NOAA Air Resources Laboratory's Capabilities to Support Fire Weather Research as Demonstrated Through Recent Campaigns

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Goals

Conduct R&D with UAS and other measurement systems to support fire weather predictions through the study of land-atmosphere interactions and PBL processes.

Improve the representation of aerosols and smoke in operational forecasting models.

ARL Observation Platforms

Instrument	Sampling Height(s) (m AGL)
HMP110 T, RH probe	2
Aspirated PRT	2 ,10
Pressure sensor	1
Hukseflux net radiometer	2.5
TP01 soil temperature probe	-0.05, -0.10, -0.20
Decagon soil moisture probe	-0.05, -0.10, -0.20
Propeller anemometer	2, 10
PAR sensor	2.5
Closed path gas analyzer	10
Sonic anemometer	10

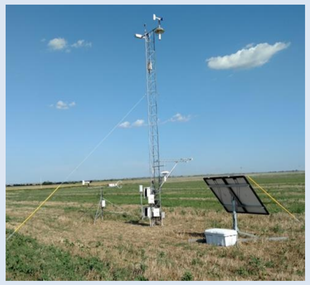
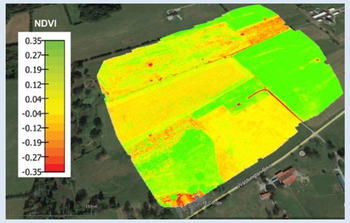


Table 1: Instruments on ARL's 10-m met. towers.

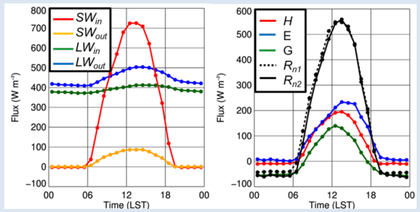
Model	CopterSonde	APH-28	BlackSwift S2
			
Variables Sampled	*T, q, p, u, v*	*T, q, u, v, LST*	*T, q, u, v, w, LST*
Instruments	Self-contained	iMet XQ2 Vis/IR camera MicaSense Altum PT	iMet XQ2 Multi-hole probe Fast-response T/RH, MicaSense Altum PT
Manufacturer	Univ. of Oklahoma	Aerial Imaging Sol.	BlackSwift Tech.
Units in Fleet	1	1	2
Gross Weight	2 kg	5 kg	6.6 kg
Autopilot	Pixhawk	AVR	SwiftPilot
Endurance	15 min	20 min	80 min

Table 2: Current UAS in ARL's fleet.

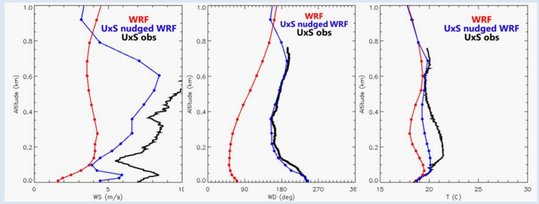
Results from Recent Campaigns



Finescale NDVI estimates from UAS.



Obs. from sfc. energy balance systems (*Lee and Buban 2020*)



UAS DA improves forecasted sfc. winds + temp. (Ngan et al. 2023)

Air Quality Modeling

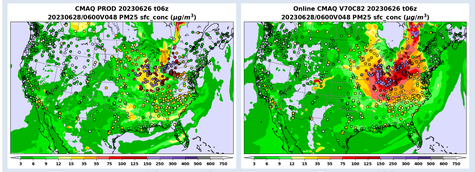
Model	Chemistry Available	Application
RRFS – Smoke + Dust	Simplified Aerosols: Smoke + Dust Tracers	Regional Wildfire Smoke Forecasts
UFS – Aerosols	Simplified Aerosols: GOCART	Global Weather Forecasts with aerosol feedbacks
Online CMAQ	Complex chemistry from CMAQ: Ozone and Aerosols	Regional Air Quality Forecasts

Table 3: Current UFS structure for atmospheric chemistry and composition.

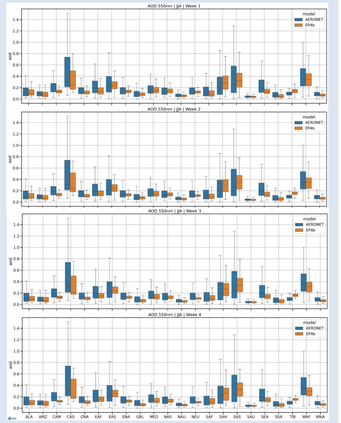
Problems / Opportunities:

- Chemistry-related code is duplicated across the UFS, which is not unified and time intensive to maintain.
- Would like to add research capabilities for atmos. composition and chemistry, but it is unclear how to do this with chemistry divided across so many models/applications.

Operational AQMv6 | **Experimental AQMv7**



Forecasting the June Canadian fire event and its impact on the CONUS using the experimental AQMv7 shows notable improvements from the operational model forecasting regional surface PM2.5 concentrations.



GEFSv13 prototype vs. AERONET stations for Weeks 1-4.

Collaboration with Other OAR Labs

- Fire weather experimental testbeds through targeted field campaigns, e.g. Study of Precipitation, the Lower Atmosphere and Surface for Hydrometeorology (SPLASH)
- Collaborative and integrated field experiment designs at Table Mountain, CO and Bondville, IL
- Plans for PBL supersites at Blodgett Forest, CA; Audubon, AZ; Reynolds Creek, ID

Advantages of a Collaborative Obs. Strategy for Fire Wx Research

Improved physical understanding of L-A interactions feedbacks

Improved model initialization through coupled DA systems

Improved short and medium range forecasts, as well as seasonal and climate predictions, by improving model physics

Improved fire, air, and water quality prediction