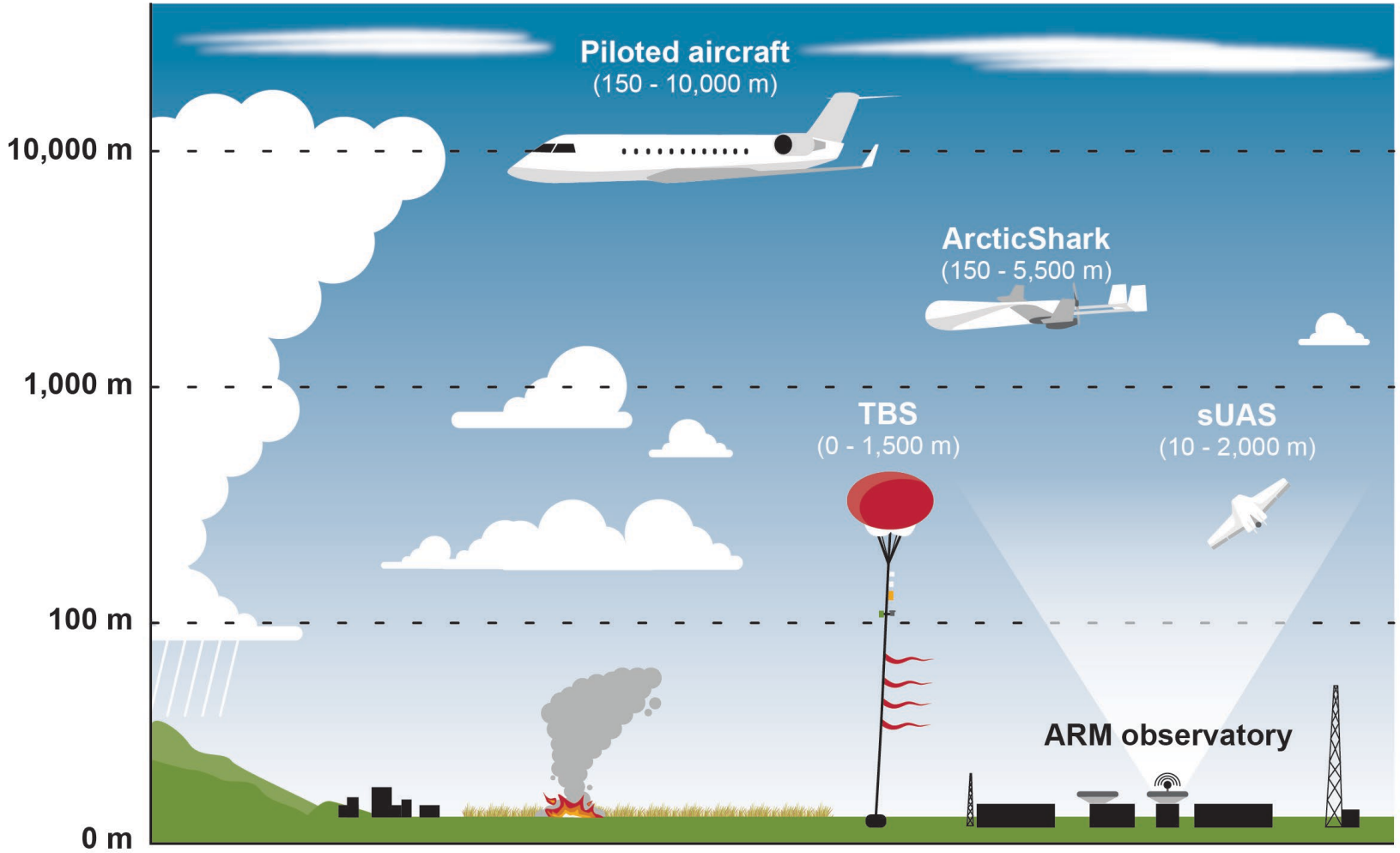
ArcticShark measurement capability

FAN MEI

Pacific Northwest National Laboratory

DOE AMSG meeting, July. 2024

ARM integrated Observational Concept



AI-Generated Concept: A More Ambitious Atmospheric Observation Illustration

AI-Generated Image. Created by an AI Assistant using a custom prompt provided by the user, via the AI Incubator platform. Accessed on [06/28/2024].

