III.7-MAPX NEXRAD MEAN AREAL PRECIPITATION PROGRAM (MAPX)

Purpose

The NEXRAD Mean Areal Precipitation program (MAPX) uses data from the
NEXRAD network that is in xmrg file format to compute estimates of
mean areal precipitation.

Program MAPX capabilities include:

  1. Read Hydrologic Rainfall Analysis Project (HRAP) grid system
      (see Chapter II.1-HRAPGRID) line segment information from the
      following:
      - file of basin boundary information (latitude/longitude pairs)
        in the form output by the OFS program PPINIT command @DUMP
        PUNCH BASIN command - this output format is also used by the
        Integrated Hydrologic Automated Basin Boundary System (IHABBS)
      - BASN parameters record in the OFS Preprocessor Parametric Data
        Base (PPPDB)
      - file of line segments created by other methods

  2. Read NEXRAD xmrg files in non-compressed or compressed format.
      The files can be in the old format (with 2 records in the header
      and a 2 digit year in the file name) or the new format (with 3
      records in the header and a 4 digit year in the file name).

  3. Create MAPX time series for a maximum of 200 basins.

  4. Compute MAPX time series for all or a subset of the basins in
      the HRAP line segment information file.

  5. Replace missing data by zero or -999. A log file is created
      indicating which xmrg data is missing.

  6. Output MAPX time series in DATACARD format. The time series are
      filled to comply with the DATACARD format requirements that a
      time series begin with the data value for the first time step of
      the first day of the month and end with the last time step of
      the last day of the month. Thus, time series are created for
      complete months even though the requested start and end date do
      not fall at the beginning or end of the month.

Program Input

The program uses free format input for all cards.

Free Format Input Rules

The free format input rules for all data in the control file are:

  1. Only columns 1-80 can be used for input. Columns beyond 80 are
      ignored.

2. Lines with a '#' in the first position are treated as comments.

3. Lines with a '@' in the first position indicate a card label.
    Card labels can be on the same line as the data or on a line
    above the data. For example:
      @A 05021999 05311999
    can be specified as
      @A
         05021999 05311999

4. If a card is not needed for particular run the label and all
    fields must be omitted.

5. One comma and/or at least one blank can be used as a delimiter
    between fields. Single or double quotes are allowed to define a
    field.

6. Blanks or commas are not allowed in character fields unless
    enclosed in quotes.

7. All fields are required. A null field (double commas) must be
    used to indicate single fields for which default values are to
    be used. If N consecutive fields use default values then N+1
    commas must be used. The following example implies that the
    first two fields use default values:
      @C , , ,

8. Not all fields have valid defaults. If the field does not have
    a default a value must be specified.

9. Consecutive commas at the end of a card can be omitted. For
    example:
      @E 1 , , ,
    can be specified as
      @E 1

Input Data

Card	Field	Format	Contents

PERIOD OF RECORD AND INPUT OPTIONS

Card	Field	Format	Contents
A	1	I	Start date in the form MMDDYYYY
	2	I	End date in the form MMDDYYYY
B	1	I	Run option number; default is 0 1/
	2	A	Name of file containing HRAP line segment information and/or latitude/longitude pairs; input depends on the run option number:

                                0   = Read input control file, check

Card   Field   Format   Contents

                              values and output results

                1   <name> = Use latitude/longitude pairs
                               file with the given name and
                               create a corresponding HRAP
                               file with a similar name; do
                               not create MAPX files;
                               Input file searched for in
                               order will be:
                                 1. <name> in local
                                     directory
                                 2. <name>.latlon in local
                                     directory
                                 3. $(calb_param)/ll_pairs/
                                     <name>
                                 4. $(calb_param)/ll_pairs/
                                     <name>.latlon
                               Output file created depending
                               on input file:
                                 1. <name>.hrap in local
                                     directory
                                 2. <name>.hrap in local
                                     directory
                                 3. $(calb_param)/line_segs/
                                     <name>.hrap
                                 4. $(calb_param)/line_segs/
                                     <name>.hrap

                2   <name> = Same as option 2 above but do
                               create MAPX files

                3   <name> = HRAP file exists; get the HRAP
                               file following the rules above
                               for output file created

