

CSU-CHILL DC3 Radar Notes

All times UTC (MDT+6) unless otherwise indicated

3 May 2012

1940 - CSU-CHILL started dual-Dop practice with Pawnee

1945 - Pawnee implemented similar scanning, basically roughly covering the east lobe where the GV is flying.

2020 - CHILL dropping back to surv, Pawnee following suit. There is a storm about 200 km away from CHILL, to north. Currently out of range. Looks like GV headed home.

2100 - GV landed.

East lobe angles: CHILL ~350-120 deg, Pawnee ~50-170 deg

West lobe angles: CHILL ~195-350 deg, Pawnee ~170-290 deg

8 May 2012

1929 - DC8 supposedly near Broomfield but satcom on aircraft preventing good chat or position updates. Cannot reach on radio.

1934 - DC8 radio contact made, flyby occurring.

1942 - DC8 heading north @ 5 kft AGL.

1948 - DC8 departing

1953 - CHILL doing RHIs centered on 90 deg E, mainly checking boundary layer.

1958 - CHILL back to PPI surv.

2009 - CHILL recently idled for maintenance. Ops done for day.

10 May 2012

Radar scientists, write your name below if you can view and edit this document.

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11 May 2012

No ops today.

16 May 2012

1824 - Started RHIs, 15-deg swath, over Hewlett Gulch fire. Plume up to 8 or so km, ZDR's positive up to that height too. Keeping Pawnee in surveillance for now. Reflectivities appear too low for meaningful other polarimetric variables (e.g., RHO_{hv}, LDR, etc.)

1833 - Up to 9 km actually. RHO is off the scale low, does appear to be distinctively lower than the weak meteorological echo around (10-20 dBZ virga/clouds about). Also some diffluence near the top of the plume.

1849 - Plume to 10 km in places. Lots of 10-20 dBZ weak echo over the mountains

1853 - CHILL back in surveillance

1857 - CHILL starting dual-Doppler volume centered on plume. Hoping for Pawnee sync at 1900, 1905 at worst; 5-min update.

1904 - CHILL topped in just over 4 min. Pawnee moving into alignment and will start at 1905.

1915 - Dual-Doppler appears to be in working order, Pawnee and CHILL updating on 5s, both topping the plume nicely. Pawnee rotation/diffluence signature @ 251 deg, 51 km, ~5 deg elevation?

1933 - Reflectivity history suggests plume really got going around 1800 UTC. News reports indicate increasing winds from surrounding virga storms have been fanning the flames today.

1944 - CHILL started RHI sector volume of the plume, will run it until 1950. Not sure if last volume topped the plume.

1950 - Restarting in PPI dual-Doppler. Boundary moving across Denver, some weak convection to our south. LMA confirms there is lightning in the plume!

1959 - LMA sources continue to increase in number, altitude is much higher than surrounding electrified storms (all at long distance), about 10 km.

2006 - There is no CHILL echo at the altitude of the sources! Max reflectivities in the plume are mid-20s.

2015 - CHILL starting another 5 min of RHIs, halved the elevation top so they complete faster.

2016 - Plume only up to 6-8 km now, lightning has decreased.

2028 - Opening up PPI to cover storm S of DIA, going to 6 min update cycle (30, 36, etc.). Pawnee adjusting timing as well. Keeping same elevation angles.

2039 - Big flash in the DIA storm around 2032. Not much recent activity. Storm unimpressive on radar, Zs in the 30s.

2044 - Pat set up time lapse photography of the plume around the time we saw the lightning. Still ongoing.

2052 - Opening up to 180 deg to cover more of the new storm east of DIA. Maintaining 6-min temporal resolution.

2055 - PyroCb seen on the smoke plume when it was at its most intense, according to Brody's roommate. He got a picture.

2104 - Storm lightning is short-lived in all the convection out there. DIA storm is petering out. Most active storms are far out of range to our west.

2123 - Maintaining 6-min 180-deg sector, even though DIA storm and everything else in range is weak or dying.

2130 - Doing RHIs on the plume again, for 6 min.

2131 - Plume narrower now, still up to 8 km in height.

2136 - Restarting RHI volume again.

2144 - KCYS shows colliding boundaries near Grover/Hereford.

2148 - Generally, the 180-deg sector completes 11 angles and starts the 12th before resetting. This is fewer tilts than expected.

2150 - To summarize, smoke plume features low Zs (maxing in the 20s, occasionally the 30s, esp. earlier) high ZDR (> 5 dB is common), low correlation (< 0.5 is common). It is very easy to spot in ZDR and the correlations are significantly reduced relative to nearby meteorological echo.

2206 - CHILL back in PPI sectors, outflow boundary passing thru radar location, van is rockin'!

2214 - Pat got 90 minutes of 1-min resolution time lapse on the plume, although some of that might have gotten obscured by intervening clouds.

2220 - Storm directly to our east producing lightning, dropping into surveillance.

2228 - Lightning is really high altitude, about 10 km, but difficult to spot cell on radar. Pawnee in surveillance now too.

2230 - Trying RHIs thru 100-110 deg, looks like a 6-8 km cell, nothing special. Looks like these are weak and short lived.

2232 - Going back into surveillance soon, another cell near WY border.

2233 - Lots of precursors in the plume lightning, Krehbiel examining in XLMA. Normal polarity IC discharges at 10 km. Horizontal size ~10 km. + charge ~10-11 km AGL, - charge ~9 km.

2236 - Nice SW-NE outflow boundary to our NW, think that is what went thru here a while ago. No good targets, storms are dying by the time you notice them. Apparently, visibility in FTC is bad due to another outflow boundary passage in that area.

2252 - Forgot to account for MSL/AGL differences in comparing LMA and CHILL, lightning occurred within the top portion of the plume, within the radar reflectivity. Krehbiel thinks they could be discharges between the main negative charge in the plume and a positive screening layer.

2305 - Trying dual-Doppler on a couple storms in the east lobe. Looks like high-based stuff, peak Zs in the 30s. Tops around 10 km max. Been producing lightning for a while, and has yet refused to die.

2319 - Last volume (2315) we finally managed to top both major cells at CHILL, after making some adjustments to the angles. Storms are over 40 dBZ! Storms are located roughly near the collided Grover boundaries. CHILL can complete 13 tilts in 5 minutes, 120-deg sector.

2330 - Dropped into a quick 1-min RHI sector during that last volume, after topping everything. Restarting in dual-Doppler.

2355 - Pawnee throttling back a bit, topping too quick and losing resolution.

0004 - Looks like PVA was supporting this convection as well, in addition to the surface lifting from the boundary collision.

0012 - Finally got CIDD working, looks fairly stratiform through the echoes.

0016 - Storm may be petering out, lightning aging and 30+ dBZ reducing in size. Still hanging out in that tri-state region.

0023 - No lightning the last 5-6 min or so.

0030 - Terminating dual-Doppler scanning, going to surveillance and moving toward shutdown of ops.

Summary - CSU-CHILL and Pawnee were operational as of 1800 UTC today. CHILL started RHI scans of the Hewlett Gulch fire's smoke plume shortly afterward. RHIs showed the plume reaching up to 11.5 km MSL at times. Dual-Doppler scanning of the smoke plume started with Pawnee and CHILL after 1900. CHILL occasionally dropped into full RHI sector volumes of the plume, instead of PPI sector scans. The plume was distinguishable from scattered nearby virga by high differential reflectivity and greatly reduced correlation coefficient. Lightning occurred near the top of the plume close to 2000 UTC, in a region of enhanced diffluent flow. About 20 intracloud flashes with numerous precursor activity (failed breakdown prior to an actual flash) occurred during a ~3-minute period. Due to the low reflectivities, it is likely that the discharging involved an electrical screening layer. About 90 minutes of 1-min resolution time lapse photography of the smoke plume occurred at CHILL during the dual-Doppler scanning. After about three hours of coordinated dual-Doppler scanning of the smoke plume, and some untargeted surveillance, CHILL and Pawnee found a high-based weak multicell storm near

the tri-state (WY/CO/NE) region and began coordinated scanning by 2305. This storm was fed by colliding surface boundaries and positive vorticity advection aloft, allowing it to last much longer than other electrified convection in the region. Scanning was terminated after 0030 when the storm stratified and stopped producing lightning. Overall, this was a very successful day with useful coordinated scanning of elevated convection along with what has to be the first ever combined dual-Doppler, polarimetric, and lightning mapping observations of an electrified smoke plume.

17 May 2012

1745 - CHILL up and running, tried some RHIs and currently in surveillance. Plume does not look as big or strong today - too windy? Some isolated showers over the foothills, peak Zs in the 30s.

1749 - Trying some RHIs through an electrified cell south of the fire area, may already be decaying tho.

1751 - Tops under 10 km, no lightning last few minutes. Core appears to have descended with highest reflectivities (over 40 dBZ) close to the surface. Back to surveillance.

1755 - Pawnee had high voltage spike issue. Bob working on repairs, down for at least a couple hours.

1800 - RHIs thru 300 deg show plume only to about 2-4 km AGL, portions are closer to radar due to winds. Only showing up on a couple sweeps, portions around 48 km range and again at 60 km range. Feeding into weak showers surrounding the plume. Back to surveillance soon.

1805 - RHIs to cell near 286 deg, west of Fort Collins. Some recent lightning and 40-dBZ reflectivities.

1809 - Cell to 10 km AGL, looks to be decaying.

1812 - RHIs to electrified cell near 35 deg azimuth.

1818 - Back to surveillance. Difficult to catch anything before it starts flashing, then when it does it's already done.

1823 - RHIs to cell east of us at 82 deg.

1838 - Nice updates, capturing full lifecycle of some of these cells, tops to about 10 km, peak Zs above 50 dBZ! Seem to be redeveloping on their southern flank.

1846 - Dropping back into surveillance in anticipation of doing PPI sectors.

1848 - PPI sectors begun, focusing on east DD lobe.

1853 - New cell near 24 deg, 30 km. Adjusting PPI elevation angles to top this one better.

1910 - Back to surveillance to check on overall picture and search for new targets.

1912 - Outflow boundary passing thru CHILL from incoming storm to west.

1916 - RHIs to 53 deg.

1931 - Decent storm, producing a steady flash rate, peak Zs over 50 dBZ. Extremely narrow rain shaft, 2-3 km wide. 10-km AGL altitudes. Some 50 dBZ above 6 km AGL, almost looking like a BWER but probably just where the updraft is relative to two precipitation cores, one mature and the other developing.

1937 - Wow really nice 50-dBZ core near 48 deg. Rotating RHIs counter-clockwise.

1942 - Nice hail shaft in this core, reflectivities peaking over 60 dBZ now. Visible CGs to our NE, along with audible thunder.

1949 - Thunderstorm has classic low-level diffluence, mid-level confluence, and upper-level diffluence.

1959 - Dropped into a quick surveillance sweep to better locate the cells, as they had rotated out of our sector and we weren't able to keep up. Back to RHIs presently

2002 - CHILL has some odd stippling occurring near the surface on downward swings of the RHIs. Sigmet disease?

2004 - Best core is out about 30 km, 68 deg. Overall, storms appear weaker than before. Some positive phase shift aloft. Also some more negative ZDRs below that region. All of this is occurring above the melting level.

2008 - Really nice melting signatures in the pol data. LDR, RHO, etc. all quite pretty.

2024 - Quick surveillance to re-establish contact, rotating RHIs to 86-90 deg.

2034 - Back to surveillance as east storm is petering out. Fort Collins basically on smog alert from the fire smoke.

2042 - CHILL doing RHIs thru the smoke plume. Looks like a storm in that region ingesting the smoke, no lightning yet.

2103 - CHILL back to surveillance.

2104 - RHIs to a storm near 5 deg.

2107 - None too exciting. CHILL going back to surveillance

2111 - RHIs to a storm near 21 deg, by Hereford. Storm is only 8 km tall, but has over 50 dBZ in it.

2117 - Nice little hail shaft, 50+ dBZ associated with near 0 dB ZDR.

2123 - CHILL back to surveillance, lightning somewhat near the fire. RHIs rotating to 298 deg to cover it, cell looks just beyond the fire at 68 km, but could be in the plume.

2127 - Cell is 8 km tall, but has 45+ dBZ in the mid-levels. Lightning no surprise.

2133 - CHILL back to surveillance soon, lightning petered out. 18 Z NAM show forcing moving out of Colorado.

2147 - Most notable cell in range is an electrified one near the tri-state region. Storm is topped by the top surveillance tilt, however, so no incentive to move to sectors. Looks like rain is occurring at the fire, from that storm we were scanning earlier.

2152 - RHIs to the fire storm, near 300 deg. Looks like one source point in it, unsure if just noise though. But good to scan that area regardless with few other notable targets.

2200 - No lightning in Larimer, Weld, Morgan counties last 10 min. Storms further out, however. NW storm peaks out at 30s for reflectivity. Not too exciting, but may be bringing some much needed rain with no lightning to the burn area.

2207 - CHILL back in surveillance. Quieting down for now.

Summary - CHILL was operational by about 1700 UTC today. Throughout the late morning and afternoon the Hewlett Gulch fire plume was significantly smaller, both in horizontal width and vertical height. Occasionally the plume appeared to have been ingested by nearby storms throughout the afternoon, but to no noticeable affect (the storms tended to be no weaker or stronger than average convection in the region). There were also many scattered cells over the plains during the afternoon. CHILL mainly focused on RHI sector volumes of storms as they tended to be small, weak, and short-lived. However, some of the stronger cells on the plains had identifiable hail shafts in the CHILL polarimetric data (high reflectivity, low differential reflectivity). Pawnee radar was down the entire day due to unplanned maintenance. Overall, a successful day of high vertical resolution scanning of weakly electrified elevated convection.

18 May 2012

DISCUSSION - FLIGHT DAY TODAY, a weak little shortwave or 2 will pass thru the target region just after 18Z, although the neither the nam or the gfs have any precip at that time. The nam starts kicking up precip around 21z with some decent forcing over the area. At 00z, nam and gfs have very large disagreements in amount and location of precip with the name showing somewhat large amounts in northeast CO and the gfs showing none anywhere in ern CO, so will be interesting to see which verifies, if either do. Very little cape and moisture to work with though so would expect some weak, high based convection over the area like the last couple of days. Once the weak convection moves east of the dryline and taps into moisture and cape, expect storms to blow up with explosive growth. This is seen in the 16z hrrr run, which breaks out showers over a good portion of eastern CO which turns much more potent once it crosses the dryline around the CO/KS border. The morning run of the ncar-wrf was more aggressive, breaking out convection along the palmer divide and eastern CO around 20z. The nssl-wrf seemed to agree more with the hrrr run so erring on the side of little potent convection. The area east of the dryline is modestly covered by the LMA and can be flown by the planes but not covered by chill or pawnee at all. Model soundings around 20z from the rapid refresh shows

very warm temperatures in the mid to upper 90s at the surface around the Sterling area with very superadiabatic lapse rates associated with the solar warming. Inverted v profile exists from the surface up to 500mb which suggests very high based convection, although the hodograph does show nice cyclonic curvature to support longer lived storms and possibly a supercell.

1800 - Pawnee and CHILL up and running, started in surv but chill tried to do some rhi's around the smoke plume area but no such luck seeing anything.

1825 - Back into simultaneous surv mode with pawnee, since nothing exciting happening yet.

1908 - G5 takes off from Salina, heading for CO. Convective initiation starting just east of Sterling, out of our radar domain.

2000 - Both aircraft in CO now, starting flight paths. Lightning in a cell that just developed near the Hewlett fire

2010 - KCYS scanning at 4:35 per scan, vcp: 212, and most recent scan at 200711. Several storms in WY north of cheyenne while nothing in chill domain. May need to dual doppler w/ KCYS.

2035 - Started DD scanning of cell west of ft collins, cell about 9 km high, scanning period of 5 minutes

2045 - Back to surv mode as per request by salina

2048 - Pawnee started dual doppler with KCYS, starting at 204817 with repeat cycle of 275 seconds

2115 - Nice storm up by Scottsbluff, NE which the G5 is currently flying, just out of Pawnee range, still continuing dual doppler w/ PAW and CYS

2135 - PAW getting nice coverage of storm northeast of cheyenne, possibly in east DD lobe but pretty close to CYS

2145 - Started some RHI scans of storm northeast of CYS, top is around 9km with core reflectivities around 40dbZ. Possible hail or graupel shaft. Nice overhang observed on the northeast side of the storm. Looks like cell formed off of 2 colliding surface boundaries.

2155 - Back into surv mode

2202 - Scanning same cell northeast of CYS again with a few RHI's, storm weakening now and main core descending to ground. This is associated with a significant lightning reduction in the cell

2207 - Now scanning a little developing cell near northwest morgan county. This cell has a lofted core and some lightning activity suggesting some modest development.

2215 - Started DD scanning

2218 - Topped by 11.3 deg, Pawnee no problem topping either

2236 - Winds are crazy at CHILL right now.

2243 - Dust Devils!!!

2256 - Continue to scan east lobe convection. Weakly electrified, line extends toward and into NE, out of range. Best stuff is in NE. Aircraft continue to work a different isolated storm in SW Nebraska, well out of range of us. LMA hole on west side of this aircraft storm associated with high dbZ echo.

2306 - Stuff in extreme NE Weld county is still producing lightning, barely in DD domain. Everything else in the east lobe has not shown lightning the last 10 min

2320 - CHILL transmitter issue, not seeing any echoes above -20 dbZ. We can still see updates so we know the plotter is not the issue.

2323 - CHILL seems to be working now!!

2334 - LMA data in aircraft storm: 2238-2246 notch, 2246-2304 hole

2345 - Both radars switching back to surv mode because nothing going on anywhere in domain

0010 - Pawnee no longer scanning due to an overcurrent issue. Bob looking into it.

