Product Development Team
for
NEXRAD Enhancements

Quarterly Report – 2nd Quarter FY 01

01.6.1 Damaging Winds

Development and enhancement of the Damaging Downburst Detection and Prediction Algorithm (DDPDA) to ensure that it meets the aviation communities' needs for the prediction and detection of damaging winds associated with both wet and dry atmospheric environments, along with larger scale downbursts.

a) Current Efforts

A paper on DDPDA has been drafted and is intended to be a refereed article in the AMS journal *Weather and Forecasting.* Upon internal review, some discrepancies in how DDPDA treats storms within 15 km of the radar were discovered. This has lead to a planned reanalysis of 100 severe downburst cases to compensate for SCIT vertical association problems. Due to other non-FAA tasks, this work has been scheduled to begin in June 2001.

Also, eight new downburst days have been added to the NSSL damaging wind events database. These days include 17 severe downburst events and 380 "null" events (cells that did not produce a severe downburst). These events are from Florida, Arizona, Pennsylvania, and North Carolina, hence expanding the geographical areas represented in the DDPDA data set.

Polarization data from Florida continues to be examined.

b) Planned Efforts

Revamp DDPDA algorithm for cells within 15 km of the radar.

c) Problems/Issues

None.

d) Interface with other Organizations

None.

e) Activity Schedule Changes

None.

01.6.2 Polarization and Frequency Diversity

Continue development of algorithms that utilize polarization data to detect and predict the movement of the volumetric extent of hydrometeors such as hail, rain, snow, sleet, icing conditions, and freezing rain that are hazardous to aircraft.

<u>a) Current Efforts</u>

(NSSL): During January, a planning meeting was held to continue coordinating preparations for the Norman Spring J-POL Experiment. Work focused on preparing documentation. NSSL is proceeding with plans to use the classification of hydrometeor algorithm in real time. Hence, Data display system work is being targeted at display of parametric data from the Cimmarron polarimetric radar in the local Norman Weather Service office, and work has begin on a data interface to deliver Cimmarron data to Norman in real time via a T1 line.

New personnel from within NSSL were identified to continue toe development of real-time HCA display. Mr. John Krause has defined various interfaces within the WDSS-II display system, and has crafted a strategy to obtain needed workstations. A revamped display strategy is necessary because the Cimmarron display system is quite old, and uses non-standard interface routines. Initially, the data provided to the Norman Weather Service office will consist of a reduced suite of products, although the HCA algorithm will deliver all the categories. However, all ice forms *except* hail will be placed into one category. Hail, rain/hail mixture, rain, and other than precipitation echoes will be shown separately. This is an important step, because the Weather Service collects hail reports and hence will provide hail verification data as a matter of course. Real-time data should be available by the end of April 2001.

(NCAR): Vertical pointing radar data from field experiments in Kansas, Florida, Brazil, Italy, and Colorado are being analyzed. These data are being used to derive new relations between radar reflectivity and terminal velocity. The key emphasis, however, is on improved definition of the melting layer, and the aggregation that often takes place just above the 0C level. These data have helped guide the development of relations between particle terminal velocity and reflectivity for particles just above and just below the melting layer. Such relations are important to help understand the microphysical processes and associated polarimetric signatures of melting layer processes. This work is hampered somewhat by the lack of in situ observations regarding hydrometeor type. Steps to avoid such problems are being taken during the planning of JPOLE.

Understanding these processes is pivotal to developing algorithms to map the freezing level. Statistics have been developed for a number of events from the STEPS experiment, which occurred in Kansas during the 2000 convective season. Also, some additional work was done on the vertically pointing data collected in all five field programs for which we have data.

A paper on icing detection with a S-band radar is being drafted for the upcoming radar conference this summer. Entitled “In situ verification of remote aircraft icing detection using S-band polarimetric radar measurements,” the paper was not available for inclusion.

Finally, the verification of HCA designations for the 5 September 1998 Florida data set is again progressing.

b) Planned Efforts

NSSL: Continue work on real-time data display system for the Cimmarron polarimetric radar.

NCAR: Continue the work on a freezing level algorithm and the verification of particle designations using the Florida data sets.

NSSL/NCAR Combined: Develop and hold a J-POLE planning meeting in the late-spring or early-summer time frame.

d) Interface with other Organizations

None.

e) Activity Schedule Changes

None.

01.6.3 Circulations

Continue to enhance NSSL's Mesocyclone Detection and Tornado Detection Algorithms (MDA, TDA) while developing in parallel a new algorithm which combines MDA and TDA into one algorithm which detects and analyzes all circulations - the Vortex Detection and Diagnosis Algorithm (VDDA).

a) Current Efforts

While the TAC recommended that MDA be included in the next Open Build, the ROC did not fund the activities, due to budgetary constraints. As a result, Dr. Caren Marzban will be developing enhance neural net equations for MDA based upon a significantly enhanced data set. These efforts are slated to begin in July. Such an analysis will provide enhanced detection of particularly significant storms for the CIWS experiment.

b) Planned Efforts

Develop enhanced MDA neural net equations.

c) Problems/Issues

None.

d) Interface with other Organizations

None.

e) Activity Schedule Changes

Proposed changes to the TD are being submitted.

