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Integrated Observations of a Near-Surface Based Supercell Located Behind a Gust Front

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- Tornadic supercell produced at least 4 tornadoes, including a long-tracked EF3 tornado, across eastern MS and northwestern AL during the late morning and afternoon of 11 April 2013
- Complex merger occurred between supercell and quasi-linear convective system (QLCS) across NW AL, with supercell remaining persistent embedded within the QLCS
- Decaying embedded supercell structure passed directly over Advanced Radar for Meteorological and Operational Research (ARMOR), the Mobile Integrated Profiling System (MIPS), and a 5-sec. surface observation site at the University of Alabama in Huntsville (UAH)
- UAH surface data, MIPS vertically-profiling data, and velocity-azimuth display (VAD) divergence profiles from ARMOR are compiled for 11 April 2013 and a control case of a typical QLCS without a circulation on 21 February 2014

Figure 1: Picture of MIPS (top) with labeled 915-MHz Doppler wind profiler (915), multi-channel profiling radiometer (MPR), X-band Doppler profiling radar (XPR), and a ceilometer, along with a map of the northern Alabama observational array (bottom).

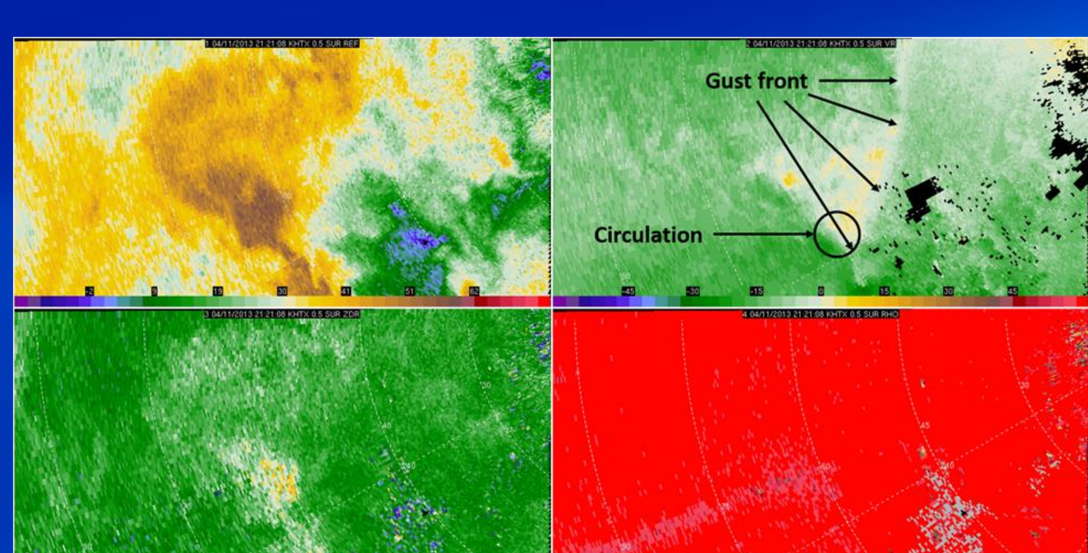

Figure 2: Four-panel plan position indicator (PPI) display of equivalent radar reflectivity factor (Z_e; upper-left), dealiased base radial velocity (V_r; lower-top), attenuation-corrected differential reflectivity (Z_{DR}; lower-left), and cross-polar correlation coefficient (ρ_{hv}; lower-right), for the ARMOR 0.7° sweep at 21:21:08 UTC 11 April 2013, showing the circulation behind the gust front.

