Assessing Deep Convection Initiation in a Mountain-Valley System Using Unmanned Aircraft System Observations

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Acknowledgements

- LAPSE-RATE

Deep Convection Initiation

Forecasting Challenge

- Forecasts of the timing and location of deep convection are inadequate (Rousseau-Rizzi et al., 2017)

- Lack of understanding of the parameters controlling deep convection initiation (Rousseau-Rizzi et al., 2017; Lock and Houston, 2014)

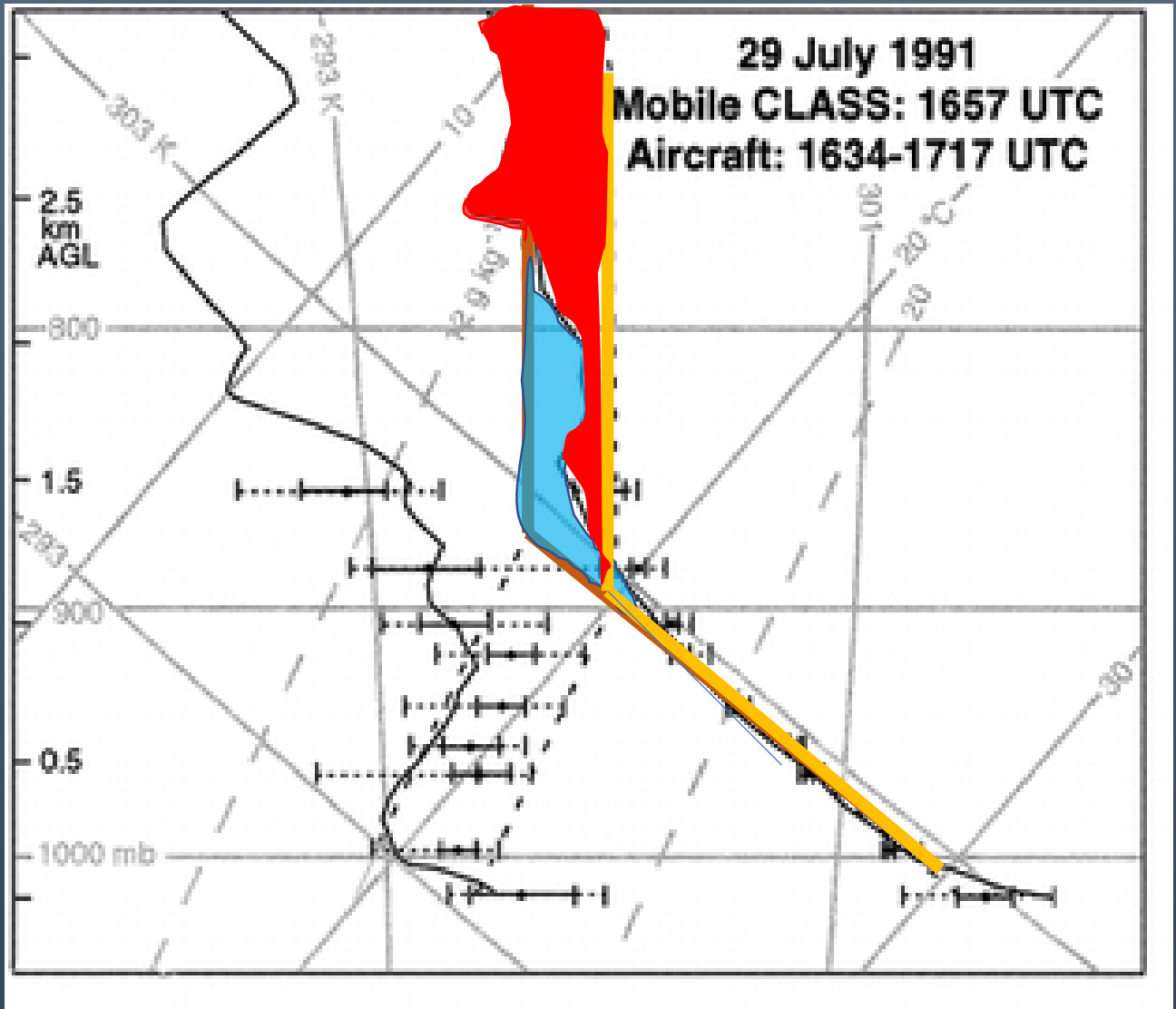
(Photo: National Weather Service)

Deep Convection Initiation

Observation Void

- Small variations in the vertical gradient of temperature and moisture have significant impacts (Crook, 1996)

- The current observational network is not sufficient for assessing convective potential (Weckwerth, 2000; Weckwerth and Parsons 2006)

