Aerosol Property Retrieval from GOCI and AHI : Implications for AMI

Jhoon Kim[1], Seoyoung Lee[1], Hyunkwang Lim[1], Sujung Go[1], and Myungje Choi[1,2]

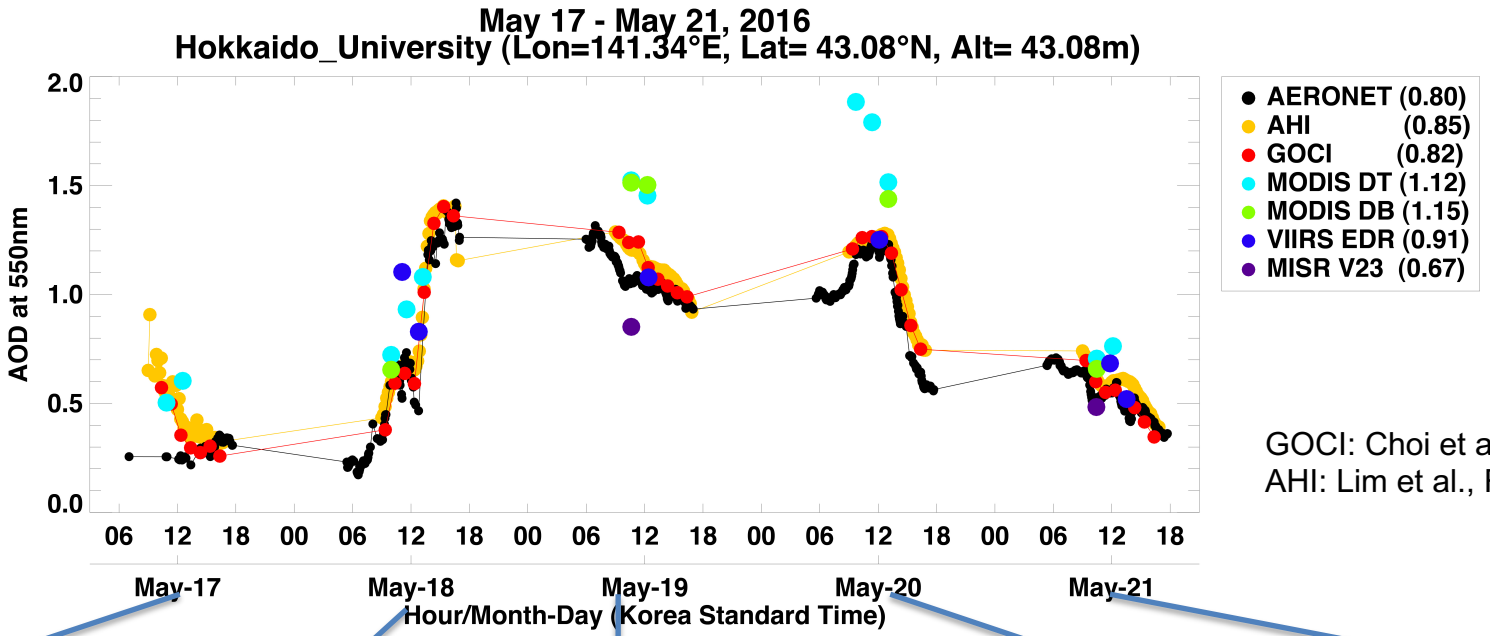
[1]Yonsei University, Seoul, Korea

[2]NASA JPL, Pasadena, CA

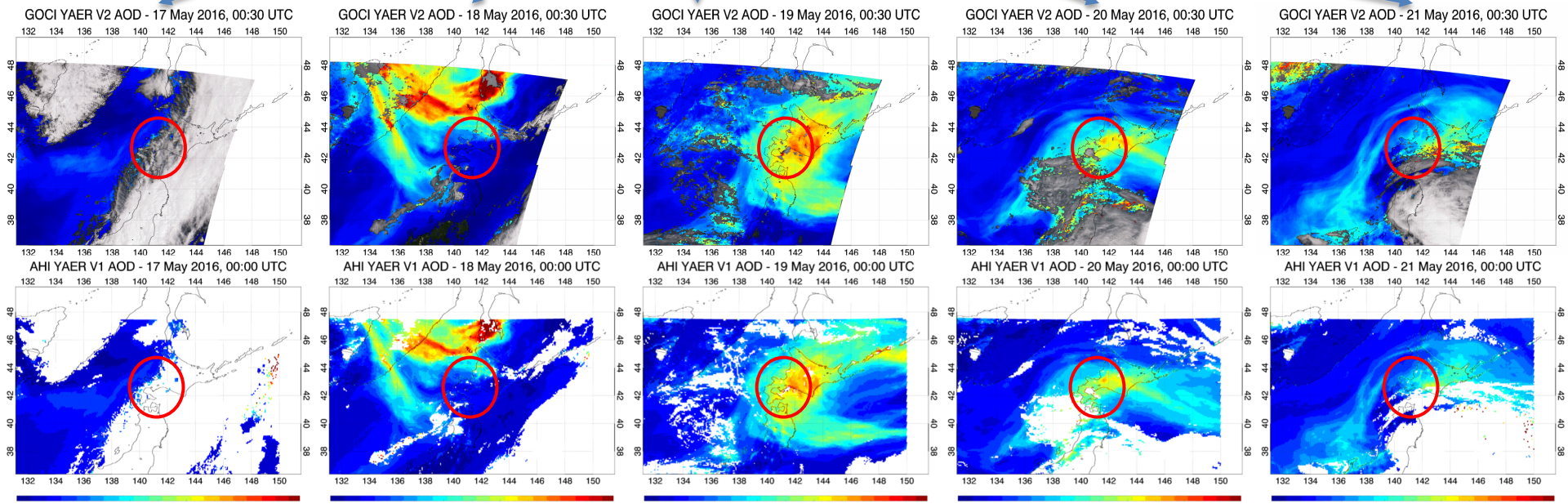
Outline

- Introduction
- Aerosol Properties from GEO
  - GOCI
  - AHI
  - Merged Products
- Application of GEO sat data
  - Trend analysis
  - PM 2.5 estimation
  - Data Assimilation
- Summary

