# CONTINUUM MAPPING WITH THE 12-M TELESCOPE

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## Foreword

This document describes the continuum mapping system at the 12-m telescope. It should be used in conjunction with the Observers' Reference Manual (in preparation) for a complete view of planning observations, data taking and analysis.

The system described here owes its existence to the contributions of many people. Outside N.R.A.O., Darrel Emerson, Glyn Haslam and Uli Klein must be particularly thanked. They not only devised the dual-beam restoration technique, but most generously supplied software, documentation and advice. In Tucson, Stuart Shaklan wrote large parts of the software, while Betty Stobie gave invaluable assistance with all "aspects computorial" (and will, poor soul, inherit this part of the system.) John Payne, Paul Rhodes and their merry men leaned over backwards (as well as sideways) to provide the best possible continuum observing system. Phil Jewell and Mark Gordon were the "perfect guinea pigs" in testing the complete system and made many valuable comments and suggestions. Bob Brown provided continual encouragement and made available telescope test time (but why did it always rain, Bob?). Jennifer Neighbours is thanked for typing this manual.

## 1. Continuum Observing at Millimeter Wavelengths

At radio wavelengths, the single-dish observer grapples with the problem of detecting and mapping weak signals in the presence of both receiver noise and varying receiver drifts. For $\lambda > 3$ cm, the effects of the terrestrial atmosphere is usually only a minor irritation. However, at millimeter wavelengths the atmosphere can absorb one half, or more, of the power incident from a radio source, while radiating a large and variable quantity of power itself.

Even in the finest possible observing weather conditions, atmospheric emission makes it impossible to use the traditional radio techniques of total power, or load-switching, observations with the N.R.A.O. 12-m telescope. For some years, observers have used a technique of "beam-switching" at these high frequencies. The system takes the power difference between two feeds separated in the telescope focal plane. One feed can be positioned on the radio source of interest, while the other provides a reference signal from "blank sky". Apart from giving similar intensities for both signal and reference phases, the technique provides a high degree of rejection of the atmospheric emission, which is similar in the two angularly-nearby beams. Until the late 1970's beam-switching of this form was used exclusively to study sources whose sizes were less than the angular separation of the two beams. For larger sources, emission from different areas of the source contribute simultaneously to the power received in each beam. This results in a complicated image (see Fig. 2) that cannot be interpreted directly.

However, Emerson, Klein and Haslam (Astron. Astrophys., 76, 92, 1979) demonstrated that a simple algorithm exists for reconstructing the brightness distribution of such sources, as if they had been observed with a single beam. It is this algorithm that is used by the present continuum mapping system in analyzing data from the 12-m telescope.

## 2. The Emerson, Klein and Haslam Algorithm

A detailed description of the algorithm can be found in both Emerson et al (see above) and Klein (Diplomarbeit, University of Bonn, 1978; in German). Only a brief outline will be included here, highlighting points of relevance to the 12-m system.

At wavelengths around λ3 cm, the effects of atmospheric emission overwhelm the importance of atmospheric absorption. At millimeter wavelengths, both must be taken into account if accurate intensity calibration is to be achieved. While the beams of a dual-beam observation diverge in the far-field of the antenna, there is a high degree of overlap in the near-field, and hence within the atmosphere. Taking the power difference between the two beams largely subtracts the atmospheric emission. Even then, it should be noted, only the best possible observing weather is suitable for making successful millimeter-wave continuum observations. This is especially true at either λ1.3 or 0.8 mm. The far-field limit of a telescope of diameter D is at $D^2/2\lambda$. For the 12-m telescope this represents a distance of 24 km at λ3 mm wavelength, while most atmospheric emission originates below heights of 2-3 km. At the 12-m telescope the two beam directions

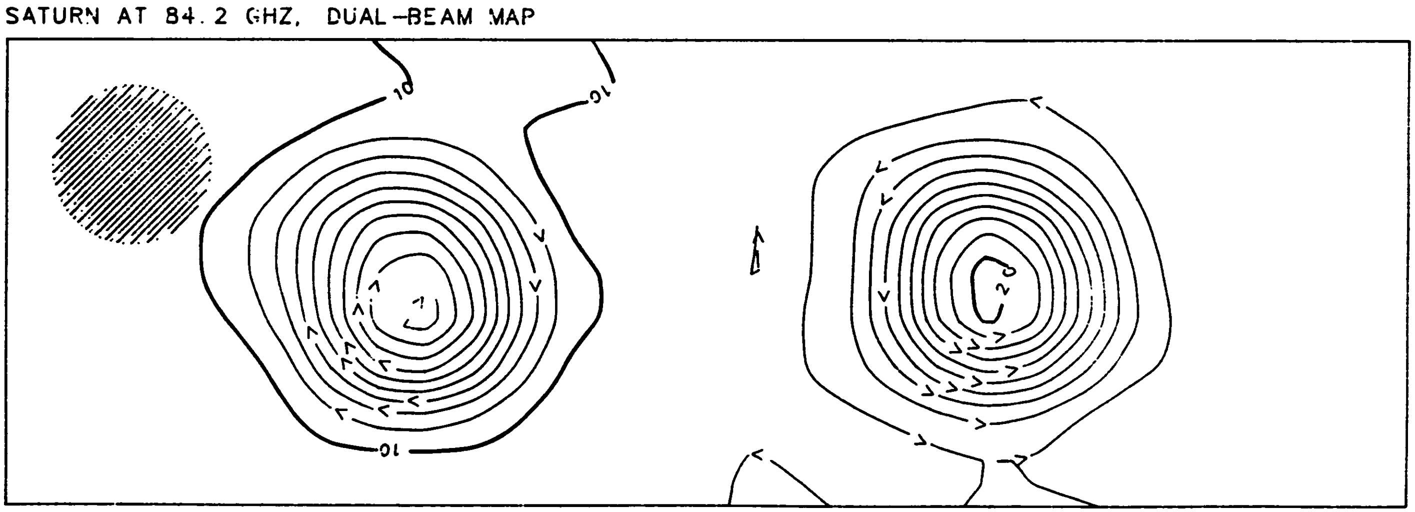


Fig. 1.

M17 AT 94.2 GHZ, DUAL-BEAM MAP

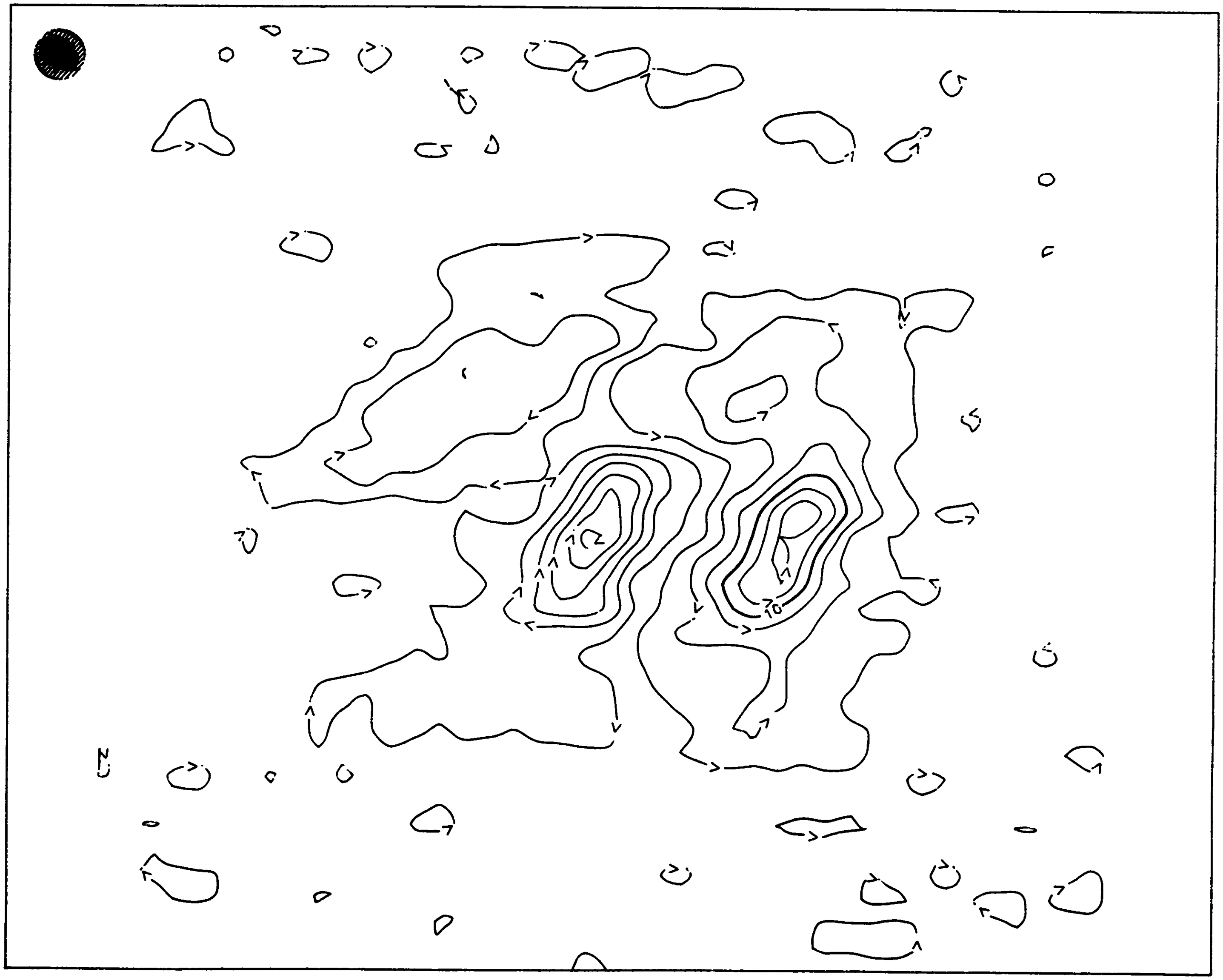


Fig. 2.

are obtained by rocking the subreflector (often called "nutating") between two fixed positions. The separation of these positions can be varied from zero up to about 5 arcmin. Typically, recommended beam separations are 4 arcmin at λ3 mm and 2 arcmin at λ1 mm.

If the object is smaller than the beam separation, Fig. 1, the images from the two beams are distinct and the observer can either map just one image, using the other beam as a reference signal, or use a "shift and subtract" method to obtain his result.

When the source is more extended that the beam separation, Fig. 2, a more sophisticated analysis technique is required. Let us suppose that our map has been made from a raster of scans, with the telescope scanning along the direction defined by the separation of the beams. At the 12-m telescope the beams are separated in azimuth to give the best possible "weather rejection". The transformation from an az-el frame to an R.A.-dec frame is made during the analysis.

Following Emerson et al, we consider what effect the dual-beam observing has had on our maps. Suppose that the two beams have identical polar diagrams. If, Figs. 3 i) - iii), S is the true source intensity distribution, B is the polar diagram of a single beam, and D is the "dual-beam function", (consisting of two δ-functions spaced by the beam separation), then I, the resulting dual-beam response, Fig. 3 iv), is

$$I = S * B * D \qquad 1)$$

(Where * denotes convolution, and x denotes multiplication)

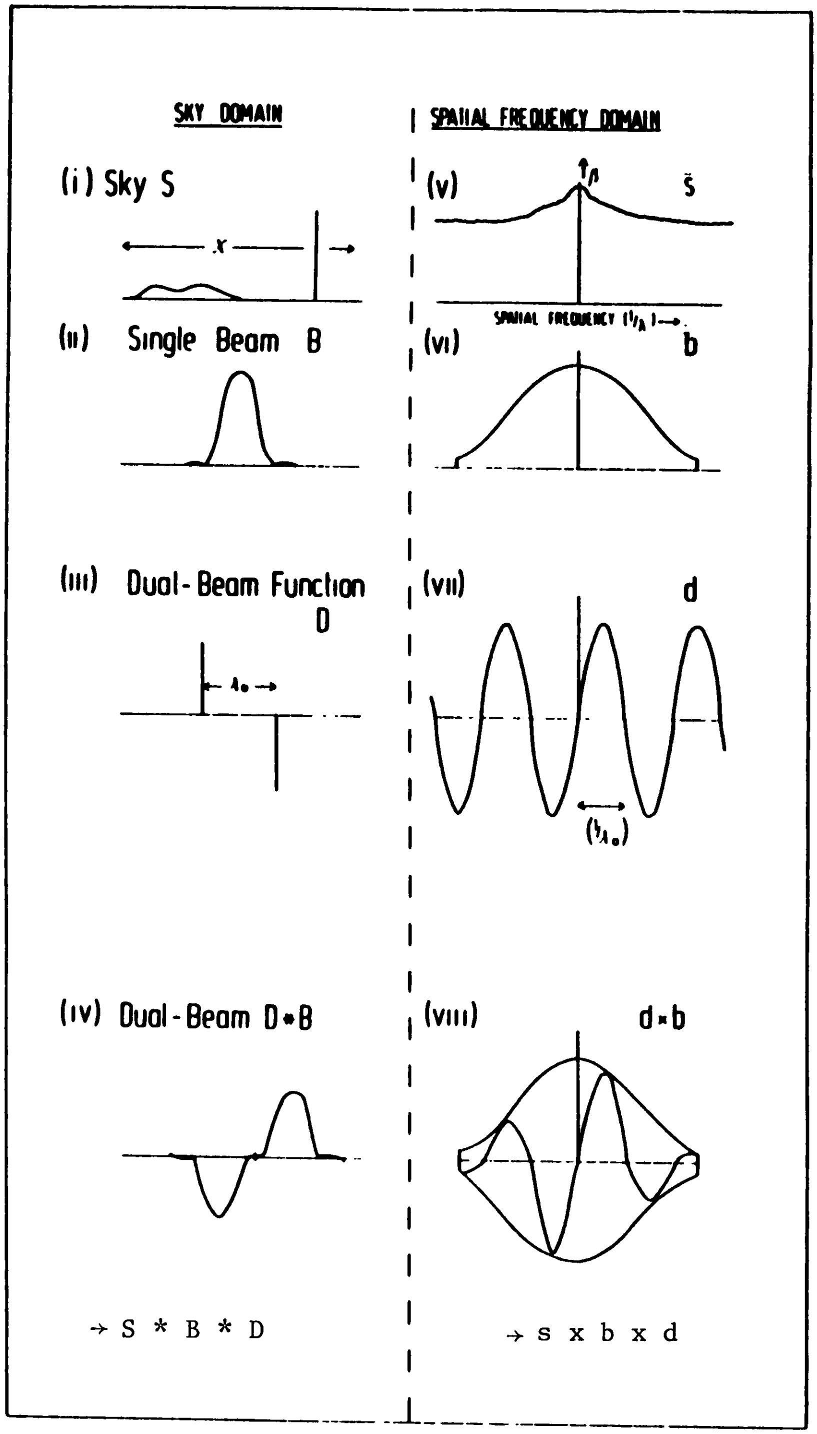


**Fig.** 3. Schematic representation of a true source brightness distribution $S$(i), the single beam $B$(ii), the dual-beam function $D$ (iii) and the dual-beam $D * B$(iv) with the amplitudes $\beta$ of the respective Fourier transform representations $s$, $\tilde{b}$, $d$, $d \times b$ shown in (v)–(viii). The scales are arbitrary

However, we wish to obtain the equivalent single-beam response, P, given by

$$P = S * B \qquad 2)$$

Denoting the Fourier transforms of these quantities by lower-case letters, Figs. 3 v) - viii), we have

$$p = s \times b \qquad 3)$$

and $$i = s \times b \times d = p \times d \qquad 4)$$

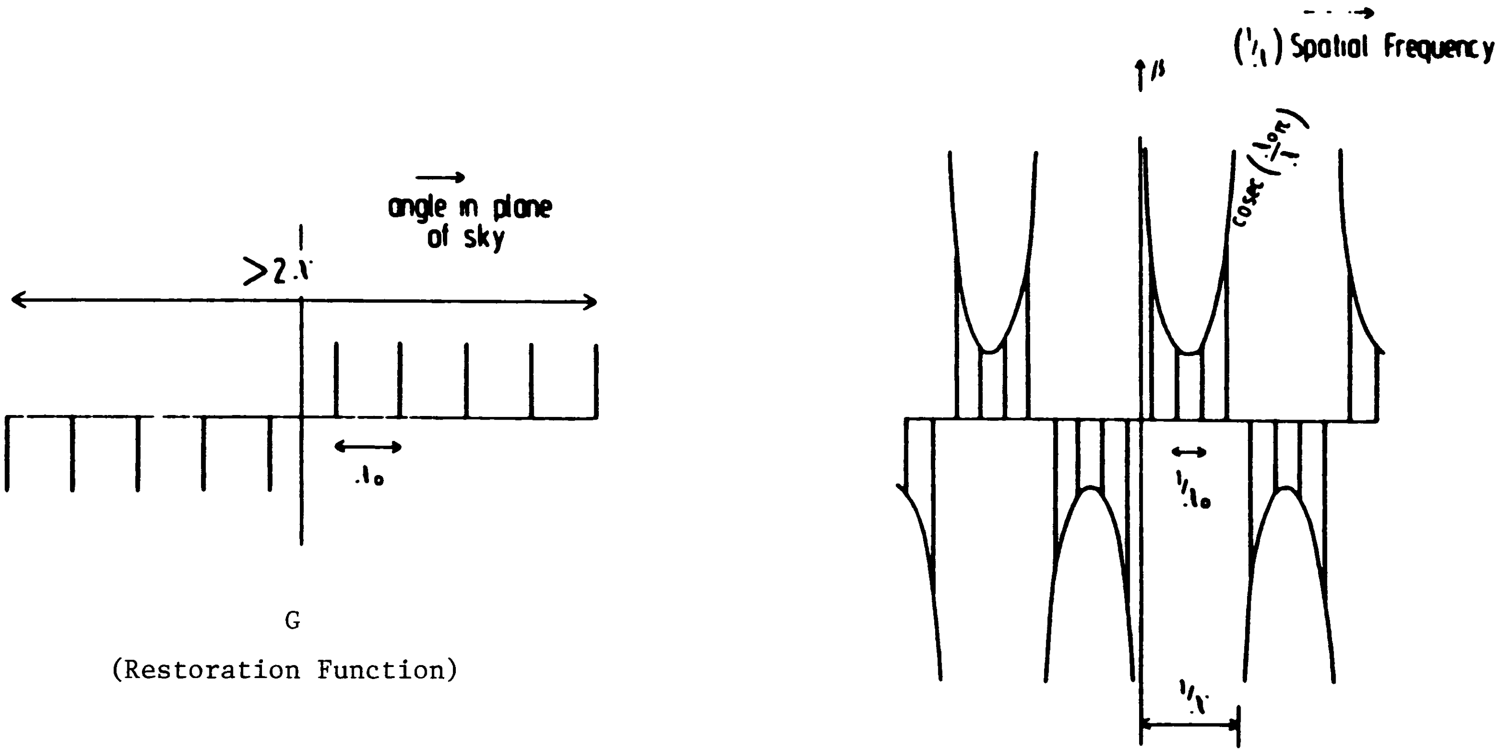
Thus, $$p = i \times (1/d) \qquad 5)$$

and $$P = I * G \qquad 6)$$

where G is the Fourier transform of (1/d), see Fig. 4.

We see that convolving the scans of our map with the function G of Fig. 4 will restore the equivalent single-beam observation. Note that G is made up of $\delta$-functions spaced by the angular separation of the two beams. The effects of the convolution with G on the signal-to-noise ratio as a function of spatial frequency, and details of the handling of finite sampling, are to be found in Emerson et al (1979) and Klein (1978).

In practice, a number of factors affect the application of the method. Firstly, the cancellation of atmospheric emission is always less than 100%, both due to less-than-complete overlap of the two beams within the atmosphere and fluctuations in the emission more rapid than the frequency of switching between the beams. Smaller beam separations cancel the atmospheric emission more completely, although as wide a separation as possible is desired to maximize the signal-to-noise ratio when mapping a large field (see below). If the weather is too choppy, it is probably



G

(Restoration Function)

(1/d)

Fig. 4.

time to consider spectroscopy! Secondly, the polar diagrams of the two beams can differ at low levels due to coma lobes or the beams may have slightly different gains. These differences, along with uncertainties in the separation-geometry of the two beams, can be the limiting factors on the dynamic range obtained for strong sources. The present implementation of the method permits a correction for the effect on the astronomical results of differing beam gains. Thirdly, the noise level increases for fields whose dimensions are many times the beam separation (see below).

The dynamic range of the final map can be improved by making several coverages of the source at different sidereal intervals, (and hence parallactic angles), and then combining the restored images. This will also reduce the variations of signal-to-noise ratio as a function of spatial frequency.

The intrinsic noise ripple on a dual-beam map following restoration can be approximated (in the case of perfect cancellation of atmospheric emission) to

$$\Delta T = \frac{\sqrt{n}\, T_{sys}}{\sqrt{\beta\tau}} \qquad 7)$$

where, $\tau$ is the integration time per point in the final map.

$\beta$ is the bandwidth

and $n$ is the total scan length in units of the beam separation.

## 3. Preparing and Making Observations

In planning observations, a number of factors should be borne in mind when deciding how to programme your observations. You will be making a raster in azimuth and elevation and must allow for the necessary extra scan length to accommodate the two beams, as well as the region of interest. A simple and safe way when choosing the size of region to map is to pick a square field size that would cover adequately the largest dimension of the source if observing with a single beam. Allow sufficient zerolevel at the edges of the field. Add the separation of the two beams to the azimuth scan length. Choose a sampling interval (grid size) that is no greater than about (H.P.B.W. / 2.5).

When deciding on the total integration time needed to achieve your mapping objective, bear equation (7) in mind. You will usually get better results if the integration time per point, $\tau$, is obtained via several maps (Say N), giving an integration time per map per point of $\tau/N$. Remember, however, that for technical reasons the 12-m telescope acquires data at present by stepping between adjacent sampling points, rather than by continuous scanning. Thus, there is 1 to 1.5 sec dead-time between each integration and it is impractical to shorten the individual integration time too much. A sensible compromise is probably 4 - 10 sec per map per point.

Detailed instructions for commanding the telescope to make an azimuth-elevation map (currently known as 360 and 361 LOAD) are to be found in the continuum section of the Observers' Reference Manual (soon to be obtainable from the Friend of the Telescope). Here we will just stress the importance of making sure that a suitable pointing correction has to be applied in azimuth to bring the nominal pointing zero to a point midway between the two beams.

