AAF UAS Update

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Pacific Northwest National Laboratory

ARM/ASR PI Meeting, October 25, 2022

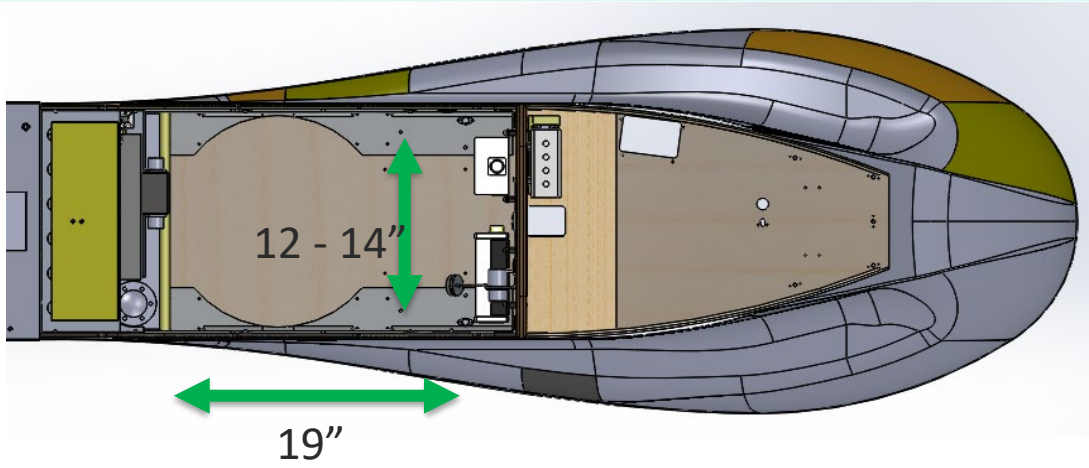
ArcticShark Technical Specifications

- Wingspan: 22’
- Length: 14’ 3”
- Empty Weight: 427 lbs.
- Max T/O Weight: 650 lbs.
- Max Payload: 100 lbs.
- Payload Power: 2,500 W
- Underwing Hard Points: 4
- Max Altitude: 18,000 ft
- Endurance: 8 hrs
- Flight Speed: 64 knots

- SatCom Capabilities
  - Over the horizon ops
- ADS-B in and out
- Onboard radios for communication with ATC and Visual Observers

ArcticShark Payload

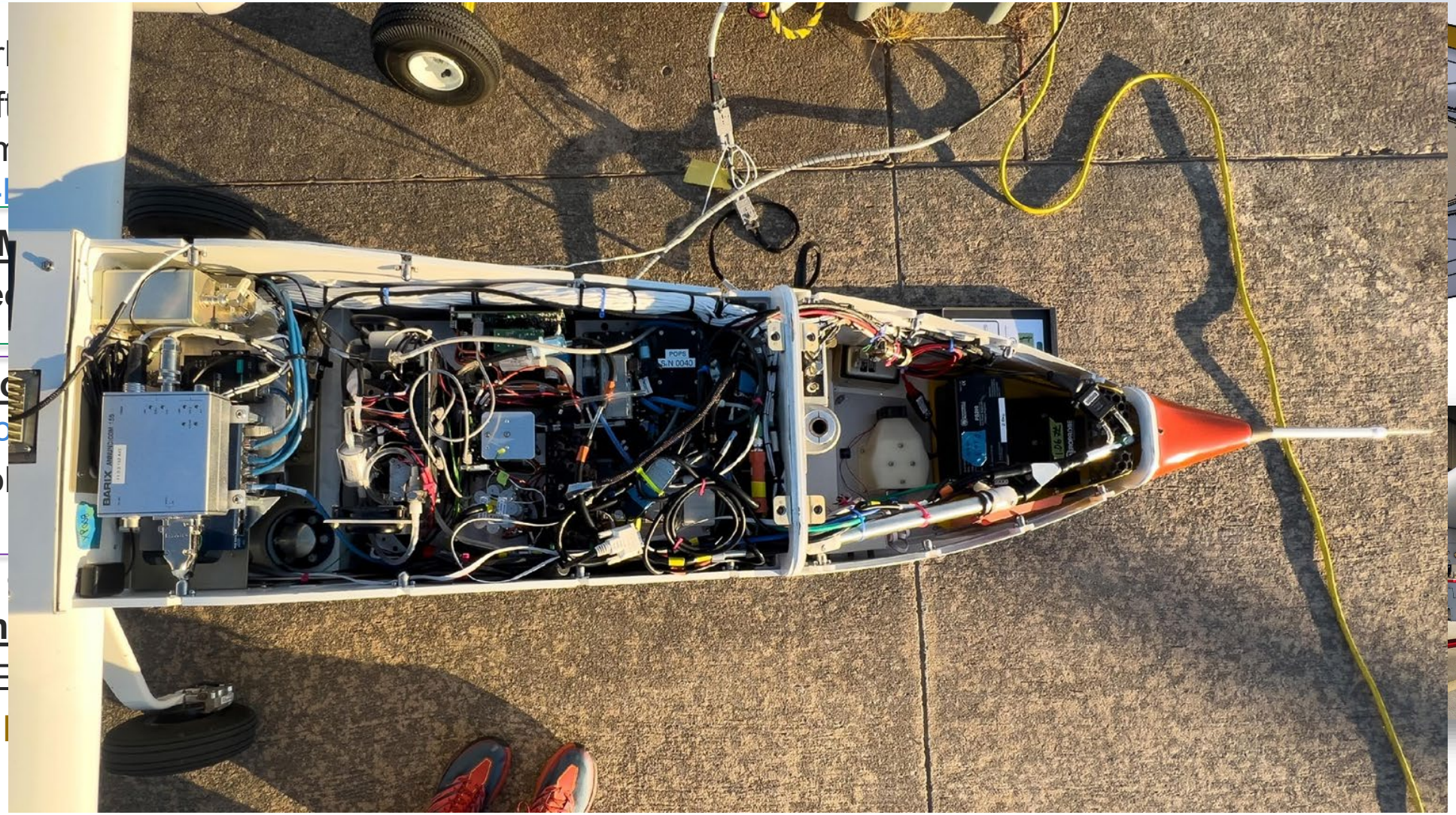
- VectorNav (VN) 200: Position and Attitude
- Aircraft Integrated Meteorological Measurement System (AIMMS)-30: Pressure, Temperature, RH, and 3-D winds (10-Hz)
- **ALTUM Camera**: Multispectral Images
- Apogee IR Thermometer: Surface Temperature

