

**National Radio Astronomy Observatory
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MEMORANDUM

To: 12 Meter Computing Report Series

From: E. B. Stobie and P. R. Jewell

Subject: New Spectral Line Mapping Analysis Routines

I. INTRODUCTION

A new set of spectral line mapping analysis routines now exist that make it much easier than before to display contour maps of observing parameters such as integrated temperature, peak temperature, specific channel temperature, channel RMS, and scan system temperature. This new technique supercedes the old method of constructing artificial spectral scans that contain row by row mapping data.

Once the mapping data has been obtained, reduction and display of the data requires three steps that are summarized here and explained in detail below:

- 1) Reduce the data (e.g., extract baselines, smooth, eliminate bad channels, etc.) and load the reduced scans into the MAP file, using the command MSAVE. LINE program procedures exist for performing this step automatically.
- 2) Construct a grid of map values to be contoured using the command GRID and associated adverbs. In this step, you can specify the grid center position, the cell size, the map boundaries, and the parameter to be mapped.
- 3) Produce the contour map with the command MAP. You can control the contour levels in this step; if they are not what you want on the first try, you can reset them and run MAP again without rerunning GRID.

II. DETAILED DESCRIPTION

1) Saving Reduced Data in the MAP File

After a mapping scan has been fully reduced, i.e., you have extracted baselines, etc., you can save it in the MAP file using the command

n MSAVE where n is the index of the scan in the MAP file.

The index is provided so that you can store multiple maps in the MAP file and so that you can redisplay stored scans. Should you want to retrieve this scan from the MAP file for display or further reduction, you can do so with the command

n MGET where m is the index of the scan that was used with
MSAVE.

If you use an index with MSAVE that has been previously used, the program will warn you that you have overwritten a previous mapping entry.

If your mapping data can all be reduced in the same manner, i.e., using the same baseline parameters, etc., you can use an automatic LINE procedure to process the whole map at once. Two sample procedures that can be INSTALLED from disk are listed below.

The following procedure, TPMPROC, can be used to automatically process total power spectral line data. Before running TPMPROC, you must do three things:

- i) Load the scans into the stack, as you would to average data (i.e., use the ADD or A commands);
- ii) Set the baseline fitting regions using the procedure BSET;
- iii) Set BMOMENT and EMOMENT, the beginning and ending channels of the temperature integration, and insure that NMOMENT = 0.

To execute the procedure, type

```
m    TPMPROC    where m is the index offset of the beginning scan of
                    the MAP. Note that if the map begins with Index 1,
                    the offset is 0.
```

The procedure is listed below; note that it averages the two polarization channels for "parallel" mode data, fits a baseline, stores in the scan header mapping values (integrated and peak temperature and scan RMS), and then writes the scan to the MAP file.

```
PROCEDURE TPMPROC (X5)
* This procedure reduces and loads total power TPM
* mapping scans into the MAP file.
FOR JJ = 1 TO ACOUNT
  XSCAN = ASTACK(JJ)
  TON (XSCAN)
* If the data are in parallel mode, average the two
* polz. channels.
  RXMODE = NORCHAN
  IF RXMODE = 2; THEN
    SLIDE ONLYA
  END
  BASELINE MOMENT
  PRINT SIZE(1)
  SIZE(1) SETILI
  PEAK
  HEIGHT(1) SETLAMP
  RMS
  VRMS(1) SETDRMS
  JJ + X5 MSAVE
END
RETURN
FINISH
```

As the procedure executes, it will print out for each scan the integrated temperature, the peak temperature, and the scan RMS. *Each of these parameters are stored in the header of the scan as it is written to the MAP file. These quantities are used to generate the final map.* Note that if this procedure doesn't do quite what you want

it to, you can modify, rename, and re-INSTALL it. For example, if you would like each scan of the map to be displayed as it is processed, insert PAGE SHOW after the BASELINE command. Alternatively, you can reduce each scan one-at-a-time and write it to the MAP file. If you take this approach, be sure to store in the scan header the mapping values (integrated and peak temperatures and scan RMS) which are needed for map generation.

