P10R.2 NEXRAD Mosaics for En Route Air Traffic Controllers

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1. INTRODUCTION

In December of 2002 the FAA began providing NEXRAD mosaics on the controller displays in each air route traffic control center (ARTCC). This has changed the way many controllers' manage their airspace. While the pilot is still ultimately responsible for avoiding hazardous weather, the controllers can now anticipate where they may have to route aircraft to avoid severe weather. Upon request, the controller may use their NEXRAD mosaic to help the pilot select the safest route.

Prior to 2002 the ARTCC controllers used weather data extracted from the FAA's long range radars (ARSR). This display showed only two levels of intensity, moderate precipitation represented by a "/" (30-40 dBZ) and heavy precipitation represented by an "H" (>40 dBZ) (see Fig 1).

The NEXRAD mosaics on the controllers display depict three intensity levels (see Table 1) in varying shades of blue. This is because the controllers' weather requirements differ from those of a meteorologist. A controller's primary attention must always be focused on keeping aircraft safely apart. Weather data, while extremely useful, must remain in the background on the controllers' display and not distract them from the aircraft data. While a meteorologist has the luxury of comparing a host of radar products with other data such as satellite images, model data, observations etc., the controller must rely almost exclusively on the NEXRAD. For these reasons, the controllers' NEXRAD must provide a simple, unambiguous depiction of potential aviation hazards. It should require a minimum of interpretation.

Table 1
NEXRAD Color Scheme for Controllers Display

Reflectivity	Color
< 30 dBZ	Blank
30-40 dBZ	Royal Blue
40-50 dBZ	Checkered Cyan
>50 dBZ	Cyan

2. BUILDING THE MOSAIC

Fig 2 shows a typical controller display prior to the introduction of NEXRAD. The NEXRAD mosaic (Fig 3) is generated by the FAA's weather and radar processor (WARP) built by Harris Corp and Unisys. WARP provides four different composite reflectivity (CR) mosaics (see Table 2). The controller can display whichever product fits his/her airspace. In addition to the controller mosaics, each ARTCC WARP produces a full 16-color CR and base reflectivity (BR) mosaic along with an echo tops mosaic. These mosaics are displayed on the center weather service unit (CWSU) meteorologist workstations and on briefing terminals distributed throughout the ARTCC.

Table 2
NEXRAD Layers Available on Controller Displays

Mosaic Name	Layer (ft)
Composite Reflectivity	0-60,000
CR Low	0-24,000
CR High	24,000-33,000
CR Super High	33,000-60,000

Fig 3 shows how the individual NEXRADS are connected to each ARTCC WARP. In addition to receiving data directly from the NEXRAD within their area, each WARP also receives data from surrounding NEXRADS. Each WARP receives enough NEXRAD data to cover a 150 nm buffer

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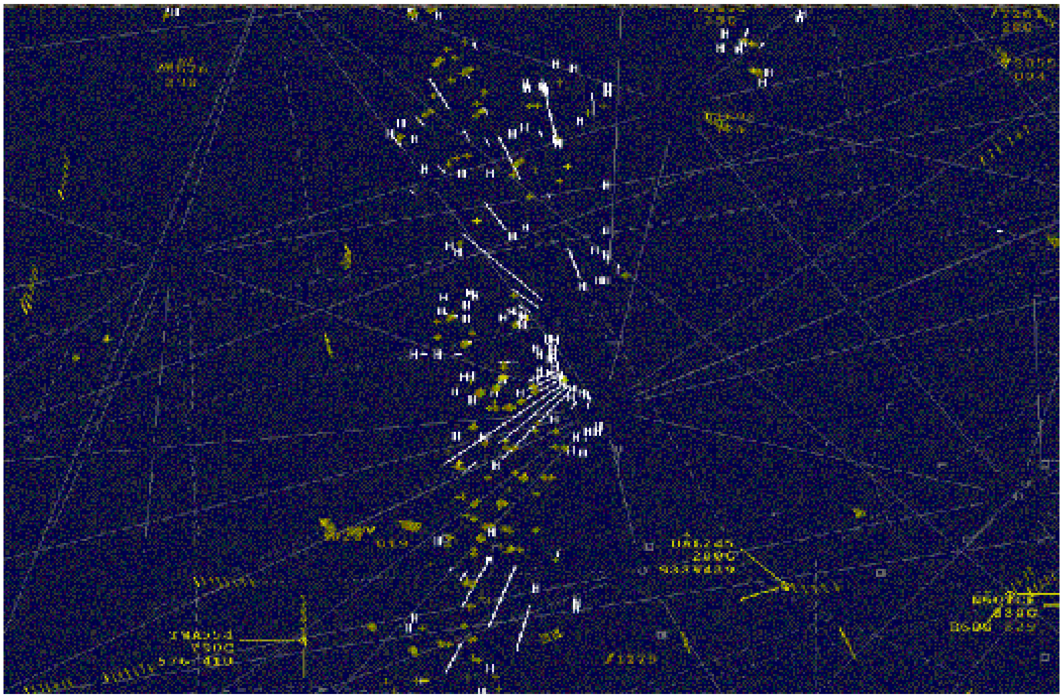

Fig 1 Air traffic controllers display showing old long-range radar depiction of “/’”’s for moderate precipitation and “H’s” for heavy precipitation.