UAS Measurements

Baseline Measurements

	Instrumentation	Measurements
Aircraft State	Aircraft Integrated Meteorological Measurement System (AIMMS)-30, VectorNav (VN) 200	Ground velocity, True Air Speed, Altitude, Latitude, Longitude, Heading, and Orientation. (100 Hz)
Meteorological State	Aircraft Integrated Meteorological Measurement System (AIMMS)-30	Static Pressure (1 Hz), Static Temperature (1 Hz & 2 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	Momentum (100 Hz) and Heat (2 Hz)
Land Surface Properties	IR Thermometer, MicaSense Camera	Infrared Surface Temperature (1Hz), Multispectral images at 475nm, 560 nm, 668 nm, 717 nm, 842 nm, and Surface temperature at 10.5 μm.
Cloud Properties	Cloud Droplet Probe (CDP)	Cloud Size Distribution (2 - 50 μm optical size) (1 Hz)

Future capabilities:

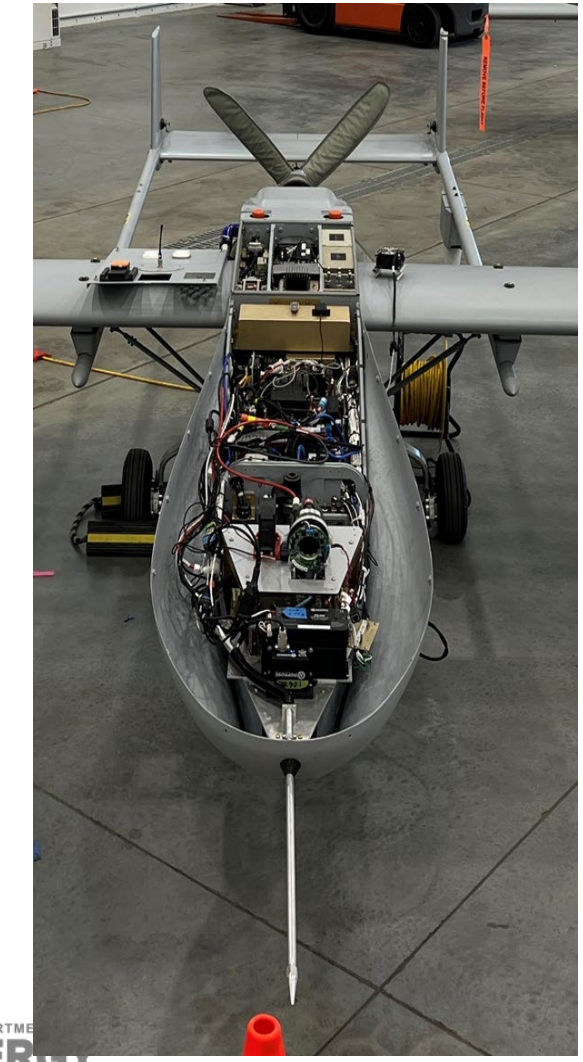
- High-sensitivity trace gas or VOC measurements
- Additional flux measurements
- Additional cloud characterization

UAS Measurements

Switchable Aerosol Measurements

	Instrumentation	Measurements
Isokinetic Aerosol Inlet	PNNL designed community inlet system	Sample line temperature and RH (1 Hz)
Coarse Mode Aerosol Size Distribution	Cloud Droplet Probe (CDP)	Aerosol Size Distribution (2 - 10 μm optical size) (1 Hz)
Package 1: Aerosol Physicochemical Properties	Advanced Mixing Condensation Particle Counter (MCPC)	Aerosol total number concentration (7-2,000 nm, 1 Hz)
	Portable Optical Particle Spectrometer (POPS)	Aerosol Size Distribution (135 - 3,000 nm optical size, 1 Hz)
	Miniaturized Optical Particle Counter (MOPC)	Aerosol Size Distribution (180 – 3,000 nm optical size, 1 Hz)
	Single Channel Tricolor Absorption Photometer (STAP)	Aerosol Light Absorption at 450 nm, 525 nm, and 624 nm
	Aerosol Filter Sampler	Eight Samples for Offline Chemical Analysis
Package 2: Aerosol Size Distribution	Miniaturized Scanning Electrical Mobility Sizer (mSEMS)	Aerosol Size Distribution (10 – 375 nm electrical mobility size, 15 secs/scan)
	Portable Optical Particle Spectrometer (POPS)	Aerosol Size Distribution (135 - 3,000 nm optical size, 1 Hz)
	Water-based Condensation Particle Counter (wCPC)	Aerosol total number concentration (5-2,000 nm, 1 Hz)