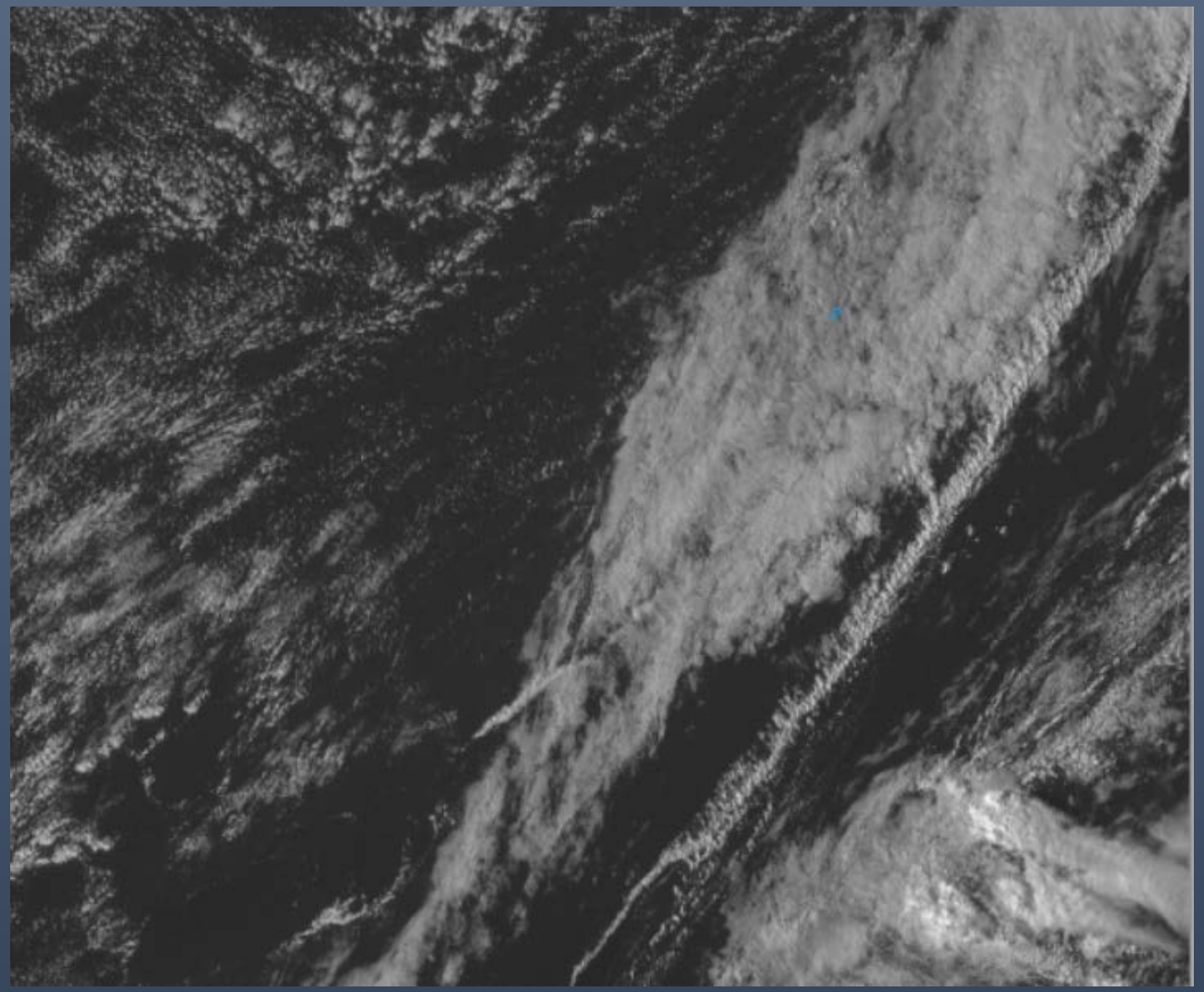


(Weckwerth 2000)

Deep Convection Initiation

Convergence Zones

- Deep convection often initiates on low-level convergence zones (Wilson and Schreiber, 1986)
- Significant-along line variability (Markowski et al., 2006)

