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Satellite Perspectives on Western US Wildfires in 2019: Comparison of Aerosol Retrievals from GOES and MISR, with Ground-Based Validation

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On 12 February 2019 the Geostationary Operational Environmental Satellite-17 (GOES-17) became operational as GOES-West, providing detailed observations of the Western United States from the Advanced Baseline Imager (ABI), which is the primary instrument on the latest GOES-R series of satellites. The summer and fall 2019 wildfire season in the Western US provided the first test of the aerosol retrieval capabilities of the new instrument, especially aerosol optical depth (AOD), associated with extreme fire events. At the same time, the Multi-angle Imaging SpectroRadiometer (MISR) instrument remains operational on the NASA Terra EOS satellite, yielding an unprecedented opportunity to compare simultaneous aerosol retrievals from both ABI and MISR. Validation of these retrievals is further enhanced by the deployment of additional Aerosol Robotic Network (AERONET) sun photometer sites as part of the joint NASA/NOAA FIREX-AQ field campaign, which took place in the summer of 2019.

Instruments

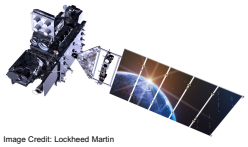


Image Credit: Lockheed Martin

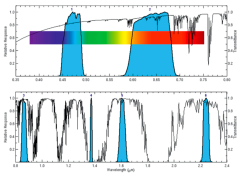
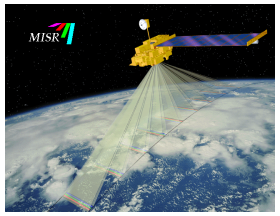
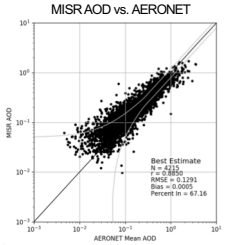


Figure from Schmit et al. (2017)

The GOES-West Satellite (GOES-17), formerly GOES-S carries the Advanced Baseline Imager (ABI) that provides sensitivity to multiple bands in the visible and shortwave infrared portion of the spectrum. This provides a new capability for aerosol retrievals that was not present with the previous generation of imaging sensors on the GOES series of satellites. Here we consider the Level 2 aerosol products designated OR_ABI-L2-AOD[F/C]-M6 from GOES-17 for the dates of 3 August through 21 August 2019 during the western phase of the FIREX-AQ field campaign.





The Multi-Angle Imaging SpectroRadiometer (MISR) instrument has been operational on NASA's polar-orbiting Terra satellite since early 2000. MISR's nine cameras observe four wavelengths in the blue, green, red, and near-infrared portion of the spectrum. Together, this information is used to retrieve aerosol amount – aerosol optical depth (AOD) – over both land and water with a spatial resolution of 4.4 km as well as particle type information. Comparisons with ground-based AERONET sun photometers show that MISR AOD retrievals are of extremely high quality (Garay et al., 2020). Here we consider the MISR AS_AEROSOL product F13_0023 (Version 23).

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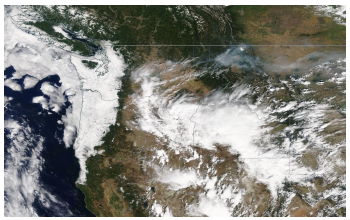
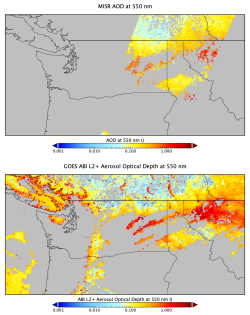
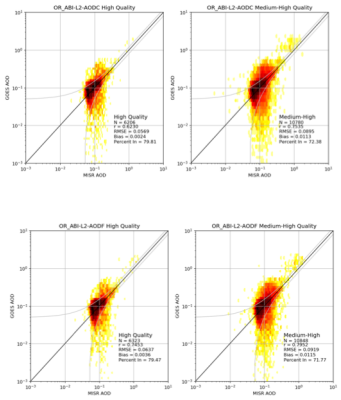
GOES comparisons with MISR





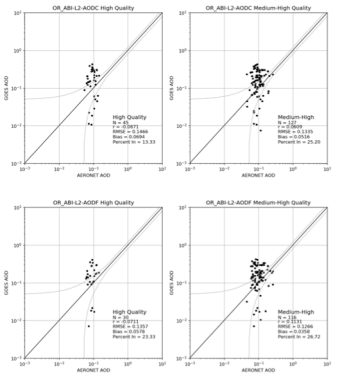
MODIS Terra view of the Pacific Northwest on 8 August 2019. Smoke from fires in Washington is clearly visible near the US-Canadian border. The aerosol retrievals to the right show generally good agreement between MISR and GOES, with somewhat more extensive coverage from the GOES algorithm.

GOES-MISR regression statistics



MISR and GOES data for 8 August 2019 were spatially matched within the latitude range from 31°N to 49°N to focus on the Western US. Regression plots and associated statistics were calculated for GOES CONUS (AODC) and GOES Full Disk (AODF) independently, as shown in the figures to the left. On this day, the agreement between MISR and GOES was very good, with better results when the GOES data were restricted to High Quality (DQF = 0) retrievals only, compared to Medium-High Quality (DQF <= 1),

GOES comparisons with AERONET



Smoke over AERONET site on 7 August 2019
Image Credit: David Giles (NASA GSFC/SSAI)

Smoke from Williams Flats Fire on 6 August 2019
Image Credit: David Giles (NASA GSFC/SSAI)

GOES data were also matched with ground-based AERONET sites for times close to the overpass time of Terra (1800–1900 UTC) for the entire time period from 3 August to 21 August 2019. The AERONET AODs were interpolated to the 550 nm reference wavelength of GOES. Some of the AERONET sites experienced heavy smoke (see photos) during the FIREX-AQ time period. Regression plots and associated statistics are more limited due to the restricted time period. These results show that the GOES aerosol products perform fairly well relative to AERONET, but the GOES aerosol retrievals tend to overestimate the AOD. However, the GOES observations provide important information on the temporal development and downwind transport of smoke during FIREX-AQ.

References

Garay, M. J. et al. (2020). Introducing the 4.4 km spatial resolution Multi-Angle Imaging SpectroRadiometer (MISR) aerosol product. *Atmos. Meas. Tech.* **13**, 593–628,, https://doi.org/10.5194/amt-13-593-2020.

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