Statistics of Cold Pool Properties from High-Resolution Simulation and Observations during AMIE/DYNAMO

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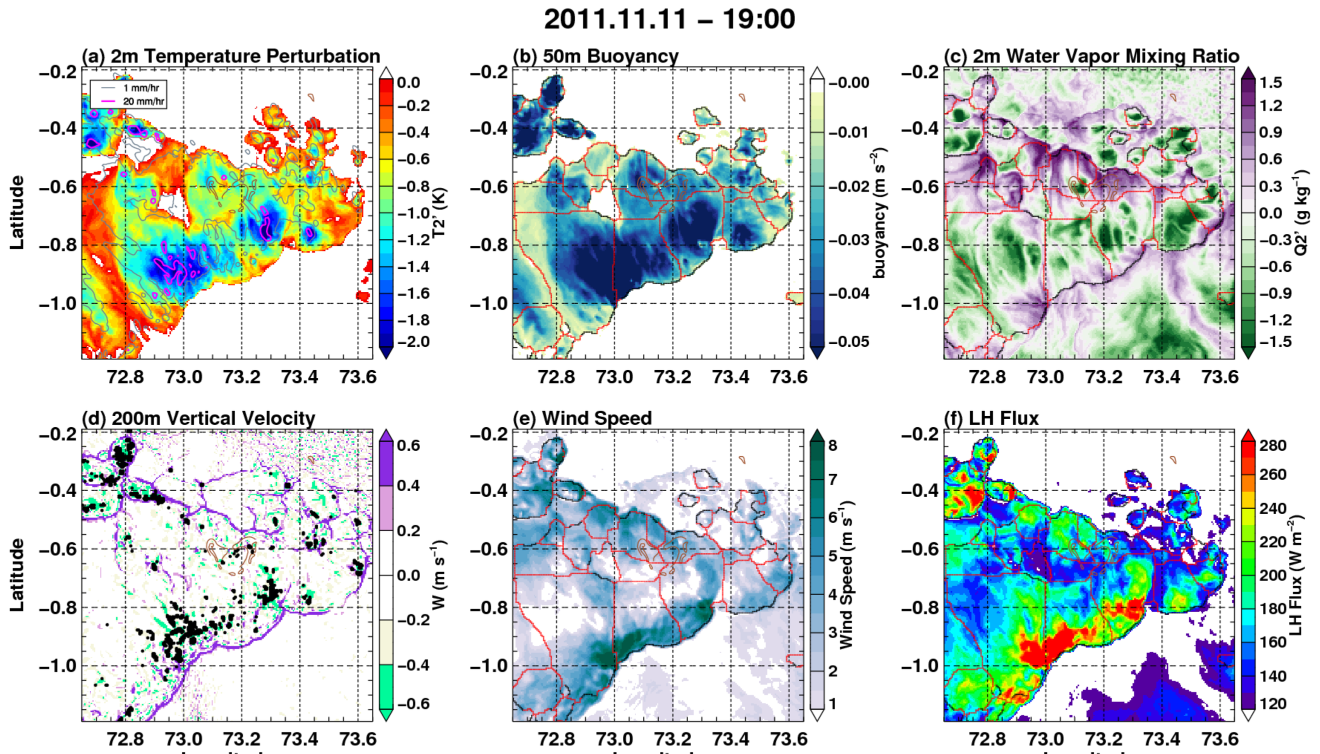
1. Introduction and objective

- Cold pools density currents produced by evaporation of precipitation and downdraft of cold air from convection into the boundary layer. They are believed to play an important role in the organization of convection. Deep convection preferentially develops at the edge of cold pool, through two mechanisms: thermodynamic effect (moist & unstable) and dynamic effect (forced ascent at gust fronts).
- **Goal: validate high-resolution simulation of cold pools by comparing with AMIE/DYNAMO observations, and use the simulation to better understand these mechanisms and parameterize them in GCMs.**

