Data Set Title -

SOCRATES CCN measurements

Data Set Author(s) -

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1.0 Data Set Overview

Abstract:

These measurements are part of the large-scale initiative Southern Ocean Clouds Radiation Transport Aerosol Transport Experimental Study (SOCRATES) coordinated by Greg McFarquhar (Univ. Oklahoma). The main objective of the SOCRATES experiment is to improve our understanding of aerosol-cloud interactions with respect to the major synoptic meteorological conditions in the Southern Ocean (SO) to reduce the uncertainties related to aerosols, clouds and their feedbacks in our climate models. Specifically, we deployed two miniaturized cloud condensation nuclei (CCN) instruments onboard the NSF/NCAR HIAPER G-V to measure horizontal and vertical spatial variability of CCN number concentrations, CCN spectra and aerosol hygroscopicity to determine their relation to ocean sources and long-range transport of aerosol and cloud microphysical properties in the SO. A total of 15 research flights (RF) were flown with the CCN instruments at latitudes between 42.5 and 62.5 degrees South within the lower 6 km of the Earth's atmosphere.

Time of Interest -

2018/01/15 to 2018/02/24

Area of Interest -

-42.50 to -62.50; 134.00 to 163.00

2.0 Instrument Description:

CCN measurements were performed with a miniature continuous-flow stream-wise thermal gradient chamber, which measures the concentration of activated CCN over a range of supersaturations (Roberts and Nenes, 2005). One CCN counter operated at constant flow and constant temperature gradient to produce a constant supersaturation at 1Hz. The other CCN counter operated with a scanning flow and scanning temperature gradient to produce a CCN spectra every 5 minutes, ranging from 0.06% to 0.87% supersaturation. The internal pressure of the CCN chamber was constant at 400 mbar. The miniature CCN instruments each weigh ca. 2 kg, measure 20 x 20 x 10 cm (length, height, width), and consume ca. 50 W.

General Dataset Description -

CCN measurements were collected on the HIAPER Gulfstream GV over the Southern Ocean during the SOCRATES field experiment. Two CCN counters were used: one that scanned through supersaturations of 0.06% to 0.87% every 5 minutes and another CCN counter that remained constant at 0.43% supersaturation (1 Hz).

3.0 Data Collection and Processing:

Data was collected continuously with both CCN counters at a rate of 1 Hz. To improve the signal to noise ratio, measurements are averaged in 10 second increments (constant supersaturation CCN counter) or averaged by supersaturation (for the CCN spectra). The standard error ($\sigma/\sqrt{N}$) was included with each CCN measurement. The CCN chambers were depressurized to 400 mb, because the internal chamber pressure must be constant to produce accurate supersaturations. The CCN number concentrations at 0.43% supersaturation agree well between both CCN instruments – which provides independent verification of instrument performance.

4.0 Data Format:

Three classes of files represent the data from both of the CCN instruments:

- CCNconstSS files represent 10 second averages of the time series from the CCN counter with a constant supersaturation of 0.43%.

- CCNscanning files represent 10 second averages of the scanning CCN counter.

- CCNspectra files contain individual CCN spectra collected on level legs over the duration of the up and down scans, indicated by start and stop times in the file [seconds since 00z]. The supersaturation in the spectra files are in intervals of 0.05% and range from 0.10% to 0.85%.

CCN measurements and CCN standard error are in units of per centimeter cubed (cm-3). Supersaturation is in units of %. Time is in units of seconds (s) since 0z. Quick look figures are available for each flight in .docx files. The quick looks include time series of the CCN measurements, GV height and CPC concentrations (unfiltered). The quick looks also include CCN spectra from above cloud and below cloud level legs. Also estimates of cloud microphysical properties, CPC concentrations and wind speed based on raw data are included. The fitted spectra in these quick looks often consist of multiple individual up and down scans which are sometimes variable due to changes in the aerosol.

Data Frequency -

10 second averages (0.1 Hz) for scanning and constant supersaturation time series. CCN spectra every approx. 5 minutes.

Data Spatial Type -

The data files are in ICARTT format. The CCNconstSS (constant supersaturation) and CCNscanning (scanning supersaturation) dataset are 10 second resolution time series. The CCNspectra data are derived from the CCNscanning data, but instead of a time series a start and a stop time is given for each full CCN scan (from 0.1-0.85% supersaturation) that was on a level leg or the ferry. Each supersaturation scan was achieved in approx. 5 min.