ArcticShark payload instruments



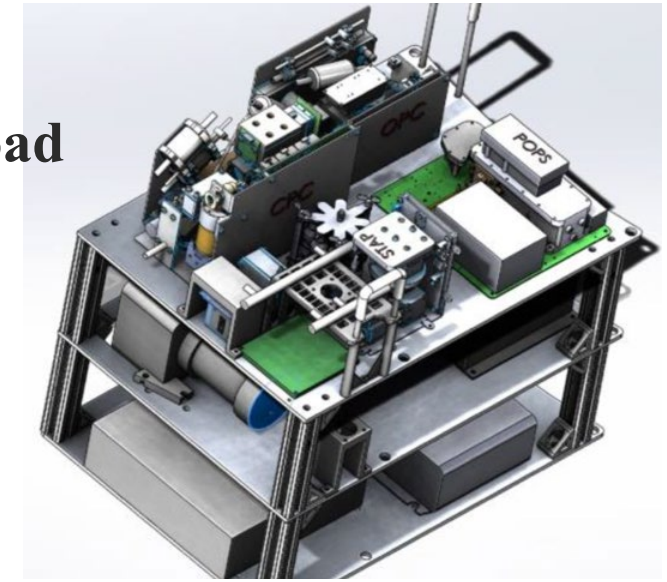
Navigation

AIMMS - 30

Cloud Droplet Probe

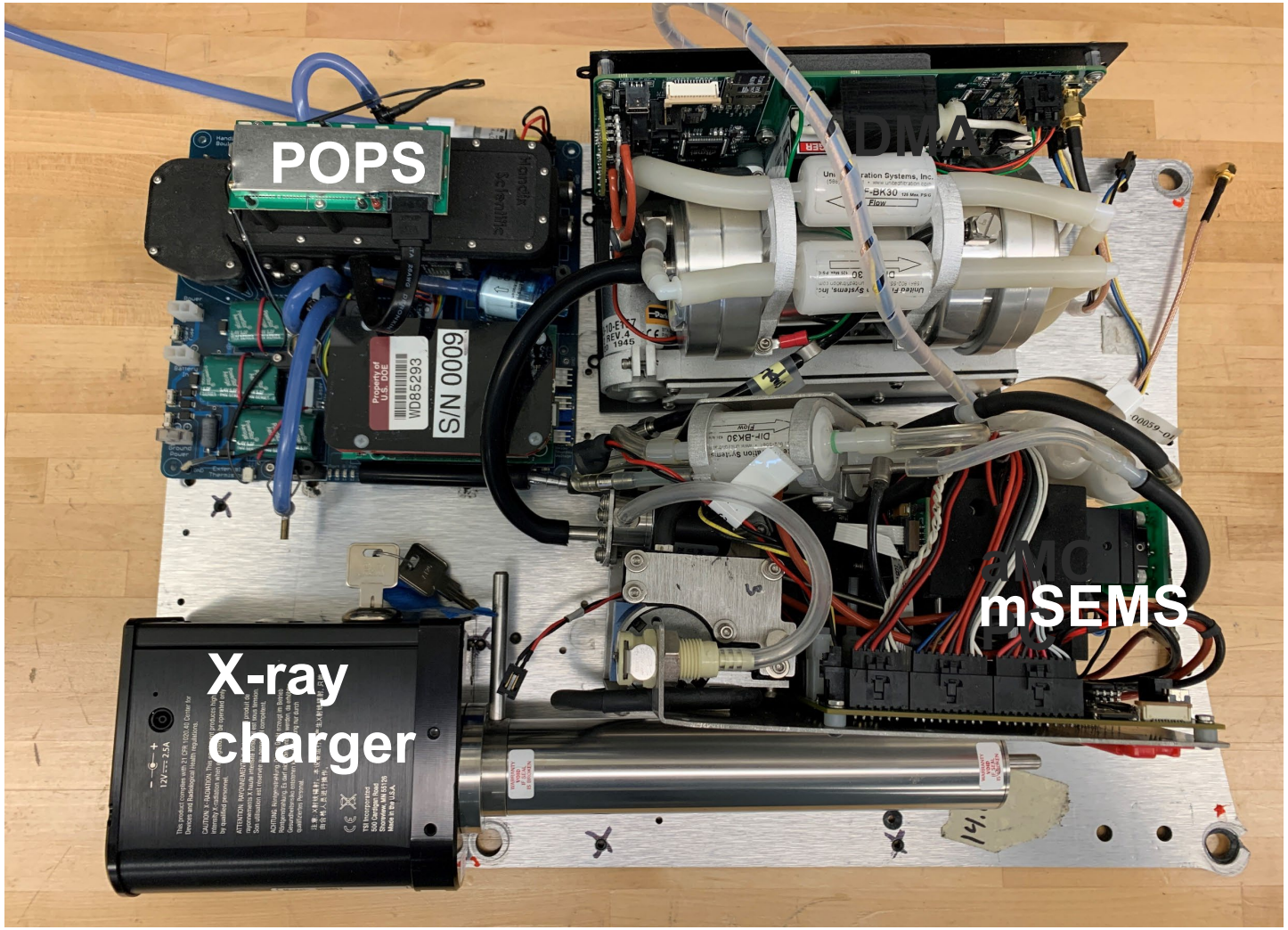
MicaSense Multispectral Sensor

ACCESS + POPS payload



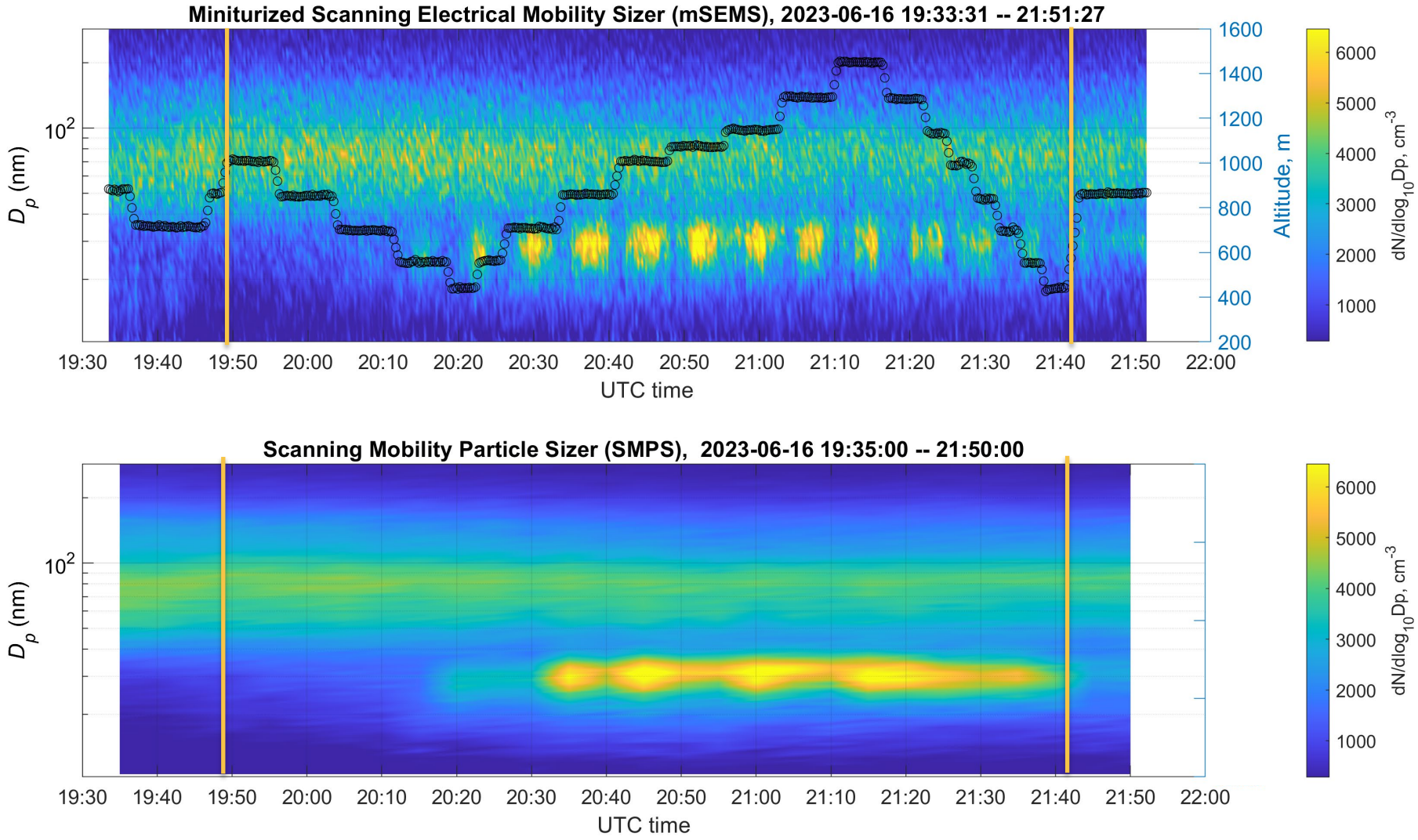
