

# Ultra-High Resolution Weather Support for Small UAS Operations

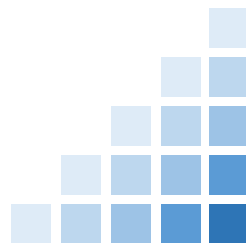
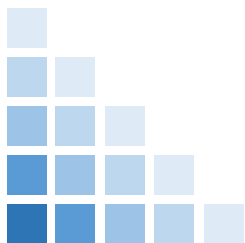
Dr James Pinto

Deputy Director

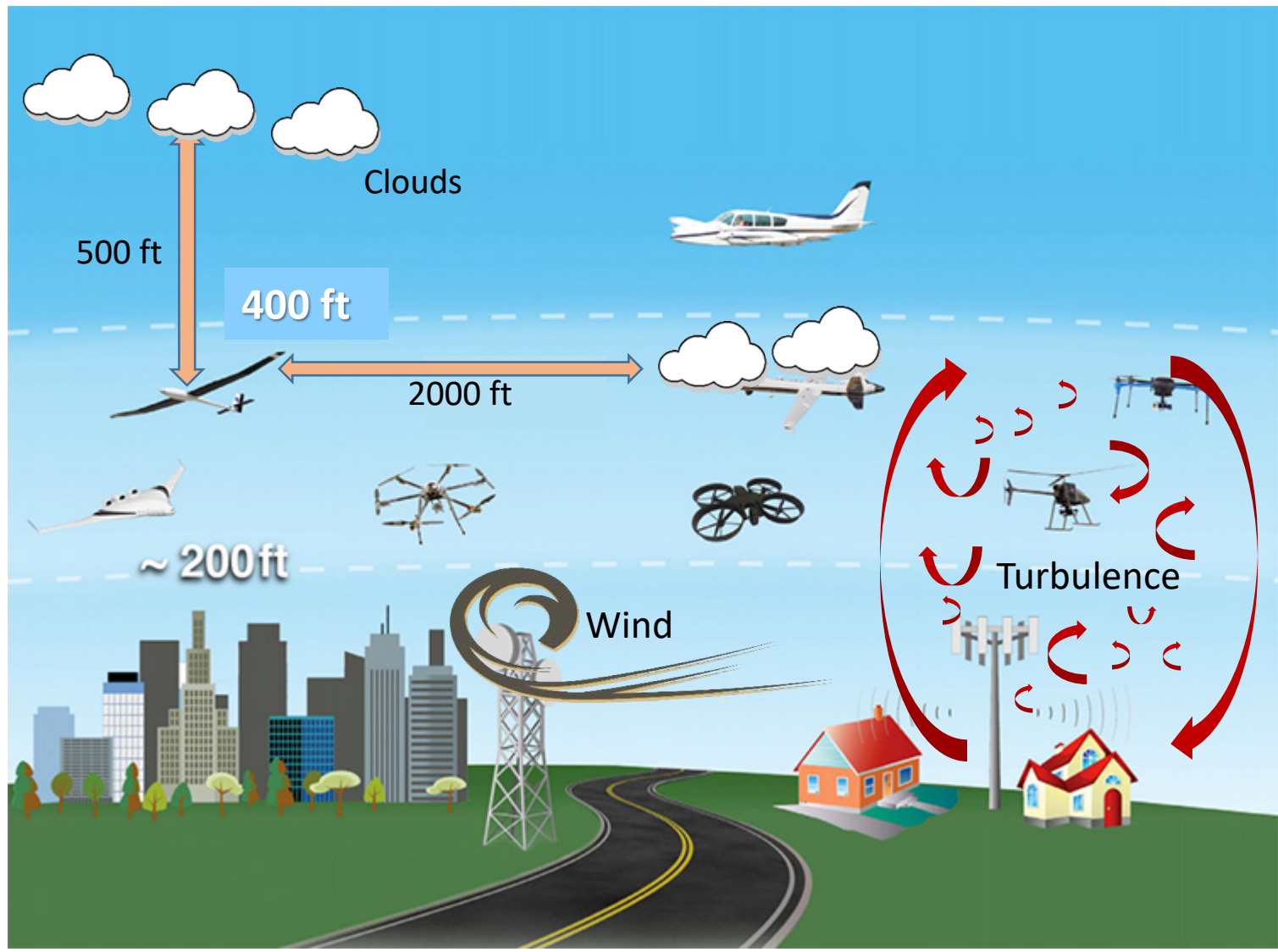
Aviation Applications Program

NCAR/Research Applications Laboratory

30 April 2018



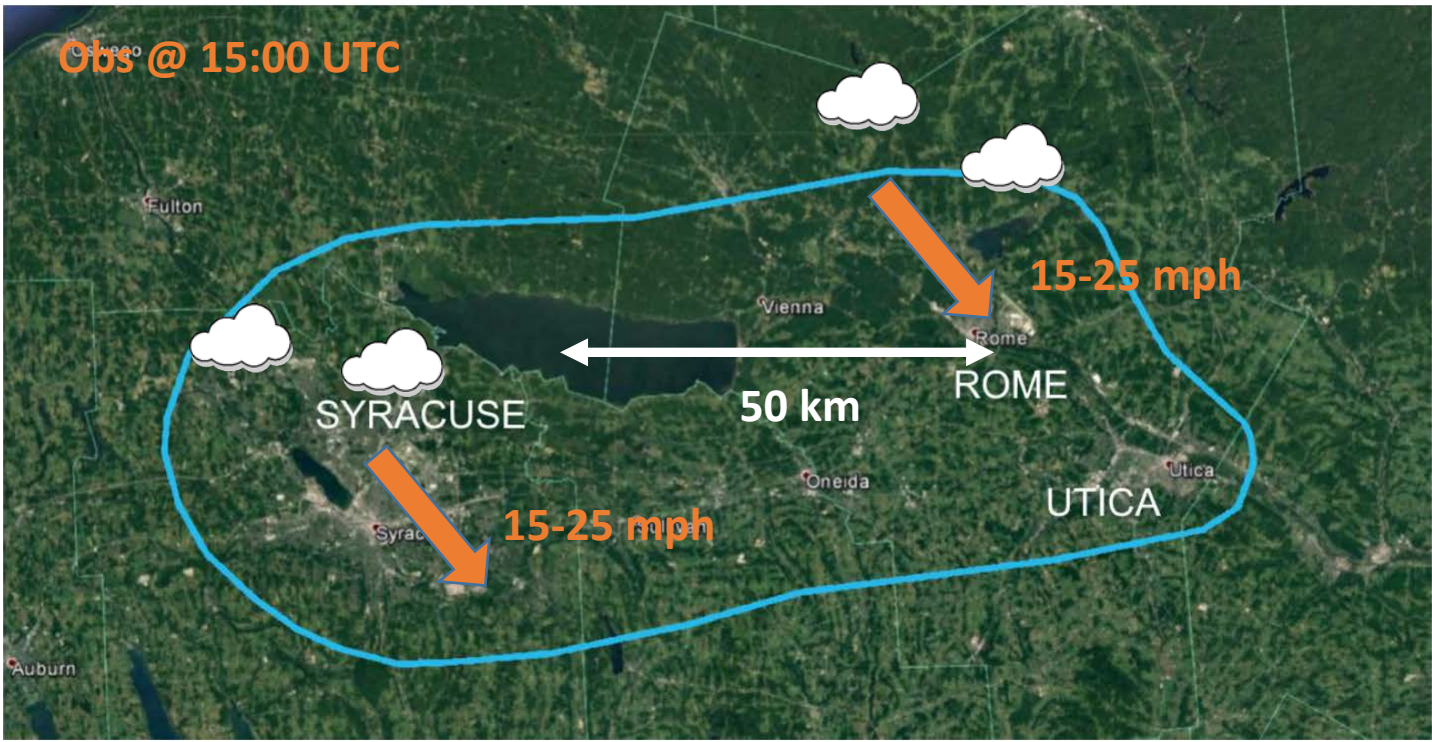
# Motivation



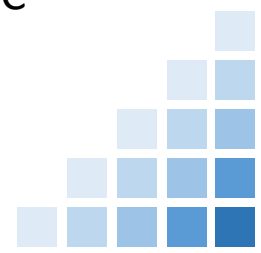
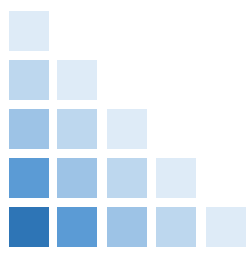
