

Visual records of clouds

1. Antenna video camera

2. Ground photos (wide angle slides, Dec. 17-Jan. 23, most days, between 6AM and noon local time, looking usually NE, N, and NW; never South.

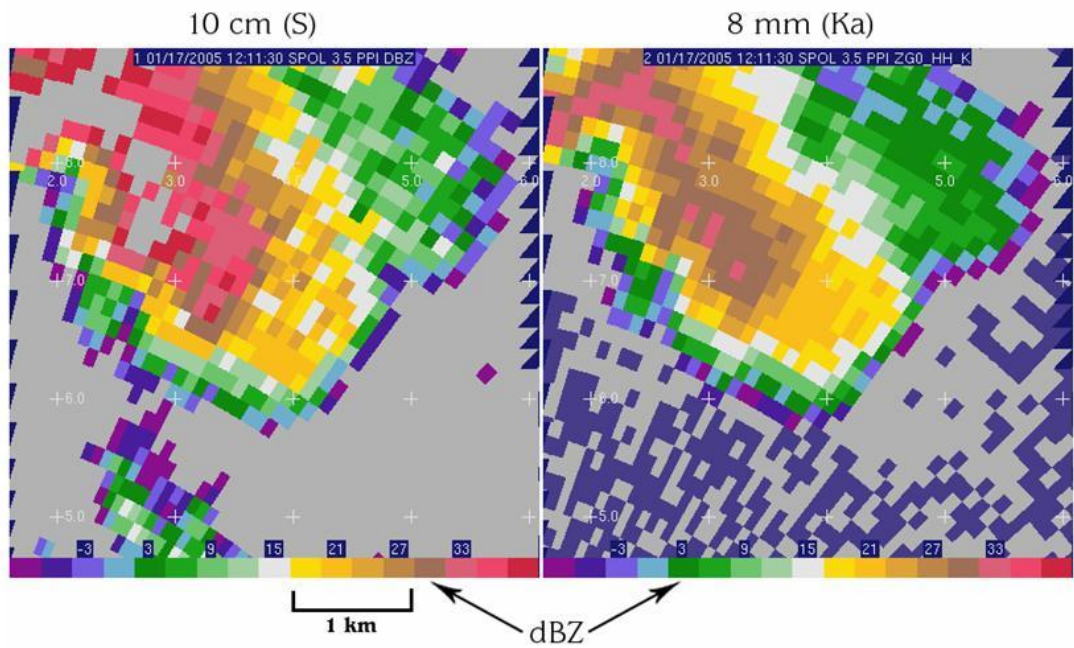
About 3000 photos, mostly 2-minute intervals. When very good clouds are present, 1-minute; no clouds or too many clouds, 5 or 10 minutes.

Radar Data

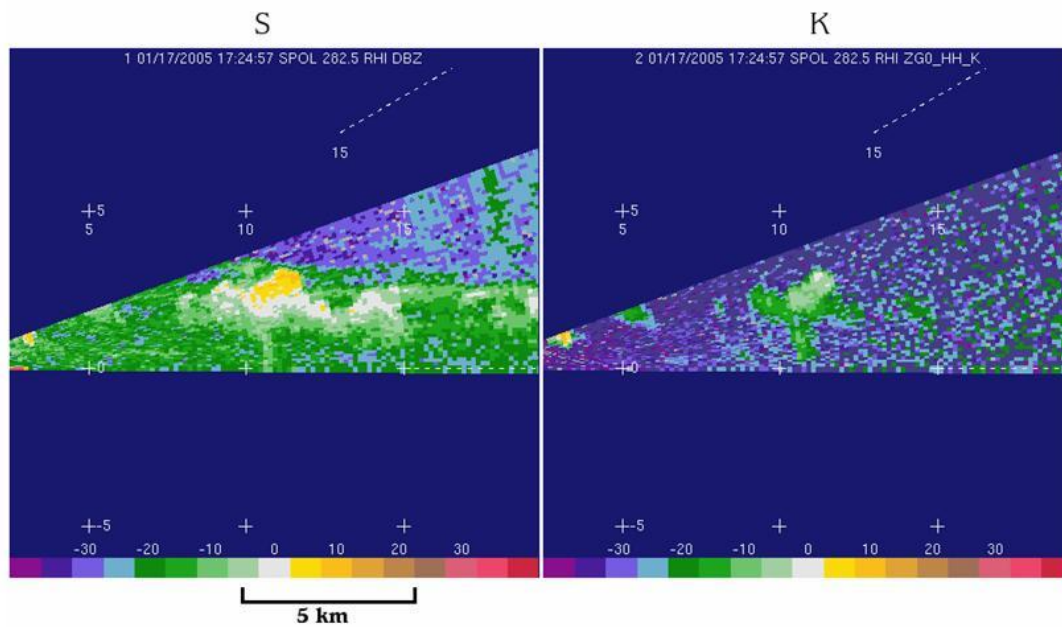
1. Not very good time resolution
2. Not very good space resolution
3. Sometimes inadequate coverage
4. Noisy S-band dBZ and Z_{DR}