                4   <name> = Read the latitude/longitude
                               values from the OFS PPPDB
                               files defined by the
                               apps_default token ofs_level
                               and create a new '.latlon'
                               file in the directory
                               determined by the same method
                               as option 1; quit after making
                               the latlon file

                5   <name> = Same as option 4 but calculate
                               the HRAP file and then quit

                6   <name> = Same as option 4 but calculate
                               the HRAP file and then the
                               MAPX files

                7   <name> = Read the latitude/longitude

| | | | values from the OFS PPPDB files defined by the apps_default token ofs_level and create a new '.hrap' file in the directory determined by the same method as option 1; quit after making the HRAP file |

| | | | 8   \<name\> = Same as option 7 but create the MAPX files after making the HRAP file |

| C | 1 | A | Pathname to directory containing NEXRAD grid files; if the pathname is not found and does not start with a slash it is prefixed with '$(calb_griddb)/' |

| D | 1 | A | Type of gridded data; default is 'xmrg' |
| | 2 | I | Number of digits of year in xmrg file name (it was 2 before late 1999 and 4 since); default is 4 |

OUTPUT OPTIONS

E	1	I	Data time interval of output time series; default is 1

	2	I	Option to create output time series; default is 0:
			   0 = create only mapx files
			   1 = create mapx, cvx and zpx files

	3	I	Option for filling missing data; default is 0:
			   0 = fill missing values with zero
			   -999 = fill missing values with -999

| F | 1 | A | MAPX data unit ('MM' or 'IN'); default is 'MM' |
| | 2 | I | Number of columns in output files; default is 1 |

| G | 1 | A | Pathname of directory for output time series files (mapx, cvx, zpx); if the pathname is not found and does not start with a slash it is prefixed with '$(calb_area_ts_dir)/'; in addition to the time series files information on missing NEXRAD data will be stored in the same directory in file 'MISSED.log' |

| I | 1-N | A8 | Basin identifiers (maximum 200); if none specified all basins listed in the HRAP line |

Card	Field	Format	Contents
			segment file specified on input line B will be processed
J	1	A8	Extension for output file if a file of the same name already exists; ihe default is the current day-of-year and hour-minute as jjj_hhmm; an underscore is added before the extension

Notes:

1/ The following table shows the files that must exist and are created for each run option number:

run option number	lat/lon file	HRAP file	OFS PPPDB	mapx file
0	n/a	n/a	n/a	n/a
1	exists	create	n/a	n/a
2	exists	create	n/a	create
3	n/a	exists	n/a	create
4	create	n/a	exists	n/a
5	create	create	exists	n/a
6	create	create	exists	create
7	n/a	create	exists	n/a
8	n/a	create	exists	create

Files Used

1. Input Control File

   The control file contains input commands.

   If running from the command line, the file name is specified as a full pathname as the first argument.

   If running in an interactive mode, the file name is specified as the first input line.

   If running using the script calb, the file name is given after the -i option and is found in the directory given by apps_default token calb_input.

   For example:

      $(calb_dir)/input/calbtest/mapx/BLUO2.cntl

2. Output Status File

   This file contains output that describes the program run status, including error and warning statements.

   If running from the command line, the file name is specified as a full pathname as the second argument.

If running in an interactive mode, the file name is specified as the second input line.

If running using the script calb, the file name is given after the -o option and will be found in the directory given by apps_default token $(calb_output)/<user-id>.<date-time>.

For example:

    $(calb_dir)/output/$(LOGNAME)/out.20010412.201706

3. Log File

   This file contains the log messages from file open and close routines.

   If running from the command line, it can be given as a standard error file after a redirection ('>') symbol.

   If running in an interactive mode, the output will be output to the terminal.

   If running using the script calb, the file name will be the same as the output file with '_log' added to it before the date-time stamp and it will be in the same directory as the output status file.

   For example:

    $(calb_dir)/output/$(LOGNAME)/out_log.20010412.204511

4. Latitude/longitude File (basin boundary file - usually ending with extension '.latlon')

   This file contains the basin name, units code, lat-lon values and area in a text file similar to the following:

    BASN(ENGL) BLUO2 'BLUE'
    (
     33.9996,96.2421
     33.9913,96.2525
    ...
)
    AREA(473.947)

   It can already exist or be created from values obtained from the OFS PPPDB files. If the OFS files are used, apps_default token ofs_level must be set.