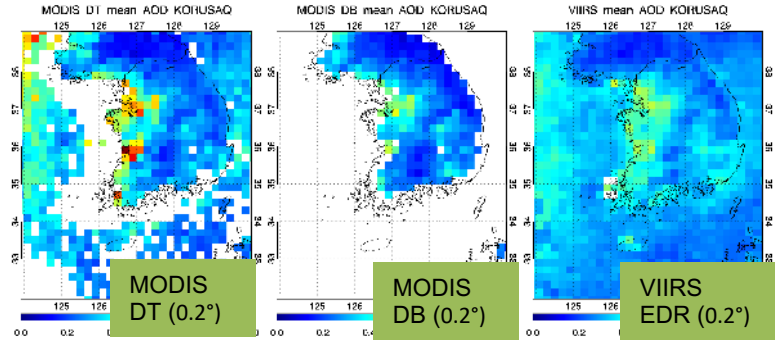
Diurnal variation for aerosol from GOCI and AHI

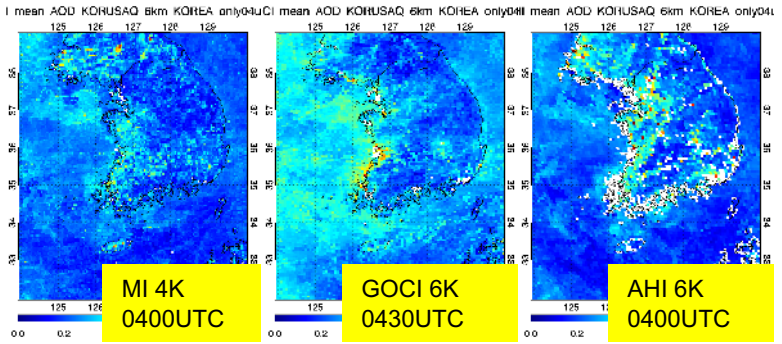


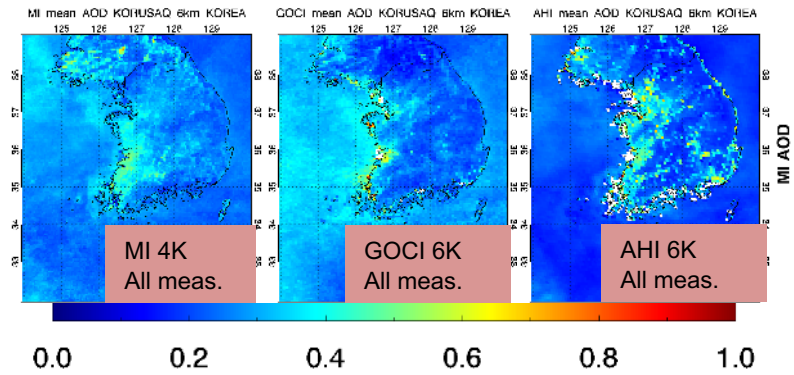
GOCI: Choi et al., AMT, 2018
AHI: Lim et al., RS, 2018

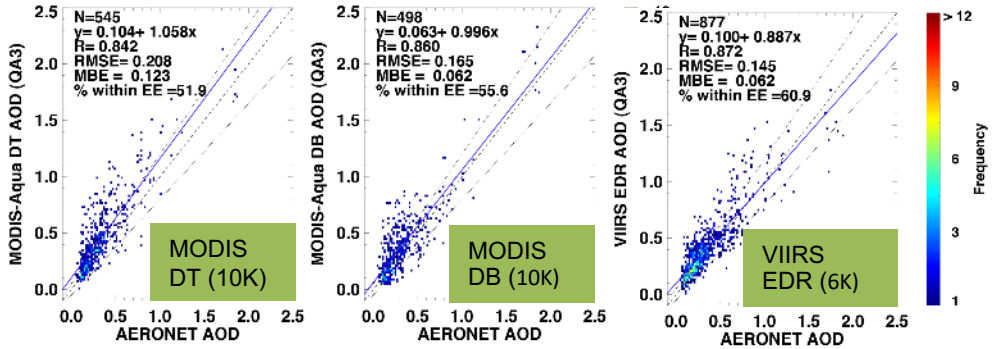


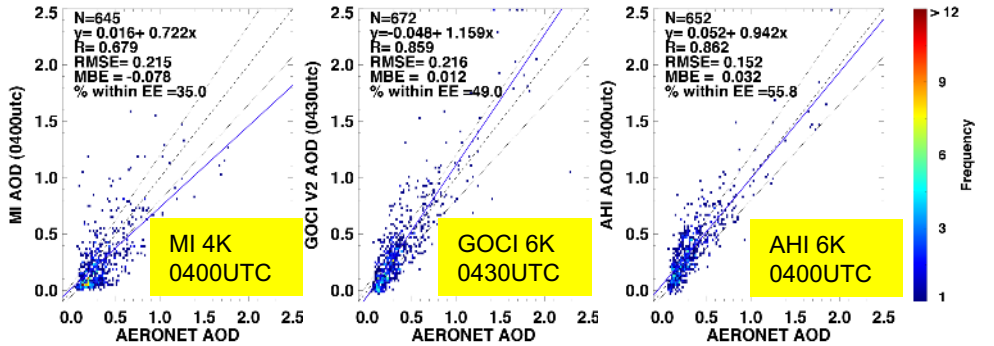
Mean AOD dist. and validation during the KORUS-AQ