Summary - CHILL and Pawnee were up and running by about 18 UTC today. Aircraft took off shortly after 19 UTC. No plume was visible over the Hewlett Gulch fire, but a thunderstorm did occur in that region after 2000. CHILL and Pawnee did about 10 minutes of dual-Doppler in the west lobe on this storm during 2035-2045. After that, Pawnee supported aircraft ops in Wyoming by doing coordinated scanning with the KCYS NEXRAD. However, today the main storms of interest for the aircraft were too far from Pawnee or CHILL for the northern Colorado network to do effective support. CHILL occasionally supported Pawnee/KCYS scanning of electrified convection with RHIs, otherwise it stayed in surveillance. At 2215 CHILL and Pawnee started coordinated scanning of weakly electrified convection in the east dual-Doppler lobe, and remained in this mode until the convection withered around 2345. The second storm that the aircraft worked, in SW Nebraska, appeared to experience a convective surge and some rotation during the 2200-2300 hour. This was seen in both the NEXRAD radar data as well as the CO LMA data, where a well-defined hole in the density of VHF sources was noted after 2230. This was indicative of a strong rotating updraft, with rotation also observed in the KLNK NEXRAD velocity data. CHILL and Pawnee ceased ops after 0000 UTC.

May 19

DISCUSSION - With the cold frontal passage this morning, surface temperatures have dropped from the mid 80s yesterday, to the mid 40s today. This has led to a stabilization of the atmosphere which we would only expect some stratiform precip. Showers, which have been forced by the trough moving through, are now exiting to the east along with the main trough axis. Behind this trough, surface obs are showing NNE winds associated with a barrier jet and cold air damming near the foothills, this had led a hydrostatic high pressure ridge bulging southward. Expect similar conditions for the rest of the day with the exception of an isolated storm as some areas may experience some surface warming. If can mix out a boundary layer, there is plenty of moisture to work with. Radar operations not needed.

May 20

DISCUSSION - Temperatures have definitely warmed up from yesterday, it is in the upper 70s here at CHILL and similar temperatures are observed where the sky is clear as opposed to mid 60s in the cloudy areas. Forecast soundings for Sterling around 00Z show a deeper mixed layer and an inverted V type sounding, suggesting cloud bases around 600 mb as the lower layers have dried out but surface temperatures have risen to around 80F so some steep lapse rates are present suggesting possibly good area for convective growth. The GFS model shows a modest shortwave in west-central CO which is progged to provide some mountain precip along with a little precip in the eastern plains of Colorado. Dew points are somewhat higher today than they've been on past radar days with numbers in the mid 30s to mid 40s. The high-res models are showing some precipitation forming in our domain around 22Z or so with the wrf-arw producing 2 supercells: one on top of us and one north of sterling so will be interesting to see if this actually occurs. This could possibly be because the deep layer shear is pretty decent with SE winds near the surface and 35 kt winds from the west at 500 mb. I find it hard to believe the ncar wrf-arw when it blows up a supercell over fort Collins but who knows. Currently at 20Z, spc mesoanalysis showing only a couple spots with > 500 surface based cape with mixed layer cape looking more bleak. Right now not much going on in terms of convective activity except for some clouds over the mountains and not really any surface bdrys as seen on radar.

2000 - Arrived at the chill site as the radar was warming up. Only chill today as pawnee is still down. As of now, nothing very interesting to see yet.

2030 - Nothing much going on so doing some rhi scans on little cell west of foco.

2035 - Back to surv mode

2100 - Another set of RHIs to the west for a cell west of Fort Collins, centered on 281° azimuth. Max reflectivities in the 40s, max height ~6 km.

2105 - Back to surv mode

2123 - Scanning cell with rhi's west of Lyons that seems to be developing and has some electrification associated with it. Nice elevated core close to 50 dbZ. Possible small hail signature at this point.

2130 - Back to surv mode, but keeping an eye on the Lyons cell

2155 - Bob notified us that we will be "lucky" to have Pawnee up and running by Wednesday, which looks like the best day in the near future

2159 - RHI series on the storm west of Longmont that is hanging on, though not much LMA sources associated with it anymore. It is pretty much dying out -- tops are about 5 km.

2201 - Since most of the activity looks to be to our west right now, switching to a PPI sector scan. 6 minute update cycle, doing a 210 to 50 degree sector

2225 - Trying dual doppler scan with CHILL and KCYS, it's running on 4:35 second update cycle. Starting this dual doppler at 223200. Top of storm about 8 km high so going to be difficult to get a lot of the storm but we have no other options at this point.

2305 - Right-moving-supercell-looking storm turning south towards Sterling. This cell has been hanging on for a long time and is now strengthening as it turns right towards the south. Strong lightning signature that shows some broad rotation. Most LMA sources around 6km msl extending up to 10km. RHI's centered at 58 degrees started at 2310. Storm core dbZ's at or above 50dbZ. No obvious hail signature from the storm. Storm really far from radar, ~100+ km from Chill. According to SPC mesoanalysis, storm moving into a more favorable thermodynamic environment so will see if storm intensifies.

2320 - Still no obvious hail signature in the polarimetric data. Storm showing a little broad rotation in what appears to be a weak mesocyclone. SPC MA showing the storm moving towards a maximum in bulk shear coincident with the CAPE max, but doesn't look like too much shear to rip it apart. Brenda's HID is showing hail and a significant area of graupel at 61 degrees azimuth

2330 - Hail signature in LDR, also Nexrad indicating strengthening broad rotation

2335 - Couple of cells forming right over Denver, showing some lightning

2355 - Went to some PPI sector scans, azimuths from 55 to 210 degrees in order to keep an eye on the right mover as well as some developing cells just east of Denver. Topping the strong NE storm at about 5 degrees. Looks like that storm is developing on the southern flank associated with strong LMA sources there.

0012 - Severe warning on storm near Sterling, 1 inch hail expected out of cell which is roughly consistent with our polarimetric data. High reflectivity core getting larger. Sticking with same

PPI scans watching Sterling storm and developing Denver storms.

0025 - Weren't quite topping the storm, so we changed the elevations to now top the storms to the south east of Denver.

0050 - Remaining in same sector scan as before, storm has been skirting along CHILL's outer flanks

0100 - Lightning hole observed in center of Sterling storm, accompanied by a turn in storm motion from SE to S.

Summary - CHILL operational as of 2000Z today as Pawnee is still down for repairs. Bob has informed us that Pawnee will not be up until at least Wednesday and that we would be lucky to have it working by then. Nothing interesting to see for the first couple of hours of operation so were mostly in surveillance mode. After ~2230Z, almost all of our scanning efforts were on scanning a storm that started in extreme southwest Nebraska that exhibited a very high intensity of lightning signatures. We first ran dual doppler with KCYS with modest success because the storm was near the edge of CHILL's range. Around 2300Z, the storm started to intensify and turn to the right while the polarimetric data started to show a hail signature. Around 2330Z, SPC mesoanalysis showed the storm moving into a better thermodynamic and shear environment and by 0010Z, the storm was severe warned as it was moving almost directly south. By 0120Z, the storm had moved out of scanning range but was still warned and producing a lot of LMA signatures. This storm was forecast very well by the NCAR WRF-ARW, and was an interesting storm to scan even though it was far from CHILL.

May 21

Discussion - Temperatures in the lower troposphere continue to warm up as it is 84 at GXY as of the 2000Z writing of this discussion. These warmer temps are contributing to higher CAPE values in the domain even though the surface dewpoints are struggling to reach 30. In the very eastern edge of the domain sits the dry line, which is sporting dewpoints around 50 near the border. For this reason, I believe the NWS has pulled any chance of a tstorm west of Sterling but has still left a 20% chance to the east of there with the best chances being around the east border of Colorado. The GFS and NAM are both hinting at some PVA to the northeast of CHILL and some precip along with that. The NAM's coverage of precip is much larger than the GFS, which only has a little blob northeast of Sterling. All of the precip that is forecast by the models is set to begin around 00Z. Shear is decent in this area, mostly because of the winds at the surface being from the southeast around 15kts as the 500mb flow is not particularly strong. The NCAR-WRF does show a line of cells forming around 21Z and the southern cell right turning and becoming a supercell but this cell looks to cross the border around Julesburg which is too far for CHILL's range. By around 03Z this supercell becomes beastly as it traverses south along the CO/KS border and doesn't die out until 07Z tomorrow morning! Completely opposite to this,

the NSSL-WRF shows nothing even close to our domain. The 18Z HRRR has a cell developing near Wellington and a line of cells just east of 21 76 by 20Z so this is already a fail. It does have a similar cell near the CO/KS border around Burlington at 01Z which is way out of our range so 0 out of 3 high-res models put a decent storm in our domain, but if one can form around us, it should have some juice in it. Currently there are some showers, possibly associated with a little shortwave, near Limon that may intensify once they hit the more unstable air. Problem with that is those are too far away for us to scan! Also keeping an eye on southeastern CO as low level shear is CAPE are very high, contributing to a tornado potential from the SPC.

2000 - CHILL operational now, PAWNEE still down but should be running by tomorrow. Whether it is operational is another question....

2030 - Still in surv mode as nothing is happening yet. NWS removed any chances for storms west of Sterling.

2115 - Still nothing going on yet... in surv mode.

2150 - Ditto

2250 - Storm starting to form between Limon and Burlington on I-70 that looks promising but out of our scanning range. Starting to get into a better environment for development.

2320 - Still nothing of interest on radar so shutting down operations.

Summary - CHILL operational as of 2000Z today as PAWNEE is still down for repairs. It still looks like Wednesday is an optimistic timetable for PAWNEE to be operational again. Nothing interesting in the domain today as the shortwave did not produce any convection north of I-70. As of 2300Z, there are a couple of cells forming along I-70 and moving east while intensifying as they move into a more favorable environment. A severe warned storm is still present near North Platte, NE which was forecast by the NCAR WRF but is too far east of CHILL to scan. Overall, a very uninteresting day for scanning.

22 May 2012

No CHILL operations today.

23 May 2012

Discussion: After a down day yesterday with neither CHILL or PAWNEE ops, today is looking more promising for convective activity. Weak stratiform precipitation is elongated along a surface cold front, which is also responsible for strong northwesterly winds at the radar. Later this afternoon, a surface low is forecasted to develop in southeastern Colorado. This should

lead to a shift in low-level winds to out of the east, providing moist upslope flow and an increase in CAPE to 500-1000 J/kg. A strong jet streak will also nudge into the area this afternoon, providing large-scale upward motion within the exit region. The associated deep vertical shear is expected to exceed 50 kts, which could lead to supercell development in the eastern plains. The aircraft is down for maintenance, but is probably for the best, considering precipitation coverage will likely be relatively widespread today.

1830 - Arrived at CHILL, which had already been running surv scans since about 1700Z. Began with an RHI to look at depth of widespread precipitation, as the surv scans were not topping the echo.

1845 - RHIs through precipitation to the WNW, relatively shallow with tops near 7 km.

1851 - Begin PPI 180-degree sector, not on schedule. Topping by 13 degrees but time greater than 6 minutes.

1900 - Start 5-min PPI schedule from 270 to 30 degrees. Topping by 13 degrees, even the stuff closer to the radar (shallow)

1924 - Begin 7.5-min RHI/PPI sequence, same azimuthal range as before, focusing RHIs to the NW near 330 deg. Shallow, widespread precipitation near foothills.

1946-1954 - Odd issues with the scheduler. Many incomplete volumes

2000 - Surv scans to reevaluate bigger picture. Deepest precipitation still appears to be to the NNW and widespread.

2002-2009 - RHIs to determine storm depth. Still can top with about 11 degrees. Only 6 km deep.

2010 - Back to 5-min PPI sectors from 270 deg to 30 deg in azimuth. Beginning to lightly rain at CHILL.

2020 - Widened azimuthal range to 240 deg starting point to capture more of the widespread stratiform precipitation to the WSW.

2033 - Intensifying bands of precip to our N and S. Will continue to focus on the echo to the NNE, but adjusting azimuths clockwise 30 deg to capture the echo as it moves off toward the E.

2035 - Synced with KCYS, as they are running VCP 21 (for shallow precipitation) on the same 5-min schedule. Echo beginning to move into eastern dual-Doppler lobe so will stick with this scanning strategy for a bit.

2046 - CHILL and KCYS are off by about a minute.

2100 - Changed elevation angles (by slightly degrading resolution) to top widespread stratiform with embedded convective elements.

2115 - Echo continues to develop and move off the foothills into the eastern plains, widespread, and difficult to choose an azimuthal range. Shifting focus to the SSW as precipitation continues to develop near Brighton.

2125 - Raining harder at CHILL. Echo very close to radar so switching to a few RHIs to reevaluate storm depth. Won't be able to top, but trying to at least capture the beautiful brightband within 20 km of the radar.

2130 - Switched to RHI/PPI 7.5-min sequence. Noticed that the RHI's elevation range was from 0 to 15 degrees. Not sure if I'm supposed to change this; will keep as is for now (with 4 RHIs near 366 deg). Raining heavily at CHILL.

2137 - Added another RHI and modified elevation angles of the PPI. Obviously not topping since strongest echo on top of CHILL, but nicely capturing the brightband.

2142 - Strongest echo moving off to our ENE so switching PPI azimuths to 0-120 deg and RHIs centered around 90 deg azimuth. Keeping same elevation angles (reaching 30+ deg).

2145 - Changed the RHI elevation angles to reach a maximum of 40 deg.

2152 - Changed azimuthal and elevation angles for the PPIs as precipitation continues to move off to our E. RHIs continue to show a nice brightband at about 1.5 km in height. Echo tops remain near 4 km near the radar, with deeper echo reaching 8 km at ranges beyond 80 km to the E.

2200 - Switch RHI azimuths to near 80 deg.

2220 - Changed to 5-min PPI-only schedule.

2226 - Something is on fire to our SW within close range (< 5 km) so changing scans to focus on this area. Off-schedule PPIs from 180-240 deg. Still raining at CHILL and can't see a smoke plume signature in the data... likely because its embedded within the widespread stratiform rain in the area.

2248 - Switched to surv scan to get the bigger picture. LMA data shows flashes out of range to the SSE.

2300 - Stopping operations per Steve's suggestion. Only widespread stratiform with no expected convective development or electrical activity.

Summary - The forecast for afternoon convection with possible supercells was a bust. Today was characterized by mainly widespread stratiform precipitation, allowing for periods of RHIs focusing on the brightband. It rained at the radar for several hours. Otherwise, a relatively uninteresting day in terms of lightning or convection.

24 May 2012

DISCUSSION: Cooler temperatures along with much weaker upper-level forcing should allow for a few weak pop-up storms due to daytime heating. Showers were observed in the morning over Fort Collins, and cumulus field has developed. Cumulus congestus also observed en route to the radar; some isolated convection beginning to pop up. Pawnee radar is still down; could be up and running tomorrow morning.

1930 - CHILL currently in survey mode.

1947- Ran a few RHIs at 32-37 degrees azimuth of a storm developing NE of CHILL. The storm is at the western end of a band of precipitation extending east-west due east of Wellington.

1950- CHILL in 5 min PPI scans from 0 to 120 azimuth of the storm.

2000- Encountered a fault in the vertical channel. Resetting the radar. The storm of interest has moved further east; recalibrating RHI scans.

2014- Entered 7:30 RHI/PPI scan of weakening storm NE of CHILL at 60 degrees. The rest of the domain is empty. Stratiform precipitation developing just east of the storm, due south of the eastern border of Wyoming and due east of Fort Collins. .

2020 - The storm has weakened considerably and shallow stratiform precipitation remains. Cloud bases much higher today than yesterday.

2025 - Returning to survey mode. Stratiform area of precipitation has moved into southwestern Nebraska. Some isolated convection out of the domain to the north, in eastern Wyoming and Nebraska.

2030- New cell has popped up in nearly the same spot as the previous storm (approx 50 degrees). Running RHIs on the area.

2032- RHI scans reveal a weak, shallow isolated storm with top at 4 km approximately 50 km NE of CHILL. Stratiform in SW Nebraska is more fragmented now; no brightband observed.

2034- Returning to survey mode.

2044- Cell in SW Nebraska at 90 km distance associated with stratiform precipitation is intensifying. Running RHI scans at 45 degrees azimuth. Strong core of near 50 dBZ is evident. Gusty WSW winds at CHILL.

2053- Running 5 min PPI scans at 38-60 degrees azimuth to capture storm in SW Nebraska.

2102 - Returning to survey mode to reevaluate RHI range and get big picture. Clouds have burned off to the west and south of CHILL. Cheyenne Ridge continues to produce small thunderstorms.

2107 - Switching to 5 min RHI+PPI scans of 30-60 degrees azimuth (PPI) and 40-52 degrees (incremented by 2 degrees) (RHI). Storm on CO/NE border is active and producing a good amount of lightning. Will continue to track this storm.

2124- Switching to 3 min RHI/PPI scans of 30-60 deg azimuth (PPI) and 44-56 deg RHI.

2131- Storm is weakening; reflectivity core showing weaker echo and lightning activity is decreasing. Continuing 3 min RHI/PPI scans.

2133- Latest RHI scans show high-based thunderstorms developing in wake of storm first mentioned at 2044.

2136- Added 1 min to RHI/PPI scan cycle; discovered the 3 min cycle was not topping the storms.

2138- Storms topped. Continuing in this mode, as NWS radar reveals no other precipitation other than the area currently being scanned. Will likely continue in this mode until storms weaken/move out of range.

2142- Modified RHI range to 46-60 deg (incremented by 2 deg).

2154- Switching to survey mode. Storms at NE/CO border have weakened significantly and no lightning in the past 10 min.

2217- Still in survey mode. Very light precipitation developing south of Limon, well out of range. Precipitation to the NE of CHILL continues to wane and taper off.

2230- Still in survey mode. CHILL site still experiencing SSW winds. Clouds continue to deteriorate in the region.

2252- Operations ceased on Pat Kennedy's suggestion and there is nothing happening in the domain. Some light development to the south and east of Limon, but it is out of CHILL's range.

Summary- A quiet day here in CO; one active storm formed off of the Cheyenne ridge and moved slowly along the CO/NE border just east of WY. There was a decent amount of lightning associated with this storm. Other than that one storm, there was little activity. Tomorrow looks to be a little more promising, as it has become increasingly likely that storms may fire off later in the day.