2. Experiment design and methodology

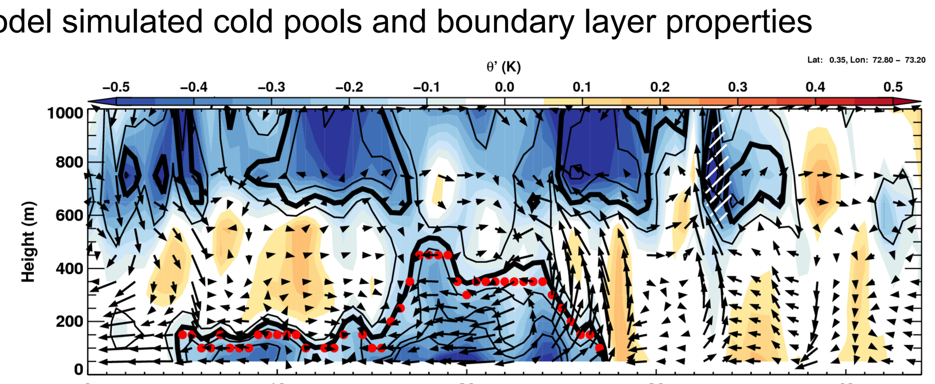
- 500m horizontal grid-spacing WRF simulation in large domain (1000x500 km), 40-levels, 50m at lowest 1km
- Period: Nov 1 – 20, 2011, forced by ERA-I analysis
- PBL: UW; Surface: Monin-Obukhov
- LW Radiation: RRTM; SW Radiation: Dudhia (1989)

- Identify and track individual cold pools
- Separate single vs. intersecting cold pools
- Q_v': moist (dry) anomaly at the edge (center)
- Enhanced vertical velocity at gust front
- LH flux influenced by surface wind speed and Q_v'



Snapshot of model simulated cold pools and boundary layer properties

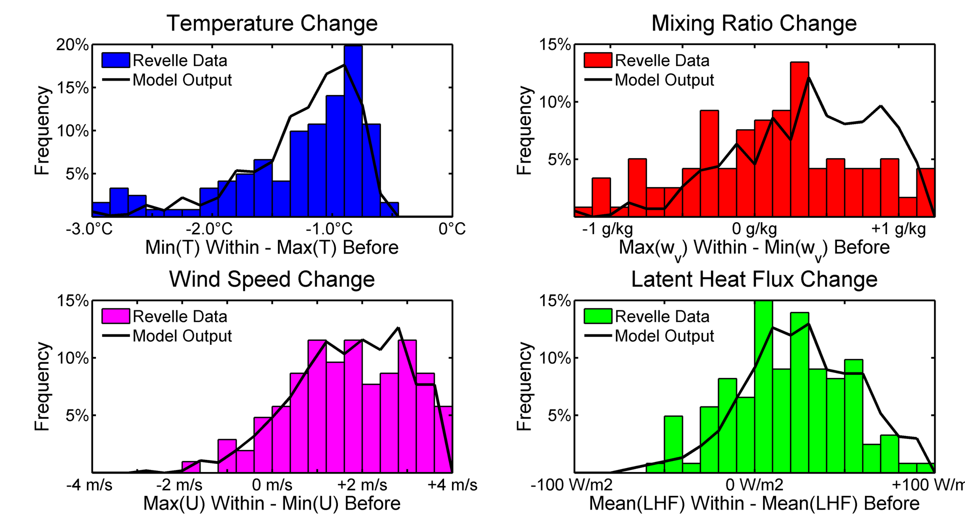
Shaded: potential temperature anomaly,
Contour: buoyancy,
Arrow: flow field,
Red dots: cold pool top



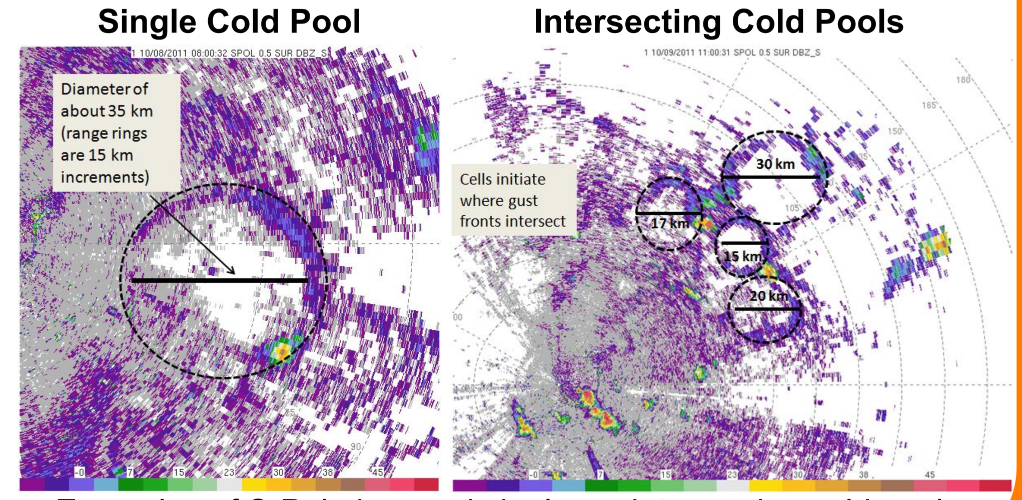
Vertical cross-section of a cold pool

3. Comparison with observed cold pools

- Model produces comparable changes in temperature, wind speed and LH flux statistics with observations, but has a moist bias.
- The simulated size of both single and intersecting cold pools also agrees with S-Pol observations.