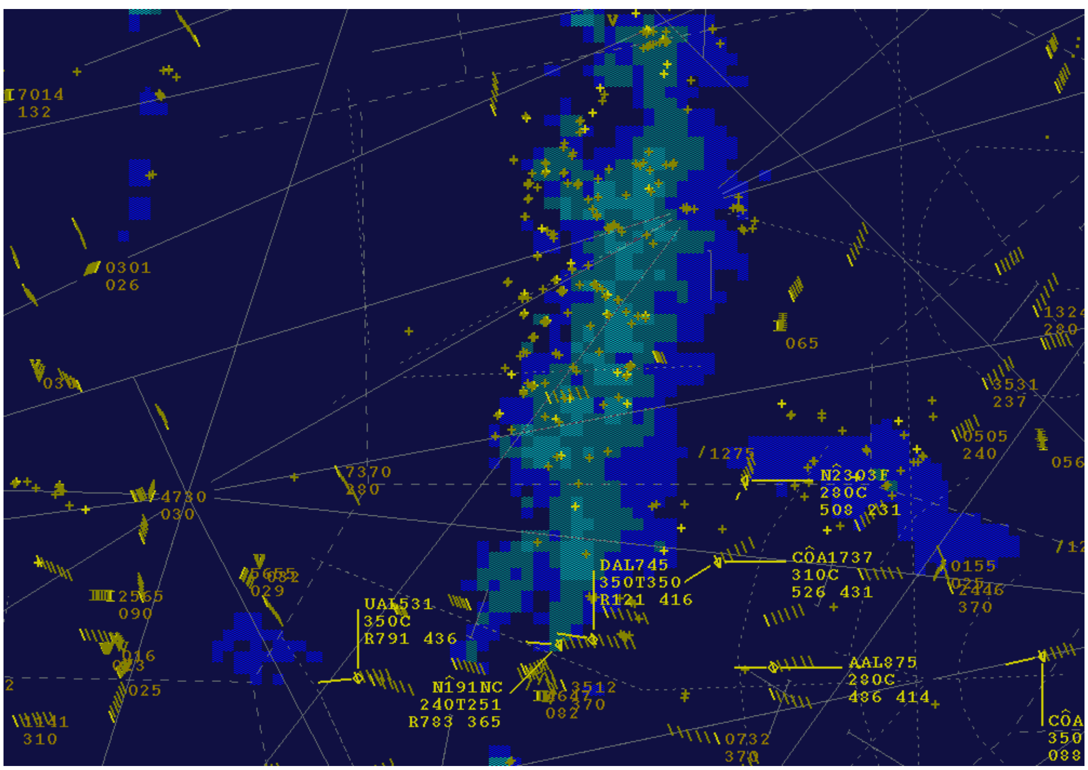

Fig 2 Typical air traffic controllers display with NEXRAD mosaic. The small plus signs around the storms are anomalous propagation returns from the long-range radar. The gold slashes are past and present aircraft positions. The text data are information about a specific aircraft.

