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The Dark Target retrieval of global aerosol properties: Past, present and future

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In the 1990's, Yoram Kaufman and Didier Tanré separately proposed to retrieve aerosol information from the future Moderate-resolution Imaging Spectrometer (MODIS). Working together, Yoram assumed responsibility for aerosol retrieval over land, whereas Didier took on aerosol retrieval over ocean. Both concepts utilized the contrast of light-scattering aerosol above a minimally-reflecting surface, yielding estimates of aerosol optical depth (AOD) and relative aerosol size. Both sub-algorithms were relatively simple, the processing quick, and the products simple to understand and use. Since the launch of MODIS, their original combined algorithm has evolved into what we now know as "Dark Target" (DT). DT remains simple, the processing quicker, and we stay committed to honestly appraising it and providing recommendations for proper use.

From 20+ years of observations from MODIS on both Terra and Aqua, the DT algorithm has yielded the beginnings of an AOD climate data record (CDR) that is robust and generally free of instrument and orbital artifacts. Although derived from Terra and Aqua separately, regional AOD trends strongly agree, and we have confidence in those trends. However, both Terra and Aqua are approaching end-of-life, and global aerosol trends may not be discernable until the records reach 30 years or more.

To lengthen and widen this aerosol CDR, we port DT to capable MODIS-like sensors in similar and new platforms. This includes Visible Near Infrared Radiometer Suite (VIIRS), currently flying on Suomi-NPP (SNPP since 2011) and NOAA's Joint Polar Satellite System (JPSS) series (on NOAA-20 since 2017), the Advanced Baseline Imager (ABI) flying on NOAA's Geostationary Environmental Observing System-R series (GOES-R) since 2016, Advanced Himawari Imager (AHI) on Japan's Himawari series (since 2015), and other sensors and platforms as opportunity arises. We think of VIIRS as helping to provide long-term continuity for the MODIS Low Earth Orbit (LEO) record, and the advanced imagers in geostationary (GEO) orbit as providing diurnal sampling and context for the LEO overpass time constraints. DT retrievals on airborne and higher-spatial resolution sensors provide additional interpretation.

Here we summarize the DT algorithm along with strengths and weaknesses [1]. We show 20-year trends from Terra and Aqua, and discuss how the newer retrievals from VIIRS (SNPP and NOAA-20) fit with and continue the MODIS CDR. We also describe the newer retrievals and products applied to ABI and AHI, and show how those widen our understanding of diurnal cycle and rapid aerosol changes.

Keywords: retrieval algorithm, aerosol, climate data record, MODIS, VIIRS, GEO

References

[1] Remer, L. A., R. C. Levy, S. Mattoo, et al. 2020. "The Dark Target Algorithm for Observing the Global Aerosol System: Past, Present, and Future." Remote Sensing, 12 (18): 2900, https://doi.org/10.3390/rs12182900.