



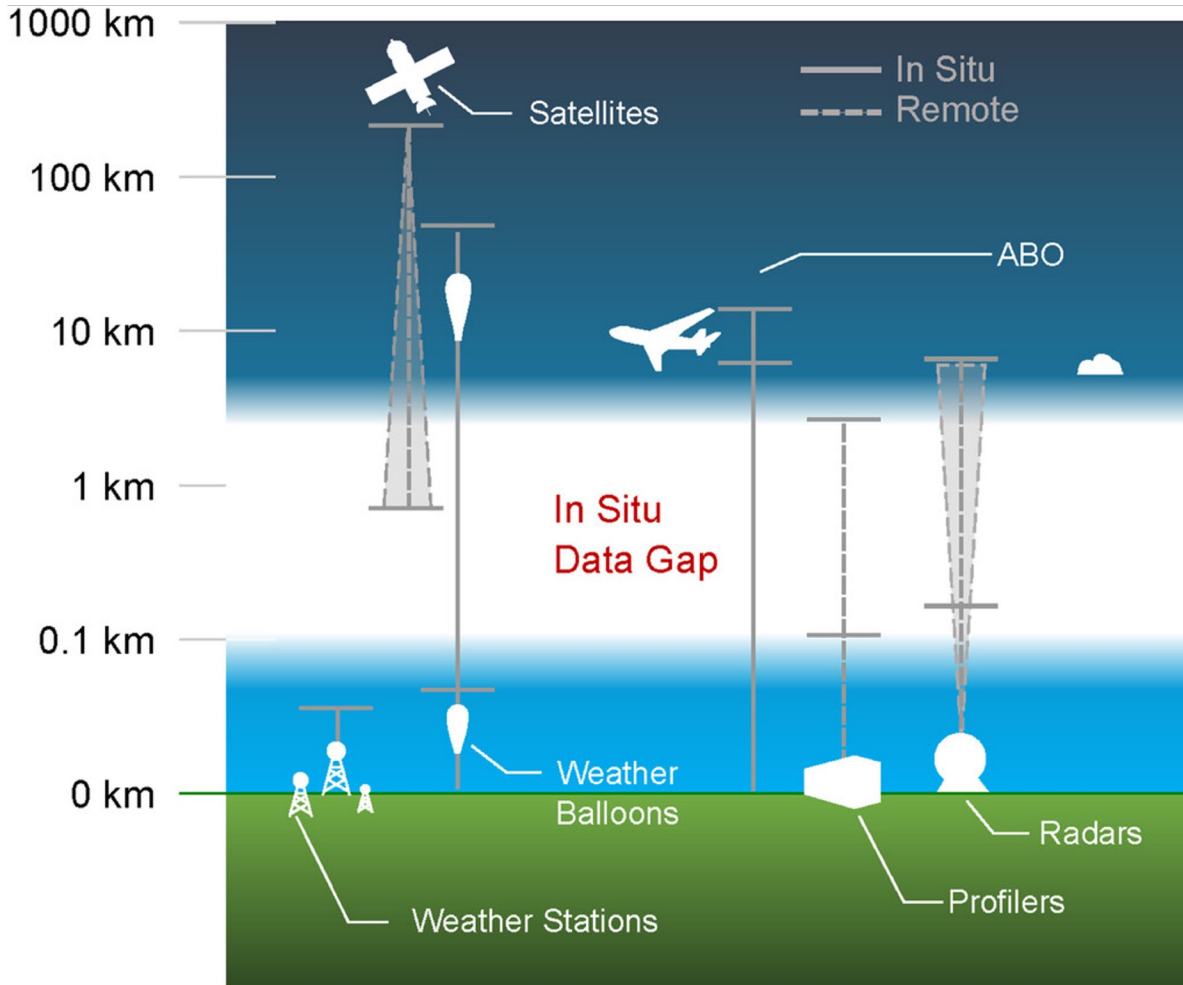
UAS weather data sharing for enhanced safety and efficiency of Advanced Aerial Mobility

James Pinto

NSF NCAR/Research Applications Lab

Friends and Partners of Aviation Weather – Dallas, Texas
1 May 2024

The Problem: In-Situ Data Gap in PBL



Adapted from Murdzek (2024 UAS Weather Forum)

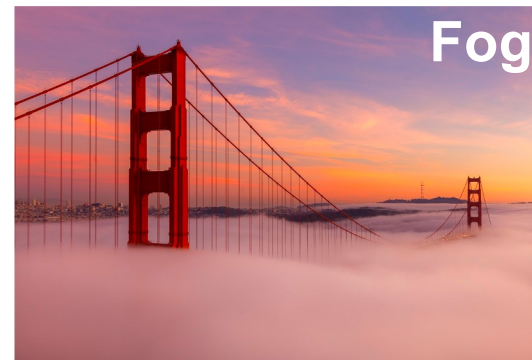
Why should we care about the planetary boundary layer (PBL)?



<https://www.news10.com/weather/weather-101/weather-101-what-cloud-is-that/>



<https://www.cnn.com/2017/06/05/americas/tornado-lawn-mowing-photo-trnd/index.html>



