Canadian Wildfire Smoke Optical Properties Using an Integrated Aerosol Monitoring System

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Presentation Preference: Poster

Canadian-born wildfire smoke during summer 2023 was monitored by using multiple remote sensing observation platforms as an integrated aerosol monitoring (IAM) system. The IAM discussed consists of surface $PM_{2.5}$ concentrations, column optical properties from the Visible Infrared Imager-Radiometer Suite (VIIRS) and Geostationary Operational Environmental Satellites (GOES-16) satellite imagery, and AERONET (daytime and lunar data products) and aerosol backscatter profiles from Unified Ceilometer Network (UCN) stations in City College of New York and Hampton University. We discuss the impact of wildfire smoke in terms of the contribution of aerosol optical depth (AOD) below and above the planetary boundary layer from daily UCN ceilometer (elastic lidar) retrievals. The ceilometer AOD is derived from aerosol extinction coefficient profiles obtained by constraining the lidar ratio to NASA AERONET AOD for solar and lunar measurements. AERONET and ceilometer aerosol optical properties are examined to determine their effectiveness in classification of particle pollution.

New Insights into Atmospheric Aerosols from Temporal Autocorrelation Applied to AERONET Observations

Climatologists have long used meteorological and land surface information to determine regions that share common characteristics. Previous research has typically focused on regional and seasonal information contained in the direct relationship between different geophysical parameters such as elevation, temperature range, and precipitation amount. More recent work has suggested that temporal autocorrelation scales can provide additional valuable insights. The autocorrelation describes how well a field *correlates with itself*. A completely homogeneous field has an autocorrelation of 1 for all temporal lags, while random noise has an autocorrelation of 0. Measurements of real, geophysical fields typically have an autocorrelation that decreases with increasing lag, and the rate of change in the autocorrelation carries information about the underlying causal mechanisms. As an example, the temporal autocorrelation for ground-based particulate matter ($PM_{2.5}$) measurements in Fresno, CA falls off more slowly than the temporal autocorrelation of AOD derived from AERONET direct sun measurements. This is apparent in the dramatically different *e*-folding times (i.e., the time it takes for the autocorrelation to fall to $1/e$), which is about three weeks for $PM_{2.5}$, but less than three days for AOD. $PM_{2.5}$ also displays stronger seasonality than AOD. The longer correlation time of $PM_{2.5}$ compared to AOD is likely due to the role played by persistent local sources of $PM_{2.5}$ around Fresno. The seasonality in $PM_{2.5}$ is related to changes in the depth of the boundary layer and changes in the pollution sources. To further explore the information about atmospheric aerosols contained in AERONET, we have created global maps of the temporal autocorrelation *e*-folding time for the V3 AERONET direct sun measurements. The autocorrelation itself and the related maps provide new insights into both the temporal and spatial behavior of aerosols that can only be gleaned from long-term, stable sets of observations.

Constraining Aerosol Properties in the MAIA Candidate PTAs with AERONET datasets

The Multi-Angle Imager for Aerosols (MAIA) mission, planned for launch in 2026, is designed to study how different types of particulate matter (PM) affect human health. The instrument will measure the amount and optical/microphysical properties of aerosols using multi-angle observations of radiance in fourteen spectral bands between 365 and 2126 nm and polarimetry from the three spectral bands at 444, 646, and 1044 nm. MAIA's radiance and polarization measurements will be used to retrieve the MAIA Aerosol Product, and then MAIA Aerosol Product will be used to derive total PM_{10}, total $PM_{2.5}$, and speciated $PM_{2.5}$ (sulfate, nitrate, elemental/organic carbon, and dust) at 1 km spatial resolution in globally distributed target areas employing geostatistical regression models. The MAIA mission insured that at least two AERONET stations will collect data within each MAIA target area for validation purposes. In addition, AERONET historical data may be considered by the MAIA optimization-based aerosol retrieval to constrain aerosol parameter space for each target.

The AERONET optical property climatology from inversion retrievals within each MAIA target will be presented together with methods developed to constrain MAIA simulated aerosol property retrievals using this information. Where insufficient inversion retrieval data were available, the monthly climatology of fine and course mode fraction was derived from the AERONET spectral deconvolution product to be used as an additional constraint for the MAIA aerosol retrieval. The advantages and challenges associated with using AERONET historical datasets as a part of the MAIA investigation will be discussed.

AEROCAN, Canada's robotic aerosol network

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Presentation Preference: Oral

AEROCAN is the Canadian cooperative arm of the global AERONET program overseeing 20 sites across Canada. AEROCAN provides long-term records of total amounts of particulate matter and supports and validates satellite remote sensing projects.

Will present 2 to 3 slides showing the AEROCAN network operations across Canada and it's diverse and unique sites spanning from high arctic, maritime, urban and rural locations.

Keywords: AEROCAN, Canada

Applications of AERONET measurements in Metro Manila, Philippines

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Presentation Preference: Oral

Metro Manila is the center of politics and socioeconomic activities in the Philippines. Similar to other megacities, its rapid development resulted in the deterioration of air quality. Over more than two decades, there has been much progress in determining aerosol levels, composition, and sources in the area. Since 2009, the Manila Observatory has been part of the Aerosol Robotic Network (AERONET) program and long-term data from this station was used to characterize the aerosol climatology over Metro Manila. Aerosols in the fine-mode fraction are dominant throughout the year while highest aerosol optical depth (AOD) values were observed from August to October, indicative of fine aerosols from urban sources and biomass burning smoke transported from insular Southeast Asia. Cluster analysis of AERONET volume size distributions revealed a major contribution from a clean marine source which could potentially explain the lower AOD values observed in Metro Manila compared with other cities in the region. Consistent with chemical speciation and receptor modeling results, aerosol-type classification using AERONET measurements showed mixtures of aerosols containing dust, black and brown carbon, and low absorbers. Potential applications of AERONET measurements in Metro Manila have yet to be explored such as how surface $PM_{2.5}$ relates to AOD measurements.

Keywords: Metro Manila, urban aerosols, aerosol optical depth

Global retrieval of aerosol optical depth over land from Landsat imagery using Transformer model on Google Earth Engine

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Abstract

Landsat imagery offers remarkable potential for various applications, including land monitoring and environmental assessment, thanks to its high spatial resolution and over 50 years of data records. However, the presence of atmospheric aerosols greatly hinders the precision of land classification and the quantitative retrieval of surface parameters. There is a pressing need for reliable and accurate global aerosol optical depth (AOD) data derived from Landsat imagery, particularly for atmospheric correction purposes and various other applications. To address this issue, we introduce an innovative framework for retrieving AOD from Landsat imagery over land, which leverages the deep-learning Transformers model (named AeroTrans-Landsat) and operates on the Google Earth Engine (GEE) cloud platform. We gathered Landsat 8 and 9 images starting from their launch dates (February 2013 and September 2021, respectively) until the end of 2022, which were used to construct a robust aerosol retrieval model. The global AOD retrievals were then rigorously validated across ~560 monitoring stations on land using diverse spatiotemporally independent methods. Leveraging information from multiple spectral channels, which contributes to 80% according to the SHapley Additive exPlanation method, our retrieved AODs from 2013 to 2022 generally agree well with surface observations, with a sample-based cross-validation correlation coefficient of 0.905 and a root-mean-square error of 0.083. Around 86% and 55% of our AOD retrievals meet the criteria of Moderate Resolution Imaging Spectroradiometer Deep Blue expected errors [$\pm$(0.05+20%)] and the Global Climate Observation System {[max(0.03, 10%)]}, respectively. Additionally, our model is not as sensitive to fluctuations in both surface and atmospheric conditions, enabling the generation of spatially continuous AOD distributions with exceptionally fine-scale information over dark to bright surfaces. This capability extends to areas characterized by high pollution levels originating from both anthropogenic and natural sources.

XULA Surface-Based Measurement Initiative for Environmental/Air quality Monitoring.

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Presentation Preference: Poster

The XULA Surface-Based Measurement Initiative for Environmental/Air Quality Monitoring, is a five-year project aimed at expanding participation in NASA's three Surface-Based Measurement Networks within Xavier and the surrounding Community. The three networks are the GPM, the PANDORA and the AERONET. Leveraging existing STEM programs and outreach capabilities, the project seeks to increase awareness of NASA's three networks among Xavier's STEM students and the local population. The initiative's goals include exposing undergraduate STEM majors to research careers in Earth System Science, fostering community awareness of NASA's networks, and complementing the ongoing Air Quality Monitoring project at Xavier. The AERONET projects include comparing PM2.5 concentrations derived from AOD data with direct surface measurements obtained from commercial sensors deployed around the Xavier campus. In addition our Advanced Earth Science course was redesigned to incorporate AERONET data analysis and real-time data projects, facilitating connections between aerosol data and local meteorology. Through these efforts, the XULA Surface-Based Measurement Initiative aims to advance environmental monitoring capabilities while nurturing scientific exploration and engagement among students and the wider community.

Keywords: PM2.5 Concentration, Aerosol Optical Depth, Air Quality Monitoring

Celebrating 53+ Years of Spectral Solar Radiometer Atmosphere-Earth Remote Sensing Research, Instrumentation, Applications and External Collaborations

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Presentation Preference: Oral

Glenn Shaw, encouraged by Ben Herman and John Reagan because of their interest in acquiring aerosol optical depth (AOD) in support of their radiative transfer and lidar investigations, undertook development and application of an automated filter-wheel solar radiometer for his PhD research. He developed a modern era radiometer incorporating three recent technological advances; a silicon photodiode detector capable of a linear response to incident radiation spanning some 10 decades, semiconductor operational amplifiers providing amplification of the full-range of photodiode responses to levels that could be accurately digitized and narrow band 1 to 10 nm interference filters with sufficient out-of-band blocking to permit accurate measurements of in-band radiation down to airmasses near the horizon. This radiometer was operated for many years, providing a testbed for advancing solar radiometer sensing and analysis techniques. It was followed by development of several other radiometers used by many research groups in support of various satellite (e.g., LandSat's, SAGE, MODIS, MISR and CALIPSO) and ground based\airborne research investigations. Included were efforts assisting in development of AERONET. Highlights will be presented of achievements advancing spectral solar radiometer research, instrumentation and applications which students and engineers/scientists at Univ AZ, often with external collaborations, have helped enable.

Keywords: Spectral Solar Radiometry, AOD

Inferring aerosol types using sunphotometer measurements over the IGB: Implications to direct radiative forcing and associated heating rate

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Presentation Preference: Oral

Abstract

The Indo-Gangetic Basin (IGB) in the northern part of India, the home to about one-seventh of the world's total population, has been identified as the region of enhanced aerosol loading, with significant seasonal heterogeneity in their characteristics, and thus considered as one of the global hotspots. The aerosol loading over the region is mainly composed of different aerosol species, attributed to the variety of anthropogenic emissions. However, the natural causes such as dust storms and forest fires further add to the overall aerosol loading over the region. Several studies have been carried out to understand direct radiative impacts due to composite aerosol; however, the magnitude of associated composite aerosol forcing largely depends on relative contribution of the individual species. The detailed knowledge of optical characteristics of the key aerosol types (e.g. desert dust, biomass burning, urban/industrial, black carbon etc.) is required to quantify their potential radiative impacts. The present study aims to understand the aerosol characteristics over the IGB based on their types, inferred from the ground-based automatic sunphotometer derived aerosol products associated with the size and radiation absorptivity of aerosol. The radiative impacts of the inferred aerosol types have also been quantified for the first time over the region.

Keywords: Aerosol types; Indo-Gangetic Basin; Optical properties; Radiative forcing; Heating rate

Intense transport of smoke to the Bolivian Andes: Insights from a unique set of instruments located at different altitudes

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Presentation Preference: Oral

The Bolivian lowlands experienced one of the worst years in terms of fires and smoke in 2023. A delayed start of the rainy season, with very low precipitation in the transition dry-to-wet season likely contributed to this scenario, along with Bolivian internal policies. A unique configuration of two AERONET stations located at the University Campus (LFA, 16.53ºS, -68.07ºW, 3420 m asl) and at the Chacaltaya GAW station (CHC, 16.35ºS, 68.13ºW, 5240 m asl), separated by a horizontal distance of around 22 km, recorded the intense transport of aerosols from the lowlands. Even though transport to the metropolitan area has been observed before, previous episodes typically lasted one or two days. However, the October 2023 episode, persisting for 10 days, was the longest recorded since 2005. An additional set of instruments deployed permanently at CHC as well as at the El Alto airport (EA, -16.51°W, -68.20°S, 4030 m asl), within the same metropolitan area, as well as back-trajectories obtained from a high resolution numerical weather model, were used to understand the smoke transport to a region with a very complex topography. The results are reported here with special emphasis on the data obtained by the sun/sky-photometers.

Keywords: Andes, smoke transport, biomass burning

The SKYNET network present status and future developments

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Presentation Preference: Oral

SKYNET is a ground-based radiation observation network dedicated to aerosol-cloud-solar radiation interaction (Nakajima et al. 2020). It consists of more than 100 sites worldwide located, most of them, in Asia where the network originally was born. In 2020 the creation of an International SKYNET data center (ISDC) set off the new structure of the network: an ISDC, providing standard aerosol products (https://www.skynet-isdc.org), and several regional sub-networks contributing for operation and maintenance of the associated instrumentation and for testing new research products. Currently, the activity is managed by four working groups: "Algorithm", "Quality Assurance and Validation", "Instruments" and "Promotional activity and Networking coordination". The new structure of SKYNET, is able to provide to the scientific community a freely downloading of the aerosol products from the web page, for each site of the network and in semi-real time, that makes now the network competitive with the other existing established realities and suitable for interesting collaboration with them. This work will show the present status of SKYNET, and the future developments both in terms of algorithms and of synergistic collaboration with other networks, showing also the most important international projects SKYNET is involved in.

Keywords: Skynet, network, sky-radiometers, aerosol, radiation.

Neural Network model to retrieve solar shortwave Irradiance from all-sky camera images

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Presentation Preference: Poster

A model based on a convolutional neural network (CNN) has been developed to retrieve the solar shortwave (SW) irradiance from daytime sky images obtained by all-sky cameras. This model has been named CNN-SW. For this purpose, the images have been collected at four different sites: Valladolid and Izaña (Spain), Lindenberg (Germany) and Marambio (Argentina/Antarctic). Measurements of SW irradiance have been also obtained by different pyranometers. The images classified at Valladolid, Izaña and Lindenberg, have been used to train and test the model. The results of this test have been compared against the measurements from the pyranometers, giving a total mean bias error (MBE) value of the differences of -9.27 W/m^2 and a standard deviation (SD) of 41.79 W/m^2. Finally, the CNN-SW model has been validated with images captured at the Antarctic station of Marambio, which has been excluded from the training process. The SW irradiance and the SW daily irradiation have been analysed comparing the predicted values of the model against the measurements of the pyranometer. In the first case, the results show an MBE of 4.96 W/m^2 with an SD of 64.77 W/m^2, while in the last one the MBE is 0.35 MJ/m^2 and the SD is 1.39 MJ/m^2.

This work has been supported by the Ministerio de Ciencia e Innovación (grant no. PID2021-127588OB-I00) and is part of the TED2021-131211B-I00 project funded by MCIN/AEI/10.13039/501100011033 and European Union "NextGenerationEU"/PRTR. This research is based on work from COST Action CA21119 HARMONIA. The authors acknowledge the support of the Spanish Ministry for Science and Innovation to ACTRIS ERIC.

Keywords: Convolutional Neural Network, all-sky camera, Shortwave Irradiance, Antarctica, AI.

Validating aerosol products from the HARP family of polarimeters using AERONET data

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Presentation Preference: Oral or Poster

The Hyper-angular Rainbow Polarimeter (HARP) series includes polarimeters designed for multi-spectral, multi-angular polarimetric observations of the Earth's atmosphere. These observations are crucial for deepening our understanding of atmospheric constituents, including aerosols and the Earth's surface. The instruments leverage Stokes vector measurements taken from the top of the atmosphere or at a suborbital level, allowing for the analysis of aerosol characteristics and the terrain below. The AirHARP, HARP, and HARP2 instruments are equipped with four spectral bands (440, 550, 670, 870 nm), featuring hyper-angular capabilities in the 670 nm channel (tailored for cloud property retrievals) and offering 10-20 viewing angles in other channels, depending on the acquisition scheme.

This study focuses on the validation of aerosol products obtained from the HARP suite of polarimeters, with a particular emphasis on using collocated data from the Aerosol Robotic Network (AERONET) for benchmarking. The Generalized Retrieval of Aerosol and Surface Properties (GRASP) algorithm is utilized to process the observations into actionable data on aerosols and surface characteristics. Specifically, we highlight the process of validating aerosol optical depth through AERONET observations for data collected by AirHARP during the ACEPOL 2017 campaign. Additionally, we discuss the validation of data products from the HARP CubeSat and HARP2 instruments, on Low Earth Orbits.

Keywords: HARP2, PACE, Polarimeter, GRASP, multiangle

AERONET-OC: an overview

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Presentation Preference: Oral

The Ocean Color component of the Aerosol Robotic Network (AERONET-OC) supports ocean color related activities such as the validation of satellite data products, the assessment of atmospheric correction schemes and the evaluation of bio-optical models, through globally distributed standardized measurements of water-leaving radiance and aerosol optical depth. The talk, benefitting of published achievements, provides an overview on AERONET-OC by: *i*. summarizing the basic above-water radiometry principles underpinning the generation of data products; *ii*. emphasizing the network expansion over more than 20 years; *iii*. showing the equivalence of data product accuracy for measurements performed with different instrument series; *iv.* illustrating the variety of water types represented by the network sites ensuring validation activities across a diversity of observation conditions; and *v*. finally documenting the rationale for the diverse water-leaving radiance data products generated applying alternative corrections for bidirectional effects.

Keywords: Ocean color, above-water radiometry.

AERONET-OC: an overview on L_{WN} uncertainties and quality control

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Presentation Preference: Oral

The Ocean Color component of the Aerosol Robotic Network (AERONET-OC) aims at supporting the assessment of satellite ocean color radiometric products with *in situ* reference data of the normalized water-leaving radiance L_{WN} data determined from automated above-water measurements. Applying metrology principles, uncertainty values were quantified for a number of AERONET-OC sites located in marine regions representative of chlorophyll-a dominated waters and a variety of optically-complex waters. Results show uncertainties typically increasing with the optical complexity of water and wind speed. The uncertainties are exploited for the quality control of AERONET-OC L_{WN} data products performed applying hierarchical tests to check: *i.* the relative-consistency of Level 1.5 L_{WN} spectra (called candidates) with respect to L_{WN} reference spectra (called prototypes) constructed using L_{WN} spectra formerly quality controlled; *ii.* the absence of any unexplained spectral feature in portions of the L_{WN} candidate spectrum; and additionally, when applicable, *iii.* the temporal consistency of the L_{WN} candidate spectrum with respect to close-in-time spectra as a criterion to further strengthen the quality control of data applicable for the validation of satellite data products.

Keywords: Ocean color, above-water radiometry, uncertainties, quality control.

Project Saver-Net: Integration of 8 Cimel Photometers into the AERONET Network in Southern South America

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Presentation Preference: Poster

In April 2013, a tri-national agreement was signed to develop a project between Argentina, Chile, and Japan, named SAVER-Net (Atmospheric Environmental Risk Management System), to conduct research and monitoring on aerosols from different sources, ozone layer, and UV radiation, in 8 stations . The Saver-Net project was carried out by the DEILAP (Department for Laser and Applications Research, DEILAP (CITEDEF-UNIDEF), Argentina) together with UMAG (University of Magallanes, Chile), and ISEE (Institute for Space-Earth Environmental Research, Japan) and was funded by the Japan International Cooperation Agency (JICA) during the period 2013-2018 .

Leveraging the experience gained from the first installation of a CIMEL photometer in the Aeronet network at DEILAP in 1999, photometers have been added since that date until the present day. Thus, new CIMEL solar photometers at SAVER-Net sites were crucial for determining aerosol properties in source areas, and identifying aerosol types, transport, and seasonal variation. Together with the rest of the instrumentation deployed allows the development of an integrated system for optical, microphysical, and radiative properties of the atmospheric aerosol.

Keywords: Saver-Net, Aerosols, UV radiation

Quality control of WATERHYPERNET measurements using AERONET-OC data

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Presentation Preference: Oral

Following the successful example of AERONET-OC, the WATERHYPERNET network has been set up to measure hyperspectral water reflectance for the purpose of satellite validation.

WATERHYPERNET integrates two autonomous hyperspectral radiometer systems, the PANTHYR, based on the mature TRIOS/RAMSES radiometer, and the HYPSTAR® radiometer, a newly developed radiometer measuring the spectral range 380-1020 nm with sampling every 0.5 nm and FWHM of 3 nm. 11 WATERHYPERNET sites are now functioning with the network currently transitioning from a prototype phase towards an operational network for satellite validation. 5 of the WATERHYPERNET sites are co-located with AERONET-OC sites, allowing a comparison of data for downwelling irradiance (using very different measurement methods) and for sky radiance, upwelling radiance and water reflectance.

In this presentation the WATERHYPERNET data processing and quality control will be presented with examples of the diverse problems that can be encountered and how they are detected by automated quality control. Comparison of WATERHYPERNET downwelling irradiance and sky radiance with a clear sky model is presented for cases with and without co-located AERONET-OC data input for the model. Conclusions are drawn for improvement of WATERHYPERNET quality control, both for individual measurements (flagging cloudy sky conditions and temporary obstructions, including birds) and for time series (detecting responsivity changes, e.g. from fore-optics contamination).