Be sure to make sufficient atmospheric tips (TPTIP or SPTIP) to allow for variations in atmospheric absorption with time. At frequencies where a noise source is available (currently λ3 mm), frequent CALIBRATES should be performed.

At least one calibration source should be mapped per day. The most accurate flux density calibration is achieved if a similar sized area is covered to that chosen for programme sources. The ideal calibration source should be strong, with angular diameter much less than the telescope H.P.B.W. and of known, or predictable, flux density. With the present receivers at λ3 mm, Saturn is close to this ideal, while Venus and Jupiter are worthy of consideration. The situation at λ1 mm is less satisfactory, but Saturn, or Mars (with subsidiary calibration to the brighter planets), could be reasonable choices. Again, despite larger angular diameters, Jupiter and Venus can be used. Sufficient "five-point" measurements of standard sources over a wide elevation range should be obtained. These are used both to determine the best telescope pointing for off-line analysis and to look for possible gain-elevation effects.

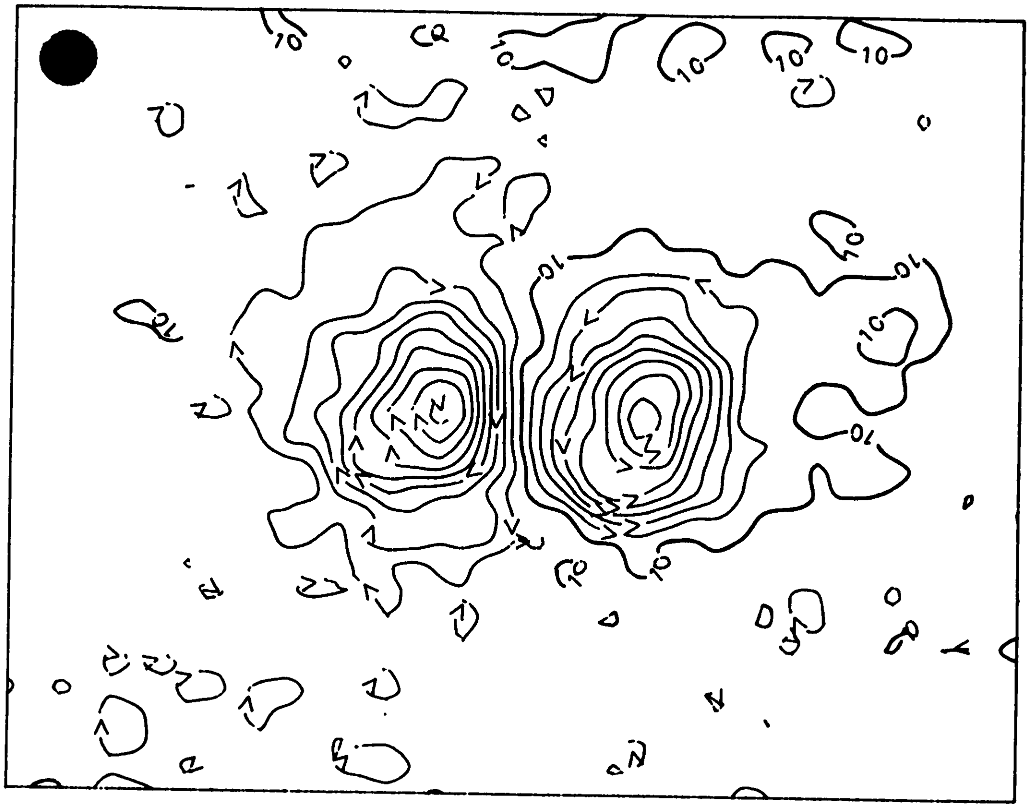
## 4. Data Analysis: General Remarks

The data reduction system for making restored, R.A.-dec maps from 12-m telescope data consists of a set of stand-alone analysis programs that lean heavily on the NOD2 programme library (Haslam, Astron. Astrophys. Suppl., 15, 333, 1974). As an example, Fig. 5 shows a single az-el, dual-beam coverage of the HII region, Orion A, the restored az-el map and the result of combining 3 such maps transformed into R.A.-dec (Gordon, Jewell, Kaftan-Kassim and Salter).

A limited number of post-processing options are available and a plot package can be used with the Zeta pen-plotter in Tucson. Maps can be written to magnetic tape and transported in either NOD2-internal, ASCII or FITS format. The FITS to NOD2 interface can be used to transfer 12-m telescope maps to an AIPS environment, or to transfer a FITS map made elsewhere into NOD2 format. Observatories currently supporting NOD2 include MPIFR (Bonn), IRAM (Grenoble and Granada), CSIRO (Parkes and Epping), Nobeyama, Bologna, Jodrell Bank and TIFR (Bangalore).

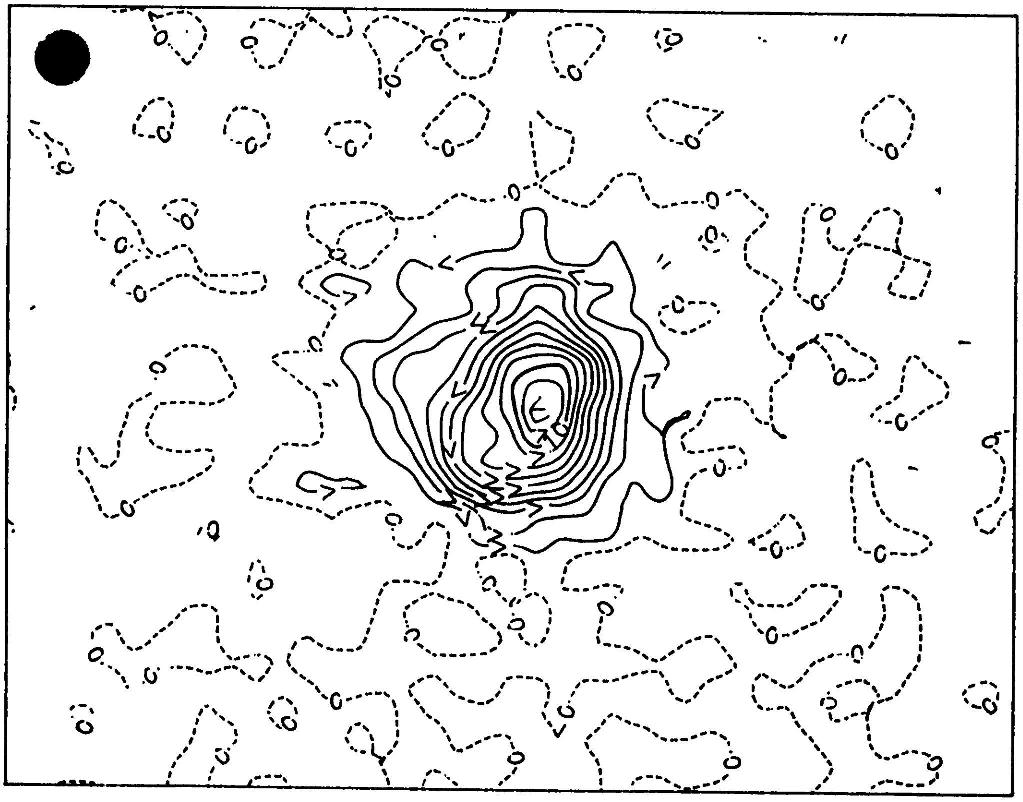
The mapping-data analysis programs are used via the Tucson CONDAR programs. They are available interactively to CONDR1 and CONDR2 users through the VMS SPAWN facility. At the end of each operation, control is returned to CONDAR. All maps, both intermediate and final versions, are stored on the main disk as files with extensions .NOD . Users are advised to stick to a rigorous naming policy for files to avoid confusion. Default names are suggested in the next section. The user should clear the disk of his files before leaving the mountain or town, having first prepared a magnetic tape of the images he wishes to export.

Maps can be made at the telescope as soon as an observation is complete. This is useful as a first-look. However, observers may prefer to make their final, calibrated maps off-line at the Tucson office later. If this is the case, they should arrange



ORION A AT 84.2 GHZ, DUAL-BEAM MAP.

Fig. 5 i)



ORION AT 84.2 GZ, RESTORED MAP.

Fig. 5 ii)

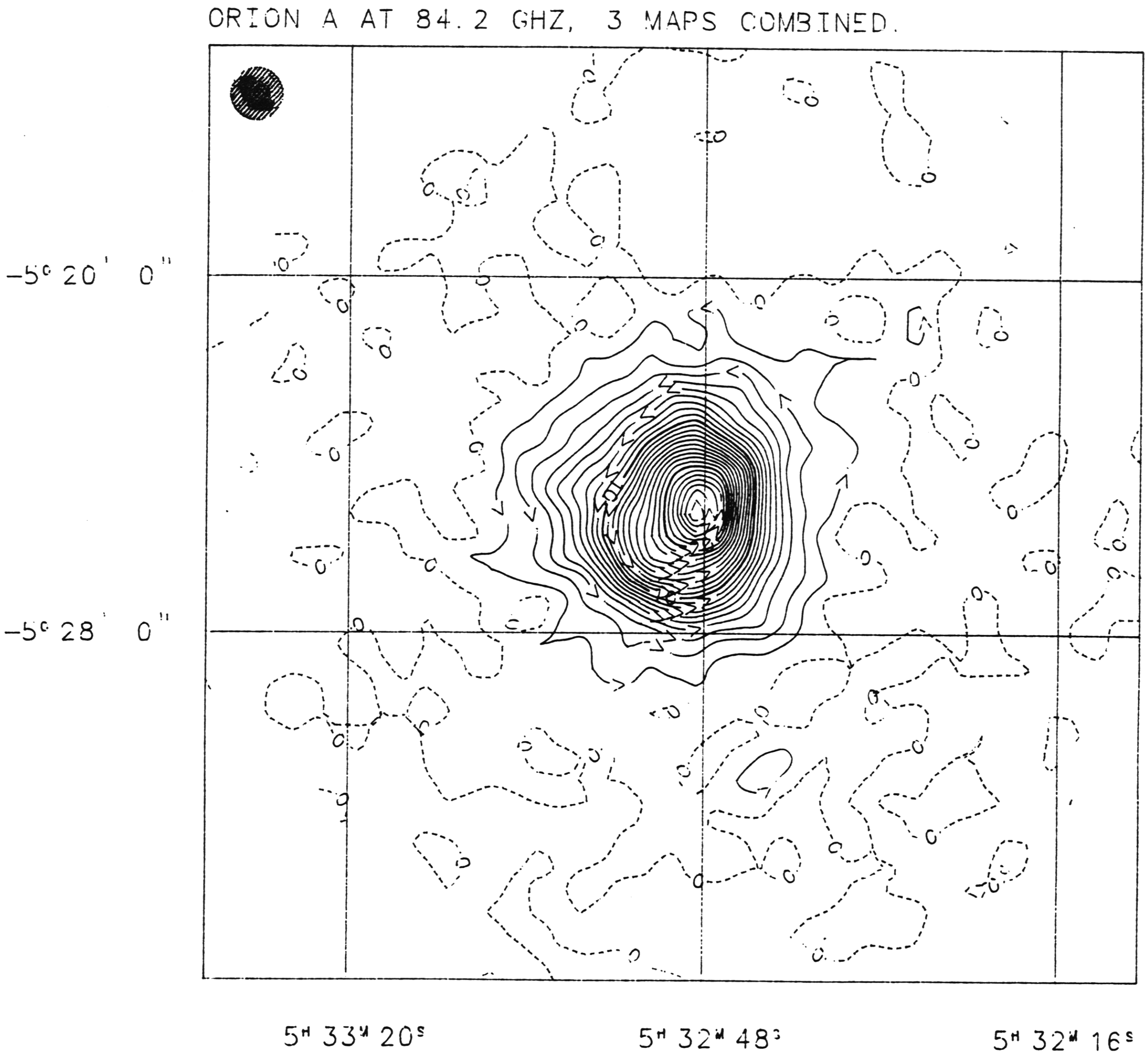

ORION A AT 84.2 GHZ, 3 MAPS COMBINED.
-5° 20' 0"
-5° 28' 0"
5H 33M 20S
5H 32M 48S
5H 32M 16S

Fig. 5 iii)

with the telescope staff to have the appropriate Pops Data File (PDFL.DAT) transferred to tape or disk for transport to Tucson.

In respect of the basic data reduction package, there is one point of which the observer should be aware, even though it is essentially transparent. Before transformation from the az-el frame into R.A.-dec, each map grid has an associated grid of sidereal times that is used in making the transformation. These sidereal times can be listed via the task MLIST, but should be otherwise hidden.

## 5. A Suggested Standard Path for Data Reduction

In this section we will describe the simplest possible passage from raw telescope data to a calibrated R.A.-dec map. Program sources and calibration sources need somewhat different processing. The processing is detailed in this section and the calibration process is described in Section 6. The format for NOD2 maps is given in Appendix A, while Appendix B describes each of the available tasks in alphabetical order.

The basic flow described here has proved sufficient for almost all cases to date. Suggested names for the files produced by each task are given. Proceed as follows, reducing calibration sources first,

i) Examine each scan as the telescope completes it using the POPS procedure M (see CONDAR manual). This can reveal problems ranging from observer errors in setting up the map to the onset of bad weather or receiver malfunctions.

ii) Gather together the calibration data you wish to use in making the map. This step can be bypassed altogether if you are having a "quick-look" or are prepared to accept the values of noise-source cals, atmospheric opacity and telescope pointing that were used by the PDP11/40 during the observation. If, however, you wish to update the noise-source calibration (#C or #CP) or atmospheric opacity, tabulate the local sidereal times and values of relevant measurements made before and after the observation. The task MAKMAP will apply a linear interpolation using these values across the observation.

If you wish to correct for an elevation-dependent pointing error, prepare the file FIVEPT.DAT on disk in the relevant VAX-user area using the EDT editor. The file FIVEPT.DAT has the format,

```
     Beam Separation (arcsec)
     Elevation (decimal degs), Az offset (arcs), El offset (arcs)
     .....................
     (repeat, one line per five-point measurement)
     .....................
     -999 (end of pointing data flag)
```

If more than one set of pointing data apply (for example if the two receiver channels have different pointing and you wish to analyze them via a single call to MAKMAP), the extra sets of pointing data should follow on after each -999, in the same file FIVEPT.DAT. See Appendix B for a description of entering the data in FIVEPT.DAT into MAKMAP. The az and el offsets are the revised thumbwheel values printed at the bottom right of the output of

CONDAR procedure F.

iii) Make the basic dual-beam map from the raster of scans in PDFL.DAT using the task MAKMAP. (Suggested filename is XXXXRAW, where XXXX is an identifier chosen by the user of from one to six letters.) The operation of MAKMAP, and all other tasks, is described in Appendix B.

iv) Look at the dual-beam map on the graphics terminal using task TOOLKIT. If necessary, edit bad points in the map within TOOLKIT. If you have performed any editing, output the map before exiting TOOLKIT (suggested filename XXXXMOD).

v) If the source is a calibrator, make two-dimensional Gaussfits to the map with task AZELFIT. See Section 6 to find how these fits are used in the calibration process.

vi) The task RESTOR converts the dual-beam map into the equivalent single-beam representation (suggested filename XXXXRES). Three numbers defining the dual-beam geometry (separation, angle and gain ratio) are entered to permit the restoration. If the source is a calibrator you can stop at this stage and follow the procedure described in Section 6.

vii) Run task SETBASE (suggested filename XXXXBAS) to take out small gradients along the scan that can be introduced during the restoration process. The scaling from raw map units into (say) mK of effective brightness temperature can be performed by this task, using the results of the intensity calibration.

viii) The task CONVERT transforms the az-el maps into R.A.-dec coordinates. Following transformation, it discards the now-redundant, sidereal time information. CONVERT can stack together several az-el maps into a single R.A.-dec map, or add a further az-el map into an existing R.A.-dec map made by CONVERT. The maps are stacked with weighting that is inversely proportional to the square of the effective system temperature.

ix) If the resultant map seems acceptable when examined by TOOLKIT, you can proceed with post-processing, making publication-quality plots and saving the final images on magnetic tape.

## 6. Calibration

### i) The Dual-Beam Parameters

The parameters describing the dual-beam geometry needed by RESTOR are obtained from Gaussfits (via task AZELFIT) to the dual-beam map of a calibration source produced by MAKMAP. These parameters are,

a) The separation of the positive and negative beams in arcmin.

b) The angle, in degrees, that the line joining the two beams makes with the horizontal (ideally 0°). This is measured anticlockwise with azimuth increasing to the right.

c) The ratio of the beam gains in the sense left hand beam to right (with azimuth increasing to the right). If the left hand beam is the negative beam (the current 12-m situation), then the ratio of the gains is conventionally taken to be negative. If you get the sign of the ratio wrong, the restored map will be the negative of your expectations (i.e. the sources become holes!).

## ii) The Brightness Calibration

The most convenient units in which to calibrate the intensity scale of a 12-m telescope map seems to be mK of full-beam effective brightness temperature. The calibration from map units (mu) into mK can be obtained in two ways. As the second method is only strictly applicable to calibration via a point source (while often millimeter-wave calibration will use the finite-sized planets), it is recommended as a cross-check and for determination of full-beam solid angle.

Method 1: Look up the total flux density of your calibrating source, or compute its total flux density for the observing epoch if it is a planet. We will call this $S_{TOT}$.

Once RESTOR has been run on the calibrating source, integrate the restored map of the source using FLUX. Tell the program that the units are mK even though they are not (i.e. enter 0.001 into FLUX when asked for the scaling factor from mu into degrees K)! FLUX will tell you that the flux density of the source is $S_{COMP}$.

The conversion factor from mu into mK (effective full-beam brightness temp.) is then

$$\frac{S_{TOT}}{S_{COMP}} \text{ mK/mu}$$

Method 2: (Applicable only to point sources)

Once RESTOR has been run on your calibrating source, integrate the restored map using the task CALFLUX which will give the result ($A_{CAL}$) in units of mu.steradians.

Make a Gaussfit to the map with AZELFIT and note the peak intensity of the source ($I_{CAL}$) in units of mu. The full-beam solid angle of the telescope, $\Omega_B$, is given by,

$$\Omega_B = \frac{A_{CAL}}{I_{CAL}} \text{ steradians}$$

Applying the Rayleigh-Jeans approximation (as we are calibrating in effective brightness temperature), for a point source the ratio of flux density to full-beam brightness temperature (S/T) is given by,

$$\frac{S}{T} = \frac{2k\Omega_B}{\lambda^2} = g \text{ (say)}$$

and

$$g = \frac{2.76 \text{ X } 10^9 \ \Omega_B \text{ (ster)}}{\lambda^2_{mm}} \text{ Jy/K (or mJy/mK)}$$

Now, if the calibrating point source has a flux density of Sp in mJy, its effective full-beam brightness temperature will be Sp/g in mK, and the scale factor is Sp/(g $I_{CAL}$) mK/mu.

## 7. Concluding Remarks

The present 12-m telescope continuum mapping system, as described in this document, is complete within itself but should not be considered as an end-point. Much additional software, especially post-processing aspects, can be easily provided and already exists at other observatories using NOD2 (see The Hitch-Hikers Guide to NOD2, M.P.I.F.R., Bonn).

A number of new hardware features will improve the continuum mapping potential of the 12-m. Firstly, the new generation of receivers, now under development, should provide vastly improved sensitivity. Also, a digital continuum back-end will be available within the next few months giving much greater accuracy and flexibility in data acquisition and processing. Hand-in-hand with this back-end will come a continuous gain calibration method which will greatly improve the certainty of the data calibration. A fast beam-switcher located at the telescope vertex is also to be introduced. This will allow beam-switching at rates of up to 100 Hz and give improved blanking between phases, more time on source and better sensitivity by reducing '1/f' noise.

A number of possible developments exist for the longer term. Emerson et al demonstrated that the ideal high frequency system should have not a dual-beam, but triple-beam, capability. The advantages of also developing a focal-plane array do not need to be spelled out. Finally, the present system maps only the total intensity of celestial sources. The possibility of measuring the polarization properties of the emission would add much to the astronomical potential of the system.

A new control system is planned for the telescope, to be installed in 1987. It is hoped that telescope scanning, rather than stepping, will then be possible. This would raise the data-taking efficiency of the telescope enormously, an important factor in view of the anticipated high sensitivity receivers.