Courtesy: <https://utm.arc.nasa.gov/images/utm-airspace.jpg>

# Ultra-fine Weather in UTM

Mission Planning within Proposed UTM System in Upstate NY

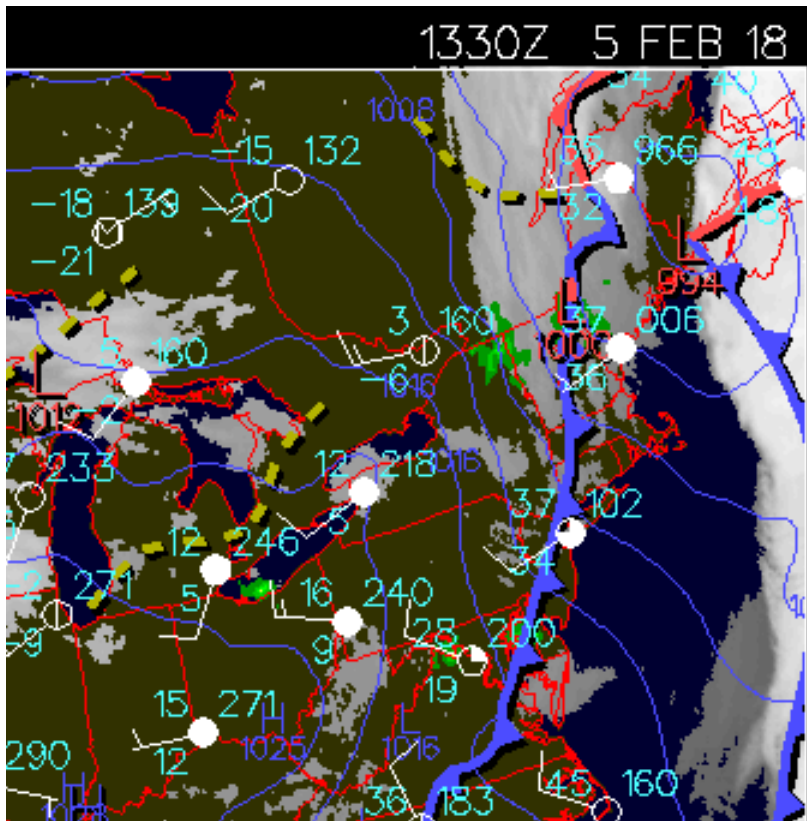


UAS Flight Plan at 300ft AGL for 18:00 UTC



# Current Weather for UAS Planning

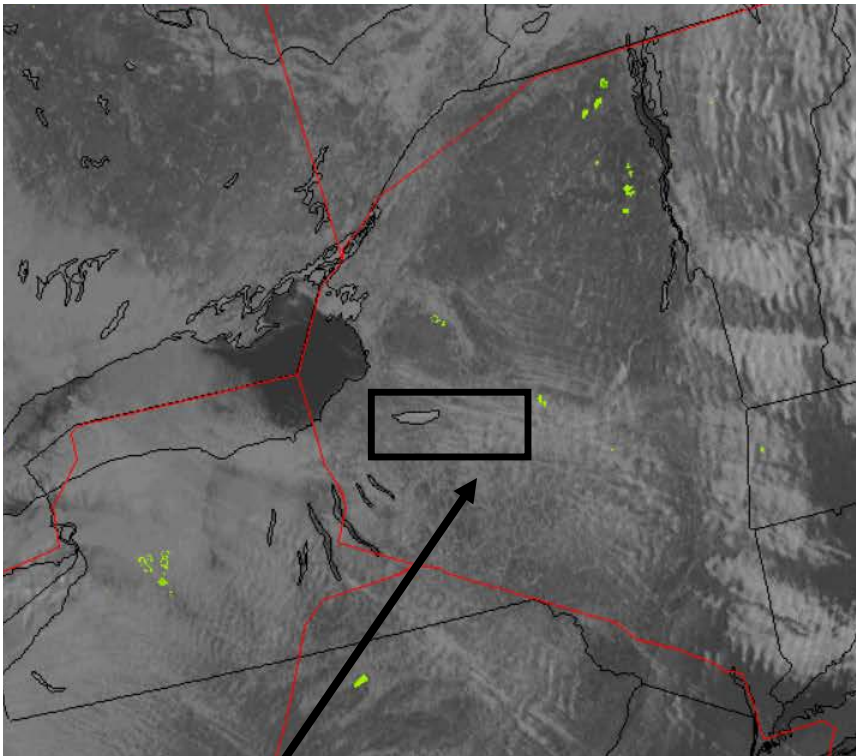
Weather Overview



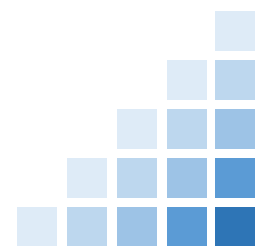
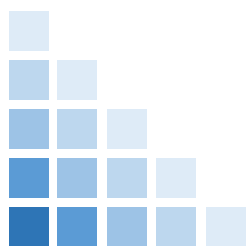
GOES-16 Visible Channel

