The Roles of Large-Scale Advection and Land surface Conditions in the Initiation of Convection during HI-SCALE

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**Scientific Question:**

- How are the land surface conditions related to the initiation of convection and how does large-scale advection affect this relationship?

- **Negative soil moisture feedback**

- Relatively drier (wetter) patches have more possibilities to receive rain in dry (wet) conditions.

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**Taylor et al., 2011, Nat. Geosci.**

**Hsu et al. 2017, J. Geophys. Res.**
Case Overview

- **Time and Location:**
  - August 30th, 2016
  - Southern Great Plain
  - HI-Scale Field Campaign
- A “golden day” with transitions from shallow to deep convection

WRF-LES Simulations

1. **Control Simulation**
   - 08/30/2016 5:29 to 17:29
   - Domain Size: 297km x 297km
   - Spatial Resolution: 300m
   - Realistic SMOIS and LU.
     (Fast et al., JAMES, 2019, in revision)

2. **“No Advection” Simulation**
Impacts of Large-Scale Advection on Clouds

- Large-scale advection causes more organized clouds on the west of the domain.
Impacts of Large-Scale Advection on LAIs

In the absence of advection,
- clouds are more likely over the dry soil;
- rain rates increase earlier than those in the control simulation.
Cluster Analysis of “No Advection” Simulations

“K-means” unsupervised learning

- Samples: $\theta_e$ close to surface (~30m)
- Features: 49 time steps
- Three clusters
- The features of convection close to the surface, represented by $\theta_e'$, are dramatically different.
Land and Cloud Properties of Each Cluster

- The cluster with positive $\theta_e$' is associated with low sensible heat, high latent heat, high soil moisture, and low cloud water path, and vice versa.
Summary

1. Large-scale advection weakens the land forcing and delays precipitations.
2. In the absence of advection, most of the clouds are over the dry soil while large-scale advection moves the clouds over the wet soil.
3. In the absence of advection, LAIs are explored by cluster analysis of $\theta_e$.
   - Learning algorithm successfully divides the time series of $\theta_e$ into three different clusters, which represent different convection features.
   - Low HFX, high LH, and high SMOIS grids are associated with high $\theta_e$.
   - Clouds forms over high HFX, low LH, and low SMOIS grids, where low $\theta_e$ are observed.

My poster is at 3:30-5:00 on Wednesday (B1).