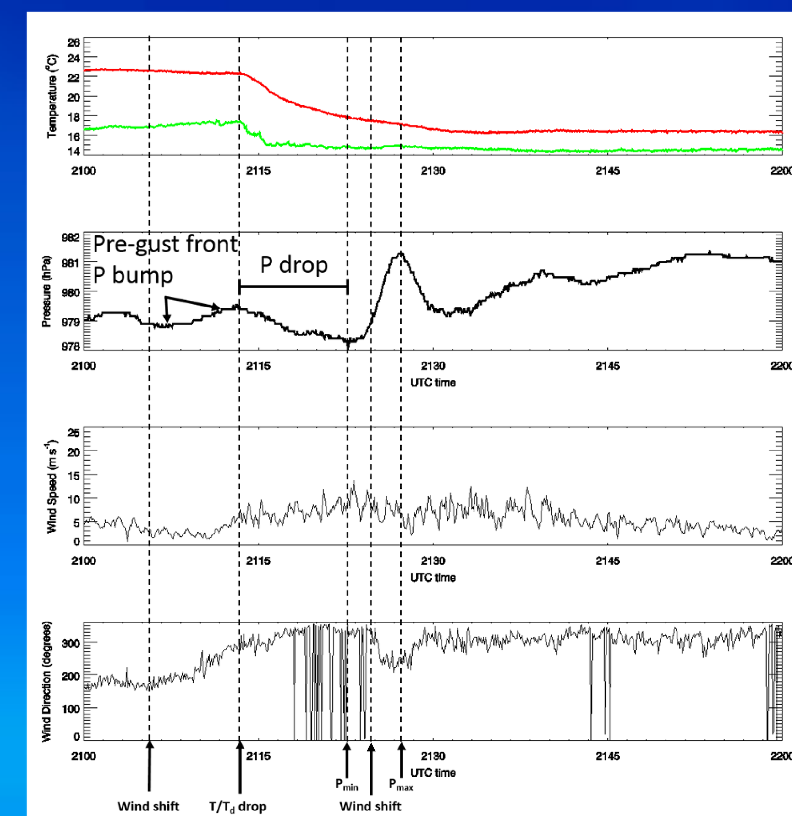

Figure 3: Time series of temperature (T) and dewpoint (T_d), pressure (P), wind speed (m s^{-1}), and wind direction (°) at UAH from 2100-2200 UTC 11 April 2013. Note the pressure drop of ~1.25 hPa after the gust front passage, along with the wind direction changes as the circulation passes overhead.

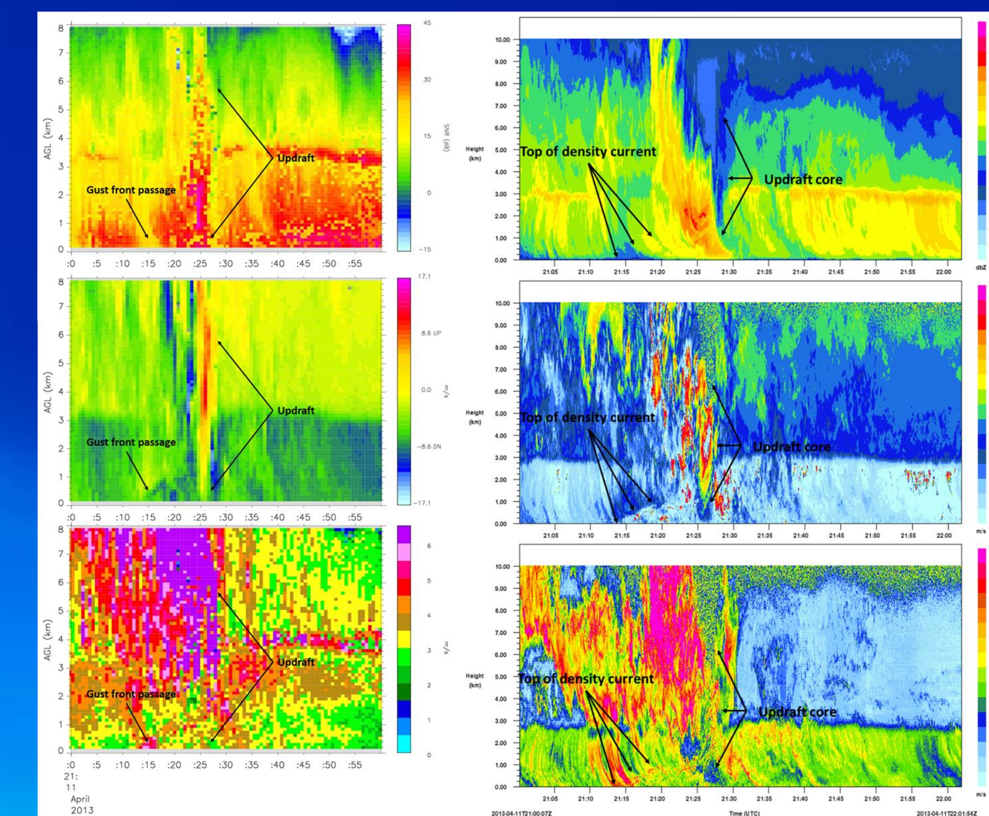

Figure 4: Time-height plots of signal-to-noise ratio (SNR; upper-left)/Z_e (upper-right), vertical particle velocity (W, middle), and spectrum width (bottom) from the MIPS 915-MHz Doppler wind profiler (left) and XPR (right) for 2100-2200 UTC 11 April 2013. The cold pool can be seen in V_r and spectrum width and is approximately 0.8 km deep as the mesocyclone moves over MIPS.