5 FEB 2018

15:00 UTC

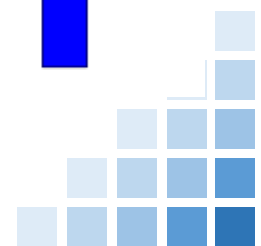
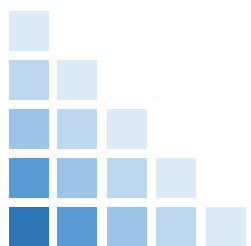
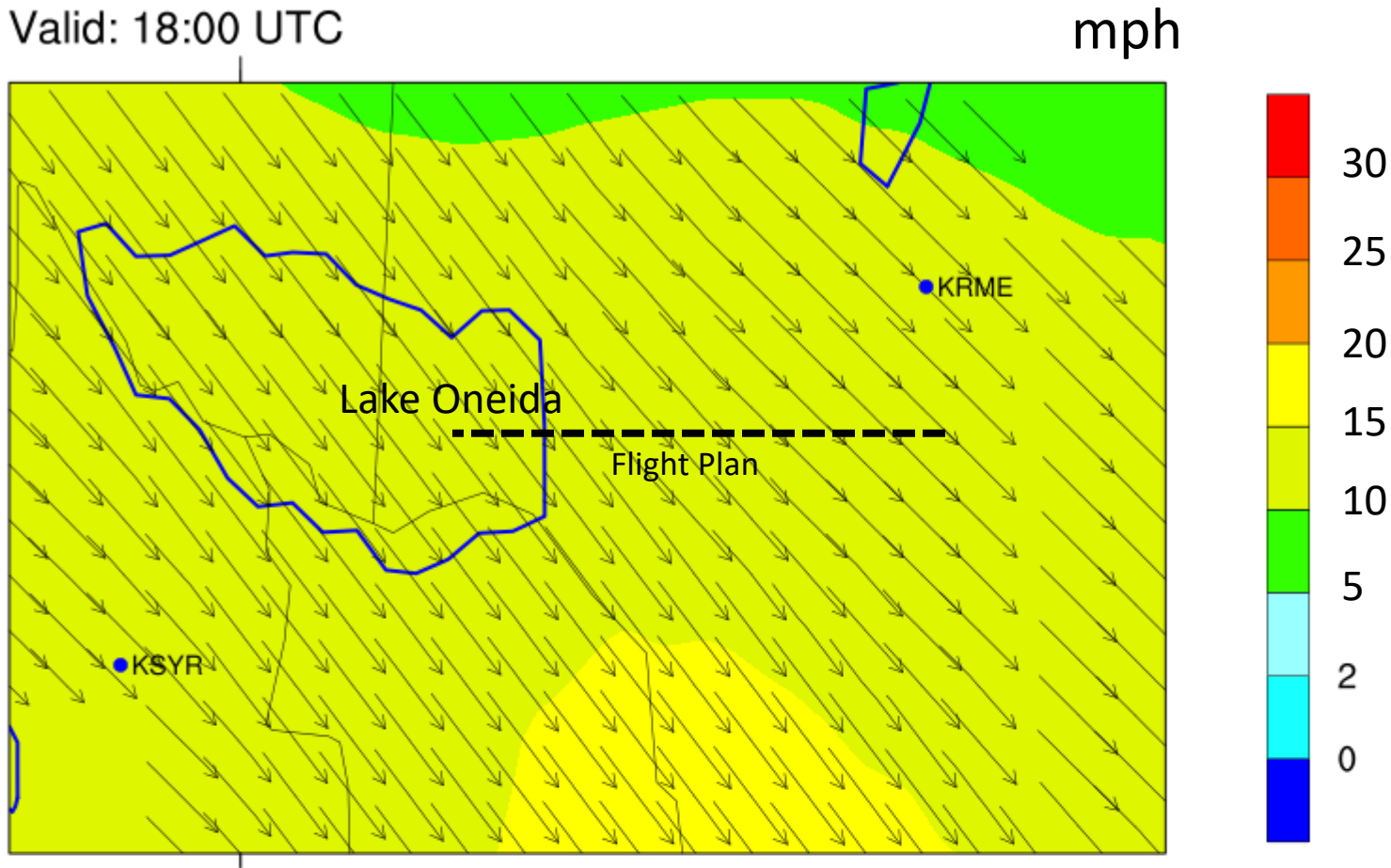