# Appendix A

## Data Formats

### i) Raw Scan Data Format

The scans, as fresh from the telescope, are in POPS CONTINUUM MAPPING format. These scans are stored in the file PDFL.DAT, are accessible to the CONDAR routines and are used by the task MAKMAP. All maps are scanned in azimuth-elevation from lower left corner to top right corner. The current format is as follows,

| Integer ITWH | Real TWH | Double DTWH | Type | Contents | Units |
|---|---|---|---|---|---|
| | 1 | | R*4 | Scan Identification Number | |
| 3-8 | | | I*2 | Source Name (12) | |
| 9-18 | | | I*2 | Obsr. Initials (4)<br>Opr. Initials (4) | |
| 19 | | | I*2 | Channel Number | |
| 20 | | | I*2 | # Blocks for this Scan | |
| | | 6 | R*8 | Modified Julian Date from 1 Jan 1950 | |
| 25 | | | I*2 | Month | |
| 26 | | | I*2 | Day | |
| 27 | | | I*2 | Year | |
| 28 | | | I*2 | Not Used | |
| | 15 | | R*4 | LST of scan start | Rad |
| | 16 | | R*4 | UT of scan start | Rad |
| 33 | | | I*2 | Telescope | |
| 34 | | | I*2 | Type of Observing | |
| 35 | | | I*2 | Scan Type | |
| 36 | | | I*2 | Number of Points | |
| 37 | | | I*2 | START | |
| 38 | | | I*2 | STOP | |
| 39 | | | I*2 | Number of Columns (Grid points per row) | |
| 40 | | | I*2 | Number of Rows | |
| | 21 | | R*4 | Total No. of Channels | |
| | 22-23 | | R*4 | Not Used | |
| | 24 | | R*4 | Scan Time | Sec |
| | 25 | | R*4 | Not Used | |
| | 26 | | R*4 | Integration Time/ Point | Sec |
| | 27 | | R*4 | % Efficiency | %/100 |
| | 28 | | R*4 | Azimuth Offset (Thumbwheel) | Sec Arc |
| | 29 | | R*4 | Elevation Offset (Thumbwheel) | Sec Arc |
| | 30 | | R*4 | Telescope Azimuth at Scan Start | Rad |
| | 31 | | R*4 | Telescope Elevation at Scan Start | Rad |
| | 32 | | R*4 | Focus Offset (F0) | mm |
| | 33 | | R*4 | Not Used | |
| | 34 | | R*4 | Zenith Attenuation (ATTN) | %/100 |
| | 35 | | R*4 | Tracking Tolerance (TOL) | Sec Arc |
| | 36 | | R*4 | Not Used | |
| | 37 | | R*4 | Not Used | |

| Integer ITWH | Real TWH | Double DTWH | Type | Contents | Units |
|---|---|---|---|---|---|
| | 38 | | R*4 | Grid Point Separation | Sec Arc |
| | 38 | | R*4 | HP | Sec Arc |
| | 40 | | R*4 | Not Used | |
| | 41 | | R*4 | Az. offset of scan start from field centre (real angle, without thumbwheels) | Sec Arc |
| | 42 | | R*4 | El. offset from field centre (without thumbwheels) | Sec Arc |
| | 43-44 | | R*4 | Reference Offsets | Sec Arc |
| | 45 | | R*4 | #C (Switched-power noise tube counts) | |
| | 46 | | R*4 | #CP (Total-power noise tube counts) | |
| | 47 | | R*4 | Map Centre RA (epoch) | Rad |
| | 48 | | R*4 | Map Centre DEC (epoch) | Rad |
| | 49 | | R*4 | TC (noise tube temp.) | Deg K |
| | 50 | | R*4 | System Temperature | Deg K |
| | 51 | | R*4 | Not Used | |
| | 52 | | R*4 | Not Used | |
| | 53 | | R*4 | Bandwidth | MHz |
| | 54-99 | | R*4 | Not Used | |
| | 100 | | R*4 | #ROW (number of the current map row starting from 1) | |
| | 101 | | R*4 | NROW (total number of rows in the full grid) | |
| | 102 | | R*4 | Map centre RA(1950) | Rad |
| | 103 | | R*4 | Map centre DEC(1950) | Rad |
| | 104-125 | | R*4 | Not Used | |
| | 126 | | R*4 | Wavelength | mm |
| | 127 | | R*4 | Ambient Temperature | Deg C |
| | 128 | | R*4 | Elevation Axle Temp. | Deg C |
| | 129-224 | | R*4 | Data Values | Deg K |
| | 225-384 | | R*4 | Mean LST of data values | Rad |

### ii) NOD2 Scan Format

Within the task MAKMAP the raw POPS scans are corrected for gain calibration and atmospheric attenuation variations. They are also regridded for pointing errors and filtered to remove "non-astronomical" Fourier components, before being combined to produce the raw map. For part of this operation the scans are put into NOD2 scan format. Although the average user will not need to know this format, it is included here for completeness. The format is compatible with that of general NOD2 documents (see Appendix A iii).

The one dimensional array, SCAN, has the following six types of information stored in it. (Page references are to the NOD2 Manual. The values set in the elements of SCAN by MAKMAP are given in parentheses.)

| Type of information | | Where stored |
|---|---|---|
| 1) Length of space declared for array SCAN. | | SCAN(1) |
| 2) Organizational parameters. | | SCAN(2) to SCAN(6) |
| 3) Progress word (see subroutine STORY Page B 2.2) | | SCAN(7) |
| 4) The identifying title. This is compatible with routines TREAD and TPRINT (see Page B 2.1) | | SCAN(8) to SCAN(25) |
| 5) Parameters associated with the data. | | SCAN(26) to SCAN(I-1) |
| | where | I=SCAN(2) |
| 6) The tabular scan data. | | SCAN(I) to SCAN(J) |
| | where | IPOINTS=SCAN(3)<br>ICHANS=SCAN(4) |
| | then | J=IPOINTS*ICHANS+I-1 |
| | also | J=MSIZE(SCAN) |

The organizational parameters are:

| | |
|---|---|
| SCAN(1) | This is the length of the array SCAN as declared by a dimension statement at the top of the job. It is used by MAPOUT and MAPIN when SCAN is transferred to or from mass storage and core. It is checked to prevent overwriting. |
| SCAN(2) | This contains the address of the first data location of the first tabular scan channel. (SCAN(2) = 200 in MAKMAP) |
| SCAN(3) | This contains the number of tabular points contained in each channel. (SCAN(3) = ITWH(39)) |
| SCAN(4) | This contains the number of channels stored in the tabular scan array. (SCAN(4) = 5) |
| SCAN(5) | This is the type number of scan data for tabular scans. 15.0 < SCAN(5) < 20.0. These are defined as:<br>A tabular Azimuth scan with positive sense = 16.0<br>A tabular Azimuth scan with negative sense = 17.0<br>A tabular Elevation scan with positive sense = 18.0<br>A tabular Elevation scan with negative sense = 19.0<br>(SCAN(5) = 16) |
| SCAN(6) | This is the dummy value that has been placed in empty or faulty data elements. SCAN(6) = 0.0 means that all dummy tests will be overlooked. (SCAN(6) = -999999.5) |
| SCAN(7) | This is the progress code word, see routines TREAD (Page B 2.1) and STORY (Page B 2.2) (Initially SCAN(7) is zeroed.) |

| | |
|---|---|
| SCAN(8-25) | The identifying title is chosen by the user and can be read in by subroutine TREAD or generated by subroutine RENAME. This title is printed by many library subroutines to identify the analysis data. The title is stored in SCAN(8) to SCAN(25). (Title is a copy of ITWH(3) to ITWH(18)<br>SCAN(24) = Date of running MAKMAP<br>SCAN(25) = Usertag) |

Astronomical Parameters for tabular scans:

| | |
|---|---|
| SCAN(26) | Epoch of observation in years.<br>(SCAN(26) = 1950. + DTWH(6) / 365.25) |
| SCAN(27) | Frequency of observation in MHz.<br>(Frequency is negated for az-el scans) |
| SCAN(28) | Latitude of observatory in degrees.<br>(SCAN(28) = 31.95333) |
| SCAN(29) | Azimuth offset of start of scan (real angle).<br>(In degrees relative to map centre) |
| SCAN(30) | Elevation offset of start of scan.<br>(In degrees relative to map centre) |
| SCAN(31) | Coordinate code. (SCAN(31) = 21) |
| SCAN(32-40) | 9 Element transformation matrix from the coordinate system of the map to RA,Dec epoch 1950.0.<br>(see AMAP(31-40), for definitions of SCAN(31-40))<br>(Matrix to RA,Dec(1950) for map centre) |
| SCAN(41) | Initial 1/2 power longitude beamwidth in degrees on the equator of the coordinate system.<br>(Entered by observer in MAKMAP) |
| SCAN(42) | Initial 1/2 power latitude beamwidth on the equator of the coordinate system. (= SCAN(41)) |
| SCAN(43) | Current 1/2 power longitude beamwidth (=SCAN(41)) |
| SCAN(44) | Current 1/2 power latitude beamwidth (=SCAN(41)) |
| SCAN(45) | The longitude tabular interval between points in degrees.<br>(SCAN(45) = TWH(38)/3600) |
| SCAN(46) | The latitude tabular interval between points in degrees.<br>(SCAN(46) = SCAN(45)) |

| | | |
|---|---|---|
| SCAN(47) | Long 1 | The starting longitude of the scan.<br>(SCAN(47) = SCAN(29)) |
| SCAN(48) | Lat 1 | The starting latitude of the scan.<br>(SCAN(48) = SCAN(30)) |
| SCAN(49) | Long 2 | The ending longitude of the scan.<br>(SCAN(49) = SCAN(47) + (SCAN(3) - 1) *SCAN(45)) |
| SCAN(50) | Lat 2 | The ending latitude of the scan.<br>(SCAN(50) = SCAN(48)) |
| | | All above angles are in degrees. |
| SCAN(51) | | Not used. |
| SCAN(52) | | The scan identifying number .<br>(SCAN(52) = TWH(1)) |
| SCAN(53) | | Not used. |
| SCAN(54) | | Not used. |
| SCAN(55) | Start gain | The calibration normalising factor at the start of the scan.<br>(SCAN(55) = 1) |
| SCAN(56) | Stop gain | The calibration normalising factor at the end of the scan. The scans are normalised by dividing each point by a linear interpolation start gain and stop gain.<br>(SCAN(56) = 1) |
| SCAN(57) | Start base | The base-level to be subtracted from the scan start. |
| SCAN(58) | Stop base | The base-level to be subtracted from the scan end. The base-levels are subtracted at each point by linear interpolation after normalisation.<br>(SCAN(57) = SCAN(58) = 0) |
| SCAN(59-79) | | Not used. |
| SCAN(80) | | Integration time per point in secs (= TWH(26)) |
| SCAN(81) | | % Efficiency in %/100 (= TWH(27)) |
| SCAN(82) | | Azimuth Thumbwheel in arcsec (= TWH(28)) |
| SCAN(83) | | Elevation Thumbwheel in arcsec (= TWH(29)) |

| | |
|---|---|
| SCAN(84) | Focus Offset in mm (= TWH(32)) |
| SCAN(85) | Zenith attenuation in %/100 (= TWH(34)) |
| SCAN(86) | Tracking tolerance in arcsec (= TWH(35)) |
| SCAN(87) | #C (switched power noise tube counts) (= TWH(45)) |
| SCAN(88) | #CP (total power noise tube counts) (= TWH(46)) |
| SCAN(89) | RA (Epoch) of map centre in degs (= TWH(47)*180/$\pi$) |
| SCAN(90) | DEC (Epoch) of map centre in degs (= TWH(48)*180/$\pi$) |
| SCAN(91) | TC (noise tube temp.) in K (= TWH(49)) |
| SCAN(92) | Bandwidth in MHz (= TWH(53)) |
| SCAN(93) | Ambient temperature in °C (= TWH(127)) |
| SCAN(94) | Total no. of rows in full grid, NROW (= TWH(101)) |
| SCAN(95) | No. of current map row starting from 1, #ROW (= TWH(100)) |
| SCAN(96) | Azimuth offset of scan start from field centre. (Real angle, without thumbwheels) (= TWH(41)) |
| SCAN(97) | Elevation offset of scan from field centre. (without thumbwheels) (= TWH(42)) |
| SCAN(98) | Receiver temperature in K, $T_{RX}$ (Entered by observer in MAKMAP) |

## The Data:

The first data element is in SCAN(K) where K=SCAN(2). The tabular scan data is held in SCAN(4) tabular channels. Each tabular channel has SCAN(3) points. The data runs from the lowest azimuth to the highest azimuth.

| | |
|---|---|
| Channel 1 | Contains the local sidereal time associated with each point. |
| Channel 2 | Not used. |
| Channel 3 | Not used. |
| Channel 4 | Contains the astronomical signal for each point in scan. |
| Channel 5 | Not used. |

### iii) NOD2 Map Format

The maps made by MAKMAP, and processed by subsequent routines, are in NOD2 map format. This is very similar to the format detailed in Appendix A ii). Again, page references are to the NOD2 Manual. The grid of local sidereal times associated with the az-el maps is an identical NOD2 array, having an l.s.t. in the corresponding position of each associated data value.

The data is assumed to be tabulated on a two dimensional rectangular grid of points. For this data to be compatible with the routines of the library, the grid of numbers is packed into a one-dimensional data array along with an identifying title and associated parameters.

This one-dimensional array, AMAP, has the following six types of information stored in it.

| Type of information | | Where Stored |
|---|---|---|
| 1) Length of space declared for AMAP. | | AMAP(1) |
| 2) Organisational parameters. | | AMAP(2) to AMAP(6) |
| 3) Progress word (see subroutine STORY). | | AMAP(7) |
| 4) The identifying title. | | AMAP(8) to AMAP(25) |
| 5) Parameters associated with the data. | | AMAP(26) to AMAP(I-1) |
| | where | I = AMAP(2) |
| 6) The data. | | AMAP(I) to AMAP(J) |
| | where | J = I-1+COLUMNS*ROWS |
| | i.e. | J = I-1+L*M |
| | | L = AMAP(3) |
| | | M = AMAP(4) |

The organisational parameters are:

| | |
|---|---|
| AMAP(1) | This is the length of the array AMAP as declared at the top of the job. AMAP(1) is used by several routines for array bound checking purposes. |
| AMAP(2) | This is the array address of the first data location. (AMAP(2) = 101 from MAKMAP) |
| AMAP(3) | This is the number of columns in the two-dimensional distribution. |
| AMAP(4) | This is the number of rows in the two-dimensional distribution. |
| AMAP(5) | This is the type number of the data. At the present time the following types of data are catered for: |

| Type of data: | AMAP(5) |
|---|---|
| A two-dimensional distribution of brightness. | 1 |
| A two-dimensional distribution of normalised brightness preserving weight. (Normalised quantity.weight +0.5) | 2 |
| A two-dimensional distribution of unnormalised brightness in the form: (unnormalised quantity.weight +0.5) | 3 |
| A two-dimensional distribution of weights (see subroutine MADD P 5.1). | 4 |

| Type of data, cont'd.: | AMAP(5) |
|---|---|
| A set of many one-dimensional distributions, i.e., tabulated scans packed together where AMAP(3) gives the length of each scan, and AMAP(4) the number of scans. The units digit of the code word has the same meaning as for types 1-3. | 11<br>12<br>13 |
| A two-dimensional tabulated beam function for use in convolution by the subroutine SMOOTH (see page P 3.1). | 21 |
| Two one dimensional beam functions stored X,Y for use in convolution. | 22 |
| An array containing parameters and a title, but no data. This is used in convolution where a Gaussian smoothing function is computed automatically. (See subroutine SMOOTH - type 23 convolution.) | 23 |

| | |
|---|---|
| AMAP(6) | This is the dummy value that has been placed in empty or faulty data elements. AMAP(6) = 0.0 means all dummy tests will be overlooked. (AMAP(6) = -999999.5 from MAKMAP) |
| AMAP(7) | This is the progress code word (see routines TREAD page B 2.1 and STORY page B 2.2). |
| AMAP(8-25) | The identifying title, date made and user name. This is normally compiled by TREAD (see page B 2.1) |

## Data Associated Parameters:

The parameters associated with the data can be of any number and stored in the correct section of the array AMAP(26) to AMAP(I) where I = AMAP(2)-1 in any order the user chooses. The exceptions to this are the astronomical processing routines and the case history routine STORY (see page B 2.2). These routines assume the data parameters have the following order and meaning:

| | |
|---|---|
| AMAP(26) | Epoch of observation, i.e. 1971.6. |
| AMAP(27) | Frequency of observation in MHz. (Frequency is negated for Az-El maps.) |
| AMAP(28) | Latitude of observatory in degrees. |
| AMAP(29) | Longitude of AMAP(1,1) in degrees. |
| AMAP(30) | Latitude of AMAP(1,1) in degrees. |

| | |
|---|---|
| AMAP(31) | Coordinate code (see MSETUP,COMBIN,MRETAB, and SMOOTH - type 23 convolution, parameter ICOORD page P 3.9). |
| AMAP(32-40) | 9 Element transformation matrix from the coordinate system of the map to RA,DEC epoch 1950. (See DANGLE page M 9.1 and VECMAT page M 11.1 for vector and matrix definitions. AMAP(32-40) = AMAT(1-9)). |
| AMAP(41) | Initial 1/2 power longitude beamwidth on the equator of the coordinate system in degrees. |
| AMAP(42) | Initial 1/2 power latitude beamwidth on the equator of the coordinate system in degrees. |
| AMAP(43) | Current 1/2 power longitude beamwidth on the equator of the coordinate system in degrees. |
| AMAP(44) | Current 1/2 power latitude beamwidth on the equator of the coordinate system in degrees. |
| AMAP(45) | The longitude separation of the grid points on the equator of the coordinate system in degrees. |
| AMAP(46) | The latitude separation of the grid points in degrees. |
| AMAP(47) | Initial temperature scale factor. |
| AMAP(48) | Initial temperature scale zero (K). |
| AMAP(49) | Current temperature scale factor. |
| AMAP(50) | Current temperature scale zero (K). |

In the current implementation at N.R.A.O. (Tucson), the locations AMAP(51) to AMAP(99) contain the following parameters.

| | |
|---|---|
| AMAP(51-79) | Not Used. |
| AMAP(80-98) | Direct copy of SCAN(80-98) for the first scan of the map. |
| AMAP(99) | Normalised effective signal-to-noise ratio, R, used by CONVERT to weight the map when combining it with other data. CONVERT gives the map a weight of AMAP(99)*AMAP(99)*AMAP(80) |

$$R = \frac{300.e^{-\tau.\sec Z}}{T_{RX}\ (1 + \frac{T_{AMB}}{T_{RX}}\ (1 - \varepsilon_{\ell} e^{-\tau.\sec Z}\ ))}$$

where $\tau$ is the zenith attenuation

Z is the zenith angle of the central scan

$T_{RX}$ is the receiver temp. in K

$T_{AMB}$ is the ambient temp. in K

$\varepsilon_{\ell}$ is the coupling coefficient to the sky (assumed to be 0.85)

The factor of 300 is to normalise R close to unity.

The Data:

The data for arrays of type number 1-3 are values at points in a two-dimensional rectangular grid. In the one-dimensional array AMAP the data is stored by row. The convention adopted is such that the first elements of data are the bottom row of the grid from left to right, and the last elements are the top row from left to right.

In a type 1 array (AMAP(5) = 1.0) the data has a pure value. In type 2 and 3 the data is of the form: value.weight, where 0.5 is defined to be zero weight and the weights lie in the range 1.0>weight>0.0, i.e. 57.3 represents a value of 57.0 (normalised if type=2, unnormalised if type=3) with weight -0.2.

## Appendix B

### Dictionary of Tasks:

Those NOD2 tasks currently available to users through CONDAR are listed alphabetically in this Appendix, along with an example of the operation of each.

One feature of NOD2 of which the user should be aware is that a NOD2-file can contain any number of maps ($N \geq 1$). These maps are written and accessed sequentially.

The available tasks can be considered under four headings,

#### i) Map Making and Calibration

AZELFIT
CALFLUX
CONVERT
MAKMAP
RESTOR
SETBASE

#### ii) Display and Editing

CNTR
DRAW
MAXMIN
MLIST
PREPPLOT
QMSPLT
SUMMARY
TEKPLT
TOOLKIT

#### iii) Post Processing

FLUX
GFIT
GSMOOTH
NOISE
TFORM

#### iv) Image Transport

FITSTONOD
NODTOFITS

## Definitions

In the 'Input Parameters' section of each TASK-description, the following conventions are employed.

| | |
|---|---|
| FILENAME | The name of a disk-file containing NOD2 maps. The default file-extension is .NOD . Any other extension (i.e. .DAT) has to be entered explicitly. |
| A | Any alphabetic Hollerith character. |
| N | A numeric quantity; could be real or integer. |
| Y/N | The answer to a question. Either Y or y will be taken as affirmative. Any other reply, including <CR>, will be taken as negative. |
| <CR> | Carriage return. |

## Task AZELFIT

Function AZELFIT is a two-dimensional Gaussfit program that performs its operation on az-el maps. It is otherwise identical to GFIT.

Inputfile The file containing the map/s to be fitted.

Output A source list directed to the lineprinter. The user can choose to subtract the fitted sources from the input map and output the residual map to a file of chosen name.

### Input Parameters

| | |
|---|---|
| FILENAME | The file containing the maps. |
| N1 N2 | The first and last maps on file to be fitted. |
| N3 | The approximate lowest flux density (in map units) to be searched for. |
| N4 | Style of fit; N4 = 1, simple 2-D fit.<br>N4 = 2, 2-D fit with prior 1-D trial.<br>N4 = 3, orthogonal 1-D fits.<br>N4 = 4, style 2 plus subtraction of all fits, and output of residual map for which a new FILENAME is requested. |
| N5 | N5 = 1 if a dual-beam map or any map that can have negative peaks (i.e. Stokes parameters Q and U).<br>N5 = 2 for a map with only positive peaks. |

### Comments

If N5 = 1, the task searches first for positive sources and then for negative sources. The complete map is searched and the task tries to fit all sources of peak intensity > N3 mu. At present the program fits only a 2-D elliptical Gaussian aligned with the X-Y axes of the map.

The uses of AZELFIT include intensity calibration procedures and determination of the dual-beam geometry for use in RESTOR (see Section 6).

```
>AZELFIT
*** CONTROL HAS NOW PASSED TO AZELFIT ***
%DCL-I-SUPERSEDE, previous value of FOR006 has been superseded
NOD2 LIBRARY, TUCSON VAX/VMS EDITION 24 APRIL 1985
NO SCAN LIBRARY ATTACHED.
NO NODPLOT LIBRARY ATTACHED.

THIS RUN WAS MADE BY  OBS      ON 27  7 85 AT 17:21:30 MST.

ENTER NAME OF MAPFILE ON WHICH TO FIT SOURCES.
VENUS1RAW
SPECIFY FIRST AND LAST MAPS TO BE FITTED.
2 2
SPECIFY MIN FLUX (IN MAP UNITS) TO BE SEARCHED FOR
10000
SPECIFY STYLE OF FITTING REQUIRED, AS FOLLOWS,
1 FOR SIMPLE 2D-GAUSSFIT,NORMAL CASE
2 FOR 2D-GAUSSFIT WITH PRIOR 1D TRIAL
3 FOR ORTHOGONAL 1D-GAUSSFIT
4 FOR STYLE 2 PLUS BEST-FIT SUBTRACTION AND MAP OUTPUT
1
SPECIFY 1 IF A DUAL-BEAM MAP, ELSE 2
1
END OF DATA.
Job PFILE (queue SYS$PRINT, entry 1007) started on SYS$PRINT
*** CONTROL NOW PASSING BACK TO POPS. ***
>
```

Maps are on file VENUS1RAW.

Just map 2.

Search down to 10,000 m.u.

Simple 2-D Gaussfit.

Include negative "sources".

The source list is being printed on the line-printer.

## Task CALFLUX

Function CALFLUX provides the integral of the emission within a specified rectangular box in units of map units.steradians.

Inputfile The file containing the map to be integrated.

Output The value of the integral printed on the terminal.