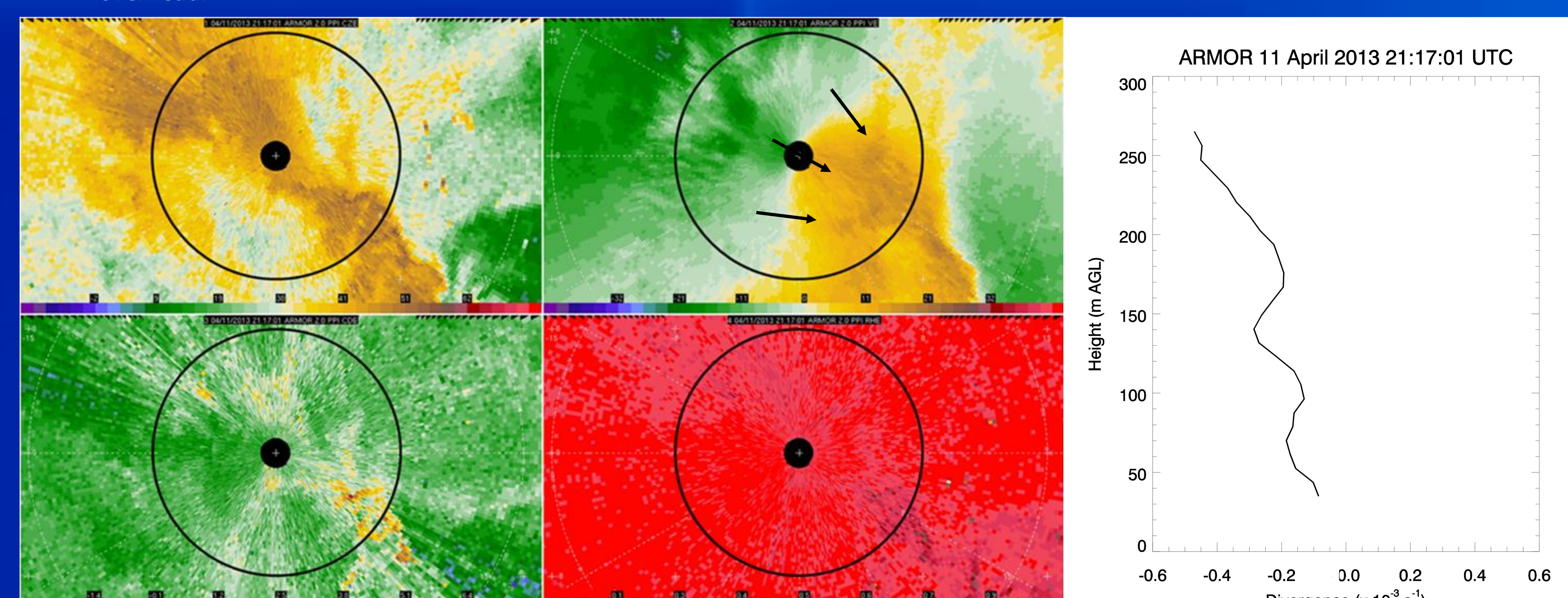

Figure 5: Four-panel PPI display of Z_e (upper-left), V_r (middle-top), Z_{DR} (lower-left), and ρ_{hv} (middle-bottom), along with a velocity-azimuth display (VAD) derived vertical profile of divergence for the ARMOR 2.0° sweep at 21:17:01 UTC 11 April 2013. The black circle on the PPIs shows the 7.5-km radius of the VAD analysis domain. The V_r PPI and VAD divergence profile indicate near-surface convergence underneath the supercell updraft, despite evidence from MIPS-XPR and the UAH surface observations that the gust front from the QLCS had propagated ahead of the updraft.

