User information for the CSU CHILL and Pawnee radar data sets collected during the May – June DC3 project.

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1.0 Data set overview:

As prescribed in the project operations manual, the CSU CHILL and Pawnee radars used several data collection methods depending on the nature of thunderstorm development:

1.) Full 360 degree surveillance volumes at relatively low elevation angles to observed the boundary layer prior to the development of thunderstorms.

2.) Synchronized PPI sector scans to collect volumetric data for the syntheses of dual-Doppler wind fields. (Depending upon storm locations, the dual Doppler scans were sometimes synchronized with neighboring WSR-88D radars).

3.) The CSU-CHILL radar performed variable quantities of RHI sector scans to observe the vertical structure of storms for microphysical and storm electrification considerations.

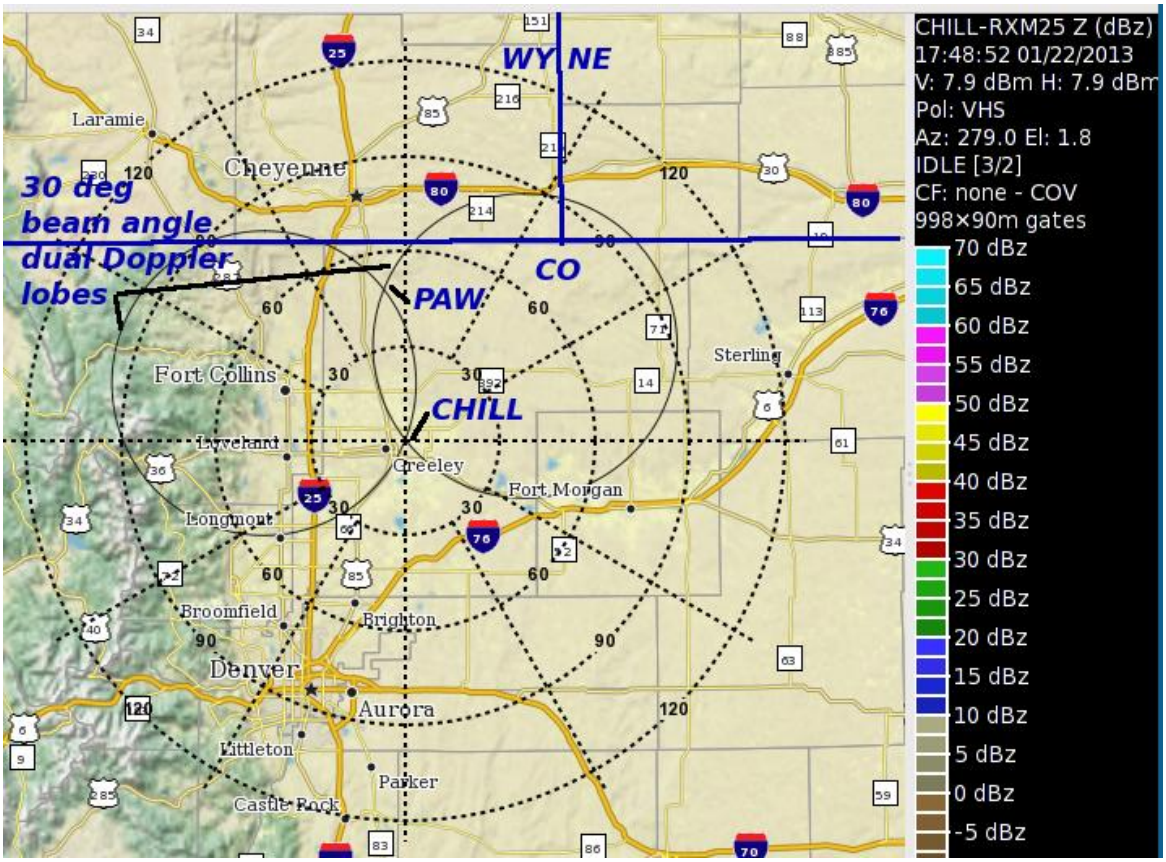
DC3 project operations were conducted between 8 May 2012 (DC8 flyby at Greeley enroute to KSLN) and 30 June 2012 (formal end of field activities).

Both radars are located in northeastern Colorado:

CSU-CHILL: 40° 26' 46.5" (N40.44625) and longitude 104° 38' 13.5" (W104.63708), at an elevation of 1432 meters MSL.

CSU-Pawnee: Latitude 40° 52.269' (N 40.87115) and longitude 104° 42.84' (W 104.714), at an altitude of 1688 m MSL.

The dual-Doppler coverage region for the CSU-CHLL and Pawnee radars is shown by the interlocking rings in the following figure:



2.0 Instrument descriptions:

Both CSU radars operate in the 10 – 11 cm wavelength / 3 GHz S-Band. During the DC3 project, the CSU-CHILL radar operated in alternating H,V polarization mode. Pawnee uses V polarization only.

Additional technical information is available at portion of the CSU-CHILL Facility web page:

http://www.chill.colostate.edu/w/Facilities

3.0 Data Collection and Processing:

Plan Position Indicator (PPI) scans were primarily used during DC3 project operations. Once storms of interest were identified, sector scans were used in an effort to allow volumetric scanning up to echo top heights while limiting the volume scan durations to ~6 minutes or less. Range Height Indicator (RHI) scans were manually inserted at the CSU-CHILL radar to obtain vertical cross sections through areas of particular interest.