### Input Parameters

| | |
|---|---|
| FILENAME | The file containing the map to be integrated. |
| N1 | The map number on file. |
| N2 N3 | The X-Y coordinates of the box centre (in arcmin) relative to the origin of the map. |
| N4 N5 | The X-Y size of the box (in arcmin). |
| N6 | The zerolevel for the rectangular box in map units. |

### Comments

CALFLUX is used in the calibration procedure (see Section 6).

```
CALFLUX
*** CONTROL HAS NOW PASSED TO CALFLUX ***
%DCL-I-SUPERSEDE, previous value of FUK006 has been superseded
NOD2 LIBRARY, TUCSON VAX/VMS EDITION 24 APRIL 1985
NO SCAN LIBRARY ATTACHED.
NO NODPLOT LIBRARY ATTACHED.

THIS RUN WAS MADE BY  OBS       ON 27  7 85 AT 17:28:57 MST.
GIVE NAME OF MAP FILE TO BE INTEGRATED.
SATURN1RES                    ←———— Map is on file SATURN1RES.
GIVE MAP NUMBER ON FILE.
1                             ←———— Integrate map 1.
GIVE X-Y COORDS OF BOX CENTRE IN ARCMIN.
           (FOR RELEVANT COORD SYSTEM OF MAP)
0 0                           ←———— Centre the box on the map centre.
GIVE X-Y SIZE OF BOX IN ARCMIN.
10 10                         ←———— Box size = 10′ x 10′.
GIVE RELEVANT ZEROLEVEL INTENSITY IN MAP UNITS.
0
                              ←———— Local zero = 0 m.u.

TITLE 277
SATURN      MAG DJC                   +4.10REST 0.9

INTEGRATION FINISHED AFTER MAP    1

FLUX=      0.7993718E-02 MAP UNITS * STER.    ←—— The flux in
FORTRAN STOP
*** CONTROL NOW PASSING BACK TO POPS. ***
>                                                 m.u. x ster.
```

## Task CNTR

Function CNTR prints out the RA-dec(1950.) coordinates of the "map centre" in decimal degrees.

Inputfile The file containing the map/s whose centre coordinates are to be investigated.

Output The RA-dec(1950.) of the centre in decimal degrees, printed on the terminal.

### Input Parameters

| | |
|---|---|
| FILENAME | Name of input file. |
| N1 N2 | First and last maps on file whose centres are to be determined. |

### Comments

The "map centre" is the origin of the map as defined by the header. The offsets for fitted sources printed by GFIT are relative to this origin.

```
CNTR
*** CONTROL HAS NOW PASSED TO CNTR ***
%DCL-I-SUPERSEDE, previous value of FOR006 has been superseded
NOD2 LIBRARY, TUCSON VAX/VMS EDITION 24 APRIL 1985
NO SCAN LIBRARY ATTACHED.
NO NODPLOT LIBRARY ATTACHED.

THIS RUN WAS MADE BY  OBS       ON 27  7 85 AT 17:29:43 MST.

ENTER NAME OF MAP FILE.
ORICOM.DAT

ENTER FIRST AND LAST MAPS ON FILE TO PROCESS.
1 1

PROCESSING MAPS    1 TO    1.
INPUT STATUS OF MAP =              0

 RA =    83.21155945082332      DEC =    -5.421666705608900
FORTRAN STOP
*** CONTROL NOW PASSING BACK TO POPS. ***
>
```

Map is on file ORICOM.DAT
(.DAT must be stated as default extension is .NOD)

Just the first map on file.

RA-dec of "map centre" in degrees.

## Task CONVERT

**Function** CONVERT takes the final az-el maps and transforms them into the RA-dec frame. Either a single map can be transformed, a number of az-el maps transformed and stacked into a single RA-dec map, or one or more az-el maps transformed and added into an existing RA-dec map already made by CONVERT.

**Inputfile** i) One or more files containing az-el map/s to be transformed into a single RA-dec map.

ii) Possibly, a previously made RA-dec map of the same region into which it is desired to add further az-el map/s. This RA-dec map must be a previous output of CONVERT.

**Output** A file containing a single RA-dec map which is the result of transforming and stacking az-el map/s. If an RA-dec map already existed as input, the final map will have the same name but a higher version number.

## Input Parameters

| | |
|---|---|
| Y/N | Does an RA-dec map already exist? |
| FILENAME1 | If you answered Y, this is the name of the existing RA-dec map file. Else, this is the name for the new RA-dec map file. |
| FILENAME2 | This is the file containing the az-el map/s. |
| N1 | Az-el map number on FILENAME2. |
| [N2 N3] | If the RA-dec map does not yet exist, N2 and N3 are the X-Y sizes of the map to be made in arcmin. |
| [TITLE] | If the RA-dec map does not yet exist, this is the title stored in the header. Enter as,<br>TITLE THIS IS A MAP NAME. |
| Y/N | Is there another az/el map to add in?<br>If N, the task finishes.<br>If Y, then is the map in the same file? |
| Y/N | If Y, we return to ask for N1 and add the new map into the RA-dec map.<br>If N, a new FILENAME2 will be asked for before asking for N1 on that file. |

## Comments

The az-el maps will be combined in the RA-dec map with relative weights proportional to,

$$(\text{integration time/point})*\cdot(\text{effective system temp.})^{-2}$$

```
CONVERT
*** CONTROL HAS NOW PASSED TO CONVERT ***
%DCL-I-SUPERSEDE, previous value of FOR006 has been superseded
NOD2 LIBRARY, TUCSON VAX/VMS EDITION 24 APRIL 1985
NO SCAN LIBRARY ATTACHED.
NO NODPLOT LIBRARY ATTACHED.

THIS RUN WAS MADE BY  OBS      ON 27  7 85 AT 17:34:19 MST.

 ENTER ,Y, IF RA-DEC MAP ALREADY EXISTS.
                                          <------- <CR> means there was no previous
GIVE FILE NAME FOR NEW RA-DEC MAP.                                    RA-dec map.
ZORIAMAP                         <-------- File name for RA-dec map to be produced.
GIVE FILENAME OF AZ-EL MAPS.
ZORIABAS.DAT                        <------- File containing first az-el map to be added.
GIVE MAP NUMBER ON AZ-EL FILE.
1                                <-------- Map no. on az-el file ZORIABAS.DAT.

TITLE
ORION 18.   MAG DAC
ENTER RA AND DEC EXTENTS OF REQUIRED RA-DEC MAP IN ARCMIN.
15 15                                         <------- Make an RA-dec map
ENTER RA-DEC MAP TITLE IN FORM, TITLE XXXXXXXXXX.              of size 15'x15'.
TITLE ORION A AT 84.2 GHZ.           <------- Title for RA-dec map.

 ENTER ,Y, IF THERE IS ANOTHER AZ-EL MAP TO ADD IN.
Y                                      <------ Yes, there is another az-el map to add in.
 ENTER ,Y, IF THIS AZ-EL MAP IS IN THE SAME FILE.
                                    <----- <CR> as it is not in the same file.
GIVE FILENAME OF AZ-EL MAPS.
ZORIBBAS.DAT                        <------ File name containing second az-el map
GIVE MAP NUMBER ON AZ-EL FILE.                                        to be added.
1                 <-------- Map no on az-el file ZORIBBAS.DAT.

TITLE
ORION 18.   MAG DAC

 ENTER ,Y, IF THERE IS ANOTHER AZ-EL MAP TO ADD IN.
                                    <--------- <CR> as there are no more az-el
FORTRAN STOP                                          maps to add in.
*** CONTROL NOW PASSING BACK TO POPS. ***
>
```

## Task DRAW

Function DRAW unspools the output of PREPPLOT to the ZETA pen-plotter. It must be run on the terminal attached to the ZETA plotter.

Inputfile A plotfile prepared by PREPPLOT.

Output A contour plot on the ZETA pen-plotter.

Input Parameters

NONE

Comments

A ZETA plotter is only available in the Tucson downtown office. DRAW deletes all plotfiles on exit, so unspool each plotfile before creating the next with PREPPLOT.

## Task FITSTONOD

Function FITSTONOD will read a single map from a FITS-tape and write it onto disk as a NOD2 file.

Inputfile A map image in FITS-format on a FITS-tape.

Output A NOD2 file containing the map in NOD2-format.

### Input Parameters

| | |
|---|---|
| T | When asked if data is on tape or disk, reply T. |
| <CR> | When FITS-tape is mounted. |
| N1 | How many files to skip on the FITS-tape. |
| FILENAME | The output NOD2 map file will be called FILENAME.NOD. |

### Comments

Not currently a task to be proud of! However, it will convert a FITS-image into a NOD2 disk file. It will only read one image at one entry and prints a bunch of garbage on the screen. The NOD2 header parameters are not guaranteed to be set up currently (although AMAP(3) and (4) will be!).

On completion, the task dismounts (but doesn't unload) the FITS-tape via VMS command,

```
$ DISMOUNT/NOUNLOAD MTA0:
```

This means that you can immediately read down another file on the tape using FITSTONOD, but the number of files to skip, N1, will always be the number of files to skip from the beginning of the FITS-tape.

Before running FITSTONOD mount your FITS-tape on the tape drive.

```
>FITSTONOD
*** CONTROL NOW PASSING TO FITSTONOD. ***
 To read FITS data and convert tn NOD?
Data from tape, or already on disk? (T/D) : T
```

Data coming from a FITS-tape

```
Press return when tape is on MTA0: 
```

<CR>

```
%MOUNT-I-MOUNTED,  mounted on _MTA0:
How many files to skip? : 0
```

We want to read the first map.

```
 THIS PROGRAM READS INPUT FROM LOGICAL NAME "TAPE"
 Tape has NOT been rewound.
 ***** ENTER TAPE-COPY PROCESSING PARAMETERS *****
PLEASE ENTER TAPE FORMAT TYPE (1-3)
  OR ENTER 0 TO SEE A LIST OF FORMAT TYPES:
ENTER INPUT RECORD SIZE:
 POSSIBLY THESE FILES ARE CARD IMAGES
DO YOU WANT TO STRIP OFF COLUMNS 73-80 AND STRIP TRAILING BLANKS (Y/N)?
DO YOU WANT TO TRANSLATE INPUT TO ASCII FROM EBCDIC OR BCD (Y/N) ?
ENTER "FILENAME.TYP" OR "STOP" OR "SKIP" OR "NEW":
HOW MANY FILES DO YOU WANT TO SKIP ? :
ENTER "FILENAME.TYP" OR "STOP" OR "SKIP" OR "NEW":
RECORD:      100
END OF FILE #         1:       144 RECORDS WRITTEN
ENTER "FILENAME.TYP" OR "STOP" OR "SKIP" OR "NEW":
USER REQUESTED EXIT
What file name for NOD2 map?: TOM4
```

File name for NOD2 map to be TOM4.NOD.

```
SIMPLE  =                    T            / FITS format

*** FITS KEYWORD NOT RECOGNISED ***
TYP
```

ETC.

```
AMETERS            X        Y
INITIAL RESOLUTION     0.1250   0.1250
CURRENT RESOLUTION     0.1250   0.1250
TABULAR INTERVAL    -0.050000 0.050000
MAP COORDINATES        0.0500   0.0500
MAP EXTENT            -2.2500   2.2500
COLUMNS AND ROWS      46.0000  46.0000

COORDINATE SYSTEM 31.0
TRANSFORMATION TO 1950.0 COORDINATES.
  0.99961452 -0.01963369  0.01962991
  0.01962991  0.99980724  0.00038548
 -0.01963369  0.00000000  0.99980724

BRIGHTNESS TO DEG K     SCALE       ZERO.
INITIAL CALIBRATION  0.000000 0.000000
CURRENT CALIBRATION  0.000000 0.000000
```

Prints a bunch of junk!

```
 IFAULT STATUS OF MAPOUT ON FOR002              0
FORTRAN STOP
*** CONTROL NOW PASSING BACK TO POPS. ***
>
```

```
>FLUX
*** CONTROL HAS NOW PASSED TO FLUX ***
%DCL-I-SUPERSEDE, previous value of FOR006 has been superseded
NOD2 LIBRARY, TUCSON VAX/VMS EDITION 24 APRIL 1985
NO SCAN LIBRARY ATTACHED.
NO NODPLOT LIBRARY ATTACHED.

THIS RUN WAS MADE BY  OBS       ON 27  7 85 AT 17:47:05 MST.
GIVE NAME OF MAP FILE TO BE INTEGRATED.
ORICOM.DAT               ←———————— Map is on file ORICOM.DAT.
GIVE MAP NUMBER ON FILE.
1                        ←———————— Integrate map 1.
GIVE X-Y COORDS OF BOX CENTRE IN ARCMIN.
          (FOR RELEVANT COORD SYSTEM OF MAP)
0 0                           ←———————— Centre the box on the map centre.
GIVE X-Y SIZE OF BOX IN ARCMIN.
14 14                 ←———————— Box size = 14′ × 14′
GIVE RELEVANT ZEROLEVEL INTENSITY IN MAP UNITS.
0
                              ←———————— Local size = 0 m.u.

TITLE
ORION A COMBINED MAP, SCALED TO 84.2 GHZ.

ENTER FACTOR TO CONVERT MAP UNITS INTO DEG K.
.001                          ←——————————————— Map is in mK, so scale factor
INTEGRATION FINISHED AFTER MAP    1                 into K is 0.001.

FLUX=        288.6954724 JY.  ←———————
FORTRAN STOP                           \
*** CONTROL NOW PASSING BACK TO POPS. ***  ——— The flux density in Jy.
>
```

## Task FLUX

Function FLUX will provide the flux density of the emission within specified rectangular box in units of Janskys. It is used to obtain the flux densities of extended sources. FLUX must be provided with the factor to convert the map units into Kelvin (i.e. 0.001 if the map is in mK).

Inputfile The file containing the map to be integrated.

Output The flux density value printed on the terminal.

Input Parameters

| | |
|---|---|
| FILENAME | The file containing the map to be integrated. |
| N1 | The map number on file. |
| N2 N3 | The X-Y coordinates of the box centre (in arcmin) relative to the origin of the map. |
| N4 N5 | The X-Y size of the box (in arcmin). |
| N6 | The zerolevel for the rectangular box in map units. |
| N7 | The factor to convert map units into Kelvin. |

Comments

Although a complete map made with the dual-beam technique has a well-defined zerolevel (identically zero, as the dual-beam observations inherently lose the zero spatial frequency), care should be taken in determining the local zerolevel for the rectangular box. This may have an offset from zero, i.e. a small-sized region within a larger area of emission.

## Task GFIT

**Function** GFIT is a two-dimensional Gaussfit program that is intended for use on maps in celestial coordinates. (For az-el maps, use AZELFIT.)

**Inputfile** The file containing the map/s to be processed.

**Output** A list of sources directed to the lineprinter. The user can choose to subtract the fitted Gaussians from the input map and output the residual distribution giving it a new filename.

### Input Parameters

| | |
|---|---|
| FILENAME | The file containing the maps. |
| N1 N2 | The first and last maps to be processed. |
| N3 | The approximate lowest flux density (in map units) to be searched for. |
| N4 | Style of fit; N4 = 1, simple 2-D fit.<br>N4 = 2, 2-D fit with prior 1-D trial.<br>N4 = 3, orthogonal 1-D fits.<br>N4 = 4, style 2, plus subtraction of fits and output of residual map. A new FILENAME will be requested. |
| N5 | N5 = 1, dual-beam map or a map that can have negative peaks (i.e. Stokes parameters Q and U).<br>N5 = 2, map with only positive peaks. |

### Comments

Very similar to AZELFIT. If N5 = 1, the task searches for positive sources first, and then for negative sources. The task searches the complete map and tries to fit all sources of peak flux density > N3 map units. At present the program fits only a 2-D elliptical Gaussian aligned with the X-Y axis of the map.

N4 = 4 can be used to subtract the strongest sources in a map, often allowing a better fit for weak sources sitting in their wings.

```
>GFIT
*** CONTROL HAS NOW PASSED TO GFIT ***
%DCL-I-SUPERSEDE, previous value of FOR006 has been superseded
NOD2 LIBRARY, TUCSON VAX/VMS EDITION 24 APRIL 1985
NO SCAN LIBRARY ATTACHED.
NO NODPLOT LIBRARY ATTACHED.

THIS RUN WAS MADE BY  OBS      ON  5  8 85 AT 13:51:55 MST.

ENTER NAME OF MAPFILE ON WHICH TO FIT SOURCES.
W49COM.DAT
SPECIFY FIRST AND LAST MAPS TO BE FITTED.
1 1
SPECIFY MIN FLUX (IN MAP UNITS) TO BE SEARCHED FOR
50
SPECIFY STYLE OF FITTING REQUIRED
1 FOR SIMPLE 2D-GAUSSFIT,NORMAL CASE
2 FOR 2D-GAUSSFIT WITH PRIOR 1D TRIAL
3 FOR ORTHOGONAL 1D-GAUSSFIT
4 FOR STYLE 2 PLUS BEST-FIT SUBTRACTION AND MAP OUTPUT
1
SPECIFY 1 IF DUAL-BEAM MAP, ELSE 2
2
END OF DATA.
Job PFILE (queue SYS$PRINT, entry 1149) started on SYS$PRINT
*** CONTROL NOW PASSING BACK TO POPS. ***
>
```

Map is on file W49COM.DAT.

Fit just map 1.

Search down to ~ 50m.u.

Simple 2-D Gaussfit.

Just look for positive sources.

The source list is being printed
on the lineprinter.

The printed source list,

```
                  TITLE
                  W49 COMBINED MAP , SCALED TO 84.2 GHZ.
                        LAT       LONG        FLUX(M.U.) X WIDTH Y WIDTH ZEROLEVEL  X GRAD  Y GRAD ITNO XPNTS YPNTS      CHI
Fit            -> -00 00 37    0  2  0.5      132.23     1.07    0.99   -130.34   26.32   15.75    6     9     9   0.6435E+00   = Source 1
R.M.S.Errors   -> +00 00 15    0  0 17.1       83.68     0.66    0.57     29.92    3.91    3.90
Fit            -> +00 00 29  359 59 56.6      562.83     1.64    1.35    125.49   -8.07   -6.65    2     9     9   0.4994E-01   = Source 2
R.M.S.Errors   -> +00 00 01    0  0  1.6       18.92     0.06    0.05     10.53    1.37    1.34
Fit            -> +00 00 44  359 52 40.3       45.52     2.01    1.05    -42.38    1.41    4.08    6     9     9   0.2576E+00   = Source 3
R.M.S.Errors   -> +00 00 04    0  0  9.2        6.96     0.37    0.18      4.61    0.96    0.56


                  SOURCE SEARCH COMPLETED.
```

Col 1 : Δ latitude in (°  ′  ″) of arc.

Col 2 : Δ longitude in (°  ′  ″) of arc, real angle.

Col 3 : Peak flux density in map units.

Cols 4-5 : X - Y half power widths of fitted Gaussian in arcmin.

Cols 6-8 : Fitted planar baselevel.

Col 9 : Number of iterations needed to converge.

Cols. 10 - 11 : Size of region fitted; no. of columns x no. of rows.

Col 12 : R.M.S. deviation of fit as a fraction of fitted peak value.

## Task GSMOOTH

Function GSMOOTH is a two-dimensional smoothing routine that uses convolution with a Gaussian to obtain a map at the required (lower) resolution.

Inputfile The file containing the map/s to be smoothed.

Output A file containing the smoothed map/s.

### Input Parameters

| | |
|---|---|
| FILENAME1 | The file containing the map/s to be smoothed. |
| FILENAME2 | The file to contain the smoothed map/s. |
| N1 N2 | The required resolution in X-Y of the map (in arcsec) after smoothing. |
| N3 N4 | First and last maps to be smoothed on the file. |

### Comments

This is a highly simplified version of the general NOD2 smoothing routine. Note that the post-smoothing resolution will be elliptical and aligned with the X-Y axes. The grid spacing will be the same in the input and output maps.

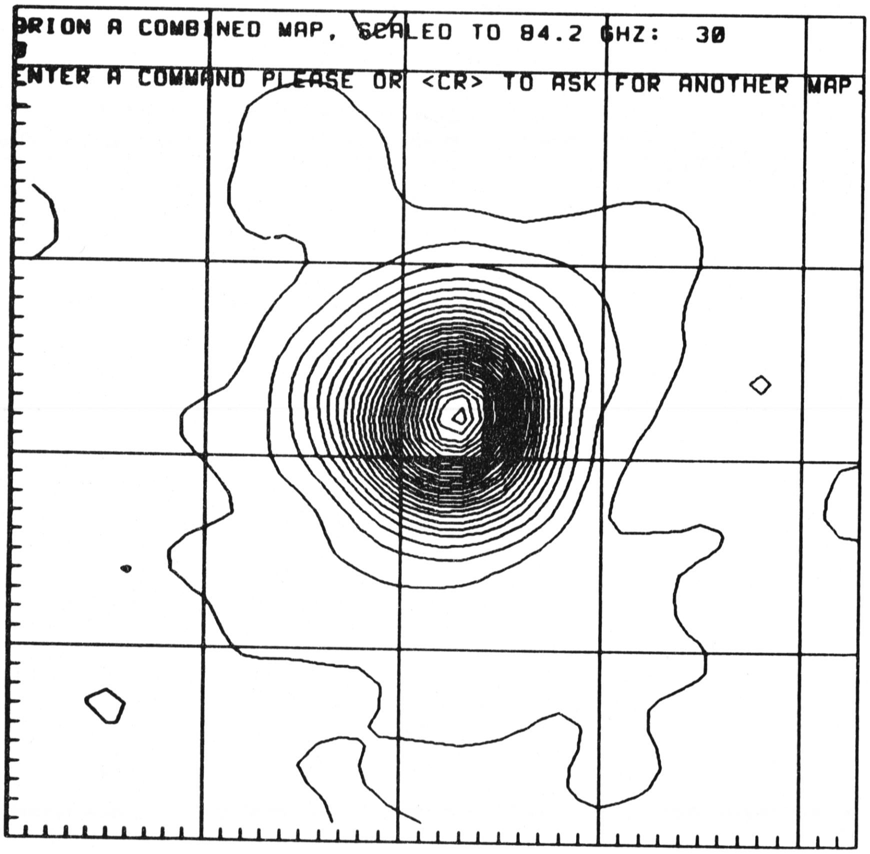
We wish to smooth the map shown in Fig 5 iii) to a resolution of 2′ x 2′.

```
GSMOOTH
*** CONTROL HAS NOW PASSED TO GSMOOTH ***
%DCL-I-SUPERSEDE, previous value of FOR006 has been superseded
NOD2 LIBRARY, TUCSON VAX/VMS EDITION 24 APRIL 1985
NO SCAN LIBRARY ATTACHED.
NO NODPLOT LIBRARY ATTACHED.

THIS RUN WAS MADE BY  OBS      ON 27  7 85 AT 17:49:46 MST.
GIVE NAME OF MAP FILE TO BE SMOOTHED.
ORICOM.DAT             <——————————— Original map is on file ORICOM.DAT.
GIVE NAME FOR SMOOTHED MAP FILE.
ORIS120
                       <——————————— Put the smoothed map into ORIS120.NOD.

TITLE
GAUSS BEAM.

GIVE REQUIRED POST-SMOOTH RESNS IN X AND Y IN ARCSEC.
120 120                 <———————————————— Post-smooth resolution is

ENTER NOS. ON FILE OF FRST AND LAST MAPS TO BE SMOOTHED.    to be 120" x 120".
1 1                     <————
MAPS   1 TO   1 WILL BE SMOOTHED.     ———— Just smooth the first map.

CONVOLUTION REQUESTED FOR STYLE 23
WITH COSINE LATITUDE CORRECTIONS.
ORTHOGONAL CONVOLUTION FOR MAP

CONVOLVED MAP(1,1) = INPUT MAP(   1,   1)
XSTEP =  1   YSTEP =  1
CONVOLUTION COMPLETED.
FORTRAN STOP
*** CONTROL NOW PASSING BACK TO POPS. ***
>
```

Now we are ready to look at the result.

