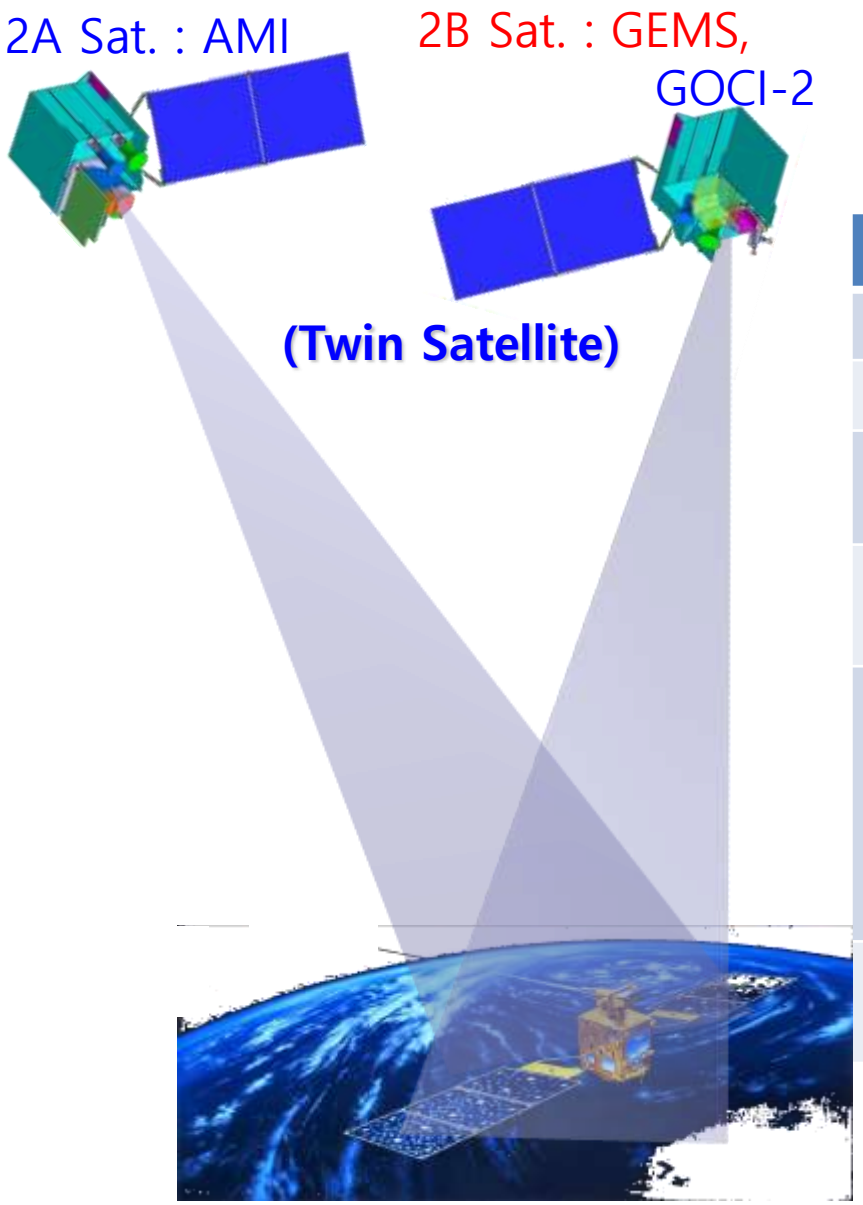
Networking *in-situ* ground measurements for validation of Korean GEMS (Geostationary Environmental Monitoring Satellite/Spectrometer) product

C.K. Song[1], GEMS Science Team[2], GEMS Program Office[3]

[1] School of Urban and Environmental Engineering, UNIST
[2] Yonsei University, EWU, GIST, GWNU, PNU, PkNU, SNU
[3] NIER, Korea

Geostationary Environment Monitoring Spectrometer/Satellite (GEMS)

GEO-KOMPSAT 2

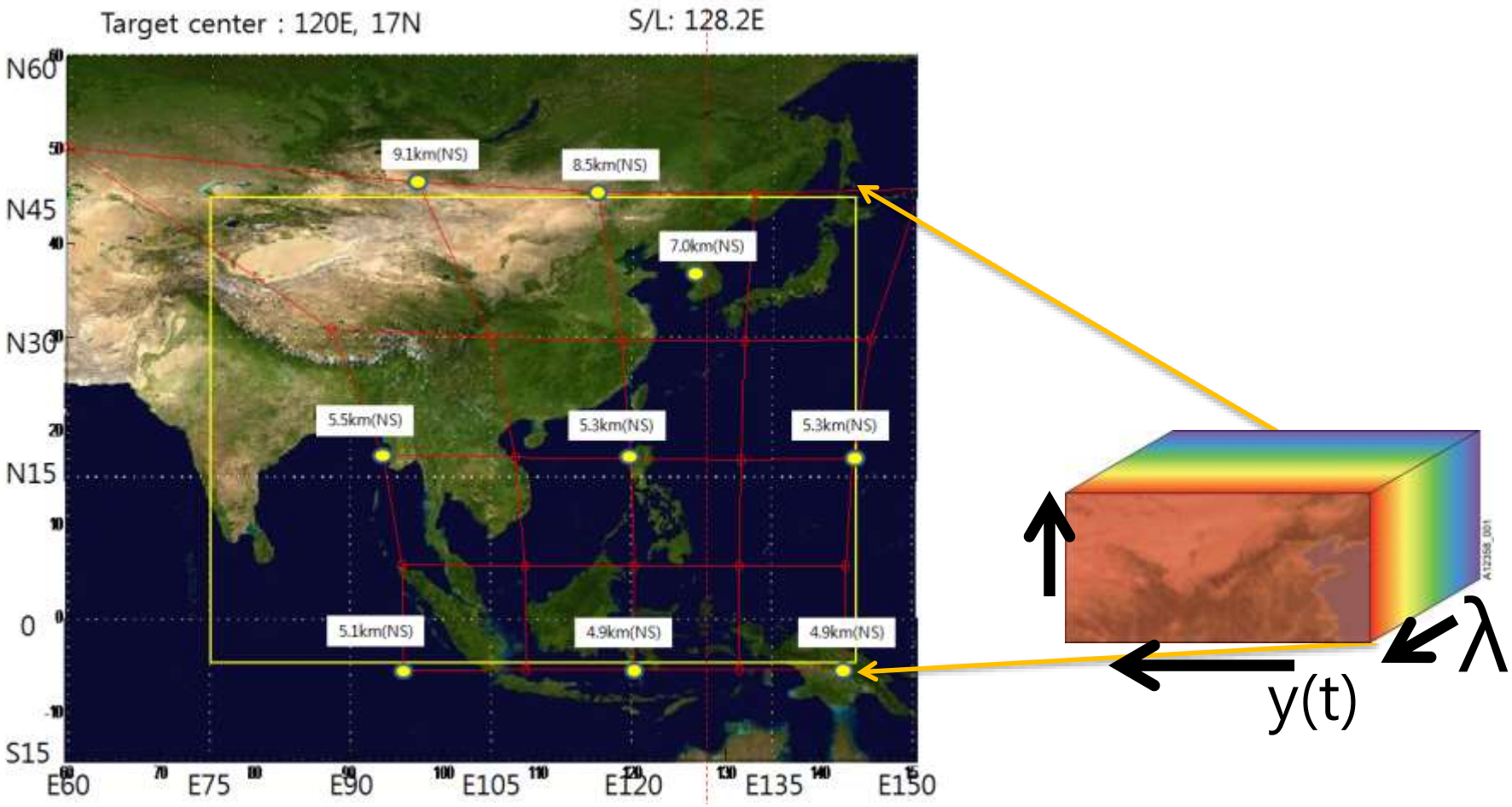


- Launch: 2018-2019

Specification

	2A	2B	
Payload	AMI	GOCI-2	GEMS
Lifetime		10 years	
Channels	16	13	1000
Wavelength range	0.4 - 13 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