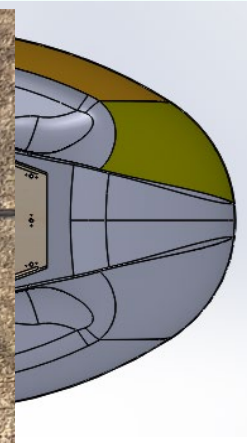


- **Aerosol Counting, Composition, Extinction and Sizing System (ACCESS):** Aerosol composition, number, size, and absorption
- Portable Optical Particle Spectrometer (POPS): Aerosol size distribution (~0.13 to 3 µm)
- Li-Cor 840A: H_20 and CO_2 (2-Hz)
- **IsoKinetic Aerosol Inlet**
  - EE08: Sample line temp and RH
- Cloud Droplet Probe: Cloud and Aerosol size distribution (~2 to >10 µm)

ArcticShark Payload

- Vectorl
- Aircraf
  System
  and 3-
- **ALTU**
- Apoge
- **Aeros**
  Aeros
- Portabl
  3 µm)
- Li-Cor
- **IsoKin**
  - EE
- Cloud

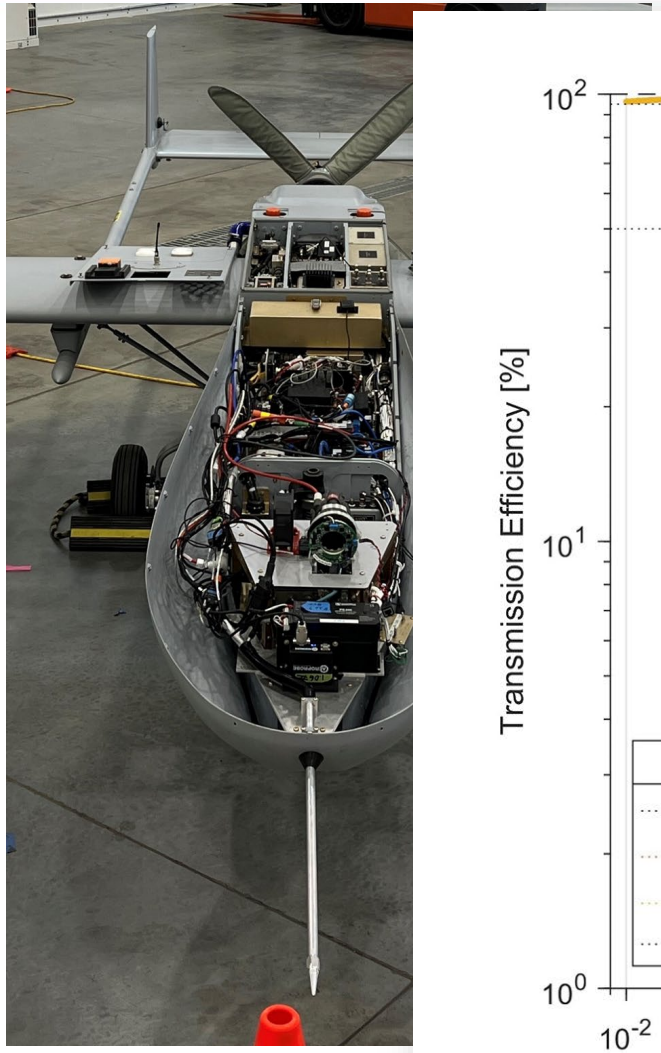


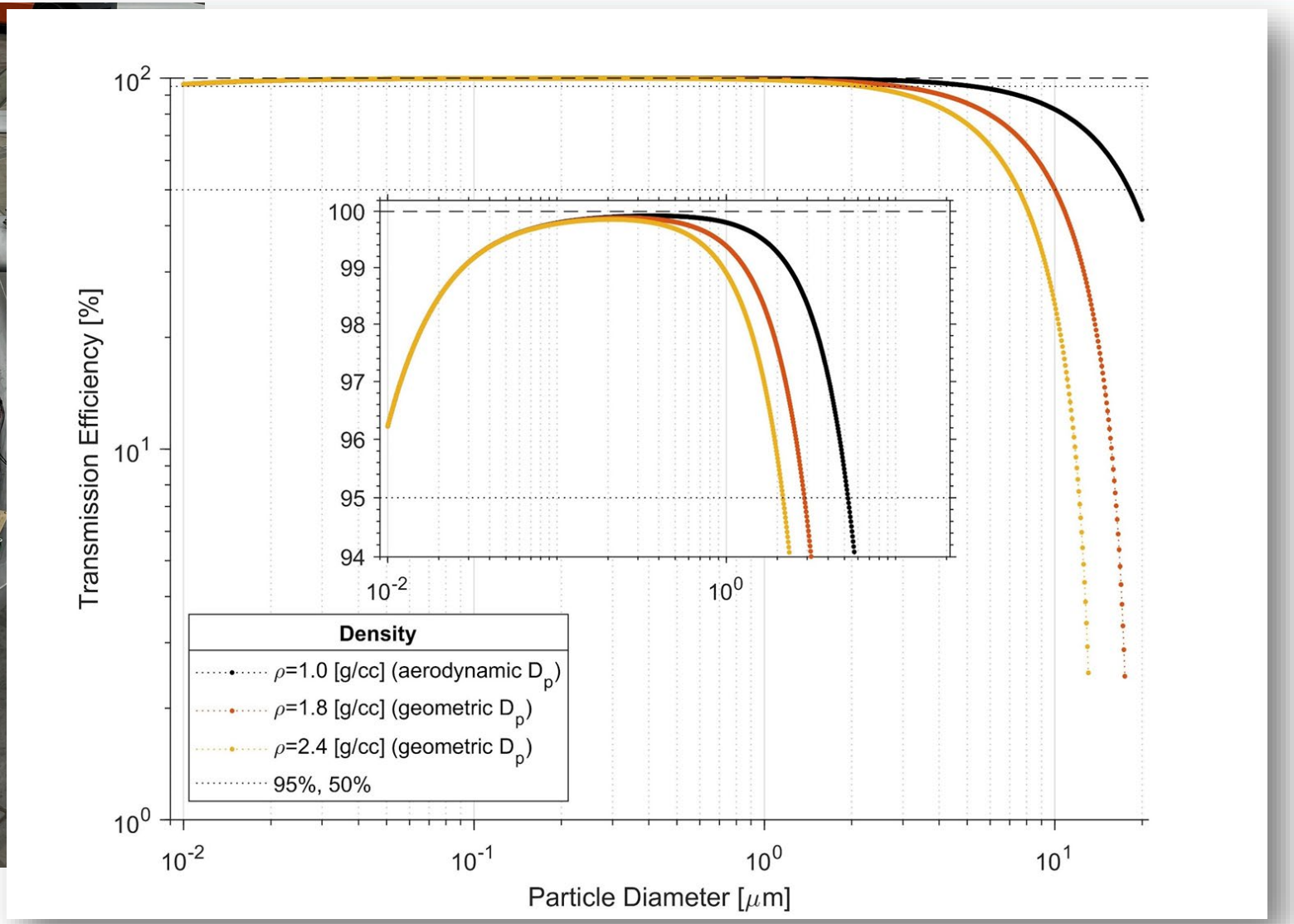


IsoKinetic Aerosol Inlet

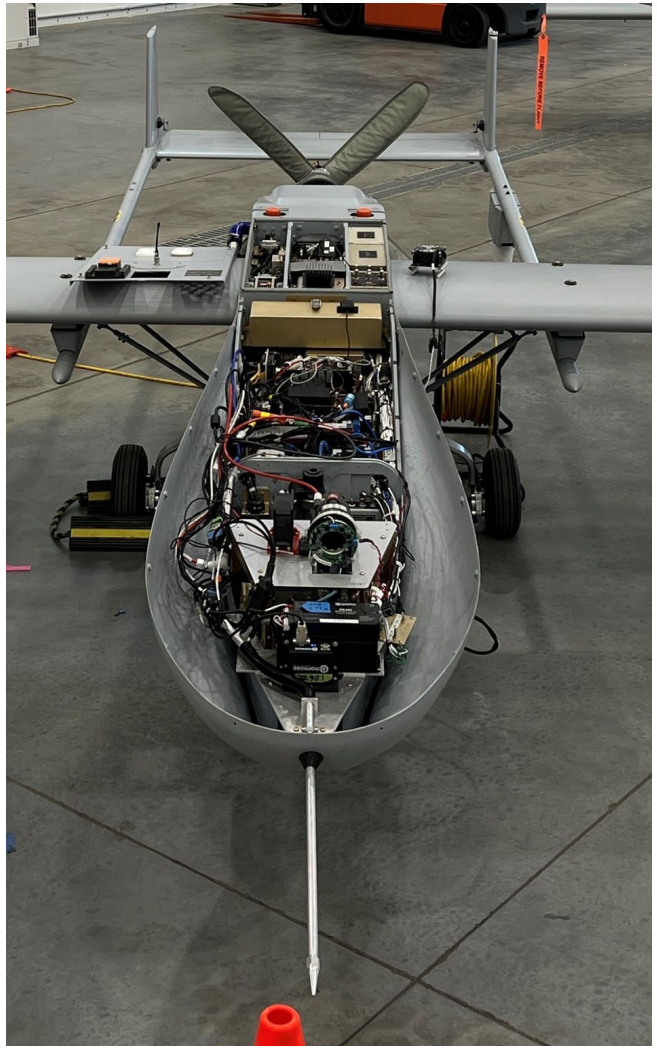
- Inlet tip is in the free air-stream
- Aligned with a 5-port Gust Probe
- Delivers air sample with minimal distortion of the aerosols and trace gases