25 May 2012

DISCUSSION: Easterly upslope winds have caused an overcast layer to form over NE Colorado. Higher dewpoints coupled with expected afternoon heating have led to a slight chance of storm activity late in the afternoon. Storms would be expected to form over the foothills or other elevated terrain and move out into the plains, weakening.

1958- Arrived at radar site. Radar was not warmed up, so the process to begin startup was started. Pawnee radar is up and running.

2048- CHILL experiencing error in antenna controller and is down at the moment. NEXRAD radars indicate no precipitation in the CHILL domain.

2056- CHILL back up and running with no problems. Entering survey mode.

2123- Running a few RHIs at about 268 deg azimuth of a shower popping up west of Loveland. Bases are high (~2 km) and tops are at about 7-8 km. Max dBZ of about 25.

2125- Returning to survey mode. Will continue to monitor the precipitation W of Loveland.

2153- Still in survey mode. Precipitation W of Loveland has weakened and is nearly stationary. Still overcast to broken overcast at CHILL radar site.

2232- Still in survey mode. Light precipitation developing and weakening in somewhat regular cycles W of Loveland and Fort Collins. Nothing of interest as of yet.

2248- RHI of precipitation W of Fort Collins at 274 deg azimuth reveals high base, reflectivity core of 25 dBZ.

2249- Returning to survey mode. Clouds broken at CHILL, but coverage well over 70% of the sky. More time is needed to determine if light precipitation over the foothills will intensify/ move out over the plains. Looking grim at this point, however.

2300- Pawnee shut down ops for the day. CHILL likely to follow suit within the hour, as there is still only light precipitation over the high terrain to the W of the Front Range.

2331- Ceased operations for the day on recommendation of Timothy Lang and Pat Kennedy.

SUMMARY: Overall, a bit of a boring day. The CHILL radar experienced blustery winds throughout the day, and the temperature didn't climb very high due to persistent cloud cover. There was light precipitation observed over the foothills, but it did not produce any significant precipitation cores or lightning.

26 May 2012

No CHILL operations today.

27 May 2012

No CHILL operations today.

28 May 2012

No CHILL operations today.

29 May 2012

No CHILL operations today.

30 May 2012

No CHILL operations today.

31 May 2012

No CHILL operations today.

1 June 2012

DISCUSSION: A weak scenario for convective storms is anticipated today. There should be some pop-up showers over the high terrain propagating southeastward, weakening quickly as they move out into the plains. Tomorrow looks to be more promising.

1940 - Arrival at CHILL; radar operational in survey mode since 1840. Currently no significant weather, other than some pop up showers to the NW, over Fort Collins extending towards the Wyoming border. Conditions at CHILL are partly cloudy with easterly winds.

2002- Aircraft have taken off from Salina. Sounding release from Fort Morgan will commence at approximately 2020. Survey angles for CHILL: 0.5 , 1.9 , 3.2 , 4.6 ; PAWNEE: 0.5 , 1.6 , 2.9 , 4.7 , 7.6 (incomplete). CHILL sur_vh sequence starts approximately 20 seconds early.

2009- 35 dBZ cell popped up at 54.2 km, 281.8 deg azimuth from CHILL. Still in survey mode.

2020- Sounding launched; but a bit early for the aircraft.

2051- Still in survey mode. Shallow convective cells continue to form and move generally east-southeastward off of higher terrain. Awaiting aircraft.

2057- Survey angle found to be stuck at 0.5 degrees for the past two minutes. Aborted and restarted schedule at 2100. Antenna elevation angle not updating.

2105- Aborted and restarted; survey mode resumed.

2140- Still in survey mode; dc3 survey mode starting 20 seconds early without fail. Aircraft on edge of CHILL's domain, approaching from the northeast.

2152- Lots of scattered, weak convection to the west of CHILL, over the high terrain. Also some convection in between CHILL and PAWNEE. Survey mode not topping the convection, but nearly doing so.

2156- G5 missed approach at Jeffco Airport. CHILL ground crew missed flyover due to lack of updates on the flight tracks.

2208- G5 missed approach at Centennial Airport. DC8 over Sterling Ethanol Plant waypoint.

2237- CHILL again experiencing the problem of survey elevation angles not updating. Aborted survey mode and restarted survey mode.

2250- Returned CHILL surveillance mode to 5 minute schedule on the 5's.

2335- Ceased CHILL operations for the day. Convection beginning to diminish and no chance for electrification.

SUMMARY: CHILL operational on the slight chance of storms originating from the high terrain and propagating southeastward as well as support for aircraft boundary layer sampling mission. Coordinated dual-doppler surveillance from 1930 UTC to 2330 UTC with PAWNEE. Sounding launched at 2020 UTC from Fort Morgan. Aircraft flyover approximately 2145 UTC (uncertain as to when it occurred due to lack of flight track update). Software issues were noted with CHILL- survey mode started 20 seconds earlier than specified time, and elevation angles did not update, causing intermittent synchronization issues with PAWNEE but was not a serious issue; no definitive reasons as to why. Shallow, weak convection noted throughout the day, with little to no electrification. Other than a few moments of down-time, dual-doppler scanning was provided for the majority of 1930-2335 UTC.

2 June 2012

DISCUSSION: Storms expected today despite broad ridging over the western US. A shortwave disturbance is expected to generate storms as early as 1700 UTC, with scattered storms and/or squall line(s) expected in eastern CO as late as 0200 in the CHILL domain. DC8 will fly to CO today for an anticipated 6 hour flight.

1815- Arrived at CHILL; radar operational and in survey mode since 1750 UTC. 20 second early start time noted again during startup. Storms noted over high terrain, with anvils building.

1818- DC8 took off from SLN.

1828- RHIs performed for storm at 45 km, azimuth 300 deg. Noted storm tops to be 10 km, with convective cores to 9 km.

1835- Returning to survey mode. LMA observations reveal clouds are electrified and producing lightning over the mountains. CHILL survey volume starting at 1835 started 2 seconds early.

1845- RHIs performed for storm at 74 km, azimuth 267 degrees. Storm tops at 12 km, with midlevel core max 53 dBZ at 6 km.

1855- Performing 5 min dual-doppler PPI scans on target at 267 deg azimuth. Azimuthal boundaries are 205 deg to 325 deg. Storm is being topped with 10.9 deg PPI sweep.

1900- PAWNEE started dual-doppler PPI scans.

1905- Restarted dual-doppler PPI scans; schedule was not constrained to 5 minutes.

1908- Noted second-trip returns from PAWNEE.

1925- Still in dual-doppler PPI sweeps for convection in west lobe. DC8 has arrived and is circling over GLL, descending to 7000 ft. Waiting for storms to move off of the high terrain.

1927- DC8 spotted by CHILL scientists.

1930- Changed resolution to 1.1 km. Storms moved closer to radar and were not being topped by 11.9 deg PPI sweep. New top PPI sweep is 12.9 deg.

1935- Anvil signatures still present at 12.9 deg PPI scan. Sticking with current dual-doppler setup. Sounding launched from Greeley at intersection of US34 and US85.

1947- Noted new storm NE of Fort Collins (essentially Wellington) at 315 deg azimuth, range 45 km. Resolution changed to 1.2 km. New top PPI angle of 14.0 deg as well as azimuthal range of 220 deg to 340 deg.

1957- DC8 flyover successfully brings all radar scientists (and visitor P. Krehbiel) outside momentarily.

2005- Continuing PPI sweeps in western dual-doppler lobe. Noted very electrically active storm from LMA observations over southern Denver metro area along northern Palmer Divide just inside of CHILL's range.

2014- Changed PPI resolution to 1.5 km to top new storm developing just SE of Loveland at 33 km, azimuth 255 deg.

2025- Westerly outflow from target storm SE of Loveland observed at CHILL. PPI sweep top angle changed to 20.5 deg.

2032- CHILL stopped running PPI scans and stalled. Entering surveillance mode after abort.

2040- PAWNEE and CHILL providing dual-doppler surveillance. Surveillance mode now capturing storm over Parker with exceptional electrical activity. LMA observations indicate electrical activity to 15 km, indicative of strong storm development. Storms are severe warned.

2042- Storm development noted due south of Fort Morgan at 86 km range, 123 deg azimuth. Electrified storms due to pass over CHILL any minute now.

2055- Sounding released from Kersey.

2056- Gust fronts observed in reflectivity field. Rain noted at CHILL.

2058- DIA commercial air traffic observed circling GLL from CHILL control trailer. Heavier rain at CHILL.

2106- Well-defined gust front oriented N-S from WY border to reflectivity feature E of Aurora well within eastern dual-doppler lobe. DC8 moving to oscillate between Fort Morgan to NE border.

2109- Heavy rain at CHILL, verified in situ by T. Lang. 2055 Kersey sounding entered cloud.

2114- NWS radar reveals squall line setting up from E of Denver to E of Pueblo. Severe warned storm that impacted Parker forms the northern end of the squall line (storm first noted at 2005 Z)

2121- Cell popped up at 30 deg azimuth, 65 km range off of Cheyenne ridge within eastern dual-doppler lobe. RHIs reveal storm top of 10 km, with good updraft signature.

2129- Entering 5 min dual-doppler PPI scan with PAWNEE of Cheyenne ridge cell. PAWNEE sees side-lobe contamination of storm.

2132- Gust front first observed at 2056 has begun to spawn line of storms in center of eastern dual-doppler lobe.

2140- PAWNEE observed 60+ dBZ of cell first noted at 2121 UTC. Possible ZDR hail signature. New cell development just W of Sterling at eastern edge of eastern dual-doppler lobe.

2157- Rotated azimuthal range to 5 deg to 125 deg to capture new development on northern flank of severe warned storm just S of Fort Morgan.

2202- Rotated further south to azimuthal range of 20 deg to 140 deg. Now conducting dual-doppler with KFTG with 5 min PPI scans of storm just S of Fort Morgan.

2205- PAWNEE entering surveillance mode.

2210- Switched to 4:30 minute PPI scan schedule for dual-doppler with KFTG.

2212- Noticed northern bookend vortex on squall line forming south of Fort Morgan in KFTG radar loop.

2215- PAWNEE observed 68 dbZ shaft at 100 km range at 130 deg azimuth (from PAWNEE).

2229 - Mix of rain and hail noted N of Fort Morgan at range of approx. 83 km at 95 deg azimuth.

2231- Second shortwave disturbance associated with line of storms over Rockies evident in NWS KFTG reflectivity. Currently the line is approximately at I70 and the Continental Divide extending SSE along Sangre de Cristo range.

2236- Mesoscale circulation associated with bookend vortex somewhat evident in NWS radar loop. CHILL still in dual-doppler mode with KFTG; PAWNEE in surveillance.

2244- Fort Morgan storm (first identified at 2005 Z) is producing a large amount of positive CMCs.

2245- Sounding launched ½ mile east of CO14/CO52 intersection.

2258- Storms E of Fort Morgan starting to weaken. CHILL likely entering surveillance mode sometime soon.

2301- DC8 returning to base.

2305- CHILL returning to surveillance mode. Storms are beginning to exit CHILL's domain. Second disturbance convection beginning to appear in CHILL's western edge.

2310- Sonde launched from CO14/CO52 vicinity was determined to be victim of bad data upload. Will retrieve later.

2318- Storms over high terrain associated with second disturbance are very shallow. Surveillance scans are topping storms.

2350- CHILL ceased operations for the day.

SUMMARY- An active day for Colorado in terms of convection, at last. Storms were building with anvils already present over the Rockies upon arrival at CHILL at 1815 UTC. Began dual-Doppler scanning with PAWNEE in western lobe at 1905 UTC, and continued to provide dual-Doppler scanning for DC8 arrival in GLL vicinity at approximately 1915 UTC. CHILL stalled in 5 min PPI sweeps at 1932. The PPI routine was then aborted and PAWNEE and CHILL then provided dual-Doppler surveillance from approximately 1940 UTC. At 2129, a storm popped up at last along the Cheyenne Ridge, nearly in the center of the eastern dual-doppler lobe with PAWNEE. PPI scans were then run encompassing the eastern dual-Doppler lobe until 2205, when the convection moved east out of PAWNEE/CHILL dual-Doppler lobe. CHILL then entered dual-Doppler PPI scanning in coordination with the KFTG NEXRAD radar of the northward-building convection then south of Fort Morgan, as well as developing convection along the Weld/Logan county line. This supported DC8 flights through the storms' forward anvil cloud. At 2305, the convection began to weaken in the Fort Morgan area and CHILL returned to surveillance mode. Large amounts of positive CMCs were observed in the squall line that formed east of the southern Front Range urban area (Pueblo-Denver). The northern end of this squall line was a very electrically active storm originating on the Palmer Divide and passing over Parker, CO. This storm was long-lived and tracked NE through the Fort Morgan area until it passed out of CHILL's range at approximately 2340 UTC. Convective lightning activity indicated a potentially inverted structure, with hundreds of thousands of sources per 10-minute period. Two pre-storm soundings were launched at Fort Morgan at 15:30 and 17:30 UTC. A first inflow sounding was launched by MGAUS in Greeley at 19:30, and a second in Kersey at 21:00. An intended third inflow sounding at Raymer became instead a post-storm sounding due to the rapid evolution of convection. This last sounding had bad data upload to the Internet but MGAUS was able to obtain the data locally.

3 June 2012

DISCUSSION: While not as active a day is expected today, the location of potential storms is ideal. Storms are expected to develop over the Cheyenne Ridge and move southeastward over the plains. It is expected that the storms will weaken as they move over the plains.

1750- CHILL in surveillance mode, per Pat Kennedy.

1831- Storm developing just west of PAWNEE radar; at 50 km distance, 345 deg azimuth. Pat Kennedy performed 2 volume RHI scans on storm.

1901- P. Kennedy entered PPI scans for 310 deg to 30 deg azimuth. The cell was noted to be electrically active, as well as storms developing to the NW of PAWNEE, along WY border just west of I25.

1908- Arrived CHILL, PPI scans still running. Storm was located directly over PAWNEE; dual-Doppler not feasible at this time. PAWNEE still in surveillance mode.

1915- 1900 sounding from Fort Morgan was noted to be released slightly late, at 1915 UTC.

1917- Performed RHIs on storm as it moved just east of PAWNEE; azimuths 1 deg to 5 deg.

1924- Started dual-Doppler with PAWNEE on 6 minute PPI schedule.

1935- Reverted to 5 minute PPI dual-Doppler scans with PAWNEE. Storm is now moving out into the eastern dual-Doppler lobe.

1945- Cell just E of Cheyenne noted to have 72 dBZ core at surface.

1950- Adjusted resolution to 1.2 km. The PPI scans are also roughly synced with KCYS eastern dual-Doppler lobe for parts of storm not contained within the PAWNEE/CHILL eastern dual-Doppler lobe.

1956- PAWNEE observing intense storm E of Cheyenne well.

2011- Using VCHILL, found a hail core associated with E of Cheyenne storm at 1945 UTC.

2022- Storm E of Cheyenne noted to have possible rotation on the mesoscale.

2026- Storm E of Cheyenne confirmed to have midlevel rotation; velocity field indicative of rotation as well as midlevel hook echo.

2032- Difficult to see lightning hole, but were able to note a lightning notch associated with rotating storm E of Cheyenne with LMA data because image resolution is quite coarse. CMC activity associated with this storm is minimal.

2055- PAWNEE having technical issues; 2055 volume will likely be incomplete/corrupted. CHILL continues to run PPI sweeps of supercell that is skirting northern edge of eastern dual-Doppler lobe with PAWNEE in the CO/WY/NE state line intersection.

2100- CHILL and PAWNEE in dual-Doppler PPI scans on 5 minute schedule. Supercell at CO/WY/NE intersection is weakening as it moves more into NE. Further development NW and NE of Cheyenne, as well as into Morgan County.

2110- Sounding released from Fort Morgan.

2124- Observed real-time updates from Fort Morgan sounding online. Supercell has weakened and shows very weak, if any rotation in velocity field. Hook echo at midlevels has disappeared.

2146- Strong NW wind gusts and rain reported at CHILL. Control trailer being noticeably buffeted by the gusts.

2158- Weak, scattered convection in the eastern dual-Doppler lobe with PAWNEE. PPI scans well-positioned to capture any convection that might fire up.

2221- Former supercell originating W of Cheyenne has moved into extreme northern Logan County, CO after strengthening. Very high electrical activity associated with this storm. Further development in the eastern dual-Doppler PAWNEE/CHILL lobe, but little to no electrical activity. Storms to the N of the dual-Doppler lobes into WY and NE are by far the most active.

2235- Storm in NW corner of Morgan County has produced some flashes of lightning, but CHILL has not been topping the storm. Attempting to top next volume with PPI sweep of 14 deg elevation angle.

2239- Storm in NW corner of Morgan County successfully topped, and is weakening.

2250- CHILL and PAWNEE entering surveillance mode.

2251- Performing RHI scans of storm due south of CHILL. Storm tops are at 12 km at a range of 84 km.

2254- Performing RHI scans of storm at 219 deg azimuth, range 60 km, just east of Boulder.

2257- Entering PPI scans at 2302 of southwestern sector to capture both storms; will try to perform dual-Doppler scanning with KFTG.

2319- Storm formerly over Boulder is now over North Denver metro area; continues to be very electrically active.

2331- PAWNEE now running 5 min PPI scans of storm in western dual-Doppler lobe NW of Fort Collins; CHILL remains in 4:30 PPI dual-Doppler scanning with KFTG of storms over northern Denver metro area.

2334- PAWNEE restarting 5 min PPI scans of storm in western dual-Doppler lobe after topping far too quickly.

2350- CHILL entering surveillance mode.

2354- CHILL joining PAWNEE in 5 minute PPI scanning storm located in western dual-Doppler lobe, just west of Wellington.

0010- Storm is growing as it passes over northeastern Fort Collins and expanding along the CO14 corridor to Ault.

0013- T. Lang observed a negative CG from CHILL associated with this storm, with multiple return strokes.

0016- Storm vector looks to pass over CHILL. New convection also noted just south of Carr, along I-25.