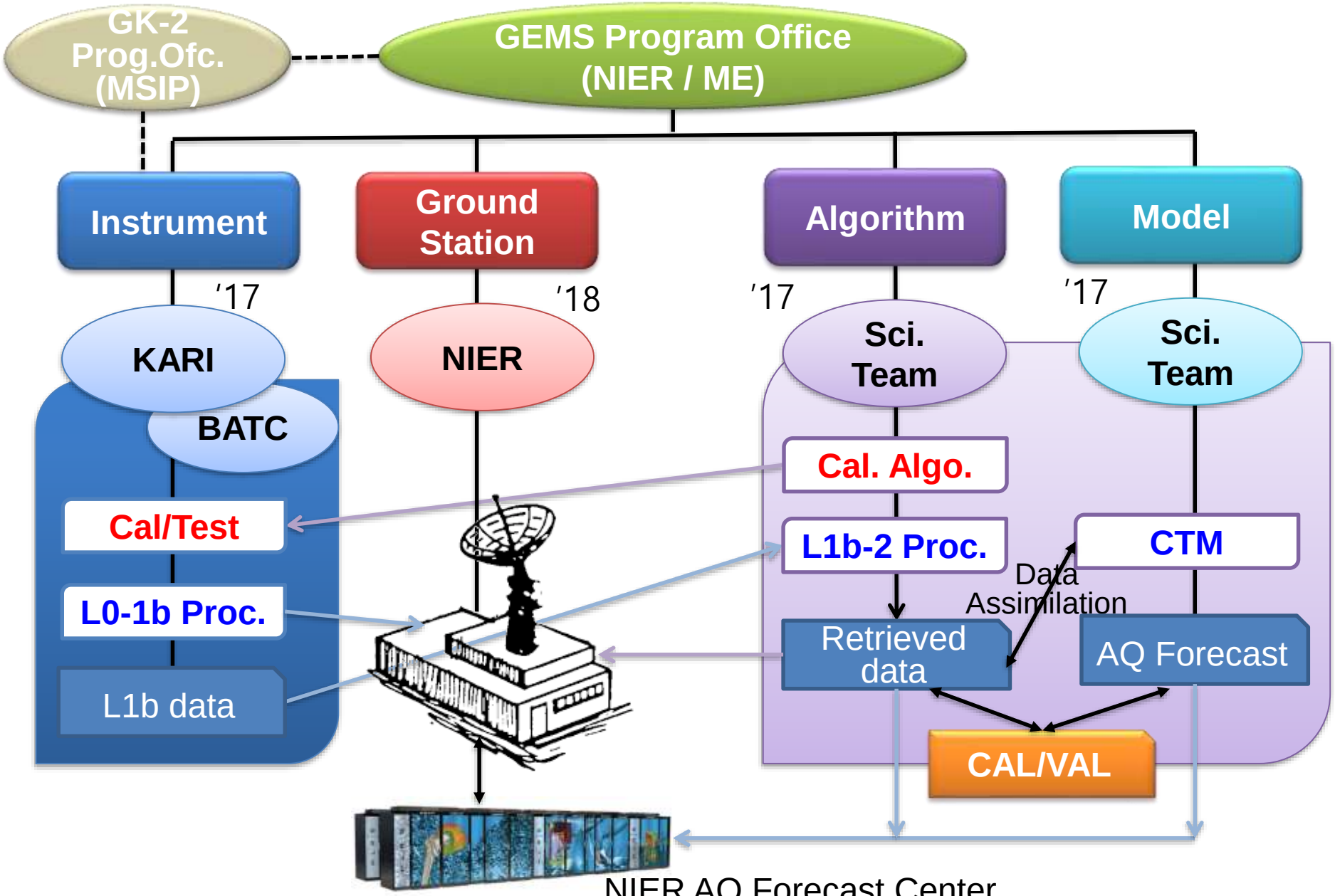
Spatial coverage



Baseline products (16)

Product	Importance	Min (cm^{-2})	Max (cm^{-2})	Nominal (cm^{-2})	Accuracy	Window (nm)	Spat Resol (km^2)@Seoul	SZA (deg)	Algorithm
NO_2	O3 precursor	$3x10^{13}$	$1x10^{17}$	$1x10^{14}$	$1x10^{15}$ cm^{-2}	425-450	7 x 8 x 2 pixels	< 70	BOAS DOAS
SO_2	Aerosol precursor Volcano	$6x10^{8}$	$1x10^{17}$	$6x10^{14}$	$1x10^{16}$ cm^{-2}	310-330	7 x 8 x 4 pixels x 3 hours	< 50 (60*)	
HCHO	VOC proxy	$1x10^{15}$	$3x10^{16}$	$3x10^{15}$	$1x10^{16}$ cm^{-2}	327-357	7 x 8 x 4 pixels	< 50 (60*)	
CHOCHO							7 x 8 x 4 px	< 50	
TropLO3 TropUO3 StratO3 TotalO3	Oxidant Pollutant O_3 layer	$4x10^{17}$	$2x10^{18}$	$1x10^{18}$	3%(TOz) 5%(Stra) 20(Trop)	300-340	7 x 8	< 70	OE TOMS
AOD AI SSA AEH	Air quality Climate	0 (AOD)	5 (AOD)	0.2 (AOD)	20% or 0.1@ 400nm	300-500	3.5 x 8	< 70	Multi-λ O_2O_2 Ring
[Clouds] ECF CCP	Retrieval Climate	0 (COD)	50 (COD)	17 (COD)		300-500	7 x 8	< 70	O_2O_2 RRS
Surface Property	Environ-ment	0	1	-		300-500	3.5 x 8	< 70	Multi-λ
UVI Solar Ira	Public health	0	12	-			7 x 8	< 70	

GEMS Mission Organization



Validation of GEMS Products

- **Comparisons with *in situ* data collected over a distributed network of ground validation sites**
  - Inter-comparison with long time series of ground-based observations at a selected set of ground validation sites

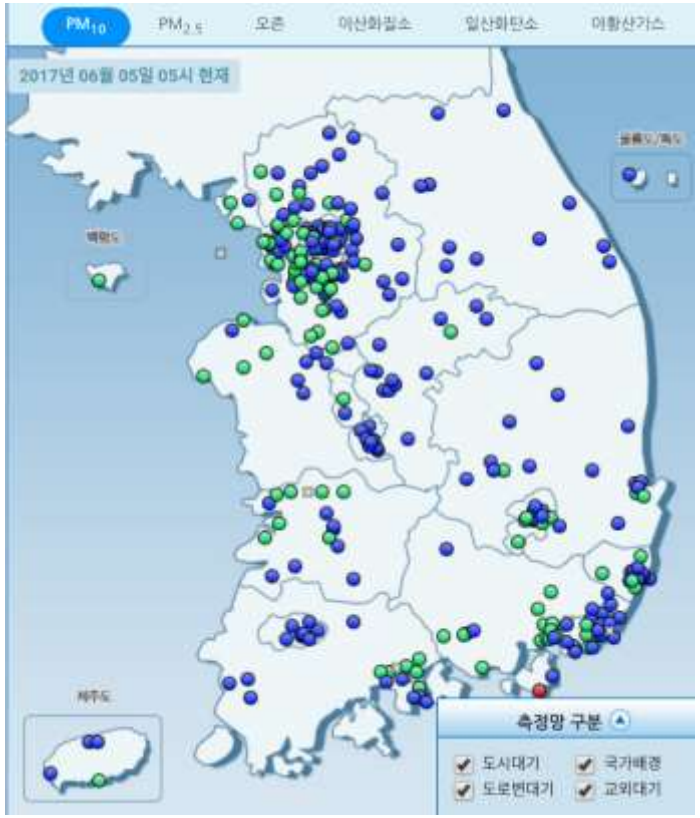
- **Comparisons with data and products from other airborne and spaceborne sensors**
  - Collection of, and comparison with, field experiment data collected from collocated airborne field experiments

