**Title -**

Ultra High Sensitivity Aerosol Spectrometer (UHSAS) Measurements in CAESAR

**Author -**

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**Award ID(s)/Grant ID(s) -**

**1.0 Data Set Description**

**Introduction –**

The data set contains measurements of aerosol size distributions made with an Ultra High Sensitivity Aerosol Spectrometer (UHSAS). Measurements are from the Cold-Air outbreak Experiment in the Sub-Arctic Region (CAESAR) campaign. The University of Wyoming UHSAS was deployed on the NCAR/NSF C-130.

**Data version number and date –**

Not Applicable.

**Data Status (Preliminary or Final) –**

This is the final data processing.

**Time period covered by the data –**

20240209 to 20240404

**Physical location (including lat/lon/elev) of the measurement or platform –**

Latitude, longitude, elevation, and UHSAS measurements are in graphics files provided for each flight. An example is **Figure 1** which shows 15 minutes of data from RF02. The graphics files are named nc_uhsas_vs_xls_uhsas_CAESARrf*_.ps.

**Data Frequency –**

During CAESAR, the University of Wyoming UHSAS was configured to report 1 Hz measurement of the aerosol size distribution. Ancillary 1 Hz measurements are UHSAS pressure, UHSAS temperature, and UHSAS sample flow rate. These measurements were written to the UHSAS' disk (ASCII *.xls files) and were also serially transmitted to the C-130 data system. NCAR staff wrote the serial data into a Network Common Data Form (NetCDF). This submission to EOL/CAESAR contains a program which graphs measurements stored in the ASCII and NetCDF files. The program's name is nc_uhsas_vs_xls_uhsas.pro.

**Data source (e.g., for operational data include agency) –**

Not applicable.

**Web address references (e.g., project web site, etc.) –**

https://www.eol.ucar.edu/field_projects/caesar

**Data set restrictions (i.e., indicate if data set needs to be restricted, requires password protection, contains personal info, description of any licensing, etc.) –**

Not applicable.

**2.0 Instrument Description -**

The University of Wyoming UHSAS has control systems for the sheath and sample flows that pass through the instrument. Other components are an optical block where the sample flow stream is axially confined by the particle-free sheath flow stream, a laser which illuminates the sample-flow particles as they transit the optical block, and a scattered light detector. During transit through the optical block, the sample-flow particles scatter laser light into the detector. The detector output is related to particle size by a calibration.

**Figures –**

These references describe the UHSAS and have graphic descriptions of the system.

https://doi.org/10.1016/j.jaerosci.2008.04.007
https://doi.org/10.5194/acp-19-12377-2019
https://doi.org/10.1080/02786826.2019.1610554

**Table of specifications (i.e., accuracy, precision, frequency, resolution, etc.) –**

These are provided in the www references.

**3.0 Data Collection and Processing -**

**Description of data collection –**

During CAESAR, aerosol was brought into the UHSAS via a forward-facing HIMIL inlet.

**Description of derived parameters and processing techniques used –**

The following NetCDF-recorded variables are sufficient for analysis of UHSAS-derived aerosol size distributions: AUHSAS_WYO,  UPRESS_WYO, UTMP_WYO, USMPFLW_WYO, and CUHSAS_WYO/Cell_Sizes. There are companion variables recorded in the ASCII files.

UHSAS measurement recorded in the NetCDF and ASCII files were compared. With some exceptions, there is perfect agreement between the NetCDF and ASCII data sets. **Figure 1** shows one of the exceptions. At ~ 15:35 UTC, it is evident that measurements are missing from the NetCDF file. This occurred infrequently during CAESAR.

A program was used to graph the ASCII- and NetCDF-recorded measurements. The program (nc_uhsas_vs_xls_uhsas.pro) is a component of this submission to EOL/CAESAR.

**Description of quality assurance and control procedures –**

This was evaluated in a laboratory and is discussed in the "**Data intercomparisons**" section.

