ACCESSORIES

DMT sells several kits for CCN consumable and spare parts, including a ship kit, consumables kit, and field repair kit. Users may also purchase an airborne CCN inlet assembly kit that contains the following items:

» CCN rail mount
» CCN aircraft inlet
» Constant pressure inlet

ACKNOWLEDGMENTS

The Cloud Condensation Nuclei (CCN) Counter is based on the design of Dr. Greg Roberts of Scripps Institute of Oceanography and Dr. Athanasios Nenes of the Georgia Institute of Technology. The patent for their design is licensed exclusively to DMT, patent number 7,656,510.

SELECTED BIBLIOGRAPHY

The following papers provide a representative sample of research conducted with the DMT CCN Counter. For a comprehensive bibliography of such publications, visit dropletmeasurement.com.

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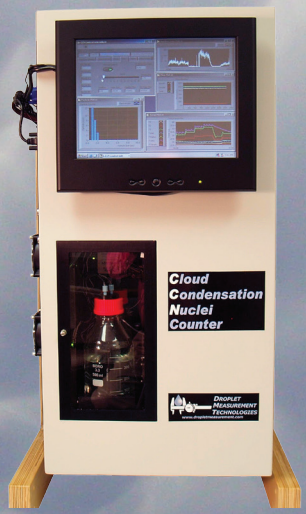
» Lance, S., et al. (2009), "Cloud condensation nuclei activity, closure, and droplet growth kinetics of Houston aerosol during the Gulf of Mexico Atmospheric Composition and Climate Study (GoMACCS)," Journal of Geophysical Research, 114, D00F15, doi:10.1029/2008JD011699.
» Padró, L., D. Tkacik et al. "Investigation of Cloud Condensation Nuclei Properties and Droplet Growth Kinetics of Water-Soluble Aerosol Fraction in Mexico City." Journal of Geophysical Research, 115: D09204, 2010.
» Roberts, G., and Nenes, A. (2005) "A Continuous-Flow Streamwise Thermal-Gradient CCN Chamber for Atmospheric Measurements," Aerosol Science and Technology, 39, 206–221, doi:10.1080/027868290913988.
» Snider, J.R., H. Wex et al. "Intercomparison of Cloud Condensation Nuclei and Hygroscopic Fraction Measurements: Coated Soot Particles Investigated During the LACIS Experiment in November (LExNo) Campaign." Journal of Geophysical Research, 115: D11205, 2010.

HOW TO ORDER

Contact DMT for pricing or more information: +1.303.440.5576,
customer-contact@dropletmeasurement.com.

CLOUD CONDENSATION NUCLEI COUNTER (CCN)



DROPLET MEASUREMENT TECHNOLOGIES

OVERVIEW

Clouds are a key factor in moderating climate change. Cloud condensation nuclei (CCN) are those aerosol particles that can form into cloud droplets, and an understanding of CCN concentrations in space and time is necessary if models are to accurately predict the magnitude of global climate change. The DMT CCN counter measures the concentration of these particles. The counter is being used in laboratories to measure how different materials form cloud droplets, in urban environments to study how pollution affects cloud and precipitation formation, and in weather modification studies to determine when and where to seed clouds. This popular instrument comes equipped with single (CCN-100) or dual (CCN-200) columns for extended versatility. Both versions can be operated on the ground or on aircraft.

ADVANTAGES

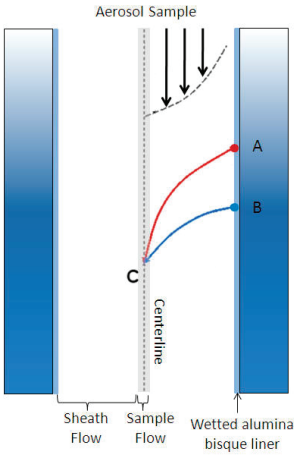
- Measures the spectrum of cloud condensation nuclei (CCN) concentration as a function of supersaturation continuously using uninterrupted flow and a multichannel, optical particle counter that measures the size of the activated droplets
- Features supersaturation as low as 0.07% and as high as 2%
- Offers complete automation of up to 250 programmable and scanned supersaturation settings
- Minimizes size and buoyancy effects with cylindrical geometry
- Features onboard computer for control and data logging
- Provides fast response and continuous flow, which allows airborne as well as ground-based applications

HOW IT WORKS

The CCN Counter features a continuous-flow thermal-gradient diffusion chamber for measuring aerosols that can act as cloud condensation nuclei. The CCN-100 draws an aerosol sample into 50-cm tall column, while the CCN-200 features two identical such columns. Inside the column(s), a thermodynamically unstable, supersaturated water vapor condition is created by taking advantage of the difference in diffusion rates between water vapor and heat. Water vapor diffuses from the warm, wet column walls toward the centerline at a faster rate than the heat. The wall temperature along the column gradually increases to create a well-controlled and quasi-uniform centerline supersaturation. Through software controls, the user can modify the temperature gradient and flow rate to change supersaturations and obtain the CCN spectra.

Seeking equilibrium, the supersaturated water vapor condenses on the cloud condensation nuclei in the sample air to form droplets, just as cloud drops form in the atmosphere. An optical particle counter uses side-scattering technology to count and size the activated droplets.

Creating Supersaturation



Water vapor is saturated at the column wall at all points. Diffusing heat originates at Point A, while diffusing mass originates at Point B. The actual partial water pressure of water vapor at C equals the partial pressure of water vapor at B. However, the temperature at C is lower than at B, meaning there is more water vapor than thermodynamically allowed.