Approximate region for planned UAS operations

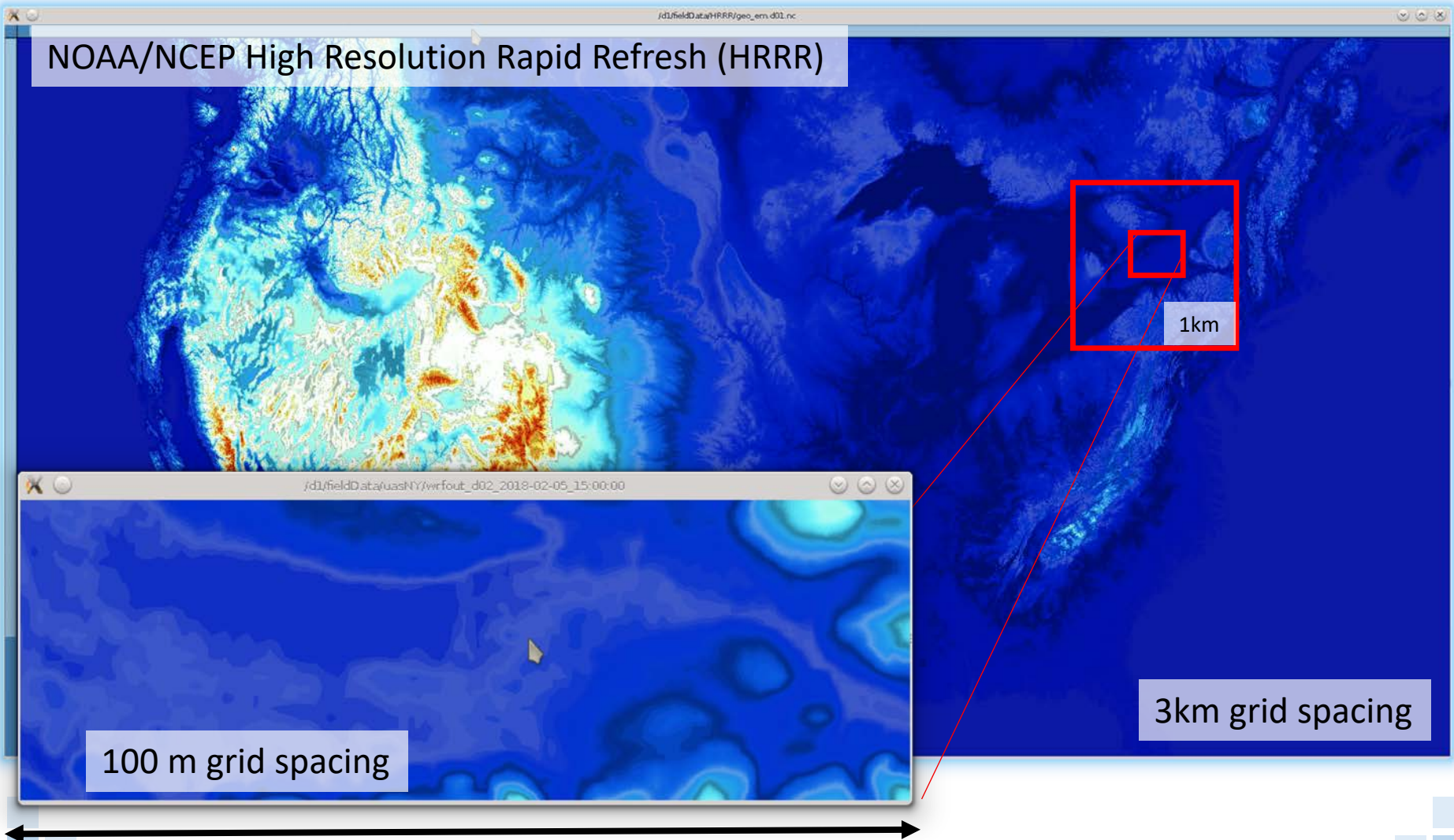


# Forecasted Winds from Best Available Model

Winds at 300 ft AGL from Operational High Resolution Rapid Refresh (HRRR) Model



# Ultra-high Resolution Model Configuration: Upstate NY



80 km

Innermost grid capable of resolving eddies in the boundary layer!

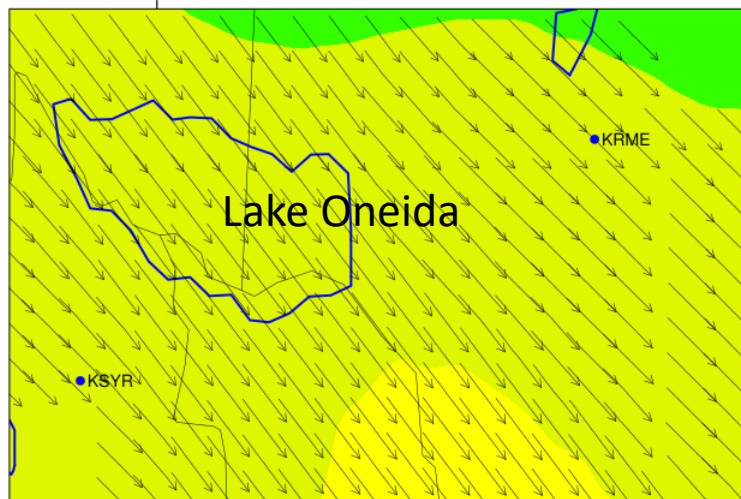
# Comparison of Models

## 3 hr Forecasts of Winds at 300 ft AGL

Operational HRRR Model

Valid: 18:00 UTC

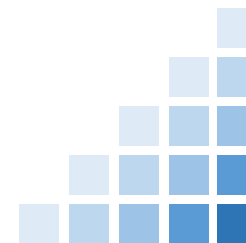
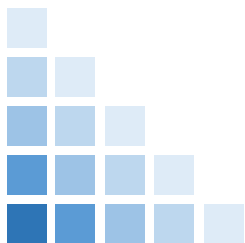
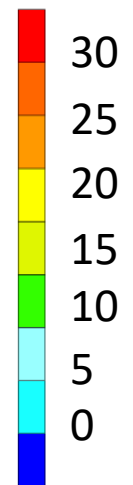
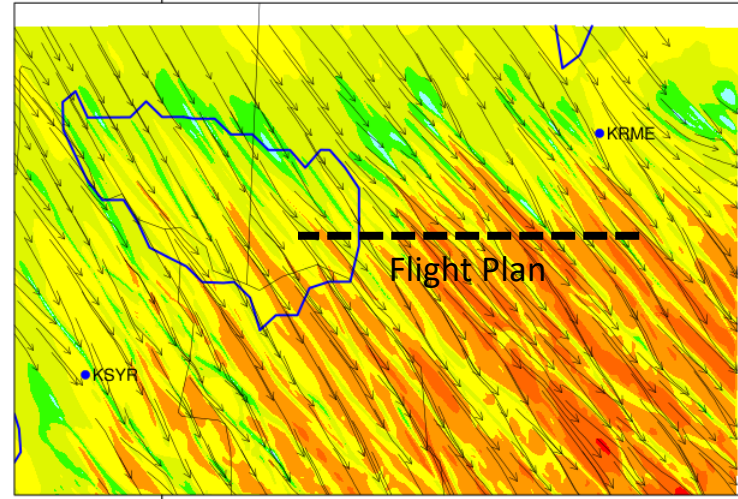
m s<sup>-1</sup>