Keywords: AERONET-OC, WATERHYPERNET, hyperspectral, water reflectance, quality control, downwelling irradiance

Early validation results of PACE HARP2 aerosol product with AERONET

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Presentation Preference: Poster

The NASA Plankton, Aerosol, Cloud, Ocean Ecosystem (PACE) mission aims to enhance our understanding of the global ocean and atmosphere. With a specific focus on refining data records related to ocean ecology, biogeochemistry, atmospheric aerosols, and clouds, the PACE satellite was successfully launched on February 8th this year. The PACE data has been officially released in April after two-month commissioning period, comprising Level 1 data from all three sensors (OCI, HARP2, and SPEXone), alongside advanced products encompassing ocean, land, and atmospheric data.

The multi-angle polarimetric measurements yield valuable insights into aerosol optical and microphysical properties. To facilitate the processing of the wide-swath HARP2 data, we employed the FastMAPOL retrieval algorithm, enhanced by a set of neural network-based radiative transfer models, on the initial six months of HARP2 data. AERONET data are pivotal in validating the data product and enhancing algorithm performance. In this study, we will summarize our findings in validating the aerosol product with respect to AERONET and examine the impacts of retrieval product uncertainties.

Keywords: PACE, HARP2, aerosol, AERONET, FastMAPOL

Wet scavenging of aerosol and surface ozone in a semi-arid region (Arizona)

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Presentation Preference: Poster

Abstract: The semi-arid climate of the southwestern United States, particularly Arizona, presents unique challenges for understanding the dynamics of particulate matter (PM), aerosol optical depth (AOD), and surface ozone (O_3) due to its distinct meteorological and environmental conditions. Arizona receives the majority of its annual precipitation during two seasons: monsoon summer and winter, characterized by varying rainfall intensity and duration. While there is a more established understanding of wet scavenging of PM and AOD in literature, limited research exists on its impact on surface O_3 concentrations. Therefore, aside from PM and AOD, this study will also explore the potential impact of wet scavenging on surface O_3, considering the interplay between aerosol removal and O_3 chemistry. We use a combination of ground-based observations (e.g., AERONET, Pandora, EPA PM and O_3 monitoring, and meteorological parameters) based in Tucson, Arizona and satellite data (e.g. MODIS) to investigate the relationship between precipitation events and the removal of air pollutants in the atmosphere, and contrast results with other regions. Results from this study will hopefully elucidate the role of wet scavenging in regulating air quality in a semi-arid environment.

Keywords: Wet scavenging, PM, AOD, surface O_3

Leveraging atmospheric chemistry observations in Arizona: Insights into the regional transport of ozone and aerosols.

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Abstract

The desert southwest of the US, particularly the state of Arizona, presents a unique environment due to its arid climate and persistent air quality issues. In particular, dust storms and surface ozone (O_3) exceedances in the region are an environmental challenge that is influenced by multiple factors, from chemical precursors (dust, NO_x, and VOCs) to meteorology (regional and hemispheric transport of dust and ozone). In this study, we explore aerosol and trace gas measurements from in-situ observations to understand their regional/hemispheric transport signatures within dust storms and air quality exceedance events. We compare data from AERONET, PANDORA, SPARTAN, and EPA sites across the southwest US (specifically Arizona) with satellite observations (TROPOMI, MODIS, and TEMPO) to determine the impact of aerosols on the uncertainty within satellite retrievals of NO_2 and HCHO. We also analyze the co-variability in ground-based AOD, NO_2, HCHO, and O_3 as well as meteorological parameters with satellite comparisons to assess regional transport signatures. The observational datasets from ground-based instrument networks and satellite retrievals present a unique opportunity to study the complex interactions between atmospheric chemistry and meteorology that drive the unique environment of the region.

Keywords: AERONET, NO_2, surface O_3, transport, remote sensing.

European contribution to AERONET

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Presentation Preference: Oral

AERONET is a federation of ground-based remote sensing aerosol networks established 30 years ago and that greatly expanded in Europe and Africa thanks to France and Spain. At present time, the European components are operating about 120 stations. Since 2011, these operational and research activities have been included in the EU ACTRIS atmospheric infrastructure projects (Aerosol Cloud and Trace gas InfraStructure). In 2023, ACTRIS became a European infrastructure consortium, an EU legal form that facilitates the establishment and operation of research infrastructures with European interest. It includes in situ and remote sensing observation technologies and associated expert communities to better characterize and monitor aerosols, cloud and trace gas. The aerosol remote sensing component of ACTRIS is combining passive (AERONET) and active (EARLINET) capabilities into the Center for Aerosol Remote Sensing (CARS). CARS mission is to offer operation support to ACTRIS monitoring stations (National Facilities) operating aerosol remote sensing instrumentation. In this presentation, we will describe the CARS contribution to AERONET.

Keywords: AERONET, ACTRIS, CARS, EARLINET

Detection of wildfire emissions in Montevideo that occur hundreds of kilometres away.

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Presentation Preference: Poster

The burning of biomass releases large quantities of aerosols and chemical species into the atmosphere, generating significant impact both locally and globally.
Ground-based observations are crucial for the analysis of these phenomena as they allow continuous registration of the presence of aerosols, trace gases and other atmospheric parameters. On November 24, 2020, aerosol optical depth (AOD) and fine mode fraction (FF) values at the AERONET station in Montevideo, Uruguay exceeded a dozen times the monthly mean value. Additionally, high levels of formaldehyde in the atmosphere were found with a MAX-DOAS instrument located next to the AERONET solar photometer.
The analysis indicates that the cause of the observed increase was the passage of a plume emitted by a distant biomass burning event. Through analysis of RGB satellite images (VIIRS), fire source data from MODIS Wild Radiative Power (WRP) and verification of the trajectories using the transport model HYSPLIT, a large fire located 800 km north of Montevideo was confirmed. Simultaneously, analysis of solar spectra showed an increase in atmospheric constituents associated with biomass burning. This demonstrates the potential of the analysis of direct AERONET measurements for the detection of these types of events.

Keywords: smoke plume, aerosols, HYSPLIT, MAX-DOAS

Advancing Radiometric Calibration of FORMOSAT-5 Through Vicarious and Cross Calibration Methods with AERONET Atmospheric Data: Insights from Over Six Years of Results

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This paper presents a comprehensive radiometric calibration approach for FORMOSAT-5, a satellite owned by the Taiwan Space Agency (TASA), spanning over a period of six years. Radiometric calibration is crucial for ensuring the accuracy and reliability of satellite imagery, particularly for applications such as environmental monitoring, disaster management, and land cover classification. In this study, we employ a combination of vicarious and cross calibration methods to refine the radiometric calibration parameters of FORMOSAT-5.

The vicarious calibration method involves utilizing ground-based measurements of known radiance targets to establish a relationship between the satellite sensor's digital numbers and the actual radiance values. We leverage the extensive network of Aerosol Robotic Network (AERONET) sites to obtain high-quality atmospheric data, which is essential for accurately characterizing the radiative transfer processes in the Earth's atmosphere.

Furthermore, we incorporate a cross-calibration step to enhance the accuracy of the radiometric calibration. This involves comparing the radiance measurements of FORMOSAT-5 with those of well-calibrated reference sensors on other satellite platforms. By leveraging the radiometric consistency between multiple sensors, we can identify and correct systematic biases, thereby improving the overall calibration accuracy of FORMOSAT-5.

The proposed calibration approach is implemented and validated using a series of observational data acquired by FORMOSAT-5 over various calibration sites with diverse surface types and atmospheric conditions, spanning over six years. Preliminary results demonstrate significant improvements in the radiometric accuracy of FORMOSAT-5 imagery, thereby enhancing its utility for a wide range of Earth observation applications.

In summary, this paper contributes to the ongoing efforts to enhance the radiometric calibration of FORMOSAT-5 by leveraging both vicarious and cross calibration methods, with the support of AERONET atmospheric data. The calibrated imagery generated through this approach holds great promise for advancing scientific research, environmental monitoring, and societal applications reliant on satellite-based Earth observation data

Keywords: FORMOSAT-5, Vicarious and Cross Calibration Methods, AERONET Atmospheric Data

Long-term optical characterization of black and brown carbon aerosols in São Paulo

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Presentation Preference: Oral

This study analyses ~24 years of data (2000 - 2024) obtained by AERONET photometers in São Paulo Megacity to characterize the aerosol optical depth (AOD) and the absorbing AAOD at 440 nm. The components due to black carbon (BC) and brown carbon (BrC) are also discriminated. The results show a small seasonality in both AOD and AAOD. Higher median values of AOD and AAOD are observed during winter (0.392 and 0.041 in September, respectively), driven particularly by regional and long-range transported biomass-burning aerosols. In contrast, during summer, the AOD and AAOD present their lowest median values, of 0.171 (January) and 0.014 (December), respectively. Similar seasonal behaviors are observed for the BC and BrC AAOD. BC dominates the fraction and seasonal dynamics of the total AAOD, with an average of 77%, while 23% is due to BrC. Maximum median values of BC (0.034) and BrC (0.012) AAOD are observed in winter. In contrast, the minimum values for BC (0.0097) and BrC (0.0036) are observed in December and May, respectively. During the analyzed period, local air pollution control regulations led to a strong reduction in both BC and BrC AAOD over the years. Aerosol physical differences were observed when identifying the extreme periods with the highest and lowest BC and BrC AAOD fractions. Larger volumes of coarse-mode aerosols were observed when the BrC fraction was higher and a higher imaginary refractive index (0.022). In contrast, higher BC fractions were observed in periods when fine-mode aerosol volume dominates, with a lower imaginary refractive index (0.010). Further details of this study will be discussed.

Keywords: Seasonality, absorbing aerosols, AERONET, brown and black carbon, São Paulo.

Comparison of AERONET retrievals of long-ranged transported African aerosol measured in Miami and Ragged Point, Barbados

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Presentation Preference: Oral

Both Ragged Point in Barbados and Virginia Key in Florida have been operated by the University of Miami to better understand the impact of African dust transport on clouds, climate, ecosystems, and air quality over the Caribbean and the Americas. Here we highlight insights into dust transport captured at both sites with AERONET, operated at both sites since 2007, as well as our daily surface filter measurements. We focus on intensive measurement periods including the EUREC^{4}A/ATOMIC measurement campaign in the winter of 2020 and the recent MAGPIE campaign in the summer of 2023—both of which captured major dust transport events. The summertime event captured by AERONET during MAGPIE shows elevated coarse mode dust while up to one-third of AOD is attributed to fine mode aerosol during the 2020 wintertime transport events in Barbados. Bulk aerosol and single-particle measurements during ATOMIC reveal that surface dust mass concentrations were evenly split between the coarse and fine aerosol modes while the fine mode also contained high concentrations of co-transported smoke. In contrast, few smoke particles and fine mode dust were observed during MAGPIE. Our findings highlight the importance of AERONET measurements at sites collecting long-term filter measurements for developing aerosol transport climatologies.

Keywords: African dust, long-range transport, biomass burning, Caribbean aerosol

AERONET for Satellite Remote Sensing of Aerosols in Asia from Geostationary Earth Orbit: retrieval, analysis, and validation

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Presentation Preference: Oral

AERONET, a federated ground-based remote sensing aerosol networks has played a critical role in observing and understanding the spatio-temporal distribution of aerosols, their changes, and transport. The systematic operation with calibration, health monitoring and timely support are the key to the success of AERONET. Beyond its global network observation, it has been a critical asset to provide a priori knowledge and validation for the satellite remote sensing of aerosol optical properties. The Korea Aerospace Research Institute(KARI) launched GEO-KOMPSAT(GK) II with Advanced Meteorological Imager(AMI) onboard the GK-2A in 2018, and Geostationary Ocean Color Imager(GOCI)-2 and Geostationary Environment Monitoring Spectrometer(GEMS) onboard the GK-2B in 2020, respectively. These GK-2 satellites continue and expand the legacy of Communication, Oceanography and Meteorology Satellite(COMS), as GK-1 which was launched in 2010. In this presentation, studies conducted with AERONET, focusing on their applications, validations, and satellite remote sensing of aerosols over Asia from GEO are highlighted with selected cases.

Keywords: AERONET, aerosol optical property, GOCI, GEMS, AMI

Assessment of Dust Size Retrievals Based on AERONET: A Case Study of Radiative Closure From Visible-Near-Infrared to Thermal Infrared

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Presentation Preference: Oral

Super-coarse dust particles (diameters >10 μm) are evidenced to be more abundant in the atmosphere than model estimates and contribute significantly to the dust climate impacts. Since super-coarse dust accounts for less dust extinction in the visible-to-near-infrared (VIS-NIR) than in the thermal infrared (TIR) spectral regime, they are suspected to be underestimated by remote sensing instruments operates only in VIS-NIR, including Aerosol Robotic Networks (AERONET), a widely used data set for dust model validation. In this study, we perform a radiative closure assessment using the AERONET-retrieved size distribution in comparison with the collocated Atmospheric Infrared Sounder (AIRS) TIR observations with comprehensive uncertainty analysis. The consistently warm bias in the comparisons suggests a potential underestimation of super-coarse dust in the AERONET retrievals due to the limited VIS-NIR sensitivity. An extra super-coarse mode included in the AERONET-retrieved size distribution helps improve the TIR closure without deteriorating the retrieval accuracy in the VIS-NIR.

Keywords: Dust, Particle size distribution, AERONET, Thermal infrared

Ground-based UV-VIS retrievals of Saharan dust absorption at Izaña Observatory

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Presentation Preference: Oral

The Izaña Atmospheric Observatory (IZO) offers a unique site for Saharan dust optical properties retrievals. We combined AERONET aerosol optical depth (AOD) measurements and inversion parameters with total, direct, and diffuse sky irradiance measurements from UV- and VIS-Multifilter Rotating Shadowband Radiometers (MFRSR) to retrieve single scattering albedo (SSA) for 2019-2023. We describe a new MFRSR on-site calibration procedure, which decreases the direct and increases the diffuse measured irradiances during Saharan dust events to ensure consistency with the AERONET AOD measurements and MFRSR Langley calibrations on days with low AOD. Only after applying such calibration corrections do our retrievals of Saharan dust SSA agree with the AERONET inversions at 440 nm. We also show that Saharan dust exhibits enhanced absorption at UV wavelengths, reducing the amount of UV radiation reaching the surface and slowing tropospheric photochemistry, which can have implications for air quality, human health, ecosystem dynamics, and the photodegradation of plastic materials. We plan to continue making MFRSR and AERONET measurements in Santa Cruz de Tenerife and compare them to space-based UV-VIS spectrometers, such as Copernicus Sentinel 5 precursor (TROPOMI) and NASA Plankton, Aerosol, Cloud, Ocean Ecosystem (PACE) Ocean Color Instrument (OCI).

Keywords: AERONET, MFRSR, DUST UV ABSORPTION, UV IRRADIANCE

Retrieval of Aerosol Optical Parameters from the Data of CIMEL Sun photometer Measurements at the «Issyk-Kul» Research Station

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Presentation Preference: Poster

At the Research Station «Issyk-Kul» of the Kyrgyz National University named after J. Balasagyn, since 1979, the impact of the parameters of the main greenhouse gases on the ecology of the mountain region has been assessed. The importance of monitoring of atmospheric gas components at the «Issyk-Kul» Research Station is determined by significant differences in their variability over the Northern Tien-Shan region compared to the global average variability of components. The measurement data correspond to the background troposphere, but in winter periods they are influenced from anthropogenic zones. This is reflected in the optical properties of the fine-mode fraction of aerosols due to the presence of soot, or BC (black carbon). It is hypothesized that global BC may be the second important component in global warming, after CO2. Therefore, determining the fraction of BC particles in fine-mode aerosols under free tropospheric conditions is relevant. Based on the aerosol column lognormal parameters of the aerosol column volume size distribution obtained earlier for the AOD (aerosol optical depth) observation period from 2007 to 2021, we obtained column single-scattering albedo, AOD scattering and absorption in addition to this fraction. Also, the processing of AOD data for 2022, 2023, 2024 is carried out.

Keywords: gases, aerosols, black carbon

AEROSPAN, Australia's robotic aerosol network

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Presentation Preference: Oral

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) oversees 10 out of the 12 operational robotic aerosol network sites in Australia, collectively known as AEROSPAN. All but one of these sites are located in remote areas, away from densely populated regions, and endure harsh environmental conditions throughout the year.

Initially, the land-based sites were established for studying dust, smoke, and aerosols. However, the recent expansion of AEROSPAN includes newer sites like Tumbarumba in New South Wales and the Pinnacles in Western Australia, which have a primary focus on optical satellite calibration and validation. The Pinnacles, situated amidst vast ferruginous quartz-carbonate-kaolinite sand dunes within the Nambung National Park, stands out as a bright target, possessing over 60% reflectance in the visible to shortwave infrared wavelength range and a significant number of cloud-free days. Plans are underway to develop this site into a Radiometric Calibration Network (RadCalNet) site, with potential expansion to include thermal infrared calibration and validation in the future.

In addition to these terrestrial sites, CSIRO operates a marine site located in coastal waters of the Great Barrier Reef (Lucinda) that feeds into AERONET-OC and has plans to establish an inland aquatic site southeast of Canberra, in the Australian Capital Territory.

Keywords: Maximum Five (5) keywords are allowed. AEROSPAN, Australia, calibration, validation

Methods for SI-traceable calibrations of network radiometers from AERONET Europe

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Presentation Preference: Poster

In the project Metrology for Aerosol Optical Properties (MAPP), three new methods were tested to provide SI-traceable measurements of solar irradiance and sky radiance to retrieve aerosol optical properties. The different possible calibration routes providing traceability to the SI are the following:

1) Spectral irradiance responsivity calibration of the sunphotometer using a tuneable laser source and a calibrated reference detector. The radiance responsivity is derived from the irradiance responsivity using solid angle measurements of the field-of-view of the sunphotometer.
2) Radiance responsivity calibration using an integrating sphere source traceable to the SI and the relative responsivity functions of the sunphotometer channels. The irradiance responsivity is derived from the radiance responsivity and solid angle measurements of the sunphotometer.
3) ToA values of the sunphotometer using Langley-plots, combined with a ToA solar spectral irradiance spectrum traceable to the SI, such as the TSIS-1 HSRS. The radiance responsivity calibration is obtained through solid angle measurements of the input optic.

While 1) and 2) are laboratory-based and do not require Langley-plots, method 3) relies on Langley-plots, solid angle measurements of the field-of-view, the relative responsivity functions of the sunphotometer channels, and a traceable ToA solar irradiance spectrum.

Keywords: Traceability, solar spectrum, calibration, aerosol properties.

Surface Reflectance Parameterization for Dark Target Aerosol Algorithm: Atmospheric Correction using AERONET AOD

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Presentation Preference: Poster

Originally developed for the Moderate Resolution Imaging Spectroradiometer (MODIS) in polar, sun-synchronous low-earth orbit (LEO), the Dark Target (DT) aerosol retrieval algorithm relies on the assumption of a Surface Reflectance Parameterization (SRP) over land surfaces. As the DT algorithm is widely adopted for other sensors, we assess whether the MODIS-based SRP can be used for other sensors in low earth orbit (LEO) and geostationary orbit (GEO). We explore this issue by calculating surface reflectance from top-of-atmosphere reflectance measured by the Visible-infrared Radiometer Suite (VIIRS) and the Advanced Baseline Imager (ABI), using atmospheric correction at AERONET sites.

The DT SRP represents spectral relationships between surface reflectance in different bands, changing with scattering angle, a normalized difference vegetation index ($NDVI_{SWIR}$) and urban percentage. The VIIRS-based SRP closely aligns with the MODIS-based SRP, but the wavelength shift results in an adjustment of the parameterization coefficients. The ABI-based SRP also matches well with the MODIS-based SRP, but differs in terms of dependence on scattering angle. Because GEO encounters an entirely different set of observation geometry than does LEO, the DT algorithm requires a new SRP to draws the angular shape of the surface bidirectional reflectance within an observation geometry of GEO.

Keywords: Dark Target algorithm, Surface reflectance parameterization, GEO

Validation and uncertainty estimation for MAIAC EPIC smoke AOD and spectral SSA using AERONET

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Presentation Preference: No preference

Accurate measurement of aerosol spectral absorption, in addition to total aerosol quantity, is crucial to advance understanding of smoke aerosol aging processes, enhance air quality monitoring and forecasting capabilities, and refine the assessment of radiative forcing. The MAIAC processing, implemented on EPIC aboard the DSCOVR spacecraft, facilitates the simultaneous retrieval of aerosol optical depth (AOD), spectral absorption spanning from UV to near-infrared wavelengths (also presented as spectral single scattering albedo (SSA) between 340 and 780 nm), and aerosol layer height for identified smoke and dust pixels and with temporal resolutions of 1-2 hours and spatial resolutions of 10 km. This study validates MAIAC EPIC smoke AOD at 443 nm and spectral SSA at 443 and 680 nm from 2015 to 2023, using AERONET data from global sites to quantify associated uncertainties. The global MAIAC EPIC SSA at 443 nm and 680 nm validation shows a good agreement with >60% of retrievals within a range of AERONET SSA of ±0.03 with minimal biases. Additionally, regional variability in retrieval performance is explored.