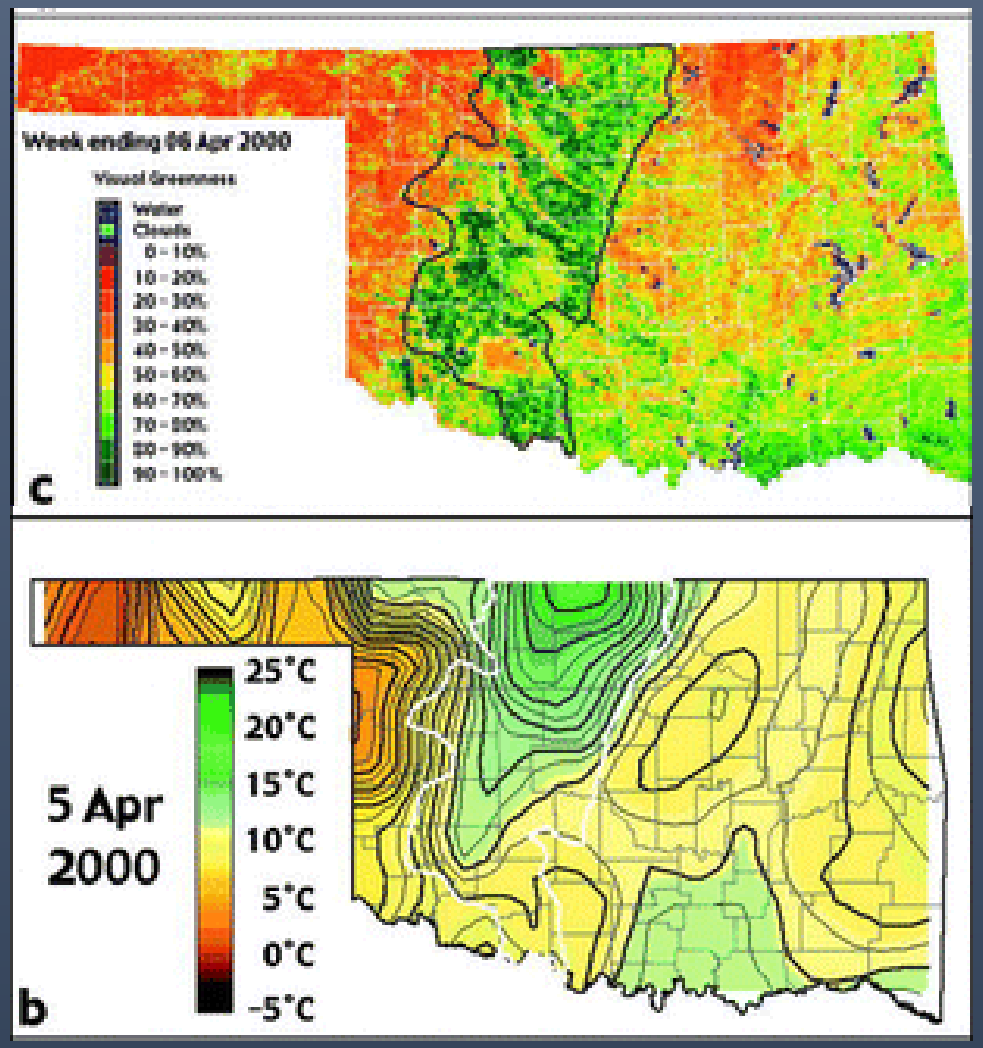


(GOES 16)

Deep Convection Initiation

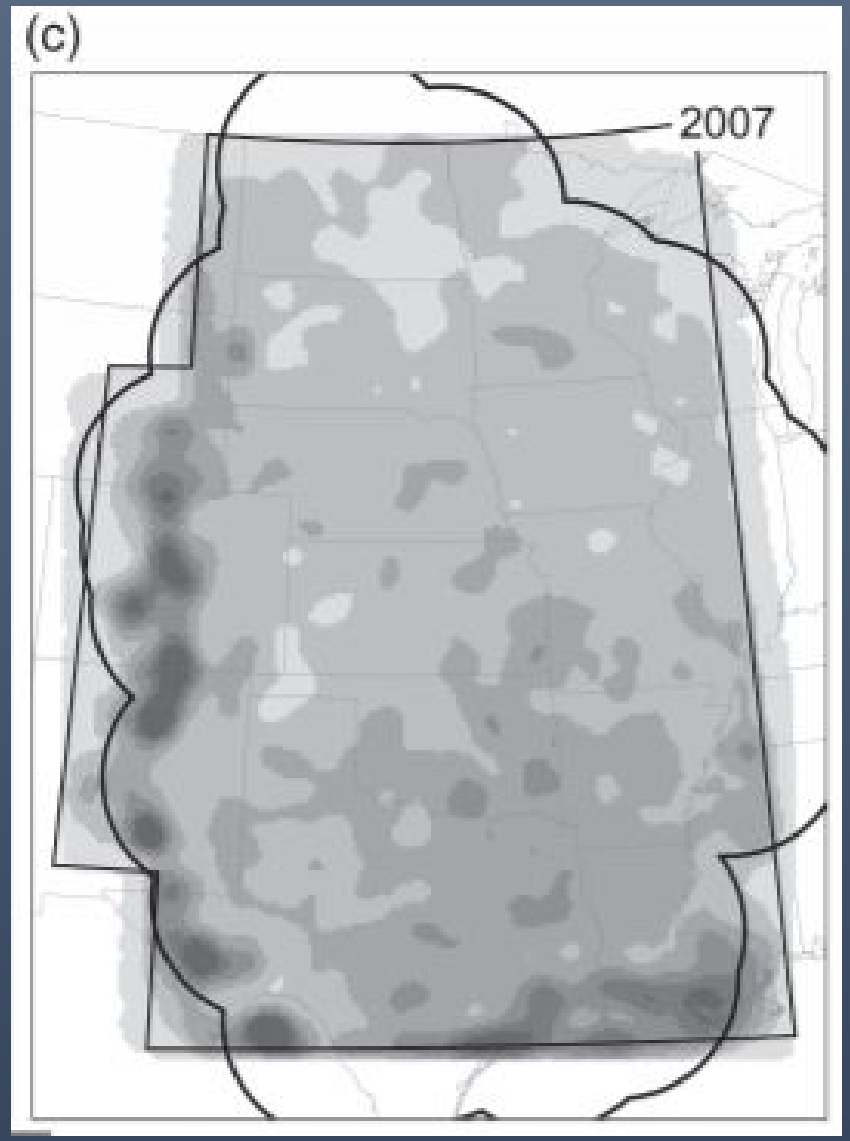
Non-Classical Mesoscale Circulation (NCMC)

- Land use changes result in surface sensible heat flux gradients (Segal and Arritt 1992)
- NCMCs can play a role in DCI (Segal and Arritt 1992)
- NCMC strength/development impacted by many factors (Segal and Arritt 1992)
- Land use changes impact low-level temperature and moisture (Segal and Arritt 1992, McPherson et al 2004, McPherson and Stensrud 2004)