ArcticShark payload instruments

Water-based CPC

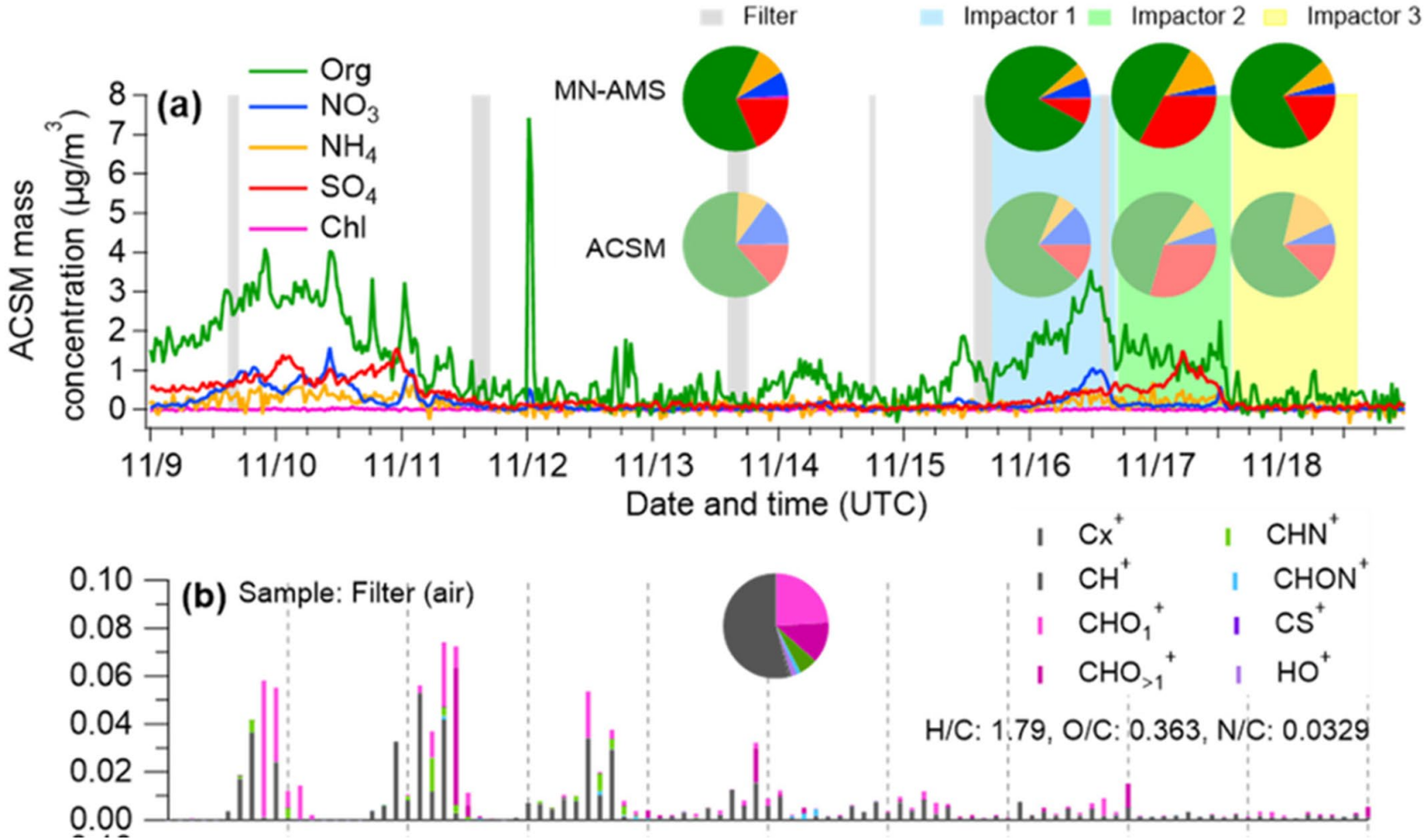


Unleashing possibilities with advanced aerosol size distribution payload

Airborne size distribution from mSEMS mirrors surface-based SMPS measurements suggesting a well-mixed boundary layer



