# 12.14 FUTURE PLANS FOR THE FAA'S WEATHER AND RADAR PROCESSOR (WARP)

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## 1. INTRODUCTION

WARP is the primary source for weather information at the FAA's en route air traffic control centers (ARTCC) and the air traffic control system command center (ATCSCC); Deans et al. (1999). These centers play a critical role in adjusting air travel as weather conditions change throughout the nation. WARP was designed to meet the special needs of the air traffic controllers and the FAA's center meteorologists. WARP has provided weather data and a workstation to the centers' meteorologists since 1997, when it replaced the meteorologist weather processor (MWP). Initially, WARP provided weather data to the controllers via separate briefing terminals scattered throughout the centers. Beginning in 2001, WARP began to directly interface with numerous other automated air traffic systems. For example, WARP provides high-resolution upper level wind forecasts from the rapid update cycle (RUC) model to a special aircraft trajectory model that is part of the FAA's Free Flight program; Celio et al. (2000). In addition, WARP now sends special state-of-the-art NEXRAD mosaics directly to the controllers display system replacement (DSR) consoles enabling them to overlay aircraft positions with the NEXRAD data; Deans et al. (2000). In the coming years many other FAA system will rely on WARP to provide their weather data.

## 2. WSR-88D DATA FOR DSR

One of the primary missions of WARP is to provide WSR-88D weather radar mosaic data for the DSR. In preliminary tests conducted at the Seattle ARTCC in 1999, controllers identified a number of problems that made them reluctant to allow full operational deployment of this capability. The most severe problem was the occasional appearance of a maintenance "bulls-eye" pattern that blocked out returns from other WSR-88D radars (see Fig 1.).

As a result of the 1999 tests, the FAA postponed inclusion of WSR-88D data on the DSR. At the same time they contracted with Harris Corporation (primary contractor for WARP) and Unisys (subcontractor to Harris) to develop algorithms for removing maintenance bulls-eyes before they reach the DSR. In July 2001 Unisys and Harris successfully demonstrated their new algorithms to the FAA; Lang and Kitterman (2001). As a result, renewed testing of WSR-88D data on the DSR was scheduled to once again begin in the fall of 2001.

The algorithms developed by Harris and Unisys include (1) interference detection and editing, (2) anomalous propagation (AP) removal, (3) ground clutter removal, (4) lint removal and (5) optimal mosaic. The center meteorologists can invoke these algorithms as needed.

### *2.1 Interference Detection and Editing*

This algorithm looks for interference patterns typically not associated with real weather echoes (e.g. maintenance bulls-eyes, radial spikes, etc.).

Fig 2 shows the effectiveness of the interference-editing algorithm. This example is a

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base reflectivity product in which only reflectivity's equal to or greater than 30 dBZ appear (The DSR will not display reflectivity's below 30 dBZ). Notice that most of the bulls-eye is removed. In similar cases where the bulls-eye is particularly intense, the interference algorithm will simply remove all the data from that radar without trying to filter it.

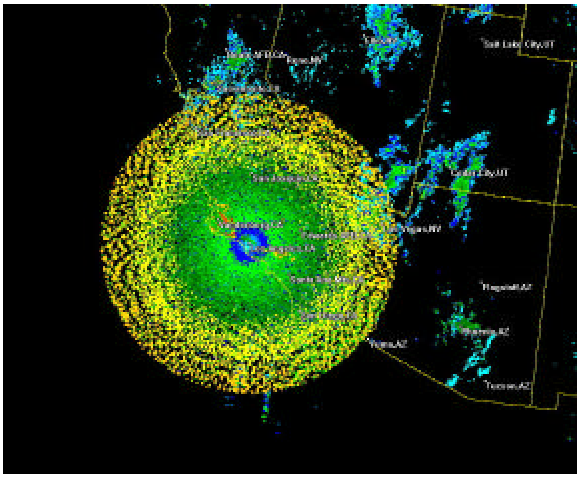


Fig 1. Maintenance bulls-eye.

