PRECIPITATATION RATE

ALGORITHM DESCRIPTION

NX-DR-03-018/29

1.0 PROLOGUE

1.1 FUNCTIONAL DESCRIPTION

The PRECIPITATION RATE algorithm executes each time the PRECIPITATION PREPROCESSING algorithm is completed. If the FLAG (Zero Hybrid) is on, the algorithm sets the FLAG (Zero Rate) and updates the reference values for the time continuity test. Otherwise, the PRECIPITATION RATE algorithm uses preprocessed reflectivity factor (HYBRID SCAN) data from the PRECIPITATION PREPROCESSING [017] algorithm to estimate precipitation rates for 1 degree by 2 km sample volumes within a radius of 230 km. The RATE SCAN is produced for input to the PRECIPITATION ACCUMULATION [019] algorithm. Also, three quality control related procedures are performed within the PRECIPITATION RATE algorithm.

Precipitation rates are empirically determined from a relationship with reflectivity factor data. The precipitation rates from two adjacent 1 degree by 1 km sample volumes along the same radial are averaged to obtain values for the 1 degree by 2 km RATE SCAN. The RATE SCAN is comprised of 41,400 1 degree by 2 km sample volumes.

Based on the time continuity of the total field volumetric precipitation rate on a scan to scan basis, a decision is made whether the current RATE SCAN should be used by the PRECIPITATION ACCUMULATION algorithm or be discarded. This test is intended to identify those cases where the between scan increase/decrease of the total volumetric precipitation rate is greater than the increase/decrease expected from precipitation development/decay. These changes could occur as a result of spurious RF interference, transient system noise, or anomalous propagation. Echo areas from storms entering/leaving the scanning region between scans could also cause this parameter to suddenly increase/decrease.

To minimize the chance of rejecting scans because of echo movements into and out of the field of view, the total volumetric precipitation rate is examined for both the entire field of view and for an area with a radius somewhat less than 230 km (inner radius). The inner radius is computed from a climatological maximum speed for echo movement and the time between scans. This test is only considered valid if the time between the current and last good scan is less than a maximum difference at which time continuity is expected.

A range effect correction is then applied to all RATE SCAN values beyond a specified cut-off range. The correction function contains three coefficients which may vary from site to site and with the season. Inputs to the correction function are the range and precipitation rate. This procedure corrects for the effects of signal degradation due to beam losses and partial beam filling which, on the average, reduce the precipitation rate estimates at further ranges.

The area-averaged precipitation rates over each 1/4 LIMITED FINE MESH (LFM) rectangular grid box (approximately 40 km x 40 km) are computed for those boxes whose centers are located within 230 km of the radar. These are obtained by averaging the rates from all RATE SCAN sample volumes whose centers fall within each 1/4 LFM grid box. These data will be used further downstream at the regional/national processing level for important quality control applications and possibly for the construction of a National Radar Summary Chart.

1.2 SOURCE

The PRECIPITATION RATE algorithm was developed by the Radar Hydrology Group of the National Weather Service's Hydrologic Research Laboratory. This algorithm was based on experiences gained through the use of real-time rainfall estimation from the D/RADEX system, the GATE project, and other experimental projects as well as an in-depth analysis of ways with which weather radar data could be better used for hydro-meteorological purposes.

REFERENCES

Ahnert, P.R., M.D. Hudlow, and E.R. Johnson, 1984: Validation of the "on-site" Precipitation Processing System for NEXRAD. Preprints, 22nd Radar Meteor. Conf., AMS, Boston, Mass.

Ahnert, P.R., M.D. Hudlow, E.R. Johnson, D.R. Greene, and M.R. Dias, 1983: Proposed "on-site" precipitation processing system for NEXRAD. Preprints, 21st Radar Meteor. Conf., AMS, Boston, Mass.

Hudlow, M.D., D.R. Greene, P.R. Ahnert, W.G. Krajewski, T.R. Sivaramakrishnan, M.R. Dias, and E.R. Johnson, 1983: Proposed off-site precipitation processing system for NEXRAD. Preprints, 21st Radar Meteor. Conf., AMS, Boston, Mass.

1.3 PROCESSING ENVIRONMENT

Reflectivity factor data being used by this algorithm are assumed to have been pre-processed as described in the PRECIPITATION PREPROCESSING [017] algorithm.