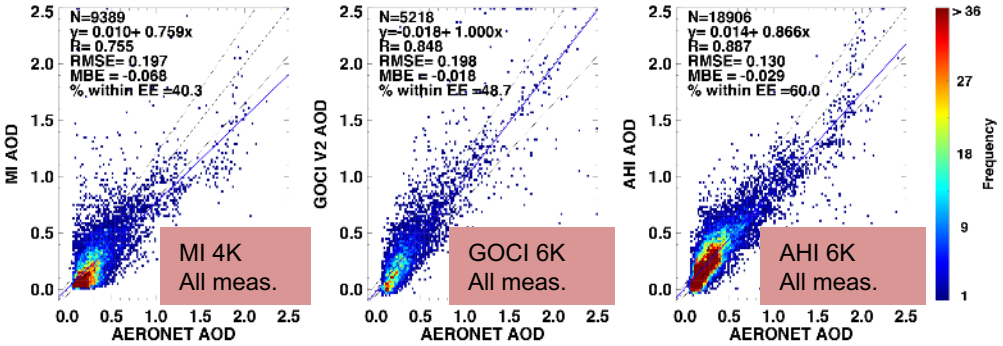








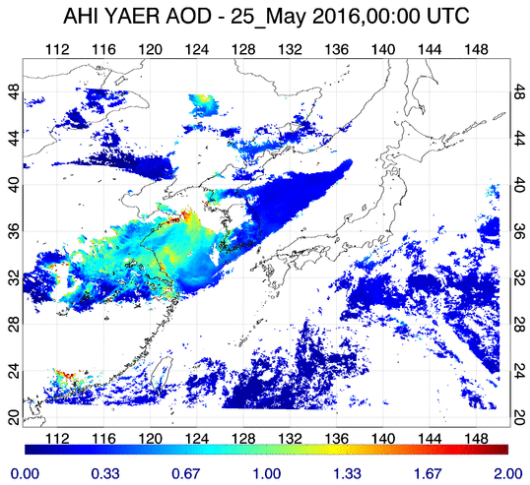




- High AOD over Western part of Korea

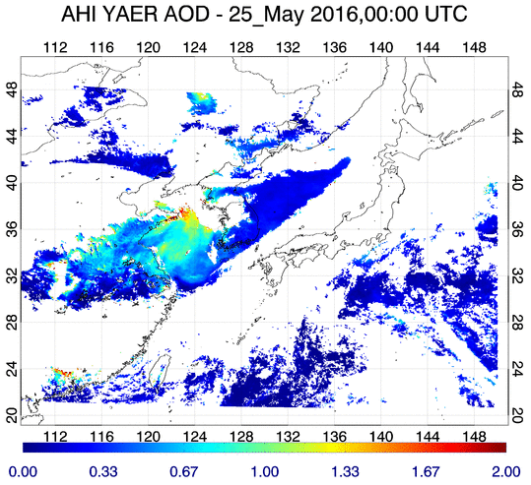
- More frequent GEO measurement
  → 10-30 times higher in No. of collocated data
- Similar accuracy with LEO

Data Merging: 25 May 2016(AHI+GOCI)



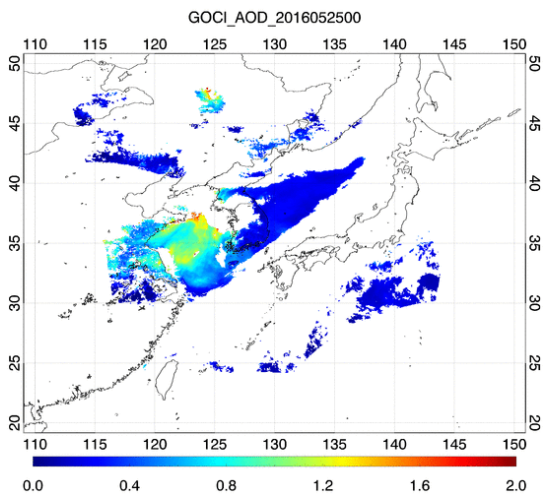
R=0.888
%EE = 60.6

AHI_ESR



AHI_MRM

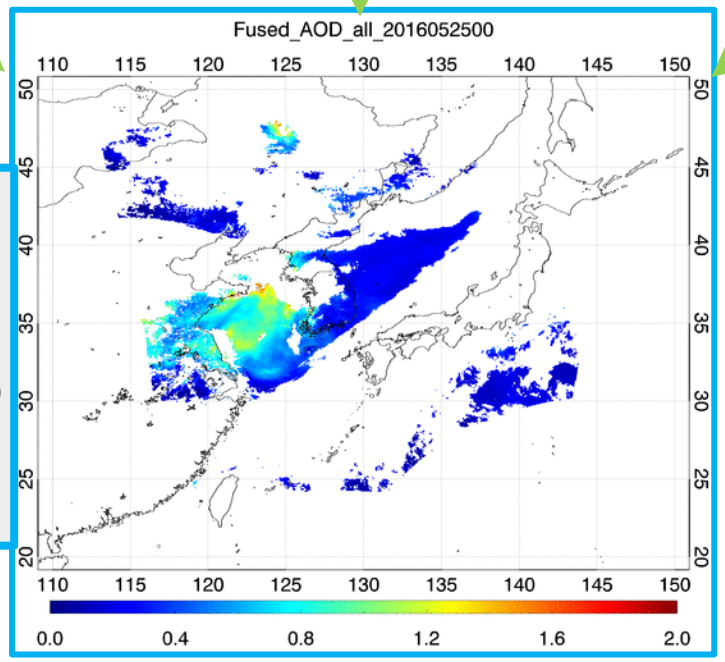
R=0.908
%EE = 63.5



GOCI

R=0.902
%EE = 61.8

Merged AOD



R=0.918
%EE = 73.4

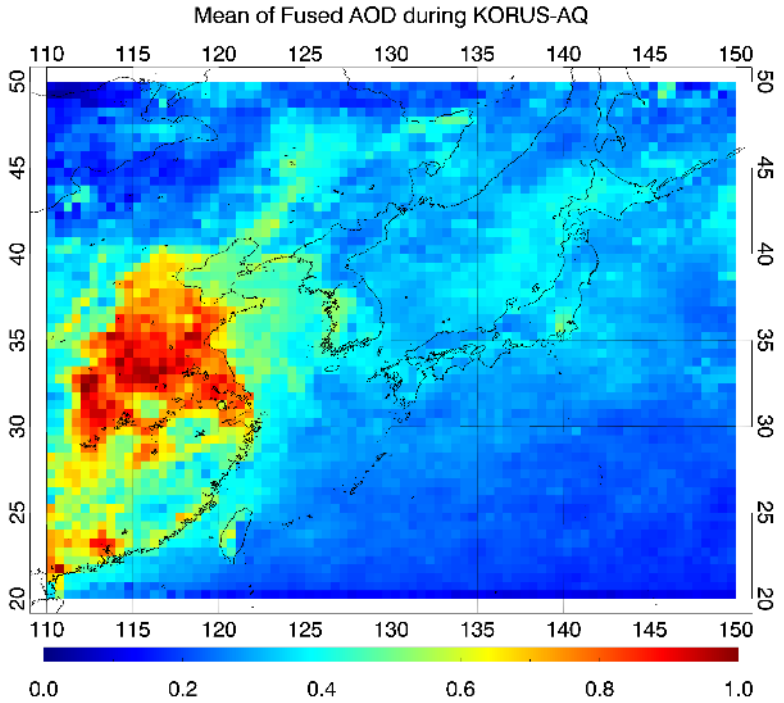
- ✓ Resample AHI AOD with GOCI pixel.
- ✓ To estimate hourly AOD using 10-minute intervals dataset (Improvement of cloud mask).

