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GEMS Status: Potential reference datasets for nearly real-time(NRT) validation

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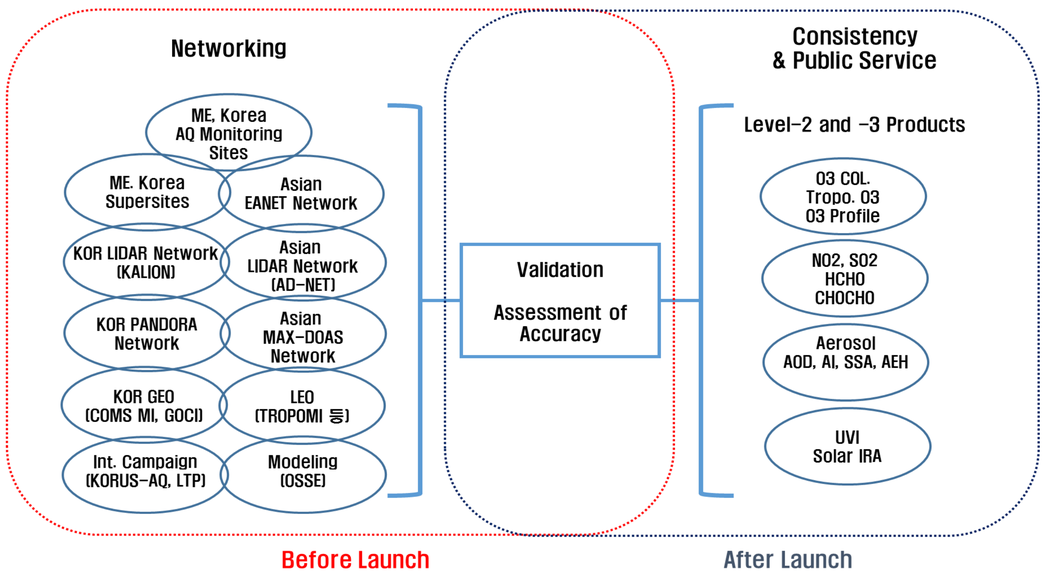
Introduction

It is a very challenging research task to establish the nearly real-time(NRT) validation strategy of GEMS L2 products. This work might be one of very important tasks for maintaining the high accuracy and consistency of its products to achieve the scientific goals of the entire satellite development project. To validate the products of Korean GEMS in operational sense, it is the highest priority to acquire the various independent geophysical measurement data and perform QA/QC process of those dataset in real time. And then we can make quantitative assessment statistics for GEMS products in the right time and provide them to relevant scientists / engineers/ officers who are in charge of real-time operation of GEMS.
In this presentation, we will show the potential reference dataset and acquisition priority of them for NRT validation of GEMS L2 products.

GEMS Validation Outline



Define GEMS main products for validation

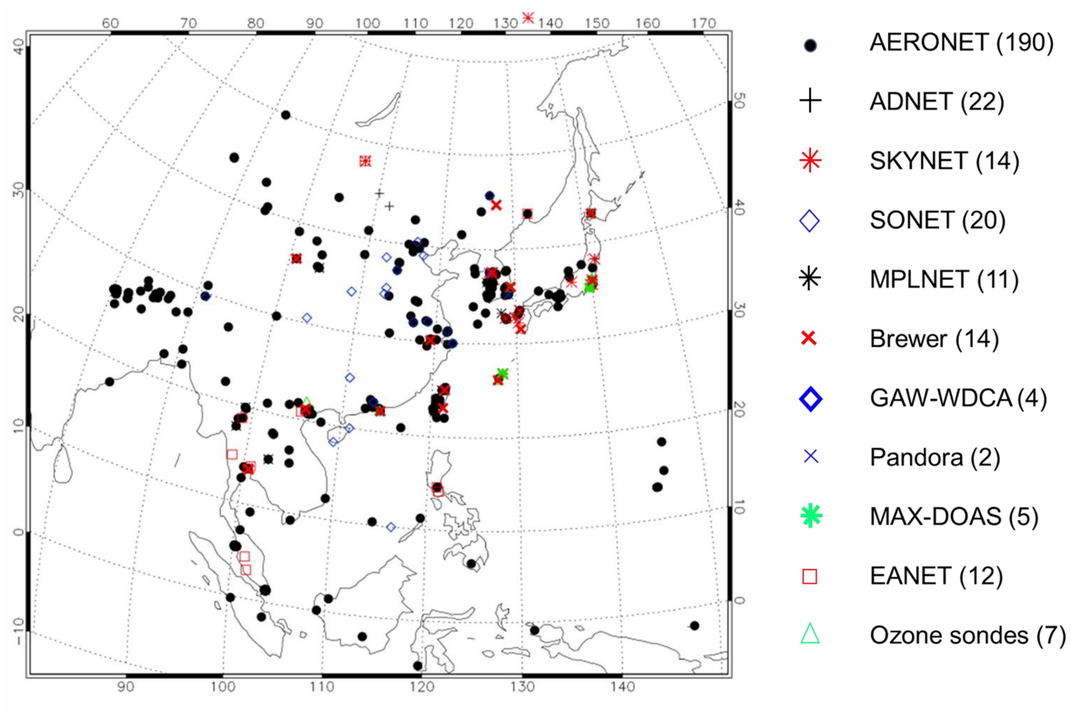
Priority	Aerosol (Main)	Aerosol (Sub)	NO_2	SO_2	O_3 (Total)	O_3 (Profile)	HCHO	Cloud	UV Index
1	**AOD**	**AEH**	VCD	VCD	**Total Column Ozone**	**Profile**	**VCD**	**Effective Cloud Fraction**	**UV-Index (Erythema Dose)**
2	SSA	(Type)	**Trop. VCD**	**Trop. VCD**		Trop. Ozone		Cloud Centroid Pressure	DNA Dose Rate
3	ALH	(AOD)	SCD	SCD		Stratos. Ozone		Cloud Radiance Fraction	Plant Dose Rate
4	UVAI		AMF	AMF		Total Column Ozone			Vit. D Dose Rate
5	Type								