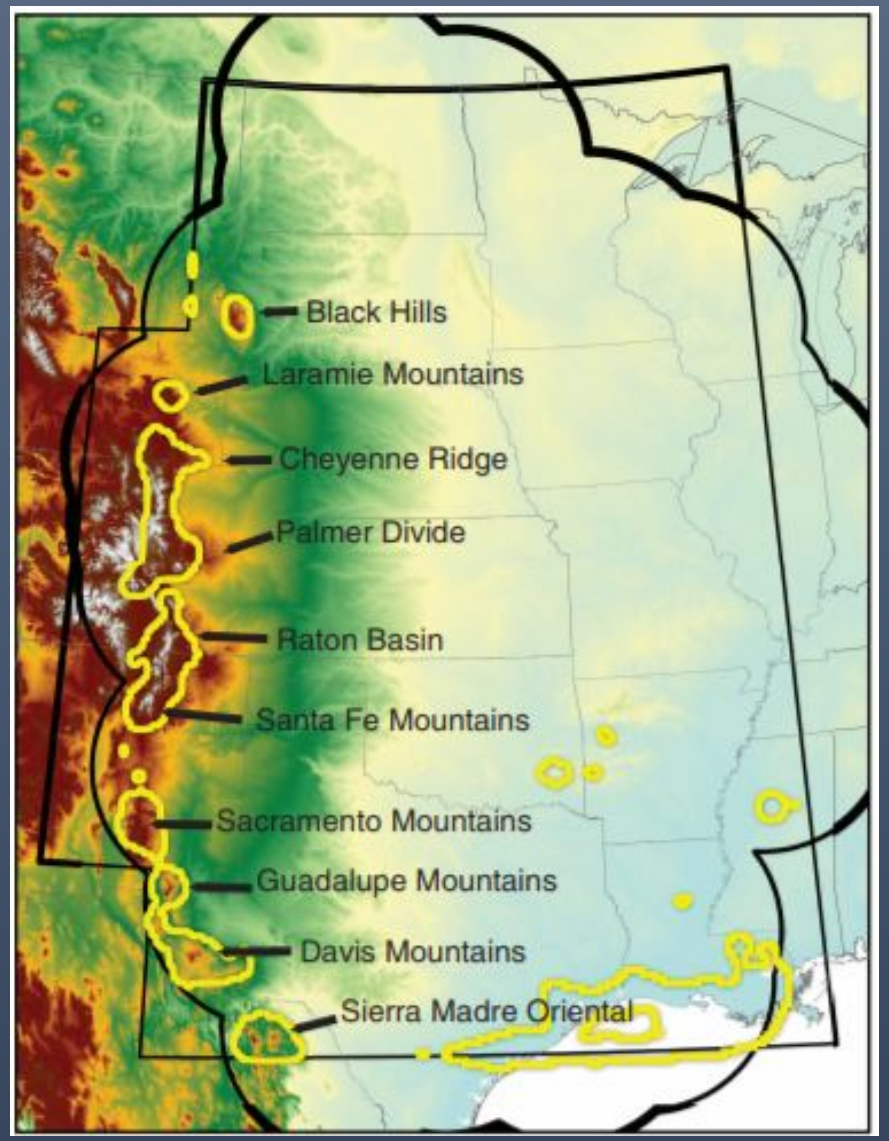


(McPherson et al. 2004)

Deep Convection Initiation



(Lock and Houston 2015)

