GEMS AOD retrieval: assessment of version v2.1 update

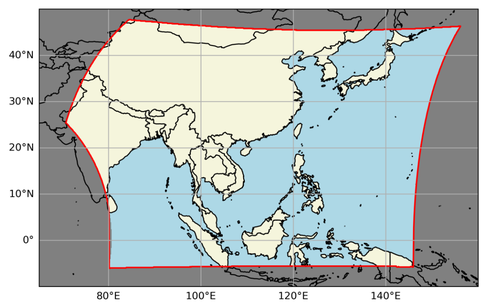
Yujin Chai[1] (lila9807@yonsei.ac.kr), Jhoon Kim[1], Yeseul Cho[1,2]
(1) Yonsei University, Department of Atmospheric Sciences, Republic of Korea,
(2) Earth System Science Interdisciplinary Center, University of Maryland, College Park, MD, USA

GEMS

- The geostationary Environment Monitoring Spectrometer (GEMS) is the first **UV-VIS hyperspectral** satellite instrument in GEO.
- GEMS provides hyperspectral measurements covering 300-500 nm at 0.2 nm spectral sampling and 0.6 nm full width at half maximum (FWHM) spectral resolution.

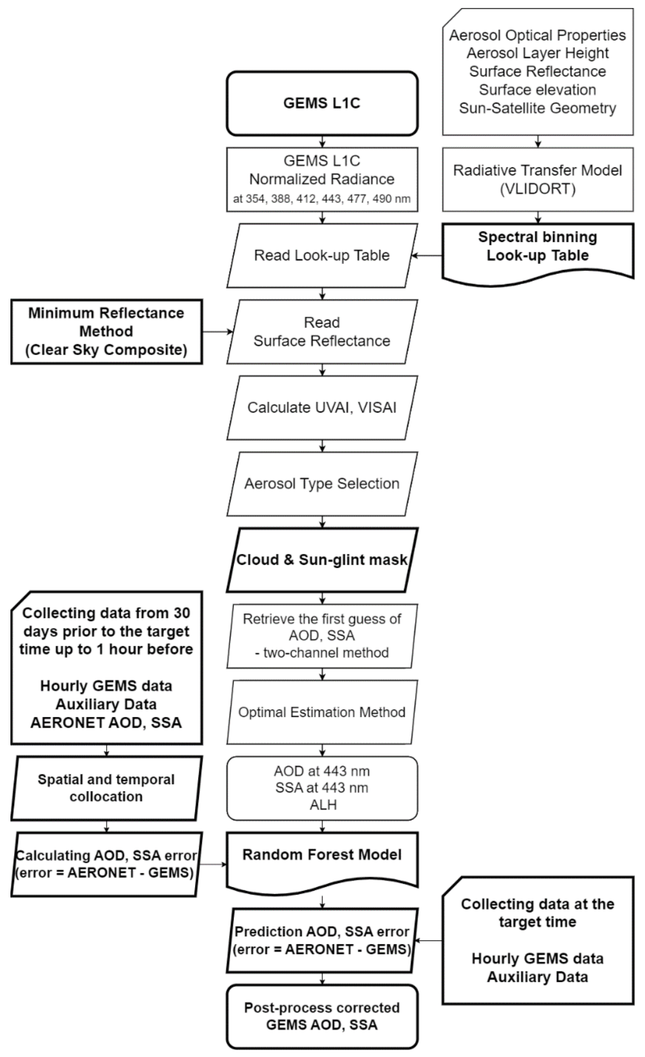
Wavelength range	300-500 nm
FWHM	< 0.6 nm
Temporal resolution	1 hour
Spatial sampling @ Seoul [km^2]	3.5 X 7.7 km^2 (Aerosol)

❖ **GEMS domain**



Aerosol retrieval algorithm

❖ **General flow of the GEMS aerosol retrieval algorithm**



- GEMS AOD retrieval uses **6 channels** in **ultraviolet** and **visible** wavelengths, which have the advantage of measuring aerosol absorption and height information.
- GEMS AOD retrieval 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.