General: Excellent data set; the compromises seem to me about right.

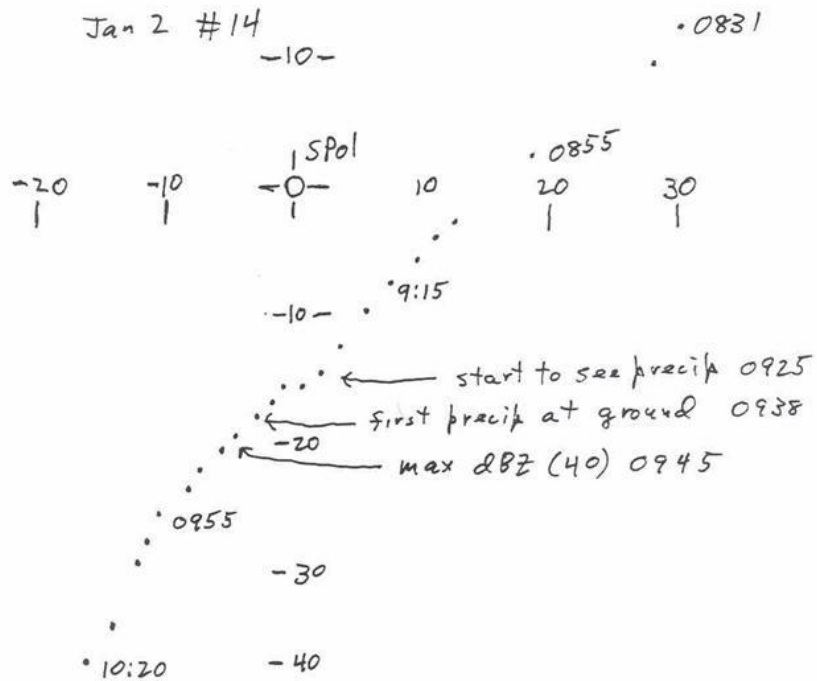
Will show some preliminary results to illustrate the data: S (Z_e and Z_{DR}), Ka (just Z_e)



Two views of the same cloud, range about 6 km, with S and Ka band radars. Note the greater variability in the S-band along the right side of the echo, probably from inadequate averaging. Mie scattering decreases the stronger Ka-band returns.

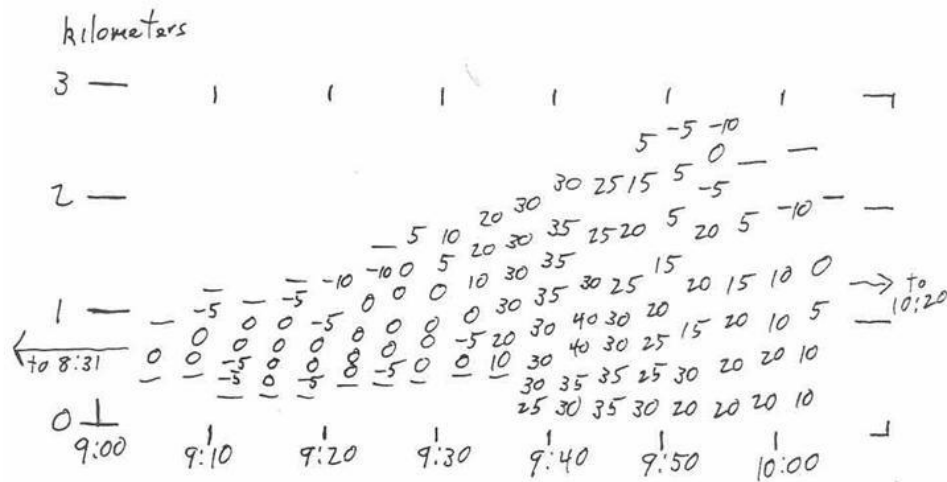


S and Ka band RHIs. Note the Bragg scattering at S-band.