The HYBRID SCAN (1 degree by 1 km) data have not been spatially averaged to obtain the 1 degree by 2 km resolution required for precipitation processing. A precipitation rate estimate based on the averaged reflectivity is not identical to the average of the precipitation rates based on the full resolution reflectivity data. Therefore, each pair of 1 degree by 1 km reflectivity values being used to estimate a 1 degree by 2 km precipitation rate are first converted from reflectivity to precipitation rate and then averaged to obtain a RATE SCAN (1 degree by 2 km) value.

The time continuity test checks whether scans are bad. Bad scans are rejected or discarded from further processing by the

PRECIPITATION ACCUMULATION and subsequent algorithms. This information is saved so that the number of bad scans can be appended to some of the final precipitation products. The intent of this test is not to identify all cases where bad data may be present. It provides a simple means to remove scans which indicate sudden and unreasonable echo development/ decay.

The Limited Fine Mesh (LFM) grid is a rectangular grid commonly used by the National Weather Service which is based on a polar stereographic projection. An LFM grid box represents an area whose size and shape varies with latitude. Therefore the size and shape of the grid boxes will vary slightly over the area covered by the radar and even more from radar to radar (35 to 45 km over the conterminous U.S. for the 1/4th LFM grid). The 1/4th LFM grid boxes used here are defined to have 1/4th LFM grid points as their centers and a mesh length of 47.625 km at the standard latitude (60° N). The information required to generate the grid are the latitude and longitude of the radar, the mesh length at 60° N latitude, and the standard longitude (105° W).

In order to cover the radar umbrella out to 230 km even at the lower latitudes of the conterminous United States, a 13 x 13 array of 1/4th LFM grid boxes will be required. This array will always be 13 x 13 regardless of the latitude of the site. This grid should be positioned in such a way that the radar site falls within grid box (7,7). This array must be compacted (e.g., elimination of all 0 rows, run-length encoding of rows) to reduce storage and especially communications loadings. Compaction must be done in such a way that the source 13 by 13 array can be reconstructed with the use of nominal computer resources.

2.0 INPUTS

2.1 IDENTIFICATION

FLAG (Zero Hybrid)	=	A set or cleared flag indicating, if set, that no precipitation exists in the current scan.
HYBRID SCAN	=	Reflectivity factor data on a 1 degree by 1 km polar grid from 1 to 230 km, in dBZe. These data were composited from four elevation scans by the PRECIPITATION PREPROCESSING algorithm. A precision of at least 1 dBZe is required.
average TIME (Scan)	=	The average scan time of the four elevation scans used to construct the HYBRID SCAN. This is a time of occurrence, not duration.
maximum SPEED (Storm)	=	The climatologically derived maximum expected storm SPEED (90.0), in km/hr.
THRESHOLD (Max Time Difference)	=	Maximum time between scans allowed by the time continuity test. A precision of at least 0.01 hour is required.
RANGE (Cut-Off)	=	The range beyond which a range effect correction must be applied (, in kilometers.
COEFFICIENTS (Range Effect)	=	Three coefficients used to specify The range effect correction function.
BOX (1/4 LFM Grid)	=	Rectangular grid box which is 1/4th of the Limited Fine Mesh (LFM) grid used by the National Weather Service. Consists of a file specifying the RATE SCAN data sample volumes whose centers fall within each of the 1/4th LFM grid boxes.
COEFFICIENT (Multiplicative Z-R)	=	Multiplicative coefficient in the Z-R conversion equation.
COEFFICIENT (Z-R Power)	=	Power coefficient in the Z-R conversion equation.
RATE (Zero Precipitation)	=	Precipitation rate assumed to be zero precipitation, in mm hr^{-1}.
PARAMETER (Time	=	The allowable rate of change of the

Continuity #1) — ratio of volumetric precipitation rates when the echo area is equal to minimum AREA (Time Continuity), in hr^{-1}.

PARAMETER (Time Continuity #2) = The allowable rate of change of the ratio of volumetric precipitation rates when the echo area is equal to the full radar umbrella out to the 230 km range, in hr^{-1}.

minimum AREA (Time Continuity) = Minimum precipitation area to allow time continuity tests on volumetric precipitation rates, in km^2.

maximum RATE (Echo Area Change) = Maximum rate of change of echo area allowed to pass the time continuity test when the volumetric precipitation rate cannot be tested due to the minimum AREA (Time Continuity), in km^2/hr.