NCAR Ultra-high Resolution Model

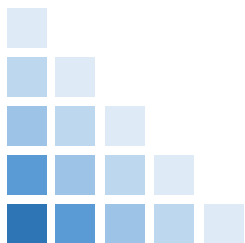
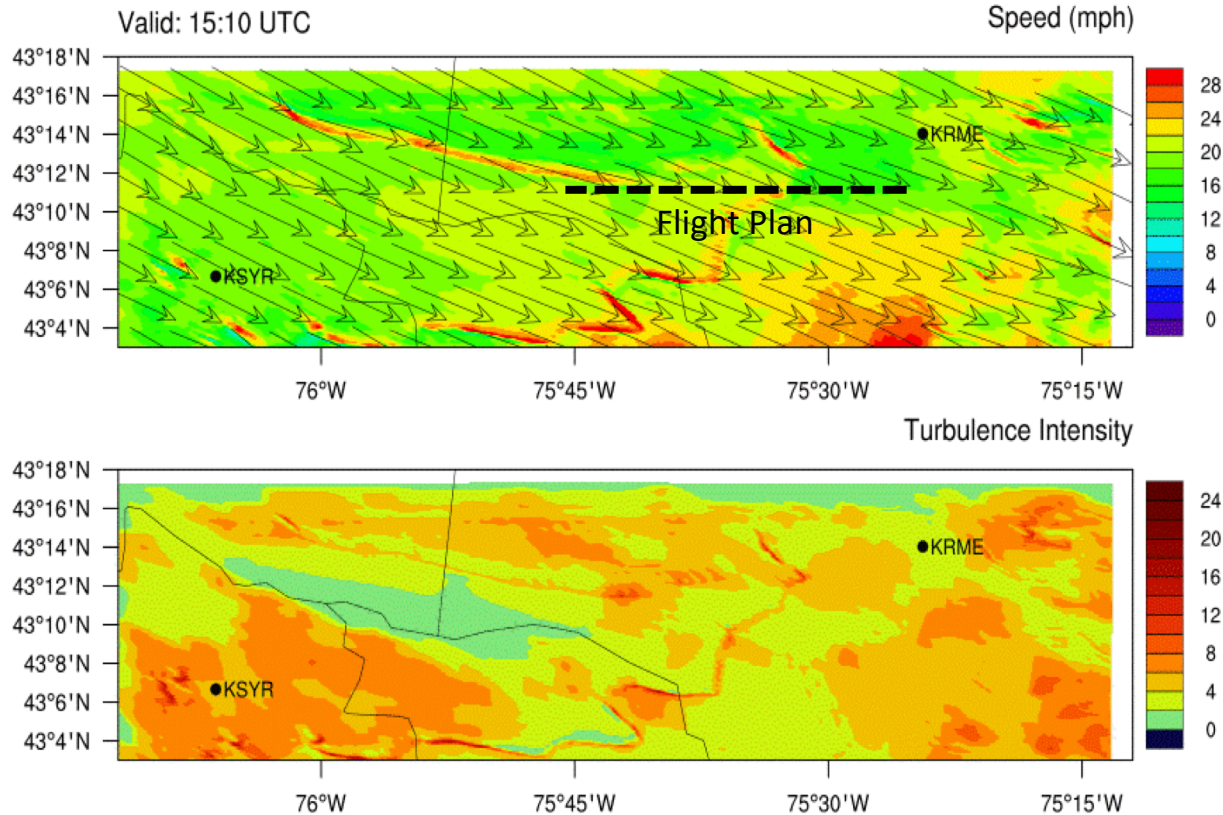
Valid: 18:00 UTC

m s<sup>-1</sup>



# Evolution of Winds and Turbulence

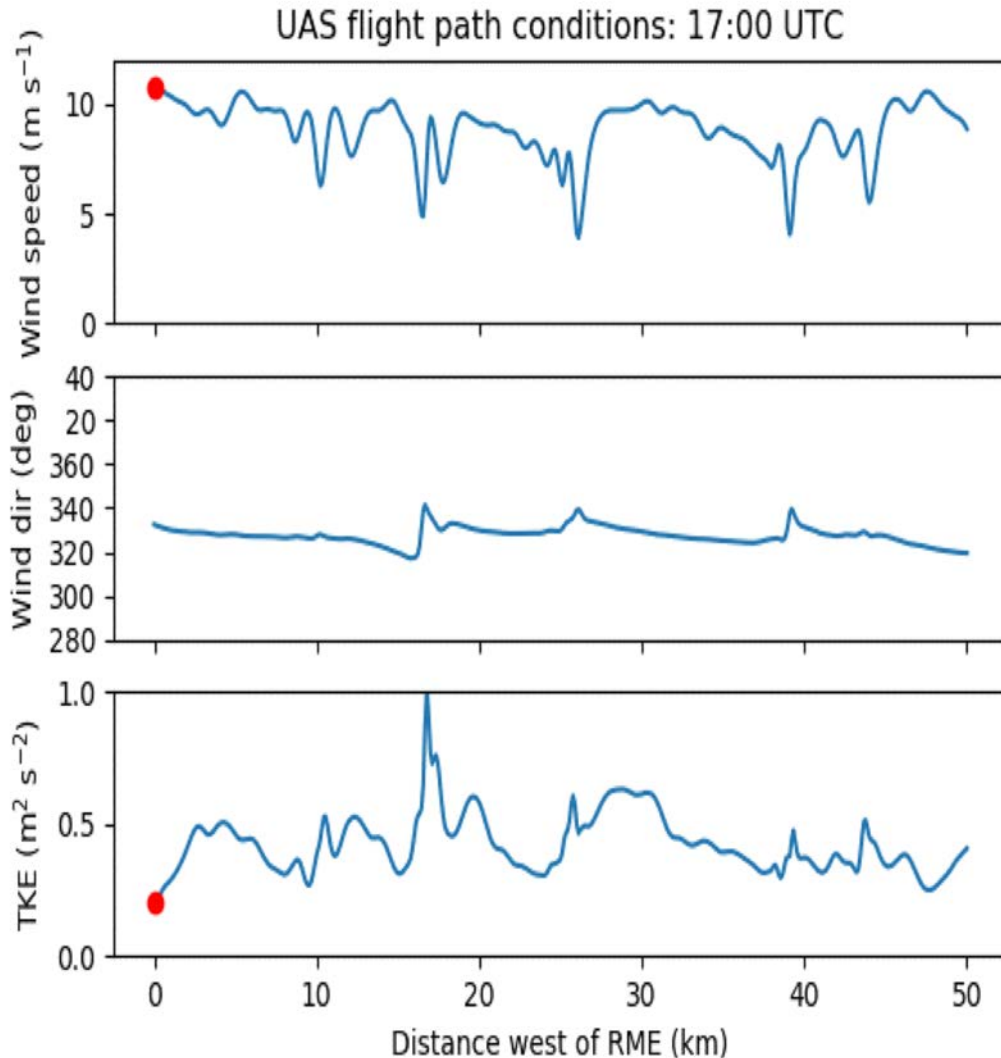
NCAR Ultra-high Resolution Model Forecast: 10 min data @ 300 ft AGL





