Title -

Wyoming Cloud Condensation Nuclei Measurements in CAESAR

Author -

Jeff Snider
University of Wyoming
Department of Atmospheric Science
307-399-7026
jsnider@uwyo.edu
ORCID - https://orcid.org/0000-0002-9318-1343

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

NSF, "Aerosol Dynamics and Autoconversion during CAESAR", Markus Petters (PI) and Jefferson Snider (co-PI), AGS-2150812

1.0 Data Set Description

Introduction –

The data set contains measurements of cloud condensation nuclei (CCN) made with a static thermal diffusion CCN instrument. The instrument is the Wyoming Cloud Condensation Nuclei counter (W-CCN). Measurements are from the Cold-Air outbreak Experiment in the Sub-Arctic Region (CAESAR) campaign. The W-CCN was deployed on the NCAR/NSF C-130.

Data version number and date –

This is the level-2 processing. Processing was conducted on 20240706.

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 and elevation are plotted in a graphic file provided for each flight. The files are named caesar_wccn_v1_CAESARrf*_.ps. An example is **Figure 1** which shows 15 minutes of data from RF02. Also provided is an output data file. The output file is discussed below.

Data Frequency –

Once per 30 seconds.

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 W-CCN consists of a static thermal-gradient diffusion chamber, a laser, and a scattered light detector. An aerosol sample is drawn into the chamber, the chamber is isolated by automated valve closures, the chamber becomes supersaturated with water vapor, and a subset of the aerosol grows by condensing water vapor. Aerosol particles characterized by a critical supersaturation less than the chamber supersaturation activate and grow to cloud droplets. The droplets reach a size (~ 5 μm in ~ 20 s) which scatters light more efficiently than the unactivated particles. Light scattered from the ensemble of droplets is measured by the detector. The maximum of the detector signal is related to the concentration of droplets by a calibration.

Figures –

These references describe the W-CCN and have graphic descriptions of the system.

https://doi.org/10.1175/JTECH1916.1
https://doi.org/10.1029/2009JD012618
https://doi.org/10.1175/JTECH1916.1

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 C-130 via a forward-facing HIMIL inlet. Four W-CCN measurements were recorded at 1 Hz by the C-130 data system. The measurements are top plate temperature (TOPTMP), bottom-to-top plate temperature difference (DTEMP), detector signal (VDET), and instrument status (ASTAT). NCAR staff wrote these measurements into a NetCDF file.

Description of derived parameters and processing techniques used –

The processor used to create the graphics and the output files is part of this submission to EOL/CAESAR. The processing code is caesar_wccn_v1.pro.

Description of quality assurance and control procedures –

This is discussed below.

Data intercomparisons, if applicable –

CCN concentration measurements from the W-CCN and DMT-CCN were compared. **Figure 2** presents CCN measurements acquired during level-flight intervals corresponding to C-130 altitudes smaller than 2500 m. These data come from RF04-RF07 and from RF09-RF10. Comparison data are also available from RF08, but these are only available for altitudes > 2500 m. DMT-CCN measurements are not available for RF01-RF03. **Figure 2** shows that there is reasonable agreement between the measurements from the W-CCN and DMT-CCN.

4.0 Data Format -

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

The output data file format is comma-delineated ASCII. The file names are caesar_wccn_v1_CAESARrf*_.csv.

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

The first line of the output file is a header.

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

Julian Date (UTC), W-CCN actual Supersaturation (%), W-CCN Activated Concentration (count of activated droplets per in-instrument cubic centimeter).

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

The following three conditions are requirements for a CCN concentration measurement to be written into an output file: 1) A CCN detection interval must contain 28 VDET samples with 26 of these from a scattering detection interval designated by ASTAT, and in addition, one sample of VDET from the chamber flush before the scattering detection interval, and one sample of VDET from the chamber flush after the scattering detection interval. 2) The absolute value of the rate of change of the 28 VDET samples must be less than 0.0095 Volt per second. This rate was evaluated from the beginning to the end of the 28 samples. 3) At least 10 of the 28 samples must lie above a straight line drawn from the beginning to the end of the 28 VDET samples.