01.6.4 Technical Facilitation

Continue to work through the process of algorithm transition to the operational WSR-88D system. This also includes development of a Common Operations Development Environment (CODE) and Application Programmer Interfaces (API's) for a more rapid integration of algorithms into the operational system.

a) Current Efforts

Graphical User Interface: In response to user suggestions and feedback, a new graphical user interface is being developed. A snapshot of this new graphical user interface, showing a radar reflectivity product in shown. The ability to display weather data along with geographical information (obtained from shape files, a standard GIS format) is retained. The display is not radar specific.

Some of the enhancements in the new display are discussed below in the context of the infrastructure changes that support them.

Disparate data sources: A common way of selecting products — whether the products are from the ORPG, through RIDDS, an archived data set, or are experimental products — has been developed along with a new product selection interface (Fig. 2). Different data sources are different "tabs" on the display and the user can select products from any of the tabs to go into the display window. Thus, the entire system can deal with multiple data sources. The design of the infrastructure is such that all the data is available through the same API's to algorithm developers. Thus, ORPG radar data is made available through the same interface as NSSL-hires (and TDWR) radar data for algorithm developers. Work is being done to ensure that an algorithm written and tested on NSSL-hires data can be made to work on the ORPG with no source code changes.

Build system: In response to developer comments, a much-simplified build system was implemented for the CODE/WDSS-II system. The build system uses the standard utility "automake." Algorithm developers can build the entire WDSS-II source code by typing in three commands.

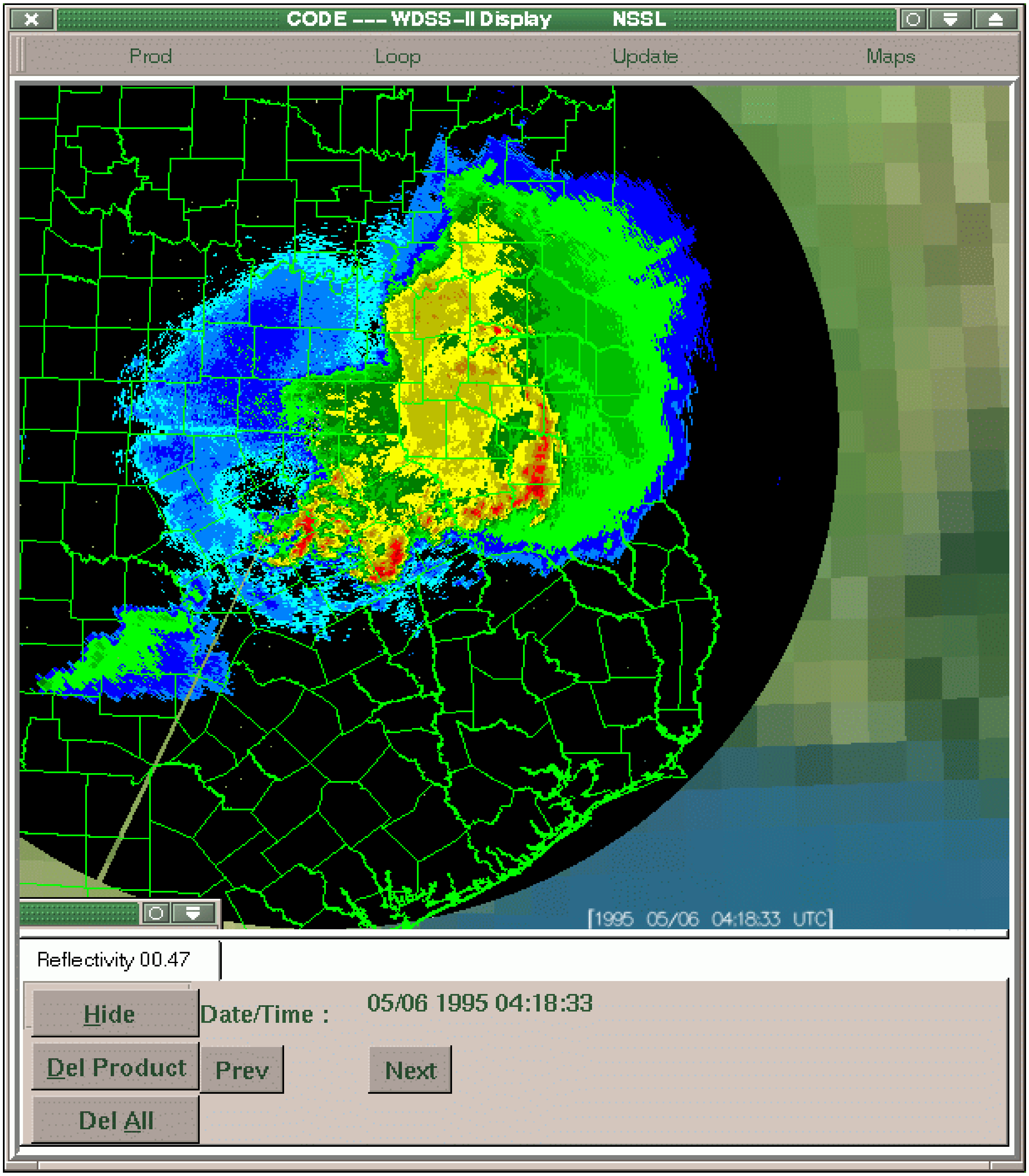

Figure 1. New WDSS-II display and graphical user interface with a radar reflectivity product.