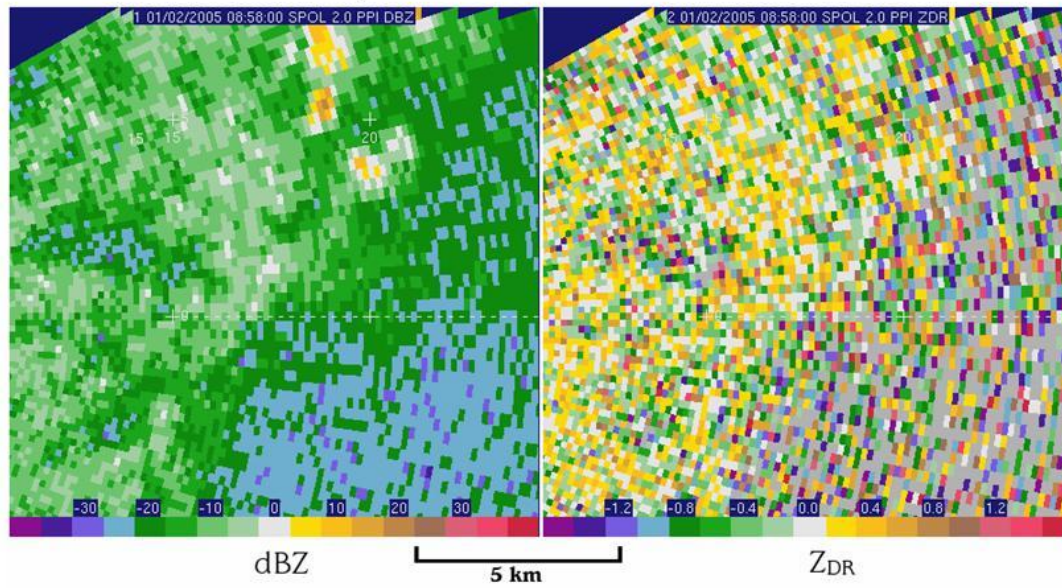
Case #14, 2 January. The track of this echo (cloud) could be followed for almost 2 hours, and almost 1 hour before the first identifiable hydrometeor echo at S-band.

Jan 2 #14



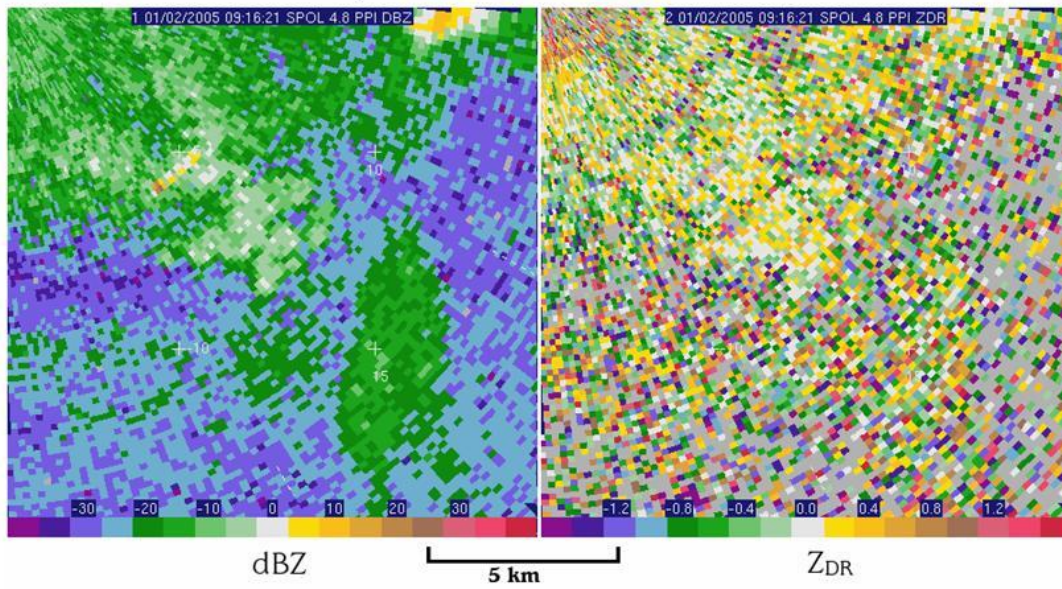
Partial time-height diagram of the same case. First precipitation echo at top of the scan starting just before 0930 GMT. From the scan just preceding this to about 0955, the scanning did not top the echo.