PRECIPITATION STATUS MESSAGE = An alphanumeric message which includes the radar ID, TIME(Stamp), current radar status, current operational mode, current scan strategy, TIME(Last Precipitation Detected), CATEGORY (Precipitation), number of gages in data base, and time since last update to the gage data base.

CATEGORY (Precipitation) = The precipitation category currently in effect.

CATEGORY	MEANING
0	No precipitation detected during last hour
1	Significant precipitation detected during the past hour
2	Light precipitation detected during the past hour

2.2 ACQUISITION

FLAG (Zero Hybrid), HYBRID SCAN data and average TIME (Scan) are obtained from the PRECIPITATION PREPROCESSING [017] algorithm.

Maximum SPEED (Storm) is a seasonally dependent unit adaptation parameter based on empirical and theoretical studies.

THRESHOLD (Max Time Difference) and RATE (Zero Precipitation) are system adaptation parameters based on empirical or theoretical studies.

RANGE (Cut-Off) and COEFFICIENTS (Range Effect) are seasonally dependent unit adaptation parameters. Initially, they will be specified theoretically based on available experimental data. Eventually, they will be determined empirically from archived data from each site.

BOX (1/4 LFM Grid) is a unit adaptation parameter file which, is generated given the mesh length at 60 degrees N latitude, reference longitude, and exact latitude and longitude of the radar site.

The COEFFICIENTs (Multiplicative Z-R) and COEFFICIENT(Z-R Power) are site adaptation parameters which may be varied seasonally.

PRECIPITATION STATUS MESSAGE and CATEGORY(Precipitation) is obtained by the Precipitation Detection support function.

The minimum AREA (Time Continuity), and maximum RATE (Echo Area Change) are unit adaptation parameters.

The PARAMETERS (Time Continuity) are unit adaptation parameters that may vary seasonally.

3.0 PROCEDURE

3.1 ALGORITHM

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BEGIN ALGORITHM (PRECIPITATION RATE)

1.0  COMPUTE (average TIME (Scan) difference)

2.0  Clear FLAG (Zero Rate)

3.0  IF   (FLAG (Zero Hybrid) is set)
     THEN
        Set FLAG (Zero Rate)
        Set RATE (Complete Volumetric Precipitation) to zero
        Set RATE (Inner Volumetric Precipitation) to zero
        Set AREA (Complete Precipitation) to zero
        Set AREA (Inner Precipitation) to zero
     ELSE
        DO FOR ALL   (Pairs of consecutive SAMPLE VOLUMEs along
                      the same radial in the HYBRID SCAN BY 2)
           COMPUTE   (RATE SCAN value)
        END DO
        COMPUTE   (RADIUS (Inner))
        COMPUTE   (RATE (Inner Volumetric Precipitation))
        COMPUTE   (AREA (Inner Precipitation))
        COMPUTE   (RATE (Complete Volumetric Precipitation))
        COMPUTE   (AREA (Complete Precipitation))
     END IF

4.0  Clear FLAG (Bad)

5.0  IF   (average TIME (Scan) difference is less than THRESHOLD
          (Max Time Difference)
     AND  CATEGORY (Precipitation) indicates precipitation has
          occurred during the past hour)
     THEN
        IF   (RATE (Complete Volumetric Precipitation) less than
             RATE (Inner Reference))
        THEN
           IF   (the AREA (Complete Precipitation)
           AND  reference AREA (Inner Precipitation) are both
                greater than the minimum AREA (Time Continuity))
           THEN
              COMPUTE   (maximum RATE (Inner Reference))
              IF   (RATE (Inner Reference) greater than maximum
                   RATE (Inner Reference))
              THEN (Set FLAG (Bad))
              END IF
           ELSE
              COMPUTE   (first ABSOLUTE DIFFERENCE)
              COMPUTE   (maximum ABSOLUTE DIFFERENCE)
              IF   (first ABSOLUTE DIFFERENCE greaterm than
                   maximum ABSOLUTE DIFFERENCE)
              THEN (Set FLAG (Bad))
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            END IF
         END IF
      END IF
      IF   (RATE (Inner Volumetric Precipitation) is greater
           than RATE (Complete Reference))
      THEN
         IF   (the AREA (Inner Precipitation) and the AREA
              (Complete Reference) are both greater than the
              minimum AREA (Time Continuity))
         THEN
            COMPUTE   (maximum RATE (Inner Volumetric
                      Precipitation))
            IF   (RATE (Inner Volumetric Precipitation) is
                 greater than maximum RATE (Inner Volumetric
                 Precipitation))
            THEN (Set FLAG (Bad))
            END IF
         ELSE
            COMPUTE   (second ABSOLUTE DIFFERENCE)
            COMPUTE   (maximum ABSOLUTE DIFFERENCE)
            IF   (second ABSOLUTE DIFFERENCE is greater than
                 maximum ABSOLUTE DIFFERENCE)
            THEN (Set FLAG (Bad))
            END IF
         END IF
      END IF
   END IF

