Retrieval of Aerosol Properties from GEMS data: Comparison to TROPOMI data

Yeseul Cho[1], Jhoon kim[1], Sujung Go[2,3], Mijin Kim[3], Seoyoung Lee[1], Won-Jin Lee[4], Dong-Won Lee[4], Omar Torres[3]

(1) Yonsei University, Seoul, Republic of Korea
(2) University of Maryland Baltimore County (UMBC), Maryland, USA
(3) NASA Goddard Space Flight Center (GSFC), Maryland, USA
(4) National Institute of Environmental Research, Incheon, Republic of Korea

Presenting author e-mail: dptmf209@yonsei.ac.kr

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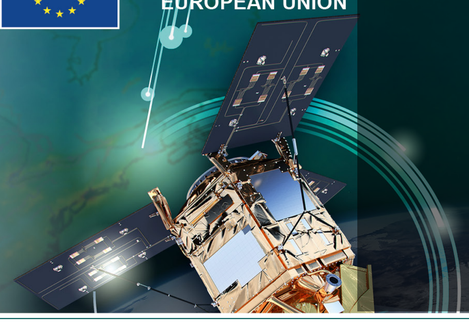
GEMS



Geostationary Environment Monitoring Spectrometer (GEMS)

Table 1. Timeline since launch

2020.02.19	Transfer orbit injection (GK-2B launch)
2020.03.23	GEMS power on
2020.04.21	First GEMS measurements for Sun/Earth/LED
2020.04.23~	Daily operation (in-orbit test)

Table 2. GEMS specifications

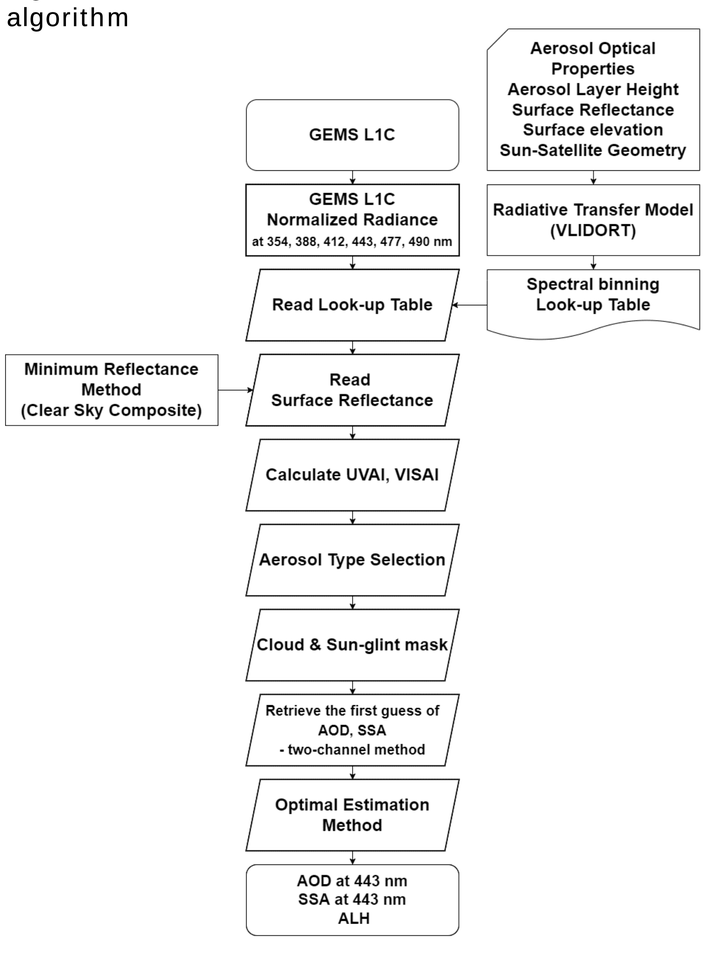
Wavelength range	300 – 500 nm
FWHM	< 0.6 nm
Temporal resolution	1 hour
Spatial sampling @ Seoul [km^2]	3.5 x 8 km^2 (Aerosol)

(Kim et al., 2020)

- The GEMS, onboard GEO-KOMPSAT-2B (GK-2B) satellite, is the first air quality monitoring sensor in geostationary earth orbit launched on February 19, 2020 (Table 1).
- GEMS measures the hyperspectral radiances with 0.6 nm spectral resolution in ultraviolet and visible ranges over the Asia-Pacific region during the daytime to provide hourly air quality information (Table 2).