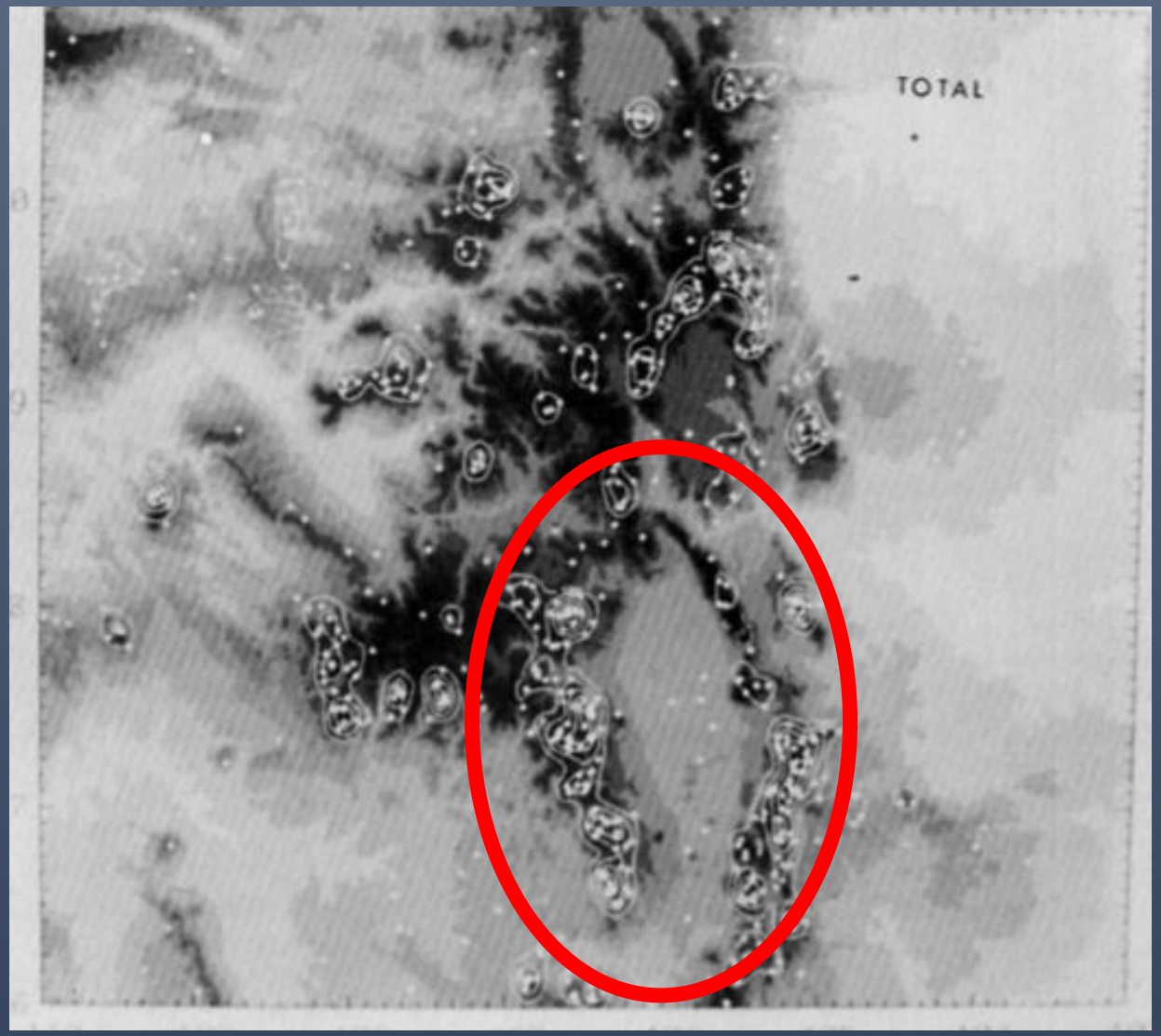


(Lock and Houston 2015)

Deep Convection Initiation

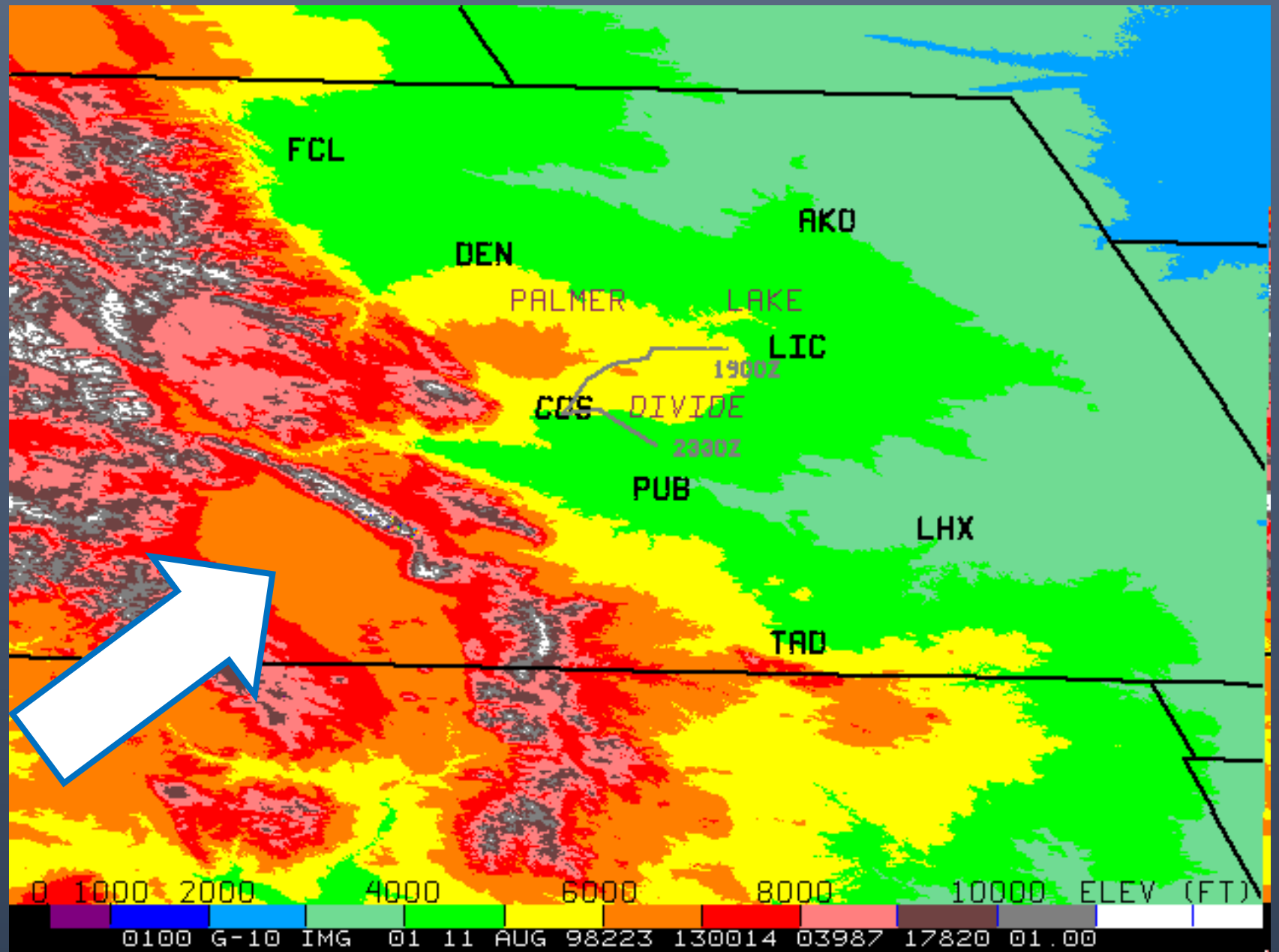
Mountain-Valley Evolution

- Relatively few pristine initiation points in valleys (Banta and Barker, 1987)



