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1. INTRODUCTION

The National Climatic Data Center (NCDC) currently receives NEXRAD Doppler radar level II (base) data from 120 NWS, 12 FAA and 26 DOD sites on 8mm tape or online. The NCDC is partnering with the NWS Radar Operations Center, the National Severe Storms Lab, the University of Oklahoma and UNIDATA on the Collaborative Radar Acquisition Field Test (CRAFT) project (Droegemeier et al. 2002). CRAFT started as a grass roots effort to transmit level II data electronically, from 6 WSR-88D sites directly to the NCDC Robotic Hierarchical Data Storage System (HDSS). To date, 58 of the 158 WSR-88D sites are transmitting level II data in real time to NCDC (Figure 1). The success of CRAFT led to the NWS decision to implement real time electronic transmission for all WSR-88D level II data to NCDC and also to the National Center for Environmental Prediction.

NCDC has truly become a “One Stop Shop” for WSR-88D radar users. Direct digital access to level II and level III radar inventories, data, and visualization software are available, at no cost to the user, via the NCDC radar resources web page.

(<http://wf.ncdc.noaa.gov/oa/radar/radarresources.html>) Large data volume requests that, in the past, took weeks to months to disseminate are accessible in minutes to hours. Plans for future user services include a web interfaced browsing tool to visualize inventoried radar data and building radar climatologies based on specific weather phenomena.

2. HISTORY

The WSR-88D network was first conceived as a real time surveillance system with no provision to archive or transmit base data to users in real time. Level II base data includes radial velocity, spectrum width, and reflectivity (Droegemeier et al., 1999). All, 158 Doppler weather radar stations have been retrofitted with a robotic tape cartridge recording system (Crum et al., 1993). The NCDC HDSS holds approximately 900 terabytes of Level II data and grows annually at a rate of 120 terabytes a year. Prior to August 2000, all incoming level II data was archived on 8mm tape (77 thousand tapes); these data have recently been migrated to the NCDC HDSS.

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Access to level II data from sites sending 8mm tapes to NCDC are not readily available to the user community until several weeks after an event. Also, the capture rate, using 8mm tape, to record level II data at the radar site for the entire NEXRAD network is 65% at best. This is due to the fact that tape recording systems are not meant to be used continuously, as they are currently being used in the field. However, sites that are able to electronically transmit level II data to NCDC have capture rates at over 95% and data is available in near real time (Figure 1). Also, there are hardware specific cost benefits for both NCDC and the NWS. For example, the NWS over a one year period spent \$768K on level II recording system repairs. To date, the stability of electronic transmission has led to suspending of recording to 8mm tape at 58 radar sites.

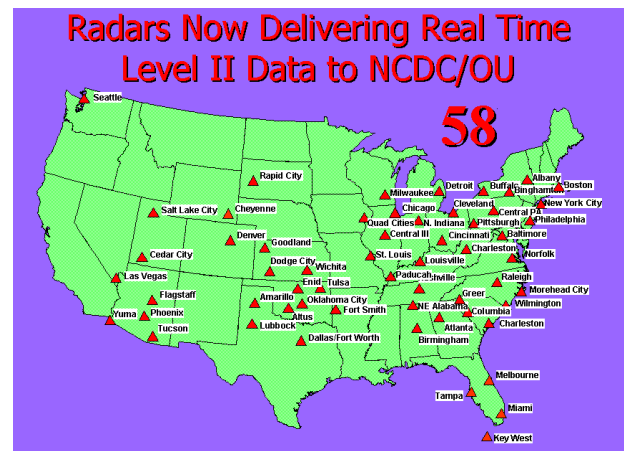


Figure 1. WSD-88D Sites electronically transmitting in near real time, courtesy University of Oklahoma

3. IMPROVEMENTS TO OPERATIONS

Until recently, the acquisition, archive and dissemination of base data required several interactive steps (Figure 2). Providing level II data for users from the 8mm tape library was both expensive and time consuming. Dissemination time for one radar site for one day from 8mm tape takes four hours. The typical level II data user requires multiple radar site data over a period of days and therefore took NCDC several days or weeks to fill an order (Del Greco et al., 2000). However, with all radar data now residing on the HDSS (Figure 3), access to and dissemination of level II and level III radar data has been substantially improved. For example,

