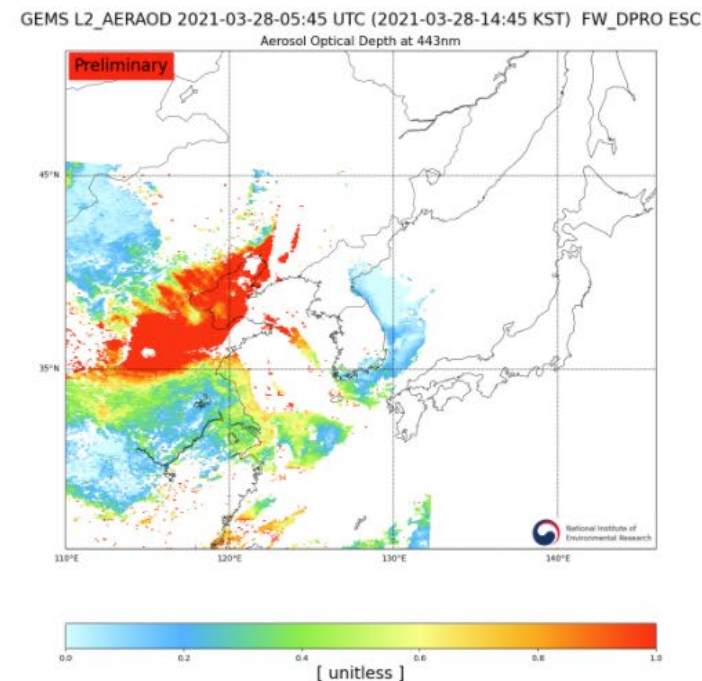
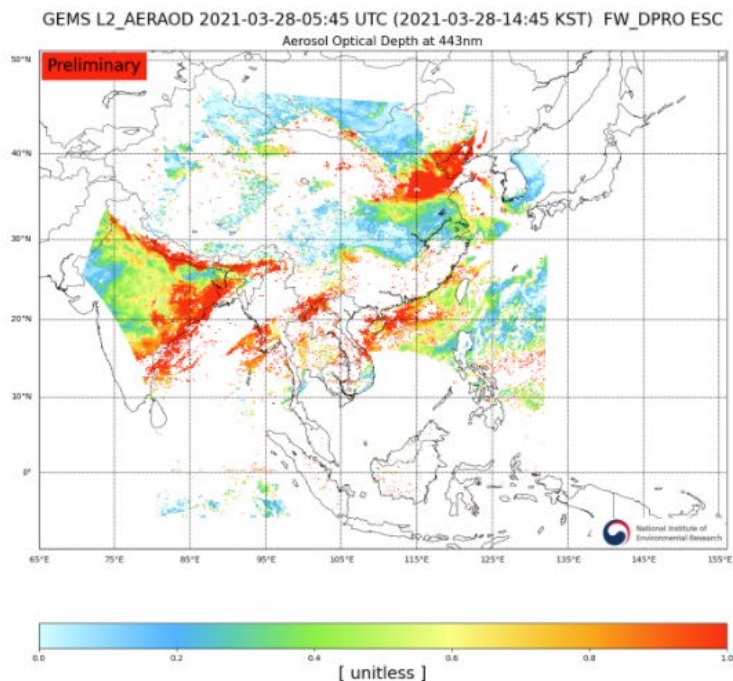
Search Keyword: **Aerosol Optical Depth (443nm)** Level: Select Product: Select Observation Mode: All Search

Period: 2021-03-28 ~ 2021-03-28 UTC / KST: UTC Time: 00:00 ~ 24:00

Interval: 0.5s Result: [6/8]

Figures are downloadable

All All Download Download



[Courtesy of
NIER]

GEMS images open to the public

28 Mar 2020

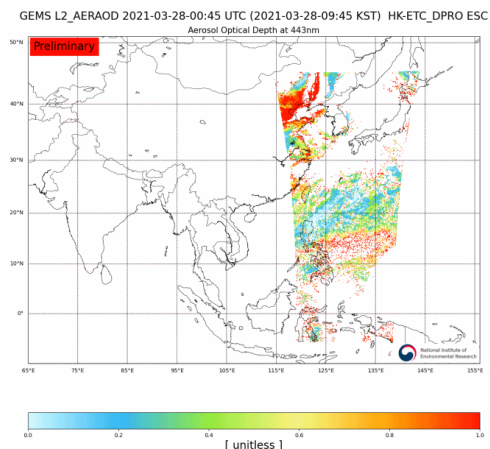
Examples of downloaded maps covering the GEMS field of regards (FOR)

<Source>
<https://nesc.nier.go.kr/product/view>

[Courtesy of NIER]