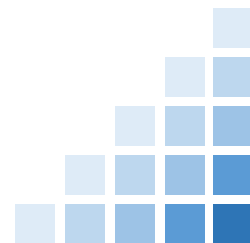
# Flight Planning

## Expected Winds and Turbulence along Flight Path

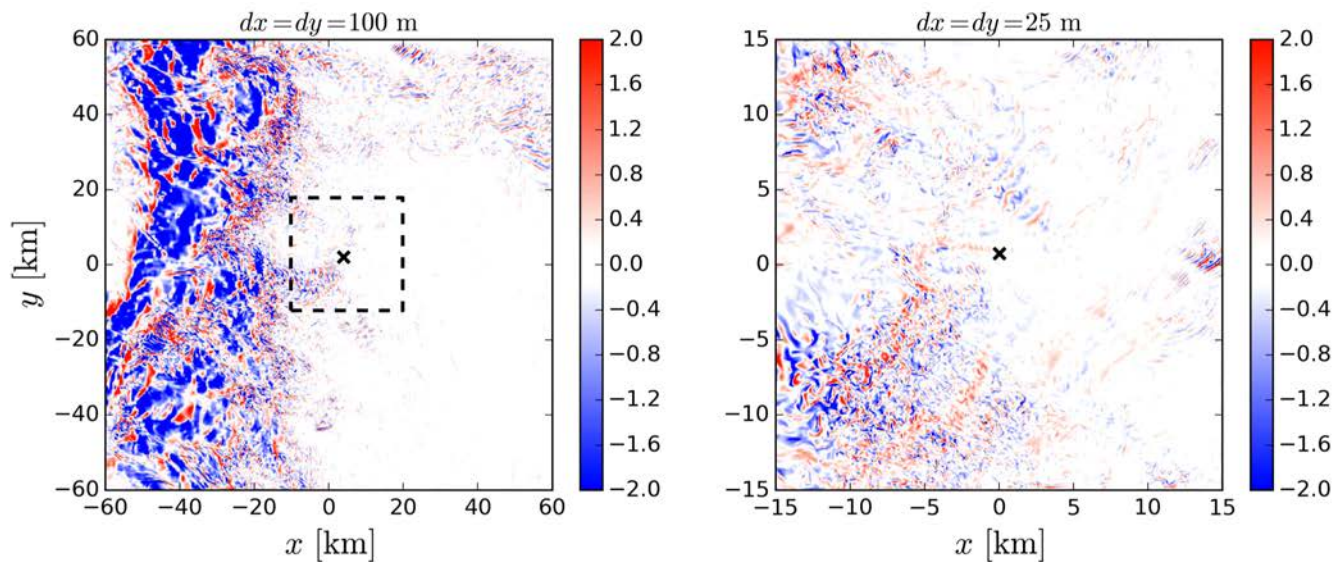


E-W Transect at 300 ft AGL  
Assumed air speed: 40 km hr-1

● = UAS position

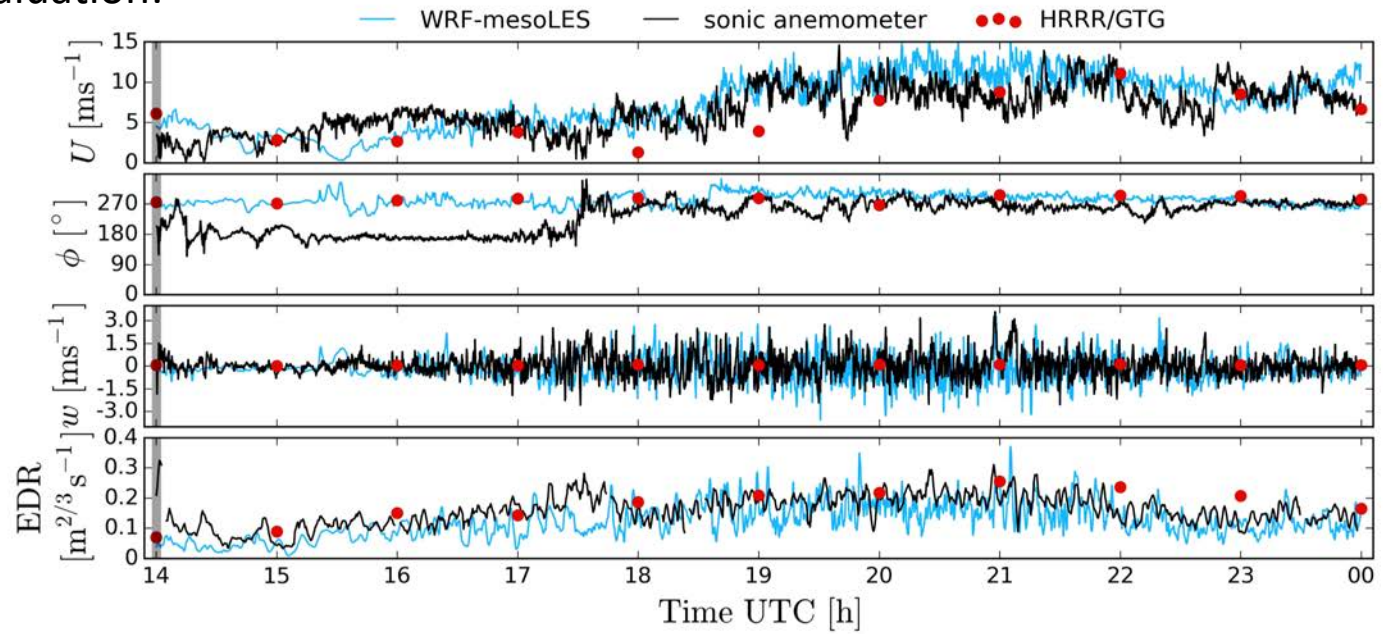