Isokinetic Aerosol Inlet

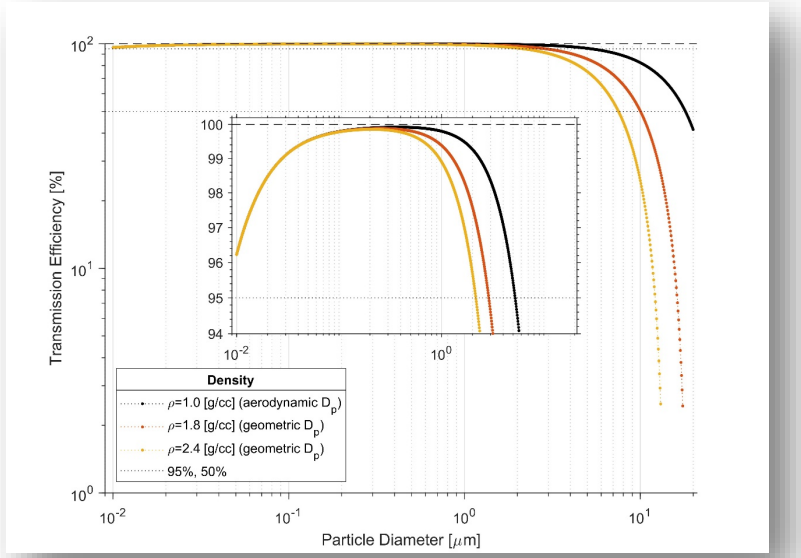


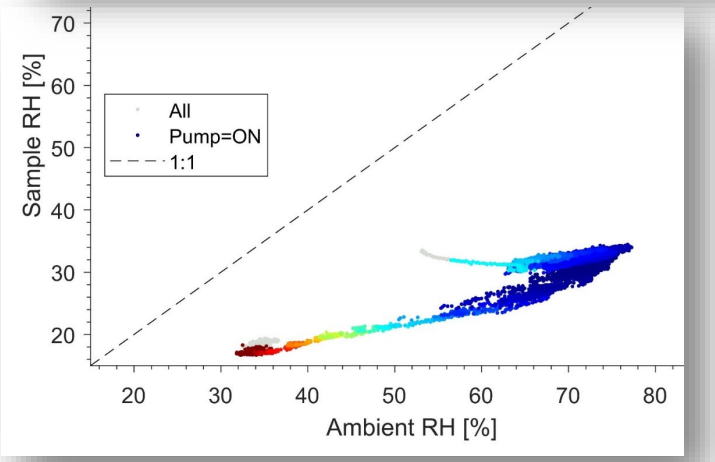


Isokinetic Aerosol Inlet



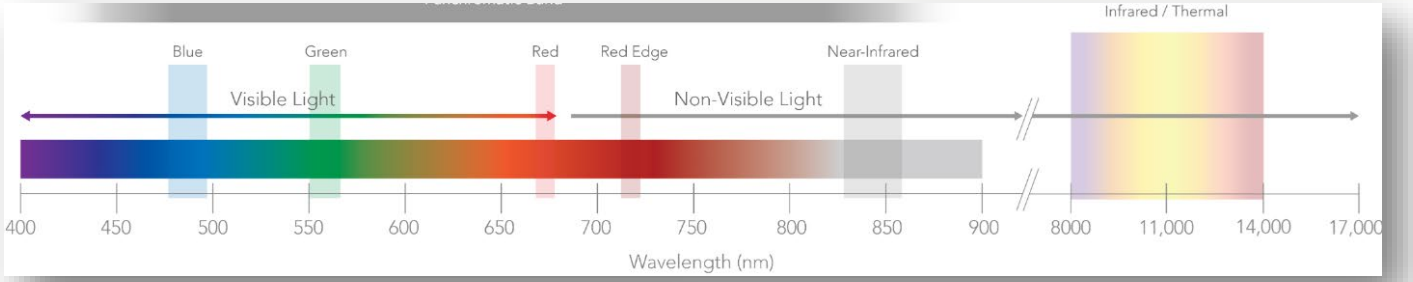
- Inlet tip is in the free air-stream
- Aligned with a 5-port Gust Probe
- Delivers air sample with minimal distortion of the aerosols and trace gases
- Control relative humidity below 40% (as per WMO/GAW recommendations)
- Provide sufficient air flow for the payload and back vacuum for the pumpless instrumentation
- Has been successfully flown on 2 UAS platforms
- Next step is automatic control