WSR-88D Level II Tape Processing

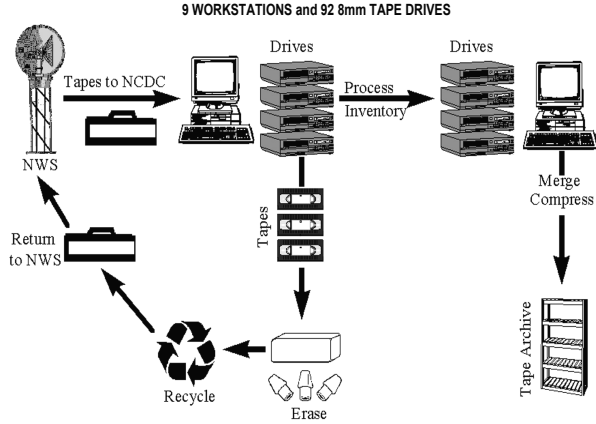


Figure 2. Recent interactive WSR-88D level II tape processing required nine workstations and 92 8mm tape drives

retrieval time for 20 gigabytes of level II data from the HDSS takes approximately 30 minutes; however, if copied from tape it requires 58 customer tapes and 9 work stations each running 26 hours for a total of 234 hours. Other benefits for using the HDSS to archive level II data include: 1) Level II base data reside on the standard NCDC archive media, 2) provides 15:1 compression ratio and tar capabilities, 3) reduces costs of tape drives and maintenance by eliminating tape sorting and merging, 4) provides more efficient and less expensive access to the data, and 5) enhance QC process by automating several interactive steps (Del Greco et al., 2000).

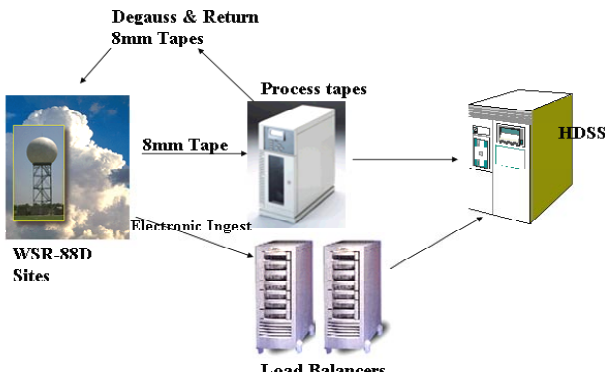


Figure 3. Current WSR-88D level II processing for electronic ingest or tape

4. WEB BASED SERVICES

The NCDC has developed a web interface to provide direct access to WSR-88D level II and level III digital data products via radar resources web page. Users are able to directly access NEXRAD data, at no cost, via FTP without contacting a NCDC customer service representative. To browse NEXRAD data inventories the user goes to <http://has.ncdc.noaa.gov>, selects the level II or level III option, and follows the instructions for dataset retrieval (Figure 4). When data processing is complete, NCDC forwards retrieval instructions to the data requester's e-mail address. Turn around time for retrieving data via FTP is dependent upon communication bandwidth. On average, retrieving one day's worth of data for one station using the internet takes approximately one hour. However, data retrieval across larger "backbone" networks such as the next generation Internet for one day's worth of radar data for one station takes minutes. To date level II data accessed from the HDSS, in terms of volume, exceeds all other NCDC data sets (Figure 5).

The screenshot shows the 'NEXRAD Level II' web interface. It includes a list of stations (KABR, KABX, KAKQ, KAMA, KAMX, KAPX, KATX, KBBX, KBGM) with their respective date ranges. There are fields for 'Start Date: (YYYY/MM/DD)' and 'End Date: (YYYY/MM/DD)'. An 'Email Address:' field is also present. The 'Output' is set to 'FTP'. Buttons for 'Continue With Selections' and 'Reset Form' are at the bottom.