### 2.2 AP Removal

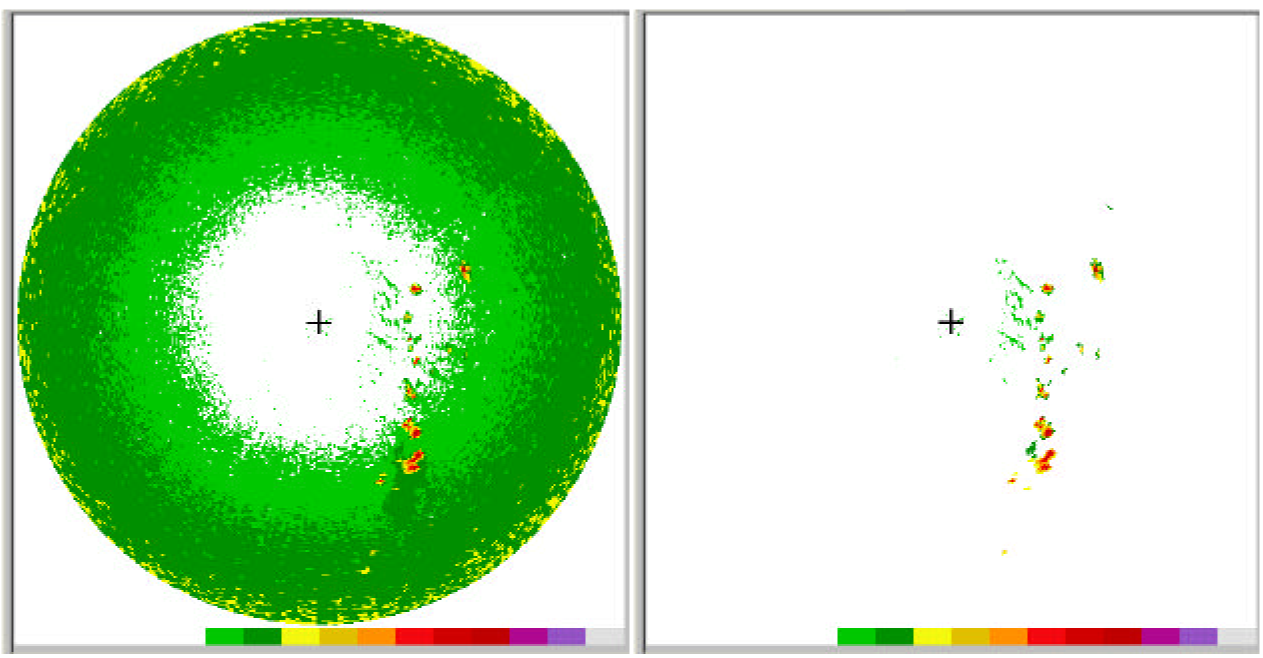
This algorithm uses the WSR-88D AP removal algorithm as a basis for removing AP in other WSR-88D products. Specifically, it assumes the WSR-88D AP-removed base reflectivity product is truth. It then uses that information to remove AP from the composite and layer-composite products.

### 2.3 Ground Clutter Removal

This algorithm builds clutter masks for each WSR-88D site. It creates the clutter masks by gathering a set of static returns in clear weather. These masks automatically adjust for the seasons as the algorithm uses only the most recent data to create the active clutter mask.

### 2.4 Lint Removal

Lint is individual-pixel returns that show up in areas where there is no precipitation. The lint removal algorithm looks for support in both the horizontal and vertical for a given one-or-two pixel reflectivity pattern. If there is no support, that piece of "lint" is removed from the mosaic.



Before Interference Editing After Interference Editing

Fig 2. Maintenance bulls-eye with embedded weather shown before and after interference editing. Notice that the interference editor successfully retains most of the real-weather echoes.

### *2.5 Optimal Mosaic*

This algorithm modifies the mosaic algorithm such that if the reflectivity from one radar disagrees significantly with the reflectivity from other radars (who have an equally good view of that point), the consensus reflectivity will be use. The previous algorithm simply used the radar with the highest reflectivity, regardless if it disagreed with the other radars. The optimal mosaic algorithm is another means of getting rid of the four problems described earlier.

## 3. RUC DATA FOR FREE-FLIGHT

The FAA's Free-Flight program is an effort to make more efficient use of the nation's air space. Under this approach pilots will be able to request deviations from traditional airways. Controllers will use the User Request Evaluation Tool (URET) to evaluate these requests for potential conflicts. URET uses aircraft velocities along with wind and temperature data to project aircraft positions 20 to 40 minutes into the future.

To make sure URET gets the most accurate winds and temperatures possible, the FAA has arranged with National Weather Service to have the rapid update cycle (RUC) model run every hour. WARP receives these RUC forecasts via a dedicated link to the National Centers for Environmental Prediction (NCEP) and subsets these data for use by URET at each individual ARTCC. The resolution of the RUC forecasts used by URET is 40-km horizontal, 25-mb vertical, and 1-hour temporal.

## 4. INTERFACES TO OTHER AIR TRAFFIC SYSTEMS

The interfaces to URET and DSR are just the beginning of a series of interfaces planned for WARP over the next several years. By early 2002 each WARP system at each ARTCC will have a weather information network server (WINS). WINS will provide other local FAA systems with direct access to the wide variety of weather data resident on WARP.

The next systems expected to interface to WARP are the Dynamic Ocean Tracking System (DOTS) and the Enhanced Traffic Management System (ETMS). DOTS will use upper level wind and temperature forecasts to project aircraft trajectories over the oceans. ETMS will use various WARP weather data, such as radar and satellite, to assist ARTCC traffic management units and ATCSCC in making strategic decisions. These decisions include actions like imposing ground delays or more restrictive en-route aircraft separations.

## 5. FOR MORE INFORMATION

For more information on WARP, see:

http://www.faa.gov/aua/ipt_prod/weather/warp/

For more information on other FAA weather systems see:

http://www.faa.gov/aua/auahome.htm

## 6. REFERENCES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