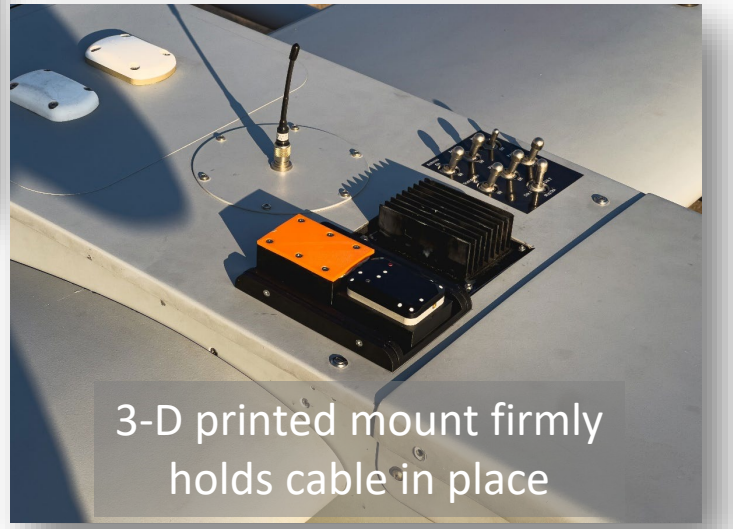


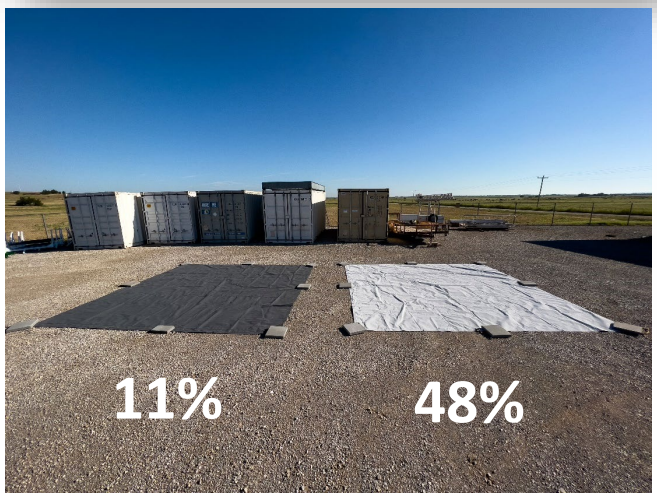


ALTUM – Multispectral Camera

- Multispectral images are routinely captured form the aircraft
  - Reflectance tarps are flown over on multiple passes during aerosol sampling
    - Calibration
    - Investigating impacts of altitude/AOD
- Also fly dedicated imaging flights
  - Legs are not flown in series to minimize turning
- Python scripts are under development to routinely process the data