   The name of the file is in the input control file (the '.cntl' file) on the B card. If the file is not found, $(calb_param)/ll_pairs is used to define the directory for this file. The following rules apply in finding this file:

    1. check for exact <name> as pathname or in cur dir
    2. check for <name>.latlon as pathname or in cur dir

3. check for $(calb_param)/<exact name>
        4. check for $(calb_param)/<name>.latlon

    For example:

        $(calb_param)/ll_pairs/BLUO2.latlon

5. HRAP File (line segment file - usually ending with extension '.hrap
   ')

   This file contains the basin name, basin number in this file,
   number of line segments, basin area and the HRAP line segments in a
   text file similar to the following:

        CTLL1
          2   20   1020.1900
           1 248 711 714
           2 247 711 715
        ...

   It can already exist or be created from either the
   latitude/longitude file or from values in the OFS PPPDB files. If
   the OFS files are used, apps_default token ofs_level must be set.

   The name of the file is the same as the lat-lon file and is
   obtained from the B card, except that the extension '.hrap' must be
   used. Also, if the lat-lon input file comes from the calb data
   directory described by apps_default token calb_param, then this
   file will be output as $(calb_param)/line_segs/<name>.hrap. If a
   file <name>.hrap exists in the current directory it will be
   overwritten; otherwise the output file will be written to
   $(calb_param)/line_segs.

   For example:

        $(calb_param)/line_segs/BLUO2.hrap

6. NEXRAD Precipitation Files (usually beginning with xmrg followed by
   a date-time code and may be compressed)

   This is a binary file containing NEXRAD precipitation values for
   the date in the time stamp. There can be a file for each hour.

   The directory containing the files is given as a full pathname on
   the C card. The beginning filename characters 'xmrg' may be
   changed along with the number of digits in the year (2 or 4) on the
   D card (e.g. '@D new 2'). An example file name is
   xmrg0731200023z.Z for month 7, day 31, year 2000, hour 23.

   For example:

        /fs/hydro/Hydro_Data/ABRFC/PRECIPITATION/RADAR/STAGE3/
         RAD_97-99/xmrg0731200023z.Z

7. MAPX Time Series Output Files (ending with extensions .mapx01,

.cvx01 and .zpx01 where '01' is the data time interval)

These files contain the MAPX precipitation time series (.mapx01)
and various statistics time series (.cvx01 and .zpx01). Output of
the later two statistical files is optional. The contents of the
'.mapx' file is a text file similar to the following:

```
$MAPX FROM FILES:
/fs/hydro/Hydro_Data/ABRFC/PRECIPITATION/RADAR/STAGE3/RAD_97-99
NEXRAD        MAP  L    IN   6      BLUO2
 7  1997  7   1997  4   F9.3
BLUO2         0797  1    0.000    0.000    0.000    0.000
BLUO2         0797  2    0.000    0.000    0.000    0.000
BLUO2         0797  3    0.000    0.000    0.000    0.000
BLUO2         0797  4    0.000    0.000    0.001    0.000
BLUO2         0797  5    0.000    0.000    0.000    0.000
BLUO2         0797  6    0.000    0.000    0.178    0.095
BLUO2         0797  7    0.000    0.000    0.000    0.000
BLUO2         0797  8    0.000    0.000    0.000    0.000
BLUO2         0797  9    0.000    0.000    0.000    0.002
BLUO2         0797 10    0.000    0.045    0.000    0.007
...
```

The directory to contain the output MAPX files is given in the
control file on card G.

The two digit number on the extension is the time series interval
in hours and is input on the E card. Also on this line the second
number is a code to indicate whether the '.cvx01' and '.zpx01'
files should be created.

If the MAPX file already exists, a suffix is added to the extension
that is either a time stamp by default or a given extension on the
J card. The time stamp has a format '_jjj_hhmm' where jjj is the
day of the year, hh is the hour and mm is the minute.

For example:

   $(calb_area_ts_dir)/calbtest/mapx/BLUO2.mapx01_099_1230

8. Missing Data Log File

A file named 'MISSED.log' is created in the same directory as
output MAPX time series files that contains information on missing
NEXRAD data. If the file already exists, the same extension
(time-stamp or given suffix) that was used for the MAPX files will
be added to the filename.