**Data intercomparisons, if applicable –**

Polystyrene latex (PSL) test particles were used to evaluate the UHSAS in the University of Wyoming aerosol laboratory. This was done before and after CAESAR. Components of the test were an aerosol atomizer, an aerosol charge neutralizer, an aerosol dryer, a Scanning Mobility Particle sizer (SMPSB), a (selection) Scanning Mobility Particle sizer (SMPSA), and the UHSAS. **Table 1** shows that the UHSAS underestimates the size of the PSL test particles by 10 %. **Figure 2** shows a comparison of size distributions from the UHSAS and SMPSB. These laboratory measurements were made on 20240510.  Except for the cell_size bias, there is reasonable agreement between the size distributions.

**4.0 Data Format -**

**Data file structure and file naming conventions (e.g., column delimited ASCII, NetCDF, GIF, JPEG, etc.) –**

NCAR staff wrote the UHSAS measurements into a file which is a Network Common Data Form (NetCDF).

**Data format and layout (i.e., description of header/data records, sample records) –**

Not Applicable.

**List of parameters with units, sampling intervals, frequency, range –**

The following UHSAS measurements were recorded in the NetCDF file:

AUHSAS_WYO: Cell-by-cell particle count; dimensionless (99 of these measurements were written to the NetCDF file at 1 Hz)

UPRESS_WYO: Pressure measured downstream of optical block; kilopascal (a measurement was written to the NetCDF file at 1 Hz)

UTMP_WYO: Temperature of optical block; Kelvin (a measurement was written to the NetCDF file at 1 Hz)

USMPFLW_WYO: Sample flow rate; standard cubic centimeter per minute. (A measurement was written to the NetCDF file at 1 Hz. This is the value from the UHSAS' sample mass flow controller multiplied by 20./23.). In the NetCDF-recorded UHSAS data there can be an error in the "corrected" sample flow variable. That variable name is UFLWC_WYO. Because of this, users of the NetCDF-recorded UHSAS data should not use the NetCDF-recorded variable called UFLWC_WYO.

Additionally, UHSAS cell_sizes are also in the NetCDF file:

CUHSAS_WYO/Cell_Sizes: Cell_sizes; micrometer (there are 100 of these in a NetCDF file)

**Description of flags, codes used in the data and definitions (i.e., good, questionable, missing, estimated, etc.) –**

NetCDF-recorded UHSAS measurements assigned the value = -32767 are discarded in nc_uhsas_vs_xls_uhsas.pro.

The cell_size bias seen in **Figure 2** is corrected in nc_uhsas_vs_xls_uhsas.pro.

**5.0 Data Remarks -**

**PI's assessment of the data (i.e., disclaimers, instrument problems, quality issues, etc.) –**

This is discussed in the "**Data Intercomparison**" and "**Description of Derived Parameters**" sections.

**Missing data periods, if applicable –**

Some NetCDF-recorded UHSAS measurements are assigned the value = -32767. In sum, the duration of intervals with value = -32767 is no larger than 2 minute per flight. An example is shown in **Figure 1**.

**Software compatibility (i.e., list of existing software to view/manipulate the data plus software repository locations/links and responsible parties' contact information) -**

A processor (nc_uhsas_vs_xls_uhsas.pro) is provided. This reads the ASCII- and NetCDF-recorded UHSAS files and plots sequences from both files.

**6.0 References -**

**List of publications and documents (e.g., conference proceedings, publications, theses, reports, etc.) cited in this data set description and/or using this data set. Provide links, if available -**

These are provided in the www references.