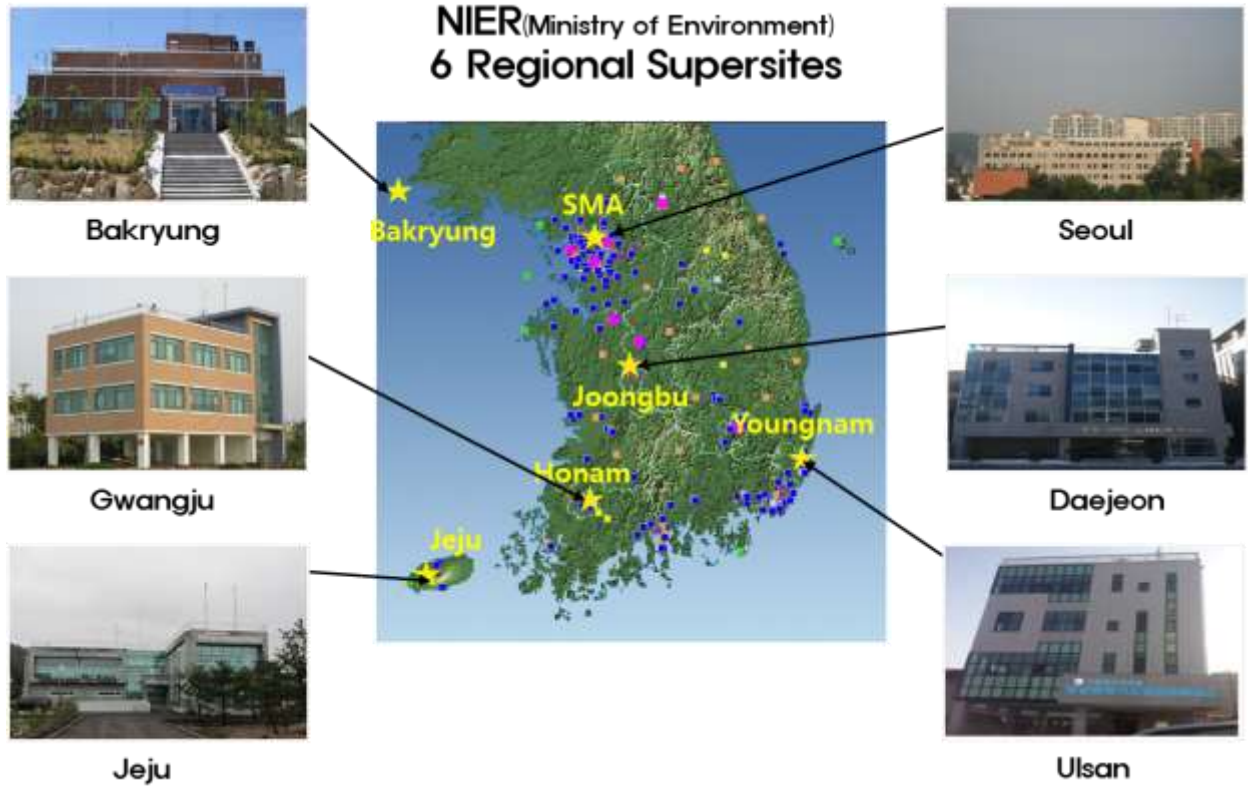
[MODIS Atmosphere Validation Plan]

Comparisons with national air quality monitoring sites

- Korea : Urban (>300 sites), Others(>200 sites), Supersite(6 sites)

  NO2, SO2, O3, PM10, PM2.5 (>350 sites) and VOCs(>50 sites), PAHs, etc.

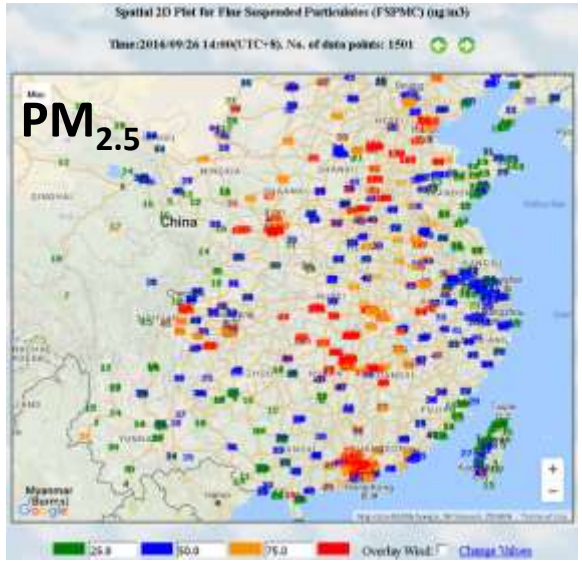


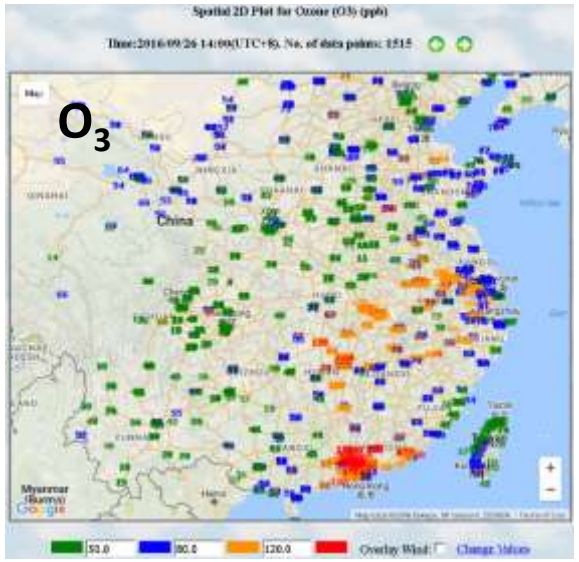


Comparisons with national air quality monitoring sites

- China : **1500 stations <Sept. 2016>**

Cooperation btw. NIER<Korea> and CNEMC(China)





