

## V-CHILL Radar Operations in Classrooms: Courseware and Research Applications

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### 1. Introduction:

Historically, participation in radar operation meant the users had to travel to the physical radar site and control the radar. Limited real-time data access programs has been set up the past where radar data for a pre-designed set of scans were sent to a remote site using expensive and dedicated links. The mode where data is collected for a fixed set of scans can be called a “push paradigm”, where the data is collected and pushed through a data pipe to remote sites. However the research radars such as CSU-CHILL mostly operate on a “pull” paradigm, where there is “a specific request” for the data based on the prevailing weather condition. This means the observation, analysis and antenna control operate on a closed loop with the user scientists and educational end users. Because of the users in the loop, the radar operation mostly involved the user traveling to the CSU-CHILL radar site.

Since 2001 CSU-CHILL launched an initiative called VCHILL where the physical distance between the various elements of the “interactive data collection” loop was increased incorporating the advances in networking technologies. Functionally the radar has three aspects, namely, sensor steering (antenna control), sensing, and processing. Historically these functions were conducted at the same location. With VCHILL, these operations have been physically and/or logically separated. Under this paradigm the radar is essentially reduced to a “high performance” sensor, whereas the instrument steering and signal processing were moved to different locations enabled through networking technology. Since the end user of CHILL such

as a scientist or an educational user is part of this loop, this loop is completed through participants located physically 1000 miles away. This fundamental paradigm change has been implemented in various stages undergoing various stages of evolution where at each stage a new concept was introduced. In addition, VCHILL has two forms namely the low bandwidth and high bandwidth versions (Chandrasekar et al. 2005).

Initial transcontinental VCHILL demonstrations were conducted in 2002. V-CHILL software was also successfully used as the basis of the laboratory portion of an AMS Radar Meteorology short course conducted at the 31<sup>st</sup> Conference on Radar Meteorology (Seattle, Washington, 2003). The first-generation V-CHILL system used in these applications could only run on Solaris environment. The latest release of VCHILL is Java based and is platform independent. Courseware, in the form of auxiliary educational web pages that are automatically linked to select archived data cases, has also been developed. This paper provides an overview of the current capabilities of the V-CHILL system.

### 2. Functional Overview of VCHILL

The current V-CHILL system is based on platform-independent Java software that is downloaded onto the remote user’s computer from a website maintained at the CSU-CHILL facility. The associated computer hardware requirements are not unusually demanding. (1000+ MHz CPU, 384+ Mb RAM, 1280x906x16 color display). Radar data is delivered to the display system over the internet via server connections. Interactive

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program control is provided through a Graphical User Interface (GUI). This interface gives the user full control over the display's magnification, centering, color scale calibration, etc.

Some simple V-CHILL features are indicated in the image of the basic V-CHILL screen (Fig. 1). Data field selection is done using a pull-down menu under the "plot" tab at the top of the screen. A new plot window is opened for each data field. A right mouse click inside of a display window brings another menu that presents various options for changing the image magnification, centering, shareholding, etc. (Fig. 2). The V-CHILL display maintains a separate control pane along the left side of the

screen. An interface in the lower portion of this pane allows the user to adjust the data values associated with the upper and lower ends of the color bar, the range ring interval, etc. (Fig. 1)

Various CSU-CHILL radar data sources are presented in the upper portion of the left screen pane (Fig. 1). The program's start-up configuration provides a server connection icon to the data archive server maintained at the CSU radar facility. Clicking on this icon presents a chronological listing of archived data dates. Selection of a date of interest provides an expanded listing of individual sweeps that are available for display.