Several internal developers have started building WDSS-II to help them in algorithm development. The system is being used in the development and testing of cross-correlation tracker output, and in the development of dual-polarization algorithms.

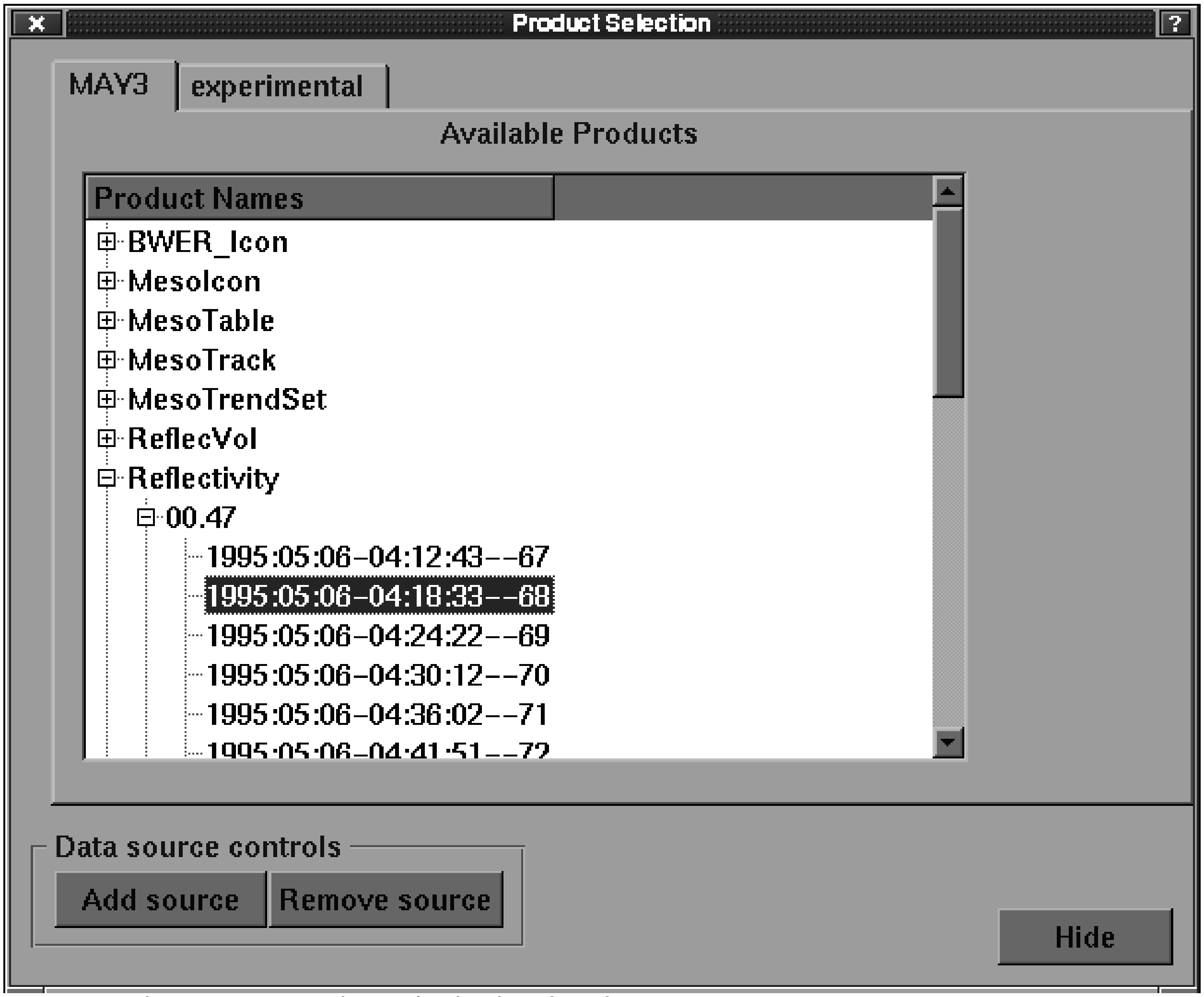

Figure 2. New product-selection interface for WDSS-II.

Table/trend infrastructure: One goal for WDSS-II has been for algorithm developers to be able to supply a single output file from which the system will draw tables, trends and icons. Currently, algorithm developers have to output three different products, leading to potential problems when new fields have to be output Fig. 3).

The infrastructure to write and read from this three-in-one output format has been completely coded. Work is in progress on a converter that will convert the legacy three products into a single one. Newer algorithms, or algorithms such as the Hail Detection Algorithm (HDA) which require additional fields, will write their output directly into the new three-in-one format.