Use TOOLKIT for a quick-look at the smoothed map.

```
TOOLKIT
*** CONTROL HAS NOW PASSED TO TOOLKIT. ***
NOD2 LIBRARY, TUCSON VAX/VMS EDITION 24 APRIL 1985
NO SCAN LIBRARY ATTACHED.
NO NODPLOT LIBRARY ATTACHED.

THIS RUN WAS MADE BY  OBS      ON 27  7 85 AT 17:50:28 MST.

ENTER THE NAME OF THE FILE TO BE READ FROM.
ORIS120

SPECIFY MAP NUMBER REQUIRED ON FILE,
OR 0 FOR HELP, OR -1 FOR A NEW MAP FILE.
1
STYLE,EL,STARTVAL,STOPVAL,-OR-,-777,NFCNT,ZERO,STEP
STYLE 5 OR 6->INPUT ROW OR COL,COL OR ROWSTART AND STOP.
ENTER A COMMAND PLEASE OR <CR> TO ASK FOR ANOTHER MAP.
```



```
ORION A COMBINED MAP, SCALED TO 84.2 GHZ:   30        15.0          30
0
ENTER A COMMAND PLEASE OR <CR> TO ASK FOR ANOTHER MAP.
```

## Task MAKMAP

Function This task makes the initial map from the raw telescope data. The user can make any number of maps during one entry to MAKMAP, the output maps being put in the same NOD2 file. The user can update the pointing, receiver gain parameter and atmospheric attenuation factor used in an observation, based on the better information available after observation.

Inputfile The Pops Data File (PDFL.DAT) containing the raw scan data.

Output A NOD2 file containing the map/s.

Input Parameters

| | |
|---|---|
| FILENAME1 | The name of the output file containing the map/s. |
| FILENAME2 | The name of the Pops Data File (usually just PDFL). |
| N1 N2 | The first and last scan numbers of the present map. Note that if the observations were made with a two-channel receiver (i.e. λ3 or 1 mm Schottky-mixer receivers) the two channels are processed separately. If the scans for the first channel begin and end with N1 and N2, the second channel values are N1+1 N2+1.<br>It is often convenient to analyze the two channels separately into different output files, or all channel 1 maps first, then channel 2. This is as different scaling factors from map units to mK will apply for the two channels. |
| Y/N | Is a modified pointing solution required?<br>If N, the data is left as observed.<br>If Y, the task reads the next set of pointing data from FIVEPT.DAT, which should have been previously prepared on disk. The pointing parameters as a function of elevation are computed and the data corrected accordingly. See Section 5 for a description of FIVEPT.DAT. |

| | |
|---|---|
| Y/N | Are modified receiver gain parameters to be used?<br>If N, the data is left as observed.<br>If Y, the user must supply the local sidereal times and calibration values (#C or #CP) for noise tube calibrations made before and after the observation. Linear interpolation is used. If Y has already been given here for an earlier map made at this MAKMAP entry, the program may ask if you wish to keep the values then entered. Read the questions carefully and reply accordingly. |
| Y/N | Are modified atmospheric attenuation factors to be used?<br>If N, the data is left as observed.<br>If Y, the user must supply the local sidereal times and attenuation values (ATTN) from TIPS made before and after the observation. Linear interpolation is used. If Y has already been given here for an earlier map made at this MAKMAP entry, the program may ask if you wish to keep the values entered. Read the questions carefully and reply accordingly. |
| Y/N | Do you wish to make a map?<br>If N, no map will be written on the output file. Useful if you've made an error above and want a second attempt.<br>Normally you will reply Y. |
| N3 | The number of points at each end of each scan used to define zero for the scan. These points should be essentially free of source emission. |
| N4 | The observing frequency in GHz. |
| N5 | The HPBW in arcsec. |
| N6 | The receiver temp. in K. If you haven't measured this, consult the Friend of the Telescope to get a reasonable value. |

| | |
|---|---|
| Y/N | Is another map to be made?<br>If N, the task terminates.<br>If Y, are the scans in the same PDFL.DAT file? |
| Y/N | If N, a new FILENAME2 will be requested. Flow of input will now return to N1 N2. |

## Comments

After running MAKMAP, use TOOLKIT to look at the maps that have been made. If anything looks too strange, ask those who ought to know why!

```
MAKMAP
*** CONTROL HAS NOW PASSED TO MAKMAP. ***
%DCL-I-SUPERSEDE, previous value of FOR006 has been superseded
NOD2 LIBRARY, TUCSON VAX/VMS EDITION 24 APRIL 1985
NO SCAN LIBRARY ATTACHED.
NO NODPLOT LIBRARY ATTACHED.

THIS RUN WAS MADE BY  OBS      ON 27  7 85 AT 17:11:39 MST.
 GIVE FILE NAME FOR OUTPUT NOD2 MAPS.
SAT1RAW          <------------ File to contain the maps made is SAT1RAW.
 GIVE FILE NAME OF PDFL FILE.
PDFL             <------------ Input scans are in PDFL.DAT.
 ENTER FIRST & LAST SCANS TO BE ANALYSED.
3694 3714                 <------------ Make the map of channel 1 first. The scans
                                         are numbered 3694, 3696, 3698 ---- 3714.
 ENTER 'Y' IF MODIFIED POINTING SOLN IS WANTED.
Y                         <------------ The file FIVEPT.DAT is ready
 POINTING SOLUTION REQUESTED.                      prepared on disk.
 VALUES WILL BE READ FROM FILE FIVEPT.DAT.

 ENTER 'Y' IF YOU WISH TO USE MODIFIED CAL VALUES
Y
 CAL UPDATING REQUESTED.    <------------ We wish to update the #C value.

 ENTER LST (TO NEAREST MINUTE) FOR FIRST CAL
 AS HH MM    EXAMPLE: 12 42
12 15                <------------ LST of CALIBRATE before the observation.
 ENTER FIRST CAL VALUE
349                  <------------ #C at that time for Channel 1.
 ENTER LST (TO NEAREST MINUTE) FOR SECOND CAL
 AS HH MM    EXAMPLE: 12 42
13 10                <------------ LST of CALIBRATE after the observation.
 ENTER SECOND CAL VALUE.
347                  <------------ #C at that time for Channel 1.
 ENTER 'Y' TO USE MODIFIED ATM. ABSORP. VALUES
Y                       <------------ We wish to update the ATTN value.
 ATM. ABSORP. UPDATING REQUESTED.

 ENTER LST (TO NEAREST MINUTE) FOR FIRST TAU
 AS HH MM    EXAMPLE: 12 42
12 18                <------------ LST of SPTIP before the observation.
 ENTER FIRST TAU VALUE
.119                 <------------ ATTN at that time.
 ENTER LST (TO NEAREST MINUTE) FOR SECOND TAU
 AS HH MM    EXAMPLE: 12 42
13 13                <------------ LST of SPTIP after the observation.
 ENTER SECOND TAU VALUE.
.141                 <------------ ATTN at that time.

 ENTER 'Y' IF YOU WISH TO MAKE A MAP
Y                    <------------ We want to make a map
 MAP MAKING REQUESTED.

 ENTER THE NO. OF PTS TO USE FOR BASELINE AT SCAN END.
4                   <------------ Use four points at both ends of each scan for setting
                                                                   a zerolevel.

 ENTER THE OBSERVING FREQUENCY IN GHZ.
84.2                <------------ Observing frequency in GHz.

 ENTER THE H.P.B.W. IN ARCSEC.
71                  <------------ HPBW in arcsec.
 R.A. =    229.4032860122645     DEC =  -15.91627029459908
 ENTER THE RECEIVER TEMPERATURE IN K.
200.                <------------ Trx in K.
```

```
 CURRENT ROW IN MAP IS =            1
 CURRENT ROW IN MAP IS =            2
 CURRENT ROW IN MAP IS =            3
 CURRENT ROW IN MAP IS =            4
 CURRENT ROW IN MAP IS =            5
 CURRENT ROW IN MAP IS =            6
 CURRENT ROW IN MAP IS =            7
 CURRENT ROW IN MAP IS =            8
 CURRENT ROW IN MAP IS =            9
 CURRENT ROW IN MAP IS =           10
 CURRENT ROW IN MAP IS =           11


MATRIX NORMALISE.
SCALE - 0.010 WEIGHT LIMIT - 0.000 LOW LIMIT - 0.000

TITLE
SATURN       MAG OJC

   0 LOW WEIGHT POINTS.

NORMALISATION COMPLETED.

MATRIX MAX-MIN.

TITLE 2
SATURN       MAG OJC
MAX =    49391.522 MIN =    -49647.480

MATRIX MAX-MIN.

TITLE
SATURN       MAG OJC
MAX =         3.447 MIN =          3.27

 ENTER 'Y' IF YOU WISH TO MAKE ANOTH
R MAP.
Y

 ENTER 'Y' IF NEW DATA IS ON SAME IN
UT FILE.
Y
```

Map of Channel 1 made. This will be the first map on file SAT1RAW.

We want to make the map for Channel 2.

Data for scans of Channel 2 is also in PDFL.DAT.

```
 ENTER FIRST & LAST SCANS TO BE ANALYSED.              The scans for Channel 2 are 3695, 3697, ---- 3715.
3695 3715                 ←———————— The scans for Channel 2 are 3695, 3697, ---- 3715.

 ENTER 'Y' IF YOU WANT TO KEEP THE SAME POINTING.
                             ←———————— We will use new pointing, as the two channels
                                                 have a small pointing difference.

 ENTER 'Y' FOR NEW POINTING OR 'N' FOR 12-M THUMB-WHLS.
Y                           ←———— We wish to read the next set of pointing data
 POINTING SOLUTION REQUESTED.                              from FIVEPT. DAT.
 VALUES WILL BE READ FROM FILE FIVEPT.DAT.

 ENTER 'Y' TO KEEP PREVIOUS CAL VALS.
                              ←———— # C values are different for the two channels
                                            so we wish to change the
 ENTER 'Y' FOR NEW CAL VALS OR 'N' FOR DEFAULTS                  values used.
Y
 CAL UPDATING REQUESTED.  ←———————— Yes, we want to enter new values.

 ENTER LST (TO NEAREST MINUTE) FOR FIRST CAL
 AS HH MM    EXAMPLE: 12 42
12 15                         ←———— LST of first CALIBRATE.
 ENTER FIRST CAL VALUE        ←———— #C at that time for Channel 2.
270
 ENTER LST (TO NEAREST MINUTE) FOR SECOND CAL
 AS HH MM    EXAMPLE: 12 42
13 10                         ←———— LST of second CALIBRATE.
 ENTER SECOND CAL VALUE.
271                           ←———— #C at that time for Channel 2.

 ENTER 'Y' TO KEEP PREVIOUS TAU VALUES
Y                             ←———— Keep values of ATTN as for Channel 1.

 ENTER 'Y' IF YOU WISH TO MAKE A MAP
Y
 MAP MAKING REQUESTED.        ←———— We want to make a map.

 ENTER THE NO. OF PTS TO USE FOR BASELINE AT SCAN END.
4
                             ←———— Use four points at both ends of each scan for
                                              setting a zerolevel.
 ENTER THE OBSERVING FREQUENCY IN GHZ.
84.2                    ←———————— Observing frequency in GHz.

 ENTER THE H.P.B.W. IN ARCSEC.
71                      ←———————— HPBW in arcsec.
 R.A. =   229.403286012264 5     DEC =   -15.91627029459908
 ENTER THE RECEIVER TEMPERATURE IN K.
200.
         ←——————————————— T_RX in K.
```

```
 CURRENT ROW IN MAP IS =            1
 CURRENT ROW IN MAP IS =            2
 CURRENT ROW IN MAP IS =            3
 CURRENT ROW IN MAP IS =            4
 CURRENT ROW IN MAP IS =            5
 CURRENT ROW IN MAP IS =            6
 CURRENT ROW IN MAP IS =            7
 CURRENT ROW IN MAP IS =            8
 CURRENT ROW IN MAP IS =            9
 CURRENT ROW IN MAP IS =           10
 CURRENT ROW IN MAP IS =           11


MATRIX NORMALISE.
SCALE = 0.010 WEIGHT LIMIT = 0.000 LOW LIMIT = 0.000

TITLE
SATURN       MAG OJC

   0 LOW WEIGHT POINTS.

NORMALISATION COMPLETED.

MATRIX MAX-MIN.
```

Map of Channel 2 made. This will be the second map on file SAT1RAW.

```
TITLE 2
SATURN       MAG OJC
MAX =     55934.522 MIN =    -56743.478

MATRIX MAX-MIN.


TITLE
SATURN       MAG OJC
MAX =         3.447 MIN =          3.27


 ENTER 'Y' IF YOU WISH TO MAKE ANOTH
R MAP.
```

<CR> as no more maps to make.

```
FORTRAN STOP
*** CONTROL NOW PASSING BACK TO POPS
 ***
>
```

# The FIVEPT.DAT file used in this example.

```
240.6
32.2 33 -9
31.4 33 -8
76.3 35 -18
65.8 38 -26
80.2 26 -17
-999
240.6
32.2 35 -12
31.4 37 -11
76.3 39 -23
65.8 44 -30
80.2 29 -26
-999
```

Beam Sepn. (arcsec) → 240.6

Elevation (°), ΔAz ("), ΔEl (") → 76.3 35 -18

End of first data set. (Channel 1) → -999

End of second data set (Channel 2) → -999

Data set for Channel 1 pointing.

Data set for Channel 2 pointing.

## Task MAXMIN

Function MAXMIN will print the maximum and minimum intensities (in map units) within a map/s.

Inputfile The file containing the map/s to be processed.

Output The maximum and minimum values on the terminal.

### Input Parameters

| | |
|---|---|
| FILENAME | The file containing the relevant map/s. |
| N1 N2 | First and last maps to be processed. |

### Comments

Useful parameters when deciding the contour levels to choose for plotting, or the minimum flux to search for in GFIT.

```
MAXMIN
*** CONTROL HAS NOW PASSED TO MAXMIN ***
%DCL-I-SUPERSEDE, previous value of FOR006 has been superseded
NOD2 LIBRARY, TUCSON VAX/VMS EDITION 24 APRIL 1985
NO SCAN LIBRARY ATTACHED.
NO NODPLOT LIBRARY ATTACHED.

THIS RUN WAS MADE BY  OBS       ON 27  7 85 AT 17:57:54 MST.
GIVE NAME OF MAP FILE TO BE MAXMINED.
ORIS120                <------------------  Map is on file ORIS120.
ENTER NOS. ON FILE OF FRST AND LAST MAPS TO BE MAXMINED.
1 1                    <--------------
MAPS   1 TO   1 WILL BE MAXMINED.       Just give max-min of first map.

MATRIX MAX-MIN.


TITLE 1
ORION A COMBINED MAP, SCALED TO 84.2 GHZ.
MAX =      807.809 MIN =       -24.029    <------  Max-min values of map.
FORTRAN STOP
*** CONTROL NOW PASSING BACK TO POPS. ***
>
```

## Task MLIST

**Function** MLIST prints the data values in a map on the lineprinter. For an az-el map, the local sidereal times can also be printed.

**Inputfile** The file containing the map/s to be printed.

**Output** A lineprinter listing of the map values.

### Input Parameters

| | |
|---|---|
| FILENAME | The file containing the map/s to be printed. |
| N1 N2 | First and last maps on file to be printed. |
| N3 N4 N5 | N3 = printing style (see below).<br>N4 = number of places before decimal point (but see below).<br>N5 = number of places after decimal point (but see below). |
| [N6] | Only requested if the maps are in az-el. Then the l.s.t.'s will be printed if N6 = 1. |
| [N7 N8] | The l.s.t.'s will be printed in style N3 = 2, with N7 places before and N8 places after the decimal point. |

### Comments

The task will print the data in a number of different formats controlled by the parameter N3. The recommended values for N3 are the following,

N3 = 2; The header parameters are listed, followed by the data. The data is printed row by row starting with the bottom row and proceeding to the top. There will be N4 places before and N5 places after the decimal point.

N3 = 4; The data is printed in the form of a grid. Successive pages can be glued together to give the complete map. N4 is the number of places allocated to each column and N5($\geq$ 2) is the number of printer lines per row. If N5 = 0, it is set to 0.6*N4. Only the integral part of the data is printed.

N3 = 5; As N3 = 4, but the fractional part is printed below the integral part. This fractional part is multiplied by 10**(N4 - 2) before printing. If the fractional part represents a weight value, then 0.5 is subtracted from it before scaling and printing. (See the NOD2 Manual for more details.)

MLIST can be used in conjunction with a map plotted by TOOLKIT for finding bad data in the raw map. This can be edited and the edited file saved with TOOLKIT.

```
MLIST
*** CONTROL HAS NOW PASSED TO MLIST ***
%DCL-I-SUPERSEDE, previous value of FOR006 has been superseded
NOD2 LIBRARY, TUCSON VAX/VMS EDITION 24 APRIL 1985
NO SCAN LIBRARY ATTACHED.
NO NODPLOT LIBRARY ATTACHED.

THIS RUN WAS MADE BY  OBS      ON 27  7 85 AT 18:01:03 MST.

ENTER NAME OF FILE TO BE PRINTED.
VENUS1RAW            <------------------ Map is on file VENUS1RAW
ENTER FIRST MAP AND LAST MAP TO BE PRINTED.
2 2                  <--------------- We wish to print the second
                                                   map on file
MAPS    2 TO    2 WILL BE PRINTED.

ENTER A) MPRINT STYLE
      B) PLACES BEFORE DECIMAL
      C) PLACES AFTER DECIMAL.
(STYLE=2 IS REREADABLE FORMAT.
 STYLE=4 IS SQUARE GRID FORM, SIGNAL ONLY.
 STYLE=5 IS SQUARE GRID FORM, SIGNAL AND WEIGHT.)
4 5 0              <------------------ Print the map in grid form with 5 places
                                       per column and 3 (= 0.6 * 5)
DO YOU WANT TO PRINT THE SIDEREAL TIME ARRAY TOO?    printer lines per row.
    ENTER 0 FOR NO
    ENTER 1 FOR YES
0   <--------------- Don't print the sidereal times.
FORTRAN STOP
```

## Task NODTOFITS

Function NODTOFITS will write a FITS-tape of one or more NOD2 maps.

Inputfile One or more files of NOD2 maps that it is wished to write as a FITS-tape.

Output A FITS-tape of maps that can be read by the AIPS-task IMLOD.

### Input Parameters

| | |
|---|---|
| <CR> | Enter 'carriage-return' when you have mounted your blank tape and been prompted by the task. |
| L/N | Whether you want 'L'ots of printout or 'N'one. |
| FILENAME | File containing maps to be written to tape. |
| N1 | Either,<br>$N1 \geq 1$; the number in the file of the map to be written to tape.<br>$N1 = -1$; to enter a new FILENAME.<br>$N1 = 0$; to finish. |

### Comments

The maps to be processed from a given file should be written (via N1) in order of increasing map number on file.

Run NODTOFITS when you wish to export your maps in FITS-format.

We wish to write the first two maps on the file [STOBIE.STUART]TOM4 and the first map on file ORICOM.DAT to a FITS-tape.