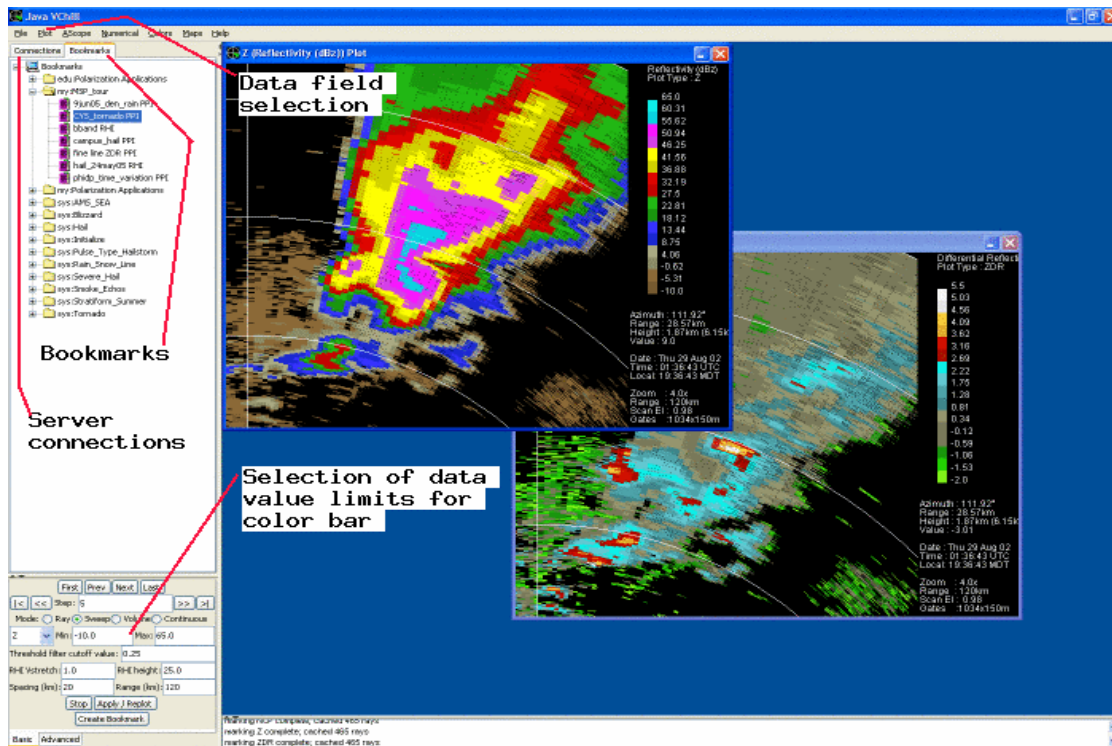


Figure 1: The basic V-CHILL screen. Items mentioned in the test are marked.

The left screen pane also contains a bookmarks tab (Fig. 1). The bookmark feature of the V-CHILL software allows the user to return to a previously defined display configuration for a designated sweep of radar data. When a bookmark is being created, the user may type related notes into an associated text file. (For example, hail observed at 2321, etc.) When the bookmarked case is being re-displayed, the contents of the notes file are displayed in a separate V-CHILL window. Bookmarks let users establish direct links to

archived data sweeps of particular interest. Thus, while preparing for class, an instructor planning to show example radar data from the CSU-CHILL archives can interactively adjust the display settings to establish an image that best illustrates the echo feature that is to be presented. Once the optimal display settings have been selected, the instructor can create an associated bookmark. During the subsequent in class presentation, clicking on this bookmark icon will bring up the archived data using the

previously defined display settings. (V-CHILL bookmarks are also useful beyond traditional classroom settings: During field experiment debriefing sessions, project scientists can use bookmarks to efficiently present key aspects of the previous day's operations, etc.)

A significant upgrade to V-CHILL has recently been made through the creation of "courseware material" for V-CHILL bookmarks. (The folder containing these bookmarks is

preceded by "edu:" on the directory listing under the "bookmarks" tab; see Fig.1). In these bookmarks, the auxiliary notes file contains a link to a web page maintained at the CSU-CHILL Facility. These web pages offer various annotated plots, image loops, etc. that provide additional information on the bookmark's topic (Fig.3). Additions to the VCHILL educational bookmark collection are being made on an ongoing basis.