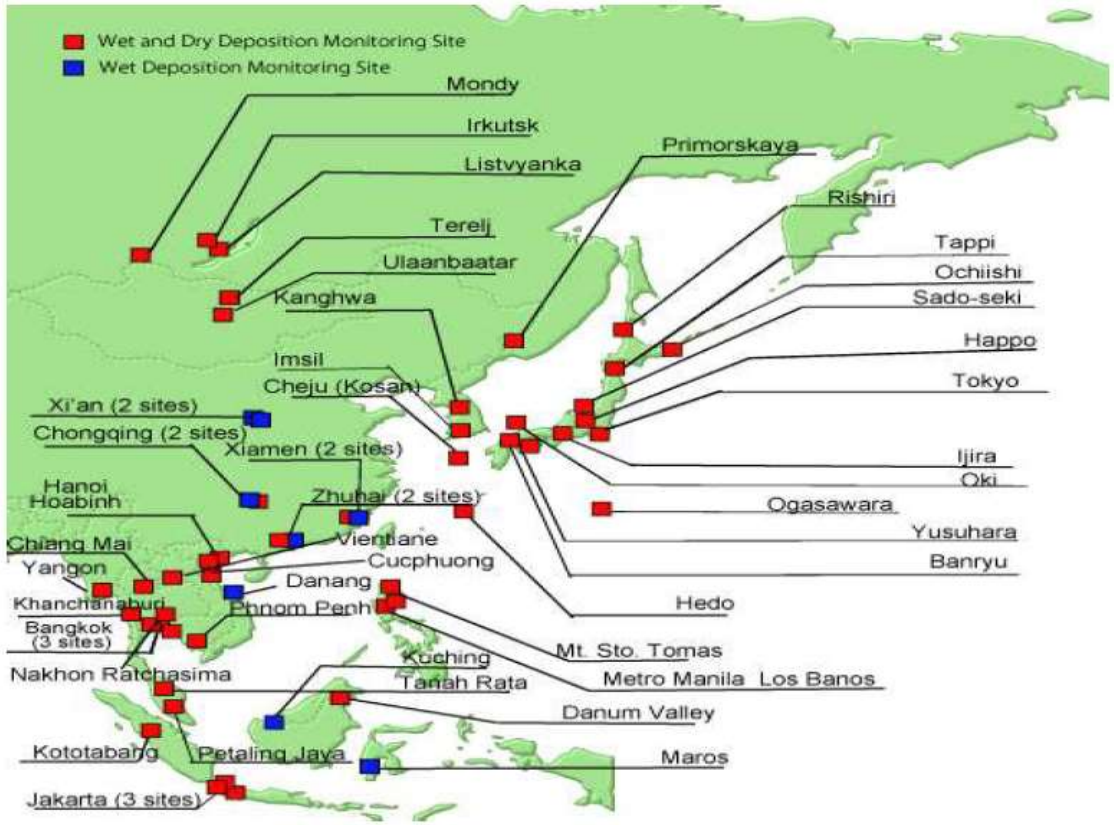
Courtesy to;
Changqing LIN, 7th GEMS Science Meeting, 2016
http://envf.ust.hk/dataview/gts/current/

Comparisons with International air quality monitoring sites

- **EANET (**Acid Deposition Monitoring Network in East Asia**)**

  Cooperation with EANET / ACAP <Dr. Sergey Gromov and Dr. Sukjo Lee>

- **INDIA air quality monitoring network** Cooperation with <Dr. Manish Naja and Dr. P. K. Bhartia>



<그림 8-15. EANET 측정소 현황> 자료 ; http://www.eanet.asia/

- Delhi – box plots & time series
- Mumbai – box plots & time series
- Bengaluru – box plots & time series
- Ahmedabad – box plots & time series
- Chennai – box plots & time series
- Chandigarh – box plots & time series
- Agra – box plots & time series
- Varanasi – box plots & time series
- Dehra Dun – box plots & time series
- Hyderabad – box plots & time series
- Patna – box plots & time series
- Jaipur – box plots & time series
- Kolkata – box plots & time series
- Raipur – box plots & time series
- Ranchi – box plots & time series
- Nagpur – box plots & time series
- Pune – box plots & time series
- Other city pages under construction