Keywords: MAIAC, EPIC, AOD, spectral SSA

Synergy of ground-based remote sensing instrumentations to explore the impact of NO_2 absorption on aerosol optical depth retrieval

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Presentation Preference: Oral

The synergy of collocated ground-based remote sensing instrumentations, specifically the Pandonia Global Network's (PGN) Pandora spectroradiometers and the Aerosol Robotic Network's (AERONET) Cimel sunphotometers, is a viable approach to analyse the impact of NO_2 on aerosol optical depth (AOD) retrievals.

In our analysis, AERONET satellite climatology-based NO_2 estimations are replaced with PGN NO_2 measurements revealing AERONET AOD overestimation in half of the cases and underestimation in others with ~33% of the total collocated stations showing mean deviation above $0.5x10^{-4}$ mol-m^{-2} in NO_2 and 0.002 in AOD at 380/440 nm, which increases further during periods of high NO_2 loading.

Currently, other AOD-measuring networks (e.g., SKYNET and GAW-PFR) do not account for NO_2 absorption in AOD retrievals, and are prone to systematic AOD overestimation when considering NO_2 correction specifically for high polluted areas or during extreme events like wildfires. Station-specific analysis for Rome reveals lower average AOD bias for AERONET (~0.003) compared to SKYNET (~0.007). Therefore, widespread deployment of instruments and Earth-observation's technological improvements, such as real-time high spatial and/or temporal resolution NO_2 products could significantly improve aerosol properties retrievals.

Keywords: Aerosol optical depth, NO_2 absorption, sunphotometer, climatology, trace gas.

Introduction to Aerosol-Related Research at Institute of Geophysics, VAST

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Presentation Preference: Oral or Poster

In this report, we summarize the AERONET sites in Vietnam, presenting some research results utilizing AERONET data including: Characteristics of aerosol optical depth (AOD) retrieved from AERONET in Vietnam and comparison with MODIS data; Impact of rainfall during the summer monsoon onset on AOD in Bac Lieu; Impact of winter monsoon circulations on AOD in Bac Lieu and Bac Giang; Evaluation of AERONET precipitable water vapor (PWV) versus GNSS data at Nghia Do; The Relationship between Biomass Burning in Indochina and AOD in Hanoi. Additionally, we also present technical and application research including: The development of a low-cost PM2.5 sensor-based monitoring device mounted on an unmanned aerial vehicle (UAV) and development of an indoor air cleaning system using HEPA (High-Efficiency Particulate Air) and carbon filters. Finally, we make some suggestions on implementing an aerosol monitoring system and research in Vietnam in the near future.

Keywords: AERONET, AOD, PWV , Vietnam.

AERONET observations as a valuable component of the PACE Postlaunch Airborne Experiment (PACE-PAX)

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Presentation Preference: Oral

The recently launched Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission is currently conducting an airborne field campaign for validation of aerosol, cloud and ocean products from PACE. The PACE Postlaunch Airborne Experiment (PACE-PAX) utilizes two aircraft, two research ships, and a host of other assets in the ocean and on land. AERONET is crucial to the latter, and instrument locations will serve as aircraft waypoints for focussed, multi-parameter validation. A Validation Traceability Matrix (VTM), which is a prioritized list of targeted observables and measurement conditions, is used for flight planning. Southern and central California and nearby coastal regions are the area of operations, with an emphasis on variety of physical conditions and the ability to determine multiple parameters simultaneously.

Final data products are due by the end of March, 2025, and will be available to the science community. For more details on PACE-PAX, see https://pace.oceansciences.org/campaigns.htm

Keywords: PACE, validation, aerosol, airborne

Overview of mobile photometer and LIDAR measurements of smoke during FIREX-AQ campaign in 2019

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Presentation Preference: Oral

In 2019, we have participated to the FIREX-AQ campaign in northwestern US with 2 mobile systems (DRAGON Mobile Units or DMUs) to map for the first time the wildfires smoke plumes spatial and vertical variability close to the source. Twenty semi-mobile AERONET sites were deployed regionally for the campaign period, as well as an MPLNET micro-pulse lidar in McCall, Idaho. Seven fires in NW states (Washington, Idaho and Oregon) were sampled in terms of AOD and vertical profiles with 2 photometers and 2 lidars embarked on SUVs. The general overview of the column-integrated properties (AOD, Angstrom Exponent, size distribution) measured by the photometers (CE 318-T and PLASMA) will be presented. Vertical profiling by the 2 lidars (CE370, mono-wavelength elastic lidar and CE376, dual-wavelength depolarization lidar) allowed to evaluate the smoke plumes altitude and to follow their spatial dispersion from the source (driving in and out of plumes, evaluate the regional transport). Main aerosol properties for different smoke types (fresh, smoldering, aged, convective, diffuse) will be presented. The mobile LIDAR and photometer datasets around fires are quite unique, as few remote sensing systems can get this close to the wildfires sources in mountainous regions.

Keywords: smoke; photometer; LIDAR; mobile; FIREX-AQ.

Radiometric Calibration and Validation of Gaofen Sensors at the Baotou Site Using AERONET and RadCalNet Data

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Presentation Preference: No Preference

The Baotou Radiometric Calibration Site, situated in northeastern China, was established in 2013 and subsequently integrated into the Aerosol Robotic Network (AERONET). This facility is equipped with automated systems that perform continuous measurements of surface-reflected spectral radiance, atmospheric profiles up to altitudes of 10 km, cloud dynamics, and aerosol measurements using the CIMEL CE318 instrument. Aerosol measurements are systematically uploaded to AERONET, ensuring standardization and consistency. This adherence to measurement protocols facilitated the inclusion of the Baotou site in the Radiometric Calibration Network (RadCalNet) in 2017.

This study presents an analysis of the clear seasonal variations in atmospheric parameters at the Baotou site, as recorded by AERONET from 2013 to 2023. Furthermore, it details the long-term monitoring and radiometric calibration activities conducted for China's Gaofen-1/WFV and Gaofen-6/WFV sensors, employing RadCalNet surface reflectance data and aerosol measurements from AERONET. The calibration accuracy was validated through cross-calibration and demonstrated long-term radiometric consistency with the Sentinel-2A/B MultiSpectral Instrument (MSI) and the Landsat-8 Operational Land Imager (OLI). An analysis of 87 paired observations and simulated values revealed a relative discrepancy of less than 3%, underscoring the method's efficacy and the precision of the Baotou site's AERONET data.

Keywords: Baotou Site, AERONET, RadCalNet, Radiometric Calibration

Validation of Version 2 VIIRS Deep Blue aerosol products

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Presentation Preference: Poster

NASA's Deep Blue aerosol project aims to create consistent, long-term climate data records of aerosols from both low-Earth-orbit and geostationary satellite sensors. The Deep Blue algorithm is an integration of the Deep Blue-land and the Satellite Ocean Aerosol Retrieval (SOAR) algorithms, providing various parameters, including aerosol optical depth (AOD) at 550 nm as the physical quantity of primary interest, spectral AOD, Ångström exponent, fine-mode AOD fraction over water, and aerosol type. To construct robust long-term time series, the Deep Blue algorithm has been adapted to the Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi National Polar-orbiting Partnership (Suomi NPP) satellite and National Oceanic and Atmospheric Administration-20 (NOAA-20) satellite. The latest VIIRS Version 2 Deep Blue aerosol products were released in April 2023 and are accessible at the LAADS DAAC and NASA Earthdata (https://earthdata.nasa.gov/). In this study, we evaluated the VIIRS Version 2 Deep Blue aerosol products using the Aerosol Robotic Network (AERONET) observations. Validation results over land indicate the consistent performance between SNPP and NOAA-20 VIIRS datasets. Additionally, we conducted error analysis for the VIIRS Version 2 Deep Blue aerosol products based on aerosol type and surface type using AERONET observations.

Keywords: VIIRS, Deep Blue aerosol product, validation

Improving Aerosol Optical Depth Retrieval from GOES-R: Deep Learning-Based Bias Correction with AERONET Data

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Presentation Preference: Poster

Accurate monitoring of atmospheric aerosols is paramount for understanding their multifaceted impacts on air quality, climate dynamics, and public health. The Advanced Baseline Imager (ABI) aboard the Geostationary Operational Environmental Satellite-R (GOES-R) series provide aerosol optical depth (AOD) every 5 minutes. In this study, we assess satellite-derived AOD against ground-based in-situ measurements and propose a deep learning-based bias correction method for improving the performance of satellite-derived AOD. Initially, the GOES-R AOD product is validated against AERONET measurements to identify and quantify any inherent biases. Subsequently, a deep neural network (DNN)-based bias correction method is employed to mitigate these biases and improve the accuracy of GOES-R AOD retrievals. The approach utilizes AERONET AOD data to effectively identify and correct for systematic biases inherent in satellite-derived AOD products. Our findings highlight the importance of integrating deep learning techniques with ground-based observations for enhancing the utility of satellite-derived AOD products in atmospheric aerosol monitoring and research applications. By integrating high-quality AERONET data for validation and DNN training, our approach demonstrates significant enhancements in the reliability and consistency of GOES-R AOD. This integrated methodology underscores the importance of rigorous validation and deep learning techniques in refining satellite-derived AOD products, thereby advancing aerosol monitoring and research capabilities.

Keywords: AERONET, AOD, machine learning, ABI, bias correction

Aerosol Optical Depth Measurements at urban Dhaka and rural Bhola in Bangladesh

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Presentation Preference: **Oral**

Abstract: Bangladesh was the top most polluted country in 2023 with an annual average of 79.9 μgm^{-3} of $PM_{2.5}$, and Dhaka became the 2nd most polluted capital city with 80.2 μgm^{-3} of $PM_{2.5}$ in the world. Two AERONET stations have been operating in the central part of the country (Dhaka University) and the most southern part of the country near the Bay of Bengal (Coastal Bhola Island) for more than a decade. The average absorption aerosol optical depths (AAOD) are 0.110 ± 0.002 in Dhaka and 0.075 ± 0.001 in coastal Bhola. Strong seasonal variations of AOD were observed at both locations, the highest during winter and the lowest during monsoon season. Biomass burning and urban/industrial types of aerosols were observed at both the locations. The absorbing aerosols dominate, with a prominent contribution of black carbon (45.9%–89.1%), at both urban and coastal locations. The associations of different aerosol optical properties (EAE and AAE, EAE and SSA, EAE and RRI, FMF and AE, FMF and AAE, and FMF and SSA) will also be presented at the conference.

Keywords: Aerosol Optical depths, Black carbon, Cimel sun photometer, AERONET, Dhaka, Bhola.

Long-term aerosol physical properties from AERONET monitoring in Thailand

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Presentation Preference: Oral

The monitoring of aerosol properties, including optical depth, Angstrom wavelength exponent, single scattering, and size distribution, has been ongoing in Thailand since 2006. Presently, there are ten AERONET monitoring sites located across the country. This study aims to analyze the variations in aerosol properties throughout the entire measurement period at each monitoring site. The results provide the behaviour of aerosols in different locations and seasons across Thailand. The study also examined the trends in aerosol properties from 2007 to 2023 at four representative sites situated in the four main regions of Thailand: Chiang Mai (18.98°N, 98.98°E), Ubon Ratchathani (15.25°N, 104.78°E, Nakhon Pathom (13.82°N, 100.04°E) and Songkhla (7.2°N, 100.60°E). Additionally, the study also presents the influences of atmospheric aerosols on solar radiation.

Keywords: optical depth, single scattering albedo, size distribution, AERONET, Trends

Mobile Aerosol Monitoring combining lidar and photometer during TRANSAMA ship-based campaign

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Presentation Preference: Poster

AMAGAS-AMARYLLIS oceanographic mission was deployed aboard the Marion Dufresne research vessel for studies on the Amazon Forest's role in past climates. Thus, TRANSAMA (transit to AMAGAS-AMARYLLIS) campaign aimed to study aerosols along the route covered by the vessel on transit towards the Amazon region (April-May 2023). Instruments installed aboard included two CE318-T photometers, one advanced-PLASMA photometer and a CE370 single-wavelength lidar (MAP-IO program).

Lidar and photometer synergetic observations revealed vertical-resolved aerosol properties (e.g., backscatter and extinction coefficients) along the route from La Réunion Island to Barbados. Very clean conditions were identified in the South Atlantic Ocean, with low Aerosol Optical Depth (AOD) values. Unexpected smoke aerosol layers detected above the Marine Boundary Layer (MBL) were likely transported from wildfires in Southern Africa savanna. These findings emphasize the influence of continental emissions even in remote oceanic regions, contributing to our understanding of climate processes. Moreover, the campaign allowed continuous assessments on the performance of the instruments. In particular, the adequate operational conditions for the lidar were evaluated, envisaging the future installation of a ship-borne CE376 dual wavelength and depolarization lidar.

Keywords: lidar-photometer synergy, mobile observations, ship-borne photometer

Introduction of GEO-LEO merged Deep Blue Product

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Presentation Preference: Poster

The Deep Blue/SOAR algorithms have been adapted for utilization of geostationary orbit (GEO) sensors, such as the Advanced Baseline Imager (ABI) on GOES-16/17/18 and the Advanced Himawari Imager (AHI) on Himawari-8/9. While low earth orbit (LEO) DB products (MODIS Terra/Aqua and VIIRS SNPP/NOAA20 DB products) are currently available, our ongoing efforts involve integrating GEO and LEO data products to enhance the dataset's convenience and comprehensiveness for aerosol research. This presentation introduces the new merged data products, including 30-minute gridded L2 (L2G), daily L3 (D3), and monthly L3 (M3) aerosol optical thickness (AOT) at reference wavelengths of 550nm retrieved from the Deep Blue aerosol retrieval algorithm using various sensors. Additionally, we discuss the utilization of AERONET datasets for product development.

Keywords: Deep Blue, GEO, LEO

The Langley ratio method, a new approach for transferring photometer calibration from direct sun measurement

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Presentation Preference: Oral

We describe here a novel method for transferring calibration from a reference sun photometer (referred to as the "master") to a secondary sun photometer (referred to as the "field"), particularly useful when the instruments have different spectral bands. This technique called the Langley Ratio (LR) method, has demonstrated its utility in transferring calibration between different photometers (for example, between CE318-T and Precision Filter Radiometer, PFR), as well as between different versions of the CE318-T photometer. This capability makes the LR technique an interesting tool for intercomparing photometric products from different networks (such as in traceability exercises) or for transferring calibration within a network consisting of similar photometers with different spectral responses.

Keywords: Calibration, AOD, Langley.

Climatology of Saharan Dust Events over the Subtropical North Atlantic with AERONET Photometric Observation

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Presentation Preference: Poster

Every year, large-scale African dust outbreaks frequently traverse the Subtropical North Atlantic (SNA) following the advection of the Saharan Air Layer (SAL) from the African continent. This transport exhibits a strong seasonal dependence, impacting the altitude, composition, and aerosol load of this dust-laden elevated layer. An operational algorithm has been developed to detect dust outbreaks over the SNA, utilizing Aerosol Optical Depth (AOD) observations conducted at two AERONET sites in Tenerife (Canary Islands, Spain): Santa Cruz de Tenerife (52 m a.s.l.) and Izaña high-altitude Observatory (2400 m a.s.l.). These more than10-year observations will be utilized to compile a climatology of dust outbreaks over Tenerife, elucidating possible trends and seasonal/intraseasonal dependencies.

Keywords: Dust, AOD, climatology.

Desert Dust Optical Properties from AERONET Observations: Spectral Absorption, Size Distributions, Spectral AOD and Seasonal Dynamics

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Presentation Preference: Oral

The AERONET multi-year global climatological database of aerosol retrievals is examined to investigate spectral aerosol optical and physical properties at several sites in major dust source regions. Comparisons are made of the retrieved spectral single scattering albedo (SSA) to the soil sample laboratory measurements of Di Biagio et al. (2019). In general the AERONET retrieved SSA agree very well with these regional mean laboratory values additionally often showing close agreement with the least and most absorbing subsets of the data for specific dust sources. The seasonal variation in retrieved SSA in dust dominated cases at selected AERONET sites are also investigated, with some regions exhibiting annual cycles in absorption, primarily at 440 nm while absorption at 675, 870 and 1020 nm is weak and relatively stable. For many dust source regions (especially the Sahel and Sahara) the retrieved volume size distribution typically exhibits a distinct or shoulder middle-sized mode in the submicron radius range. Sub-micron 'middle mode' sized particles (<0.99 micron radius) may be a significant physical reason for the relatively large spectral drop-off in Aerosol Optical Depth (AOD) in the wavelengths beyond the visible in most dust events where Angstrom Exponent is low.

Keywords: Desert Dust, Spectral Absorption, Size Distribution, Spectral AOD

Advancing Night-time Aerosol Monitoring with Lunar Photometry: Insights from RIMO Model and Comparison with the AERONET Lunar Product

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Presentation Preference: Poster

Lunar photometry is a promising technique addressing gaps in night-time aerosol monitoring where solar photometry falls short. An obstacle in night-time aerosol monitoring using the Moon as a light source is the need for accurate lunar irradiance due to the Moon's changing illumination. The RIMO model, based on the ROLO lunar irradiance model (RObotic Lunar Observatory), can be corrected by the RCF (RIMO correction factor), which significantly enhances its accuracy to estimate night-time Aerosol Optical Depth (AOD). Similar bias-correction methods over lunar irradiance models are used by AERONET and Skynet teams.
This study utilizes an 11-month dataset of day and night-time photometric observations from the CE318-T photometer at the AERONET station in Roque de Los Muchachos, Spain. Situated at 2396m above sea level, this observatory provides an ideal setting for astronomical and atmospheric research. Comparisons between AOD values retrieved using the CE318-T photometer with RCF and AERONET lunar products under pristine conditions are conducted, shedding light on potential differences and improvements in night-time aerosol monitoring.

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Keywords: lunar photometry, AOD, AERONET, RIMO, RCF.

Assessing aerosol species mass and optical depth closure across the Bengal Gangetic Plain utilizing the Aero-Opt Matlab package and AERONET's aerosol optical properties

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In the present study, we evaluated the pre-monsoon urban atmosphere (UA) aerosol characteristics remotely sensed by the Aerosol Robotic Network (AERONET) over the Bengal Gangetic plain (BGP) at Kolkata (KOL) and their implication in potential source types and spatiotemporal features. Further, to obtain the aerosol speciated mass and optical depth closure, we utilised the AERONET obtained aerosol optical depth (AOD) in conjunction with measurements of black carbon and aerosol mass concentration in an indigenously developed MATLAB package, Aero-Opt. The Aero-Opt leads to estimate aerosol species mass concentration and their optical properties for the particular location and spatial distribution for the entire region by optimising a constrained nonlinear multi-variable objective function.The Aero-Opt package provides essential optical parameters like extinction, scattering and absorption coefficients, single scattering albedo (SSA), asymmetric factor, phase function, and visibility in two modules, viz., point-based and spatial module (spatial distribution at a chosen grid resolution) at eight different relative humidity and 61 wavelengths. Investigation of aerosol characteristics using AERONET and Aero-Opt deduced aerosol optical properties showed persistent high values of both fine mode and coarse mode AOD over the BGP (at KOL). The spectral distribution of the monthly mean of UA aerosol single-scattering albedo (SSA) exhibited an increasing trend with an increase in wavelength throughout all wavelengths. Potential aerosol source fields were identified over the Indo-Gangetic Plain (IGP), east coast, northwestern India, and oceanic regions.

Implementation of the truncation/correction method on the AERONET polarized radiative transfer solver

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Presentation Preference: Oral

The computational efficiency of solving the RT (radiative transfer) equation is an important issue for Earth observation with remote sensing. In order to model scattering of sunlight by large aerosol and cloud particles, a large number (~200) of azimuthal (Fourier) decomposition moments and discrete ordinates are required due to anisotropic phase function. The delta-scaling technique was introduced to reduce the computational burden with the small number of terms (~20) in Fourier decomposition by replacing the forward peak of the phase function with a Dirac's delta function. This technique reconstructs the radiance field rather adequately (<1%), except for solar aureole. The solar aureole can be reconstructed by the further calculation with the series of IMS (Nakajima and Tanaka, 1988; Momoi et al., 2022ab) methods, which takes the forward peak contribution into account with successive order of scattering concept. This study implemented the P^{n}IMS, extending the original IMS to including the polarization effects, on the AERONET polarized RT solver SORD. Our study indicated that the original SORD in the AERONET inversion algorithm version 3 requires massive computational resources (i.e., supercomputer), whereas the updated SORD works accurately with less computational burden especially in the case of the dominant large particles.

Keywords: radiative transfer solver, truncation and correction method, SORD, P^{n}IMS

Potential and limitations of AERONET observations to monitor super coarse desert dust aerosol particles

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Presentation Preference: Oral

The potential presence of super coarse desert dust aerosol particles with volume radii larger than 15 microns in the atmosphere has recently become one of hot topics intensively discussed in the modelling and observation community. Such large particles may represent an essential part of aerosol mass in the atmosphere and while their contribution to the measurements of atmospheric radiation is rather moderate. Therefore, the characterization of super coarse aerosols is very challenging while they are responsible for sizable overall contributions in aerosol effects environment and climate dynamics. Indeed, AERONET network, that is considered among the most comprehensive source of information about ambient aerosol does not consider aerosol particles with radius larger than 15 microns. In contrast, in situ observation and chemical transport models suggests presence of such particles. This presentation describes efforts to test and evaluate the capabilities and limitations of detecting the super coarse dust particles from AERONET measurements. Several modifications of the retrieval approaches that allow for optimizing AERONET retrieval to the presence of super coarse particles are proposed and discussed. The presentation is also discusses the sensitivities of other remote sensing methods that could complement AERONET observations such as lidar observations and measurements in IR spectral range.