0032- Storm appearing to become more stratiform as it progresses towards CHILL. Convective cells developing along trailing flank.

0038- Storm has been and continues to produce about one flash per minute.

0049- CHILL and PAWNEE entered surveillance, as storm stopped producing lightning.

0100- CHILL and PAWNEE ceased operations for the day.

SUMMARY: The day got off to an earlier than expected start. Pat Kennedy was already performing PPI scanning of storms building on the Cheyenne ridge upon arrival at CHILL around 1915 UTC. Cheyenne ridge storms moved east, with one cell becoming a supercell with a defined midlevel hook echo and evidence for rotation in the corresponding velocity fields. This particular storm skirted along the northern edge of the PAWNEE/CHILL eastern dual-Doppler lobe, with a storm forming either independently close to or as an appendage of the parent supercell within the eastern dual-Doppler lobe. A hail shaft with max dBZ of 72 was observed

at 1945 Z in this storm when it was just east of Cheyenne, WY. A bounded weak echo region was also continuously observed in this storm from approximately 2030 to shortly after 2045 Z. The hook echo and the bounded weak echo region also corresponded spatially to a reduction in lightning activity. PPI scans were conducted along with PAWNEE of this storm complex until it moved out of radar range at approximately 2230. Soupy stratiform with embedded convection encompassed much of the eastern dual-Doppler lobe during this time, in which gusty winds were observed at CHILL. After the northern storms moved out of range, CHILL then looked south and performed dual-Doppler scanning at 4:30 intervals starting at 2302 (to sync with the NEXRAD KFTG radar) of targets at 167 deg and 219 deg azimuth, both about 80 km from CHILL. PAWNEE then scanned for new targets in surveillance mode and performed solo PPI scans on a new storm NW of Fort Collins starting at 2331. CHILL remained on north Denver storms until 2354, when it engaged in 5 minute dual-Doppler scans with PAWNEE of the storm in the western lobe, located just west of Wellington. CHILL and PAWNEE continued to scan the storm as it tracked southeastward toward CHILL. The storm consistently produced about 1 lightning flash per minute. The storm then weakened and got too close to CHILL, whereupon operations eased.

June 5

Note: Possible smoke affected day as shown by the flexpart model

2000 - Radar operational and in surveillance mode, storm going up west of ft. collins

2010 - Running RHI's thru storm, fresh lightning at this point and storm tops clearing 10 km. storm was about 70 km from us so we were able to top it by about 9 degrees

2015 - Back into surv mode as storm seems to fizzle out

2030 - Starting PPI DD scans with kpaw on same storm west of ft collins, seems to be strengthening

2040 - Storm seems to be dying so going to back to surv mode

2100 - 18Z hrrr shows convection blowing up around us at this time but none to be found as of yet

2130 - A little convective activity in the moutains

2140 - Ran couple of RHI's on electrified storm sw of loveland, now running DD scans with kpaw on same parameters as before (230-350), top scan at 9.5 degrees

2150 - Storm west of fort collins intensifying, we proactively started scanning higher to anticipate development. We almost topped storm at 9.6 degrees. storm is ~70 km from radar

2155 - With new ppi scan elevation angles, were able to top storm by 9.9 degrees or around 12 km

2205 - Planes flying convection around the foothills, GV flying outflow wall northeast of storms, also now topping storms by 10.8 degrees

2200 - Sounding launched from Greeley

2215 - Still in DD scanning mode w/ pawnee, DC8 sampling inflow around Greeley and GV flying NW-SE wall in front of convection to sample upper outflow

2230 - Northernmost convection is dying out but new convection firing on the southern flank of the cluster

2240 - Cell developing rapidly west of Loveland along the southern flank of the system. Reflectivities close to 60 dBZ, good lightning activity storm near Estes Park right now moving nne

2245 - DC8 running kcys-kfnl track now to sample inflow as best they can

2248 - Storm topping 65 dBZ and showing a very low ZDR in the core, screen capture taken

2258 - Storm weakening and you can see in the volumetric scan that the core is descending, still strong echoes though (> 60 dBZ)

2303 - Latest volumetric scan shows anvil very nicely as it blows off to the north

2310 - Storm producing no flashes anymore

2315 - Storm produced a single flash, still with > 60 dBZ echoes

2330 - Sounding launched around 34/25 intersection while still running DD scans in same place, possible merger soon with same old storm and some new convection to the south

0000 - Storm near Ft Collins almost completely dead, but some new lightning north of Hot Sulphur Springs, still staying in dual Doppler as the aircraft are still sampling inflow and outflow from dying storm

0018 - Planning to launch another sounding from the Loveland area at 0100. Old storm is just a small echo now. A couple of echoes moving in from west with some lightning and echoes around 45 dBZ.

0030 - Back to surv mode because nothing out there that keeps us in PPI scanning

Summary - CHILL and PAWNEE were both operational as of 2000Z today. A storm popped up just west of Fort Collins so we ran some RHIs on it before it dissipated not long after formation. By 2130Z, convective activity started forming in the mountains at which time CHILL and PAWNEE started dual-Doppler PPI scans in western DD lobe. A main line of convection formed with a north/south orientation which continued to develop along the southern flank. Around 2240Z, a small storm formed rapidly on the southernmost flank of the line with rather impressive echoes over 60 dBZ with strong lightning and hail signatures with very low ZDR in the core of the storm. At 2245Z the aircraft were sampling the storm with the DC8 sampling the inflow from the southeast and the GV sampling upper level outflow from the northeast. The aircraft continued to sample the storm as it moved NNW while CHILL and PAWNEE continued to run dual-Doppler scanning in the region. Just before 0000Z, the storm began to dissipate as its core descended towards the ground. 2 pre-storm soundings, 2 inflow soundings and 1 post-storm sounding were also taken near the I-25 corridor. CHILL and PAWNEE were able to run dual-Doppler scans of the entire life cycle of the storm system including the cell sampled by

the aircraft.

June 6

1900 - DC8 takeoff already as both radars are operational, expecting a busy day in terms of convection and possibly some severe weather. All high-res models are showing supercells in our area around 22Z-00Z. Strong SE surface winds are in place currently but sfc dew points are not as high as forecast.

1928 - GV takeoff from Salina

1948 - Ran RHIs through a little cell by Nederland. This cell showed some lightning for a short while, but now it seems done.

2000 - Nice Denver cyclone signature on radar, and a westward moving boundary about to hit Denver as well as CHILL. This can be seen on radar as well as satellite images.

2005 - 20Z sounding off at Ft. Morgan, awaiting results

2040 - Possible initiation near western edge of morgan county, ran some rhis through the cell

2046 - Storm top around 11km at about 100 degrees az from chill. Trying to top 13.5 degrees. Echoes around 45 dBZ and lightning present, starting at 2050

2053 - Topped morgan cty storm at 14.5 degrees elevation

2110 - Still running Dual-doppler on storm just east of us. Storm appears to be splitting and right mover strengthening while left mover dissipating.

2124 - Storm developing just to the ENE of Pawnee so rotating PAW CCW to get that storm as well, CHILL rotating from 10 to 130 to catch both storms

2130 - Rotated CHILL to 0 to 120 azimuth, did not top storm due to delays from changing angles. The radar only got up to 14.5 degrees

2140 - Both storms topped now by 15.8 degrees, storm top on ft. morgan storm looks to be around 12 km

2145 - Cells backbuilding on the southern flank, keeping an eye on storms near Orchard. Overshooting tops already associated with them

2148 - PAW having trouble getting full coverage of storm just to east of them. Trying to watch southern development of impressive storms.

2150 - Did not top storm near Orchard by 15.8 degrees so decreased res in order to top

2200 - Scan will not be on time and top storm due to mini radar malfunction. Should be on schedule for 2206 scan

2206 - Now expanding range from 120 to 150 degrees and going to 6 minute scans, also

increase antenna rate from 8 to 10, Wiggins storm seems to be restrengthening and shows a nice mesocyclone

2218 - Wiggins storm now moved NE towards Keota, and has now be severe storm warned, screenshot taken of storm and echoes close to 70 dBZ.

2223 - Decreased top elevation because easily topping storms

2227 - PAWNEE having transmitter issues, not showing any echoes for around 20 degrees at a time

2228 - Storm NE of PAWNEE showing nice BWER around 6 km accompanied by a small lightning hole

2245 - Storms still forming just east of bdry and strengthening, bdry about 10 km east of CHILL currently. Still running dual-Doppler in east lobe on a number of storms including both severe warned storms

2300 - Boundary is right up against CHILL and storms are starting to fire closer to CHILL

2318 - Storm about 30km NE of chill so took some RHIs, top around 13km and an elevation angle about 28 degrees. A nice BWER on the storm. Adjusted dual-Doppler PPI elevation angles to top the storm.

2324 - Storm not topped at 28 degrees, only anvil not topped. Hoping it moves farther away.

2335 - Storms dying on the far east edge of the line but developing farther west closer to the westward moving convergence line

2336 - Severe storm warning issued on cell just NE of us by Briggsdale, ping pong ball size hail possible with it. Echoes near 70 dBZ observed by CHILL. Storm top around 12km.

2344 - Observed a mid level mesocyclone with Briggsdale storm, PAWNEE reported 74 dBZ with the storm in the low levels

2350 - Storm rapidly developed near Roggen with almost 70dBZ, became severe storm warned

0000 - Still scanning with dual-Doppler with same scan parameters.

0015 - PAWNEE experiencing some transmission issues again.

0025 - Storm forming just east of CHILL, running coordinated RHIs with CHILL and xband radar

0027 - High ZDR column just outside of the updraft in storm by CHILL

002723 - CG lightning just outside our window at CHILL

0029 - enhanced LDR and reduced rho hv around 3km due to freezing of lofted raindrops

0031 - Raindrops starting to fall on trailer, most likely melted hail, also some small pea-sized hail falling

0044 - PAWNEE still running volumetric coverage on storm in CHILL area

0055 - dual RHIs with MRI X-band at 30 degrees azimuth to look for phi dp electric alignment signatures, CHILL seeing strong, skinny and tall core on storm ~50km away

0103 - Now running multiple azimuth RHIs on storm from 25-35 deg azimuth

0105 - Switch az angles to 30-40 to try to get to "meat" of the storm

0110 - CHILL switched to surv mode as just realized a tornado warned storm is by Castle Rock as is nearly stationary. CHILL performed PPI sector volumes of the tornadic storm, which contained well-resolved rotational signatures and a hook echo. Many of these volumes were synced with KFTG, although storm was not well located in the lobes.

Pawnee's issue was likely due to the signal generator. Repair scheduled for tomorrow. Operations at Pawnee secured after 0100 to facilitate this.

0155 - CHILL switch to surveillance then RHIs thru cell to NE, 11 km tops, indications of melting hail depressing ZDRs in the core

0204 - Back to surveillance.

0208 - Running Combined PPIs and RHIs on NE storm, with repeat cycle of 7.5 min.

2014 - Running PPIs at 10 deg/sec, so going with 5-min repeat times now.

0224 - Storm collapsing, switching to southern convection.

0225 - Big old strat flash down south in the last two minutes. Switched targets just in time!

0229 - RHIs fantastic on tornadic storm, tops to 14 km AGL, nice looking hail cores and reflectivity overhang, went by too quickly for a screenshot, however.

0231 - More northern storm near Commerce City also looks a little wrapped up.

0233 - Another big recent strat flash emanating north from tornadic convection.

0238 - Not topping everything in southern sector, but am topping the stuff making the most lightning. Keeping it this way to preserve resolution on long-distance severe storm.

0239 - Huge +ZDR blob aloft in RHI, disconnected from everything else. Not sure what that was about, couldn't get a SS tho.

0242 - Liking this PPI/RHI mix. 3 RHIs, 11-12 or so PPI sweeps, all complete in 5 min with 10 deg/sec PPI rate.

0244 - Another big strat flash in the last 5 min. Got hints of an elevated ZDR blob in the RHIs, but nothing like last set of RHIs.

0249 - Hell of a ZDR column in that last set of RHIs.

0254 - Added a few tilts to the top to get more of the nearby convection, which has been putting out a few big strat flashes. Also upping repeat cycle to 6 minutes to account for this.

0257 - Small cell producing lightning right over DIA. Wiebke will be thrilled.

0259 - *NOW* the mountains are firing? - UPDATE: Looks like a boundary helped this along, according to KCYS

0301 - Get at least 14 tilts in with a 6-min repeat.

0306 - Even tho it is 100+ km away, I could run RHIs on this storm all the time. They are absolutely gorgeous. Great examples of ZDR columns, hail shafts, the works.

0310 - Scattered big iCMCs (not huge, just big) in the CO convection.

0315 - Nice strat flash in the last 2 min, to our SE.

0316 - Mountain convection forming a squall line, according to NEXRAD.

0319 - Definitely into the decay stages on this southern storm, but system continues making occasional stratiform flashes that are of great interest.

0327 - Oh that was a beautiful strat flash, the biggest to date, easily propagated over 50 km NE from the biggest cell to our south, may have been close to melt level.

0348 - Mostly rain in the southern cells now, tops only to about 12 km or so. Opening up the left PPI azimuth a bit, will reduce number of sweeps but get better coverage of convection making strat flashes in Morgan County, and we have some tilts to spare at this point.

0352 - Cell by Parker is the big lightning producer now, the cell I had been following with RHIs appears to be not making much lightning anymore.

0354 - Flash Flood Warning in central Larimer County. I believe it. That convection is stationary.

0400 - Going to surveillance. Getting cooked out here. Gonna check out the Larimer flood stuff.

0402 - Nice phase shifts, ZDRs consistent with ice-based precip.

Summary

Both CHILL and PAWNEE were operational today as of 1900Z in anticipation of the arrival of GV and the DC8. By 2000Z, the KFTG radar showed a clear signature of the Denver convergence and vorticity zone as shown by the rotation north of Denver and the westward moving convergence boundary just east of KFTG (denver velocity image). The 2000Z Fort Morgan sounding showed the cap near 700 mb lifting and eroding. Concurrent with this time was the convergence boundary continuing to move westward. At 2045Z, convection initiated just to the east of the boundary, just west of Fort Morgan. This cell rapidly intensified and was accompanied by a cell that formed just to the east of PAWNEE shortly after (hereford image). Both CHILL and PAWNEE adjusted the dual-Doppler PPI scans in the east lobe to view both storms. Both storms topped 12 km agl shortly after. By 2145Z storms were starting to develop on the southern flank of the line just to the east of the boundary but the northern storms were still able to thrive because the inflow was not cut off (screenshot image). Around this time

the storm near PAWNEE was too close to the radar which meant it could only be topped by CHILL which was accompanied by a minor radar malfunction at CHILL. At 2200Z both radars switched from a 120 degree scan to a 150 degree scan due to the expansive development along the southern flank of the line of storms east and southeast of CHILL. As boundary moved westward, the easternmost storms died off in favor of the western development. Around 2320Z, a storm rapidly developed NE of CHILL about 30 km away so we ran some RHIs through the core to find a clear BWER up to about 6 km. CHILL then adjusted the elevation angles of the dual-Doppler PPI scans to top this storm which became storm warned shortly after echoes > 70 dBZ were observed by both radars concurrent with a mid-level mesocyclone. The 2330Z Fort Morgan sounding showed that all caps had been eroded. In all, soundings were taken in Fort Morgan at 18Z, 20Z, 21Z, 2230Z, and 2330Z. The soundings at 18Z and 20Z were pre-storm soundings and the rest of the soundings were all inflow as the storms stayed to the west of the area. During the time period from around 2100Z to 0000Z, CHILL and PAWNEE were running dual-Doppler scans of the east lobe to get convective initiation and evolution of these storms. At 0025Z, a cell formed just to the east of CHILL at which time CHILL and the MRI X-band radar ran Krehbiel type RHIs and PPIs to look at electrical alignment. Just southeast of Denver a supercell storm became tornado warned as indicated by Doppler radar. Image ___ is a cross section taken around 0129Z that shows gate-to-gate rotation on the ground and Image ___ is a volume scan taken in the same area. A very good day for a flight to Colorado as dual-Doppler scanning took place from initiation of the line of storms east of CHILL through a good portion of the life cycle which was accompanied by extensive sampling by the aircraft.

UPDATE 0400 UTC - With some interruptions to scan other electrified convection, CHILL continued to scan the south Denver storms for a few more hours with a mixture of PPI and RHI sectors. These storms produced numerous stratiform flashes as they graduated decayed into widespread soupy convection. Many of the flashes occurred in the vicinity of DIA.

7 June 2012

1900 - CHILL operational just before 1900Z, running in surv mode.

1910 - Turned off transmitter for "tourists"

1930 - Back to surv mode

1945 - Ran RHIs on little cell west of cheyenne

2050 - PAWNEE up and scanning now, has been running since 1600 according to Bob

2105 - ran more RHIs on storm east of cheyenne, nice hook forming and good velocity rotation signature

2115 - back to surv mode

2122 - Tornado reported near wheatland, wy. Too far from CHILL and just at edge of KPAW scanning

2130 - Ran some more RHIs on storm to east of KCYS

2136 - 2 storms in wyoming of interest, so running dual-Doppler with KPAW and KCYS, az range of 280 to 70 as storms are west and east of KCYS, starting scan at ~2144

2143 - Running RHIs on storm to west of Fort Collins, storm top around 11km and echoes near 50 dBZ

2148 - Back to surv mode

2200 - running RHIs on storm near bennett, storm has split and developing pretty quickly

2204 - back into surv mode to scan cells forming off of the palmer divide

2211 - Storms forming in KCYS area and along the palmer divide, tornadic supercell now in scanning range of KPAW as it moves southeast

2216 - Running RHIs with CHILL through the storm to the east of Bennett. Nice 55 dBZ core and 14 km tops. Lots of lightning associated with this storm now. Pawnee is getting 67 dBZ in the storm north of Cheyenne. Going to do an RHI through that cell with CHILL, though it's pretty far from CHILL (over 100 km). Definitely seeing a depression in rhohv, high LDR and 65 dBZ in the core. Looks like that storm is also 14 km high. Doing a 2nd set of RHIs. Core is really impressive.