6.0  WRITE  (FLAG (Bad))

7.0  IF   (FLAG (Bad) is set)
   THEN
      STOP (restart after next volume scan is completed with
           PRECIPITATION PREPROCESSING [017] algorithm)
   ELSE
      Replace value of (RATE (Complete Reference)) with (RATE
      (Complete Volumetric Precipitation))
      Replace value of (Rate (Inner Reference)) with (RATE
      (Inner Volumetric Precipitation))
      Replace value of (reference AREA (Complete
      Precipitation)) with (AREA (Complete Precipitation))
      Replace value of (reference AREA (Inner Precipitation))
      with (AREA (Inner Precipitation))
      Replace value of (reference average TIME (Scan)) with
      (average TIME (Scan))

   END IF

8.0  IF   (FLAG (Zero Rate) not set)
   THEN
      DO FOR ALL   (RATE SCAN sample volumes beyond the RANGE
                   (Cut-Off))
         IF   (RATE SCAN value greater than RATE (Zero
              Precipitation))
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            THEN
               COMPUTE   (RATE (Range Corrected Precipitation))
               Replace RATE SCAN value with RATE (Range Corrected
               Precipitation)
            END IF
         END DO
         WRITE   (RATE SCAN)
      END IF

9.0   DO FOR ALL   (BOX (1/4 LFM Grid))
         IF   (FLAG (Zero Rate) set)
         THEN
            IF   (RANGE (CENTER 1/4 LFM BOX) less than or equal to
                 230 km)
            THEN
               Set RATE (1/4th LFM Grid Box) to zero
            ELSE
               Set RATE (1/4th LFM Grid Box) to 7
            END IF
         ELSE
            IF   (RANGE (CENTER 1/4 LFM BOX) less than or equal to
                 230 km)
            THEN
               COMPUTE   (RATE (1/4th LFM Grid Box))
            ELSE
               Set RATE (1/4th LFM Grid Box) to 7
            END IF
         END IF
         WRITE   (RATE (1/4th LFM Grid Box))
      END DO

