WEATHER MODIFICATION OPERATIONS WITH NEXRAD LEVEL-II DATA AND PRODUCTS

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1. INTRODUCTION

Operations for weather modification field programs are highly dependent on timely and accurate radar information. The quality of that radar information can impact the success of weather modification missions. The Oklahoma Water Resources Board (OWRB) and the Texas Weather Modification Association (TWMA) have partnered with Weather Decision Technologies to develop a decision support system for use in weather modification field operations.

2. BACKGROUND

The Oklahoma Weather Modification Program (OWMP) began in 1996 as an operational water management and hail suppression program and ran through 2001. Due to financial restraints, only two 5-cm radars (C-Band) were employed to cover the OWMP's target area comprised of the entire state. After reviewing Oklahoma's weather modification activities, Kuhnert et al. (2000) recommended the utilization of 10–cm radar data (S-Band) in addition to other state-of-the science weather forecasting technologies to enhance operations in Oklahoma.

The operational cloud seeding programs of Texas since the late 1990s, have made extensive use of TITAN-equipped C-band radars to conduct project operations and for subsequent evaluation. The target areas of seven rain enhancement projects in 1999 totaled close to 36 million acres (Bomar, 1999). These project radars suffered from problems including attenuation of the beam in heavy rain and ground clutter. Also, none of the projects operated their radars around-the-clock, making it impossible to measure accurate rainfall amounts during the project season (Woodley, et al. 2001).

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3. DECISION SUPPORT SYSTEM

The TWMA, OWRB and WDT have designed a Hydromet Decision Support System (HDSS) to support weather modification field operations in Texas and Oklahoma. The system depends on the NEXRAD wideband or Level-II data, the highest resolution data produced by the national network of S-Band radars. The WDT HDSS system produces products for display in an interactive web-based display (Figure 1). The HDSS generates products such as reflectivity fields at constant temperature levels, time height trends of reflectivity within storms and quantitative precipitation estimates for various time periods. The web-based display allows multiple users to view the products simultaneously at various physical locations, making coordination more efficient.

3.1 3D Mosaic

For several years the National Severe Storms Laboratory (NSSL) has been developing a 3D Radar Mosaic capability. This sophisticated application cleans up single site volumetric data in preparation for mosaicking the data to a grid covering an arbitrary domain. The result is a very clean, very timely 3D grid of radar data.

As Level-II data began to become available for research through the CRAFT network and then for commercial use through the NWS, the 3D Mosaic capability has evolved and improved. The NEXRAD Level II data are now available for over 130 radars in the CONUS. Weather Decision Technologies, Inc. has licensed this 3D Mosaic capability from the University of Oklahoma and NSSL. WDT has since implemented a 3D Mosaic domain over Oklahoma and Texas to support weather modification operations in both Oklahoma and Texas.