2230 - Tornado warning was just issued for the storm we just did RHIs through, to the north of Cheyenne. Since nothing of interest in is either dual-Doppler lobe, we are back to Surv but will change to dual-Doppler PPI mode synched with KFTG to catch the stuff developing to the south. A sector from 120-240, starting at 223508, repeat cycle of 4:40. rmax = 75 km, top = 14 km, sres = 1 km. The Bennett storm is building to the north, and it now has a severe thunderstorm warning on it.

2240 - We were not topping the storm, so we will increase the 1.1 km.

2246 - Changed PAW parameters to rmax 60 km, sector from 295 - 55° since the storm west of Cheyenne is getting closer to PAW. Talked to NCAR sounding folks. The last sounding will be launched at 2330 Z.

2253 - Changed the CHILL azimuth limits by 15° because the Bennett storm is building to the northeast towards Fort Morgan. We are topping the storm at 14.5°. New storm east of Bennett has a severe thunderstorm warning now.

2307 - Called the sounding folks. They were preparing the 2330 Z sounding, but they will now launch as soon as possible as the storm is bearing down on Fort Morgan. The storm to the southeast of Bennett now has a tornado warning. We are going to take 5 minutes to do RHIs through the Fort Morgan storm and the Bennett storm.

2312 - Started RHIs through Fort Morgan storm (which I was formerly calling the Bennett storm). Core looks like it might be splitting and there are hail signatures in the Pol variables. Zdr column, Ldr cap and 65 dBZ cores.

2319 - Went back to PPI scan for a volume, now running RHI scan through the Bennett tornadic storm. Nice reflectivity 153° azimuth -- really nice core with 50 dBZ echo up to 12 km, overshooting top above 14 km. LMA shows lightning activity in this cell up to 15 km.

2326 - Synch PPI scans back to KFTG. PAW still going strong on the convection in Wyoming.

2331 - Running RHIs through the Bennett storm (tornadic storm). Has a really nice LMA sources associated with it. Solidly going up to 15 km in a vertical shaft. Seeing negative phase shifts in the upper levels of the storm.

2344 - Back into dual-Doppler PPI scan with CHILL. PAW still faithfully scanning all the stuff to the north; the stuff to the SE of CHILL hasn't moved into the dual-Doppler coverage area quite yet.

2350 - Storm NE of Fort Morgan has severe thunderstorm warning. Just adjusted the CHILL azimuth by 10° clockwise to capture it.

0002 - Beautiful cloud development to the east of CHILL. STorm is about 30 km from CHILL at 98° azimuth. Rotated the scan sector counterclockwise to capture. Possible wall cloud observed with GR Analyst.

0014 - STuff in Wyoming is still pretty intense with flash flood and tornado warnings, but it is not within the dual-Doppler coverage with KCYS. Requesting PAW to rotate sector around to eastern dual-Doppler lobe as new stuff is starting to fire there. New az limits for PAW are 30-150°, rmax 60 km, 12 km height, repeat time of 280 sec. That should sync with CHILL and KFTG. Scanning should start at 001657.

0023 - Golfball sized hail reported at Fort Morgan (at 2353), tennis ball sized hail reported at 0022 east of Kiowa on the torandic storm. Lots of lightning activity on the storm in Weld county, but lightning activity is much less on the southeastern stuff now.

0032 - Holy moly -- 77 dBZ core in the storm west of Sterling as observed by Pawnee. Significant lightning sources. Going to do RHIs with CHILL. RHIs through several storms along these azimuths. Seeing differential attenuation in Zdr, and negative phase shift. Need to increase the RHI elevation tops to capture a storm at 35 km from CHILL that the MRI X-band is also scanning these. 50 dBZ up to almost 12 km.

0052 - Going to 6 minute dual-Doppler with PAW and CHILL, with CHILL doing some extra RHIs at the end through 73-77° azimuth.

0057 - Running some quick RHIs through the tornadic storm to the south. Large anvil blowoff. 65+ dBZ cores.

0100 - Start coordinated scanning with PAW and CHILL. PAW will be on a 6 minute scan with limits of 35-170°, rmax 70 km, and 14 km height. sres of 1.0 km. CHILL will be doing a PPI sector with RHIs. We will test timing on this scan as we have not run this scan before. To quote Brody, 'the storms are pretty lazy today', as in they aren't moving very fast anywhere.

0104 - Paul K. sees a notch in the lightning sources associated with the hook echo on the storm to the Deer Trail tornadic storm.

0107 - Tornado warning issued for the storm just west of Sterling. Timing of RHI/PPI seemed to work out.

0119 - Changing the RHIs to be 2° wide on the storm in the dual-Doppler lobe since that is a wide storm. We are not topping the storm due east of CHILL at 35 km, but we are topping the

storm of interest west of Sterling, north of Fort Morgan. We are also not topping the storm west of Pine Bluffs (it has 65 dBZ cores as well and significant lightning sources), but that is outside the dual-Doppler lobe.

0130 - RHIS did go through the core. Tops are about 12 km and reflectivity was about 55 dBZ.

0147 - Shifting CHILL azimuth to 0-120° so that we can catch a storm that is crossing the Colorado / Wyoming border right now. The storm was just warned on with a severe thunderstorm warning. Impressive lightning sources on that storm as well, with a lightning hole. Looks like a good hook and velocity signature as well. Adjusting RHIs to capture this storm now.

0156 - Changing PAW scan to try to top the storm moving over the border, now calling the Hereford storm. Change sres to 1.2 km, 45 km range, 14 km tops. There is also a storm just to the west of PAW with a meso rotation signature. PAW reports 'BB sized hail' and light rain. Hail report on the storm of 0140 Z golf ball sized hail. 4.5" hail reported 0157 Z.

0203 - Switched to RHI series for the Hereford storm. Really nice vertical alignment signature in Phase shift. Nice hail shaft with Ldr cap and Zdr columns (with negative Zdr above). Pawnee storm was just warned on. Bob is reporting large drops with 'moderate rain', no hail. LMA sources at 15 km. Convective surge in Hereford storm is discontinuously up to 15 km at 0015 LMA plot.

0218 - Really strong upper altitude lightning signature in Pawnee storm. We are going to do an RHI series through that storm. Saw hail signature in the Pawnee storm. Core reflectivity is 65+ dBZ. Overhanging structure at 0222.

0238 - Pawnee storm just got a tornado warning until 9 pm. We are going to go back to the CHILL PPI / RHI mixed scan. RHIs going through the RHI storm at 344°. Also rotated the CHILL sector to capture the Pawnee storm. Pat is scanning the Pawnee storm with the MRI.

0241 - Really beautiful clouds outside CHILL to the north, including mammatus! D3R is doing RHIs as well as the MRI scanning. Nice horizonatl extensive lightning noted at CHILL.

0245 - Moderate rain at Pawnee, a few strikes on the van from hail. Mostly pea sized. D3R is going to do RHIs along the 344° azimuth semi-coordinated with CHILL. Increasing the RHI height to 45°. Mammatus over CHILL with nice IC flashes noted at 0251 Z.

0258 - Pretty good wind at Pawnee, but rain is dying down and lightning is to the south. Changed the CHILL scanning to 10°/sec on the PPI, the right limit is now 80°, and changed the Rmax to 60 km, 1.1 km sres, maxrange 14 km. New tornado warning on the storm until 9:30 pm, with damaging straight line winds, and damaging hail. Moving 10 mph to the south.

0302 - Another convective surge noted in the LMA data, up to 15 km. MRI notes strong convergence between Nunn and Pierce. Pawnee is actually not scanning the storm, so rotating to 60°-180° to see how that does. Brody is in Ault and notes nice wall cloud, lots of lightning and good inflow. Unfortunately some of the storm is right along the Paw-Chill baseline. Rotating another 30° CW. Actually looks like the 'good' part of the storm is in the western dual-Doppler lobe.

0313 - Rotating another 30°. Also going to rotate CHILL CCW by 30°. Looks to be a nice

hail signature in the core -- high Ldr, high reflectivity. Lightning is still going gangbusters and significant differential attenuation at X-band. Changed RHI for CHILL to 323°. See how that goes. Pawnee internet is not happy -- perhaps because it goes through Nunn...

0323 - Request from Manuel running D3R to get an RHI at 330°. So we will do that followed by an RHI series to get the vertical resolution for lightning. Doing 6 RHIs from 327 - 333° up to 45°. Really nice 65+ dBZ core. I think hail is probably hitting the ground.

0333 - Quite the lightning show + getting windy here at CHILL! Thinking about going to diesel generator in case we loose commercial power.

0345 - New storm to the east of Fort Collins. Pawnee is picking it up with PPIs. We are still doing RHIs through the hail core -- pretty significant hail signature even at the surface with near zero Zdr, high Kdp and low Rhohv. Still significant lightning up to 15 km.

0354 - go back to PPI scans for a while with CHILL. Setting the RHIs for 294-296°. New Tornado and Severe thunderstorm warning on the 'twin' storms to the N and NW of CHILL. Intense lightning show outside at the moment.

0404 - Lightning has an interesting 'circle' structure right now on the Eaton storm. Still some extensions up to 14 km. CHILL is having a hard time fully capturing this storm as it moves closer, but PAW is doing a good job.

0415 - Raining at CHILL now. Since we are unable to fully capture the storm with CHILL, going to move to RHI series over the Timnath storm. Loud thunder too!

0425 - Pea sized hail at CHILL. We are doing a large number of RHIs up to 75°. Pawnee is still scanning to the south.

0432 - Impressive LMA sources on the storm to the west, which is also bowing out.

0440 - We are ceasing operations with both PAW and CHILL due to impending storm. Now getting a little bigger hail here at CHILL - dime to penny sized. Also raining pretty good now.

0450 - Pea sized or less hail now, rain is waning.

SUMMARY

Wow, intense day at CHILL! Both CHILL and PAW were operational by 2050 UTC and ceased operations at 0440 due to impending storm and tired scientists. Soundings were taken at Fort Morgan at 20 Z, 22Z, and just after 23Z. Around 21 Z started scanning some stuff up in Wyoming with SUR scans. Started running dual-Doppler scans with KCYS and PAW to get the tornadic storms in Wyoming around 2130 Z. RHIS were run with CHILL through a storm near Bennett. Started coordinated dual-Doppler between CHILL and KFTG to capture the storms firing to the SE of CHILL. Just after 00 Z on June 8, started coordinated dual-Doppler between PAW and CHILL in the eastern lobe on a storm near Bennett and Fort Morgan. 70+ dBZ core, extensive lightning sources from the LMA and hail signatures in RHIs taken in the storms. LMA sources up to 15 km! CHILL did mixed RHI and PPI scans with 6 minute update times coordinated with PAW. Nice negative phase shifts were noted in the storms. Around 02 Z a storm moved south over the border from WY to CO and ended up skirting PAW to the west and then moving about due south towards CHILL. Around 0244 and 0325 the D3R, MRI X-band

and CHILL were all scanning the storm moving down from the north, with CHILL and the D3R scanning at an azimuth of $\sim 330^\circ$. The storm initially near Pawnee was warned on for a possible tornado, large hail and damaging winds. Several storm surges were noted with the LMA data, which was intense throughout the day in the storms scanned by CHILL and PAWNEE. Tried to incorporate RHI sectors throughout the time period to get more of the vertical microphysics associated with these intense cores. Echo tops throughout the day were pushing 14 km above radar ground level, with some intense cores with 40-50 dBZ above 10 km. Overall, CHILL and PAWNEE performed dual-Doppler coordinated scanning on several severe supercells, and CHILL performed various RHIs through the storm cores. Intense lightning shows from CHILL, as well as heavy rain, pea-sized hail, mammatus, and strong winds by the end of operations.

NOTE by BD: Due to a disk filling up at Pawnee, we were not receiving Pawnee files in real-time for much of the time period. Any real-time images and data generated do not include Pawnee data (most important for dual-Doppler winds).

8 June 2012

No CHILL operations today.

9 June 2012

No CHILL operations today.

10 June 2012

No CHILL operations today.

11 June 2012

DISCUSSION: CHILL and PAWNEE are conducting dual-Doppler scanning of the High Park Fire plume today. The fire itself has grown explosively the past couple of days, and LMA sources may have been detected in the fire's vicinity, prompting the dual-Doppler scans. Weatherwise, the broad ridging pattern continues over the Western US, with a very slight potential for some thunderstorms due to afternoon heating and a slight increase in humidity from easterly winds.

1640- Arrived CHILL; Pawnee and CHILL both in surveillance mode, on 5 minute schedule on the 5's. The smoke plume is not visible in the reflectivity field at the moment, so CHILL and Pawnee will remain in surveillance mode until there is a return. CHILL has been in surv. mode since 1510.

1720- Noticed that CHILL's horizontal channel had faulted. Reset the radar and remaining in surveillance mode on the 5's.

1800- Plume is still not visible in the reflectivity field.

1909- Plume is now visible in the reflectivity field. Running RHIs over the plume location, at 291

deg azimuth.

1915- RHIs reveal plume is reaching 3.6 km. Returning to surveillance mode

1930- Surveillance sweeps continue to top the plume, so CHILL and Pawnee will remain in surv mode until the plume is not topped or does not change significantly.

1938- Plume has been topped by 4.6 deg elevation angle sweep. More spatial structure is evident in the plume as it drifts east. The source of the plume is well-topped by the 3.2 deg elevation angle sweep, and there are echoes evident in the 4.6 deg sweep as the plume drifts eastward and closer to the radar. Will continue to conduct surveillance mode.

2042- Plume has grown in intensity recently. The 4.6 degree sweep topped the plume, but the source plume increased to almost 20 dBZ at 3.2 degrees. Remaining in surveillance mode. May add a tilt or two to increase the resolution.

2050- Adding two sweeps to test an 8 minute surveillance volume. The elevation angles are: 0.5, 1.4, 2.3, 3.2, 4.1, and 5.0 deg. Upon completion of the volume, will decide whether or not to continue in this vein.

2100- Plume was topped by the 4.1 deg sweep. Will return to 5 minute surveillance and await afternoon update from T. Lang.

2115- CHILL user interface temporarily down upon reboot of server. Returning to surveillance mode to ascertain plume boundaries for 5 minute RHI scans starting at 2125. Will manually perform RHI/surveillance switching until 2200. Pawnee remains in surveillance mode.

2125- RHI scans entered from 288 to 302 deg azimuth to capture plume.

2130- Returning to surveillance mode.

2135- RHI scans on same schedule, except added 287 deg and 303 deg azimuths.

2140- Returning to surveillance mode.

2150- Entering RHI scans on same schedule as 2140 scan.

2155- Entering survey mode.

2205- Ceased operations at CHILL and Pawnee.

Summary- The High Park Fire smoke plume did not reach its Vesuvius-like demeanor of the past two days today, as winds were light and humidity was a little higher. Still, CHILL and Pawnee provided dual-Doppler analysis on the evolution of the plume for several hours. CHILL provided RHI scans at varying intervals, while Pawnee remained in surveillance mode.

June 12

DISCUSSION - Dry line setup east of CHILL near Akron, very dry around CHILL and towards the foothills. Will watch for convection to fire near or east of the dry line which will hopefully be

in scanning range. To start out, will be scanning smoke plume from the wildfire. Also possibly keeping an eye out for any storms that could ingest fire smoke.

1900 - Brody arrived at CHILL to find ppi/rhi scanning already taking place

1918 - Modified scanning schedule to do one PPI scan of 80 degrees around the smoke plume, 2 surv scans and some RHI's in the plume area.

1936 - Turns out I didn't hit run so it hasn't actually been doing any surv scans, but now it is

1942 - Not even close to getting to RHIs in 6 minute update cycle, sped up surv from 5 to 6 and going to 7:30 intervals

1945 - Starting new scans now with 7:30 update cycle

1953 - Got through half of the RHI scans and all of the surv and PPI scans, smoke plume echoes only between -10 and 10 dBZ, not too impressive

1958 - Changed the PPI scans in hopes of getting more RHI scans in the allotted time

2005 - Smoke seems like it's only showing appreciable echoes around 6-8 km, or about 8 degrees elevation, also showing marked westerly velocity signature in RHI's

2007 - Also moved RHI's up in the priority list and put surv at the end

2009 - First sign of convection along dryline as cell has just popped up in the far northeastern corner of CO, east of Sterling

2015 - Storms starting to fire farther south along the dryline down to I-70, these storms are forming along the KS/CO border though, unfortunately

2022 - Radar had a slight malfunction where the antenna stopped moving, just put into surv mode until 2030

2025 - Started smoke schedule early to see if it's working and it doesn't look like it is. Archiver says not writing

2035 - Issue fixed and RHI's given priority over surv scans

2037 - Started smoke schedule on the 7:30 update at 203730

2040 - Having same issue, antenna going below 0 degrees elevation which shuts it off

2052 - Back up and running, slowed down the RHI rate and increased bottom elevation from 0 to 0.3

2140 - Still no convection in the CHILL scanning region, storms continuing to strengthen in NE and KS.

2225 - Can see smoke plume up to 5-6 km in some places, as noted by the high ZDR

2255 - Left moving storm with a decent anticyclonic velocity signature west of Burlington, CO. Also a burn pulse in the plume seen in the last hour associated with the plume reaching up to 6 km.

2330 - Shutting down ops.

Summary: CSU-CHILL operated during 1900-2330 today, for plume scanning and support of a potential Falcon flight. No significant convection developed in range of CHILL. However, long-term PPI/RHI volumetric scanning focused on the plume occurred and had some success, capturing a growth phase of the plume in the late afternoon that saw it reach upwards of 6 km AGL. The plume featured the standard polarimetric values, with low reflectivity, high ZDR, reduced correlation coefficient, and elevated LDR. It appeared to be feeding into some mid-level clouds in the area, which were distinguished by low ZDR and higher correlation coefficient. No Pawnee radar or soundings today.

13 June 2012

No CHILL operations today.

