RICO CCN spectra submitted March, 2022

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1.0 Data Set Description

Abstract

This is an additional more detailed CCN data set for specific time periods that are being used in a manuscript. This data set has concentrations at many more supersaturation, S, than the previous CCN data set by this author. However, it shows only average values obtained at 100m altitude at the beginnings and ends of the RICO research flights. Data has been carefully edited to exclude any periods of detected clouds according to FSSP measurements with liquid water contents in excess of 0.0002 g/m^3. All measurements included in these averages are made outside of any clouds. Beginning and end times in GMT are given but the measurements included for these averages often do not include every second between the beginning and end times because of occasional clouds.

This is the 2nd version of DRI CCN measurement submitted in March, 2022.
These data are final.
The time period is December 7, 2004 to January 23, 2005.
The flights are Dec. 7, 8, 9, 10, 13, 16, 17, 19, 20 and January 5, 7, 11, 12, 14, 16 & 23. There are 2 measurements per flight except for Dec. 8, which was a short flight with only one CCN measurement. For the other 15 flights one 100m measurement was made at the beginning of the flights and the other was at the end of the flights. They are designated m and a for morning and afternoon.
All measurements were made on board the RAF C-130 airplane.
This data set is unrestricted.

2.0 Instrument Description

The DRI CCN spectrometer is a parallel plate thermal diffusion chamber with vertical plates with six temperature zones in series with increasing delta T as sample passes toward the exit to a white light ROYCO optical particle counter, which counts and sizes the droplets exiting the cloud chamber. The principle of operation is that particles with lower critical supersaturations, S_c, should achieve larger sizes than usually smaller higher S_c particles. The sample flowrate is directly measured by an electronic flowmeter. It is less than 1 cm^3/s. All particles within the sample flow that grow to droplets are counted and sized. The sample air flow is sandwiched to the central area between the plates where S is maximum by particle-free

filtered sheath air in the horizontal dimension. Sample is restricted to the central third of the vertical width by a series of 10-20 holes in the sample entry tube that is perpendicular to the flow direction. This keeps sample away from the sidewalls that could perturb S. The sidewalls are at the top and bottom of the vertical chamber. A calibration curve is applied to convert the sizes of the light to electronic pulses to S_c. The instrument is calibrated with salt particles of known composition and size by aspirating pure NaCl or ammonium sulfate solutions and passing them through an electrostatic classifier to produce monodisperse size distributions. Approximately 5 different sizes are sent to the instrument within a period of 10-20 minutes during the other portions of 100m altitude flights legs of the reported ambient measurements. These calibrations often occurred during cloud penetrations. The instrument is described in the following paper.

Hudson, J.G., 1989: An instantaneous CCN spectrometer. *J. Atmos. & Ocean. Techn.,* **6,** 1055-1065.

Other papers that have included RICO CCN measurement from this instrument are

Hudson, J. G., & Noble, S. 2021. Cumulus cloud and drizzle microphysics relationships with complete CCN spectra. *Journal of Geophysical Research: Atmospheres*, *126*, e2021JD034966. https://doi.org/10.1029/2021JD034966

Hudson, J.G., S. Noble and V. Jha, 2012: Cloud droplet spectral width relationship to CCN spectra and vertical velocity. *J. Geophys. Res.*, Vol. 117, D11211, doi:10.1029/2012JD017546, 2012.

Hudson, J.G., S. Noble, and V. Jha, 2011: On the relative role of sea salt cloud condensation nuclei (CCN). *J. Atmos. Chem*. Volume 68, Number 1, Pages 71-88, DOI: 10.1007/s10874-011-9210-5.

Thornton, D.C., A.R. Bandy, and J.G. Hudson, 2011: Fast sulfur dioxide measurements correlated with cloud condensation nuclei spectra in the marine boundary layer. *Atmos. Chem. Phys.*, **11**, 11511–11519, 2011, doi:10.5194/acp-11-11511-2011.

Hudson, J.G., V. Jha, and S. Noble, 2011: Drizzle correlations with giant nuclei. *Geophys. Res. Lett.*, **38**, L05808, doi:10.1029/2010GL046207.

Hudson, J.G. and S. Noble, 2009: CCN and cloud droplet concentrations at a remote ocean site. *Geophys. Res. Let.*, **36,** L13812, doi:10.1029/2009GL038465.

Hudson, J.G., S. Noble, V. Jha, and S. Mishra, 2009: Correlations of small cumuli droplet and drizzle drop concentrations with cloud condensation nuclei concentrations. *J. Geophys. Res.*, **114**, D05201, doi:10.1029/2008JD010581.

Gerber, H., G. Frick, J.B. Jensen, and J.G. Hudson, 2008: Entrainment, mixing, and microphysics in trade-wind cumulus. *J. Met. Soc. Japan*, **86A**, 87-106

Hudson, J.G., and S. Mishra, 2007: Relationships between CCN and cloud microphysics variations in clean maritime air, *Geophys. Res. Lett*., **34**, L16804, doi:10.1029/2007GL030044.

Hudson, J.G., 2007: Variability of the relationship between particle size and cloud-nucleating ability. *Geophys. Res. Let*., **34**, L08801, doi:10.1029/2006GL028850.

3.0 Data Collection and Processing

The instrument operates continuously. The recording rate varies from 1 to 10 s with a few tenths s deadtime between measurements. Pulses are sorted into 128 voltage channels that convert to S by the calibration curve. Counts are converted to concentrations per cm3 from the sample flowrate and data collection duration.

4.0 Data Format

Data are in three columns per measurement. The first column is labeled S and then the date, D for December of J for January and the date of the month followed by m or a for morning or afternoon, except December 8 when there was only one CCN measurement. S is given in percent supersaturation from approximately 1.6% to 0.01%. The second column provides the concentration of CCN active at the corresponding S of the 1st column. Concentration units are per cm^3. The concentrations are cumulative with S so that all particles with $S_c < S$ are given in column 2. The third column for each measurement displays the beginning and end times of the measurements within which the average concentrations are displayed. This is in units of GMT hours (hour fractions thereof). There are 31 CCN measurements, 2 for each of the 15 longer flights and 1 measurement for the short December 8 flight. Thus there are 93 columns of data.

5.0 Data Remarks

Data is good.

6.0 References

Shown in Section 2.