Title: Calculated AOD_{355} during 2018 BB-FLUX

Author: Rainer Volkamer; University of Colorado Boulder; 303-492-1843; 215 UCB, Boulder, CO 80309-0215; Rainer.Volkamer@colorado.edu

1.0 Data set description

Abstract: The 2018 Biomass Burning Fluxes of Trace Gases and Aerosols (BB-FLUX) campaign aimed to quantify emission fluxes of CO, CO_2, and other gases, characterize plume injection heights, study radical sources and plume chemistry that leads to secondary production of O_3, and explore synergistic benefits of remote sensing and in-situ observations to quantify speciated total emission fluxes from wildfires. The University of Colorado Solar Occultation Flux instrument (CU AirSOF) uses a Fourier transform infrared spectrometer to measure vertical column densities (VCDs) of carbon monoxide, which can then be converted into an aerosol optical depth by multiplying the column by the *in situ* ratio of the extinction at a given wavelength to the carbon monoxide number density. While extinction measurements were not made during BB-FLUX, they were made during two airborne projects looking at fires in the same region of the United States: the 2018 Western wildfire Experiment for Cloud chemistry, Aerosol absorption and Nitrogen (WE-CAN) on the NSF/NCAR C-130; and the 2019 Fire Influence on Regional to Global Environments Experiment - Air Quality (FIREX-AQ) on the NASA DC-8. This dataset contains calculated AODs at 355, 450, and 550 nm, and is a companion dataset to the columns reported from SOF.

Data version: R0, 2023-04-10

Data status: Final data

Temporal coverage:

Begin datetime: 2018-07-21 00:00:00

End datetime: 2018-09-15 23:59:59

Spatial coverage

Maximum (North) Latitude: 47.00 N

Minimum (South) Latitude: 39.00 N

Minimum (West) Longitude: -123.00 E

Maximum (East) Longitude: -109.00 E

Platform: NSF/U Wyoming King Air. Latitude, longitude, and altitude for each flight are included in the data files.

Data frequency: Continuous data, includes start, mid, and stop times

Data source: University of Colorado Airborne Solar Occultation Flux (CU AirSOF)

Web address: https://volkamergroup.colorado.edu/timeline/field/bb-flux

Data set restrictions: Use of these data require prior ok from PI. Funding from NSF AGS-1754019 must also be acknowledged.

2.0 Instrument description

See the SOF column dataset for a description of the instrument operation and references. *In situ* ratios of extinction to CO were derived using data from FIREX-AQ (https://doi.org/10.5067/SUBORBITAL/FIREXAQ2019/DATA001). Extinction was measured at 405, 532, and 664 nm using the NOAA airborne cavity ring down system (PI: Dan Murphy, daniel.m.murphy@noaa.gov; Landridge et al. 2011). CO was measured using both a commercial off-axis integrated cavity output spectrometer (Los Gatos Research, PI: Jeff Peischl, jeff.peischl@noaa.gov) and a tunable diode laser absorption spectrometer. These two measurements agreed well (Bourgeois et al. 2022), and the LGR instrument was used for subsequent analysis.

Aerosol extinction was only measured at two wavelengths (450 and 660) during WE-CAN, but it was compared to the FIREX-AQ data. Extinction was measured with an Aerodyne cavity attenuated phase shift spectrometer (PI Shane Murphy, smurph19@uwyo.edu), while CO was measured with both a PICARRO G2401-m and an Aerodyne CS-108 miniQCL. The Picarro data were used for the analysis (PI: Teresa Campos, campos@ucar.edu).

The extinction from both campaigns is for dry aerosol, but little water uptake was observed during FIREX-AQ, so we assume that the dry values are representative of the ambient data.

3.0 Data collection and processing

Only data from the first half of FIREX-AQ, which focused on western wildfires, was used (Stockwell et al. 2022, Warneke et al. 2023). In-plume data were background corrected, and the CO mixing ratios were converted to number densities. The slope of extinction versus CO at each wavelength was determined for each plume, and then a power law fit was applied to the average of the slopes to determine the wavelength dependence of extinction to CO. Except for several plumes from FIREX-AQ RF06, the data were generally consistent from plume to plume and fire to fire. Minimum and maximum values of the scaling were determined from the scatter in the measured extinction to CO ratios.

The wavelength dependent extinction to CO ratio was -3.0871e-19 + 2.2703e-14 * Wavelength^(-1.5913). The scaling factors at the three wavelengths are:

355 nm: min: 1.18241e-18, avg: 1.67891e-18, max: 3.53023e-18, Lidar:
450 nm: min: 7.25300e-19, avg: 1.05282e-18, max: 2.63770e-18
550 nm: min: 4.69240e-19, avg: 6.80630e-19, max: 1.86020e-18

The background corrected CO columns measured by CU AirSOF during the plume underpasses were then multiplied by the extinction to CO ratio to calculate the AODs.

