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Supplement of

Measurement report: Vertically resolved atmospheric properties observed over the Southern Great Plains with the ArcticShark uncrewed aerial system

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Table S1 ArcticShark payload instrumentation

Baseline Measurements

	Instrumentation	Measurements
Aircraft State	Aircraft Integrated Meteorological Measurement System (AIMMS)-30 (Aventech Research Inc.), VectorNav-200 (VectorNav Tech.)	Ground velocity, True Air Speed, Altitude, Latitude, Longitude, Heading, and Orientation. (100 Hz)
Meteorological State	Aircraft Integrated Meteorological Measurement System (AIMMS)-30 (Aventech Research Inc.)	Static Pressure (1 Hz), Static Temperature (1 Hz & 49 Hz), RH (1 Hz), Water Vapor Conc. (2 Hz) and 3-D winds (100 Hz)
Flux Measurements	Aircraft Integrated Meteorological Measurement System (AIMMS)-30, Fast Temperature sensor(OpSens)	Momentum (100 Hz)
Land Surface Properties	Infrared Radiometer (Apogee), Multispectral Camera (MicaSense)	Infrared Surface Temperature (1Hz), Multispectral images at 475nm, 560 nm, 668 nm, 717 nm, 842 nm, and Surface temperature at 10.5 mm.

Switchable Aerosol Measurements

	Instrumentation	Measurements
Isokinetic Aerosol Inlet	PNNL-designed community inlet system	Sample line temperature and RH (1 Hz)
Package 1: Aerosol Physicochemical Properties	Advanced Mixing Condensation Particle Counter (MCPC, Brechtel Inc.)	Aerosol total number concentration (7-2,000 nm, 1 Hz)
	Portable Optical Particle Spectrometer (POPS, Handix Sci.)	Aerosol Size Distribution (135 - 3,000 nm optical size, 1 Hz)
	Miniaturized Optical Particle Counter (MOPC, Brechtel Inc.)	Aerosol Size Distribution (180 – 3,000 nm optical size, 1 Hz)
	Single Channel Tricolor Absorption Photometer (STAP, Brechtel Inc.)	Aerosol Light Absorption at 450 nm, 525 nm, and 624 nm
	Aerosol Filter Sampler (Brechtel Inc.)	Eight Samples for Offline Chemical Analysis

Package 2: Aerosol Size Distribution	Miniaturized Scanning Electrical Mobility Sizer (mSEMS, Brechtel Inc.)	Aerosol Size Distribution (10 – 375 nm electrical mobility size, 15 secs/scan)
	Portable Optical Particle Spectrometer (POPS, Handix Sci.)	Aerosol Size Distribution (135 - 3,000 nm optical size, 1 Hz)
	Water-based Condensation Particle Counter (wCPC, Aerosol Dynamics Inc.)	Aerosol total number concentration (5-2,000 nm, 1 Hz)

