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Near Term Planned Mission Enhancements for the WSR-88D Open Radar Product Generator

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(1) Introduction

At the time this paper was written, the Open Radar Product Generator (ORPG) component of the **W**eather **S**urveillance Radar-19**88 D**oppler (**WSR-88D**) had successfully completed Beta testing at 2 non-collocated National Weather Service (NWS) sites. This is a major part of the upgrades included in the NEXRAD Open Systems (1) program. With most of the system design issues addressed and full deployment now approved and underway, the focus will shift to improving and enhancing the software capabilities of the ORPG (2). This paper presents planned enhancements and provides background information on both the science and the potential benefits of new and improved algorithms that will be incorporated into the system.

The implementation of the ORPG, and the use of the Common Operations and Development Environment (CODE) (3), will allow more rapid development of tri-agency applications for potential inclusion in future builds. Applications developed, tested, documented, and ready for introduction into the ORPG will be integrated into the ORPG by the Applications Branch of the NWS Radar Operations Center (ROC), located in Norman, OK, which has tri-agency membership, and was formerly named the NEXRAD Operations Support Facility (OSF). This integration will occur after the planned enhancement is agreed to by the tri-agency System Recommendation Enhancement Committee (SREC). The plans are to introduce the new science in six to nine month intervals.

(2) ORPG Algorithm/Product Development Philosophy

The objectives and goals for the ORPG program were clearly stated at the SREC meeting held in March 1999 (4). The top priorities for future development of ORPG software builds were stated as: (a) accommodate/facilitate the completion of the tri-agency modernizations and (b)support more efficient agency operations. The products and enhancements being discussed were developed with the above goals in mind. This grouping of potential enhancements was assembled from the ROC Applications Branch (5,6).

(3) ORPG Build 1.X

These products have been built and will be introduced into the ORPG as part of a software maintenance upgrade in the Spring of 2002.

Velocity Base Data Array Product

This product will provide full resolution (8-bit or 256 data levels) velocity data. The value of this product will be to improve velocity resolution for severe weather warnings, hurricane monitoring, and also for ingestion into external systems, such as numerical prediction models and the FAA Integrated Terminal Weather System (ITWS) program.

Reflectivity Base Data Array Product

This product provides full resolution of reflectivity data. The impacts have similar value as those stated for the full resolution Velocity data.

(4) ORPG Build 2

These enhancements are being built and tested now and should be ready for implementation by the Fall of 2002.

User Selectable Layer Composite Reflectivity Product

This product will allow operators to define height limits for Layer Composite products. Operators will be able to view layers that are deemed appropriate for severe weather warnings, bright-band

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identification, etc. Careful selection of the lower limit will aid in the removal of many ground clutter and anomalous propagation artifacts.

Super Observation Product

This product will filter, average, reformat, and compress full resolution base data for ingest into analyses and forecast models produced at the NWS National Center for Environmental Prediction (NCEP). It will enable NCEP to more easily accommodate the high density radar data of the WSR-88D network into short range numerical weather prediction models.

Anomalus Propagation (AP/Clutter) Removal Algorithm

This is an update of the process to remove AP/clutter from the low level WSR-88D layer composite reflectivity product used by the FAA's Weather And Radar Processor (WARP) and ITWS programs. FAA requirements are to eliminate to the extent possible non-meteorological echoes in products used by air traffic controllers (ATC).

Enhancements to Precipitation Processing System (PPS)

These enhancements will resolve precipitation truncation errors, implement rain gage bias adjustments, implement a new Range Correction Algorithm (RCA), and implement a new Digital Storm-total Precipitation (DSP) product.

The precipitation truncation errors were partially corrected in Build 10, and will now be completely corrected. The results will be improved estimates during light rain events.

The rain gage bias adjustments will be sent in the form of a table from the NWS Advance Weather Interactive Processing System (AWIPS) to the ORPG, and are computed once an hour by AWIPS's Multi-sensor Precipitation Estimator algorithm.

The RCA will attempt to correct the biggest deficiency of the current PPS, the lack of accounting for the nonuniform vertical profile of reflectivity (VPR). The use of a VPR will compensate for range biases, bright-band contamination, and virga contamination. This should result in much improved Quantitative Precipitation Estimation (QPE) at longer distances from the radar site.