For example:

   $(calb_area_ts_dir)/calbtest/mapx/MISSED.log_099_1230

Program Execution Information

See Chapter I.2 for program execution information.

<u>Sample Input and Output</u>

Figure 1 is sample program input.

Figure 2 is sample program output.

Figure 1. Sample input for program MAPX

```
# INPUT FOR PROGRAM MAPX

@A 07011997 07211997
@B 6 pppdb_basn
@C /fs/hydro/Hydro_Data/ABRFC/PRECIPITATION/RADAR/STAGE3/RAD_97-99
@D xmrg 4
@E 6 1 0
@F IN 4
@G _area_ts
@I BLPK1 BLUO2
@J new
```

Figure 2. Sample status file output from program MAPX

   ========> MAPX   ver: b5.1.2r19   date: 05/14/01

   ========>   MAPX CONTROL FILE INPUT VALUES

@A: ISTART is: 07011997
    IEND is: 07211997
@B: LLRUN is: 6
    NAMLLG is: pppdb_basn
@C: DIRGRD is: /fs/hydro/Hydro_Data/ABRFC/PRECIPITATION/RADAR/STAGE3/RAD_97-99
@D: PREF is: xmrg
    NYY is: 4
@E: DT is: 6
    ICV is: 1
    RMISS is: 0
@F: UNIT is: IN
    NCOL is: 4
@G: DIRMAP is: _area_ts
@I: NAREA is: 2
    BASINS(1): BLPK1
    BASINS(2): BLUO2
@J: XTIME is: new

LAT/LON PAIRS FILE: /fs/home/scv/nwsrfs/calb/calbtest/mapx/_param/ll_pairs/pppdb_basn.latlon
LINE SEG HRAP FILE: /fs/home/scv/nwsrfs/calb/calbtest/mapx/_param/line_segs/pppdb_basn.hrap

   NOTE: the hrap file already exists for: pppdb_basn
            it will be overwritten

GRID DIRECTORY: /fs/hydro/Hydro_Data/ABRFC/PRECIPITATION/RADAR/STAGE3/RAD_97-99
MAPX DIRECTORY: /fs/home/scv/nwsrfs/calb/calbtest/mapx/_area_ts
MISSED LOG FILE: /fs/home/scv/nwsrfs/calb/calbtest/mapx/_area_ts/MISSED.log

  ========> BEGIN PROCESSING LAT/LON FILE
   basin name BLPK1
   no of this basin   1
   no of line segments ...   5
   computed area 85.55 MI2
     I= 1   IY(I)= 382   IXB(I)= 561   IXE(I)= 562
     I= 2   IY(I)= 381   IXB(I)= 563   IXE(I)= 564
     I= 4   IY(I)= 379   IXB(I)= 564   IXE(I)= 565
     I= 5   IY(I)= 378   IXB(I)= 563   IXE(I)= 565
   normal end
   basin name BLUO2
   no of this basin   2
   no of line segments ...   18
   computed area 474.15 MI2
     I= 1   IY(I)= 305   IXB(I)= 587   IXE(I)= 589
     I= 2   IY(I)= 304   IXB(I)= 587   IXE(I)= 590
     I= 17   IY(I)= 289   IXB(I)= 598   IXE(I)= 602
     I= 18   IY(I)= 288   IXB(I)= 599   IXE(I)= 601
   normal end
  ========> END PROCESSING LAT/LON FILE

  ========> BEGIN PROCESSING MAPX RUN

     ====>   PROCESSING NEXRAD GRIDS

     ====>   GENERATE CARD FORMAT FILES

MAPX06 OUTPUT FILE: _area_ts/BLPK1.mapx06

     ====>   TIME SERIES GENERATED FOR: BLPK1

CVX06 OUTPUT FILE: _area_ts/BLPK1.cvx06

```
ZPX06 OUTPUT FILE:  _area_ts/BLPK1.zpx06


MAPX06 OUTPUT FILE: _area_ts/BLUO2.mapx06

     ====>  TIME SERIES GENERATED FOR: BLUO2

CVX06 OUTPUT FILE:  _area_ts/BLUO2.cvx06


ZPX06 OUTPUT FILE:  _area_ts/BLUO2.zpx06

 ========>  END PROCESSING MAPX RUN
```