Contour data: The infrastructure to represent and display contoured data in WDSS-II is complete. A K-Means clustering technique developed at NSSL locates regions within radar reflectivity data and arranges them in a hierachical

SCIT_Table [1995 05/06 04:24:22 UTC]

CellId	Azimuth	Range	Circ	Burst	SVRH	HailSize	POH	VIL	MXZ	HgtMXZ	Ba
23	104	14.0			0%	0.00	0%	1	37	3.3	6
8	111	27.6			0%	0.00	0%	1	37	1.7	2
22	150	45.8			0%	0.00	0%	2	38	3.9	9
21	141	39.0			0%	0.00	0%	1	38	2.2	3
2	140	50.9			0%	0.00	0%	2	38	1.5	4
86	134	59.4			0%	0.00	0%	2	39	1.8	6
16	155	27.2			0%	0.00	0%	2	40	5.4	1
15	129	83.5			0%	0.00	0%	5	40	5.7	9

Figure 3. Typical table output from WDSS-II using the new data format.

tree structure (a storm cell is contained in a larger reflectivity mass). This algorithm can also provide bounding areas of the various hierarchical levels. The display of this output at an intermediate level of the hierarchical tree is shown. The thin brown lines represent the storm boundaries detected by the algorithm (Fig. 4).

b) Planned Efforts

Continue development of algorithm development tools.

c) Problems/Issues

None.

d) Interface with other Organizations

None.

e) Activity Schedule Changes

An update to the TD to better describe Technical Facilitation activities is being submitted.

01.6.6 Rapid Update

Develop software that produces algorithm output after each tilt, thus providing immediate information to the users.

a) Current Efforts

While rapid update was considered technically complete at the departure of Ms. Yidi Liu, the code was never registered within the Concurrent Version System

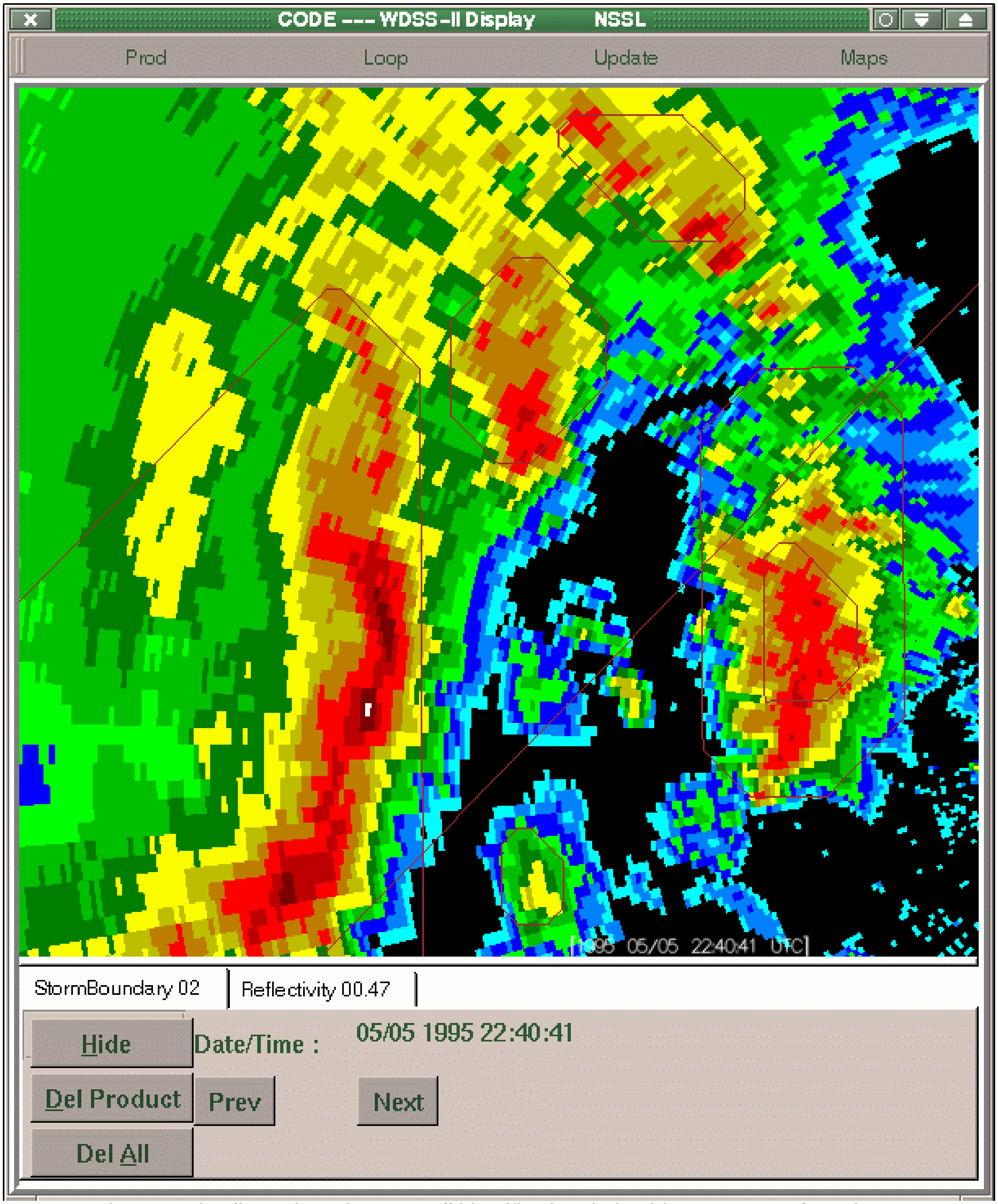

Figure 4. Fine lines show the new cell identification derived from K-mean clustering.