The new DSP is a storm total linear rainfall accumulation on a 2-km Cartesian Hydrologic Rainfall Analysis Project (HRAP) grid for ease of mapping inputs from all radars in a given NWS River Forecast Center (RFC) area of coverage. Together these new capabilities should result in improved QPE from the WSR-88D PPS.

(5) ORPG Build 3

These enhancements have been presented to and received favorably by the NEXRAD Technical Advisory Committee (TAC). They are in testing but must be programmed under the new ORPG paradigm (3).

Snow Accumulation Algorithm

This product provides a quantitative areal estimation of snow water equivalent and snow depth, similar to the current precipitation accumulation products. The plan is to present the information similar to present PPS products. The goal is to improve winter weather warnings and hydrological forecasts.

Multi Pulse Repetition Frequency (PRF) De-aliasing Algorithm (MPDA)

This algorithm will be used to reduce range folding in displays of velocity data (so-called purple haze) and improve velocity estimation. These enhancements should improve severe weather and tropical cyclone warnings by allowing more of the base velocity data to be observed by the forecaster and to be input into ORPG algorithms.

Optimized Volume Coverage Patterns (VCP)

The introduction of these VCPs will satisfy the operational need for increased vertical and temporal resolution of radar coverage for varying meteorological situations. These inputs will improve the capabilities inherent in RPG algorithms that should result in improved performance for severe weather monitoring and warning.

Radar Echo Classifier (REC) Algorithm

This algorithm will automatically classify radar targets as meteorological or non-meteorological. This capability should allow algorithms and operators to discriminate quickly real weather from AP/Clutter and to be able to better monitor existing weather as observed by the WSR-88D.

(6) ORPG Build 4

These enhancements have also been presented to and met favorably with the TAC, but are in early stages of reprogramming for the ORPG implementation. The plan is to introduce these enhancements in Fall of 2003.

Mesocyclone Detection Algorithm (MDA)

This product will improve identification and diagnosis of all important circulations within thunderstorms. The obvious goal will be to improve performance statistics related to severe weather warnings.

Reflectivity Compensation (ZCOMP) Algorithm

This process will compensate for reflectivity biases (losses) that occur due to clutter filtering. It will increase the reflectivity estimates at given azimuth range bins according to the amount of local power and clutter filtering. This product will benefit hydrology by improving QPE.

Rapid Updates of Algorithms/Products

This technique will provide algorithm and product outputs after a few lowest elevation scans, both for total volume products and lower level products. The remaining part of the volume will be from the previous scan. The goal here is to increase temporal data availability which will increase lead times for severe weather warnings.

Ground Based Velocity Track Display (GBVTD) Algorithm

This product will provide estimates of the total horizontal velocities within tropical cyclones. The goal here is to improve wind speed forecasts and wind speed related parameters for tropical cyclones. These are particularly important for the prediction of storm surges related to hurricanes coming onshore.

Machine Intelligent Gust Front Algorithm (MIGFA)

The output for this algorithm will identify and track the leading edge of mesoscale boundaries, or gust fronts. This is an FAA sponsored algorithm with the expectation that the information produced will improve nowcasts and aviation warnings for wind shear. The implications for airport terminal ATC operations are evident.

Hail Detection Algorithm (HDA)

This is a proposed enhancement for the hail algorithm that exists in the legacy RPG. The obvious expectation here is to improve diagnosis of hail probabilities and size for the purpose of increasing lead times for severe weather warnings.

(7) Beyond Build 4

The algorithms listed here are the result of several years of planning. While the time line for implementation of each build is still not settled, the next SREC meeting which will be held in December 2001 will address the prioritization of new algorithms for inclusion into future ORPG builds. At that time, an objective scoring method for rank ordering new science into future builds will be discussed. The underlying goal of providing products that will enhance the ability of each agency to fulfill it's mission goals will be the paramount consideration.

(8) References

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(5) ORPG Build 1,2, & 3 matrix summaries, NWS ROC Applications Branch Personnel, 23 July 2001

(6) ORPG Build 4 Algorithm Matrix final draft. NWS ROC Applications Branch Personnel, 23 July 2001