WE-CAN data were analyzed in the same way, but since there were only two wavelength no power law fit was applied.

4.0 Data format

Data are archived as ICARTT v2.0 files. See https://www.earthdata.nasa.gov/s3fs-public/imported/ESDS-RFC-029v2.pdf for the full file specification. The files contain metadata in a header followed by the measurement data as comma separated columns. Times are stored as seconds since midnight UTC on the first day of the measurement. The measurement start date is listed in the header.

The short names, units, NASA standard names, and long descriptions for the parameters are given in the table below in the same order as they appear in the data files.

Short name	Units	Standard name	Description
Time_Start	seconds_past_midnight	Time_Start	Measurement start
Time_Stop	seconds_past_midnight	Time_Stop	Measurement stop
Time_Mid	seconds_past_midnight	Time_Mid	Measurement midpoint
Latitude	degN	Platform_Latitude	King Air latitude
Longitude	degE	Platform_Longitude	King Air longitude
AltitudeMSL	meters	Platform_AltitudeMSL	King Air altitude msl, WGS84
AOD_355nm_Min	unitless	AerOpt_VertCol_RHD_None_PM1_UV_None_AOD	AOD at 355 nm using minimum scaling factor
AOD_355nm_Average	unitless	AerOpt_VertCol_RHD_None_PM1_UV_None_AOD	AOD at 355 nm using average scaling factor
AOD_355nm_Max	unitless	AerOpt_VertCol_RHD_None_PM1_UV_None_AOD	AOD at 355 nm using maximum scaling factor
AOD_450nm_Min	unitless	AerOpt_VertCol_RHD_None_PM1_Blue_None_AOD	AOD at 450 nm using

			minimum scaling factor
AOD_450nm_Average	unitless	AerOpt_VertCol_RHD_None_PM1_Blue_None_AOD	AOD at 450 nm using average scaling factor
AOD_450nm_Max	unitless	AerOpt_VertCol_RHD_None_PM1_Blue_None_AOD	AOD at 450 nm using maximum scaling factor
AOD_550nm_Min	unitless	AerOpt_VertCol_RHD_None_PM1_Green_None_AOD	AOD at 550 nm using minimum scaling factor
AOD_550nm_Average	unitless	AerOpt_VertCol_RHD_None_PM1_Green_None_AOD	AOD at 550 nm using average scaling factor
AOD_550nm_Max	unitless	AerOpt_VertCol_RHD_None_PM1_Green_None_AOD	AOD at 550 nm using maximum scaling factor

Flags for missing data are provided in the headers for each file. Missing data are represented by negative numbers large enough to never be construed as actual data using only 9s for the digits.

5.0 Data remarks

ICARTT files are plain text ASCII files and are compatible with a range of data analysis programs.

6.0 References

Bourgeois, I., et al: Comparison of airborne measurements of NO, NO_2, HONO, NO_y, and CO during FIREX-AQ, Atmos. Meas. Tech., 15, 4901–4930, https://doi.org/10.5194/amt-15-4901-2022, 2022.

Langridge, J. M., et al.: Aircraft Instrument for Comprehensive Characterization of Aerosol Optical Properties, Part I: Wavelength-Dependent Optical Extinction and Its Relative Humidity Dependence Measured Using Cavity Ringdown Spectroscopy, Aerosol Sci. Tech., 45, 1305–1318, 2011.

Stockwell, C. E., et al.: Airborne emission rate measurements validate remote sensing observations and emission inventories of Western U.S. Wildfires, Environmental Science & Technology, 56(12), 7564–7577, https://doi.org/10.1021/acs.est.1c07121, 2022.

Volkamer, R., et al.: BB-FLUX Overview paper, *in prep.*

Warneke, C., et al.: Fire influence on regional to global environments and air quality (FIREX-AQ), Journal of Geophysical Research: Atmospheres, 128, e2022JD037758, https://doi.org/10.1029/2022JD037758, 2023.

7.0 Appendix

GCMD keywords:

- EARTH SCIENCE > ATMOSPHERE > AEROSOLS > AEROSOL EXTINCTION
- EARTH SCIENCE > ATMOSPHERE > AEROSOLS > AEROSOL OPTICAL DEPTH/THICKNESS
- EARTH SCIENCE > ATMOSPHERE > AIR QUALITY > PARTICULATES
- EARTH SCIENCE > ATMOSPHERE > AIR QUALITY > EMISSIONS