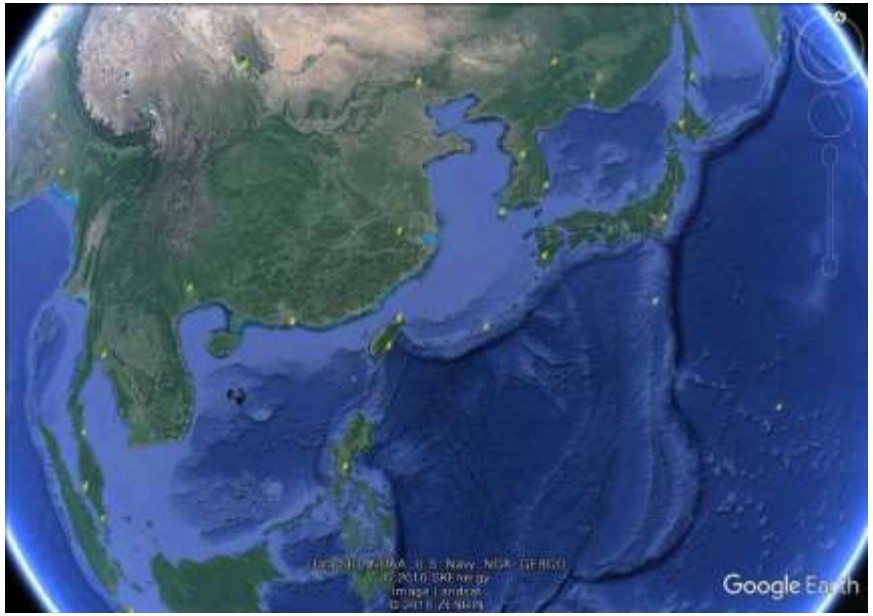
http://www.indiaairquality.info

Comparisons with established remote sensing networks

AERONET sites

AOD, SSA

WOUDC stations

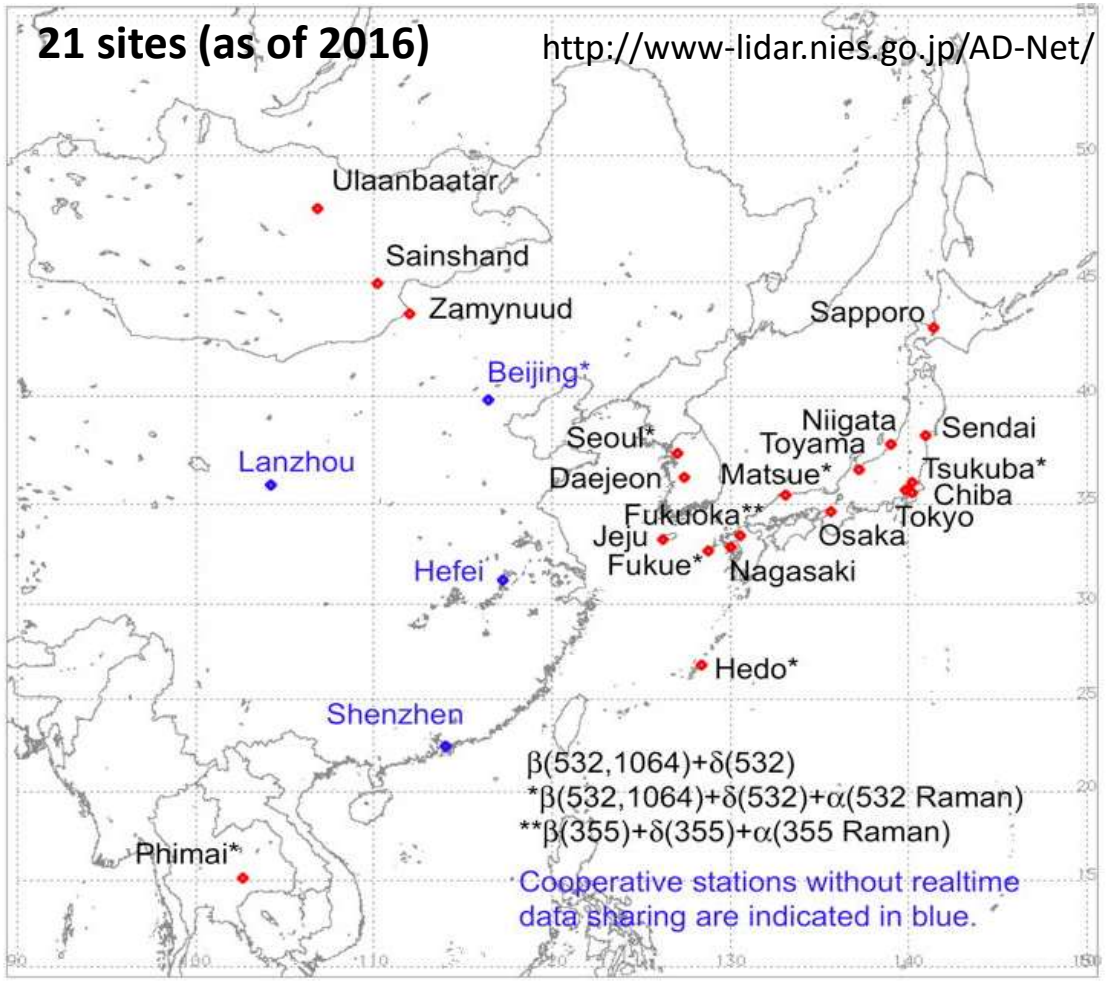


O_3 Total/Trop. column, Profile

Comparisons with established remote sensing networks

AD-Net

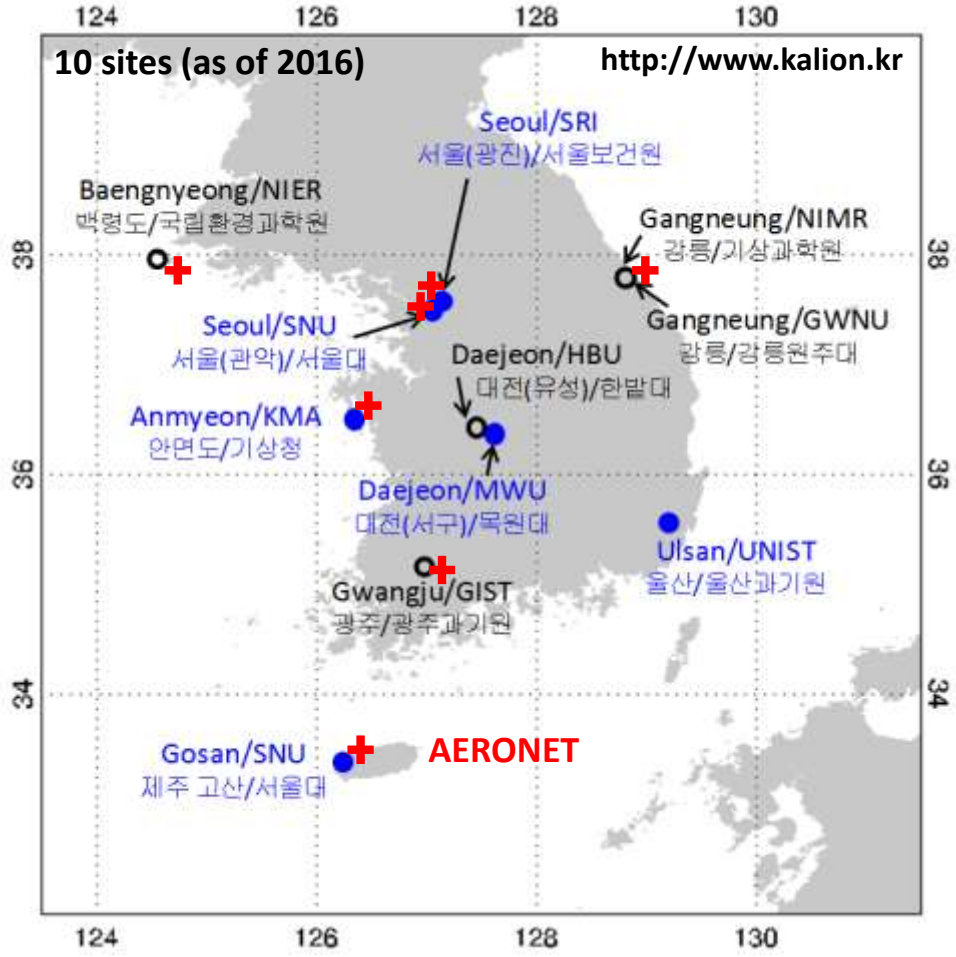
Asian dust and aerosol lidar observation network



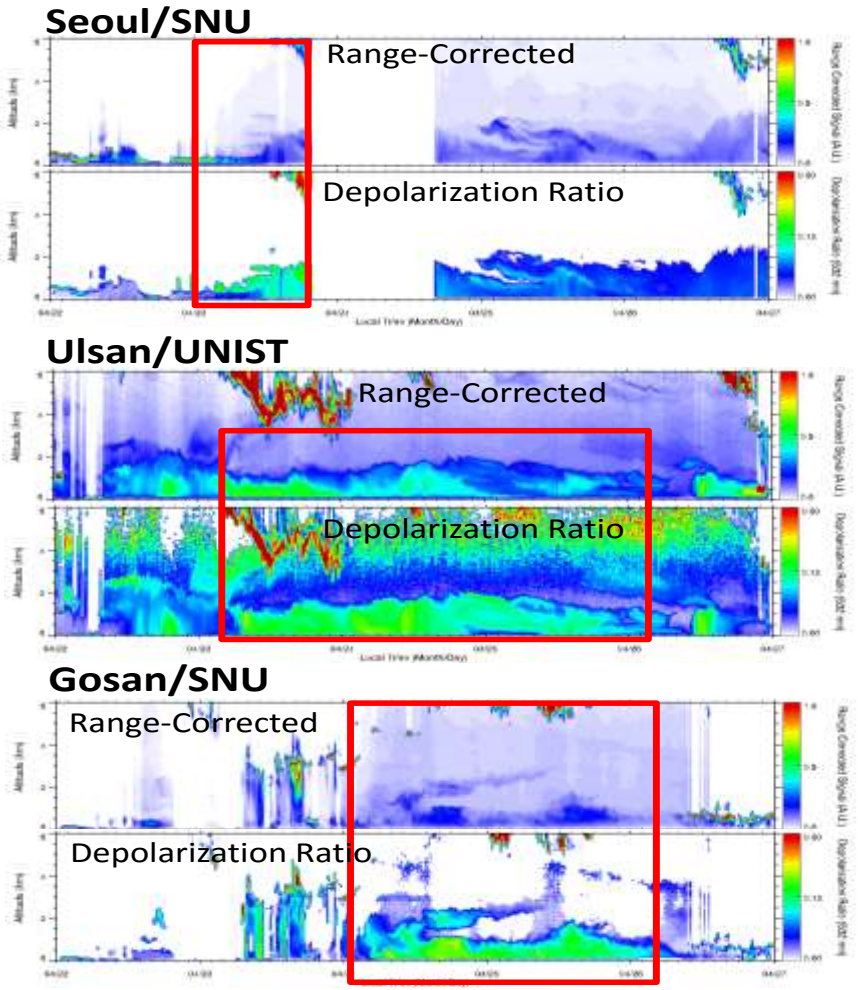
WMO/GAW GALION (MPL-NET, EARLINET, AD-NET, ...)