# Ultra-high resolution weather modeling

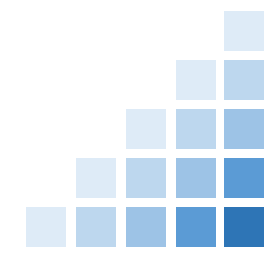


X = BAO Tower location, Erie, CO

## Evaluation:

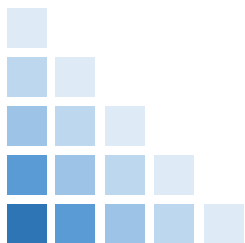
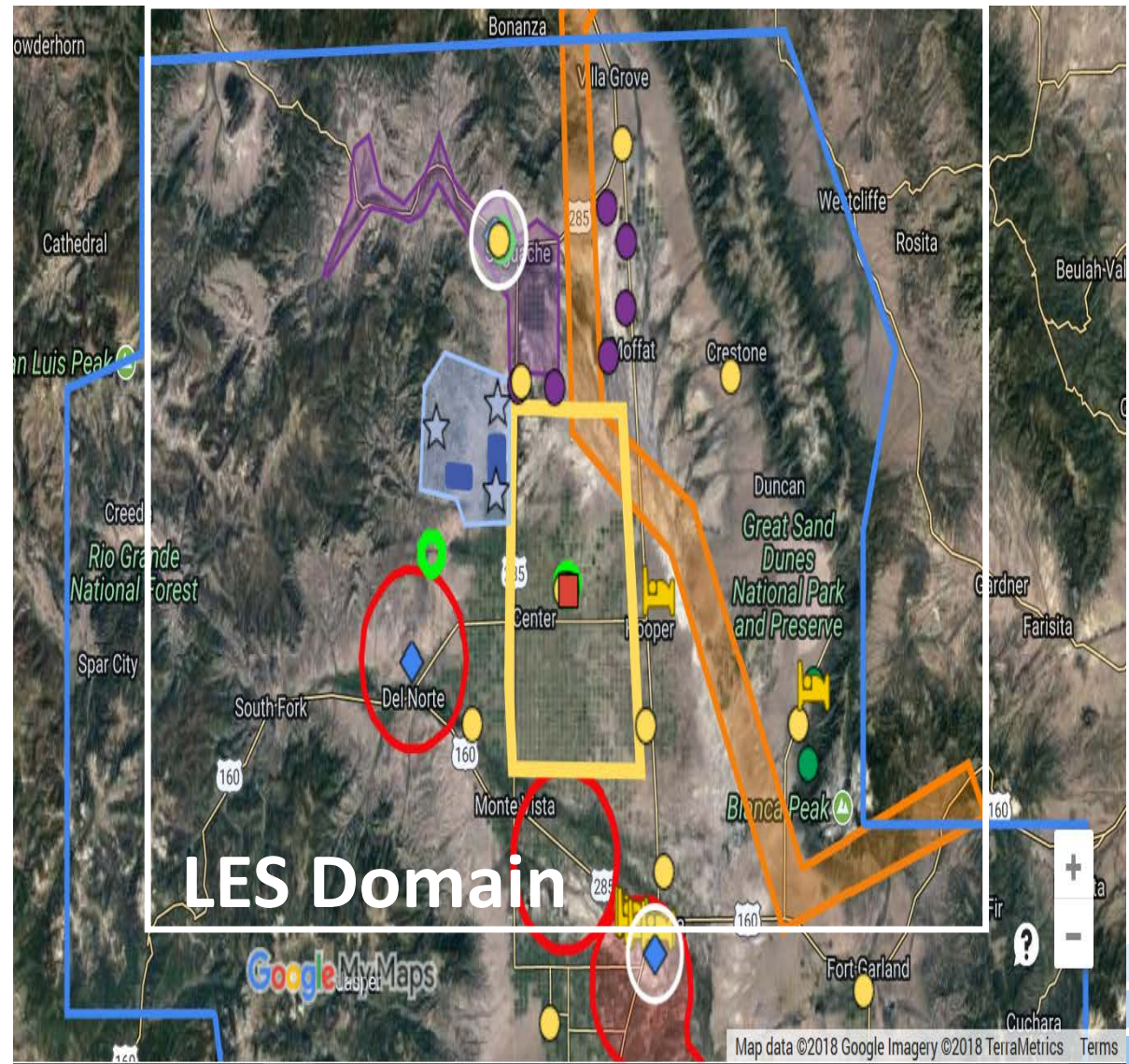


Munoz-Esparza et al. 2018  
J. Appl. Meteor.

