VI.3.3C DESCRIPTION OF ALGORITHMS USED BY PROGRAM PPINIT

Purpose

This Section describes the algorithms used by program PPINIT to compute parametric values.

The algorithms described are those used to:

- o define basin boundary parameters
- o compute weights for precipitation, temperature and potential evaporation stations
- o determine appropriate MDR boxes for stations or basins

HRAP Grid Coordinate System

Several of the algorithms used are derived from simple geometric principles. The most basic element common to all the geometric computations is the grid coordinate system used to identify the locations of stations and basin boundaries. The grid used is the same coordinate system used by the Hydrologic Rainfall Analysis Project (HRAP) described in Chapter II.1-HRAPGRID.

Basin Boundary Definition

Basin boundaries are used for computing Mean Areal Precipitation (MAP), NEXRAD Mean Areal Precipitation (MAPX) and Mean Areal Temperature (MAT) station weights and determining the MDR boxes to be assigned to a basin. The boundaries are defined by user specified pairs of latitude and longitude, input in clockwise order. The basin boundary definition algorithm connects the latitude/longitude pairs with straight lines and determines which HRAP grid line intersections, called grid points, fall within the boundary. The grid point definition for the basin is stored as HRAP segments. Each segment is defined by the row number (Y coordinate) and the beginning and ending column (X coordinate) on the row.

The accuracy of the specified latitude/longitude pairs is checked by comparing the basin area specified by the user with an area computed from the latitude/longitude points. The specified points are converted to HRAP coordinates and then used in the following equation to compute the area:

$$AREA = 1/2 \left(\sum_{i=1}^{N} X_{i+1} \; Y_i - \sum_{i=1}^{N} X_i \; Y_{i+1} \right)$$

where AREA is the area in grid units
X and Y are the HRAP grid coordinates

N is the Number of user specified points

The area is converted from square grid units to square miles or kilometers using Equation 1 in Chapter II.1-HRAP for the mean latitude of the basin.

One of the available methods for computing station weights uses the location of the centroid of the basin. The centroid is determined from the grid point definition. The algorithm computes the centroid by finding the first moment of the grid points in the X and Y directions:

$$XC = \frac{\sum_{i=1}^{M} Xi}{M}$$

$$YC = \frac{\sum_{i=1}^{M} Yi}{M}$$

where XC and YC are the centroid HRAP grid coordinates
X and Y are the HRAP grid coordinates
M is the number of HRAP grid points within the basin boundary

Station Weights

Station weights are used in determining mean areal precipitation, temperature and potential evaporation values. Several algorithms are available for computing the weights. In each method a distance is computed between a specified point and all stations designated as having the appropriate type of data (i.e. PCPN, PE, etc.).

The available station weighting methods are:

1/d**2 This weighting method divides the basin into four quadrants with the intersection of the axes located at the centroid of the basin. The axes are defined parallel to the axes of the HRAP coordinate system and the quadrants are numbered counter-clockwise beginning in the upper right corner. The axis on the clockwise side of each quadrant is considered to be part of the quadrant. The distance in grid units between the centroid and each station is computed and the station found to be closest to the centroid in each quadrant is stored. The weights stored for the four stations are the reciprocals of the squared grid unit distances. This weighting method is available only for determining MAP timing weight stations.

1/d**power	This method is similar to the 1/d**2 method in that the distance in grid units is measured between the centroid and each station. However, no quadrants are defined in this scheme and the stations to be stored for mean areal computations are the N closest stations to the centroid. The maximum value of N is 10 for MAP, MAPX and MAT and 5 for MAPE. The weights given to the stations are determined by raising the grid unit distances to the user specified power, computing the reciprocals of the values and normalizing the results. If any station has been given a weight of less than the minimum value defined by the user, the station is dropped and the remaining stations are renormalized.
Grid point	The grid point station weighting method is described in Section II.6. Weights for each station are determined from the accumulated incremental weights computed at each grid point. The grid points used in the algorithm are the HRAP grid intersections which fall within the basin boundary. In the computations to determine MAT station weights, the weight calculated at each grid point is the reciprocal of the distance between the closest station in each quadrant and the grid point. Similar calculations are performed for MAP station weights, except the distances are squared before the reciprocals are computed. As in the 1/d**power algorithm, the weights are normalized and then renormalized if any station is dropped because the weight is less than STMNWT.
Thiessen	The Thiessen station weighting method for counting grid points is described in Section II.6. The algorithm is similar to the grid point weighting algorithm, except quadrants are not used and the closest station to each grid point is given an incremental weight of 1.0. At the end of the algorithm the weights are normalized and renormalized if any station weight falls below the STMNWT criterion. The Thiessen weight algorithm is available only for computing station weights for use in calculating MAP values.

<u>Radius of Influence</u>

The radius of influence is used to determine which stranger precipitation reports might affect an MAP area. Reports located at a distance which is greater than the radius of influence from the centroid of the basin are not considered in the MAP calculations. The radius of influence is computed after the station weights have been determined. It is defined as the distance between the centroid of the basin and the farthest station from the centroid that is used in station weighting.

MDR Box Determination

Algorithms have been developed to determine which MDR boxes are to be used to estimate precipitation for a particular station or basin. In defining the USER parameters, the user can specify the subset of MDR boxes to be considered for a particular Forecast Area. All MDR boxes that are computed for basins or stations are compared against this subset to be sure they fall within the Forecast Area.

When a user defines a station and specifies that MDR can be used to estimate missing precipitation values, an algorithm determines the coordinates for the MDR box containing the station location. The national MDR grid consists of 113 boxes in the horizontal direction and 89 boxes in the vertical direction (Figure 1). The grid is oriented such that the edges of the boxes fall along the HRAP grid points. In order to determine the appropriate MDR box for a station, the station's HRAP coordinates (X,Y) are determined first. The MDR box length is ten times the HRAP grid length, therefore the MDR row and columns can be computed from:

MDR Row = ((Y-1)/10)+1

MDR Column = ((X-1)/10)+1

The MDR boxes which affect an MAP area with defined basin boundaries also can be computed. Basins are defined by the HRAP grid points which fall within their boundaries. The MDR box algorithm computes the subset of MDR boxes which covers every part of the defined basin. Each MDR box is checked to compute how many basin grid points fall within its border. Three rules are used to determine which MDR boxes will be stored for use with the basin. The rules are:

- o An MDR box is used if the basin covers more than one-half the box.
- o An MDR box is used if the box covers more than 20 percent of the basin.
- o If neither rule 1 nor 2 is satisfied, the MDR box which contains the most basin grid points is used.

Figure 1. MDR box locations