June 14

DISCUSSION

Dew points near 40 observed through a good chunk of the domain at 1800Z with northerly flow which is decreasing the moisture for the time being. Once the flow turns easterly, CAPE and moisture expected to return but a cap should keep things quiet in the eastern part of the domain but will have a chance for some showers/storms around the foothills area where the cap is much weaker. Also will be running DD scans on the smoke plume which is very unimpressive as of 1800Z both visually and on radar.

1800 - Chill and PAW operational as of 1800Z and both running surv scans on the 5's until something interesting pops up. No marked signature of smoke plume visually or on radar.

1920 - Some showers going up west of fort collins, probably west of the smoke plume but moving towards the smoke plume. Planned on running DD scan in that region w/ PAW but PAW not cooperating at the moment

1925 - CHILL topped showers very easily so increased Rmax from 70km to 80km for 1930 scan as I was too late for 1925. Also PAW now running correct scans.

1930 - Showers topped by 8.6 degrees elevation from CHILL and PAW so had PAW increase sres from 1km to 0.8km, also has some lightning associated with it

1935 - Both radars topped storm in appropriate time so will keep same scan parameters. Storm now showing echoes around 45 dBZ but lightning appears to be weakening. Some cells also firing near Laramie along wwd moving sfc bdry

1945 - Moved CHILL's scanning limits 15 degrees CW so to get convection along bdry near Laramie

1950 - Fort collins cell and cells near laramie moving towards PAW so changed sres back to 1km in order to keep topping

1952 - PAW noting that possible fire or something burning near Laramie so storms may be ingesting smoke up there as well as west of foco

2000 - Breaking out of DD for 5 mins to run RHIs near foco to see shower by plume

2002 - PAW noted any possible smoke in the laramie area now obscured, was visible around 1800-1900

2005 - Expanded RHI scans for 5 more mins

2006 - Sfc winds still northerly and dew points still dropping to around 40. Dry line tightening up near eastern border of state

2010 - Back to DD scanning

2015 - Nice looking cell formed just east of Laramie along boundary, keeping an eye on it

2023 - Moved PAW limits CW to keep an eye on cell near laramie and other cells just north of CO border

2037 - Weak smoke signature near between Bellvue and Poudre Park as seen by 3 dB Zdr

2042 - Had PAW decrease Rmax because storms moving towards it, having some trouble topping it

2100 - Second trip echo in area of plume

2014 - Cell just west of KCYS showing high echoes lofted to around 10 km, also increased lighting at high altitudes and a lightning hole

2107 - Storm top up to 12 km agl, very pronounced upper diffluence pattern

2108 - Sounding going up near west foco

2110 - Odd signature with negative ZDR values associated with high echoes and also a marked updraft signature, these seen in RHIs

2120 - See negative zdr's at the sfc coincident w/ high corr. coeff., enhanced LDR, and a negative phase shift with echoes around 50 dBZ, possibly conical graupel or hail

2133 - Plume barely visible from chill now in PPIs

2139 - Plume only getting to 2km agl around 75 km from CHILL at about 290 azimuth

2205 - Tornado reported on the ground just east of springfield, co. Public reported

2230 - Spotter confirmed thin stovepipe tornado on the ground

2251 - Fire flare-up and plume enhancement with the plume being blown off to the NW, just west of Mishawaka. Plume at 75km , 296 azimuth but only about 3km high. Plume is feeding into cell just above it to the east. No lightning as of now.

2335 - Fire has hopped north of hwy 14 and Glacier view is now being evacuated, this can be seen by radar

SUMMARY -

CHILL and PAWNEE operational by 1800Z today in hopes of scanning the High Park Fire plume and possible storms in the foothills area. Showers formed west of the fire around 1900Z and by 1920Z, CHILL and PAWNEE were dual-Doppler scanning those showers that were moving towards the fire plume. The showers actually appeared to die down and lose their lightning as they encountered the plume area. By 1935Z, storms fired along a westward moving surface boundary between Cheyenne and Laramie, WY at which time both radars adjusted their scans to include these storms. These storms were mostly short lived, with the exception of one storm just east of Laramie. By 2040Z the plume was barely visible on radar ([Image 1](#)), which was indicative of its behavior for most of the day. At 2110Z we noticed a storm with an odd polarimetric signature near Laramie ([Image 2](#)). This storm exhibited negative ZDR echoes at the surface coincident with high correlation coefficient, enhanced LDR, and a negative phase shift with echoes around 50 dBZ, we believe this was caused by falling conical graupel or hail but more analysis needs to be done to confirm this. A sounding was also launched on the western edge of Fort Collins at this time. Storms in the west DD lobe weakened as time went on, but we were able to see two flare-ups with the fire near Mishiaka as the fire jumped over highway 14 and the Poudre River at which time the Glacier View area was evacuated. Overall, the plume was not very strong today as it has moved farther west into better fuel. Some interesting storm microphysics were observed as well.

15 June 2012

Summary: Chance for convection today in NE Colorado, with DC8 and GV aircraft slated to study storms in Colorado. The High Park Fire plume has been blown to the north by strong southerly winds at the surface. The lower levels are noticeably moist, and a chance for potentially severe convection on the plains exists. Anvils already developing quickly over the mountains by 1630 UTC.

Notes by P. Kennedy prior to Beavis/Lang arrival:

1600 - surveillance started after normal calibrations.

1653:28 - Manual restart after brief commercial power outage.

1712:51: - CHILL starts PPI sectors due to visible cells, two of which are generating lightning.

1730 - Start 5 minute dual Doppler scans over W lobe with Pawnee

1740 - CHILL not quite topping storm over High Park fire area. Adjusted CHILL optimizer to

rmax=75, htmax=12, sres=1000m; rate=10 deg /sec

1750 - N Beavis arrival at CHILL; storms well developed over High Park burn area. Some updrafts reaching well over 11 km. Electrification and heavy rain noted over Donetsk during Euro 2012 group stage game.

1815 - Storm over High Park Fire area not being topped by 10 deg PPI sweep. Changing resolution to 1.1 km effective at 1820 UTC.

1825- Storm was topped. Continuing dual-Doppler PPI sweeps in W lobe with Pawnee.

1839- Possible lightning hole observed in storm over High Park. Velocity folds also observed in diffluent outflow.

1841- BWER also observed in lower levels as well as possible velocity couplet. Storm over High Park is potentially rotating.

1843- RHIs attempted for 270-272 deg azimuth; data would not write.

1845- Resuming PPIs until issue with RHIs is resolved.

1849- RHIs resumed, tops found to be 13 km. Strong updraft with overshooting top observed.

1850- PPIs on the 5's resumed.

1856- CHILL acting up; radar abruptly stopped PPI scans at 1856. RHIs now being run for 267,269,271 deg azimuth.

1900- PPIs resumed. Will continue to monitor the scheduling issue. PPIs reveal an anticyclonic hook echo in mid-upper levels in storm formerly over High Park burn. The storm has moved slowly to the SSW and is now over US34 east of Estes Park.

1905- PPI schedule noted to have started 11 seconds late. Large ZDR's observed just north of US34 (~2.5 to 3)

1910- CHILL schedule started 20 seconds late. Anvil beginning to move closer to radar.

1916- CHILL schedule did not start. Restarted PPI scans.

1920- CHILL schedule started on time. Anvil not topped due to late start; may have to adjust PPI angles because anvil is moving well out over the plains. DC8 arrived in the N. Colorado area.

1922- Rotated azimuth CW by 10 degrees to 230 deg to 350 deg.

1925- CHILL schedule started on time again.

1928- Electrically active storm passing into CHILL's outer fringes near Laramie. DC8's spirals evident in LMA data.

1930- GV preparing for anvil pass; DC8 will conduct the same at a lower altitude.

1932- BWER noted in storm near Laramie, along with velocity couplet. Another rotating storm? Storm over US34 between Loveland and Estes Park beginning to die down electrically.

1937- Storm development over US36 between Estes Park and Longmont noted.

1939- MGAUS sounding launch by 20Z in Loveland; MIS sounding launch in Ft. Morgan at 20Z.

1944- Stratiform flashes noted in US36 storm initiating in new convective core and propagating to the stratiform region in the north of the storm.

1949- Adjusted PPI scans to top the anvil extending east of Fort Collins on the US36 storm.

1956 - New electrified cell just NW of W lobe, kind of a southern extension of the Laramie storm. Anvil well over CHILL by now.

2000- CHILL continues to start on schedule. Sounding in Ft. Morgan ready for launch.

2002- Ft. Morgan sounding launched. DC8 in High Park Fire smoke plume NE of Ft. Collins near WY border.

2030- 6 minute 150 deg azimuth PPI sweeps started at CHILL and Pawnee. Added 30 deg to the northern section of the sweeps.

2054- Switched to 180 deg azimuth PPI sweeps from 170 deg to 350 deg, upped rotation rate to 12 deg; still on 6 min schedule.

2107- Rotated 5 degrees CCW to track storm over E Denver metro area that is severe warned. Funnel cloud reported at KFTG.

2112- Almost exclusively small positive CMCs associated with CO and WY convection.

2117- Rotated another 5 degrees to continue to track storm moving east of Denver.

2119- Switched to 150 deg scan of southern sector, including the Denver storm. Pawnee reverts to surveillance on 6 min schedule.

2130- Storm E of Denver is now both severe and tornado warned. Rotation evident in velocity field.

2136- Storm E of Denver is no longer tornado warned.

2148- New cell E of CHILL popped up in eastern dual-Doppler lobe with Pawnee. Shifting azimuths by 20 deg CCW. Still on 6 min PPI sweep schedule. Pawnee also targeting this storm.

2151- Rotating a further 10 degrees CCW. Azimuths now at 65 to 215 degrees.

2154- Added some tilts to the 2154 volume. Also rotating the scanning sector 10 degrees CCW. 20 Z sounding from Ft. Morgan reveals a strong cap still present.

2200- Cell first identified at 2148 is firing off of boundary E of CHILL. Added one more PPI tilt at 19.8 deg.

2207- MGAUS soundings launched from Greeley at 22Z reveal eroded cap.

2254- Still in PPI scans of south and eastern sectors; continuing to scan storm E of Denver that is now north of Limon.

2256- Cells popping up in Morgan County in just inside of eastern dual-Doppler lobe.

2301- Switched to eastern lobe 120 degree PPI sector scan on the 5's. Azimuths 60 deg to 180 deg.

2311- Noted by T. Lang: "Morgan-Weld Counties are death to all storms".

2314- MGAUS sounding launch scheduled at Brush, ahead of potential line of storms.

2318- Large positive CMCs detected in CO convection E of Denver. Also large isolated positive CMCs in North Central NM and SE NM.

2321- MGAUS sounding launched from Brush directly beneath cells.

2324- CHILL tilted angles down. Convection moving away from CHILL's range.

2328- Changed CHILL sector scans to 150 deg PPI scans from 20 to 170 deg to capture south-building storms in the CO/WY/NE border intersection. Storms may build along a boundary extending westward along the CO/WY border or southward along an N/S boundary in eastern Weld and Morgan counties. Storm in west-central Larimer county building and is electrically active.

2346- Storms in Tri-State area are much more active electrically. The boundary stretching westward along the CO/WY border appears to be the more active boundary and may produce storms. Storm in Larimer County was found to have an echo over the High Park burn area. It is unknown whether the rain reached the ground or not.

2351- Eastern dual-Doppler lobe all quiet. Echo features are currently out of the lobe. Storm along NE/WY border has moved into NE and is severe warned.

2355- Storms in eastern CO are outside of CHILL's range. Aircraft continue to fly this line of convection. Pawnee experiencing second-trip returns.

2357- Storms in eastern CO beginning to form bowed squall line.

0001- Squall line in eastern CO now in range of the Goodland, KS radar.

0006- Performing RHIs for storm in WY/NE border area at 33 deg azimuth, 120 km range. 50 dBZ core observed at 8 km height.

0017- Continuing RHIs on WY/NE storm, while Pawnee provides PPIs on it.

0025 - DC8 is flying near the storm we are scanning right now.

0032 - Running quick surveillance to reset azimuths, then back to RHIs.

0043 - CHILL running 750 Hz PRF, getting better coverage of NE storms.

0055 - Been tons of second-trip on the Pawnee display, from the SE storms.

0105 - Storm has lightning hole now. Did a quick drop into surveillance and now doing RHIs again. Pawnee released to secure operations.

0115 - CHILL processor had issues, scanning halted. Calling off scientific operations for the day.

-----Event updates here-----

SUMMARY: Early start to the day as large thunderstorms built over the high terrain, including the High Park Fire burn area by 1700 UTC. The DC8 and GV were in Colorado today to conduct flights through convection and potentially smoke plumes. The storms tended to move east-southeast to due east. One storm that formed over the burn area moved southeastward and appeared to be anticyclonically rotating. A bounded weak echo region along with a slightly defined hook echo, velocity couplet, and lightning hole led to this conclusion. Nearly all of the early storms moving off of the high terrain today exhibited characteristics of a lightning hole or lightning notch. Also noted were the occurrences of almost exclusively large positive charge moment changes associated with the Colorado convection. CHILL and Pawnee provided dual-Doppler analysis of the storm until approximately 2100 Z. The DC8 flew through the High Park Fire smoke plume north of Fort Collins at approximately 20 Z. The storm that formed over the High Park burn area eventually dissipated and a new storm formed over the northern Palmer Divide and moved eastward across the southern Denver metro area. CHILL scanned that storm while Pawnee remained in surveillance. The aircraft then conducted flights around the Denver convection. CHILL remained scanning the Denver storm that was at one point severe warned and tornado warned with a reported funnel cloud at FTG until it moved out of range after 23 Z. Pawnee and CHILL provided dual-Doppler analysis of convection flaring up along a north-south boundary identified by models in eastern Weld and central Morgan Counties. New cell development occurred in the eastern dual-Doppler lobe with Pawnee just prior to 23 Z, but the convection was weak in terms of echo and electrification. At about 2330 Z, storms popped up in the area of the CO/WY/NE border intersection, just outside the far northern reaches of the eastern dual-Doppler lobe with Pawnee. The lightning activity within these storms was considerably more intense, however the storms stayed out of the eastern dual-Doppler lobe. At about 00 Z, the storms that started in the Denver metro area had moved out of CHILL's range, with the aircraft still conducting flights ahead of the line of storms. CHILL then conducted RHIs on a storm in extreme SW NE near the border with WY and CO, while Pawnee provided PPI sector sweeps starting just after 00 Z. The storm eventually developed a lightning hole after 0100. Pawnee secured operations after 0100, while CHILL secured operations somewhat later. Three pre-storm soundings in Fort Morgan occurred at 16, 18, and 20 Z, while MGAUS provided three inflow soundings ranging from Loveland (20 Z), Greeley (22 Z), and Brush (2330 Z).

June 16

DISCUSSION -

2000 - CHILL operational as of 2000Z today, no PAWNEE ops, currently a severe storm warning just west of Castle Rock which is just barely in scanning range of CHL, also a tornado warning west of PUB which is way out of the scan range of CHL. Starting in surv mode for the time being.

2025 - Starting 180 degree sector scan from 150 to 330 deg. azimuth on a 5 min cycle in order to scan both the storms NW of fort collins and the one near castle rock. Both cells have respectable lightning activity in them. Also 2 little electrified cells to the west of foco and boulder.

2100 - Nice anvil on storm just south of Denver, although appears to be dying as very little lightning activity in past 10 minutes

2110 - Not topping anvil on storm south of Denver, so changing resolution from 1000m to 1200m in an attempt to top.

2140 - Shower over fire currently, not sure if rain making it to the ground but not electrified. No electrified cells in our domain yet.

2150 - Some lightning in cell near fire now as cell strengthening a bit

2156 - Lightning has died out now, just was that one burst of lightning

2210 - Running set of RHIs through cell west of Fort Collins, echoes max around 40 dBZ, not producing any lightning currently

2215 - Back to running 4-5 minute PPI scans to the west. Storm west of FC died out as it moved east.

2235 - Nothing much to look at anymore. Some lightning associated with the cell on our very SW most edge, but most of the booming convection is way to the south, out of our range.

2315 - Concluding ops today as nothing is happening!!!

SUMMARY - CHILL operational as of 2000Z, no PAWNEE ops today. At the start of operations there were 2 severe storms south of CHILL, one west of Pueblo that was beyond CHILL's scanning range and one near Castle Rock which we scanned for a short amount of time before it decayed. Most of the day was spent scanning the western DD lobe as there were numerous showers over the foothills area. All of the showers had a short lifespan and were weakly electrified at best. Storms panned out just as forecast with the stronger cells located south of CHILL's scanning range.

17 June 2012

No CHILL operations today.

18 June 2012

No CHILL operations today.

19 June 2012

No CHILL operations today.

20 June 2012

No CHILL operations today.

21 June 2012

No CHILL operations today.

22 June 2012

DISCUSSION: A hot day for Colorado today, with afternoon high temperatures in the CHILL domain expected to push triple digits. The forecast for convection is very slim in the CHILL domain, but it has warranted a trip from the DC3 aircraft for a high-risk, high-reward setup. Storms could potentially be high-based isolated supercells if they do develop. CHILL operations will commence at 2000 UTC.

1935- CHILL up and running in surveillance mode. Pawnee also up and running in surveillance mode. Aircraft departure expected at 2000 UTC.

1954- Performing RHIs through the significantly more active High Park Fire plume at azimuths 283-292.

2005- Upped surveillance rate to 7 deg/sec and added two tilt angles. Conducting 5 minute survey scans on the 5's to top the plume.

2025- Survey rate to 8 deg/sec to top plume.

2029- Plume topped with 7.2 deg survey sweep.

2039- Soundings from Ft. Morgan and Akron show eroding cap and plenty of CAPE above 600 hPa.

2043- Cell SE of Ft. Morgan has popped up. No electrification as of yet; storm is topped by surveillance scans at 7.2 deg.

2055- Despite topping the storm with surveillance, the cell now E of Ft. Morgan is weakly electrified.

2105- Upped scan rate to 10 deg/sec and added a survey tilt at 9.8 deg to top Ft. Morgan storm.

2114- Slowed scan rate to 9 deg/sec.