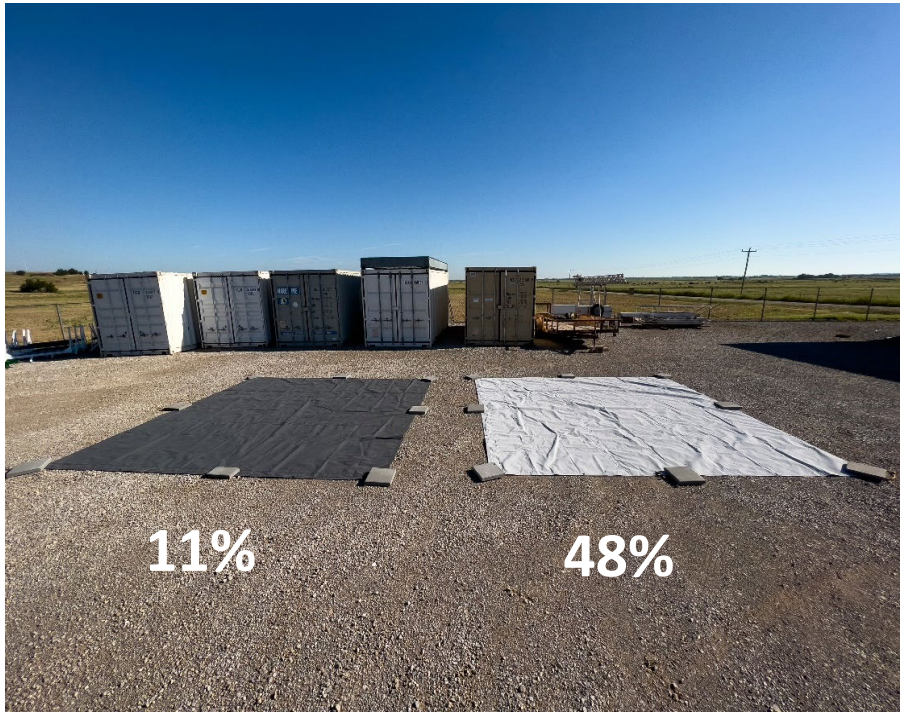


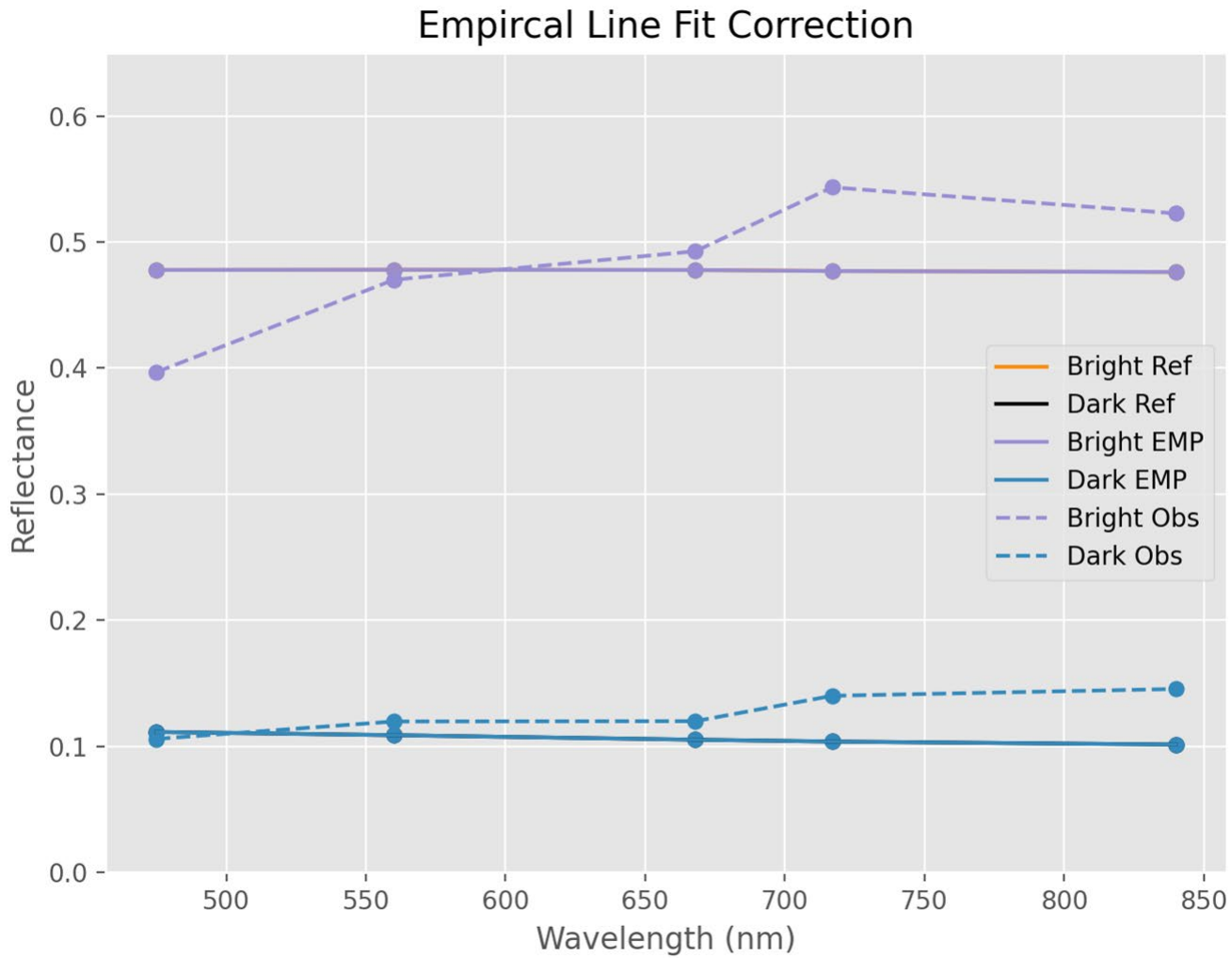




EXIF → Convert to Reflectance → Agisoft → Image-to-image registration → Empirical line fit → Output Images

ALTUM – Multispectral Camera





Multispectral Mentor & Products

Jerry Tagestad

Chand D., L.K. Berg, J.D. Tagestad, B. Putzenlechner, Z. Yang, S. Tai, and J.D. Fast. 2022. "Fine Scale Variability in Green Vegetation Fraction Over the Southern Great Plains Using Sentinel-2 Satellite: A Case Study." *Remote Sensing Applications: Society and Environment* 27. PNNL-SA-164656. doi:10.1016/j.rsase.2022.100799

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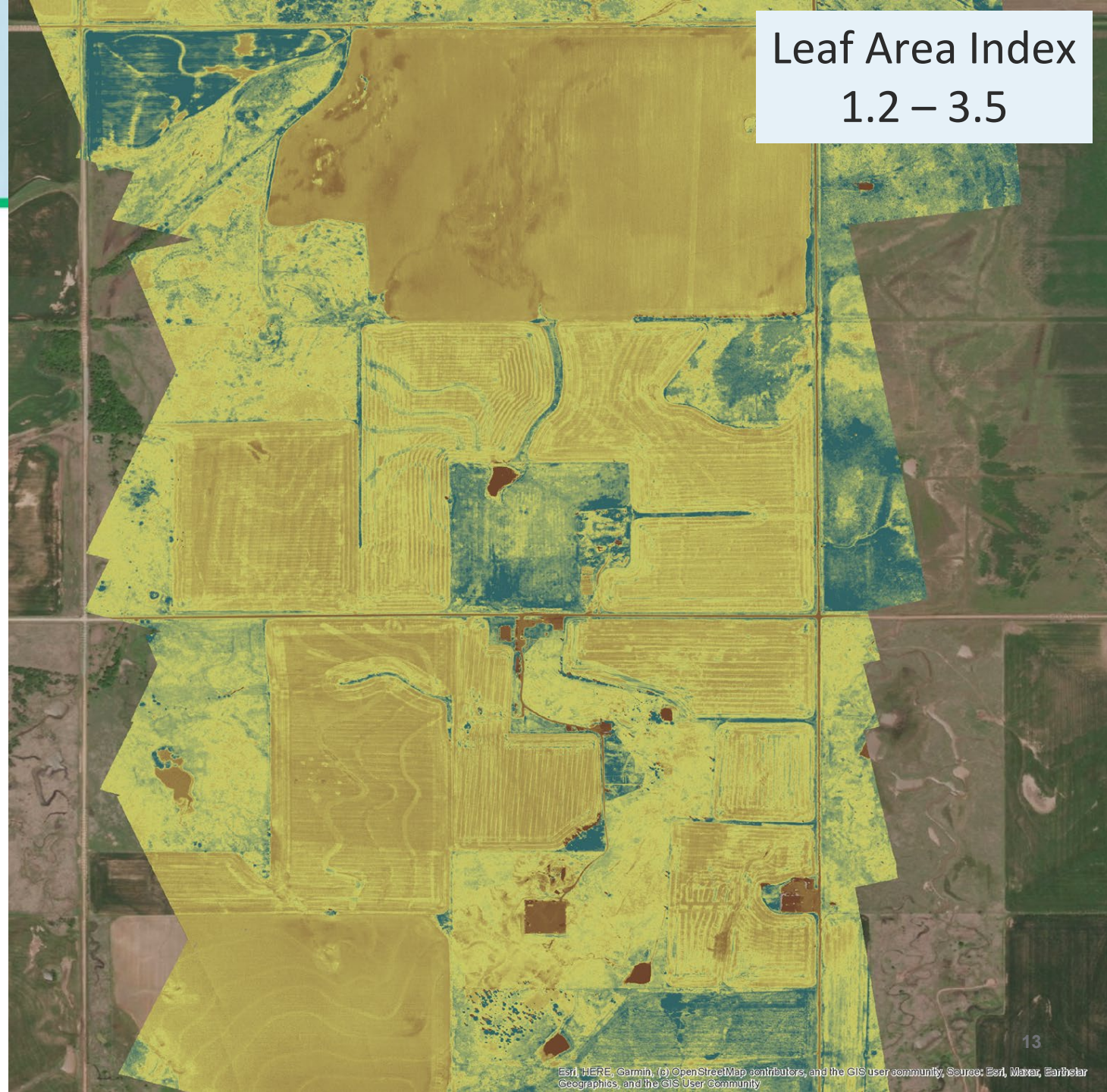
- Orthomosaic TIF images are archived
  - 6 bands represented per pixel that represent surface reflectivity
  - Surface temperature for the 6th band
  - These images can be converted into gridded products which can be used for analysis.
- November 2021 TIF images have been submitted to OME
- July 2022 will be submitted in the next few weeks

