M.S. Defense Announcement
Faith Groff
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Post Defense Meeting
Riehl Conference Room (211 ACRC)

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Response of MCSs and Low-Frequency Gravity Waves to Vertical Wind Shear and Nocturnal Thermodynamic Environments

Mesoscale convective systems (MCSs) are prolific generators of gravity waves, revealing themselves through satellite imagery of undulations riding along anvils as well as arced radar fine lines. Though not always easily detected, their subtle but substantial ability to alter large-scale thermodynamics and kinematics can change environmental favorability as well as support or suppress convection initiation (CI). This study investigates the sensitivities of MCSs to changes in the vertical wind and thermodynamic profiles through idealized cloud model simulations, highlighting how internal MCS processes impact low-frequency gravity wave generation, propagation and environmental influence. A common feature among all of the simulations is that fluctuations within the internal latent heating profile, the generation mechanism behind n = 1 (N1) waves, display concurrent cellularity with the MCS updrafts. Spectral analysis is performed on the rates of latent heat release, updraft velocity, and deep-tropospheric descent ahead of the convection as a signal for N1 wave passage. Results strongly suggest that perturbations in mid-level descent up to 100 km ahead of the MCS occur at the same frequency as N1 gravity wave generation due to fluctuations of latent heat release caused by the cellular variations of MCS updrafts. The frequency at which the cyclical nature of these variables occur remains consistent even with the introduction of deep-layer shear, however under a nocturnal environment, cellularity of the updrafts occurs more often and subsequently increases gravity wave generation. The associated deep-tropospheric descent of N1 waves acts to adiabatically warm the vertical column and decrease convective available potential energy, potentially suppressing CI.

In response to surges of latent cooling within the lower half of the troposphere, n = 2 (N2) low-frequency gravity waves are generated, however this only occurs with cooling contributions from both evaporation and melting of hydrometeors. Results indicate that in environments with minimal upper-level wind shear atop more pronounced shear below, the N2 wave generation mechanisms and environmental influence behave the same among daytime and nocturnal MCSs. The introduction of deep-layer shear supports increased rates of latent cooling large enough to generate strong N2 waves that support cloud development ahead of the MCS as well as sustain and support convection within the domain.