WESTERN REGION TECHNICAL ATTACHMENT
NO. 96-26
OCTOBER 22, 1996

OVERVIEW OF THE NATIONAL WEATHER SERVICE WESTERN REGION RADAR PROJECT

Steve Vasiloff - NSSL/NWS WR-SSD, Salt Lake City, UT

1. Introduction

The National Weather Service Western Region Headquarters (NWS WRH), National Severe Storms Laboratory (NSSL), the NWS WSR-88D Operational Support Facility (OSF), and the University of Utah have begun a joint project that focuses on weather radar applications in mountainous areas. The Salt Lake City NWS Forecast Office's (SLC) Weather Surveillance Radar (WSR-88D) on Promontory Point near the Great Salt Lake will be used to test various hypotheses. Results will be applied to other offices dealing with complex terrain issues and similar weather patterns.

The operating paradigm in this project is that WSR-88D system development and current applications were largely based on results from experiments conducted in the Midwest U.S. This project will focus on weather in the western U.S. However, results will have relevance to areas east of the Rockies that have complex terrain. Specifically of interest are prediction of low-precipitation storms that are frequently accompanied by lightning-induced forest fires and damaging "microburst" winds, other types of storms that produce larger swaths of damaging winds, and snowfall rates and accumulations.

The NSSL has developed computer hardware and software that processes WSR-88D data and runs state-of-the-art computer algorithms that assist the forecaster in examination of storms and, ultimately, the prediction of severe weather. NSSL's new Damaging Downburst Prediction and Detection Algorithm (DDPDA) is designed to predict and detect damaging winds by evaluating Doppler radar "signatures" that are related to the production of microburst. Other algorithms that are being tested are new storm-cell identification and tracking, hail, mesocyclone, and tornado detection algorithms. Except for the mesocyclone algorithm, these algorithms will be part of future radar system enhancements. Two innovative features of the system include a table display that ranks storm cell according to severity (utilizing all algorithm products) and graphics that show time histories of such key variables as the height of the maximum radar return in a storm.

On the colder side of things, winter weather is a concern in the West (as it is elsewhere). However, radar-derived rainfall rates are much more accurate than snowfall rates due to several factors including the microphysics of cold precipitation processes and the shallow vertical nature of most snow events. Enlisting the expertise at the National Center for Atmospheric Research, a goal of this project is to obtain real-time snowfall data to help calibrate radar data. This software will ingest data from a network of precipitation, wind, temperature, and relative humidity sensors that is being deployed along the Wasatch Range ("Snow-net"). The precipitation gages are specially designed to catch snow. Two of the Snow-net sites will be at venues for the 2002 Winter Olympics (Snowbasin and Park City) with another higher up in the Deer Valley ski area. Five remaining sites will be placed along the Wasatch Front from Ogden to Sandy.

There are several other elements of the project that will not be discussed in any detail here. Briefly, they include optimizing radar scan strategies for better sampling of weather phenomena and work being done with forecasters to translate experimental results into more effective forecasts and warnings.

This overview document is intended to be a fluid communication medium which will be updated periodically on the NWS Western Region Web page (http://www.wrh.noaa.gov; radar "hotlink"). Following are more-detailed descriptions of various elements of the project. Section 2.1 describes the NSSL radar algorithm and display system. A summary of preliminary findings related to microburst storms is given in Section 2.2. Section 2.3 outlines work related to acquisition of snow data and the use of those data to calibrate WSR-88D data.

2. Project Elements

2.1 NSSL Radar Algorithm and Display System

The NSSL has devised a connection to the WSR-88D Wideband 3 port which allows access to the base data called archive level II (A-II). The data are sent to a separate computer that runs several severe storm algorithms including the Storm Cell Identification and Tracking, Mesocyclone Detection, Tornado Detection, Hail Detection, and prototype Damaging Downburst Prediction and Detection algorithms. Another graphics program displays radar base data as well as output from the algorithms. All of this information is displayed on computer displays in the forecast office.

Figure 1 shows a typical display of radar data and algorithm output using NSSL's Radar Algorithm and Display System (RADS). (Data are from the Phoenix, Arizona WSR-88D.) The RADS control panel is at the top. Below is the cell table which ranks and color-codes storm cells and their attributes according to severity. In the cell table, the highest-rank cell (#1) has a 80% probability of severe hail with hailstone diameters up to 1.25 inches possible. In addition, a severe downburst is predicted, indicating that surface winds greater than 50 kts are possible.