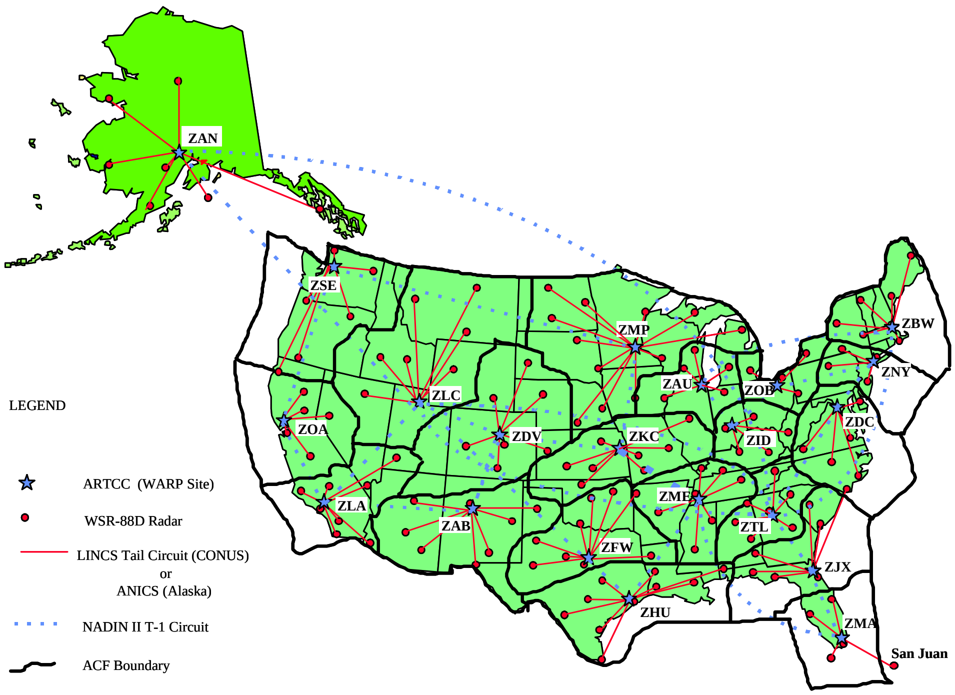

Fig 3 This map shows the 21 ARTCC regions in the CONUS and Alaska. Each ARTCC is directly connected to the NEXRADS within their geographic boundary. In addition, they receive products from the surrounding NEXRADS indirectly from their neighboring ARTCCS.

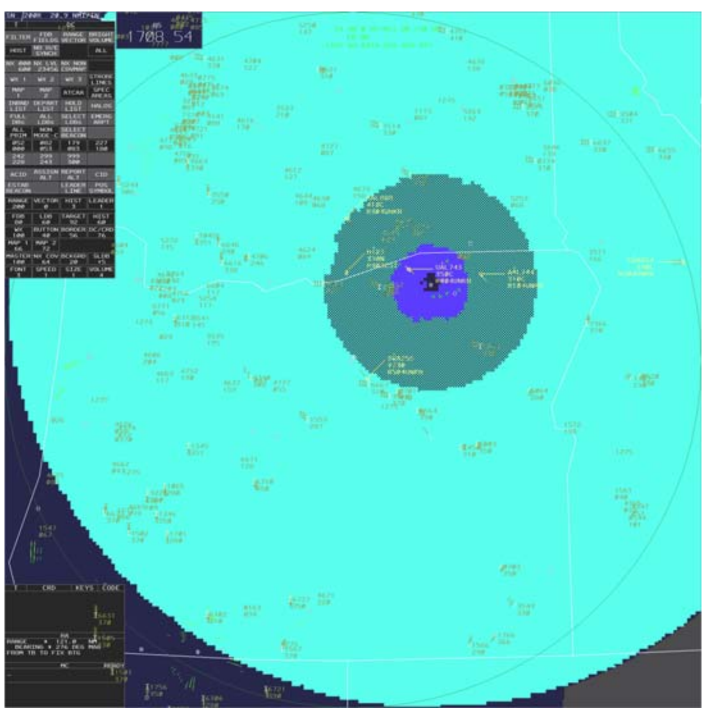

Fig 4 NEXRAD maintenance test pattern (bulls-eye) as it would appear on the controller's display.

around the ARTCC, such that data from at least two radars cover each point within the buffer zone, if possible. Thus a single WARP can have up to 38 radars feeding its mosaic.

Finally, the Air Traffic Control System Command Center (ATCSCC) WARP splices together the individual ARTCC 16-color CR, BR and echo tops mosaics into national mosaics. These are then distributed back to the individual ARTCC.

3 Quality Enhancements

Controllers only need to see NEXRAD information that indicates hazards to aviation. Thus, the NEXRAD mosaics used on their displays undergo several quality enhancements.

The first enhancement is to remove all echoes with reflectivity below 30 dBZ. This eliminates all light precipitation, which is generally not hazardous to aviation, and also removes most anomalous propagation (AP) and ground clutter.

The second enhancement is an interference editor developed by Unisys. This algorithm looks for radials of data that appear to be from a constant or near constant power source. It effectively removes interference like bulls-eyes created by maintenance test patterns (see Fig 4).

The third enhancement is an optimal mosaic algorithm that compares data from multiple radars and removes outliers. This removes most of the AP and clutter that exceed the 30 dBZ threshold. Fig 5 is and example of the optimal mosaic.

Finally, there is the AP-mitigated product, product 67, which is available from each NEXRAD. Product 67 removes AP and clutter in the surface-to-24,000 ft layered CR using an algorithm developed by MIT Lincoln Lab. In fact, controllers were using product 67 up until the summer of 2003 when the FAA discovered that the algorithm was too aggressive. It was removing significant amounts of real weather along with the AP and clutter. Since then the Forecast Systems Laboratory has isolated the bug and has recommended a fix. This fix is scheduled for implementation in the spring of 2006. If this new version of product 67 passes FAA validation, it will be restored to the controllers' displays. This should help controllers west of the Rocky Mountains where there is little overlapping coverage and thus the optimal mosaic has little benefit.