2117- Performed RHIs on the storm E of Ft. Morgan. Storm is now up to 13 km, and well

electrified with normal polarity.

2125- Returning to surveillance mode. The storm is not in range of the dual-Doppler lobes of CHILL and KFTG.

2130- Performing RHIs centered at 101 deg for storm to the E of Fort Morgan. Another small storm has formed in its wake to the SE of Ft. Morgan.

2133- Returned to survey mode.

2139- Performing RHIs centered at 98 deg for storm E of Fort Morgan.

2141- Changed the PRF and # of gates in the processor parameters.

2145- Returning to survey mode.

2151- Performing 11 RHI's centered on 95 deg azimuth; storm is beginning to move out of CHILL's range.

2155- Returning to survey mode.

2156- Pawnee experiencing second-trip returns.

2200- RHI's centered at 98 deg; storm is severe warned.

2205- Returning to survey mode.

2206- Noticed that radial velocities and differential phase fields are noisy.

2207- Strobbling noted in velocity fields.

2210- RHI's centered at 96 deg.

2215- Returning to survey mode. RHI's ceased because the storm is moving out of range and is dying.

2216- Velocities look much improved; experiencing folding because of low PRF setting.

2220- New cell on border of Weld and Logan counties NW of Sterling is electrified. Cell is just outside of eastern CHILL/Pawnee dual-Doppler lobe.

2230- Increased the scan rate to 10 deg/sec.

2240- Switched to PPI sector scans from 20-140 deg azimuth on the 5's. S-res at 1.1 km. The cell NW of Sterling has new development into the far NE edge of the eastern dual-Doppler lobe.

2257- Storm is now severe warned, as per the NOAA alert box in the command trailer.

2304- Storm was being topped quickly; s-res dropped from 1.1 km to 1 km. Noted double-anvil structure in LMA data by P. Krehbiel.

2309- Lightning observed in LMA data as high as 15 km in storm in Logan county. Anvil sources well into NE.

2314- New storm in SW Morgan County noted to have BWER and is recently electrically active. Storm in extreme northern Logan County also has BWER in backbuilding regime.

2319- HID reanalysis has small hail IDed up to 10 km in severe warned storm moving into NE as recent as 2305 UTC.

2322- Hook echo observed in extreme NE Weld Co. associated with severe warned storm.

2325- Velocity couplet and lightning hole also observed co-spatially with hook echo. Storm is likely rotating in lower levels.

0005- CHILL no longer has full coverage of the storm along CO/NE border in Logan County.

0107- Performing 7 RHIs on storm on the edge of CHILL's range centered at azimuth 91 deg.

0111- ZdR has been negative, on the order of 0.5 dB throughout the day.

0115- RHIs now centered on 90 deg.

0122- RHIs now centered on 88 deg.

0129- Entering surveillance mode. Plume noted by scientists at CHILL to have been ingested by storms in NE.

0136- Entering RHIs centered on 90 deg azimuth for last-second hail core scanning, with 70+ dBZ found. Two embedded cells also noted by P. Krehbiel in storm in NE. Major convective surging occurring in the 70+ dBZ core.

0141-CHILL RHI display issue briefly caused panic about missing data. Values found, and life is good. Hail core moved out of range of CHILL.

0148- Performing RHIs on the smoke plume; 11 RHIs centered on 298 deg. azimuth. Plume reaching heights of 6 km AGL; 8 km MSL.

0153- Performing 21 RHIs on the smoke plume centered on 303 deg azimuth.

0157- Strong turbulence noted in smoke plume from velocity field.

0200- Pawnee experiencing large ashfall debris.

0208 - CHILL in RHIs on storms in Morgan county to our SE, tops over 10 km. Aircraft returning to base.

0215 - Back to surveillance. Took some gorgeous pics of the sun thru the fire plume.

0220 - PPI sectors started on convection to our SE.

0240 - Decent storm, though small by today's standards. About 90 km out and moving NE. PPI

sectors continue.

0242 - A lot of velocity folds today. Combination of lower PRF plus 60+ kt winds aloft.

SUMMARY: An uncertain forecast was upstaged by thunderstorms forming just east of the CHILL/Pawnee eastern dual-Doppler lobe. At first, CHILL entered surveillance with Pawnee and was able to provide dual-Doppler surveillance of the significantly more active High Park Fire plume. The storms that formed later were strongly electrified and some exhibited some signs of rotation. The first storm to be scanned formed SE of Fort Morgan and tracked east-northeastward, eventually becoming severe. Another storm formed along a boundary NW of Sterling and moved east-northeastward into Nebraska. This storm exhibited signs of rotation, including a weakly defined velocity couplet, a hook echo, and a lightning hole. The aircraft conducted flights in and around this storm as it moved further into Nebraska and spawned embedded convection within the anvil. Storms continued to form along a boundary in north central CO, with CHILL providing PPI scans for storms to the east, and Pawnee continuing to scan the fire plume with PPI sector scans. The fire plume reached heights greater than 7 km MSL, while storms east of CHILL reached heights greater than 16 km MSL. In general, the aircraft storms were only covered well by dual-Doppler (either CHILL/Pawnee or CHILL/KCYS) early, before 0000 UTC. CHILL continued to scan storms with RHIs until they moved out of range at approximately 0145 UTC, with a very intense hail core (70+ dBZ) and lightning hole. Lightning structures in NE storms were noted to be unusual; high-altitude lightning exhibited over embedded cells, but not at low altitudes. It was also noted that the smoke plume was being ingested by storms in Nebraska. CHILL then performed RHIs on the fire plume with Pawnee still conducting PPI scans of the plume until operations ceased close to 0200 UTC. The plume exhibited a great deal of turbulence from the velocity field. CHILL finished operations by doing some RHI and PPI sector scanning of a small storm that developed in southern Morgan County. The storm was persistent and relatively electrically active, though it paled in comparison to the earlier storms.

24 June 2012

2000 - CHILL up and running surveillance. Sub-20 dBZ cell to our SE in Washington County, more impressive visually than via microwave. Otherwise, substantial 10-20 dBZ echo scattered about the foothills and Cheyenne Ridge, as usual this time of day.

2027 - Nice boundary running from near Parker up toward Sterling. This is the boundary upon which the SE cells formed.

2030 - Running Smoke schedule (PPI, RHI, Surv) centered on the plume, which is near 287 deg and 75 km range, well west of its typical location. Repeat cycle is 7.5 min.

2033 - Plume is up to 8 km high, not bad.

2051 - Smoke is feeding into a 10-20 dBZ meteorological echo. Lightning in Jackson County, near max range. Summit and Park Counties also have thunderstorms.

2102 - Some recent lightning in Washington County.

2125 - Differential phase quite noisy in the plume, unlike nearby meteorological echoes.

2132 - 21Z sounding away, according to NCAR, but not updating on the web. Unlikely to have real-time sounding information from any soundings today.

2159 - Lightning in southern Grand County, but cell is mostly topped by 3.2 deg, and near max range, so I am unimpressed.

2207 - Current WRF and HRRR hi-res forecasts are way ahead of the present echo situation.

2215 - RHIs and surveillance on some cells to our north. First one was within 30 km but only 8 km tall. Peak Z 40 or below.

2220 - Some lightning in the further north cell, about 60 km out near the WY border. Tops again to 8 km, but over 40 dBZ in cell. Widening and maintaining RHI sectors.

2231 - New lightning in NE Weld.

2233 - Combined RHIs and PPIs on northern sector convection. Three RHIs plus a full PPI sector. Repeating every 5 min on the 5s.

2246 - Tops over 12 km in the NE storm. Lightning in north central Larimer county too. Widening PPI sector and speeding up scan rate to try to cover both storms, since they are so far apart. Using 6-min updates now.

2258 - NCAR will launch a 0000 UTC sounding and that will be that.

2300 - Had to manually restart, the sequence bombed out halfway thru the PPI sector. Did not top the NE storm. Nice little hail shaft in the core. Looks like some mid-level cyclonic rotation.

2320- Began RHIs on azimuths 35-52 deg.

2322- Electric alignment signature noted in cell in phi-DP field. Azimuth approximately 45 deg.

2341- Main workstation suffered a likely hardware failure; switched workstations and restarted RHIs at 29-45 deg.

2345- Strong vertical electrical alignment noted across the top of the cloud at 35 deg azimuth, near the center of the storm.

2346- Entered RHI scans on 35 deg only, with repeat time of approximately 10 sec.

2350- Entered RHI scans on 32-37 deg, and then 30-37 deg.

2352- Two precipitation shafts noted, LMA data shows N/S extent and dual lightning shafts. Excellent vertical alignment noted at 30 deg. azimuth.

2355- Entered survey mode after RHI sequence completed.

2358- Software issues causing temporary delay.

0001- RHIs resumed from 23 deg to 37 deg. Alignment signatures are very beautiful, and two precipitation cores are readily visible.

0004- Changed ZdR bias from 1.2 to 1.7, and then 1.6.

0018- RHI scans from 16 to 35 deg.

0020- RHI scans from 16 to 29 deg.

0022- RHI scans from 18 to 29 deg.

0029- Entered surveillance mode.

0032- Entered RHI scans from 14 deg to 52 deg incremented by 2 deg. New cell at 40 km, 26 deg. azimuth from CHILL. Vigorous development and corresponding lightning sources noted.

0121- Storms continue to fire off the Cheyenne Ridge in the same spot, just south of the CO/WY/NE border intersection.

0124- Entered survey mode. Interesting line of storms progressing NNE-ward from Denver metro area.

0127- Entered RHIs from 16-38.5 deg by 1.5 deg steps of storms generated near Cheyenne Ridge.

0130- Lightning hole noted in nearer of two storms along NNE vector.

0135- Possibly an inverted polarity storm in extreme SW Nebraska? Strong midlevel positive noted.

0139- Hail shaft aloft noted at 9 km AGL, for azimuth ~23 . High reflectivities coincided with drop in rho HV.

0146- Hail signatures at 23 deg. azimuth are very narrow now.

0147- Horizontal alignment signature noted in stratiform area NE of cells, into Nebraska. Anvil is now out of CHILL's range. A storm with lightning sources to 13 km is over DIA (surprise, surprise!), with storms flanking it extending to the NW over Boulder and the foothills.

0151- Entered survey mode. RHI scans likely coming for the DIA storm.

0154- Entered RHIs from 186-208.5 deg incremented by 1.5 deg of storm near DIA. Storm is weaker than its counterparts to the NE of CHILL, but still reaches to 11 km AGL. Overhanging structure noted.

0200- Horizontal rho-HV signature noted in core of storm at 7 km, 197 deg azimuth. Reflectivity was uniform.

0203- Entered PPI sector scan from 170-290 deg. DIA storm was boring, and new storm just S of Loveland popped up and is active.

0212- Storms in northern Denver metro area have all merged into a line. Entering RHIs from 180-270 deg, incremented by 3 deg. Storm S of Loveland still active.

0218- Changed azimuth limits to 200 to 270 deg.

0225- CHILL experiencing data issues.

0230- Changed azimuths from 220 to 280 deg, incremented by 3s. Very strong brightband in rho HV at 3 km, indicative of melting level.

0233- Changed azimuths from 235 to 292 deg. Storms continue to build north-northeastward. Depressed brightband in v-shape in rho HV at 262 deg indicative of graupel falling out.

0242- Big drops noted in south Fort Collins by T. Lang along with continuous thunder. Zdr values noted to be larger than 4 in vicinity of KFNL.

0244- Changed azimuths from 251 to 308 deg.

0246- Convective surge of 40 dBZ to 13 km AGL noted at 269 and 272 deg azimuth.

0251- Convective surges of 50 dBZ to 14 km AGL noted at 281 deg azimuth.

0256- Changed azimuths to 260 deg to 305 deg.

0259- Huge convective core to 15 km noted at 33 km, 284 deg azimuth. Zdr values saturating above 4.0.

0302- Control trailer experiencing small magnitude earthquake. Rather, a gust front has made its presence known by shaking the control trailer at CHILL.

0307- Changed azimuths from 270 to 330 deg. Storms building well north into WY, east of Cheyenne.

0316- Changed azimuths to 288 to 333 deg. Storm NE of Fort Collins is extremely active.

0321- 66 dBZ at 9 km AGL(!) observed in storm at 321 deg azimuth, range 48 km.

0322- Entered PPI sweep at 2.5 deg elevation from 240 to 360 deg. Hail shaft of 70 dBZ corresponding to storm NE of Ft. Collins.

0326- Added azimuths to 345 deg from 288 deg. Zdr much smaller now, but still very high reflectivities. Conclusion: hail.

0335- Changed azimuths from 320 to 335, incremented by 1 deg. Visual observations of lightning at CHILL included frequent in-cloud lightning as well as a few bright single CGs- probably positive strokes.

0344- Changed azimuths from 320 to 350 deg, incremented by 2 deg. Big positive CMCs observed in this convection as well as to the north, in WY/NE. Almost all of the CMC activity is positive in this convection.

0351- Switched azimuths to 290 to 320 deg; storm backbuilt just NE of Fort Collins. Dual cores noted; HID also identified large swaths of precipitation NE of Fort Collins as hail.

0357- Wasp exterminated via foam spray in control trailer by J. George. No remorse was noted.

0359- Entered PPI to determine best region for scanning storm NE of Fort Collins.

0402- Entered RHI scans from 300 deg to 330 deg, incremented by 2 deg.

0406- Convective surge to 17 km MSL corresponds to lightning surge to 17 km MSL. Very pretty overshooting top. Storm NE of Fort Collins continues to regenerate.

0426- Continue to scan storms NE of Fort Collins. Vertical electrical alignment signatures very strong.

0437- Storms NE of Fort Collins traveling north on I-25. Rotating 20 deg to bring azimuths to 326 to 358 deg.

0449- Entered surveillance mode.

0455- Operations at CHILL ceased.

SUMMARY: A great day for studying convection, as it went well into the night with very active lightning and convective surging. CHILL only operated today, starting at 2000 UTC and ceasing operations well after 0400 UTC. There was moderate activity to begin the day, with small, shallow popup storms over the foothills and plains. Soon, the storms became more vigorous and began to reach higher. Some RHI/PPI combinations were performed on decent storms in Nebraska and NW of CHILL over the high terrain around 2300 UTC. These storms began to weaken, and new storms began to form along the Cheyenne Ridge. Primarily RHI sweeps were used after 0000 UTC to characterize all storms and structure. RHIs were run for storms that fired off of the same spot just south of the CO/WY/NE border intersections from just after 0000 UTC to 0145 UTC, when the storms moved into NE and weakened. Storms then formed over west Denver metro area and moved NNE, uncannily passing over DIA. RHIs were run for the DIA storm, which ended up being fairly run of the mill. The storms to the west and north of DIA then developed rapidly northward starting at 0200 UTC. By 0245, the storms had reached south Fort Collins, where a convective surge associated with a lightning surge to 14 km AGL was noted. Large raindrops with ZdR values above 4.0 were also observed in the vicinity of KFNL around 0300 UTC. Very heavy lightning activity was observed in this storm, with several convective surges observed in the data. Also noted were regions of vertical electrical alignment in the cloud tops. Some other points in time were noted to have horizontal electrical alignment. The storms to the east eventually died out and storms along the foothills continued to build and rebuild. A storm just to the NE of Fort Collins then became the focal point of scanning after 0300 UTC as it rebuilt in the same spot and produced a very impressive surge of 40+ dBZ to 17 km MSL as well as lofting a region of 65+ dBZ to 9 km near 0320 UTC. HID (Hydrometeor Identification) showed a large swath of hail identified at the surface at this time. The storm backbuilt once more around 0400 before finally heading off to the north along I-25 into WY and weakening around 0455, when operations at CHILL ceased. Screenshots of convective surges and electrical alignment signatures in phi DP fields are attached.

27 June 2012

19 Z BD and BF arrived at radar. Radar was already in 5 min SUR scans, as was Pawnee.

There is relatively intense stuff already firing to the west over the foothills, in particular in the vicinity of the fire. Changed into PPI sector scans for the west dual-Doppler

2005 - Front easily visible on radar running w/e near I-70 right on top of Last Chance. Not much of a temp difference but a wind shift noted and higher dew point north of the front (40s vs. 30s). Also a NW-SE stationary boundary is in place which is firing off cells now including some near KFTG all the way up to Fort Collins

2022 - Sending the MGAUS sounding to just east of the storm N of Bennett. They will launch in a few minutes and then find a way to head east and await further instructions.

2030 - Raining at CHILL! What is this liquid stuff falling from the sky?

2035 - Thunder! And the lights blinked here at CHILL ... sure hope we don't lose power. :S Lost radar control connection briefly.

2037 - Lost radar control, Dave resetting transmitter now. Looks like the storm of interest might be the one NNW of Limon.

2045 - Going to change strategy for the time being. Put Pawnee in a PPI sector to the north to catch the stuff around CYS (after a SUR scan to see what's out there), while CHILL will scan to the SE to try to pick up the storms targeted by the aircraft and other radars. Will reassess as the aircraft arrives.

2100 - Expanded CHILL scan range to capture cell near Boulder (150 degrees)

2107 - Lots of confusion here about where the aircraft are going and doing. I guess there is an FAA radar out so they are limited in what they can do. There are storms firing over Fort Collins, Boulder. There is now a pretty interesting storm in the SW corner of Morgan county. Lots of lightning associated with that cell. We will do an RHI series through Fort Morgan storm.

2113 - Starting RHIs on SW Morgan storm and also getting some of the Limon storm although it is far from the radar. Nice rain shaft signature in Morgan storm

2116 - At 2030, MGAUS launched inflow sounding 5 miles north of hwy 36 on cr 225

2124 - Flipping PAW over to the eastern dual-Doppler lobe in the hopes the Fort Morgan storm moves north into the dual-Doppler lobe. There is a nice boundary draped from Fort Collins to the NE as well. The Smart Rs are also in that area.