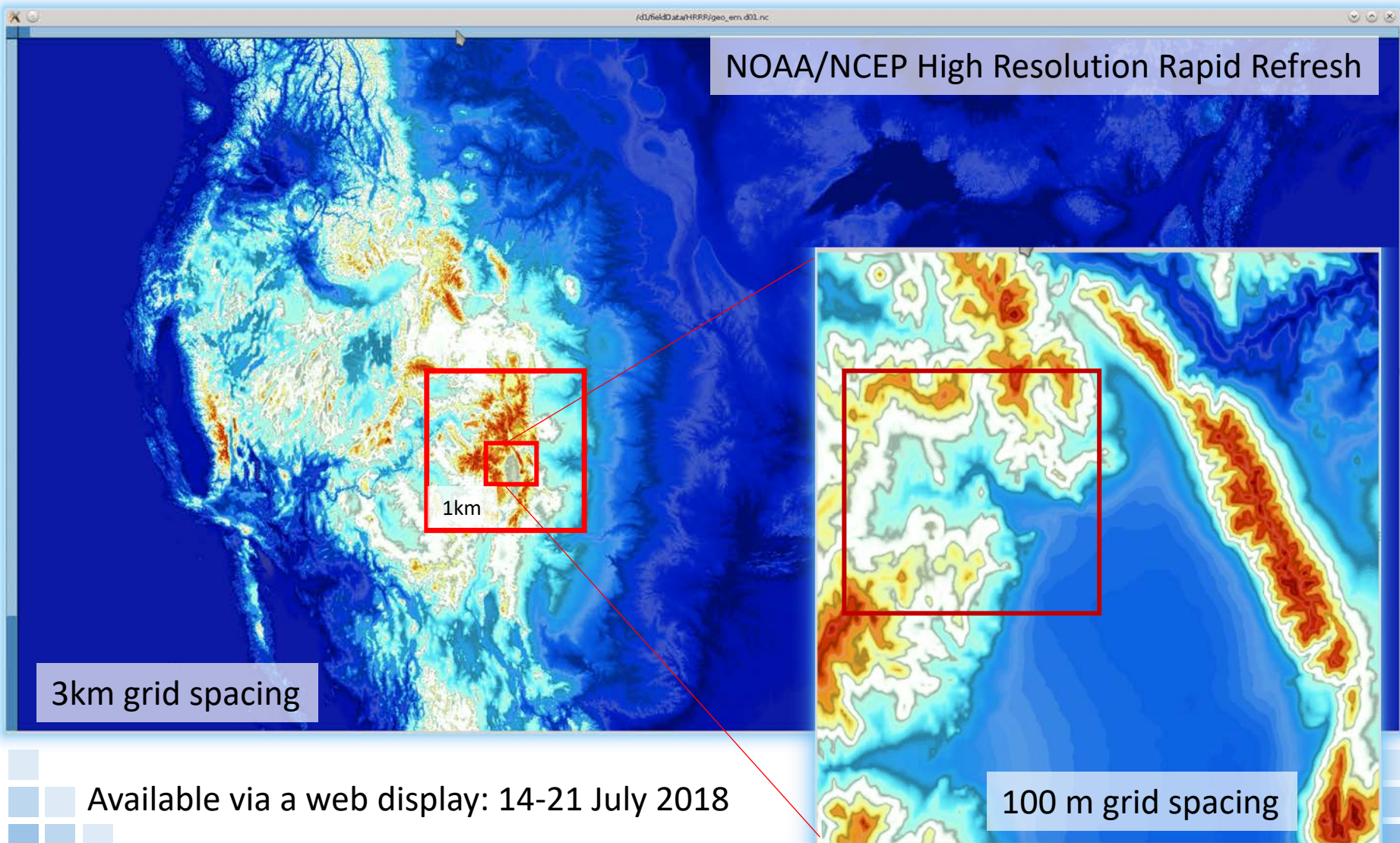


# Realtime Weather Demonstration

- Support ISARRA Flight Week
- Period: 15-21 July 2018
- Location: San Luis Valley, South-central Colorado
- Nearly 100 planned participants
- ~20 UAS + ground-based observing stations and remote sensors.



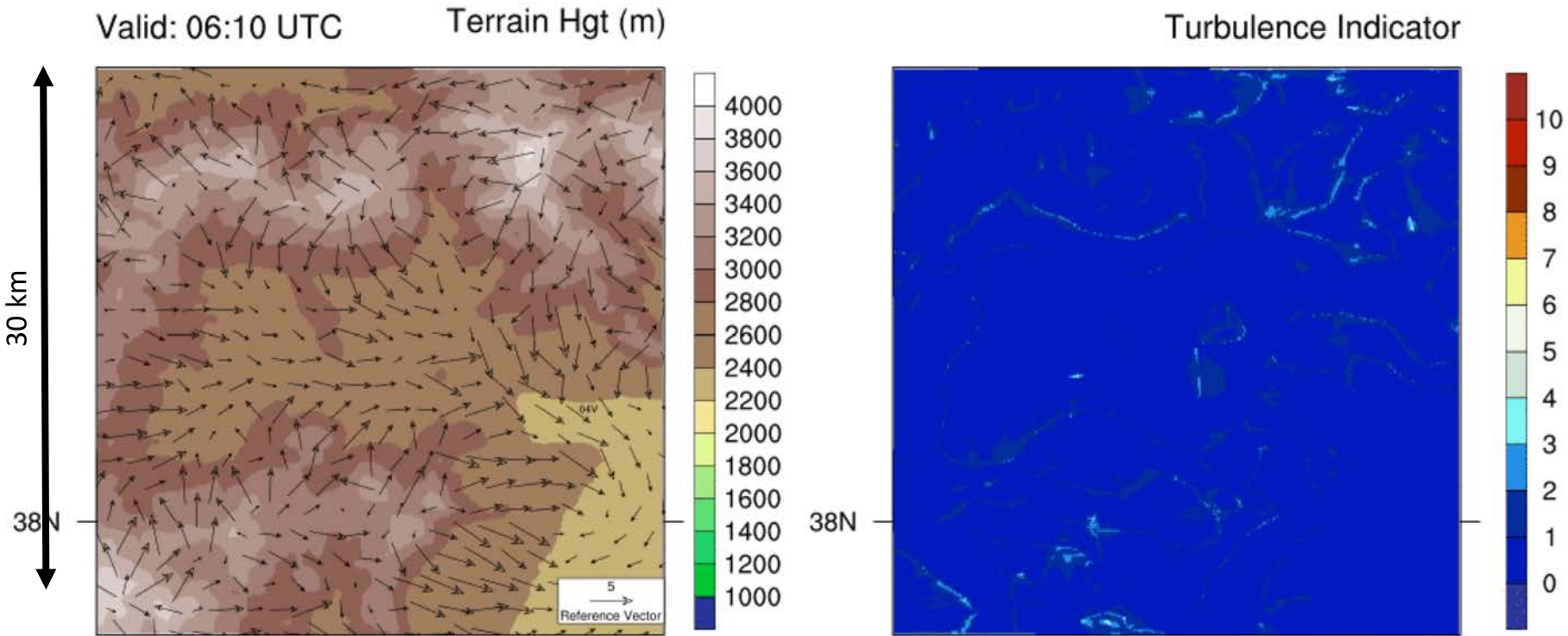
# Realtime System to Support ISARRA Flight Week



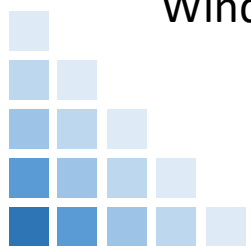
Available via a web display: 14-21 July 2018

# Hindcast for ISARRA Flight Week Planning

Movie of Winds and Turbulence over the Saguache River Canyon Region

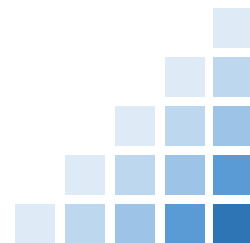
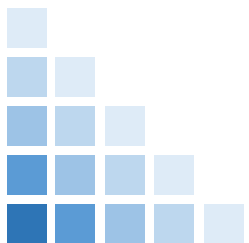


Winds and turbulence can vary greatly across a small area in complex terrain.



# Summary Points

- Need for accurate finescale weather information for efficient and safe operations of small UAS.
- NCAR has developed a relocatable ultra-high resolution modeling system that can provide realtime wx support for UAS operations.
- Fine-scale weather info can be coupled with aircraft performance characteristics to get UAS specific impacts (e.g., battery life, ability to maintain approved trajectory).
- Realtime ultra-high weather prediction capability will be demonstrated during ISARRA flight week in mid-July.



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# Questions?