<https://www.goldengate.org/exhibits/when-its-foggy-foghorns/>

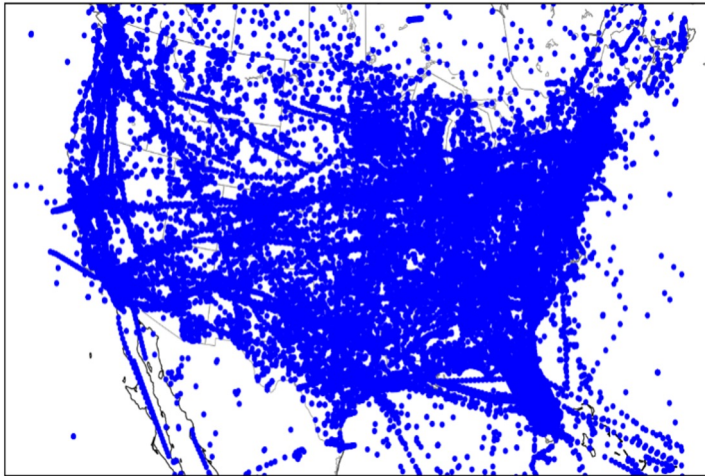


<https://www.weather.gov/safety/winter-snow-squall>

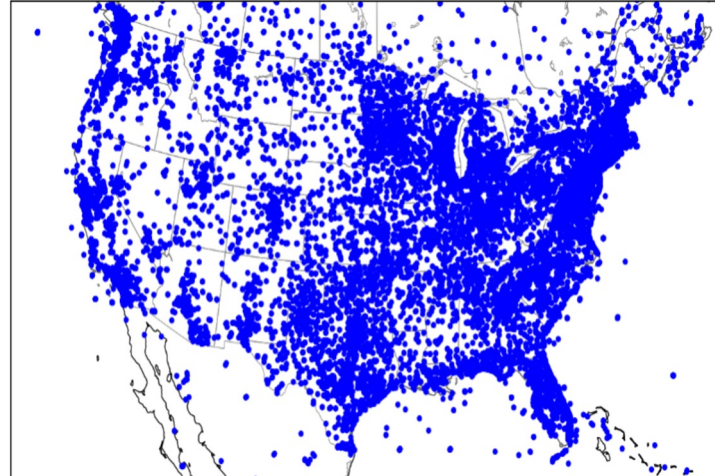
Observational Data Gap

Data Assimilated into the NOAA High Resolution Rapid Refresh

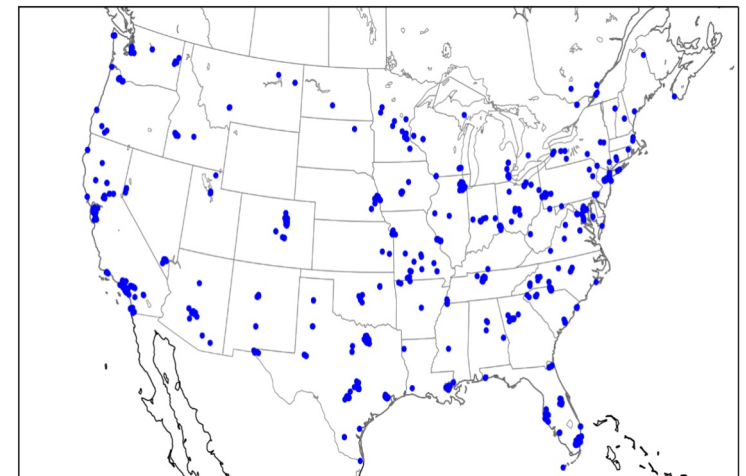
All Observations



Near-Surface Observations

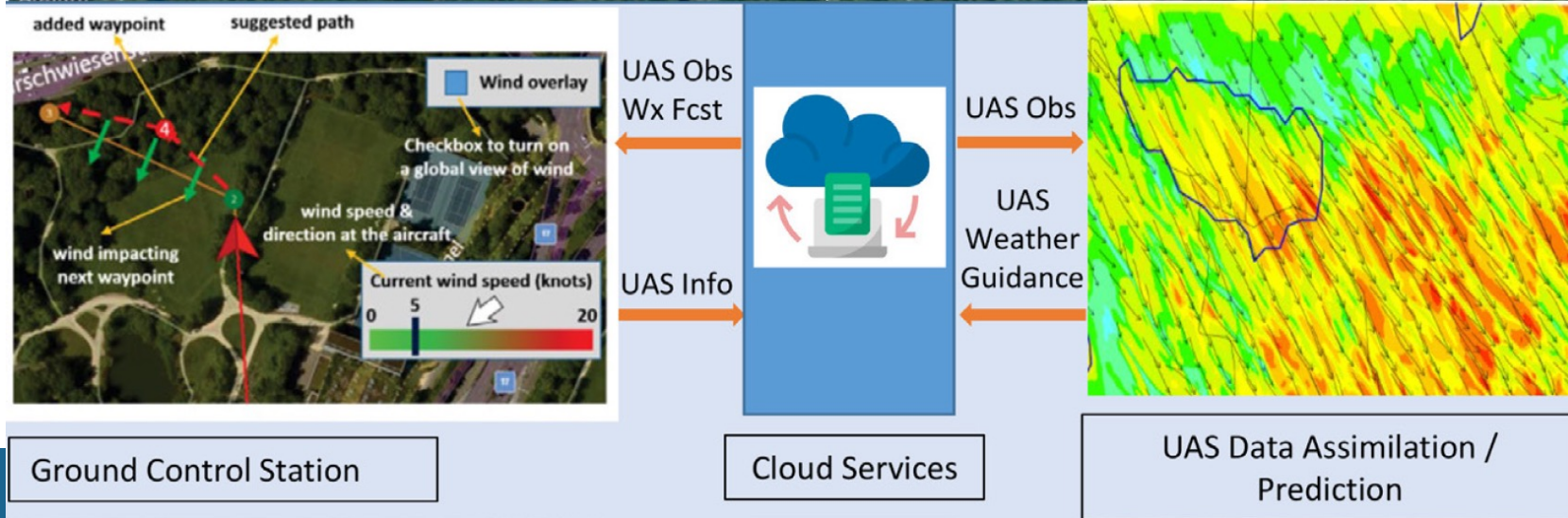
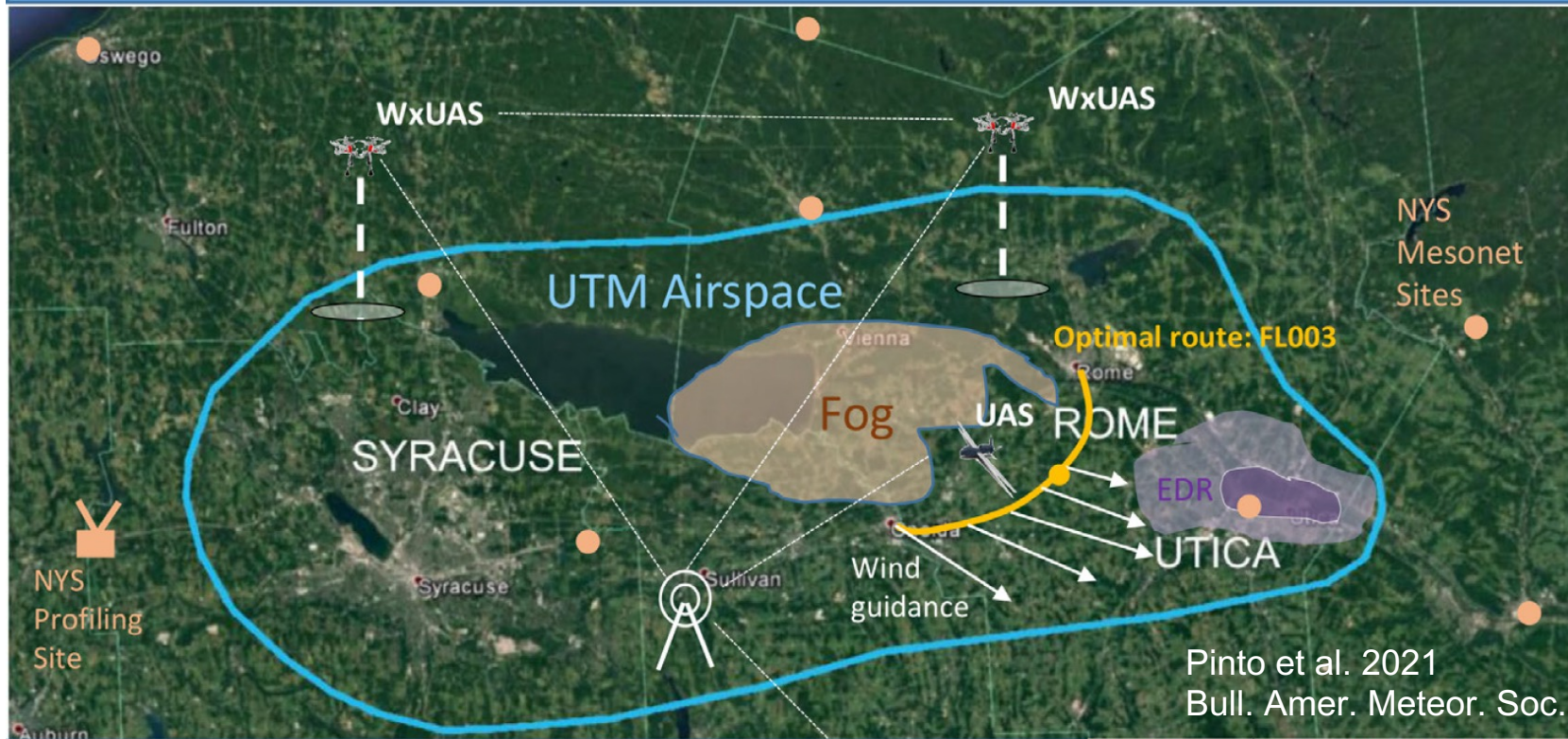


PBL Observations



Adapted from Shawn Murdzek (2024 UAS Weather Forum)