Table S2 ArcticShark SGP deployment overview

FLIGHT DATE	FLIGHT #	FLIGHT HOURS	PAYLOAD	MAXIMUM ALTITUDE, M
06-MAR-2023 21:24:18, 06-MAR-2023 22:56:47	RF1	1.53	Package 1	2000
09-MAR-2023 21:13:03, 09-MAR-2023 23:04:38	RF2	1.7	Package 1	1000
10-MAR-2023 16:43:52, 10-MAR-2023 21:15:16	RF3	4.55	Package 1	2000
12-MAR-2023 16:20:38, 12-MAR-2023 20:27:03	RF4	4.09	Package 1	2000
13-MAR-2023 15:26:26, 13-MAR-2023 18:01:29	RF5	2.57	Package 1	2000
14-MAR-2023 17:25:46, 14-MAR-2023 21:28:53	RF6	3.9	Package 1	2000
17-MAR-2023 21:30:12, 17-MAR-2023 23:39:36	RF7	2	Package 1	2000
22-MAR-2023 15:22:14, 22-MAR-2023 16:42:04	RF8	1.2	Package 1	2000
23-MAR-2023 16:44:41, 23-MAR-2023 20:44:31	RF9	3.78	Package 1	2000
25-MAR-2023 16:19:37, 25-MAR-2023 19:29:55	RF10	3	Package 1	1850
RF MARCH TOTALS:	**10**	**29.5**		
08-JUN-2023 16:28:32, 08-JUN-2023 19:07:35	RF1	2.6	Package 1	2000
09-JUN-2023 13:49:41, 09-JUN-2023 17:40:26	RF2	3.8	Package 1	2000
10-JUN-2023 21:00:45, 11-JUN-2023 01:06:33	RF3	4	Package 1	2000
12-JUN-2023 17:45:15, 12-JUN-2023 19:42:54	RF4	2	Package 1	2000
6/13/2023	FCF	0.3	Package 1	1000
16-JUN-2023 19:19:22, 16-JUN-2023 22:04:03	RF5	2.6	Package 2	1550
17-JUN-2023 18:34:18, 17-JUN-2023 20:37:57	RF6	1.5	Package 2	1600
6/17/2023	FCF	0.5	Package 2	1000
18-JUN-2023 18:37:26, 18-JUN-2023 21:49:20	RF7	3	Package 1	2000
19-JUN-2023 15:40:03, 19-JUN-2023 19:55:07	RF8	4.1	Package 1	2000
22-JUN-2023 14:13:04, 22-JUN-2023 16:58:55	RF9	2.6	Package 1	2000
23-JUN-2023 14:32:15, 23-JUN-2023 16:13:09	RF10	1.6	Package 1	2000
RF JUNE TOTALS:	**10**	**29.1**		
14-AUG-2023 15:06:28, 14-AUG-2023 16:58:28	RF1	1.7	Package 1	1900
17-AUG-2023 14:58:51, 17-AUG-2023 17:40:44	RF2	2.6	Package 1	2150
18-AUG-2023 14:04:58, 18-AUG-2023 17:44:39	RF3	3.5	Package 1	2000
20-AUG-2023 14:22:55, 20-AUG-2023 17:13:19	RF4	2.7	Package 1	4300
21-AUG-2023 14:45:33, 21-AUG-2023 17:08:09	RF5	2.4	Package 1	1300

22-AUG-2023 14:45:51, 22-AUG-2023 17:56:11	RF6	3.2	Package 1	2100
23-AUG-2023 14:14:00, 23-AUG-2023 17:39:00	RF7	2.9	Package 1	4900
24-AUG-2023 13:40:19, 24-AUG-2023 17:43:36	RF8	3.7	Package 1	2000
26-AUG-2023 13:51:58, 26-AUG-2023 19:38:54	RF9	2.2	Package 1	3600
27-AUG-2023 13:58:04, 27-AUG-2023 17:14:29	RF10	3.1	Package 1	5000
29-AUG-2023 15:18:35, 29-AUG-2023 19:49:11	RF11	4.4	Package 1	1300
30-AUG-2023 15:17:50, 30-AUG-2023 20:32:42	RF12	5.1	Package 1	2100
RF AUGUST TOTALS:	**12**	**38.5**		

Note: FCF stands for function checking flight, and RF stands for research flight.

