Title: Data associated with “Constraining aerosol phase function using dual-view geostationary satellites”

Abstract: Passive satellite observations play an important role in monitoring global aerosol properties and helping quantify aerosol radiative forcing in the climate system. The quality of aerosol retrievals from the satellite platform relies on well-calibrated radiance measurements from multiple spectral bands, and the availability of appropriate particle optical models. Inaccurate scattering phase function assumptions can introduce large retrieval errors. High-spatial resolution, dual-view observations from the Advanced Baseline Imagers (ABI) on board the two most recent Geostationary Operational Environmental Satellites (GOES), East and West, provide a unique opportunity to better constrain the aerosol phase function. Using dual GOES reflectance measurements for a dust event in the Gulf of Mexico in 2019, we demonstrate how a first-guess phase function can be reconstructed by considering the variations in observed scattering angle throughout the day. Using the reconstructed phase function, aerosol optical depth retrievals from the two satellites are self-consistent and agree well with surface-based optical depth estimates. We evaluate our methodology and reconstructed phase function against independent retrievals made from low-Earth-orbit multi-angle observations for a different dust event in 2020. Our new aerosol optical depth retrievals have a root-mean-square-difference of 0.019– 0.047. Furthermore, the retrievals between the two geostationary satellites for this case agree within about 0.059±0.072, as compared to larger discrepancies between the operational GOES products at times, which do not employ the dual-view technique.

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Recommended data citation – Bian, Q., Kreidenweis, S., Chiu, J.C., Miller, S.D., Xu, X., Wang, J., Kahn, R.A., Limbacher, J.A., Remer, L.A., & Levy, R.C. (2021). Data associated with “Constraining aerosol phase function using dual-view geostationary satellites.” Colorado State University. Libraries. http://dx.doi.org/10.25675/10217/233940

Associated article citation – Bian, Q., Kreidenweis, S., Chiu, J. C., Miller, S. D., Xu, X., Wang, J., et al. (2021). Constraining aerosol phase function using dual-view geostationary satellites. Journal of Geophysical Research: Atmospheres, 126, e2021JD035209. https://doi.org/10.1029/2021JD035209

Format of data files – CSV, HDF5

Location where data were collected – Gulf of Mexico

Time period during which data were collected – 2019-06-24, 2020-06-29

Description – The files include the data for figures shown in the paper. Two opposing GEOS satellites capture a dust event in the Gulf of Mexico in June 2019. We demonstrate a first-guess phase function to reconstruct dust phase function by leveraging GEOS satellites then evaluate our methodology using a different dust event over the Gulf of Mexico in June 2020.

File Information – The files mainly include the analyzed, rendered/visualized data for our JGR paper and are organized in the order of Figures shown in the paper. There are 32 files total including the README file and codebook.

- Fig2a-e. csv –Scattering angle pairs of G16 and G17 for selected locations, including (a) (48°N, 126°W), (b) (31°N 118°W), (c) (21°N, 90°W), (d) (30°N, 81°W) and (e) (44°N, 63°W). Calculations were performed over the course of sunrise to sunset on March 1, June 1, September 1, and December 1 to represent different seasons. Sun glint region is defined where the glint angle is less than 40°. Pixels that are within the sun glint region are excluded.