*VCD : Vertical Column Density
*SCD : Slant Column Density
*AMF : Air Mass Factor
*Gas Column Density Unit : Dobson Unit (for Ozone), molecule cm^{-2} (for others)

Suggested target accuracy for validation by GEMS algorithm team

L2 Products	Correlation coefficient (R)	a, Slope	*b, Intercept*	RMSE	Error (%)	Reference
O3 (Total)	0.82 - 0.97	0.83-0.97	35.5 DU	*7%*	N/A	M. Anton et al.(2010), Park et al.(2012)
O3 (Trop)	0.5-0.8	0.5-0.9	0-15 DU	*5-10 DU [10-20%]*	3-6 DU *[10-20%] [f(SZA)]*	J.R. Zimke et al. (2005, 2006)
HCHO	0.57-0.77	0.75-0.88	$-2.3-1.8x10^{15}$	*N/A*	*N/A*	Wittrock et al.(2006)
AOD	0.7	N/A	N/A	T/V	30% at AOD > 0.1	Ahn et al.(2008), Torres et al.(2007)
NO2	0.8	0.5	$3.0x10^{15}cm^{-2}$	*N/A*	20%	Irie et al.(2008, 2009)
SO2	0.7	*1.0±0.6*	0.5 DU	*N/A*	*50-100%*	Lee et al.(2009)
CF	0.90	0.9~1.1	N/A	N/A	2% ~ 5%	Wager et al. (2008)
CP	0.80	0.9~1.1	N/A	N/A	5% ~ 20%	Wager et al. (2008)
UV Index	0.86-0.96	0.8-1.3	1-20 mW/m^2	14-17 mW/m^2 (20-58%)	20~50% at high AAOD	I. Ialongo et al. (2008) V. Buchard et al. (2009)
Surface Reflectance	0.70~0.91	N/A	N/A	0.03	5~40%	Kleipool et al., (2008), Vermote et al.(2002)

In-situ remote sensing observation network



Potential Reference datasets for GEMS LRT validation

Product	Instruments		Application to GEMS: Geographical coverage	Application to GEMS: Temporal coverage
O3 (total)	G	Brewer/Dobson spectrophotometer Data access: WOUDC, NDACC, EVDC, AVDC	Dobson: Japan(3/5), Korea(1), Russia(2), Taiwan(1), Thailand(1) Brewer: India(3), China(6), Korea(3), Japan(5), Taiwan(2), Vietnam(3), Thailand(2), Russia(1), Malaysia(1)	not real time
		Pandora	Seoul (Yonsei Univ.), Busan, USTC China	**Near real time**
		ZLS DOAS/ MAX-DOAS	MAX-DOAS (5 stations) : Gwangju, Yokosuka, Hefei, etc.	not real time
		Airborne	Campaign obs. (KORUS-AQ)	not real time
	S	TROPOMI/OMI/OMPS /GOME-2 IUP retrievals/SCIAMACHY/TEMPO		

Product	Instruments		Application to GEMS: Geographical coverage	Application to GEMS: Temporal coverage
AOD	G	AERONET (sun photometer & CIMEL)/ SKYNET PREDE (sun sky radiometer)/ MFRSR	**AERONET**: almost 190 sites in the GEMS domain	**Near real time**
			SKYNET (16 stations) : Seoul, Chiba, Osaka, etc.	-
		Brewer Data access: WOUDC, NDACC, EVDC, AVDC	Brewer: India(3), China(6), Korea(3), Japan(5), Taiwan(2), Vietnam(3), Thailand(2), Russia(1), Malaysia(1)	not real time
		Pandora	Seoul (Yonsei Univ.), Busan, USTC China	**Near real time**
		Lidar Data access: EARLINET, MPLNET, ADNET, KALION	MPLNET (8 stations) : Kaohsiung, Kanpur, etc.	**Near real time** (for level 1 and level 1.5)
		Airborne	Campaign obs. (KORUS-AQ)	
	S	CALIOP/GOCI/OMI/ IASI/Himawari/KMA MI		