10.0  WRITE   (FLAG (Zero Rate))

END ALGORITHM   (PRECIPITATION RATE)
```

3.2 COMPUTATION

3.2.1 NOTATION

RSP = RATE SCAN, precipitation rate data on a 1 degree by 2 km polar grid from 1 to 230 km.

AZ = AZIMUTH, azimuthal position, in degrees.

CZM = COEFFICIENT (Multiplicative Z-R), multiplicative coefficient in the Z-R conversion equation.

CZP = COEFFICIENT (Z-R Power), power coefficient in the Z-R conversion equation.

DBZE = REFLECTIVITY FACTOR (DBZE), the effective radar reflectivity factor of a SAMPLE VOLUME, in dBZe. A precision of at least 1 dBZe and a dynamic range of at least 0-71 dBZe are required.

Tsavgdif = average TIME (Scan) difference, the difference in time at which scans were taken, in hours to the nearest 1/1200 hour.

TSavg = average TIME (Scan), the average scan time of the four elevation scans used to construct the HYBRID SCAN. A precision of at least 1/1200 hours and accuracy to within 1/120 hours are required. This is a time of occurrence, not duration.

TSavgref = average reference TIME (Scan), the reference scan time (of the last good scan) to the nearest 1/1200 hour.

RI = RADIUS (Inner), the inner radius, in kilometers.

SSmax = Maximum SPEED (Storm), the climatologically derived maximum expected storm SPEED, in km/hr.

RIV = RATE (Inner Volumetric Precipitation), the total volumetric precipitation rate within the RADIUS (Inner), in mm km^2 hr^{-1}.

FB = FLAG (Bad), when set, designates a precipitation rate scan as including bad data and removes it from further processing.

FZR = FLAG (Zero Rate), a set or cleared flag for each average TIME (Scan) indicating, if set, that all precipitation rate values can be

assumed to be equal to RATE (Zero Precipitation).

ASV = AREA (Sample Volume), the area of a particular SAMPLE VOLUME in the RATE SCAN to the nearest 0.01 km^2, in km^2.

RSmid = Midpoint RANGE (Slant), the slant range to the midpoint of a RATE SCAN sample volume in kilometers to the nearest 0.1 km.

RVP = RATE (Complete Volumetric Precipitation), the total volumetric precipitation rate over the entire field of view out to 230 km, in mm km^2 hr^{-1}.

RIR = RATE (Inner Reference), the RATE (Inner Volumetric Precipitation) for the last good scan, in mm km^2 hr^{-1}.

RCR = RATE (Complete Reference), the RATE (Complete Volumetric Precipitation) for the last good scan, in mm km^2 hr^{-1}.

ACP = AREA (Complete Precipitation), the precipitation echo area included within a 230 km radius from the radar, in km^2.

AIP = AREA (Inner Precipitation), the precipitation echo area included within the RADIUS (Inner) from the radar, in km^2.

ACPref = Reference AREA (Complete Precipitation), the value of AREA (Complete Precipitation) from the previous (good) scan, in km^2.

AIPref = Reference AREA (Inner Precipitation), the value of AREA (Inner Precipitation) from the previous (good) scan, in km^2.

ATCmin = Minimum AREA (Time Continuity), minimum precipitation area to allow a time continuity tests on volumetric precipitation rates, in km^2.

P1 = PARAMETER (Time Continuity #1), the allowable rate of change of the ratio of volumetric precipitation rates when the echo area is equal to minimum AREA (Time Continuity) in hr^{-1}. Precise to 0.1 hr^{-1}.

P2 = PARAMETER (Time Continuity #2), the allowable rate of change of the ratio of volumetric precipitation rates when the echo area is equal

to the full radar umbrella out to the 230 km range in hr^{-1}. Precise to 0.1 hr^{-1}.

RACmax = Maximum RATE (Echo Area Change), maximum rate of change of echo area allowed to pass the time continuity test when the volumetric precipitation rate cannot be tested due to the minimum AREA (Time Continuity), in km^2 hr^{-1}.

RIRmax = Maximum RATE (Inner Reference), the maximum RATE (Inner Reference) for which the current scan can pass the time continuity test, in mm km^2 hr^{-1}.

RIVmax = Maximum RATE (Inner Volumetric Precipitation), the maximum RATE (Inner Volumetric Precipitation) for which the current scan can pass the time continuity test, in mm km^2 hr^{-1}.

ADmax = Maximum ABSOLUTE DIFFERENCE, the maximum ABSOLUTE DIFFERENCE in echo area allowed in order to pass the time continuity test, in km^2.

AD1 = First ABSOLUTE DIFFERENCE, the ABSOLUTE DIFFERENCE between the AREA (Complete Precipitation) and the reference AREA (Inner Precipitation), in km^2.