(CVS), which is used for WDSS-II version control. Performing this task revealed some coding inconsistencies that had to be remedied.

Hence, NSSL had to re-finalize the integration of the Rapid Update code into the WDSS-II display system. The primary work associated with this task included merging Rapid Update modifications to the algorithms (SCIT, HDA, TDA, MDA) with other changes that had been made to these routines along a different development path. A real-time test of the rapidly updating algorithm output will take place during the 2001 spring convective season in Central Oklahoma, employing multiple WSR-88D radars (KTLX, KAMA, KINX, KFWS, KSRX, KLBB).

b) Planned Efforts

1. Prepare for real-time testing.

None.

d) Interface with other Organizations

None.

e) Activity Schedule Changes

A modification to the TD is being drafted.

01.6.7 Cell and Area Tracking

Integration of the Storm Cell Identification and Tracking (SCIT), the Correlation Tracking (CT) and Scale Separation (SS) algorithms into a single multi-scale precipitation tracking and forecast package.

a) Current Efforts

Software engineering efforts focussed on providing the capability of displaying forecasts from MIT/LL's GDST on NSSL's WDSS-II system.

b) Planned Efforts

Additional efforts are underway to allow the forecasts to be looped in succession.

c) Problems/Issues

None.

d) Interface with other Organizations

None.

e) Activity Schedule Changes

None.

01.6.9 Composite Products

Develop high resolution radar layer products that are rapidly updated.

a) Current Efforts

During this quarter the three-dimensional multi-radar reflectivity integration and gridding procedure is further improved and basically finalized. The bright band identification algorithm is finalized and documented. The documentation (a PowerPoint presentation) can be find at (http://www.nssl.noaa.gov/western/qpe/bbid/index.htm).

A gap-filling scheme has been developed for the 3-d mosaic in order to fill in the data voids between the upper tilts of the WSR-88D scans in VCP21 (Fig. 5) or

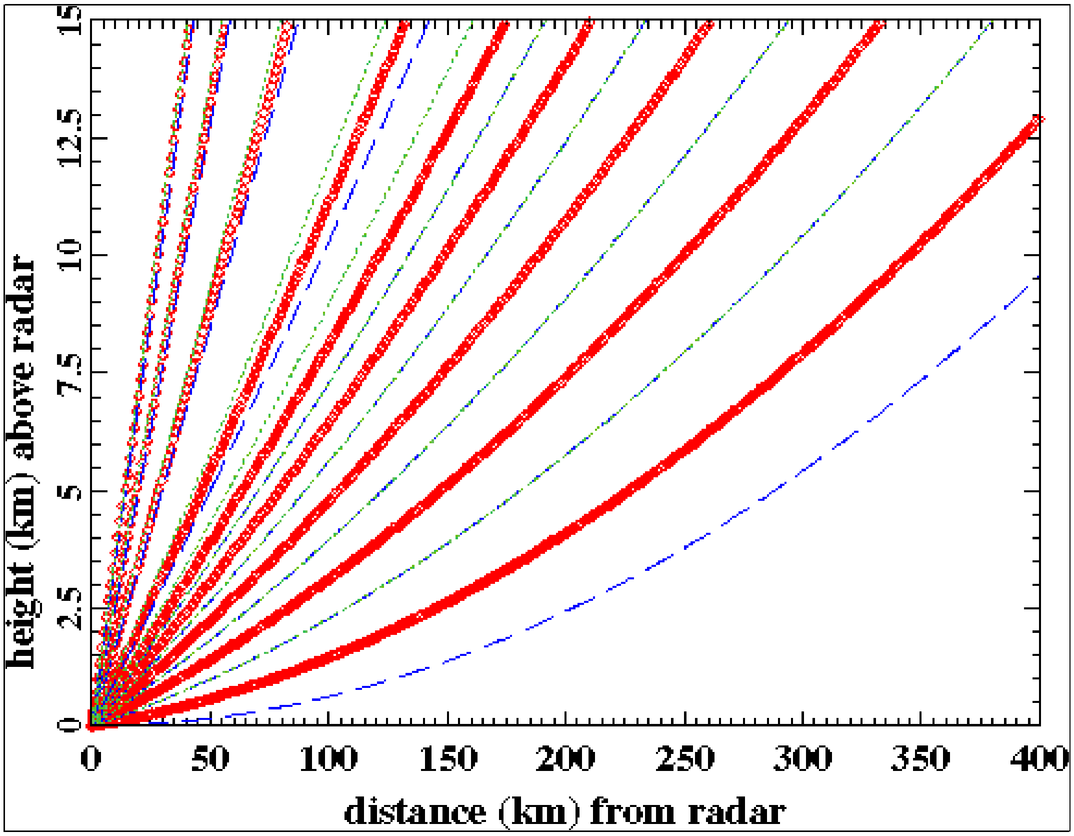

Figure 5. Radar data distributions on a x-z plane in VCP 21. The circles represent the centers of radar bins; the dashed lines indicate the bottom of radar beams, and the dotted lines the top of radar beams. Note that the circles are overlapped on the top of each other at the lower elevation angles.