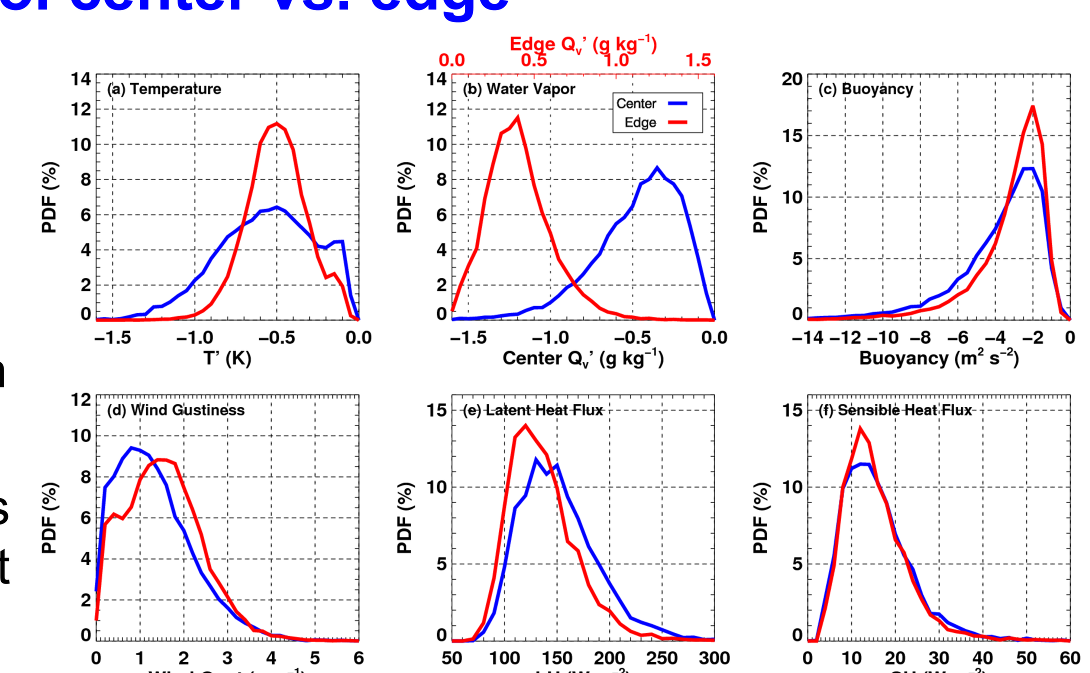
Comparison of the changes of surface variables at the passage of cold pools between Revelle observations and model



