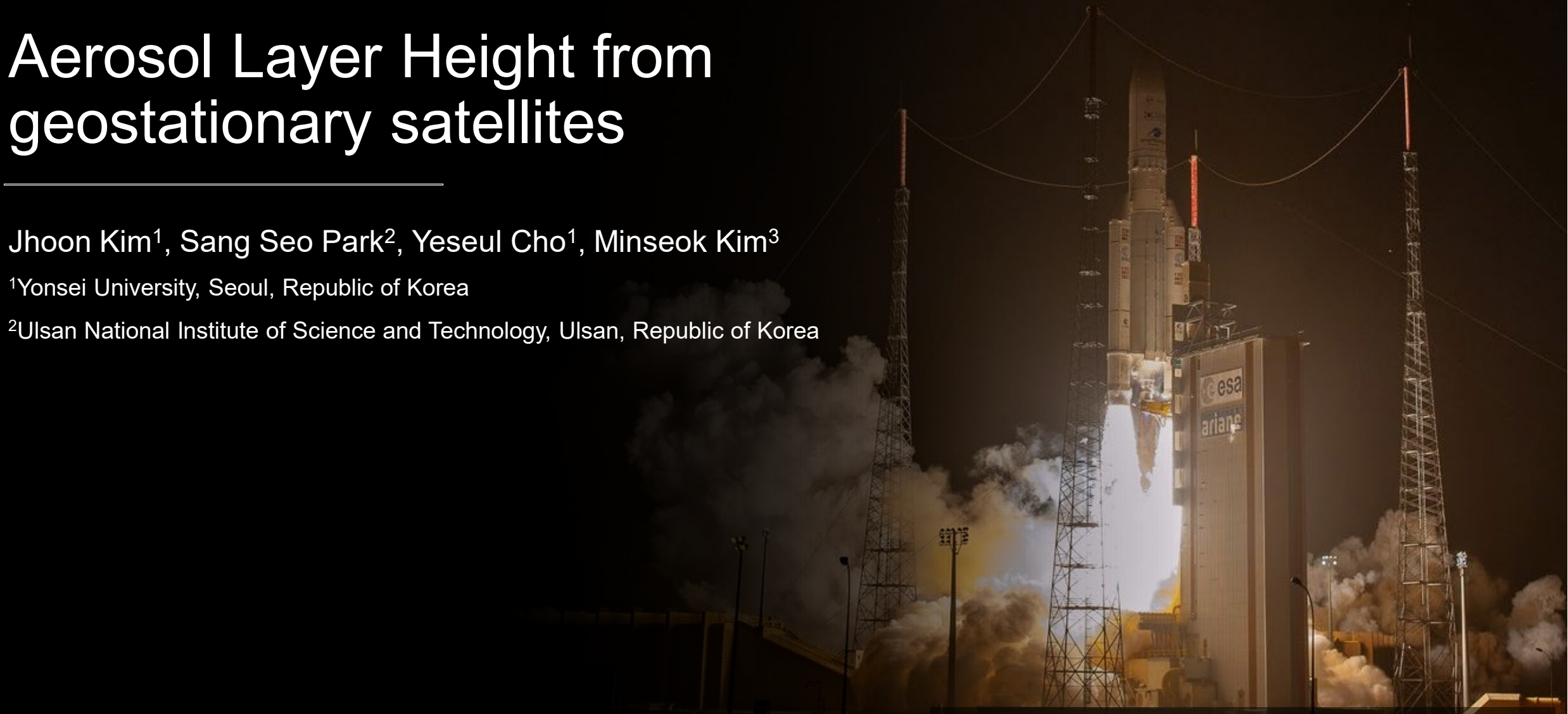# Aerosol Layer Height from geostationary satellites