Comparisons with established remote sensing networks

KALION Korea aerosol lidar observation network



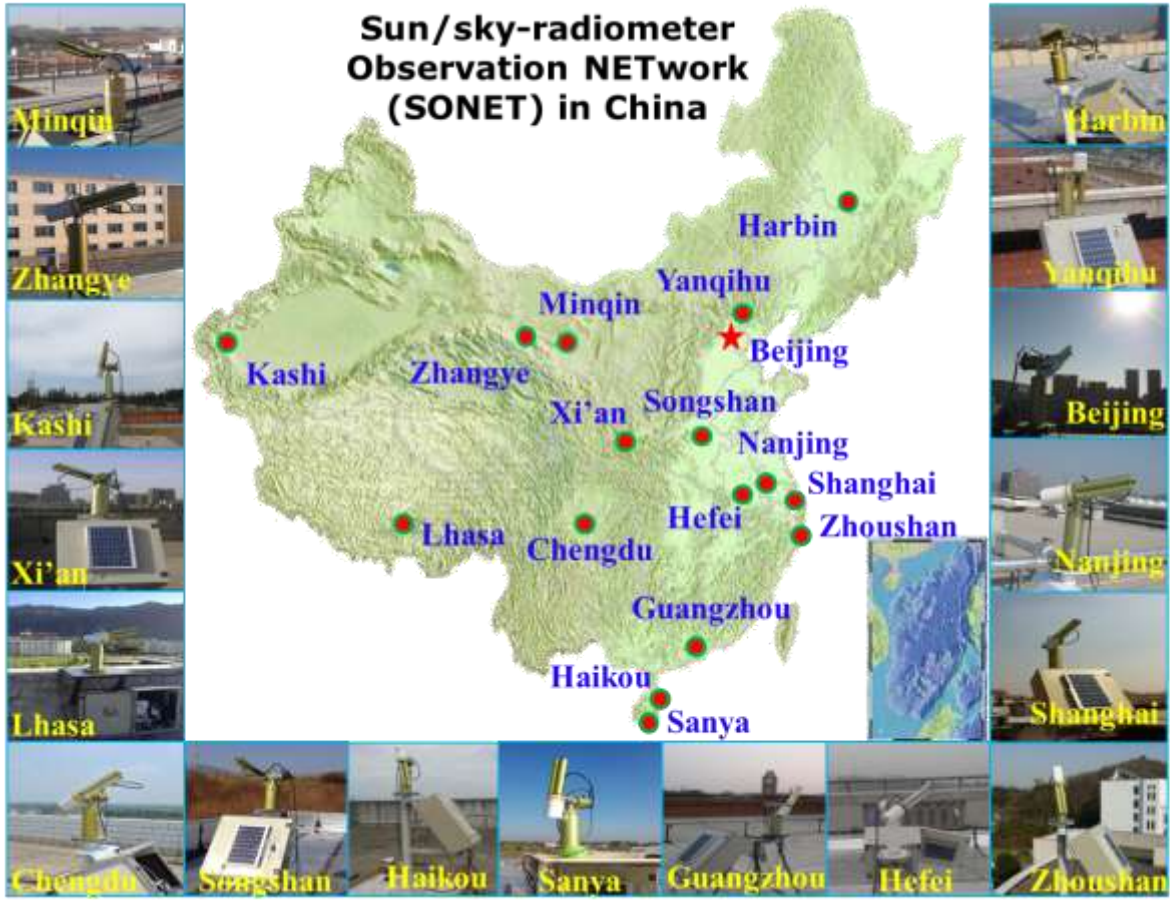
Asian dust event (April 22-25, 2016)



Comparisons with established remote sensing networks

SONET Chinese Sun/sky-radiometer observation network

Courtesy to Zhengqiang LI , 7th GEMS Science Meeting, 2016



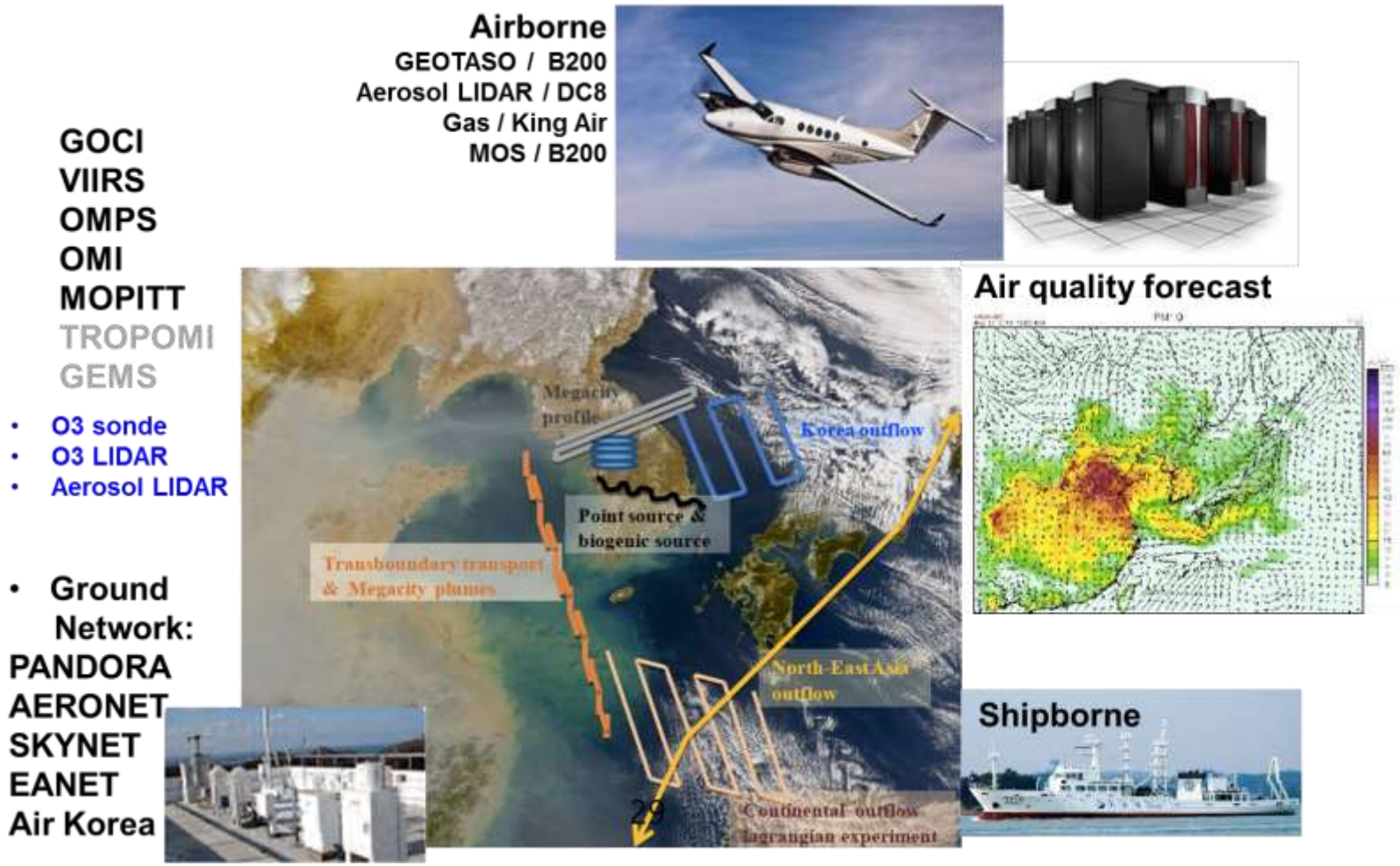
- Total 17 permanent sites since 2010 over China

Site types:

- ☐ Urban
- ☐ Rural
- ☐ Coastal
- ☐ Mountain
- ☐ Basin
- ☐ Plateau
- ☐ Dust
- ☐ Haze

…

Participation in community field campaigns(e.g., KORUS-AQ)



- Developing the **GeoTASO** (on an aircraft) **algorithm** using GEMS retrieval theory.
  ➔ We can verify GEMS algorithms with GeoTASO observations

Collaboration with other instrument teams(e.g., GOME-2, OMPS, TROPOMI)

Instrument	Wavelength range	Spectral resolution	Spectral sampling	Spatial resolution
GOME-2	240 – 790 nm	0.24 – 0.53 nm	0.12-0.21 nm	40*40 km^2
OMPS-nadir Nadir profile (NP)	NP: 250 – 310 nm NM: 300 – 380 nm	1 nm	0.42 nm	NP: 250 km NM: 50 km
TROPOMI	270 – 2385 nm	0.25-0.54 nm	0.07-0.22 nm	7*7 km^2

Including level 1b products

- To determine the quality of the level 2 data products
- Very important because all other data products depend on…