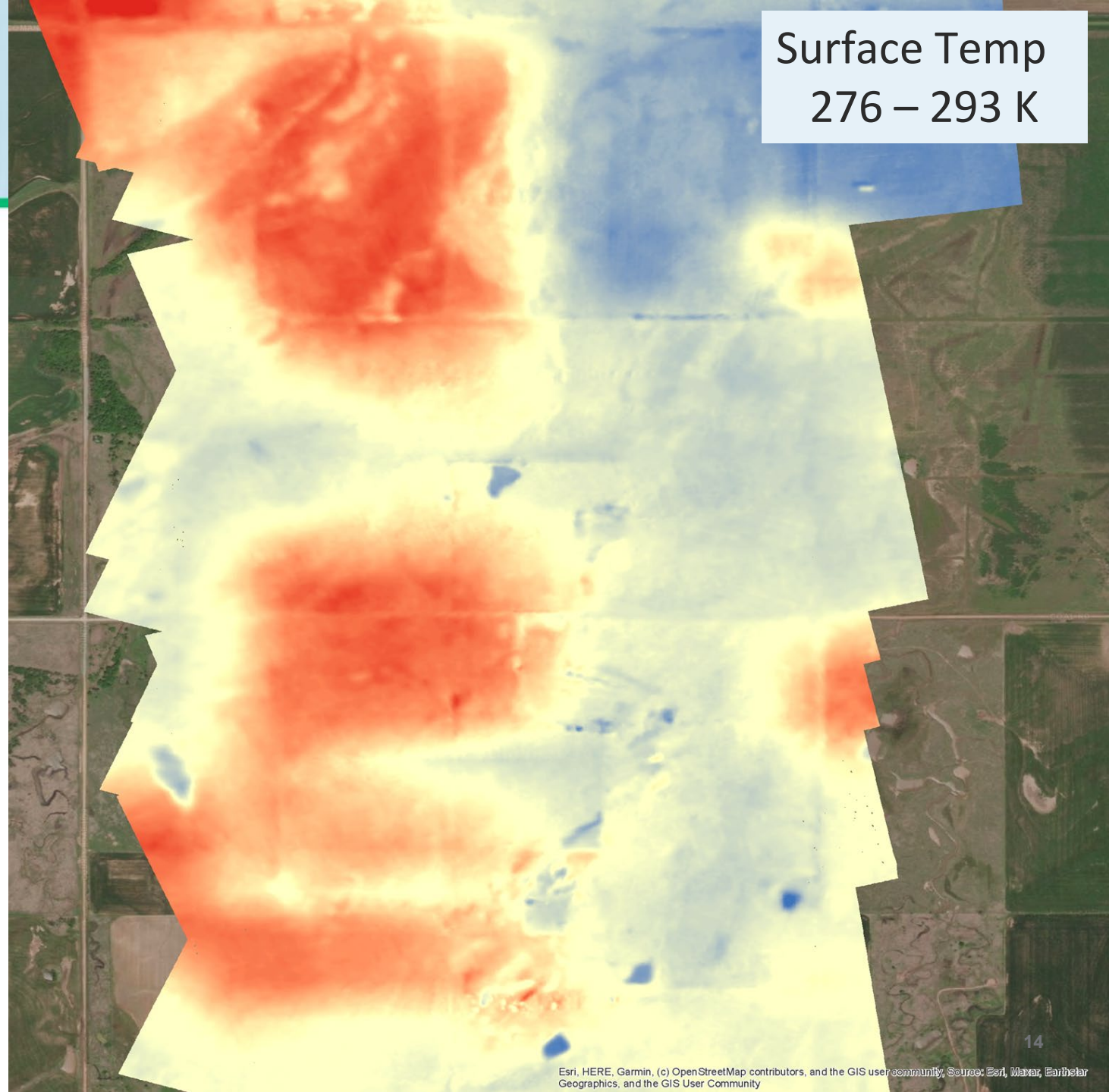

November 15, 2021
RGB


Albedo
0.13 - 0.46
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community, Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community


November 15, 2021
RGB


Leaf Area Index
1.2 – 3.5
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community, Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community