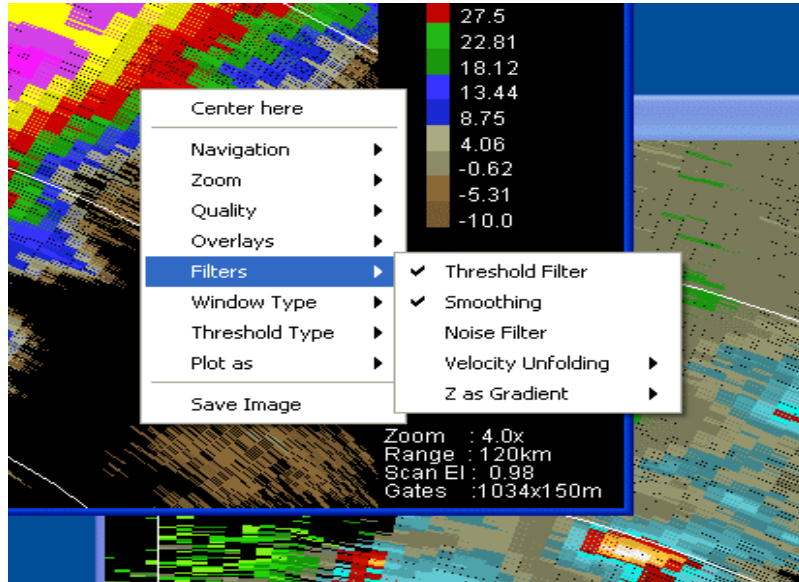


Figure 2: Interactively-controllable plotting options.

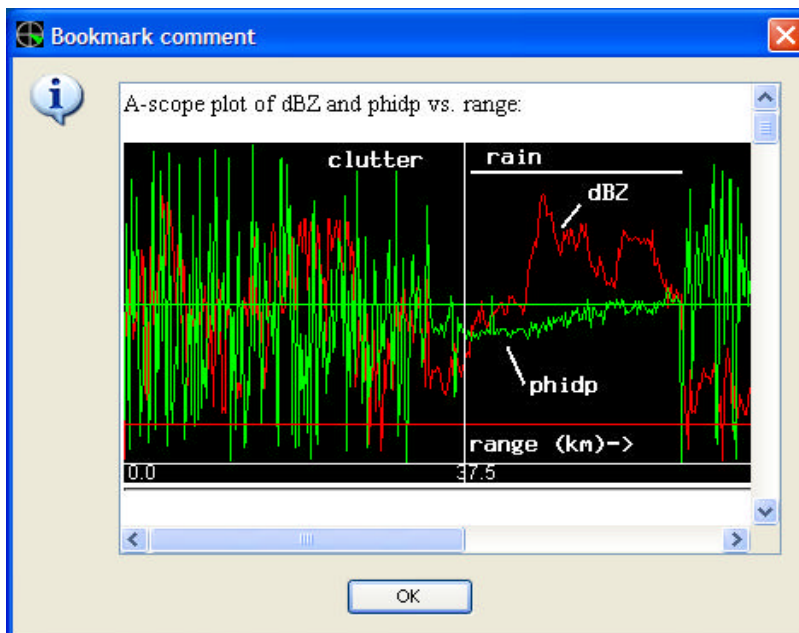


Figure 3: Portion of an educational bookmark "courseware" web page. In this example the difference in  $F_{dp}$  variability in ground clutter and precipitation echoes is being illustrated.

### 3. Real time data access

In addition to accessing archived data files, the V-CHILL system also supports connections to the CSU-CHILL radar's real time data stream and to the antenna control program. Both of these operations are restricted to password-identified users. Access to these capabilities is initiated under the file menu's connect to real time data option. Selection of the real time option opens a server identification dialogue box. (The default settings point to the standard real time server location at the CSU-CHILL radar. The provision to select other servers is provided for users who need to connect to other radars (i.e., CASA sites, etc.) Selection of a real time server opens a dialogue box that allows the user to send his real time connection request to the CSU-CHILL operator workstation Fig. 4). Check boxes allow the user to separately request access to the real time data stream and to the antenna control interface.

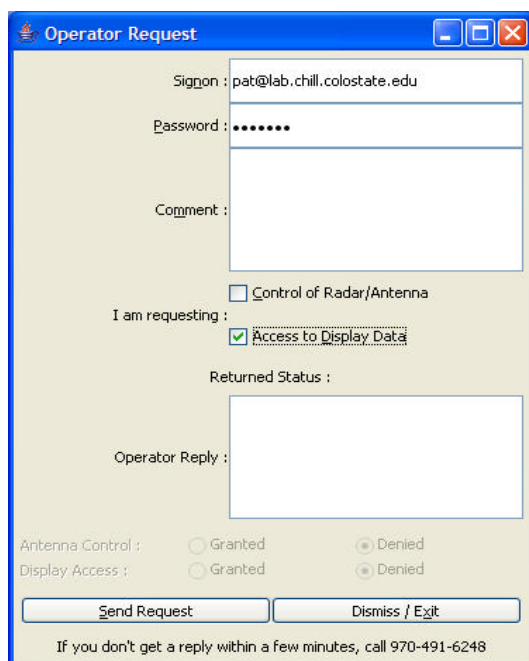


Figure 4: V-CHILL window that allows users to request access to the real time data stream and antenna control program.