Overview plots of the ArcticShark flights in March, June and August 2023

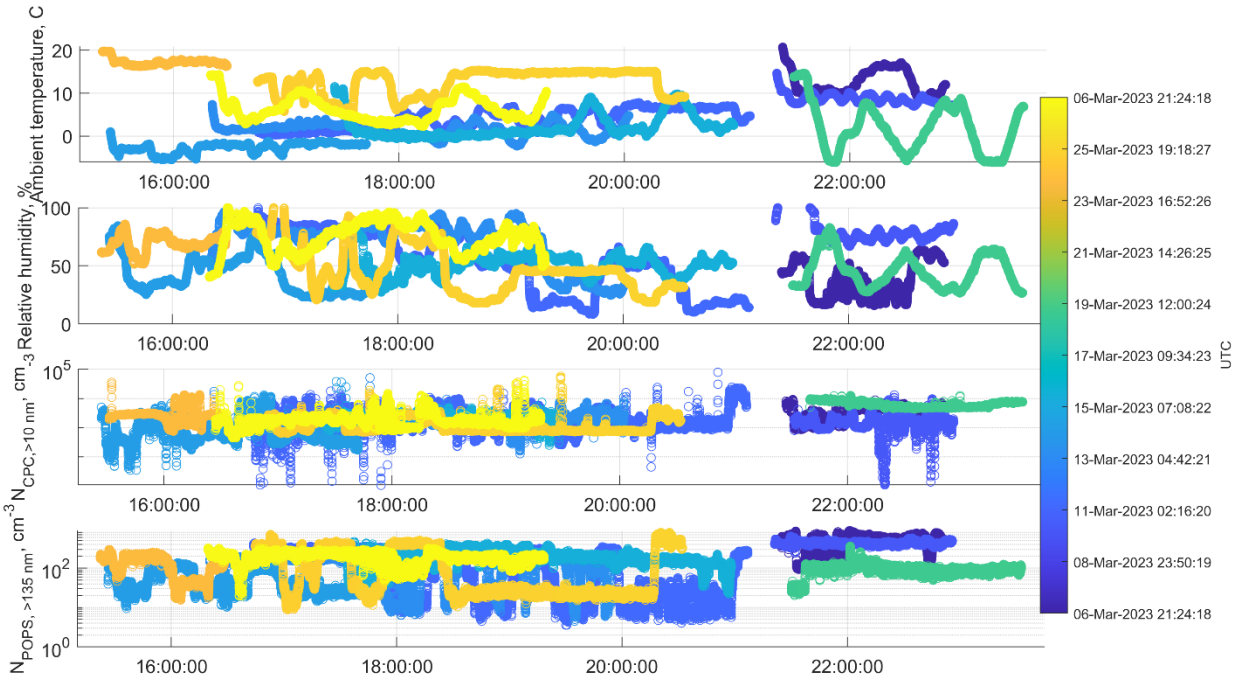

Figure S1. Time series representation of UAS ambient temperature, relative humidity and aerosol number concentrations, colored by flight dates in March.

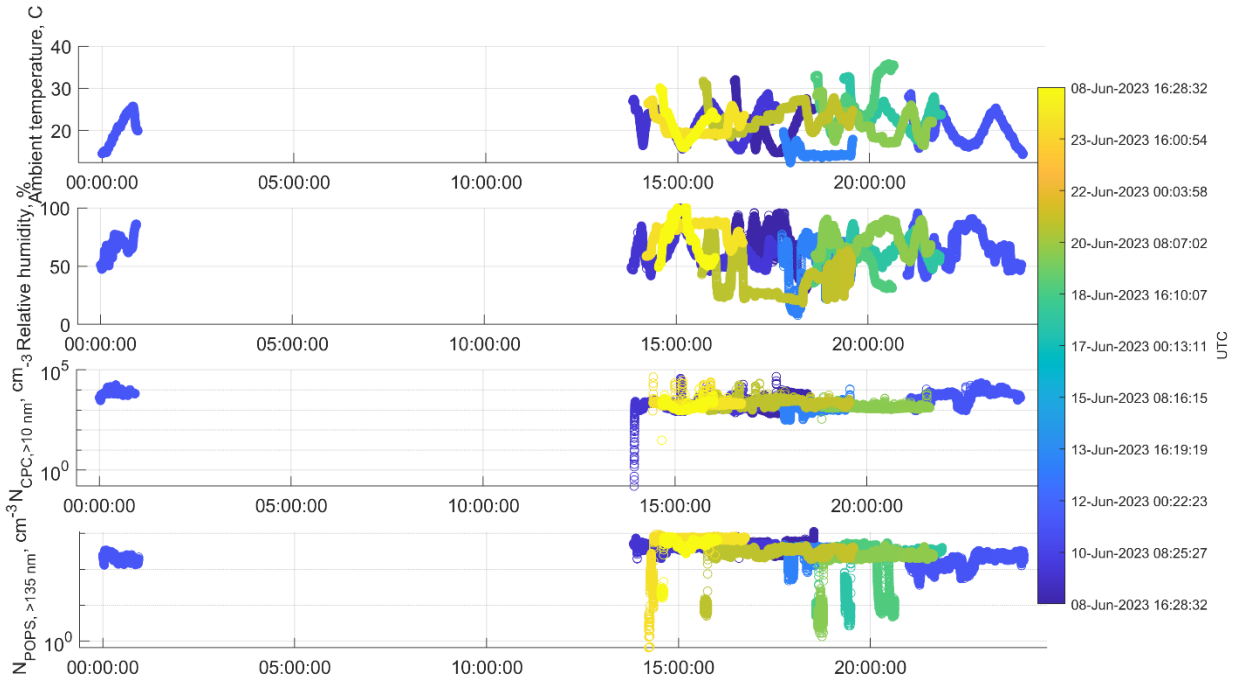

Figure S2. Time series representation of UAS ambient temperature, relative humidity, and aerosol number concentrations, colored by flight dates in June.