Unraveling chemical composition: advanced offline analysis with Micronebulization AMS



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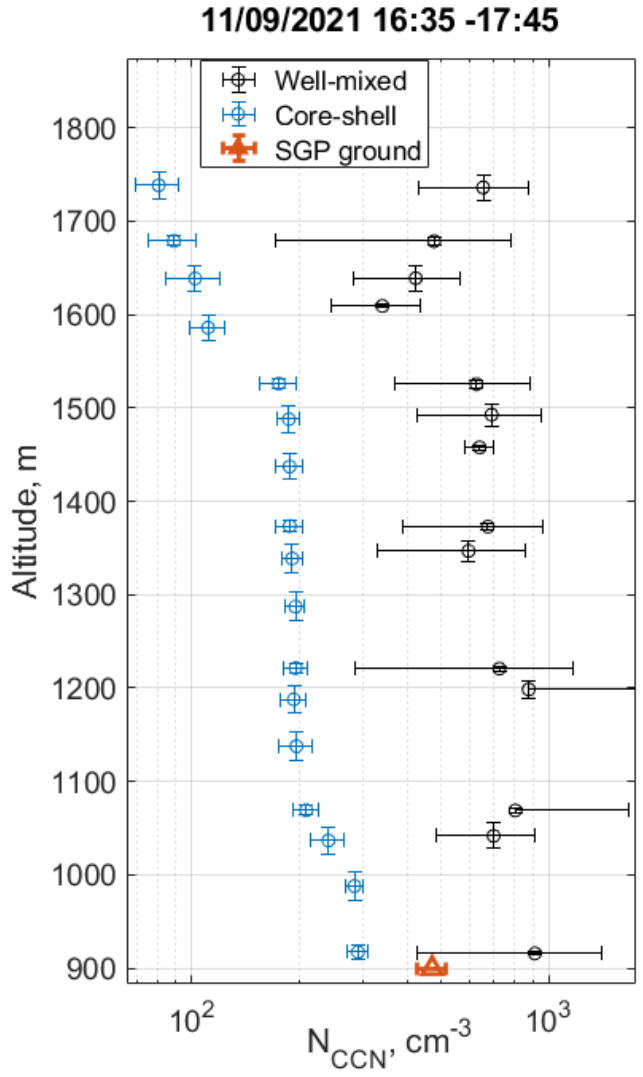
Niedek, C. R., Mei, F., Zawadowicz, M. A., Zhu, Z., Schmid, B., and Zhang, Q.: Quantitative chemical assay of nanogram-level particulate matter using aerosol mass spectrometry: characterization of particles collected from uncrewed atmospheric measurement platforms, Atmos. Meas. Tech., 16, 955–968, https://doi.org/10.5194/amt-16-955-2023, 2023.