(Banta and Barker 1987)

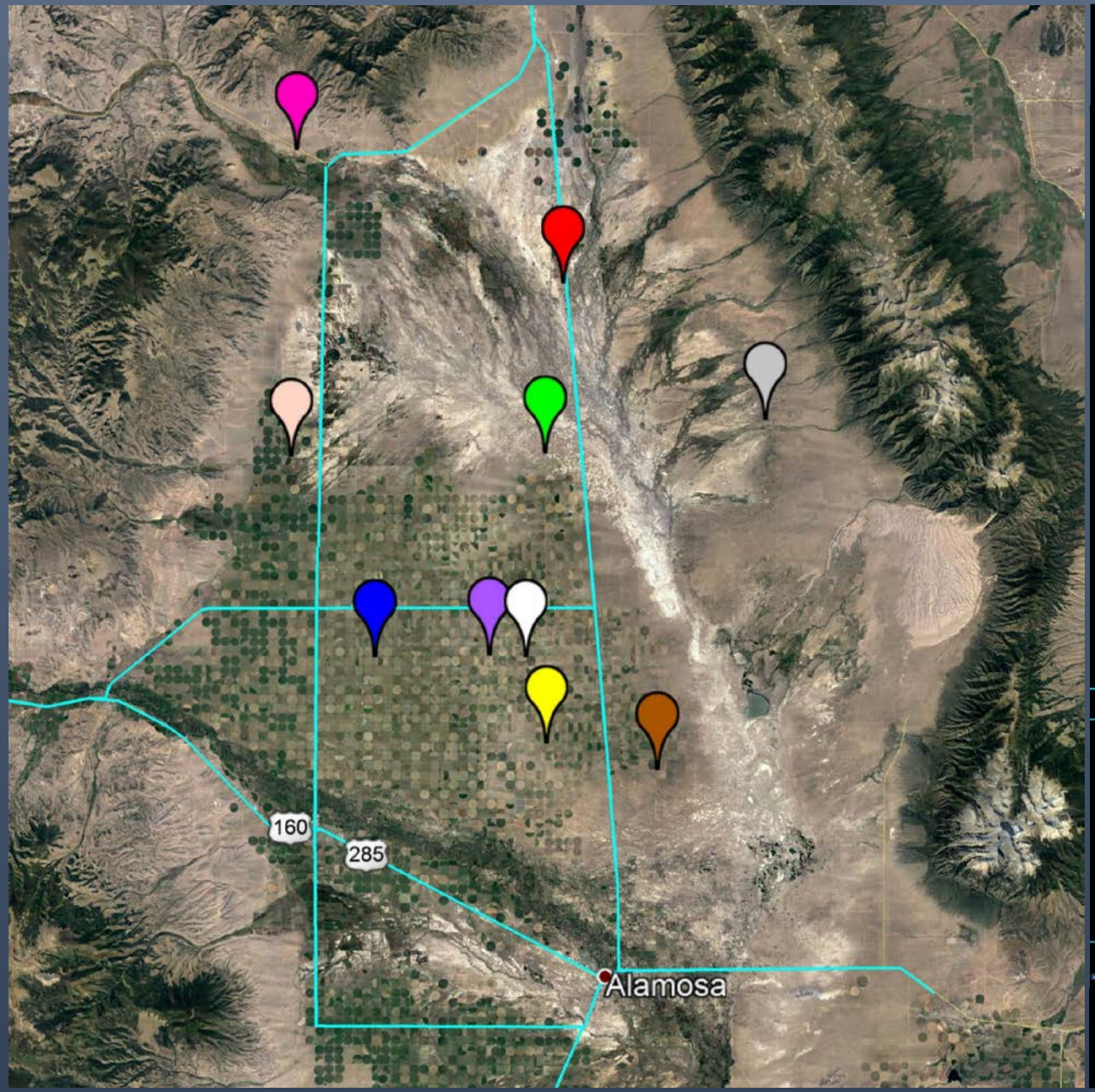
San Luis Valley



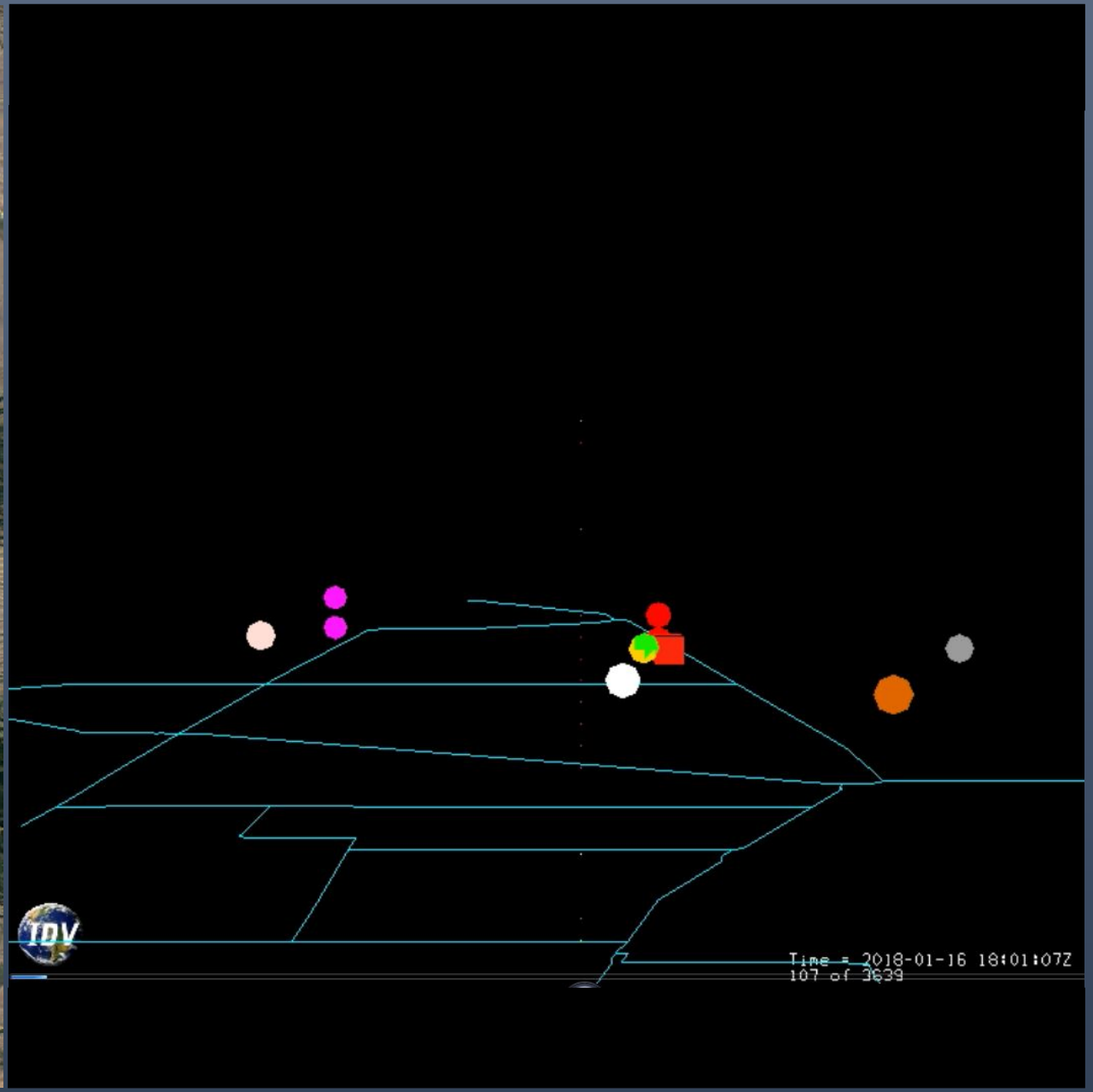
San Luis Valley

LAPSE-RATE

Plan View



Animation View



July 15: Radar Loop

July 15 & 16: Flights

Analysis Objectives

1) Determine if mesoscale thermodynamic and