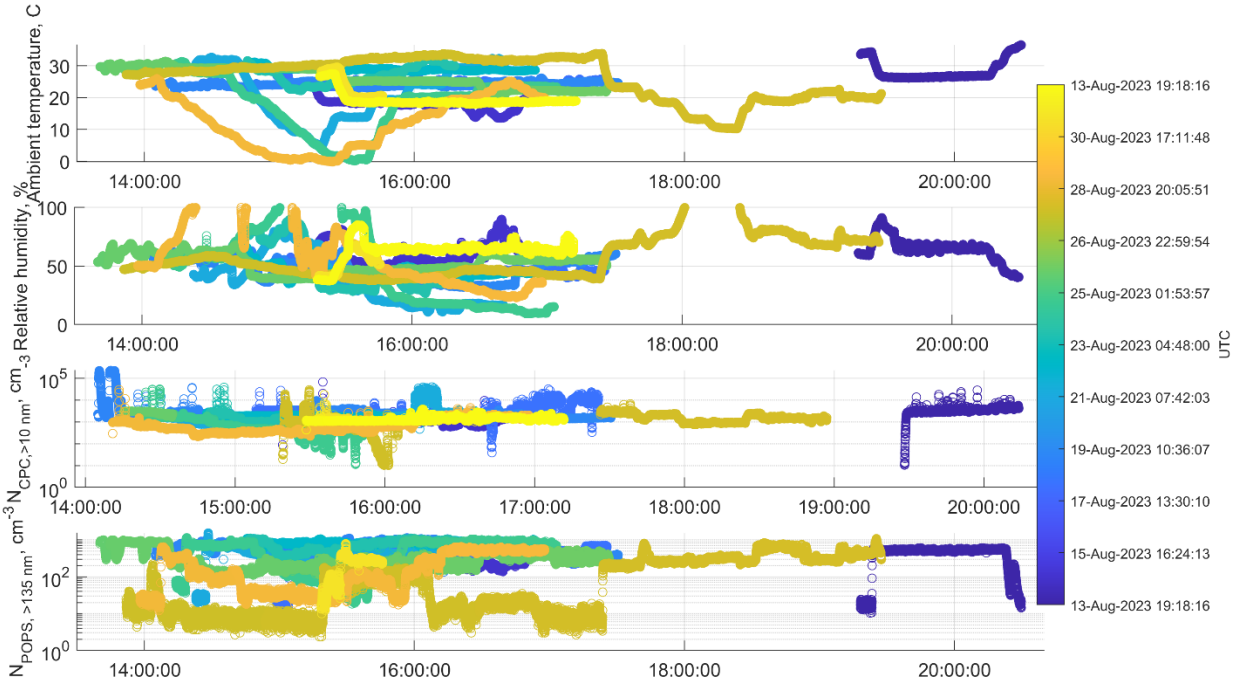

Figure S3. Time series representation of UAS ambient temperature, relative humidity, and aerosol number concentrations, colored by flight dates in August.