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GEMS

Retrieval of Aerosol Layer Heights

Satellite	Definition	Retrieval Method	Validation Reference	Validation Period	N	EE% (1km), R	Reference
EPIC (Lagrange-1 point)	$ALH = \sum_{i=1}^{n} H(i)\left[\dfrac{\beta_e(i)}{\sum_{i=1}^{n}\beta_e(i)}\right]$ aerosol extinction coefficient : β_e	O2A O2B DOAS	CALIOP L2 aerosol extinction coefficient (km^{-1}) at 532 nm	2017.8.25 2017.8.26	100 32	EE% =90 EE% =84	Xu et al., 2019
TROPOMI (LEO)		O2A optimal estimation		2018.06.01 2018.06.08 2018.06.10 2018.12.22	791 (4 cases)	R = 0.64	Nanda et al., 2020
				2018.05.01~ 2019.02.28	(Land) 731347 (Ocean) 1742695 (Ocean)	(Land) Mean bias = -2.25km, SD=3.83 (Ocean) -0.41 km SD=6.86	
OMI (LEO)		O2–O2 Neural network		2006.10.02 2006.10.06 2006.11.1	3 cases	-	Chimot et al., 2017,2018
TROPOMI (LEO)		O2A O2B LUT based		2018.08.10 2018.11.10 2019.03.02 2019.07.09 2019.07.28 2020.06.18 2020.09.09	687 (7 cases)	R = 0.87	Chen et al., 2021
GEMS (GEO)		UV and O2–O2 Optimal estimation		2021.11.01~ 2022.10.31	77318	Mean bias =-0.225 SD= 1.5 km EE%=55.28	Cho et al., submitted
OMI (LEO)	$\int_{z=0}^{AEH} \beta_e(z)dz = (1-e^{-1})\times AOD$	O2–O2 DOAS		2007~2008	491 (8cases)	EE%=59.7 R=0.22	Park et al., 2016
GEMS (GEO)		O2–O2 DOAS		2021.03.28~03.30	325	EE%=53.8	Park et al., in review

GEMS AEH vs CALIOP AEH
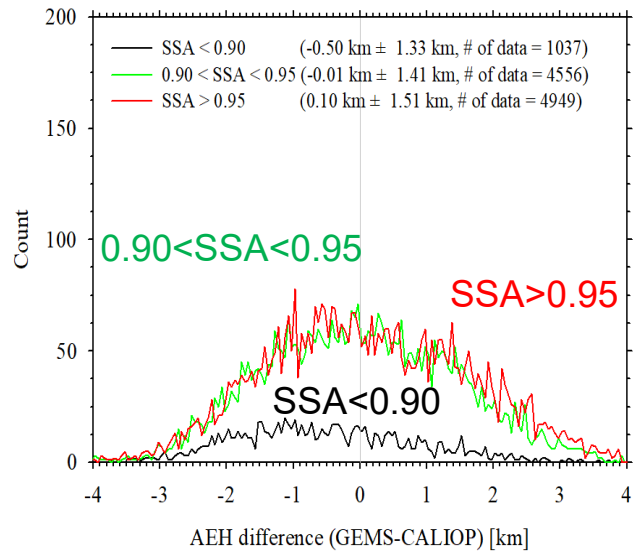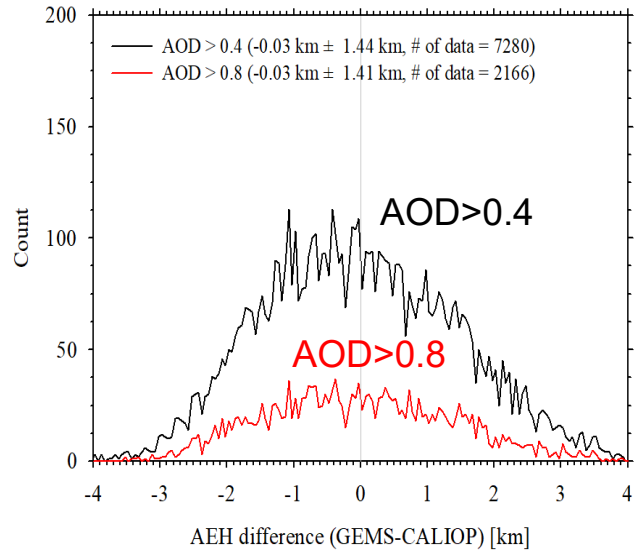
GEMS AEH vs TROPOMI ALH
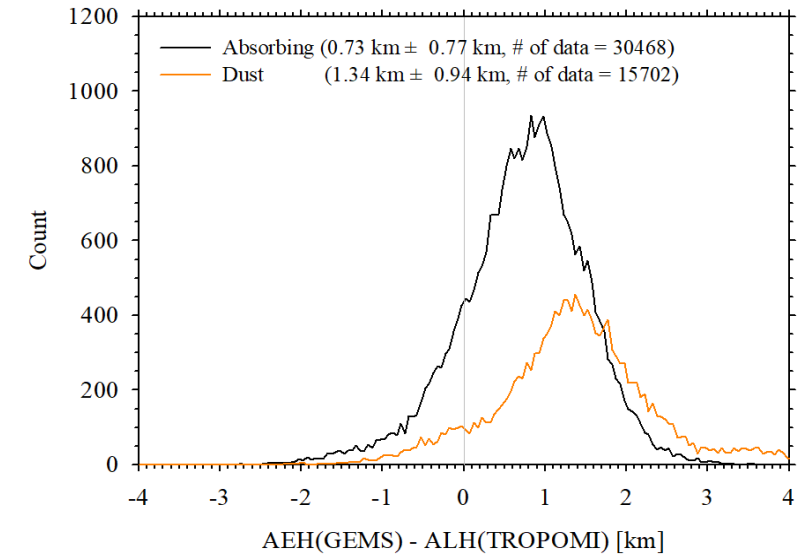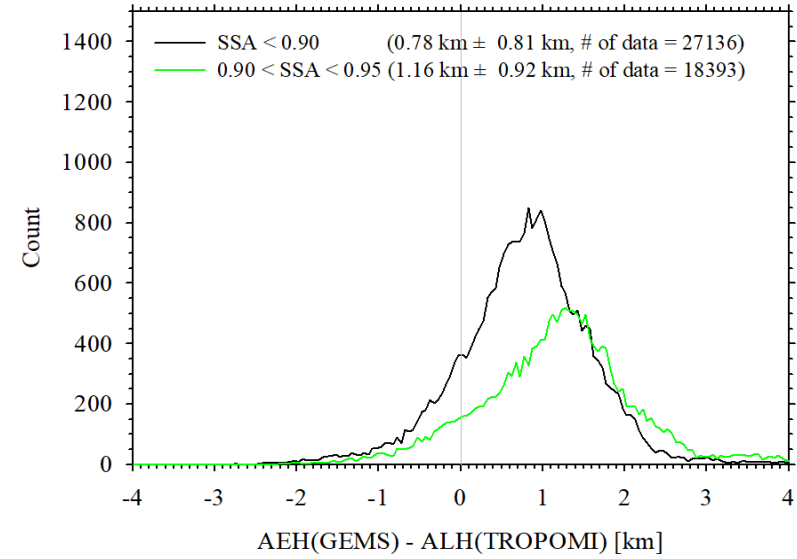
Large variability is still remain due to the variability of aerosol vertical distribution.