File Names -

CCNconstSS_SOCRATES_GV_RF06_20180128_R0.ict
CCNconstSS_SOCRATES_GV_RF07_20180131_R0.ict
CCNconstSS_SOCRATES_GV_RF09_20180204_R0.ict
CCNconstSS_SOCRATES_GV_RF10_20180207_R0.ict
CCNconstSS_SOCRATES_GV_RF11_20180217_R0.ict
CCNconstSS_SOCRATES_GV_RF15_20180224_R0.ict
CCNscanning_SOCRATES_GV_RF01_20180115_R0.ict
CCNscanning_SOCRATES_GV_RF02_20180119_R0.ict
CCNscanning_SOCRATES_GV_RF03_20180122_R0.ict
CCNscanning_SOCRATES_GV_RF04_20180123_R0.ict
CCNscanning_SOCRATES_GV_RF05_20180125_R0.ict
CCNscanning_SOCRATES_GV_RF06_20180128_R0.ict
CCNscanning_SOCRATES_GV_RF07_20180131_R0.ict
CCNscanning_SOCRATES_GV_RF08_20180203_R0.ict
CCNscanning_SOCRATES_GV_RF09_20180204_R0.ict
CCNscanning_SOCRATES_GV_RF10_20180207_R0.ict
CCNscanning_SOCRATES_GV_RF11_20180217_R0.ict
CCNscanning_SOCRATES_GV_RF12_20180218_R0.ict
CCNscanning_SOCRATES_GV_RF13_20180219_R0.ict
CCNscanning_SOCRATES_GV_RF14_20180221_R0.ict
CCNscanning_SOCRATES_GV_RF15_20180224_R0.ict
CCNspectra_SOCRATES_GV_RF01_20180115_R0.ict
CCNspectra_SOCRATES_GV_RF02_20180119_R0.ict
CCNspectra_SOCRATES_GV_RF03_20180122_R0.ict
CCNspectra_SOCRATES_GV_RF04_20180123_R0.ict
CCNspectra_SOCRATES_GV_RF05_20180125_R0.ict
CCNspectra_SOCRATES_GV_RF06_20180128_R0.ict
CCNspectra_SOCRATES_GV_RF07_20180131_R0.ict
CCNspectra_SOCRATES_GV_RF08_20180203_R0.ict
CCNspectra_SOCRATES_GV_RF09_20180204_R0.ict
CCNspectra_SOCRATES_GV_RF10_20180207_R0.ict
CCNspectra_SOCRATES_GV_RF11_20180217_R0.ict
CCNspectra_SOCRATES_GV_RF12_20180218_R0.ict
CCNspectra_SOCRATES_GV_RF13_20180219_R0.ict
CCNspectra_SOCRATES_GV_RF14_20180221_R0.ict
CCNspectra_SOCRATES_GV_RF15_20180224_R0.ict

5.0 Data Remarks

For the scanning CCN counter, it is normal that for every 5 minute scan, there are about 2 minutes without data due to the time it takes for the temperature gradient across the diffusion chamber and flow rate to adjust when changing between up and down scans. CCN measurements have been filtered and data removed when the CCN instrument were not operating correctly (i.e. flow issues or drying of the diffusion column). In-cloud measurements were filtered out due to the effect of droplet shattering. During low level legs on RF05, RF06 and RF08, the generated supersaturation within the CCN chamber required a minor correction (+/- 0.07%) because the pressure oscillated around the set point (400 mb +/- 20 mb).

During the first five research flights, the scanning CCN counter laser optical threshold was high, causing the instrument to count a fraction of the activated CCN. Post-experiment lab

test corrected these measurements by applying a scaling factor between 1.0 to 1.6 as a function of supersaturation. The observed standard deviation (σ) in the scaling factor was less than 7% for all supersaturations and was included in the standard error ($\sigma/\sqrt{N}$) calculation.

Data restrictions -

The CCN data will be available for public use when at the same time the rest of the SOCRATES data is available, though we request users contact:
Kevin Sanchez (kjs356@gmail.com) and Greg Roberts (gcroberts@ucsd.edu).
Digital Object Identifier (DOI) - To be generated.
GCMD Keywords -

Cloud Condensation Nuclei (CCN)
Condensation Nuclei (CN)
Aerosol
Clouds
Southern Ocean
Aerosol-cloud interactions
Airborne measurements

6.0 References

Roberts, G. C. and Nenes, A.: A continuous-flow streamwise thermal-gradient CCN chamber for atmospheric measurements, Aerosol Sci. Technol., 39, 206 221, https://doi.org/10.1080/027868290913988, 2005