Keywords: super coarse dust particle, aerosol retrieval, inversion algorithm

Applications of AERONET and MPL data at Miami Florida

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Presentation Preference: Poster

An AERONET station has been operating near Key Biscayne, Florida, continuously since 2007, monitoring north African dust events and fire emissions within a background of marine aerosols and relatively light anthropogenic emissions for a major city. The data have been applied in combination with micro pulse lidar data and size-resolved surface dust mass concentrations to assess aerosol representations within MERRA2. In another application, the data have been combined with micro pulse lidar data to characterize optically-thin clouds that commonly occur near the lifting condensation level in this near-tropical environment. This poster will detail the two applications and serves to increase awareness of this long-term site.

Keywords: Miami FL; dust; optically-thin cloud; MERRA2; aerosol closure

The AERONET Site at the Chesapeake Bay Bridge Tunnel Island-3

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Presentation Preference: Poster

Hampton University (HU) has been involved in the AERONET network since May 26, 2017. The present HU instrument location on campus is a coastal site to the AERONET network. All HU instruments are on the rooftop of Turner Hall on the HU campus. On September 25, 2023, HU installed a CIMEL instrument on the rooftop of the operations building at the Chesapeake Bay Bridge Tunnel (CBBT) Island-3 through the NASA IPMSI program. This location was chosen because it is safe, secure and has access to electricity and internet. The site is accessible for routine maintenance and emergency procedures in advance of extreme weather events (tropical storms, Nor'easters, etc.). This site was also utilized in the summer of 2017 during the OWLETS 1 campaign. The CBBT Island-3 is near the transition zone between the Chesapeake Bay and the Atlantic Ocean and is adjacent to the channel for ships either heading up (northward) the Chesapeake Bay towards Baltimore or returning from that region of the bay. The AERONET instrument is strategically located to monitor this marine pathway and record potential effluents from ships passing by. This location adds a vital marine site to AERONET network as aerosol information on a variety of time scales will be collected, analyzed and compared to coastal and purely continental sites. It also adds an off-shore TEMPO validation site for aerosol. We will present the unique features of the site, hardware installation, and results of initial comparisons with the HU and NASA LaRC AERONET instruments.

Keywords: aerosols, Chesapeake Bay, marine environment

Complementary analysis of lunar photometry to detect wildfire emissions in Montevideo

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Presentation Preference: Poster

Nighttime aerosol optical depth (AOD) using lunar photometry has attracted great interest in recent years due to improved ground-based lunar irradiance measurements. The night is a large window of time that is not frequently used and during which aerosol dynamics evolve under conditions different from daytime. In this way, the amount of information obtained during the night is a complement to the register of the day.
This work shows a first approximation of a night-time analysis that complements the day-time detection of emissions from wildfires that are transported from long distances. We based on two events detected during the day where emissions come from other countries. We confirm the presence of wildfire emissions by detecting high levels of formaldehyde, and then we monitor the Lunar AOD to analyze the behavior of fine and coarse particles through the Ångström exponent at 500 nm (AE_{500}) since forest fires have a high proportion of fine particles.

Keywords: wildfire emissions, aerosols, fine particles, Lunar AOD, MAX-DOAS.

AERONET Data: Bridging Knowledge Gaps with Interactive Online Tools

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Presentation Preference: Poster

In this data-driven world, dissemination of readily accessible scientific information is paramount for providing a broader perspective on sophisticated systems to individuals less familiar with their data transfer, processing, and distribution algorithms. The AErosol RObotic NETwork (AERONET) offers valuable insights into atmospheric aerosol research, yet the true impact of its data lies in its accessibility to the public. Online tools providing access and visualization of AERONET data are essential conduits for spreading this knowledge to those outside the network, whether it is students, colleagues, or enthusiasts. Over the recent years, the development of new tools with intuitive, user-friendly interfaces for accessing AERONET Spectral Aerosol Optical Depth (AOD) data, Inversion Products, and precipitable water data has not only facilitated comprehension, but has also fostered more participation and collaboration both in and outside the AERONET research community. Such tools include JavaScript-based mapping platforms, web APIs, Jupyter notebooks, and Map Explorers. Those tools offer an easy and interactive way to view and download AERONET data, whether it is near real-time data, daily/monthly averages, or even instrument troubleshooting. Beyond accessibility, these tools serve as catalysts for innovation by stimulating collaboration and exchange of knowledge between the global AERONET community and the public.

Keywords: Aerosols, Data accessibility, Leaflet, GeoPandas, Interactive Web Maps

Evaluation of the impact of clouds on the retrieval of aerosol properties

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Presentation Preference: Oral

Atmospheric aerosols influence the Earth's energy balance through direct (aerosol-radiation) and indirect (aerosol-clouds) effects. Aerosol properties are very variable in space, time and type. An accurate knowledge of the microphysical and optical properties is key to assess their impact on climate. Sky radiances contain information about the aerosol properties and are commonly used in inversion algorithms to retrieve them. One example is AERONET (Aerosol Robotic Network), which uses the sky radiances measured by their photometer CE318 together with aerosol optical depth (AOD) to retrieve aerosol properties. This algorithm employs a cloud-screening to reject measurements from sky points in which a cloud was present; nevertheless, clouds can also affect sky radiances from cloud-free sky points. To evaluate the potential of this effect to alter the retrieval of aerosol properties, different cloudy skies (and the corresponding cloud-free ones) have been created and modelled with the radiative transfer model MYSTIC, a 3D solver from libRadtran (Emde et al., 2016), to simulate sky radiances for several known aerosol scenarios. These radiances have been used in GRASP (Generalized Retrieval of Atmosphere and Surface Properties; Dubovik et al., 2021) to retrieve aerosol properties for cloudy and the corresponding clear sky scenarios and evaluate the differences between them.

Keywords: Inversion algorithm, aerosol properties, clouds radiative effect, GRASP, MYSTIC.

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CAECENET: Columnar and vertical aerosol properties from continuous and automatic retrievals of photometer and ceilometer measurements

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Presentation Preference: Oral

CAECENET allows for continuous, automatic and near real-time monitoring of both vertical and columnar aerosol properties, such as vertical profiles of volume concentration, extinction, scattering, backscattering and absorption coefficients, size distribution and single scattering albedo, among others, which are very useful for analysing regional events.

It employs the GRASP algorithm (Generalized Retrieval of Atmosphere and Surface Properties) [1], utilizing as input aerosol optical depth (AOD) and sky radiance measurements from sun-sky photometers from the CÆLIS database [2], as well as range-corrected signal (RCS) measurements from ceilometers from the ICENET database (Iberian Ceilometer Network) [3].

For now, the stations are located on the Iberian Peninsula and have allowed the analysis of various transport events, taking into account the speed of event dissemination, variations in aerosol altitude, or external factors influencing its concentration, and the resulting impacts on aerosol optical properties.

The future goal is configuring CAECENET to assimilate data from other types of lidar systems, so that it can provide products in a greater number of locations. Moreover, this data could be used in the computation of aerosol vertical radiative forcing, in order to study the climate and environmental impacts of aerosols.

[1] Dubovik, O. et al., GRASP: a versatile algorithm for characterizing the atmosphere, SPIE: Newsroom, 2014.
[2] Fuertes, D., et al., CÆLIS: software for assimilation, management and processing data of an atmospheric measurement network, Geoscientific Instrumentation, Methods and Data Systems, 7, 67–81, 2018.
[3] Cazorla, A., et al., Near-real-time processing of a ceilometer network assisted with sun-photometer data: monitoring a dust outbreak over the Iberian Peninsula, Atmospheric Chemistry and Physics, 17, 11 861–11 876, 2017.

Keywords: CAECENET, GRASP, photometry, ceilometer.

This research has been supported by the Ministerio de Ciencia e Innovación (grant no. PID2021-127588OB-I00), is part of the TED2021-131211B-I00 project funded by MCIN/AEI/10.13039/501100011033 and European Union "NextGenerationEU"/PRTR, and is based on work from COST Action CA21119 HARMONIA. The authors acknowledge the support of the Spanish Ministry for Science and Innovation to ACTRIS ERIC.

Solar and lunar photometry for daytime and night-time aerosol optical depth analysis at North Central Iberian Peninsula

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Presentation Preference: Poster

This study analyses all daytime and night-time aerosol optical depth (AOD) data available from CÆLIS at Valladolid (Spain) from October 2016 to March 2022, measured by AERONET photometers.

The daily averages show an annual pattern, with higher AOD values during the summer, and maximum mean value in July. It is possible to see transport of biomass burning aerosol during summer, as the mean Ångström Exponent (AE) values are not as low as expected for this season, due to frequent desert dust transport events.

During the daytime, AOD mean values vary only ±0.02 remaining almost constant except at sunrise and sunset when there is less data availability. For the typical day of the series, the highest AOD value is found at 6:00 UTC and the lowest at 18:00 UTC.

In general, the same hourly patterns are observed trough the seasons. There is continuity between the statistical parameters provided by each type of data. Is more probable that outliers during night-time are contaminated by the presence of cirrus due to the impossibility to carry out moon's aureole measurements for the cloud-screening of the CE318 sun-sky-moon photometer.

A deeper study into the daily evolution could help to understand the smaller variations between sunrise and sunset. Improving cloud-screening algorithms could help to reduce the uncertainties in these hours.

Keywords: Lunar photometry, CÆLIS, AERONET, AOD, Moon, Valladolid.

This research has been supported by the Ministerio de Ciencia e Innovación (grant no. PID2021127588OB-I00), is part of the TED2021-131211B-I00 project funded by MCIN/AEI/10.13039/501100011033 and European Union "NextGenerationEU"/PRTR, and is based on work from COST Action CA21119 HARMONIA. The authors acknowledge the support of the Spanish Ministry for Science and Innovation to ACTRIS ERIC.

Traceability of Lunar direct irradiance measured with a Precision FilterRadiometer

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Presentation Preference: Poster

The growing interest in nocturnal observations of aerosol optical depth (AOD) to fill the gap in the annual cycle of Arctic aerosol climatology, led to the development of the Lunar Precision FilterRadiometer (L-PFR) at PMOD/WRC measuring Lunar direct irradiances at four wavelengths (412 nm, 500 nm, 675 nm, 862 nm). Working towards the reduction of AOD uncertainty from lunar observations to form a compatible timeseries for climatological studies, the compatibility of ground-based measurements and lunar irradiance models is investigated. The L-PFR has been characterised and calibrated at PTB with an expanded uncertainty of 0.6% within the EMPIR 19ENV04-MAPP project. A campaign was organized within a few months of the calibration at Izaña observatory during one lunar cycle, 7 nights were favourable for the retrieval of the top-of-atmosphere lunar irradiance. The SI- traceable calibration procedure as well as the Langley calibration based on the ROLO and LIME models will be presented. The validation of the observed differences to the models is done by interpolation of daytime AOD over the night under relatively stable and different aerosol loads. An independent SI-traceable validation dataset of lunar irradiance measurements has been acquired at Davos using the QASUME spectroradiometer, with an expanded uncertainty of 2%.

Keywords: nighttime AOD, lunar irradiance

SDA / FMC / SDA+: Associated error-model product and some recent science results

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Presentation Preference: Oral

An overview will be given of the SDA / FMC / SDA+ suite of products and SDA error simulations due to spectrally random AOD input errors (U43 type of error product). An overview of recent science results will include a FMF (fine mode fraction) comparison with the SMF (sub-micron fraction) of the AERONET (AOD / sky radiance) inversion product and tests of the integrity of FM and CM AOD retrievals carried out at the PEARL high-Arctic site in Eureka, Nunavut, Canada.

Keywords: Maximum SDA, fine mode AOD.

Day and night-time retrieval of vertical and columnar aerosol properties using GRASP with sun photometer and lidar measurements during an episode of Canadian wildfires smoke transported over the Atlantic.

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Presentation Preference: Poster

Aerosol particles significantly impact climate and air quality, making accurate characterization of their properties essential. The GRASP algorithm (Generalized Retrieval of Atmosphere and Surface Properties; Dubovik et al., 2021) allows the use of sun-lunar-sky photometers and multi-wavelength Lidar data to extract aerosol microphysical and optical properties in the atmospheric column and the vertical. This approach allows the detailed analysis of aerosol properties in both fine and coarse modes when Lidar vertical profiles at different wavelengths are available. Our study feeds GRASP with aerosol optical depth (AOD) and sky radiances data from the AERONET station at Izaña Atmospheric Observatory (IZO; 28.3ºN; 16.5ºW; 2401 m.a.s.l.; Tenerife, Spain), coupled with range-corrected signal (RCS) data at 532nm and 808nm from the CE376 Cimel Lidar, collected during June 29 to July 2, 2023. This period coincided with a significant smoke plume from Canadian wildfires, mixed with desert dust, affecting the Canary Islands. The event presents an opportunity to show GRASP capability to differentiate aerosol types and retrieve their optical and microphysical properties during both day and night, characterizing the aerosols present.

Keywords: Aerosols, Canadian wildfires, GRASP, sun-sky-lunar photometer, Lidar.

Acknowledgments: The authors would like to thank the NASA-AERONET network, AEROSPAIN Central Facility (https://aerospain.aemet.es/) and ACTRIS (grant agreement No 871115) to ensure the calibration of the sun photometers.

References: Dubovik et al. (2021), A Comprehensive Description of MultiTerm LSM for Applying Multiple a Priori Constraints in Problems of Atmospheric Remote Sensing: GRASP Algorithm, Concept, and Applications. Front. Remote Sens. 2:706851. doi: 10.3389/frsen.2021.706851.

Traceability chain of the WMO AOD reference and GAW-PFR network

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Presentation Preference: Oral

World Optical depth and Calibration Center (WORCC) of PMOD/WRC was assigned by the WMO to form and maintain the reference for aerosol optical depth measurements, consisting of three PFR instruments (GAW-PFRtriad). The WMO AOD scale realized by this reference is based on Langley calibrations while the stability and precision are assessed on a yearly basis against the traveling standard PFRs calibrated at Izaña, Spain and Mauna-Loa, Hawaii, USA. In the project Metrology for Aerosol Optical Properties (MAPP), funded by the European Metrology Program for Innovation and Research (EMPIR), one of the reference instruments was calibrated at PTB and provides SI - traceable solar irradiance measurements at 368 nm, 412 nm, 500 nm and 862 nm and top-of-atmosphere solar irradiance in agreement with the TSIS-1 HSRS within 0.5% at these wavelengths. Building up on these results, a long-term collaboration between PMOD/WRC and PTB has been started within EURAMET with the aim of establishing SI traceability of the WMO AOD references.
The procedures and uncertainty budget of WORCC calibration chain and dissemination to the GAW-PFR network and ACTRIS AOD network will be presented.

Keywords: WMO AOD reference, calibration, calibration transfer

Investigation of long-range transport aerosols in mountainous region of Japan during DRAGON J-Alps

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Presentation Preference: Oral

The first deployment of the AERONET network in Japan was established at three sites (Shirahama, Noto, and Osaka) in the early 2000s. The measurements show that aerosols in Japan consist of locally emitted aerosols and long-range transported aerosols (LRT), i.e., Asian dust and pollutants. It is easy to assume that transportation of pollutants may affect by the mountainous regions.

Twelve AERONET system were deployed around the central mountain ranges in Japan in 2020, and 2021, which is called DRAGON J-Alps (Joint research for AerosoL characterization and Process Simulation), to investigate contribution of mountain ranges on aerosol transportation, evaluation of regional model simulations, comparison of remote sensing results in complex mountain and valley and so on.

The objective of this study is to determine the contribution of long-range transport (LRT) aerosols across the mountain range to observed measurements. Obtained results are compared with other AERONET sites to assess mountain effects.

Keywords: DRAGON, AOD

Analysis of daytime precipitable water vapor timeseries in L'Aquila (Italy) with long-term sun-photometer and radiosondes data

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Presentation Preference: Poster

The site of L'Aquila (Italy), located at 684 m ASL., is the only AERONET site within the central Appennines. It is orographically protected from moist airmasses, resulting in a drier climate respect to the sites outside the mountain range.

We have compared the AERONET level 2.0 data of precipitable water vapor (PW) collected by a sun-photometer (SP, 2015-2023) against the PW from radiosounding profiles (RS, 1994-2023). To our knowledge, no study of PW exists about the yearly evolution and intra-annual cycles over the central Appennines area.

A comparison of PW between temporally co-located data from SP and RS observations shows a statistically significant correlation (r=0.98), with a relative bias like other studies in literature.

The time series of monthly PW shows a negligible trend. The average PW at L'Aquila site can be estimated in 1.41 cm with both instruments. The intra-annual cycle shows summer months having higher PW respect winter months.

Using the SP measurements only, we have analysed the diurnal evolution of PW anomaly. This cycle is comparable to the pattern found in literature. The PW anomaly seems to be correlated with the temperature diurnal cycle, except for a 9:00-10:00 UTC local minimum likely due to mountain breeze.

Keywords: Precipitable Water Vapor, AERONET, Radiosonde.

Growth and global persistence of stratospheric sulfate aerosols from the 2022 Hunga Tonga–Hunga Ha'apai volcanic eruption

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Presentation Preference: Oral

Stratospheric sulfate aerosols play a key role on atmospheric chemistry and Earth's radiation budget, but their size distribution, a critical parameter in climate models, is generally poorly known. We address such gap for the 2022 Hunga Tonga–Hunga Ha'apai (HT–HH) volcanic eruption by exhaustively analyzing a set of satellite observations (S5P/TROPOMI, MetOp/IASI, HIMAWARI-8/AHI, and CALIPSO/CALIOP) together with photometric ground observations from the worldwide open-access AERONET network (Boichu et al. 2023). Thanks to a novel method of analysis of photometric data, we document a rapid growth of HT–HH sulfate aerosols in the days following eruption. This aerosol growth is faster than observed for 1991 Pinatubo eruption and likely due to the exceptional hydration of the stratosphere by this phreatomagmatic eruption. An unusual aerosol fine mode (peak radius in 0.3–0.5 μm) associated to HT-HH is persistently identified at 23 AERONET stations of the Southern Hemisphere until March 2024 (time of writing). Thanks to the vast geographical coverage of the AERONET network, the size of HT-HH sulfate aerosols in the Northern Hemisphere and Antarctica is also determined. Two years after eruption, HT–HH sulfate aerosols show a stable size and remain smaller than Pinatubo particles. Smaller aerosols backscatter more efficiently visible light and sediment more slowly than larger particles, potentially leading to a stronger and longer-lasting negative radiative forcing. On the other hand, the abundance and altitude of stratospheric aerosols, together with the stratospheric water content, also need to be considered. Therefore, better constraining the size of aerosol with an improved time and space resolution and coverage is critical for disentangling the physical processes at play in the net climatic impact of the HT-HH eruption.

Keywords: Hunga Tonga-Hunga Haápai stratospheric volcanic eruption, sulfate aerosols, aerosol size, photometry, climate

Reference:

Boichu, M., Grandin, R., Blarel, L., Torres, B., Derimian, Y., Goloub, P., Brogniez, C., Chiapello, I., Dubovik, O., Mathurin, T., Pascal, N., Patou, M., & Riedi, J. (2023), "Growth and global persistence of stratospheric sulfate aerosols from the 2022 Hunga Tonga-Hunga Ha'apai volcanic eruption". *Journal of Geophysical Research : Atmospheres, 128,* e2023JD039010, https://doi.org/10.1029/2023JD039010

Introducing aerosol inhomogeneity in remote sensing retrievals

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Presentation Preference: No preference

Although inhomogeneity is common for atmospheric aerosol, inhomogeneous particle model is not considered in present-day remote sensing algorithms. The current study addresses this gap by an attempt to introduce aerosol core-shell parameterization into the aerosol remote sensing retrieval algorithm GRASP. We model aerosol inhomogeneity by Mie calculations for layered sphere, where ammonium nitrate/sulfate is used as liquid shell and various composition is assumed for particle core. We analyse the obtained optical characteristics as function of core/shell dimensions, changes in refractive index and size. The analysis reveals sensitivity to particles inhomogeneity in single scattering approximation. Feasibility of inhomogeneity retrieval from measured radiances yet needs to be evaluated. To this end, we calculated new kernels that consider particle core-shell model and implement then in an updated GRASP/Components algorithm. This new algorithm is about to be applied for AERONET measurements as a global network that provides aerosol observations in different environmental conditions and with high sensitivity to aerosol optical properties. We expect improvement of retrievals in situations where aerosol coating is important and providing new information on degree of aerosol inhomogeneity. The application and tests are in advanced stages which results will be presented.

Keywords: aerosol inhomogeneity, core-shell, GRASP, AERONET.

Potential of employing polarization measurements in AERONET aerosol retrieval algorithm: enhancement in information content and quality control of the measurements.

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Presentation preference: Oral.

We discuss the potential of adding measurements of the degree of linear polarization (DOLP) to the standard AERONET inversion input: measurements of the spectral aerosol optical depth (AOD) and multiangle spectral sky radiance intensity measurements.
Analysis of the information content of polarization measurements confirmed earlier findings of other authors: adding DOLP observation results in improving accuracy of retrievals of the real part of refractive index and aerosol particles shape. Due to rather low sensitivity of DOLP measurements to aerosol absorption, no improvement in the accuracy of the retrieved single scattering albedo (SSA) is expected. This is partially related to inability of added DOLP measurements to prevent fitting of biases in sky radiances intensity by the retrieval code.
A procedure for quality control of the DOLP measurements is proposed. It is based on checking of the symmetry between polarized sky radiances measured during left and right scans by the Sun-sky scanning radiometer. The procedure is applied to quality assure DOLP measurements for all the polarized CIMEL instruments which are the part of the network.