Product	Instruments		Application to GEMS: Geographical coverage	Application to GEMS: Temporal coverage
NO2	G	DOAS/ZLS DOAS/MAX-DOAS Data access: Ground-based MAX-DOAS network	MAX DOAS (5 stations): Gwangju, Yokosuka, etc.	not real time
		Pandora	Seoul (Yonsei Univ.), Busan, USTC China	**Near real time**
		NO2 sonde	Campaign obs.	
		Airborne	Campaign obs. (KORUS-AQ)	
	S	TROPOMI/OMI/GOME-2A/GOME-2B/SCIAMACHY/TEMPO		

Product	Instruments		Application to GEMS: Geographical coverage	Application to GEMS: Temporal coverage
O3 (trop)	G	Brewer/Dobson Data access: WOUDC, NDACC, EVDC, AVDC	Dobson: Japan(5), Korea(1), Russia(2), Taiwan(1), Thailand(1) Brewer: India(3), China(6), Korea(3), Japan(5), Taiwan(2), Vietnam(3), Thailand(2), Russia(1), Malaysia(1)	not real time
		Pandora	Seoul (Yonsei Univ.), Busan, USTC China	**Near real time**
		FTIR	N/A	N/A
		Ozone sondes Data access: SHADOZ, GAW (GALION), NDACC, NASA DISC	SHADOZ(2): Hanoi, Kuala Lumpur	not real time
			Pohang	not real time
			NDACC : N/A	N/A
			GALION(5): Mt. Waliguan, Danum valley, etc.	not real time
		Ozone lidar Data access: NDACC	Tsukuba (Japan): stratospheric ozone (stopped in 2010)	not real time
		Airborne	Campaign obs. (KORUS-AQ)	not real time
	S	GOME-2 IUP retrievals/ OMPS nadir/OMPS limb IUP/OSIRIS/MLS limb /TEMPO		

Product	Instruments		Application to GEMS: Geographical coverage	Application to GEMS: Temporal coverage
HCHO	G	FTIR Data access: Ground-based network within TCCON	Current 4 sites+1 future site (Anmeyondo, Rikubetsu, Tsukuba, Saga, Hefei)	not real time
		DOAS/MAX-DOAS Data access: Ground-based MAX-DOAS network	MAX DOAS (5 stations) : Gwangju, Yokosuka, etc.	not real time
		Pandora	Seoul (Yonsei Univ.), Busan, USTC China	**Near real time**
		Airborne	Campaign obs. (KORUS-AQ)	not real time
	S	OMI/OMPS/S5P /TEMPO		

Product	Instruments		Application to GEMS: Geographical coverage	Application to GEMS: Temporal coverage
SO2	G	Brewer Data access: WOUDC, NDACC, EVDC, AVDC	Brewer: India(3), China(6), Korea(3), Japan(5), Taiwan(2), Vietnam(3), Thailand(2), Russia(1), Malaysia(1)	not real time
		Pandora	Seoul (Yonsei Univ.), Busan, USTC China, Palau	**Near real time**
		BIRA DOAS / MAX-DOAS	MAX DOAS (5 stations): Gwangju, Yokosuka, etc.	not real time
		SO2 sondes	Campaign obs.	
		Airborne	Campaign obs. (KORUS-AQ)	not real time
	S	TROPOMI/OMI/OMPS /GOME-2/IASI (MetOp-A and -B)/AIRS/CRIS/VIIRS/MODIS/TEMPO		

Acquisition priority of reference datasets for GEMS LRT validation

Product	Ground-based	Satellite-based
O3 (total)	1. Pandora	1. TROPOMI
	2. MAX-DOAS	2. OMI
	3. Brewer/Dobson	3. OMPS
O3 (trop)	1. Ozone-sonde	1. GOME-2
	2. Pandora, Brewer/Dobson	2. OMPS limb
	3.	3.
AOD	1. AERONET (or SKYNET)	1. GOCI, Himawari, KMA MI
	2. Lidar(MLPNET, ADNET, SONET, KALION)	2. OMI/TROPOMI
	3. Pandora	3. CALIOP
HCHO	1. Pandora	1. TROPOMI
	2. MAX-DOAS	2.
	3. FTIR	3.
NO2	1. Pandora (MAX-DOAS by Trop. VCD)	1. TROPOMI
	2. MAX-DOAS (PANDORA by total VCD)	2.
	3.	3.
SO2	1. Pandora (MAX-DOAS by Trop. VCD)	1. TROPOMI
	2. MAX-DOAS (PANDORA by total VCD)	2.
	3.	3.