Both radars used in-house designed and built receivers and signal processing hardware to output meteorological moment data. Ground clutter returns were reduced through the use of a narrow (~1 ms^{-1} stop band width) digital clutter filter. More specific information on the signal processing procedures is available upon request from the engineering staff at the CSU-CHILL Facility.

Basic system calibration checks involving recordings of the S-Band power received from the sun and system response to CW test signals injected into the waveguide were done on each operational day at both radars. An overall system gain calibration was done at the CSU-CHILL radar using a balloon-borne foil covered sphere target on 4 June 2012. Post-project reflectivity inter-comparisons were done between the CHILL and Pawnee radars by interpolating observations to a common set of Cartesian grid points. Scatterplots based on the gridded data indicated that the Pawnee reflectivity values were biased ~4 dB above those of CSU-CHILL. (Due to the sphere calibration results, the CHILL reflectivity values were used as the reference.) A bias adjustment was applied to the Pawnee reflectivity values in the DORADE files that were generated for the DC3 project archives. (It should be recognized that since the Pawnee radar uses vertical polarization, its reflectivity values may differ from those of CHILL by several dB when non-spherical hydrometeors are being observed.)

Both radars routinely used pulse repetition frequencies (PRF) of ~1 KHz, allowing a data collection range of ~150 km. On a few occasions, at the request of the radar scientists on duty at CSU-CHILL, the PRF was reduced to increase the data collection range to ~180 km. The scientist's daily operations notes (link shown in section 5.0 below) indicate dates and times when PRF adjustments were done.

4.0 Data Format:

As per policies established in the pre-project planning discussions, CSU radar data submitted to the NCAR project archives is in DORADE sweep file format. Data dates and times use UTC basis. The data field name mnemonics in the DORADE files are as follows:

CSU-CHILL data:

DZ Horizontal polarization reflectivity (dBZ)

VE Radial velocity (ms^{-1})

DR Differential reflectivity (Zdr; dB)

DP Differential propagation phase (degrees)

KD Specific differential propagation phase (one way basis; deg km^{-1})

RH Co-polar H,V correlation adjusted to 0 time lag (data collected in alternating H, V mode)

NC Normalized coherent power (normalized first lagged autocorrelation magnitude; Keeler, 1990)

LH Linear depolarization ratio (LDR) with H being co-polar (dB)

LV Linear depolarization ratio (LDR) with V being co-polar (dB)

CH H polarization co-polar received power (dBm)

CV V polarization co-polar received power (dBm)

Pawnee data:

DZ Vertical polarization reflectivity (dBZ)

VE Radial velocity (ms^{-1})

NC Normalized coherent power (normalized first lagged autocorrelation magnitude; Keeler, 1990)

CV V polarization co-polar received power (dBm)

W2 Radial velocity spectral width (ms^{-1})

For both radars, the range resolution is 150 m. During PPI scans, both radars output indexed beam data at 1^o azimuth intervals. Beam indexing was not used in the CHILL RHI scans; instead beams were output after 256 pulses had been received. At the $1 – 2\ ^o s^{-1}$ scan rates used in these RHI's, this resulted in a beam spacing of ~0.3^o.

5.0 Data Remarks:

The Pawnee radar suffered the following outages during DC3:

On 17 May 2012, the high voltage diodes failed while the radar was being brought up; the radar was out of service for the rest of that day.

At the end of operations on Friday, 18 May 2012, the Pawnee suffered a failure of the Klystron final power amplifier tube. It returned to service with a replacement tube on the following Friday (25 May 2012).

Minimal thresholding is applied to the CHILL data in the DC3 project DORADE files. In the CHILL data, differential reflectivity and linear depolarization values are set to missing in the signal processor when the co-polar signal to noise ratio (SNR) is less than ~0 dB. (i.e., signal power equals noise power as

based on the receiver calibration results). RhoHV values below 0.6 are reset to 0.6; this is true irrespective of the SNR level.

Known data artifacts are of the types typically encountered meteorological radar data sets:

Ground clutter returns due to targets strong enough to exceed the clutter filter stop band depth.

Antenna side lobe artifacts (especially in the Pawnee data).

Aliasing of both range and velocity.

Data perusal:

It is suggested that users examine the radar scientist daily logs for the CHILL facility as collected in the DC3 project data archive:

http://catalog.eol.ucar.edu/cgi-bin/dc3_2012/report/status.pl

The easiest way to examine the archived CHILL and Pawnee radar data is through the use of the Virtual CHILL (VCHILL) interactive display program. VCHILL is available as a free software download from this web site:

http://www.chill.colostate.edu/w/VCHILL_Download_Instructions

(For additional information on using VCHILL, please contact Pat Kennedy)

4.0 Data Format:

NCAR is responsible for the DORADE sweepfile format; see:

http://www.eol.ucar.edu/instrumentation/airborne-instruments/eldora/eldora-help-center/manual/users-guide/appendices/appendix-a-dorade-format-overview

5.0 Data Remarks:

As noted earlier, the radar scientist operations summaries collected in the DC3 field catalogue are the primary source of data remarks. In terms of data processing, the DORADE sweep files may be directly ingested into the NCAR SOLO and REORDER programs for display, editing, and Cartesian gridding. The NCAR "Radx" software library is also useful for converting DORADE data files to other formats:

http://www.ral.ucar.edu/projects/titan/docs/radial_formats/

6.0 References:

Keeler, R. J. and R. Passarelli, 1990: Chapter 20a (p224) in Radar in Meteorology, David Atlas, editor, AMS, 1990

http://www.eol.ucar.edu/projects/dc3/