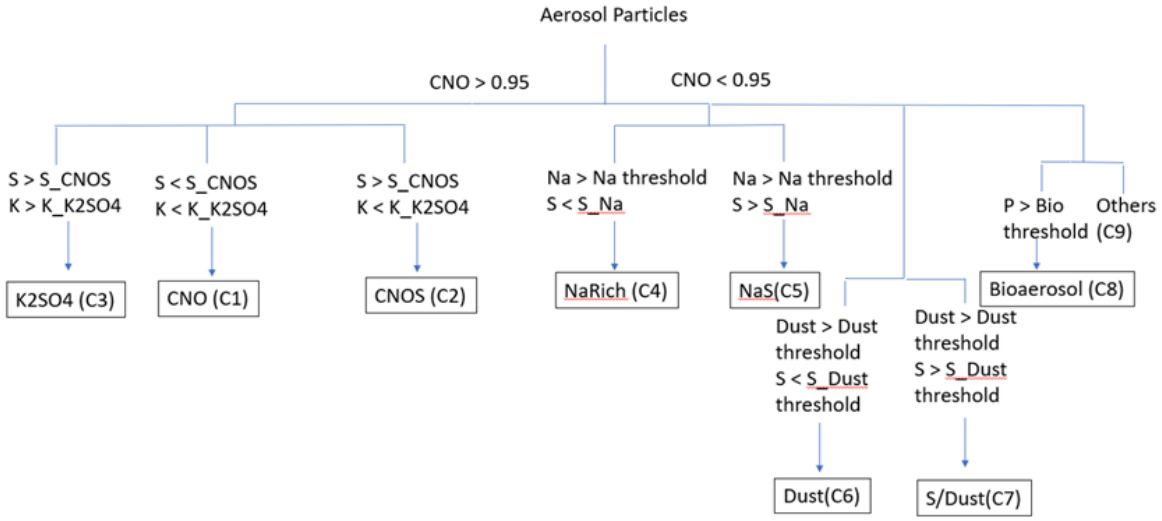

Figure S4. Particle classification scheme sorted based on the CCSEM/EDX results.

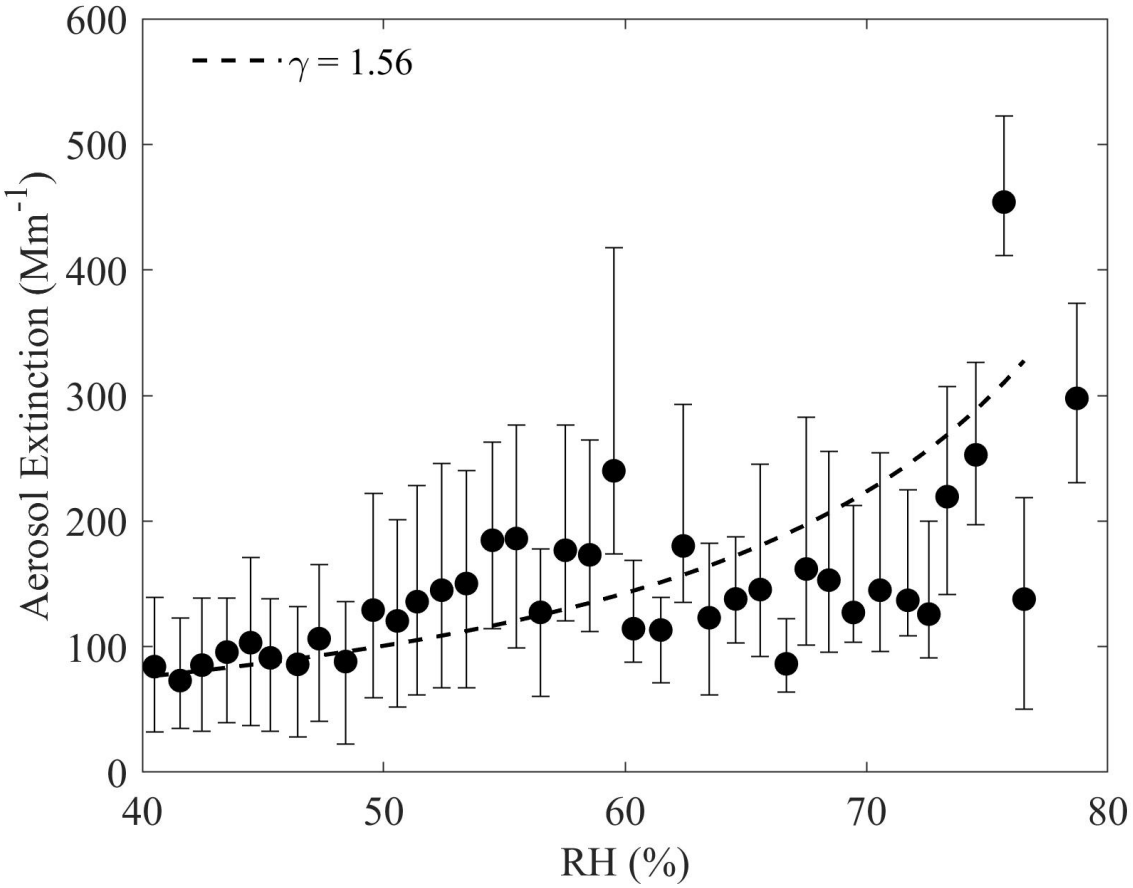

Figure S5. Humidogram of aerosol extinction at 355 nm based on the data between Aug 16 -26, 2023