First put up your blank magnetic tape, with write-ring in, on the tape drive.

```
NODTOFITS
*** CONTROL HAS NOW PASSED TO NODTOFITS ***
%DCL-I-SUPERSEDE, previous value of FOR006 has been superseded
Put your blank tape on MTA0:
Press return when it is ready:     <----------  <CR> as tape is mounted.
%MOUNT-I-MOUNTED,  mounted on _MTA0:
NOD2 LIBRARY, IRAM VAX/VMS EDITION SEPTEMBER 1982
NO SCAN LIBRARY ATTACHED.
NO NODPLOT LIBRARY ATTACHED.

THIS RUN WAS MADE BY  OBS       ON 27  7 85 AT 17:39:45 MEZ.
Lots of print output or none? (L/N)
N                          <----------  No print-out required.
GIVE NAME OF MAP FILE TO BE USED.
[STOBIE.STUART]TOM4        <----------  First write maps from [STOBIE.STUART]TOM4.
 GIVE EITHER MAP NUMBER ON FILE,
      OR -1 FOR NEW FILE,
      OR  0 TO END.
1        <----------  Write up first map on file.

 ==========      0  DUMMIES FOUND AND SET TO      0.0000000000E+00  =======
==

MATRIX MAX-MIN.


 TITLE
TOM4 AT 1720 MHZ TOTAL INTENSITY.
MAX =     4.011E+03 MIN =     -139.



 GIVE EITHER MAP NUMBER ON FILE,
      OR -1 FOR NEW FILE,
      OR  0 TO END.           <----------  Write up second map on file.
2
 ==========      0  DUMMIES FOUND AND SET TO      0.0000000000E+00  =======
==

MATRIX MAX-MIN.


 TITLE
TOM4 AT 1720 MHZ CORRECTED POLARIZED INTENSITY.
MAX =     233.      MIN =     -24.2



 GIVE EITHER MAP NUMBER ON FILE,
      OR -1 FOR NEW FILE,
      OR  0 TO END.
-1       <----------  We want to select a new file.
```

```
GIVE NAME OF MAP FILE TO BE USED.
ORICOM.DAT
```

Now select file ORICOM.DAT.

```
 GIVE EITHER MAP NUMBER ON FILE,
      OR -1 FOR NEW FILE,
      OR  0 TO END.
1
```

Write up first map on file.

```
 ==========   280  DUMMIES FOUND AND SET TO     0.0000000000E+00  =======
==

MATRIX MAX-MIN.


 TITLE
ORION A COMBINED MAP, SCALED TO 84.2 GHZ.
MAX =    1.097E+03 MIN =    -59.5



 GIVE EITHER MAP NUMBER ON FILE,
      OR -1 FOR NEW FILE,
      OR  0 TO END.
0
```

No more maps to write, so end.

```
 header read from tape                  18     IDENT10 =            0.36873E
  1      SIMPLE   =                    19T        // IFdleTR iffoyrimagt parameters

  2      BITPIX   =                     189    IDENT1116 =bits      0.33908E
                                       19         / Identifying parameters
  3      NAXIS    =                      2         / 2 axis
                                         20    IDENT12 =            0.33908E
  4      NAXIS1   =                    145        // INtba.n talff yOanlgupror ameters

  5      NAXIS2   =                     421    IDENT1Nb .= of Rows  0.33908E
                                       19         / Identifying param_
  6      TYPE     =         0.20000E+01            / Type number of data

  7      DUMMY    =         0.00000E+00            / Uummy value in empty c
lls
  8      CODE     =         0.00000E+00            / Progress code word

  9      IDENT 1  =         0.00000E+00            / Identifying parameters

 10      IDENT 2  =         0.89005E+09            / Identifying parameters

 11      IDENT 3  =         0.25020E+01            / Identifying parameters

 12      IDENT 4  =         0.26403E-05            / Identifying parameters

 13      IDENT 5  =         0.42035E+08            / Identifying parameters

 14      IDENT 6  =         0.68861E+12            / Identifying parameters

 15      IDENT 7  =         0.12667E+08            / Identifying parameters

 16      IDENT 8  =         0.88608E+12            / Identifying parameters

 17      IDENT 9  =         0.21642E+06            / Identifvino oarameters
```

Prints a lot of junk!

```
  25

  26

  27

  28

  29

  30

  31

  32

  33

  34

  35

  36


 Tape data: bytes reversed to original format

 Tape data: bytes reversed to original format
 Mt unit closed now. end prog
FORTRAN STOP
*** CONTROL NOW PASSING BACK TO POPS. ***
>
```

More junk!

## Task NOISE

**Function** NOISE is used to estimate the mean and r.m.s. of the data within a specified region/s of a map/s.

**Inputfile** The file containing the map/s to be processed.

**Output** The mean and r.m.s. of the data within each specified region are given on the terminal. The total sum of the data point values and number of points are also displayed.

### Input Parameters

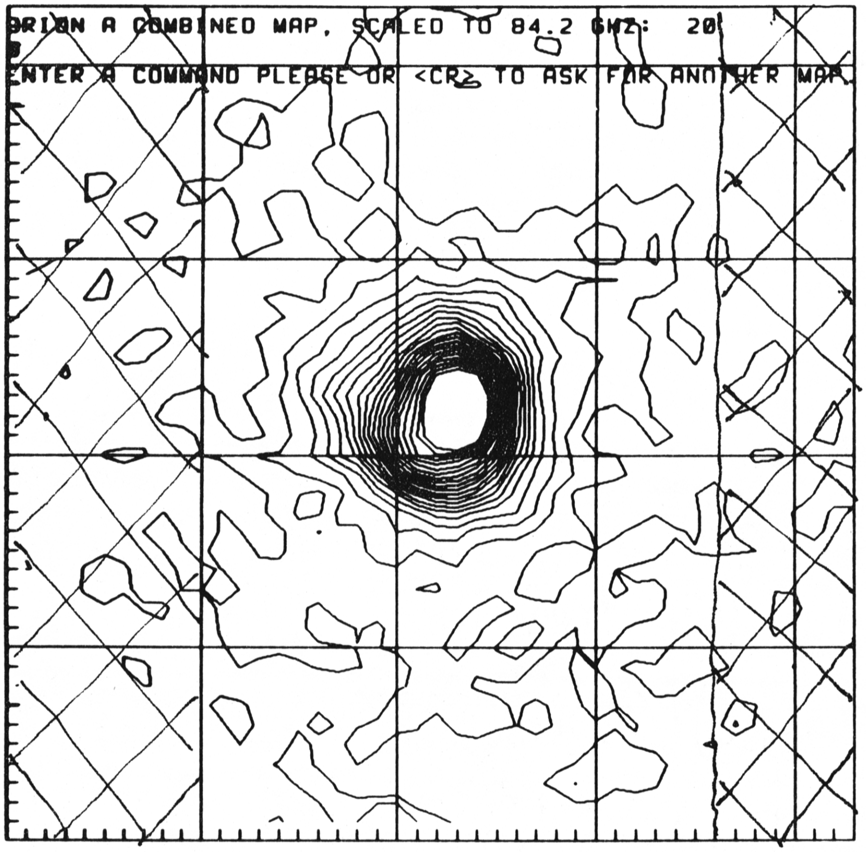
| | |
|---|---|
| FILENAME | The file containing the map/s to be processed. |
| N1 N2 | First and last maps on file to be processed. |
| N3 | Number of regions within the current map to be processed. |
| N4 N5 N6 N7 | The rectangular region to be processed given in row and column number.<br>N4 N5 are the first and last columns in the region.<br>N6 N7 are the first and last rows. |

[N4 - N7 are requested afresh for each separate region.]

[N3 is requested afresh for each separate map.]

### Comments

NOISE is useful for estimating local zeros for regions whose flux density is to be estimated by FLUX. The r.m.s. noise of the data in a map can be estimated by NOISE, using regions devoid of source emission.



```
ORION A COMBINED MAP, SCALED TO 84.2 GHZ:   20          20.0          40
0
ENTER A COMMAND PLEASE OR <CR> TO ASK FOR ANOTHER MAP.
```

We wish to estimate the noise on this map by obtaining the r.m.s. of the data values in the two hatched areas.

```
NOISE
*** CONTROL HAS NOW PASSED TO NOISE ***
%DCL-I-SUPERSEDE, previous value of FOR006 has been superseded
NOD2 LIBRARY, TUCSON VAX/VMS EDITION 24 APRIL 1985
NO SCAN LIBRARY ATTACHED.
NO NODPLOT LIBRARY ATTACHED.

THIS RUN WAS MADE BY  OBS      ON 27  7 85 AT 18:04:51 MST.
NOISE MEASURING AND INTEGRATION PROGRAM.

ENTER NAME OF FILE
ORICOM.DAT ←———————— The map is on file ORICOM.DAT
ENTER FIRST AND LAST MAPS REQUIRED FROM INPUT FILE.
1 1              ←———————————— It is the first map on file.
MAPS      1 TO      1 ON INPUT FILE WILL BE EXAMINED.
========= IFAULT STATUS OF MAPIN IS:       0

MATRIX MAX-MIN.


TITLE
ORION A COMBINED MAP, SCALED TO 84.2 GHZ.
MAX =      1096.524 MIN =       -59.495
ESTIMATION OF MAP NOISE LEVEL FOR A SELECTED NUMBER OF AREAS
   (FOR SMALL VALUES BEWARE OF ERRORS CAUSED BY THE WEIGHT FACTORS OF PO
NTS.

INPUT NUMBER OF AREAS TO BE PROCESSED
2          ←—————————————————————— We want the r.m.s.'s for two regions
                                                            of the map.
TOTAL NUMBER OF AREAS TO BE ANALYZED =      2

SPECIFY AREA BY START & STOP COLS AND ROWS (I.E. X0 X1 Y0 Y1.)
1 10 1 43    ←—————————— First region is cols. 1 to 10, rows 1 to 43.
XRANGE     1 TO    10
YRANGE     1 TO    43
USING    282 POINTS  MEAN IS        4.16 AND RMS DEVIATION  IS     16.90
 SUM OF THESE POINTS WITHIN CHOSEN REGION IS:        1171.90


SPECIFY AREA BY START & STOP COLS AND ROWS, (I.E. X0 X1 Y0 Y1.)
36 43 1 43    ←—————————— Second region is cols. 36 to 43, rows 1 to 43.
XRANGE    36 TO    43
YRANGE     1 TO    43
USING    240 POINTS  MEAN IS        4.02 AND RMS DEVIATION  IS     17.97
 SUM OF THESE POINTS WITHIN CHOSEN REGION IS:         964.30

FORTRAN STOP
*** CONTROL NOW PASSING BACK TO POPS. ***
>
```

The noise is seen to be ~ 17·5 m.u.

Task PREPPLOT (To be used only in Tucson Downtown Office)

Function PREPPLOT prepares a plotfile for the ZETA-plotter that can be unspooled by a subsequent call to DRAW. Various styles of contour labelling can be used and astronomical grids can be plotted on the final map. PREPPLOT can overlay the contours with polarization vectors and mark star positions for comparison with optical plates.

Inputfile The file containing the map to be plotted.

Output A plotfile which can be unspooled to the ZETA-plotter by DRAW. The user can print a logfile on exit which will help identify unlabelled grid lines.

Input Parameters

| | |
|---|---|
| FILENAME | The file containing the relevant map. |
| N1 | The map number on file. |
| Y/N | Is there an associated polarization map to be overlayed as vectors?<br>If Y, answer the questions as to which file and map. |
| Y/N | Is a 20 cm high default-sized plot required?<br>If N, the plot scale in cm. per degree for both X and Y will be requested. |
| N2 N3 N4 | N2 = the lowest contour level to be plotted in map units.<br>N3 = the basic contour interval in map units.<br>N4 = the polarization scale factor (N4 = 0 if there is no polarization map).<br>If the polarization value at a point is I mu, a vector will be drawn there of length I * N4 tabular units. (tabular unit = grid spacing) i.e., if I = 100 mu and N4 = 0.01, the vector will have a length of one grid separation distance. |
| N5 | Enter -1 for default contour style. This gives thickened and labelled contours (major contours) every tenth contour, with the contour interval always being N3. |

| | |
|---|---|
| | Enter 0 to give your own instructions as to how frequently you wish to have a major contour and at what multiples of N3 you wish contours to be drawn. You will be asked for a set of numbers,<br>N5A<br>N5B N5C<br>where, N5A is the number of major contours for which the subsequent N5B and N5C apply.<br>(N5B - 1) is the number of unlabelled (minor) contours between successive major contours.<br>N5C defines the contour interval N3 * N5C between successive contours. N5A, N5B, and N5C <u>must</u> be integer. |
| N6 | Enter -1 <u>unless</u> you wish to mark star positions for making the contours into an overlay. If you enter 1 or 2, the RA-dec of stars must be entered as follows,<br><br>N6 = 1; HH MM SS.S DD MM SS.S<br>N6 = 2; DD MM SS.S DD MM SS.S<br><br>If N6 = 1 or 2, the task asks for N6A<br>N6A = 5 to enter star positions from the terminal.<br>N6A = XX (where XX is a one or two digit positive no. ≠ 5) to read the positions in from a file FOROXX.DAT.<br>Entry of positions from either terminal or file is terminated by typing the word END (terminal) or having END as the last entry in FOROXX.DAT. END should be on a new line. |
| TITLE | The caption to be printed at the top of the map. Enter this preceded by the word TITLE, i.e.,<br>TITLE THIS IS A MAP, |
| N7 N8 | The spacing between RA-dec grid lines in arcmin.<br>N7 = N8 = -1 for no RA-dec grid. |
| N9 N10 | The spacing between l, b (Galactic coordinate) grid lines.<br>N9 = N10 = -1 for no l, b grid. |

<u>Comments</u>

The lowest level will be dotted and labelled '0'. The HPBW will be hatched in the top left hand corner of the plot. Unspool the file with DRAW <u>before</u> preparing another plotfile, as DRAW deletes all plotfiles on completion.

```
PREPPLOT
*** CONTROL HAS NOW PASSED TO PREPPLOT ***
%DCL-I-SUPERSEDE, previous value of FOR006 has been superseded
NOD2 LIBRARY, TUCSON VAX/VMS EDITION 24 APRIL 1985
NO SCAN LIBRARY ATTACHED.
CYBER NODPLOT LIBRARY MADE 11 NOV 76.

THIS RUN WAS MADE BY  OBS      ON 27  7 85 AT 14:59:35 MST.
GIVE NAME OF MAP FILE TO BE CONTOURED.
VENUS1RAW      <-------------- Map to be plotted is on VENUS1RAW.
GIVE MAP NUMBER ON FILE.
2              <-------------- Plot the second map on the file.
 ENTER, Y , IF THERE IS A MAP TO VCTR.
               <-------------- No polarization map.

 ENTER, Y , FOR A PLOT 20CM HIGH.
Y              <-------------- Make the plot 20 cm high.
PLOT SCALE =    364.0894507553252    CM. PER DEGREE.
ENTER THE FOLLOWING.
  A) THE LOWEST CONTOUR (MAP UNITS, WILL BE DASHED).
  B) THE BASIC CONTOUR INTERVAL (MAP UNITS).
  C) THE POLN VECTOR SCALE FACTOR( = 0 IF NO POLN).
-32500 5000 0  <-------------- Plot contours at intervals of 5000 m.v.
IF YOU WANT DEFAULT CONTOURS TYPE -1,ELSE 0
-1                             starting from -32500 m.v.
               <-------------- Default style contours.
ITYPE=
ITYPE=1  R.A. IN HOURS MIN SEC
ITYPE=2  R.A. IN DEGREES ARC MIN ARC SEC
ITYPE=-1 IF NO STARS TO BE PLOTTED
-1             <-------------- No star positions to be plotted.
ENTER A CAPTION FOR THE MAP AS, TITLE XXXXXXX ETC.
TITLE SATURN AT 84.2 GHZ, DUAL-BEAM MAP. <---- Write this caption (minus the word TITLE)
GIVE SPACING BETWEEN RA & DEC GRID LINES (IN ARCMIN)     at the head of the plot.
     IF EQUATORIAL GRID NOT WANTED ENTER -1 -1.
-1 -1          <-------------- No RA-dec grid to be plotted.
GIVE SPACING BETWEEN L & B GRID LINES (IN ARCMIN)
     IF GALACTIC GRID NOT WANTED ENTER -1 -1.
-1 -1
666            <-------------- No l, b grid to be plotted.
*** CONTROL NOW PASSING BACK TO POPS. ***
>DRAW          <-------------- Unspool to the Zeta-plotter via task DRAW.
```

The result was Fig. 1.

## Task QMSPLT

**Function** QMSPLT prepares a plotfile for the QMS laser-printer and unspools this plotfile to the device. It is very similar to PREPPLOT, to which frequent reference will be made below.

**Inputfile** The file containing the map to be plotted.

**Output** A finished plot via the laser-printer.

### Input Parameters

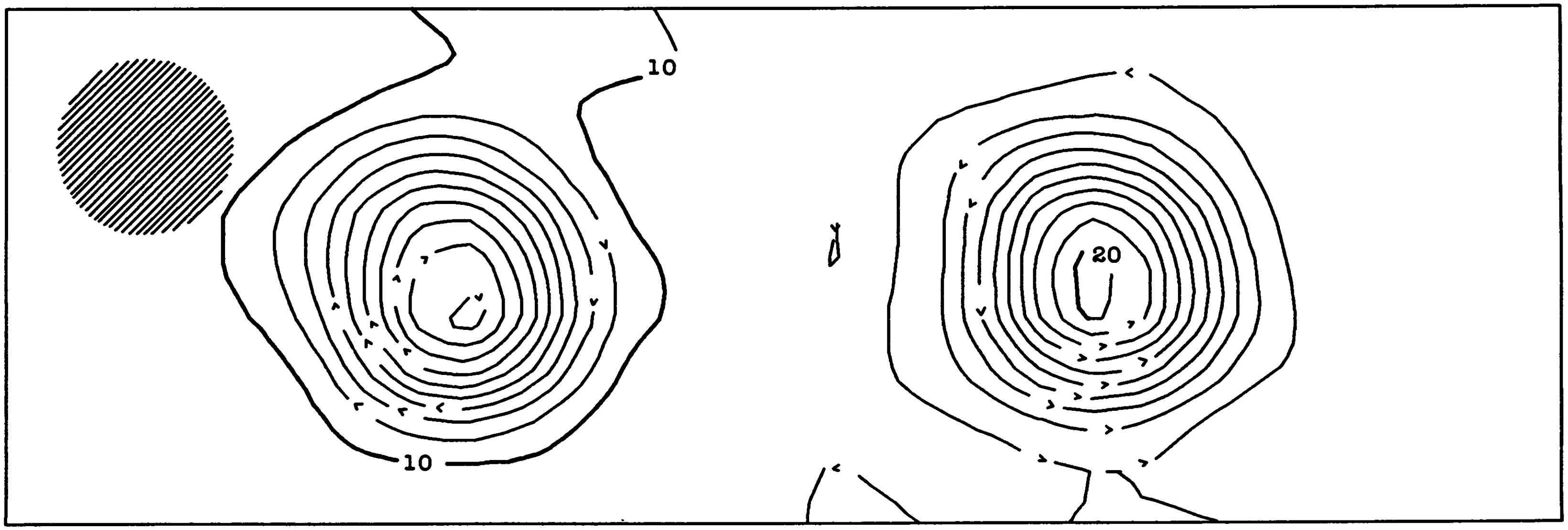
| | |
|---|---|
| FILENAME | The file containing the relevant map. |
| N1 | See task PREPPLOT. |
| Y/N | |
| Y/N | |
| N2 N3 N4 | |
| N5 | |
| N6 | |
| CAPTION | A caption of up to 40 characters that will be printed at the head of the plot. Enter this *without* any preceding word TITLE, i.e.,<br>THIS IS A MAP. |
| N7 N8 | See task PREPPLOT. |
| N9 N10 | |

### Comments

Almost identical to PREPPLOT, but *note* that the caption has no preceding word TITLE!

```
QMSPLT
*** CONTROL HAS NOW PASSED TO QMSPLT ***
%DCL-I-SUPERSEDE, previous value of FOR006 has been superseded
NOD2 LIBRARY, TUCSON VAX/VMS EDITION 24 APRIL 1985
NO SCAN LIBRARY ATTACHED.
CYBER NODPLOT LIBRARY MADE 11 NOV 76.

THIS RUN WAS MADE BY  OBS      ON 27  7 85 AT 14:47:38 MST.
 GIVE NAME OF MAP FILE TO BE CONTOURED.
VENUS1RAW  <—————————————— Map to be plotted is on file VENUS1RAW.
 GIVE MAP NUMBER ON FILE.
2                   <——————————— Plot the second map on file.

 ENTER 'Y' IF THERE IS A MAP TO VCTR.
                      <————————————— No polarization map.

 ENTER 'Y' FOR A DEFAULT-SIZED PLOT.
Y                                 <————— Make a default-sized plot
 PLOT SCALE =   130.2383199814775    CM. PER DEGREE.
 ENTER THE FOLLOWING.
   A) THE LOWEST CONTOUR (MAP UNITS, WILL BE DASHED)
   B) THE BASIC CONTOUR INTERVAL (MAP UNITS).
   C) THE POLN VECTOR SCALE FACTOR( = 0 IF NO POLN)
-52500 5000 0          <——————————————— Plot contours at intervals of 5000m.u.
 IF YOU WANT DEFAULT CONTOURS TYPE -1,ELSE 0
-1                  <—————————— Default style contours.    starting from -52500m.u.

 1 SEQUENCES     HEIMIN= 5000.00     CLAMIN=   1.000      IO=0
 ITYPE=
 ITYPE=1  R.A. IN HOURS MIN SEC
 ITYPE=2  R.A. IN DEGREES ARC MIN ARC SEC
 ITYPE=-1 IF NO STARS TO BE PLOTTED ————— No star positions to be plotted.
-1                              <
 ENTER TITLE (NO MORE THAN 40 CHARACTERS)
SATURN AT 84.2 GHZ, DUAL-BEAM MAP.
 GIVE SPACING BETWEEN RA & DEC GRID LINES (IN ARCMIN)
 IF EQUATORIAL GRID NOT WANTED ENTER -1 -1
-1 -1                                  <————————— No RA-dec grid to be plotted.
 GIVE SPACING BETWEEN L & B GRID LINES (IN ARCMIN)
 IF GALACTIC GRID NOT WANTED ENTER -1 -1
-1 -1                                <————————— No l,b grid to be plotted.
666
*** YOUR PLOT WILL APPEAR POST-HASTE. ***  <———— Plot has been sent to the

*** CONTROL NOW PASSING BACK TO POPS. ***              laser-printer.
```

SATURN AT 84.2 GHZ, DUAL-BEAM MAP.



This is the laser-printer plot.

## Task RESTOR

Function RESTOR will restore a dual-beam map to the equivalent single-beam representation via the Emerson et al algorithm.

Inputfile The file containing the map/s to be restored.

Output A file containing the restored map/s.