Keywords: DOLP measurements, information content, quality control.
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Intercomparison and evaluation of Aerosol Optical Depths from four reanalyses using AERONET data

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Abstract

The emergence of aerosol reanalyses in recent years has facilitated a comprehensive and systematic evaluation of Aerosol Optical Depth (AOD) trends and attribution over multi-decadal timescales. Notable multiyear aerosol reanalyses currently available include NAAPS-RA from the U.S. Naval Research Laboratory; the NASA MERRA-2; JRAero from the Japan Meteorological Agency (JMA); and CAMSRA from Copernicus/ECMWF. These aerosol reanalyses are based on differing underlying meteorology models, representations of aerosol processes, and data assimilation methods and treatment of AOD observations. This study presents the basic verification characteristics of these four reanalyses using AERONET retrievals in monthly AOD properties and identifies the strength of each reanalysis and the regions where divergence and challenges are prominent. Regions with high pollution and often mixed fine-coarse mode aerosol environments such as South Asia, East Asia, Southeast Asia, and the Maritime Continent pose significant challenges, as indicated by higher monthly AOD root mean square error. Moreover, regions that are distant from major aerosol source areas, including the polar regions and remote oceans, exhibit large relative differences in speciated AODs and fine-mode vs coarse-mode AODs among the four reanalyses.

Characterizing smoke plume optical properties and mixture with urban aerosols with lidar and AERONET sunphotometer observations in New York City area

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Abstract

Wildfires in North America emit large amounts of smoke plumes that can be transported over long-distance and affect air quality downwind in the continental-regional scale. Dense smoke plumes have been observed by the co-located CCNY lidar, ceilometer and multiple AERONET sunphotometers in New York City area (NYC, 40.82°N, 73.95°W). This study will characterize the optical properties of aged smoke particles and their mixture with urban aerosols. We combine the lidar and AERONET observations to constrain aerosol extinction profiles and lidar ratios. For dense smoke particles, the case studies indicate different variation trends of Angstrom exponents at the visible, UV and IR-wavelength pairs that is associated to different particle size and absorption properties between smoke and urban aerosols. By analyzing the NASA airborne HSRL observations during LISTOS campaign, aerosol depolarization ratios at visible and IR wavelength show different variations for the smoke and urban aerosols, which can be used to discriminate smoke particles and their mixing with urban pollutants in the PBL. In addition, smoke plume effects on the correlation between aerosol optical depth (AOD) and ground-level PM2.5 are investigated with these synergistic observations in NYC area.

Keywords: Smoke Plume, Optical Properties, AERONET, Lidar.

The Nation-first Sun-sky-moon-polarimetric Multi-spectral Radiometer for Aerosol and Precursor Gas Studies at AUH, Gurugram, India

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Presentation Preference: Oral

Studies relating to the effects of atmospheric aerosols at regional and global scales on climate change, environmental evolution and health are sparse over pristine locations, and are critical for future of our planet sustainability challenges that balance economic growth, social well-being, and ecological stewardship. To address these issues, aerosol measurements during daytime using the instrument, CE318-AERONET have been in progress at Amity University Haryana (AUH), Panchgaon, a pristine location in the Haryana State, India since August 2017. To acquire more detailed information on round-the-clock aerosol products, as a part of the ongoing long-term research collaboration between NASA-AERONET, GSFC, USA and AUH, this system has been upgraded to a new sun-sky-lunar-polarimetric multiband photometer (CE318-T) in June 2023. Thus, the present system provides daytime and nighttime measurements, and yields additional enhanced operational functionalities including the depolarization ratio. It started regular operation from June 2023 onwards. The initial results indicated diurnal variation in Aerosol Optical Depth (extinction) and Angstrom Exponent (microphysics) with larger mean daytime values as compared to their nocturnal counterpart, while the water vapour exhibited lower values during daytime and higher during nighttime, which is consistent. Other results together with the future plan of AMINET will be presented in this communication.

Keywords: Aerosol Optical Depth, Microphysics, Polarization, Water Vapor, Radiative Forcing

Cohort Study of Day-Night Aerosol Characteristics over Different Environments in India: A Recent Start-up and Initial Results

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Presentation Preference: Oral

Both daytime (sun and sky) and nighttime (moon) ground-based passive remote sensing of aerosol properties is sparse over the globe. Measurements available from satellites need accurate calibration and validation with ground truth for different types of aerosols prevailing over characteristic environments. The NASA-AERONET mission made such measurements possible with the model CE318-T since 2016 onwards. This study reports some initial results of the round-the-clock observations of aerosol products carried out over three different environments from the NASA-AERONET CE318-T photometers, installed at Amity University Haryana (AUH), Panchgaon (pristine) in August 2017; Indian Institute of Tropical Meteorology (IITM), Pune (mixed with more industrial) in December 2023; and IITM-ARTCI, Bhopal (urban) in January 2024. The results show (i) higher AODs (Aerosol Optical Depth) during daytime as compared to those during nighttime, (ii) inverse relationship between AOD and wavelength, (iii) larger Angstrom Exponent (AE) values, indicating dominance of fine-mode particles over urban and industrial sites while smaller AE (coarse-mode) over rural environment, (iv) seasonal variations are associated with local meteorology. Precipitable water vapor exhibited larger values during nighttime and smaller during daytime. The results obtained from the analysis of synchronous MODIS and CALIPSO satellite data, and HYSPLIT trajectory model for transport are also presented.

Passwords: Day-Night Sky Radiometer, AOD, Water Vapor, Angstrom Exponent, Satellite

Evaluation of stubble burning aerosol features over a pristine location using ground-based, model and spaceborne data

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Presentation Preference: Oral

This paper reports the results of a study of variations in aerosol optical, microphysical, and radiative properties during biomass (crop residue) burning events recorded at Amity University Haryana (AUH), a rural station, Gurugram (28.31ºN, 76.90ºE, 285 m above mean sea level), employing ground-based observations of NASA-AERONET Radiometer and Aethalometer, as well as satellite and model simulations during 2021-2023. Furthermore, smoke events that affected the station during the study period are simulated using the regional NAAPS model to assess the role of smoke aerosols in regional aerosol characteristics. Higher atmospheric forcing was observed during smoke periods due to the atmosphere which was apparently attributable to smoke aerosols. In addition, the higher values of Black Carbon (BC) mass concentration and Biomass Burning (BB), and lower values of Absorption Angstrom Exponent (AAE) are also observed during the peak intensity of smoke events. A prominent smoke thick layer extending from surface to an altitude of about ~3 km, whereas the CALIPSO observations of the vertical profile of aerosols agree with the results of AERONET observations. In addition, the transport of a wide-spread agricultural crop residue burning of smoke plumes is observed across the country as evidenced by the MODIS imagery and HYSPLIT back trajectories.

Keywords: Burning-Smoke Aerosols, AERONET, CALIPSO, NAAPS, HYSPLIT Trajectories.

Aerosol Characterization Studies Using SKYNET and AERONET Radiometers in India

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Presentation Preference: Oral

There are several ground-based networks (AERONET, SKYNET, CARSNET, MPLNET, EARLINET, ARFINET etc.) for aerosol studies across the globe. In the Asian region, AERONET, SKYNET, CAESNET and ARFINET are the maximum of the users among the ground-based networks. The India Meteorological Department (IMD), functioning under the Ministry of Earth Sciences (MoES), has established a network composed of Prede Sun-Sky Radiometers in June 2011 for aerosol characterization over different environments to assess their impacts on weather, health, water, and climate. Combined concurrent observations from AERONET and SKYNET sun-sky radiometers provide excellent, aerosol data inventory needed for a detailed study of variability, trends and forecast of column-integrated aerosol properties almost from surface to the stratospheric altitudes covering the entire globe. Such studies carried out over some characteristic hotspots in India are reviewed. The results obtained from the studies carried out under the SKYNET network in India, and also from Indian Institute of Tropical Meteorology (IITM), Pune, where the AERONET and SKYNET radiometers, operated side-by-side, for inter-comparison were presented as a special case. The results are found useful for satellite data validation and climate analysis. Similar joint observations, planned with Cimel (AERONET) and Prede (SKYNET) at Amity University Haryana (AUH), Gurugram will be outlined.

Keywords: Aerosols, Optical and Micro-Physical Characteristics, Clouds, Radiative Forcing

NEON Update – A quick overview of NEON and CIMEL support

Janae Csavina and Brianna Richards

Understanding the causes and responses of ecological change at the continental scale is the goal of the National Ecological Observatory Network (NEON). Throughout the United States, a network of infrastructure has been built which includes in-situ sensors on towers, in soil plots, and in streams and lakes to monitor observations such as energy and gas fluxes, aerosols, soil moisture, water chemistry, etc. CIMEL AERONET is a supported component of this infrastructure and will speak to our calibrations and support of this instrument in the larger framework of NEON.

Variability of Aerosol Concentrations and Characteristics in the Indo-Gangetic Plains

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Understanding the dynamics of aerosol properties at different locations and long-term impacts are important to in the context of climate change. The Indo-Gangetic plains (IGP) one of the most volatile places due to their dense population and numerous sources of aerosols and pollutants, which includes long-range transport of dust, crop-residue burning, thermal power plants, mining, brick kilns, vehicular emissions, and forest fires. We have carried out the analysis of the aerosols optical and radiative properties using AERONET stations in India and other surrounding regions. The dynamics of aerosol properties and characteristics are studied locally and long-range transport of airmass from the dust source region in the Arabia peninsula along the track to the Kanpur location has data for more than two decades. In Karachi (PAK), Lahore (PAK), and Jaipur (IND), the impact of dust dominance along with anthropogenic aerosols. Lahore (PAK) and Delhi (IND) suffer with a high rise in finer aerosols due to crop-residue burning and transport of air mass from west to east with the prevailing westerly winds. Kanpur (IND) and Gandhi College (IND) suffer from higher dust density in summer along with biomass-burning aerosols during winter season. In Pokhara (NEP) and QOM_CAS (CHI), we have found a sudden rise in finer aerosols during summer seasons caused by summer biomass burning along with forest fires in the Himalayan region. Dhaka (BAN) and Bhola (BAN) stations show a significant rise in aerosol concentration due to local sources along with long-range transport of air mass from IGP. In Dibrugarh (IND), finer aerosol is a concern, but sometimes the long-range transport of dust affects aerosol properties during pre-monsoon months (MAM). The long-range transport of pollutants causes higher aerosol density, but the optical properties show significant changes due to the atmospheric aging of aerosols. meteorology plays an important role in the transport of aerosols in this region.

AERONET/MPLNET measurement and retrieval of optical properties of urban and biomass burning aerosols during ASIA-AQ/ Kao-Ping Experiment (KPEx)

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The short-term air quality and long-term climate effects of aerosols over Asian megacities are currently neglected. To elucidate the relationship between local emissions and long-range transport from biomass burning, the Kao-Ping (Kao-Hsiung City and Ping-Tung County) Experiment (KPEx) was conducted in southern Taiwan under a 1°x1° domain as a downwind receptor of the 7-SEAS (Seven SouthEast Asian Studies) 2024 international field campaign over the northern region of peninsular Southeast Asia. During KPEx, the dense network of 7 AERONET sites, 2 MPLNET lidars, 3 Doppler wind lidars, more than 20 air quality stations, and a high-altitude background station at Mt. Lulin (2,862 m) provides an important anchor for the distribution of three-dimensional aerosol properties. The regional ground network observations also support and cooperate on NASA's ASIA-AQ flight observation experiment. According to the precise spatial configuration of the AERONET/MPLNET stations, the long-range transport event of biomass burning was clearly captured under both the urban (Kaohsiung and Wanluan) and background (Lulin and HengChun) stations. The local emission events dominated by regional circulation (e.g., mountain-valley breeze and land-sea breeze) were also clearly observed by comparing the offshore (Xiaoliuqiu) and foothill (Wanluan) stations.

Keywords: KPEx, ASIA-AQ, 7-SEAS

Monitoring Dust using NASA AERONET Dushanbe site (2010-2023)

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Presentation Preference: Oral

Tajikistan is situated in the global dust belt on the way of transport routes of dust from some major dust sources like the Aralkum desert of the desiccating Aral Sea, the Kyzyl-Kum and Karakum deserts east of the Caspian Sea, the Iranian Dasht-e-Kavir and Dasht- e-Lut deserts and the deserts in Afghanistan, Sahara and Taklamakan desert. Therefore, Tajikistan is frequently affected by severe dust events every year (from April un till November) and is a net accumulator of dust. Furthermore, Central Asia and especially Tajikistan are highly affected by climate change. For example, the dramatic glacier shrinking took place in the last decades, which has also an effect on the water resources of Tajikistan and the whole Central Asian area. Since the trans-regionally important rivers as Amu Darya and Syr Darya are fed by glacier melt water, which were originally feeding the Aral Sea, which now became itself a strong dust source. On the other hand, deposited dust itself can accelerate glacier melt by altering the glacier's surface albedo. This paper presents the results of the study on columnar aerosol optical and physical properties and radiative effects directly observed over Dushanbe (Tajikistan), a NASA AERONET site (equipped with a CIMEL sunphotometer) in Central Asia during the observation period from July 2010 to August 2023.

Keywords: Dushanbe, AERONET, AOD, Water vapor, Angstrom Exponent.

Title: Advances in Surface-Based Atmosphere and Surface Observation by Optical Remote Sensing

By Didier CROZEL / CIMEL ELECTRONIQUE

CIMEL is dedicated to advancing optical remote sensing for sustainable environmental stewardship. The presentation will review progress in overcoming challenges with ground-based reference instrumentation to develop innovative solutions for research activities and for space, meteorology, and air quality observation organizations. We will highlight the evolution of the CE318 photometer within AERONET, focusing on functional and design improvements, validation of calibration methods, the range of applicable models, and customized solutions. Lessons learned from the innovation process will be discussed, emphasizing the importance of long-term partnerships for laboratory characterization, field experiments, algorithm development, and operational adaptation. Integration of state-of-the-art components considers the demanding constraints of environmental observation to ensure operability across diverse climates and for campaigns on various mobile platforms. With expertise in both passive and active optical remote sensing solutions, including lidars, TIR radiometers, and cameras, CIMEL is now exploring hyperspectral radiometry and gas lidars for comprehensive atmosphere property retrieval. Recent technological advances and instrumental synergies will be illustrated across various applications, from atmosphere and cloud research to atmosphere, ocean, and land monitoring, as well as air quality assessment and forecasting, and satellite-to-ground laser communications, paving the way for collaborative instrumental research in new areas.

Comprehensive monitoring of variability in the composition of climate-active pollutants in the atmosphere of the mountainous region of Central Asia

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Presentation Preference: Oral

Keywords: aerosols, ozone, climate, Issyk-Kul station.

More than 43 years of monitoring of trace atmospheric impurities at the high-mountain stations “Issyk-Kul” (in AERONET, GAW network) and “Issyk-Kul OMD” made it possible to determine features in interannual variations and trends in aerosols, ozone and other gases content in the atmosphere over Central Asian mountainous region in conditions of rapidly changing solar, geophysical processes and anthropogenic load. The observed features are due to powerful impact of the mountain ecosystems of Tien Shan, Pamir-Alai and Himalayas on the thermodynamic, physical, and chemical processes determining the spatiotemporal variability of measured impurities in the atmosphere of the region in comparison with coastal, plain and oceanic ones. The aerosol optical depth was calculated from measured atmospheric transparency from 1984 to 2009. Since 2007, measurements of the aerosols optical characteristics have been carried out with an automatic radiometer CIMEL, CE 318N-V8S5-M9. Measurements of total O_3, SO_2, NO_2, CO_2, H_2O from 1980 to 2021 were carried out with special spectrophotometric installations, since 2021, O_3, SO_2, NO_2 measurements have been carried out using the Brewer MkIV spectrophotometer. The monitoring results are used to validate satellite measurements, adjust and develop atmospheric models, taking into account continental mountain effects, and assess active anthropogenic impacts on the biosphere.

Comparison of MERRA-2 and CAMS reanalysis aerosol optical depth products with AERONET observations at two locations in Sub-Saharan Africa for PV yield Assessments

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Presentation Preference: Poster

Abstract
Ground-based infrastructure for data collection and monitoring is reliable for studying the impact of aerosols on PV performance. However, this dataset is sparse and often suffers from data consistency. This study compares Aerosol Optical Depth (AOD) at 550 nm from CAMS and MERRA-2 reanalysis to a reference AERONET (AERO) retrievals from 2016–2022 at two distinct locations (Koforidua and Banizoumbou) to evaluate their accuracy. MEERA-2 performed well with a correlation of 0.942 and RMSE of 0.201 with AERO in Koforidua, compared to a correlation of 0.931 and RMSE of 0.207 between CAMS. In Banizoumbou, CAMS has a slightly higher correlation of 0.842 with AERO than 0.805 with MERRA-2. However, MERRA-2 has a marginally lower RMSE of 0.210, suggesting slightly better accuracy than 0.219 for CAMS. Both sites have an identical MAE of 0.13. Overall, MERRA-2 tends to provide more accurate and reliable AOD estimates, evident in its lower RMSE at both locations. Despite CAMS's higher correlation in Banizoumbou, MERRA-2's error metrics are better, and its residuals are closer to zero. When ground-based measurements for the sub-region are not available, this study aims to assist users in selecting the appropriate AOD reanalysis data for PV preconstruction site surveys and system sizing.

Keywords: AOD, MERRA-2, CAMS, AERONET, reanalysis

AERONET Operations at Two CERES Radiation and Validation Experiment (CRAVE) Sites

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AERONET operations have been occurring for several years at two CERES (Clouds and the Earth's Radiant Energy System) Radiation and Validation Experiment (CRAVE) measurement sites. One site is located at Granite Island (46.72 N, 87.41 W). Granite Island is privately owned, located in Lake Superior, approximately 20 km north of Marquette, Michigan, USA, and 10 km to the nearest land point, and has been active since the summer of 2018. The other AERONET site is in Hampton, Virginia, USA, at Nasa Langley Research Center (37.10 N, 76.38 W), and has been operating since December 2014.

Due to its remoteness, Granite Island measurements, including AERONET, is on a solar powered system. Cleaning, inspections, and maintenance are performed on a bi-yearly basis, but also when local help is available when island visits occur for other activities in the warm season. Winter can be demanding with ice buildup during strong storms and days of overcast skies that can limit data availability. Nasa Langley measurements are much easier to maintain as it is on the grid, close to work, and any issues can be corrected quickly due to unlimited access to the site. We will describe both AERONET site operations, logistics and challenges.

Data analysis will be presented showing AERONET detecting smoke originating from Canadian wildfires with the aerosol optical depth (AOD) data product at 500nm consistently over 1 at Nasa Langley, and well over 2 at Granite Island.

Temporal Evolution of Long-Range Transported Biomass Burning Aerosols using Remote sensing

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Presentation Preference: Oral

Biomass burning aerosols (BBA) from wildfires across southern Africa account for approximately a third of carbonaceous particles in the atmosphere. These particles have strong direct radiative effects in the southeast Atlantic (SEA), which depend on the radiative contrast between the aerosol layer residing in the free troposphere (FT) and the underlying cloud layer over the SEA Ocean. As such, there are large disagreements in model estimates of aerosol-driven climate forcing due to uncertainties in the vertical distribution, optical properties, and lifecycle of these particles.

Here, we use ground-based and airborne remote sensing observations to investigate the aging of the BBA and its impact on the optical properties during transatlantic transport from emission within Africa across the SEA ocean. We find distinct variations in Ångstrom exponent (AE) and single scattering albedo (SSA) with aerosol age. Our analysis showed that BBA becomes more absorbing during extended transport across the SEA attributable to chemical aging processes in the FT. The results presented here offer a new methodology and insight into aerosol-radiation interactions and the energy balance over the SEA.

Keywords: smoke aerosols, AERONET, biomass burning, absorption

Comparison of Brown and Black Carbon absorption in the Central Amazon using AERONET and in-situ measurements

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Presentation Preference: Poster

Understanding the dynamics of carbonaceous aerosols in tropical forests, particularly in regions like central Amazonia with minimal human influence, is crucial for scientific research. Questions persist about how these aerosols form, change over time, and move through the atmosphere, highlighting the importance of accurately measuring radiation absorption by major components like black carbon (BC) and brown carbon (BrC). Our study conducted detailed measurements of atmospheric aerosols' absorption properties using Nuclepore filters, aethalometers, and AERONET absorption aerosol optical depth (AAOD) at the Amazon Tall Tower Observatory (ATTO) from March to November 2019. By integrating spectral dependencies with Mie modeling of BC contributions, we determined that BrC constitutes approximately 16% of total absorption at the ATTO site throughout the measurement period, with variations between wet and dry seasons. Moreover, we characterized the BrC fraction during transition periods, contributing approximately 17%. This study provides insights into BrC and BC's roles in aerosol radiation absorption in the Amazon.

Keywords: Amazon, Absorption, Brown Carbon, Black Carbon, and Remote Sensing.