- σ(CALIOP vs GEMS) > σ(TROPOMI vs GEMS) ➔ Due to aerosol layer thickness and shape differences
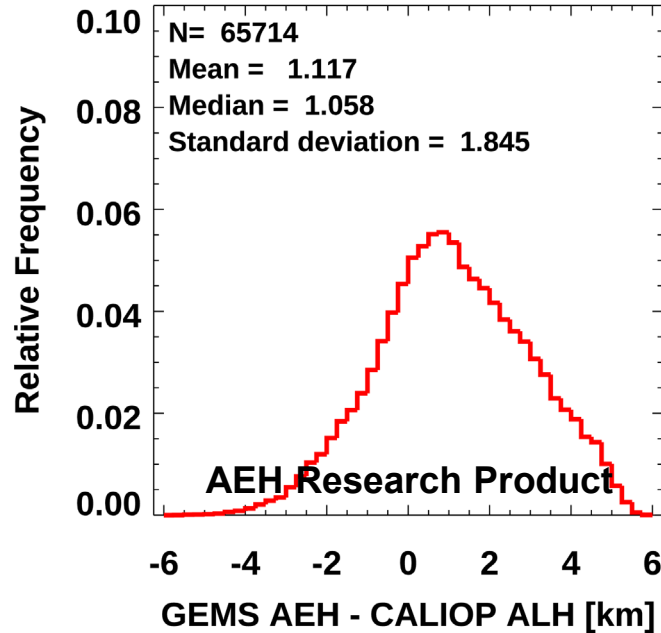
GEMS ALH or AEH vs CALIOP ALH

Referene dataset:
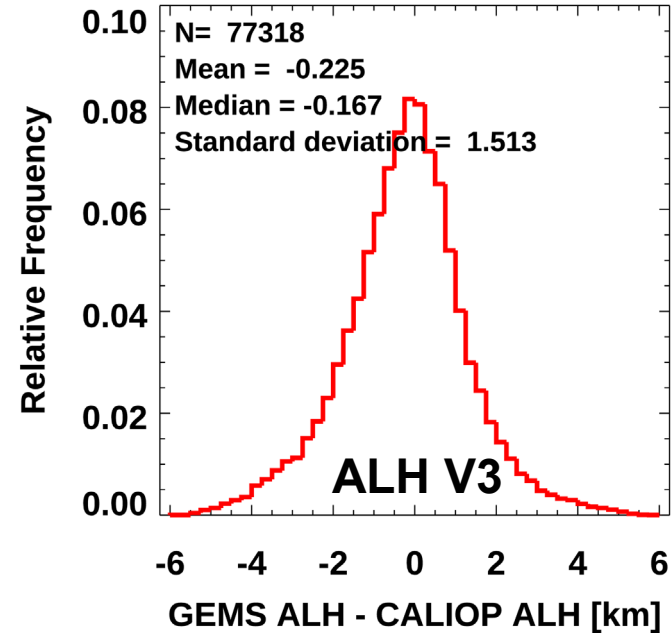CALIOP level-2 aerosol extinction coefficient at 532 nm