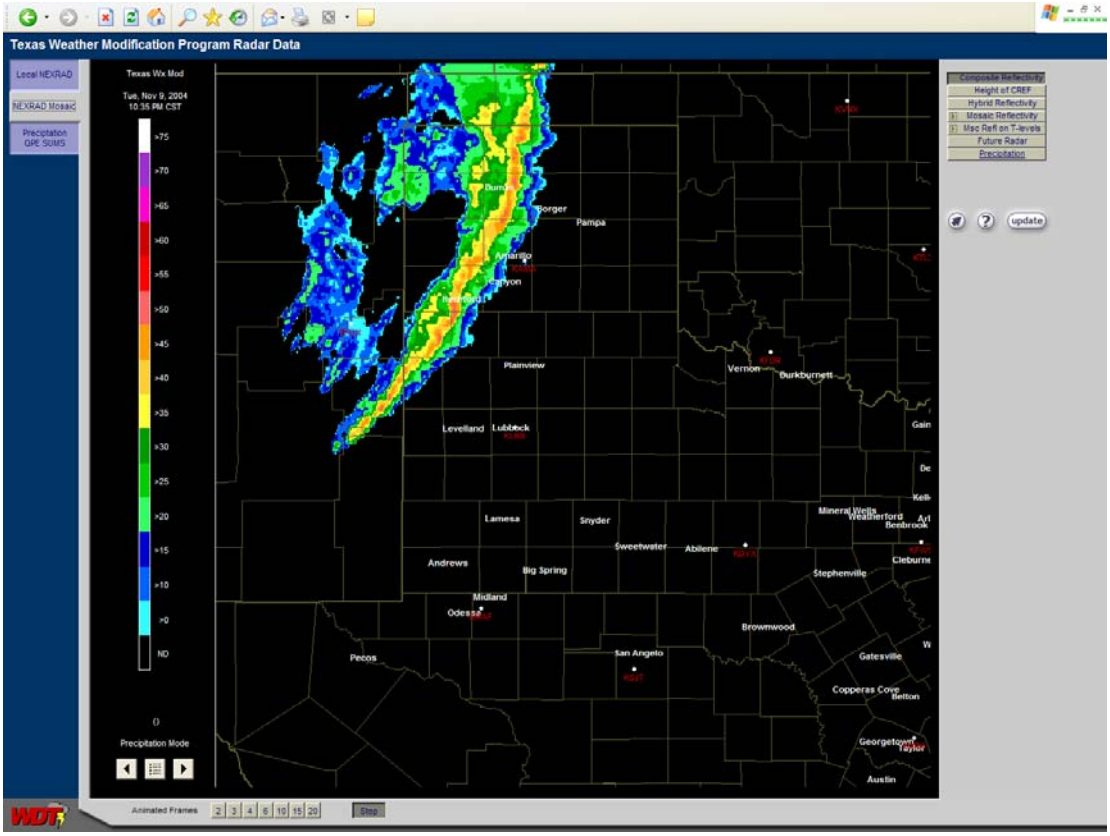

Figure 1. Web-based user interface for viewing HDSS products[MDE1]**.**

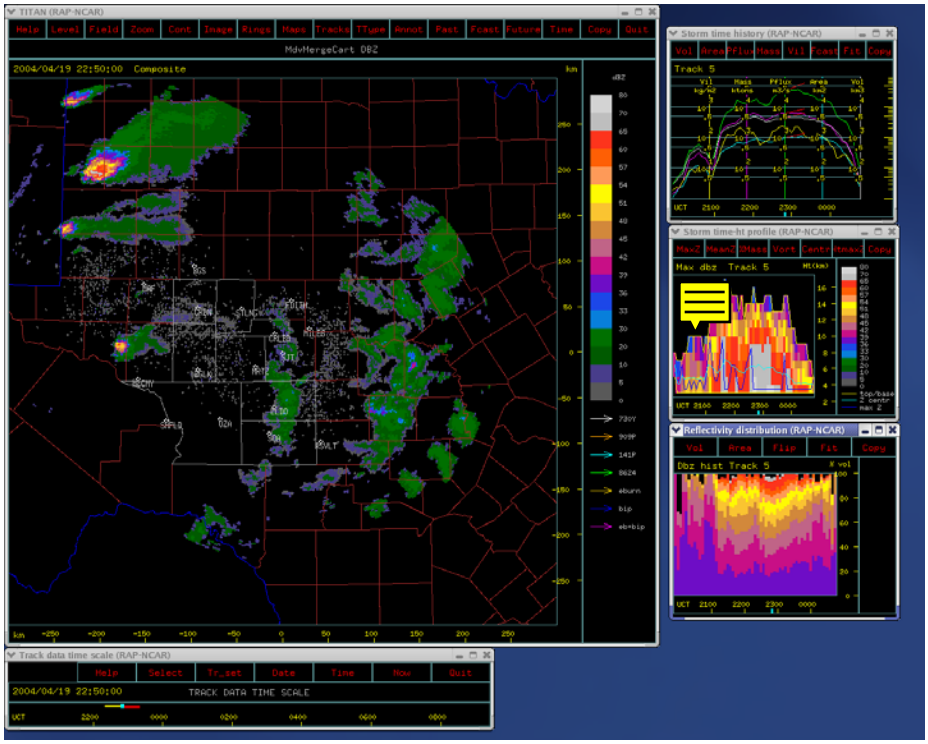

Figure 2. TITAN user interface for viewing NEXRAD Level-II data.

3.2 Severe Storms Analysis

Storm Cell Identification and Tracking, Hail Detection, Mesocyclone Detection, Tornado Detection and Damaging Downburst Detection algorithms are all run on the Level-II data. These severe weather algorithms provide users with information on the existence of severe weather related phenomenon. A useful product for the weather modification programs is a time-height trend plot of reflectivity produced by the Damaging Downburst Detection algorithm. This plot shows the depth of a storm, the vertical distribution of reflectivity in a storm, and the tendency of the storm (growth, decay, evolution).

3.3 QPE-SUMS

QPE-SUMS is a sophisticated algorithm that utilizes a suite of sub-algorithms to arrive at a set of precipitation estimates, including an integrated estimate. The resulting precipitation estimates are far better than estimates from any other operational QPE algorithm.

Once the 3-D Mosaic Grid is developed, as described above, another suite of algorithms use that output along with satellite, rain gauge, and sounding data to provide a final integrated precipitation estimate. Typically, new precipitation estimates are generated every 5 minutes and are accumulated from hours to days to months.

4. TITAN

WDT also implemented the latest version of NCAR's Thunderstorm Identification, Tracking, Analysis, and Nowcasting (TITAN) software package for ingesting and locally displaying NEXRAD Level-II data (Figure 2). TITAN allows the radar meteorologist to examine the three-dimensional structure of radar echoes in real time using the single site NEXRAD data. Individual echoes and groups of echoes can be tracked and their development and motion projected in time. Airborne Data Acquisition and Telemetry System onboard the research aircraft allows the radar meteorologist at each seeding target to track the research aircraft on TITAN and vector the aircraft to regions of enhanced convection within the (UHF) range of the telemetry system.

5. IMPLEMENTATION

Level-II radar data are transmitted from WDT to each field office in the TWMA where the data for certain radars are ingested into TITAN. The user can then interrogate the data with TITAN's user interface. Each field office has the ability to locally archive the Level-II data for use in post-analysis.

The Level-II radar data are also ingested at WDT's operations facility into the 3D Mosaic, SSAP and QPE-SUMS algorithms. The algorithm products are then available for display in the HDSS web-based user interface (see Figure 1).

6. DISCUSSION

WDT, TWMA and OWRB have partnered to develop and implement a system to support weather modification operations in OK and TX that overcomes the limitations of the local 5-cm radars previously used by the weather modification programs. This system can be reproduced around the country by other weather modification programs.

As WDT continues to improve these products and exploit the benefits of the Level-II data, these new products will help the weather modification programs have more accurate radar information to streamline their operations.

Changes planned for the operational Level-II data stream include 0.5 degree beam-width and 250 m gate spacing for reflectivity data. In addition, the National Severe Storms Laboratory in cooperation with the NEXRAD program is testing a dual-polarized NEXRAD radar in Norman, OK. Dual-polarization holds tremendous promise in helping to understand the microphysical changes caused by seeding.

7. REFERENCES

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