Jan 2 #14 8:58 0.6 km



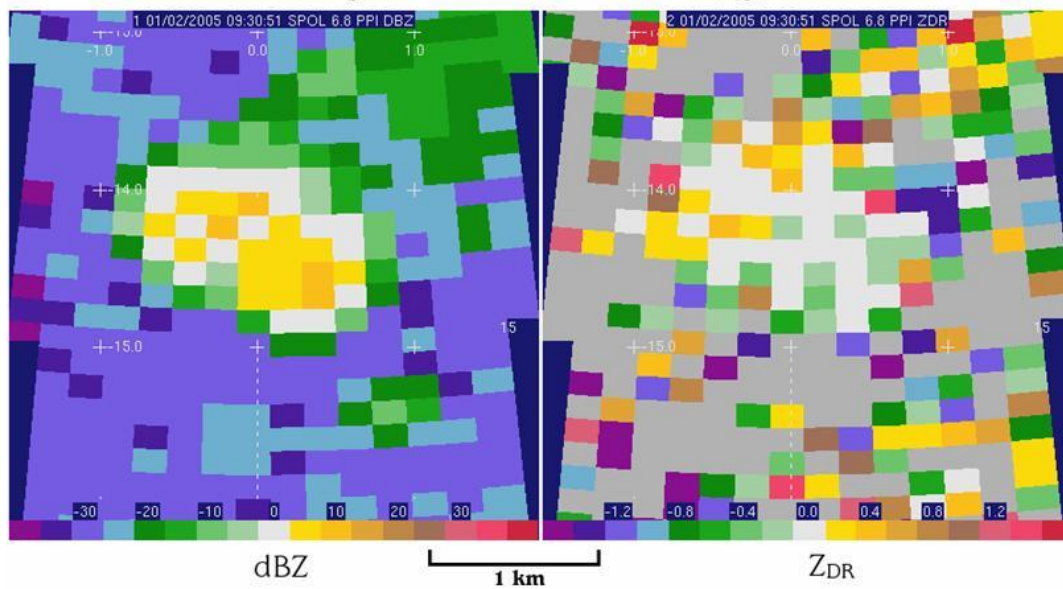
Example from early in this case. The target echo is centered in the frame.

Jan 2 #14 9:16 0.9 km



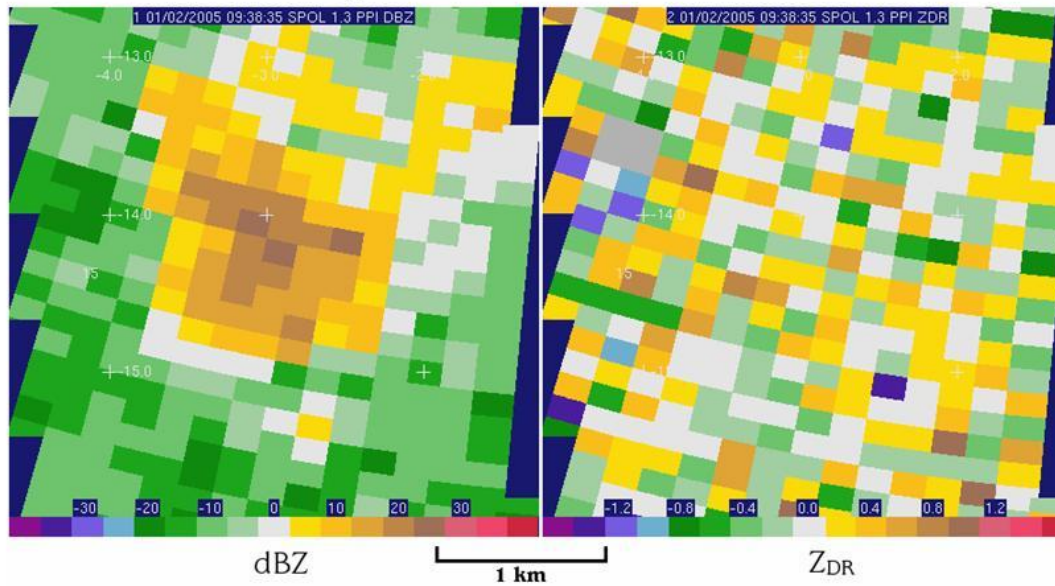
Later example, still preceding the precipitation echo.