Figure 4. Web interface to Level II radar data inventories

The NCDC collaborated with the National Severe Storms Laboratory to modify the Interactive Radar Analysis Software (IRAS) visualization software (Figure 6). IRAS is a platform independent software application and is available for download at the following URL: <http://wf.ncdc.noaa.gov/oa/radar/iras.html>. The IRAS development is part of the activity surrounding the CRAFT project to deliver high-resolution WSR-88D Level II radar data via the Internet in real time. The software application allows users to read and display real time and archived Level II radar data on platforms supporting Java (version 1.3 and higher).

HAS Statistics (for selected criteria above):			
DATASET	TOTAL REQUESTS	TOTAL FILES TRANSFERRED	TOTAL BYTES TRANSFERRED
NEXRAD LEVEL II	257	9,099	445,426,961,920
99%	385	457,523	286,401,849,530
ATOB	19	6,661	119,898,000,000
ISH	29	44,300	44,920,711,764
SRRS TEXT	272	940	41,861,729,427
ISCCP/BI	24	5,753	28,111,292,744
SRRS GRAPHICS	34	76	15,687,353,973
NEXRAD LEVEL III	30	476	9,833,861,839
GHRR	75	115	6,838,604,280
3280	33	1,151	1,753,289,230
6301	50	369	1,646,076,474
LHRR	7	16	779,693,600

Figure 5. Data transfer stats from the HDSS for August 01, 2002 – September 23, 2002. Total bytes transferred for level II, 445,426,961,920

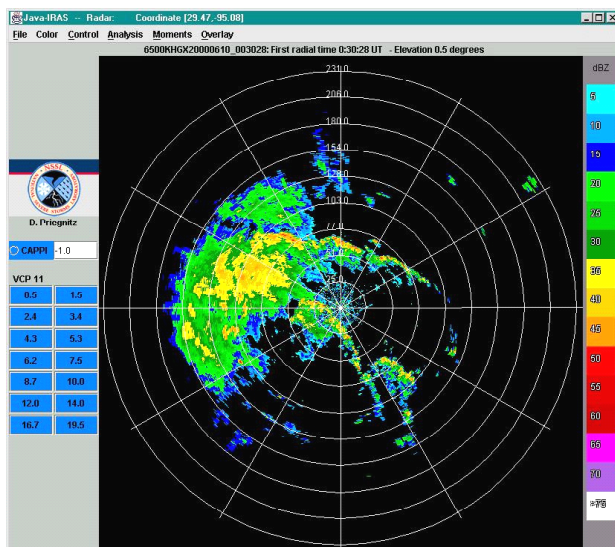


Figure 6. IRAS depicts flash flooding event June, 2000

Java-IRAS functions include:

- PPI displays of selected elevation cuts
- CAPPI displays at selected heights
- RHI displays at selected azimuths
- Auto-update of selected or all elevation cuts when new data are available
- Basic looping of PPI or CAPPI displays
- High resolution map overlays
- Standard WSR-88D color tables based on VCP

- Zoom and recenter capability for PPI and CAPPI displays

NCDC is currently integrating IRAS to be used as a web-based browser. Users will be able to peruse the inventories and visualize the three types of radar moments (reflectivity, spectrum width, velocity) prior to ordering.

5. FUTURE DATA SERVICES

NCDC is partnering with the University of Oklahoma and University of Alabama, Huntsville to develop and implement data mining tools that will be used to browse the NCDC, level II radar data archives in an effort to depict, analyze, and extract unique unknown continuous parameters in the data that may lead to the identification of specific weather events. These tools will be used by researchers at universities and government locations. Science Operational Officers within the National Weather Service can use these tools to learn from the historical data and improve their understanding of hazardous weather events. This will eventually lead to improved prediction. Also, identified weather parameters (tornado signature, hail, etc.) extracted from the level II data will be used for the development of climatology data sets.

6. REFERENCES

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- Droegemeier, K.K., Zong, J., Brewster, K., Xue, M., Crum, T.D., Edmon, H., Fulker, D., Miller, L., Rew, R., Martin, J., 1999: The explicit numerical prediction of an intense hailstorm using WSR-88D observations: The need for real time access to level II data and plans for a prototype acquisition system. *15TH International Conference on Interactive Information Processing Systems for Meteorology, Oceanography, and Hydrology*, 10-15 January 1999, Dallas, TX, American Meteorology Society, Boston, MA