**7.0 Appendix -**

**Suggest GCMD science keywords to describe dataset. A tool that may be helpful is the GCMD Science Keyword Viewer –**

marine aerosol, Aitken mode aerosol particles, accumulation mode aerosol particles
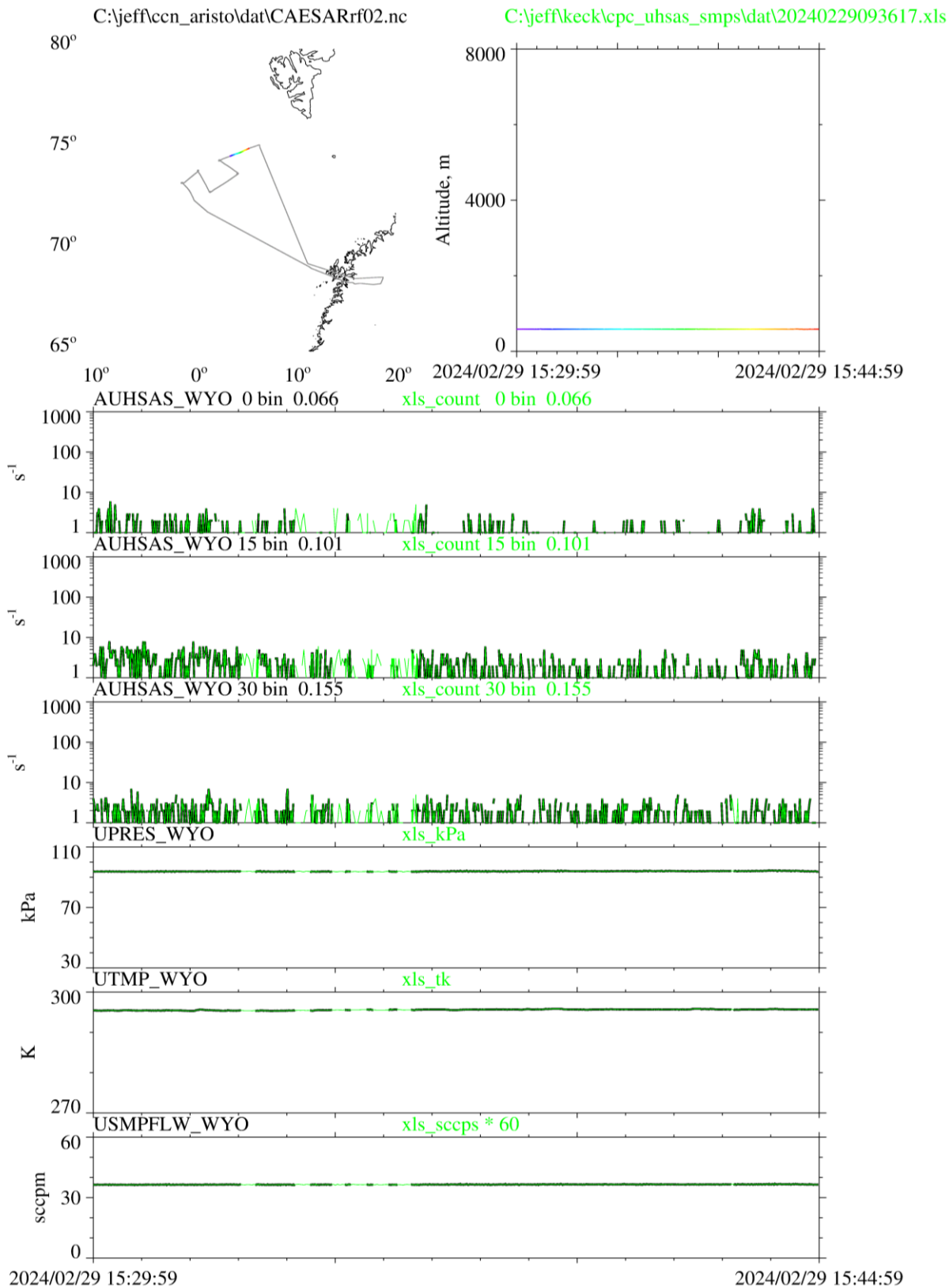
**Figure 1** – Example UHSAS measurements from the NetCDF and ASCII files. Black and green is used to designate NetCDF-recorded and ASCII-recorded data, respectively. This figure shows brief intervals, at ~ 15:35, with UHSAS measurements missing from the NetCDF file.