GOCI: Choi et al., AMT, 2018
AHI: Lim et al., RS, 2018

KORUS-AQ Daily Merged AOD product (0.5°×0.5° grid)

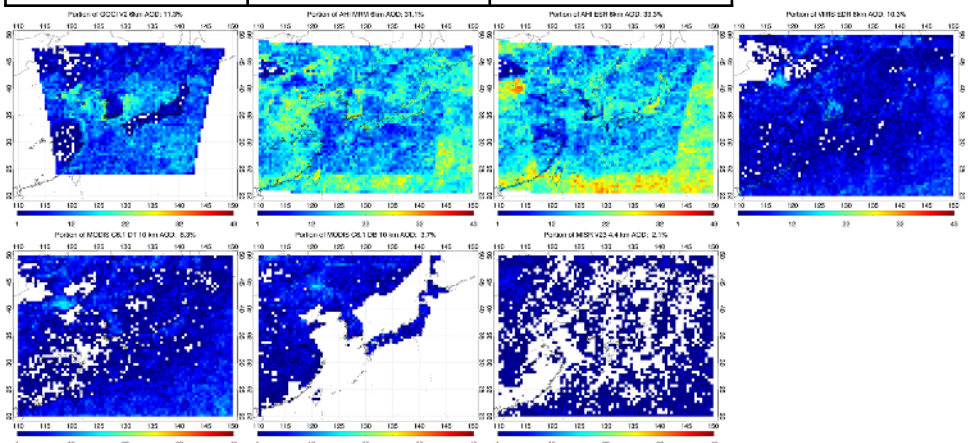
- Purpose: finding daily representative AOD from multiple LEO and GEO AOD products
- Study domain: 110-150°E, 20-50°N (0.5°×0.5° lon-lat grid resolution)
- Order of calculation

1) Spatiotemporal mean for each product within each day
   - Spatial gridding for each scene, and temporal averaging for daily mean.
   - additional filtering based on *Hyer et al. (2011) to reduce cloud contamination*
2) For each grid, select **median value AOD** product as daily representative AOD (only when at least two products are available)
3) Average of daily fused AOD during the Campaign period (5/1-6/12)