VCP11. The data gaps are due to large elevation angle spacings.

To fill in the gaps, one can increase the radius of influence of a radar bin in elevation for the higher tilts. However, we found that this solution results in arc-shaped discontinuities or concentric circles in the interpolated field when there is horizontally homogeneous echo having strong vertical gradients (e.g., stratiform precipitation). Fig. 6 shows a vertical cross-section of reflectivity with a

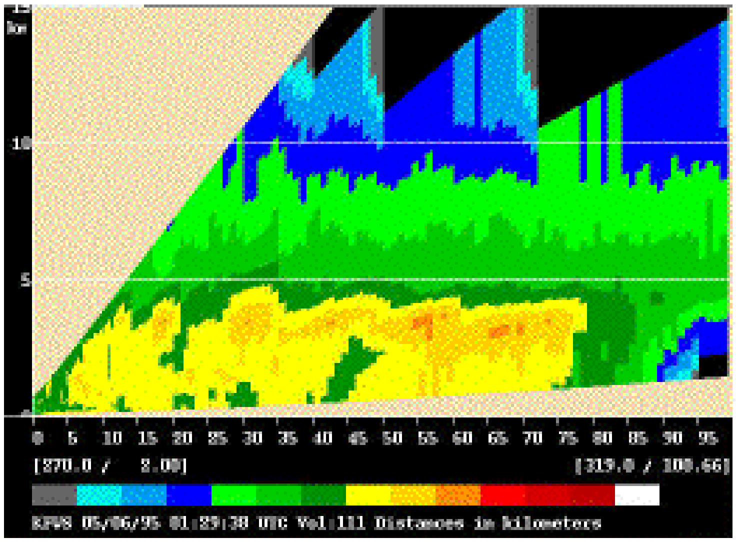

Figure 6. A vertical cross-section of the reflectivity observed by KFWS at 1:30 UTC, May 6, 1995. The cross-section was taken along a line from “A” to “B” in Fig. 7a.

melting layer between 2-4 km. Fig. 7a shows a horizontal cross-section of an interpolated reflectivity field at 3.5 km. The high reflectivity arcs seen northwest of the radar are associated with places where the melting layer intercepts the center of radar beams, while the intervening gaps correspond to locations where the bright band intercepts vertical scanning gaps. For grid points in these intervening gaps, the interpolated values are derived from reflectivity in radar bins much higher above or much lower below. This height uncertainty problem has been discussed in previous studies (Howard et al., 1997, Maddox et al., 1999, and Brown et al., 2000). To alleviate this problem, we used an alternate gap-filling scheme in which a horizontal interpolation is performed between the gaps. Fig. 7b shows the same horizontal section after the horizontal gap-filling scheme was employed. The discontinuities have been effectively removed.

b) Planned Efforts

The activities for the next quarter will be focused on the improvement of the AP and GC filters by incorporating radial velocity data, satellite IR data and surface (METAR) observations.

c) Problems/Issues

None.