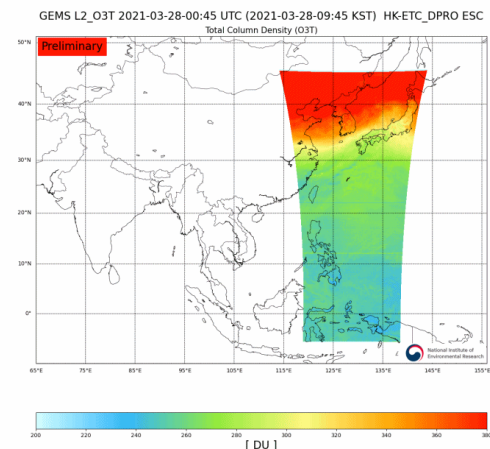
AOD 443 nm

00:45 UTC



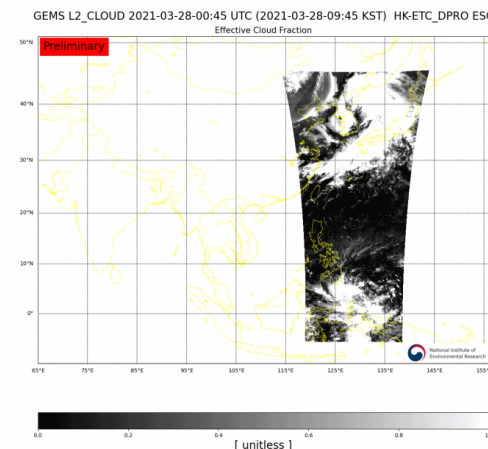
Total O₃

00:45 UTC



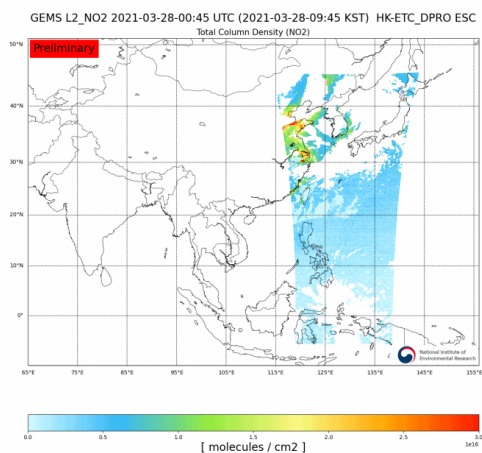
Cloud fraction

00:45 UTC



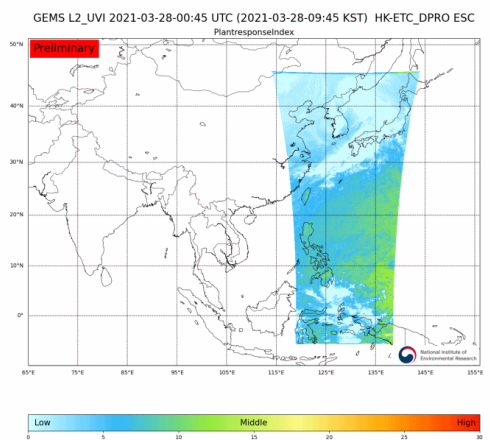
Total NO₂

00:45 UTC



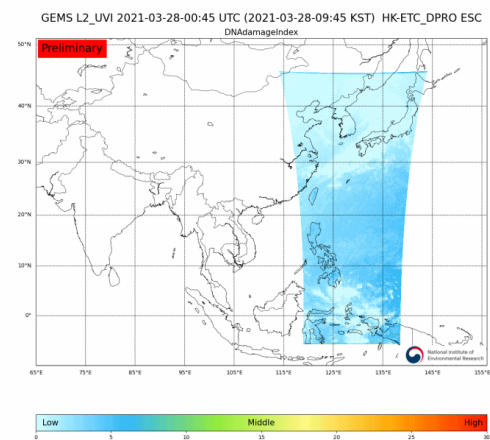
Plant response index

00:45 UTC



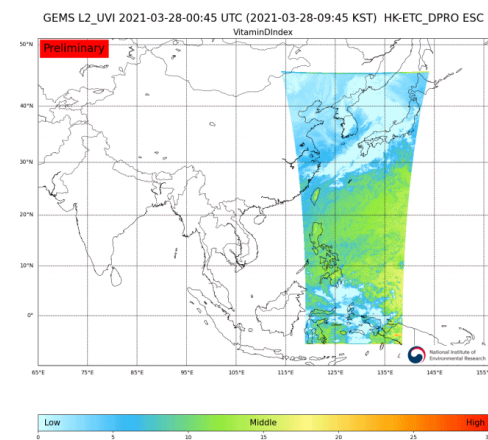
DNA damage index

00:45 UTC



Vitamin D index

00:45 UTC



GEMS images open to the public

28 Mar 2020

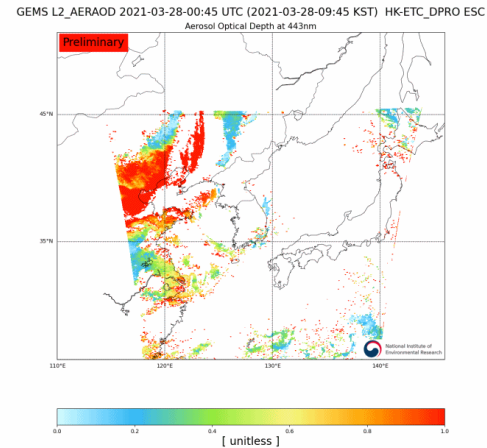
Examples of downloaded maps covering regions around the Korean Peninsula