A trend set is shown on the right that depicts the time history of several cell attributes. This particular trend set shows the evolution of several microburst precursors. Radar reflectivity and Doppler velocity images are shown in the remaining two windows. These images can have many algorithm products overlaid. Please note the red and yellow cell identification icons on the images. The circled blue "S's" on the velocity images indicates the severe prediction mentioned earlier.

This system has been in use, on an experimental basis, in the SLC forecast office since April 1996 with very positive feedback from the forecasters. As mentioned earlier, several of the new algorithms will be in future radar system enhancements. Thus, preliminary assessment of algorithm performance is being done to give forecasters in SLC and around the country insight into future capabilities.

2.2 Damaging winds

Various field projects have discovered signatures or patterns in radar data that are precursors to damaging winds at the surface, i.e. microbursts. Microbursts can produce winds on the order of 120 mph. Results of these experiments have been incorporated into NSSL's new Damaging Downburst Prediction and Detection Algorithm (DDPDA). One important predictor is convergence of air into middle-altitudes of a storm cell. Please refer to Fig. 1 and preceding text for examples and description of DDPDA output.

A critical aspect of the project is the verification of predictions and detections with accurate surface data regarding when damaging winds begin, their peak values and areal extent (this is called "ground truth"). In the example shown in Fig. 1, the predictions occurred in a non-populated area and no ground truth data were available. The University of Utah is helping provide this information as they archive data from several surface wind sensor networks (called mesonets) in north-central Utah. Other sources of wind verification include television stations and storm spotters.

Several microburst data cases have been obtained and include several in the Salt Lake City area. A description of a microburst event that occurred on 8 June 1996 can be seen in TA LITE 96-12 on the Western Region Web page. Another Technical Attachment is in the works that will give an overview of this past summer's microburst activity in the SLC area where limited ground truth data are available.

2.3 Winter Weather

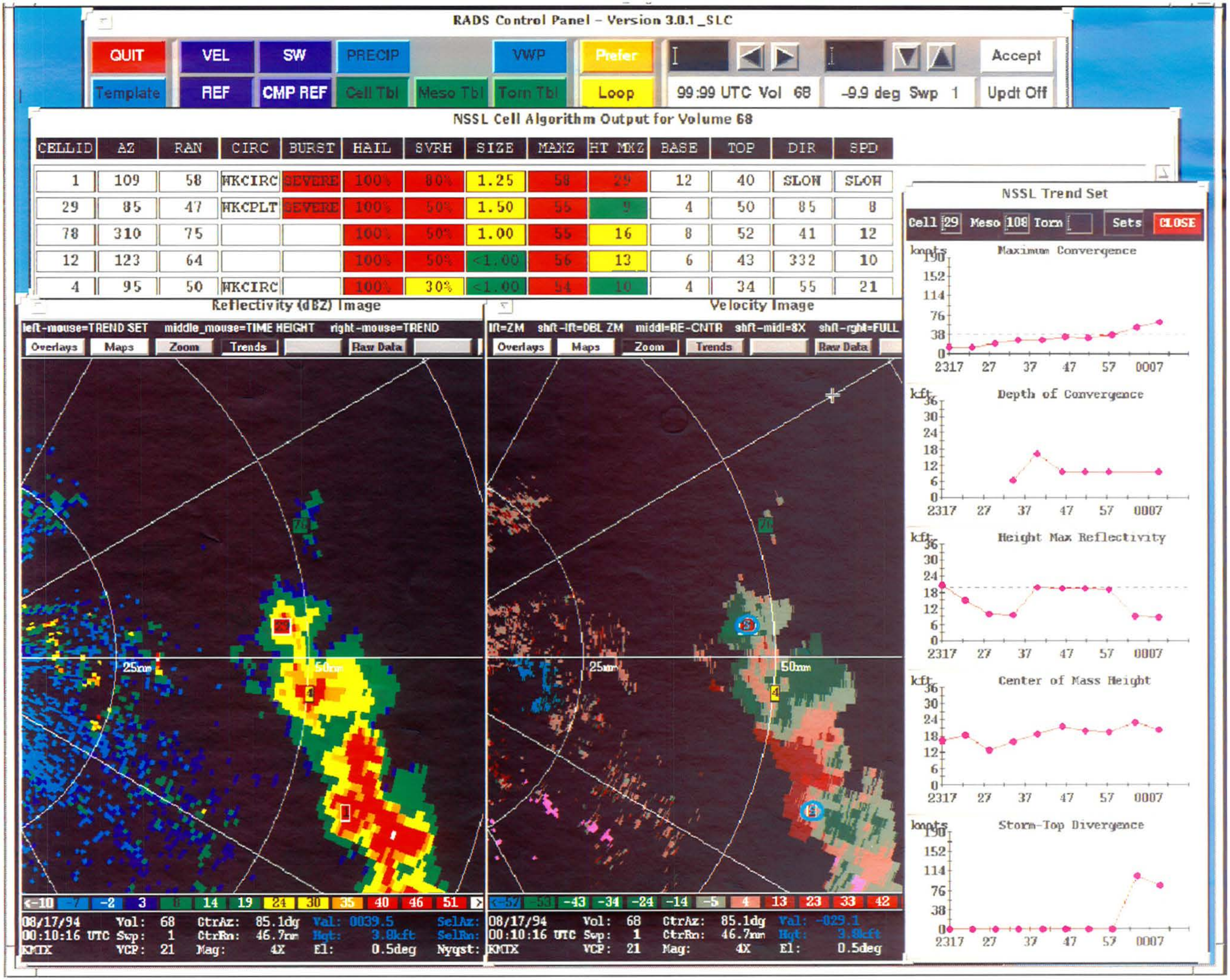
A network of precipitation gages, wind speed and direction, temperature and humidity sensors is being installed. The gages are specially designed to measure snow (the network is called "Snow-net"). Ultrasonic snow-depth sensors are being included at 4 of the Snow-net sites. Seven of the gages will be polled by phone every 5 minutes and the remaining site will use radio transmission. Figure 2 shows a map of north-central Utah with the Snow-net sites indicated by red dots. The radar's location on Promontory Point on the east side of the Great Salt Lake is indicated as well.