Jan 2 #14 9:31 1.7 km (top)



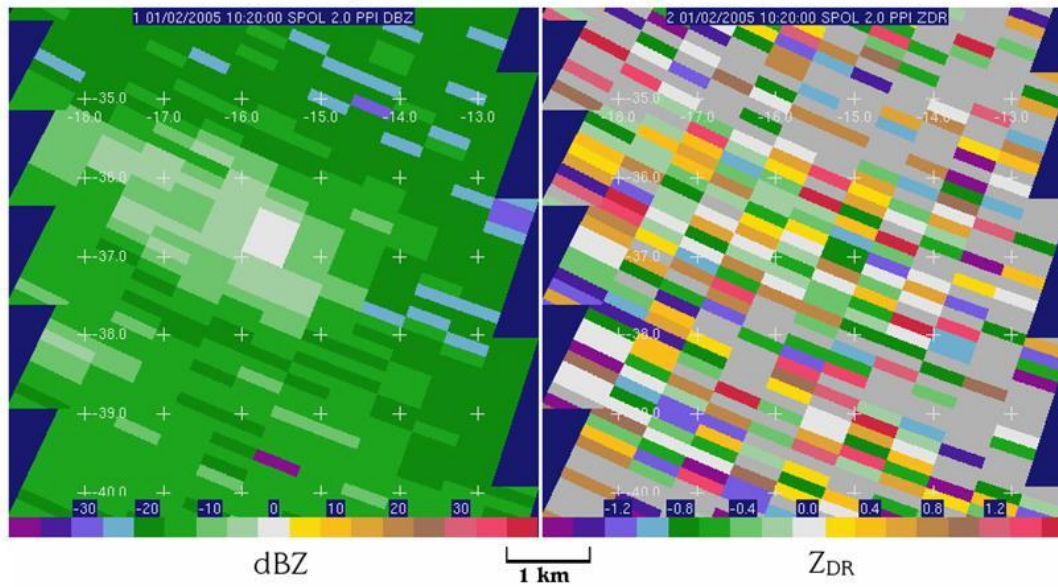
The earliest precipitation echo.