Real time data stream connections are routinely approved. Once the real time data stream is available, it may be displayed using all of the V-CHILL interactive display controls

(variable zoom, etc.) outlined in Section 2. The relinquishment of real time CSU-CHILL antenna control to a remote user is done through a prior approval arrangement. Users who are remotely controlling the radar are provided with a GUI interface that gives them access to the various scan definition files that are stored in the antenna control program (Fig. 5).

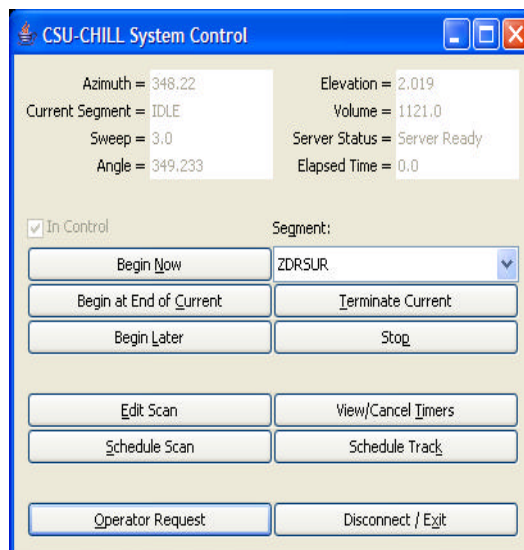


Figure 5: GUI interface to the scan segments in the CSU-CHILL antenna control program. In this example, the segment named "ZDRSUR" has been selected. The various buttons on the interface indicate additional actions that the user may initiate. (i.e., starting the scan immediately, editing the scan definition parameters, etc.)

### 4. Example of archival and real-time applications

#### a.) Archived system:

As summarized above, the V-CHILL software gives users full control over the plotting parameters applied during the replay of archived data files. The merits of this user flexibility are illustrated in the developing thunderstorm echo situation shown in Figure 6. The storm of interest was developing in the vicinity of a pre-existing fine line echo (Fig. 6a). The insects collected in the convergence zone along the fine line have highly positive differential reflectivity values. To better represent these fine line  $Z_{dr}$  values, the color

scale limits in Fig. 6b have been expanded to -3 to +9 dB. However, this broad  $Z_{dr}$  display range makes it difficult to appreciate the  $Z_{dr}$  variations within the storm's precipitation region. In Fig 6c the  $Z_{dr}$  display range has been reduced to -2 to +6 dB. The  $Z_{dr}$  patterns within the rain area are now apparent while the  $Z_{dr}$  patterns in the fine line have become saturated at the upper end of the color scale. The proper  $Z_{dr}$  color scale limits depend on which echo feature is of greater interest. The V-CHILL system allows the user to adjust the display parameters to suit their particular desires.

**b.) Real time access:**

The capability of displaying real time CSU-CHILL data at remote locations via the internet has multiple applications: On a number of occasions, faculty at distant institutions (The University of Alabama at Huntsville, The South Dakota School of Mines and Technology, Texas A and M, The University of Washington) have scheduled CSU-CHILL radar operations during their specific class meeting hours. Remote presentations of real time data, as well as various remote antenna control demonstrations, were then available in these distantly-located classrooms.

During field experiment operations, V-CHILL remote displays allow project scientists to be directly involved with real time data collection without physically traveling to the radar site. During the 2004 Global Precipitation Measurement Mission Front Range Pilot

Project (Rutledge et al., this conference proceedings), scientists located in their Ft. Collins homes were able to use remote V-CHILL displays to maintain detailed surveillance of the echoes passing through the project's ground instrumentation network.

