**Dataset title: Radar data and wind syntheses for the 5 June 2009 tornadic supercell intercepted by VORTEX2 in Goshen County, Wyoming**

**Contact: Paul Markowski, Professor of Meteorology, Department of Meteorology,** **pmarkowski@psu.edu****, 814-865-0428**

Files (all have been frozen since June, 2011):

radar-grids.tar

raw-radar-data.tar

code.tar

These data are the basis for the following two publications on the early lifecycle of the Goshen County, Wyoming, tornadic supercell:

Markowski, P., Y. Richardson, J. Marquis, J. Wurman, K. Kosiba, P. Robinson, D. Dowell, E. Rasmussen, and R. Davies-Jones, 2012a: The pretornadic phase of the Goshen County, Wyoming, supercell of 5 June 2009 intercepted by VORTEX2. Part I: Evolution of kinematic and surface thermodynamic fields. *Monthly Weather Review*, **140**, 2887–2915.

Markowski, P., Y. Richardson, J. Marquis, R. Davies-Jones, J. Wurman, K. Kosiba, P. Robinson, E. Rasmussen, and D. Dowell, 2012b: The pretornadic phase of the Goshen County, Wyoming, supercell of 5 June 2009 intercepted by VORTEX2. Part II: Intensification of low-level rotation. *Monthly Weather Review*, **140**, 2916–2938.

Both papers are freely available from the American Meteorological Society at <http://journals.ametsoc.org>. Users are encouraged to read the analysis methodology (e.g., the objective analysis and dual-Doppler techniques) in Part I (Markowski et al. 2012a).

Detailed descriptions of the contents of the files appear on the subsequent pages .

**radar-grids.tar**

Extracting the contents of this file produces two directories: SINGLEDOPP and DUALDOPP.

The SINGLEDOPP directory contains gridded radar data from the KCYS WSR-88D radar. The files in the SINGLEDOPP directory are NETCDF files (http://www.unidata.ucar.edu/software/netcdf/) named as *hhmmss.radar.nc,* where *hhmmss* is the time (UTC) and *radar* refers to the radar name. NETCDF is a heavily used data format used in the field of meteorology.

The field names, field descriptions, and scaling factors for each variable in the NETCDF files appear below:

REF  logarithmic reflectivity factor (dBZ)   1.0
VG  radial velocity (m/s)  1.0
AZ  objectively analyzed beam azimuth angles (degrees)   1.0
EL objectively analyzed beam elevation angles (degrees)   1.0
TIME objectively analyzed gate times (seconds)  1.0
AZSHEAR  azimuthal wind shear (/s)   1.0

Notes on the SINGLEDOPP files:

1. The details of how azimuthal wind shear was computed are explained in Markowski et al. (2012a).

2. A two-pass Barnes smoothing algorithm was used. The Barnes smoothing parameter on the first pass was 2.64 km2. The second pass used a smoothing parameter reduced to 0.3 times the first-pass value.  The grid was translated at (10.45,–1.34) m/s, which is the mean storm motion during the period.

The DUALDOPP directory contains dual-Doppler wind retrievals, either from the DOW6 and DOW7 mobile radars, or from the DOW7 and KCYS radars. The files in the DUALDOPP directory also are NETCDF files named as *hhmmss.rad1rad2.dd.fine*.*nc* and *hhmmss.rad1rad2.dd.smooth*.*nc*, where *hhmmss* is the time (UTC), *rad1* is radar #1 in the dual-Doppler pair, *rad2* is radar #2 in the dual-Doppler pair, and *fine* or *smooth* refers to the scales resolved in the wind syntheses.

The *smooth* dual-Doppler wind syntheses were created using KCYS and DOW7 data from 2129:58–2139:07 UTC. The *fine* dual-Doppler wind syntheses were created using DOW6 and DOW7 data from 2142:00–2148:00. Additional *smooth* dual-Doppler wind syntheses were created using DOW6 and DOW7 data from 2142:00–2148:00 (i.e., using the same smoothing as for the KCYS–DOW7 wind syntheses). Both the DOW6 and DOW7 data are oversmoothed, but if one wants to look at long-period trajectories or evolution from 2129:59–2148:00, it is desirable to apply a consistent degree of smoothing over the entire period so that the scales resolved don’t suddenly shift at 2142 UTC.

For the *fine* wind syntheses, the Barnes smoothing parameter on the first pass was 0.48 km2. The second pass used a smoothing parameter reduced to 0.3 times the first-pass value.  The field names, field descriptions, and scaling factors for each variable in the *fine* files appear below:

U grid-relative zonal wind component (m/s) 1.0

V grid-relative meridional wind component (m/s) 1.0

W vertical wind component (m/s) 1.0

VORTZ z component of vorticity (/s) 100.0

VR1 radial velocity from radar #1 (m/s) 1.0

RF1 logarithmic reflectivity factor from radar #1 (dBZ) 1.0

VR2 radial velocity from radar #2 (m/s) 1.0

RF2 logarithmic reflectivity factor from radar #2 (dBZ) 1.0

CONV horizontal convergence (/s) 100.0

DEF horizontal deformation (/s) 100.0

OW Okubo-Weiss number (/s2) 10000.0

WSPD horizontal wind speed (m/s) 1.0

VORTX x component of vorticity (/s) 100.0

VORTY y component of vorticity (/s) 100.0

HORVORT magnitude of horizontal vorticity (/s) 100.0

P retrieved perturbation pressure (mb) 1.0

DPDX pressure gradient in x direction (mb/m) 10000.0

DPDY pressure gradient in y direction (mb/m) 10000.0

HPGF magnitude of horizontal pressure gradient (mb/m) 10000.0

M angular momentum (m2/s) 0.001

MDPDPHI azimuthal pressure gradient [-d(pressure)/dphi] (mb/rad) 1.0

VERTMADV vertical advection of angular momentum (m2/s2) 0.01

VERTMFLX vertical flux of angular momentum (m2/s2) 0.01

Notes on the *fine* DUALDOPP files:

1. Retrieved pressure perturbations (P) are not unique owing to the Neumann boundary conditions used in the retrieval. The horizontal gradients (DPDX,DPDY) are unique. In Fig. 2 of Markowski et al. (2012b), the following constants (mb) were added to the P field at 2142, 2144, 2146, and 2148 UTC, respectively: –0.20, 0.02, 0.24, and 0.09.

2. The grids are translating at (10.45,–1.34) m/s, which is the mean storm motion during the period. Thus, U and V are storm-relative winds.

3. The angular momentum (M) is with respect to the circulation center and circulation-relative motion on the grid. The circulation's motion relative to the grid at 2142, 2144, 2146, and 2148 UTC, respectively, are (0.9, –1.0), (–2.4,1.0), (–3.6, –1.0), and (1.0, –4.7), where each pair is the x and y motion components (all motion components are in m/s). The circulation centers are indicated in Fig. 9 of Markowski et al. (2012b).

For the *smooth* wind syntheses, the Barnes smoothing parameter on the first pass was 2.64 km2. The second pass used a smoothing parameter reduced to 0.3 times the first-pass value.  The field names, field descriptions, and scaling factors for each variable in the *fine* files appear below:

U grid-relative zonal wind component (m/s) 1.0

V grid-relative meridional wind component (m/s) 1.0

W vertical wind component (m/s) 1.0

RFMAX max of RF1 and RF2 (dBZ) 1.0

VORTX x component of vorticity (/s) 100.0

VORTY y component of vorticity (/s) 100.0

VORTZ z component of vorticity (/s) 100.0

TILT tilting term in vertical vorticity equation (/s2) 10000.0

STRETCH stretching term in vertical vorticity equation (/s2) 10000.0

VR1 radial velocity from radar #1 (m/s) 1.0

RF1 logarithmic reflectivity factor from radar #1 (dBZ) 1.0

VR2 radial velocity from radar #2 (m/s) 1.0

RF2 logarithmic reflectivity factor from radar #2 (dBZ) 1.0

CONV horizontal convergence (/s) 100.0

HORVORT magnitude of horizontal vorticity (/s) 100.0

DEF horizontal deformation (/s) 100.0

OW Okubo-Weiss number (/s2) 10000.0

Notes on the *smooth* DUALDOPP files:

1. The grids are translating at (10.45,–1.34) m/s, which is the mean storm motion during the period. Thus, U and V are storm-relative winds.

**raw-radar-data.tar**

Extracting the contents of this file produces three directories: KCYS, DOW6, and DOW7 (one for each radar). Within each radar’s subdirectory are “sweep” files from the 2100-2148 UTC time period. The sweep files can be viewed with standard radar software such as the SOLO software available from the National Center for Atmospheric Research. Basic descriptions of the variables are self-contained in the files. Additional information appears below.

Notes on the DOW6 and DOW7 data:

VE is the original, raw, radial velocity

DZ is the original, raw, reflectivity

DM is the original, raw, returned power

NCP is the original, raw, normalized coherent power

All other variables are derived/edited variables (e.g., noise was removed, ground clutter was removed, and aliased velocities were dealiased during editing). The final velocity and reflectivity fields that were objectively analyzed for the dual-Doppler wind syntheses, analyses in the publication, etc., are “VDB” and “DDA,” respectively.

Notes on the KCYS data:

VEL is the original, raw, radial velocity

REF is the original, raw, reflectivity

SW is the original, raw, spectrum width

VG is edited VEL that was used in the gridding of the KCYS velocity data (some light editing was required owing to some data being not properly dealiased or being otherwise questionable).

**code.tar**

Extracting the contents of this file creates the following subdirectories, each of which contains the FORTRAN code used for the analyses presented in Markowski et al. (2012a,b):

angM\_v1.1 computes fields related to angular momentum

angM\_budget\_v1.1 similar to angM, but computes some budget terms (see

Fig. 8 in Markowski et al. 2012b)

azimuthal\_shear\_v1.3 computes azimuthal shear

circuits\_v2.7 material circuit code (see Markowski et al. 2012b)

gradient\_v1.1 computes gradients

horvort\_v1.0 computes horizontal vorticity magnitude

radar-analysis-input-files input files for the oban and dualdop executables that can be

built from the code in the radar\_oban directory

radar\_oban code for gridding (objectively analyzing) radar data and

performing dual-Doppler wind syntheses (original

code comes from David Dowell)

retrieval\_v3.6 performs pressure and buoyancy retrieval

smooth\_v1.1 smooths fields

trajectories\_v2.7b computes trajectories

vortconv\_v1.0 computes vorticity and convergence

vortex\_lines\_v2.3 computes vortex lines

vorthigherorder\_v1.0 computes vorticity components

wspd\_v1.0 computes horizontal wind speed

Each subdirectory contains README files that explain how to compile and run the code, with the exception of the directory “radar-analysis-input-files,” which contains input files for the radar objective analysis and dual-Doppler analysis codes that were used to perform the gridding and wind syntheses that served as the basis for Markowski et al. (2012a,b).