2128 - Nice electrical alignment signature seen in phi dp

2140 - cluster of storms around foco so switching to DD scanning west lobe with CHILL and PAWNEE, high park fire may be getting some rain and storms may be ingesting smoke

2144 - There is a storm pretty close to PAW (just to the west), hard to top even with max elevation of 40°. The storm right near Fort Collins is really electrified.

2200 - Sending the MGAUS to Elba. It's getting hard to get to the inflow of all this soupy stuff. Hopefully they can launch at 2230 Z.

2213 - Flash flood warning out for the high park fire area, running RHIs through the storm

2220 - Back to DD PPI mode with pawnee. Mobile radars and GV are targeting the storm in Washington county. However, this is outside the DD lobe and is 120-150 km from CHILL and moving away. Thus we have decided to stick with the stuff to the west. Severe thunderstorm warning for the Last Chance storm.

2240 - Starting DD PPI scanning mode in western lobe as a lot of convection in the foothills and may interact w/ wwd moving boundary

2242 - Boundary about to collide w/ storms near foco/foothills

2245 - Noticed that PAWNEE is not being included in real-time images. Turns out the disk filled up again. Dave fixed the problem, we should be getting PAW files now.

2253 - Severe thunderstorm warning now issues to the SW of what we are calling the Last Chance storm. Not sure what they are seeing on the radar. The Last Chance storm is really a lightning monster and is well-developed. The G-V, mobile radars and sounding are covering that storm, but we are going to stick to the west dual-Doppler lobe as there is still some lightning in the foothills of Larimer County, and the Last Chance storm is a bit far from us. MGAUS launched a sounding from Elba at 2238 Z. Report is it was directly inflow. He is moving to Yuma.

2258 - PAW reports some rain showers, no 'frog stranglers' but some rain.

2308 - Really nice boundary interaction just NE of Fort Collins. LMA shows a line starting to form along the boundary.

2316 - Adjusted CHILLs elevation angles to go higher in an effort to top more stuff close to us

2330 - Will start an RHI series to the north. Echo tops are ~10 km, core is 50 dBZ +. Nice melting layer seen at 3 km in rho hv and LDR and ZDr. Angles are 355-7°. Rotated PAW slightly CW.

2347 - Flipping PAW over to eastern dual-Dopp lobe with CHILL for storm just to the east.

2352 - MGAUS launched a sounding from 5 mi north of Yuma at 2340 Z. They are now out of standard sondes and will be pretty far from home base, so they will be returning after the sonde is complete.

2357 - Nice lightning activity in the cell we are scanning in Weld county. X-band is also scanning. PAW is having to scan pretty coarsely in order to top the storm.

0006 - Running an RHI series through the core of the storm in the DD lobe. Not particularly impressive, 56 dBZ core, 8 km heights for the most part.

0025 - Storm in our dual-Doppler is falling apart. No more lightning, max reflectivities are now in the upper 40's, maybe 50 dBZ.

0042 - Pat is noticing some positive Kdp shifts up near -20° C in the northern quadrant of the

domain.

0130 - Going to shut down operations at Pawnee as the storm is really dying out and we hope the GV is headed home soon--it is spiraling in eastern NE. There is no lightning within the dual-Doppler coverage area. There is a nice line of LMA sources in central Washington County. I think we are just clipping the edge of this with CHILL, as it's about 120-130 km from us.

0150 - Ceasing CHILL operations as the G-V heads back to Salina.

SUMMARY:

CHILL and Pawnee were operational beginning at 19 Z. The day was generally pretty 'soupy' with nothing really organized within the CHL-PAW domain. Initially there was some convection over the terrain to the west. As a storm started developing near Limon, we attempted to scan it with CHILL as it seemed like it might organize and was very active in terms of lightning. Finally, a storm developed to the SW of Morgan county -- we started calling it the Last Chance storm. Mobile radars and G-V coalesced around this storm, which turned out to be the most organized game in town. The MGAUS soundings launched initially at Last Chance just after 19 Z, then at 2030 Z 5 miles north of Hwy 36, Elba at 2238 Z, and finally 5 miles N of Yuma at 2340 Z. Should provide some good inflow soundings, although at least the last two didn't make it very high. Initially did some RHIs with CHILL of the Last Chance storm before flipping to the west dual-Doppler lobe with Pawnee for some storms over the foothills including the High Park Fire around 2140 Z. There was a flash flood warning issued for that area. Remained in dual-Doppler coordinated scans with Pawnee as everything moved east, taking some RHIS with CHILL as it passed over the baseline, and then switched to scanning the eastern dual-Doppler lobe. Things were pretty electrified, although not extremely impressive in terms of echo heights (10 km) or maximum reflectivities (mid-50's). It's possible these storms were ingesting smoke from the High Park or Boulder Flagstaff fire. There were some nice bright-band signatures noted in both Pawnee and CHILL.

28 June 2012

DISCUSSION: Looks like soupy convection today, with the chance for some decent convection in the eastern plains of CO later in the day. Science debrief at CHILL at 9 AM this morning; CHILL expected to be operational by 2000 UTC.

1800- CHILL up and running surveillance.

1930- Storms have popped up along the northern Front Range. Performed RHI on storm at 290 deg azimuth in western dual-Doppler lobe to determine height.

1940- Entered PPIs from 210 to 330 deg azimuth with 5 minute schedule on the 5s. Pawnee also scanning western lobe with PPI.

1947- Upped the scan rate from 8 deg/sec to 9 deg/sec, as CHILL was not topping the convection. Pawnee reports topping the convection.

2005- Anvil has drifted nearer to CHILL, upping scan rate to 10 deg/sec.

2012- Anvil over CHILL now; will keep the current settings.

2015- Ran RHI at 298 deg. Storms are at 18 deg elevation angle to top in western lobe.

2017- Changed Rmax to 40 km; top angle should be 19.7 deg to top.

2025- Actual tilt angle only reached 18.5 deg. Changed Rmax to 30 km; top angle should be 20 deg to top.

2027- 1935 MGAUS sounding from Wray shows that the cap has almost completely burned off in eastern CO.

2055- Italy vs. Spain in the final of Euro 2012; much lamenting.

2110- Changed Rmax to 42 km and Sres to 1.1 km, as storms continue to develop in the western dual-Doppler lobe. Lots of virga observed at CHILL, with total sky cloud cover.

2137- Continuing to scan western dual-Doppler lobe as cells continue to fire off of the high terrain. Storms getting close to Pawnee.

2156- Hail hole noted in ZdR of storm NE of Wellington in between I25 and US85. Reflectivities up to 65 dBZ, ZdR near 0.

2205- MGAUS launched sounding from Idalia. Very dry surface air.

2214- Scaled back Sres to 1.0 km and Rmax to 50 km. The radar is topping the storms that are out in the bulk of the western dual-Doppler lobe too quickly, and nothing is making it much past US85 with much intensity.

2233- MISS sounding just launched; MISS has been launching every 1.5 hr since 1800 UTC.

2236- Convection over the foothills starting to peter out; strong convection in extreme southern Washington county and extending southward is out of CHILL's range.

2303- Changed Rmax to 60 km; top elevation angle of 14.0 deg; scan rate of 8 deg/sec.

2310- Changed Rmax to 50 km. Convection is much soupier now.

2332- Weakly electrified storms continue to pop up over the foothills and weaken as they enter the plains. Strong convection just out of CHILL's range to the SE, in SE Washington County. Gust fronts collided and strongly invigorated new convection.

2352- Very subtle lightning hole observed in storm just to the NW of Fort Collins over High Park burn area. Storm appeared to have died off earlier, but reinvigorated over the burn area. Still a tiny storm compared to the 24 Jun storms in the area. Only one big positive CMC in the CO convection this afternoon.

2356- Eastern CO convection beginning to weaken, from LMA data.

0012- 0130 sounding eliminated for today. 0000 sounding from Idalia is very dry and hot (45 C).

0022- Storms continue to form along CO14 and move eastward. Weakly electrified storms.

0045- CHILL and Pawnee ceased operations for the day.

SUMMARY- Storms started firing off of the high terrain early today and continued to do so throughout the day. CHILL and Pawnee conducted dual-Doppler PPI surveillance on the 5's of the western dual-Doppler lobe continuously from 1940 to 0045. Storms formed and decayed nearly constantly within the western lobe for several hours and both radars did not need to adjust scanning sectors. At times, the storms in the western dual-Doppler lobe were moderately electrified. One storm that propagated eastward in a track just north of Wellington produced a classic ZdR "hail hole" (Image 1) around 2200 UTC. Most storms were shallow and stayed below 10 km MSL, but some storms (such as the aforementioned) reached 11 or 12 km MSL. Strongly electrified convection was treating the mobile radars and the GV to a show on the eastern plains, but it was out of range of CHILL. One observation to note was that storms moving east through central Larimer county intensified in the same spot that was just northwest of the High Park burn perimeter. The fire was very inactive today due to rain last night and this afternoon over the burn. Overall, a decent day with good dual-Doppler coverage on small airmass thunderstorms, but the big storms were out east.

29 June 2012

1836 - CHILL up and running in surveillance for a little while. Significant insect echo out to 120 km; weakly electrified cell near 210 deg and 86 km.

1839 - Running RHI sectors thru the distant southwestern echo. 8 km tops, 40 dBZ cores

1901 - North JeffCo convection remains electrified. Continue to scan with RHIs, no general changes in character, maybe a little taller and stronger.

1920 - Quick surveillance and back into RHIs to re-establish appropriate sector limits. RHIs continue on the closest cells to Denver.

1933 - Have a 30-deg RHI sector working now, sub-4 min res.

1947 - New convection to the south, rotating RHIs to account for this.

2005 - Back to surveillance. Not enough recent nearby lightning.

2009 - New lightning along the Cheyenne Ridge. Rotating RHI sector north to cover that region.

2037 - Main antenna controller display computer froze. Working on adjacent computer. Was a decent 50-dBZ core at 100 km, 2 deg a few minutes back

2051 - Nice echo overhang at 100 km, 23 deg. Lightning picking up in WY. Boosting sector size to 40 deg, about a 5-min update cycle.

2057 - NEXRAD loops show a pretty significant N-S boundary over the foothills.

2114 - Tightening up sector to concentrate more on individual cells, getting too busy out there to try to focus on everything at once.

2119 - Rotating clockwise to get developing cells NE of us.

2124 - Further tightening up sector and raising elev limit to get more of nearby NE storm at higher temporal resolution.

2159 - RHIs continue on various cells to our north. Working off a 20-deg sector. Storms getting a little taller - 9 km or so.

2206 - Surveillance then RHIs to cover recurring convection near Loveland.

2209 - Finally! Something reaching 11 km MSL.

2220 - RHIs starting to look really pretty. Mostly rain cores and storm is getting bigger and more electrified. Strong mid-level VHF activity - inverted?

2229 - Storm not moving much, situated west of Loveland/Longmont line. Classic flash flood situation, though I don't know of many rivers where it's at. I guess Carter Lake is right around there.

2235 - Running a PPI sector on storm to get some better context for where to center the RHIs.

2236 - Transmitter kicked out. Whee!

2237 - It's back.

2242 - Unlike the Ft Collins flood storm of 1997, this one has strong ice-based microphysics and plenty of lightning. But overall pattern of redevelopment in place is a classic flash flood scenario.

2245 - Trying a mixture of PPIs and RHIs, since storm is so large and so close.

2301 - Finally some eastward propagation of this storm. Quite close and difficult to top. Compromises are being made.

2309 - Unimpressive phase shifts in these storms. Big drops but not much water mass. Wait, 227 deg looks pretty good for both.

2315 - Now that core is much smaller, switching back to RHI sectors only.

2317 - Transferring to diesel, shutting off scanning for a couple min.

2318 - Scanning resumed, widening sector but coarsening resolution since storm is so close.

2332 - Having a hard time staying ahead of this storm. Once it started moving east it booked!

2338 - Widening to 30 deg with 3-deg steps, all sorts of electrified convection surrounds the radar, though no rainfall here really. Sticking with southern convection for now. That boundary that came south from WY convection is firing stuff off all over Weld County.

2347 - Swapping storms to one to our NNE. Better geometry to follow it with RHIs.

0003 - LMA shows weakening storms to our east. Back to surveillance. Stuff near Boulder County is active.

0005 - RHIs on Boulder County stuff.

0019 - Significant *positive* phase shifts aloft, classic stratiform signature (aggregation). Convective character today has been very soupy once anything gets larger than a rinky-dink cell.

0029 - Storm stratifying out and weakening.

0035 - Going to surveillance.

0039 - Trying long-range RHIs on distant storm near Sterling.

0053 - Back to surveillance. Wrapping up for the evening.

Summary - Operations at CHILL started by 1900 UTC today, with small, electrically active storms already in range. CHILL focused primarily on RHI sector volumes thru convection today. Storms started over the western foothills, and then the Cheyenne Ridge became active. Later in the day, towards 2200, a stationary storm developed near Carter Lake between Loveland and Longmont. This storm was much larger than earlier storms. It redeveloped in place for at least 30-60 min, then finally began propagating east rapidly. For a while CHILL combined PPI and RHI sector volumes to capture the entirety of this large multicell. Once it passed south of CHILL it had shrunk considerably and also was so close it was difficult to scan properly. Then convection fired off a boundary that had moved into Weld County from the earlier Cheyenne Ridge convection, and CHILL was surrounded by weak convection, though it barely rained here. That convection did not last long, however, and after 0000 CHILL started scanning some cells that had developed in Boulder County. Overall, storms in CHILL's domain today produced some surface rainfall with obvious contributions from melted graupel and hail, and were moderately electrified. The pattern was generally very similar to the previous 2-3 days. Tops remained between 8 and 11 km, with the taller echoes more common later in the day.

30 June 2012

DISCUSSION: The forecast for today has gotten considerably better throughout the week, and the chance for a monsoonal-type storm regime is good. CHILL should be up by 1900 Z and expect to operate until 0000 Z or later.

1935- Arrival at CHILL at 19 Z revealed all things locked up. D. Brunkow arrived at 1925, and CHILL was up and in surveillance mode by 1935. So far, no notable convection. Some at the far southern end of CHILL's range.

1938- Raining at CHILL; originally thought it was virga.

1944- Some storms along WY border with CO have become weakly electrified. Storm at edge of range in southern Denver metro area is moderately active and may warrant a potshot RHI or two.

1946- RHIs entered at 1 deg resolution for azimuths 177-181. Storm tops are 11 km, with core to 55 dBZ+, but on edge of CHILL's range.

1948- Returning to survey mode; soupy clear sky signal evident; Haze is also prevalent today.

1951- Storm along Cheyenne Ridge has started to become more developed. Entering RHIs for azimuths 20-40 by 1 deg intervals. Modest storm with tops to 9 km.

1956- RHIs further reveal storm tops to 10 km in Cheyenne Ridge convection. Earlier convective surge produced some lightning, but is now quiet and a relatively run of the mill high-based airmass thunderstorm.

2000- RHIs reveal high base and virga now falling from Cheyenne Ridge storm. Will let RHIs finish on this volume, then return to surveillance mode, potentially to only get new azimuths for the convection.

2006- Entered PPI 180 deg scans at 10 deg/sec to identify targets. New source of electrified convection has popped up E of Wellington from colliding outflow boundaries, but convection NE of CHILL on Cheyenne Ridge looks most promising at the moment. Also, small storm in extreme NW Morgan County has erupted.

2012- Entered RHIs on storms just E of Wellington; azimuths 345 to 3 deg, with 1 deg resolution.

2014- Changed RHI tilt max to 20 deg. Cloud tops are at 10 km AGL. Overhang noted in convection at 355 deg azimuth; BWER likely at ~7-8 km (13 deg tilt) if PPI was run through it.

2016- Added a few angles to the RHI list, to 7 deg azimuth. Storm is beginning to weaken. May switch to tri-state (CO/WY/NE border intersection) region as there is a newly-electrified cell popping up there.

2020- Bulk of Wellington storm at 356 deg azimuth seems to be raining itself out. Will switch to surv mode if the electrification of the storm doesn't reintensify.

2026- Chopped off azimuths 345-348. Storm is moving east rapidly.

2032- New RHI range 3 deg to 20 deg. Storm continues to produce lightning, but is weakly electrified at this moment. Bonus points for the storm being well within the LMA.

2035- Vertical electrical alignment signatures noted in phi DP at 10 deg azimuth.

2049- Rotated 10 deg CW to follow storm as it scoots along to the east. It is the only interesting bit in the domain.

2057- Running PPI to ascertain angles for storm.

2058- Storm is screaming along to the east; new angles are 31 deg to 60 deg azimuth, 1 deg resolution. May up the resolution to 2 deg.

2111- Entering surveillance mode; storm has weakened. Some new development just N of Briggsdale.

2115- Running RHIs for 70-85 deg azimuth of convection to the NE of Briggsdale. If storms continue to move due east, then CHILL should be able to capture them as they move out of range.

2119- Nothing of note in the western domain. Very weakly electrified storms over the foothills, west of Longmont. Added 5 deg CW to the RHI range.

2139- Still scanning RHIs 70-90 deg. Storms seem to be weakening across the board. Will continue to scan 70-90 deg until the LMA sources disappear. Storms max height is approx. 10 km.

2208- Entered survey mode.

2223- Small storm in central Larimer Co has popped up and has been deemed worthy of RHIs. Running azimuths from 270-283 deg azimuth.

2235- LMA has picked up activity again from storms in Larimer Co. and some over southern WY hills. Noted overhanging structure for storm at 285 deg azimuth.

2259- After an antenna fault, CHILL is scanning remnants of storm at 270 deg azimuth.

2305- And the storm died. Nothing but virga now. No LMA sources remotely in the CHILL domain, so operations shall cease.

SUMMARY: The day began at around 1930 UTC, with small airmass thunderstorms popping up over the high country and rapidly moving eastward. CHILL provided some RHI coverage of weakly to moderately electrified storms through to 2300 UTC, when everything died and rained out. The action was again east of CHILL's range and wasn't horribly impressive. Most storms didn't grow higher than 11 km AGL, with bases hovering in the 3.5-4 km range. CHILL reported a short rain shower right after ops began. Overall, it was a nice peaceful end to a very successful DC3 campaign.