Major updates in GEMS AOD v2.1

❖ Surface Reflectance

- Calculation of surface reflectance considering the background AOD to reduce the error of surface reflectance overestimation
- Inclusion of surface reflectance in the output variables

❖ ALH

- The first guess of ALH in OE is based on CALIOP ALH climatology
- V2.0 uses 2km for the first guess of ALH

❖ Retrieval of high AOD

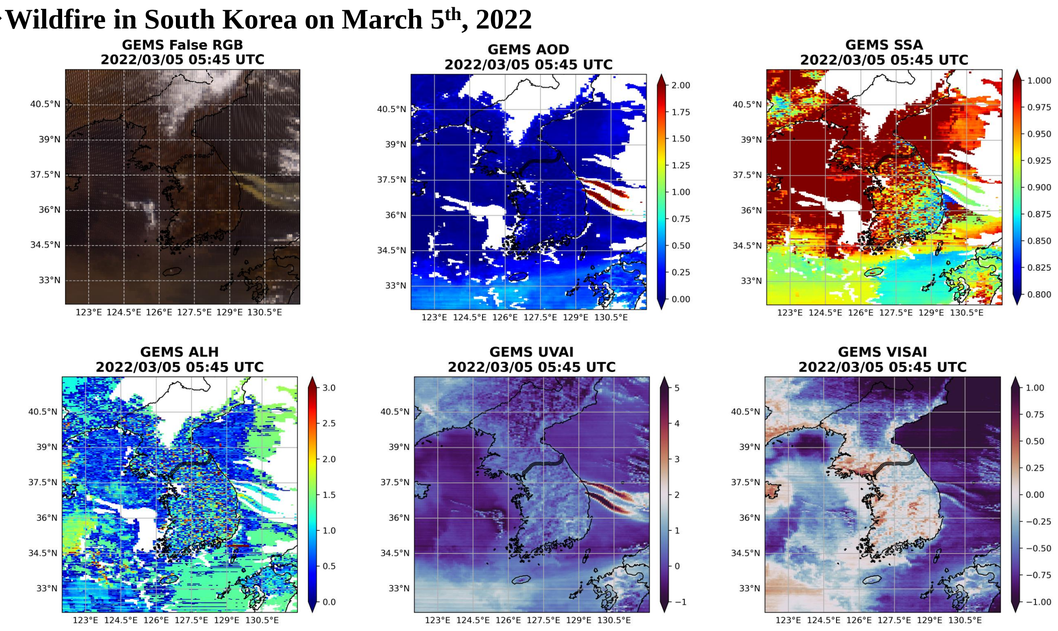
- The nodes of LUT's AOD have been added at 5 and 10. (v2.0: 3.6)
- Change in high AOD callback criterion to UVAI >3 (v2.0: UVAI >6)

❖ Aerosol Type selection

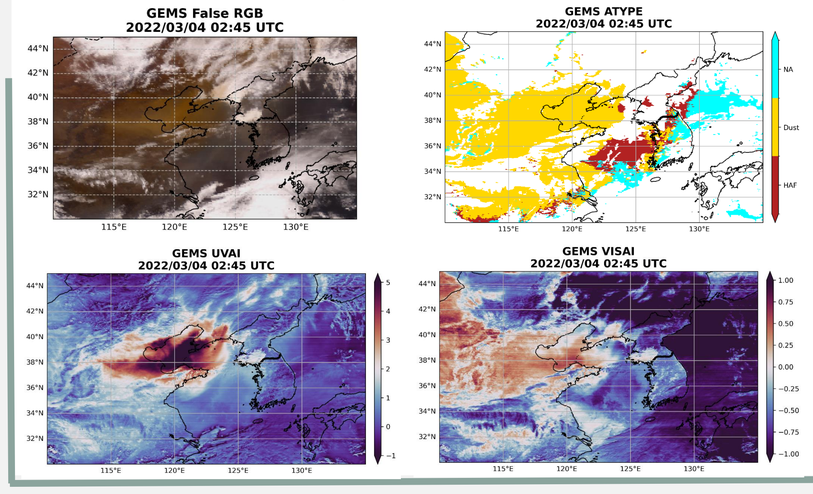
- The threshold of Aerosol Index for type selection has been adjusted to follow the diurnal variation of UVAI and VISAI