<Source>
<https://nesc.nier.go.kr/product/view>

[Courtesy of NIER]

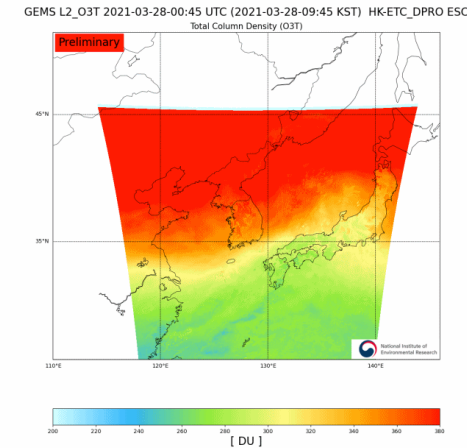
AOD 443 nm

00:45 UTC



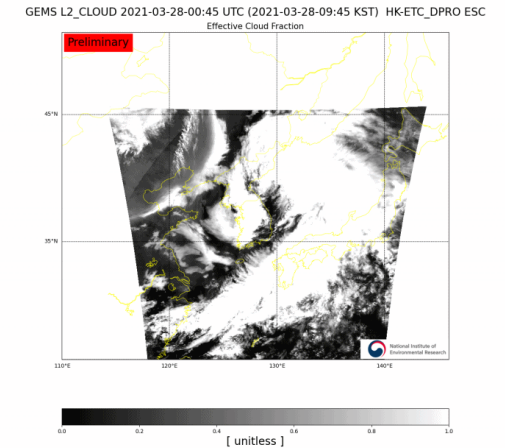
Total O₃

00:45 UTC



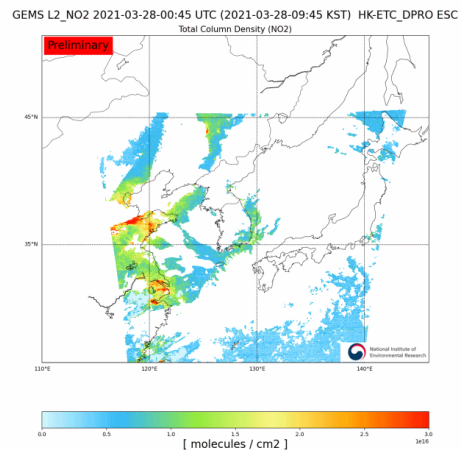
Cloud fraction

00:45 UTC



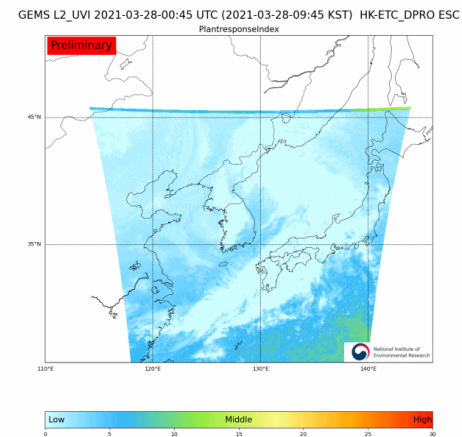
Total NO₂

00:45 UTC



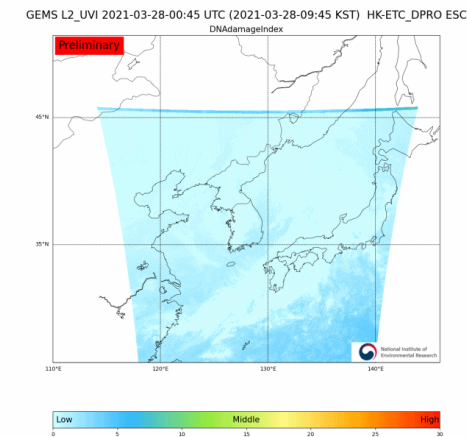
Plant response index

00:45 UTC



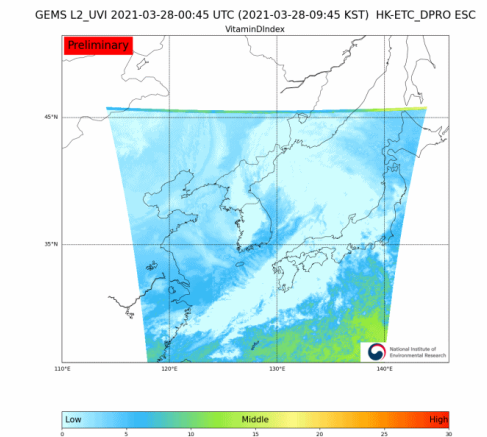
DNA damage index

00:45 UTC



Vitamin D index

00:45 UTC



- GEMS has been successfully operating after its launch in Feb 2020.
- Early retrieval results of trace gases and aerosols from GEMS are presented.
- GEMS retrievals are in good agreement with other satellite and ground-based observations.
- Images of some L2 products (AOD, total O_3 , cloud, NO_2 , and UVI) are now open to the public.

Acknowledgements



Thank you!