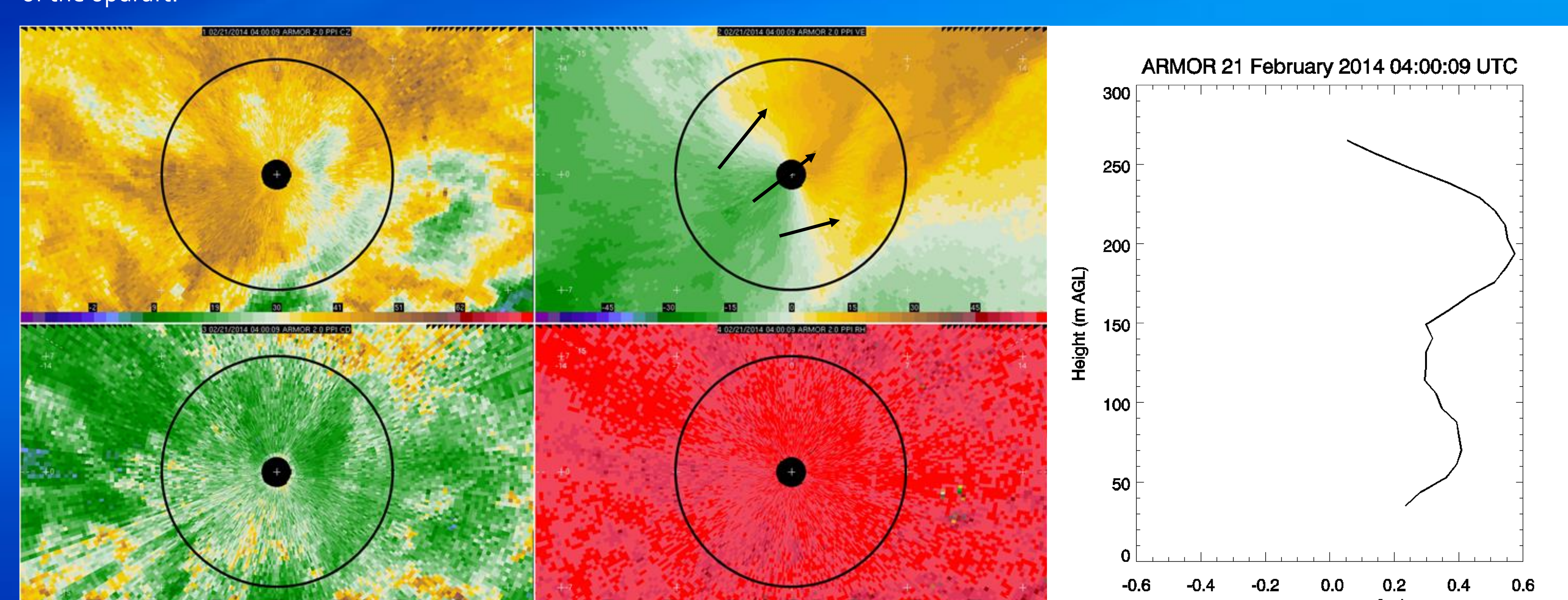

Figure 6: As in Fig. 5 for the ARMOR 2.0° sweep at 04:00:09 UTC 21 February 2014, used as a control case for showing divergence in the cold pool using a VAD profile. The V_r PPI and VAD divergence profile indicate the typical near-surface divergence associated with the cold pool of the QLCS. Divergence decreases rapidly above 200 m AGL due to the domain catching a small portion of the convergence along the gust front.

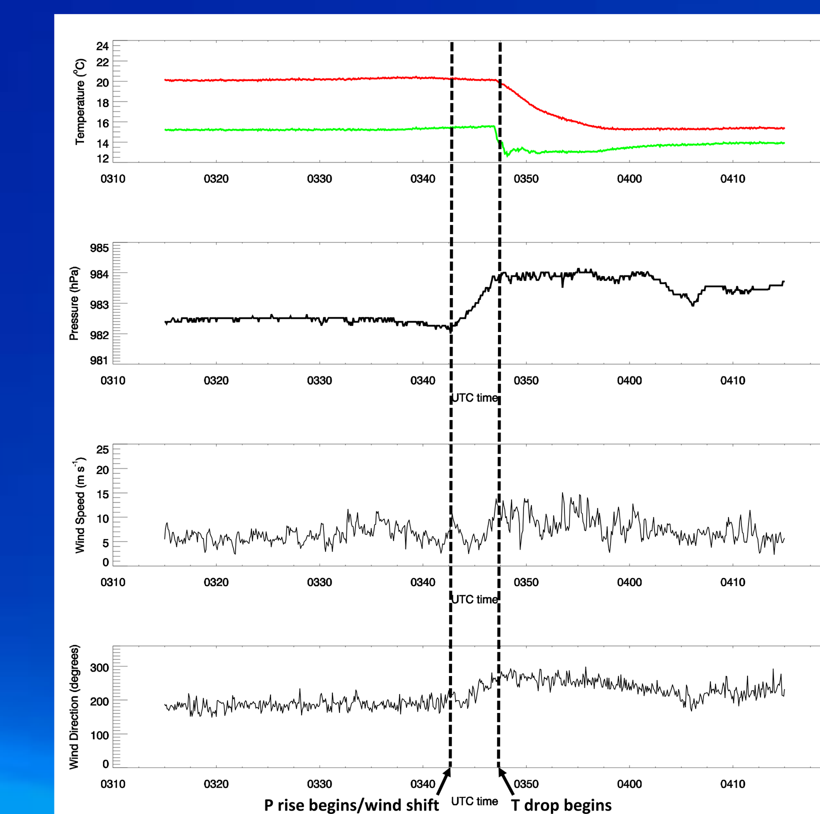

Figure 7: As in Fig. 3 from 0315-0415 UTC during the 21 February 2014 control case.