Examples of S-Pol observed single vs. intersecting cold pools

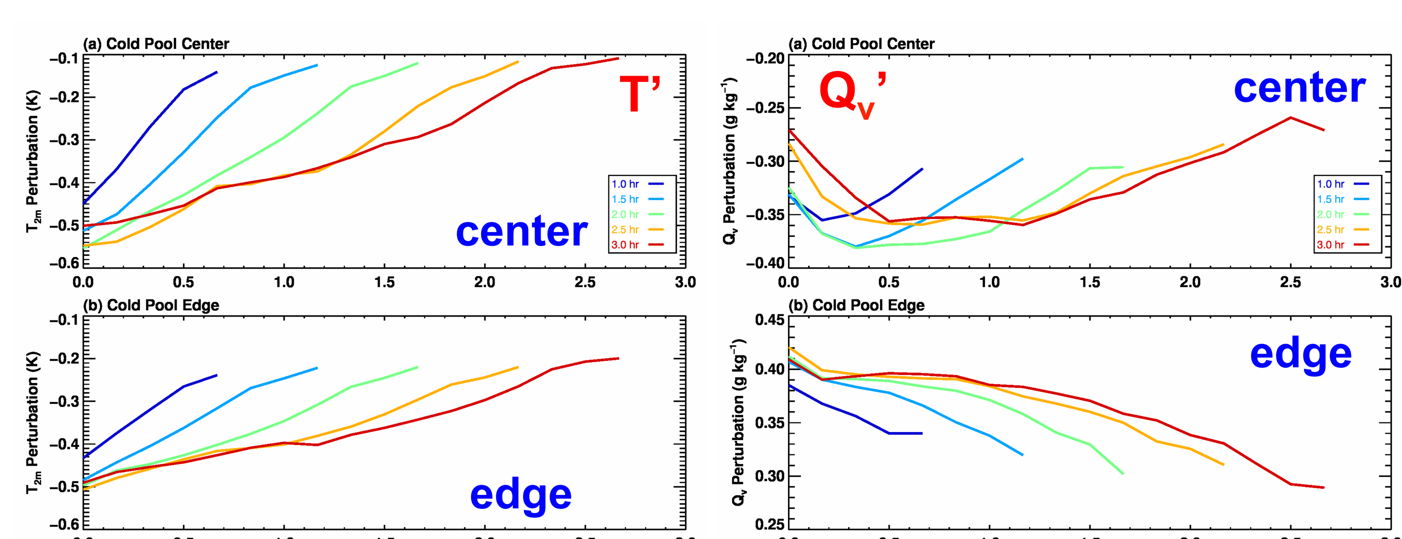
4. Cold pool center vs. edge

- Cold pool edges are warmer, more moist, have stronger wind gustiness than the centers.
- SH heat fluxes are similar, but LH fluxes at the center are stronger (drier).



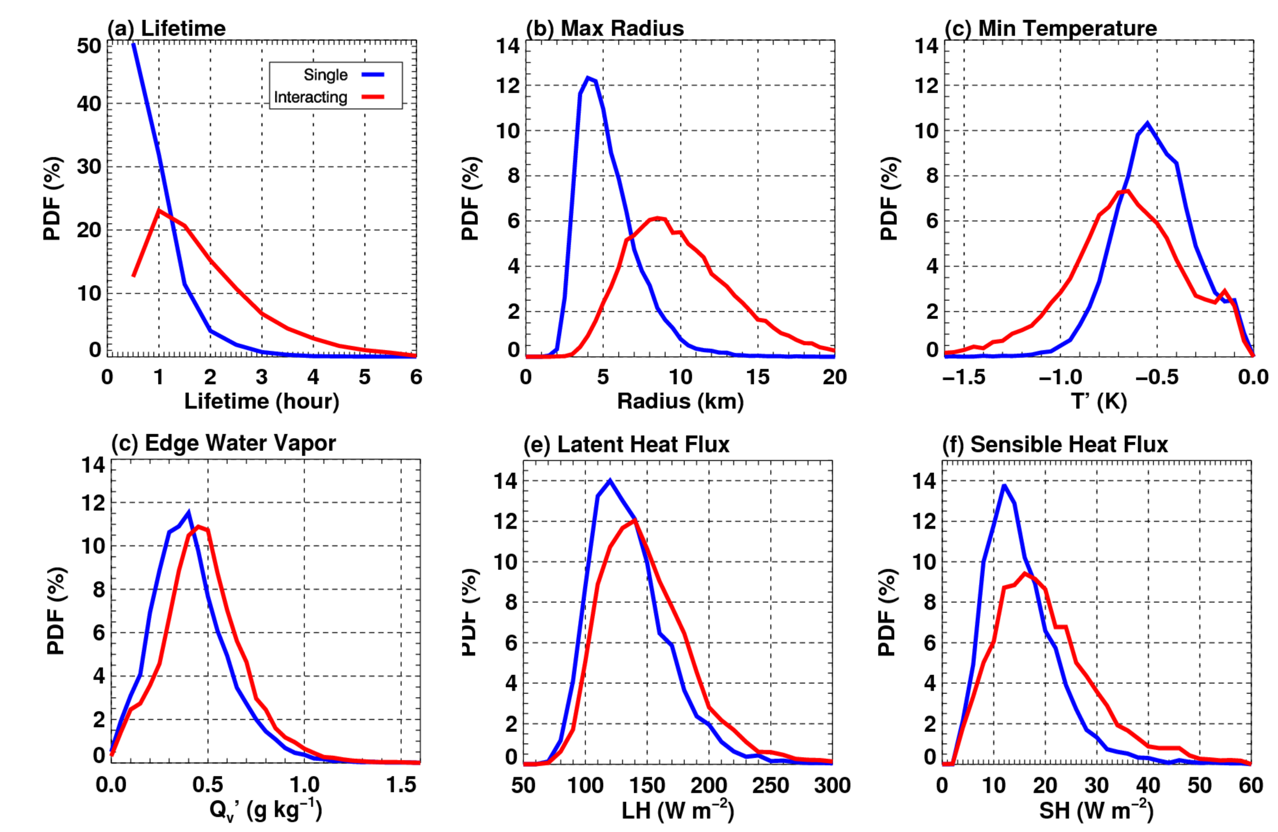
PDF of surface variables at cold pool centers vs. edges

