M.S. Defense Announcement
Nicholas Falk
Tuesday, November 30, at 9:00 a.m. MT

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November 30, 2021
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Defense
ATS West Seminar Room (121 ATS West) or in Zoom (full meeting information below)

Post Defense Meeting
Riehl Conference Room (211 ACRC)

Committee:
Susan van den Heever (Adviser)
Russ Schumacher
Subhas Venayagamoorthy (Civil and Environmental Engineering)

Strong and Weak Cold Pool Collisions

Collisions between convective cold pools commonly initiate new convective storms. This occurs through enhancements to the vertical velocity through mechanical forcing, and increased water vapor content via thermodynamic forcing. The goal of this study is to investigate the impact of the following four parameters on the mechanical and thermodynamic forcing associated with cold pool collisions: (1) the initial temperature perturbation of cold pools, (2) the initial distance between cold pools, (3) the environment in which cold pools exist, and (4) the strength of atmospheric diffusion. To achieve this goal, the dynamical and thermodynamical processes of colliding pairs of cold pools is investigated using a two-dimensional, high- resolution non-hydrostatic anelastic model. The four parameters of interest were varied across a wide range of values in a model suite comprised of 11,200 large eddy simulations in total. To facilitate our analysis, a classification of cold pool collisions into categories of "mechanically strong" and "mechanically weak" is proposed. "Mechanically strong" cold pool collisions occur when the updraft velocities resulting from the collisions are greater than those produced by the flow of air forced up the leading edges of individual cold pools. In "mechanically weak" collisions, the updraft velocities produced by individual cold pools are greater than those from cold pool collisions. An analogous classification of "thermodynamically strong/weak" collisions is also proposed.

The results of this analysis show that the initial temperature perturbation of the cold pools has the largest impact on mechanical and thermodynamic forcing from cold pool collisions. Colder cold pools have greater horizontal wind velocities at their heads, leading to greater near- surface horizontal convergence when they collide. This in turn leads to greater updraft velocities which are also more effective at advecting water vapor upwards. The second largest impact on mechanical and thermodynamic cold pool forcing is from the environment in which the cold pools exist. Due to a decreased vertical gradient of potential temperature, weaker low-level static stability increases mechanical forcing as the air lofted by the collisions is decelerated less by negative buoyancy. Environments with larger low-level vertical moisture gradients are associated with increased thermodynamic forcing through enhanced vertical moisture advection.

The initial edge-to-edge distance between the cold pools has the third largest impact on the proxies for convective initiation. Mechanical forcing is found to peak at an optimal initial distance between cold pools of ~2.5 km due to a balance between the creation and dissipation of kinetic energy. Thermodynamic forcing, on the other hand, peaks for much greater initial cold pool distances than those associated with the mechanical forcing. This is likely a result of the

faster updraft winds generated during collisions for closely spaced initial cold pools also being more effective at advecting moisture away during the collision, thereby decreasing the thermodynamic forcing. The smallest impact on the proxies for convective initiation comes from the atmospheric diffusion rate which impacts cold pool strength through mixing. Thus, this work finds that convective initiation becomes increasingly likely from a cold pool collision when the cold pools are colder, the environment is less stable and has a greater vertical water vapor gradient, the cold pools start close to some optimal separation distance, and the atmospheric diffusion rate is low.

Topic: M.S. Defense: Nicholas Falk
Time: Nov 30, 2021 09:00 AM Mountain Time (US and Canada)

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