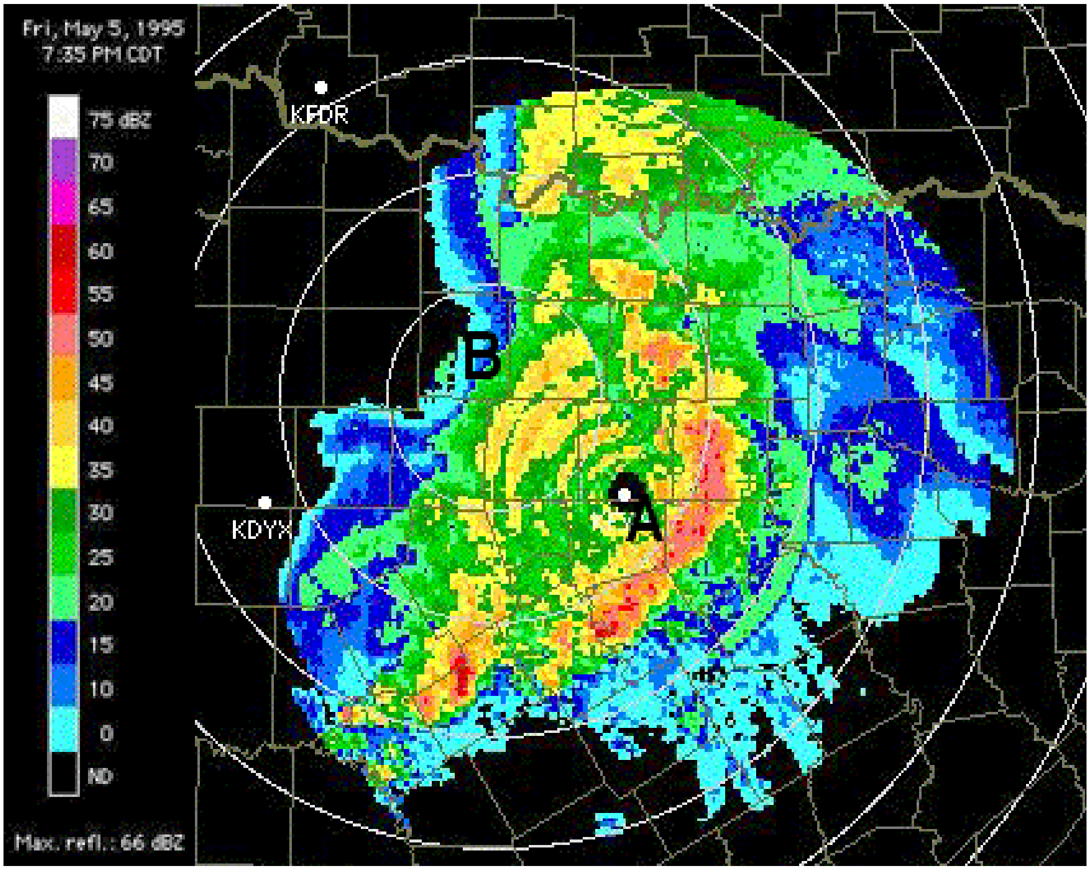

Figure 7a. Horizontal sections of interpolated reflectivity at 3.5 km MSL prior to horizontal gap filling.

d) Interface with other Organizations

None.

e) Activity Schedule Changes

None.

01.6.11 Volume Coverage Patterns

Develop and implement Volume Coverage Patterns (VCP's) relevant to the goals of the AWR PDT's.

a) Current Efforts

Experimental VCP data was collected on the following dates:

01/25/01 Light rain event, collected VCP 56.
02/09/01 Rain/winter mix event, collected VCP 56.
02/14/01 Rain event, collected VCP 56.

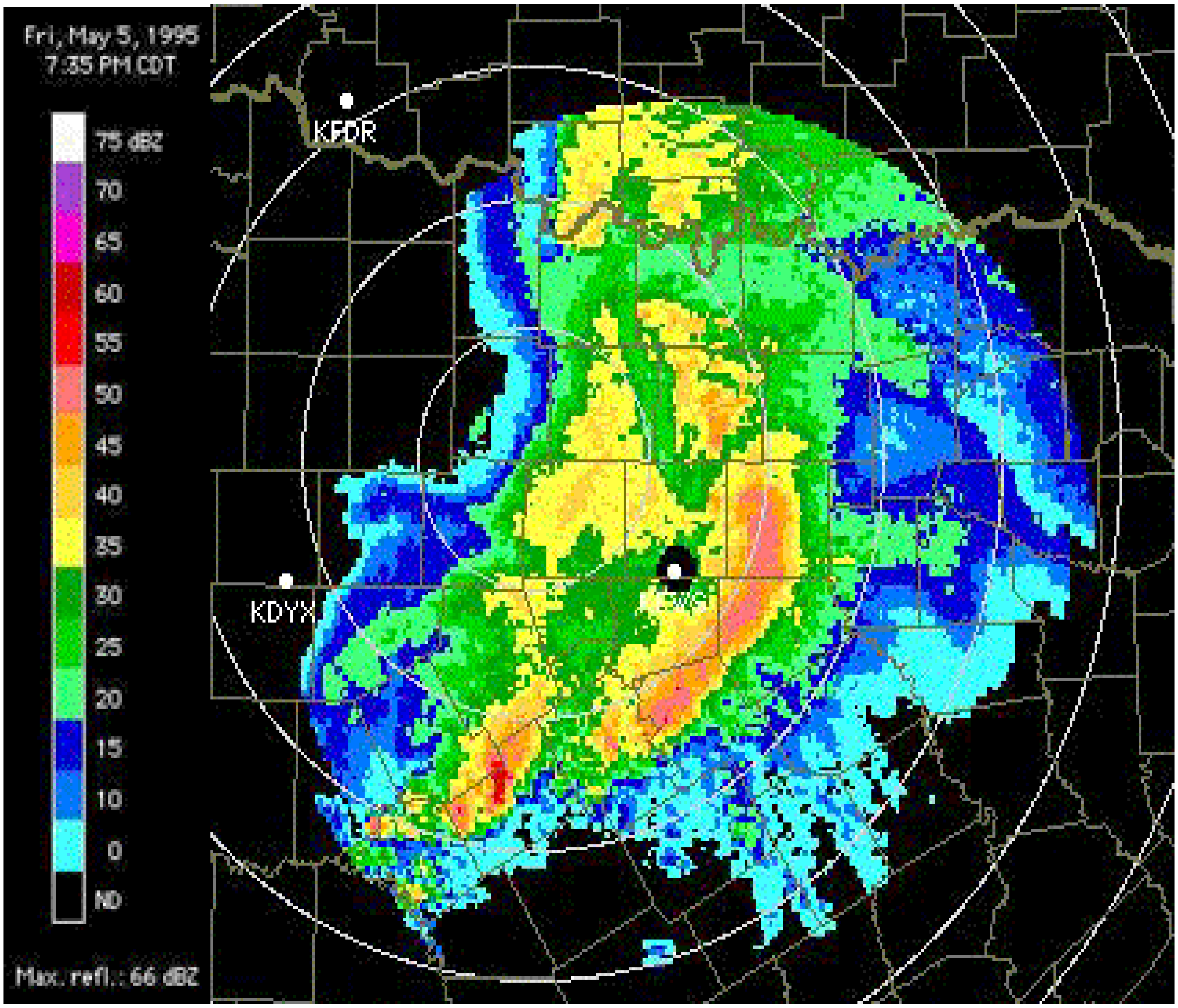

Figure 8. Same as Fig. 7a after gap filling has been applied.