Validation period:
2021.01.01−2021.06.30

04:45,05:45,06:45,07:45 UTC

Validation area : GEMS entire area

Temporal Collocation : ±60 min, Spatial Collocation : 0.05°

Left panel (AEH Research Product):
N= 65714
Mean = 1.117
Median = 1.058
Standard deviation = 1.845

X-axis: GEMS AEH - CALIOP ALH [km]
Y-axis: Relative Frequency

Right panel (ALH V3):
N= 77318
Mean = -0.225
Median = -0.167
Standard deviation = 1.513

X-axis: GEMS ALH - CALIOP ALH [km]
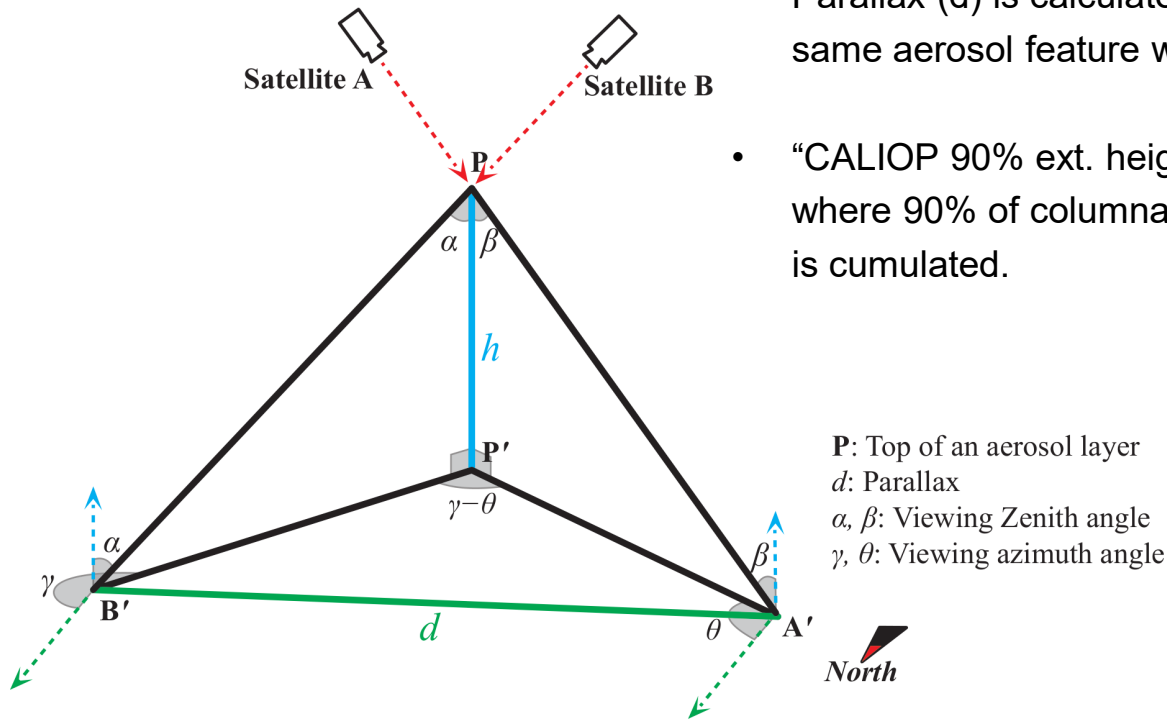Y-axis: Relative Frequency

AEH denotes the middle of layer between top and center height.

ALH defines the altitude of the thickest layer.

Retrieval concept of stereoscopic aerosol top height (ATH)

- Parallax (d) is calculated after identifying same aerosol feature with AHI & AGRI.

- "CALIOP 90% ext. height" is an altitude where 90% of columnar aerosol extinction is cumulated.

P: Top of an aerosol layer
d: Parallax
α, β: Viewing Zenith angle
γ, θ: Viewing azimuth angle

Comparison of stereoscopic ATH with CALIOP 90% ext. height

- Stereoscopic ATH shows low variability because of spatial resolution limitation during aerosol feature identification process.
- Stereoscopic ATH & GEMS AEH ~ CALIOP 90% ext. height
- GEMS ALH ~ CALIOP ext. weighted height