Products of GEMS AERAOD v2.1

❖ **Wildfire in South Korea on March 5th, 2022**



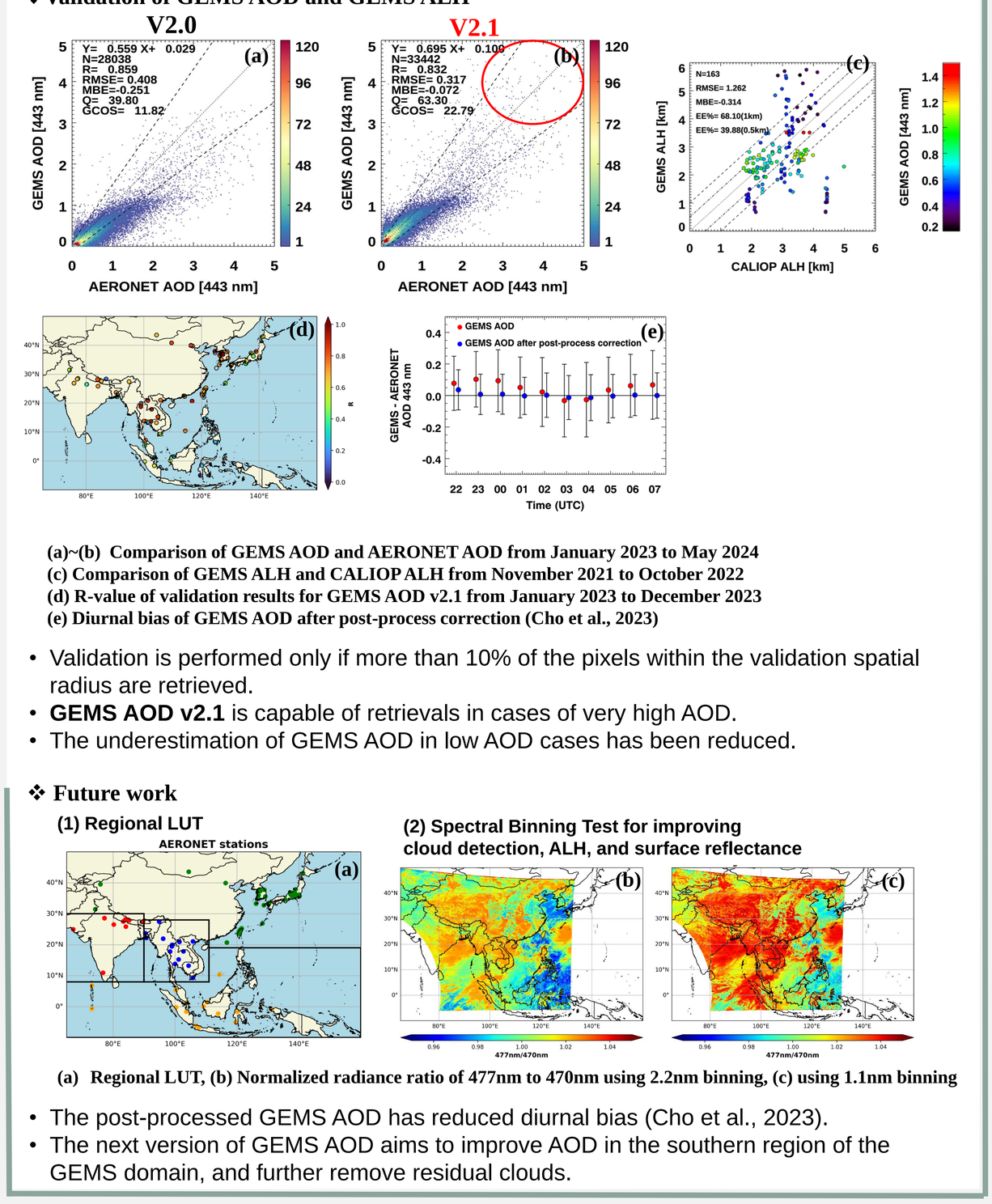
❖ **Dust Case on March 4th, 2022**



- GEMS AOD shows a value over 4 at 05:45 UTC on March 5th, 2022.
- UVAI in the GEMS aerosol product reveals the features of wildfire and dust transportation.
- GEMS AOD v2.1 detects the **high AOD** from wildfire and **dust aerosols** during dust transportation.

Validation and Future work

❖ **Validation of GEMS AOD and GEMS ALH**



(a)~(b) Comparison of GEMS AOD and AERONET AOD from January 2023 to May 2024
(c) Comparison of GEMS ALH and CALIOP ALH from November 2021 to October 2022
(d) R-value of validation results for GEMS AOD v2.1 from January 2023 to December 2023
(e) Diurnal bias of GEMS AOD after post-process correction (Cho et al., 2023)

- Validation is performed only if more than 10% of the pixels within the validation spatial radius are retrieved.
- **GEMS AOD v2.1** is capable of retrievals in cases of very high AOD.
- The underestimation of GEMS AOD in low AOD cases has been reduced.

❖ **Future work**

(1) Regional LUT

(2) Spectral Binning Test for improving cloud detection, ALH, and surface reflectance

(a) Regional LUT, (b) Normalized radiance ratio of 477nm to 470nm using 2.2nm binning, (c) using 1.1nm binning

- The post-processed GEMS AOD has reduced diurnal bias (Cho et al., 2023).
- The next version of GEMS AOD aims to improve AOD in the southern region of the GEMS domain, and further remove residual clouds.

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