**Table 1** – Date, test particle type, test particle diameter, UHSAS-derived mode diameter, and relative difference between the test particle and UHSAS-derived particle diameters

| Date | Test Particle Type | Test Particle Diameter, μm | UHSAS Mode Diameter, μm | Relative Size Difference, % |
|---|---|---|---|---|
| 20230327 | Polystyrene Latex | 0.600 | 0.543 | 9.5 |
| 20230327 | Polystyrene Latex | 0.600 | 0.543 | 9.5 |
| 20240510 | Polystyrene Latex | 0.125 | 0.111 | 11.2 |
| 20240513 | Polystyrene Latex | 0.200 | 0.184 | 8.0 |
| 20240513 | Polystyrene Latex | 0.600 | 0.543 | 9.5 |
| | | | | |
| average | | | | 10 |
| stdev | | | | 1 |

2  20240510 172330 UTC
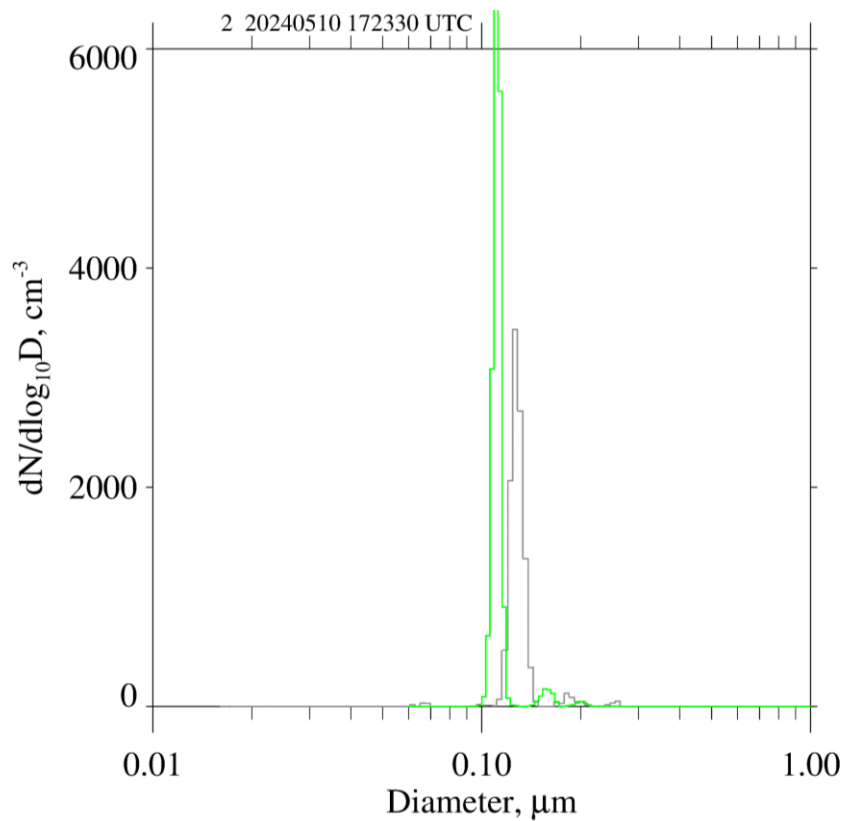
SMPS  174. cm$^{-3}$,  0.126 μm
UHSAS  222. cm$^{-3}$,  0.111 μm
CPC  220. cm$^{-3}$

**Figure 2** – Aerosol size distributions from SMPSB and UHSAS. The test particles were PSL and were mobility-selected at 0.125 μm. The averaging interval is 300 s. These laboratory measurements are from 20240510.