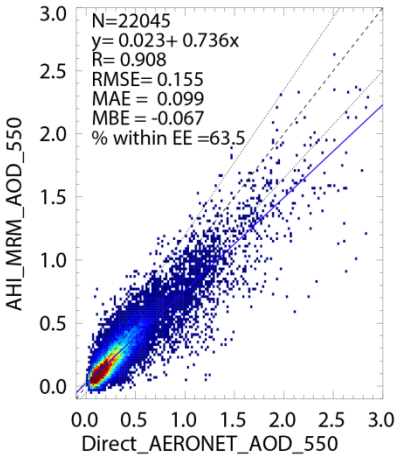
Portion for Fused AOD

GOCI	AHI MRM	AHI ESR	VIIRS EDR
11.3%	31.1%	33.3%	10.3%
MODIS DT	MODIS DB	MISR	
8.3%	3.7%	2.1%	

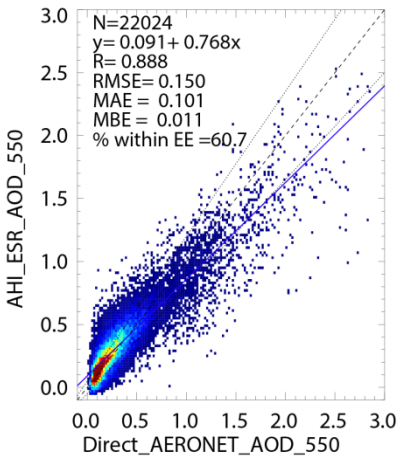


Results of MLE in 2016

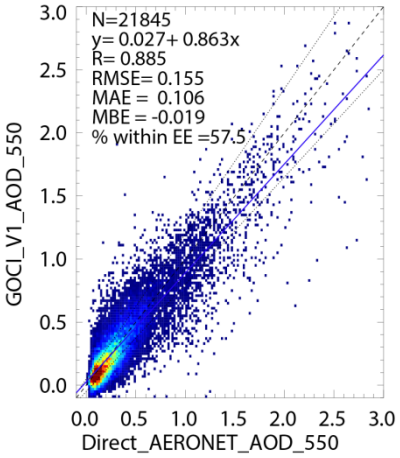
AHI_MRM