5.0 Data Remarks -

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

Figure 2 shows W-CCN measurements compared to measurements made with the DMT-CCN.

Missing data periods, if applicable –

There are periods when measurements from the W-CCN are not available. In sum, these are no larger than 2 hourd per flight. These occurred because of operator servicing of the W-CCN.

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

The processing code is caesar_wccn_v1.pro and is attached to this submission to EOL/CAESAR. Jeff Snider is responsible for this.

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 -

Snider, J. R., M. D. Petters, P. Wechsler, and P. S. K. Liu, 2006: Supersaturation in the Wyoming CCN Instrument. J. Atmos. Oceanic Technol., 23, 1323–1339, https://doi.org/10.1175/JTECH1916.1.

Snider, J. R., et al. (2010), Intercomparison of cloud condensation nuclei and hygroscopic fraction measurements: Coated soot particles investigated during the LACIS Experiment in November (LExNo), J. Geophys. Res., 115, D11205, doi:10.1029/2009JD012618.

Snider, J. R., D. Leon, and Z. Wang, 2017: Droplet Concentration and Spectral Broadening in Southeast Pacific Stratocumulus Clouds. J. Atmos. Sci., 74, 719–749, https://doi.org/10.1175/JAS-D-16-0043.1.

7.0 Appendix -

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

cloud condensation nuclei, marine clouds, polar marine clouds

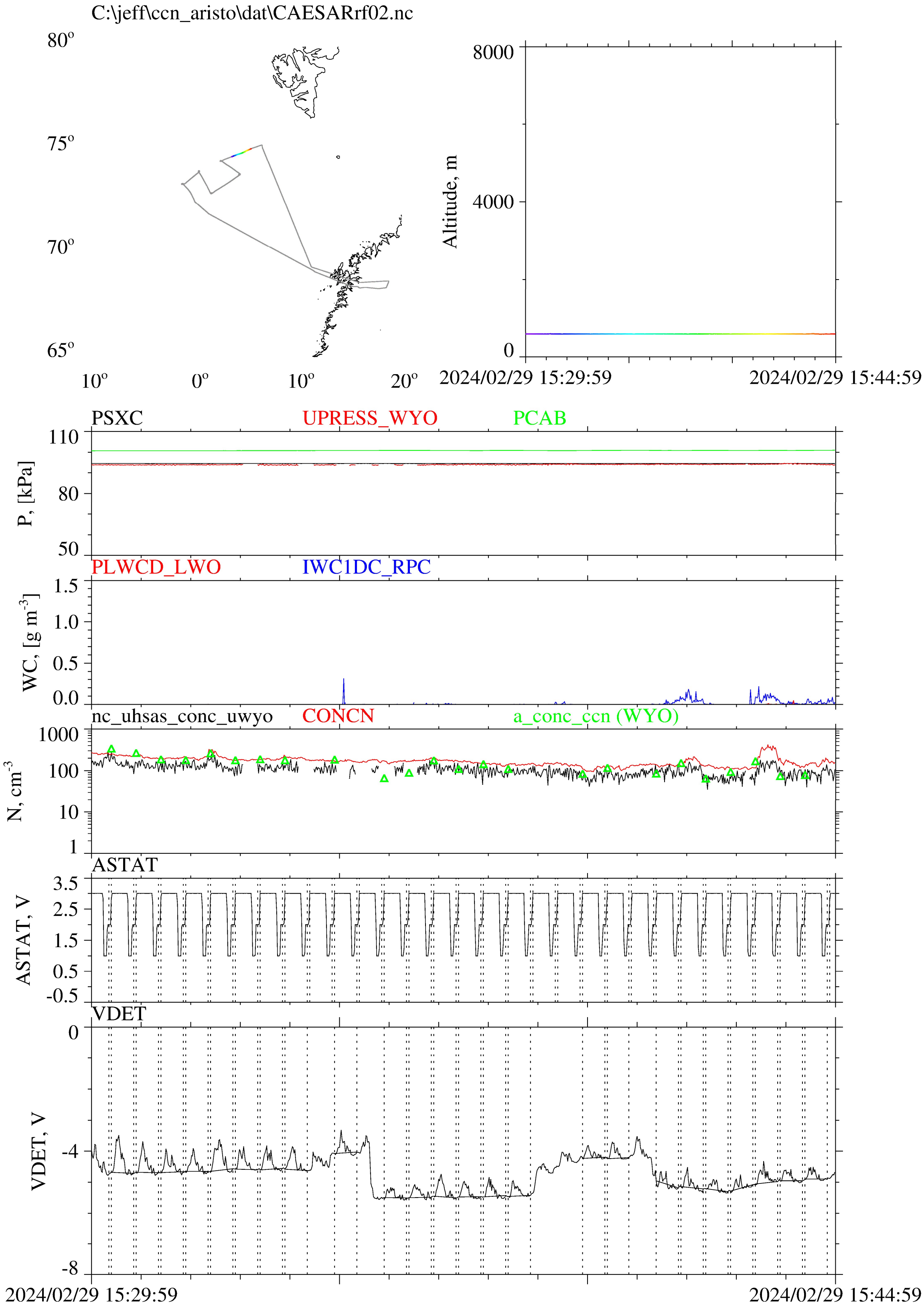

Figure 1 – The third-from-bottom panel shows W-CCN concentration measurements as green triangles. W-CCN concentration measurements are available approximately once per 30 seconds. The W-CCN status (ASTAT) is plotted in the second-from-bottom panel. The W-CCN detector signal (VDET) is plotted in the bottom panel.

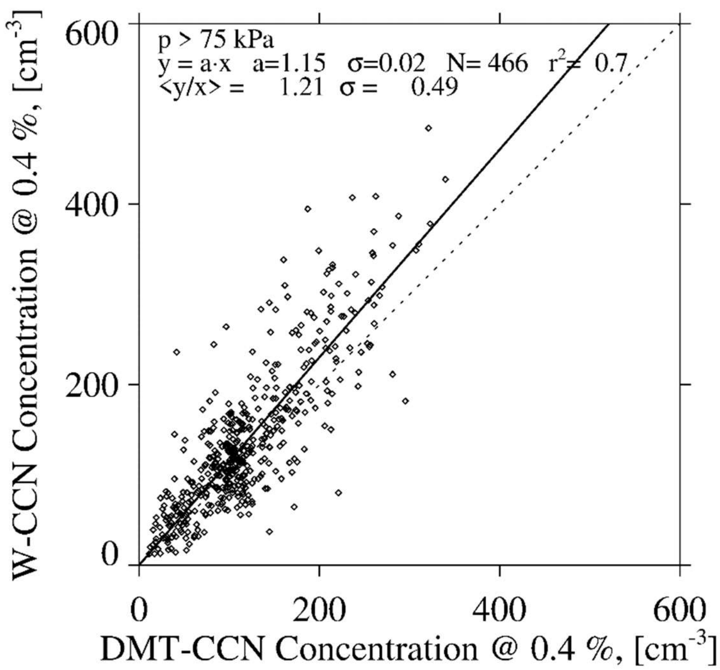

Figure 2 – Scatterplot of CCN concentrations at supersaturation = 0.4 %. The W-CCN and DMT-CCN pairs were selected from level C-130 flight segments with pressure > 75 kPa (i.e., flight altitude < 2500 m MSL). The black-solid line is the linear-least-square fit line (forced through the origin), and one-to-one agreement is indicated by the black-dashed line.