4 Future Plans

To help fill in data gaps out west and to overcome NEXRAD data latency, the WARP will soon make lightning data from the national lightning detection network (NLDN) to the controllers' displays. While WARP has already been modified to provide these data, system that drives the controller displays is not ready to accept it as it will undergo a major upgrade over the next several years. Lightning data will thus probably not be available on the controller displays until that upgrade is completed in 2009. Finally, the FAA is investigating the feasibility of putting alternative NEXRAD mosaics on the controllers display such as the high resolution vertically integrated liquid water (HRVIL) and enhanced echo tops (EET).

5 REFERENCES

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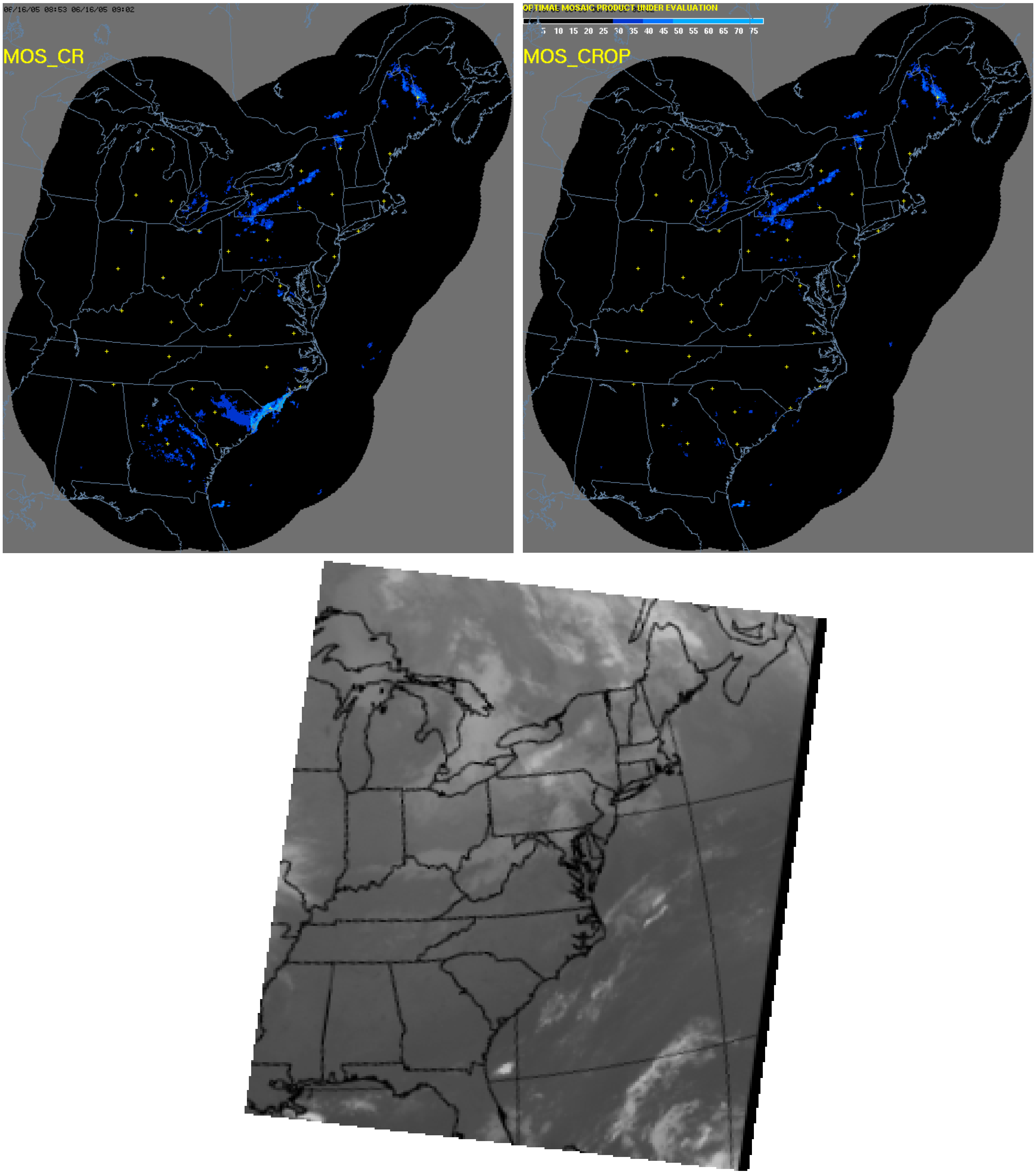

Fig 5 Optimal mosaic. The NEXRAD mosaic on the left uses the old maximum reflectivity rule while the one on the right uses the optimal mosaic. Notice how the optimal mosaic removed AP and clutter in Georgia and the Carolinas as evidence by the infrared satellite image at the same time. Also notice how it retained the echoes associated with the squall line in New York.