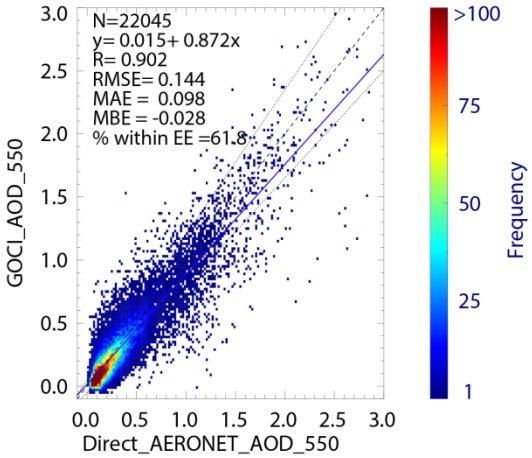
AHI_ESR

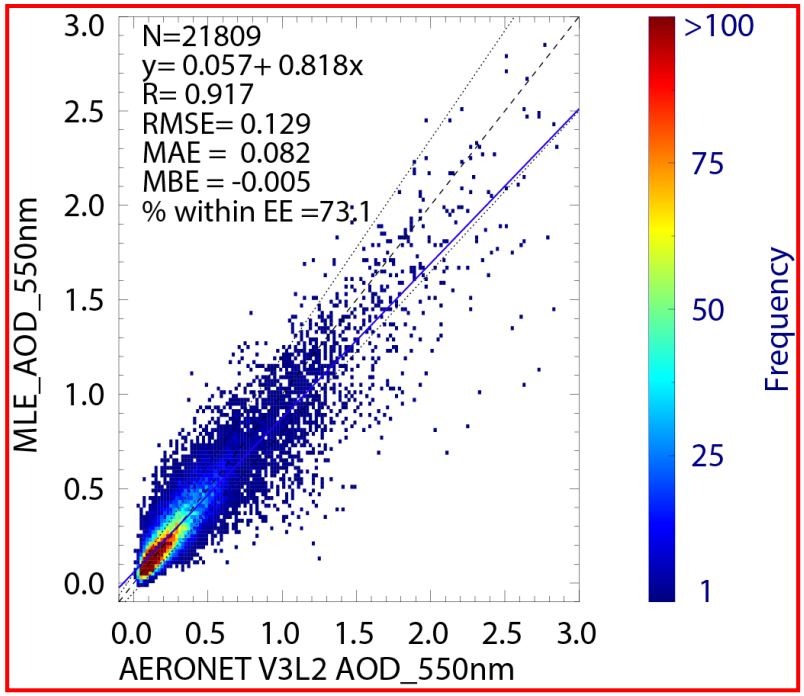


GOCI_V1

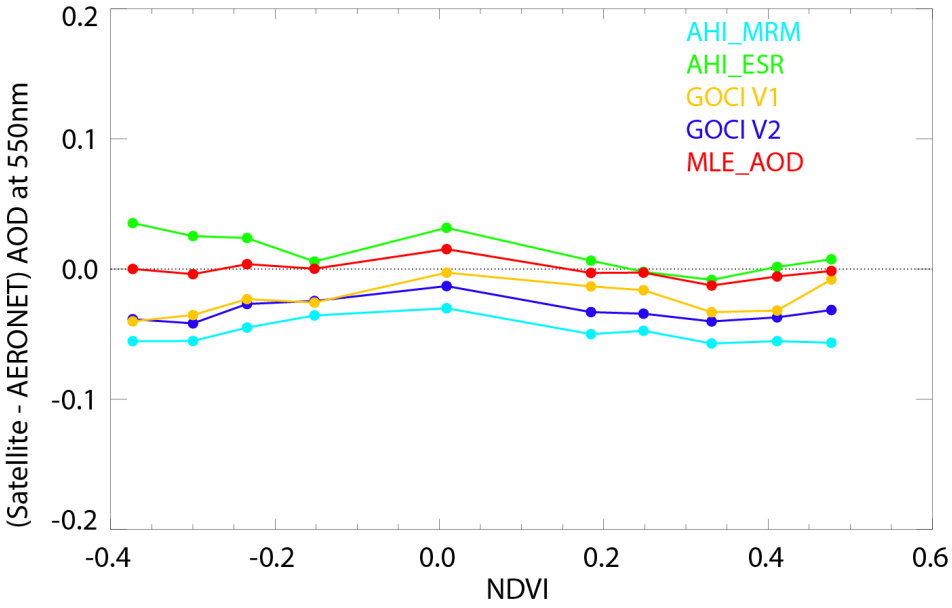


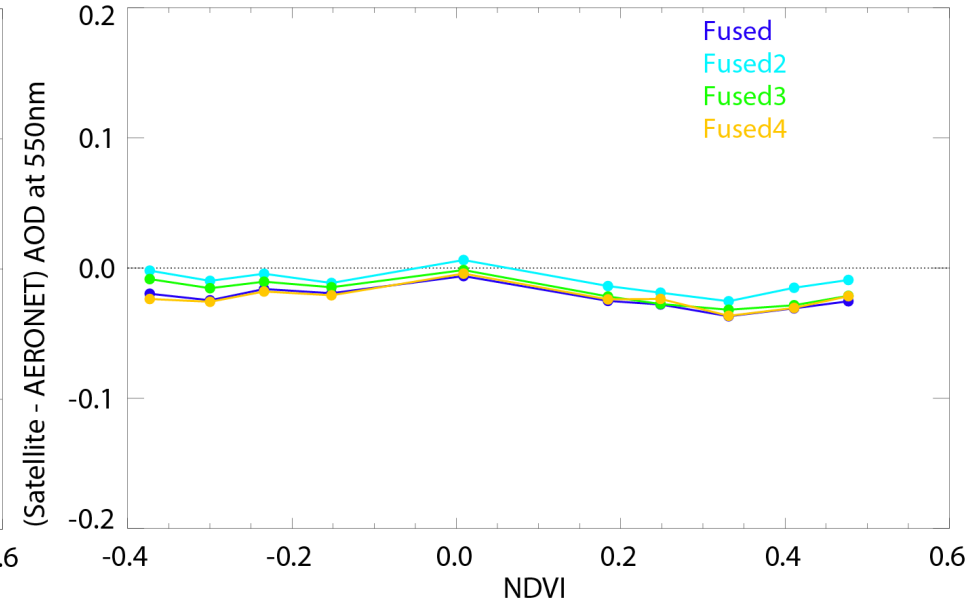
GOCI_V2

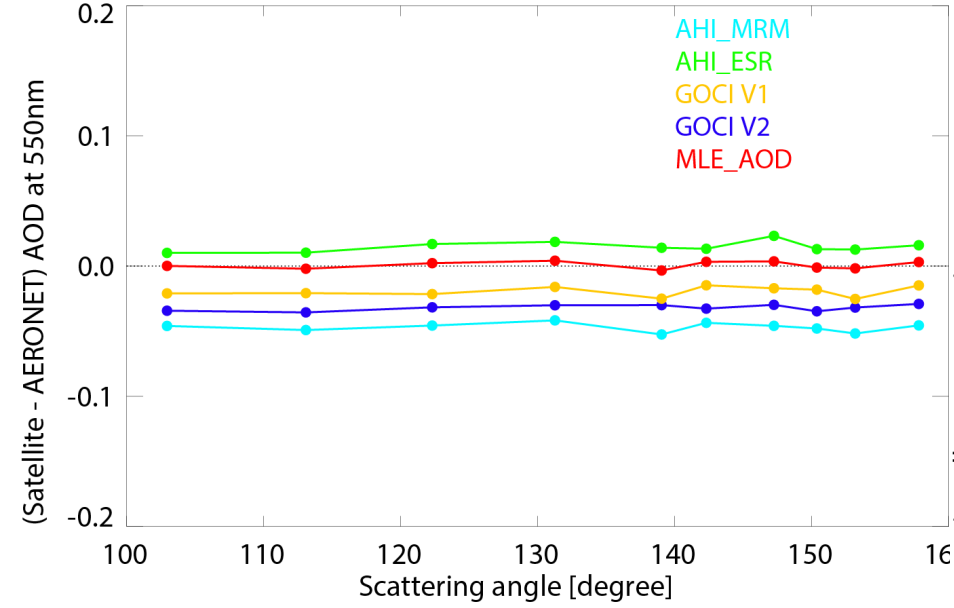


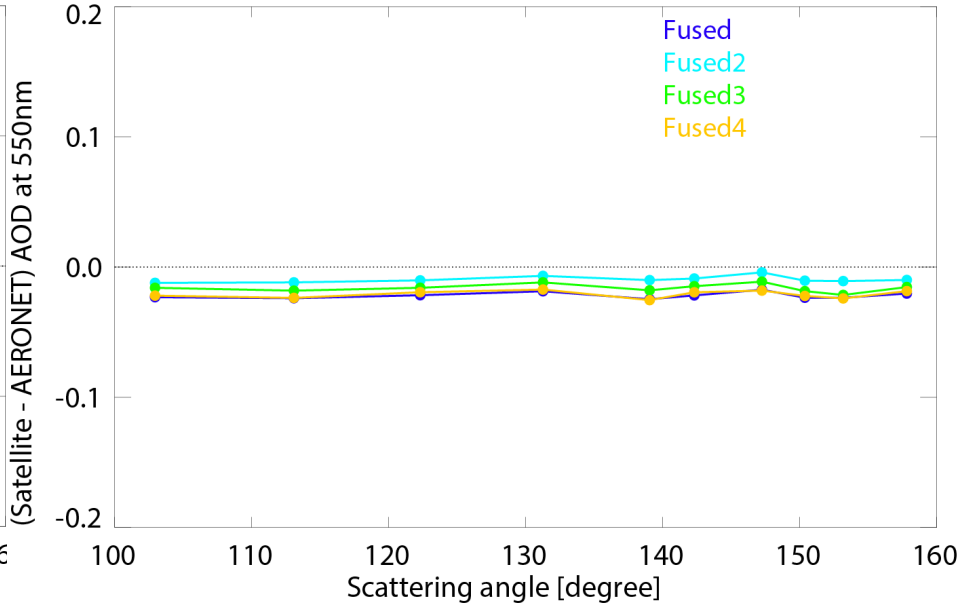


Comparison of Biases (2016)