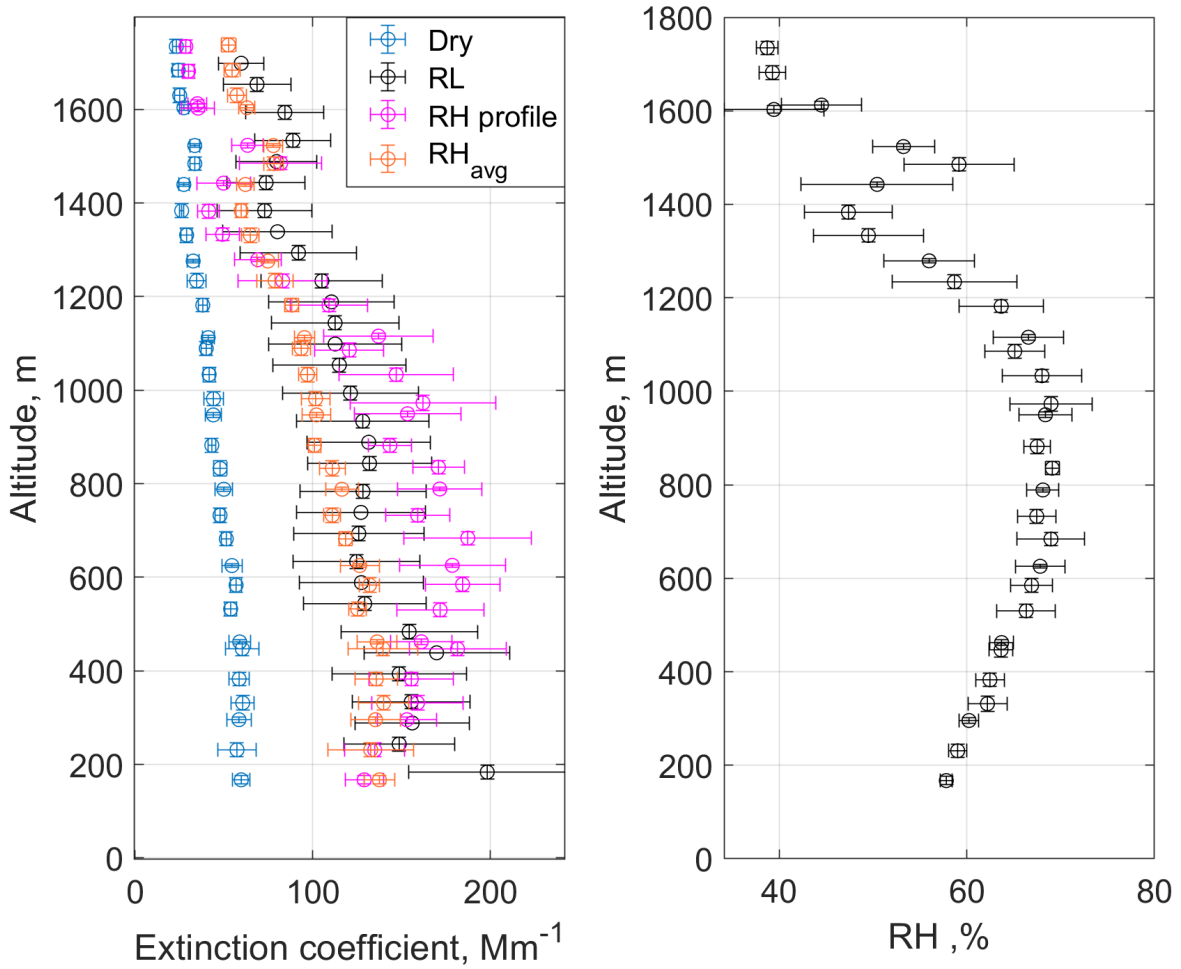
Unlocking the skies with vertical cloud condensation nuclei distribution



Estimated the vertical profiles of CCN concentrations (at 0.1% supersaturation)

- Aerosol chemical composition measured by MN-AMS
- Aerosol mixing state unveiled by time-of-flight secondary ion mass spectrometry (TOF-SIMS)
- Aerosol size distribution from POPS and mOPC

Validating remote sensing retrievals with optical property profiles



Aerosol extinction coefficients comparison with the Raman Lidar (RL) retrieval on Aug. 22, 2023. Note that the altitude is above ground level. The estimated aerosol extinction coefficients were under three conditions: the sampling dry condition, corrected with the averaged ambient RH condition, and corrected with the ambient RH profile condition.