Jan 2 #14 9:38:30 0.3 km

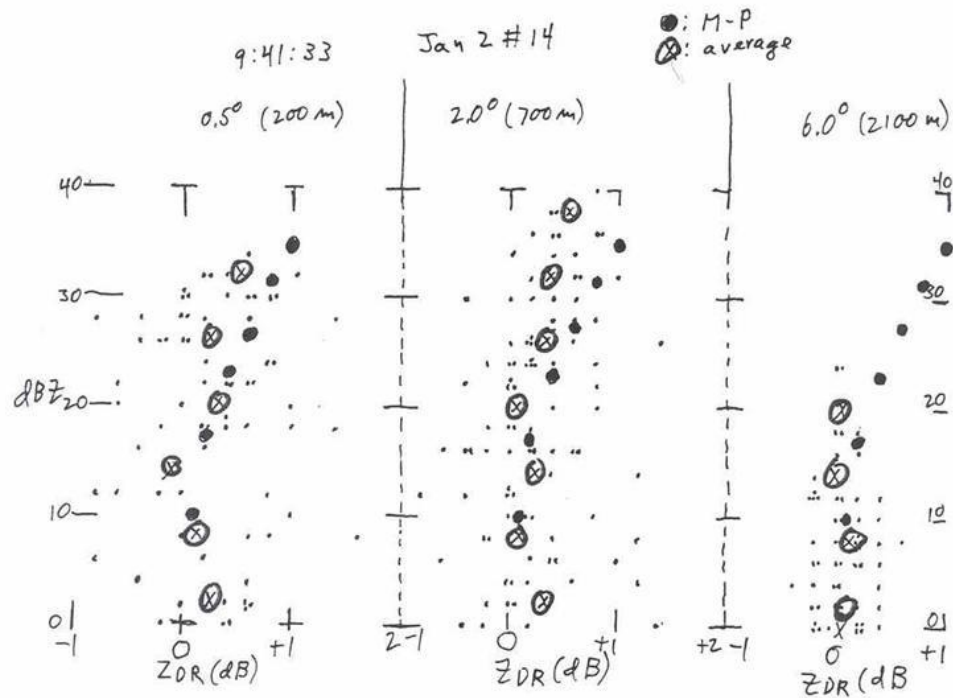


A stronger precipitation echo – note the lack of a significant-looking positive ZDR in this and the preceding image.

Jan 2 #14 10:20 1.4 km

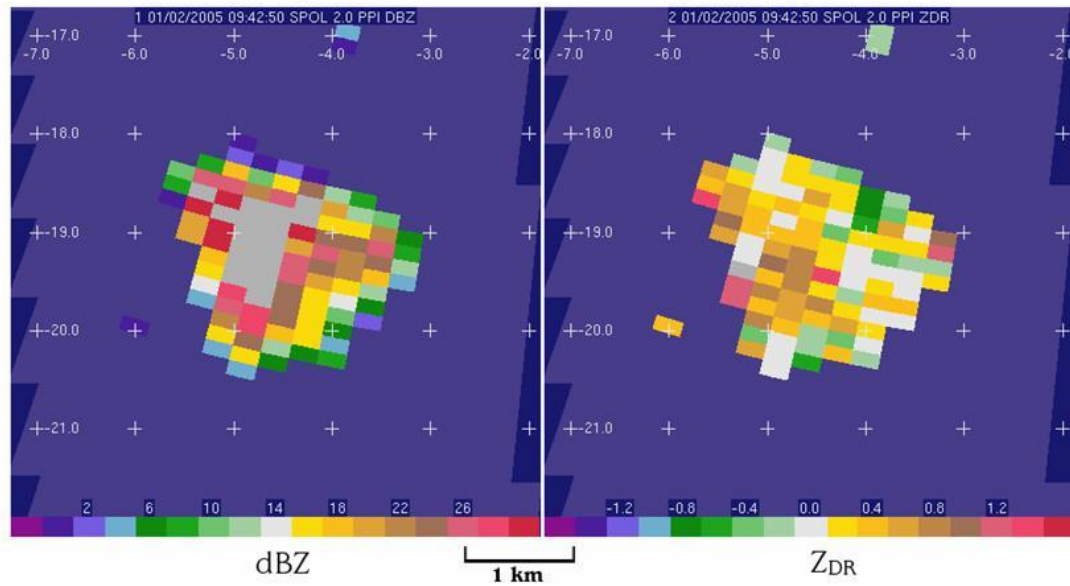


The last echo (after this the scan limits were changed and data were not obtained).



Scatter plots of Z_e vs. ZDR for three elevation angles at time of maximum reflectivity. Solid circles are from a Marshall-Palmer distribution, $N_0 = 8000$ per mm per m cubed, which shows consistently greater contributions from large drops at the highest values of Z_e . Each data point is a single pulse volume; all with greater than 0 dBz are included.

Jan 2 #14 9:43 2.0° (0.7 km)



The 2.0 degree echo and ZDR from the last figure. Note the obviously significant positive ZDR, but not strongly positive.

Conclusions (not generalizable at all at this point):

Surprisingly low ZDR in earliest S-band echo (drizzle, not big drops)

Small clouds surprisingly long-lived, if strong Bragg scattering always indicates cloud, which it probably does, but that can be checked as a general principle using the visual data. Clouds may have very long lifetimes before first S-band precipitation echo (>5dBZ).