GEMS aerosol retrieval algorithm

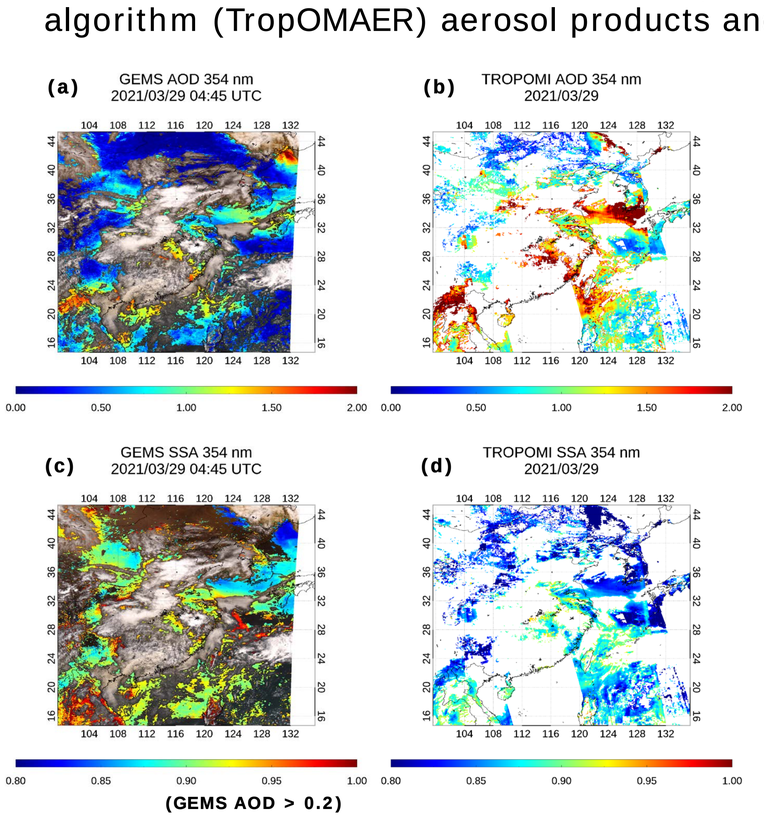
Figure 1. Flowchart of GEMS aerosol retrieval algorithm



- The general flow of the GEMS UV–VIS aerosol algorithm is summarized in Figure 1 (Kim et al., 2018; Go et al., 2020).
- The aerosol retrieval algorithm for GEMS uses 6 channels in ultraviolet and visible wavelengths, which have the advantage of measuring aerosol absorption and height information.
- The aerosol retrieval algorithm for GEMS is based on an optimal estimation method finding the optimized values for the aerosol optical depth (AOD), single scattering albedo (SSA), and aerosol layer height (ALH) by minimizing differences between simulated and observed radiances.

Results

- **GEMS AOD and SSA at 354 nm** : comparison to TROPOMI aerosol algorithm (TropOMAER) aerosol products and AEROENT data



← Figure 2. Example of GEMS AOD (a), TROPOMI AOD at 354 nm (b), GEMS SSA (c) and TROPOMI SSA at 354 nm (d) on March 29, 2021 at 04:45 UTC

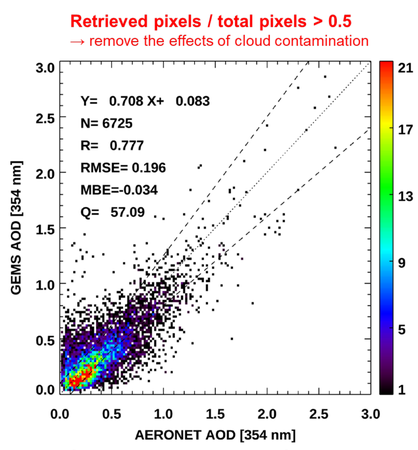


Figure 3. Comparison results for GEMS AOD 354 nm with AEROENT data (January to June 2021)