Twenty-year AERONET measurement at Mt. Lulin (2,862m) and certification of cimel sun/sky calibrations

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The Lulin Atmospheric Background Station (LABS) located at Mt. Lulin (2862 m a.g.l) in central Taiwan was established to monitor the atmospheric compositions and radiation in the lower free troposphere of Ease Asia since 2006. The Cimel sun-photometer was the first instrument installed at LABS and has been successfully operating for nearly 20 years. In the presentation, we will focus on the overall climatology of aerosol optical depth (AOD) and aerosol optics at LABS. The annual mean AOD is 0.07, with a maximum value of 0.2 observed in March. The higher AOD is associated with the high loading of biomass-burning aerosols transported from Indochina in spring. Compared with other AERONET high-elevation sites, the Lulin site shows a significant seasonal variation and is relatively sensitive to influences of continental outflows. In addition to aerosol climatology, we will also present our recent efforts in establishing a time sunphotometer calibration platform at LABS, part of the Asia Pacific AERONET Calibration and Training Center (APAC). Throughout an operational test from October 2023 to January 2024, we learned that the Lulin calibration platform can perform "Sun Calibration" and "Direct Calibration Transfer" for radiance calibration. An analysis shows that 47 days in 2023 had clear skies at Mt. Lulin from morning till midday, with more than 15 measurements during midday and less than 0.2 AOD at 500nm on those days. These criteria are used to determine the day suitable for sun calibration. This analysis also suggests that the period from November to March is most suitable for sun calibration at the Lulin AERONET calibration platform. Finally, the presentation will also present the potential for Langley calibration at Lulin and APAC's future plan.

Keywords: High mountain AOD, long-term aerosol variation, biomass burning, sunphotometer calibration

Analyzing Trace Gases Differences using the PANDORA network within the Washington, D.C., Baltimore, MD, I-95 Corridor Region

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The NASA Pandora instrument utilizes spectroscopy to analyze ultraviolet (UV) and visible wavelengths of light, providing insights into atmospheric composition. Focused on tropospheric columns, particularly water vapor, SO2, O3, NO2, and HCHO, the Pandora enhances surface monitoring networks to understand emissions, chemistry, and meteorology dynamics in key locations. This study presents an analysis of Pandora data from three sites in Maryland and D.C. – HUBC, NASA Goddard (GFSC) in Maryland, and McMillan station in Washington, DC. The McMillan station is located in an urban setting, and GFSC and HUBC are located in a suburban, suburban/rural landscape, respectively.

Through time-series plots, seasonal patterns in water vapor and SO2 concentrations are examined. Results reveal distinct seasonal patterns, with water vapor peaking in summer and SO2 showing winter maxima. Differences between urban and suburban locations in SO2 levels are noted, with the urban site showing higher offsets. Despite the proximity of HUBC and GSFC, significant differences are observed, particularly with "less abundant" gases like SO2, underscoring the need for further analysis.

Keywords: NASA Pandora, Trace Gases, Seasonal Patterns, Spatial Variation

Sensitivity analysis of aerosol optical and radiative properties, and in-situ calibration results obtained from three high-altitude sites at Ladakh in the Hindu Kush Himalayan region

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Presentation Preference: Oral

Abstract:

The study is focused on sensitivity analysis of aerosol optical and radiative properties measured by a multiwavelength sun-sky radiometer instrument (Prede, P0M-01, Japan) over the three high-altitude (> 3000 m amsl) remote sites in Ladakh (Hanle, Merak and Leh), located in the Hindu Kush Himalayan (HKH) region. Due to more clear skies, high altitude advantages and other promising meteorological parameters, these sites have several potential parameters to perform cross calibration networks for sun photometer instruments. Hanle and Merak sites are associated under the SKYNET program among the three sites. The instrument works on a robotic mode which consists of a spectral scanning radiometer, an automatic sun tracker and a rain sensor. The raw data is processed using a data processing software tool, SKYRAD.Pack (version 4.2) written in Fortran. The proposed work will elaborate more on in-situ calibration results and sensitivity analysis of aerosol optical and radiative properties from the three sites using full clear observation taken during January, 2019 to March, 2024. The de-convolution of AOD into fine and coarse mode components will be performed using the Mie scattering algorithm. Such de-convolution of AOD into fine and coarse mode components will be studied to perform aerosol classification over the study region.

Keywords: radiometer; SKYNET; aerosol; calibration; de-convolution

Evaluation of Near-UV Aerosol Products from the EP-TOMS, Aura/OMI, S5p/TROPOMI, and DSCOVR/EPIC Sensors using AERONET Measurements

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Presentation Preference: Poster

We have processed a multi-year record from multiple space-borne instruments including the EP-TOMS, Aura/OMI, S5p/TROPOMI, and DSCOVR/EPIC with the consistent UV aerosol algorithms over the last 26 years. The algorithm uses observations from the two near-ultraviolet wavelengths (331 nm and 360 nm for EP-TOMS, 354 nm and 388 nm for OMI and TROPOMI, 340 nm and 388 nm for EPIC) for simultaneously retrieving aerosol optical depth (AOD), single scattering albedo (SSA), aerosol absorption optical depth (AAOD), and above-cloud aerosol optical depth (ACAOD), along with the qualitative UV aerosol index (UVAI). In this presentation, we will compare the performances of retrieved AOD and SSA from these instruments with collocated AERONET measurements, primarily over land covering major aerosol environments of biomass burning, desert dust, and urban locations. The ACAOD product is also evaluated against the airborne direct measurements collected during ORACLES campaign over the south-eastern Atlantic Ocean. In addition, we will discuss possible remaining algorithmic and instrumental issues through the inter-comparison analysis among different sensors.

The European COST Networking Action Harmonia: International network for harmonization of atmospheric aerosol retrievals from ground-based photometers

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Presentation Preference: Oral

Harmonia is a networking action funded by the European Cooperation in Science and Technology (COST) (2022-2026). Its scientific activities are related with columnar aerosol measurements and involves scientists dealing with sun photometric measurements, model assimilation, satellite validation but also software and instrument developers. Harmonia aims to provide information towards related scientists on homogenization of aerosol retrievals using mainly solar and sky but also lunar and star photometers from different networks. Currently has 150 scientists involved mainly from Europe. It aims bridging user needs and the science and technology expertise residing in academia and industry.

Harmonia's main objectives have to do with:

- Increasing the interactions and knowledge exchanges between several atmospheric aerosol measurement networks and standardizing and improving of existing products and tools
- Stimulating the communication between operational agencies and academia, increasing the applicability of aerosol related products.
- Capacity building towards instrument operators on improving the use of solar, lunar and stellar radiometry/photometry instrumentation.

The presentation aims to provide a "Harmonia" overview and first two years results of the Action and to encourage sun photometer operators, scientists or simply aerosol measurement users, also outside Europe, to follow and take part on the Harmonia activities in the future.

Keywords: Aerosol optical properties, sun photometry, networking

Source Apportionment of $PM_{2.5}$ Nitrate using Isotope Techniques Coupled with AERONET Optical Properties

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Presentation Preference: Poster

Abstract:

Air quality degradation is a global concern, particularly in densely populated regions where anthropogenic emissions are concentrated, necessitating measures to safeguard public health. Urban areas face significant challenges from particulate matter (PM) pollutants, particularly $PM_{2.5}$ and PM_{10}, including detrimental effects on human health and contribution to acid rain and nutrient pollution. The first step to mitigating PM emissions is to determine their source origin. This project aims to use isotopic techniques to apportion the NOx emission sources (i.e., industrial, biomass burning, soil biogenic, vehicles, lightning) contributing to the particulate nitrate portion of $PM_{2.5}$ and AERONET optical properties coupled with reference clusters (i.e., maritime, biomass burning, industrial/urban, dust, mixed) to identify aerosol types in a semi-arid coastal urban airshed (Corpus Christi, TX, USA). To accomplish this, weekly $PM_{2.5}$ samples will be collected on quartz fiber filters using a URG3000abc medium-volume sampler located adjacent to a Cimel Sun Photometer. Filter eluents will be analyzed for nitrate isotopic composition ($\delta^{15}N$, $\delta^{18}O$, $\delta^{17}O$), and delta values will be employed in Bayesian isotope mixing models to determine emission source apportionment. The AERONET optical properties and reference clusters will complement these isotope results and aid in creating informed emission mitigation strategies for urban coastal regions.

Keywords: AERONET, Particulate Matter (PM), Isotope Mixing Models

The filter radiometer comparison international campaigns for AOD traceability

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Presentation Preference: Poster

Filter Radiometer Comparisons (FRC) for Aerosol optical depth (AOD) are organized every 5 years by the World Radiation Center (WRC) of the WMO at Davos, Switzerland. The objective of the FRC campaigns is to compare AOD and Ångström exponents (AE) derived from different instruments from different global or national networks. The aim is to demonstrate the current level of agreement, and work towards homogenization of the AOD measurements on a global scale. The comparison protocol is based on WMO recommendations published in GAW report No. 162. Measurements of each instrument are compared to the WMO AOD reference consisting of three Precision Filter Radiometers. The fifth FRC was held in October 2021, with one year delay due to the COVID-19 pandemic. Instrumentation belonging to various AOD global networks participated, including three reference instruments from the ACTRIS pan-European research infrastructure Centre for Aerosol Remote Sensing, SKYNET, Chinese and Australian networks. 31 filterradiometers and spectroradiometers from 12 countries participated, while 30 provided AOD data, with 90% to fulfil the WMO traceability recommendation in the Vis to NIR ranges.
The comparison results from FRC-V and improvements since the FRC-IV are presented. Plans for the next FRC scheduled for October 2025 are discussed, outlining additional traceability exercises and analysis options.

Keywords: Aerosol optical depth, Filter radiometers, homogenization, international comparison

An overview of Sunphotometer deployment to ARM sites and data availability at ARM Data Discovery

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Presentation Preference: Poster

For over two decades, the U.S. Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) user facility has deployed Cimel Sunphotometer instruments at its fixed and ARM mobile facility (AMF) deployments (e.g., Mather and Voyles, 2013). While it is uncommon that observations simultaneously provide information on the cloud droplet sizes and cloud optical depth (COD), for over a decade ARM has implemented a "cloud mode" strategy for its photometers that enables such key cloud property estimates. Throughout this process, ARM has collaborated closely with AErosol RObotic NETwork (AERONET) in operating these instruments and facilitating data transfer, which ensures the effective functioning of the Sunphotometers and seamless data transfer.

ARM has progressed towards implementing a new Sunphotometer Cloud Mode "Value-Added Product" (VAP, SPHOT VAP). This VAP employs a three-channel COD retrieval algorithm (e.g., Chiu et al. 2012), leveraging ground-based zenith radiance readings, and performs additional retrievals for cloud droplet effective radius, and the liquid water path. A multi-site, multi-year product validation will be completed this year, with these datasets available at the ARM Data Discovery Archive for active use.

Keywords: ARM, cloud optical depth, cloud droplet effective radius, liquid water path, SPHOT VAP

Exploring Seasonal and Monthly Variations in Columnar Aerosol Optical Properties over the Sultanate of Oman

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Abstract

This study presents the first analysis of aerosol optical characteristics over the Sultanate of Oman using ground-based AERONET observations in Nizwa, focusing on aerosol optical depth (AOD), Ångström exponent (AE), single scattering albedo (SSA), and volume size distributions during 2023. AOD varies significantly, peaking in summer (0.51 ± 0.19) and hitting a low in winter (0.15 ± 0.06). Conversely, AE peaks in winter (0.91 ± 0.32) and drops in summer (0.34 ± 0.14), indicating a higher presence of coarse mode particles, notably dust aerosols, in summer. There's a strong correlation (0.740) between AOD and water vapor content, with the highest correlation in November and December. Single scattering albedo's spectral dependence increases in summer, reflecting dust aerosol presence, and decreases across other seasons, indicating fine-mode aerosol dominance in winter. Coarse mode particles (dust) dominate in every season, contributing significantly to aerosol property variations over Nizwa. Throughout the study period, aerosol radiative forcing values averaged -17.74 W m−2 at the top of the atmosphere (TOA) and -44.27 W m−2 at the surface, resulting in an atmospheric forcing of 26.53 W m−2, with maximum forcing occurring in summer.

Keywords: Aerosol optical depth, Ångstrom exponent, Single scattering albedo, Aerosol type Radiative forcing.

Aerosol classification using machine learning on sun photometer and lidar data with focus on United Kingdom climatology

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Presentation Preference: Oral (or Poster)

Keywords: Aerosol Classification, Machine Learning, Climatology

We employed the K-nearest neighbour technique for identifying aerosol types to sun photometer data from AERONET. We used Extinction and Absorption Angstrom Exponent, Single Scattering Albedo, and Index of Refraction (Real and Imaginary). The training data set include level 2.0 data from GSFC (Goddard Space Flight Center NASA, Maryland) for urban industrial aerosols, Mongu for biomass burning aerosols, Solar Village for dust, Lanai for marine aerosols, and Pune for mixed aerosols.

The Met Office operates a network of nine ground-based polarisation Raman lidars and sun photometers across the United Kingdom (UK). The relationship between particle linear depolarisation ratio and lidar ratio from the lidars is utilized to validate the aerosol type. Initial results demonstrate a high accuracy of 92% on the test/train dataset. Several case studies have shown good agreement with lidar predictions of aerosol types. The climatological study across the UK reveals dominating aerosols for various locations, e.g., Camborne is near the English Channel dominated by industrial pollution and Nottingham mainly influenced by mixed aerosols. Despite limitations of the column integrated sun photometer data, we have confidence that our algorithm yields plausible aerosol identifications. Future plans include incorporating a volcanic ash cluster, as well as comparison with satellite data.

Obtaining surface $PM_{2.5}$ concentrations from column AOD observations: Insights from collocated AERONET and EPA data and modeling analysis

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Presentation Preference: Oral or Poster

In this study, we analyze the relationship between column AOD and surface $PM_{2.5}$ at hourly, daily, and monthly timescales and the key controlling factors of these relationships. Our goal is to determine how to use the remote-sensing aerosol data for air quality study and applications. We will (1) show the relationship between collocated AOD from AERONET and $PM_{2.5}$ from EPA measurements, (2) examine the factors, including column water vapor, aerosol size parameter, aerosol height information, planetary boundary layer height, and other meteorological information that modulate the AOD- $PM_{2.5}$ relationship with GEOS/GOCART model simulations and MERRA-2 reanalysis of meteorological fields, and (3) suggest feasible synergistic approach to obtain $PM_{2.5}$ from AOD observations globally at various time scales.

Keywords: $PM_{2.5}$, AOD, Air quality

A Novel Approach for Weather-specific Evaluation of Satellite Aerosol Optical Depth Retrievals using AERONET Observations

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Presentation Preference: Oral

Accurately estimating the total aerosol columnar burden (aerosol optical depth, AOD) is crucial for assessing aerosol radiative forcing, which is vital for quantifying anthropogenic climate change. The rapidly warming Earth's climate has exacerbated the spatio-temporal variations in aerosol properties via blurring the distinctions between long-term climate and short-term weather, particularly in arid areas. Using meteorological measurements and applying the concept of encroachment model, we explored the impact of myriad synoptic conditions on AOD anomalies in the drylands of Southern High Plains from 2018-2022 by comparing Deep Blue (DB) AOD product from Visible Infrared Imaging Radiometer Suite (VIIRS) with AERONET observations. The changes in weather regimes were categorized via near-surface temperature change rate, distinguishing benign (typically associated with higher dT/dt) and active synoptic conditions (relatively lower dT/dt). The VIIRS AOD exhibited a median bias of <-0.001 and RMSE of 0.05, with significantly higher uncertainty ($p<0.0001$, bias ~0.02, RMSE in bias ~0.08) during frontal/dryline passages, highlighting the impact of synoptic passages on AOD retrieval accuracy. Our analysis underscores the importance of weather-specific evaluation of satellite products to better identify AOD retrieval inconsistencies and enhance algorithms used therein.

Keywords: Aerosol Optical Depth, Deep Blue (DB) AOD, VIIRS AERONET Comparison, Weather-specific AOD Evaluation.

Diurnal variability of aerosol optical depth observed at AERONET sites.

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Presentation Preference: Poster

The current paper analyses diurnal variability of aerosol optical measured on various AERONET sites. Our analysis included aerosol types, seasons, and source regions. We computed aerosol diurnal variability using two procedures, based on absolute departure from daily means. Multi-year statistics allowed establishment robust diurnal patterns for several sites and aerosol types, however, on a few monitoring stations aerosol optical depth did not show any diurnal variation. Geostationary satellites provide the first good opportunity to provide systematic aerosol dynamics. Thus, the need to validate satellite-based diurnal retrievals will eventually lead to a synergistic global assessment between ground and satellite systems. Examples of such a comparison are included.

Keywords: aerosols, remote sensing, sunphotometer

Increasing AERONET Inversion Product Yield by Mitigating Radiance Calibration Uncertainty via Colocated Cimel and MFRSR Stations

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Presentation Preference: Poster

AERONET is frequently used as a ground truth for satellite remote sensing and climate model assessments of total column aerosol properties. However, the availability of the level 2 quality-assured SSA inversion product is often limited by the requirement that AOD at 440 nm exceed 0.4. For example, at the ARM Southern Great Plains site, fewer than 5% of AOD measurements meet this criterion, suggesting that successful level 2 SSA inversions may be outliers rather than representative of typical conditions.

We can utilize AERONET stations colocated with Multifilter Rotating Shadowband Radiometers (MFRSR) to increase the frequency of quality-assured inversion results. Our approach will relax the AOD acceptance threshold while adding the constraint that the AOD and calibrated sky radiance be consistent with the calibration-independent MFRSR direct/diffuse ratio. The resulting dataset will be processed at the University of Oklahoma with AERONET's inversion algorithm to generate an original inversion product in which the calibration adjustments to the radiance fields result in new SSAs that can be trusted to lower AODs because it is not as influenced by calibration uncertainty. Concurrent AERONET and MFRSR measurements are available at 25 AERONET sites in diverse climates, with a cumulative duration of over 140 years.

Keywords: Aerosols, SSA, Remote Sensing, MFRSR.

Relationship of aerosol optical and chemical properties from synergetic use of SPARTAN and AERONET observations

Sujin Eom[1], Jhoon Kim[2], Yeseul Cho[2], Sang Seo Park[1]

To study the air quality and public health for particulate matter (PM), we need to know the chemical composition of PM2.5. Various characteristics of chemical compositions of PM2.5 is also affected to overall optical properties of aerosols. To precisely understand this, we simultaneously analyzed in-situ observations through SPARTAN (Surface Particulate Matter Network) and remote-sensing data through AERONET (Aerosol Robotic Network). In this study, we used SPARTAN and AERONET data from 2016 to 2022 in 11 global observation sites. Focusing on three dominant components—Ammoniated Sulfate, BC, and Fine Soil—found in SPARTAN sampling data, we observed that during periods when Fine Soil mass exceeded BC mass, the wavelength difference of single scattering albedo (SSA) between 870 and 440 nm from AERONET was positive. Conversely, during periods with higher BC mass, this difference was negative. This relationship suggest that the chemical characteristics of aerosols have optically influenced their absorption and size properties. Therefore, we propose some improvements in existing aerosol type classification algorithms, regarding aerosol chemical states.

Investigating Temporal and Spatial Differences within the AERONET network over the Mid-Atlantic Region

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This study examines variations in Aerosol Optical Depth (AOD) and water vapor across urban, suburban, and rural environments in the Maryland and D.C. region, aiming to deepen our understanding of aerosol distribution and its environmental impacts. Aerosols significantly affect both public health and climate, making this research crucial for developing targeted air quality management strategies and refining atmospheric prediction models.

AOD data was collected from three locations: the Howard University Interdisciplinary Research Building (HU-IRB), the NASA Goddard Space Flight Center (GSFC), and the Smithsonian Environmental Research Center (SERC). These sites provide a spectrum from urban to rural settings, offering insights into how aerosol behavior varies across different landscapes.

The analysis aims to delineate AOD differences related to geographic location and seasonal shifts. We hypothesize that urban areas, particularly around HU-IRB, will display higher AOD due to local human activities, while the rural SERC site might reflect influences from natural sources and regional transport.

Preliminary findings support our hypothesis, with urban sites showing higher AOD peaks, likely linked to local emissions. Additionally, episodic events like distant wildfires have caused significant regional AOD spikes. These results highlight the complex interaction between local and regional sources, emphasizing the need for a comprehensive approach to air quality monitoring in the region.

Keywords: AERONET, AOD, Seasonal Patterns, Spatial Variation

Validation and support of space-based measurements with the Pandonia Global Network of ground-based spectrometers

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Presentation Preference: Oral or Poster

Since 2019 the NASA Pandora and ESA Pandonia projects have been collaborating to coordinate and facilitate the expansion of a global network of ground-based spectrometers to support space-based measurements of trace gases relevant to air quality (NO2, O3, HCHO, SO2, …). This network of standardized, calibrated Pandora instruments, the Pandonia Global Network (PGN, https://www.pandonia-global-network.org), is focused on providing data needed to help validate satellite measurements and to contribute to scientific studies of air quality. As of May 2024, the PGN is comprised of 165 official sites in 34 countries. This presentation will describe recent efforts to expand and improve the network to support the increased capability and complexity of space-based measurements. Collaborative efforts by partner agencies, especially the US Environmental Protection Agency (EPA) and the Korean National Institute of Environmental Research (NIER), and new programs such as the Increasing Participation in Minority Serving Institutions (IPMSI) and Satellite Needs Working Group (SNWG) have accelerated the growth of the PGN, providing greater global coverage and allowing improved data products. With these improvements and continued input from other suborbital assets, the PGN is well positioned to facilitate the interpretation and validation of high spatial resolution and diurnal measurements provided by the newest orbiting and geostationary satellite instruments.