AD2 = Second ABSOLUTE DIFFERENCE, the ABSOLUTE DIFFERENCE between the AREA (Inner Precipitation) and the reference AREA (Complete Precipitation), in km^2.

RRC = RATE (Range Corrected Precipitation), the RATE (Range Corrected Precipitation) in mm hr^{-1}.

C01, C02, CO3 = COEFFICIENTS (Range Effect), three coefficients used to specify the range effect correction function.

RGB = RATE (1/4th LFM Grid Box), area-average rate (8 level coded value) in each 1/4 LFM grid square. A 13 by 13 grid of values for each RATE SCAN used in constructing the hourly accumulations.

Note Precision will be units specified unless otherwise stated.

3.2.2 SYMBOLIC FORMULAS

COMPUTE (average TIME (Scan) difference)

TSavgdif = TSavg - TSavgref

COMPUTE (RATE SCAN)

RSP (RSmid,AZ) =

$$10 \log \left[\frac{10^{\frac{(DBZE\ (RSmid-0.5,AZ)-10 \log CZM)/10}{CZP}}}{2} + \frac{10^{\frac{(DBZE\ (RSmid+0.5,AZ)-10 \log CZM)/10}{CZP}}}{2} \right]$$

COMPUTE (RADIUS (Inner))

RI = MAXIMUM [150.0;230.0 - ((TSavgdif)(SSmax))]

COMPUTE (RATE (Inner Volumetric Precipitation))

$$RIV = \sum_n \left(ASV_n \quad 10^{RSP_n/10} \right) (1 mm/hr)$$

where;

$$ASV_n = \frac{2\mathrm{B}\ RSmid_n}{360} (2km)$$

sum is over all n sample volumes in the RATE SCAN with values greater than the RATE (Zero Precipitation) within the RADIUS (Inner).

COMPUTE (AREA (Inner Precipitation))

$$AIP = \sum_n ASV_n$$

where the sum is over the same n sample volumes as above.

COMPUTE (RATE (Complete Volumetric Precipitation))

$$RVP = RIV + \sum_n \left(ASV_n\ 10^{RSP_n/10} \right) (1 mm/hr)$$

where the sum is over all n sample volumes in the RATE SCAN from the RADIUS (Inner) out to 230 km with values greater than the RATE (Zero Precipitation).

COMPUTE (AREA (Complete Precipitation))

$$ACP = AIP + \sum_n ASV_n$$

where n is defined above.

COMPUTE (Maximum RATE (Inner Reference))

$$RIRmax = (RVP)(TSavgdif)\left[P2 + \frac{(P1 - P2)(B(230)^2 - Min(ACP, AIPref))}{(B(230)^2 - ATCmin)}\right]$$

COMPUTE (First ABSOLUTE DIFFERENCE)
ADl = | ACP - AIPref |

COMPUTE (Maximum ABSOLUTE DIFFERENCE)

ADmax = (RACmax)(TSavgdif)

COMPUTE (Maximum RATE (Inner Volumetric Precipitation))

$$RIVmax = (RCR)(TSavgdif)\left[P2 + \frac{(P1 - P2)(B(230)^2 - Min(ACP, AIPref))}{(B(230)^2 - ATCmin)}\right]$$

COMPUTE (Second ABSOLUTE DIFFERENCE)

AD2 = | AIP - ACPref |

COMPUTE (RATE (Range Corrected Precipitation))

RRC = C01 + C02(RSP) + C03 log (RSmid/1 km)

COMPUTE (RATE (1/4th LFM Grid Box))

Step 1

$$RGB = \frac{\sum_n ASV_n \; 10^{RSP_n/10}}{\sum_n ASV_n}$$

where the sum is over all n sample volumes in the RATE SCAN whose centers fall within the boundaries of the BOX (1/4 LFM Grid) under consideration and ASV is defined above.

Step 2

RGB(code) <---- RGB (mm/hr)

8 level code - categories are specified in Federal Meteorological Handbook, Number 11.

4.0 OUTPUTS

4.1 IDENTIFICATION

The FLAG (Zero Rate) is output by this algorithm.

Whenever the FLAG (Zero Rate) and the FLAG (Bad) are both clear, the RATE SCAN, a scan set of rainfall rate values in dBR, is the major output from this algorithm.

A flag for bad data (FLAG (Bad)) is output by this algorithm. This information will be added to SUPPLEMENTAL DATA.

RATE (1/4th LFM Grid Box) are output for each BOX (1/4 LFM Grid). This array is included in SUPPLEMENTAL DATA.

4.2 DISTRIBUTION

The RATE SCAN and FLAG (Zero Rate) are intended for input to the PRECIPITATION ACCUMULATION [019] algorithm.

RATEs (1/4 LFM Grid Box) are intended for input to the PRECIPITATION PRODUCTS [021] algorithm.

RATE SCANs and FLAG(Zero Rate) are intended for input to the FLASH FLOOD PRECIPITATION PROJECTION [030] algorithm.

5.0 INFERENCES

5.1 LIMITATIONS

This algorithm does not accurately account for snow which may have a significantly different Z-R relationship and range effect correction function.

5.2 FUTURE DEVELOPMENTS

A range effect correction to operate on the RATE SCAN values will be refined further. The range effect correction is made using an empirically derived range dependent correction factor. This procedure corrects for the long term effects of signal degradation due to beam attenuation and partial beam filling which, on the average, reduce the precipitation rate estimates at further ranges. One possibility being investigated may be to vary the range effect correction function coefficients as a function of precipitation characteristics.

Adaptation parameters will be "fine tuned" using actual NEXRAD data.