Results

- **GEMS UV aerosol index** : comparison to TROPOMI UV aerosol index (AER_AI) Version 2.3.1

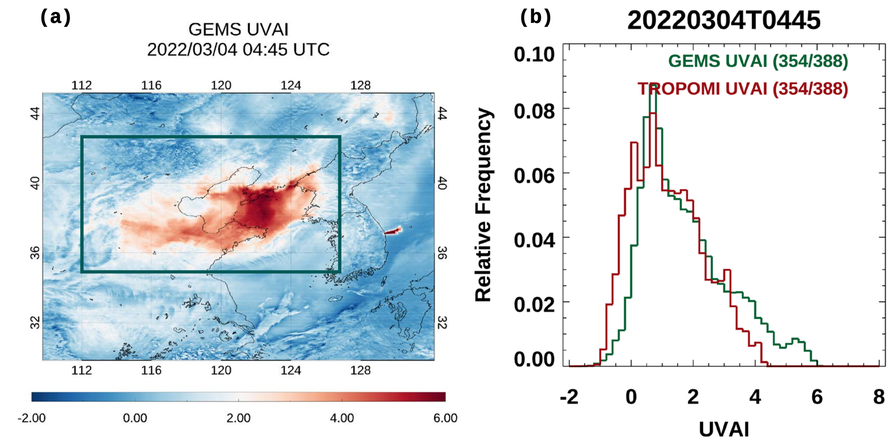


Figure 4. Example of GEMS UVAI (a) on March 04, 2022 at 04:45 UTC and the histogram of GEMS and TROPOMI UVAI in the green box (b)

- Thick dust plume over northeastern China and the Yellow Sea.
- The histogram of GEMS UVAI had a similar distribution to that of TROPOMI UVAI.

- **GEMS ALH** : comparison to TROPOMI Aerosol mid height (AER_LH) Version 2.3.1 and CALIOP data