Keywords: Ozone, NO2, HCHO, Pandora

Update on activities at the Ilorin Nigeria AERONET site

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Abstract

The Ilorin, Nigeria AERONET site in the sub-Sahel of Africa has been established in 1997 and is operational since then. The data collected and distributed in the AERONET framework, in addition to their contribution to the scientific community, are serving to educate students of the Department of Physics, University of Ilorin. Many of them became members of educational institutions in Nigeria and contribute to generate awareness on environmental issues in their country. Selected work that was done with the Ilorin AERONET data will be described.

JPSS AEROSOL PRODUCT VALIDATION USING AERONET

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Presentation Preference: Oral

Aerosol Robotic Network (AERONET) is a NASA-sponsored federated network of sun/sky scanning radiometers that provides valuable measurements for validation of satellite-based aerosol retrievals. For the past decade, the AERONET datasets have been used as ground truth to validate the JPSS Visible Infrared Imager Radiometer Suite (VIIRS) aerosol products, namely Aerosol Optical Depth (AOD) and Angstrom Exponent (AE) as a proxy to validate smoke and dust detection. The AERONET has provided the JPSS aerosol science teams with the quality assured spectral AOD, AE, and other aerosol properties such as refractive index, volume size distributions etc. from all ~500 active and globally distributed sites through the AERONET website; per NOAA request, the AERONET team often set up the Sun photometers co-located with other instruments during special field campaigns. The excellent ground truth data allowed characterization of VIIRS aerosol retrievals over different surface types such dark, bright, semi-bright, near coasts, lakes, and so forth. The AERONET data set has been extraordinarily valuable to the JPSS aerosol science team and to the science community. In this presentation, the contributions of AERONET data sets for JPSS products' validation will be summarized and highlighted with examples during the recent NOAA-21 calibration and validation reviews to demonstrate AOD and smoke/dust mask detection products' maturity.

Keywords: JPSS, LEO, AERONET, Aerosols, Validation

Assessing health implications due to aerosol dynamics and climate trends using ground-based and Satellite observations

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Presentation Preference: Oral

The seasonal nature of climate in Ghana present health risks to the people because of their characteristic nature and different levels of associated air pollution, a leading environmental health threat in Ghana. Ghana has one AERONET station to assess aerosol characteristics. Satellite technology is the main platform for aerosol observations, which may have limitations. This study examines aerosol dynamics and climate trends including their health implications using ground-based and satellite observations and reported health cases. The satellite and ground observations are based on AOD derived from OMI and MODIS at 500nm and AERONET station at ANU respectively. Climate and respiratory disease data were obtained for Koforidua. Satellite observations capture well both the diurnal and seasonal cycles including the dust load events. Aerosol level is high in the dry season, peaks in February, and reaches a minimum in August. Satellite observations MODIS (0.90) and OMI (0.80) strongly correlated with the ground-based data. Respiratory diseases for the past six years peak in July. There was a correlation of 0.7 and 0.46 between respiratory diseases and aerosols in 2020 and 2018, respectively. Temperature is rising consistent with global warming. Annual total rainfall, rain days and heavy rainfall events remain variable.

Keywords: Respiratory, Temperature, Rainfall, Aerosol, Satellite

UV-VIS Spectral aerosol absorption models derived from AERONET-OMI-MODIS synergy and its applications

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Presentation Preference: Poster

Measuring spectral aerosol absorption remains a challenging task in aerosol studies, especially in the UV region, where ground and airborne measurements are sparse. Here, we introduce an aerosol single scattering albedo (SSA, ω_o) database in the UV-to-visible wavelength range (340–670 nm) derived from the synergistic combination of collocated ground measurements of spectral aerosol optical depth (AOD) from 110 AERONET (AErosol RObotic NETwork) sites with radiance measurements at 340, 354, and 388 nm from OMI (Ozone Monitoring Instrument) and at 466 and 676 nm from MODIS (MODerate Imaging Spectrometer). The approach followed relies on explaining satellite-measured near-UV and visible radiances in terms of measured total column extinction AOD and retrieved total column wavelength-dependent SSA using radiative transfer calculations. Required information on aerosol particle size distribution is adopted from AERONET-based aerosol type-dependent seasonal climatology specifically developed for this project. We will present the resultant regional and seasonal spectral SSA dataset over different regions. The derived aerosol spectral SSA data set provides a valuable addition to the existing aerosol absorption record from AERONET by extending it to the near-UV region. In addition to improving our understanding of spectral aerosol absorption properties, the combined UV-VIS dataset also offers wavelength-dependent dynamic aerosol absorption models for use in satellite-based aerosol retrieval algorithms. Results from the application of regional and seasonal spectral aerosol absorption models to the operational UV aerosol products are discussed.

Long-term observation of aerosol optical properties by ground-based and ship-borne Sky radiometer

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Presentation Preference: Oral

Aerosol optical properties play an important role in the earth climate and radiation budget. We investigated the long-term observation of aerosol optical properties at ground-based and ship-borne measurements since 1990's by using the Sky radiometer (POM-01, 02: PREDE Co. Ltd., Tokyo, Japan.). One of the objectives was to understand the effect on climate and radiation budget, and the other was to validate satellite (e.g., GCOM-C/SGLI, EarthCARE, Himawari and so on), numerical models. Direct and indirect solar radiation measurements from the ground and maritime have been successfully employed for aerosol optical properties. These data have revealed various events (anthropogenic and/or natural aerosols), seasonal and long-term trends. However, there are still some things to consider in different observation environments and different climatic conditions, such as changes in radiation algorithm for some atmospheric conditions and parameters, which are also related to spatial and temporal variability. Therefore, they are considering how to obtain more detail results of aerosol optical properties. We show the possibility to the wavelength dependence of solar aureole, in this presentation, on the comparison between SKYRAD, GRASP-SKYRAD, Aeronet, Satellite of aerosol optical properties with temporal and spatial variability in the long-term record.

Keywords: Aerosol optical properties, Climate change, Observation of land and ocean.

AERONET Project: The Next 30 Years of Software Development

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Presentation Preference: Oral.

Rigorous protocols for instrument absolute calibration and data processing, developed and maintained by a dedicated international team for over three decades, have established AERONET as the global standard for aerosol research. Software has been, and will continue to be, a crucial contributor to the project's success.

AERONET relies on various software including data processing (primarily implemented in C-language), and research (forward and inverse modelling - mostly in Fortran). This disparity between C and Fortran, and the lack of support for modern software development tools (Python, Intel MKL high-performance mathematical library, Doxygen) disrupts seamless data flow and hampers research progress.

Furthermore, scientific software serves both as a research tool and an object of study. As science evolves, the software undergoes modifications, often incorporating "temporary" patches that persist indefinitely within the codebase without proper documentation. Decades of extensive development without systematic cleanup inevitably turn software into "black boxes" with "spaghetti code".

Our presentation will outline updates to scientific software, relevant to AERONET, over the past few years, including radiative transfer solver, atmospheric absorption spectroscopy, and light scattering by spheroids. We will share ideas based on our experience to stimulate discussion on enhancing and advancing one of the AERONET project's critical components.

Keywords: scientific software development, radiative transfer.

Closure of Aerosol Radiative Properties from ORACLES 4STAR and In Situ Measurements – Implications for AERONET QC Requirements

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Presentation Preference: Oral

Currently, AERONET (AErosol RObotic NETwork) requires an Aerosol Optical Depth (AOD) greater than 0.4 at 440nm to be considered a Level 2 inversion. Lower aerosol loadings that are typical in the atmosphere, such as those with AOD between 0.2 and 0.4, are incapable of meeting AERONET's highest quality control (QC) criteria, and thus are excluded from many analyses.

To assess the reasonability of AERONET's minimum AOD requirements, we will perform closure between aerosol radiative properties from remote sensing retrievals and in situ measurements, both from the NASA ORACLES (ObseRvations of Aerosols above CLouds and their intEractionS) 2016-2018 airborne field campaigns. Remote sensing retrievals come from 4STAR (Spectrometer for Sky-Scanning, Sun-Tracking Atmospheric Research), a spectrophotometer that acts as a mobile, airborne AERONET station. In situ measurements come from the filter-based Particle Soot Absorption Photometer (PSAP) and Nephelometers (Neph).

For a proper comparison, corrections must first be made to the in situ data, including for relative humidity, chemical speciation, and comparison against non-filter measurements. 4STAR and in situ scattering and absorption coefficients will then be correlated and binned by AOD. Strong correlations at lower AOD would indicate that AERONET can reasonably include lower aerosol loading events in its Level 2.0 data record.

Keywords: Aerosols, Closure, Remote Sensing, In Situ, Quality Control

Squares, Circles and GIANT Spreadsheets: AERONET and the Dark Target aerosol algorithm

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Presentation Preference: Oral

The Dark Target (DT) aerosol retrieval algorithm, developed for the Moderate Resolution Imaging Spectroradiometer (MODIS) on the Terra and Aqua satellites, retrieves aerosol optical depth (AOD) and fine-mode aerosol weighting (FMW). For continuing long-term data records while adding new information about short-term aerosol variability, DT has been ported to additional multispectral imagers in Low Earth Orbit (LEO), Geostationary orbit (GEO) and sub-orbit (airborne).

AERONET and the Marine Aerosol Network (MAN) are integral to DT. AERONET data were used for algorithm development prior to Terra's launch in 1999, and are still used for improving the algorithm and products. AERONET-derived climatology of aerosol optical properties inform the choices of aerosol optical models, and AERONET-observed AOD and AE have long been used for evaluation.

Here, we provide a brief history of the AERONET / Dark Target synergy, such as development of optical models, the invention of the GIANT spreadsheet, and the transition from squares to circles for validation exercises. In early 2000, there were just dozens of satellite/AERONET collocations, that GIANT spreadsheet fit on a piece of paper (as witnessed by the named authors). Now, after 25 years and 9 sensors, dozens of *et al* researchers have led to millions of collocations.

Keywords: MODIS, Dark Target, Aerosol Optical Depth (AOD), LEO + GEO, collocation

Comparing the Differences in Nitrogen Deposition Modeled from Satellite, Ground-Level Remote Sensing, and in-situ Networks in Terrestrial and Marine Watersheds Across Texas.

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Presentation preference: Poster

Reactive Nitrogen species (N_r) as gases and aerosols are deposited into the environment via wet and dry deposition, which leads to eutrophication, soil acidification, algal blooms, hypoxia, and reduced crop yields. Across watersheds—marine and terrestrial—wet deposition of N_r is well documented while dry deposition is under characterized. To have an accurate representation of the total nitrogen budget and its relationship to critical load exceedance, it is essential to have an accurate representation of dry deposition specific to each watershed. Here we model NO_2 and NO_3^- dry deposition in terrestrial and marine watersheds (i.e., Galveston Bay, Corpus Christi Bay, Trinity River, and San Antonio River watersheds) using in situ federal equivalent networks by TCEQ and EPA, ground-level remote sensing from Pandora and AERONET, as well as data from OMI. This allows us to compare the accuracy of both satellite-borne and ground-based remote sensing to a more robust FEM network. Preliminary data from the Galveston watershed suggest that deposition hotspots might not always be captured by satellite data with lower spatial and temporal resolutions. Determining the accuracy of dry deposition from remote sensing instruments can offer a lower cost and larger coverage, leading to better mitigation strategies for N_r deposition.

Key words: Pandora, satellite, dry deposition, AERONET, reactive nitrogen

Maritime Aerosol Network as a component of AERONET – dreams of the 1980s became realities of the 2020s.

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Presentation Preference: Oral

Aerosol optical depth (AOD) is an atmospheric optical parameter critical for various applications ranging from Earth radiative balance computations to ocean color studies, from understanding of global aerosol distribution to aerosol remote sensing from space and global aerosol transport modelling. Long-term island based comprehensive AOD measurements, which seemed to be a luxury for various applications in the 1980s, do not satisfy contemporary needs of remote sensing and modelling research. Establishment of Maritime Aerosol Network (MAN) as a component of AERONET allowed to improve our knowledge of aerosol optical properties over the oceans and fill existing data gaps in various oceanic areas.

Keywords: maritime aerosol, remote sensing, sunphotometer, atmospheric correction

Saharan and Arabian dust episodes during A-LIFE experiment in Cyprus

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Presentation Preference: Poster

The field experiment conducted in Cyprus in April 2017 as part of the A-LIFE (Absorbing aerosol layers in a changing climate: aging, lifetime, and dynamics) project featured the utilization of a diverse set of instruments from various measurement disciplines (see Groß et al., 2024).

This study presents the columnar records obtained by sun photometry. Two sun/sky/lunar photometers, operating within AERONET framework, were strategically positioned at two distinct sites: Pafos and Limassol (40 km apart). Optical and microphysical aerosol properties (AERONET level 2.0 data) were analysed to establish an inventory of aerosol event days throughout the experiment, highlighting mineral dust as the predominant type.

Saharan dust comprises smaller and less absorbing particles compared to Arabian dust. The columnar volume efficiency factor, calculated through the linear fit between aerosol optical depth and total volume concentration, emerged as a useful proxy for identifying dust origin. There was no signal of black carbon-rich aerosols because of absorption Ångström exponent values.

This work was supported by the Spanish Ministry for Science and Innovation (MICINN) Grant PID2021-127588OB-I00, ACTRIS ERIC and project TED2021-131211B-I00375 by MCIN/AEI/10.13039/501100011033 and EU “NextGenerationEU”/PRTR. The A-LIFE project was funded by an ERC Starting Grant (support from DLR).

Groß, et al (2024). EGUsphere, https://doi.org/10.5194/egusphere-2024-140.

Keywords: mineral dust; AERONET; absorbing properties; Saharan and Arabian dust.

The NASA Micro Pulse Lidar Network (MPLNET): 25 years of collaboration with AERONET

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What is now the NASA Micro Pulse Lidar Network (MPLNET) was originally proposed to the NASA Radiation Sciences Program 25 years ago in the Fall of 1999. The original concept was a four-year plan to deploy six NASA micro-pulse lidars (MPL) to AERONET and BSRN sites supporting the EOS project, collaborate with existing MPL sites in the DOE ARM program, and reserve one MPL for mobile field deployments. The proposal was successful and renamed MPLNET, beginning operations in early 2000. From the beginning, MPLNET was integrated with AERONET as the primary goal was to establish joint lidar sites at key AERONET locations to compliment the column data provided by the photometer. Original MPLNET goals were to provide identification of thin cirrus, retrieval of aerosol layer heights, and aerosol extinction profiles. This has since expanded to a large and varied MPLNET data collection of cloud, aerosol, and PBL properties. AERONET team members, infrastructure, and data (primarily aerosol optical depth) were critical to the both the early success of MPLNET and its continued longevity. I will present a brief history and evolution of MPLNET, including contributions from NASA team members and our global network partners which are shared with AERONET. I will also discuss the current status of MPLNET and some research highlights over the years. I will end with a brief overview of the WMO GAW Aerosol Lidar Observation Network (GALION), a network of lidar networks that can provide global coverage closer to the scale that has been achieved by AERONET.

Analysis of Aerosol Optical Properties in the Southern Gobi region of Mongolia

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Presentation Preference: Oral

Abstract

The AERONET is a global ground-based network of Sun/sky automated radiometers supported by NASA's Earth Observing System (EOS) and other international research institutions. Aerosols, both natural and anthropogenic, are an important but complex component of the Earth's climate system. The Gobi Desert is one of the Asian dust sources, which includes Dalanzadgad Aeronet station, which is located in a southern suburban area of Mongolia.

The Pandora Asia Network (PAN), and integration with the Pandonia Global Network (PGN), which is a network of ground-based remote sensing instruments (Pandora system) for 3-D air quality monitoring and the validation of satellite data with ground data through regional cooperation installed. The pandora instrument was installed in Dalanzadgad in July 2022.

In this study, we have analized aerosol optical thickness (AOT) for long term data for the period 1998-2024. Also, we compared data of the AERONET sun photometer with the Pandora instrument 2022-2023 data and numerical weather modelling results of the dust storm case. This study was addressed to analyze the AERONET sun photometer data, to compare Pandora instruments, modelling results and other satellite data and finally to understand aerosol optical properties in the Southern of Gobi region of Mongolia.

Keywords: AERONET, AOT, Pandora

Effect of Biomass Burning Emissions to Air Quality in Africa

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Presentation Preference: Poster

Aerosols sources from fires do not only affect air quality and human-health but also the climate. It is estimated that 54% of global biomass burning every year occurs in Africa due to high concentration and frequency of fires in this region. We report on an enhanced aerosol optical depth (AOD) captured by NASA AERONET (Aerosol Robotic Network) sun photometer located at All Nations University (ANU) in Ghana presumed to be triggered by fires. We also employ NASA's Global Modelling Initiative Chemistry and Transport Model (GMI-CTM) to quantify the contribution of the fires to air quality. We start by comparing AERONET AOD with AOD derived from three satellite sensors, the Ozone Monitoring Instrument (OMI), the Moderate Resolution Imaging Spectrometer (MODIS), and the Multi-angle Imaging Spectroradiometer (MISR) at six African AERONET stations. We also include comparison between AERONET AOD and PurpleAir PM2.5 at ANU. On average, MODIS shows a better agreement with AERONET than OMI and MISR. AERONET AOD correlation with PM2.5 at ANU is about 0.60. According to the GMI-CTM simulations most of the winter biomass burning impact (92 %) is due to local burning while the summer burning impact (96 %) is due to burning from outside.

Keywords: Aerosol, Biomass, Air Quality, Fires.

First year of AERONET-OC data from the Río de la Plata turbid waters: analysis and comparison with hyperspectral automated WATERHYPERNETS radiometric data

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The RdP-EsNM AERONET-OC site, located at the end of a 1.1 km-long jetty 60 km South of Buenos Aires city (Argentina), has been successfully collecting radiometric data in the turbid waters of Río de la Plata estuary since March 2023. The RdP-EsNM site, the fourth in the Southern Hemisphere and second in South America, is strategically located between a water intake and an active commercial harbor. It is characterized by sediment-rich turbid waters, but intense phytoplankton blooms (including toxic Cyanobacteria) have also been recorded frequently since 2020, presenting human health risks and causing temporal problems to the water intake. The SeaPRISM (CE-318T, 12-channel sea configuration) is collocated with the automated hyperspectral HYPSTAR® radiometer (WATERHYPERNETS) deployed in December 2021. Multi- and hyperspectral data acquisition, processing, and data quality analysis are described. The RdP-EsNM site is characterised in relation to the spectral features and temporal patterns found using the first year of SeaPRISM data and compared to existing data from ship borne as well as from simultaneous HYPSTAR® measurements. Comparison between water-leaving radiance data of SeaPRISM and HYPSTAR® shows very good consistency. Match-up analysis of multi- and hyperspectral imagery shows the potential of these systems to improve validation activities of current and future satellite missions.

Keywords: *in situ* above-water radiometry, Río de la Plata, turbid coastal water, SeaPRISM and HYPSTAR® comparison, satellite validation.

Operational applications of AERONET to global aerosol forecasting

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Presentation Preference: Oral

AERONET has grown well beyond its initial design as a biosphere cal/val network. One such application is air quality monitoring, and beyond that specifically support for the operational centers that perform aerosol forecasting. In this presentation, we will provide an overview of AERONET's history with numerical weather prediction (NWP) and its current use by members of the International Cooperative for Aerosol Prediction (ICAP) for global aerosol forecasting and the development of aerosol reanalyses. Suggestions will be provided from the ICAP community to further enhance AERONET's and MAN's utility to NWP development, including long term monitoring, data assimilation, and validation and verification.

Keywords: air quality, verification, data assimilation

Relationship between AOD measurements obtained from the Sun-photometer (CIMEL), PM2.5 and temperature from Purple Air in Medellín – Colombia

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Abstrac

AOD, particulate matter PM2.5 and temperature are related and affect various aspects of climate, air quality and atmospheric radiation. Where AOD is a measure of the amount of sunlight that is attenuated or absorbed as it passes through the atmosphere. PM2.5 are airborne particles with an aerodynamic diameter of 2.5 micrometers or less which can include dust, soot, ash, organic compounds and aerosols. An increase in AOD due to the presence of PM2.5 particles or aerosols can reduce the amount of solar radiation reaching the Earth's surface, which can affect surface warming and therefore temperature. The relationship between AOD and PM2.5 particles can affect atmospheric temperature in several ways. On the one hand, they act as condensation nuclei for the formation of clouds, they can also influence the distribution of solar radiation and, therefore, the temperature. This article shows the measurements from a NASA AERONET Cimel Solar Photometer and the Purple Air sensor installed at the National University of Colombia Medellín Campus, during the month of December 2021 until beginning of May 2022

Key words: Aerosol optical Depth (AOD), PM2.5, temperature, solar radiation, condensation nuclei.

RIMO Correction Factor: a correction of a lunar irradiance model to estimate accurate AOD values.

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Presentation Preference: Oral

Moon photometry has emerged as a reference technique to estimate aerosol optical depth (AOD) at night-time. It requires an accurate knowledge of the extraterrestrial lunar irradiance, which is usually obtained from models like ROLO (Robotic Lunar Observatory), or its public implementation named RIMO (Barreto et al., 2019). However, the use of ROLO and RIMO for AOD calculation has shown that these models overestimate the extraterrestrial lunar irradiance, since they provide non-realistic AOD values. This work proposes a correction over RIMO (RIMO Correction Factor; RCF), fitting the AOD retrieved with RIMO and the expected AOD during night-time in the high-altitude Izaña station (28.3ºN; 16.5ºW; 2401 m asl.; Tenerife, Spain). For this, a sun/sky/moon CE318-T photometer, calibrated transferring the sun calibration to the lunar one, has been used. As result, the obtained RCF values, which are different for each photometer wavelength, depend on the Moon phase angle, and they have been fitted to a second order polynomial. The AOD values have been obtained correcting RIMO by RCF in Granada (37.16 N; 3.61W; 680m asl), and the obtained values have been compared against independent AOD measurements retrieved by a star photometer, showing a high correlation between both data series.