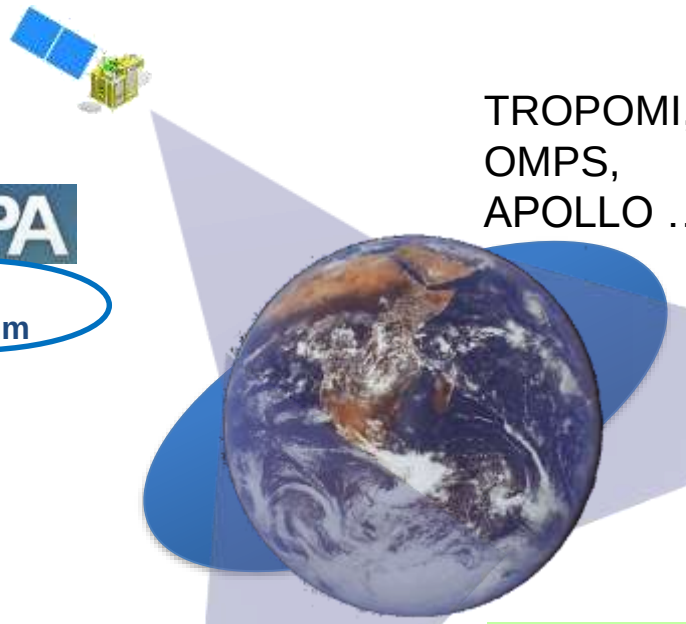
Iterative process

- To improve algorithms when significant improvements are expected
- Specified accuracy requirements are obtained, or the theoretical accuracy limit is reached

Spatial and temporal Collocation

- Ideally, independent data should be selected based on requirements
- If measurements are not available, model results can be used

Constellation of GEO Mission for Synergetic Products



TEMPO
+ GOES-R
(America)

UV-Vis
290-690 nm

TROPOMI,
OMPS,
APOLLO …

Himawari 8
FY-2, 3,
COMS
INSAT …

GEMS + AMI + GOCI2
GEO KOMPSAT
(Asia)

UV-Vis 300-500 nm

UV-Vis-NIR
305-500, 750-775 nm

GMES S4 UVN
+ FCI + IRS
MTG (Europe)

Constellation synergy
- Improving spatial and temporal coverage
  to monitor globalized pollutants & SLCF
- Sharing basic requirements on data products and
  instrument to maintain data quality
- Consolidating socio-economic benefit analysis
- Supporting QA and CAL/VAL

The CEOS Air Quality Satellite Constellation

(Jay Al-Saadi, 7th GEMS Science Meeting, 2016)

	Europe Sentinel 4	USA TEMPO	Korea GEMS	Europe Sentinel 5 Precursor TROPOMI
Orbit	Geostationary	Geostationary	Geostationary	Low-Earth
Domain	Europe and surrounding	North America	Asia-Pacific	Global
Revisit	1 hour	1 hour	1 hour	1 day
Status	Detailed Design, Phase C	Instrument delivery 2017	Instrument delivery 2017	Instrument complete
Launch	2021 (Flight Acceptance Review first instrument)	2019-2021 pending host selection	2019	2017
Payload	UV-Vis-NIR 305-500, 750-775 nm	UV-Vis 290-490, 540-740 nm	UV-Vis 300-500 nm	UV-Vis-NIR-SWIR 270-500, 675-775, 2305-2385 nm
Products	O_3, trop. O_3, NO_2, SO_2, HCHO, AAI, AOD, height-resolved aerosol	O_3, trop. O_3, 0-2km O_3, NO_2, HCHO, SO_2, CHOCHO, AOD, AAI	O_3, NO_2, SO_2, HCHO, AOD	O_3, trop. O_3, NO_2, SO_2, HCHO, AAI, AOD, height-resolved aerosol, CO, CH_4
Spatial Sampling	8 km x 8 km at 45N	≤ 2.22 km N/S x 5.15 km E/W @35N	3.5 km N/S x 8 km E/W @38N	7 km x 3.5 km nadir
Nominal product resolution	8.9 km N/S x 11.7 km E/W @40N	≤ 8.88 km N/S x 5.15 km E/W @35N	7 km N/S x 8 km E/W @38N (gas), 3.5 km N/S x 8 km E/W @38N (aerosol)	7 km x 7 km nadir
Notes	Two instruments in sequence on MTG-S; use TIR sounder on MTG-S (expected sensitivity to O3 and CO). Synergy with imager on MTG-I w.r.t. aerosol and clouds.	GEO-CAPE precursor or initial component of GEO-CAPE. Synergy with GOES-R/S ABI w.r.t. aerosol and clouds.	Synergy with AMI and GOCI-2 instruments w.r.t. aerosol and clouds.	In formation with S-NPP for synergy w.r.t. clouds and O_3.