November 15, 2021
RGB

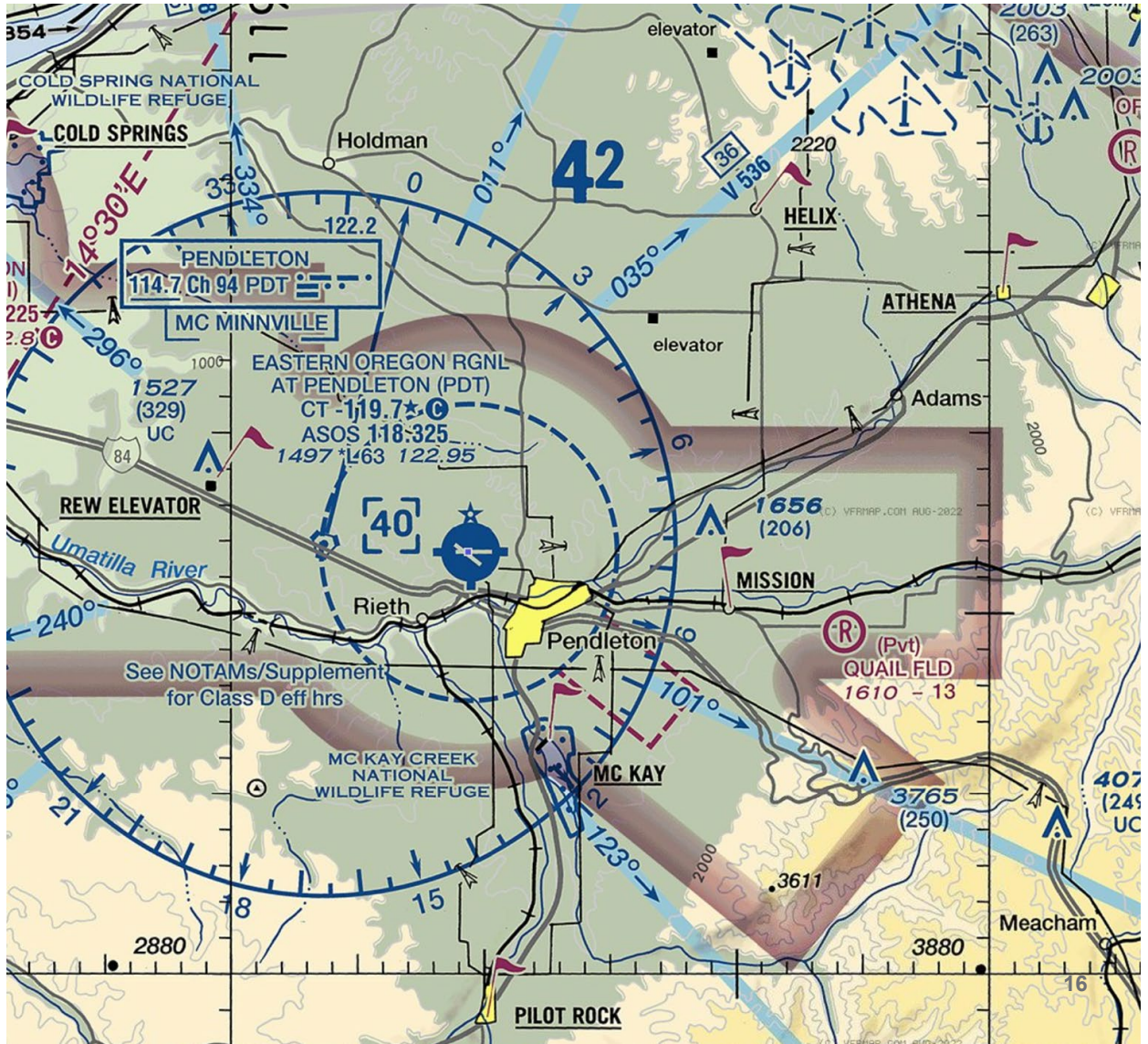

Surface Temp
276 – 293 K
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community, Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

ArcticShark Flight Operations in 2022

- Rome, NY February 2022
  - 1.8 Hours, 1 Flights
  - Solved an engine temp indicator issue
  - Pneumatic mast installation
    - Tracker Head at 25 ft AGL
- Rome, NY May 2022
  - 6.8 Hours, 5 Flights
  - Fully Instrumented test flights
- SGP - Blackwell, OK July 2022
  - Operated under a COA
  - 12.5 Hours, 7 Flights
  - Staggered Visual Observers
  - Fully instrumented flights
  - Hot environment and operations were mostly confined to the morning

Preparing for 2023 ArcticShark Flight Operations – November and February

- Implement SGP Lessons Learned
  - Payload bay temperatures were too high
    - Moved the pump
    - Added a vent
  - We need to fly lower to achieve science objectives
    - Goal is below 1,000 ft AGL over the SGP site
    - Ideally down to 500 ft AGL
    - Verify a solid Silvus radio link
    - We will practice in November
- Verify stall speed with a full payload package
    - Instrumented wings
    - Sample inlet
    - Payload installed
- Optimize ALTUM sampling pattern



ArcticShark – Upcoming Actions in the next 12 months

Flight Operations and Technician Training	Pendleton, OR	PNNL, MSU, and NASC	November 2022
Technician training	Pasco, WA	PNNL and NASC	December 2022
Flight Operations	Pendleton, OR	PNNL and NASC	February 2023
Science Missions with staggered VOs at SGP	Blackwell, OK	PNNL, MSU, and NASC	March, June, and August 2023

ARM baseline capability for at least the next few years

Thank you

Questions | Comments

Observational data from uncrewed systems over Southern Great Plains

Fan Mei et al.

Earth System Science Data

July 2022

14(7):3423-3438

DOI:10.5194/essd-14-3423-2022