- Fig3a-e.csv **–** Aerosol Robotic Network (AERONET) Level l.5 retrieval products at the Merida site (Level 2 data were unavailable for this case), used for reconstructing the dust phase function. (a) Aerosol optical depth and (b) extinction Ångström exponent during June 2019. (c), (d) and (e) provide the averaged volume particle size distribution, single scattering albedo, and phase function (at 675 nm), respectively, for June 24, 2019.
- Fig4.csv **–** Aerosol Robotic Network -derived aerosol optical depths at 550 nm on June 24, 2019 at the Merida site (20.984°N, 89.645°W), along with G16 and G17 operational products for a pixel located at (21.452°N, 89.604°W).
- Fig5a-c.csv **–** (a) Aerosol optical depth (AOD) retrievals at 640 nm from the AERONET Merida site, and from G16 and G17 observations using the SSA and phase function from the June 24, 2019 Aerosol Robotic Network (AERONET) inversions at Merida. (b) The corresponding scattering angles for G16 and G17 over the course of the case study day. The dotted lines represent data points for which the glint angle is <40°. (c) AOD percentage difference (((retrieved AOD–obs. AOD)/obs. AOD) × 100%) as a function of the scattering angle, where obs. AOD is from AERONET. AERONET AODs were interpolated to the G16 and G17 time stamps for this comparison.
- Fig6.csv **–** Comparison of original Aerosol Robotic Network phase function (golden dots) and modified phase function (black dots) after increasing the original phase function by 30%. This adjustment was based on the differences between observed and retrieved aerosol optical depths at scattering angles of 110°–150°. The adjusted phase function is smoothed and normalized.
- Fig7.csv **–** Same as Figure 5a, but using the adjusted phase function shown in Figure 6 to re-build the look-up tables for the G16 and G17 retrievals.
- Fig8ab.csv – (a) The prior sea salt phase function and the resulting adjusted phase function, both assuming a single scattering albedo of 0.968. For comparison, our adjusted phase function using the Aerosol Robotic Network (AERONET) phase function as the first guess is also shown. (b) aerosol optical depth (AOD) retrievals at 640 nm from G16 and G17 observations using the prior sea salt phase function and the resulting adjusted phase function. AERONET AOD observations (as shown in Figures 5a and 7) are also shown
- Fig9.h5 **–** retrieved (a) aerosol optical depth, (b) non-spherical aerosol optical depth (AOD) fraction, (c) fine mode fraction, and (d) single scattering albedo at 16:45 UTC on June 29, 2020, as determined by multi-angle imaging spectroradiometer (MISR) Research Algorithm retrievals for Orbit 109209. Cloud contamination precludes retrievals (white areas) over most of the land (southeast corner) as well as the northern and much of the eastern parts of the scene. In the southwest corner, retrieved particles are smaller, darker, and mostly spherical, likely smoke from the Yucatan.
- Fig10ab– Retrieved aerosol optical depths (AODs) at 640 nm for selected pixels that are marked by a line in Figure 9a. Retrievals include those from the Multi-angle Imaging SpectroRadiometer (MISR) Research Algorithm, the geostationary operational environmental satellites (GOES) operational products, and GOES using our adjusted dust phase function. All products except the ones using the adjusted phase function report AODs at 550 nm and have been converted to 640 nm using spectral scaling coefficients available in the standard MISR product. (b) AOD difference compared to those from the MISR Research Algorithm
- Fig11a-f.csv – Scattering angle (a) and retrieved aerosol optical depths at 640 nm (c) from the operational geostationary operational environmental satellites products and (e) those using the adjusted phase function for the sixth pixel shown in Figure 10. (b, d, and f) on the right panel are the same as (a, c, and e), respectively, but for the 12th pixel.
- FigC2a-c.csv – (a) Aerosol optical depth (AOD) retrievals at 640 nm for the Merida case study on June 24, 2019, using the Aerosol Robotic Network (AERONET) phase function but two different values for single scattering albedo (SSA) (0.9 and 1.0). (b) Phase functions from the AERONET operational product (blue), the adjustments based on an assumed SSA of 0.968 (red), and the adjustments based on a given SSA of 0.9 (black). (c) The corresponding AOD retrievals at 640 nm using the phase function that has been adjusted assuming SSA = 0.9.
- FigC3a-c – (a) G16 and G17 aerosol optical depth (AOD) retrievals for the Merida case study on June 24, 2019, using the Aerosol Robotic Network (AERONET) phase function and surface reflectances assuming chlorophyll-a concentrations of 0 mg m^{-3} and 1.85 mg m^{-3}. AODs from AERONET products are also shown. (b) The adjusted phase function, applying the methodology using the surface reflectances from different chlorophyll-a concentrations. (c) Same as (a), but using the adjusted phase function in (b).
- FigD1a-f.csv – (a) scattering angles, and retrieved aerosol optical depths from (b) geostationary

operational environmental satellites (GOES) operational products, and from (c) GOES observations but using the adjusted phase function, for the first 10 pixels in Figure 10 (ordered top to bottom, with the sixth pixel excluded). (d)–(f) are the same as (a)–(c), but for the last 10 pixels in Figure 10 (with the 12h pixel excluded).

Definitions of acronyms, site abbreviations, or other project-specific designations used in the data file names or documentation files
G16: NOAA/NASA Geostationary Operational Environmental Satellites-R series (GOES)-East or GOES-16
G17: NOAA/NASA Geostationary Operational Environmental Satellites-R series (GOES)-West or GOES-17
AOD: aerosol optical depth
Idx: index
scat_angle: scattering angle
std: standard deviation

Variable information – Codebook is provided for reference

Uncertainty, precision, and accuracy of measurements- The operational aerosol optical depth (AOD) retrieval is available at a temporal resolution of 10 min and a spatial resolution of 2 km at nadir. The uncertainty in retrieved AOD over the ocean is reported as 0.03 ± 0.05AOD.
The two ABI sensors on G16 and G17 have been compared with the Visible Infrared Imaging Radiometer Suite (VIIRS) onboard the Suomi National Polar-Orbiting Partnership. G16 and G17 both agree within 5% with VIIRS (Yu et al., 2019). Based on this result, we perturbed the reflectances of G16 and G17 by 5%, which generally leads to an AOD difference of less than 0.05.

Environmental or experimental conditions – Ambient condition

Method(s) – Please refer to the methodology section in our paper.

Standards or calibrations that were used – The two ABI sensors (raw data) on G16 and G17 satellite have been compared with the Visible Infrared Imaging Radiometer Suite (VIIRS) onboard the Suomi National Polar-Orbiting Partnership.

Software – We used Matlab, Python and Excel to process the raw data.

Quality assurance and quality control that have been applied – Our retrieval is evaluated against the ground-based observation.

Data source – AERONET data and products can be freely accessed via https://aeronet.gsfc.nasa.gov/new_web/. The operational GOES aerosol products for both satellites were available as of January 1, 2019, at https://www.avl.class.noaa.gov/saa/products/search?sub_id=0&datatype_family=GRABIPRD&submit.x=28&-submit.y=2.

Acknowledgement:
We thank for Brent Holben and his staff for establishing and maintaining the Merida site used in this investigation.
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