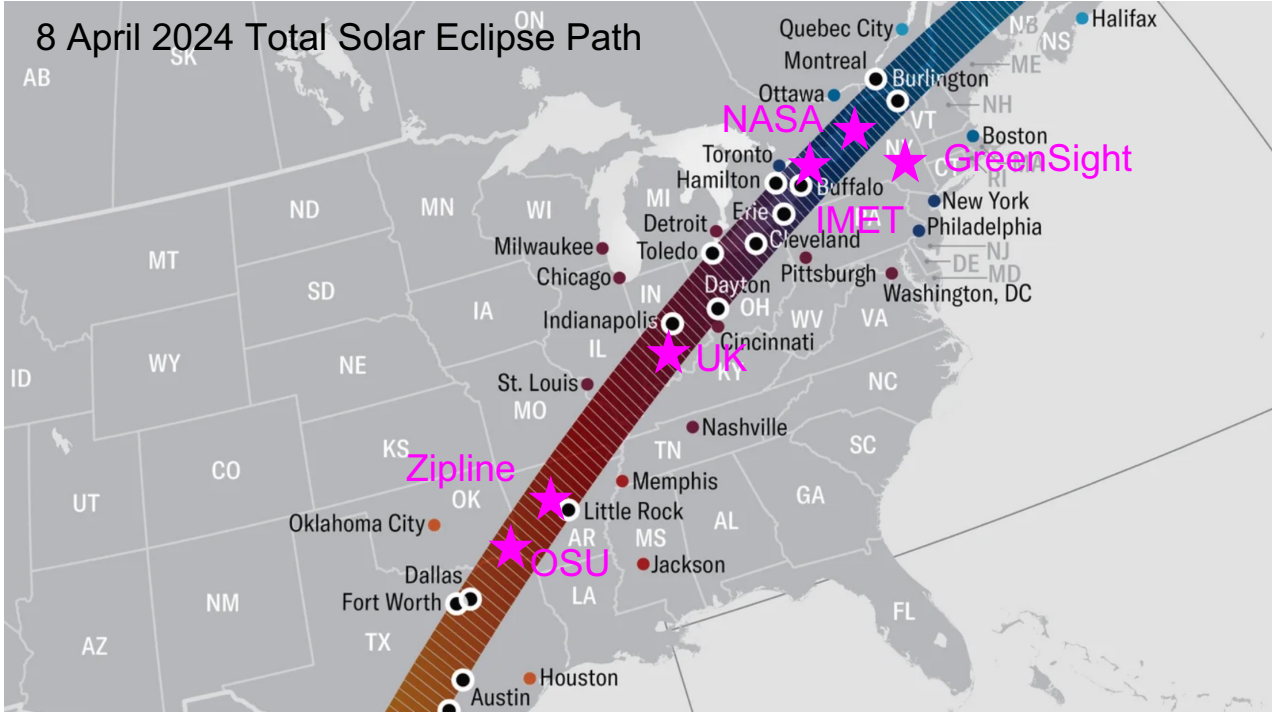
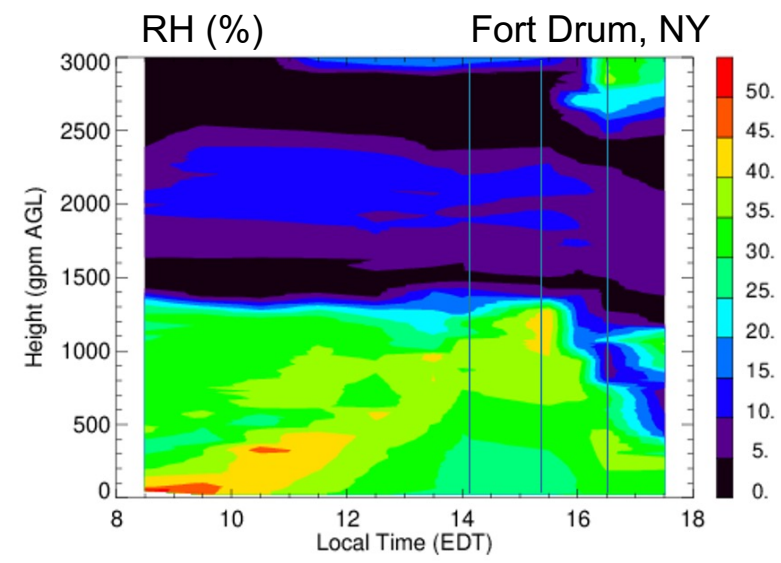
WEATHER-AWARE UAS TRAFFIC MANAGEMENT SYSTEM



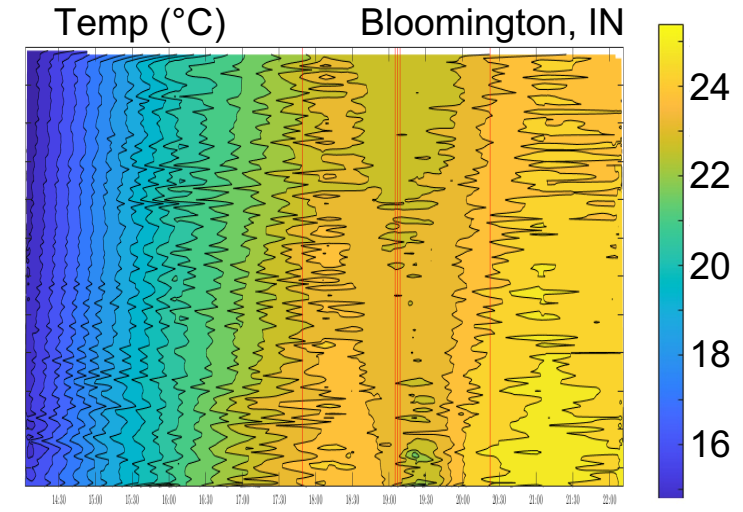
2024 WMO UAS Demonstration Campaign

- 1st Intensive Observation Period 1st week of April (Eclipse flights)
- 2nd IOP : Sept 2024 (ISARRA Flight Week = Tulsa SCALES)
<https://go.okstate.edu/aerospace/isarra-flight-week-objectives.html>
- Over 1000 profiles uploaded to cloud already
- Commercial, government agencies, universities, international
- Some WxUS collecting observations up to 10,000 ft
- Data being made available to modeling centers in realtime.

