Surface Measurement of the Fog Droplet Spectrum at a Continental Site using the Cloud Droplet Probe (CDP)

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Abstract

Accurate characterization of fog droplet size distributions is essential for understanding fog microphysical processes, improving visibility forecasting, quantifying fog collection efficiency, and validating numerical models. The Cloud Droplet Probe (CDP) is widely used on research aircraft to measure cloud droplets in the approximately 2–50 μm size range, but its application to ground-based fog studies has been less common. Results are presented from a surface deployment of a CDP where the airflow (~ 25 m/s) is created using three Mounto 8-inch, 1/3-hp high-pressure axial blower fans placed behind the CDP. The CDP tip heaters were connected to a power supply, and the 8-inch sampling tube inlet and fan blades were heated after poor performance during a prolonged supercooled fog event on March 3-4.

The ground CDP (G-CDP) was deployed at the University of North Dakota during spring of 2026 alongside active and passive fog gauges to characterize radiation fog events. Sizing accuracy was verified using monodisperse glass beads following manufacturer maintenance and calibration. Observed fog events (March 3-4, March 19, and April 12-13) exhibited low droplet number concentrations with two modes in droplet size. One size mode had droplet diameters peaking at approximately 4.5 μm (channel 3) and another size mode peaking at 15 μm (channel 13). This bimodal spectrum is interpreted as having a "haze" mode (4.5 μm peak) and a cloud activation mode (15 μm). The "haze" mode is consistent with deliquesced, unactivated aerosol at near-saturation. The two size modes were present throughout the fog formation and dissipation phases of the observed fog events. Droplet distributions will be used to estimate fog water accumulations from individual events and compared against collections from the collocated active and passive. Implications for accurate fog collection yield estimates are discussed, along with the relationships to concurrent aerosol and vertical electric field measurements.