The second procedure, PSMPROC, is used to automatically store position-switched mapping data (collected with the PSM observing procedure) in the MAP file. To run PSMPROC, follow exactly the same steps as for TPMPROC.

```

PROCEDURE PSMPROC (X5)
* This procedure reduces and loads PSM mapping scans
* into the MAP file.
FOR JJ = 1 TO ACOUNT
  XSCAN = ASTACK(JJ)
  GET(XSCAN)
* If the data are in parallel mode, average the two polz. channels.
  RXMODE = NORCHAN
  IF RXMODE = 2; THEN
    SLIDE ONLYA
  END
  BASELINE MOMENT
  PRINT SIZE(1)
  SIZE(1) SETILI
  PEAK
  HEIGHT(1) SETLAMP
  RMS
  VRMS(1) SETDRMS
  JJ + X5 MSAVE
END
RETURN
FINISH

```

You can also use these mapping routines with maps generated from cataloged source positions (i.e., APM mapping), but it requires that you set several header parameters before executing MSAVE that are set automatically in TPM and PSM mapping. These header parameters are

DELTA XR	[X grid spacing in arcsec]
DELTA YR	[Y grid spacing in arcsec]
XCELL0	[Row number of the scan]
YCELL0	[Column number of the scan]
XZERO	[X offset from map center in arcsec]
YZERO	[Y offset from map center in arcsec]

2. Preparing a Grid of Mapping Data Points

Once the mapping scans are stored in the MAP file, you can automatically generate a grid of data points for subsequent contour plotting. Before running GRID, you must enter the following input parameters:

XAXIS = 'R' [means the x-axis is 1950 Right Ascension]

YAXIS = 'D' [means the y-axis is 1950 Declination; note that you could reverse the meaning of the two axes if you wanted to]

XCENTER = HH,MM,SS.S [the RA of the center of the field; NOTE THAT THE
 COMMAS ARE ESSENTIAL]
YCENTER = DD,MM,SS [the declination of the center of the field]
XCELL = SS [the X grid spacing in arc seconds; should be, in
 general, the grid spacing of the observation]
YCELL = SS [the Y grid spacing in arc seconds; should be, in
 general, the grid spacing of the observation]
XDELTA = SSS [one-half the extent of the map in the X direction in
 arc seconds]
YDELTA = SSS [one-half the extent of the map in the Y direction in
 arc seconds]

Before running GRID, you will usually want to limit the scans in the MAP file that go into the map. There are three options for doing this:

- a) **BSCAN = nnnn** [the beginning scan number to be processed]
ESCAN = mmmm [the ending scan number to be processed]
- b) **SOURCE = 'source_name'** [the name of the source; enclose the string in
 single quote marks]
- c) **FB = rrrr** [the filter bank resolution in kHz]

The program tests each one of these conditions using "AND" type logic; i.e., only those scans that meet all of the specified conditions are selected. The selection criteria can be nullified as follows: to end scan number selection, set BSCAN and ESCAN to 0; to end source name selection, set SOURCE to a blank (' '), and to end filter bank selection, set FB to 0.

To run the gridding program, simply type

GRID

3. Making the Contour Map

To produce the contour map, you must set two parameters:

- a) **MAPVAL = 'aaaa'** [the mapping quantity to be displayed; the
 options are:
= 'ILI' [integrated line intensity]
= 'CHAN nnn' [a specific channel number]
= 'LAMP' [Line Amplitude]
= 'STSYS' [System Temperature]

= 'RMS' [channel rms of the scan]

b) LEVS = i, j, k, l, m, n, ..., -9999

[the contour levels in the units of the chosen mapping parameter; to terminate entry, type -9999. Up to 20 levels can be specified.]

To run the contouring program and produce a plot, type

MAP