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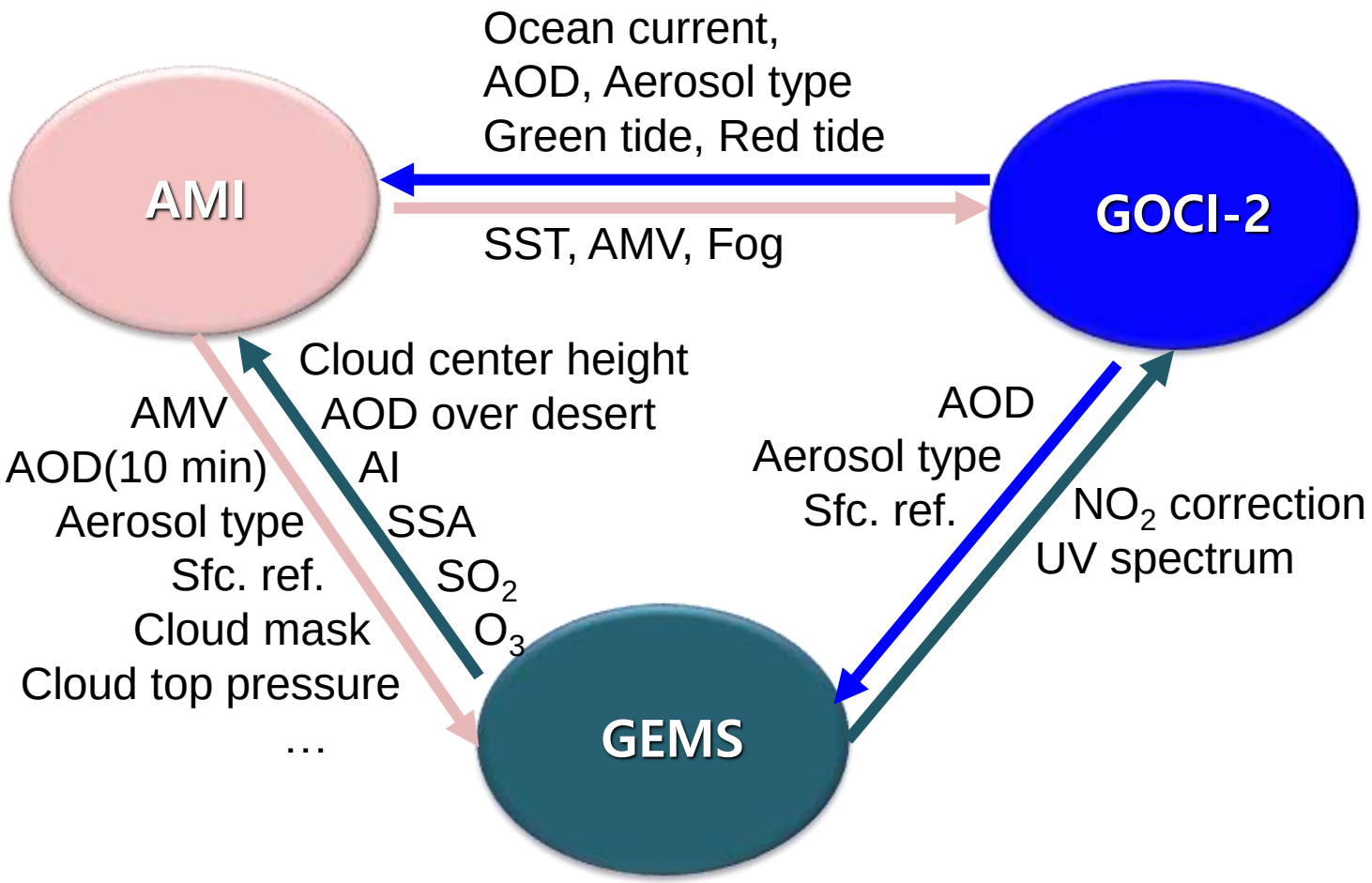
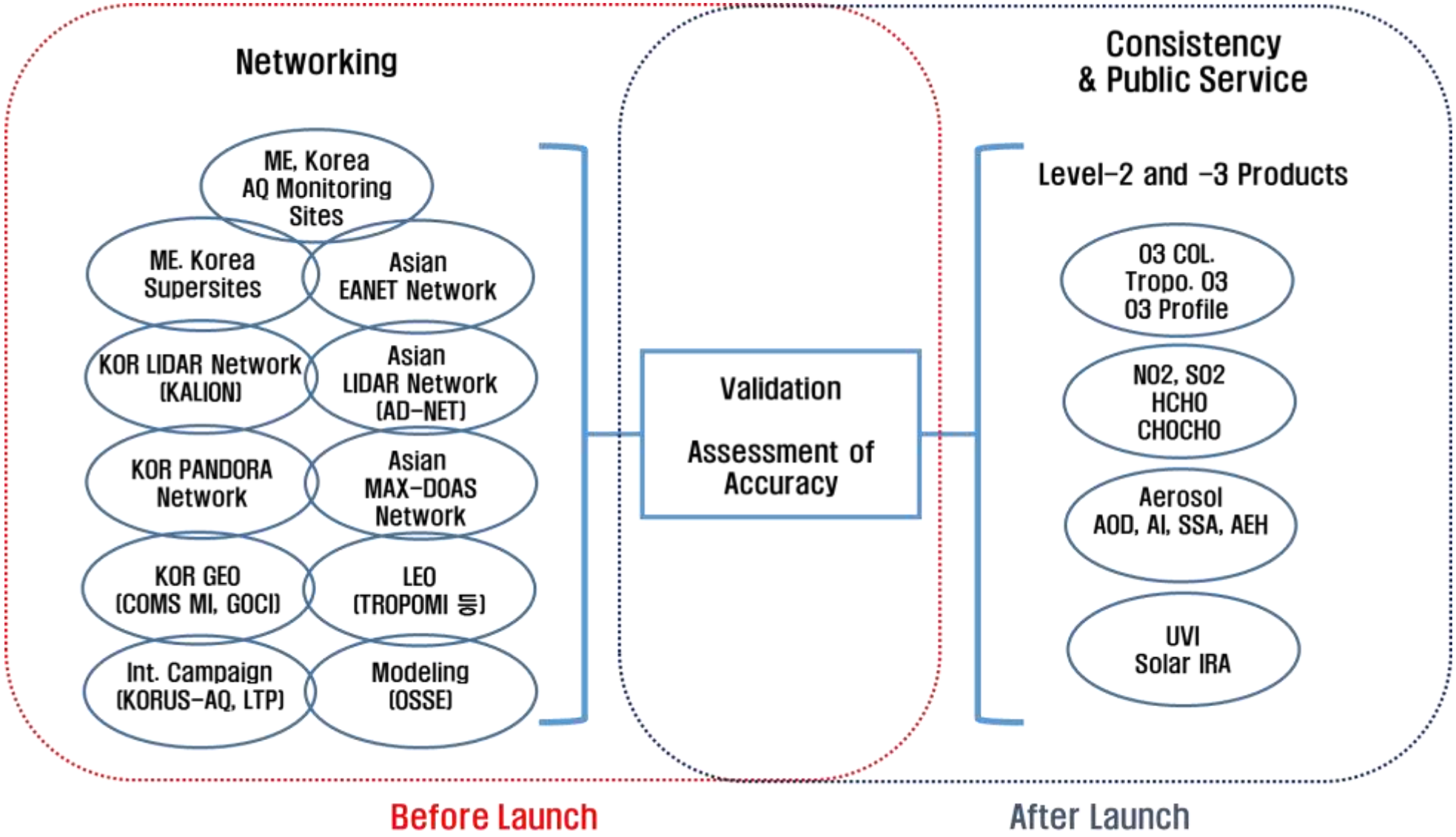
Synergistic products with 3 Korean GEO missions



- ✓ 24 hr Asian dust monitoring over dark and bright surface
- ✓ PBL thickness
- ✓ Cloud morphology (thickness, fraction, type …)

Summary


Networking
ME. Korea AQ Monitoring Sites
ME. Korea Supersites
Asian EANET Network
KOR LIDAR Network (KALION)
Asian LIDAR Network (AD-NET)
KOR PANDORA Network
Asian MAX-DOAS Network
KOR GEO (COMS MI, GOCI)
LEO (TROPOMI 외)
Int. Campaign (KORUS-AQ, LTP)
Modeling (OSSE)
Validation
Assessment of Accuracy
Consistency & Public Service
Level-2 and -3 Products
O3 COL. Tropo. O3 O3 Profile
NO2, SO2 HCHO CHOCHO
Aerosol AOD, AI, SSA, AEH
UVI Solar IRA
Before Launch
After Launch

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GEMS Science Team

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KARI

GEMS Science Team

Changwoo Ahn
Jay Al-Saadi
P.K. Bhartia
Kevin Bowman
Greg Carmichael
Kelly Chance
Mian Chin
Yunsoo Choi
Ron Cohen
Russ Dickerson
David Edwards
Annmarie Eldering
Ernest Hilsenrath
Daneil Jacob
Scott Janz
Glen Jaross
Siwan Kim
Thomas Kurosu
Qinbin Li
Xiong Liu
Randall Martin
Steve Massie
Jack McConnel*
Tom McElroy
Jessica Neu
Mike Newchurch
Stan Sander
Jochen Stutz
Omar Torres
Dong Wu
Liang Xu
Ping Yang
Dusanka Zupanski
Milija Zupanski

Beri Ahlers
Heinrich Bovensmann
John Burrows
Marcel Dobber
Joerg Langen
Pieternel Levelt
Ulrich Platt
Piet Stamnes
Pepijn Veefkind
Ben Veihelmann
Thomas Wagner

Myung Hwan Ahn
Yong Sang Choi
Myeongjae Jeong
Jae Hwan Kim
Young Joon Kim
Hanlim Lee
Kwang Mog Lee
Rokjin Park
Seon Ki Park
Chul Han Song
Jung Hun Woo
Jung-Moon Yoo

Seung Hoon Lee
Sang Soon Yong
D.G. Lee
J.P. Gong
Dai Ho Ko
S.H. Kim
J.H. Yeon
Y.C. Youk
…

Ji-hyung Hong
Lim Seok Chang
Sang-kyoon Kim
Chang Keun Song
Jae-Hyun Lim
K.J. Moon

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H.W. Seo
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Sachiko Hayashida
Hitoshi Irie
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Thank you for attention !!

Collaboration opportunity with you is always open..

Please contact to;

Prof. C. K. Song <cksong@unist.ac.kr>

and

Prof. Jhoon Kim, PI of GEMS <jkim2@yonsei.ac.kr>