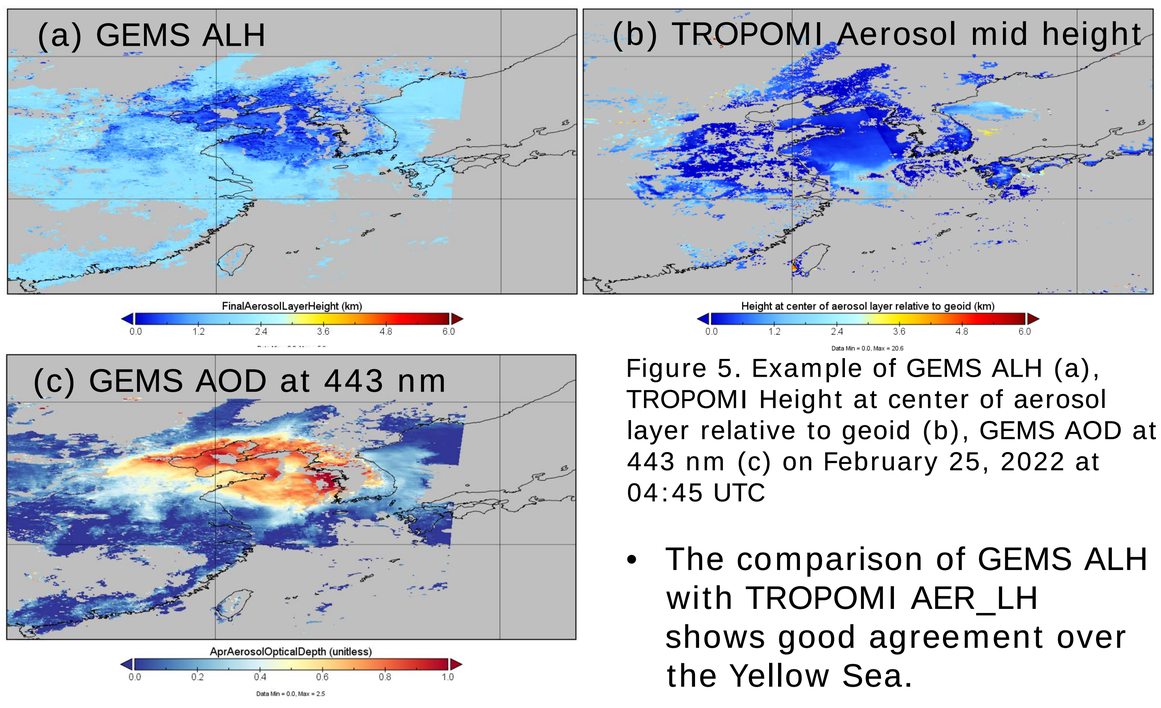


Figure 5. Example of GEMS ALH (a), TROPOMI Height at center of aerosol layer relative to geoid (b), GEMS AOD at 443 nm (c) on February 25, 2022 at 04:45 UTC

- The comparison of GEMS ALH with TROPOMI AER_LH shows good agreement over the Yellow Sea.

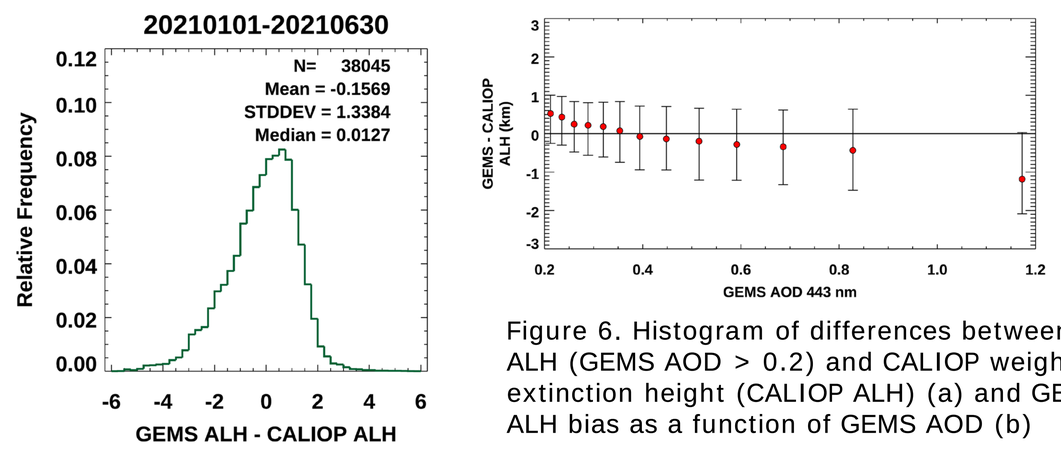


Figure 6. Histogram of differences between GEMS ALH (GEMS AOD > 0.2) and CALIOP weighted extinction height (CALIOP ALH) (a) and GEMS ALH bias as a function of GEMS AOD (b)

- Validation area : GEMS entire area
- Validation period : 2021.01.01-2021.06.30
- GEMS ALH shows negative bias with average differences of – 0.15 km.
- GEMS ALH has a positive (negative) bias in the low (high) AOD range.

Conclusion

- This study shows the retrieved results of aerosol optical properties over Asia from GEMS. We present GEMS aerosol retrieval results for high aerosol loading case over East Asia.
- The GEMS AOD and SSA are compared to TropOMAER aerosol products and AEROENT data. GEMS UV aerosol index is analyzed and compared to TROPOMI UV aerosol index (AER_AI).
- The GEMS ALH is compared to TROPOMI Aerosol mid height (AER_LH) and CALIOP data.
- By comparing GEMS aerosol products to TROPOMI aerosol products, we can understand the performance of the passive satellite retrievals and it can help to utilize the aerosol products for various purposes.

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