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

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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)

(4) (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)
Convergence Zones

• Deep convection often initiates on low-level convergence zones (Wilson and Schreiber, 1986)

• Significant-along line variability (Markowski et al., 2006)
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)
Deep Convection Initiation

(Lock and Houston 2015)
Deep Convection Initiation

Mountain-Valley Evolution

• Relatively few pristine initiation points in valleys (Banta and Barker, 1987)
San Luis Valley
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)
Example 2 Constant Height
(Above MSL)
Next Steps

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

(Barbieri et al 2019)
References


References

- National Academy of Sciences, 2009: Observing Weather and Climate from Ground Up
Questions?
Vertical Interpolation Weighting Function