02/26/01 Rain event, collected VCP's 55, 57.
02/27/01 Rain/winter mix event, collected VCP's 56,57.
02/28/01 Rain/winter mix event, collected VCP 56.

Analysis and data collection continue.

b) Planned Efforts

Continue analysis and data collection on new VCP's. In particular, check that current algorithms are compatible with new VCP's, and correct any incompatibilities.

c) Problems/Issues

None.

d) Interface with other Organizations

None.

e) Activity Schedule Changes

None

01.6.12 Product Implementation

Explore and define implementation paths within the aviation community systems that are best for NEXRAD PDT products.

a) Current Efforts

A meeting at MIT/LL to plan the CIWS activities resulted in significant re-evaluation of NEPDT products and goals. Some specific reference has been made to passing-through severe storm analysis package (SSAP) output to NCAR in an effort to assist them in nowcasts of areas of severe convection. There was particular, and significant, interest in the NSSL 3-D gridded radar products. The results of this activity is has been incorporated in the 7 year plan.

Also, NSSL will be handling RIDDS connections to various radars within the CIWS domain.

Other PDT's interest in polarimetric products have been investigated in some detail. Initially, the Icing PDT may have some interest, as might the CWPDT.considered at length for other

b) Planned Efforts

Continue evaluating the efficacy and appropriateness of NEPDT products.

c) Problems/Issues

None.

d) Interface with other Organizations

None.

e) Activity Schedule Changes

None

01.6.14 Multi-radar Composites

Develop a vision for FAA use of high resolution, rapid update, composite products which are produced from the integration of multiple WSR-88Ds.

a) Current Efforts

Activities for this quarter of multi-radar composites include initial investigations of different possibilities for multi-radar mosaic of radial velocity (V_r) or V_r-related fields. The focus is on the generating grids and mosaics of single Doppler wind fields because dual- or triple-Doppler wind analysis is less possible given the current spacings between WSR-88Ds.

The possibilities for multi-radar velocity integration include:

1) Mosaic of V_r using a 3D background wind field

This concept is to update a 3D background wind field using Doppler radial velocities from different radars. The incorporation of the high-resolution radial velocity fields can provide better descriptions of fine wind structures, e.g., a convergence zone or microburst. These informations can be used for storm diagnosis and warnings and can provide better initial conditions for numerical weather predictions than conventional wind analyses that use mainly soundings. This concept had been used in the ARPS (Advanced Regional Prediction System) data assimilation system, and a full report may be found at: http://www.caps.ou.edu/ARPS/ADAS432.doc.html.

2) Gridding and display of wind shears derived from Doppler velocity fields.

This concept is to derive azimuthal and radial wind shear fields from single Doppler radar data, and then map the fields onto a 3-D Cartesian grid. The shear fields are important factors for diagnosing particularly violent storms that are potentially hazardous to airplanes. Elmore et al. (1993: NASA/NCAR airborne and ground-based win shear studies. Final report, NASA Contract Number NCC1-155) developed an algorithm that uses a local, linear least-squares method to estimate both azimuthal and radial shear. It is shown that the estimated shear fields compare well with in-situ aircraft measurements. Display of the wind shear along with the 3D reflectivity mosaic on various horizontal and vertical cross sections can be very useful.

3) Single Doppler wind retrievals.

There have been more complex means of dealing with single Doppler velocity data, e.g., single Doppler wind retrieval (SDWR) techniques (e.g., Shapiro et al., 1995; Xu et al., 1995; Zhang and Gal-Chen, 1996) that are developed at the Center for Analysis and prediction of Storms in the University of Oklahoma. The SDWR schemes employ a time-sequence of radar-observed winds and reflectivity to diagnose the total wind field. These techniques can provide high-resolution 3-D wind fields in space and time using (single) radar data only, but they are relatively expensive in computation and are not suited for operational applications currently.

b) Planned Efforts

Further investigations on the feasibility and the potential applications of these aforementioned concepts will continue.

c) Problems/Issues

None.

d) Interface with other Organizations

None.

e) Activity Schedule Changes

None.

01.6.15 WARP Activities

Examine adaptable parameters associated with NEXRAD data algorithms in WARP and determine optimal settings according to location and season as appropriate.

a) Current Efforts

A white paper describing the various meteorological ground clutter and AP mitigation techniques is being drafted

General coordination with WARP concerning scheduled product testing. Initially, there were no plan to attend any of the testing at the FAA Tech. Center. however, due to scheduling problems with the proposed summer test, there are now plans to have an NSSL person attend some part of the Tech center testing activities.

b) Planned Efforts

Continue coordination for NSSL presence at the Operational Test and Evaluation.

c) Problems/Issues

None.

d) Interface with other Organizations

None.

e) Activity Schedule Changes

None.