NASA ALTA UAS Flights

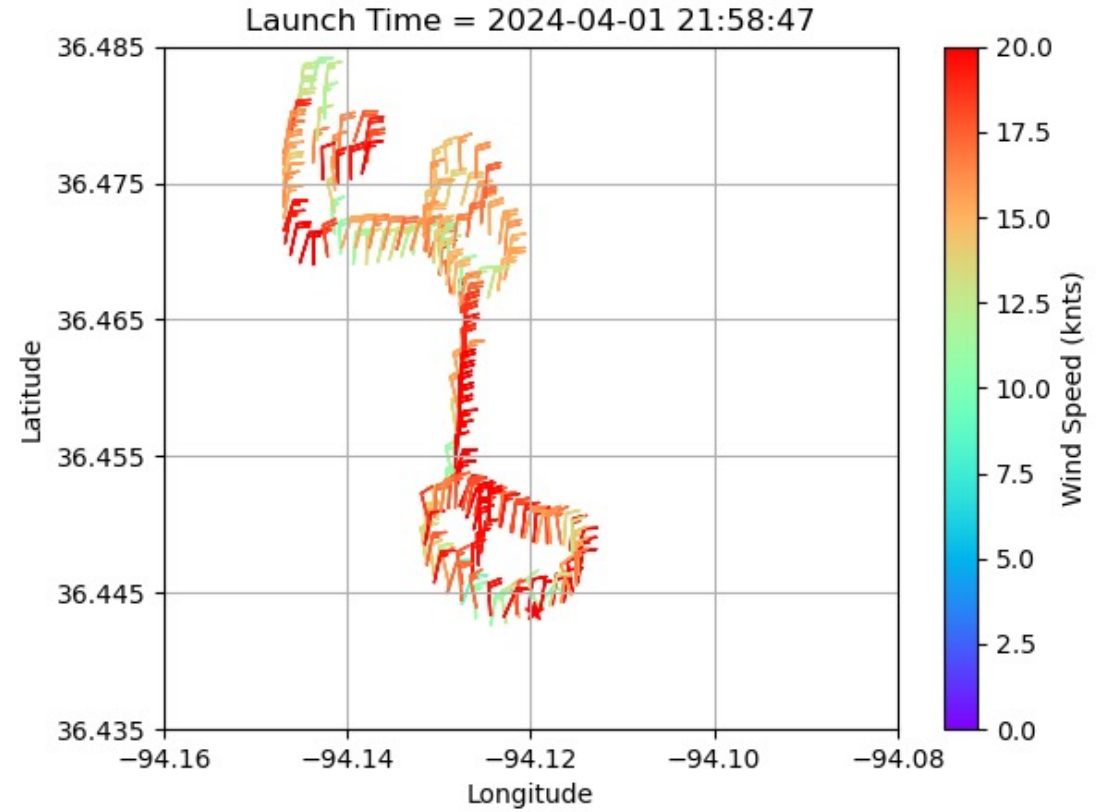
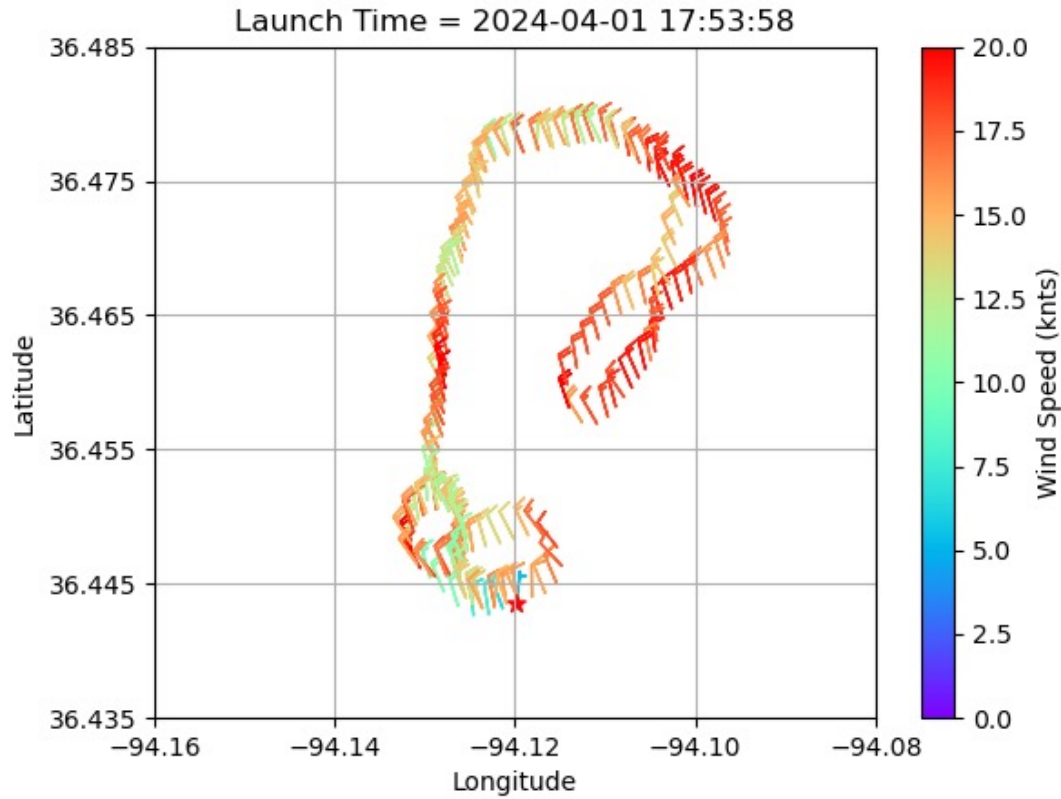


University of Kentucky Flights



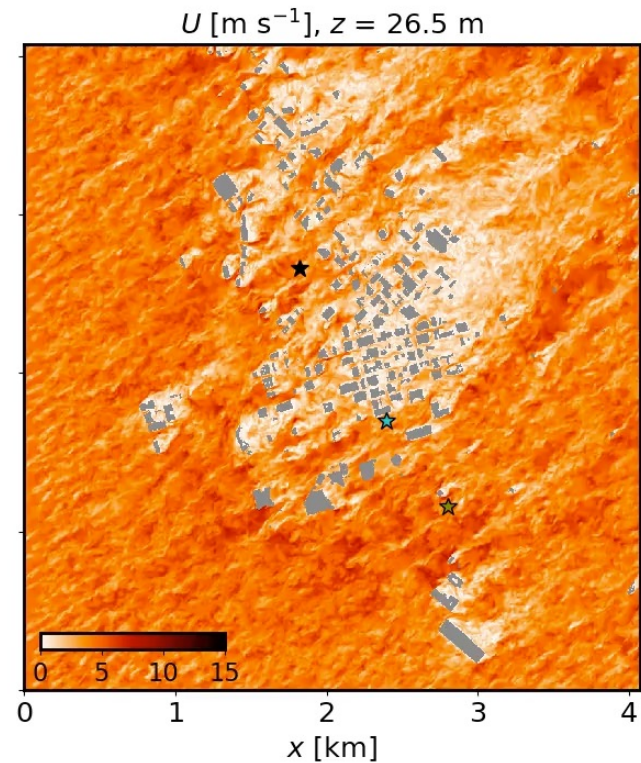
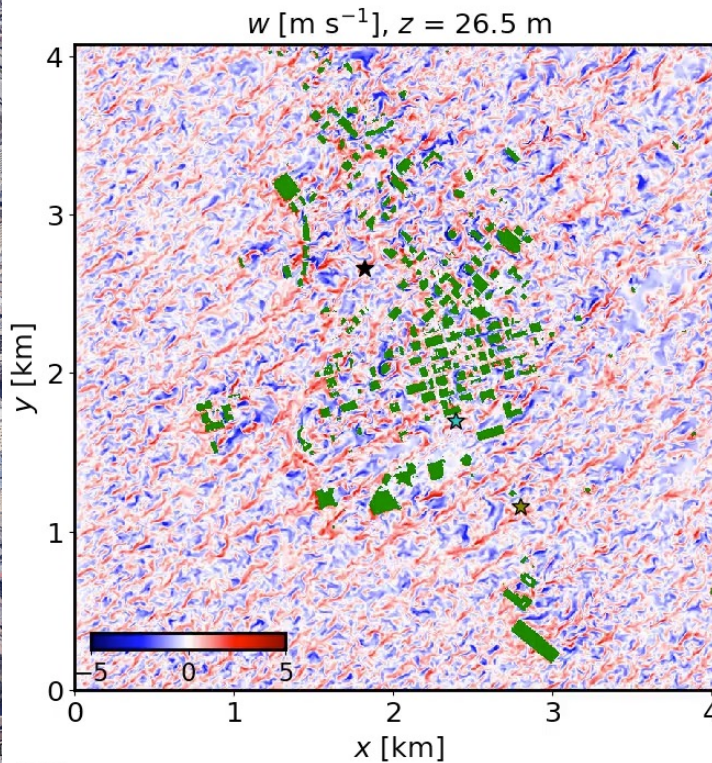
<https://community.wmo.int/en/uas-demonstration>