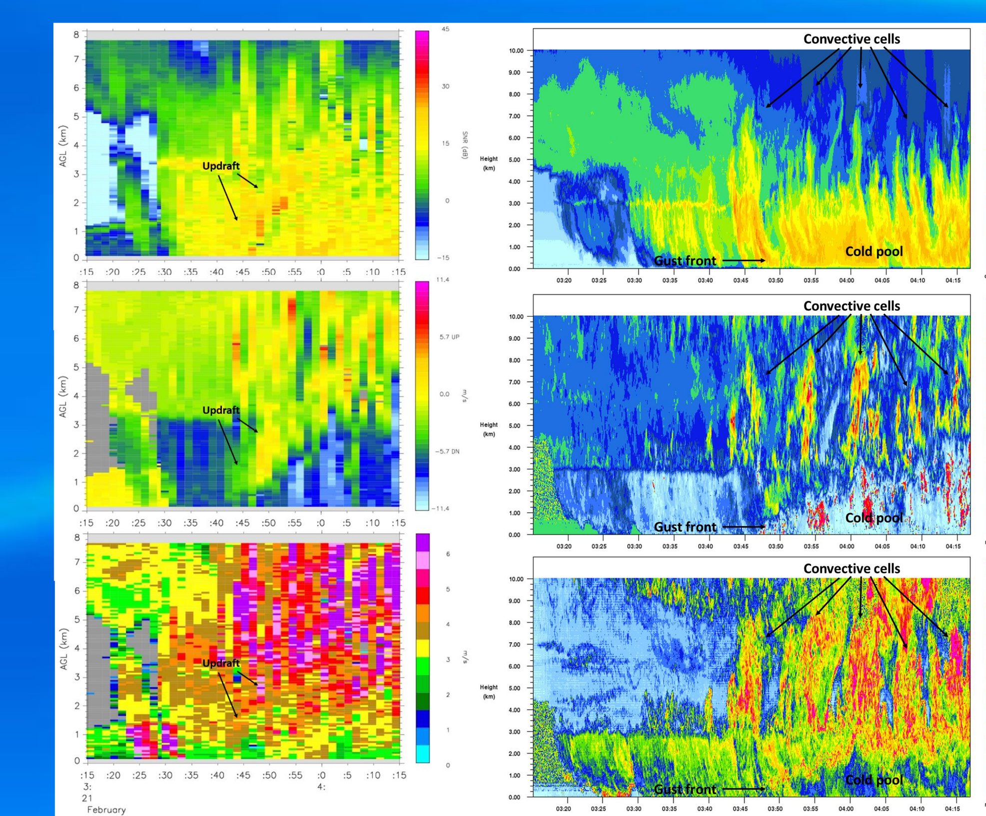

Figure 8: As in Fig. 4 for 0315-0415 UTC during the 21 February 2014 control case.

Conclusions

- Surface observations from UAH on 11 April 2013 show a distinct P drop of ~1.25 hPa after the T falls commence in association with the cold pool, followed by a sharp pressure rise immediately after, with a total T deficit of 6.2 K observed
- MIPS XPR and 915-MHz Doppler wind profiling measurements indicate cold pool passage at 21:14 UTC, with a depth of 0.8 km, and updraft passage at 21:25 UTC, with a max. W of 11.47 m s^{-1} observed by the 915-MHz Doppler wind profiler
- Updraft appeared rooted near the surface in the XPR and 915-MHz Doppler wind profiler observations
- VAD divergence analysis from ARMOR shows convergence in the surface layer and lower PBL within the cold pool as updraft
- Control case from 21 February 2014 more indicative of typical QLCS cold pool characteristics, including P rises and T falls in surface data, vertical structure as detected by MIPS instruments, and divergence in the cold pool associated with the mesohigh
- *Observations from UAH, ARMOR, and MIPS indicate that supercell, although weakening and undercut by the cold pool of the QLCS, still contained an updraft that was rooted near the surface*

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