APPLICATIONS

- Atmospheric research
- Climate change studies
- Pollution research
- Weather modification

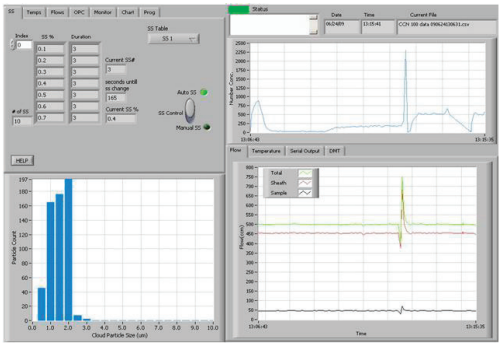
Above: The National Oceanic and Atmospheric Administration (NOAA) research station in Barrow, Alaska. Inset: The CCN (in black) inside the research station. Photos courtesy of Robert Albee, NOAA Earth System Research Laboratory.

SOFTWARE

The CCN comes with a software program that provides a user-friendly virtual instrument panel for the control, data display, and data logging of the CCN instrument. For instance, the program enables the user to do the following tasks:

- Collect data
- Change supersaturation settings
- Adjust temperature and air flow settings
- Manipulate instrument pumps (e.g., turn air pumps on high to prevent condensation)
- Quickly detect any operational problems
- Update instrument calibration parameters
- Adjust the instrument to prepare it for shipping or re-humidify it after shipping

Information gathered during sampling sessions is written to output files that can be viewed in real-time and played back later for detailed analysis.



The software also regulates the instrument to prevent hardware damage due to factors such as excessive temperature, leaks, and laser problems.

In addition to the standard software, the CCN Counter interfaces with DMT's Particle Analysis and Display System (PADS) software.

CCN SPECIFICATIONS

Measured Parameters	» Single-particle light scattering (for activated nuclei) » Temperature » Pressure
Number Concentration Range	Depends on supersaturation: » 6,000 particles/sec at supersaturations below 0.2% » 20,000 particles/sec at supersaturations above 0.3%
Particle Size Range (from OPC, after supersaturation)	0.75 – 10 µm
Aerosol Medium	Air, 5- 40 °C (41 - 104°F)
Number of Particle Size Bins	20
Sampling Frequency	1 Hz / 1 sec
Supersaturation Range	0.07 - 2.0%
Time Required for Supersaturation Change	~30 seconds for 0.2% change
Maximum Number of Automatically Scanned Supersaturation Settings	250
Optical Particle Counter Laser	660 nm, 35 mW
Flow Range	» Total flow: 200 – 1000 volume cc/min (factory calibrated at 500 Vccm) » Sample flow: 20 – 100 Vccm » Sheath flow: 180 – 900 Vccm
Pump	Solenoid pumps for water; diaphragm pump for air
Routine Maintenance	*Every Four Days/Before Every Flight:* » Empty and refill water bottles » Check OPC water trap and bottom of case for water leakage *Monthly:* » Check air inlet filters » Check flow calibration » Check desiccant tube *Every Three Months:* » Replace sheath airflow filter
Recommended Service	» Annual Cleaning and Calibration at DMT service facility
Computer System	» On-board Intel® Celeron® 1 GHz processor » 512 MB RAM » 80 GB hard drive for data storage » User interface via standard keyboard and monitor (included)
Software	» CCN Counter Software, Playback Software » Optional Particle Analysis and Display System (PADS) (to record data in an aircraft system—not required for instrument operation)
Data System Interface	RS-232, 9.6 Kb/sec Baud Rate (single CCN Counter) or 57.6 Kb/sec (Dual CCN Counter)
Data System Features	» Onboard computer for control and data logging » Touch screen control and display » Serial data output for external computer
Calibration	Comparison of CCN Counter output to reference instruments (Differential Mobility Analyzer (DMA) and a CN Counter)
Features for Easy Aircraft Mounting	» Rack-mount compatible » Center of gravity located 15.5” from bottom of back base plate » Instrument plumbing system sealed for operation on pressurized aircraft
Power Requirements	28 VDC
Current	» CNN-100: 15 A at startup, nominal 7 A during normal operation » CCN-200: 25 A at startup, nominal 20 A during normal operation
Shipping Container	Durable Atlas Case Corporation ATA Transit Case that conforms to the Air Transport Association’s Specification 300 Category 1 standards
Size (same for CCN-100 and CCN-200)	*For lab use (with frame):* » 35.0” H x 19.3” W x 15.6” D / » 88.9 cm H x 48.9 cm W x 39.7 cm D *For aircraft use (without frame):* » 32.0”H x 15.25” W x 10.6” D / » 81.3 cm H x 38.7 cm W x 27 cm D
Weight	*CCN-100:* » For lab use (with frame): 35.2 kg / 77.5 lb » For aircraft use (without frame): 29.0 kg / 64.0 lb *CCN-200:* » For lab use (with frame): 50 kg / 110 lb » For aircraft use (without frame): 43.8 kg / 96.5 lb
Environmental Operating Conditions	» Temperature: 5 – 40°C (41 – 104 °F) » Relative Humidity: 0 – 100% RH non-condensing

DROPLET MEASUREMENT TECHNOLOGIES

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Specifications are subject to change without notice. The CCN is a Class I Laser Product.

Rev B-2

April 9, 2013