Zipline Example: Near-realtime winds for WMO DC

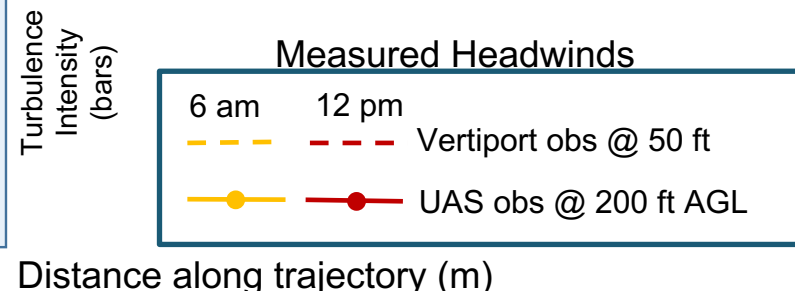
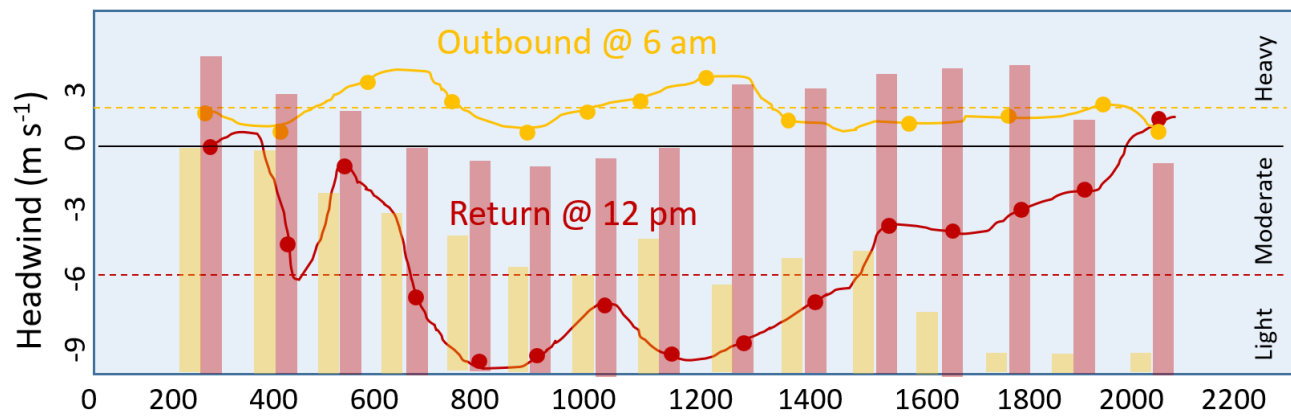


Optimizing Flights in Urban Landscapes

Building-Resolving Wind Simulation (DFW)



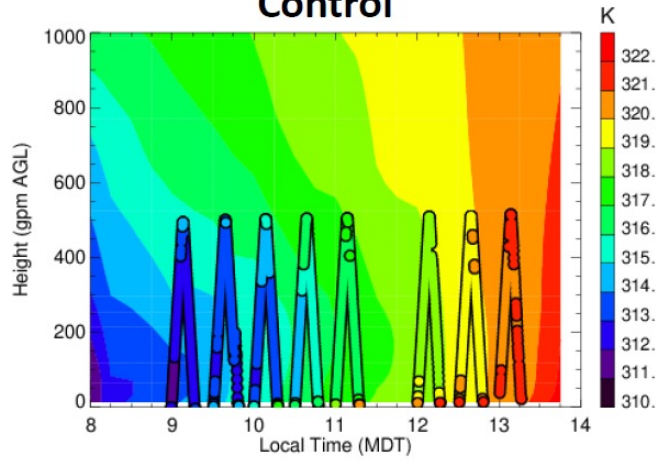
5 m resolution FastEddy LES Output



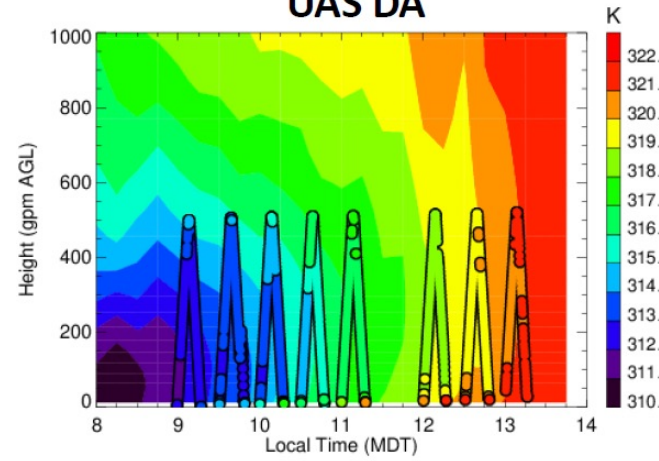
UAS DA Impacts Research

Observing System Experiments (Real UAS Observations from LAPSE-RATE) – data denial experiments

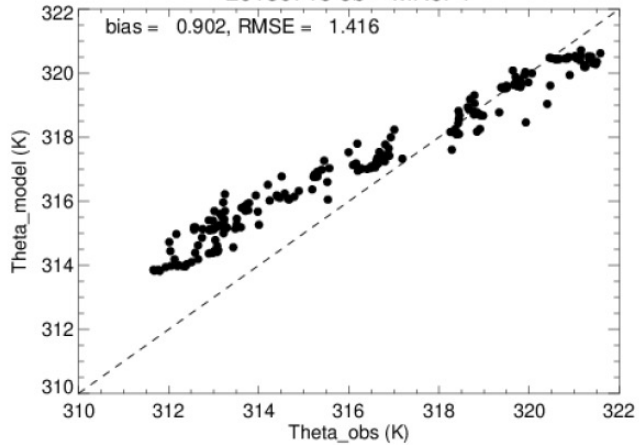
Control



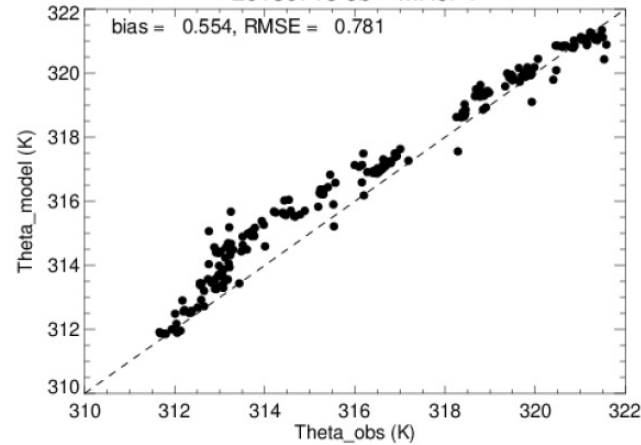
UAS DA



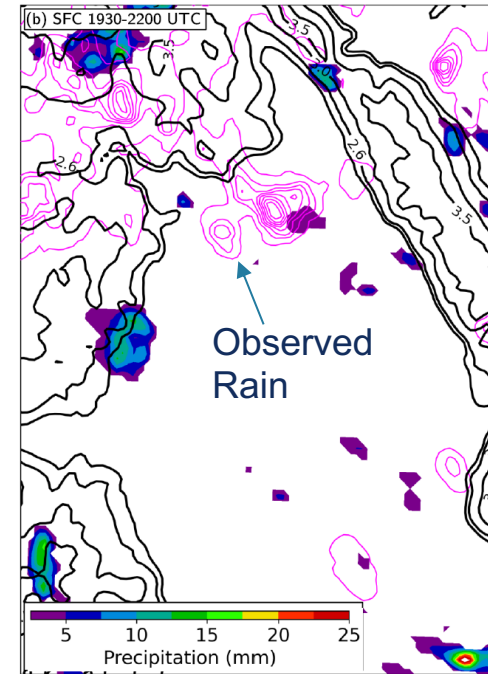
20180715 ob = MR6P1



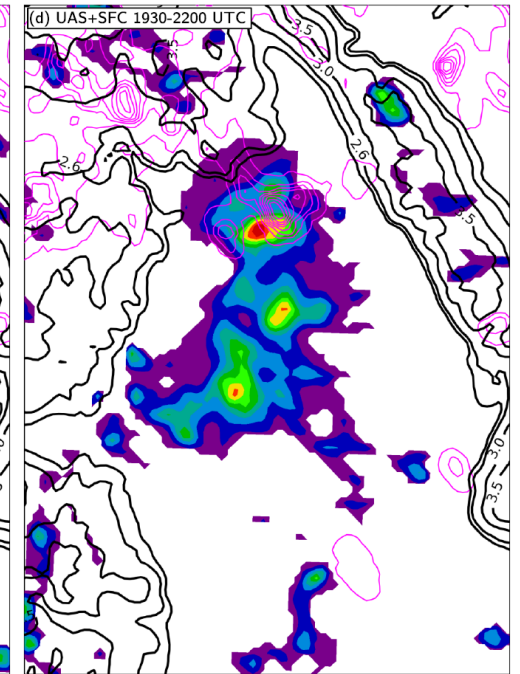
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Control