Keywords: RIMO, Moon, AOD, night-time, star photometer

Barreto et al. (2019): Evaluation of night-time aerosols measurements and lunar irradiance models in the frame of the first multi-instrument nocturnal intercomparison campaign. Atmos. Environ., 202, 190-211. doi: 10.1016/j.atmosenv.2019.01.006

Evaluation of Satellite Retrievals of UV Aerosol Optical Depth and Single Scattering Albedo using AERONET Observations

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Presentation Preference: Oral

The development of the near-UV spaceborne retrieval capability was the fortunate unintended result of an upgrade to the TOMS total ozone algorithm in the mid-90's. For over 30 years aerosol optical depth (AOD) and single scattering albedo (SSA) in the near ultraviolet (UV) spectral region has been retrieved from a variety of instruments of varying spatial resolution from 50 km (Nimbus-7 TOMS) in the 1980's, to 1 km of the recently deployed PACE-OCI sensor. Ground-based AOD measurements suitable for validation were not available for the early part of the TOMS AOD record (Nimbus7, 1979-1992), but AERONET observations at locations around the word were used in the evaluation of the post-1996 Earth Probe TOMS record. Since then, AERONET has played a crucial role in the analysis of retrieved parameters. In this presentation we will discuss the many ways the AERONET data base of both, directly measured and retrieved aerosol parameters, has contributed to the science value of the multidecadal long satellite near UV aerosol record.

Keywords: Optical Depth, Absorption, Validation

An Update on the Lunar AOD AERONET Product

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Lunar AOD has been a provisional product for many years now. Known inaccuracies in the ROLO lunar irradiance model introduce a bias that require a correction to be applied as a function of the lunar phase angle. Additionally, the cloud-screening protocol is slightly different for the lunar AOD than the solar AOD as it lacks the curvature check derived from the cross-scan procedure. Both of these factors added uncertainty that needed to be properly evaluated before these data could be designated as Level 2. The bias correction has now been revised and expanded based on recent years of lunar Langleys at MLO and other sites. An assessment of the current lunar AOD dataset will be shared derived from multi-site comparisons of day and night AOD and Angstrom Exponent.

Validation Key Role of AERONET-OC for Satellite Ocean Color Missions from SeaWiFS to PACE

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Presentation Preference: Oral

The success of satellite ocean color missions and development of bio-optical algorithms heavily relies on the availability of optical field measurements for validation. NASA's SeaWiFS Bio-optical Archive and Storage System (SeaBASS) has served the ocean color community since the late 1990s as the primary repository for in-situ radiometric and pigment data. These data have provided a solid source for validation spread across decades. However, there is an omnipresent need for new and additional data to validate ongoing and new satellite missions; especially, because clouds, data quality, and other limitations often reduce validation matchup results to less than 10% of the total data points. Different to the traditional ship-based sampling, AERONET-OC has provided a high volume of reliable, quality controlled, and systematic source of radiometric data since the 2000s. Validation results between MODIS-Aqua and AERONET-OC for remote sensing reflectance at 488nm yielded 5237 matchups (MAE= 0.00102, mean bias = -0.00086), while traditional field data yielded 730 matchups only (MAE= 0.00080, mean bias = -0.00041). Here, we present validation results from SeaWiFS to a sneak peek into PACE early results. We will discuss the limitations and challenges of ocean color validation and share the plans and expectations for the PACE mission.

Keywords: PACE, validation, radiometry, matchups, AERONET-OC

Enhancing Aerosol Characterization with Curvature Cross Scan aureole and optical depth measurements: Introducing GRASP-CCS

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Presentation Preference: Oral

This study evaluates the potential of integrating curvature cross scan aureole (CCS) data into the GRASP-AOD retrieval algorithm to enhance the characterization of the microphysical and optical properties of atmospheric aerosols in a new retrieval scheme called GRASP-CCS.
CCS scans are routinely performed by CE318-T photometers in the 3.0º to 7.5º scattering angle range at 0.3º increments (left and right) at 1020 nm after each triplet direct solar measurement. Studies applying the GRASP-AOD algorithm have shown that using only spectral AOD as input allowed for a reliable characterization of fine mode properties, while characterization of the coarse mode was less accurate. The angular distribution of scattered light in the aureole region at 1020 nm, as provided by CCS data, is known to strongly depend on the coarse mode size distribution properties.
The information content of these measurements for improving coarse mode characterization compared to GRASP-AOD is demonstrated through a series of numerical tests in this presentation. Initial retrievals using real data have confirmed that the inclusion of CCS scans offers a reliable characterization of coarse mode size distribution when compared with AERONET standard retrieval algorithms. Consequently, they have also revealed a better characterization of effective radius and total volume concentration compared to the results obtained with GRASP-AOD.

Keywords: Aerosol retrieval, CCS-scans, aerosol optical depth, Version 3.

Three years of Aerosol Measurements Using an Automated Photometer on the First long-term AERONET Ship Site

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Presentation Preference: Oral

The Earth's oceans are vital for regulating global climate and atmospheric processes, with aerosols significantly influencing weather patterns, air quality, and climate dynamics. Despite extensive research on land-based aerosols through networks like AERONET, understanding oceanic aerosol dynamics remains a critical gap. Efforts to address this gap involve enhancing monitoring infrastructure, advancing satellite technologies, and innovating approaches to oceanic aerosol study.

The work focuses on surface ship-based aerosol observations using a ship version of the automatic CIMEL 318-T photometer (AERONET standard instrument) in development since 2017. This innovation brings surface ocean photometry to the precision and automation standards of ground-based AERONET sites. In 2021, a significant milestone was achieved with the establishment of the first permanent ship-site on the RV Marion Dufresne in the Indian Ocean (MAP-IO program, www.mapio.re).

Our primary analysis focuses on presenting the first 3-years of Aerosol Optical Depth (AOD) data from Marion Dufresne automatic photometer. Also we show the first microphysical and optical aerosol properties retrieved from sky/sun measurements meeting AERONET Level 2 criteria (AOD(440)>0.4), during a biomass burning event in the Indian Ocean region in October 2023. Finally, we utilize AOD measurements from the ship-based automatic photometer to validate AOD data from satellite sensors, particularly S3-OLCI.

Keywords: ship-borne photometer, aerosol retrieval, MAP-IO program

Retrieval of Tropospheric Trace Gas Nitrogen Dioxide (NO2) by exploiting 1st South Asia's NASA Pandora Spectrometer

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Presentation Preference: Poster

Climate change is the result of a sudden shift in atmospheric chemistry. The combustion of fossil fuels and wildfires are two key contributors to disrupting the natural balance and significantly increasing atmospheric trace gas concentrations. The primary anthropogenic causes of nitrogen oxide emissions are fossil fuel combustion, industrial pollution, and intentional burning. Nitrogen dioxide is an important atmospheric trace gas necessary for the synthesis of tropospheric ozone, a temporary climatic pollutant. Short-lived climate pollutants are a key source of concern since they can harm human health while also contributing to global warming. In South Asia, there is an absence of competent ground-based monitoring equipment for assessing trace gas atmospheric profiles. In Pakistan, a NASA Pandora Spectrometer was recently installed to continuously monitor the amounts of these trace chemicals. In this study, two ground-based instruments (the Pandora Spectrometer and the Horriba NOx Analyzer) are evaluated against two satellite-based instruments (OMI and TROPOMI). Pandora tropospheric NO2 column densities exhibited a correlation of 71 and 77 percent with OMI and TROPOMI, respectively, while Pandora Surface NO2 concentrations were also highly correlated with Horriba NO2 surface concentrations. In addition, meteorological inputs such as solar radiation and wind speed followed similar trends to Pandora tropospheric NO2 column levels.

Keywords: Tropospheric nitrogen dioxide, Seasonal, In-situ

Initial comparison of AERONET-OC measurements against WATERHYPERNET at the Chesapeake Bay Tower, USA

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Presentation Preference: Oral

The WATERHYPERNET (https://waterhypernet.org) is a growing federated network of automated, high-spectral resolution radiometers on zenith- and azimuth- pointing systems deployed on fixed structures worldwide. A WATERHYPERNET instrument system was installed on a tower in the upper Chesapeake Bay in July 2023; the first of its kind in North America. The installation added to the tower a PAN-and-Tilt HYperspectral Radiometer system (PANTHYR), which uses two TriOS RAMSES radiometers to simultaneously measure downward irradiance and radiance. Sky and water radiance are both measured by pointing one radiometer, while the irradiance radiometer remains fixed. This station was set up to serve as part of the validation infrastructure for the future NASA Surface Biology and Geology (SBG) mission, a component of NASA's planned Earth Systems Observatory (ESO). The station will also serve to validate water-leaving reflectance measurements for the NASA Plankton Aerosol Cloud ocean Ecosystem (PACE) mission. Also installed on the same tower is an AERONET-OC multi-spectral CIMEL SeaPRISM, which has been in operation since 2021. This study compared the two co-located radiometric systems over a period spanning parts of 2023 and 2024. The results help inform both systems regarding quality control and acquisition of ground truth for the validation of satellite measurements.

Keywords: Maximum Five (5) keywords are allowed.

Primary Sources of Uncertainties in Remote Sensing Reflectance from Satellite Ocean Color Sensors and AERONET-OC

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Presentation Preference: Oral

Uncertainties in the retrieval of remote sensing reflectance, R_{rs}, from Ocean Color (OC) satellite sensors have a strong impact on the performance of algorithms for the estimation of chlorophyll-a and water properties. The uncertainties are highest in the blue bands. The total radiance measured at the top of the atmosphere includes radiances from molecular and aerosol scattering, sky and Sun glint reflected from the wind-roughened ocean surface. Each of these components has associated uncertainties, and when combined with the additional uncertainties from the atmospheric correction process, they contribute to the total uncertainty budget for the retrieved R_{rs}. The contribution of each uncertainty component to the total R_{rs} uncertainties is analyzed for SNPP-VIIRS and Sentinel 3 OLCI sensor products, taking advantage of the spectral differences between the components. The retrieved R_{rs} were compared to in-situ measurements made at several AERONET-OC sites and at the Marine Optical Buoy (MOBY) site. It is shown that uncertainties associated with the molecular (Rayleigh) scattering play the most significant role, while the contributions of other components are usually smaller. Uncertainties in Rayleigh scattering are primarily attributed to the variability of Rayleigh optical thickness (ROT) with a standard deviation of approximately 1.5% of ROT.

Keywords: atmospheric correction, uncertainties, Rayleigh scattering.

Routine Satellite Ocean Color Products Monitoring and Validation Using AERONET-OC Measurements

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Presentation Preference: Oral

In this presentation, we describe our effort to monitoring and validation of satellite ocean color products from VIIRS (NOAA/NASA) on the SNPP, NOAA-20, NOAA-21 satellites, OLCI (EUMETSAT) on the Sentinel-3A and Sentinel-3B satellites, and SGLI (JAXA) on the GCOM-C satellite using the AERONET-OC measurements. Thanks to the NASA AERONET/AERONET-OC team, NOAA has been supporting several AERONET-OC sites for routine operations since early 2010s, including the sites of CSI (Sherwin Ladner, NRL), LISCO (Alex Gilerson, CUNY), USC (Matthew Ragan, USC), and Lake Erie (Steve Ruberg, NOAA), providing in situ optics data for satellite ocean color data validations, and for various research and applications. The NOAA/STAR Ocean Color Science Team has developed and implemented the ocean color data quality monitoring system (https://www.star.nesdis.noaa.gov/socd/mecb/color/) to routinely evaluate satellite ocean color products using the AERONET-OC in situ measurements from all available AERONET-OC data, including satellite/in-situ comparisons from time series, scatter plots, and quantitative statistical analyses. Our evaluation results show that the AERONET-OC network has been providing important data for routine satellite ocean color data quality monitoring/evaluation over various coastal and inland waters. Such data quality monitoring activity (along with open ocean data) is critical to the user community for various satellite data applications.

Keywords: satellite ocean color; validation; data quality monitoring

The Critical Role of AERONET for Aerosol Modeling and Data assimilation in GEOS

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GEOS is NASA's flagship global Earth System Model and Assimilation System, maintained by the Global Modeling and Assimilation Office (GMAO) and developed in partnership with several Goddard Labs as well as other NASA centers and NOAA. GEOS contains components for atmospheric circulation and composition (including data assimilation), ocean circulation and biogeochemistry, and land surface processes. In addition to traditional meteorological parameters, GEOS includes modules representing the atmospheric composition, most notably aerosols and tropospheric/stratospheric chemical constituents, taking explicit account of the impact of these constituents on the radiative processes of the atmosphere. GEOS is used to produce near real-time analysis in forecasts in support of NASA airborne campaigns and provide ancillary data to inform NASA instrument teams, as well as reanalyzes covering multiple components of the Earth system (land, ocean, atmosphere).

In this talk we will provide several illustrations of the critical role of AERONET measurements for aerosol modeling and data assimilation in GEOS. In particular, AERONET is the anchor observing system that permits homogenization of the satellite derived aerosol optical depth from multiple satellites.

Validation of NOAA EPS Aerosol Detection Product with AERONET Measurements

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Presentation Preference: Oral

Monitoring smoke and dust globally is essential for understanding and mitigating their impacts on air quality and their feedback to the climate system. NOAA EPS aerosol detection product (ADP) identifies smoke and dust-laden pixels from various satellite sensors like VIIRS on SNPP, NOAA-20 and NOAA-21, and ABI on GOES-16,17, and 18. However, validating the accuracy of smoke and dust mask product is challenging due to the absence of direct truth data for their binary classification. To address this challenge, indirect validation approaches are employed. One such approach involves comparing satellite smoke/dust mask detection with smoke/dust classification from observations obtained from ground-based instruments. Observations from the Aerosol Robotic Network (AERONET) have become a primary and valuable dataset for validation. In this presentation, we will discuss an approach that combines Angstrom Exponent (AE) and Aerosol Optical Depth (AOD) measurements to classify smoke and dust events. We will compare these classifications with the smoke/dust masks generated by ADP. This approach enables the derivation of evaluation metrics such as the probability of correct detection (POCD), probability of false detection (POFD), and accuracy. These metrics serve as key parameters used in NOAA EPS ADP maturity reviews, providing insights into the performance and reliability of the ADP in identifying smoke and dust events globally.

Keywords: Aerosol detection, Air quality, Smoke and dust, Validation.

Initial evaluation of the PACE OCI aerosol products using AERONET

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Presentation Preference: Oral

NASA's Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission launched on Feb 8 2024 and is in routine operations. PACE's primary payload, the Ocean Color Instrument (OCI), is a broad-swath imager with hyperspectral capabilities from the ultraviolet (UV) to near-infrared and has several discrete shortwave infrared bands. OCI has a 1.2 km horizontal pixel size at the sub-satellite point and tilts to decrease Sun glint exposure over ocean; it provides data over both land and water surfaces.

These features provide continuity with and enhancement beyond many heritage spaceborne sensors used for aerosol property retrieval. To that end, the well-known Deep Blue (DB) and Dark Target (DT) retrieval algorithms have been applied to OCI data. A new approach known as the Unified Aerosol Algorithm (UAA) combining these with the UV bands for additional information on aerosol type, absorption, and altitude has also been developed. This presentation introduces the OCI aerosol products and provides an initial evaluation of them against AERONET data.

Keywords: PACE, OCI, validation, aerosol

AOD MEASURES AT TAMANRASSET (ALGERIA)

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Presentation : Poster

Abstract:

The program AERONET was established at the site of Tamanrasset (Algeria) since September 2006 with the collaboration of research center of Izana (Tenerife - Spain).

The station of Tamanrasset is located in south of Algeria , at about 2000 km from the capital Algiers , in middle of Sahara at position : 22°47' North , 05°31'East , 1377 m above sea. This region is characterized by dry weather with very low humidity about a mean of 22% and a total of rain fall 40-50 mm by year . The climate of this region is influenced by African monsoon in period May to September.

The photometer Cimel was installed on the roof of the station at about 8 m above soil . Since the start of measures in september 2006 , the raw data are collected regulary by a PC automatically with a software installed by staff of Izana , then this data are sent by Intenet to NASA for processing , publishing and archiving . The Cimel works very regulary without important interruption , each week we proceed of control and cleaning of the equipment.

The calibration of filters are made each 1 to 1.5 year at Izana center , the equipment is transported by an operator from Tamanasset with financial support of AEMET.

The analysis of the eight AOD channels show a very good correlation between the weather of the region and values and optical depth . In winter period (dry time) from November to February the values of AOD are very low and de crease around 0.020 to 0.040 and in most time are under 0.100 . Since April to September , the region is influenced by phenomen of sand haze , the values of AOD increase rapidly and exceed 0.500 and can reach 1.000 .

Keywords : desert , dust ,AOD

20 years of Aerosol optical depth trends from the GAW-PFR network and collocated measurements with AERONET

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Presentation Preference: Poster

Ground-based sun-photometers have been deployed during the last 20-25 years in order to provide long term series of aerosol optical depth (AOD) measurements at various locations worldwide. PMOD/WRC has developed the Precision Filter Radiometer (PFR) during the 90's that has been used for long term AOD measurements under the WMO Global Atmosphere Watch program (GAW-PFR Network, stations primarily under background conditions, without significant influence from local pollution sources). GAW-PFR started in 1995 at Davos Switzerland. Currently, more than 40 PFR instruments are operating worldwide. 15 of them are located at GAW monitoring sites, maintained/calibrated by PMOD/WRC. Measurement locations include AERONET collocated measurements (e.g. Mauna Loa, USA, since 2000, Izaña, Spain, (2002), Davos, Switzerland (2007)).

This study presents ground-based AOD time-series and climatology from the GAW-PFR network. Daily AOD and Ångström exponent values for all PFR stations were analyzed using the Mann Kendal method. Results showed that only 4 stations are showing AOD positive trends. The remaining 11 stations showed generally small but negative trends (5 stations with 95% statistical significant) in all cases lower t than 0.02 in AOD units per decade. High mountain stations showed small but negative trends. Results with collocated AERONET sites are presented.

Keywords: Aerosol optical depth, aerosol climatology

Seasonal variations in aerosol properties: observations from AERONET Kyiv station

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Presentation Preference: Poster

Atmospheric aerosols are particles that impact both human life quality and climate and the radiation balance. The AERONET Kyiv station has been conducting measurements of aerosol properties since 2008. Over this period, a dataset was compiled and utilized to analyze seasonal variations and overall trends. Changes in aerosol optical depth (AOD), Angstrom exponent (AE), single scattering albedo (SSA), refractive index, and size distribution of aerosol particles were analyzed for the period 2008–2019, focusing on data at level 2.0. The analysis conducted at this level enables the determination of typical seasonal characteristics of aerosols, predominant types, and potential sources of aerosol particle data. Despite the full-scale Russian invasion and two years of war, the AERONET Kyiv station continues its measurements. Thanks to these observations, data has been obtained and analyzed to assess the impact of the war on aerosol properties.

Keywords: Atmospheric aerosols, AERONET Kyiv, seasonal variations, aerosol properties

Dancing together:
The symbiotic relationship between aerosol satellite remote sensing and AERONET

Beginning in the late 1980s, the Earth Observing System (EOS) was NASA's driving Earth Science program. There was an ambitious plan for multiple platforms, each carrying multiple instruments. At the time aerosols were the bane of satellite remote sensing objectives that were primarily focused on terrestrial and ocean targets. Very few people cared about a climatically relevant global aerosol system. "Atmospheric correction" was the catch phrase that kept aerosol remote sensing alive as a discipline. Yet, as the 1980s turned the corner into the next decade, interest began to grow in aerosol remote sensing for its own sake. It was at this time that two NASA proposals led by Goddard PIs were selected for funding. 1. Brent Holben's plan to purchase Cimel "sun photometers" for validation of atmospheric correction for terrestrial observations. 2. Yoram Kaufman's proposal to be on the MODIS science team for remote sensing of aerosol characteristics. These two innovative remote sensing scientists inherently understood how a high-quality ground-based network with global reach complemented a global aerosol product derived from satellite. The two measurement systems: AERONET and satellite-derived aerosol products have been dancing together ever since.

Atmosphere aerosol contamination due to russian inroad in Ukraine by AERONET data

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Presentation Preference: Poster

The impact of the russian invasion and military activities on aerosol parameters in the atmosphere over Kyiv and Ukraine was investigated using data from the AERONET station in Kyiv. The effect of the war on annual aerosol properties (Angstrom Exponent, aerosol optical depth, fine particle fraction, aerosol absorption optical depth, complex refractive index) over Kyiv city was assessed using observations from AERONET. Following the invasion, there was a brief surge in aerosol contamination. The temporary improvement in air quality in Kyiv city is associated with a decrease in traffic load. AERONET observations reveal changes in the annual dynamics of the Ångström Exponent, with lower values observed in 2022 and a decrease in the fine aerosol fraction. Analysis of the aerosol complex refractive index indicates a shift in the dominant aerosol type present in the atmosphere. The analysis of sun photometer observations from the AERONET station in Kyiv using the GRASP algorithm shows a significant increase in black carbon concentration after russia's invasion.

Keywords: Atmospheric aerosol, AERONET Kyiv, invasion, war activity, contamination