## 5. Summary

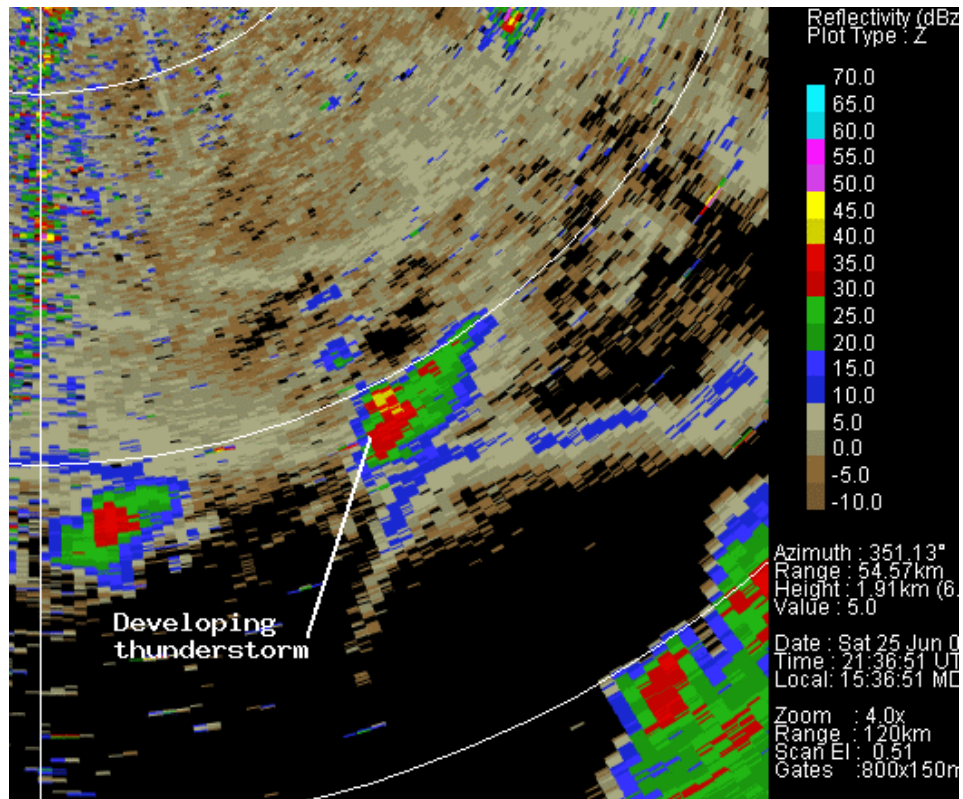
The Java version of the V-CHILL software greatly expands the system's utility. Both archived at real time CSU-CHILL data may now readily be displayed on lap top computers with rather typical performance levels and internet connections. The system has undergone extensive evolution based on feedback from the users.

The V-CHILL software may be downloaded from: <http://chill.colostate.edu/java>

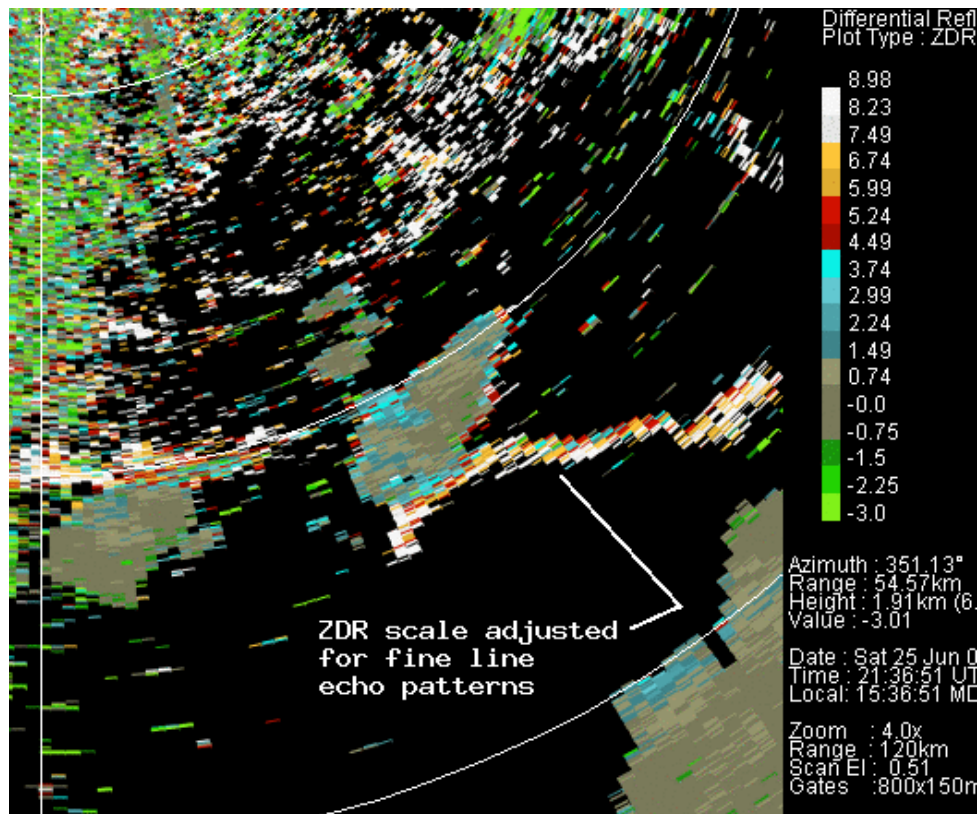
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## References:

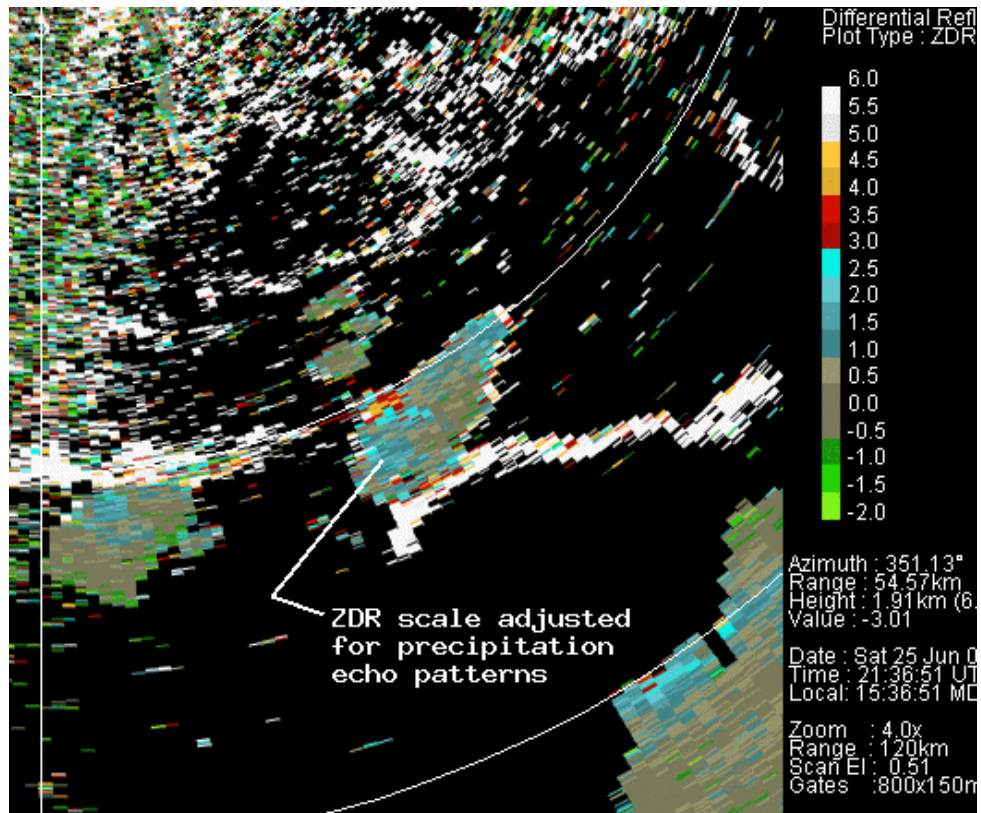
V. Chandrasekar, Yoong-Goog Cho, D. Brunkow and A. Jayasumana. 2005: **Virtual CSU-CHILL Radar: The VCHILL**. *Journal of Atmospheric and Oceanic Technology*. Vol. 22, No. 7, pp. 979–987.



(a) V-CHILL PPI reflectivity PPI display. (Note: all of the images in this figure were obtained by use of V-CHILL's capability of saving a displayed radar image as a disk file.)



(b) V-CHILL  $Z_{dr}$  image with color bar limits set to -3 to +9 dB.



(c) As in 6b except color bar limits changed to -2 to +6 dB.

Figure 6: V-CHILL display.