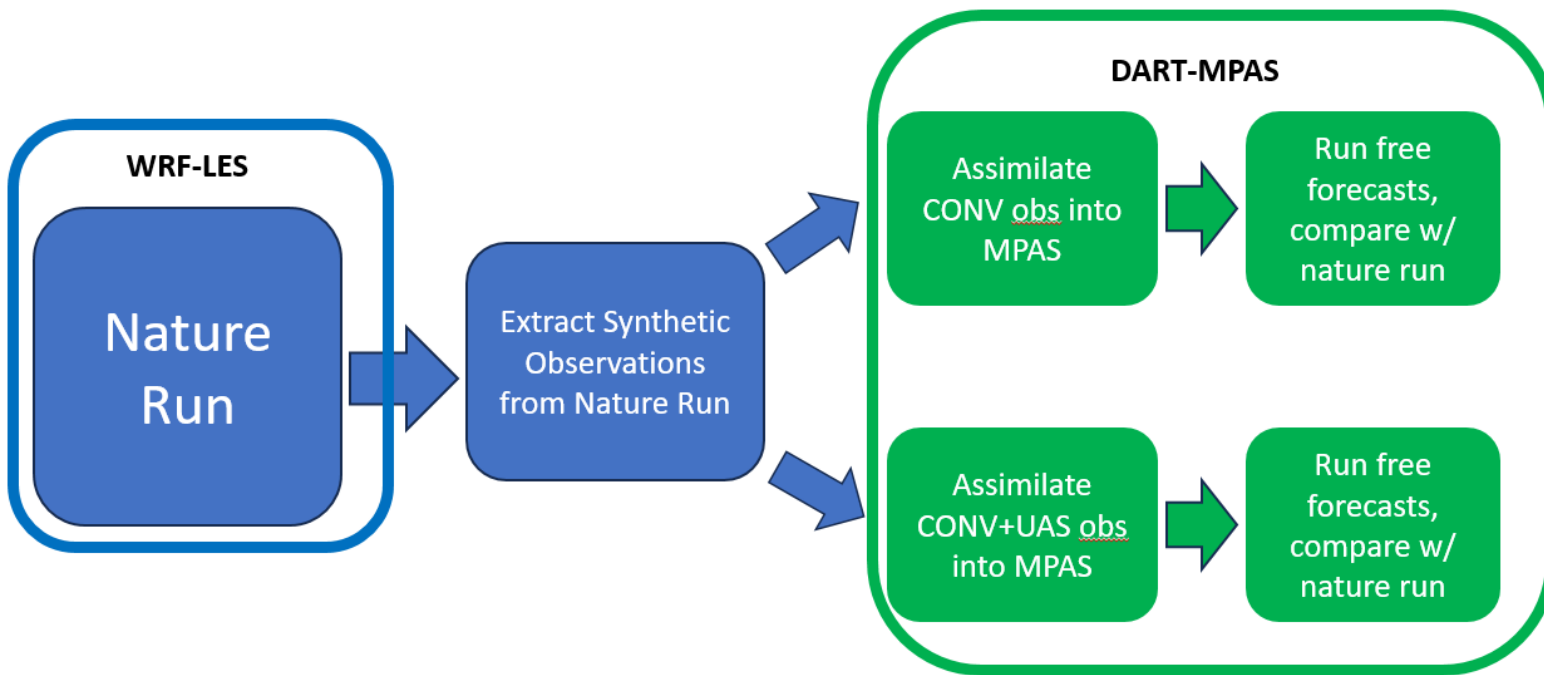


UAS DA

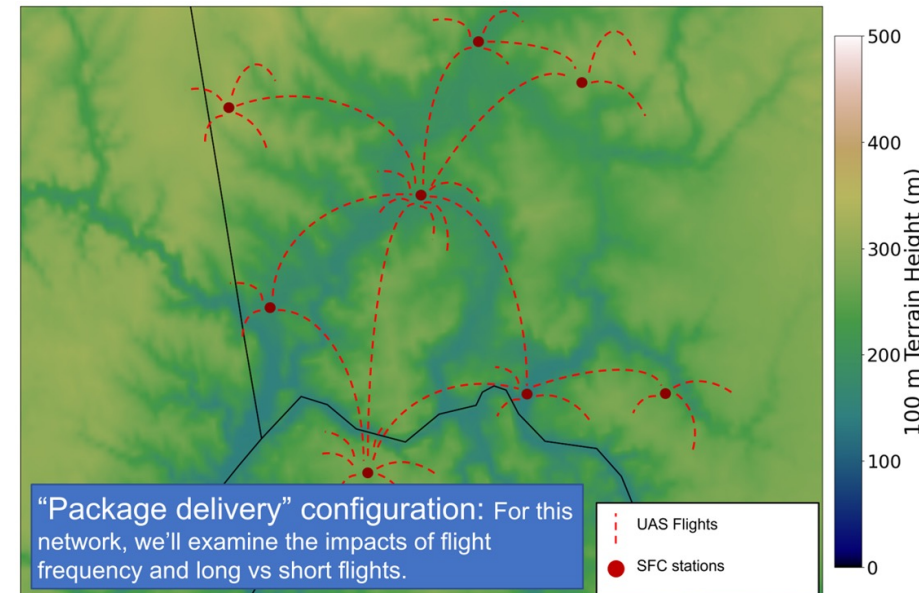
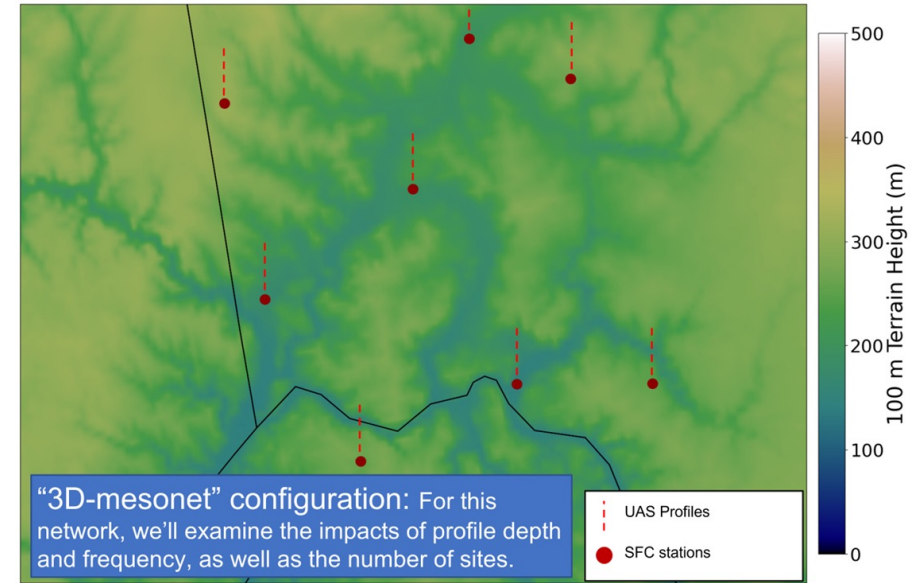


Jensen et al. 2021, 2022

Brief Overview of Observing System Simulation Experiments (OSSEs)