Input Parameters

| | |
|---|---|
| FILENAME1 | The file containing the az-el map/s to be restored. |
| FILENAME2 | The file to contain the restored az-el maps. |
| N1 N2 | First and last maps to be restored on FILENAME1. |
| N3 N4 N5 | The parameters giving the dual-beam geometry. These will be requested afresh for each of the maps to be restored.<br>N3 = the beam separation between the dual-beam responses in arcmin.<br>N4 = angular offset in degrees of the line joining the two beams to the horizontal. N4 is measured anticlockwise from the horizontal with azimuth increasing to the right.<br>N5 = the relative amplitudes of the left-hand beam to the right. If the beam to the left is the negative beam, then N5 is conventionally defined to be negative. |

Comments

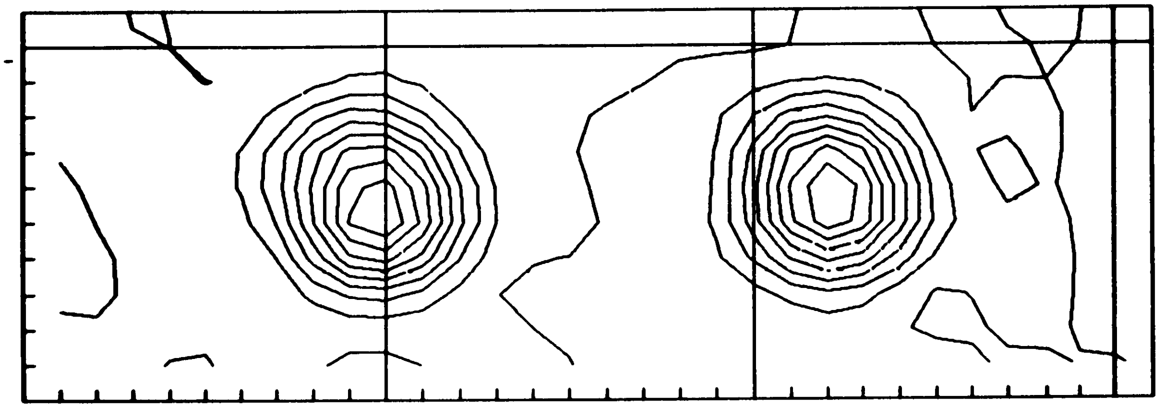
If the sign of N5 is wrong, all sources will appear as holes!

```
RESTOR
*** CONTROL HAS NOW PASSED TO RESTOR ***
%DCL-I-SUPERSEDE, previous value of FOR006 has been superseded
NOD2 LIBRARY, TUCSON VAX/VMS EDITION 24 APRIL 1985
NO SCAN LIBRARY ATTACHED.
NO NODPLOT LIBRARY ATTACHED.

THIS RUN WAS MADE BY  OBS       ON 27  7 85 AT 18:08:40 MST.

PROGRAM TO RESTORE DUAL-BEAM OBSERVATIONS TO A SINGLE-BEAM MAP


GIVE FILE NAME FOR INCOMING DUAL-BEAM MAPS.
VENUS1RAW              <----------------------  The dual-beam maps are on
 GIVE FILE NAME FOR OUTPUT RESTORED MAPS.                     file VENUS1RAW.
VENUS1RES          <-------------------------  The restored maps will go to file VENUS1RES.

INPUT NUMBER OF FIRST AND LAST MAPS ON FILE TO BE PROCESSED.
2 2                          <----------------  Restore the second map in VENUS1RAW.
MAPS FROM      2 TO      2 WILL BE PROCESSED.
IFAULT STATUS IS      0  ; MAP NO =  1
IFAULT STATUS IS      0  ; MAP NO =  2

INPUT A) THE SEPARATION OF THE TWO BEAMS, IN ARC MIN
      B) THE ANG. OFFSET (DEGS) OF THE LINE JOINING THE TWO BEAMS,
        (MEASURED ANTICLOCKWISE FROM HORIZ., IDEALLY 0.0).
      C) THE RELN. AMPL. OF LFT-HAND BEAM TO  RT-HAND BEAM (IDEALLY  1.0)

        (IF LFT-HAND BEAM IS -VE, RELN AMPL IS -VE.)
4.1 0. -1.                 <-------------------  Dual-beam geometry parameters.
FORTRAN STOP
*** CONTROL NOW PASSING BACK TO POPS. ***
>
```

The result is shown overleaf.

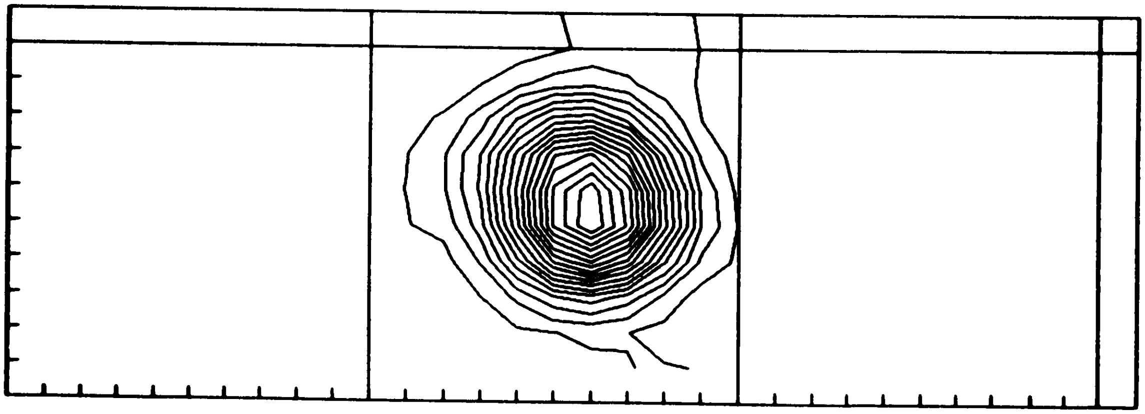
```
SATURN       MAG DJC                 :  18        -49516.5         5523.7
ENTER A COMMAND PLEASE OR <CR> TO ASK FOR ANOTHER MAP.
```

The dual-beam map.



```
SATURN       MAG DJC                 :  18         -1371.0          2800.0
ENTER A COMMAND PLEASE OR <CR> TO ASK FOR ANOTHER MAP.
```

The restored map.



## Task SETBASE

Function SETBASE sets a zerolevel for each row of a map, defined by the average value of a given number of points at each end of each row. The task also allows the scaling of the maps by an arbitrary factor.

Inputfile The file to be processed.

Output A file containing the scaled and baselined maps.

Input Parameters

| | |
|---|---|
| FILENAME1 | The file of maps to be processed. |
| FILENAME2 | The file to contain the processed maps. |
| N1 | The scale factor by which to multiply the current map. |
| N2 N3 | The number of points at the left- and right-hand ends of each row to be used in the baselevelling process for the current map. If the user does not wish to change the baselevel of a particular map, N2 = N3 =0.<br>(N1 N2 N3 will be requested afresh for each map in the file.) |

Comments

SETBASE can be used at any stage of the analysis, but is particularly useful after RESTOR both for rebaselining and entering the scale factor to bring the intensities into calibrated units.

```
SETBASE
*** CONTROL HAS NOW PASSED TO SETBASE ***
%DCL-I-SUPERSEDE, previous value of FOR006 has been superseded
NOD2 LIBRARY, TUCSON VAX/VMS EDITION 24 APRIL 1985
NO SCAN LIBRARY ATTACHED.
NO NODPLOT LIBRARY ATTACHED.

THIS RUN WAS MADE BY  OBS      ON 27  7 85 AT 18:10:15 MST.
 GIVE NAME OF MAP FILE TO BE BASELEVELLED.
VENUS1RES
 GIVE FILE NAME FOR BASELEVELLED MAP.
VENUS1BAS


TITLE 2
SATURN      MAG DJC                   +4.10REST 0.0

MAP            1 ENTER SCALE FACTOR BY WHICH TO MULTIPLY MAP.
                   ( ENTER 1. IF SCALING NOT REQUIRED.)
.1787



MATRIX SCALE TYPE    2
        GAIN          B11          BX1          B1Y
        0.179         0.000        0.000        0.000

SCALING COMPLETED.
GIVE NO OF PTS AT SCAN START & END FOR SETTING ZEROLEVEL.
4 4
FORTRAN STOP
*** CONTROL NOW PASSING BACK TO POPS. ***
>
```

We will scale and rebaseline the map on file VENUS1RES.

The result will be put in file VENUS1BAS.

Scale factor to convert the data values into mK.

Set the baselevel using four points at each end of each row.

## Task SUMMARY

**Function** SUMMARY gives the user a brief synopsis of the parameters of the map.

**Inputfile** The file containing the map/s for which summaries are required.

**Output** The summary printed on the terminal.

### Input Parameters

| | |
|---|---|
| FILENAME | The file containing the map/s for which summaries are required. |
| N1 N2 | The first and last maps on file for which summaries are required. |
| N3 | The angular units in which angular quantities will be printed.<br>N3 = 0 for degrees.<br>= 1 for minutes.<br>= 2 for seconds.<br>The same angular units will be presumed for all maps for which summaries have been requested. |

### Comments

Useful when you've lost track of what you are doing!

```
SUMMARY
*** CONTROL HAS NOW PASSED TO SUMMARY. ***
%DCL-I-SUPERSEDE, previous value of FUK00b has been superseded
NOD2 LIBRARY, TUCSON VAX/VMS EDITION 24 APRIL 1985
NO SCAN LIBRARY ATTACHED.
NO NODPLOT LIBRARY ATTACHED.

THIS RUN WAS MADE BY  OBS       ON 27  7 85 AT 18:11:00 MST.
 ENTER NAME OF INPUT FILE
ORICOM.DAT
```

The map we wish to get a summary of is on file ORICOM.DAT.

```
ENTER FIRST AND LAST MAP ON FILE TO BE SUMMARIZED.
1 1

SUMMARIES WILL BE GIVEN FOR MAPS   1 TO   1
```

It is the first map on the file.

```
IN WHICH ANGULAR UNITS DO YOU WANT THE INFORMATION ?
   ENTER 0 FOR DEGREES.
         1 FOR MINUTES.
         2 FOR SECONDS.
1
```

Give angular units in arcmin.

```
TITLE
ORION A COMBINED MAP, SCALED TO 84.2 GHZ.
DOCUMENT OF TYPE     2.0 DATED  5  7 85 MADE BY OBS
DUMMY VALUES ARE-999999.50
THE MAP HAS BEEN OBSERVED AT   84200.00MHZ,EPOCH 1985.48
THE OBSERVATORY LATITUDE WAS   31.9533
DATA PARAMETERS          X         Y
INITIAL RESOLUTION      1.1667   1.1667 MINUTES
CURRENT RESOLUTION      1.1667   1.1667
TABULAR INTERVAL      0.499534 0.499534
MAP COORDINATES        10.4902 -10.4902
MAP EXTENT             20.9804  20.9804
COLUMNS AND ROWS       43.0000  43.0000

COORDINATE SYSTEM 21.0
TRANSFORMATION TO 1950.0 COORDINATES.
  0.11767483 -0.99298938  0.01116844
  0.98854705  0.11820363  0.09382239
 -0.09448478  0.00000000  0.99552631

BRIGHTNESS TO DEG K    SCALE      ZERO.
INITIAL CALIBRATION  1.000000 0.000000
CURRENT CALIBRATION  2.917153 0.000000


-FORTRAN STOP
 *** CONTROL NOW PASSING BACK TO POPS. ***
 >
```

The summary.

## Task TEKPLT

**Function** TEKPLT prepares a plotfile for the TEKtronix 4010 or MODgraph graphics-terminals and unspools it to the device. It is very similar to PREPPLOT, to which frequent reference will be made below.

**Inputfile** The file containing the map to be plotted.

**Output** A finished plot on the graphics terminal.

### Input Parameters

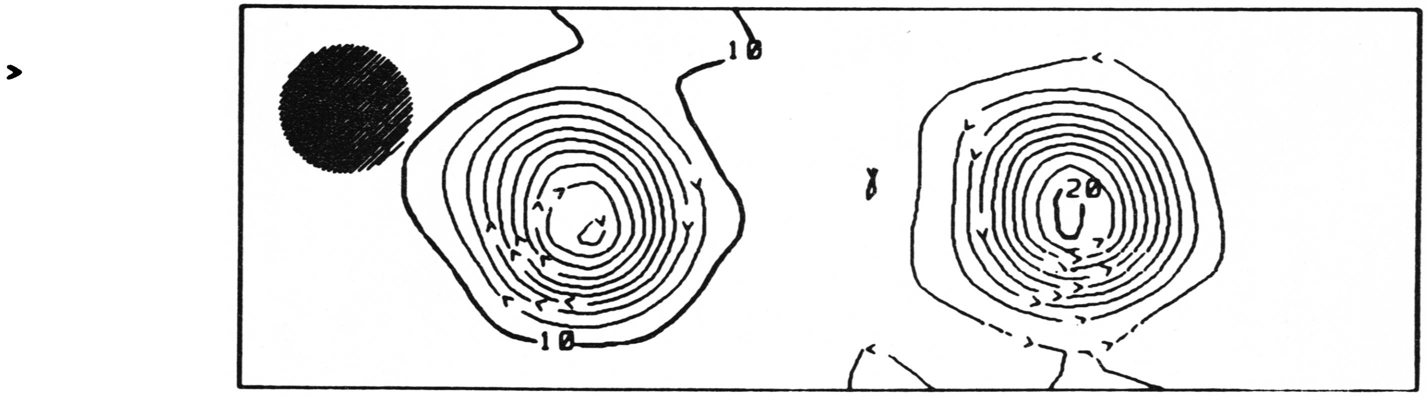
| | |
|---|---|
| FILENAME | The file containing the relevant map. |
| N1 | See Task PREPPLOT |
| Y/N | |
| Y/N | |
| N2 N3 N4 | |
| N5 | |
| N6 | |
| CAPTION | A caption of up to 40 characters that will be printed at the top of the plot. Enter this *without* preceding it by TITLE, i.e.,<br>THIS IS A MAP. |
| N7 N8 | See Task PREPPLOT |
| N9 N10 | |

### Comments

Almost identical to PREPPLOT, only *note* that the caption has *no* preceding word TITLE!

```
TEKPLT
*** CONTROL HAS NOW PASSED TO TEKPLT ***
%DCL-I-SUPERSEDE, previous value of FOR006 has been superseded
NOD2 LIBRARY, TUCSON VAX/VMS EDITION 24 APRIL 1985
NO SCAN LIBRARY ATTACHED.
CYBER NODPLOT LIBRARY MADE 11 NOV 76.

THIS RUN WAS MADE BY  OBS       ON 27  7 85 AT 14:56:09 MST.
 GIVE NAME OF MAP FILE TO BE CONTOURED.
VENUS1RAW    <-----------------  Map to be plotted is on file VENUS1RAW.
 GIVE MAP NUMBER ON FILE.
2                 <------------  Plot the second map on file.

 ENTER 'Y' IF THERE IS A MAP TO VCTR.

                      <--------  <<R> as there is no polarization map.
 ENTER 'Y' FOR A PLOT OF DEFAULT SIZE.
Y                     <--------  Make a default-sized plot.
 PLOT SCALE =   117.4482099210727    CM. PER DEGREE.
 ENTER THE FOLLOWING.
   A) THE LOWEST CONTOUR (MAP UNITS, WILL BE DASHED)
   B) THE BASIC CONTOUR INTERVAL (MAP UNITS).
   C) THE POLN VECTOR SCALE FACTOR ( = 0 IF NO POLN).
-52500 5000 0         <--------  Plot contours at intervals of
 IF YOU WANT DEFAULT CONTOURS TYPE -1,ELSE 0
-1      <---------  Default style contours.  5000m.u. starting from -52500m.u.

  1 SEQUENCES     HEIMIN= 5000.00     CLAMIN=   1.000     ID=0
 ITYPE=
 ITYPE=1  R.A. IN HOURS MIN SEC
 ITYPE=2  R.A. IN DEGREES ARC MIN ARC SEC
 ITYPE=-1 IF NO STARS TO BE PLOTTED
-1           <-----------------  No star positions to be plotted.
 ENTER TITLE (NO MORE THAN 40 CHARACTERS)
SATURN AT 84.2 GHZ, DUAL-BEAM MAP.
 GIVE SPACING BETWEEN RA & DEC GRID LINES (IN ARCMIN)
 IF EQUATORIAL GRID NOT WANTED ENTER -1 -1
-1 -1                    <-----  No RA-dec grid to be
 GIVE SPACING BETWEEN L & B GRID LINES (IN ARCMIN)              plotted.
 IF GALACTIC GRID NOT WANTED ENTER -1 -1
-1 -1     <--------  No l, b grid to be plotted
```

SATURN AT 84.2 GHZ, DUAL-BEAM MAP.



This is the plot that appears on the MOD graph.

## Task TFORM

Function TFORM performs various coordinate transformations on maps, i.e. from RA,dec to l, b or vice-versa.

Inputfile The file containing the map/s to be included in the transformation process.

Output A file containing the (single) map in transformed coordinates.

Input Parameters

| | |
|---|---|
| FILENAME1 | The file containing the map/s to be transformed. |
| FILENAME2 | The file containing the transformed map. |
| N1 | A coordinate code identifier.<br>0 = absolute l, b.<br>1 = absolute RA,dec.<br>20 = A map in real angle centred on the given l, b position (N2,N3). Zero rotation (N4 = 0) aligns the axes with l, b at the centre of the new map.<br>21 = A map in real angle centred on the given RA,dec position (N2,N3). Zero rotation (N4 = 0) aligns the axes with RA,dec at the centre of the new map. |
| N2 N3 | The coordinates of the required field centre in degrees.<br>If N1 = 0 or 20, the centre should be given in absolute l, b.<br>If N1 = 1 or 21, the centre should be given in absolute RA,dec. |
| N4 | If N1 = 20 or 21, N4 is the rotation angle in degrees for the output map relative to the nominal axes.<br>(Enter 0 for N1 = 0 or 1.) |
| N5 N6 | Total X-Y sizes of the output map in arcmin. |

| | |
|---|---|
| N7 N8 | Grid point separation in arcmin for the output map. |
| N9 N10 | First and last maps in the input file to be included in the transformed (output) map. |
| TITLE | A title for the new map entered as,<br>TITLE THIS IS A MAP. |

Comments

Apart from the obvious use of transforming from one coordinate frame to another, the task has other uses. It can be employed to interpolate a map on to a different grid spacing. This is handy for T.V. image display, where a degree of oversampling improves the appearance of the image. It can also be used to mosaic a number of adjacent, or overlapping, maps into a single output map (with or without coordinate transformation). A small section of a large map can also be extracted. Different frequency maps can be produced on identical grids (probably following the smoothing of one) for inter-comparison. Rotation of the image is useful for long, thin objects such as edge-on spiral galaxies.

We wish to transform the RA-dec map of Orion A on file ORICOM.DAT into l,b coordinates.

```
TFORM
*** CONTROL HAS NOW PASSED TO TFORM ***
%DCL-I-SUPERSEDE, previous value of FOR006 has been superseded
NOD2 LIBRARY, TUCSON VAX/VMS EDITION 24 APRIL 1985
NO SCAN LIBRARY ATTACHED.
NO NODPLOT LIBRARY ATTACHED.

THIS RUN WAS MADE BY  OBS      ON 31  7 85 AT 14:30:06 MST.
GIVE NAME OF MAP FILE TO BE TRANSFORMED.
ORICOM.DAT
GIVE NAME FOR TRANSFORMED MAP FILE.
ORIGAL
GIVE COORDINATE CODE FOR THE NEW MAP.
     0 = NEW GALACTICS             :  1 = RA-DEC(1950)
    20 = FIELD-CENTRED GALACTICS : 21 = FLD-CEN RA-DEC50
20
GIVE X AND Y COORDS IN DEGS (NEW SYSTEM) OF FLD CNTRE.
209.0 -19.4
GIVE CLOCKWISE ROTN (DEGS) ABOUT FIELD CENTRE; 0=NO ROTN.
0.
GIVE X AND Y EXTENTS OF THE NEW FIELD IN ARCMIN.
15 15
GIVE X AND Y GRID-SEPN IN NEW GRID IN ARCMIN.
.5 .5
GIVE FIRST AND LAST MAP NO ON INPUT FILE.
1 1
 ENTER A TITLE FOR NEW MAP AS, TITLE XXXXXXXX
TITLE ORION A AT 84.2 GHZ, IN GALACTIC COORDS.

DATA USED FROM   1 MAP(S).

FORTRAN STOP
*** CONTROL NOW PASSING BACK TO POPS. ***
>
```

The map is on file ORICOM.DAT

The l,b map will be on file ORIGAL.

Make the map in field centre (i.e. rectangle) l,b.

l,b of field centre of new map.

No rotation of image required.

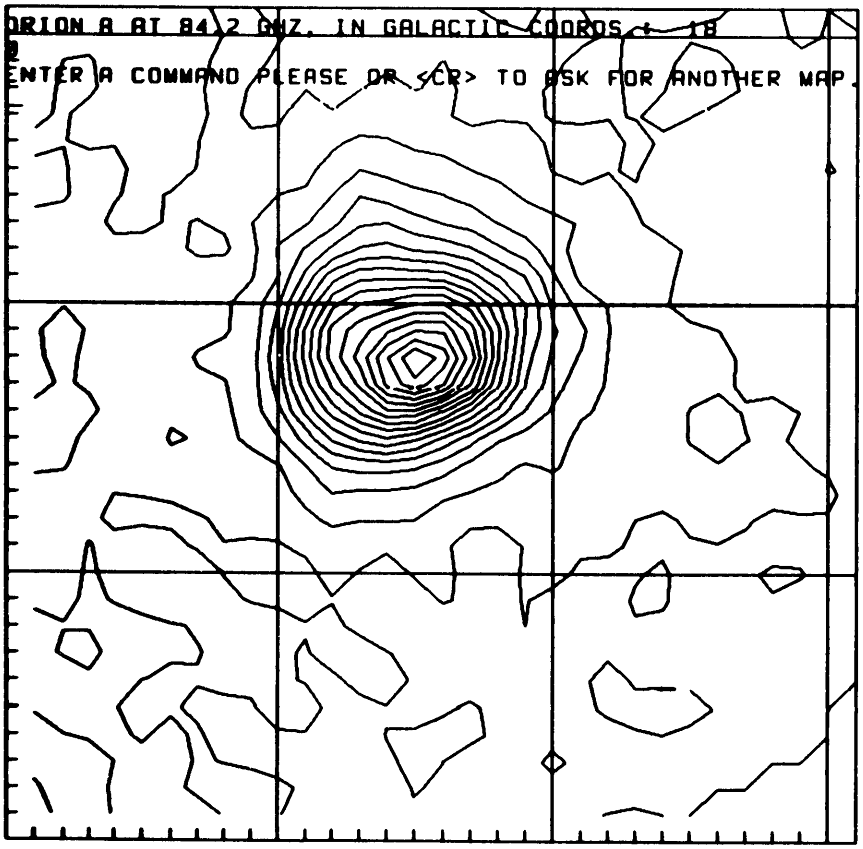
Make a 15'×15' field.

Grid separation to be 30"×30".

Title for the l,b map.