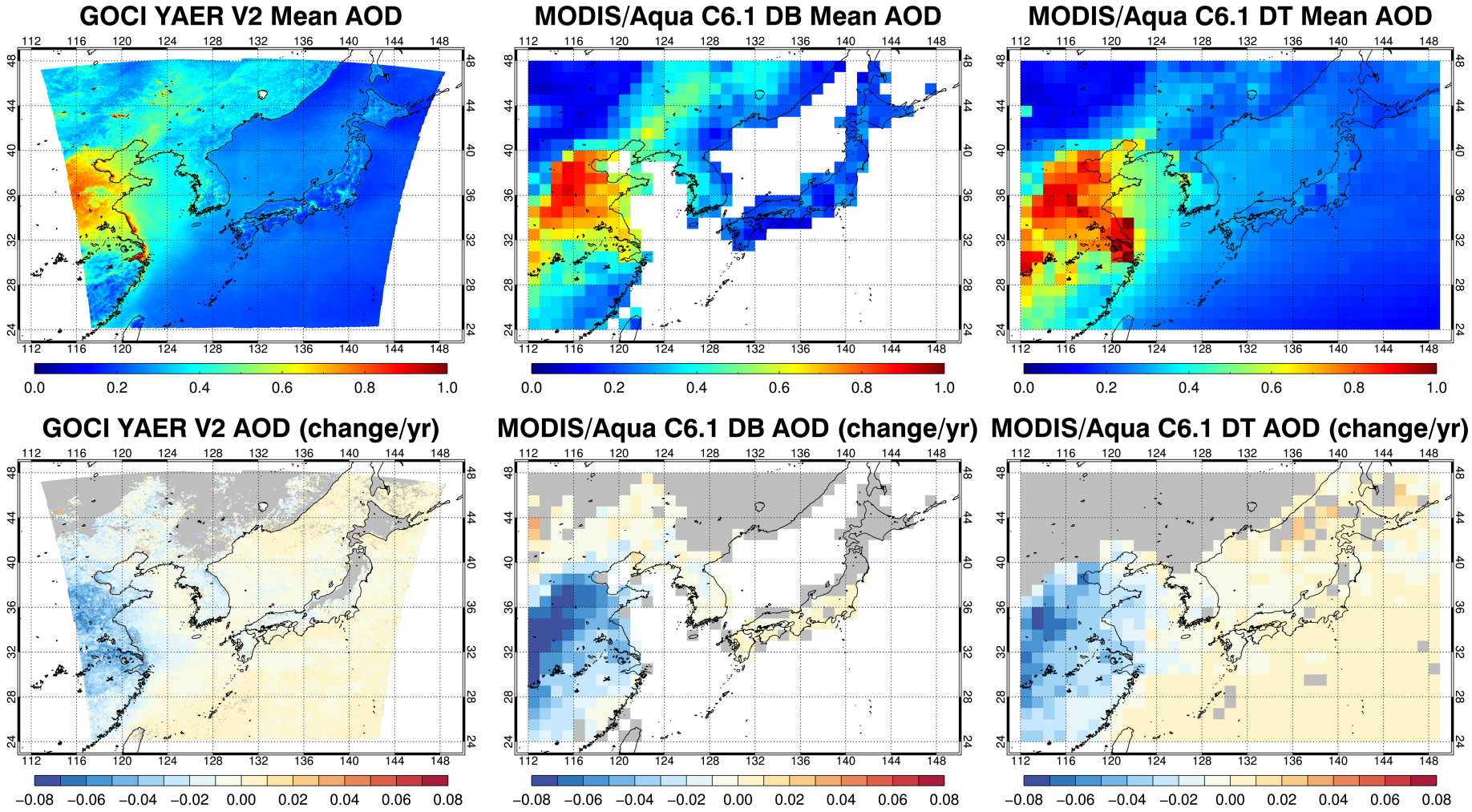






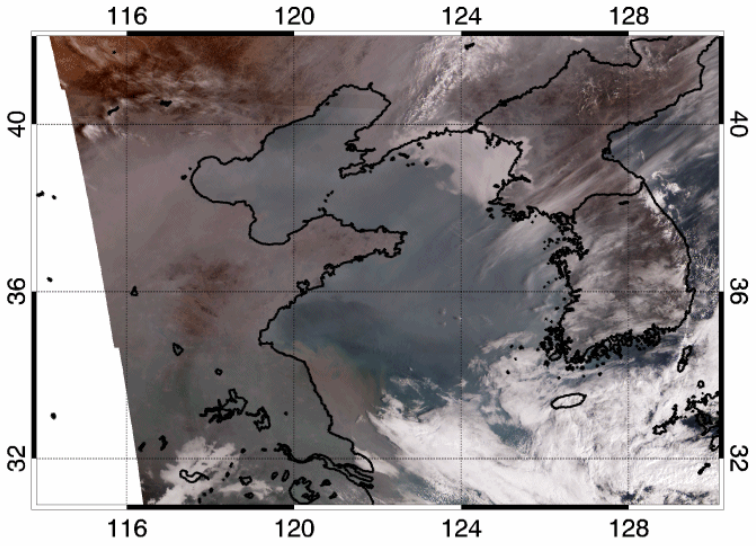


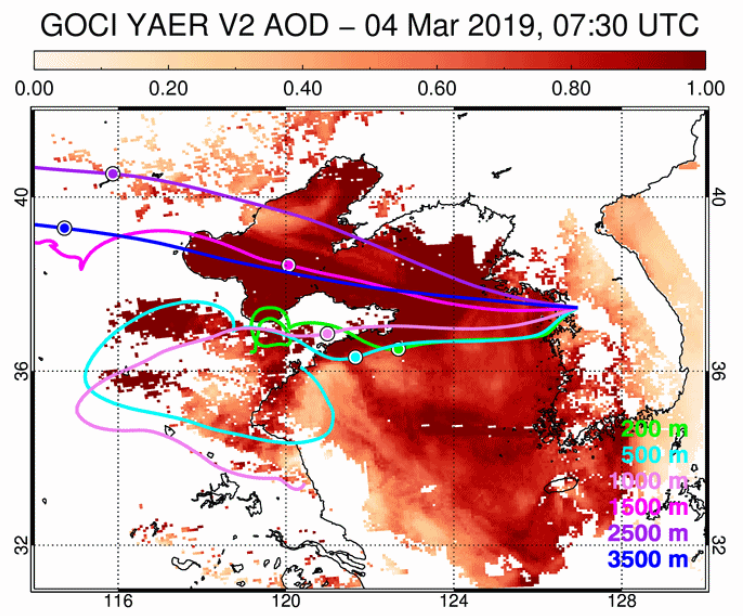
Mean AOD and Trends (Mar 2011 - Feb 2018)

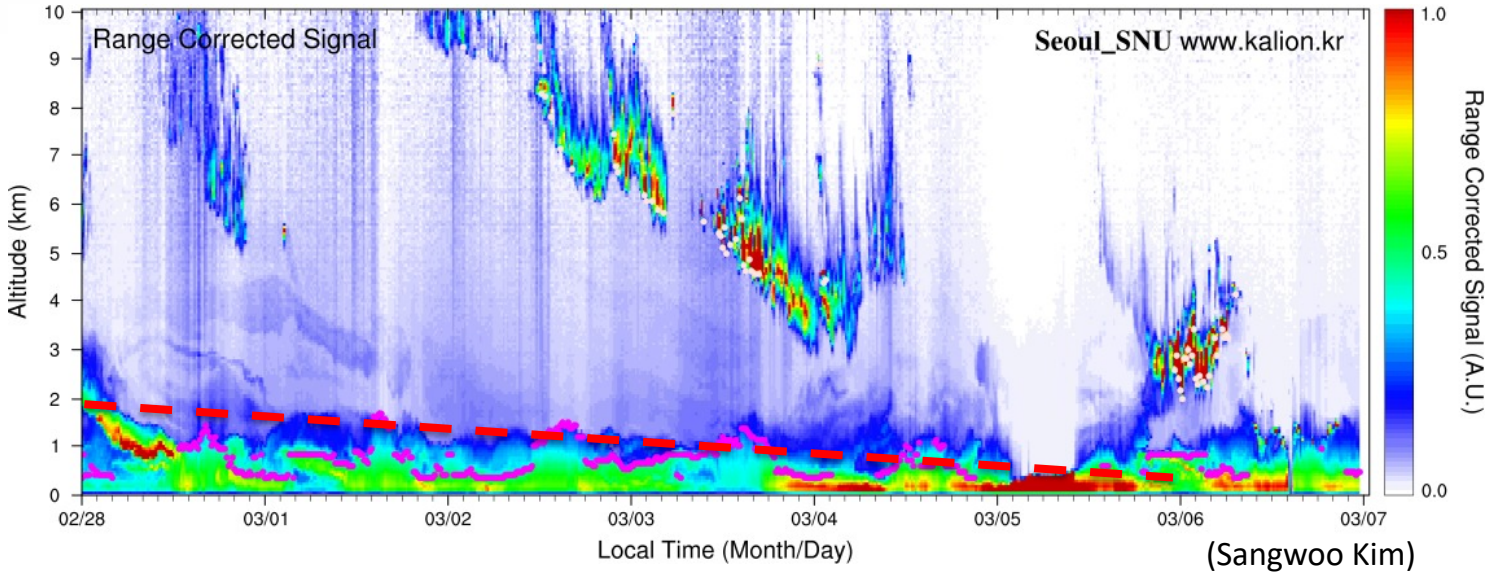


- For pixels with data points more than 80% of the period only
- Color: Statistically significant at the 95% confidence level (gray: no statistically significant, not enough data points)
- GOCI: 6 km spatial resolution, MODIS DT, DB: 1 degree grid

Detection of Long Range Transport: case of March 4, 2019







(Sangwoo Kim)

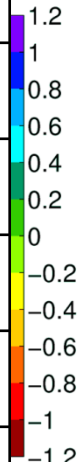
Channels from GEO Satellites over E. Asia

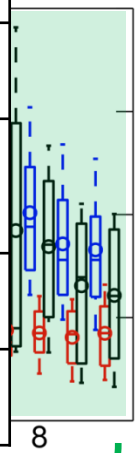
(unit: μm)

Channel No	Channel	AMI	AHI	MI	GOCI-1	GOCI-2	GEMS
1	VIS(blue)	0.470	0.46		- 0.412 0.443	0.380 0.412 0.443	0.3 – 0.5 1000 channels
2	VIS(green)	0.511	0.51		0.490 - 0.555	0.490 0.510 0.555	
3	VIS(red)	0.640	0.64	0.675	- 0.660 0.680 - 0.745	0.620 0.660 0.680 0.709 0.745	
4	VNIR	0.865	0.86		0.865	0.865	
5	SWIR	1.380					
6	SWIR	1.610	1.6				
			2.3				
7	MWIR	3.830	3.9	3.75			
8	MWIR(WV)	6.241	6.2				
9	MWIR(WV)	6.952	7.0	6.75			
10	MWIR(WV)	7.344	7.3				
11	TIR	8.592	8.6				
12	TIR	9.625	9.6				
13	TIR	10.403	10.4	10.8			
14	TIR	11.212	11.2				
15	TIR	12.364	12.3	12.0			
16	TIR	13.31	13.3				
Reference			Lim et al. (RS 2018)	Kim et al (IJRS 2008)	Choi et al (AMT 2016)	Choi et al (AMT 2018)	Kim et al (revised)