Software has been developed by the National Center for Atmospheric Research (NCAR) to calibration radar data to determine an accurate liquid-equivalent snowfall rate using gage data as input. The project, lead by Dr. Roy Rasmussen, is called the Weather Support for De-icing Decision Making system. This system is being installed on a separate computer network in the forecast office. Fields of liquid-equivalent snowfall rates will be displayed for use by forecasters. Applications are widespread including aircraft deicing, transportation planning, avalanche control, and a climate database for the 2002 Winter Olympic venues.

3. Project Updates and Results

Please consult the Western Region Web page periodically for project details, updates, and results (http://www.wrh.noaa.gov; radar "hotlink"). The primary method for documentation of results will be in the form of Technical Attachments and TA "LITES", which are more cursory and preliminary in nature.

Comments and discussion are always welcome (please use the mail tool at the bottom of Web page documents) as this project encompasses a vast user community in not only the Salt Lake City area but the entire Nation.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PRECIP
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Prefer
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Template
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CMP REF
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Torn Tbl
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-9.9 deg Swp 1
Updt Off
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CELLID AZ RAN CIRC BURST HAIL SVRH SIZE MAXZ HT MXZ BASE TOP DIR SPD
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29 85 47 WKCPLT SEVERE 100% 50% 1.50 55 9 4 50 85 8
78 310 75 100% 50% 1.00 55 16 8 52 41 12
12 123 64 100% 50% <1.00 56 13 6 43 332 10
4 95 50 WKCIRC 100% 30% <1.00 54 10 4 34 55 21
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kft Depth of Convergence
kft Height Max Reflectivity
kft Center of Mass Height
knots Storm-Top Divergence
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Overlays Maps Zoom Trends Raw Data
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50nm
08/17/94 Vol: 68 CtrAz: 85.1dg Val: 0039.5 SelAz:
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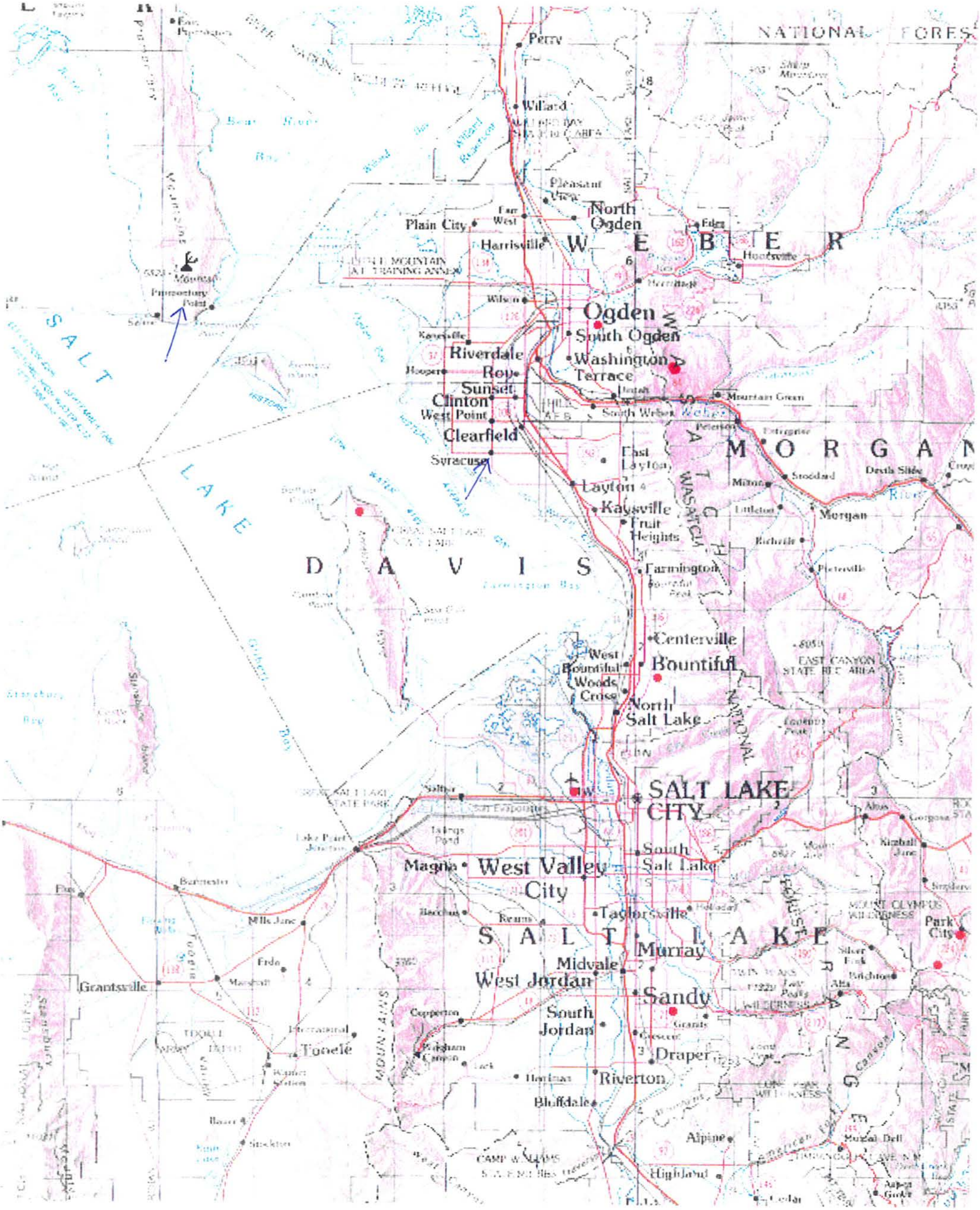
KMTX VCP: 21 Mag: 4X El: 0.5deg



NATIONAL FOREST
Perry
Willard
Pleasant View
North Ogden
Plain City
Farr West
Harrisville
W E B E R
Eden
Huntsville
Ogden
South Ogden
Washington Terrace
Riverdale
Roy
Hooper
Sunset
Clinton
West Point
Clearfield
Syracuse
Mountain Green
South Weber
M O R G A N
East Layton
Layton
Kaysville
Fruit Heights
Milton
Stoddard
Morgan
Devils Slide
D A V I S
Farmington
Centerville
West Bountiful
Bountiful
Woods Cross
North Salt Lake
EAST CANYON STATE REC AREA
SALT LAKE
LAKE
SALT LAKE CITY
Magna
West Valley City
South Salt Lake
Taylorsville
S A L T L A K E
Murray
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South Jordan
Draper
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Highland
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