Let's look at our l,b map on file ORIGAL with TOOLKIT.

```
TOOLKIT
*** CONTROL HAS NOW PASSED TO TOOLKIT. ***
NOD2 LIBRARY, TUCSON VAX/VMS EDITION 24 APRIL 1985
NO SCAN LIBRARY ATTACHED.
NO NODPLOT LIBRARY ATTACHED.

THIS RUN WAS MADE BY  OBS       ON 31   7 85 AT 14:31:33 MST.

ENTER THE NAME OF THE FILE TO BE READ FROM.
ORIGAL

SPECIFY MAP NUMBER REQUIRED ON FILE,
OR 0 FOR HELP, OR -1 FOR A NEW MAP FILE.
1
STYLE,EL,STARTVAL,STOPVAL,-OR-,-777,NFCNT,ZERO,STEP
STYLE 5 OR 6->INPUT ROW OR COL,COL OR ROWSTART AND STOP.
ENTER A COMMAND PLEASE OR <CR> TO ASK FOR ANOTHER MAP.
/
```



```
ORION A AT 84.2 GHZ. IN GALACTIC COORDS +  18       -42.1            63
0
ENTER A COMMAND PLEASE OR <CR> TO ASK FOR ANOTHER MAP.
```

## Task TOOLKIT

**Function** TOOLKIT can be used as a quick-and-easy display task on a graphics terminal. It can also be used for data editing, scaling, baselevelling, changing titles and dummy values. The modified maps can be output to a new file.

**Inputfile** The file containing the map/s of interest.

**Output** A plot on the graphics terminal and/or a file containing edited maps.

### Input Parameters

| | |
|---|---|
| FILENAME1 | The file containing the map/s of interest. |
| N1 | If N1 > 0, it specifies the map number of file.<br>N1 = 0 for a HELP display.<br>N1 = -1 to give a new FILENAME1 and select that file.<br>N1 = A (alphanumeric character) to exit TOOLKIT. |
| N2 | A command sequence. N2 gives a command code and the operation will depend on this and other parameters entered. The details of the commands are as follows; |

| | |
|---|---|
| N2(=0) N3 N4 N5 N6 | This command will first scale the map by N3 and *then* add a planar distribution defined by N4 (at BLC), N5 (at BRC) and N6 (at TLC). |
| N2(=1) N3 N4 N5 | This will add values to all points in row N3 varying smoothly from N4 (map units) at the left-hand end to N5 at the right-hand end. |
| N2(=2) N3 N4 N5 | The same as N2 = 1, but the values are added along column N3. |
| N2(=3) N3 N4 N5 | In row N3 the data in columns N4 through N5 will be replaced with dummies (= AMAP(6)). |

| | |
|---|---|
| N2(=4) N3 N4 N5 | As N2 = 3, but the dummies are inserted in column N3 for rows N4 through N5. |
| N2(=5) N3 N4 N5 N6 N7 | In row N3, for columns N4 through N5, values will be added varying smoothly from N6 (map units) to N7. |
| N2(=6) N3 N4 N5 N6 N7 | As N2 = 5, but the values are added in column N3 for rows N4 through N5. |
| N2(=-222) TITLE | A new title is read into the map header. The title is preceded by the word TITLE as in,<br>TITLE THIS IS A MAP. |
| N2(=-333) N3 | The dummy values in the map, and the value in AMAP(6), are changed to be N3. |
| N2(=-777) N3 N4 N5 | This plots a contour map on the graphics terminal. N3 contour levels will be plotted, the lowest being N4 map units and the contour-interval being N5 map units. The plot will have equal separation between adjacent rows and adjacent columns, and vertical and horizontal lines are drawn at each tenth column and row. |
| N2(=/) | This gives an N2 = -777 style plot with default contour interval chosen to give a fixed number of levels between the map minimum and maximum values. |
| N2(=-888) N3 N4 N5 | As N2 = -777 except that the separation of adjacent rows and columns is such that the plot just fills the screen. |

| | |
|---|---|
| N2(=-999)<br>[FILENAME2] | This will write an edited (or unedited!) map to the file FILENAME2. The name FILENAME2 is requested the first time that N2 = -999 is entered. All subsequent calls will write further maps to the same file. |
| N2(=<CR>) | This will request the user to give a new value for N1, allowing the selection of a fresh map or a new map file. If you have used any command N2 = 0 through 6 on the presently selected file, you will be asked if you really meant the <CR>, as it would lose your editing. Answering anything but Y or y will cancel the <CR>. |
| N2(=A) | Entering an alphanumeric character will exit TOOLKIT. If any editing has been done on the map, as with N2 = <CR> the task will ask if you really want to exit and possibly lose the editing. |

## Comments

This is a general display and editing task. It can be useful at any stage of analysis in either role.

We wish to have a "quick-look" at a map.

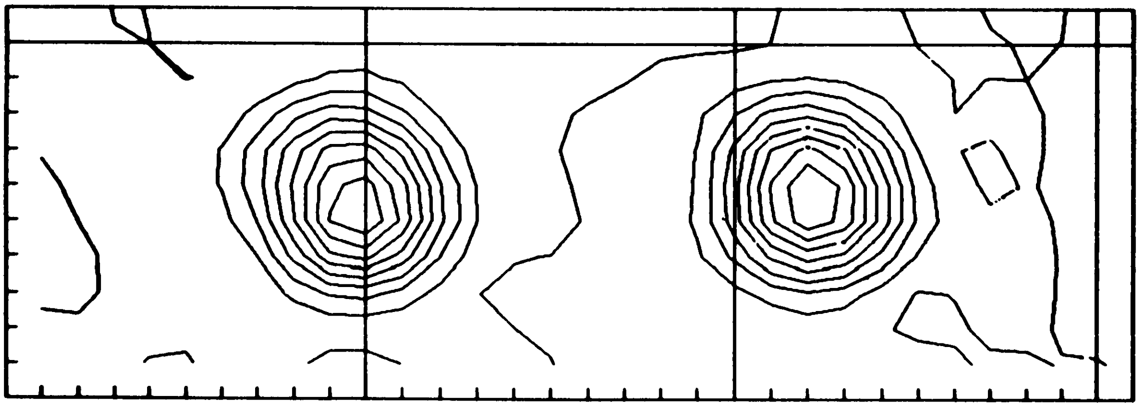
```
TOOLKIT
*** CONTROL HAS NOW PASSED TO TOOLKIT. ***
NOD2 LIBRARY, TUCSON VAX/VMS EDITION 24 APRIL 1985
NO SCAN LIBRARY ATTACHED.
NO NODPLOT LIBRARY ATTACHED.

THIS RUN WAS MADE BY  OBS       ON 27  7 85 AT 17:23:03 MST.

ENTER THE NAME OF THE FILE TO BE READ FROM.
VENUS1RAW

SPECIFY MAP NUMBER REQUIRED ON FILE,
OR 0 FOR HELP, OR -1 FOR A NEW MAP FILE.
2
STYLE,EL,STARTVAL,STOPVAL,-OR-,-777,NFCNT,ZERO,STFP
STYLE 5 OR 6->INPUT ROW OR COL,COL OR ROWSTART AND STOP.
ENTER A COMMAND PLEASE OR <CR> TO ASK FOR ANOTHER MAP.
/

SATURN      MAG DJC                :  18        -49516.5         5523.7
ENTER A COMMAND PLEASE OR <CR> TO ASK FOR ANOTHER MAP.
-777 20 -52500 5000
```

Map is on file VENUS1RAW.

It is the second map on the file.

Default plot with 18 levels.

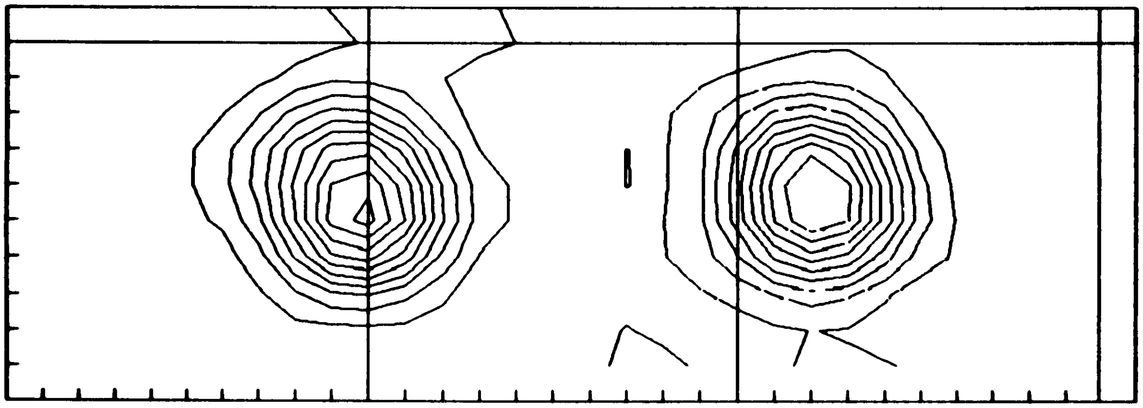
Replot with 20 levels of 5000 m.v.
starting at -52500 m.v.



The default plot

```
SATURN       MAG DJC                :  20        -52500.0         5000.0
ENTER A COMMAND PLEASE OR <CR> TO ASK FOR ANOTHER MAP.
O
THANK YOU
*** CONTROL NOW PASSING BACK TO POPS. ***
>
```

Exit from TOOLKIT by entering the Hollerith character 'O'.



The plot with 20 levels of 5000 m.v. starting at -52500 m.v.

We wish to look at our map of Orion A on file ORICOM.DAT and then do some editing on it.

```
TOOLKIT
*** CONTROL HAS NOW PASSED TO TOOLKIT. ***
N002 LIBRARY, TUCSON VAX/VMS EDITION 24 APRIL 1985
NO SCAN LIBRARY ATTACHED.
NO NODPLOT LIBRARY ATTACHED.

THIS RUN WAS MADE BY  OBS       ON 31  7 85 AT 18:05:44 MST.
ENTER THE NAME OF THE FILE TO BE READ FROM.
ORICOM.DAT
```

The map is on file ORICOM.DAT.

```
SPECIFY MAP NO. ON FILE, 0 FOR HELP, OR -1 FOR NEW MAP FILE.
0
```

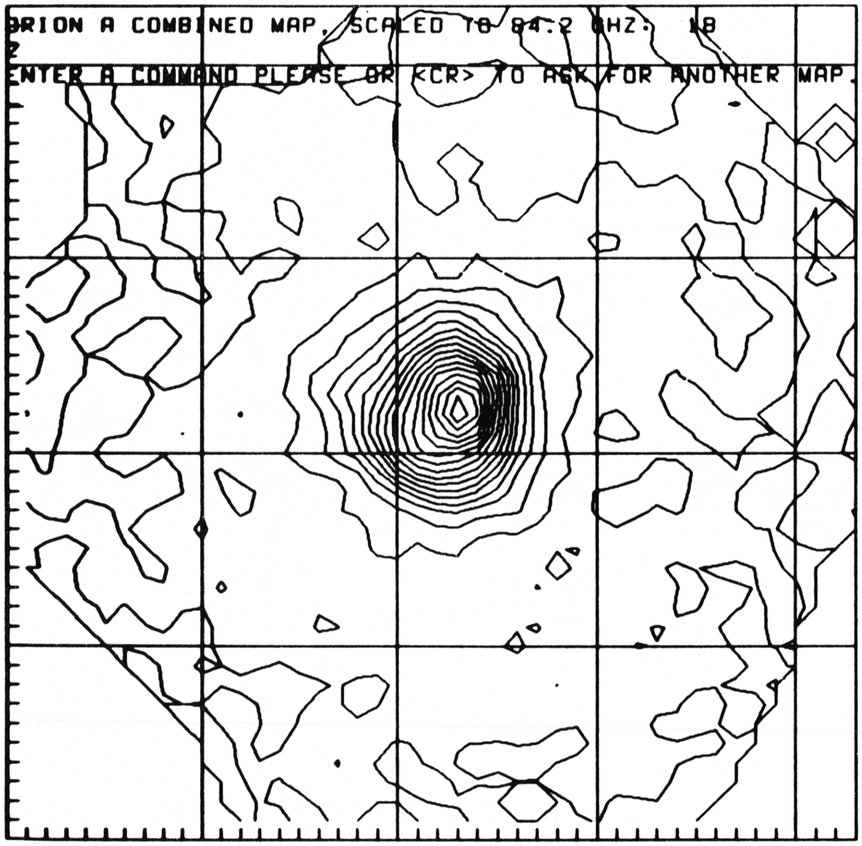
Ask for the "Help" display.

```
FIRST NO. INPUT IS MAP NO. ON FILE OR -1 FOR NEW FILE.
AFTER MESSAGE -COMMAND PLEASE-, PUT IN FOLLOWING COMMANDS:
0 (CR) =>MSCALE, NOTE BASE B00,B0X,B0Y ADDED AFTERGAIN  APPLIED.
1 I A B (CR) =>ADD NOS. ALONG ROW I VARYING SMOOTHLY FROM A TO B,
   NO. ADDED ROUNDED TO NRST INT,SO WT PRESERVED.
2 I A B (CR) =>AS ABOVE, ADD ALONG COL I.
3 I A B (CR) => REPLACE ROW I WITH DUMMY BTWN COL A,B.
4 I A B (CR) => REPLACE COL I WITH DUMMY BTWN ROW A,B.
5 I A B (CR) => ADD TO ROW I BETWEEN COLS A AND B;
   THEN ENTER START AND STOP VALUES.
6 I A B (CR) => ADD TO COL I BETWEEN ROWS A AND B.
-222 (CR),THEN  WORD TITLE FOLLOWED BY NEW TITLE FOR MAP.
-333 I (CR) CHANGE ALL DUMMIES TO NEW DUMMY, I.
-777 I A B (CR)=> PLOT I CONTOURS, FIRST LEVEL A,
   CONTOUR INT B; PLOT IN NORMAL PROPORTIONS.
-888 I A B (CR)=> SAME, BUT PLOT TO FILL SCREEN.
-666 (CR)=> THEN 4 NUMBERS  DEFINE A REGION OF MAP TO PLOT
   INPUT ROWSTART,STOP,COLSTART,STOP.RESET WHOLE MAP 0 0 0 0.
-999 (CR)=> OUTPUT MODIFIED MAP TO REQUESTED FILENAME.
IF YOU SIMPLY INPUT / WHEN ASKED,YOU GET A DEFAULT PLOT.
IF INPUT CARRIAGE RETURN ONLY,GO BACK TO READ NEW MAP.
TYPE ALPHA-CHAR. TO EXIT PROGRAM......WE MADE IT CAPTAIN!
SPECIFY MAP NO. ON FILE, 0 FOR HELP, OR -1 FOR NEW MAP FILE.
1
```

The "Help" display.

```
STYLE,EL,STARTVAL,STOPVAL,-OR-,-777,NFCNT,ZERO,STEP
STYLE 5 OR 6->INPUT ROW OR COL,COL OR ROWSTART AND STOP.
ENTER A COMMAND PLEASE OR <CR> TO ASK FOR ANOTHER MAP.
/
```

Make an 18 level default plot.



```
ORION A COMBINED MAP, SCALED TO 84.2 GHZ:  18          -59.5          64
2
ENTER A COMMAND PLEASE OR <CR> TO ASK FOR ANOTHER MAP.
```

The original map

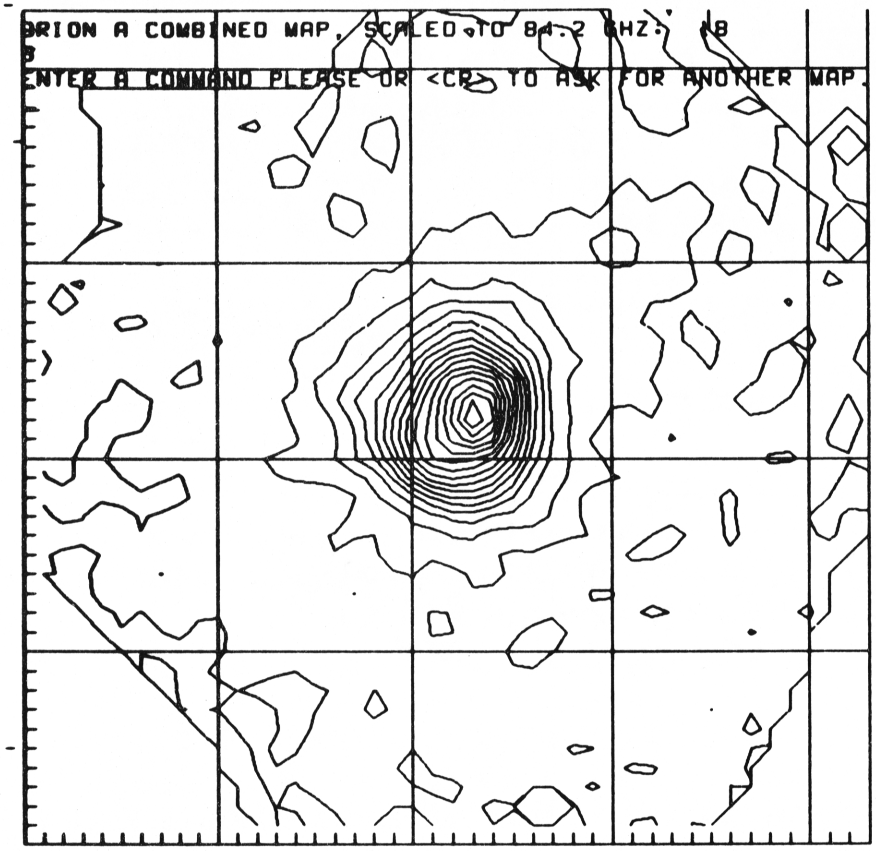
Enter a new scale and add a planar baselevel to the map

```
0
ENTER GAIN AND BOO,BOX,BOY FOR MSCALE
2. 0. 100. 100.
```

Scale factor = 2., Planar baselevel defined by 0. (at BLC), 100. (at BRC), 100. (at TLC).

```
MATRIX SCALE TYPE    2
          GAIN            B11             BX1             B1Y
          2.000           0.000         100.000         100.000

SCALING COMPLETED.
ENTER A COMMAND PLEASE OR <CR> TO ASK FOR ANOTHER MAP.
/
```

Make a default plot of the modified map.



```
ORION A COMBINED MAP, SCALED TO 84.2 GHZ.  18            -87.5              132
8
ENTER A COMMAND PLEASE OR <CR> TO ASK FOR ANOTHER MAP.
```

The modified map.

```
-222
TITLE WE ARE ENTERING A NEW TITLE.
ENTER A COMMAND PLEASE OR <CR> TO ASK FOR ANOTHER MAP.
3 19 30 43
   3   19      30.0000      43.0000
ENTER A COMMAND PLEASE OR <CR> TO ASK FOR ANOTHER MAP.
1 9 500 0
   1    9     500.0000       0.0000
ENTER A COMMAND PLEASE OR <CR> TO ASK FOR ANOTHER MAP.
5 29 1 12
   5   29       1.0000      12.0000
ROW   29 BETWEEN COLS    1    12
SPECIFY VALUES TO ADD AT START AND STOP.
1000 500
ENTER A COMMAND PLEASE OR <CR> TO ASK FOR ANOTHER MAP.
/
```

Give the map a new title.

This is the new title.

Replace columns 30 to 43 in rows 19 with dummies.

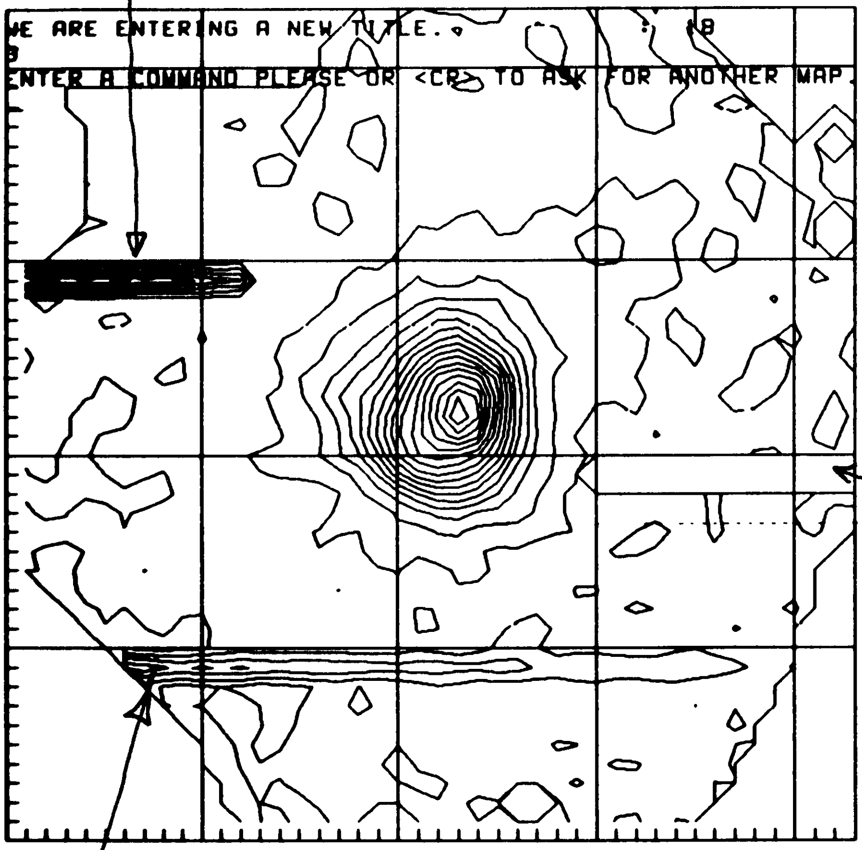
Add values to row 1 starting with 500 m.v. at column 1 and varying linearly to be 0 m.v. by column 43.

Add values to columns 1 to 12 of row 29.

The values added are to vary linearly from 1000 m.v. at column 1 to 500 m.v. at column 12.

Make an 18 level default plot.

The effect of S 29 1 12
1000. 500.



```
WE ARE ENTERING A NEW TITLE.                       -87.5          132
B
ENTER A COMMAND PLEASE OR <CR> TO ASK FOR ANOTHER MAP.
```

The remodified map.

Effect of
3 19 30 43

The effect of 1 9 500. 0.

```
ENTER A COMMAND PLEASE OR <CR> TO ASK FOR ANOTHER MAP.
-999

ENTER NAME FOR OUTPUT FILE.
ORIMAD
ENTER A COMMAND PLEASE OR <CR> TO ASK FOR ANOTHER MAP.
A

 ENTER, Y , IF YOU REALLY WANT TO LOSE YOUR EDITTING.
Y
THANK YOU
*** CONTROL NOW PASSING BACK TO POPS. ***
>
```

Write modified file to disk.

Map written to file ORIMAD.

Hollerith characters to exit TOOLKIT.

As you have performed some editting, the program asks for confirmation before exitting.