Data Assimilation of GOCI AOD data

	Model / data used	Product
Park et al., ACP, 2014	CMAQ , DA	DA, to quantify long range transport
Saide et al., GRL, 2014	WRF-Chem, DA	DA, surface PM validation
Xu et al., ACP, 2015	GEOS-Chem	Surface PM2.5
Xiao et al., ACP, 2016	VIIRS, GOCI, MODIS AOD	Validation
Lee et al., GMD, 2016	CMAQ	To improve PM forecast
Jeon et al., GMD, 2016	CMAQ + STOPs v1.5	To Improve PM10 forecast
Pang et al., AE, 2018	WRF-Chem 3D Var	To improve PM2.5 forecast
Ed Hyre et al. JCSDA news., 2018	NAAPS	sub-daily variation comparison with model and observation (AERONET, GOCI, MODIS)
Lee et al., RSE, 2017	WRF-Chem, DA using OMI	Evaluation of DA using GOCI
Lennartson et al ACP, 2018	AERONET, GOCI, in-situ PM2.5, WRF-Chem	Comparison of diurnal variation of AOD and PM2.5





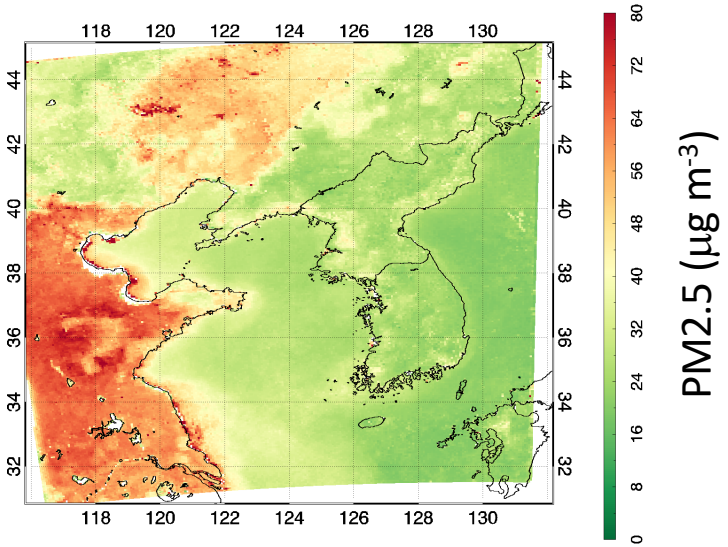
Day

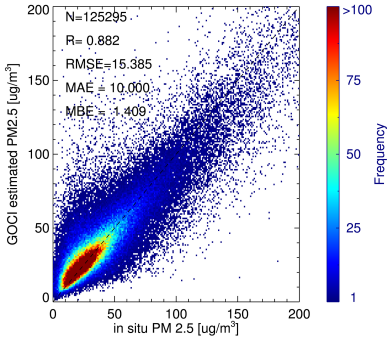
Dust Anthro Anthro Smoke Anthro

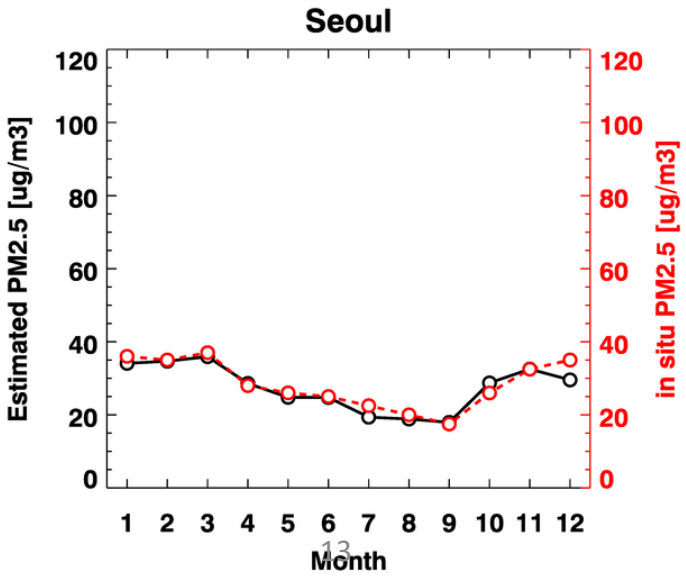
Saide et al., GRL 2014

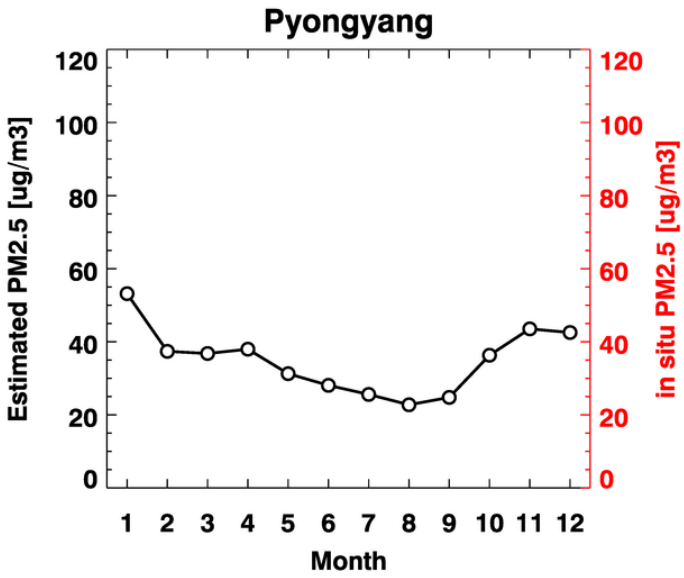
Column to Surface Concentration – Aerosol

- Machine Learning Algorithm
- Monthly average estimated PM2.5 and in situ $PM_{2.5}$, 2017









Summary

- The retrieved GOCI V2 AOPs show reliable qualities against ground-based AERONET. YAER algorithm is being improved for GOCI-II with its higher spatial resolution of 250 m and additional channels in UV.
- Aerosol products from GOCI (hourly) and AHI (every 10 minute) YAER algorithm provide diurnal variation information of aerosols. Therefore, these can provide observational dataset for data assimilation with air-quality forecasting over Asia.
- Merged dataset from different satellites and algorithm provide improved results with reduced bias and better spatial coverage.
- PM estimation from satellite AOD has been demonstrated using CTMs and machine learning algorithms, both of which showed reasonable results. Further studies are undergoing to improve accuracy.

Acknowledgement

AHI dataset – Yasko Kasai, GOCI – KIOST, AMI – KMA, GEMS – NIER