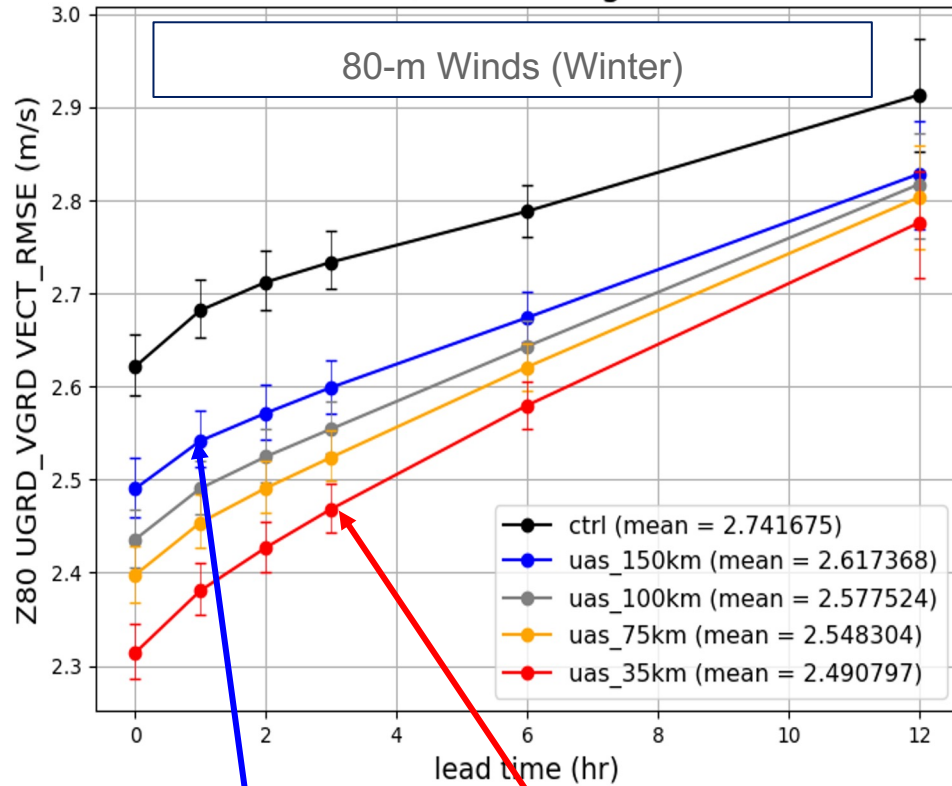


Impacts Experiments



UAS DA Impacts Research : OSSE Results

RMSE vs Spacing between UAS Profiling Sites



~5% reduction
in RMSEs

~12% reduction
in RMSEs

Observing System Simulation Experiment (OSSE) Study

- Study conducted at NOAA/GSL, CIRES
- Uses a digital twin of the atmosphere to perform experiments
- Profiling UAS up to 2 km AGL
- Hourly flights
- 2 week evaluation period

Adapted from Shawn Murdzek (2024 UAS Weather Forum)

ISARRA Conference / Flight Week

SCALES: Small-UAS Coordination for Atmospheric Low-Level Environmental Sampling

Location: Tulsa, OK

Host: Conference Oklahoma State University

Jamey Jacob

Victoria Natalie

Flight Week Leads:

Elizabeth Smith, Tyler Bell : Univ. of Oklahoma/NSSL

Adam Houston: Univ. Nebraska-Lincoln

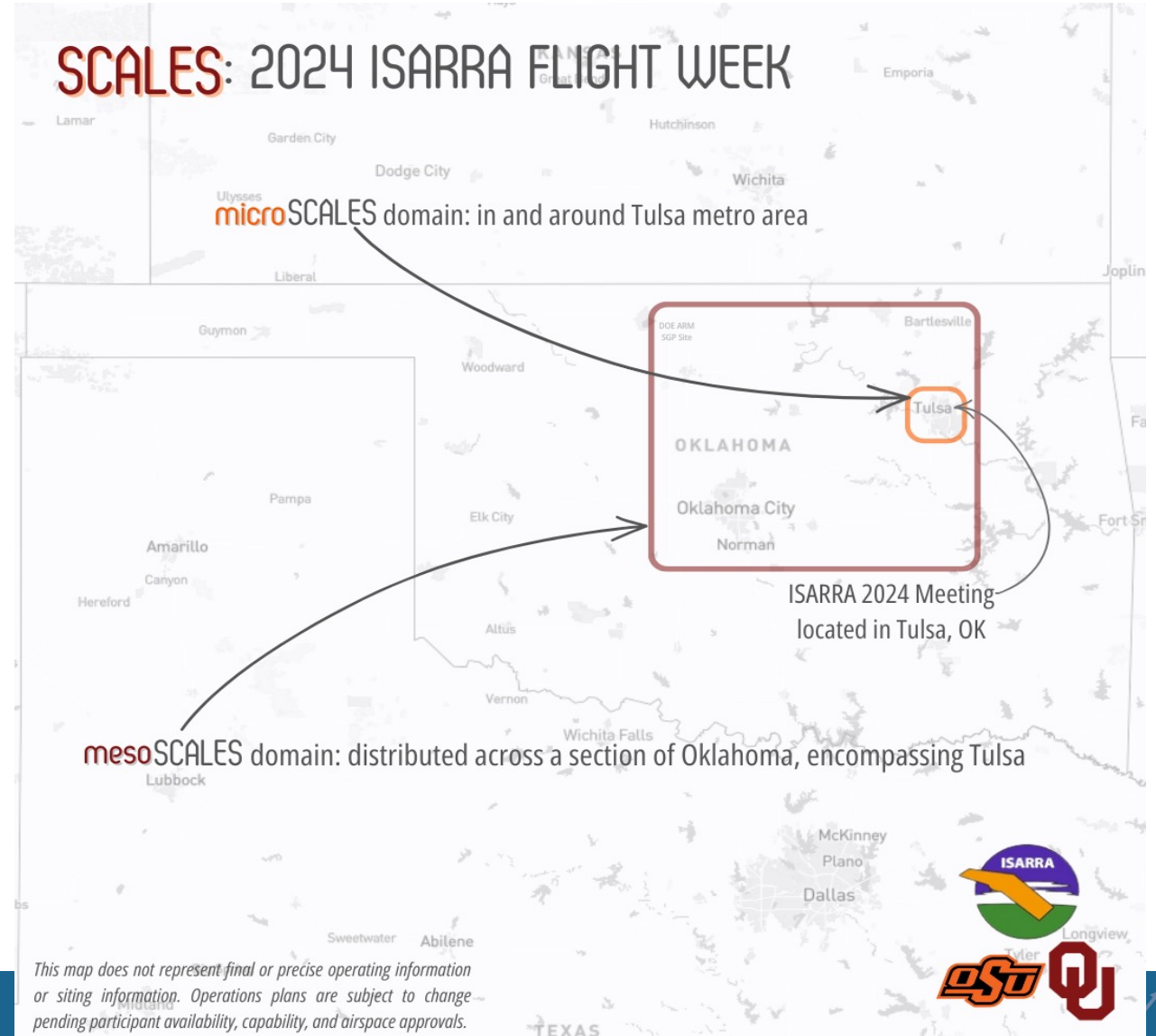
James Pinto: NSF NCAR

Dates:

Sept 3-6 : ISARRA Conference

Sept 8-13 : Flight Week Field Campaign

ISARRA: International Society for Atmospheric Research using Remotely piloted Aircraft