kinematic “hot spots” exist, and if these correspond to actual locations of DCI

2) Investigate the existence of a NCMC and its role in DCI

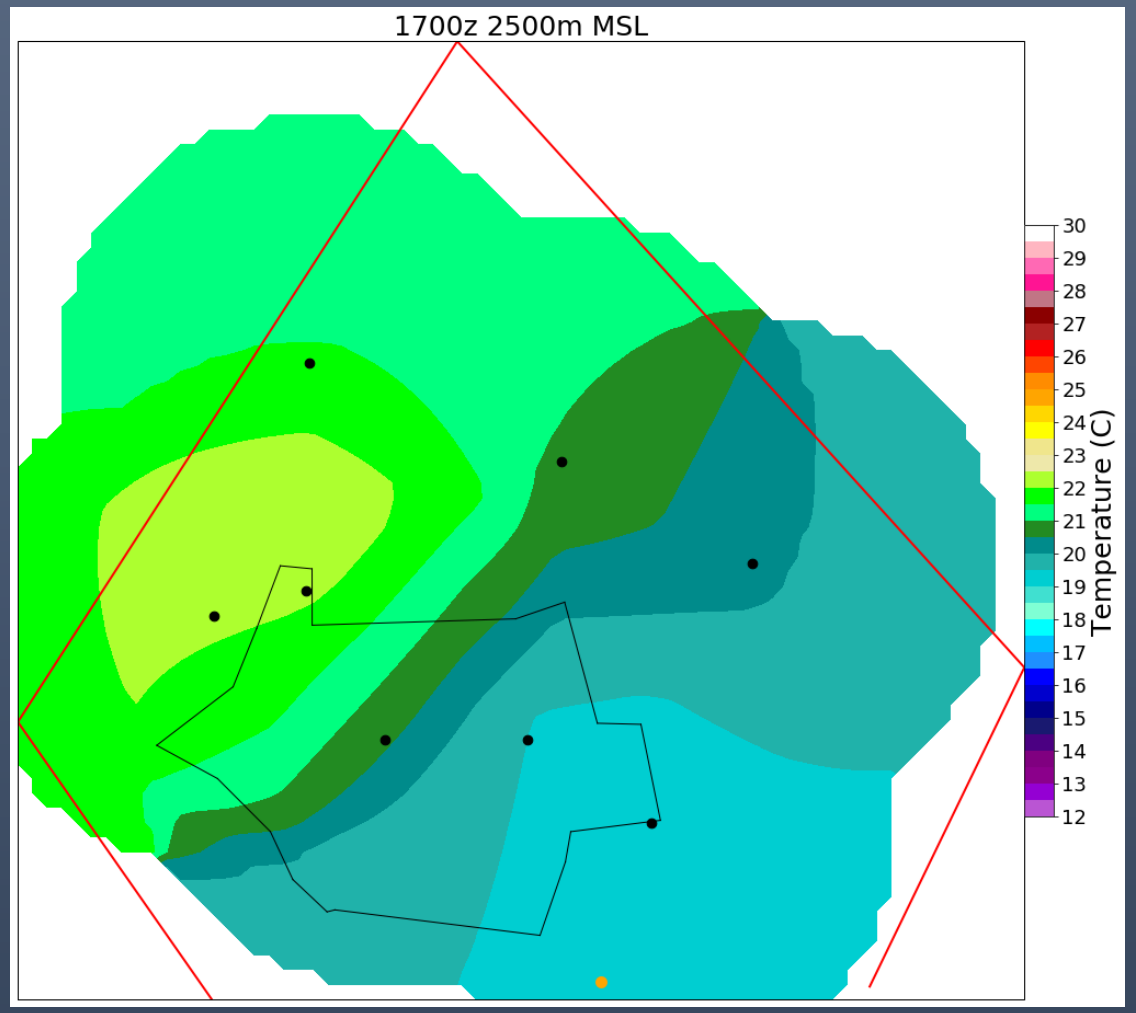
3) Analyze the conditions and mechanisms that result in pristine DCI leading to secondary DCI in the San Luis Valley