- Center continues to get drier before recovery from mixing of BL air above and surface LH fluxes.



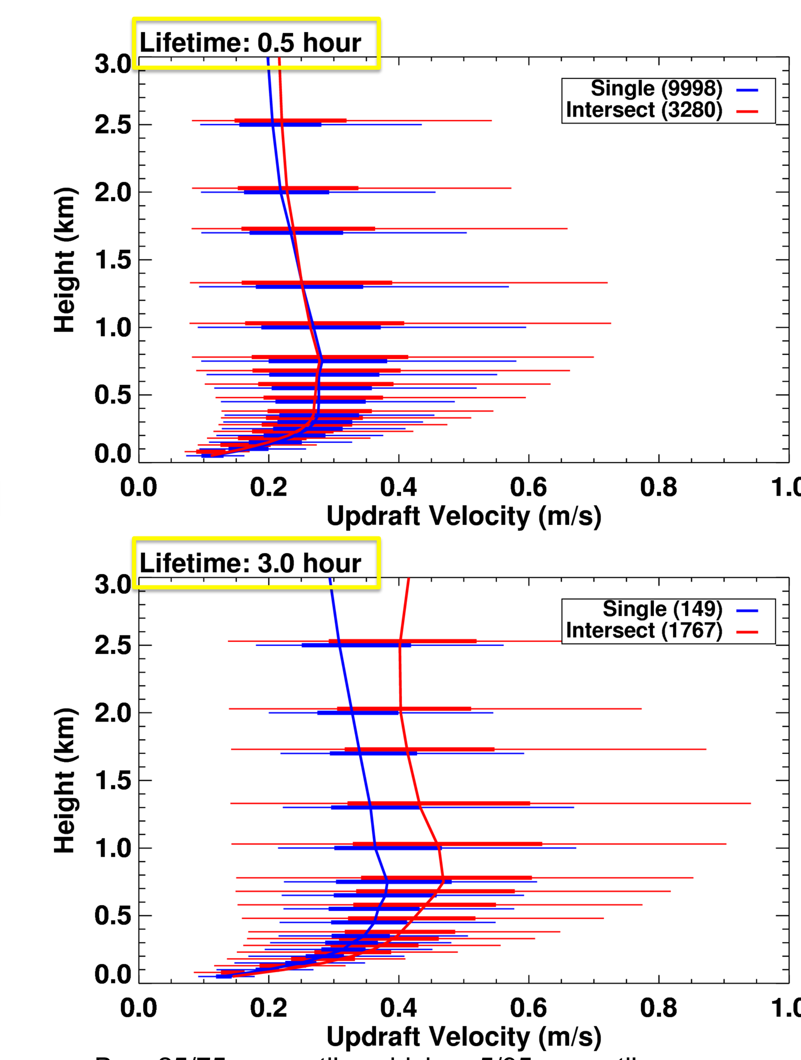
Composite evolution of T' and Q_v' by cold pool lifetimes

5. Single vs. intersecting cold pools



PDF of surface variables between single vs. intersecting cold pools

- Intersecting cold pools last longer, grow larger, are more intense with slightly enhanced fluxes than single cold pools.
- Intersecting cold pools produce stronger BL updrafts than single cold pools, particularly at the upper quartiles; updraft area is about 2X larger (not shown).
- Longer lasting cold pools amplify this effect.



Box: 25/75 percentile, whisker: 5/95percentile
Profile: median. Numbers in () are number of cold pools.

5. Summary

- Cold pool statistics produced by high-res simulation is comparable to those from AMIE/DYNAMO observations.
- **Intersecting cold pools last longer, are more intense, with slightly enhanced surface fluxes and significantly stronger forced updraft than single cold pools, suggesting both thermodynamics and dynamics play a role in promoting new convection.**
- Currently working on using data from the simulation to parameterize these processes in GCMs

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