SCALES Objectives

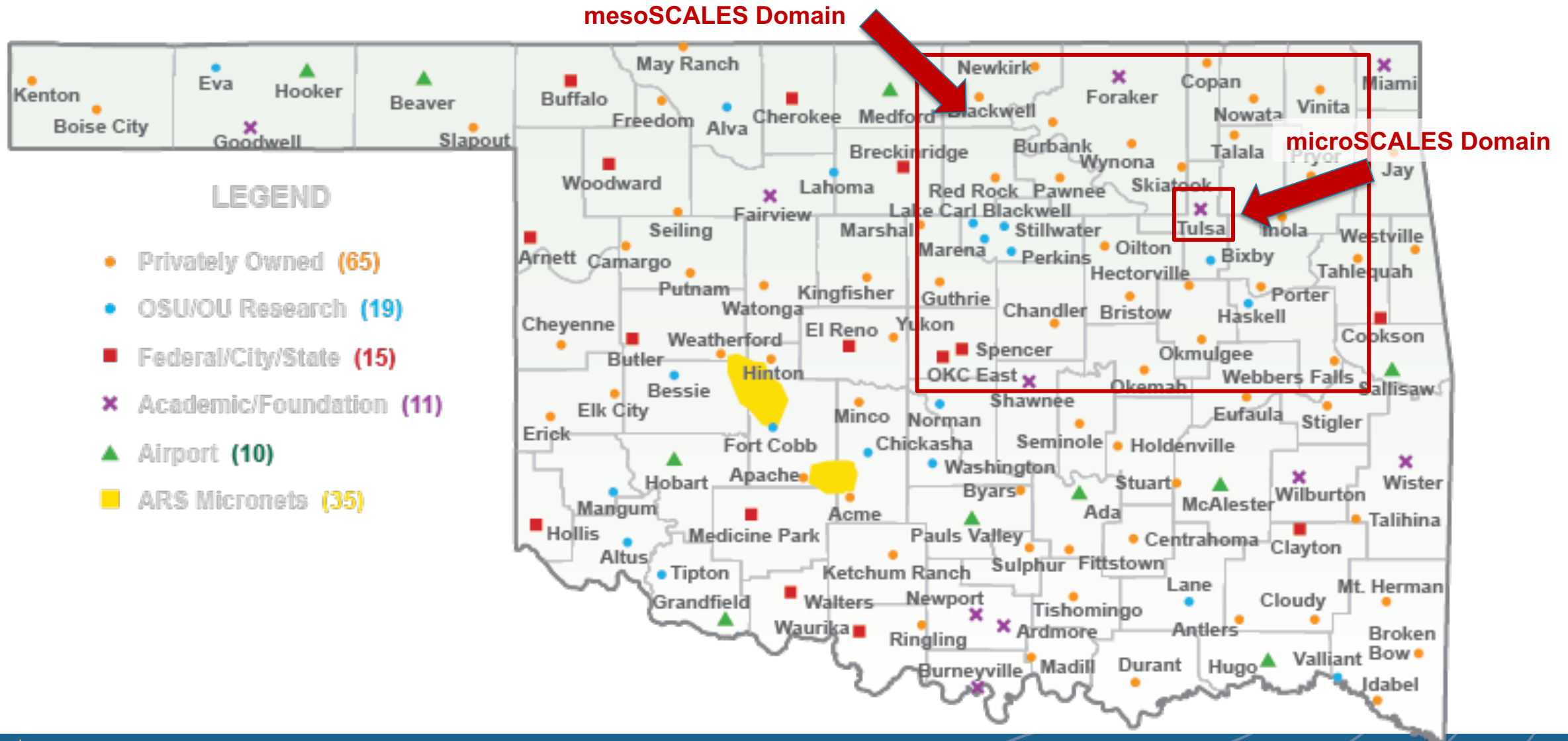
- mesoSCALES – deploy UAS to collect observation to test the 3D mesonet concept
- microSCALES – deploy UAS to sense Urban Heat Island effects and localized impacts of the urban landscape on winds and turbulence for UAM/AAM planning and microscale model validation.
- WxUAS observation intercomparison.
- Profiling WxUAS data will be coordinated through the WMO UAS Demonstration Campaign requiring standardized data formats and near-realtime dissemination.

<https://go.okstate.edu/aerospace/isarra-flight-week-objectives.html>

Goal of Flight Week

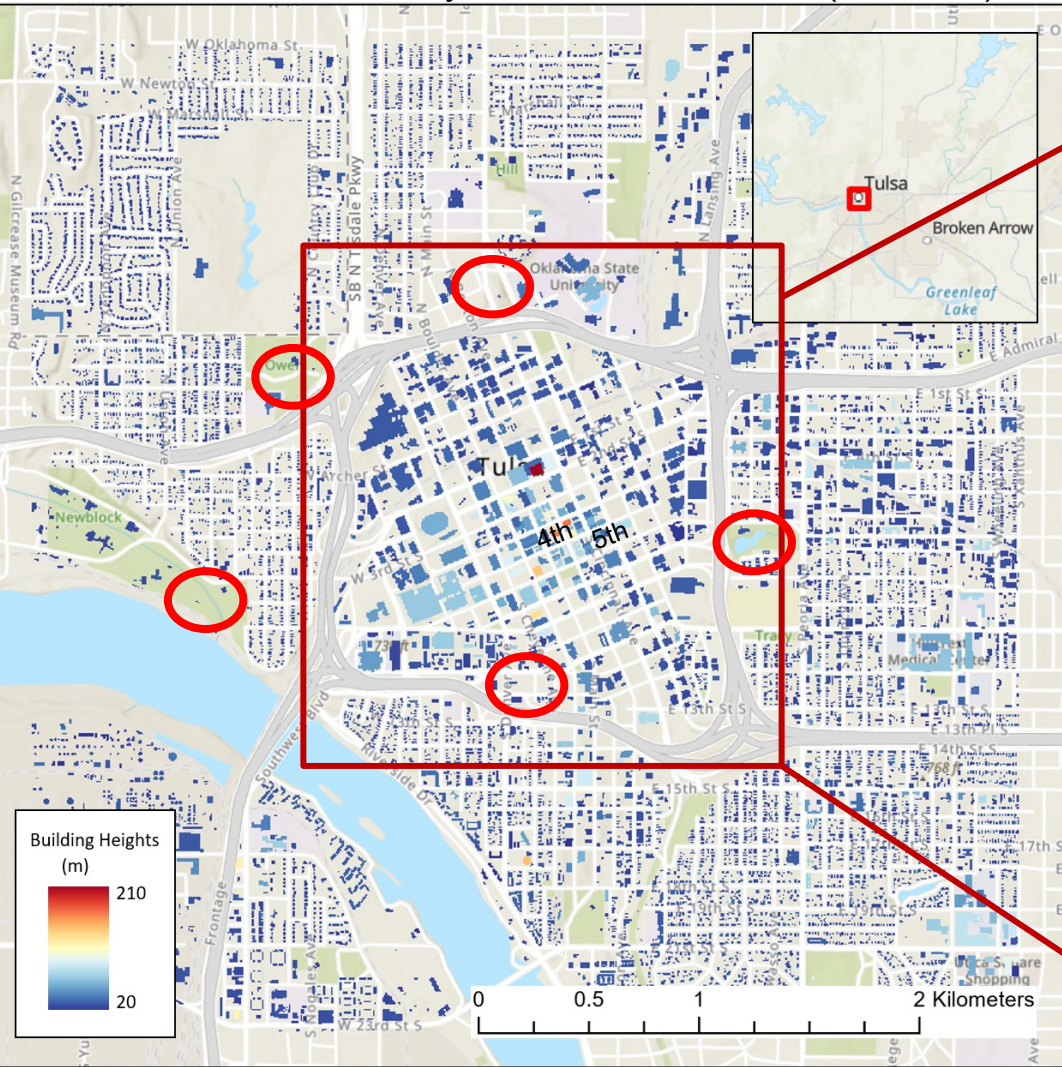
To support meso-to-microscale research activities.

Potential 3D Mesonet sampling region
Following Chilson et al. (2019)



microSCALES Model Configuration

Resident-GPU FastEddy Domain 4.5 x 4.5 km ($\Delta x = 5$ m)



Gridpoints: 122 x 944 x 992 pts
Cell perturbation applied at LBCs



microSCALES – Evaluate Simulated Turbulence Hazards

- Use LES to identify areas to sample with turbulence sensing UAS during microSCALES.
- Evaluate skill of LES at predicting potential hazard areas for AAM/UAM.
 - Sharp winds and vertical motions gradients
 - Areas of more intense turbulence
- Skill at predicting these hazards requires accurate representation of the mesoscale environment!