Accessible documentation for all ARM users

https://doi.org/10.5194/essd-2022-73
Preprint. Discussion started: 21 March 2022

Open Access Earth System Science Data Discussions

Observational data from uncrewed systems over Southern Great Plains

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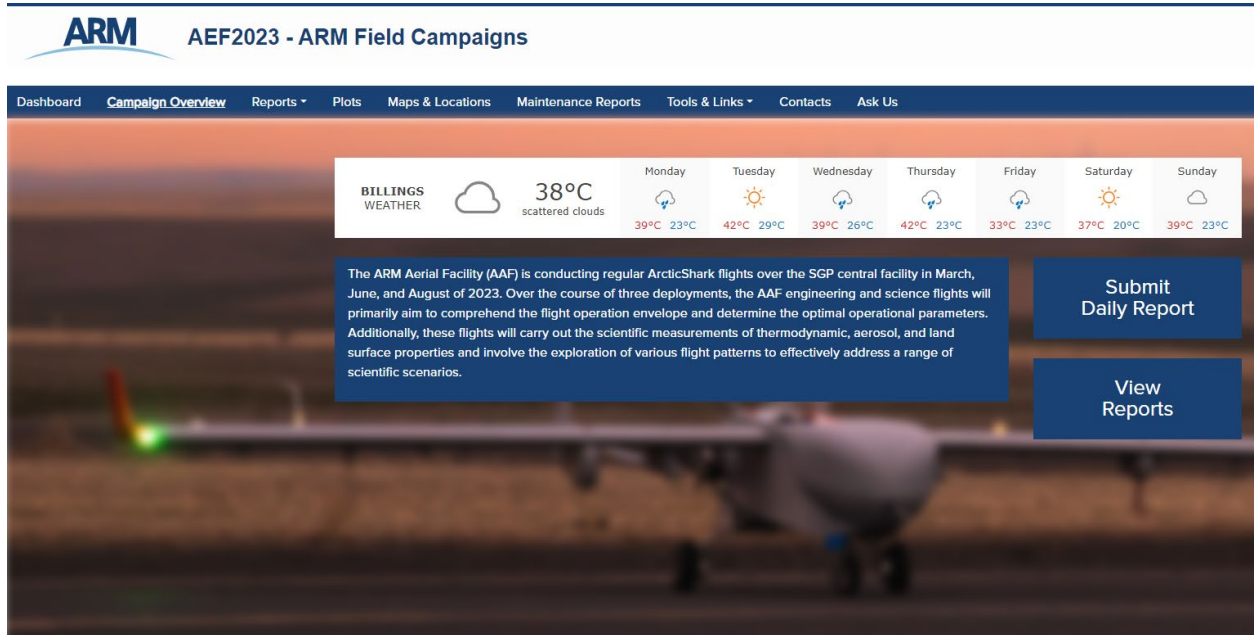
Abstract. Uncrewed Systems (UxS), including uncrewed aerial systems (UAS) and tethered balloon/kite systems (TBS), are significantly expanding observational capabilities in atmospheric science. Rapid adaptation of these platforms and the advancement of miniaturized instruments have resulted in an expanding number of data sets captured under various environmental conditions by the Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) user facility. In 2021, observational data collected using ARM UxS platforms, including seven TigerShark UAS flights and 133 tethered balloon system (TBS) flights, were archived by the ARM Data Center (https://adc.arm.gov/discovery/#/) and made publicly available at no cost for all registered users (https://www.doi.org/10.5439/1846798) (Mei and Dexheimer, 2022). Note that a specific directory has been created for the anonymous reviewer to access the data at https://adc.arm.gov/essd/. These data streams provide new perspectives on spatial variability of atmospheric and surface parameters, helping to address critical science questions in Earth system science research. This manuscript describes the DOE UAS/TBS datasets, including information on the acquisition, collection, and quality control processes, and highlights the potential scientific contributions using UAS and TBS platforms.



https://adc.arm.gov/afcd/#/aef2023/overview

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