Methods

- 1-D Vertical Cressman Interpolation
  - Every 1m in the vertical
  - Start with 50m radius of influence (Ri)
  - 4 corrective passes
- 2-D Horizontal Cressman Interpolation Using MetPy*
  - Every 50m in the vertical
  - Every 30 minutes
  - Ri depends on average data spacing

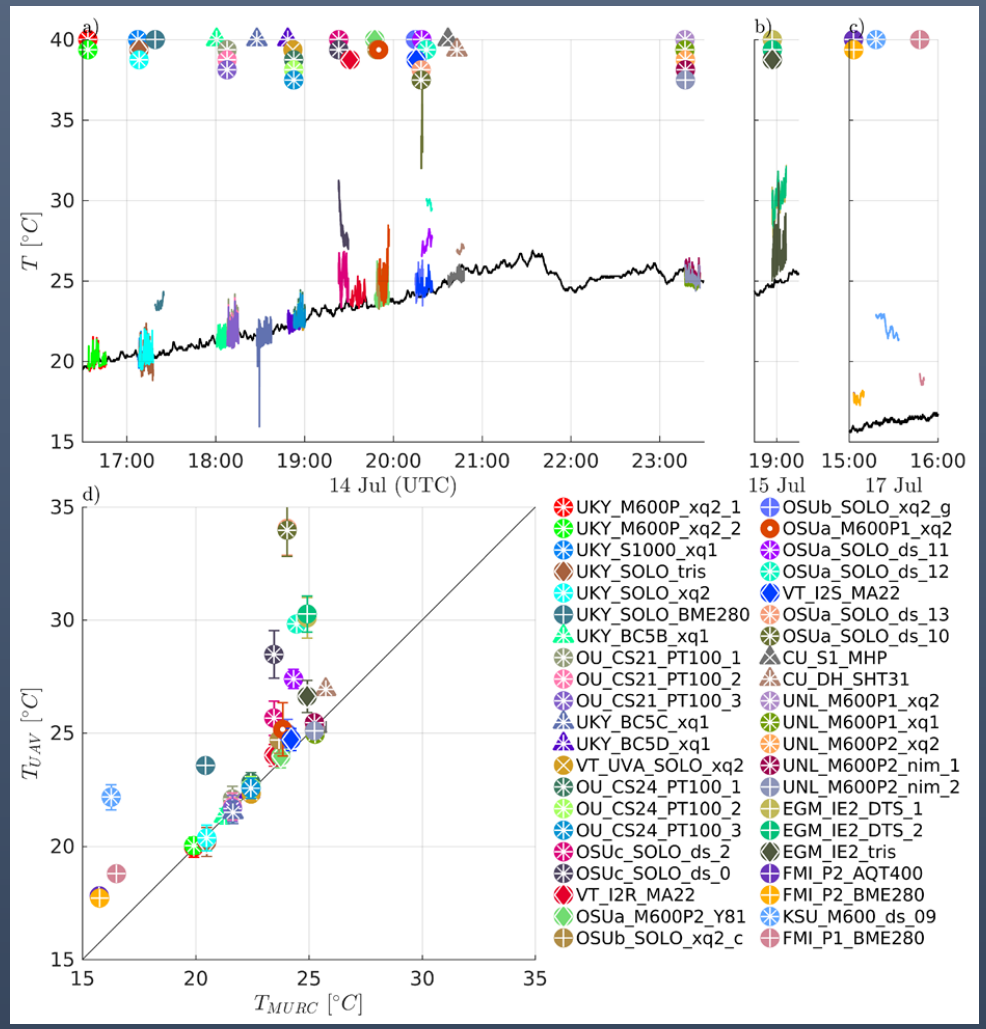
$$W = \frac{N^2 - d^2}{N^2 + d^2}.$$

(Cressman 1959)



Next Steps

- Fine tune the objective analysis
  - Radii of influence
  - Multiple horizontal iterations
- Additional fields
- Address sensor biases



(Barbieri et al 2019)

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Questions?

Vertical Interpolation Weighting Function